Priority Focus Area for Weeki Wachee Spring

Division of Environmental Assessment and Restoration

Florida Department of Environmental Protection

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More Information

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Introduction

Under the Florida Springs and Aquifer Protection Act, the Florida Department of Environmental Protection (department) is required to delineate priority focus areas (PFA) for all Outstanding Florida Springs that are identified as impaired. According to the Florida Springs and Aquifer Protection Act, adopted by the Florida Legislature in 2016 (Chapter 373, Part VIII, 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 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:

- 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 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, which include 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, which include roads, natural boundaries, and political jurisdictions.

Delineation of the PFA for Weeki Wachee Spring, which has been documented as impaired by nitrate nitrogen, is described in the following section.

Steps in Delineating Weeki Wachee Spring PFA

The PFA for Weeki Wachee Spring 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 the water quality restoration and protection perspectives. The following steps were taken to develop a draft PFA for review and input by stakeholders. The overlap of mapped characteristics that express high vulnerability, high potential for pollutant mobility, and likely pollutant sources provide 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 estimated springshed was developed by the Southwest Florida Water Management District (SWFWMD) based on U. S. Geological Survey (USGS) potentiometric surface contour maps. The springshed and the PFA are is shown in **Figure 1**.

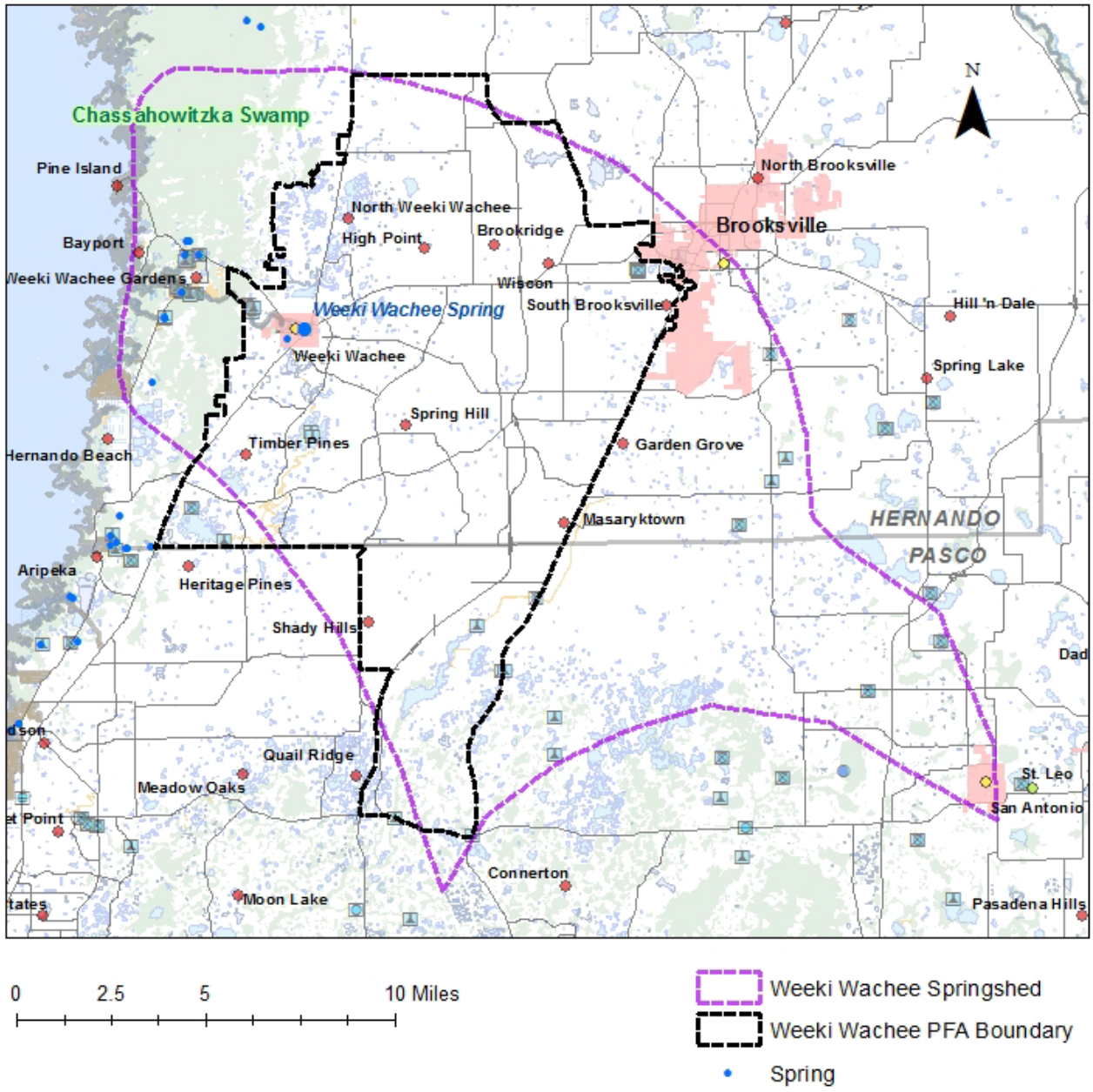

Figure 1. Weeki Wachee Spring springshed and priority focus area

Step 2. Identify regions within the contributing area where 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 the areas of highest recharge to the aquifer, which could occur as uniform 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 for causing adverse impacts to the 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 a GIS coverage developed by the USGS in 2002 and later refined by SWFWMD. **Figure 2** shows the area of greatest recharge (≥10 inches per year) according to the USGS methodology. To help further refine the recharge regime for priority setting, another recharge map, which was developed by the Florida Natural Areas Inventory (FNAI) for state land acquisition priority ranking, was also considered. This layer identifies areas of potential recharge important for natural systems and human use based on features that contribute to aquifer vulnerability as well as areas within springshed protection zones in proximity to public water supply wells.[1] The FNAI recharge coverage is shown in **Figure 3**.

Step 3. Identify regions within the springshed where the Floridan Aquifer is most vulnerable. There is not a county-scale aquifer vulnerability assessment for either Hernando or Pasco County, so the statewide Florida Aquifer Vulnerability Assessment (FAVA) model for the Floridan Aquifer, was used to map aquifer vulnerability in the springshed of Weeki Wachee Spring (**Figure 4**). Higher vulnerability areas exist where the upper Floridan Aquifer is unconfined or semiconfined, and/or where there is a strong vertical gradient and potential for water to move vertically between the surficial aquifer and the underlying Floridan Aquifer. This modeling tool was developed by the Florida Geological Survey to provide a spatial coverage of aquifer vulnerability ranges across an area.[2] Often, areas of greatest aquifer vulnerability occur where aquifer recharge is also greatest. According to the statewide FAVA model, which is quite generalized, almost the entire springshed falls within the "more vulnerable" category.

