

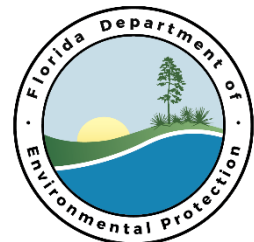
Nitrogen Source Inventory and Loading Estimates for the Contributing Areas of Homosassa Springs Group and Chassahowitzka Springs Group

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This assessment was conducted by the Florida Department of Environmental Protection Groundwater Management Section of the Water Quality Evaluation and Total Maximum Daily Loads (TMDL) Program to assist in the development and implementation of the basin management action plan (BMAP) for the Homosassa and Chassahowitzka Springs Groups to address the TMDL for nitrate. The results of this assessment are based on the information provided in the document.

Disclaimer: Note that all values listed in this report are rounded, while the actual calculations were completed using whole numbers.

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Summary of Findings

Both the Homosassa and Chassahowitzka Springs Groups are first magnitude spring groups discharging water from the karstic Upper Floridan aquifer (UFA), creating the Homosassa River and Chassahowitzka River, respectively. The Homosassa Springs Group discharged an estimated average of 173 cubic feet per second (cfs) in 2015, while the Chassahowitzka Springs Group discharged approximately 85 cfs. There are a number of other smaller springs and seeps in these spring basins, including Trotter Spring, Pumphouse Spring, Hidden River Springs, and Bluebird Spring in the Homosassa Group and Ruth Spring, Beetejay Spring, and Baird Springs in the Chassahowitzka Group.

Both of these spring groups and associated rivers were identified as impaired because of ecological imbalances attributed to elevated nutrient concentrations. In 2014, a total maximum daily load (TMDL) of 0.23 milligrams per liter (mg/L) for nitrogen (Bridger et al. 2014; Dodson et al. 2014) was developed to establish a water quality restoration threshold. Elevated nitrate concentrations in the spring result from current and historical land use practices that have contributed large amounts of nitrogen to groundwater in the spring basin.

The Florida Department of Environmental Protection (DEP) developed a Nitrogen Source Inventory and Loading Tool (NSILT) to provide information on the major sources of nitrogen (atmospheric deposition, wastewater treatment facilities [WWTFs], urban fertilizers, septic systems, livestock wastes, and agricultural fertilizers) in the groundwater contributing area for the Homosassa and Chassahowitzka Springs Groups. In addition, this tool is used to estimate nitrogen loads to groundwater from these sources in the spring contributing areas.

The NSILT is an Arc geographic information system (ArcGIS)– and spreadsheet-based tool that provides spatial estimates of the relative contribution of nitrogen from major nitrogen sources, and accounts for the transport pathways and processes affecting the various forms of nitrogen as they move from the land surface through the soil and geologic strata overlying the UFA. The NSILT does not account for legacy loads of nitrogen that may already be present in the aquifer and continue to adversely impact groundwater quality. Several spring basin studies have reported increasing nitrate-N concentrations in groundwater and springs over time. Nitrogen that entered groundwater from past anthropogenic practices may slowly exit the groundwater flow system via springs, given that the average groundwater residence times in large spring basins in Florida is on the order of decades (Katz et al. 1999; Katz 2004; Phelps 2004; Happell et al. 2006; Knowles et al. 2010).

This report describes the methods, information, and data sources used in developing the NSILT to estimate nitrogen loads to groundwater in the contributing areas for each spring group. The information is provided as a planning tool for the development and implementation of a basin management action plan (BMAP), which addresses the nitrate impairment in these spring groups.

The NSILT is being used in the BMAP development process to identify source categories and areas where nitrogen source reduction efforts from current land uses and activities could be

focused to achieve the most beneficial effects on water quality for Homosassa and Chassahowitzka Springs and Rivers. The current total annual nitrogen input to the land surface in the Homosassa contributing area from all sources is 3.4 million pounds of nitrogen (lb-N). Atmospheric deposition contributes 31 % of the total nitrogen (TN) input. Other nitrogen sources, in order of decreasing nitrogen inputs to the land surface, include livestock waste (22 %), farm fertilizer (19 %), urban turfgrass fertilizer (19 %), septic systems (7 %), sports turfgrass fertilizers (2 %) and WWTFs (0.4 %).

In the Chassahowitzka contributing area, an estimated 2.3 million lb-N reach the land surface, with 32 % attributed to atmospheric deposition. Other nitrogen sources, in order of decreasing nitrogen inputs to the land surface, include farm fertilizer (22 %), livestock waste (20 %), urban turfgrass fertilizer (12 %), sports turfgrass fertilizer (7 %), septic systems (6 %) and WWTFs (1 %).

The NSILT results indicate an estimated total annual load of 582,076 lb-N to the UFA in the Homosassa Springs groundwater contributing area and 380,462 lb-N in the Chassahowitzka Springs contributing area, representing 17 % and 16 %, respectively, of the amount of nitrogen inputs to the land surface. Most of the nitrogen in a given year does not reach groundwater due to nitrogen attenuation processes and variations in the rate of aquifer recharge. In areas of the contributing areas where recharge rates are categorized as low (0 to 3.9 inches per year [in/yr]) medium (4 to 9.9 in/yr), or high (greater than 10 in/yr), the UFA is more vulnerable to contamination than in areas where recharge rates are low.

Groundwater discharge areas were not included in the calculations of nitrogen loads to the groundwater contributing area, as these areas do not contribute nitrogen to the aquifer. To account for variations in recharge rates to the UFA, nonattenuated nitrogen inputs in high-rate recharge areas are multiplied by a weighting factor of 0.9, while nitrogen inputs are multiplied by a weighting factor of 0.5 for medium-rate recharge areas and 0.1 for low.

The highest estimated nitrogen loads in the groundwater contributing area to the Homosassa Springs Group are from urban turfgrass fertilizer (24 %), followed by livestock waste (23 %) and farm fertilizers (19 %). Sources contributing smaller amounts of nitrogen include septic systems (16 %), atmospheric deposition (14 %), sports turfgrass fertilizer (3 %), and the land application of treated wastewater (1 %).

The highest estimated nitrogen loads in the groundwater contributing area to the Chassahowitzka Springs Group are from farm fertilizer (24 %), followed by urban turfgrass fertilizer (19 %) and atmospheric deposition (16 %). Sources contributing smaller amounts of nitrogen include septic systems (15 %), sports turfgrass fertilizer (12 %), livestock waste (11 %), and the land application of treated wastewater (1 %).

The NSILT results provide a baseline understanding of existing nitrogen loads to groundwater from multiple sources in areas where the spring basins are likely to contribute the greatest loads of nitrogen to groundwater. This tool can also be used to evaluate the nitrogen load reduction benefits of various management actions and nitrogen reduction projects at various locations in the contributing areas for both the Homosassa Springs Group and the Chassahowitzka Springs Group.

1. Introduction

In Florida, springs provide sites of recreational and cultural value as well as sources of potable water, and afford a way to assess regional groundwater quality. Springs integrate groundwater vertically, spatially, and temporally from the Upper Floridan aquifer (UFA) (Bush and Johnston 1988; Katz 1992; Katz 2004; Davis 1996). Rainfall that infiltrates into the subsurface and recharges the aquifer system contains nitrogen and other dissolved chemicals of concern originating from anthropogenic activities at or near the land surface. Groundwater with elevated nitrate concentrations flows towards the Homosassa and Chassahowitzka Springs Groups, which include Homosassa-Trotter-Pumphouse Springs Group, Bluebird Spring, Hidden River Springs, Chassahowitzka Springs, Crab Creek Spring, Baird Springs, Ruth Spring, and Beteejay Springs. **Figure 1** shows the boundaries of the contributing areas for both spring groups.

Elevated nitrate concentrations in Florida's springs contribute to water quality degradation in their receiving surface waters. This problem will continue if nitrogen inputs are not reduced. Restoration plans to reduce these inputs must include strategies to address the most significant nitrogen sources by obtaining detailed nitrogen loading information from sources within springsheds or groundwater contributing areas, such as fertilizer applied to cropland and turfgrass, septic systems, the land application of treated domestic wastewater, atmospheric deposition, and livestock wastes.

To identify and quantify the major sources of nitrogen in groundwater contributing areas to springs, the Florida Department of Environmental Protection (DEP) developed the Nitrogen Source Inventory and Loading Tool (NSILT). This tool quantifies nitrogen inputs to the land surface based on the best available, current information on land uses, agricultural practices, urban fertilizer use, waste disposal methods, and atmospheric sources. The NSILT is also used to estimate current nitrogen loads to groundwater in the contributing area by taking into account the attenuation of various forms of nitrogen from sources and recharge rates to the UFA.

The NSILT does not account for legacy loads of nitrogen that may already be present in the aquifer and continue to adversely impact groundwater quality in some areas. Several spring basin studies have reported increasing nitrate-N concentrations in groundwater and springs over time. Nitrogen that entered groundwater from past anthropogenic practices may slowly exit the groundwater flow system via springs, given that the average groundwater residence times in large spring basins in Florida is on the order of decades (Katz et al. 1999; Katz 2004; Phelps 2004; Happell et al. 2006; Knowles et al. 2010).

The NSILT results are used in the development and implementation of the basin management action plan (BMAP) for the Homosassa Springs Group and the Chassahowitzka Springs Group by helping to focus nitrogen source reduction efforts to achieve the greatest improvement in water quality.

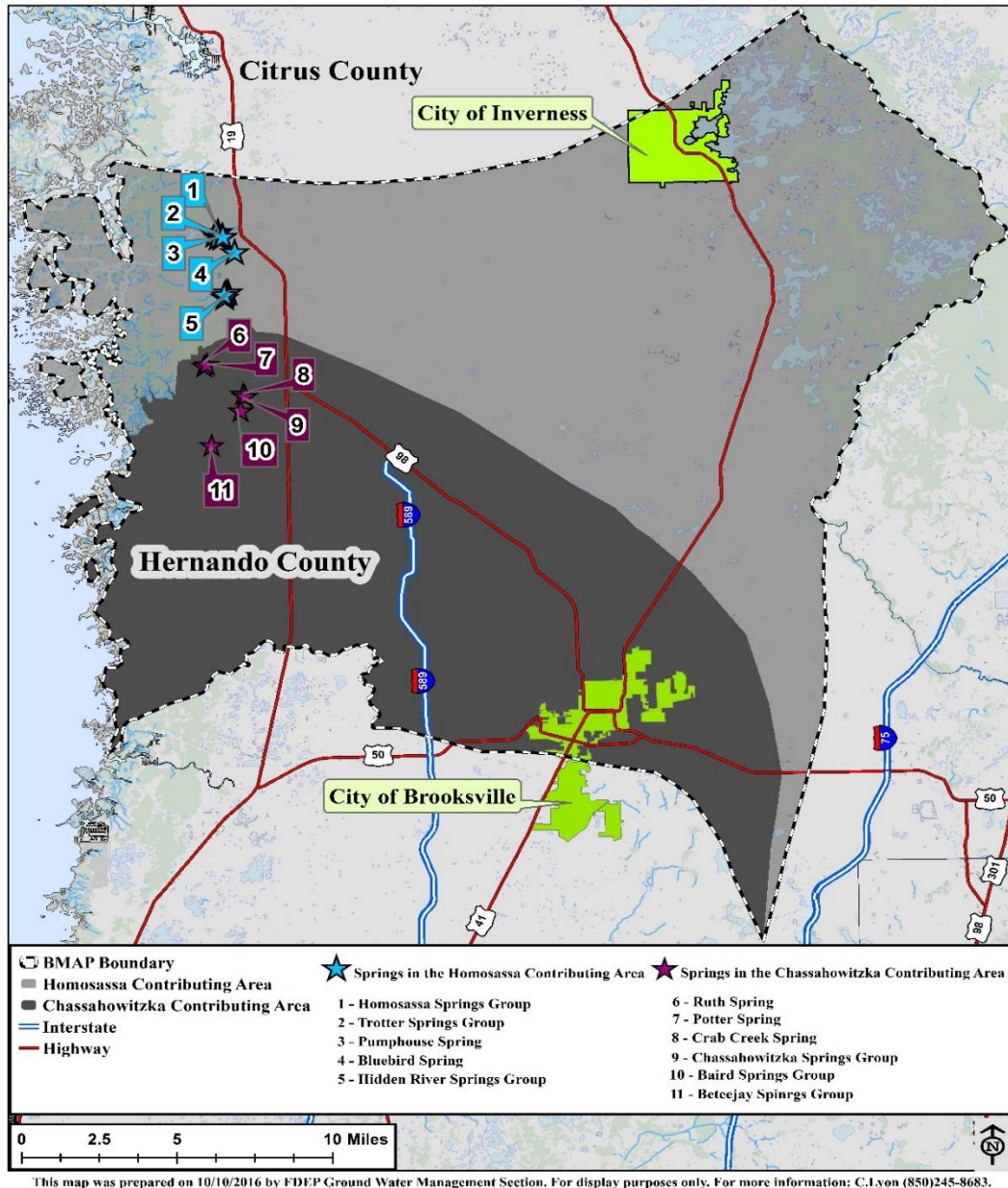


Figure 1: Homosassa and Chassahowitzka Springs Groups groundwater contributing areas

1.1 Homosassa Springs Group and Contributing Area

The Homosassa Springs Group includes many springs that comprise the source waters for the Homosassa River on the west coast of the Florida peninsula (**Figure 1**). The largest are the first magnitude Homosassa Springs, which include three distinct vents. Other significant springs include Trotter Main, Trotter #1, Belcher, and Abdoney Springs, located in Spring Cove just

south of the wildlife park. The smallest contributing springs are Bluebird Spring, Hidden River Main, and Hidden River #2 Spring, located downriver (Bridger et al. 2014).

In 2012, these springs were verified as impaired because of ecological imbalances attributed to elevated nutrient concentrations. In 2014, a total maximum daily load (TMDL) was developed to establish a water quality restoration threshold for nitrate-N of 0.23 milligrams per liter (mg/L) (Bridger et al. 2014).

The groundwater contributing area for this springs group covers Citrus and Hernando Counties and runs adjacent to the southern boundary of the Kings Bay contributing area (Eller and Katz 2016a). This groundwater contributing area is largely based on the springshed boundary delineated by the Southwest Florida Water Management District (SWFWMD) (Jones et al. 1997) and is the source of water flowing to the springs group. The contributing area covers 201,234 acres. Land uses include 39 % forested areas, 23 % wetlands and marshes, 22 % urban landscapes, and 12 % agriculture. The remaining 4 % is composed of waterbodies, rangeland, and miscellaneous land uses.

1.2 Chassahowitzka Springs Group and Contributing Area

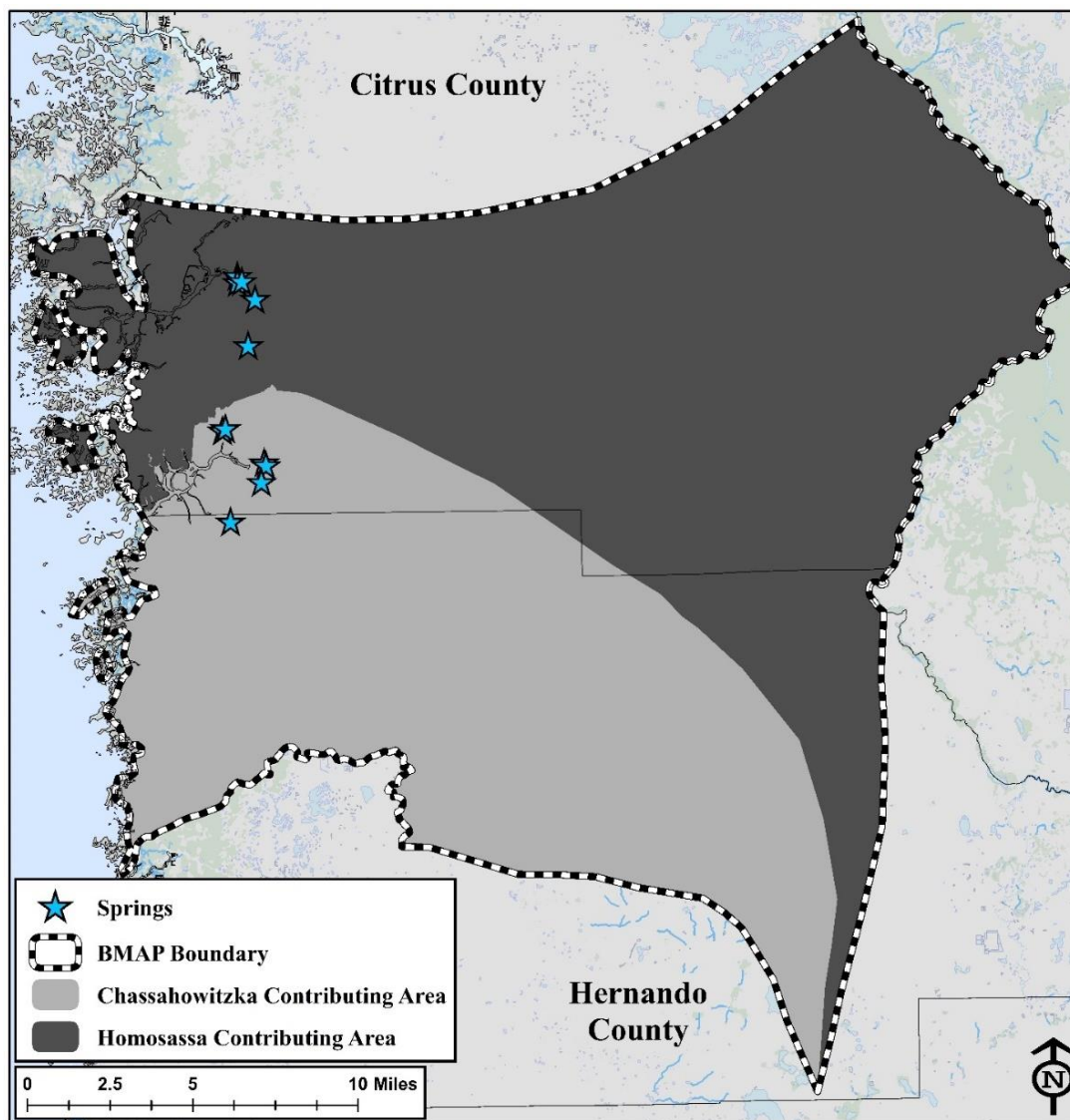
The Chassahowitzka contributing area lies to the south of the Homosassa contributing area. It contains many small springs as well as the large Chassahowitzka Springs Group (Main, #1, and #2). These make up the headwaters of the Chassahowitzka River, which discharges into the Gulf of Mexico. In 2012, the river and 6 springs were identified as impaired—Chassahowitzka Main Spring, Chassahowitzka #1, Crab Creek Spring, Ruth Spring, Baird Spring, and Beetejay Spring. In 2014, a total maximum daily load (TMDL) was developed to establish a water quality restoration threshold for nitrate-N of 0.23 milligrams per liter (mg/L) (Dodson et al. 2014).

The groundwater contributing area for the Chassahowitzka Springs Group spans Citrus and Hernando Counties and runs adjacent to the southern boundary for the Homosassa contributing area (**Figure 1**). This contributing area is largely based on the springshed delineated by the SWFWMD (Jones et al. 1997). It has a relatively even distribution of land uses, consisting of 17 % forest, 17 % wetlands and marshes, 17 % waterbodies, 16 % agriculture, 16 % urban, and 16 % rangeland, with the remaining 1 % classified as miscellaneous. The southern boundary coincides with the northern boundary of the Weeki Wachee contributing area (Eller and Katz 2016b).

1.3 BMAP for the Homosassa and Chassahowitzka Springs Groups

Elevated nitrate concentrations in the Homosassa area and Chassahowitzka area springs result from current and historical land use practices that contribute nitrogen to the land surface. Recharge to the UFA transports nitrate, which then moves through the highly transmissive limestone aquifer and flows to the springs. The NSILT analysis described in this report provides stakeholders with current information on the sources of nitrogen in both groundwater contributing areas and the relative nitrogen contributions of each source to the UFA. The

analyses for each contributing area were completed independently but are reported jointly, as they will both be addressed in the BMAP to be developed by DEP (**Figure 2**).



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Figure 2: BMAP boundaries for the Homosassa and Chassahowitzka Springs Groups

1.4 Hydrogeology and Aquifer Recharge

The Floridan aquifer system in this area is composed of thick sequences of limestone and dolostone of Eocene to Miocene age that are exposed at or very near to (within 10 to 20 feet of) the land surface. The UFA is the predominant source of water discharging from all the springs in the BMAP area (Jones et al. 1997; Faulkner 1970).

The dissolution of the carbonate rocks comprising the UFA has created numerous karst features (sinkholes, caves, and conduits) over geologic time in this area. These features, along with a thin layer of sediments overlying the UFA, allow water from the land surface to move directly and relatively rapidly into the aquifer.

Consequently, groundwater in the UFA responds relatively quickly to changes in rainfall and recharge, and groundwater flows through small openings in the aquifer matrix and through large conduits toward springs. Groundwater discharging from springs originates from both nearby source areas and from more distant areas in the springshed. As a result, water flowing from springs includes a mixture of groundwater that has resided in the aquifer for varying amounts of time, ranging from days to several decades.

Most of the drainage within the springsheds is internal, and rainwater that recharges the UFA infiltrates from the land surface directly into closed depressions or through thin overlying sediments into the unconfined limestone of the UFA. Jones et al. (1997), Dodson et al. (2014) and Bridger et al. (2014) describe the hydrogeologic framework for these area in greater detail. Recharge rates to the UFA are affected by spatial variations in the hydrogeological characteristics of the surficial aquifer and intermediate confining unit, karst features, and average annual rainfall.

