CENTRAL DISTRICT • MIDDLE ST. JOHNS RIVER BASIN

Final TMDL Report

Nutrient TMDL for Blue Spring (Volusia County) and Blue Spring Run (Volusia County), WBIDs 28933 and 28933A

Kathryn Holland and Kristina Bridger
Ground Water Management Section
Division of Environmental Assessment and Restoration
Florida Department of Environmental Protection

July 2014

2600 Blair Stone Road
Mail Station 3575
Tallahassee, FL 32399-2400

Acknowledgments

Thanks for contributions from Rick Hicks, Brian Katz, Gary Maddox, Edgar Wade, and Kirstin Eller in the Florida Department of Environmental Protection's Water Quality Evaluation and TMDL Program, Ground Water Management Section.

Map production was carried out by Janis Morrow in the Department's Data Services Section.

Rob Mattson, Stan Williams, Don Boniol, and Nathan Johnson at the St. Johns River Water Management District, and Megan Keserauskis at Blue Spring State Park, provided valuable hydrologic and vegetation data, and information on the springs and river.

Editorial assistance was provided by Linda Lord.

For additional information on the watershed management approach and impaired waters in the Middle St. Johns River Basin, contact:

Charles Gauthier
Florida Department of Environmental Protection
Bureau of Watershed Restoration
Watershed Planning and Coordination Section
2600 Blair Stone Road, Mail Station 3565
Tallahassee, FL 32399-2400
Email: charles.gauthier@dep.state.fl.us
Phone: (850) 245–8418
Fax: (850) 245-8434

Access to all data used in the development of this report can be obtained by contacting:

Richard Hicks, P.G.
Florida Department of Environmental Protection
Water Quality Evaluation and TMDL Program
Ground Water Management Section
2600 Blair Stone Road, Mail Station 3575
Tallahassee, FL 32399-2400
richard.w.hicks@dep.state.fl.us
Phone: (850) 245–8229
Fax: (850) 245–8236

Contents

List of Tables

List of Figures

Websites

Florida Department of Environmental Protection, Bureau of Watershed Restoration

TMDL Program

http://www.dep.state.fl.us/water/tmdl/index.htm

Identification of Impaired Surface Waters Rule

http://www.dep.state.fl.us/legal/Rules/shared/62-303/62-303.pdf

Florida STORET Program

http://www.dep.state.fl.us/water/storet/index.htm

2014 Integrated Report

http://www.dep.state.fl.us/water/docs/2014_integrated_report.pdf

Criteria for Surface Water Quality Classifications

http://www.dep.state.fl.us/legal/Rules/shared/62-302/62-302.pdf

Basin Status Report and Water Quality Assessment Report: Middle St. Johns

http://www.dep.state.fl.us/water/basin411/sj_middle/status.htm

Florida Springs

http://www.floridasprings.org/

U.S. Environmental Protection Agency, National STORET Program

Region 4: TMDLs in Florida

http://www.epa.gov/region4/water/tmdl/florida/

National STORET Program

http://www.epa.gov/storet/

Chapter 1: INTRODUCTION

1.1 Purpose of Report

This report presents the Total Maximum Daily Load for nitrate (NO_3), which was determined to be a cause of the impairment of Blue Spring (Volusia County) and Blue Spring Run (Volusia County), in the Lake Woodruff Planning Unit of the Middle St. Johns River Basin. These waterbodies were verified by the Florida Department of Environmental Protection as impaired for nutrients (algal mats) and included on the Verified List of impaired waters for the Middle St. Johns River Basin that was adopted by Secretarial Order on May 19, 2009. The TMDL establishes the allowable level of nutrient loadings to Blue Spring and Blue Spring Run that would restore these waterbodies so that they meet their applicable water quality criteria for nutrients. This report will be used as the basis for discussions during the development of the Basin Management Action Plan.

1.2 Background

This report was developed as part of the Department's watershed management approach for restoring and protecting state waters and addressing TMDL Program requirements. The watershed approach, which is implemented using a cyclical management process that rotates through the state's 52 river basins over a five-year cycle, provides a framework for implementing the TMDL Program–related requirements of the 1972 federal Clean Water Act and the 1999 Florida Watershed Restoration Act (FWRA) (Chapter 99-223, Laws of Florida).

A TMDL represents the maximum amount of a given pollutant that a waterbody can assimilate and still meet water quality standards, including its applicable water quality criteria and its designated uses. TMDLs are developed for waterbodies that are verified as not meeting their water quality standards and provide important water quality restoration goals that will guide restoration activities. This TMDL report will be followed by the development and implementation of a BMAP to reduce the amount of nutrients that caused the verified impairment of Blue Spring and Blue Spring Run. The restoration of these waterbodies will depend heavily on the active participation of stakeholders in the contributing area, including Volusia County, the cities of DeLand, Deltona, DeBary, Lake Helen and Orange City, Blue Spring Alliance, St. Johns River Water Management District (SJRWMD), Florida Department of Agriculture and Consumer Services (FDACS), other local governments, landowners, businesses, and private citizens.

The 2,644-acre Blue Spring State Park provides significant economic value to Volusia County, and that value depends directly on the physical and biological health of the system. The park attracted nearly 500,000 visitors between 2011 and 2012 and provided over $22 million in direct economic impact while supporting approximately 450 jobs. Visitors come to the park to swim, kayak, dive, fish, tube, and watch the endangered West Indian manatee (*Trichechus manatus latirostris*) during winter months. The numbers of visitors to the park are greatest in the colder months when manatees congregate in the spring run, and also in the early summer when the spring and spring run are most popular for swimming and diving (SJRWMD 2006).

Blue Spring Run, which was recognized by the Manatee Sanctuary Act of 1978 (Rule 68C-22-.012, Florida Administrative Code [F.A.C.]) as important manatee habitat, provides the primary warm-water winter refuge for manatees on the St. Johns River. Park records indicate that the winter manatee population has increased since counts began in the early 1970s, from about 20 manatees counted in the spring run during the winter of 1975 to 1976 to over 320 manatees during the winter of 2012 to 2013.

Blue Spring Run also provides the only known habitat for two endemic snail species, the Blue Spring hydrobe (*Aphaostracon asthenes*) and the Blue Spring siltsnail (*Floridobia parva*) (Franz 1982). Other important species that utilize these waterbodies include wading birds (herons, egrets, and limpkins), various sportfish, and a number of marine fish species that penetrate up the St. Johns River (*e.g.*, tarpon, striped millet, ladyfish).

1.3 Identification of Waterbodies

For assessment purposes, the Department has divided the Middle St Johns River Basin into water assessment polygons with a unique **w**ater**b**ody **id**entification (WBID) number for each watershed or stream reach. Blue Spring and Blue Spring Run are WBIDs 28933 and 28933A, respectively. They are located in Volusia County, Florida, about two miles west of Orange City in Blue Spring State Park (**Figure 1.1**).

Blue Spring (WBID 28933), the largest first-magnitude spring on the St. Johns River, discharges from an elongated limestone opening or "vent" about 20 feet beneath the surface, and a cave system has been mapped to a depth of about 125 feet. The spring pool is circular with a limestone and sand bottom, and measures about 135 feet from north to south and 105 feet from east to west. Steep, sandy banks between 15 and 20 feet high surround the spring pool. **Blue Spring Run** (WBID 28933A) flows about 0.4 miles from Blue Spring to the St. Johns River and ranges from 70 to 100 feet wide with steep, sandy banks and steeply wooded slopes. **Figure 1.2** shows the impaired WBIDs**.**

Evidence of human activity along an ancient sea shoreline is found in the prehistoric shell middens and seashells in the spring run. The topography to the north and east of the impaired WBIDs is primarily deep, well-drained sands at higher elevations (~115 feet above mean sea level [AMSL]) along the DeLand Ridge. The land surface slopes gradually westward to less than five feet AMSL in elevation towards the St. Johns River floodplain.

1.4 Ground Water Hydrology

The upper Floridan aquifer (UFA), which occurs in Eocene-era limestone and dolostone in Volusia County, is the primary water source that discharges from Blue Spring. The UFA lies approximately 100 feet below the land surface. The shallower surficial aquifer system (SAS), which occurs between the land surface and up to 100 feet below the land surface, is composed of Holocene and Pleistocene sands, clays, and shell material, and is also present in the area of Blue Spring (Wyrick 1960; Rutledge 1985; Kimrey 1990). Water movement between the SAS and the UFA is slowed by a low-permeability layer of clay, silt, and fine sand, which form an intermediate confining unit that is perforated by sinkholes. **Figure 1.3** depicts a generalized cross-section of the aquifer system in the area of Blue Spring.

Blue Spring is located on the western edge of the DeLand Ridge, which is a large area of karst development that occurs in western Volusia County. Karst features, such as sinkholes and disappearing springs, are developed by the dissolution of limestone. The DeLand Ridge is an area of particularly high recharge to the underlying Floridan aquifer (Knochenmus and Beard 1971). According to the SJRWMD's Floridan aquifer recharge geographic information system (GIS) coverage (2005), potential recharge rates in the Deland Ridge area range from 12 to greater than 20 inches per year.

Water discharging from Blue Spring contains higher levels of sodium and chloride than other springs discharging from the UFA (Toth and Katz 2006; German 2008). A higher concentration of saline indicators may be present in this spring water due to the upwelling of relict seawater from the lower Floridan aquifer (LFA), (Toth and Katz 2006), although the percentage of LFA water is relatively small in Blue Spring discharge (B. Katz, pers. comm., July 2013). Tibbals (1990) speculated that the north-south trending geologic fault underlying the St. Johns River in the Blue Spring area provides hydraulic connectivity between the UFA and the LFA. Chloride concentrations at Blue Spring appear to cycle over time, with concentrations increasing during periods of low discharge (German 2008).

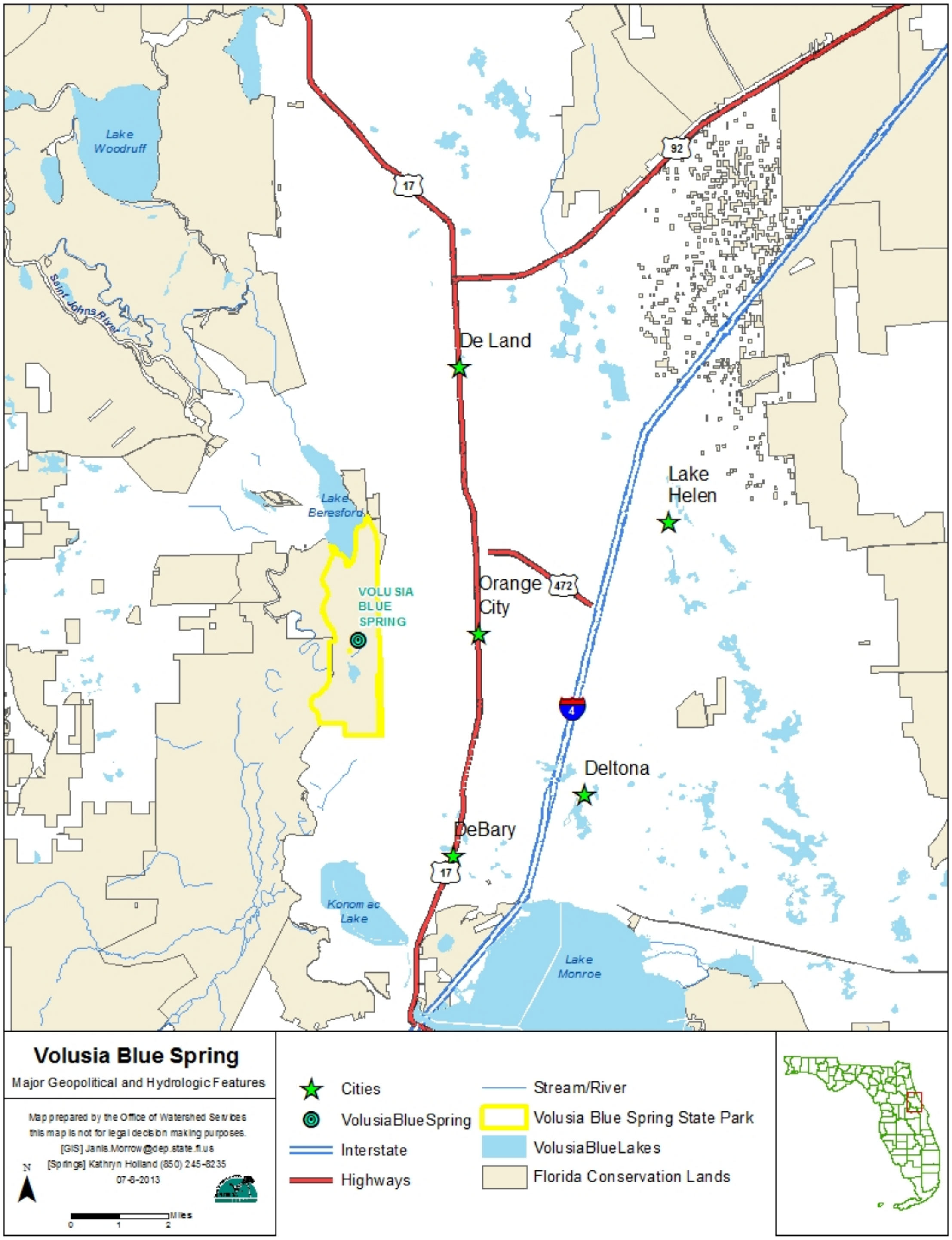

Figure 1.1. Major geopolitical and hydrologic features in the vicinity of Blue Spring and Blue Spring Run