[1] Florida Natural Areas Inventory, December 2000. Florida Forever Conservation Needs Assessment Summary Report to the Florida Forever Advisory Council.

[2] Arthur, J. D., Wood, H. A. R., Baker, A. E., Cichon, J. R., Raines, G. L., 2007, Development and Implementation of a Bayesian-based Aquifer Vulnerability Assessment in Florida: Natural Resources Research, Vol. 16, No. 2., P. 93-107. Also for more information go to http://www.dep.state.fl.us/geology/programs/hydrogeology/fava.htm.

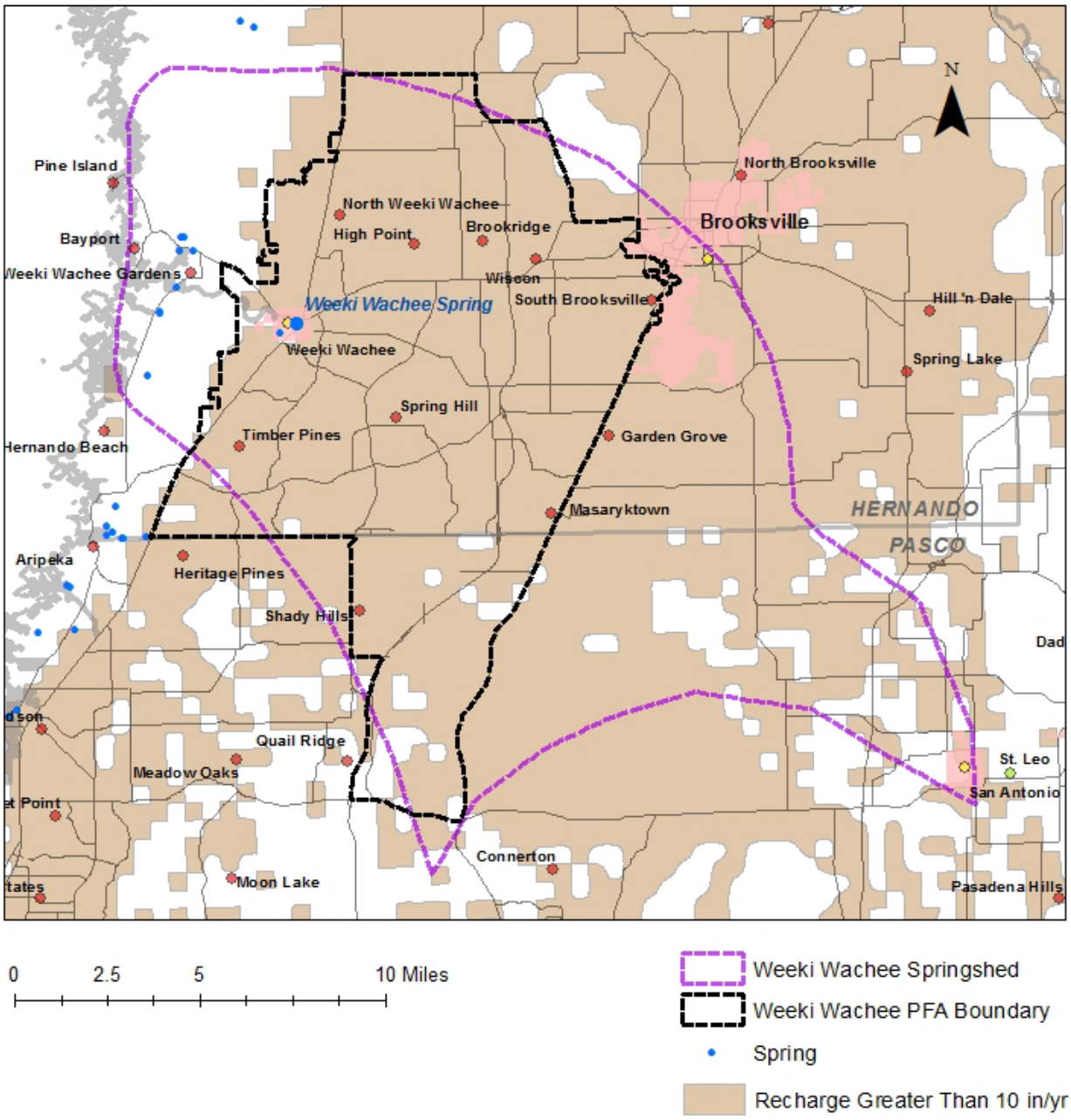

Figure 2. Areas of high recharge to Floridan aquifer (≥10 inches/year) and priority focus area