Information on recharge to the UFA was obtained from a groundwater flow model that was developed in 2013 by HydroGeoLogic, Inc., and contracted by the SJRWMD. This model was based on the existing Northern District Model (HydroGeoLogic, Inc. 2013). The modeled area includes more than 5.5 million acres of peninsular Florida and is composed of uniform model grid dimensions of 144-acre cells. The raster-based data were smoothed to create 3 recharge rate categories for the BMAP area: low rate (0 to 3.9 inches per year [in/yr]), medium rate (4.0 to 9.9 in/yr), and high rate (10.0 in/yr or greater) (**Figure 3**). The amount of annual recharge affects the transport of nitrogen to the aquifer. Therefore, it is likely that more nitrogen reaches the aquifer annually in high recharge rate areas than in lower recharge rate areas, if both areas were to receive similar nitrogen inputs to the land surface.

1.5 Land Use

Land use/land cover (LULC) was assessed using the most recent land use ArcGIS coverages obtained from the SWFWMD and county property appraisers. The BMAP area lies completely within the SWFWMD boundary. All land use classifications used by the SWFWMD were based on the Florida Land Use/Land Coverage and Forms Classification System (FLUCCS). The 2011 land use was created through the interpretation of digital imagery taken in December 2010. The land use classifications were determined through photo interpretation, editing, and quality check processes. **Table A.2** through **Table A.5** provide additional details of these data.

Additional land use information was obtained from the Citrus and Hernando County property appraisers. Staff from each county property appraiser's office conduct routine field visits to update and verify the land use classification of parcels for tax purposes. These visits occur at

least every five years, although most parcels are visited more frequently. This system allows for continual updates and for 2014 data to be used for this analysis (**Table A.6** through **Table A.9**).

For the assessment of current land use, the property appraisers also provided detailed information on the specific agricultural practices used for estimating nitrogen contributions from fertilizer use on farmland. The land use information obtained from property appraisers is designated as "PA" in this report.

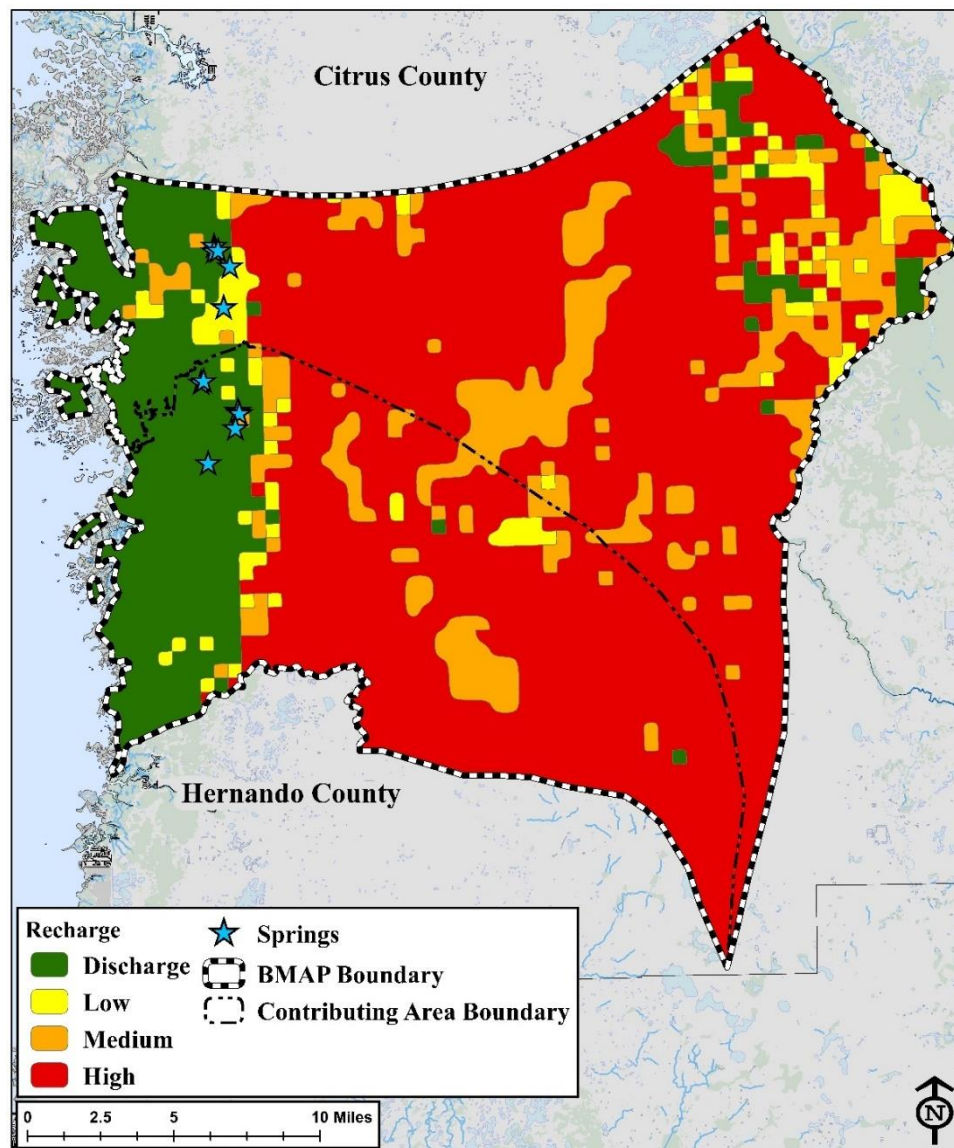


Figure 3: UFA recharge rate categories in the BMAP area for the Homosassa and Chassahowitzka Springs Groups

2. Estimating Nitrogen Inputs to the Land Surface

Nitrogen inputs to the land surface in the BMAP area were estimated for atmospheric deposition, WWTF land application sites, septic systems, urban and agricultural fertilizer use, and livestock waste. The methods used to estimate nitrogen inputs for these sources were based on a detailed synthesis of information, including direct water quality measurements, Census data, surveys, wastewater facility permits, published scientific studies and reports, and information obtained in meetings with agricultural producers and other stakeholders.

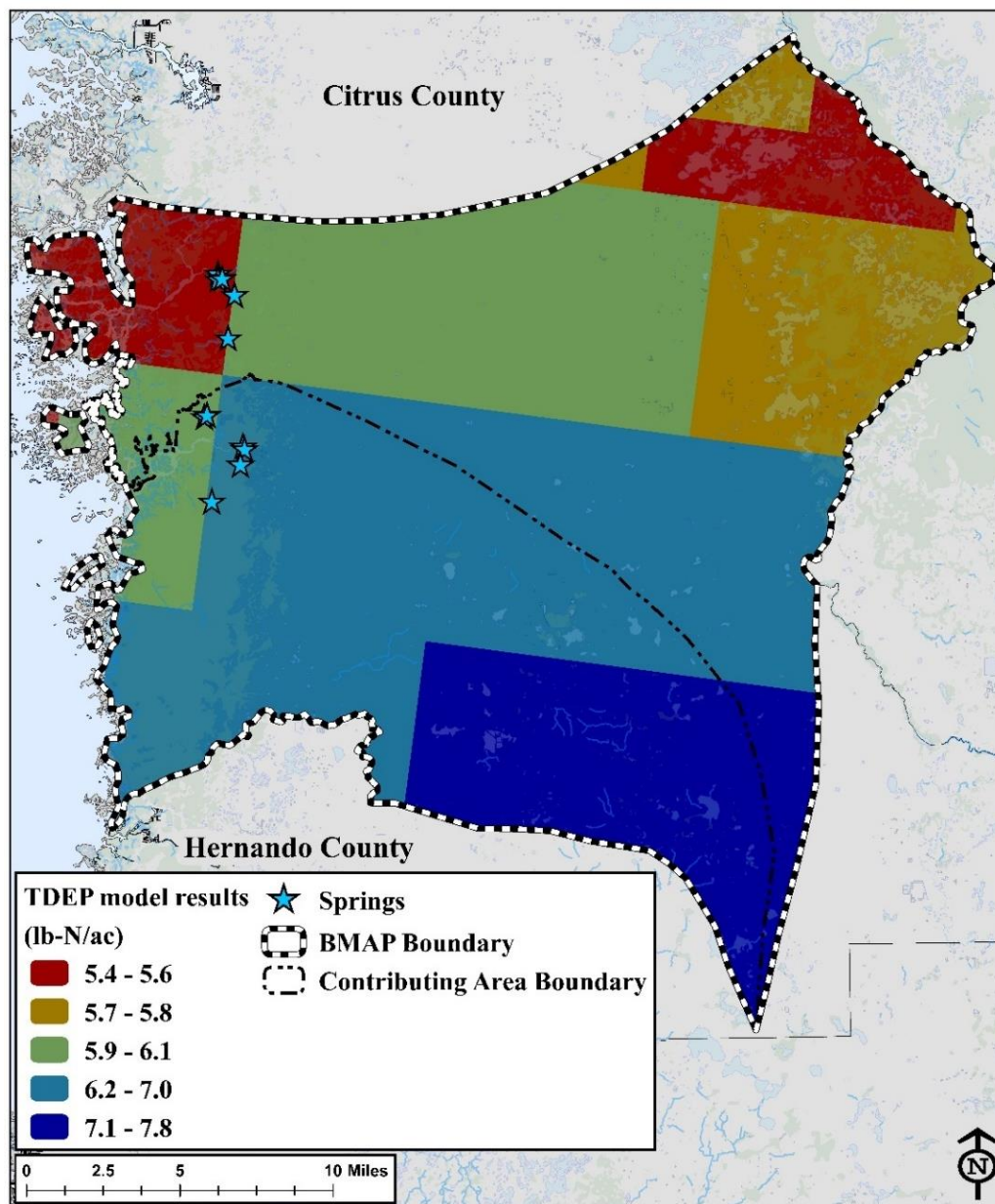
For some nitrogen source categories, the estimation of nitrogen inputs included reasonable assumptions and extrapolations, and as a result these estimated nitrogen inputs are subject to further refinement as more detailed information becomes available. The approach and sources of information used to estimate the annual input (in pounds of nitrogen per year [lb-N/yr]) to the land surface for each source category are discussed below.

2.1 Atmospheric Deposition

Atmospheric deposition is largely a diffuse, albeit continual, source of nitrogen. Nitrogen species and other chemical constituents are measured in wet and dry deposition at discrete locations around the U.S. In Florida, the Clean Air Status and Trends Network (CASTNET) has two stations that collect dry deposition data for analysis. Wet deposition data currently are collected at nine stations around the state as part of the National Atmospheric Deposition Program (NADP) National Trends Network (NTN).

Recently, Schwede and Lear (2014) developed a hybrid model for estimating the total atmospheric deposition (TDEP) of nitrogen and sulfur for the entire U.S. Deposition data from several monitoring networks—including CASTNET, the NADP Ammonia Monitoring Network, the Southeastern Aerosol Research and Characterization Network, and modeled data from the Community Multi-Scale Air Quality Model—are combined in a multistep process with National Trends Network wet deposition values to model total deposition in 16-kilometer (km) grid cells.

Multiple TDEP model runs are available, providing atmospheric data for individual and multiple years, with average values calculated for the multiyear models. The TDEP model run used for the NSILT includes data from 2011 to 2013. The TN data are available in a nationwide coverage (.e00) file and were converted into ArcGIS shapefiles for the purpose of this analysis. **Figure 4** illustrates the model results for TN deposition within the BMAP boundary. The deposition amounts in high, medium, and low recharge rate areas are 626,520 lb-N/yr; 93,240 lb-N/yr; and 29,677 lb-N/yr, respectively.



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Figure 4: Atmospheric deposition model results used for the NSILT

2.2 Wastewater Treatment Facilities

WWTFs receive and treat domestic wastewater. In the BMAP area, treated effluent containing nitrogen from WWTFs is discharged to the land surface from sprayfields, rapid infiltration basins (RIBs), and percolation ponds. While other areas in Florida use reclaimed water from WWTFs for irrigation and fertilization, these practices are not currently being used in the Homosassa or Chassahowitzka contributing areas. There are 9 WWTFs located in the Chassahowitzka contributing area and 18 in the Homosassa contributing area. There are 4 facilities discharging more than 100,000 gallons of treated effluent per day within the BMAP area (**Figure 5**).

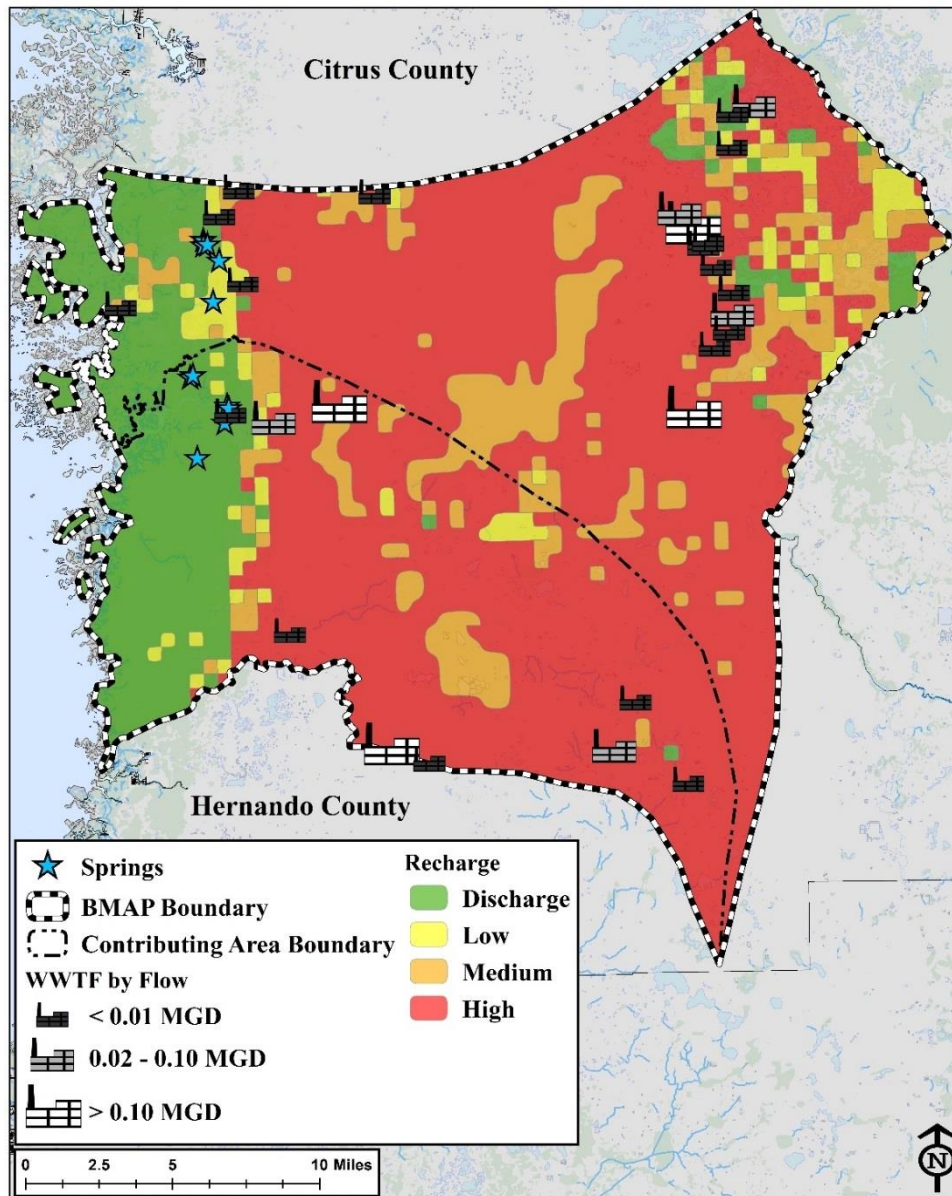


Figure 5: Distribution of WWTFs in the BMAP area

The required water-quality monitoring varies between facilities depending on permitting requirements, and not all facilities report the same type of data. The annual effluent input of nitrogen to the land surface was estimated using the average TN concentration and the discharge (volume), but this information was not always available for smaller facilities. Smaller WWTFs (< 0.1 million gallons per day [mgd] by volume) are not always required to monitor and report TN effluent concentrations, and therefore not all these facilities had data available in the DEP Wastewater Facility Regulation (WAFR) Database.

For these facilities, DEP estimated TN concentrations from nitrate-N ($\text{NO}_3\text{-N}$) data (assuming the $\text{NO}_3\text{-N}$ concentration was 38.5 % of the TN, based on a 2009 cooperative study with the Water Reuse Foundation of 40 domestic WWTFs across the state). For this calculation, the $\text{NO}_3\text{-N}$ value was divided by 0.385, resulting in an estimated TN concentration. The WWTF data were compiled for each facility and include the most recent complete year of data. The years of data vary with the individual facilities; however, the majority of the data are from November 2014 to October 2015 for the Homosassa contributing area and April 2015 to March 2016 for the Chassahowitzka contributing area.

For facilities permitted to apply treated wastewater to the land surface (sprayfields, RIBs, and absorption fields), the reported annual average flows were used to calculate an average discharge. For the purpose of this analysis, absorption fields were included with RIBs because they have similar processes that attenuate nitrogen. The nitrogen inputs for each WWTF were calculated using the average annual TN concentration and the average yearly flow for each facility. The average annual nitrogen inputs from wastewater facilities were estimated for each recharge rate category based on the location of the effluent treatment sites in the contributing area.

Table 1 and **Table 2** summarize the nitrogen input data from facilities in the contributing area. In total, an estimated 31,147 lb-N/yr are applied to the land surface from these facilities in the high recharge rate areas, and an additional 1,736 lb-N/yr are applied in the medium recharge rate areas and 211 lb-N/yr in the low recharge rate areas.

2.3 Septic Systems

Onsite sewage treatment and disposal systems (OSTDS), commonly referred to as septic systems or septic tanks, are widely used throughout the BMAP area where municipal sewer lines are not available. These systems can contribute to elevated nitrogen concentrations in groundwater (Chang et al. 2010).

Beginning in 2014, the Florida Department of Health (FDOH) began the process of updating the septic system inventory for the entire state, called the Florida Water Management Inventory. The results of this process can be obtained through FDOH and were used to estimate the total number of septic systems within the BMAP boundary. ArcGIS files were obtained that provided the [locations of both known and estimated septic systems](#). **Figure 6** shows the distribution of septic systems within the BMAP boundary.

After the number of septic systems in the contributing area was determined, the population served by septic systems was estimated using the [2010 U.S. Census Bureau data](#) for population and household occupancy in each county. The Census makes a distinction between occupied and nonoccupied households. The county population was divided by the number of occupied households in the county to obtain an average number of people per occupied household (2.23 in Citrus County and 2.41 in Hernando County).

Table 1: Data for WWTFs in the Homosassa contributing area

* TN data estimated based on available NO₃ data.

MHP = Mobile home park

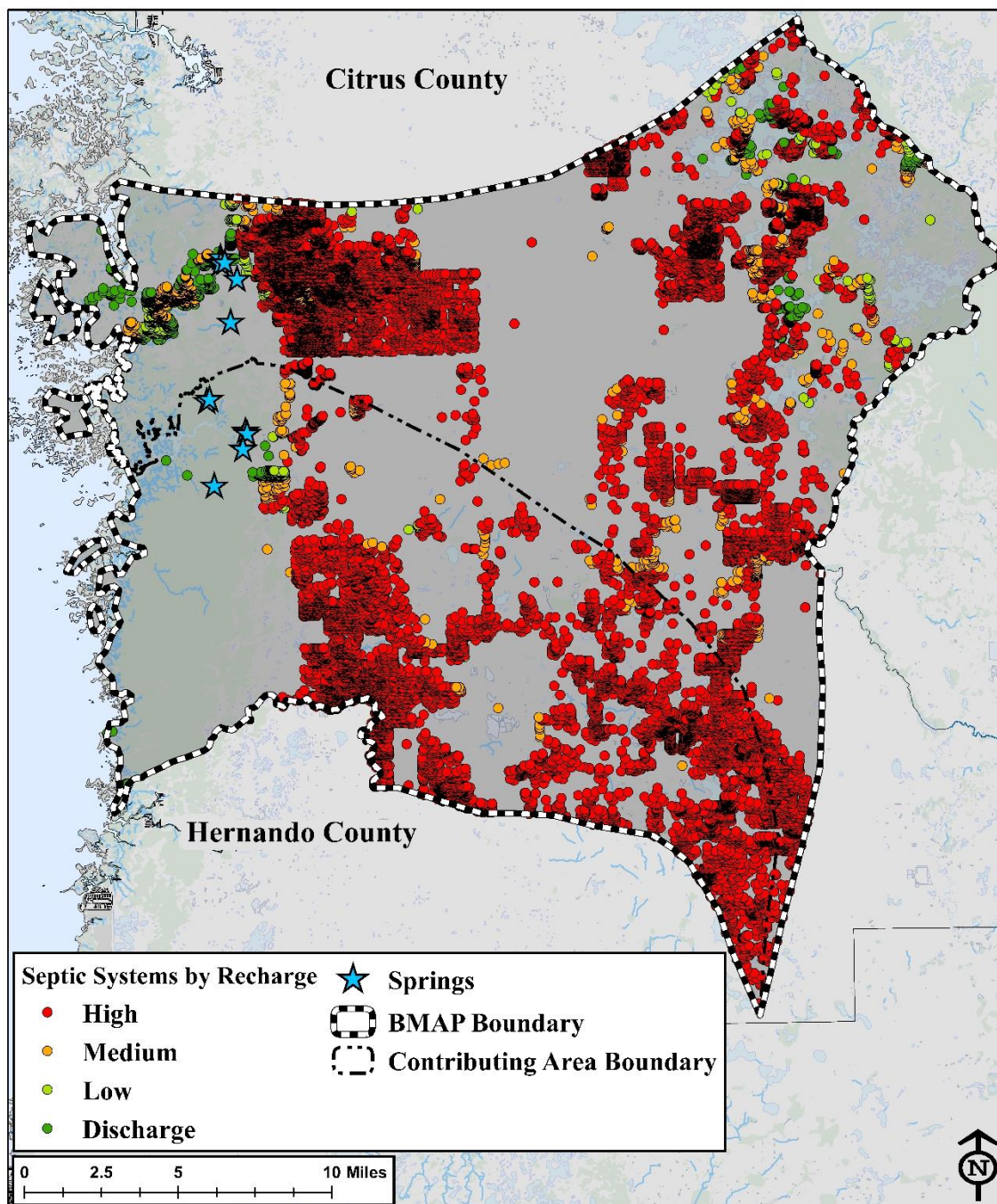
WWTF Name	Facility ID	County	Treatment Type	Recharge Area	Annual Average TN (mg-N/L)	Annual Flow (mgd)	Nitrogen Input (lb-N/yr)
Aunt Vera's Antique Store	FLA011853	Citrus	RIB	Medium	1.87*	0.0001	1
Bell Villa MHP	FLA011901	Citrus	RIB	Discharge	8.24*	0.006	149
Bell Villa MHP	FLA011901	Citrus	RIB	Low	8.24*	0.001	31
Cedar Lakes MHP	FLA011899	Citrus	RIB	Medium	4.64*	0.003	46
City of Inverness	FLA011847	Citrus	Sprayfield	High	4.15	0.283	3,571
City of Inverness	FLA011847	Citrus	Reuse	High	4.15	0.449	5,682
City of Inverness	FLA011847	Citrus	Reuse	Medium	4.15	0.017	215
Evanridge MHP	FLA011907	Citrus	RIB	Low	6.08*	0.006	106
Floral City Elementary School	FLA011839	Citrus	RIB	High	11.73*	0.001	45
Floral Oaks Apartments	FLA011884	Citrus	RIB	High	8.42*	0.003	64
Harbor Lights Mobile Home Resort	FLA011898	Citrus	Sprayfield	High	2.60*	0.003	25
Moonrise Resort	FLA011864	Citrus	RIB	High	10.09*	0.006	172
Oak Pond Mobile Home Estates	FLA011879	Citrus	RIB	High	3.86*	0.0005	6
Oak Pond Mobile Home Estates	FLA011879	Citrus	RIB	Low	3.86*	0.006	73
Oasis MHP	FLA011904	Citrus	RIB	High	0.74*	0.001	3
Palm Terrace Village	FLA011902	Citrus	Sprayfield	High	4.83*	0.005	66
Point O Woods	FLA011893	Citrus	RIB	High	11.04*	0.008	283
Point O Woods	FLA011893	Citrus	Reuse	High	11.04*	0.013	446
Royal Oaks Manor	FLA011900	Citrus	RIB	High	4.21*	0.016	208
Singing Forest MHP	FLA011891	Citrus	RIB	High	3.51*	0.019	205
Stonebrook MHP	FLA011883	Citrus	RIB	Medium	3.43*	0.010	104
Stoneridge Landing	FLA011880	Citrus	RIB	High	8.70*	0.007	197
Tarawood Adult Community	FLA011927	Citrus	RIB	High	5.94*	0.169	3,064

Table 2: Data for WWTFs in the Chassahowitzka contributing area

* TN data estimated based on available NO₃ data.

