Priority Focus Area for Volusia Blue Spring

Division of Environmental Assessment and Restoration

Florida Department of Environmental Protection

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2600 Blair Stone Road, MS 3575
Tallahassee, FL 32399-2400
www.dep.state.fl.us

More Information

For more information about the priority focus area for Volusia Blue Spring, contact the following individuals:

Moira Homann
Basin Coordinator
DEP Watershed Planning and Coordination Section
Email: Moira Homann
Phone: (850) 245-8460

Richard Hicks, P.G.
Professional Geologist Administrator
DEP Groundwater Management Section
Email: Rick Hicks
Phone: (850) 245–8229

Introduction

Under the Florida Springs and Aquifer Protection Act, the Florida Department of Environmental Protection (DEP) is required to delineate priority focus areas (PFAs) for all Outstanding Florida Springs (OFS) identified as impaired. According to the Florida Springs and Aquifer Protection Act, adopted by the Florida Legislature in 2016 (Chapter 373, Part VIII, Florida Statutes [F.S.]):

> *" 'Priority focus area' means the area or areas of a basin where the Floridan Aquifer is generally most vulnerable to pollutant inputs where there is a known connectivity between groundwater pathways and an Outstanding Florida Spring, as determined by the department* [DEP] *in consultation with the appropriate water management districts, and delineated in a basin management action plan. Using the best data available from water management districts and other credible sources, the department, in coordination with the water management districts, shall delineate priority focus areas for each Outstanding Florida Spring or group of springs that contains one or more Outstanding Florida Springs and is identified as impaired in accordance with s. 373.807. In delineating priority focus areas, the department shall consider groundwater travel time to the spring, hydrogeology, nutrient load, and any other factors that may lead to degradation of an Outstanding Florida Spring. The delineation of priority focus areas must be completed by July 1, 2018, shall use understood and identifiable boundaries such as roads or political jurisdictions for ease of implementation, and is effective upon incorporation in a basin management action plan.*"

Factors to consider in establishing these geographically bounded areas include the following:

- Groundwater travel time to the spring, which could be based on empirical data from tracer studies and/or predicted travel time from modeling, if such data or studies are available.

- Hydrogeology, which includes the spring's groundwater contributing area (or springshed), the amount of confining material protecting the Floridan aquifer, the aquifer recharge characteristics, the capacity for the aquifer to transmit water, and other characteristics that help determine the aquifer vulnerability and the likelihood of adverse water quality impacts to springs.

- Nutrient load to the spring, which includes the actual measured load in the water discharging from the spring as well as the potential nutrient load based on land uses in specific regions that would most probably influence water quality in the spring.

- Other factors, including soil characteristics that are favorable for pollutant leaching to the aquifer in the springshed and the presence or absence of pollutant sources in the area.

- Identifiable boundaries, including roads, natural boundaries, and political jurisdictions.

Steps in Delineating the Volusia Blue Spring PFA

A PFA was delineated for Volusia Blue Spring because of an impairment for nitrate nitrogen. The PFA boundary was developed using geographic information system (GIS) tools, spring-specific data, and published information to help identify the portion of the spring contributing area that is most important from both water quality restoration and protection perspectives. The steps listed below were taken to develop a PFA for review and input by stakeholders. The overlapping of mapped characteristics that express high vulnerability, a high potential for pollutant mobility, and likely pollutant sources provides the best assurance that the PFA includes the areas of greatest concern for water quality restoration and protection.

Step 1..Establish the springshed for the priority spring(s). The springshed area was defined by the St. Johns River Water Management District (SJRWMD) based on U.S. Geological Survey (USGS) potentiometric surface contour maps. Flow pathways were compared for multiple measurement dates to develop the contributing area that accounts for seasonal variation in flow direction. **Figure 1** shows the location of the springshed, which also comprises the Volusia Blue Spring Basin Management Action Plan (BMAP) area, and the proposed PFA.

Step 2..Identify regions in the contributing area where the greatest recharge occurs. Several GIS coverages developed by the USGS and water management districts delineate areas of high, medium, and low recharge to the Floridan aquifer system as well as areas of aquifer discharge.

The areas to be considered in the PFA delineation are those with the highest recharge to the aquifer. These could occur as diffuse infiltration through permeable geological material as well as focused recharge to sinkholes that breach confining layers. Pollutant sources in high-recharge areas have the greatest potential to cause adverse impacts to groundwater and springs because water is impeded the least as it infiltrates to the aquifer from the surface. In high-recharge areas, recharge is 10 inches per year or greater based on 2015 GIS coverage developed by the SJRWMD. **Figure 2** shows the area of greatest recharge (≥10 inches per year) based on the SJRWMD methodology.[1]

[1] Boniol, D., and K. Mouyard. 2015. *Recharge to the upper Floridan aquifer in the St. Johns River Water Management District.* Technical Fact Sheet SJ2016-FS1.

Step 3. Identify regions in the springshed where the Floridan aquifer is most vulnerable. There is no county-scale aquifer vulnerability assessment for Volusia County, and so the statewide Florida Aquifer Vulnerability Assessment (FAVA) model for the Floridan aquifer was used to evaluate aquifer vulnerability in the Volusia Blue Springshed (**Figure 3**). Higher vulnerability areas exist where the upper Floridan aquifer is unconfined or semiconfined, and/or where there is a strong vertical gradient and the potential for water to move vertically between the surficial aquifer and the underlying Floridan aquifer. The FAVA modeling tool was developed by the Florida Geological Survey to provide spatial coverage of aquifer vulnerability ranges across an area.[2] The model shows the entire springshed to be in the "more vulnerable" category.

[2] Arthur, J. D., H.A.R. Wood, A.E. Baker, J.R. Cichon, and G.L. Raines. 2007. Development and implementation of a Bayesian-based aquifer vulnerability assessment in Florida. *Natural Resources Research,* Vol. 16, No. 2., pp. 93–107. For additional information, see the DEP FAVA website.