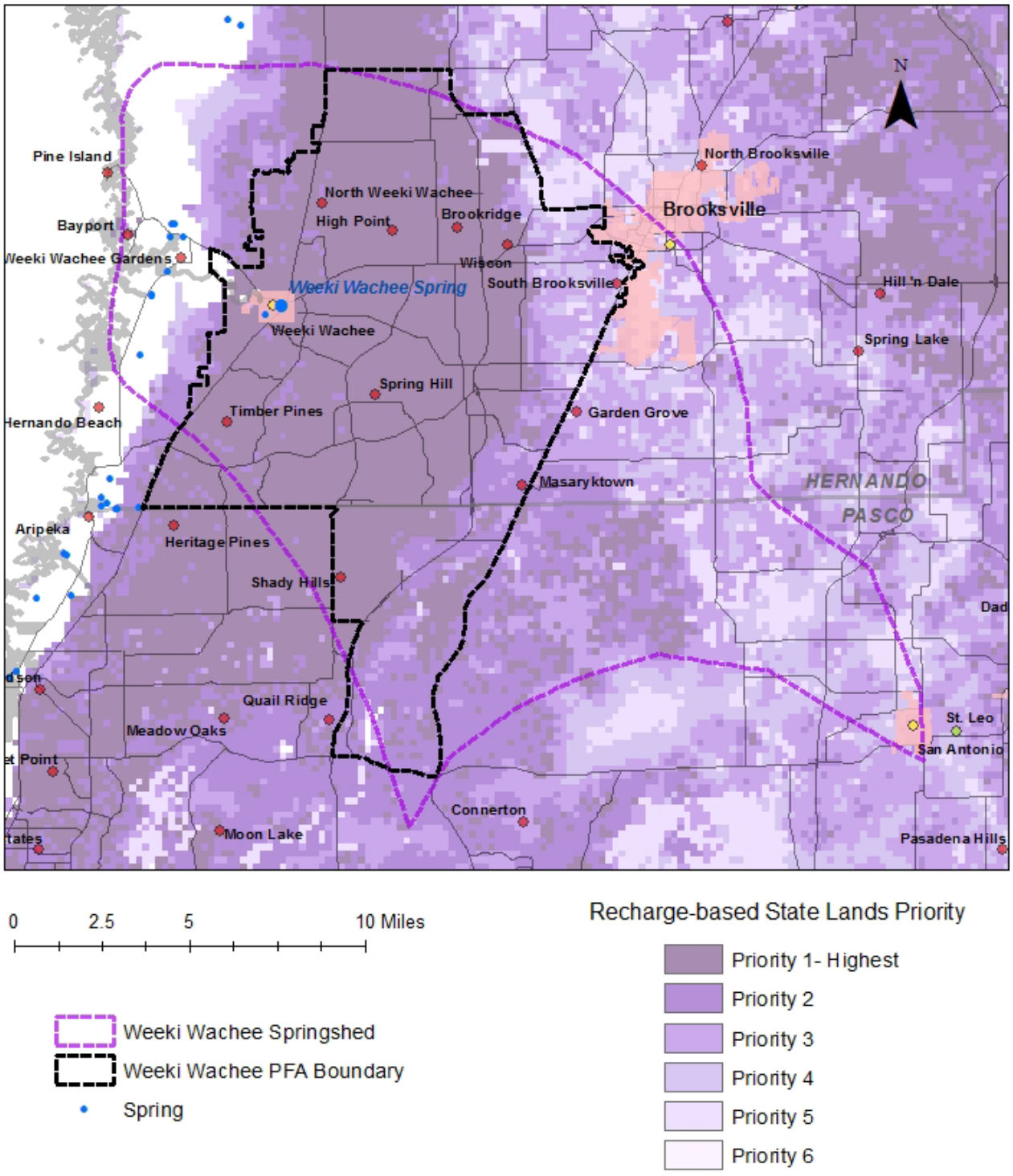

Figure 3 Florida state lands recharge-based prioritization coverage and priority focus area

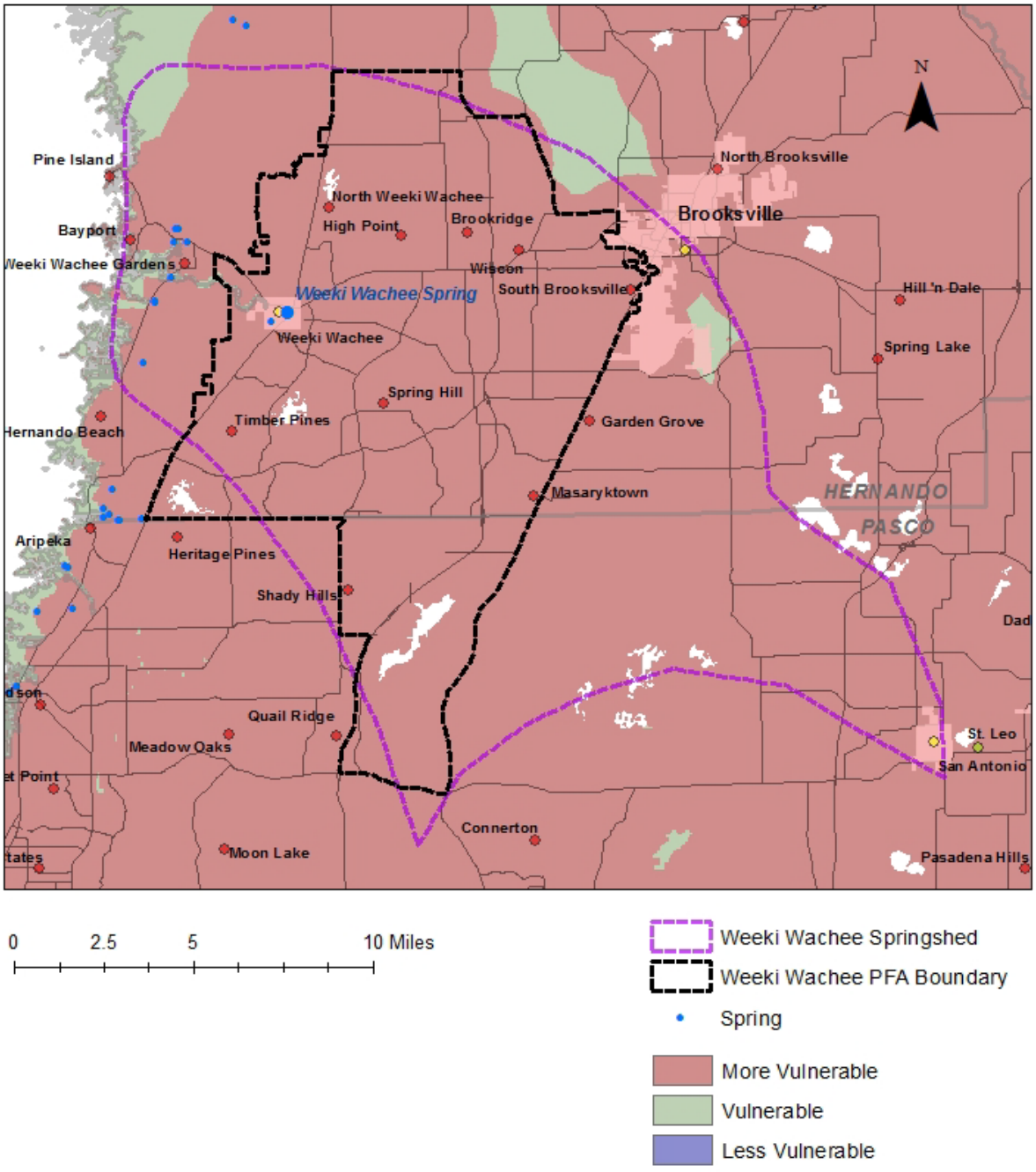

Figure 4. Statewide aquifer vulnerability assessment and priority focus area

Step 4. Consider nitrogen load. Weeki Wachee Spring and Weeki Wachee River, which have been monitored on a routine basis for many years, were listed by the department as impaired by nitrate. In 2014, total maximum daily loads (TMDL) were adopted for the spring and the river. The TMDL report can be found at this link: http://www.dep.state.fl.us/water/tmdl/docs/tmdls/final/gp5/WeekiWachee-nutr-TMDL.pdf