WWTF Name	Facility ID	County	Treatment Type	Recharge Area	Annual Average TN (mg-N/L)	Annual Flow (mgd)	Nitrogen Input (lb-N/yr)
Brookridge Subregional	FLA012028	Hernando	RIB	High	11.814	0.302	10,874
Brooksville Golf and Country Club	FLA012046	Hernando	RIB	High	10.706	0.001	48
Chassahowitzka River Lodge	FLA011852	Citrus	RIB	Medium	4.134	0.002	20
Countryside Estates	FLA012062	Hernando	RIB	High	6.872	0.006	124
Frontier Campground MHP	FLA012054	Hernando	RIB	High	2.084	0.010	62
Sugarmill Woods	FLA011903	Citrus	Sprayfield	High	4.393	0.383	5,129
Sugarmill Woods	FLA011903	Citrus	Sprayfield	Medium	4.393	0.101	1,351
Walden Woods MHP	FLA011916	Citrus	RIB	High	2.374	0.019	137
Weeki Wachee North MHP	FLA012038	Hernando	RIB	High	2.916	0.010	92
Wesleyan Village	FLA012071	Hernando	RIB	High	14.323	0.007	324
Wesleyan Village	FLA012071	Hernando	Sprayfield	High	14.323	0.007	324

However, many people with a home septic system potentially have access to a facility connected to a sewer system during their weekly routine (i.e., work, school), thus reducing nitrogen inputs to their septic systems. To estimate the effective number of people per household and the associated nitrogen input to septic systems, population age distribution information was obtained for Citrus and Hernando Counties from the 2010 Census. In Citrus County, 48.0 % of the population is of school or working age and, according to the [Bureau of Labor Statistics](#), spending an estimated average of 43.5 hours, or 25.9 %, of the week away from home and therefore is not using the septic system. This effectively reduces the number of people per household using septic systems in Citrus County by 12.5 %, resulting in an effective number of 1.95 people per household. A similar calculation was made for Hernando County, which has a school or working age population of 53 %, resulting in an adjusted number of 2.07 people per household (based on a reduction of 13.7 %). For more information, see **Table A.10**, **Table A.11**, and **Table A.12** in **Appendix A**.



This map was prepared on 08/24/16 by FDEP Ground Water Management Section. For display purposes only. For more information: K.Eller (850)245-8652.

Figure 6: Distribution of septic systems in the BMAP area

The total population in the BMAP area served by septic systems was estimated by multiplying the estimated effective number of people per household (adjusted for estimated actual use) by the number of septic systems. Several literature sources have reported a per capita contribution of 9.012 lb-N/yr, and this value was multiplied by the estimated number of people using septic tanks within the different regions of the contributing area (U.S. Environmental Protection

Agency [EPA] 2002; Toor et al. 2011; Viers et al. 2012). **Table 3** summarizes the septic system data.

Table 3: Estimated number of septic systems and associated input to the land surface in the Homosassa and Chassahowitzka contributing areas

Contributing Area	Land Category	Number of Septic Systems	Estimated Input to Land Surface (lb-N/yr)
Homosassa	Citrus High Recharge	10,249	180,379
Homosassa	Citrus Medium Recharge	1,012	17,811
Homosassa	Citrus Low Recharge	257	4,523
Homosassa	Hernando High Recharge	1,168	21,867
Homosassa	Hernando Medium Recharge	91	1,704
	TOTAL	12,777	236,492

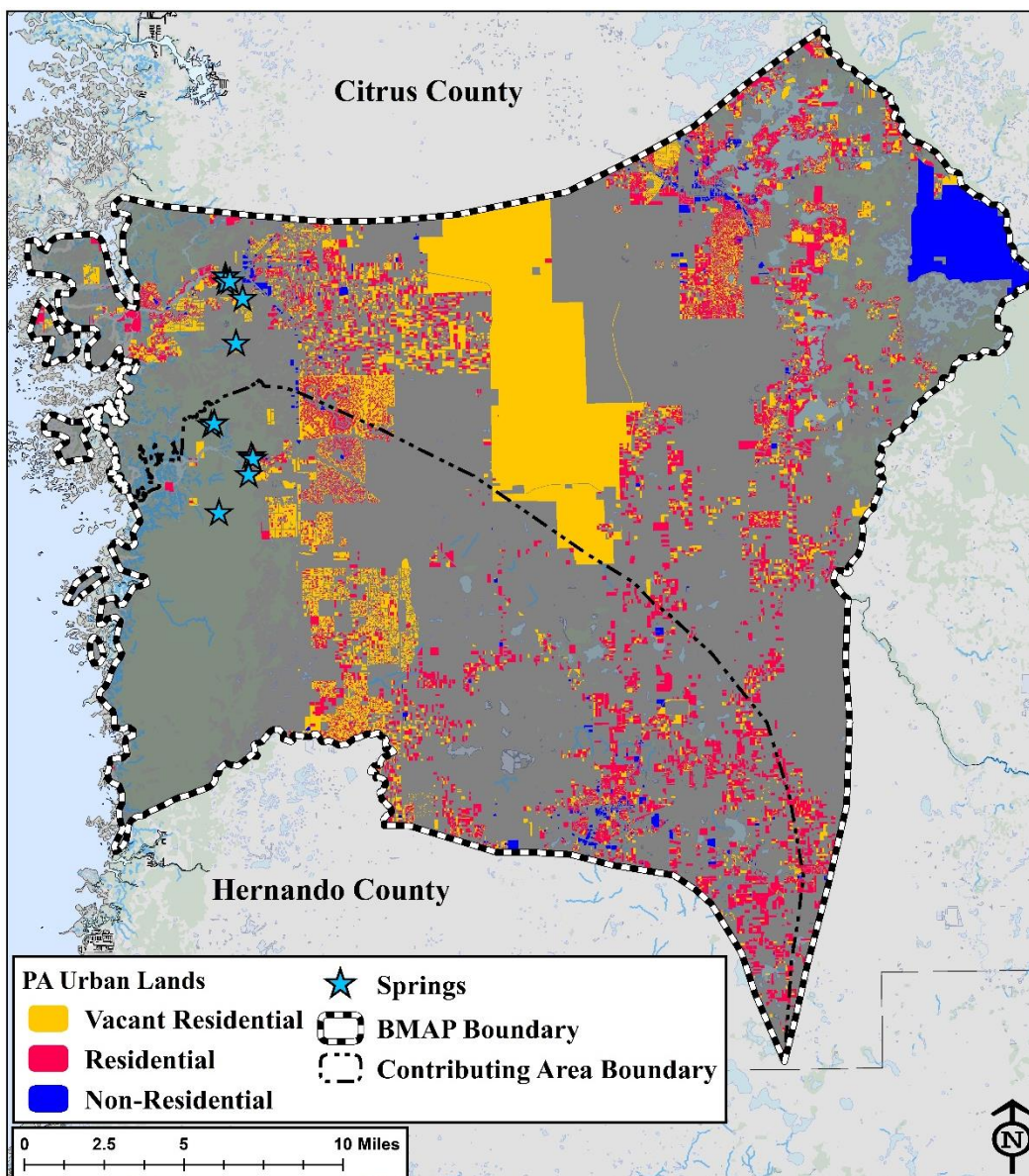
Contributing Area	Land Category	Number of Septic Systems	Estimated Input to Land Surface (lb-N/yr)
Chassahowitzka	Citrus High Recharge	113	1,989
Chassahowitzka	Citrus Medium Recharge	74	1,302
Chassahowitzka	Citrus Low Recharge	58	1,021
Chassahowitzka	Hernando High Recharge	6,736	126,112
Chassahowitzka	Hernando Medium Recharge	70	1,311
Chassahowitzka	Hernando Low Recharge	8	150
	TOTAL	7,059	133,399

BMAP Total = 19,836 septic systems
Estimated Input to Land Surface (lb-N/yr) = 353,989

2.4 Urban Turfgrass Fertilizer

2.4.1 Fertilizer Application Rates

Fertilizers applied to turfgrass typically found in urban areas (including residential lawns and commercial and public green spaces) are referred to as urban turfgrass fertilizers (**Figure 7**). Results from surveys and workshops pertaining to fertilizer application on turfgrass in nearby counties were used to estimate the nitrogen application rates for urban turfgrass in the BMAP area.



This map was prepared on 08/24/16 by FDEP Ground Water Management Section. For display purposes only. For more information: K.Eller (850)245-8652.

Figure 7: Urban noncommercial lands in the BMAP area according to county PA data

Fertilizer is applied by either the homeowner or a hired lawn service company on residential properties, and on other properties it may be applied by contractors or maintenance staff.

In 2008, a SWFWMD contractor conducted a telephone survey to solicit information about residential fertilizer use in Citrus County and southern Marion County. The results from this survey were used to estimate fertilizer application rates to all urban turfgrass in the BMAP area. According to the survey results (Martin 2008), 68 % of the surveyed population applied fertilizer to their own lawns 3 times per year at variable rates that may range as high as 45.56 lb-N/ac (**Table 4**). Additionally, 32 % of those surveyed hired a lawn service company that would typically apply fertilizer at rates consistent with the *Green Industries Best Management Practices (BMP) Manual* recommendation of 21.78 lb-N/ac twice a year (Martin 2008; DEP 2010; Downs et al. 2012). Fertilizer applications on commercial and public green spaces were assumed to be performed by lawn service professionals or by trained staff using application rates and frequencies similar to those recommended in the *Green Industries BMP Manual*.

Table 4: Estimated fertilizer application rates by homeowners from surveys in Citrus and Marion Counties

Basis for Application Rate	% of Population and Basis for Fertilizer Rate Selection	Estimated Rate (lb-N/ac)
Green Industry BMP Guidelines	15	21.78
Fertilizer Bag Label	74	34.78
Do Not Apply Fertilizer	11	Not applicable

2.4.2 Nonresidential Parcel Estimations

The acreage of public green space parcels receiving fertilizer applications was estimated from the PA information for each category listed in **Table 5** to obtain nitrogen inputs for nonresidential parcels. Parcel types included businesses, hotels, schools, churches, and other facilities. These data were combined with zoning data provided by Citrus and Hernando Counties. The zoning attributed to each parcel contains information on the amount of impervious surfaces (i.e., structures, pavement, etc.), referred to as the "max lot coverage." For each parcel, the max lot coverage was used to estimate the acreage of impervious and pervious land. For this analysis, it was assumed that all pervious acreage was fertilized by lawn service companies at the previously mentioned rate and frequency. Details of the PA data and max lot coverages are listed in **Appendix A, Table A.6** through **Table A.9**, and **Table A.13** and **Table A.14**. **Table 5** and **Table 6** summarize these data.

Table 5: Summary of the fertilizable urban land area and associated nitrogen input for nonresidential parcels in the Homosassa contributing area

Parcel Type	Citrus High Recharge (acres)	Citrus Medium Recharge (acres)	Citrus Low Recharge (acres)	Hernando High Recharge (acres)	Hernando Medium Recharge (acres)	Total Input (lb-N/yr)
Retirement Homes	2	0	3	0	0	5
Supermarkets	4	0	0	0	0	4
Community Shopping Centers	123	3	9	0	0	135
Office Buildings	70	2	2	0	0	74
Office Buildings, Multi-story	3	0	0	0	0	3
Professional Services Buildings	79	0	1	0	0	80
Financial Institutions	21		6	0	0	27
Hotels Motels	24	3	0	0	0	28
Churches	331	10	11	21	0	373
Privately Owned Hospitals	1	0	0	0	0	1
Homes for the Aged	14	0	0	0.1	0	14
Mortuaries, Cemeteries	62	0	0	0.03	3	62
Clubs, Lodges, Union Halls	2,408	0	0	0	0	5,717
Sanitariums, Convalescent	8	0	0	0	0	8
Cultural Organizations	0.4	0	0	0	0	0.4
Hospitals	30	0	0	0	0	30
Total	138,545	72,430	73,778	21.4	2.8	285,803

Table 6: Summary of the fertilizable urban land area and associated nitrogen input for nonresidential parcels in the Chassahowitzka contributing area

Parcel Type	Citrus High Recharge (acres)	Citrus Medium Recharge (acres)	Citrus Low Recharge (acres)	Hernando High Recharge (acres)	Hernando Medium Recharge (acres)	Total Input (lb-N/yr)
Supermarkets	0	1	0.3	0	0	1
Community Shopping Centers	0	0.3	0	63	0	63
Office Buildings	2	3		87		92
Office Buildings, Multistory	0	0.2	0	14	0	14
Professional Services Buildings	0.5	4	0	76	0	81
Financial Institutions	0	0	0.4	12	0	12
Hotels Motels	0	0.5	0	5	0	6
Churches	0	0	0	253	19	272
Privately Owned Hospitals	0	0	0	34	0	34
Homes for the Aged	0	1	0	85	3	89
Mortuaries, Cemeteries	0	0	0	26	0	26
Clubs, Lodges, Union Halls	16	0.3	0.3	20	0	37
Sanitariums, Convalescent	0	0	0	1	0	1
Cultural Organizations	0	0	0	26	0	26
Hospitals	0	0	0	63	0	63
Total	770	422	39	701	21	817

2.4.3 Residential Parcel Estimations

For residential parcels such as single and multifamily homes, the acreage receiving fertilizer applications is estimated in the same manner as nonresidential parcels. Prior to applying the fertilizer application rates to the pervious land area, two factors are taken into account: (1) the percentage of their property that a homeowner will fertilize, and (2) the probability that a homeowner will apply fertilizer to a property.

The majority of homeowners will apply fertilizer to all the pervious area on their property (lawns, shrubs, etc.), but for those with larger lot sizes, this is less likely. For this analysis, it was assumed that the owners of properties greater than one acre of pervious land area would apply fertilizer to a maximum of one acre.

The second factor taken into account is the probability that homeowners would apply fertilizer to their property. Based on socioeconomic studies, property value can be a reasonable indicator of landscape fertilization in a residential setting, with higher valued properties receiving more fertilizer (Kinzig et al. 2005; Law et al. 2004; Zhou et al. 2008; Cook et al. 2012). To apply this factor, the range of property values for single-family homes was evaluated for all counties in the springs coast (Citrus, Hernando, and Pasco) and subdivided into three categories based on the distribution of property values: high, medium, and low (**Appendix B**). **Table 7** lists the estimated probability of fertilization for each property value category based on previous studies.

Table 7: Distribution of property value and the probability of fertilization for the BMAP area

Property Value Label	Property Value	Probability of Fertilization (%)
High	> \$150,000	90
Medium	\$50,001 – \$150,000	75
Low	≤ \$50,000	10

The probability factors in **Table 7** are based on socioeconomic studies of lawn care trends in urban environments (Kinzig et al. 2005; Grove et al. 2006; Carey et al. 2012). These factors were applied to the pervious acreage of residential properties to adjust the land area presumed to be fertilized. The land area estimated to receive fertilizer applications was multiplied by the annual application rate, listed in **Table 4**, to obtain the estimated input of nitrogen in fertilizer to the land surface on residential parcels (**Table 8** and **Table 9**). **Appendix B** provides more detailed information on this methodology.

Table 8: Summary of urban fertilizer data attributed to residential parcels in the Homosassa contributing area

Parcel Type	Citrus High Recharge (acres)	Citrus Medium Recharge (acres)	Citrus Low Recharge (acres)	Hernando High Recharge (acres)	Hernando Medium Recharge (acres)	Total Input (lb-N/yr)
Single-Family Residential	3,527	437	104	400	33	4,502
Multifamily Residential	53	5	3	0	0	61
Condominium	6	1	0	0	0	7
Vacant Residential	476	69	36	21	1	603
Total	4,063	511	143	421	35	5,173

Table 9: Summary of urban fertilizer data attributed to residential parcels in the Chassahowitzka contributing area

Parcel Type	Citrus High Recharge (acres)	Citrus Medium Recharge (acres)	Citrus Low Recharge (acres)	Hernando High Recharge (acres)	Hernando Medium Recharge (acres)	Hernando Low Recharge (acres)	Total Input (lb-N/yr)
Single-Family Residential	656	118	4	2,562	30	3	3,373
Multifamily Residential	4	2	0	30	0	0	36
Condominium	1	0	0	1	0	0	1
Cooperatives	0	0	0	1	0	0	1
Vacant Residential	56	17	4	0	0	0	76
Total	716	137	7	2,594	30	3	3,488

2.5 Sports Turfgrass Fertilizer

Fertilizer applied to sports turfgrass areas is another potential source of nitrogen to the land surface. These areas fall into two main categories and were evaluated separately: golf courses and sporting facilities (such as baseball, football, and soccer fields, as well as other fields where fertilizers are likely applied).

To estimate the fertilization rate at golf courses, the NSILT used a statewide annual average application rate (previously vetted by golf course professionals) of 141.1 lb-N/ac/yr (or 72 % of the course area at 4.5 lb-N/1,000 square feet [ft²]) (Sartain 2002; DEP 2007). Some golf courses span both contributing areas, and the nitrogen input was estimated based on the land area within each boundary. **Table 10** summarizes the input to the land surface from each golf course in the contributing area.

Table 10: Summary of urban fertilizer input of nitrogen for golf courses

* = A portion of the golf course is located in the Weeki Wachee contributing area.

Golf Club Name	Contributing Area	County	High-Recharge Land Area (acres)	Medium-Recharge Land Area (acres)	Total Input (lb-N/yr)
Sugarmill Woods Country Club	Homosassa	Citrus	142	0	19,991
Sugarmill Woods Country Club	Chassahowitzka	Citrus	119	0.1	16,828
Inverness Golf and Country Club	Homosassa	Citrus	123	5	18,065
Southern Woods Golf Club	Homosassa	Citrus	61	0	8,654
Southern Woods Golf Club	Chassahowitzka	Citrus	92	0	13,017
Point O'Woods Golf Club	Homosassa	Citrus	20	0	2,767
Brookridge Country Club*	Chassahowitzka	Hernando	92	0	12,995
Brooksville Country Club	Chassahowitzka	Hernando	182	0	25,686
World Woods Golf Club	Chassahowitzka	Hernando	577	154	103,143
Sweet Swing Driving Range	Chassahowitzka	Citrus	0	8	1,171

Sports facilities were assessed based on feedback from county parks departments and school boards that provided detailed information on annual fertilization rates as well as the locations where the fertilizers are applied (see **Table A.15** through **Table A.17** in **Appendix A**). In total, in Citrus County 39 acres of land were associated with sports fields in the high-recharge areas and 9 acres in the medium-recharge areas. In Hernando County, there were 99 acres of sports fields in the high-recharge area. **Table 11** summarizes data for all sports fields.