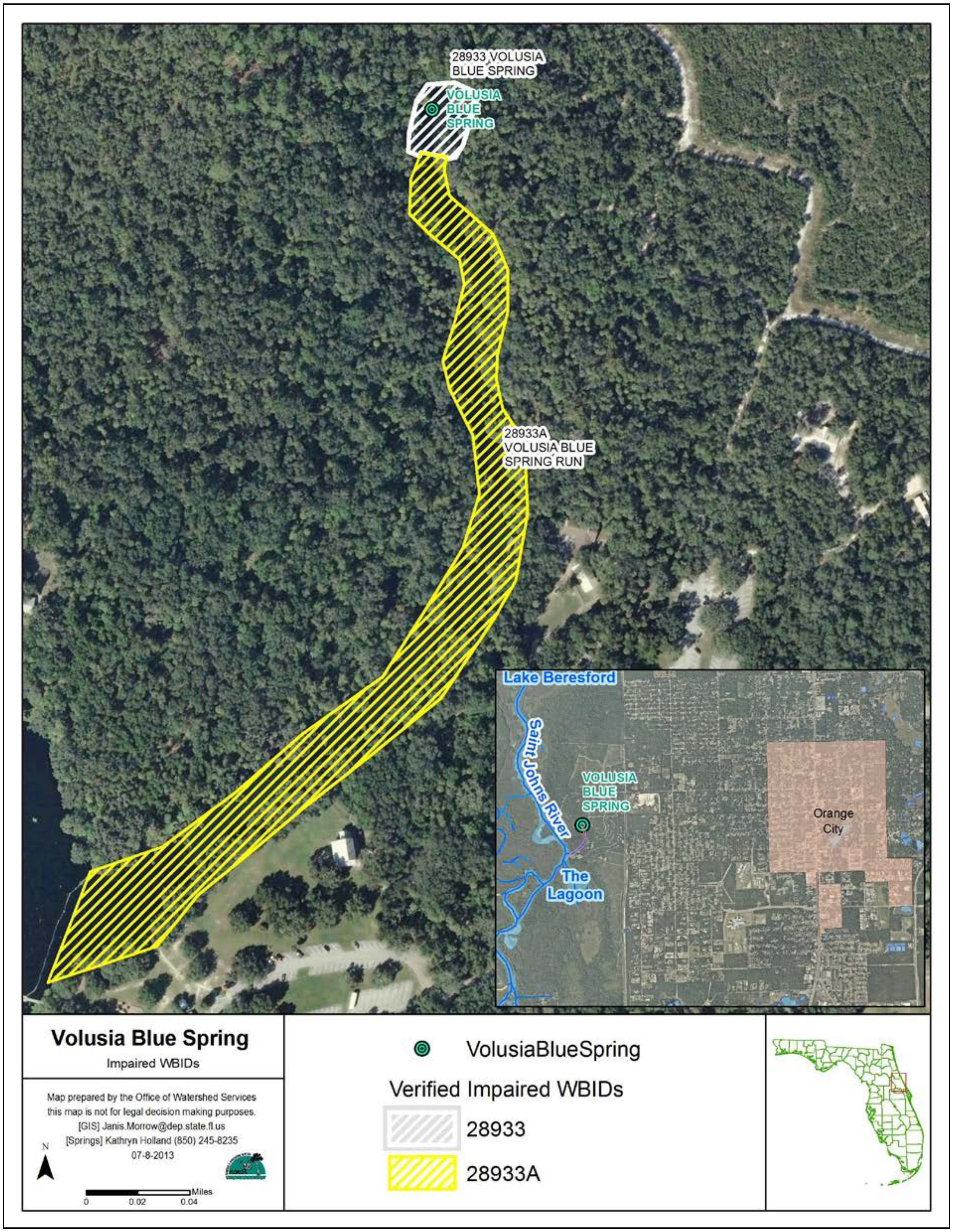

Figure 1.2. Location of the two impaired WBIDs in Volusia County

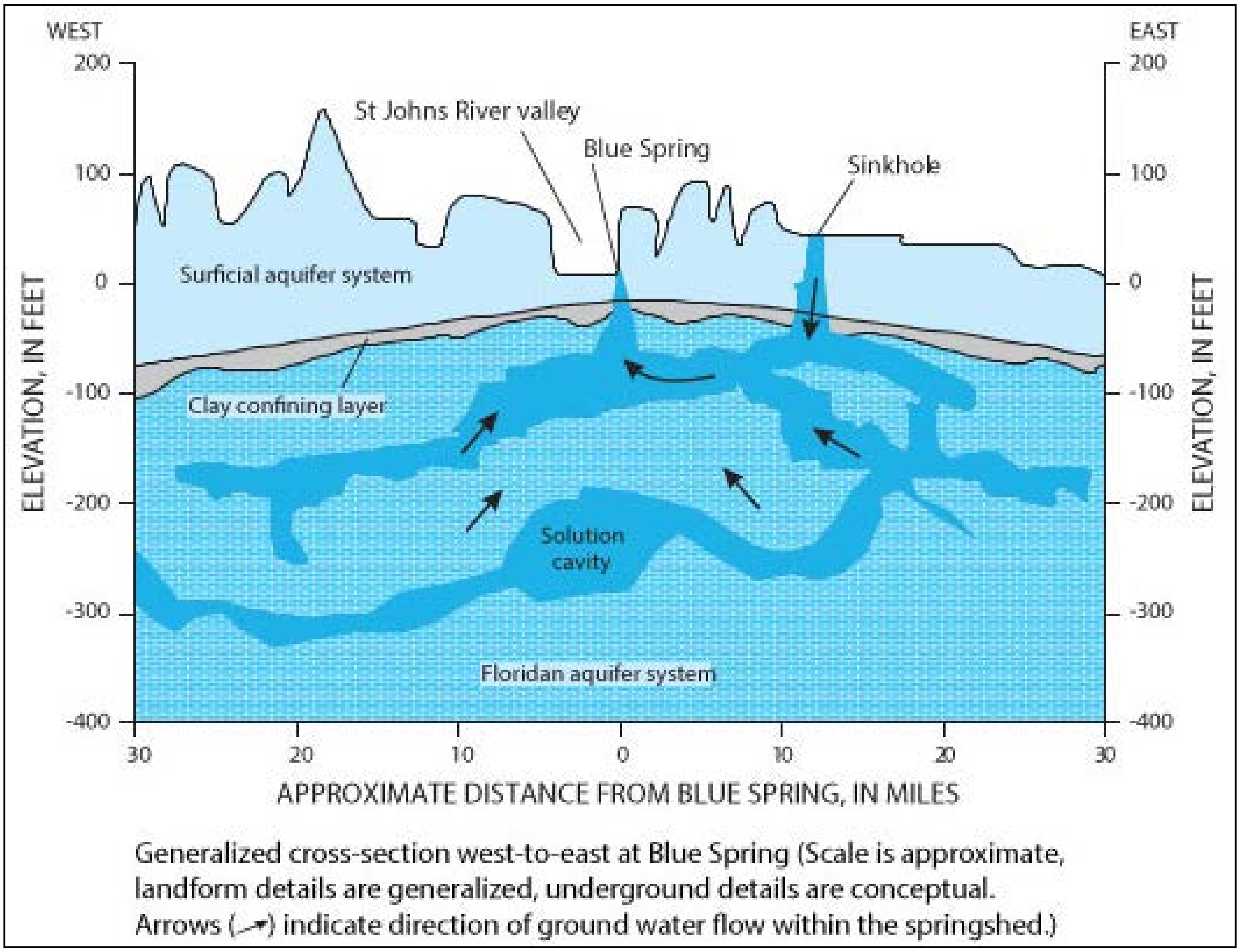

Figure 1.3. Conceptualized aquifer cross-section in the Blue Spring area (Source: German 2008)

Age dating indicates that spring flow is dominated by ground water with an average estimated age of less than 43 years (SJRWMD; available: http://www.sjrwmd.com/springs/blue-volusia.html). Toth (1999) found that water discharging at Blue Spring flowed through a short, shallow system and that a majority of the water had been in the aquifer for only a few decades. Toth and Katz (2006) measured concentrations of specific tracers and used geochemical modeling to conclude that water discharging from Blue Spring was a mixture of water recharged during 1965, 1975, and 1990. However, spring response to rainfall events suggests that there is also a shallower, more recent component of flow from Blue Spring. **Figure 1.4** displays the aquifer recharge rates.

1.5 Blue Spring Springshed

The area of land that contributes to spring water via ground water recharge and migration and surface water inputs (*e.g.,* sinkholes) is known as its springshed. The terms "recharge area" and "ground water contributing area" are also used to describe a springshed. **Figure 1.4** displays the aquifer recharge rates for the Volusia Blue springshed. For this report, the Department uses the term "springshed" and the springshed boundary developed by the SJRWMD, which is based on MODPATH/MODFLOW particle tracking methodology (Shoemaker *et al.* 2004) (**Figure 1.5**). It is important to note that all delineated springshed areas are indefinite and dynamic, depending on precipitation and withdrawals. The Blue Spring springshed is about 104.3 square miles, and all of the drainage in this area is internal and entirely dependent on recharge by local rainfall. A portion of the springshed lies west of the St. Johns River, but the majority of the springshed is east of the river (Shoemaker *et al.* 2004).

The Department evaluated potential sources of nitrogen impacting the spring and spring run in the estimated springshed. Aquifer Vulnerability Assessments, or AVAs, are useful tools for evaluating the potential for pollutants to enter ground water for a specific area. Modeled aquifer vulnerability is a function of several factors, including the nature of confining sediments above the aquifer, depth to ground water, and the presence or absence of karst features. The relative vulnerability of the FAS in the Blue Spring springshed was assessed using the statewide Floridan Aquifer Vulnerability Assessment (FAVA) model developed by the Florida Geological Survey (FGS) (Arthur *et al.* 2007). The model indicates that the majority of the springshed is classified as "more vulnerable" to contamination (**Figure 1.6**).

1.6 Population

The total estimated population in the Blue Spring springshed is 128,920, or an average of 1,236 people per square mile, based on the 2010 United States Census tract information (**Figure 1.7**). Estimated population is based on the actual number of people in a given tract at the time of the Census and the percentage of each tract that falls within the springshed. This calculation method assumes an even distribution within the Census tracts.

Population centers in the springshed include Deltona, Orange City, DeBary, Lake Helen, and DeLand. Approximately 47% of the springshed is zoned residential, the majority of which is medium-density residential, allowing for two to five dwelling units per acre. Low-density residential allows for fewer than two dwelling units per acre.

1.7 Climate

The climate in the Blue Spring area is subtropical, with hot, rainy summers and cool, drier winters. Annual average air temperature is about 70°F. Long-term rainfall averages 58 inches per year. In a typical year, more than half of the rainfall in the DeLand area (about 32 inches on average) occurs during the four months from June through September as a result of seasonal thunderstorms and tropical systems. The rest of the year is comparatively dry, averaging about three inches per month (Station "DeLand 1 SSE," Southeast Regional Climate Center [SERCC] 2013).

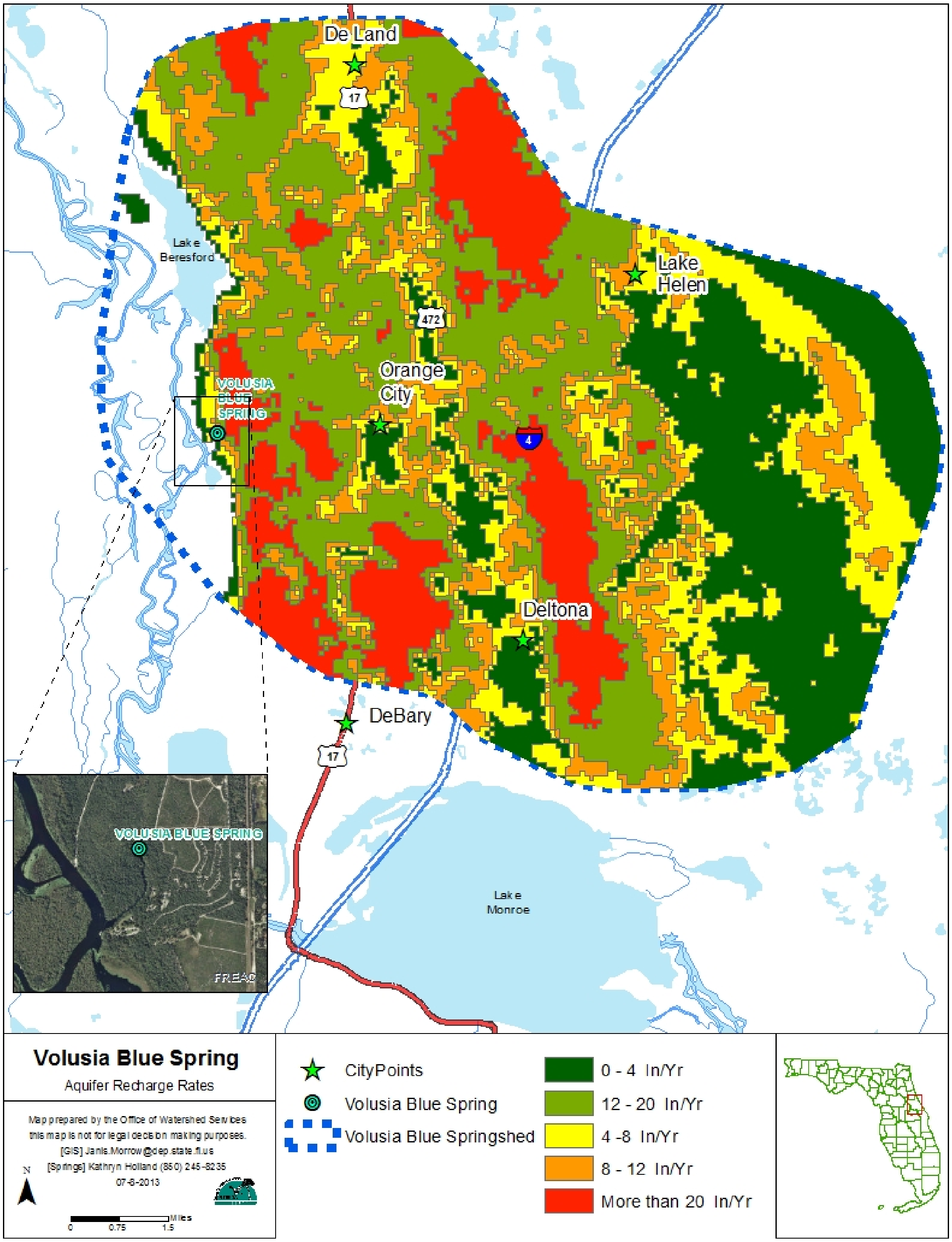

Figure 1.4. Aquifer Recharge Rates for the Volusia Blue Springshed

Figure 1.5. Springshed for Blue Spring and Blue Spring Run (Source: SJRWMD)

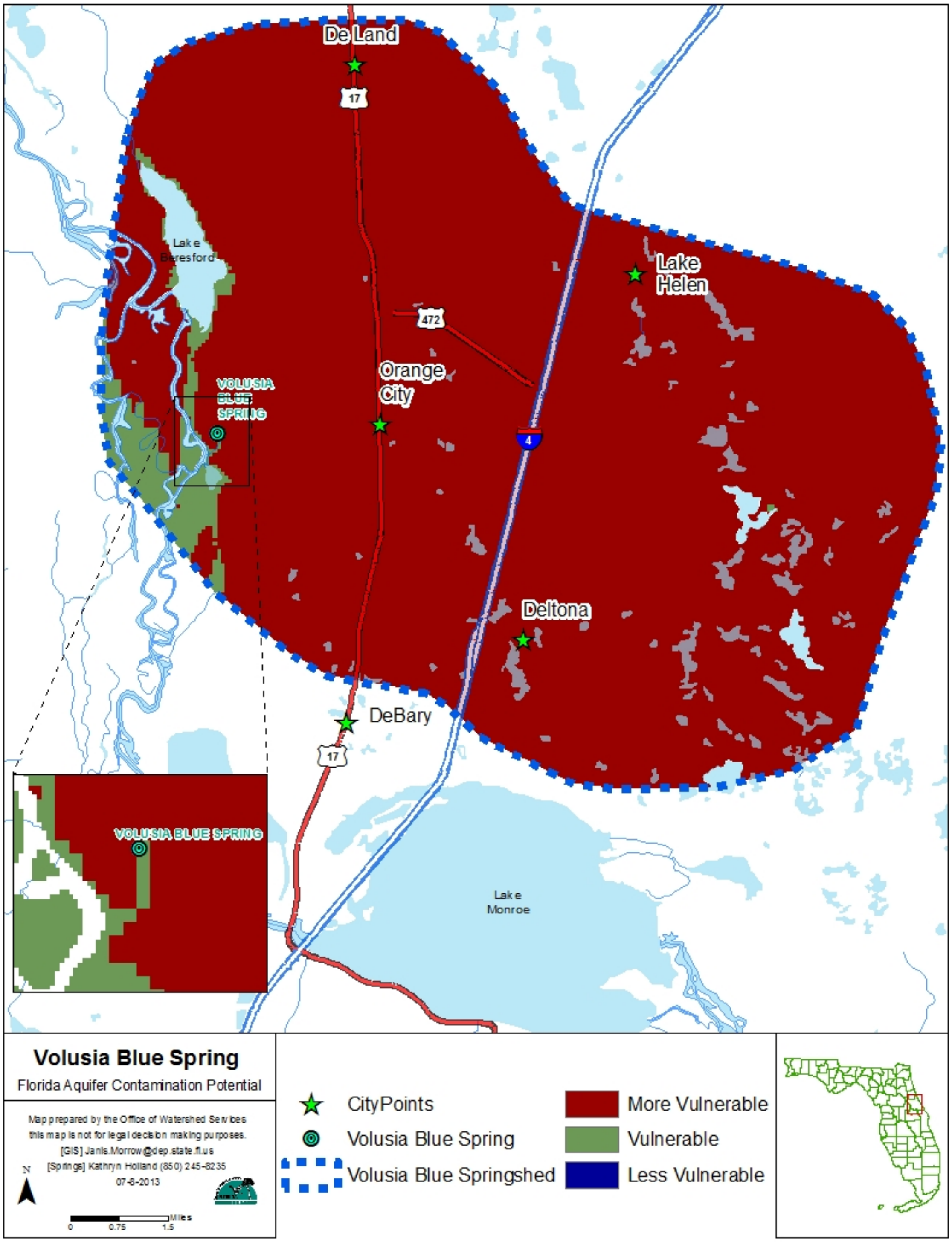

Figure 1.6. Floridan aquifer vulnerability in the Blue Spring springshed

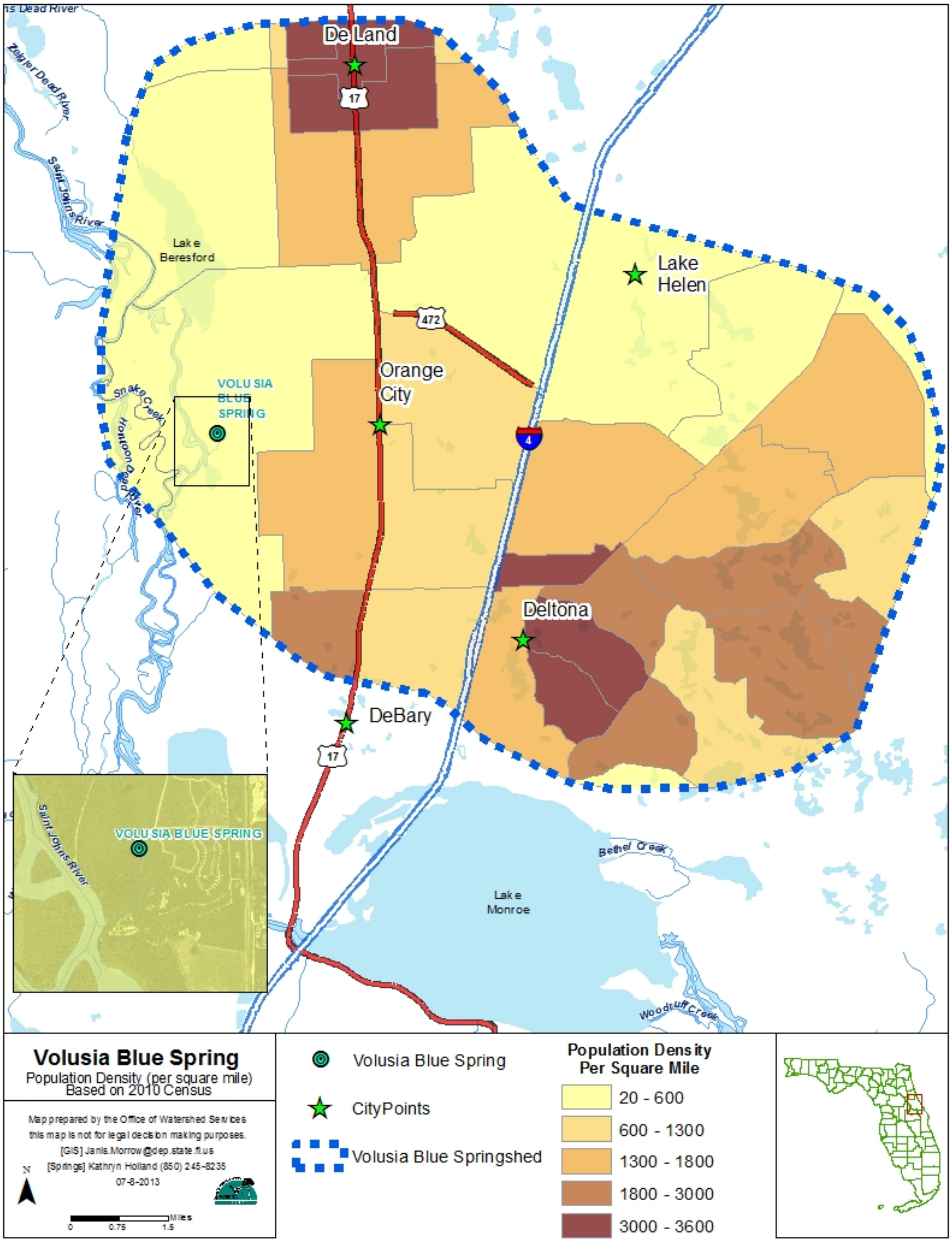

Figure 1.7. Population density in the Blue Spring springshed (based on 2010 Census data)

Chapter 2: DESCRIPTION OF WATER QUALITY PROBLEM

2.1 Statutory Requirements and Rulemaking History

Section 303(d) of the federal Clean Water Act requires states to submit to the United States Environmental Protection Agency (EPA) a list of surface waters that do not meet applicable water quality standards (*i.e.*, impaired waters) and establish a TMDL for each pollutant causing the impairment of listed waters on a schedule. The Department has developed such lists, commonly referred to as 303(d) lists, since 1992. The list of impaired waters in each basin, referred to as the Verified List, is also required by the FWRA (Subsection 403.067[4], Florida Statutes [F.S.]), and the state's 303(d) list is amended annually to include basin updates.