The TMDL report documents annual average nitrate concentrations in Weeki Wachee Spring that range from 0.67 to 0.89 milligrams per liter during the period of record used for the evaluation, with an increasing trend noted. The load of nitrogen from Weeki Wachee Spring depends on concentration and flow. In the draft nitrogen source inventory for the Weeki Wachee BMAP area, estimated load from the spring vent was in excess of 300,000 pounds of nitrogen per year.

The nitrogen inventory developed by the department for the Weeki Wachee BMAP area, which is very similar to the springshed area, shows that during recent years, the estimated load of nitrogen to the groundwater is estimated at more than 900,000 pounds per year.[3] The greater estimated nitrogen load to the aquifer in comparison to 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 showed that more than 88 percent 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 treatment and disposal systems (septic tanks, 30 %), urban turf fertilizer (22 %), and farm fertilizer (17 %). These were followed by atmospheric deposition (10 %), livestock waste (10 %), sports turfgrass fertilizer (including golf courses, 6 %) and domestic wastewater treatment sites (5 %). The areas where septic tanks are present in high numbers and density and the urban and agricultural areas where fertilizer would be applied were considered in delineation of the PFA.

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 Outstanding Florida Spring areas, dye traces have been conducted by researchers to measure the travel times and information from these studies can be incorporated into the 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, best professional judgement of groundwater professionals experienced in the spring area may be considered.

[3] Eller, K. and Katz, B. October 2016. Nitrogen Source Inventory and Loading Estimates for the Weeki Wachee Spring Basin Management Action Plan Area. DEP Groundwater Management Section.

In the Weeki Wachee Spring area, SWFWMD conducted a dye trace to confirm connection between nearby wells and Weeki Wachee Spring.[4] This study traced groundwater flow during drought conditions from wells located 550 and 2,600 feet to the Weeki Wachee Spring vent. From the closest well, the dye trace showed an average groundwater travel time of 30 feet per day and from the well located 2,600 feet from the vent the estimated travel time was about 150 feet per day. The rates of groundwater movement from these wells may be much different during wet weather conditions.

No dye tracing work has yet been conducted to evaluate groundwater transport from more remote areas of the springshed. However, if the velocities measured from the two dye traces were extrapolated, velocities from some locations in the springshed might be from 5 to 10 miles per year. Much of the Weeki Wachee springshed is an area of karst, with limestone close to land surface and numerous karst erosional features. Along the flank of the Brooksville Ridge in the eastern part of the springshed, the limestone is mantled by layers of sand and clay, but recharge is still high. It can be assumed that groundwater travel times could be quite rapid within most of the springshed, but specific areas of potentially rapid transport of groundwater are not known and none have been mapped for this purpose. It is, however, understood that proximity to the springs has to be a consideration in creating the PFA boundary. **Figure 5** shows 5- and 10-mile radii surrounding Weeki Wachee Spring. It is possible that groundwater transport from specific locations in high recharge areas within either radius could be quite rapid.

[4] Dewitt, D. J. December 2010. Results of a Groundwater Dye Trace Study at Weeki Wachee Spring, Hernando County, Florida. Southwest Florida Water Management District Water Quality Monitoring Program.