Table 11: Summary of fertilizer nitrogen applied to the land surface for sporting facilities

Property Name	Contributing Area	County	Application Rate (lb-N/ac/yr)	High Recharge	Medium Recharge	Total
Homosassa Recreation Park	Homosassa	Citrus	321	4	0	1,367
Citrus High School	Homosassa	Citrus	96	23	0	2,256
Lecanto High School	Homosassa	Citrus	212	12	9	2,448
Winding Waters K-8	Chassahowitzka	Hernando	30	11	0	334
D.S. Parrott Middle School	Chassahowitzka	Hernando	30	20	0	582
West Hernando Middle	Chassahowitzka	Hernando	30	33	0	974
Ernie Weave Youth Park	Chassahowitzka	Hernando	39	31	0	1,207
Kennedy Park	Chassahowitzka	Hernando	39	4	0	155
Total				138	9	9,323

2.6 Livestock Waste

2.6.1 Nondairy Livestock

The BMAP area contains mainly small-scale nondairy livestock farms that are predominantly cow-calf operations. Information on agricultural practices specific to this type of livestock management was obtained through meetings with agricultural producers and stakeholders. Typical cattle stocking rates in Citrus County are estimated as one cow per six to eight acres of pasture (Public stakeholder discussion, Lecanto, FL, July 2014). The estimation of pasture acreage was based on PA data and included improved, semi-improved, and native pastures.

Table 12 and **Table 13** lists the estimated pasture acreage and the associated cattle populations within both of the contributing area boundaries.

Table 12: PA pasture data and estimated cattle populations based on stocking rates for the Homosassa contributing area

County	Property Code	PA Land Description	Estimated Improvement	High-Recharge Area (acres)	Medium-Recharge Area (acres)	Low-Recharge Area (acres)	Estimated Cattle Population
Citrus	60	Grazing Land	Improved	3,538	181	100	546
Citrus	61	Grazing Land	Semi-Improved	2,510	493	16	431
Citrus	62	Grazing Land	Semi-Improved	6,493	830	240	1,080
Citrus	63	Grazing Land	Rangeland	6,139	336	140	945
Hernando	60	Improved Pastureland	Improved	2,530	450	0	426

Table 13: PA pasture data and estimated cattle populations based on stocking rates for the Chassahowitzka contributing area

County	Property Code	PA Land Description	Estimated Improvement	High-Recharge Area (acres)	Medium-Recharge Area (acres)	Low-Recharge Area (acres)	Estimated Cattle Population
Citrus	60	Grazing Land	Improved	65	24	1	13
Citrus	61	Grazing Land	Semi-Improved	10	0	0	1
Citrus	62	Grazing Land	Semi-Improved	459	39	0	71
Citrus	63	Grazing Land	Rangeland	245	7		36
Hernando	60	Improved Pastureland	Improved	13,834	733	205	2,110
Hernando	65	Grazing Land Soil Capab IV	Rangeland	23			3

Other livestock animal populations were estimated using data from the U.S. Department of Agriculture (USDA), which publishes a Census of Agriculture (CoA) every five years. This comprehensive report provides summary data on the agricultural practices and livestock populations for each state and county in the U.S. The 2012 CoA report was used to provide data on livestock populations for this assessment. However, since the CoA reports entire county data, estimates of livestock populations in the BMAP area were made based on land use coverage.

To estimate the number of livestock animals in the contributing area, the SWFWMD land use coverage was used to identify land use categories likely to contain livestock, i.e., pastures, feeding operations, and specialty farms. These land areas were totaled for Citrus and Hernando Counties and subdivided by recharge rate category. The summations were used to calculate percentages of countywide livestock area within the BMAP area and within the high, medium and low recharge areas.

These percentages were applied to the populations provided by the CoA to estimate the number of animals in the contributing area and in the medium and high recharge rate areas of Citrus and Hernando Counties (**Table 14** and **Table 15**, respectively). For example, if 10,000 cows were reported for a particular county in the CoA, but only 10 % of the livestock lands in that county were inside the BMAP area, it was assumed that the contributing area contained 1,000 cows. Note that according to the CoA, there are approximately 900,000 layer chickens in Hernando County. Both the SWFWMD and the PA office confirmed there was a large-scale chicken operation in the area, but this has closed since the CoA was taken. Based on this information, this analysis for Hernando County does not include layer chickens.

Table 14: SWFWMD land use percentages and miscellaneous livestock population data for Citrus County (Homosassa and Chassahowitzka contributing areas)

Contributing Area	Land Category	Land Area (acres)	Land Use %	Horses	Broiler Chickens	Layer Chickens	Goats	Hogs	Sheep	Turkeys
	Citrus County	29,613		1,159	348	1,775	903	196	279	27
Homosassa	High Recharge	16,396	55	642	193	983	500	109	154	15
Homosassa	Medium Recharge	841	3	33	10	51	26	6	8	1
Homosassa	Low Recharge	171	1	7	2	10	5	1	2	0

Contributing Area	Land Category	Land Area (acres)	Land Use %	Horses	Broiler Chickens	Layer Chickens	Goats	Hogs	Sheep	Turkeys
	Citrus County	29,613		1,159	348	1,775	903	196	279	27
Chassahowitzka	High Recharge	621	2	24	7	37	19	4	6	1
Chassahowitzka	Medium Recharge	40	0.1	2	0.5	2	1	0.3	0.4	0.04
Chassahowitzka	Low Recharge	15	0.1	1	0.2	1	0.5	0.1	0.1	0.01

Table 15: WMD land use percentages and miscellaneous livestock population data for Hernando County (Homosassa and Chassahowitzka contributing areas)

Contributing Area	Land Category	Land Area (acres)	Land Use %	Horses	Broiler Chickens	Goats	Hogs	Sheep
	Hernando County	33,851		2,080	546	1,034	328	318
Homosassa	High Recharge	4,753	14	292	77	145	46	45
Homosassa	Medium Recharge	347	1	21	6	11	3	3

Contributing Area	Land Category	Land Area (acres)	Land Use %	Horses	Broiler Chickens	Goats	Hogs	Sheep
	Hernando County	33,851		2,080	546	1,034	328	318
Chassahowitzka	High Recharge	11,567	34	711	187	353	112	109
Chassahowitzka	Medium Recharge	341	1	21	5	10	3	3
Chassahowitzka	Low Recharge	74	0.2	5	1	2	1	1

Nitrogen waste factors were assigned for each animal type and applied to the estimated livestock populations to estimate the nitrogen input to the land surface. The nitrogen waste factors in lb-N/day per animal were as follows: cattle, 0.337; broiler chickens, 0.159; layer chickens, 0.003; goats, 0.035; hogs, 0.190; sheep, 0.198; turkeys, 0.006; and horses, 0.273 (Goolsby et al. 1999; Katz et al. 1999; Chelette et al. 2002; Ruddy et al. 2006; Meyer 2012; Sprague and Gronberg 2013). **Table 16** lists the TN input to the land surface attributable to livestock waste for the low, medium, and high recharge rate areas in the contributing area.

Table 16: Estimated nitrogen applied as animal waste to the land surface in the BMAP area

Land Category	Cattle	Horses	Broiler Chickens	Layer Chickens	Goats	Hogs	Sheep	Turkeys	Total N Input (lb-N/yr)
High	585,756	154,081	34,631	1,117	50,233	21,643	24,997	34	872,493
Medium	46,499	6,045	1,285	58	1,635	815	999	2	57,338
Low	12,355	1,283	273	12	350	173	212	0.4	14,660
Total	644,611	161,409	36,189	1,187	52,219	22,632	26,208	36	644,611

2.6.2 Dairy Livestock

In the Homosassa contributing area, there is 1 large dairy operation located approximately 8 miles southwest of the springs. This family-owned operation on 322 acres has been at this location since 2003 and has been incorporating BMPs. The farm includes two 6-row free stall barns that contain a total of 840 stalls for approximately 700 cows. Each stall includes a dual-chambered waterbed mattress covered with composted separated manure solids that are frequently changed. The barns are flushed and the wastewater is collected and passed through a screen solid separator prior to being held in tanks and applied to the crop fields (corn, sorghum and ryegrass) as irrigation and fertilizer (P.A. Robertshaw, personal communication, August 17, 2016; McClellan 2013).

For the purpose of the NSILT analysis, actual dairy management practices are taken into consideration to estimate the nitrogen input to the land surface. According to McClellan (2013), this dairy has fewer than 700 cows, and thus DEP used a population of 675 cows. A daily nitrogen waste factor for a dairy cow is approximately 0.794 lb-N/day (Sutton et al. 2001; Hubbard and Lowrance 2002; USDA Agricultural Research Service [ARS] 2003; American Society of Agricultural Engineers [ASAE] 2005; Cabrera et al. 2006). In total, an estimated 240,708 lb-N/yr from dairy waste are applied to the land surface from this dairy operation.

2.7 Farm Fertilizer

Nitrogen in agricultural fertilizer is applied at widely varying rates, depending on the crop, time of year, and individual farm practices. The PA offices in Citrus and Hernando Counties provided detailed information on the types of crops grown in the area. Nitrogen inputs to the land surface were estimated based on the type of crops grown in each PA land use category and the recommended nitrogen application rates for crops by the University of Florida Institute of Food

and Agricultural Sciences (UF–IFAS) (Hochmuth and Hanlon 2000, 2010, 2013; Wright et al. 2011; Mylavarapu et al. 2012; Liu et al. 2012). **Table 17** and **Table 18** summarize the nitrogen inputs to the land surface from fertilizers applied to cropland for the recharge areas within the Homosassa and Chassahowitzka contributing areas, respectively.

Table 17: Summary of crop types and nitrogen application rates for the Homosassa contributing area

* = According to Hernando County agricultural producers, 25 % of improved pastures are fertilized at 60 lb-N/ac/yr.

Property Code	PA Land Description	Estimated Crop Type	N Application Rate (lb-N/ac)	County	High-Recharge Area (acres)	Medium-Recharge Area (acres)	Low-Recharge Area (acres)	Total Input (lb-N/yr)
51	Cropland Soil Class 1	Hay	80	Citrus	1,829	103	19	156,014
52	Cropland Soil Class 2	Hay	80	Citrus	110	0	51	12,918
60	Grazing Land	Improved Pasture	25	Citrus	3,538	181	100	95,484
61	Grazing Land	Semi-Improved Pasture	17	Citrus	2,510	493	16	51,317
62	Grazing Land	Semi-Improved Pasture	17	Citrus	6,493	830	240	128,563
63	Grazing Land	Rangeland Pasture	0	Citrus	6,139	336	140	0
66	Orchard Groves Citrus	Orchards	150	Citrus	82	106	0	28,268
69	Ornamentals Misc Ag	Ornamentals	80	Citrus	310	30	1	27,329
51	Cropland Soil Capability CLS 1	Hay, Berries, Watermelons	80	Hernando	726	59	0	62,815
60	Improved Pasture	Improved Pasture	60*	Hernando	2,530	450	0	44,697
66	Orchard Groves	Orchards	150	Hernando	210	0	0	31,547
69	Ornamentals	Ornamentals	80	Hernando	3	0	0	265

Table 18: Summary of crop types and nitrogen application rates for the Chassahowitzka contributing area

Property Code	PA Land Description	Estimated Crop Type	N Application Rate (lb-N/ac)	County	High-Recharge Area (acres)	Medium-Recharge Area (acres)	Low-Recharge Area (acres)	Total Input (lb-N/yr)
51	Cropland Soil Class 1	Hay	80	Citrus	46	0.02	0	3,684
60	Grazing Land	Improved Pasture	25	Citrus	65	24	1	2,248
61	Grazing Land	Semi-Improved Pasture	17	Citrus	10	0	0	164
62	Grazing Land	Semi-Improved Pasture	17	Citrus	459	39	0	8,471
63	Grazing Land	Rangeland Pasture	0	Citrus	245	7	0	
69	Ornamentals Misc Ag	Ornamentals	80	Citrus	5	6	0	906
51	Cropland Soil Capability CLS 1	Hay, Berries, Watermelons	80	Hernando	1,921	20	0	155,347
60	Improved Pasture	Improved Pasture	60	Hernando	13,834	733	205	221,568
65	Grazing Land Soil Capab VI	Rangeland Pasture	0	Hernando	23	0	0	0
66	Orchard Groves	Orchards	150	Hernando	280	2	0	42,283
69	Ornamentals	Ornamentals	80	Hernando	27	0	0	79,305

2.8 Summary of Estimated Nitrogen Inputs to the Land Surface

Figure 8 and **Figure 9** summarizes the relative contributions of nitrogen (in percent) from the major sources for each contributing area. The total annual nitrogen input to the land surface from all sources is 3.4 million lb-N in Homosassa and 2.3 million lb-N in Chassahowitzka.

Atmospheric deposition is the largest nitrogen source to the land surface for both areas, followed by agricultural sources and urban turfgrass fertilizers.

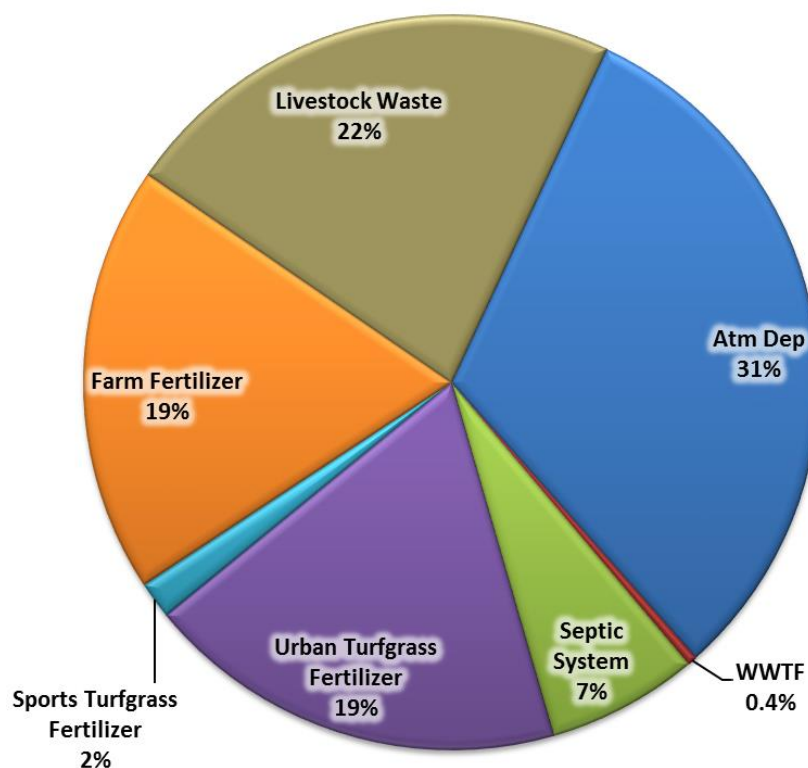


Figure 8: Relative nitrogen inputs to the land surface in the Homosassa Springs contributing area from major anthropogenic source categories in lb-N/yr

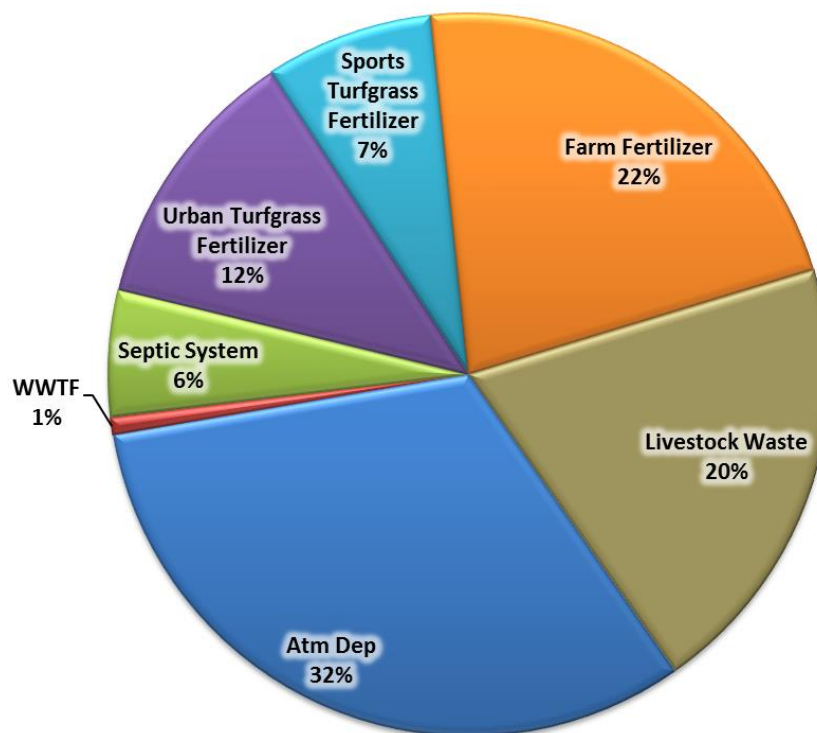


Figure 9: Relative nitrogen inputs to the land surface in the Chassahowitzka Springs contributing area from major anthropogenic source categories in lb-N/yr

3. Nitrogen Attenuation and Loading to Groundwater

The movement of nitrogen from the land surface to groundwater is controlled by biological and chemical processes that occur as part of the nitrogen cycle, in combination with hydrogeological processes. Many of these processes attenuate (impede or remove) the amount of nitrogen transported to groundwater. An understanding of how water moves through the subsurface and the processes that transform the different forms of nitrogen is essential for estimating nitrogen loading to groundwater from various sources (Liao et al. 2012; Wang et al. 2013).

To estimate the amount of nitrogen loading to the aquifer in the BMAP area, DEP applied two nitrogen attenuation factors. The specific biochemical attenuation factor (BAF) is applied to each nitrogen source category to account for biochemical processes that remove or transform the different forms of nitrogen. The hydrogeological attenuation factor (HAF) accounts for spatial variations in hydrogeological properties that affect the rate of water infiltrating through geologic material to recharge the UFA. Both factors control the amount of nitrogen reaching the UFA annually and in the movement of groundwater moving towards the Homosassa and Chassahowitzka Springs Groups.

3.1 Biochemical Attenuation

Several near-surface biochemical processes within the nitrogen cycle increase nitrogen availability for plants, including fixation (the conversion of atmospheric nitrogen to a plant-available form), mineralization (the conversion of organic nitrogen to ammonium), and nitrification (the conversion of ammonium to nitrate). Losses of nitrogen from the root zone can result from denitrification, volatilization, immobilization, and cation exchange (affecting ammonium). These processes occur to varying degrees depending on how the form of nitrogen is introduced, soil properties, and several other factors (Cockx and Simonne 2011; Costa et al. 2002; Horsley Witten Group 2009).

Specific BAFs were used to account for the various processes that affect the movement of nitrogen from each source category in the subsurface and were obtained through an extensive literature review of relevant studies conducted throughout Florida as well as other areas with similar environmental characteristics. Additionally, research scientists in Florida (UF–IFAS, universities, and USDA ARS) and local stakeholders provided additional guidance and review. The BAFs, listed in

Table 19, represent the average percentage of the nitrogen attenuated or removed by subsurface processes and not available to leach to groundwater.

As a first step in estimating loading to groundwater, the nitrogen inputs at the land surface from each category, discussed previously, are multiplied by their respective BAFs (

Table 19). For example, atmospheric deposition has an average nitrogen attenuation of 90 % (mainly from uptake by vegetation). This means that only 10 % of the atmospheric nitrogen input to the land surface has the potential to infiltrate to groundwater.

Table 19: BAFs applied to the nitrogen input calculations

* Both sports and urban turfgrass.

** These percentages represent the average amount of nitrogen removed by the environment over varying soil characteristics.

N Source Category	BAF (%)**	Literature References
Atmospheric Deposition	90	Katz et al. 2009; Lombardo Associates 2011; Howard T. Odom Florida Springs Institute 2011
WWTFs–RIBs	25	Merritt and Toth 2006; Sumner and Bradner 1996
WWTFs–Sprayfield	60	Katz et al. 2009; Lombardo Associates 2011; Howard T. Odom Florida Springs Institute 2011
WWTFs–Reuse	75	Jordan et al. 1997; Candela et al. 2007; Rahil and Antonopoulos 2007
Urban Fertilizer*	80	Goolsby et al. 1999; Erikson et al. 2001; Barton and Colmer 2006; Katz et al. 2009
Septic Systems	50	Poiani et al. 1996; Aravena and Robertson 1998; Tomasko et al. 2001; Corbett et al. 2002; Otis 2007; Toor et al. 2011
Livestock Waste–Nondairy	90	Dubeux et al. 2007; Silveira et al. 2007; Burns et al. 2009; Dubeux et al. 2009; Obour et al. 2010; Sigua 2010; Sigua et al. 2010; Silveira et al. 2011; Woodard et al. 2011; White-Leech et al. 2013a; White-Leech et al. 2013b
Livestock Waste–Dairy	50	Woodard et al. 2002; Landig et al. 2010
Farm Fertilizer	80	McNeal et al. 1995; Wang and Alva 1996; Paramasivam and Alva 1997; Newton et al. 1999; Hochmuth 2000a; Hochmuth 2000b; Simonne et al. 2006; He et al. 2011; Liu et al. 2013

3.2 Hydrogeological Attenuation

Nitrogen (usually in the form of nitrate) that is not attenuated by biochemical attenuation processes can leach to groundwater. Leaching to groundwater is a function of the properties of the soil and unsaturated zone, such as composition (particle size, organic matter content), texture, drainage, wetness, and thickness. The rate of groundwater recharge (from rainfall or irrigation water) ultimately controls how rapidly nitrogen moves from below the root zone to the UFA. The amount of water recharging the UFA each year also depends on the amount of rainfall, evapotranspiration, and runoff, in addition to subsurface hydrogeological properties.

The final step in estimating nitrogen loads to groundwater is to account for the additional attenuation associated with the rate of recharge in a given year. Recharge rates incorporate soil and unsaturated zone properties, and they are geospatially assessed based on information from a U.S. Geological Survey (USGS) recharge map (see **Section 1.4, Hydrogeology and Aquifer Recharge**). Therefore, the rate of recharge to the UFA used in the NSILT is an aggregated indicator of the various hydrogeological processes that can further attenuate the nitrate as it moves to groundwater. In areas with lower annual recharge rates, the vertical movement of water and associated chemical constituents is impeded, which may allow for increased biological uptake and denitrification (Liao et al. 2012; Wang et al. 2013).