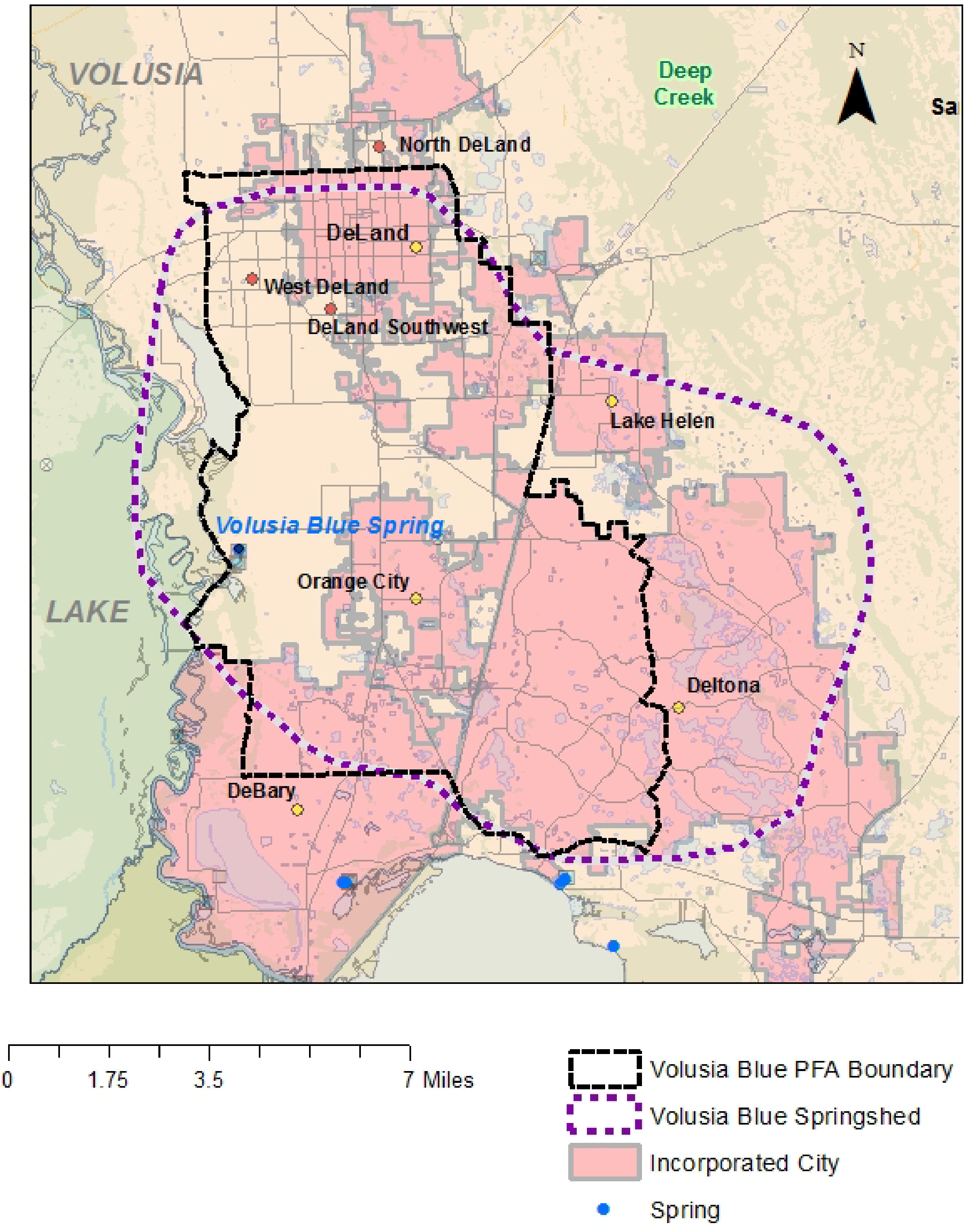

Figure 1. Volusia Blue Spring Springshed and PFA boundary

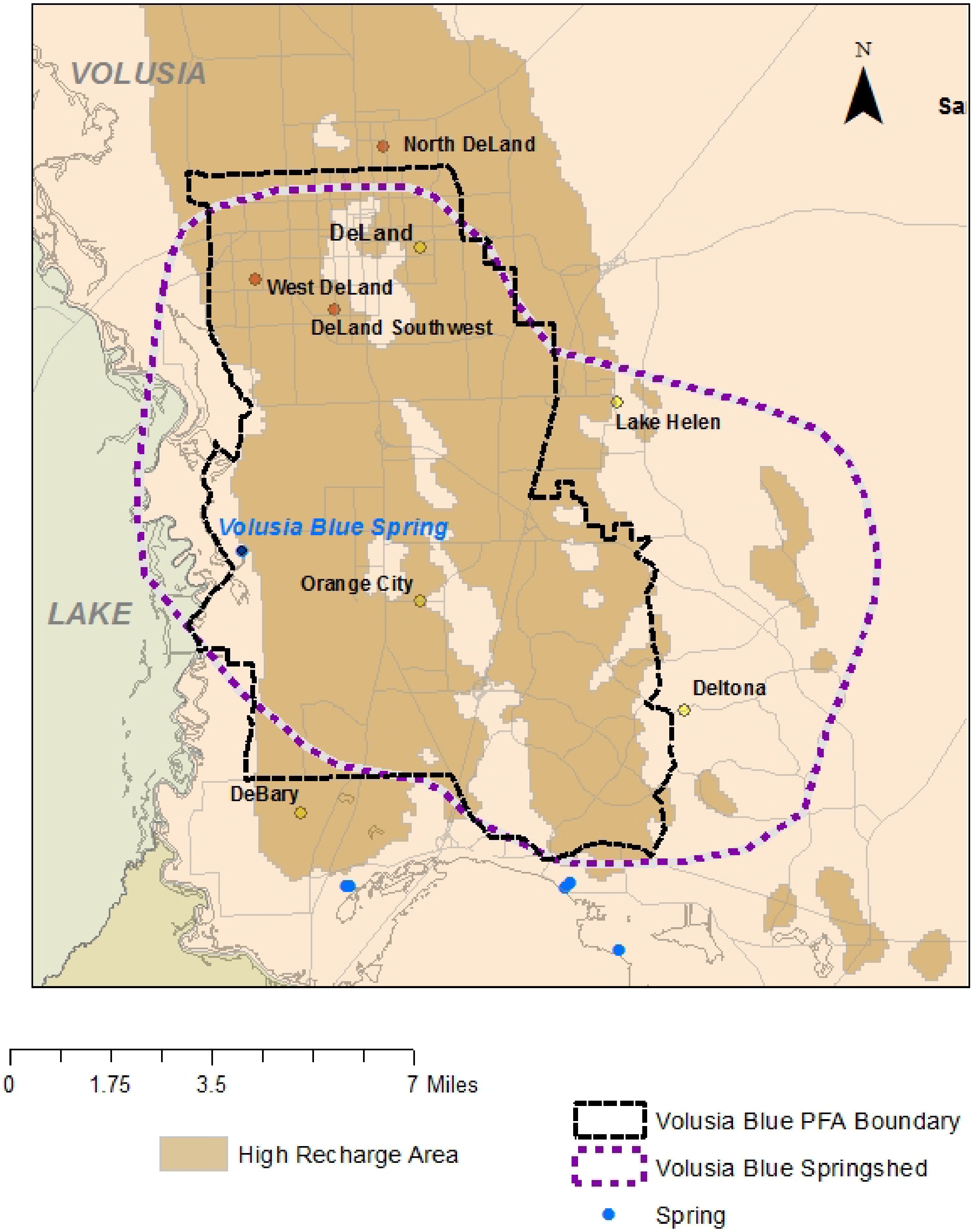

Figure 2. Areas of high recharge to the Floridan aquifer (≥10 inches/year) and PFA boundary