Florida's 1998 303(d) list included Blue Spring; however, the FWRA (Section 403.067, F.S.) stated that all previous Florida 303(d) lists were for planning purposes only and directed the Department to develop, and adopt by rule, a new science-based methodology to identify impaired waters. After a long rulemaking process, the Environmental Regulation Commission adopted the new methodology as Rule 62-303, F.A.C. (Identification of Impaired Surface Waters Rule, or IWR), in April 2001. The IWR was subsequently modified in 2006 and 2007.

2.2. Information on Verified Impairment

Rule 62-303, F.A.C., now includes a methodology for listing nutrient-impaired surface waters based on documentation that supports the determination of an imbalance of flora or fauna. In 2009, the Department used available water quality data provided by the SJRWMD, United States Geological Survey (USGS), data in the IWR database, Department Springs Monitoring Network data from 2001 to 2009, Department *EcoSummaries*, and other available information to document nitrate concentrations and the effects of nutrient enrichment in the spring. WBIDs 28933 and 28933A were listed as impaired for nutrients because of their consistently elevated concentrations of nitrate (above 0.6 milligrams per liter [mg/L]) and the corresponding evidence of an imbalance of flora and fauna downstream. This information, documented by Hicks *et al.* (2009), supplemented the determination of impairment for the 2010 Verified List of impaired waters. **Table 2.1** lists the waterbodies in the Middle St. Johns River Basin on the Cycle 2 Verified List that are addressed in this report.

Table 2.1. Verified impaired spring-related segments in the Middle St. Johns Basin

WBID	Waterbody Segment	Parameters Assessed Using the IWR	Projected Year of TMDL Development
28933	Blue Spring (Volusia County)	Nutrients (Algal Mats)	2013
28933A	Blue Spring Run (Volusia County)	Nutrients (Algal Mats)	2013

To ensure that this nutrient TMDL was developed based on current conditions in the spring and spring run and that recent water quality trends in these waterbodies were adequately captured, monitoring data collected from January 1, 2001, to May 22, 2013 were used to develop the TMDL.

2.3 Nutrients

Nutrient overenrichment can cause the impairment of many surface waters, including springs. The two major nutrient groups monitored are nitrogen (N) and phosphorus (P), which are essential nutrients to plant life. For aquatic vegetation and algae to grow, both nutrients must be present. One nutrient can be present in excess, but if the other is absent, the overgrowth of vegetation or algae is unlikely to occur. Historically, many spring systems have had sufficient naturally occurring phosphorus to promote an overgrowth of vegetation or algae, but this did not occur because nitrogen was only a minor constituent of spring water.

Nitrate concentrations in many of Florida's springs have increased since the 1970s. With sufficient phosphorus in the water column, seemingly low nitrogen concentrations can cause a significant shift in the balance of spring ecological communities, leading to the degradation of biological systems due to the overgrowth of algae and proliferation of invasive aquatic plants (Harrington *et al.* 2010). Several studies suggest that other attributes such as dissolved oxygen (DO), flow, conductivity, and salinity may also contribute to increased algal coverage (Cowell and Botts 1994; Stevenson *et al.* 2004; Heffernan *et al.* 2010).

2.4 Ecological Issues Related to Nutrients

The problems caused by increasing nutrient concentrations are not completely understood, although nitrate levels above the natural background concentration of 0.05 mg/L support increased algal growth and growth of the invasive exotic plant *Hydrilla* (Maddox *et al.* 1992; Harrington *et al.* 2010). Stevenson *et al.* (2007) provides evidence of algae growth fueled by nitrate in spring-run river systems.

The Department's Environmental Assessment Section documented the biological health of the spring run on multiple occasions between October 2000 and May 2007, and the results are presented in 13 *EcoSummaries* (available: http://www.dep.state.fl.us/labs/cgi-bin/reports/results.asp). The high percentage of diatoms and some blue-green algae, which are indicative of eutrophic conditions, and the lack of macroinvertebrate habitat contributed to an overall stream health score in the "impaired" range in 12 of the 13 *Ecosummaries*. The first assessment scored the stream (*i.e.*, spring run) health in the "fair" range. Additional biological sampling results by the Department in 2007 and 2008 noted that while the dominant algal group was *Bacillariophyta* (diatoms), filamentous algae dominated the periphyton community and were in greater abundance in the upper and middle portions of the spring run, contributing to a poor-quality macroinvertebrate community (Department 2008).

J. Hand used chemical parameters and algal measurements taken by Stevenson *et al.* (2004) to develop an algal ranking system in springs. Hand determined that macroalgae thickness was in the "high" range (50% to 75%) and the algal mat coverage was in the "very high" range (>75% coverage) at Blue Spring (Department unpublished data). The epiphyte thickness was in the "low" range (<25%) because of the lack of aquatic plant growth in the spring run.

Photographic evidence from 1997 documented algal growth at the spring and in the spring run and was used to support listing the WBIDs for impairment. Additional photographs from 2009 through 2011 provide evidence of the imbalance of flora and fauna in the spring and spring run (**Figures 2.1** through **2.5**).

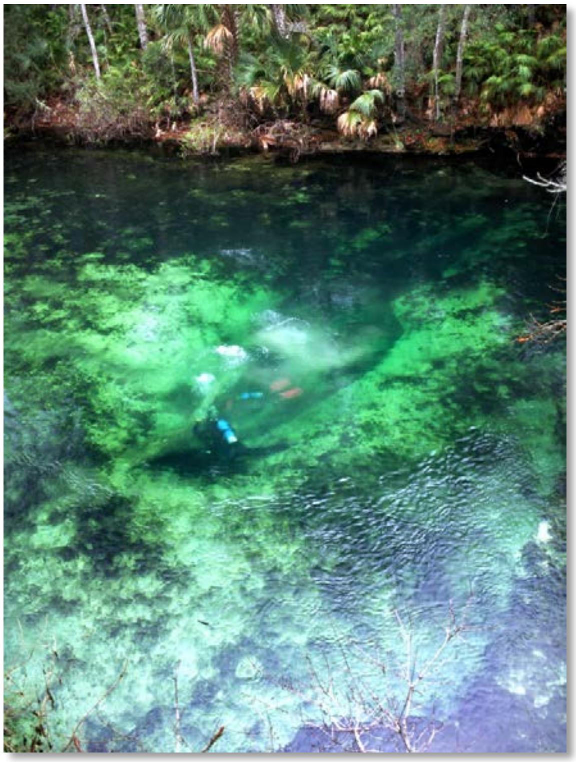

Figure 2.1. Blue Spring vent, 1997. Dark patches are algae and detritus.

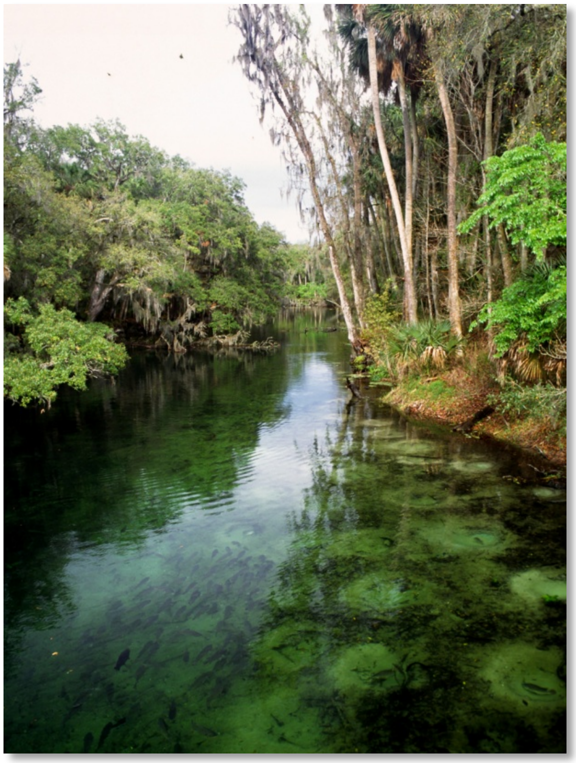

Figure 2.2. Blue Spring Run, 1997. Note fish beds and algae.

Figure 2.3. Blue Spring Run south of vent, 2009. Algal growth on bare bottom (Source: Ground Water Management Section [GWMS]).

Figure 2.4. Algal mats north of spring vent, 2011. Greenish tint of water is due to chlorophyll in water column (Source: GWMS).

Figure 2.5. Blue Spring Run looking upstream, 2010. Dark areas are algae (Source**: FGS).**

2.5 Other Ecological Issues

In addition to contributing to increased algal problems, excess nutrients in springs may also contribute to decreased plant and animal diversity and productivity, increased organic matter deposition, and reduced aesthetics of the spring ecosystems (Department 2012). The potential consequences of nitrate enrichment in springs include an increase in opportunistic primary producers, increased organic matter deposition, greater number of nuisance algae species and algal biomass, decreased plant and animal productivity and diversity, reduced water quality, and faunal toxicity (Mattson *et al.* 2007). It should be noted that factors such as the degree of recreational use, decreased DO concentrations in Blue Spring discharge, increased abundance of non-native, invasive fish, and elevated conductivity may either magnify or mask the effects of nutrient enrichment (Department 2012).

A kow abundance and diversity of aquatic plants may also be a result of the high level of manatee feeding and use of the spring run during the winter months, although observations from the 1960s and 1970s suggest that manatee grazing is not entirely responsible for the loss of submersed aquatic vegetation (SAV) in this system (R. Mattson, pers. comm.)

2.6 Water Quality

2.6.1 Monitoring Sites and Monitoring Results

Historical water quality data for Blue Spring and Blue Spring Run provide an indication of current versus "background" water quality. Water quality data have been collected from various locations at the spring and in the spring run since the 1960s. **Figure 2.6** shows the locations of current and past water quality and biological sampling stations monitored by the Department, SJRWMD, USGS, and Volusia County. Of the 15 stations depicted, water quality data were not collected at two of the stations, which were used for biological sampling by the Volusia County Environmental Health Department. One station was sampled by the Department in the early 1970s, but the sampling method is no longer in use and those data were excluded. One additional station reported results from one sample collected in 2000, and that result is included in long-term trend analysis but not in the verified period analysis. The bulk of the water quality data used in this evaluation were collected by the Department.

2.6.2 Nitrate

Nitrogen is found in several forms and is ubiquitous in the environment. Nitrate (NO_3) is the form of nitrogen that occurs in the highest concentrations in ground water and springs. Nitrite (NO_2), an intermediate form of oxidized nitrogen, is almost entirely converted to nitrate in the nitrogen cycle in the presence of oxygen. While nitrate and nitrite are frequently analyzed and reported together as one concentration (nitrate + nitrite), the nitrite contribution is almost always insignificant. In this report "nitrate" is the sum of NO_3 and NO_2 total mg/L as nitrogen.

Nitrate data ranges from the 11 water quality sampling stations with data were assessed for spatial trend. Based on the means and standard deviations for each station, the results indicate that the data ranges for individual stations are similar (**Figure 2.7**). Therefore, the datasets from the spring vent and run were combined and analyzed together for verified period trend analysis and target setting.

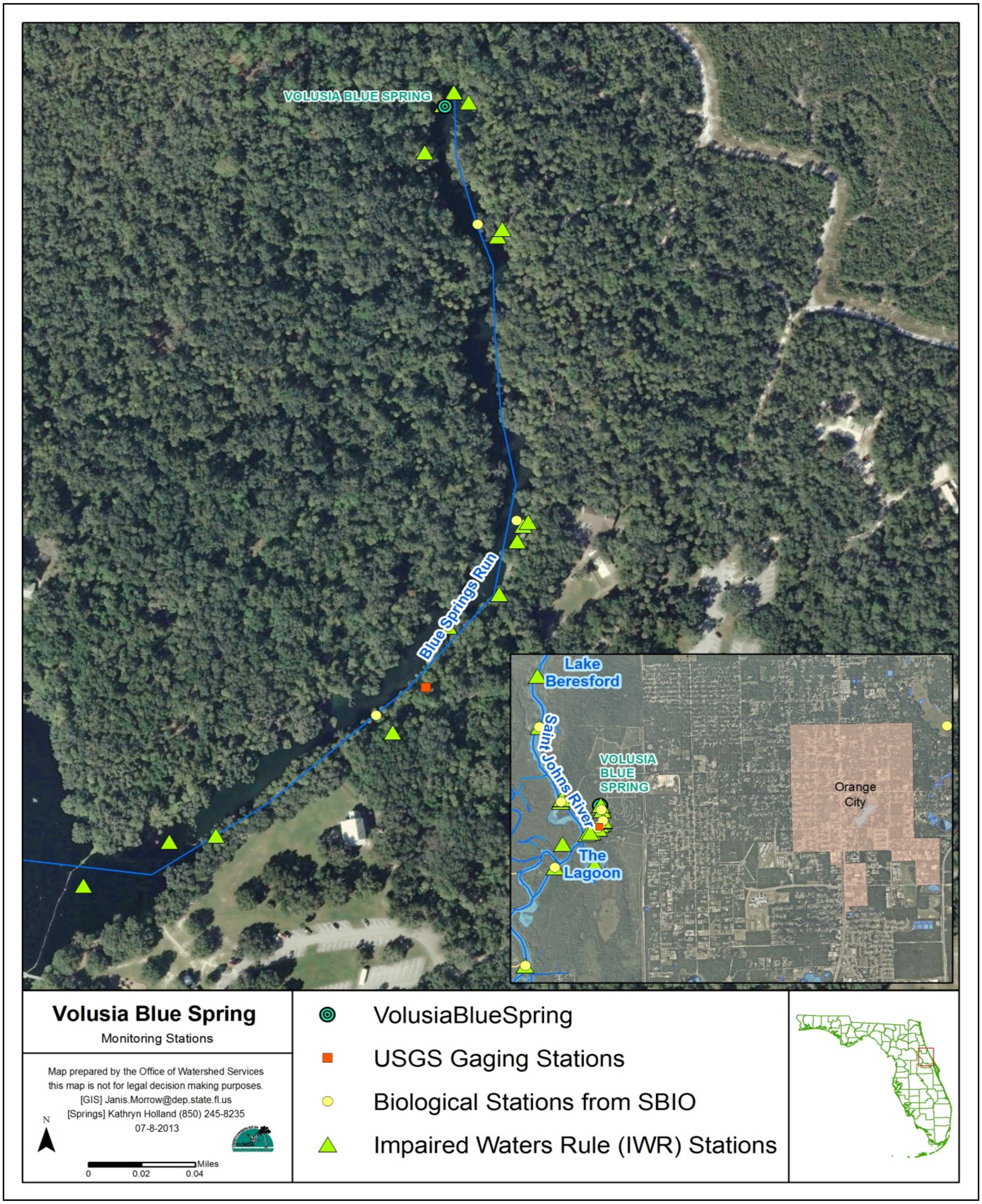

Figure 2.6. Surface water monitoring sites associated with Blue Spring and Blue Spring Run