In contrast, for areas with higher recharge rates, water spends less time in the soil/root zone, decreasing the opportunity for biochemical attenuation. This likely results in the increased leaching of nitrogen as well as a higher potential for nitrogen transport to the aquifer in a given year (Scanlon et al. 2002; Liao et al. 2012).

Additional nitrogen attenuation factors related to recharge rates were arbitrarily assigned as follows: 90 % in high recharge rate areas (≥ 10 in/yr), 50 % in medium recharge rate areas (4 to 9.9 in/yr), and 10 % in low recharge rate areas (0 to 3.9 in/yr) (HydroGeologic Inc. 2013). For example, in high-rate recharge areas, 90 % of the nonattenuated nitrogen mass is assumed to reach the aquifer in a year, while only 50 % of the nonattenuated nitrogen mass is assumed to reach the aquifer annually in medium-rate recharge areas and 10 % in low recharge. These attenuation factors are based on the recharge characteristics specific to the hydrogeological conditions in the BMAP area.

3.3 Estimated Nitrogen Loads to Groundwater

Table 20, **Table 21**, and **Table 22** summarize estimated annual nitrogen inputs, attenuation factors, and loads to the UFA, respectively, in the springs contributing areas for the recharge rate categories. The results indicate an estimated total annual load of 582,076 lb-N (2.9 lb-N/ac) to the UFA in the Homosassa contributing area, representing 17 % of the amount of nitrogen inputs to the land surface. In the Chassahowitzka contributing area, an annual total load was estimated of 380,462 lb-N (2.7 lb-N/ac), which is 16 % of the input to the land surface. As discussed previously, the difference is due to various nitrogen attenuation processes and variations in the quantity and movement of water recharging the aquifer.

Figure 10 and **Figure 11** show the relative contribution of estimated annual loads of nitrogen to the UFA by source category. The NSILT results indicate that most of the nitrogen load to groundwater originates from fertilizers and septic systems. This is consistent with nitrogen isotopic and other chemical data. Nitrogen-isotope signatures in water samples collected in 2013 indicated that elevated nitrate-N concentrations in groundwater originate from a mix of both inorganic (fertilizer) and organic (human and animal waste) sources (Dodson et al. 2014; Bridger et al. 2014). Aquifer recharge rates have strongly influenced the loading of nitrogen to the UFA in the groundwater contributing area.

Figure 12 and **Figure 13** summarize the estimated nitrogen loads to groundwater for the high, medium, and low recharge rate areas, including a breakdown for each source category. The majority of the nitrogen loading to groundwater in both contributing areas occurs in high rate recharge areas.

Table 20: Estimated inputs to the land surface by nitrogen source category in the Homosassa and Chassahowitzka contributing areas and the BMAP area (lb-N/yr)

Contributing Area	Recharge Category	Atmospheric Deposition	WWTFs–RIBs	WWTFs–Sprayfields	WWTFs–Reuse	Septic Systems	Urban Turf Fertilizers	Sports Turf Fertilizers	Farm Fertilizers	Livestock Waste–Nondairy	Livestock Waste–Dairy	Total
Homosassa	High	802,581	4,245	3,662	6,128	202,246	440,417	53,783	561,567	515,835	195,622	2,786,086
Homosassa	Medium	206,304	150	0	215	19,515	108,460	1,764	65,109	48,503	0	450,020
Homosassa	Low	60,456	211	0	0	4,523	81,845	0	12,542	0	0	159,576
	Total	1,069,340	4,606	3,662	6,343	226,284	630,721	55,547	639,218	564,338	195,622	3,395,681

Contributing Area	Recharge Category	Atmospheric Deposition	WWTFs–RIBs	WWTFs–Sprayfields	WWTFs–Reuse	Septic Systems	Urban Turf Fertilizers	Sports Turf Fertilizers	Farm Fertilizers	Livestock Waste–Nondairy	Livestock Waste–Dairy	Total
Chassahowitzka	High	626,520	11,659	5,452	0	128,101	267,920	153,189	496,158	441,974	0	2,130,974
Chassahowitzka	Medium	93,240	20	1,351	0	2,613	12,304	22,905	14,708	19,687	0	166,827
Chassahowitzka	Low	29,677			0	1,171	536		3,111	4,877	0	39,372
	Total	749,437	11,679	6,803	0	131,885	280,759	176,094	513,977	466,538	0	2,337,173

Contributing Area	Recharge Category	Atmospheric Deposition	WWTFs–RIBs	WWTFs–Sprayfields	WWTFs–Reuse	Septic Systems	Urban Turf Fertilizers	Sports Turf Fertilizers	Farm Fertilizers	Livestock Waste–Nondairy	Livestock Waste–Dairy	Total
BMAP	High	1,429,101	15,905	9,115	6,128	330,347	708,337	206,972	1,057,725	957,810	195,622	4,917,059
BMAP	Medium	299,543	170	1,351	215	22,127	120,763	24,669	79,817	68,190	0	616,846
BMAP	Low	90,133	211	0	0	5,694	82,381	0	15,653	4,877	0	198,948
	Total	1,818,777	16,285	10,465	6,343	358,169	368,376	911,480	1,153,195	1,030,876	195,622	5,732,854

Table 21: Average biochemical attenuation factors by source category in the Homosassa and Chassahowitzka contributing areas and the BMAP area (lb-N/yr)

Contributing Area	Recharge Category	Atmospheric Deposition	WWTFs–RIBs	WWTFs–Sprayfields	WWTFs–Reuse	Septic Systems	Urban Turf Fertilizer	Sports Turf Fertilizer	Farm Fertilizers	Livestock Waste–Nondairy	Livestock Waste–Dairy	Total
	BAF (%)	90	25	60	75	50	70	70	80	90	50	
Homosassa	High	80,258	3,184	1,465	1,532	101,123	132,125	16,135	112,313	51,583	97,811	597,530
Homosassa	Medium	20,630	113	0	54	9,757	32,538	529	13,022	4,850	0	81,493
Homosassa	Low	6,046	158	0	0	2,262	24,553	0	2,508	0	0	35,527
	Total	106,934	3,454	1,465	1,586	113,142	189,216	16,664	127,844	56,434	97,811	714,550

Contributing Area	Recharge Category	Atmospheric Deposition	WWTFs–RIBs	WWTFs–Sprayfields	WWTFs–Reuse	Septic Systems	Urban Turf Fertilizers	Sports Turf Fertilizers	Farm Fertilizers	Livestock Waste–Nondairy	Livestock Waste–Dairy	Total
	BAF (%)	90	25	60	75	50	70	70	80	90	50	
Chassahowitzka	High	62,652	8,745	2,181	0	64,051	80,376	45,957	99,232	44,197	0	407,390
Chassahowitzka	Medium	9,324	15	540	0	1,306	3,691	6,872	2,942	1,969	0	26,659
Chassahowitzka	Low	2,968		0	0	585	161	0	622	488	0	4,824
	Total	74,944	8,760	2,721	0	65,942	84,228	52,828	102,795	46,654		438,872

Contributing Area	Recharge Category	Atmospheric Deposition	WWTFs–RIBs	WWTFs–Sprayfields	WWTFs–Reuse	Septic Systems	Urban Turf Fertilizers	Sports Turf Fertilizers	Farm Fertilizers	Livestock Waste–Nondairy	Livestock Waste–Dairy	Total
	BAF (%)	90	25	60	75	50	70	70	80	90	50	
BMAP	High	142,910	11,928	3,646	1,532	165,174	212,501	62,092	211,545	95,780	97,811	1,004,919
BMAP	Medium	29,954	128	540	54	11,064	36,229	7,401	15,963	6,819	0	108,152
BMAP	Low	9,013	158	0	0	2,847	24,714	0	3,131	488	0	40,351
	Total	181,878	12,214	4,186	1,586	179,084	273,444	69,492	230,639	103,088	97,811	1,153,422

Table 22: Load to groundwater with recharge factors applied by nitrogen source category in the Homosassa and Chassahowitzka contributing areas and the BMAP area (lb-N/yr)

§ = Combination of all WWTF subcategories: RIBs, sprayfields, and reuse.

* = Combination of nondairy and dairy subcategories.

Contributing Area	Recharge Category	HAF (%)	Atmospheric Deposition	WWTFs§	Septic Systems	Urban Turf Fertilizers	Sports Turf Fertilizers	Farm Fertilizers	Livestock Waste*	Total
Homosassa	High	90	72,232	5,563	91,011	118,913	14,521	101,082	134,455	537,777
Homosassa	Medium	50	10,315	83	4,879	16,269	265	6,511	2,425	40,747
Homosassa	Low	10	605	16	226	2,455	0	251	0	3,553
	Total		83,152	5,662	96,116	137,637	14,786	107,844	136,880	582,076

Contributing Area	Recharge Category	HAF (%)	Atmospheric Deposition	WWTFs§	Septic Systems	Urban Turf Fertilizers	Sports Turf Fertilizers	Farm Fertilizers	Livestock Waste*	Total
Chassahowitzka	High	90	56,387	9,833	57,645	72,338	41,361	89,308	39,778	366,651
Chassahowitzka	Medium	50	4,662	278	653	1,846	3,436	1,471	984	13,329
Chassahowitzka	Low	10	297	0	59	16	0	62	49	482
	Total		61,346	10,111	58,357	74,200	44,797	90,841	40,811	380,462

Contributing Area	Recharge Category	HAF (%)	Atmospheric Deposition	WWTFs§	Septic Systems	Urban Turf Fertilizers	Sports Turf Fertilizers	Farm Fertilizers	Livestock Waste*	Total
BMAP	High	90	128,619	15,396	148,656	191,251	55,882	190,390	174,233	904,427
BMAP	Medium	50	14,977	361	5,532	18,115	3,700	7,982	3,409	54,076
BMAP	Low	10	901	16	285	2,471	0	313	49	4,035
	Total		144,498	15,772	154,473	211,837	59,583	198,685	177,691	962,538

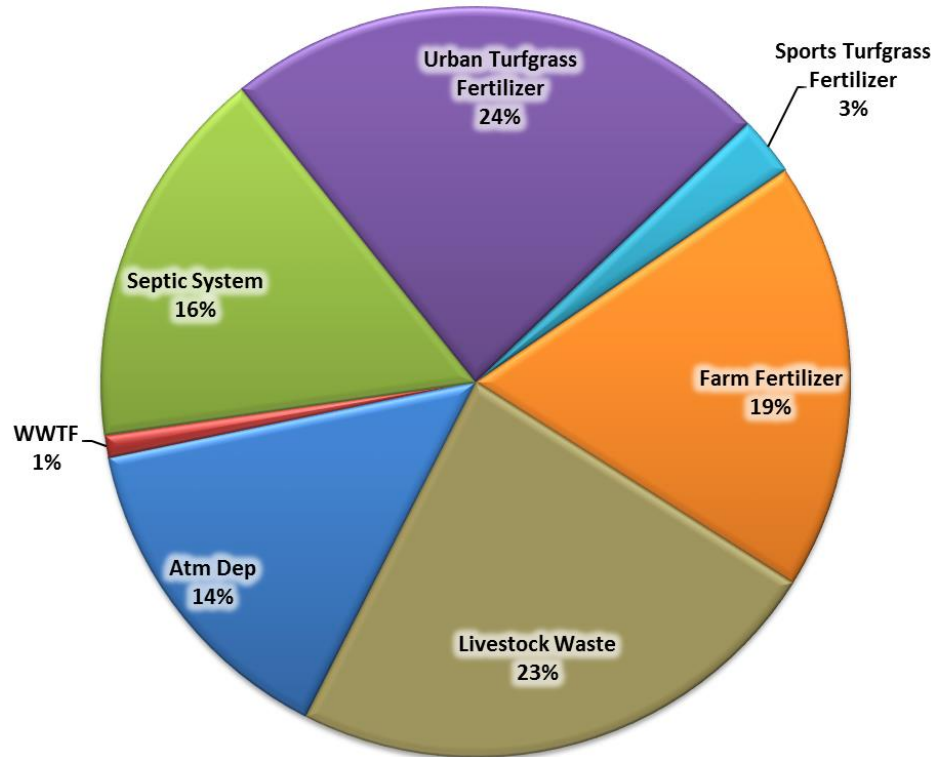


Figure 10: Relative percent contributions of nitrogen loading to groundwater for source categories in the Homosassa Springs contributing area

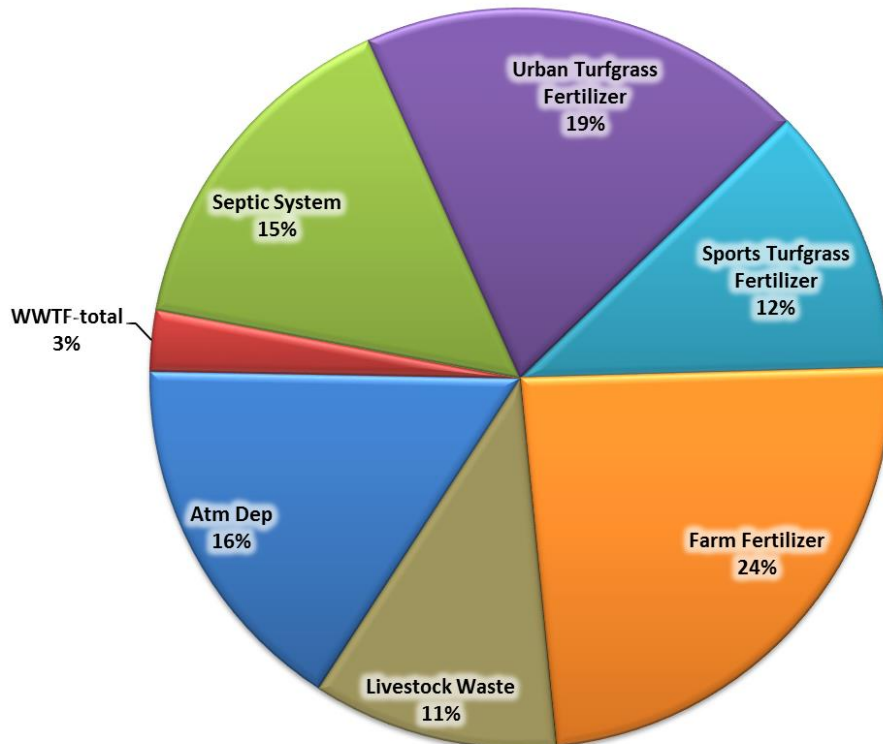


Figure 11: Relative percent contributions of nitrogen loading to groundwater for source categories in the Chassahowitzka Springs contributing area

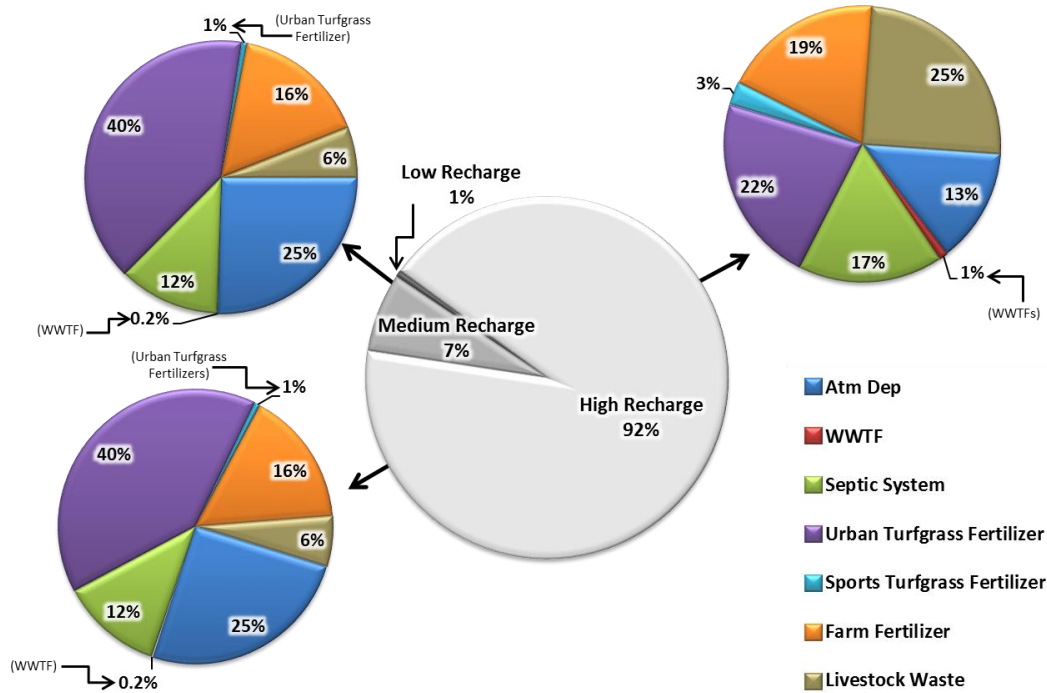


Figure 12: Estimated annual nitrogen loading to groundwater by recharge category for the Homosassa Springs contributing area

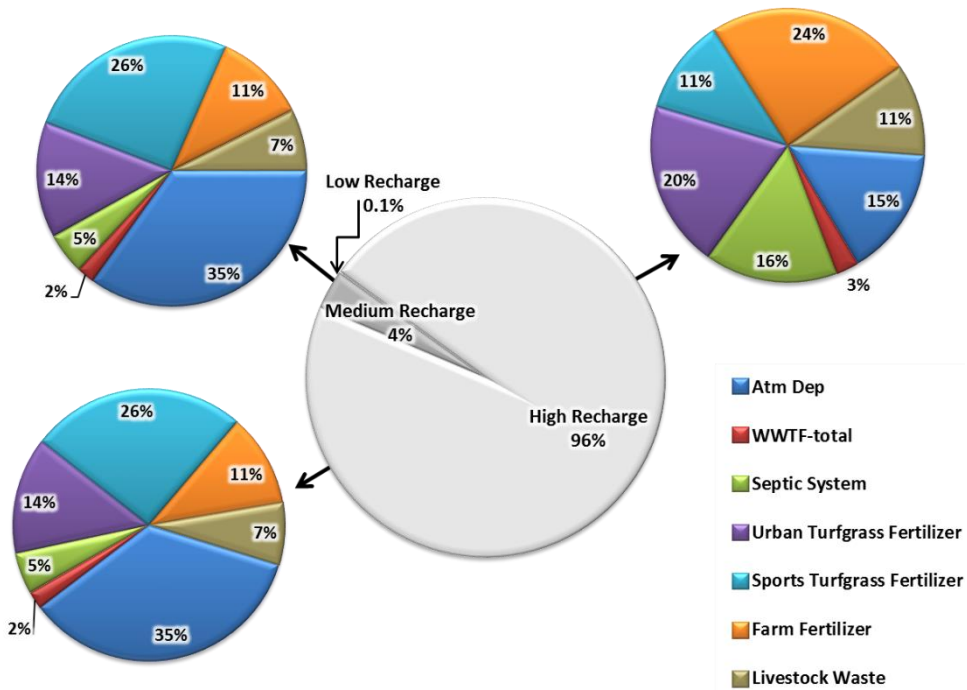


Figure 13: Estimated annual nitrogen loading to groundwater by recharge category for the Chassahowitzka contributing area

3.4 Accounting for Uncertainty in Nitrogen Attenuation Factors in Estimating Loading to Groundwater

The pie charts in **Section 3.3** provide information about the relative contribution of nitrogen loading to groundwater from each source. However, if the contribution from one nitrogen source category were to increase or decrease, the contribution of all the other sources would change proportionally. The amount of nitrogen attenuation for each source can vary substantially, both spatially and with depth in the subsurface, and can affect the amount of nitrogen leaching to groundwater and its relative contribution. The range (or uncertainty) in nitrogen attenuation can result from variability in soil properties, crop types, agricultural practices, nitrogen storage, the volatilization of ammonia to the atmosphere, uptake by vegetation, denitrification, and other removal processes. The density of nitrogen sources can also dramatically affect the attenuation potential of the environment.

Given the relatively large range in nitrogen attenuation for each source, DEP opted to use an average attenuation factor estimated based on land use practices and hydrogeological conditions in the BMAP area. Greater emphasis was placed on information on nitrogen attenuation from studies in central Florida, other locations in Florida, or areas with very similar soil and vegetation characteristics. **Table 23** lists the range in nitrogen attenuation for each source.

Table 23: Range of environmental attenuation of nitrogen from a detailed literature review

* Both sports and urban turfgrass.

N Source Category	Minimum BAF (%)	Average BAF Used To Estimate N loads to Groundwater (%)	Maximum BAF (%)
Atmospheric Deposition	85	90	95
WWTFs-RIBs	10	25	40
WWTFs-Sprayfields	50	60	75
WWTFs-Reuse	50	75	85
Septic Systems	40	50	75
Livestock Waste-Nondairy	80	90	95
Livestock Waste-Dairy	40	50	70
Farm Fertilizers	50	70	85
Urban Fertilizers*	50	80	85

Using the minimum and maximum BAFs in **Table 23**, the corresponding range of nitrogen loading to groundwater was estimated from each source in the BMAP area (**Figure 14** and **Figure 15**). Even with the relatively large range in nitrogen attenuation for each source, the total estimated nitrogen load to groundwater in the both springsheds greatly exceeds the target load (TMDL) estimated for the Homosassa and Chassahowitzka Springs Groups. The target N load

was calculated based on the most recent discharge data and the average TN concentration in water discharging from the spring vent.

For the Homosassa Springs Group, the estimated total discharge is 172.6 cfs (USGS Gauge Stations 02310678, 02310688, 0230675; January 2015–December 2015), and the adopted TMDL is 0.23 mg/L for the springs (Bridger et al. 2014), resulting in a target nitrogen load of 78,048 lb-N/yr. Using the maximum nitrogen attenuation factors for each source, the minimum estimated load to groundwater in the contributing area is 328,989 lb-N/yr, which is considerably higher than the TMDL target nitrogen load for the Homosassa Springs Group (**Figure 16**).