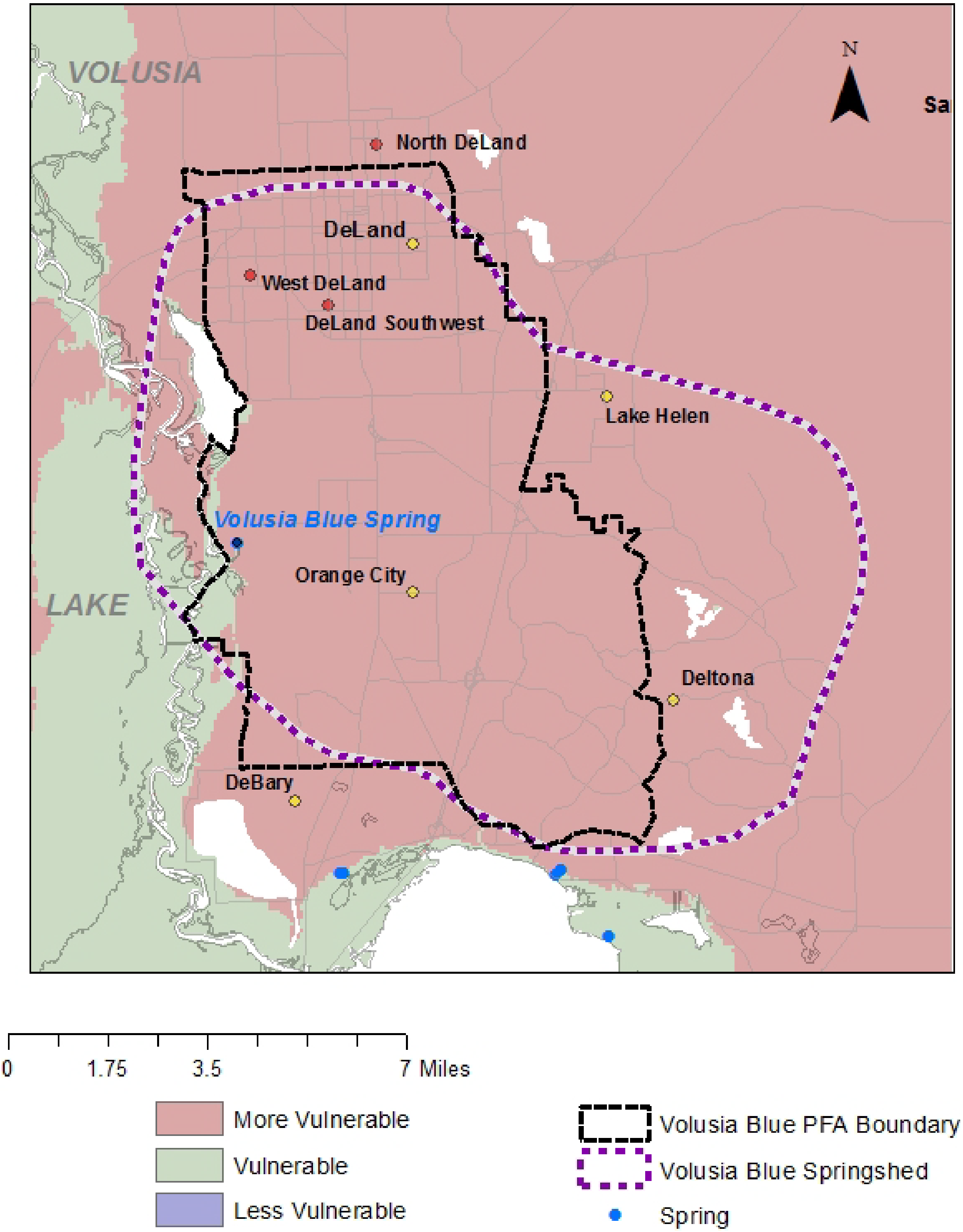

Figure 3. Statewide aquifer vulnerability assessment and PFA boundary

Step 4. Consider nitrogen load. DEP listed Volusia Blue Spring and Blue Spring Run as impaired for nitrate. In 2014, total maximum daily loads (TMDL) were adopted for the spring and the river. The TMDL report is available online.

The report documents monthly average nitrate concentrations in Volusia Blue Spring ranging from 0.40 to 0.64 milligrams per liter (mg/L) during the period of record used for the evaluation (January 2001–May 2013). The nitrogen load from Volusia Blue Spring depends on concentration and flow. In the draft nitrogen source inventory for the spring, the load from the spring vent was slightly greater than 86,000 pounds of nitrogen per year (lb-N/yr).

The nitrogen inventory developed by DEP for the Volusia Blue Springshed shows that during recent years, the load to groundwater was more than 300,000 lb-N/yr.[3] The higher nitrogen loading to the aquifer compared with the current load from the spring may indicate that nitrate concentrations in the spring vent will continue to increase over time as groundwater from the springshed migrates toward the point of discharge. The inventory estimated that 81 % of the nitrogen load to groundwater occurred in the high-recharge area shown in **Figure 2**. The most significant nitrogen source categories identified in the evaluation were onsite sewage treatment and disposal systems (OSTDS), or septic tanks (54 %); urban turfgrass fertilizer (22 %); and wastewater treatment facility (WWTF) application sites (8 %). The areas where OSTDS are present in high numbers and density and where urban turfgrass fertilizer would be applied were considered in delineating the PFA.

In a recent modeling effort, the SJRWMD used the STUMOD-FL model developed as part of the Florida Department of Health (FDOH) Florida Onsite Nitrogen Reduction Strategies study to estimate nitrogen loading to the vadose zone from OSTDS in the Volusia Blue Spring contributing area[4] [5]. Coupling this result with recharge data, the SJRWMD was able to simulate OSTDS-related loading to the Floridan aquifer and identify "hot spots" in the springshed where loading may be greatest. Higher loads occur where the combination of high OSTDS density, soils favorable for nitrogen leaching, and high-recharge conditions exist. The modeled results indicate the percentage of original nitrogen load that remains after attenuation. **Figure 4** shows the areas of higher potential loading based on the modeled results and recharge factors.

[3] Escribano, Y., K.T. Eller, and B.G. Katz. October 2016. *Draft nitrogen source inventory and loading estimates for the Volusia Blue Spring and Blue Spring Run contributing area*. Tallahassee, FL: DEP Groundwater Management Section.

[4] Canion, A. September 13, 2016. *Spatial OSTDS load estimates for Volusia Blue Spring using STUMOD-FL*. SJRWMD Interoffice memorandum to Casey Fitzgerald.

[5] Hazen and Sawyer. June 2014. *Task D.10. Validate/refine complex soil model.* Prepared for FDOH Onsite Sewage Programs. FDOH Contract CORCL.