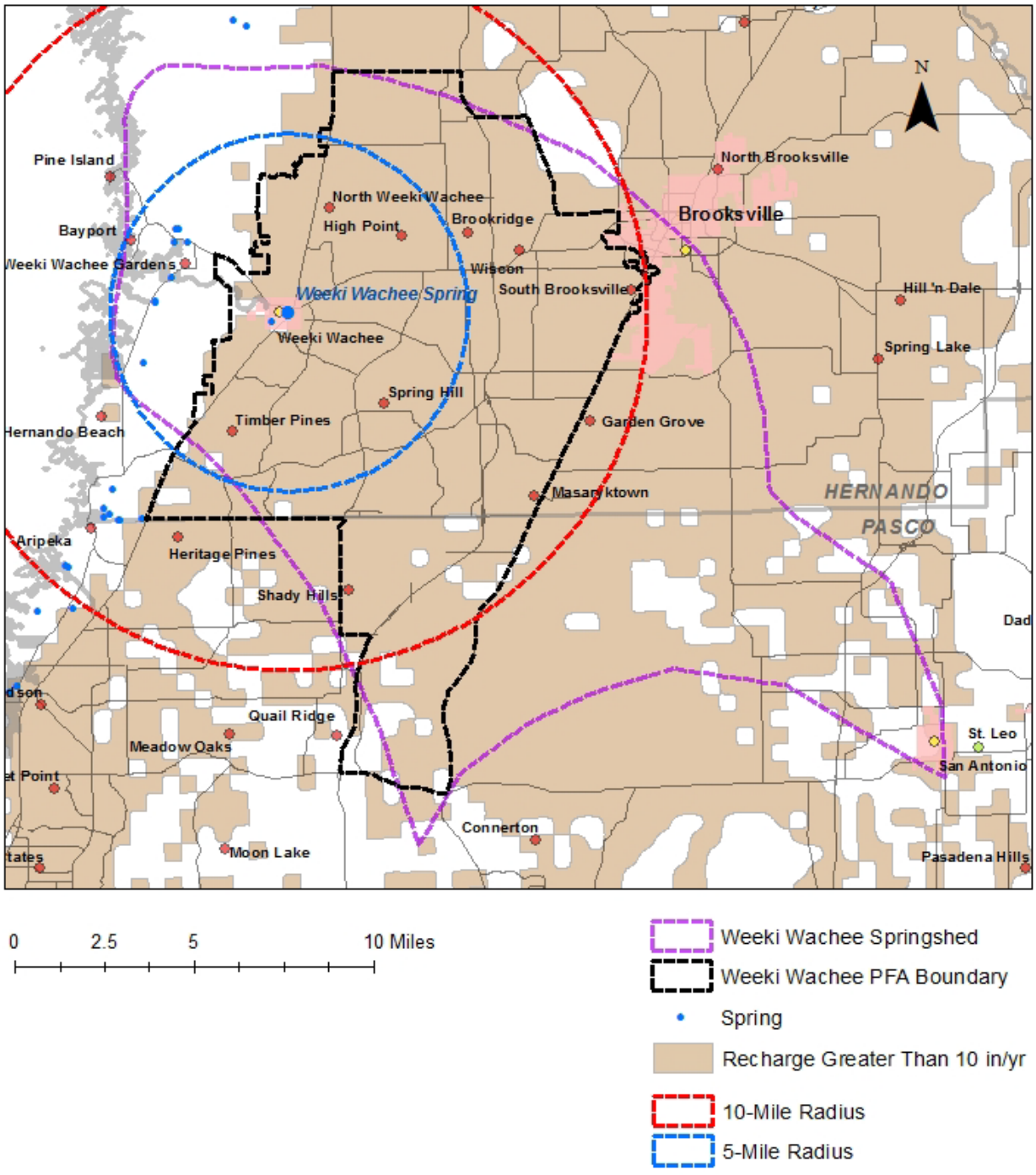

Figure 5. Weeki Wachee Spring, surrounding 5-mile and 10-mile radii, and priority focus area

Step 6. Identify regions within the contributing area where soil conditions are most favorable for leaching of nitrogen from surface sources. Nitrogen has been identified as the target nutrient for spring restoration. Research has shown that removal of nitrogen in the soil zone through denitrification and its tendency to leach can be related to soil drainage class.[5] Denitrification is lowest and leaching of nitrogen 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 leaching of nitrogen 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 can be mapped using the U. S. Department of Agriculture Natural Resources Conservation Service soil survey geographic (SSURGO) database for Florida. 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. This area is very similar to the "high priority" area in the FNAI recharge coverage.

[5] 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 Florida Department of Health.
Hofstra, N. and Bowman, 2005. Denitrification in Agricultural Soils: Summarizing Published Data and Estimating Global Annual Rates. Nutrient Cyclieing in Agroecosystems (2005) 72: 267-278.

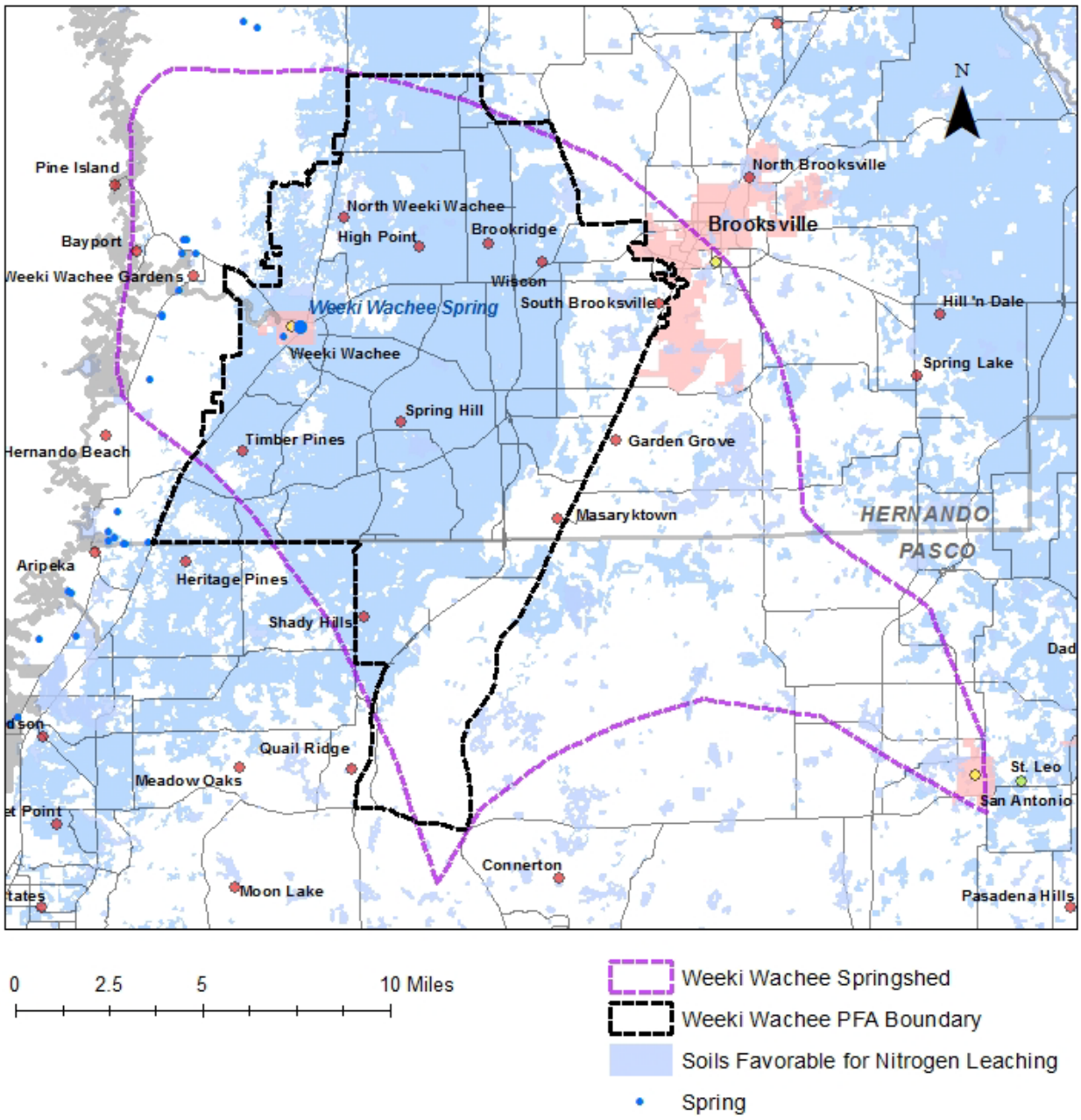

Figure 6. Areas of high nitrogen leaching potential soils and priority focus area

Step 7. Identify regions within the contributing area to exclude or include based on land use and potential for pollutant sources to occur. Conservation lands, wetlands, and undeveloped open land that are protected from development are land areas that 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. Large land areas within the Weeki Wachee Spring springshed along the coast are designated conservation lands. These areas are shown in **Figure 7** and the PFA boundary aligns with several conservation area boundaries.