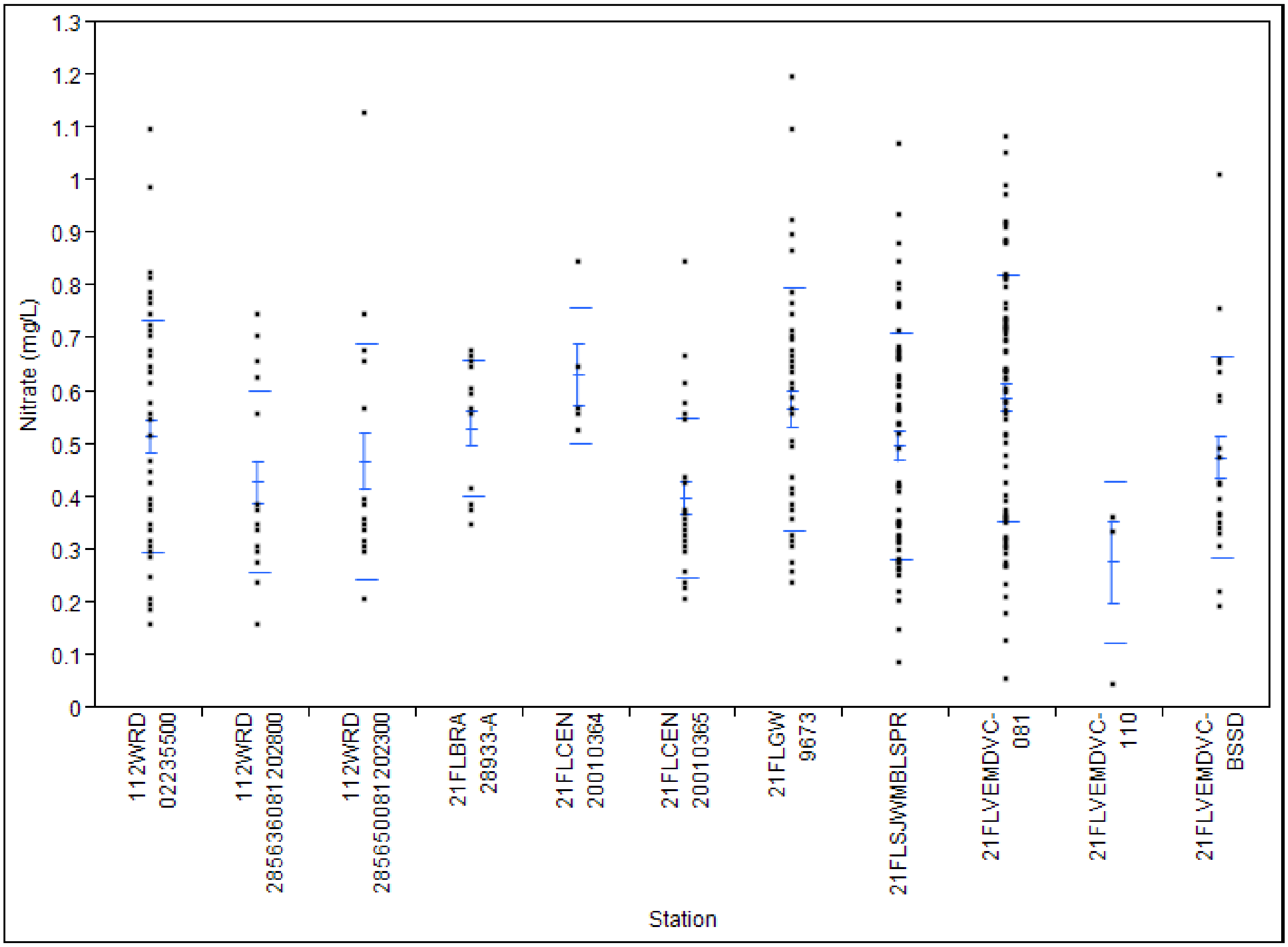

Figure 2.7. Mean comparison by station for the verified period, plus more recent data (2001–13)

For this TMDL, long-term data were assessed to detect temporal trends. Older sampling and analysis methods were excluded, resulting in a long-term dataset with a period of record from 1975 until 2013, although there are some years in which no nitrate data were available (1982–84; 1986–93). The nonparametric Mann-Kendall statistical test was used to detect temporal trends in nitrate concentrations, and the results indicate that concentrations are increasing over time (N [results] = 28, Kendall tau = 0.51, prob = 0.0001) (**Figure 2.8**). The long-term annual mean concentration is 0.49 mg/L, with actual concentrations ranging from 0.01 mg/L in May 1975, to 1.20 mg/L in October 2008 (**Figure 2.9**). **Figure 2.9** also depicts a discernible fluctuation in nitrate levels that may indicate an influence from precipitation events. **Table 2.2** summarizes the long-term nitrate results for all samples collected.

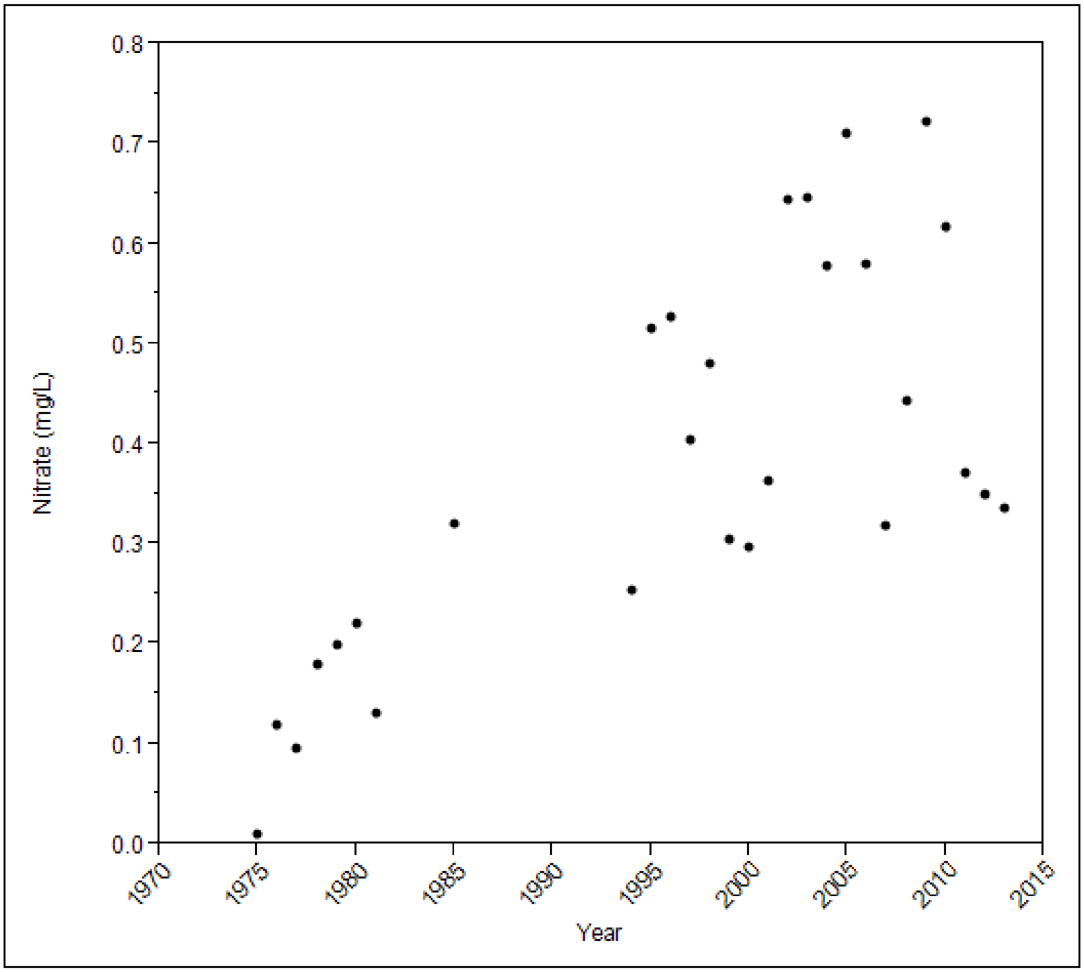

Figure 2.8. Annual average nitrate concentrations in Blue Spring (WBID 28933) and Blue Spring Run (WBID 28933A) during the period of record (1975–2013)

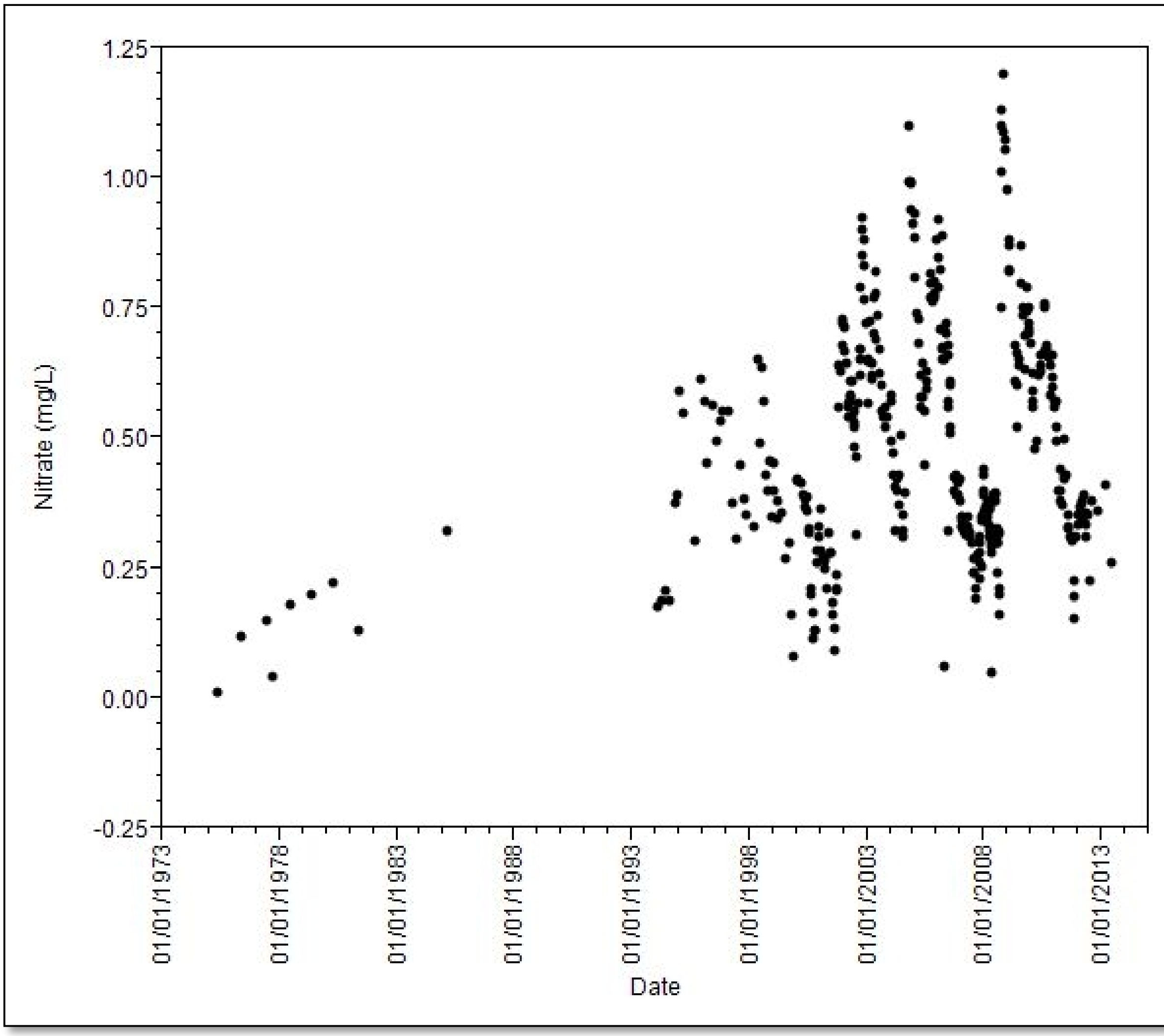

Figure 2.9. Long-term nitrate concentrations in the impaired WBIDs, 1974–2013

Table 2.2. Summary data for nitrate in Blue Spring and Blue Spring Run by year, 1975–2013

Year	n	Mean	Minimum	Maximum
1975	1	0.01	0.01	0.01
1976	1	0.12	0.12	0.12
1977	2	0.10	0.04	0.15
1978	1	0.18	0.18	0.18
1979	1	0.20	0.20	0.20
1980	1	0.22	0.22	0.22
1981	1	0.13	0.13	0.13
1985	1	0.32	0.32	0.32
1994	6	0.25	0.18	0.39
1995	4	0.51	0.30	0.62
1996	6	0.53	0.45	0.57
1997	6	0.40	0.31	0.55
1998	9	0.48	0.33	0.65
1999	9	0.30	0.08	0.45
2000	20	0.30	0.11	0.42
2001	24	0.36	0.09	0.73
2002	34	0.64	0.32	0.93
2003	21	0.65	0.52	0.82
2004	22	0.58	0.31	1.10
2005	25	0.71	0.45	0.93
2006	34	0.58	0.06	0.92
2007	41	0.32	0.19	0.44
2008	55	0.44	0.05	1.20
2009	24	0.72	0.52	0.88
2010	26	0.62	0.48	0.76
2011	26	0.37	0.15	0.57
2012	13	0.35	0.22	0.39
2013	2	0.34	0.26	0.41

2.6.3 Phosphorus

Phosphorus is naturally abundant in the geologic material in much of Florida and is often present in both surface water and ground water. Total phosphorus (TP) is a measurement of phosphorus that includes organic particulate forms of phosphorus found in sources such as stormwater runoff and decomposing vegetation, and orthophosphate (PO_4), which is the dissolved inorganic form of phosphorus. In general, orthophosphate is the main form of phosphorus found in ground water in Florida, and its occurrence is usually related to the natural abundance of phosphate in geologic material. This is also the case for most springs.

The annual average TP concentration was calculated from 1972 to 2012 and plotted over time. Phosphorus does not show an increasing temporal trend in the Blue Spring system, and concentrations remain close to levels found in the 1970s. **Table 2.3** displays the annual averages for TP in Blue Spring and Blue Spring Run. The median TP concentration is 0.07 mg/L. Florida has not established numeric criteria for TP in springs or spring runs; however, an in-stream protection value not exceeding 0.12 mg/L of TP more than once within a three-year period was established in the Peninsula (Department 2012). Phosphorus was not considered a target nutrient for the listing of Blue Spring or Blue Spring Run or for this TMDL because the available data indicate that its occurrence is due to natural sources.

Table 2.3. Summary data for orthophosphate (mg/L) in Volusia Blue Spring (WBID 28933) and Volusia Blue Spring Run (WBID 28933A), 2001–12

Year	N	Mean	Minimum	Maximum
2001	2	0.069	0.063	0.074
2002	3	0.072	0.064	0.078
2003	4	0.067	0.062	0.07
2004	6	0.066	0.05	0.079
2005	9	0.060	0.05	0.07
2006	14	0.065	0.0595	0.071
2007	22	0.060	0.045	0.07
2008	52	0.068	0.02	0.118
2009	26	0.063	0.052	0.072
2010	26	0.070	0.05	0.079
2011	26	0.066	0.055	0.074
2012	2	0.070	0.063	0.074

2.7 Discharge

Long-term discharge measured from 1932 to May 2013 indicates the annual average discharge from Blue Spring is 155.3 cubic feet per second (cfs), or about 100.4 million gallons per day (MGD). A maximum discharge of 214 cfs was measured in November 1960, and a minimum discharge of 62.7 cfs was measured in November 1935. Blue Spring discharge varies seasonally and has been shown to correlate directly with rainfall. The mean monthly average computed between 1935 and 2013 was lowest in August (147.2 cfs) and highest in December (163.4 cfs) (USGS National Water Information System [NWIS] 2012). The Mann-Kendall statistical test was used to detect temporal trends in discharge, and the results indicate that discharge is decreasing over time (N [results] = 723, Kendall tau = -0.21, prob = 0.0001) for the period from March 7, 1932, to May 30, 2013 (**Figure 2.10**).

The SJRWMD conducted several investigations using intermittent and continuous discharge data collected by the USGS from March 1932 until June 2006 and intermittent and continuous data by the SJRWMD between 1983 and 1996. Median discharge rates during the manatee season (November–March) were significantly greater than for the nonmanatee season. A decline in spring discharge was also observed between 1970 to 1990, coinciding with an extended dry period (Osburn 2011).

The SJRWMD established a minimum flow regime (MFR) in 2006 (Rule 40C-8.031, F.A.C.) that is considered sufficient to protect the manatees' use of the spring run as a warm-water refuge. The MFR increases from 133 cfs in 2009 to 157 cfs minimum long-term mean flow by March 2024.

Rouhani *et al.* (2007) investigated the relationship between stage height in the St. Johns River and Blue Spring flow and determined that the stage in the spring run is controlled by the stage of the St. Johns River and not by the spring discharge.