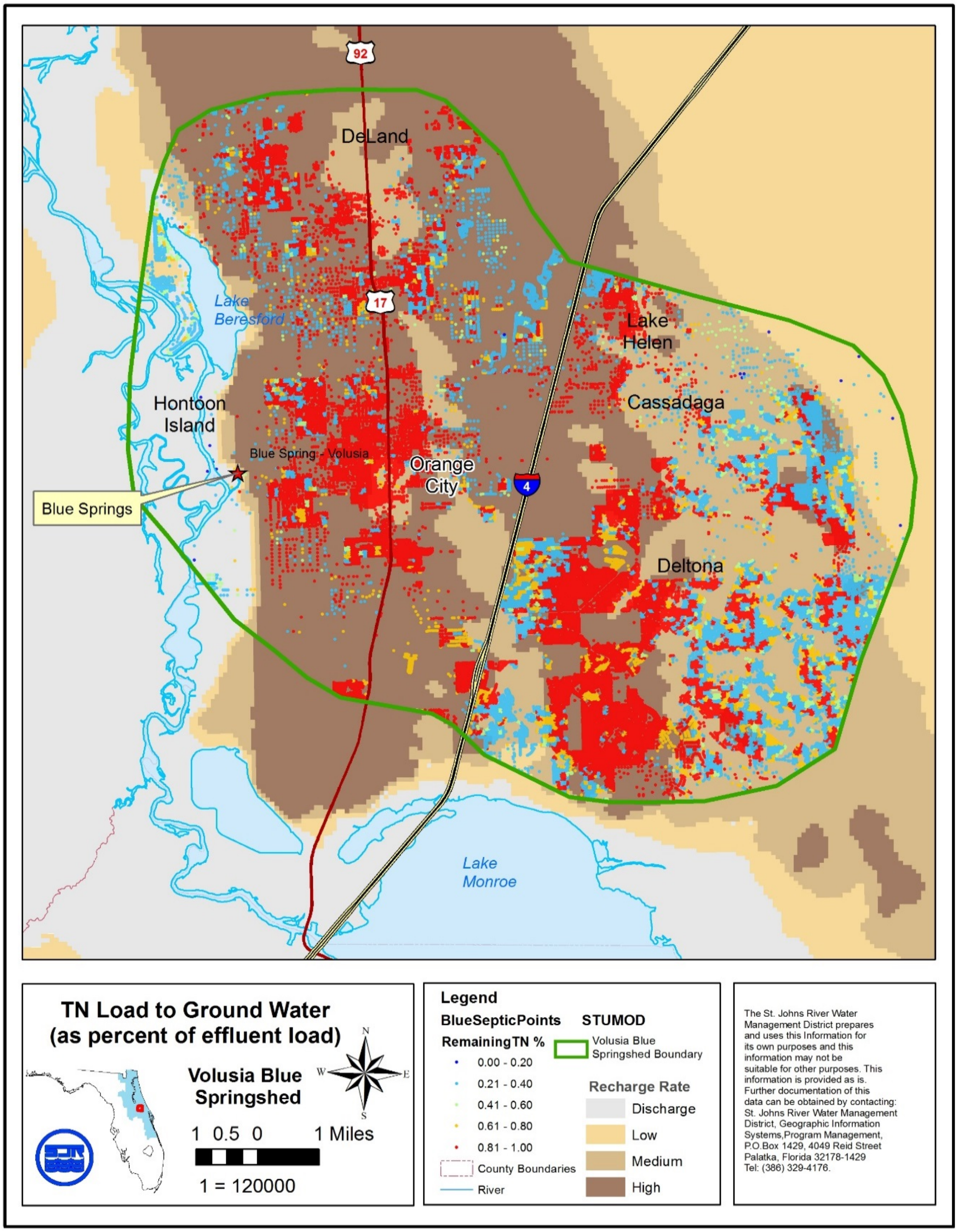

Figure 4. SJRWMD total nitrogen load to groundwater from OSTDS, expressed as percent of original effluent load (incorporates STUMOD-FL model runs and recharge weighting of load)

Step 5. Consider groundwater travel time in creating PFA boundaries. To the extent possible, PFAs should include parts of contributing areas that have demonstrated or anticipated short travel times to the springs. Springs occur in areas of karst terrain where surface and subsurface erosion of the limestone can result in the development of complex networks of solution channels and conduits in the aquifer material. In these areas, groundwater can move rapidly from points where the water enters the aquifer to the spring vents.

In some OFS areas, researchers have conducted dye trace studies to measure travel times, and information from these studies can be incorporated into PFA development. In some other areas, models have been used to estimate travel times and define protection zones, and can also be used to help define PFAs. In the absence of modeled or demonstrated travel times, the best professional judgment of groundwater professionals experienced in the spring area may be considered.

Volusia Blue Spring is located on the western edge of the DeLand Ridge, a large area of karst development that occurs in western Volusia County. This is also an area of particularly high recharge to the Floridan aquifer. It is assumed that groundwater travel times are quite rapid in some areas of the springshed, but specific areas where groundwater may be rapidly transported are not known and none have been mapped for this purpose.

To date, no dye trace work has been conducted to evaluate groundwater flow pathways or rates from areas in the springshed to Volusia Blue Spring. USGS researchers have used models to evaluate recharge areas and flow paths to the spring using particle-tracking techniques.[6] These models are complex but do not incorporate flow through karst features and therefore tend to underestimate groundwater flow, transport, and flushing rates. The models were used to predict particle travel time from points in an area approximating the springshed as a percentage of total spring discharge. The results showed that within 100 years, water from the areas of introduced particles constituted 50 % to 80 % of the spring discharge. Dye traces in other spring areas have demonstrated that groundwater velocity can be much faster than model simulations because of the conduits and enlarged pore spaces that permit rapid flow.

In the absence of travel time data, it is still understood that proximity to the springs should be a consideration in creating the PFA boundary. **Figure 5** shows a five-mile radius surrounding Volusia Blue Spring. Groundwater transport from specific locations in high-recharge areas within this radius would likely be quite rapid.