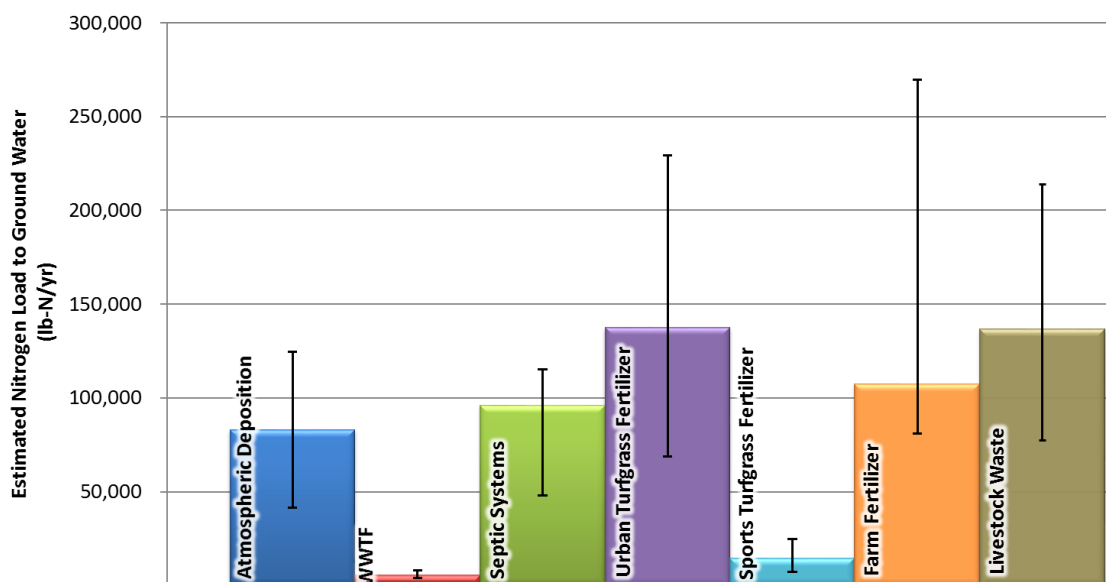


Figure 14: Influence of the range of attenuation factors on estimated nitrogen loads to groundwater from each category in the Homosassa Springs contributing area

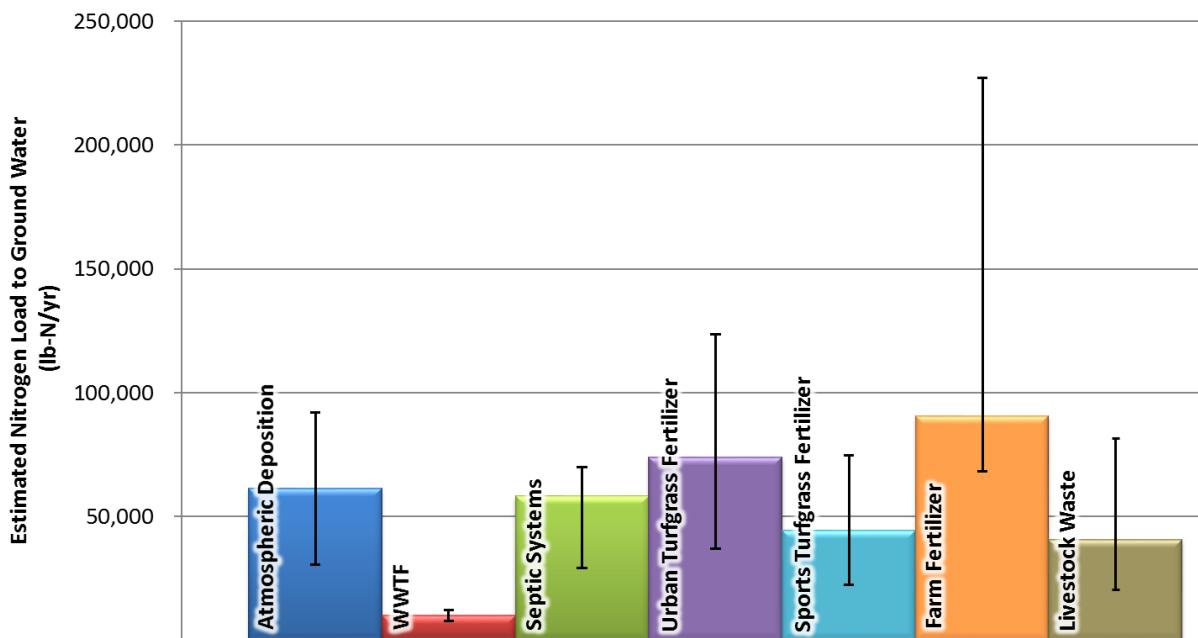


Figure 15: Influence of the range of attenuation factors on estimated nitrogen loads to groundwater from each category in the Chassahowitzka Springs contributing area

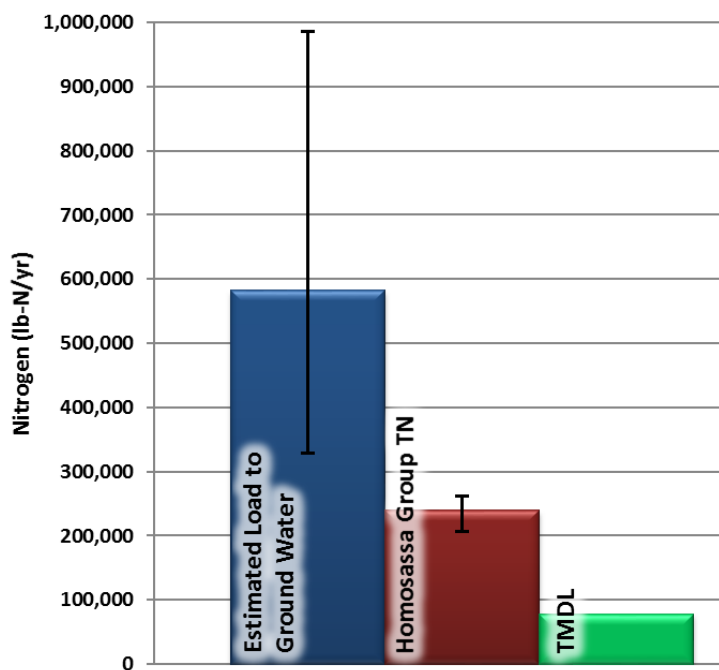


Figure 16: Estimated nitrogen load to groundwater compared with the current nitrogen discharging from Homosassa Spring #1, Homosassa Spring #2, Homosassa Spring #3, Trotter Spring, Pumphouse Spring, Hidden River Springs, and Bluebird Spring and the TMDL goal

For the Chassahowitzka Springs Group, the estimated total discharge is 85.48 cfs (USGS Gauge Stations 02310656, 02310650, 02310660). These data are largely from 2015. However, data are limited for all stations except for USGS Gauge Station 02310650 at Chassahowitzka Spring Main and Chassahowitzka Spring #1. The adopted TMDL is 0.23 mg/L for the springs (Dodson et al. 2014), resulting in a target nitrogen load of 38,654 lb-N/yr. Using the maximum nitrogen attenuation factors for each source, the minimum estimated load to groundwater in the contributing area is 215,584 lb-N/yr, which is considerably higher than the TMDL target nitrogen load for the Chassahowitzka Springs Group (**Figure 17**).

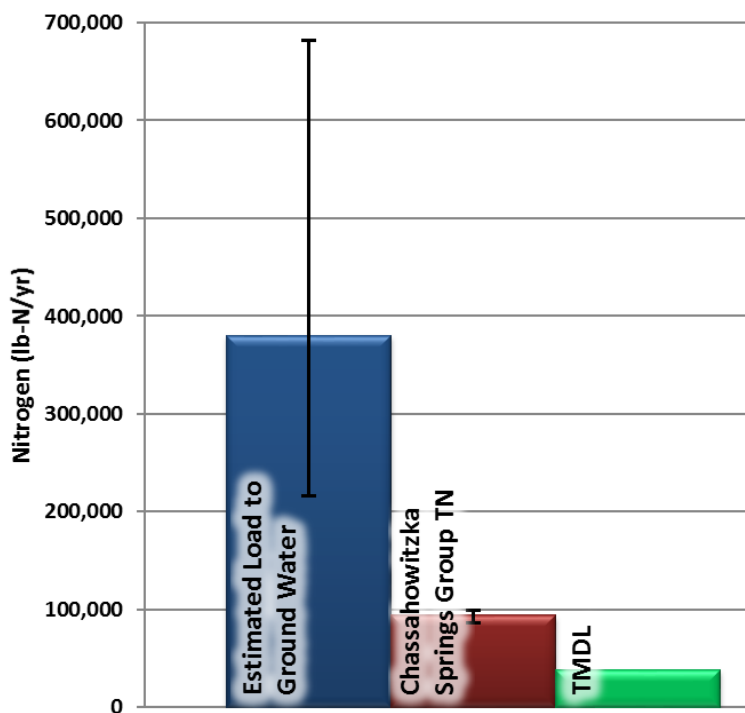


Figure 17: Estimated nitrogen load to groundwater compared with the current nitrogen discharging from Chassahowitzka Spring Main, Chassahowitzka Spring #2, Ruth Spring, Beeteejay Spring, and Baird Springs and the TMDL goal

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Appendices

Appendix A: Tables

Table A.1: Useful conversion factors

Convert from	To	Multiply by
Pounds	kilograms	0.4535924
NO₃ milligrams per liter	NO ₃ grams-nitrogen per liter	2.260 X 10 ⁻⁴
NH₄ milligrams per liter	NH ₄ grams-nitrogen per liter	7.765 X 10 ⁻⁴
milligrams	grams	0.001
grams	kilograms	0.001
milligrams	kilograms	1 X 10 ⁻⁶
acre	hectares	0.4046873
square meters	hectares	0.0001
cubic centimeters	liters	0.001
tons	kilograms	907.1847
cubic feet	liters	28.31685
second	year	3.170979 X 10 ⁻⁸
rainfall (centimeters)	rainfall (liters per hectare)	104

Table A.2: Summary of SWFWMD land use data in Hernando County in the Homosassa Springs contributing area

Land Use Code	Land Use Description	Hernando County	High Recharge	Medium Recharge
2100	Cropland and Pastureland	31,912	4,714	328
2300	Feeding Operations	393	30	
2500	Specialty Farms	1,547	9	19
2140	Row Crops	105		
2200	Tree Crops	877	99	
2400	Nurseries and Vineyards	1,279	4	
1100	Residential Low Density < 2 Dwelling Units	41,835	4,167	299
1200	Residential Medium Density 2 – > 5 Dwelling Units	24,602	94	
1300	Residential High Density	5,388	69	
1800	Recreational	939		
1820	Golf Courses	2,567		

**Table A.3: Summary of SWFWMD land use data in Hernando County for the
Chassahowitzka Springs contributing area**

Land Use Code	Land Use Description	Hernando County	High Recharge	Medium Recharge	Low Recharge	Discharge
2100	Cropland and Pastureland	31,912	10,842	341	54	137
2300	Feeding Operations	393	72			0
2500	Specialty Farms	1,547	653		20	
2140	Row Crops	105	9			
2200	Tree Crops	877	122			
2400	Nurseries and Vineyards	1,279	832	3		
1100	Residential Low Density < 2 Dwelling Units	41,835	18,169	342	29	43
1200	Residential Medium Density 2 – > 5 Dwelling Units	24,602	2,017	1		25
1300	Residential High Density	5,388	1,235			
1800	Recreational	939	204	38		
1820	Golf Courses	2,567	648	36		

**Table A.4: Summary of SWFWMD land use data in Citrus County for the Homosassa
Springs contributing area**

Land Use Code	Land Use Description	Citrus County	High Recharge	Medium Recharge	Low Recharge	Discharge
2100	Cropland and Pastureland	28,873	16,010	844	171	119
2300	Feeding Operations	26	26			
2500	Specialty Farms	699	360			
2550	Tropical Fish Farms	15				
2140	Row Crops	162	48	61		
2200	Tree Crops	94	62	19		13
2400	Nurseries and Vineyards	308	205			
1100	Residential Low Density < 2 Dwelling Units	73,629	21,135	1,671	321	525
1200	Residential Medium Density 2 – > 5 Dwelling Units	18,366	6,876	1,138	293	541
1300	Residential High Density	3,863	867	67	40	100
1800	Recreational	903	245	57	3	66
1820	Golf Courses	2,390	345	5		

Table A.5: Summary of SWFWMD land use data in Citrus County for the Chassahowitzka Springs contributing area

Land Use Code	Land Use Description	Citrus County	High Recharge	Medium Recharge	Low Recharge	Discharge
2100	Cropland and Pastureland	28,873	621	40	15	37
2300	Feeding Operations	26				
2500	Specialty Farms	699				
2550	Tropical Fish Farms	15				
2140	Row Crops	162				
2200	Tree Crops	94				
2400	Nurseries and Vineyards	308				
1100	Residential Low Density < 2 Dwelling Units	73,629	1,334	352	4	63
1200	Residential Medium Density 2 – > 5 Dwelling Units	18,366	836	284	58	121
1300	Residential High Density	3,863	156	3	1	
1800	Recreational	903	10	2		1
1820	Golf Courses	2,390	194	0		

**Table A.6: Summary of land use provided by the Hernando County PA office for the
Homosassa Springs contributing area**

Property Code	Description	High-Recharge Area	Medium-Recharge Area	Low-Recharge Area	Discharge Area
0	Vacant Single Family Residence	510	48		
1	Single Family Residential	2,205	200		
2	Mobile Homes	1,427	93		
10	Vacant commercial	12			
11	Stores 1 story	1			
12	Stores office resident combo	0.2			
28	Mobile Home Parks	4			
51	Cropland Soil Class 1	726	59		
54	Timber Natural Stand	127	104		
55	Timberland Site 80-89	479	246		
56	Timberland Site 70-79	32	3		
59	Timberland not class to pines	389	223		
60	Grazing Land	2,530	450		
66	Orchard Groves Citrus	210			
69	Ornamentals Misc Ag	3			
71	Churches	22			
74	Homes for the Aged	0.2			
75	Nonprofit services	276			
76	Mortuaries cemeteries cremetor	0.03	3		
80	Vacant Government	159	112		
82	Forest Parks Recreational Area	1,631	28		
83	Public County Schools	20			
86	Counties Govt no schools	7			
87	State Govt	6,310	834		
88	Federal Govt	2,423	32		
91	Utilities	3	5		
94	Rights of way	45	2		
96	Wastelands	4			
99	Acreage non Ag	535	100		

**Table A.7: Summary of land use provided by the Hernando County PA office for the
Chassahowitzka Springs contributing area**

Property Code	Description	High-Recharge Area	Medium-Recharge Area	Low-Recharge Area	Discharge Area
0	Vacant Single Family Residence	6,976	307	26	19
1	Single Family Residential	10,918	215	13	41
2	Mobile Homes	5,449	49	7	0
3	Multi Family 9 units	101			
4	Condo	1			
5	Cooperatives	11			
7	Misc Res (Boarding Homes, Camps)	27			
8	Multifamily 10 units	39			
10	Vacant commercial	736	1	1	0
11	Stores 1 story	117	0	0	
12	Stores office resident combo	37			
13	Department Stores	17			
16	Community Shopping Centers	63			
17	Office Buildings, nonprofessional	87			
18	Office Buildings, nonprofessional, multi st	14			
19	Professional services buildings	76			
20	Airport, bus, marinas	3			
21	Restaurants cafeterias	26			1
22	Drive-in Restaurants	8			
23	Financial Institutions	12			
25	Repair Service Shops	5			
26	Service Stations	26			
27	Vehicle Sales and Service	41			
28	Mobile Home Parks	466			
29	Wholesales Outlets	10			
33	Clubs Lounges Bars	2			
34	Bowling Skating Pool Arenas	4			
35	Tourist Attractions	1			
36	RV Campgrounds	24			
38	Golf Courses Driving Ranges	379			
39	Hotels Motels	5			
40	Vacant Industrial	201	3	244	0
41	Light Manufacturing	25	5		
42	Heavy Industrial, Heavy Equip	17	8		
43	Lumber Yards	12			
44	Packing Plants, Fruit & Vege	4			
45	Canneries, Fruit & Vegetable				1
47	Mineral Processing	910	831	172	
48	Warehouses Terminals	211	8		

*Nitrogen Source Inventory and Loading Estimates for the Contributing Areas of Homosassa Springs Group and
Chassahowitzka Springs Group, January 2017*

Property Code	Description	High-Recharge Area	Medium-Recharge Area	Low-Recharge Area	Discharge Area
49	Open Storage Junk Yards	12			
51	Cropland Soil Class 1	1,921	20		0
54	Timber Natural Stand	7,180	2,817	7	743
55	Timberland Site 80-89	3,003	437		83
56	Timberland Site 70-79	455			518
59	Timberland not class to pines	2,911	572	513	1
60	Grazing Land	13,834	733	205	334
65	Grazing Land Soil Capab VI	23			
66	Orchard Groves Citrus	280	2		
67	Poultry Bees Fish Rabbits	27			
69	Ornamentals Misc Ag	991			
70	Vacant Industrial	51			
71	Churches	263	19		
72	Private Schools and Colleges	38			
74	Homes for the Aged	34			
75	Nonprofit services	57			
76	Mortuaries cemeteries cremetor	88	3		
77	Clubs Lodges Union Halls	29			
78	Sanitariums Convalescent	20			
79	Cultural Organizations	1			
80	Vacant Government	484	2	59	
82	Forest Parks Recreational Area	2,068	729	1,419	15,819
83	Public County Schools	488			
84	Colleges	220			
85	Hospitals	26			
86	Counties Govt no schools	179		135	
87	State Govt	6,716	2,045	546	5,769
88	Federal Govt	1,215	57		8
89	Municipal	360			
90	Leasehold interests	1			
91	Utilities	574	33	3	
92	Mining Petro Gas lands	2,399	1,378	59	
94	Rights of way	455	3		14
95	Submerged lands		5		5
96	Wastelands	442	35	2	1,722
99	Acreage non Ag	4,078	122	44	82

**Table A.8: Summary of land use provided by the Citrus County PA office for the
Homosassa Springs contributing area**

Property Code	Description	High-Recharge Area	Medium-Recharge Area	Low-Recharge Area	Discharge Area
0	Vacant Single Family Residence	24,716	8,303	610	1,115
1	Single Family Residential	12,306	1,533	419	1,300
2	Mobile Homes	8,114	608	187	159
3	Multi Family 9 units	57	0.3	5	1
4	Condo	17	1		2
6	Retirement homes	2		3	6
8	Multi family 10 units	130	21	10	8
10	Vacant commercial	550	98	24	14
11	Stores 1 story	115	20	1	0.1
12	Stores office resident combo	129	19	1	3
13	Department Stores	33			2
14	Supermarkets	4			
16	Community Shopping Centers	123	3	9	6
17	Office Buildings, nonprofessional	70	2	2	0.1
18	Office Buildings, nonprofessional, multi st	3			
19	Professional services buildings	79		1	
20	Airport, bus, marinas		7		2
21	Restaurants cafeterias	29	11		1
22	Drive-in Restaurants	10		1	
23	Financial Institutions	21		6	
25	Repair Service Shops	20	7		1
26	Service Stations	3			
27	Vehicle Sales and Service	97	13	2	
28	Mobile Home Parks	185	68	24	25
29	Wholesale Outlets	40			
33	Clubs Lounges Bars	5	3		
34	Bowling Skating Pool Arenas	8			
35	Tourist Attractions	1			
36	RV Campgrounds	885	130	7	200
38	Golf Courses Driving Ranges	287			
39	Hotels Motels	24	3		3
40	Vacant Industrial	35	0.4	3	
41	Light Manufacturing	32	1	5	
43	Lumber Yards	5			
46	Other Food Processing		2		
47	Mineral Processing		1	18	
48	Warehouses Terminals	67	8	6	1
49	Open Storage Junk Yards	9	0.4		
50	Improved Ag	3,517	1,557	382	267

*Nitrogen Source Inventory and Loading Estimates for the Contributing Areas of Homosassa Springs Group and
Chassahowitzka Springs Group, January 2017*

Property Code	Description	High-Recharge Area	Medium-Recharge Area	Low-Recharge Area	Discharge Area
51	Cropland Soil Class 1	1,829	103	19	0.1
52	Cropland Soil Class 2	110		51	
55	Timberland Site 80-89	828	211	328	8
56	Timberland Site 70-79	2,720	417	48	58
57	Timberland Site 60-69	1,039	178	29	40
58	Timberland Site 50-59	1,104	9		10
59	Timberland not class to pines	76			
60	Grazing Land	3,538	181	100	31
61	Grazing Land	2,510	493	16	27
62	Grazing Land	6,493	830	240	33
63	Grazing Land	6,139	336	140	19
66	Orchard Groves Citrus	82	106		36
67	Poultry Bees Fish Rabbits	7			
68	Dairies Feed Lots	4			25
69	Ornamentals Misc Ag	310	30	1	
70	Vacant Industrial	7			
71	Churches	331	10	11	8
72	Private Schools and Colleges	86	0.2		0.001
73	Privately owned hospitals	1			
74	Homes for the Aged	14			
75	Nonprofit services	6			0.4
76	Mortuaries cemeteries cremetor	62			
77	Clubs Lodges Union Halls	2,408	1,645	1,661	48
78	Sanitariums Convalescent	8			
79	Cultural Organizations	0.4			
80	Vacant Government	7,373	4,707	2,938	17,181
82	Forest Parks Recreational Area	9,000	4,456		144
83	Public County Schools	204	65		
85	Hospitals	30			
86	Counties Govt no schools	414	1	0.4	9
87	State Govt	1,770	2,129	1,439	636
88	Federal Govt	35		17	1
89	Municipal	128	2		6
90	Leasehold interests	1			
91	Utilities	262	2	7	7
92	Mining Petro Gas lands	240	24	54	
94	Rights of way	274	8	10	4
95	Submerged lands	7	5	2	0.3
96	Wastelands	371	417	394	1,113
99	Acreage non Ag	1,410	348	271	972