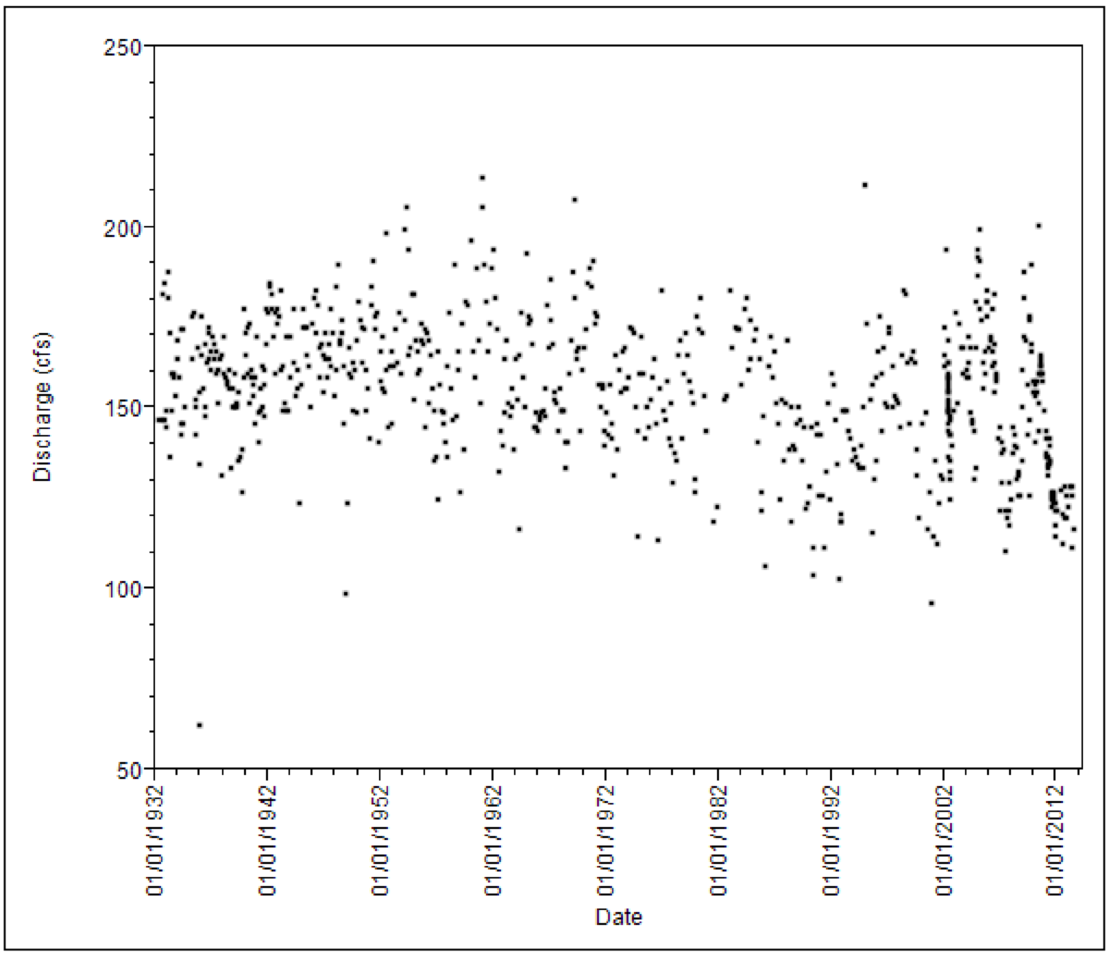

Figure 2.10. Discharge in Blue Spring Run, USGS Station 02235500 (Source: USGS 2013)

Chapter 3. DESCRIPTION OF APPLICABLE WATER QUALITY STANDARDS AND TARGETS

3.1 Classification of the Waterbody and Criterion Applicable to the TMDL

Florida's surface waters are protected for six designated use classifications, as follows (available: http://www.dep.state.fl.us/water/wqssp/classes.htm):

Class I	**Potable water supplies**
Class II	**Shellfish propagation or harvesting**
Class III	**Fish consumption, recreation, propagation, and maintenance of a healthy, well-balanced population of fish and wildlife**
Class III-Limited	**Fish consumption, recreation or limited recreation, and/or propagation and maintenance of a limited population of fish and wildlife**
Class IV	**Agricultural water supplies**
Class V	**Navigation, utility, and industrial use (there are no state waters currently in this class)**

Blue Spring and Blue Spring Run are Class III fresh waterbodies (with designated uses of fish consumption, recreation, propagation, and maintenance of a healthy, well-balanced population of fish and wildlife). The Class III water quality criterion applicable to the impairment addressed by this TMDL is excessive nutrients, which have been demonstrated to adversely affect flora or fauna.

3.2 Applicable Water Quality Standards and Numeric Water Quality Targets

3.2.1 Nutrients

Thresholds of nutrient impairment for streams have been interpreted in the IWR, Rule 62-303.351, F.A.C. (Nutrients in Streams) to include stream segments if an imbalance of flora or fauna occurs due to nutrient enrichment. This imbalance includes algal blooms, changes in alga species richness, excessive macrophyte growth, a decrease in the coverage or density of seagrasses or other SAV, and excessive diel oxygen variation. In 2009, Blue Spring and Blue Spring Run were included in Florida's list of impaired waters based on these narrative criteria (algal mats). At that time, elevated nitrate in the water was determined to cause excessive algal growth.

Excessive algal growth can result in a variety of adverse ecological impacts, including reduced water clarity, habitat smothering, the provision of nutrition and habitat for pathogenic bacteria, the production of toxins that may affect biota, the reduction of oxygen levels, and an increase in diurnal swings of the

DO regime in the stream. Ongoing research on many Florida springs has resulted in significant progress in understanding the threshold concentrations of nutrients that cause nuisance macroalgae growth (Stevenson *et al.* 2007).

3.2.2 Numeric Nutrient Criterion for Spring Vents

The Department's numeric nutrient criterion (NNC) of 0.35 mg/L nitrate for spring vents was adopted in Rule 62-302, F.A.C., by the Environmental Regulation Commission on December 8, 2011. Following legal challenges and federal rulemaking actions on November 30, 2012 the EPA approved the Department's NNC for spring vents. The NNC for springs is 0.35 mg/L nitrate-nitrite as an annual geometric mean, not to be exceeded more than once in any 3 calendar year period. The complete technical support document on how the Department calculated the NNC is available at: http://www.dep.state.fl.us/water/wqssp/nutrients/docs/tsd-nnc-lakes-springs-streams.pdf.

Paragraph 62-302.530(47)(b), F.A.C., states that "in no case shall nutrient concentrations of a body of water be altered so as to cause an imbalance in natural populations of aquatic flora or fauna." This narrative criteria is still applicable statewide, but the Department's hierarchical approach gives preference to the numeric nutrient value of 0.35 mg/L nitrate-nitrite for springs based on quantifiable stressor-response relationships between nutrients and biological response. In addition, if there are sufficient site-specific data for a particular spring, a site-specific alternative criterion can be set. However, the Department did not find sufficient algal growth response data to support a different site-specific criterion for Blue Springs and Blue Spring Run. **Chapter 5** discusses the nitrate impairment and the setting of the TMDL target concentration of nitrate.

3.2.3 Outstanding Florida Water (OFW) and Other Designations

Blue Spring and Blue Spring Run together are designated as an OFW pursuant to Chapter 62-302, F.A.C. Portions of the spring run are within the Wekiva/Middle St. Johns River/Tomoka Marsh Aquatic Preserve as designated under the Florida Aquatic Preserve Act of 1975, Section 258.35, F.S.). These waterbodies were also registered in the Florida Natural Features Program in 1980.

The FAS in Volusia County is designated by the EPA as the sole-source Volusia-Floridan aquifer (VFA) because it provides nearly all of the area's drinking water (available: http://www.epa.gov/region4/water/groundwater/r4ssa.html). This sole-source designation provides the

EPA with the authority to determine if federally financed projects in the area contaminate or create public health hazards to the VFA (EPA 1987).

Chapter 4: ASSESSMENT OF SOURCES

4.1 Types of Sources

Nitrogen is present in the environment in many forms, and each form is a possible pollutant source to Blue Spring and Blue Spring Run. An important part of the TMDL analysis is the identification of pollutant source categories, source subcategories, or individual sources of nutrients in the watershed and the magnitude of pollutant loading contributed by each of these sources.

Pollutant sources occur in two broad categories, "point sources" and "nonpoint sources." Historically, the term "point sources" meant discharges to surface waters that typically have a continuous flow via a discernible, confined, and discrete conveyance, such as a pipe. Wastewater treatment facilities (WWTFs) that discharge treated effluent directly into surface waters are examples of traditional point sources. The term "nonpoint sources" was used to describe intermittent, rainfall-driven, diffuse sources of pollution associated with everyday human activities, and sources not directly discharged to the impaired surface water, such as stormwater runoff, wastewater sprayfield sites, agricultural fields, mining sites, septic system drain fields, and atmospheric deposition.

The 1987 amendments to the Clean Water Act redefined certain nonpoint sources of surface water pollution as point sources subject to regulation under the EPA's National Pollutant Discharge Elimination System (NPDES) Program. These nonpoint sources included certain urban stormwater discharges to surface water, such as those from local government master drainage systems, construction sites over five acres, and a wide variety of industries (see **Appendix A** for background information on the federal and state stormwater programs).

To be consistent with Clean Water Act definitions, the term "point source" is used in this document to describe traditional point sources (such as domestic and industrial wastewater discharges to surface water) and **urban** stormwater system discharges to impaired surface waters that require an NPDES stormwater permit when allocating pollutant load reductions required by a TMDL (see **Section 6.1**).

4.2 Information on Potential Sources of Nitrate in the Blue Spring Springshed

The nitrate in the impaired spring and spring run may have come from a variety of sources in the springshed. Relationships between the ratios of stable isotopes of nitrogen ($\delta^{15}N$/ $\delta^{14}N$) in water samples can provide information on the predominant nitrate sources. Values of less than six per mil (*i.e.*, parts per thousand) are generally indicative of inorganic sources (primarily fertilizers) while values greater than nine per mil indicate organic sources of nitrogen such as wastewater or animal waste (Katz *et al.* 1999). The further evaluation of $\delta^{15}N$ and $\delta^{18}O$ ratios can also provide information on sources and possible denitrification trends.

The results from isotope sampling by the Department between 2011 and 2012 display a distinct denitrification trend, and predenitrification isotopic signatures may indicate a mixture of inorganic and organic sources; however, the degree of denitrification in the samples is uncertain (Department unpublished data). This finding supports conclusions from Albertin *et al.* (2012), who found high $\delta^{15}N$ and $\delta^{18}O$ values and evidence of denitrification in water samples taken from Blue Spring in 2008, which was considered a relatively dry year. These researchers speculated that the mixing of older FAS water during drier conditions provides a greater potential for denitrification. Residential development in the springshed and associated septic tanks, wastewater reuse, and fertilizer application to lawns and commercial properties may provide sources of nitrogen, while conditions in the FAS may provide an environment that is favorable for denitrification of these sources. The reuse of treated domestic wastewater effluent (initially an organic form of nitrogen) for irrigation may also increase the appearance of denitrification in water samples in the springshed.

Sucralose is used as an artificial sweetener. Because it passes through water treatment systems largely intact, it has recently been used as a human wastewater tracer. Low levels of sucralose were detected in samples from Blue Spring collected during 2012, indicative of possible wastewater influences in the springshed.

4.2.1 Discharge Sources Permitted under the NPDES Program

WWTF Discharges

There are 29 permitted facilities in the Blue Spring springshed that treat industrial and domestic wastewater, according to the Department's Wastewater Facilities Regulation (WAFR) database. Four of the facilities (concrete batch plants) have NPDES permits to discharge to surface water, but none discharge to the impaired waters, and concrete batch plants are not significant sources of nitrogen. Four other facilities have industrial wastewater permits, but these facilities include minor sources that are not likely to have appreciable impacts on Blue Spring or Blue Spring Run.

Twenty-one of the facilities in the springshed treat domestic wastewater, which is a more significant potential source of nitrogen than the industrial facilities (**Table 4.1** and **Figure 4.1**). These facilities are permitted to discharge to nonsurface waters, including ground water via drain fields, rapid infiltration basins (RIBs), or spray irrigation, and are therefore considered nonpoint sources. However, it is difficult to evaluate potential nitrogen inputs to ground water from domestic wastewater application sites, as they vary in treatment methods, nitrogen concentrations in effluent, and method of application, as well as in the amount of attenuation in the soil profile.

Five domestic WWTFs in the springshed have design flows of greater than 0.1 MGD, the largest being the City of DeLand Wiley M. Nash Water Reclamation Facility with a design capacity of 6 MGD. This facility has a permitted outfall in the St. Johns River but has not discharged any reclaimed water to the river for more than two years. Most of the plant's effluent is used as reclaimed water for irrigation, stored for future use, or disposed of in RIBs (K. Riger, pers. comm., July 2013).

In addition to treated wastewater application sites, municipal wastewater sewer systems contribute to losses of nitrogen through sewer line leaks, lift station overflows, and other incidents.

Stormwater Discharges

A municipal separate storm sewer system (MS4) is a publicly owned conveyance or system of conveyances (*i.e.*, ditches, curbs, catch basins, underground pipes, *etc.*) that is designed or used for collecting or conveying stormwater and that discharges to surface waters of the state. There are six Phase II MS4 permits in the Blue Spring springshed: city of DeLand (FLR04E078), Lake Helen (FLR04E125), city of Orange City (FLR04E126), city of DeBary (FLR04E120), Florida Department of Transportation District 5 (FDOT D5) (FLR04E099), Deltona (FLR04E099), and Volusia County (FLR04E078) (**Figure 4.2)**. None of the permittees discharge directly to Blue Spring or Blue Spring Run.

While it may not be appropriate to assign a specific allocation or reduction to the existing NPDES entities as potential point sources, some of them may still be included in the BMAP process because of their nonpoint source contributions. These nonpoint source discharges include discharges of stormwater to the UFA via retention ponds and sinkholes.

Table 4.1. Permitted WWTFs in the Blue Spring springshed (Department WAFR)

[1] Permit limit for volume treated and discharged in MGD
[2] DW = Domestic waste; IW = Industrial waste; CBP = Concrete batch plant; WRF = Water reclamation facility
[3] NPDES Permit = Federal National Pollutant Discharge Elimination System permit for discharge to surface water.
Note: Facilities shown in boldface type with yellow highlighting have design flows greater than 0.1 MGD.

Facility ID	Facility Name	Design Capacity[1]	Facility Type[2]	NPDES Permit
FLG110451	CEMEX Construction Materials FL LLC - Orange City CBP	0.00	CBP	Yes
FLG110780	CEMEX Construction Materials FL LLC - Deland Ready Mix Plant	0.00	CBP	Yes
FLG110324	Maschmeyer Concrete	0.00	CBP	Yes
FLG110687	Tarmac - Deland Concrete Batch Plant	0.02	CBP	Yes
FLA011216	Tropical Resort and Marina WWTF	0.00	DW	No
FLA011220	Days Inn of Orange City	0.00	DW	No
FLA011276	Hontoon Island State Park	0.01	DW	No
FLA011197	Arlington Square Apartments	0.01	DW	No
FLA011263	St Johns River Club Condominium WWTF	0.01	DW	No
FLA011203	Quality Inn	0.01	DW	No
FLA011223	1876 Heritage Inn	0.01	DW	No
FLA011198	Lakeview Terrace WWTF	0.01	DW	No
FLA016691	Volusia Pines Elementary School WWTF	0.01	DW	No
FLA011204	Holly Bluff Marina, Inc.	0.01	DW	No
FLA011234	Paradise Lakes Campground	0.02	DW	No
FLA011237	Clark Family Campground KOA WWTF	0.02	DW	No
FLA011279	Blue Spring State Park	0.02	DW	No
FLA011219	Land O Lakes WWTF	0.03	DW	No
FLA011265	Candlelight WWTF	0.03	DW	No
FLA011199	Lake Helen Mobile Home Villas	0.03	DW	No
FLA011118	**Volusia County - Four Townes WWTF**	**0.60**	**DW**	No
FLA011121	**Volusia County - Deltona North WWTF**	**1.20**	**DW**	No
FLA011128	**Volusia County - Southwest WRF**	**1.20**	**DW**	No
FLA111724	**Deltona Lakes**	**1.40**	**DW**	No
FL0020303	**Deland, City of - Wiley M Nash WRF**	**6.00**	**DW**	**Yes**
FLA626848	Enterprise Carwash	0.00	IW	No
FLA724891	Deland Truck Center Inc	0.00	IW	N
FLA625655	Circle K #9753 Car Wash	0.00	IW	N
FLA011180	TG Lee Foods	0.07	IW	N

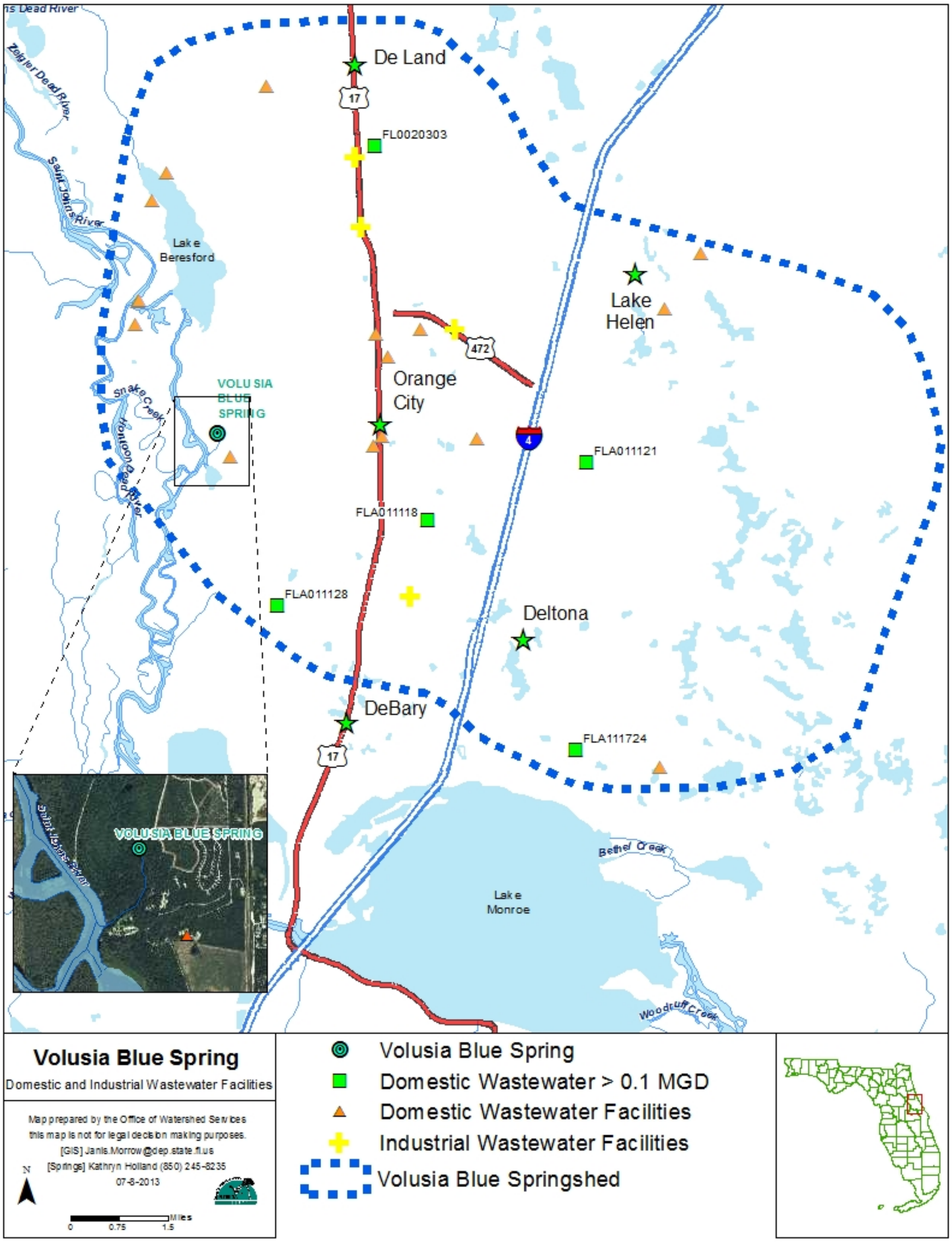

Figure 4.1. Domestic and industrial wastewater facilities in the Blue Spring springshed