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

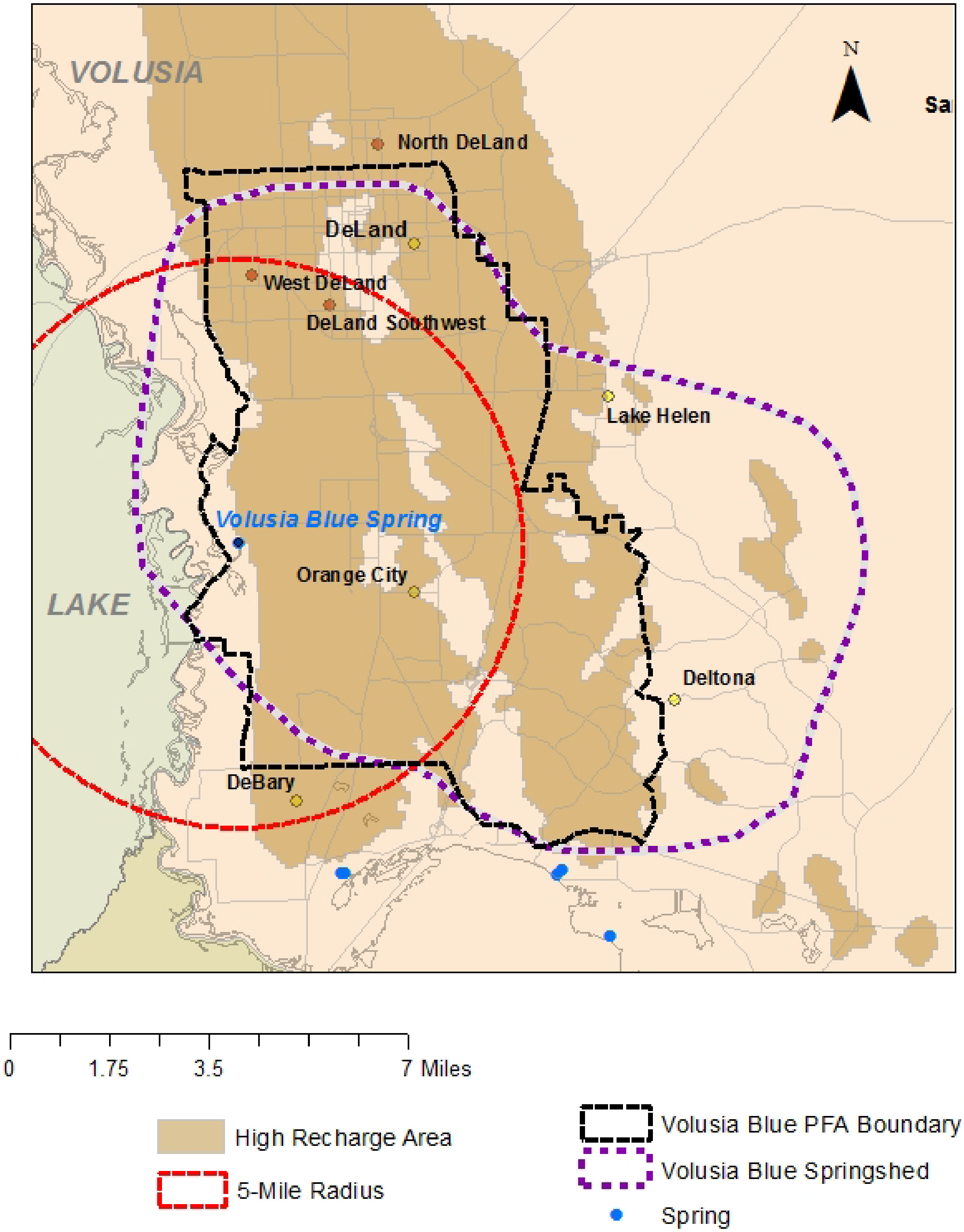

Figure 5. Volusia Blue Spring, surrounding 5-mile radius, and PFA boundary

Step 6. Identify regions in the contributing area where soil conditions are most favorable for nitrogen to leach from surface sources. Nitrogen is identified as the target nutrient for spring restoration. Research has shown that the removal of nitrogen in the soil zone through denitrification and its tendency to leach are related to soil drainage class.[7] [8] Denitrification is lowest and nitrogen leaching is highest in areas with soils that are excessively drained, somewhat excessively drained, or well drained. Leaching may occur in areas with moderately well-drained soils and is least likely to occur in soils that are poorly drained, somewhat poorly drained, or very poorly drained because of their greater potential for denitrification.

The portions of the contributing area where soil conditions are more favorable for nitrogen leaching were mapped using the U.S. Department of Agriculture Natural Resources Conservation Service Soil Survey Geographic (SSURGO) Database for Florida.[9] These excessively to well-drained soils tend to occur in areas where aquifer recharge is highest and vulnerability is greatest.

Figure 6 shows the area where soil conditions are most favorable for nitrogen leaching. This includes soils in the excessively drained, somewhat excessively drained, and well-drained SSURGO drainage classes. The mapped areas of higher soil drainage are similar to the higher groundwater recharge areas.

[7] Otis, R.J., 2007. *Estimates of nitrogen loadings to groundwater from onsite wastewater treatment systems in the Wekiva Study Area, Task 2 Report Wekiva Onsite Nitrogen Contribution Study.* Prepared by Otis Environmental Consultants for FDOH.

[8] Hofstra, N., and A.F. Bouwman. 2005. Denitrification in agricultural soils: Summarizing published data and estimating global annual rates. *Nutrient Cycling in Agroecosystems* 72: 267–278.

[9] The SSURGO Database is a digital soil survey developed by the National Cooperative Soil Survey. The dataset includes georeferenced digital map data and computerized attribute data. Metadata can be found online.