Much of the area in the western half of the Weeki Wachee Spring contributing area is in urban land uses, with agricultural land uses occurring further to the east. Delineation of the PFA also includes consideration of areas with significant potential for nitrogen leaching to groundwater based on the presence of land uses or activities that have been documented in the nitrogen inventory as potentially significant pollutant sources. The draft nitrogen inventory for the Weeki Wachee BMAP area suggests that these potential source areas include areas of intensive urban development and high densities of septic systems and areas of farmland. Mapped urban and agricultural lands are shown in **Figure 8.** Septic tank locations from a recent Florida Department of Health inventory are shown in **Figure 9**. Existing domestic wastewater facilities with design flows greater than 0.1 million gallons per day (mgd) are also shown in **Figure 9** because they also have potential for contributing nitrogen to groundwater.

Step 8. Create PFA boundaries that correspond with understood and identifiable boundaries. For stakeholders to implement restoration and protection actions described in the ones within the PFAs, the boundaries have to be clearly defined and associated with features easily recognizable on a map. For that reason, the actual boundaries of PFAs that are used for planning and restoration will be made to conform to easily recognizable natural features, roads and political boundaries.

Development of the PFA for Weeki Wachee Spring included several conservation area boundaries, the Hernado-Pasco County line and major roads that will provide readily identifiable boundaries. The Weeki Wachee BMAP area boundary was also considered in refinement of the PFA.