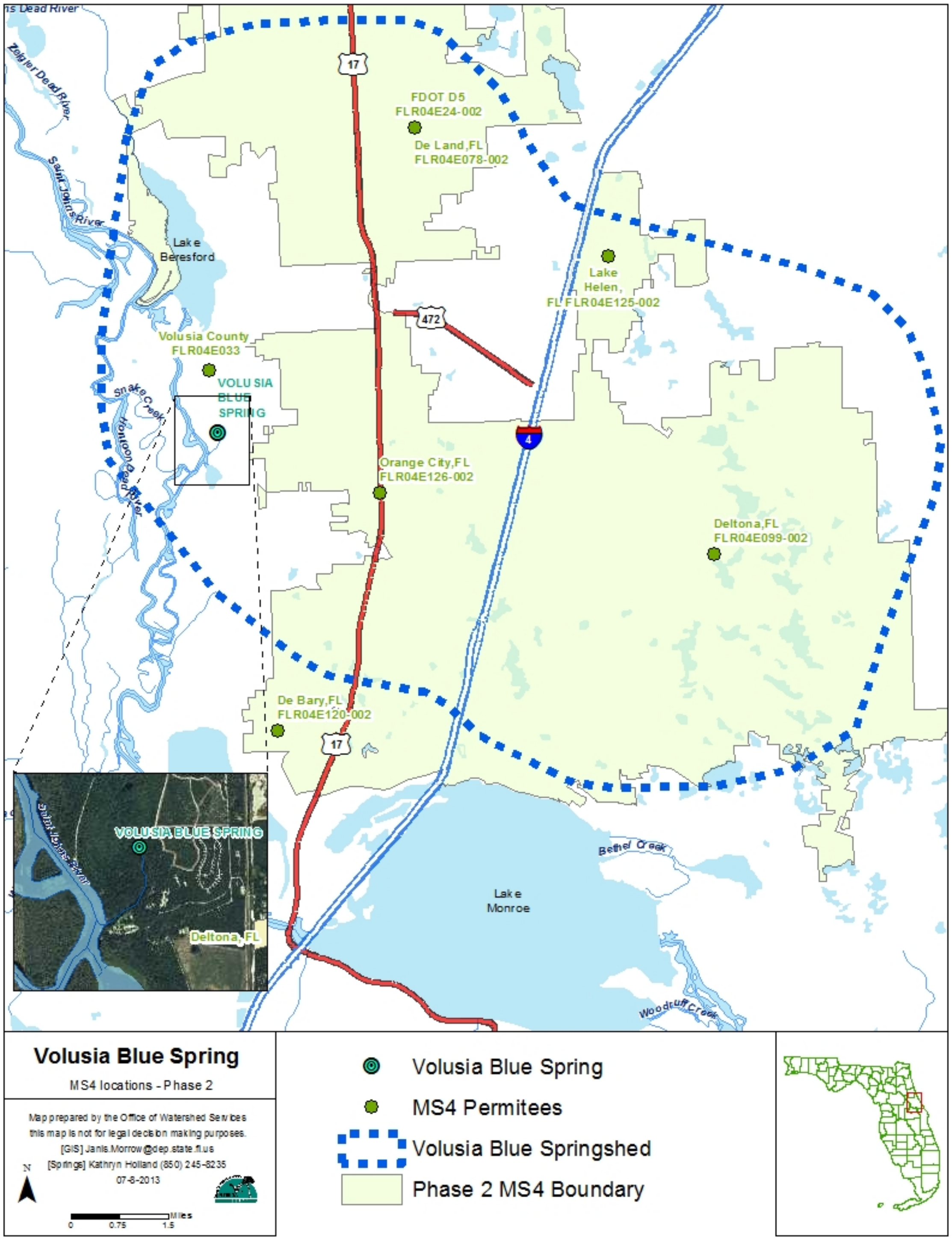

Figure 4.2. Permitted MS4s in the Blue Spring springshed

4.2.2 Land Uses and Additional Nonpoint Sources

Most of the nitrogen input in the springshed comes from nonpoint sources that discharge to ground water. These sources typically include fertilizer applied to lawns, golf courses, and agricultural areas (although this is a minor land use in the springshed), septic tanks, domestic wastewater application sites, and atmospheric deposition.

Land Use and Land Cover

The distribution of different land use categories in the contributing area for Blue Spring was assessed using the 2009 SJRWMD land use GIS coverages. **Table 4.2** and **Figure 4.3** show the distribution of various land use categories and land covers. Medium-density residential areas were the predominant land use in the springshed, covering around 31.5% of the area, followed by upland forest (19%), low-density residential (15%), and wetlands (10%). The upland forest/wetlands land uses are found primarily in the western portion of the springshed along the St. Johns River, in county conservation areas, and in Blue Spring State Park.

Table 4.2. Major land uses in the springshed (SJRWMD 2009 land use coverage)

Land Use	Acres	Square Miles	% of Contributing Area
Low-Density Residential	9,593.84	14.99	14.4%
Medium-Density Residential	20,131.86	31.46	30.1%
High-Density Residential	1,592.70	2.49	2.4%
Urban and Built-Up	4,525.54	7.07	6.8%
Golf Courses	936.58	1.46	1.4%
Agriculture	2,436.05	3.81	3.6%
Rangeland	1,637.30	2.56	2.5%
Upland Forest	12,698.96	19.84	19.0%
Water	4,760.17	7.44	7.1%
Wetlands	6,624.32	10.35	9.9%
Barren Land	270.28	0.42	0.4%
Transportation/Commercial/ Utilities	1,584.77	2.48	2.4%
Total	**66,792.36**	**104.36**	**100%**

Fertilizer

Fertilizer is applied to both urban and agricultural areas in the Blue Spring springshed. About 47%, or 49 of the 104 square miles in the springshed, is designated residential land use (a combination of low, medium, and high density).

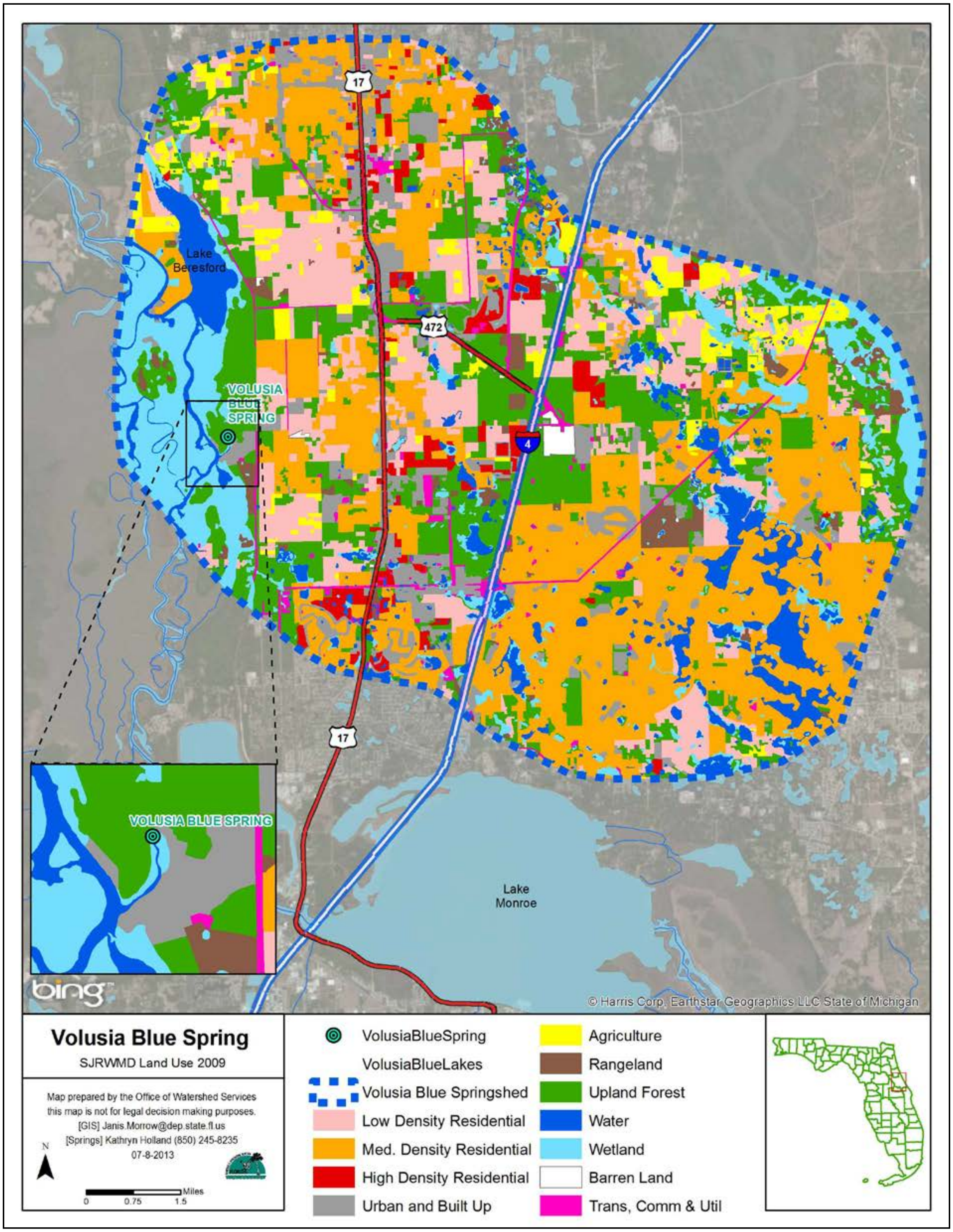

Figure 4.3. Principal land uses in the Blue Spring springshed (based on 2006–08 GIS coverages)

Onsite Sewage Treatment and Disposal Systems (OSTDS)

OSTDS, also known as septic systems, are used for the disposal of domestic waste at homes that are not on central sewer, often because providing central sewer is not cost-effective or practical. When properly sited, designed, constructed, maintained, and operated, OSTDS are a sanitary means of disposing of domestic waste. The effluent from a well-functioning OSTDS is generally higher in TN concentration than secondarily treated wastewater from a sewage treatment plant, although the wastewater profile can vary from home to home.

On average, the TN concentration released to the environment by a typical OSTDS is 57.7 mg/L (Hazen and Sawyer 2009). However, septic tank effluent may undergo some denitrification in and below the drain field, resulting in an even lower TN input to ground water. Under a low-density residential setting, nitrogen inputs from OSTDS may not be significant unless the OSTDS sources are close to the spring, but under a higher density setting, one could expect a TN input of 129 pounds per acre per year (lb/ac/yr) (Harrington *et al.* 2010). The actual load to ground water is a portion of this amount. For the Wekiva River Basin, MACTEC (2010) estimated that the load to ground water from septic systems was approximately 56% of the input (the amount discharged from the tank to the drain field).

According to the Florida Department of Health (FDOH), as of November 2011, there were about 16,406 OSTDS in the Blue Spring springshed. Data for estimating septic tank numbers in the springshed are based on the FDOH statewide inventory of permitted OSTDS GIS layer (FDOH 2011), which is updated annually (**Figure 4.4**). There is some uncertainty about the septic tank counts in this inventory, depending on how current the records are at local health departments and if older paper records are included in the inventory. As a result, the actual numbers of septic tanks may be undercounted.

Atmospheric Deposition

Atmospheric deposition was also identified as an important potential nitrogen source. Atmospheric deposition from wet fall was estimated from the closest National Atmospheric Deposition Program (NADP) monitoring station located in Orlando, Florida (Station FL32). This station has been in operation since December 14, 2005; however, 2005 data were excluded from the calculation due to the limited dataset (NADP website).

Wet deposition is computed by multiplying the precipitation-weighted mean ion concentration (mg/L) for valid samples by the total precipitation amount in centimeters for the summary period and dividing by 10. Records indicate an annual average input of nitrogen from wet deposition to be 2.97 kilograms per hectare (kg/ha) at the station from 2006 to 2012, or about 2.7 lb/ac/yr. Wet deposition and dry deposition of nitrogen are not proportional, with dry deposition sometimes exceeding wet deposition in arid regions or in urban areas where air emissions are high. Dry deposition data were not available for this area.

Invasive Fish

Vermiculated sailfin catfish (*Pterygoplichthys disjunctivus*) and blue tilapia (*Oreochromis aureus*) have recently become a problem in Blue Spring and are common in the spring-run, potentially disrupting the reproduction of native fish species. Sailfin catfish use Blue Spring Run as a thermal refuge during cold weather, and studies indicated that their feces may contribute a significant nutrient source to the spring run through recycling, even though they consume algae (K. Work and M. Gibbs, pers. comm.).

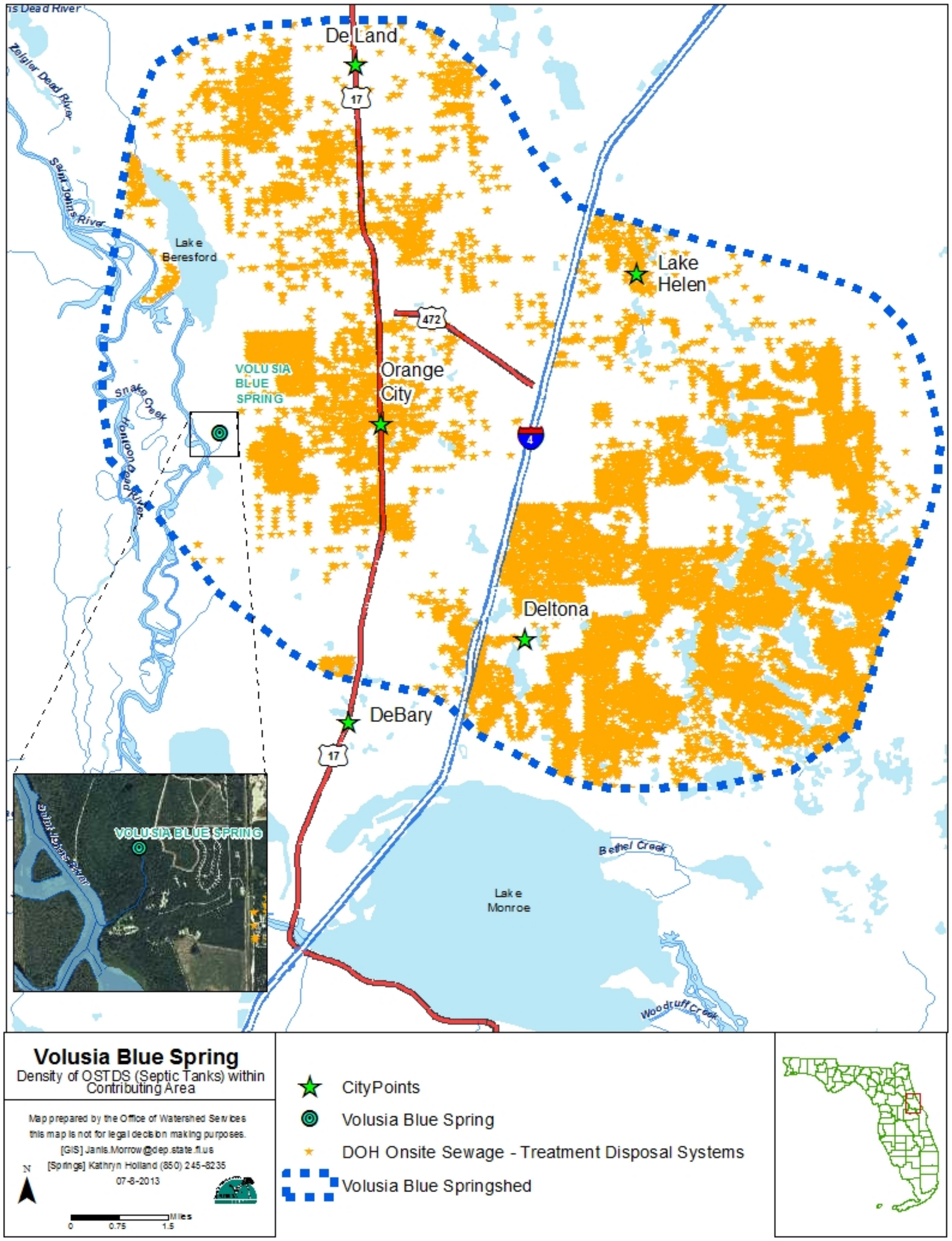

Figure 4.4. **Density of OSTDS (septic tanks) in the Blue Spring springshed (FDOH November 2011)**

Chapter 5: DETERMINATION OF ASSIMILATIVE CAPACITY

The Department often uses hydraulic and water quality models to simulate loading and the effect of the loading within a given waterbody. However, there are other appropriate methods to develop a TMDL that are as credible as a modeling approach. Such an alternative approach was used to estimate existing conditions and calculate TMDLs for Blue Spring and Blue Spring Run.