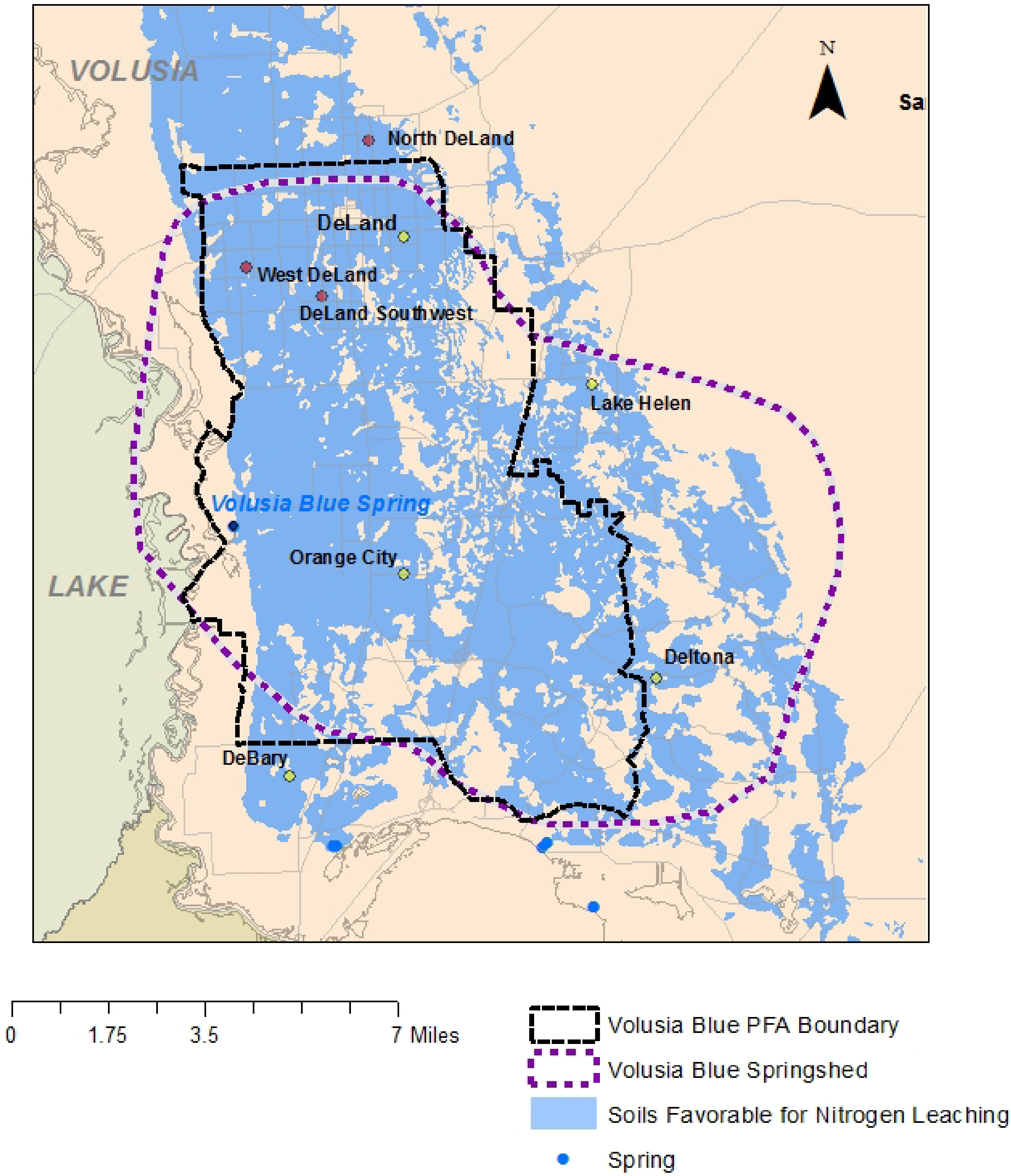

Figure 6. Areas of soils with high nitrogen leaching potential and PFA boundary

Step 7. Identify regions in the contributing area to exclude or include based on land use and the potential for pollutant sources to occur. Conservation lands, wetlands, and undeveloped open land protected from development may be excluded from the PFA if there is no expectation that they would include pollutant sources affecting springs in the foreseeable future and are under protection. A large land area in the western part of the Volusia Blue Springshed along the St. Johns River is designated as conservation land. The springshed also contains other, smaller conservation land areas. **Figure 7** shows the location of conservation lands from the Florida Natural Areas Inventory (FNAI) Conservation Lands (Managed Areas) GIS layer. The PFA boundary aligns with some conservation area boundaries.

Most of the Volusia Blue Spring contributing area is in urban land uses, with only small areas of agriculture. The PFA delineation also includes the consideration of areas with significant potential for nitrogen leaching to groundwater based on the presence of land uses or activities documented in the nitrogen inventory as potentially significant pollutant sources. The draft nitrogen inventory for the Volusia Blue Spring BMAP area suggests that these potential sources include areas with intensive urban development and high septic system densities. **Figure 8** shows mapped urban lands in the area (based on the 2009 SJRWMD land use–land cover GIS coverage).

Figure 9 shows septic tank locations from a recent FDOH inventory. These are based on GIS coverage of parcels associated with septic tanks in the FDOH Florida Water Management Inventory Project.

Figure 8 also shows the locations of existing domestic wastewater facilities and facilities with design flows greater than 0.1 million gallons per day (mgd) because they also have the potential to contribute nitrogen to groundwater. Domestic wastewater facility information for the 2 springsheds was obtained from the DEP Wastewater Facility Regulation (WAFR) Database.

Step 8. Create PFA boundaries that correspond with understood and identifiable boundaries. For stakeholders to implement restoration and protection actions in a PFA, the boundaries must be clearly defined and associated with features easily recognizable on a map. For that reason, the actual PFA boundaries used for planning and restoration should conform to easily recognizable natural features, conservation areas, roads, and political boundaries. The development of the PFA for Volusia Blue Spring included a number of such areas that will provide readily identifiable boundaries.