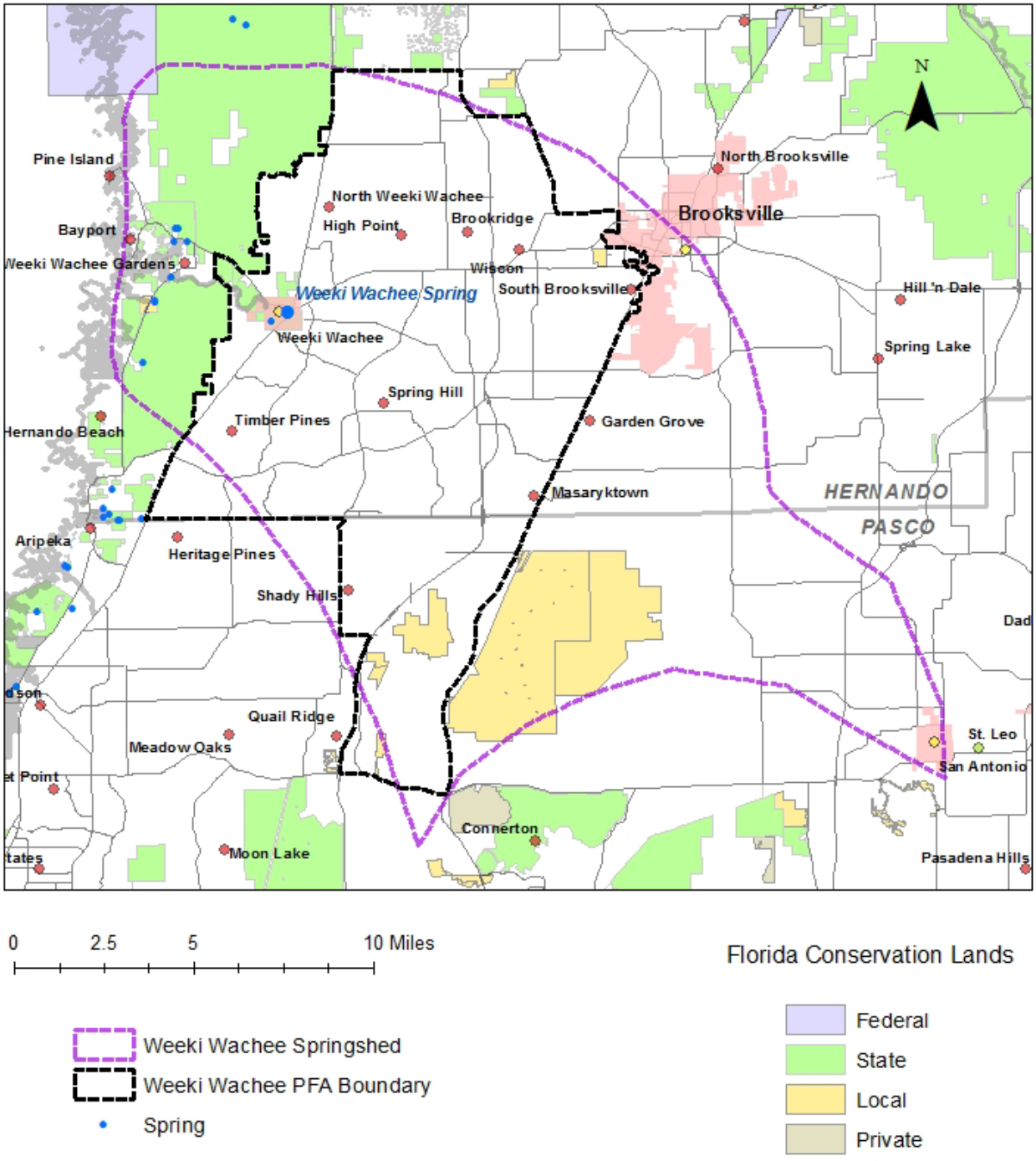

Figure 7. Conservation lands and priority focus area

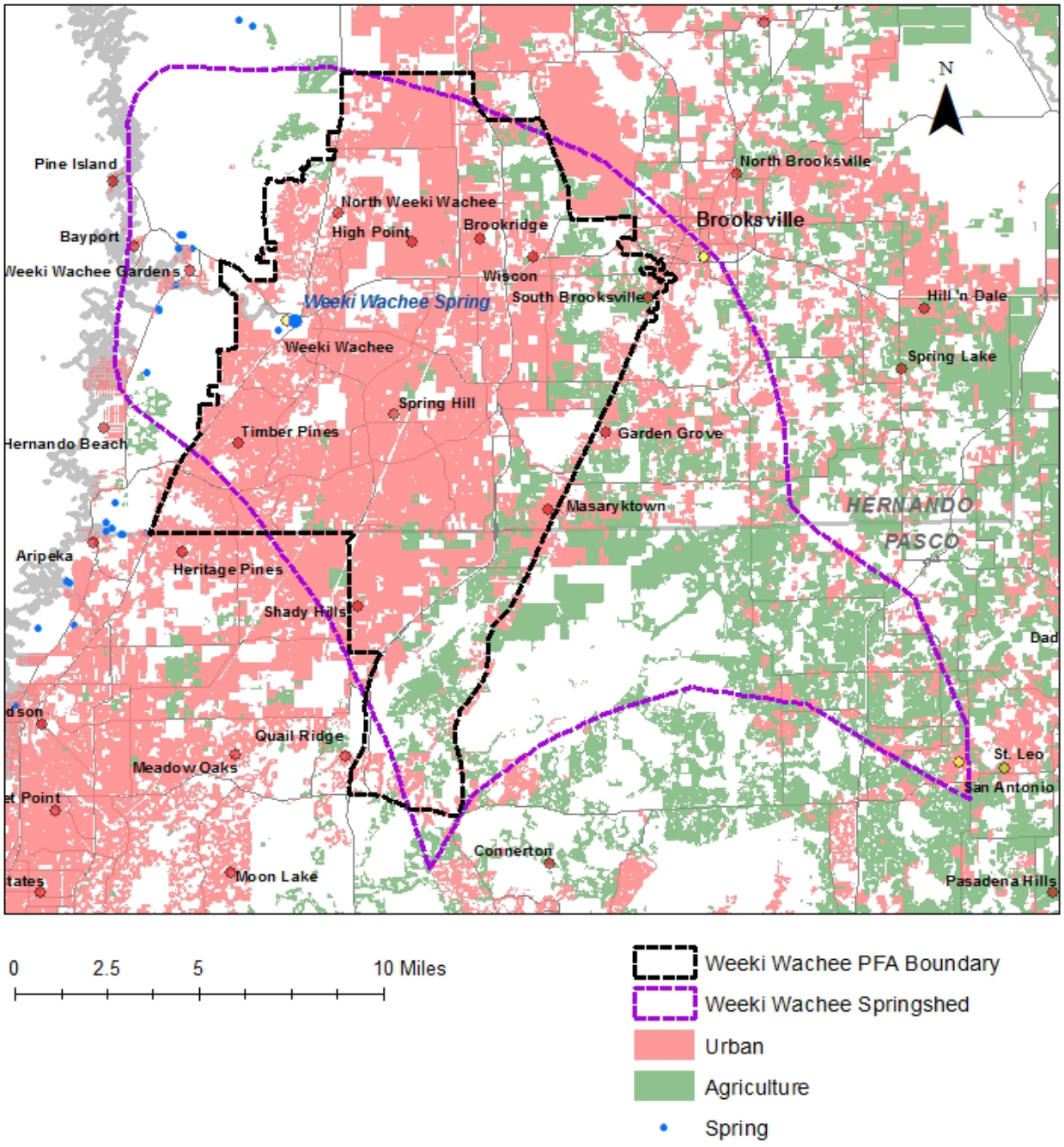

Figure 8. Urban and agricultural lands and priority focus area

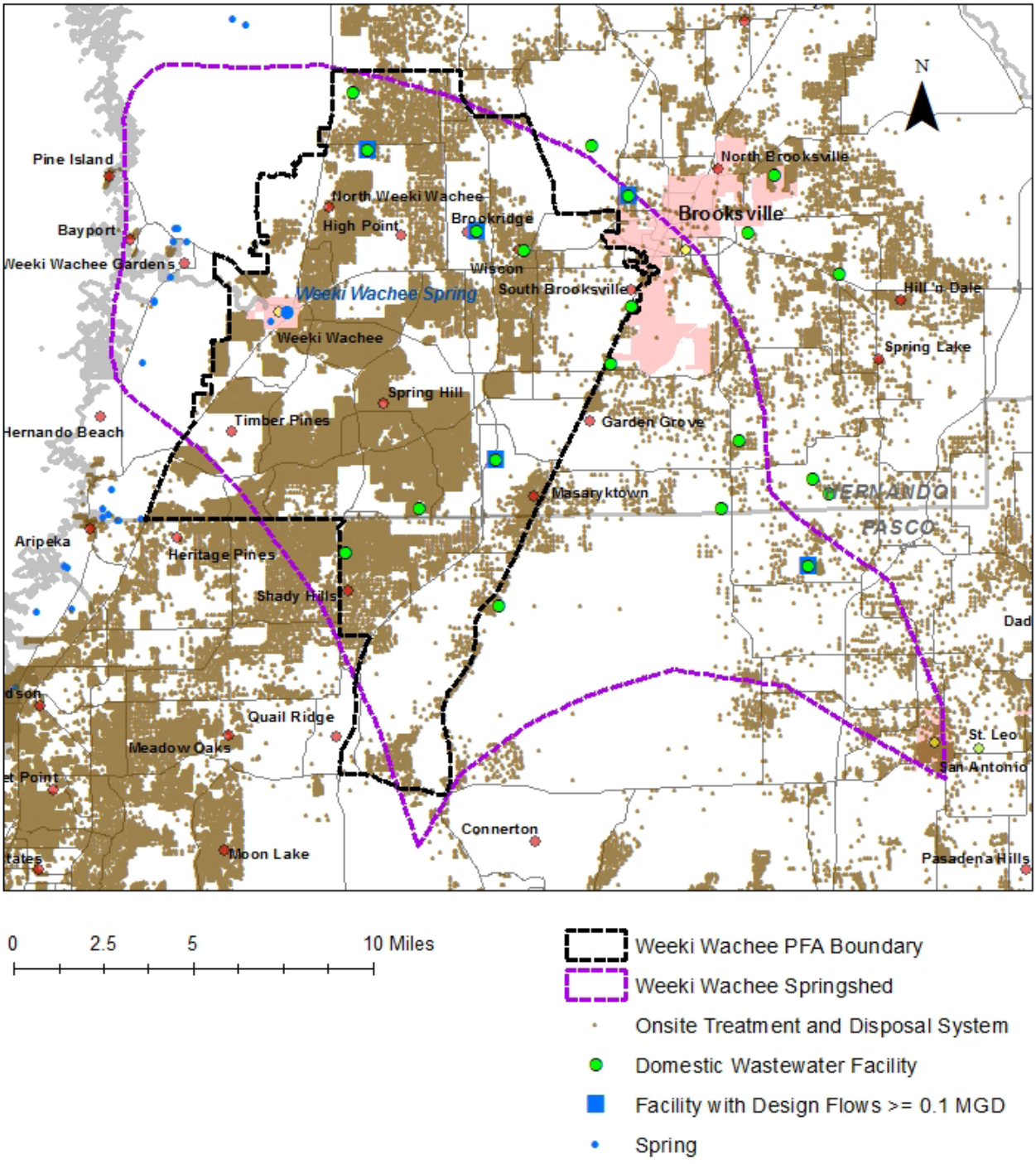

Figure 9. Onsite treatment and disposal systems, domestic wastewater treatment facilities and priority focus area