5.1 Determination of Loading Capacity

Typically, the target loading and existing loading for a stream or watershed are based on hydrologic and water quality modeling. Many of these models depend on the relationship between flow and surface water drainage area, as well as the relationship between land use and soils and pollutant delivery. The predominant source of nitrate loading to Blue Spring and Blue Spring Run is ground water, which discharges from the major spring vent and from smaller seeps near the spring boil and along the spring run. Thus, a direct relationship between surface water loadings in the watershed is not appropriate. This atypical situation requires the use of an alternative approach for establishing the nutrient TMDL.

Existing stream (spring run) loading can sometimes be estimated by multiplying the measured stream flow by the measured pollutant concentrations in the stream. To estimate the pollutant loading this way, synoptic flow and concentration data measured at the outlet of the stream segment being analyzed are required. These types of data are not always available for all sources covering the same period. Estimates of current nutrient loads from the ground water of Blue Spring and Blue Spring Run could possibly be made based on spring flow and concentration. However, as both current and TMDL loads would be generated from the same flow data, there would be a linear or proportional relationship based on current and target concentrations. Therefore, the loads of nitrate were not explicitly calculated.

Instead, the percent load reduction required to achieve the nitrate concentration target was calculated assuming the percent loading reduction would be the same as the percent concentration reduction. The percent reduction required to achieve the water quality target was calculated using the following formula:

[(existing mean concentration – target concentration)/existing mean concentration] x 100

Once the target concentration is consistently achieved, the WBID will be reevaluated to determine if nitrogen continues to contribute to an imbalance of flora and fauna. If such a condition still exists, the TMDL will be reassessed as part of the Department’s watershed assessment cycle. The target concentration may be changed if the Department determines that further reductions in the nitrogen concentration are needed to address the imbalance. The purpose of a TMDL is to set a pollutant reduction goal that, if achieved, will result in attainment of the designated uses for that waterbody.

5.2 TMDL Development Process

5.2.1 Target Setting

The Department's numeric nutrient criterion (NNC) of 0.35 mg/L nitrate for spring vents was adopted in Rule 62-302, F.A.C., by the Environmental Regulation Commission on December 8, 2011. Following legal challenges and federal rulemaking actions on November 30, 2012 the EPA approved the Department's NNC for spring vents. The NNC for springs is 0.35 mg/L nitrate-nitrite as an annual geometric mean, not be exceeded more than once in any 3 calendar year period. The complete technical support document on how the Department calculated the NNC is available at: http://www.dep.state.fl.us/water/wqssp/nutrients/docs/tsd-nnc-lakes-springs-streams.pdf.

Paragraph 62-302.530(47)(b), F.A.C., states that "in no case shall nutrient concentrations of a body of water be altered so as to cause an imbalance in natural populations of aquatic flora or fauna." This narrative criteria is still applicable statewide, but the Department's hierarchical approach gives preference to the numeric nutrient value of 0.35 mg/L nitrate-nitrite for springs based on quantifiable stressor-response relationships between nutrients and biological response. In addition, if there are sufficient site-specific data for a particular spring, a site-specific alternative criterion can be set. However, the Department did not find sufficient algal growth response data to support a different site-specific criterion for Blue Springs and Blue Spring Run. For that reason, the Department believes that a monthly average nitrate concentration of 0.35 mg/L should be sufficiently protective of the aquatic flora or fauna in Blue Spring and Blue Spring Run. A monthly average is considered to be the appropriate time frame, because algal growth is not instantaneously responsive to a nitrate concentration increase or decrease, but rather the response of algae to nutrients is on the order of weeks. In addition, a monthly average is more appropriate than an annual average considering the significant fluctuations of nitrate concentrations that occur in Blue Spring (discussed in **Section 5.4**).

5.3 Setting the Monthly Average Concentration for Nutrients

Nitrate

Based on the adoption of the NNC for springs, the Department has determined that a monthly average of 0.35 mg/L nitrate (nutrients) should be established as the TMDLs for Blue Spring and Blue Spring Run, mainly because changes in aquatic vegetation biomass do not respond to the change of nutrient concentration instantaneously. Therefore, short-term exceedances of the target concentration may not produce negative biological or ecological effects. The nitrate TMDL target established as the NNC was based primarily on multiple lines of evidence, including relationships between long-term average nitrate concentrations and periphyton cell density and biomass on the Suwannee River, ecosystem metabolism data from spring-run streams in the St. Johns River, and the Department's periphyton bioassessment data. Therefore, the TMDL target should be considered a long-term average target instead of an instantaneous value.

Natural processes such as competition between other periphyton and plants, grazing from aquatic animals, removal effects from the shearing force of stream flow, and light attenuation from changing water color in natural systems such as Blue Spring and Blue Spring Run could significantly influence the response of algae to changes in water column nitrate concentrations. Therefore, treating the nitrate concentration as an exact instantaneous value is not necessary. It is more appropriate to treat the target value as an average concentration over a certain period. The Department established the nitrate TMDL for the Wekiva and Suwannee Rivers and Wakulla, Silver, and Rainbow Springs as a monthly average target. Expressing the target as a monthly average provides a margin of safety because restoration activities designed to address the highest monthly average nitrate concentrations should help to ensure that average nitrate concentrations over the rest of the year are even lower.

Since the nitrate target will be established as a monthly average in this TMDL, monthly average concentrations were calculated for each month based on measured concentrations over the verified period (January 1, 2001–June 30, 2008) plus more recent data (2001–13). To ensure that the monthly average concentrations will meet the concentration target even under the worst-case scenario, the highest monthly average nitrate concentrations were used as existing monthly mean concentrations to calculate the percent reduction required to achieve the nitrate target. This approach adds to the margin of safety of the TMDL and was also the approach used for the TMDLs for the Wekiwa and Suwannee Rivers and Wakulla, Silver, and Rainbow Springs.

For Blue Spring and Blue Spring Run, the percent reductions required for this TMDL were calculated using the monthly values for nitrate averaged over the period from January 2001 through May 2013. The maximum monthly average was then considered in the calculation of a target for percent reduction (**Table 5.1**). **Table 5.1** summarizes the monthly averages with monthly average rainfall. These data show that elevated nitrate concentrations occur in September through January during the verified period.

Table 5.1. Monthly average nitrate concentrations and rainfall for Blue Spring and Blue Spring Run (January 2001–May 2013

Month	Blue Spring (WBID 28933) Average (mg/L)	Blue Spring Run (WBID 28933A) Average (mg/L)	Rainfall Verified Period 2001-2013 (inches)	30-Year Rainfall 1981–2010 (inches)
January	0.55	0.55	2.27	2.98
February	0.48	0.48	2.70	2.89
March	0.46	0.46	3.62	4.03
April	0.44	0.44	2.33	2.72
May	0.51	0.51	3.88	3.62
June	0.48	0.48	9.05	8.17
July	0.44	0.44	9.72	8.50
August	0.40	0.40	9.27	8.34
September	0.62	0.62	6.72	7.27
October	0.62	0.62	3.25	4.08
November	0.64	0.64	2.37	2.51
December	0.58	0.58	2.85	2.80
Maximum Monthly Average	**0.64**	**0.64**	**July**	**July**

5.4 Critical Conditions/Seasonality

Establishing the critical condition for nitrogen inputs that affect algal growth in a given springshed depends on many factors, including the presence of point sources and the land use pattern in the springshed. The critical condition for point source loading to a waterbody typically occurs during periods of low flow, when dilution is minimized. Typically, the critical condition for nonpoint source loading is a period of rainfall-related flushing that was preceded by an extended dry period. During the wet weather period, rainfall mobilizes nitrogen that has accumulated on the land surface and in the soil during dry conditions, resulting in higher pollutant concentrations or flushes of pollutants discharging from a spring vent. A lag time can exist between nitrogen inputs into the SAS and the UFA and the pollutant discharge from the spring vent. The water from Blue Spring comes from precipitation that has infiltrated ground water somewhere in the springshed and migrated in the aquifer to discharge from the spring vent. Water discharging from the vent may range from days to decades in age.

Nitrate data from water quality sampling stations for the Cycle 2 verified period (January 1, 2001–June 30, 2008) plus more recent data (2001–13) were evaluated to identify temporal trends. While the annual average is slightly higher during the verified period (0.52 mg/L) compared with the long-term average, the past three years have shown a slight decrease in nitrate concentration. The influence of rainfall on nitrate concentrations is dramatic compared with the response seen from other springs in the state (**Figure 5.1**).

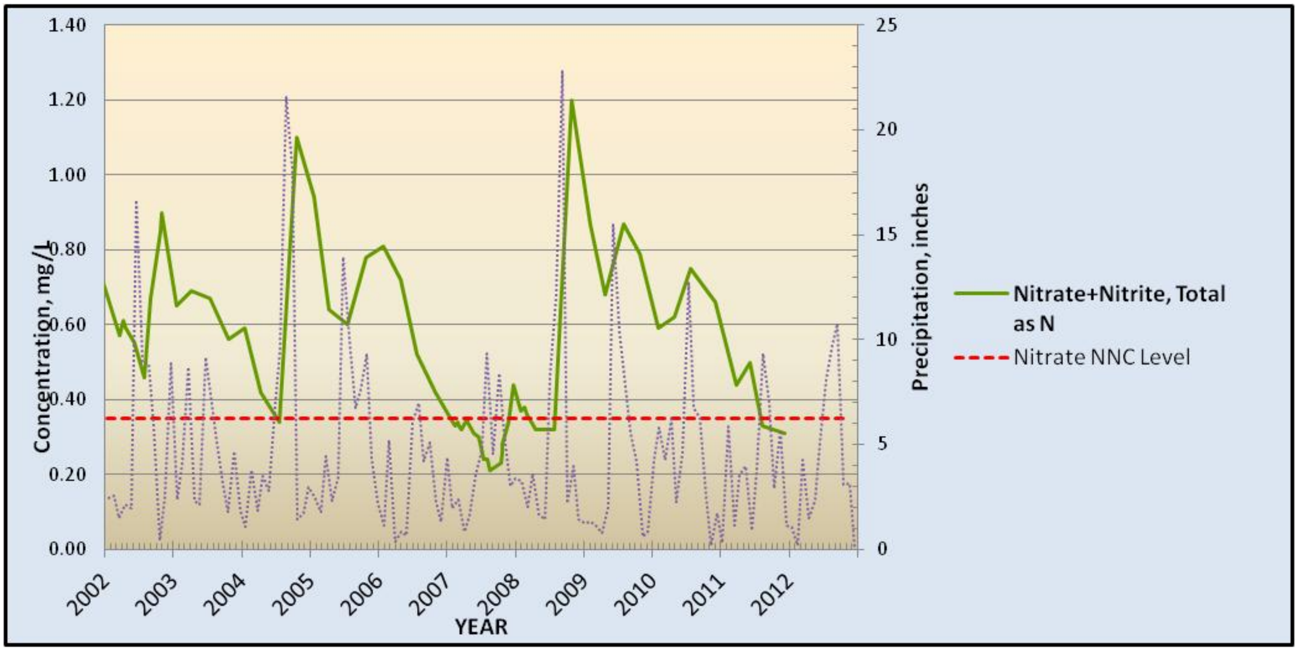

Figure 5.1. Rainfall and Nitrate Concentrations in the Volusia Blue Springs and Volusia Blue Spring Run, 2001–13

Copeland *et al.* (2009) found a strong positive relationship between higher flow levels and higher nitrate concentrations at Blue Spring, indicating that nitrate sources may be from relatively younger water (**Figure 5.2**). This finding suggests that the younger water discharging from Blue Spring may contain a highly concentrated source of nitrate.

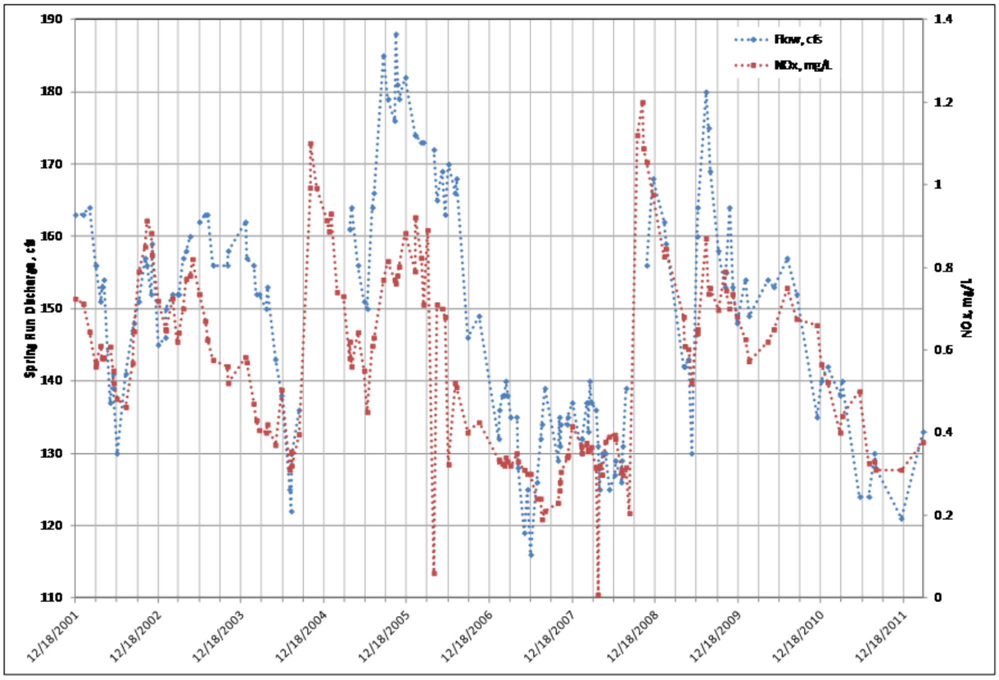

Figure 5.2. Flow Data (Station USGS 2235500) and Paired Nitrate Concentrations in the Volusia Blue Springs and Volusia Blue Spring Run, 2001–13

5.5 Calculation of TMDL Percent Reduction

Based on an examination of the data depicted in **Table 5.1**, the percent reductions for Blue Spring and Blue Spring Run were based on the highest monthly average nitrate concentration, which occurred in November. This approach will be protective for all seasons and add to the implicit margin of safety.

The maximum monthly average nitrate concentration for Blue Spring and Blue Spring Run was 0.64 mg/L in November. This average was calculated from data available between January 2001 and May 2013. The percent reduction required to achieve the water quality target was calculated using the following formula:

[(existing mean concentration – target concentration)/existing mean concentration] x 100

For Blue Spring and Blue Spring Run:

[(0.64 mg/L – 0.35 mg/L) / 0.64 mg/L] * 100

Equals a 45% reduction in nitrate.

A 45% percent reduction in nitrate concentrations in both WBIDs is proposed because it is a protective value that, when achieved, will satisfy the nutrient reduction requirement for the system.

Chapter 6: DETERMINATION OF THE TMDL

6.1 Expression and Allocation of the TMDL

The percent load reductions were established to achieve the monthly average nitrate concentration of 0.35 mg/L. While these percent reductions are the expression of the TMDL that will be implemented, the EPA recommends that all TMDLs and associated load allocations and wasteload allocations include a daily time increment in conjunction with other appropriate temporal expressions that may be necessary to implement the relevant water quality standard. Maximum daily limit (MDL) targets for nitrate were determined using the equation below, established by the EPA (2006). In the following equation, it is assumed that the nitrate data distributions are lognormal:

$$MDL = LTA * \exp(Z_p \sigma_y - 0.5\sigma_y^2)$$
$$\sigma_y = \text{sqrt}(\ln(CV^2 + 1))$$

Where:

LTA = long-term average (0.35 mg/L).
Z_p = p^{th} percentage point of the standard normal distribution, at 95% (Z_p = 1.645).
σ = standard deviation.
CV = coefficient of variance.

For the maximum daily nitrate limit, it was assumed that the average monthly target concentration should be the same as the average daily concentration. Also, assuming the target dataset will have the same CV as the existing measured dataset (**Table 6.1**) and allowing a 5% exceedance (EPA 2007, pp. 19 and 20), the daily maximum nitrate limit for Blue Spring and Blue Spring Run is 0.36 mg/L.

Table 6.1. Daily maximum for target nitrate concentration (mg/L)

Statistics	Blue Spring (WBID 28933), Blue Spring Run (WBID 28933A)
Mean (mg/L)	0.52
CV	0.42
Daily maximum to achieve monthly average nitrate of 0.35 mg/L	0.36

It should be emphasized that these daily maximum targets were developed for illustrative purposes. The implementation of the TMDL will be based on the monthly average concentration targets.

This TMDL has been developed for nitrate, which is a product of the chemical and biochemical conversion of organic and ammonium nitrogen, and the amount of nitrate released from sources can depend on the factors that influence these conversion processes. Thus, there is no straightforward relationship between loading of nitrogen and nitrate released.