**Table A.9: Summary of land use provided by the Citrus County PA office for the
Chassahowitzka Springs contributing area**

Property Code	Description	High-Recharge Area	Medium-Recharge Area	Low-Recharge Area	Discharge Area
0	Vacant Single Family Residence	279,874	208,024	141	162
1	Single Family Residential	76	56	30	101
2	Mobile Homes	43	109	6	120
8	Multi family 10 units	1	25		25
10	Vacant commercial	131	251	158	
11	Stores 1 story	3	5		
12	Stores office resident combo	5	15		
13	Department Stores		2		
14	Supermarkets		5	5	
17	Office Buildings, nonprofessional	3	9		
19	Professional services buildings	4	7		
23	Financial Institutions			1	
28	Mobile Home Parks	132	76		
36	RV Campgrounds		3,263	3,258	6,516
38	Golf Courses Driving Ranges	1,306	296		
48	Warehouses Terminals	4	12		
49	Open Storage Junk Yards		2		
50	Improved Ag	11	111	80	23
51	Cropland Soil Class 1	47	14		
55	Timberland Site 80-89	145	219	219	219
56	Timberland Site 70-79		68		76
58	Timberland Site 50-59				77
60	Grazing Land	111	42	20	20
61	Grazing Land	10			
62	Grazing Land	677	106		
63	Grazing Land	844	22		22
69	Ornamentals Misc Ag	11	11		
71	Churches				2
74	Homes for the Aged		4		
77	Clubs Lodges Union Halls	17	1	1	
80	Vacant Government	10,391	8,729	5,527	8,620
86	Counties Govt no schools	90	90		
88	Federal Govt	36			
91	Utilities	1,464,307	188,211		
94	Rights of way	16	10	4	
96	Wastelands		25	81	159
99	Acreage non Ag	573	161	291	262

Table A.10: 2010 labor and statistics data for Hernando and Citrus Counties

Category	Hernando County	Citrus County
Total Labor Force	66,470	52,847
Employed Labor Force	57,464	45,594
Unemployed Labor Force	9,006	7,253

Table A.11: 2010 Census population data for Hernando and Citrus Counties

Population Category	Hernando County	Citrus County
Under 18	34,158	22,394
18 to 64	94,097	73,801
65 or older	44,523	45,041
Total	172,778	141,236

Table A.12: Estimated population data for calculation of effective septic systems population

Population Category	Equation	Hernando County	Citrus County
Non-working	= 18 to 64 population – employed labor force	36,633	28,207
Retired	= 65 or older	44,523	45,041
School	= under 18	34,158	22,394
Work	= employed labor force	57,464	45,594

Table A.13: Hernando County zoning data

Zoning Code	Zoning Description	% Maximum Lot Coverage
AC	AC Agricultural Commercial District	
AG	AG Agricultural District	
AR	AR Agricultural Residential District	
AR1	AR1 Agricultural Residential District	
AR2	AR Agricultural Residential District	
C1	C1 General Commercial District	
C2	C2 Highway Commercial District	
C3	C3 Neighborhood Commercial District	
C4	C4 Heavy Highway Commercial District	
CITY	City	
CM1	CM1 Marine Commercial District	
CM2	CM2 Heavy Marine Commercial District	
CPDP	CPDP (Combined)	
CV	CV Conservation District	
I1	I1 Industrial District	
I2	I2 Heavy Industrial District	

Zoning Code	Zoning Description	% Maximum Lot Coverage
M	M Mining District	
OP	OP Office-Professional District	
PDP(AF)	PDP (Aviation Facilities)	
PDP(CM)	PDP (Commercial Marine)	
PDP(CP)	PDP (Corporate Park)	
PDP(GC)	PDP (General Commercial)	
PDP(GHC)	PDP (General Highway Commercial)	
PDP(HC)	PDP (Highway Commercial)	
PDP(HHC)	PDP (Heavy Highway Commercial)	
PDP(HID)	PDP (Heavy Industrial)	
PDP(IND)	PDP (Industrial)	
PDP(LI)	PDP (Light Industrial)	
PDP(MF)	PDP (Multifamily)	0.35
PDP(MH)	PDP (Mobile Home)	0.35
PDP(NC)	PDP (Neighborhood Commercial)	
PDP(OP)	PDP (Office/Professional)	
PDP(OP)	PDP (Single-Family)	0.35
PDP(PSF)	PDP (Public Service Facility Overlay District)	
PDP(REC)	PDP (Recreational)	
PDP(RR)	PDP (Resort Residential)	0.35
PDP(RUR)	PDP (Rural)	
PDP(SF)	PDP (Single-Family)	0.35
PDP(SU)	PDP (Recreational)	
PDP(SU)	PDP (Single-Family)	
PDP(SU)	PDP (Special Use)	
R1A	R1A Residential District	0.35
R1B	R1B Residential District	0.35
R1C	R1C Residential District	0.35
R1MH	R1MH Residential Single-Family Manufactured Housing	
R2	R2 Residential District	0.35
R2.5	R2.5 Residential District	0.35
R3	R3 Residential District	0.45
R4	R4 Residential District	0.45
RC	RC Recreational Commercial District	
RM	RM Residential Mobile Home District	0.35
RR	Residential District	0.45

Table A.14: Citrus County zoning data

Zoning Code	Zoning Description	% Maximum Lot Coverage	Exception
AGR	Agricultural District	0.1	0.3 if < 1.0 ac
AGR MH	Agricultural District with Mobile Homes	0.1	0.3 if < 1.0 ac
CG	General Commercial	0.7	
CH	High Intensity Commercial	0.7	
CITY	Within City Limits	0.7	
CL	Low Intensity Coastal and Lakes District	0.25	0.3 if < 1.0 ac
CL MH	Low Intensity Coastal and Lakes District with Mobile Homes	0.25	0.3 if < 1.0 ac
CLC	Coastal and Lakes Commercial District	0.35	
CLC MH	Coastal and Lakes Commercial District with Mobile Homes	0.35	
CLR	Coastal and Lakes Residential District	0.35	0.4 if < 10,000 ft ²
CLR M	Coastal and Lakes Residential District with Mobile Homes	0.35	0.4 if < 10,000 ft ²
CLR MH	Coastal and Lakes Residential District with Mobile Homes	0.35	0.4 if < 10,000 ft ²
CON	Conservation District	0.1	0.3 if < 1.0 ac
CON MH	Conservation District with Mobile Homes	0.1	0.3 if < 1.0 ac
CRR	Central Ridge Residential District	0.35	
CRR MH	Central Ridge Residential District with Mobile Homes	0.35	
CW	Waterfront Commercial	0.7	
EXT	Extractive District	0.7	
EXT MH	Extractive District with Mobile Homes	0.7	
GNC	General Commercial District	0.7	
GNC MH	General Commercial District with Mobile Homes	0.7	
HDR	High Density Residential District	0.55	
HDR MH	High Density Residential District with Mobile Homes	0.55	
IND	Heavy Industrial District	0.7	
LD	Low Density Residential District	0.35	
LDR	Low Density Residential District	0.35	
LDR MH	Low Density Residential District with Mobile Homes	0.35	
LIN	Light Industrial District	0.7	
MDR	Medium Density Residential District	0.5	
MDR MH	Medium Density Residential District with Mobile Homes	0.5	
MHP	Mobile Home Park	0.4	
NBR	Neighborhood Business Residential	0.7	
NEC	Neighborhood Commercial District	0.7	
PDR	Planned Residential Development District		
PDR MH	Planned Residential Development District with Mobile Homes		
PDR-SC	Planned Residential Development District		
PI	Public Institutional	0.7	
PORT	Port District	0.5	
PSI	Public/Semi-public, Institutional District	0.7	
PSI MH	Public/Semi-public, Institutional District with Mobile Homes	0.7	
PSO	Professional Services/Office District	0.7	
PSO MH	Professional Services/Office District with Mobile Homes	0.7	

Zoning Code	Zoning Description	% Maximum Lot Coverage	Exception
PUD	Planned Unit Development		
R-1	Low Density Residential	0.35	
R-2	Medium Density Residential	0.5	
R-3	High Density Residential	0.55	
R-C	Residential Conservation	0.5	
REC	Recreation District	0.25	
REC MH	Recreation District with Mobile Homes	0.25	
RUR	Rural Residential District	0.2	0.3 if < 1.0 ac
RUR MH	Rural Residential District with Mobile Homes	0.2	0.3 if < 1.0 ac
RVP	Recreational Vehicle Park/Campground District	0.4	
R-W	Residential Waterfront	0.5	
TCU	Transportation/Communication/Utilities District	0.7	
TCU MH	Transportation/Communication/Utilities District with Mobile	0.7	

Table A.15: Citrus County fertilizer application data for sports fields

Property Name	Contributing Area	Applications Per Year	# of Dry Bags Per Application	N Content Per Dry Bag (lb-N)	# of Sludge Bags Per Application	N Content Per Sludge Bag (lb-N)
Homosassa Recreation Park	Homosassa	3	46	8	35	2.5
Bicentennial	Kings Bay	3	45	8	36	2.5
Central Ridge District Park	Kings Bay	3	51	8	35	2.5
Holden Community Park	Kings Bay	3	37	8	30	2.5
Citrus High School	Homosassa	3	47	16		
Lecanto High School	Homosassa	3	51	16		
Crystal River High School	Kings Bay	3	50	16		

Table A.16: Hernando County school sports fields fertilizer data based on 300 bags a year of 16-0-8 fertilizer

Property Name	Contributing Area	Area (acres)	% Area of Total	N Applied (lb-N/yr)
	County	81		2,400
Challenger K-8	Weeki Wachee	7	8	193
Explorer K-8	Weeki Wachee	2	3	70
Winding Waters K-8	Chassahowitzka	11	14	334
D.S. Parrott Middle School	Chassahowitzka	20	24	582
Fox Chapel Middle	Weeki Wachee	3	4	98
West Hernando Middle	Chassahowitzka	33	41	974
Powell Middle	Weeki Wachee	5	6	149

Table A.17: Hernando County Parks sports fields fertilizer data based on 2 applications of quick (21-0-0) and slow (24-2-12) release fertilizer at 1-lb/1,000 ft²

Property Name	Contributing Area	Area (acres)	N Applied (lb-N/yr)
Anderson Snow Sports Complex	Weeki Wachee	30.94	1,212.85
Veterans Memorial Park	Weeki Wachee	8.48	332.40
Delta Woods Park	Weeki Wachee	3.54	138.86
Ernie Weave Youth Park	Chassahowitzka	30.79	1,206.92
Kennedy Park	Chassahowitzka	3.95	154.99
Ridge Manor Community Park	East of all boundaries	30.94	1,212.85

Appendix B. Estimating Fertilized Residential Acreages within the Springs Coast of Florida

This appendix describes the information and GIS methods used to estimate fertilized acreages for residential landscapes in Citrus, Hernando, and Pasco Counties, including single-family residential, multifamily residential, and condominiums.

One of the key components of the method is obtaining the most recent county PA data for residential parcels. Each county populates these data differently, and the available datasets may or may not contain all the relevant information. However, as a basis for estimating fertilizer inputs for residential areas in each county, the dataset should include the following:

- **Parcel Identifier:** A number or series of characters that individually identifies a parcel; this may be labeled under a field name such as Parcel ID, Alt Key, or something similar.
- **DOR Code:** A numeric-based land use code used by the U.S. Department of Revenue. If not available, other land use codes can be used, such as PC code or LU code.
- **DOR Code Description:** Description of the land use associated with each numeric DOR code.
- **Zoning Code:** An alpha-numeric code that defines the county zoning limits.
- **Zoning Code Description:** A description of the zoning category associated with the alpha-numeric zoning code.
- **Max Lot Coverage:** The percentage of a parcel that can be covered by impervious surfaces. This is usually found within zoning data and zoning laws (varies by county).
- **JV:** "Just value," or the assessed value of the property.
- **Parcel Acreage:** The acreage associated with each parcel identifier, calculated using the Calculate Geometry tool.

For these calculations, it is imperative to maintain the original parcel geometry. The impervious and pervious acreages are estimated as follows: the impervious acreage is equal to the total parcel acreage multiplied by the max lot coverage, and the pervious acreage is the remaining land area associated with the parcel. For parcels with pervious areas greater than 1 acre, it is assumed that only 1 acre of land will receive fertilizer because it is unlikely that in most cases large parcel owners will fertilize their entire property. A parcel with a pervious acreage greater

than 1 can be identified using an if/then statement in the field calculator and assigning a pervious acreage of 1, while all remaining parcels maintain the previously calculated pervious acreages.

This assumption affects less than 10 % of the parcels in the three Springs Coast counties. The distribution of pervious areas for residential parcels (DOR code = 0,1,3,4,5,8) was obtained by exporting the dataset within GIS to Excel and completing a histogram analysis for each county. The results are shown in **Table B.1, B.2, and B.3** for Citrus County, Hernando County, and Pasco County, respectively.

The final factor used to estimate the estimated fertilizable acreage is the probability that a homeowner will fertilize a property, which is based on property values (Kinzig et al. 2005; Zhou et al. 2008). According to several socioeconomic studies of fertilizer usage by homeowners, homeowners with high property values are more likely to fertilize their lawns than homeowners with low property values.

property appraiser data for single-family residential properties were used to assess the ranges of high, medium- and low property values for each Springs Coast county. The single-family residential parcels (DOR code = 1) were selected for each county using a definition query, and the data were exported from GIS to Excel. A histogram was completed on these data to determine the frequency of parcels within different assessed value ranges. **Table B.4** and **Figure B.1** show the distribution of the number of single-family parcels for various ranges of property values in Citrus, Hernando, and Pasco Counties.

Table B.1: Pervious parcel size histogram results for Citrus County

Bin	Citrus County Pervious Parcel Acreage	Frequency	Cumulative %
0.25	0–0.25	58,293	48.84
0.5	0.26–0.5	30,069	74.03
0.75	0.51–0.75	9,810	82.24
1	0.76–1.0	9,575	90.27
1.5	1.01–1.5	3,646	93.32
2	1.51–2.0	2,289	95.24
3	2.01–3.0	1,968	96.89
4	3.01–4.0	1,644	98.26
5	4.01–5.0	959	99.07
10	5.01–10	847	99.78
20	10.01–20	190	99.94
50	20.01–50	60	99.99
More	Greater than 50	16	100.00

Table B.2: Pervious parcel size histogram results for Hernando County

Bin	Hernando County Pervious Parcel Acreage	Frequency	Cumulative %
0.25	0–0.25	54,425	60.34
0.5	0.26–0.5	20,374	82.93
0.75	0.51–0.75	4,648	88.08
1	0.76–1.0	2,794	91.18
1.5	1.01–1.5	1,682	93.05
2	1.51–2.0	596	93.71
3	2.01–3.0	2,723	96.72
4	3.01–4.0	565	97.35
5	4.01–5.0	1,106	98.58
10	5.01–10	969	99.65
20	10.01–20	247	99.93
More	Greater than 20	67	100.00

Table B.3: Pervious parcel size histogram results for Pasco County

Bin	Pasco County Pervious Parcel Acreage	Frequency	Cumulative %
0.25	0–0.25	2,213	39.89
0.5	0.26–0.5	452	48.04
0.75	0.51–0.75	387	55.01
1	0.76–1.0	635	66.46
1.5	1.01–1.5	359	72.93
2	1.51–2.0	543	82.71
3	2.01–3.0	458	90.97
4	3.01–4.0	316	96.67
5	4.01–5.0	47	97.51
10	5.01–10	110	99.50
20	10.01–20	21	99.87
More	Greater than 20	7	100.00

Table B.4: Histogram results for the number of parcels for various ranges of property values for Citrus, Hernando, and Pasco Counties

Bin	Property Value Range (\$)	# of Parcels in Citrus County	# of Parcels in Hernando County	# of Parcels in Pasco County	Total # of Parcels in Springs Coast
10000	0–10,000	456	935	154	1,545
20000	10,001–20,000	253	292	683	1,228
30000	20,001–30,000	2,390	1,156	3,750	7,296
40000	30,001–40,000	3,916	2,848	13,032	19,796
50000	40,001–50,000	4,497	4,077	15,652	24,226
60000	50,001–60,000	4,797	5,336	12,276	22,409
70000	60,001–70,000	4,695	5,929	7,943	18,567
80000	70,001–80,000	4,380	6,379	6,461	17,220
90000	80,001–90,000	3,499	5,903	5,642	15,044
100000	90,001–100,000	3,024	5,517	6,641	15,182
110000	100,001–110,000	2,815	4,366	7,117	14,298
120000	110,001–120,000	2,381	3,815	7,788	13,984
130000	120,001–130,000	2,057	3,091	8,320	13,468
140000	130,001–140,000	1,788	2,415	7,814	12,017
150000	140,001–150,000	1,518	1,797	6,998	10,313
160000	150,001–160,000	1,473	1,438	6,286	9,197
170000	160,001–170,000	1,336	1,081	4,565	6,982
180000	170,001–180,000	1,065	937	3,909	5,911
190000	180,001–190,000	967	792	3,451	5,210
200000	190,001–200,000	851	674	3,105	4,630
225000	200,001–225,000	1,482	1,202	5,947	8,631
250000	225,001–250,000	945	684	3,925	5,554
275000	250,001–275,000	688	451	2,766	3,905
300000	275,001–300,000	448	265	1,802	2,515
350000	300,001–350,000	504	284	2,046	2,834
400000	350,001–400,000	270	159	1,007	1,436
450000	400,001–450,000	153	56	608	817
500000	450,001–500,000	114	37	299	450
550000	500,001–550,000	68	24	184	276
600000	550,001–600,000	47	10	97	154
650000	600,001–650,000	24	13	71	108
700000	650,001–700,000	21	6	49	76
More	Greater than 700,000	51	15	150	216

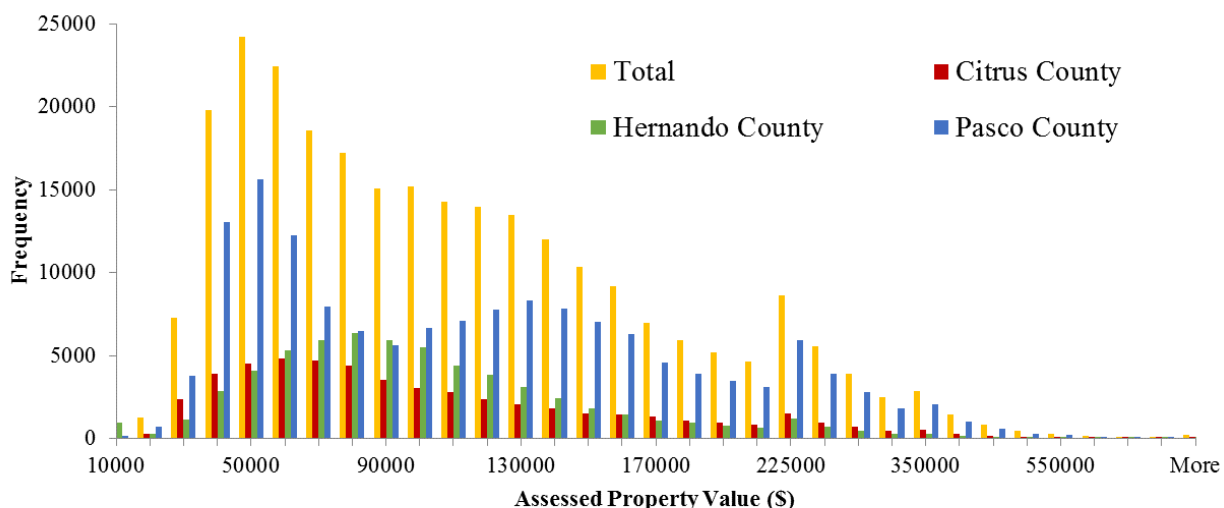


Figure B.1: Parcel frequency based on property value for single-family residential properties in the Springs Coast counties

The property value ranges were selected based on the distribution of property values throughout the counties. Property value categories were assigned as follows: low, less than \$50,000; medium, \$50,001 to \$150,000; and high, greater than \$150,001. Of the single-family residential properties, 57 % fell into the medium property value category, 22 % in the high, and 20 % in the low.

Homeowners with low property values were assigned a low probability (10 %) that they would fertilize their lawn, the medium property values category was assigned a 75 % probability, and the high property values were assigned the highest probability (90 %) (Kinzig et al. 2005; Grove et al. 2006; Carey et al. 2012). These probabilities of fertilization were added to all residential properties in the attributes tables within GIS, and a new field was created to calculate the estimated acreage fertilized for the Springs Coast counties. The fertilized acreage was calculated by multiplying the pervious acreage (with a maximum value of 1 acre) by the probability of fertilization (0.1, 0.75, or 0.9) value. The final nitrogen input calculations for residential fertilizer applications were based on the fertilization application rates described in **Section 2.4** of this report. The residential fertilizer inputs for nitrogen were further subdivided by the recharge rate areas within each BMAP boundary.

Appendix C: Comparison of Methods and Results for the Homosassa Springs Group NSILT and Jones et al. (1997)

In 1997, the SWFWMD Ambient Ground Water Quality Monitoring Program conducted a study to determine the sources of increasing nitrate concentrations in Homosassa Springs (Jones et al. 1997). The study objectives were to delineate the areas where nitrate was entering the aquifer system, identify the land uses contributing nitrate, and determine management actions to slow or reduce nitrate loading to groundwater in the Homosassa Springs contributing area.