PFA Boundary for Weeki Wachee Spring

The PFA boundary shown in **Figure 10** was developed by considering GIS coverages of recharge, vulnerability, soils, conservation lands, and potential contaminant nitrogen source information. The PFA includes a region in the western part of the springshed for Weeki Wachee Spring. This area includes high groundwater recharge/vulnerability conditions and soil conditions that tend to leach nitrogen. It is also based on dye trace results, which indicate a potential for rapid movement to the spring from 5 to 10 miles away most likely within areas of highest recharge and with soils having greatest potential for leaching of nitrogen. The PFA also includes interconnected areas of urban development, high densities of septic tanks, several larger wastewater treatment facilities, and agricultural lands which can all contribute to nitrogen enrichment in the aquifer and springs. Septic tanks, urban fertilizer and agricultural fertilizer were identified in the draft nitrogen source inventory as significant sources of nitrogen loading to groundwater.

Conservation land boundaries, natural features, county lines and major roadways in the area were also considered in the development of a readily identifiable boundary. The PFA is bounded to the west by the Chassahowitzka Wildlife Management Area and Weeki Wachee Preserve and to the south east and north by Department of Transportation (DOT) roads. The Brooksville city limits also forms part of the eastern boundary. A portion of the southern boundary is formed by the Hernando-Pasco County line. The PFA includes the city of Weeki Wachee, Weeki Wachee Springs State Park, and all or part of several unincorporated areas including North Weeki Wachee, High Point, Brookridge, Wiscon, Spring Hill, Timber Pines, Masaryktown, South Brooksville, and Shady Hills. Most of the PFA occurs in Hernando County but the PFA also includes a small area of northwestern Pasco County. The springshed of Weeki Wachee Spring adjoins the springshed of Chassahowitzka Springs, and a portion of the northern Weeki Wachee Spring PFA boundary will also serve as the southern PFA boundary for Chassahowtizka Springs.

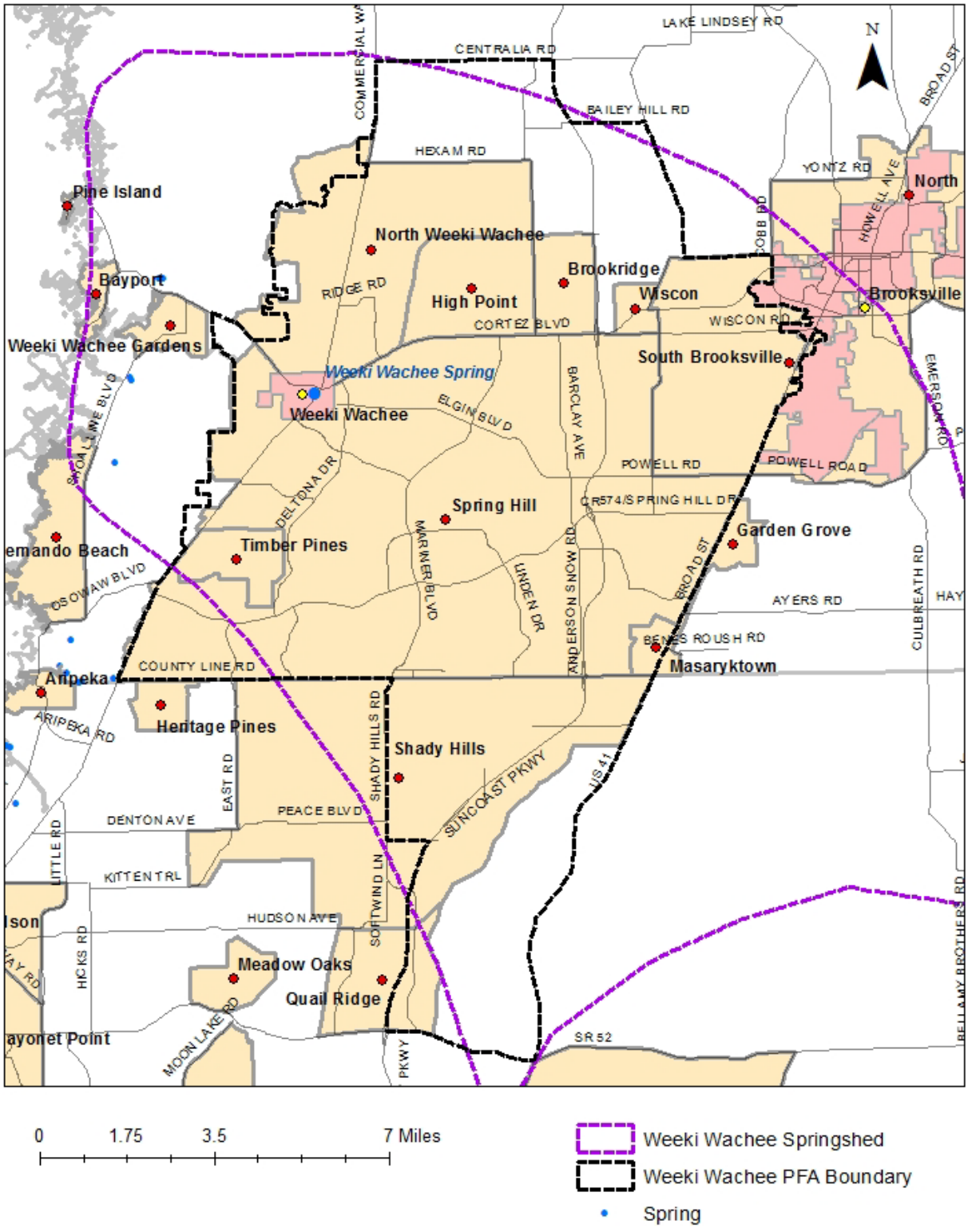

Figure 10. PFA boundary for Weeki Wachee Spring