The objective of a TMDL is to provide a basis for allocating acceptable loads of the target pollutant among all of the known pollutant sources in a watershed so that appropriate control measures can be implemented and water quality standards achieved. A TMDL is expressed as the sum of all point source loads (wasteload allocations, or WLAs), nonpoint source loads (load allocations, or LAs), and an appropriate margin of safety (MOS), which takes into account any uncertainty concerning the relationship between effluent limitations and water quality:

TMDL = $\sum \square \text{WLAs} + \sum \square \text{LAs} + \text{MOS}$

As discussed earlier, the WLA is broken out into separate subcategories for wastewater discharges and stormwater discharges regulated under the NPDES Program:

TMDL $\cong \sum \square \text{WLAs}_{\textbf{wastewater}} + \sum \square \text{WLAs}_{\textbf{NPDES Stormwater}} + \sum \square \text{LAs} + \text{MOS}$

WLAs for stormwater discharges (if applicable) are typically expressed as a “percent reduction” because it is very difficult to quantify the loads from MS4s (given the numerous discharge points) and to distinguish loads from MS4s from other nonpoint sources (given the nature of stormwater transport). The permitting of stormwater discharges also differs from the permitting of most wastewater point sources. Because stormwater discharges cannot be centrally collected, monitored, and treated, they are not subject to the same types of effluent limitations as wastewater facilities, and instead are required to meet a performance standard of providing treatment to the “maximum extent practical” through the implementation of best management practices (BMPs). WLAs for wastewater may be addressed in the BMAP process through upgrades to WWTFs, but a wastewater allocation is not proposed as part of this TMDL.

This approach is consistent with federal regulations (40 CFR § 130.2[I]), which state that TMDLs can be expressed in terms of mass per time (*e.g.*, pounds per day), toxicity, or **other appropriate measure**. The TMDL for Blue Spring and Blue Spring Run is expressed in terms of concentration of nitrate and represents the loading of nitrate that the spring run can assimilate and maintain ecological balance (**Table 6.2**).

Table 6.2. TMDL components for Blue Spring and Blue Spring Run

[1] N/A = Not applicable

WBID	Parameter	TMDL (mg/L)	TMDL % reduction	Wasteload Allocation for Wastewater[1]	Wasteload Allocation for NPDES Stormwater % Reduction	LA % reduction	MOS
Blue Spring (WBID 28933), Blue Spring Run (WBID 28933A)	Nitrate as monthly average	0.35	45%	N/A	45%	45%	Implicit

6.2 Load Allocation

Because no target loads were explicitly calculated in this TMDL report, the TMDL is represented as the percent reduction of nitrogen loadings required to achieve the nitrate target. The percent reduction assigned to all the nonpoint source areas (LA) is the same as that defined for the TMDL percent reduction. To achieve the monthly average nitrate target of 0.35 mg/L in Blue Spring and Blue Spring Run, the nitrate contribution to the impaired waters that comes from sources in the contributing area needs to be reduced by 46%. The target monthly average nitrate of 0.35 mg/L and the percent reduction represent an estimate of the maximum amount of reduction required to meet the target. It may be possible to meet the target before achieving the percent reductions.

The nonpoint sources included in the LA include fertilizer, domestic wastewater from OSTDS and wastewater application sites, animal waste, atmospheric deposition, and stormwater discharges to ground water. The LA also includes loading in the springshed from stormwater discharges regulated by the Department and the water management district that are part of the NPDES Stormwater Program but do not discharge to the impaired waters (see **Appendix A**).

6.3 Wasteload Allocation

6.3.1 NPDES Wastewater Discharges

Currently, there are no NPDES wastewater facilities that discharge directly into Blue Spring or Blue Spring Run. Any new potential discharger is expected to comply with the Class III criterion for nutrients and with nitrate limits consistent with this TMDL.

6.3.2 NPDES Stormwater Discharges

There are currently no direct stormwater outfalls from NPDES MS4 stormwater facilities to the Blue Spring or Blue Spring Run. If any occur in the future, they must meet the wasteload allocation for permitted stormwater discharges.

6.4 Margin of Safety

Consistent with the recommendations of the Allocation Technical Advisory Committee (Department 2001), an implicit MOS was used in the development of this TMDL, and was provided by the conservative decisions associated with a number of assumptions and the development of assimilative capacity. For example, the NNC nitrate target for springs was established based on a conservative concentration from multiple lines of evidences (Department 2012). Requiring the 0.35 mg/L target to be met every month should result in a nitrate concentration even lower than the target concentration during the summer algal growth season based on a seasonal analysis of the nitrate concentration, and therefore adds to the MOS. In addition, when estimating the required percent reduction to achieve the water quality target, the highest long-term monthly average of measured nitrate concentrations was used instead of the average of the monthly averages. This will make estimating the required percent load reduction more conservative and therefore adds to the MOS.

Chapter 7: NEXT STEPS: IMPLEMENTATION PLAN DEVELOPMENT AND BEYOND

7.1 Basin Management Action Plan

Following the adoption of this TMDL by rule, the Department will determine the best course of action regarding its implementation. Depending on the pollutant(s) causing the waterbody impairment and the significance of the waterbody, the Department will select the best course of action leading to the development of a plan to restore the waterbody. Often this will be accomplished cooperatively with stakeholders by creating a Basin Management Action Plan, referred to as the BMAP. BMAPs are the primary mechanism through which TMDLs are implemented in Florida (see Subsection 403.067[7], F.S.). A single BMAP may provide the conceptual plan for the restoration of one or many impaired waterbodies.

A BMAP will be needed to support the implementation of this TMDL. The BMAP will be developed through a transparent, stakeholder-driven process intended to result in a plan that is cost-effective, is technically feasible, and meets the restoration needs of the applicable waterbodies. The restoration plan will take into account the sources of nitrogen in the contributing area, including legacy loads from past land use activities, as well as the complexity of the aquifer system that conveys pollutants to the impaired waters.

Once adopted by order of the Department Secretary, BMAPs are enforceable through wastewater and municipal stormwater permits for point sources and through BMP implementation for nonpoint sources. Among other components, BMAPs typically include the following:

- Water quality goals (based directly on the TMDL).
- Refined source identification.
- Load reduction requirements for stakeholders (quantitative detailed allocations, if technically feasible).
- A description of the load reduction activities to be undertaken, including structural projects, nonstructural BMPs, and public education and outreach.
- A description of further research, data collection, or source identification needed in order to achieve the TMDL.

- Timetables for implementation.
- Implementation funding mechanisms.
- An evaluation of future increases in pollutant loading due to population growth.
- Implementation milestones, project tracking, water quality monitoring, and adaptive management procedures.
- Stakeholder statements of commitment (typically a local government resolution).

BMAPs are updated through annual meetings and may be officially revised every five years. Completed BMAPs in the state have improved communication and cooperation among local stakeholders and state agencies; improved internal communication within local governments; applied high-quality science and local information to the management of water resources; clarified the obligations of wastewater point source, MS4, and non-MS4 stakeholders in TMDL implementation; enhanced transparency in the Department's decision making; and built strong relationships between the Department and local stakeholders that have benefited other program areas.

References

Albertin, A., J.O. Sickman, A. Pinowska, R.J. Stevenson and M. Anderson. 2012. Identification of nitrogen sources and transformations within karst springs using isotope tracers of nitrogen. *Biogeochemistry*. DOI 10.1007/s10533-011-9592-0.

Arthur, J.D., H.A.R. Wood, A.E. Baker, J.R. Chichon, and G.L. Raines. 2007. Development and implementation of a Baysean-based aquifer vulnerability assessment in Florida. *Natural Resources Research* 16(2), 93–107.

Climate Information for Management and Operational Decisions. 2011. *Southeast Regional Climate Center.* Available: http://climod.meas.ncsu.edu/.

Copeland, R., N.A. Doran, A.J. White, and S.B. Upchurch. 2011. *Regional and statewide trends in Florida's spring and well groundwater quality (1991 – 2003).* Bulletin No. 69 (Revised). Published for the Florida Geological Survey, Tallahassee, FL.

Cowell, B.C., and C.J. Dawes. 2004. Growth and nitrate-nitrogen uptake by the cyanobacterium *Lyngbya wollei*. Notes. *Journal Aquatic Plant Management* 42: 69–71.

Florida Department of Environmental Protection. 2005. *Blue Spring and Hontoon Island State Parks unit management plan.* Tallahassee, FL: Division of Parks and Recreation.

———. 2008. *General biological structure of Volusia Blue Spring Run.* Tallahassee, FL: Division of Water Resource Management, Bureau of Assessment and Restoration.

———. 2011. *Florida State Park system economic impact assessment, FY 2010/2011*. Prepared by the Division of Recreation and Parks. Available: http://www.nasorlo.org/wp-content/uploads/2011/11/FPS-2010-2011-Economic-Impact-Assessment1.pdf..

———. 2012. *Technical support document: Development of numeric nutrient criteria for Florida lakes, spring vents, and streams.* Prepared by the Standards and Assessment Section. Unpublished report. Tallahassee, FL.

Florida Department of Health. 2010. *Onsite sewage - Treatment and disposal systems vector digital data.*

———. 2011. Available: http://www.doh.state.fl.us/.

Franz, R. 1982. *Rare and endangered biota of Florida, Volume six, Invertebrates.* Gainesville, FL: University Press of Florida.

German, E.R. 2008. *Volusia Blue Spring – A hydrological treasure.* United States Geological Survey Fact Sheet 2008-3035. Available: http://pubs.usgs.gov/fs/2008/3035/.

Hand, J. 2009. *Typical Florida spring values.* Unpublished PowerPoint presentation for the Department.

Harrington, D., G. Maddox, and R. Hicks. February 2010. *Florida Springs Initiative Monitoring Network report and recognized sources of nitrate.* Tallahassee, FL: Florida Department of Environmental Protection, Division of Environmental Assessment and Restoration, Bureau of Watershed Restoration, Ground Water Protection Section.

Hazen and Sawyer. August 2009. *Florida onsite sewage nitrogen reduction strategies study: Task A.2, Final report, Literature review of nitrogen reduction technologies for onsite sewage treatment systems.* Florida Department of Health Contract CORCL.

Heffernan, J.B., D.M. Liebowitz, T.K. Frazer, J.M. Evans, and M.J. Cohen. 2010. Algal blooms and the nitrogen-enrichment hypothesis in Florida springs: Evidence, alternatives, and adaptive management. *Ecol. Applications* 20(3), 816–829.

Hicks, R., D. Harrington, and G. Maddox. March 2009. *Documentation to support listing of nutrient impaired springs and spring runs (Volusia Blue Spring and Volusia Blue Spring Run; DeLeon Spring; Jackson Blue Spring and Merritts Mill Pond; Silver Springs, Silver Springs Group, and Upper Silver River; Rainbow Springs Group and Rainbow Springs Group Run; and Weeki Wachee Spring and Weeki Wachee Spring Run.* Tallahassee, FL: Florida Department of Environmental Protection, Division of Environmental Assessment and Restoration, Bureau of Watershed Restoration, Ground Water Protection Section.

Katz, B.G., H.D. Hornsby, J.K. Bohlke, and M.F. Mokray. 1999. *Sources and chronology of nitrate contamination in spring waters, Suwannee River Basin, Florida.* U.S. Geological Survey Water-Resources Investigations Report 99-4252.

Kimrey, J.O. 1990. *Potential for ground-water development in central Volusia County, Florida.* United States Geological Survey Water-Resources Investigations Report 90-4010.

Knochenmus, D.D., and M.E. Beard. 1971. *Evaluation of the quantity and quality of the water resources of Volusia County, Florida.* Florida Bureau of Geology RI No. 57.

MACTEC. March 2010. *Wekiva River Basin nitrate sourcing study*. Final report. Prepared for the St. Johns River Water Management District and Florida Department of Environmental Protection. MACTEC Project No. 6063090160A.

Maddox, G.L., J.M. Lloyd, T.M. Scott, S.B. Upchurch, and R. Copeland (eds). 1992. *Florida's Ground Water Quality Monitoring Program, background geochemistry.* Florida Geological Survey Special Publications 34.

Mattson, R.A., M. Lehmensiek, and E.F. Lowe. 2007. *Nitrate toxicity in Florida springs and spring-run streams: A review of the literature and its implications*. St. Johns River Water Management District Professional Paper SJ2007-PP1. Available: http://floridaswater.com/technicalreports/pdfs/PP/SJ2007-PP1.pdf.

National Atmospheric Deposition Program. 2014. Available: http://nadp.sws.uiuc.edu/.

National Oceanic and Atmospheric Administration. 2010. *Online meteorological data.*

Osburn, W.L. 2011. *Evaluation of discharge data for Blue Spring, Volusia County, Florida, for the period 1392–2006.* St. Johns River Water Management District Professional Paper SJ 2011-PP1.

Rouhani, S., P. Sucsy, G. Hall, W. Osburn, and M. Wild. 2007. *Analysis of Blue Spring discharge to determine a minimum flow regime.* St.Johns River Water Management District Special Publication SJ2007-SP17.

Rutledge, A.T. 1985. *Ground-water hydrology of Volusia County, Florida, with emphasis on occurrence and movement of brackish water.* United States Geological Survey Water-Resources Investigations Report 84-4206.

Sartain, J.B., L.T. Trenholm, E.F. Gilman, T.A. Obreza, and G. Toor. 2009. *Frequently asked questions about landscaping fertilization for Florida-friendly landscaping ordinances*. University of Florida Institute of Food and Agricultural Sciences, ENH1115.

Shoemaker, B., A.M. O'Reilly, N. Sepulveda, S.A.M. Williams, L.H. Motz, and Q. Sun. 2004. *Comparison of estimated areas contributing recharge to selected spring in north-central Florida by using multiple ground-water flow models.* United States Geological Survey Open-File Report 03-448.

Stevenson, R.J., A. Pinowska, and Y.K. Wang. 2004. *Ecological condition of algae and nutrients in Florida springs.* Tallahassee, FL: Florida Department of Environmental Protection.

Stevenson, R.J., A. Pinowska, A. Albertin, and J.O. Sickman. 2007. *Ecological condition of algae and nutrients in Florida springs: The synthesis report.* Submitted to the Florida Department of Environmental Protection.

St. Johns River Water Management District. 2006. *Human use and ecological evaluation of the recommended minimum flow regime for Blue Spring and Blue Spring Run, Volusia County, Florida.* Prepared by Wetland Solutions, Inc. Special Publication SJ2007-SP19.

Tibbals, C.H. 1990. *Hydrology of the Floridan aquifer system in east-central Florida.* United States Geological Survey Professional Paper 1403-E.

Toth, D.J. 1999. *Water quality and isotope concentrations from selected springs in the St. Johns River Water Management District.* St. Johns River Water Management District Technical Publication SJ1999-2.

Toth, D.J., and B.G. Katz. 2006. Mixing of shallow and deep groundwater as indicated by the chemistry and age of karstic springs. *Hydrogeology Journal* 14: 1060–1080.

United States Census Bureau. 2010. Available: http://www.census.gov/.

United States Environmental Protection Agency. November 1987. *Fact sheet – Volusia-Floridan sole source aquifer*. Atlanta, GA.

———. November 2006. *Memorandum establishing TMDL "daily" loads in light of the decision by the U.S. Court of Appeals for the D.C. Circuit in Friends of the Earth, Inc. v. EPA et al., No.05-5015 (D.C. Cir. 2006) and implications for NPDES permits.* Washington, DC.

———. June 2007. *Options for expressing daily load in TMDLs (The Option).*

United States Geological Survey. 2008.

———. 2012. *National Water Information System web interface.* Available: http://waterdata.usgs.gov/nwis.

Wyrick, G.G. 1960. *The ground-water resources of Volusia County, Florida.* Report of Investigations No. 22. Tallahassee, FL: United States Geological Survey.

Appendix A: Background Information on Federal and State Stormwater Programs

In 1982, Florida became the first state in the country to implement statewide regulations to address the issue of nonpoint source pollution by requiring new development and redevelopment to treat stormwater before it is discharged. The Stormwater Rule, as authorized in Chapter 403, F.S., was established as a technology-based program that relies on the implementation of BMPs that are designed to achieve a specific level of treatment (*i.e.,* performance standards) as set forth in Chapter 62-40, F.A.C. In 1994, the Department's stormwater treatment requirements were integrated with the stormwater flood control requirements of the water management districts, along with wetland protection requirements, into the Environmental Resource Permit (ERP) regulations.

Chapter 62-40, F.A.C., also requires the state's water management districts to establish stormwater pollutant load reduction goals (PLRGs) and adopt them as part of a Surface Water Improvement and Management (SWIM) plan, other watershed plan, or rule. Stormwater PLRGs are a major component of the load allocation part of a TMDL. To date, stormwater PLRGs have been established for Tampa Bay, Lake Thonotosassa, the Winter Haven Chain of Lakes, the Everglades, Lake Okeechobee, and Lake Apopka.

In 1987, the United States Congress established Section 402(p) as part of the federal Clean Water Act Reauthorization. This section of the law amended the scope of the federal NPDES permitting program to designate certain stormwater discharges as "point sources" of pollution. The EPA promulgated regulations and began implementing the Phase I NPDES Stormwater Program in 1990. These stormwater discharges include certain discharges that are associated with industrial activities designated by specific standard industrial classification (SIC) codes, construction sites disturbing five or more acres of land, and the master drainage systems of local governments with a population above 100,000, which are better known as MS4s. However, because the master drainage systems of most local governments in Florida are interconnected, the EPA implemented Phase I of the MS4 permitting program on a countywide basis, which brought in all cities (incorporated areas), Chapter 298 urban water control districts, and FDOT throughout the 15 counties meeting the population criteria. The Department received authorization to implement the NPDES Stormwater Program in 2000.

An important difference between the federal NPDES and the state's Stormwater/ERP Programs is that the NPDES Program covers both new and existing discharges, while the state's program focuses on new discharges only. Additionally, Phase II of the NPDES Program, implemented in 2003, expands the need for these permits to construction sites between one and five acres, and to local governments with as few as 1,000 people. While these urban stormwater discharges are now technically referred to as "point sources" for the purpose of regulation, they are still diffuse sources of pollution that cannot be easily collected and treated by a central treatment facility, as are other point sources of pollution such as domestic and industrial wastewater discharges. It should be noted that all MS4 permits issued in Florida include a reopener clause that allows permit revisions to implement TMDLs when the implementation plan is formally adopted.