This appendix compares the methods and results from the SWFWMD study and the DEP NSILT. In addition, several factors are listed to account for the differences in estimated nitrogen inputs for the two studies. This comparison provides insights into how the relative contributions of nitrogen may have changed for various potential nitrogen sources and land uses over the past 20 years.

Study Area

- The NSILT used the spring contributing area largely based on the Homosassa springshed as the study area. This area encompasses 201,234 acres of land with varying degrees of associated recharge. However, the analysis used only data from high-, medium-, and low-recharge areas, which cover 174,475 acres.
- The Jones et al. (1997) study area comprised 960 square miles, or 614,398 acres, with no acreage estimates for the varying recharge areas. The authors state the large study area may be overestimated based on limited potentiometric data
- The study areas used in both methods were based on the same shape of the springshed and groundwater flow direction to the spring vent. However, the Jones et al. (2007) study area was over 60 % larger than that of the NSILT study area. This size difference influenced the inputs calculated for each method.

Atmospheric Deposition

- The NSILT used data from the multiyear TDEP model developed by the EPA. The annual nitrogen input to the land surface from atmospheric deposition was 1,069,340 lb-N.
- The SWFWMD study (Jones et al. 1997) used an average wet deposition concentration of 1.0 mg/L of TN, based on 9 rainfall samples collected from a station in northwestern Citrus County, north of the springs. Using an average

annual rainfall of 56 inches, researchers calculated a total of 1,219 tons/yr, or 2,438,000 lbs, over the entire study area.

- The SWFWMD estimate was larger by 1,368,660 lb-N/yr, likely because of the higher nitrogen concentration in rainfall used in the study. Several factors may have accounted for these differences, including the period when the rainfall was collected or differences in collection and analytical methods. The difference in study areas contributes to the higher estimation.

Septic Systems

- The NSILT relied on the estimated number of septic systems provided by FDOH. An average of 1.95 people contributed to each septic system in Citrus County and 2.08 people in Hernando County. With an annual input of 9.012 lb-N/person, this equaled an input of approximately 18 lb-N per septic system. With 12,777 systems in the contributing area, 226,284 lb-N were applied to the land surface every year.
- Jones et al. (2007) estimated 6,300 septic systems within the boundary area based on an aerial imagery survey. With 3 people per household and an average nitrogen input of 55 lb-N/yr per tank, the total input attributable to septic systems was 173 tons/yr or 346,000 lb-N/yr. Additionally, Jones et al. (2007) incorporated the input from the land spreading of septage waste, which was determined to be a very minor source of nitrogen equaling 600 lb-N/yr.
- There were two main differences between these methods: the number of estimated septic systems and the annual input per system. The NSILT analysis included almost 2 times the number of septic systems compared with Jones et al. (1997). This could be attributable to the more accurate counting methods used for the NSILT as well as population growth in the area. Additionally, the annual input per system used by the SWFWMD was over double compared with that used by DEP. The combination of these factors resulted in a similar estimate for septic systems, with a difference of only 120,316 lb-N/yr. The addition of land spreading of septage also increased the Jones et al. (2007) septic system estimation in a minor way, given the small contribution of this source.

Urban Turfgrass Fertilizers

- The NSILT relied on regional fertilizer application rates for the pervious land area associated with urban land uses. The estimated TN input was 630,721 lb-N/yr over the 11,100 acres fertilized within the contributing area.
- Jones et al. (1997) used Florida Department of Agriculture and Consumer Services (FDACS) annual fertilizer sales data. The residential acreage was calculated from land use maps developed from 1990 aerial photography. It was assumed the fertilizer was applied evenly across this acreage, resulting in 342,000 lb-N/yr applied within the Homosassa Springs study area.
- The higher NSILT calculation is likely due to a combination of factors, including the different methods used, the increased urbanization of the area over the past 20 years, and the inclusion of nonresidential urban land uses in the NSILT calculations.

Sports Turfgrass Fertilizer

- For the NSILT, 4 golf courses covering 351 acres were identified. An average application rate of 141 lb-N/ac resulted in an input to the land surface of 49,477 lb-N/yr. Calculations for sporting facilities were made based on fertilization rates for lawn service companies. These added 6,071 lb-N/yr, for a total of 55,547 lb-N/yr attributable to sports turfgrass fertilizers.
- Jones et al. (1997) included 3 golf courses covering a total of 169 acres. The authors used an application rate of 260 lb-N/acres based on a study completed in Sarasota Bay, for a total of 44,000 lb-N/yr, or 111 tons-N/yr.
- The difference of 11,547 lb-N/yr was likely due to changing trends in golf course maintenance over the past 20 years. While the golf course acreage was larger in the NSILT area, the application rates were lower, resulting in a lower input to the land surface. The inclusion of sporting facilities in the NSILT also increased this estimate compared with Jones (1997).

Wastewater Treatment Facilities

- The NSILT used reported effluent data from 18 facilities in the contributing area. These had an average actual flow of 0.05 mgd, with an average nitrogen concentration of 5.89 mg/L. The annual input attributable to these facilities

equaled 14,611 lb-N/yr. The assessment did not include input associated with domestic WWTF residuals because of the lack of supporting data.

- Jones et al. (1997) evaluated WWTFs in two different categories: sewage effluent disposal and the land disposal of sludge. The total effluent disposal was estimated by assessing 45 facilities with an average flow of 0.03 mgd. The total input was estimated using an average nitrogen concentration of 40 mg/L, equaling 116,000 lb-N/yr. Additionally, 17,980 lb-N/yr were calculated for the land spreading of sludge in the study area.
- There is a very large difference between the two studies because the Jones et al. (1998) study used the much higher effluent concentration and included the sludge estimate. Additionally, since the first study was completed, considerable advances in waste treatment were made and applied in this area that would contribute to the lower effluent concentration used in the NSILT.

Farm Fertilizers

- To obtain nitrogen inputs from farm fertilizers, the NSILT used PA data, known crops grown in the area, and agricultural producer feedback, as well as UF IFAS–recommended fertilizer application rates. The 33,092 acres of cropland and pastures in the contributing area contributed 639,218 lb-N/yr.
- Jones et al. (1997) estimated fertilization for citrus, row crops, and pastureland. Row crops were calculated based on a fertilizer application rate of 170 lb-N/ac/yr over 715 acres. Citrus fertilization was based on the application of 180 lb-N/ac/yr over 1,800 acres. Pastureland was estimated using FDACS fertilizer sales data. The amount of fertilizer attributable to row crops and citrus was subtracted from the amount of reported fertilizer sold for farming practices. The remaining fertilizer was assumed to be used for pasture fertilization. The estimated pasture acreage in the study area was not disclosed. In the Homosassa Springs study area, the nitrogen attributed to farm fertilization equaled 2,262,000 lb-N/yr.
- Jones et.al (1997) estimated an input to the land surface 1,622,782 lb-N/yr greater than the NSILT. The application rates used for the Jones et al. (1997) study were higher, in addition to the large quantity of fertilizer reported in the sales data.

Livestock Waste

- The NSILT included cattle as well as other livestock animals within the BMAP boundary. Based on stocking rates gathered from feedback from cattle farmers, the cattle population was 3,428 with a dairy population of 675. Additional livestock animal populations estimated from the 2012 CoA were assigned to the contributing area based on the distribution of livestock lands (such as improved pasture). Daily waste factors were applied based on the nitrogen content for each animal. The total input to the land surface equaled 154,245 lb-N/yr.
- The SWFWMD separated livestock waste estimates into 3 different categories: poultry, dairies, and cattle. FDACS estimated the animal populations, and daily waste factors were applied. Poultry produces 0.053 lb-N/day/animal, resulting in an annual input of 2,378,000 lb-N. Dairy cows produce 0.45 lb-N/day/1,000 lb of body weight, equaling a total input of 98 tons/yr, or 196,000 lb-N/yr. Cattle, which were assumed to represent beef cattle, have a daily waste factor of 0.33 lb-N/1,000 of body weight, with an associated input of 1,384,000 lb-N/yr. The individual Homosassa Springs study area populations were not specified. In total, Jones et al. (1997) calculated livestock waste at 3,958,000 lb-N/yr.
- There was a large difference between these two estimates (3,803,755 lb-N/yr). The daily waste factors used in both studies were comparable and likely did not contribute to the discrepancy. Without knowing the exact population used in the Jones et al. (2007) study, DEP could not directly determine the population differences. However, this was the most likely factor leading to such a large difference. Although poultry farming in Hernando County has dramatically decreased since the 1990s and was not even calculated in the NSILT due to vastly incorrect populations reported in the CoA, this decrease in poultry farming contributed to a difference of almost 3 million pounds.

Stormwater

- The NSILT did not estimate the influence of stormwater-sourced nitrogen on groundwater.
- Jones et al. (1998) calculated that 32,000 lb-N/yr runs off from golf courses, residential areas, commercial properties, and cropland via stormwater.

Comparison of TN Inputs

The TN inputs to the land surface calculated by Jones et al. (1998) were 9,388,600 lb-N/yr (based on 614,398 acres of land area, resulting in an average of 15 lb-N/ac). The 2 sources that contributed the highest percentages of nitrogen to the land surface were livestock waste (41 %) and atmospheric deposition (26 %).

The NSILT estimated TN inputs of 3,395,681 lb-N/yr to the land surface (174,475 acres) in the Homosassa Springs contributing area, or an average of 19 lb-N/ac. The three sources contributing the largest percentages of nitrogen inputs to the land surface were atmospheric deposition (31 %), livestock waste (22 %) and farm fertilizers (19 %). **Table C.1** compares the relative percentages calculated using both methods.

As described above, there were notable differences between the two studies in the methods used to estimate nitrogen inputs to the land surface. The biggest differences were attributable to the study area sizes, the development of more accurate methods to identify land uses, and the application of nitrogen for different land use practices.

The SWFWMD study (Jones et al. 1997) provided an important baseline for comparison with the nitrogen inventory for the Homosassa Springs contributing area. Current information on the nitrogen source inventory and nitrogen loads to groundwater generated from the NSILT will be used for the BMAP to determine where present-day nitrogen loading to groundwater can be reduced to restore water quality for the Homosassa Springs Group.

Table C.1: Comparison of nitrogen input percentages to the land surface in the Homosassa Springs contributing area calculated by the NSILT and Jones et al. (1997)

N Loading Category	NSILT (%) (2016)	Jones et al. (%) (1997)
Atmospheric Deposition	31	26
Septic Systems	7	4
WWTFs	0.4	1
Urban Turfgrass Fertilizers	19	4
Sports Turfgrass Fertilizers	2	0.5
Farm Fertilizers	19	24
Livestock Waste	22	41
Stormwater	0	0.3

Appendix D: Comparison of Methods and Results for the Chassahowitzka Springs Group NSILT and Jones et al. (1997)

In 1997, the SWFWMD Ambient Ground Water Quality Monitoring Program conducted a study to determine the sources of increasing nitrate concentrations in Chassahowitzka Springs (Jones et al. 1997). The study objectives were to delineate the areas where nitrate was entering the aquifer system, identify the land uses contributing nitrate, and determine management actions to slow or reduce nitrate loading to groundwater in the springs contributing area.

This appendix compares the methods and results from the SWFWMD study and the DEP NSILT. In addition, several factors are listed to account for the differences in estimated nitrogen inputs for the two studies. This comparison provides insights into how the relative contributions of nitrogen may have changed for various potential nitrogen sources and land uses over the past 20 years.

Study Area

- The NSILT used the spring contributing area largely based on the Chassahowitzka springshed, which encompasses 139,375 acres of land with varying degrees of associated recharge. However, the analysis used only data from high-, medium-, and low-recharge areas, which cover 107,309 acres.
- The Jones et al. (1997) study area comprised 190 square miles, or 121,600 acres, with no acreage estimates for the varying recharge areas.
- The study areas used in both methods were based on the same shape of the springshed and groundwater flow direction to the spring vent. However, the Jones et al. (2007) study area was nearly 10 % smaller than that of the NSILT study area. This size difference influenced the inputs calculated for each method.

Atmospheric Deposition

- The NSILT used data from the multiyear TDEP model developed by the EPA. The annual nitrogen input to the land surface from atmospheric deposition was 749,437 lb-N.
- The SWFWMD study (Jones et al. 1997) used an average wet deposition concentration of 1.0 mg/L of total N, based on 9 rainfall samples collected from a station in northwestern Citrus County, north of the springs. Using an average annual rainfall of 56 inches, researchers calculated a total of 772 tons/yr, or 1,544,000 lb, over the entire study area.

- The SWFWMD estimate was larger by 794,563 lb-N/yr, likely because of the higher nitrogen concentration in rainfall used in the study. Several factors may have accounted for these differences, including the period when the rainfall was collected or differences in collection and analytical methods.

Septic Systems

- The NSILT relied on the estimate of septic systems by FDOH. An average of 1.95 people contributed to each septic system in Citrus County and 2.08 people in Hernando County. With an annual input of 9.012 lb-N/person, this equaled an input of approximately 18 lb-N per septic system. With 7,059 systems in the contributing area, 131,885 lb-N were applied to the land surface every year.
- Jones et al. (2007) estimated 1,700 septic systems within the boundary area based on an aerial imagery survey. With 3 people per household and an average nitrogen input of 55 lb-N/yr per tank, the total input attributable to septic systems was 47 tons/yr, or 94,000 lb-N/yr. Additionally, Jones et al. (2007) incorporated the input from the land spreading of septage waste, which was determined to be a very minor source of nitrogen equaling 3,800 lb-N/yr.
- There were two main differences between these methods: the number of estimated septic systems and the annual input per system. The NSILT analysis included over 4 times the number of septic systems compared with Jones et al. (1997). This could be attributable to the more accurate counting methods used for the NSILT as well as population growth in the area. Additionally, the annual input per system used by the SWFWMD was over double compared with that used by DEP. The combination of these factors resulted in a similar estimate for septic systems, with a difference of only 34,085 lb-N/yr. The addition of land spreading of septage also increased the Jones et al. (2007) septic system estimation in a minor way, given the small contribution of this source.

Urban Turfgrass Fertilizers

- The NSILT relied on regional fertilizer application rates for the pervious land area associated with urban land uses. The estimated TN input was 280,759 lb-N/yr over the 4,163 acres fertilized within the contributing area.
- Jones et al. (1997) used FDACS annual fertilizer sales data. The residential acreage was calculated from land use maps developed from 1990 aerial

photography. It was assumed the fertilizer was applied evenly across this acreage, resulting in 104,000 lb-N/yr applied within the Chassahowitzka Springs study area.

- The higher NSILT calculation is likely due to a combination of factors, including the different methods used, the increased urbanization of the area over the past 20 years, and the inclusion of nonresidential urban land uses in the NSILT calculations.

Sports Turfgrass Fertilizer

- For the NSILT, 6 golf courses covering 1,225 acres were identified. An average application rate of 141 lb-N/ac resulted in an input to the land surface of 172,842 lb-N/yr. Calculations for sporting facilities were made based on fertilization rates for lawn service companies. These added 3,252 lb-N/yr, for a total of 176,094 lb-N/yr attributable to sports turfgrass fertilizers.
- Jones et al. (1997) included 3 golf courses covering a total of 253 acres. The authors used an application rate of 260 lb-N/acres based on a study completed in Sarasota Bay, for a total of 66,000 lb-N/yr, or 111 tons-N/yr.
- The difference of 110,94 lb-N/yr was likely due to changing trends in golf course maintenance over the past 20 years. While the golf course acreage was largely in the NSILT area, the application rates were lower, resulting in a lower input to the land surface. The inclusion of sporting facilities in the NSILT also increased this estimate compared with Jones (1997).

Wastewater Treatment Facilities

- The NSILT used reported effluent data from 10 facilities in the contributing area. These had an average actual flow of 0.09 mgd, with an average nitrogen concentration of 7.39 mg/L. The annual input attributable to these facilities equaled 18,482 lb-N/yr. The assessment did not include input associated with domestic WWTF residuals because of the lack of supporting data.
- Jones et al. (1997) evaluated WWTFs in two different categories: sewage effluent disposal and the land disposal of sludge. The total effluent disposal was estimated by assessing 17 facilities with an average flow of 0.04 mgd. The total input was estimated using an average nitrogen concentration of 40 mg/L, equaling 54,000 lb-N/yr. Additionally, 40,020 lb-N/yr were calculated for the land spreading of sludge in the study area.

- The difference between the two studies is 35,518 lb-N/yr, attributable to the Jones et al. (1998) study using the much higher effluent concentration and including the sludge estimate. Additionally, since the first study was completed, considerable advances in waste treatment were made and applied in this area that would contribute to the lower effluent concentration used in the NSILT.

Farm Fertilizers

- To obtain nitrogen inputs from farm fertilizers, the NSILT used PA data, known crops grown in the area, and agricultural producer feedback, as well as UF IFAS–recommended fertilizer application rates. The 18,916 acres of cropland and pastures in the contributing area contributed 513,977 lb-N/yr.
- Jones et al. (1997) estimated fertilization for citrus, row crops, and pasturelands. Row crops were calculated based on a fertilizer application rate of 170 lb-N/ac/yr over 175 acres. Citrus fertilization was based on the application of 180 lb-N/ac/yr over 240 acres. Pastureland was estimated using FDACS fertilizer sales data. The amount of fertilizer attributable to row crops and citrus was subtracted from the amount of reported fertilizer sold for farming practices. The remaining fertilizer was assumed to be used for pasture fertilization. The estimated pasture acreage in the study area was not disclosed. In the Chassahowitzka Springs study area, the nitrogen attributed to farm fertilization equaled 428,000 lb-N/yr.
- The results from these two methods were comparable, with a difference of 88,977 lb-N/yr. The application rates used for the Jones et al. (1997) study were higher. However, the acreage used in the NSILT was considerably larger. These differences resulted in a similar estimated nitrogen input for farm fertilizer.

Livestock Waste

- The NSILT included cattle as well as other livestock animals within the BMAP boundary. Based on stocking rates gathered from feedback from cattle farmers, the cattle population was 2,206. Additional livestock animal populations estimated from the 2012 CoA were assigned to the contributing area based on the distribution of livestock lands (such as improved pasture). Daily waste factors were applied based on the nitrogen content for each animal. The total input to the land surface equaled 466,538 lb-N/yr.

- The SWFWMD separated livestock waste estimates into 3 different categories: poultry, dairies, and cattle. FDACS estimated the animal populations, and daily waste factors were applied. Poultry produces 0.053 lb-N/day/animal, resulting in an annual input of 666,000 lb-N. Dairy cows produce 0.45 lb-N/day/1,000 lb of body weight, equaling a total input of 98 tons/yr, or 196,000 lb-N/yr. Cattle, which were assumed to represent beef cattle, have a daily waste factor of 0.33 lb-N/1,000 of body weight, with an associated input of 830,000 lb-N/yr. The individual Chassahowitzka Springs study area populations were not specified. In total, Jones et al. (1997) calculated livestock waste at 1,692,000 lb-N/yr.
- There was a large difference between these two estimates (1,225,462 lb-N/yr). The daily waste factors used in both studies were comparable and likely did not contribute to the discrepancy. Without knowing the exact population used in the Jones et al. (2007) study, DEP could not directly determine the population differences. However, this was the most likely factor leading to such a large difference. Although poultry farming in Hernando County has dramatically decreased since the 1990s and was not even calculated in the NSILT due to vastly incorrect populations reported in the CoA, this decrease in poultry farming contributed to a difference of almost 3 million pounds.

Stormwater

- The NSILT did not estimate the influence of stormwater-sourced nitrogen on groundwater.
- Jones et al. (1998) calculated that 18,000 lb-N/yr runs off from golf courses, residential areas, commercial properties, and cropland via stormwater.

Comparison of TN Inputs

The TN inputs to the land surface calculated by Jones et al. (1998) were 4,058,000 lb-N/yr (based on 121,600 acres of land area, resulting in an average of 33 lb-N/ac). The two sources that contributed the highest percentages of nitrogen to the land surface were livestock waste (42 %) and atmospheric deposition (38 %).

The NSILT estimated TN inputs of 2,337,173 lb-N/yr to the land surface (107,309 acres) in the Chassahowitzka Springs contributing area, or an average of 22 lb-N/ac. The 3 sources contributing the largest percentages of nitrogen inputs to the land surface were atmospheric deposition (32 %), farm fertilizers (22 %), and livestock waste (20 %). **Table D.1** compares the relative percentages calculated using both methods.

As described above, there were notable differences between the two studies in the methods used to estimate nitrogen inputs to the land surface. The biggest differences were attributable to the study area sizes, the development of more accurate methods to identify land uses, and the application of nitrogen for different land use practices.

The SWFWMD study (Jones et al. 1997) provided an important baseline for comparison with the nitrogen inventory for the Chassahowitzka Springs contributing area. Current information on the nitrogen source inventory and nitrogen loads to groundwater generated from the NSILT for the BMAP will be used to determine where present-day nitrogen loading to groundwater can be reduced to restore water quality in the Chassahowitzka Springs Group.

Table D.1: Comparison of nitrogen input percentages to the land surface calculated by the NSILT and Jones et al. (1997)

N Loading Category	NSILT (%) (2016)	Jones et al. (%) (1997)
Atmospheric Deposition	32	38
Septic Systems	6	2
WWTFs	1	2
Urban Turfgrass Fertilizers	12	3
Sports Turfgrass Fertilizers	7	2
Farm Fertilizers	22	11
Livestock Waste	20	42
Stormwater	0	0.4

Appendix E: Important Links

Cover page: DEP homepage – <http://www.dep.state.fl.us/mainpage/default.htm>

Page 2:

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Section 2.3:

Locations of known and estimated septic systems:

<http://ww10.doh.state.fl.us/pub/bos/Inventory/FloridaWaterManagementInventory/>

Estimated population served by septic systems in Citrus and Hernando Counties:

<http://www.census.gov/>

Bureau of Labor Statistics: <http://www.bls.gov/cps>