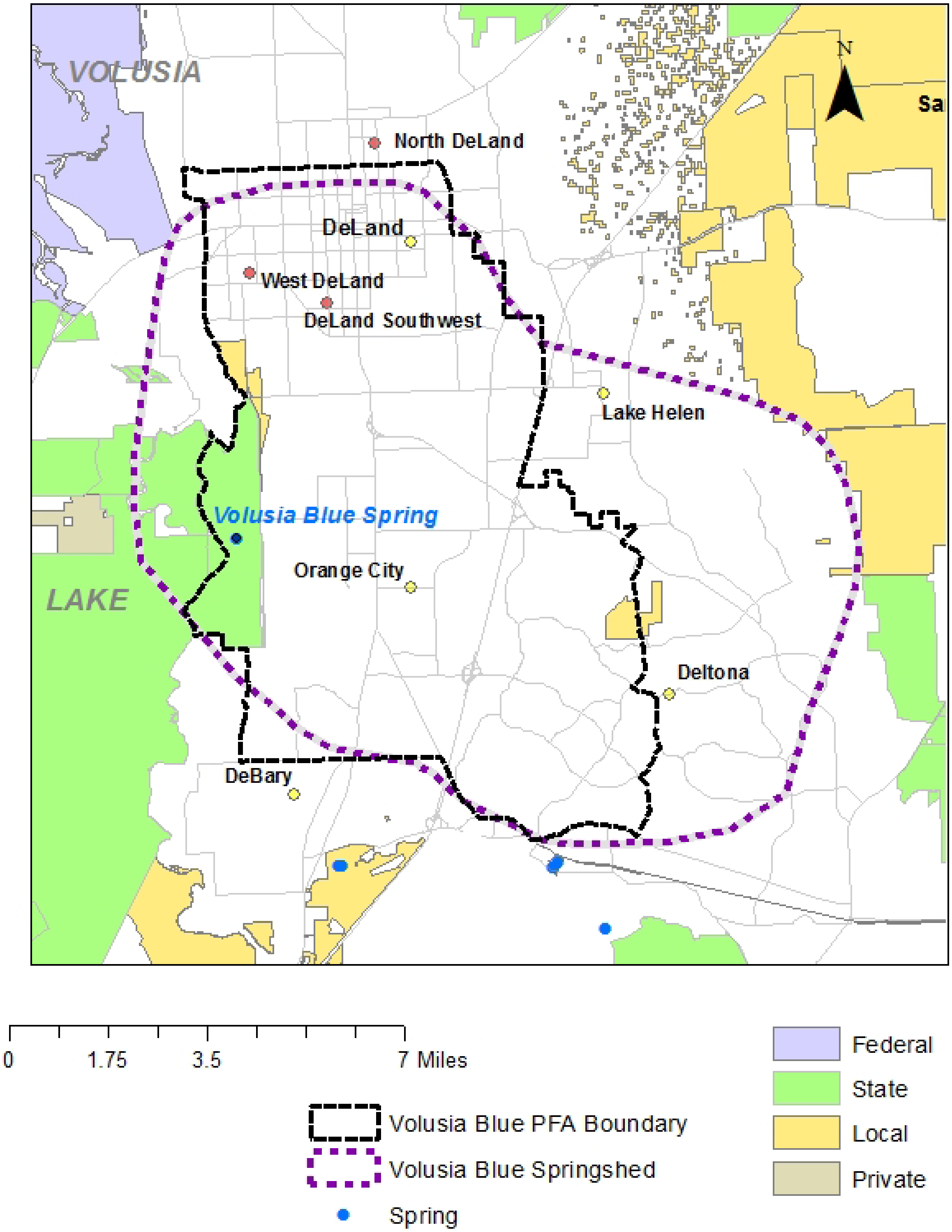

Figure 7. Conservation lands and PFA boundary

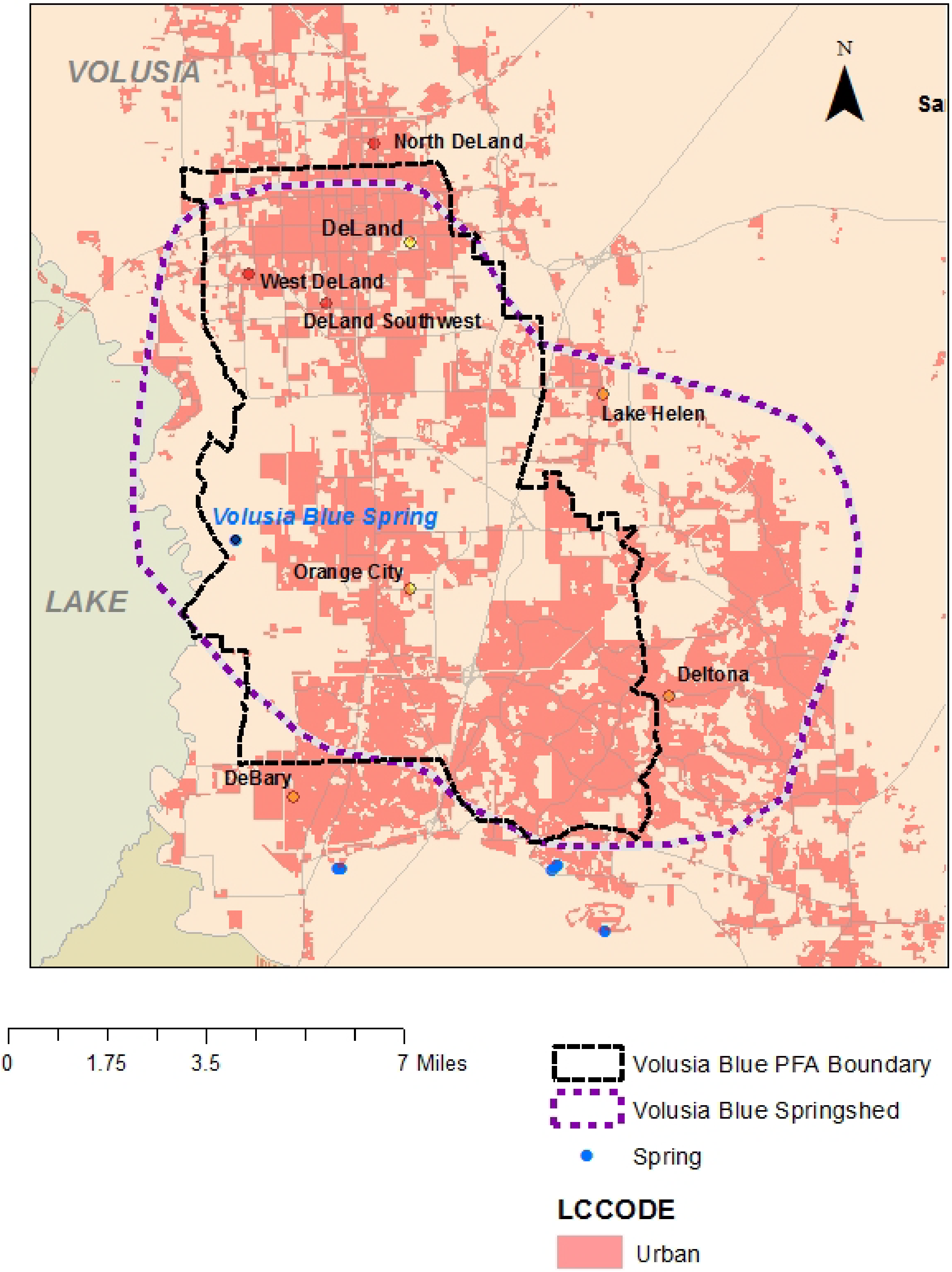

Figure 8. Urban land use areas and PFA boundary

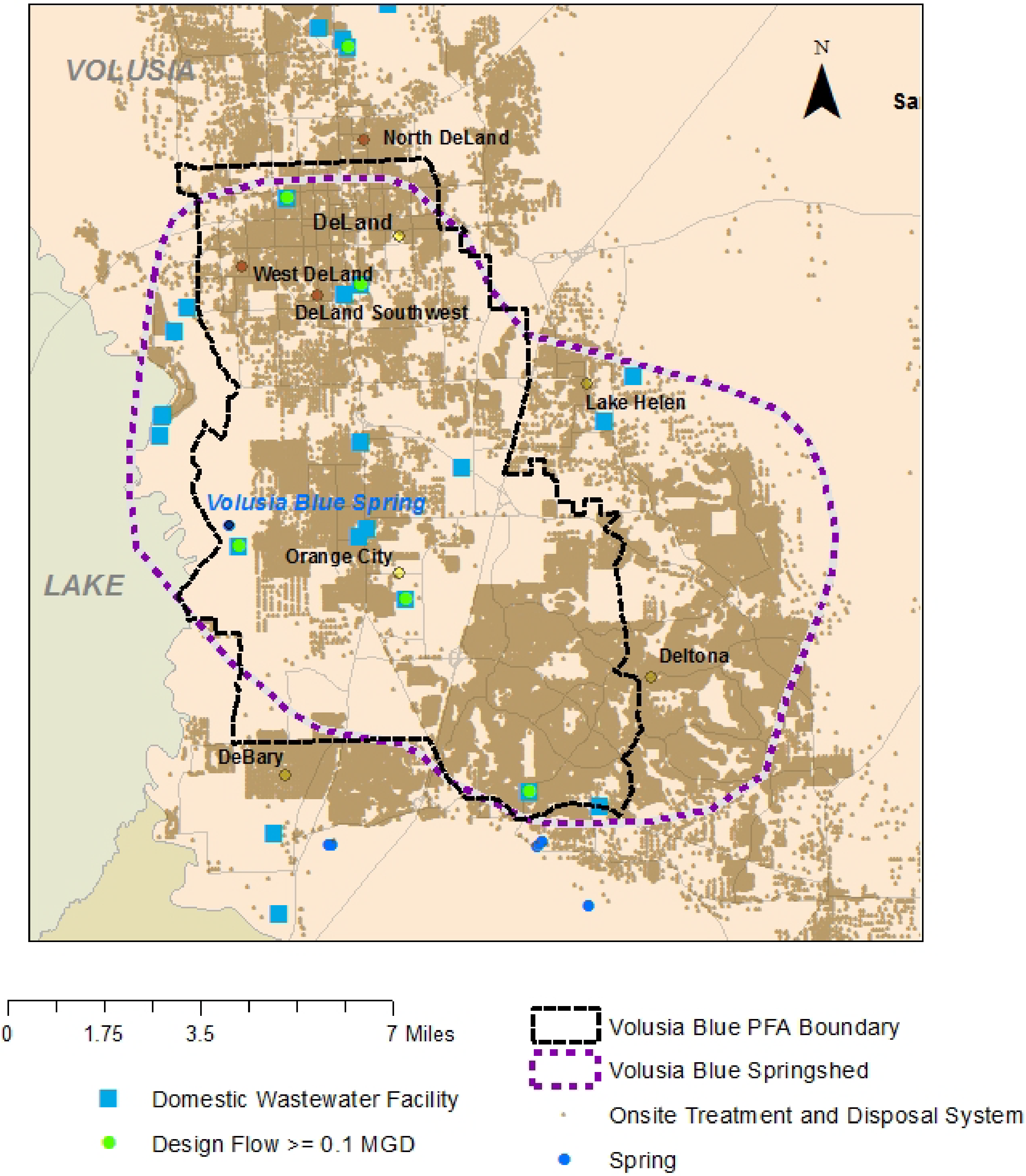

Figure 9. OSTDS (in areas of high density appearing as a solid pattern), domestic WWTFs, and PFA boundary

PFA Boundary for Volusia Blue Spring

The PFA boundary shown in **Figure 10** was developed by overlaying GIS coverages of recharge, vulnerability, soils, conservation lands, and information on potential nitrogen contaminant sources. The PFA includes a region in the western part of the Volusia Blue Springshed. This area includes high groundwater recharge/vulnerability conditions and soil conditions that tend to leach nitrogen. It includes modeled areas of high nitrogen loading from OSTDS. It also includes areas close to the spring where groundwater travel time to the spring may be short. In addition, the PFA includes interconnected areas of urban development, high OSTDS densities, and several larger WWTFs, all of which have the potential to contribute to nitrogen enrichment in the aquifer and springs. OSTDS and urban turf fertilizer were identified in the draft nitrogen source inventory as the most significant sources of nitrogen loading to groundwater.

Conservation land boundaries, natural features, political boundaries, and roads in the area were also considered in the development of a readily identifiable boundary. The proposed PFA is located in Volusia County. It includes Orange City; parts of the Cities of Deland, Debary, and Deltona; and a portion of Blue Spring State Park containing Volusia Blue Spring and Blue Spring Run.

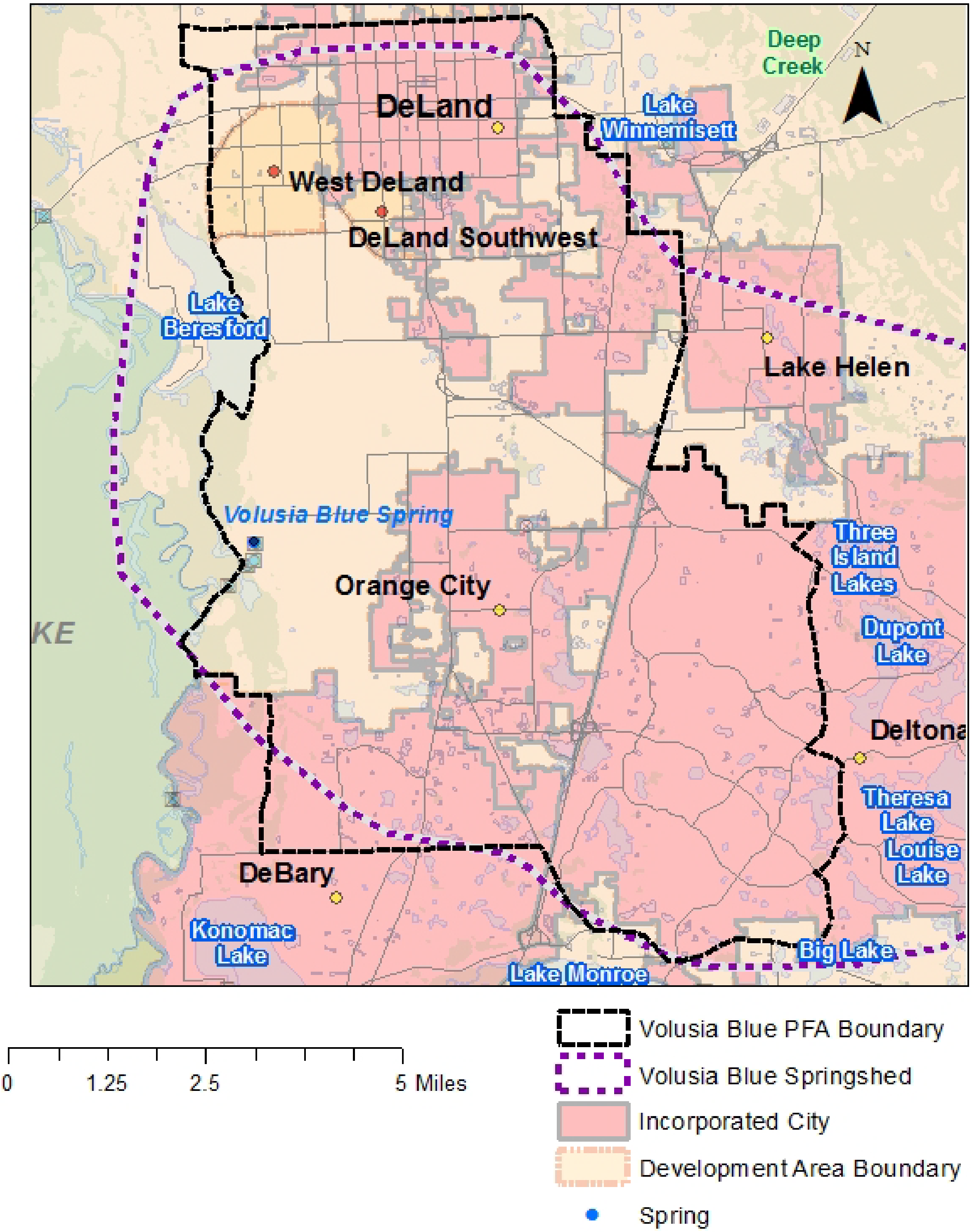

Figure 10. PFA boundary for Volusia Blue Spring

Appendix A: Important Links

Cover Page:
DEP website – www.dep.state.fl.us

More Information:
Email address for Moira Homann – moira.homann@dep.state.fl.us
Email address for Rick Hicks – richard.w.hicks@dep.state.fl.us

Step 4:
Volusia Blue Spring and Blue Spring Run TMDL report –
http://www.dep.state.fl.us/water/tmdl/docs/tmdls/final/gp2/VolusiaBlueSpgTMDL.pdf

Step 7:
FDOH Florida Water Management Inventory Project website –
http://www.floridahealth.gov/environmental-health/onsite-sewage/research/flwmi/index.html

Footnotes:
DEP FAVA website – http://www.dep.state.fl.us/geology/programs/hydrogeology/fava.htm

SSURGO Database metadata website – https://catalog.data.gov/dataset/soil-survey-geographic-ssurgo-database-for-various-soil-survey-areas-in-the-united-states-