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MINIMUM RECOMMENDED LAKE LEVELS: LAKE SANTA FE, FLORIDA

November 2022

Prepared for:



Suwannee River Water Management District
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Live Oak, FL 32060

The Suwannee River Water Management District (SRWMD) was created by the Florida Legislature in 1972 to be one of five water management districts in Florida. It includes all or part of 15 counties in north central Florida. The mission of SRWMD is to ensure the sustainable use and protection of water resources for the benefit of the people of the District and the state of Florida. SRWMD accomplishes its mission through regulation; applied research; assistance to federal, state, and local governments; and land acquisition and management.

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Executive Summary

Under task work assignments (TWAs): 19/20-061.005 and 19/20-061.009, Environmental Consulting and Technology, Inc. (ECT) was authorized by the Suwannee River Water Management District (SRWMD or District) to prepare a report titled Minimum Recommended Lake Levels: Lake Santa Fe, Florida.

This report presents the Suwannee River Water Management District's (SRWMD's) recommended minimum flows and levels (MFLs) for Lake Santa Fe, Alachua County, Florida. These MFLs are based on work performed by Greenman-Pederson, Inc. (GPI); ECT; and SRWMD staff using methodology developed by the St Johns River Water Management District (SJRWMD).

Summary Table. Recommended minimum lake levels for Lake Santa Fe, Alachua County.

Minimum Level	Recommended Elevation (ft NAVD88)	Recommended Hydroperiod Categories	Recommended Duration (days)	Recommended Return Interval (years)
Minimum frequent high level (FH)	139.10	Seasonally flooded	30	2
Minimum average level (MA)	137.89	Typically saturated	180	1.7
Minimum frequent low level (FL)	136.52	Semi-permanently flooded	120	5

ft NAVD88 = feet above North American Vertical Datum of 1988

The SJRWMD event-based MFLs method (SJRWMD 2006, Neubauer et al. 2008) are used to determine MFLs based on the evaluation of topography, vegetation, and soils associated with a water body. The event-based methods allow for the proposal of three MFLs for Lake Santa Fe, based upon separate hydroperiod categories, specifically the minimum frequent high (FH) level, minimum average (MA) level, and minimum frequent low (FL) level. Hydroperiod categories describe the seasonal and cyclical patterns of water in a wetland and are defined from adaptations of water regime modifiers developed by Cowardin et al. (1979).

The recommended FH for Lake Santa Fe is a stage elevation of 139.10 feet (ft) above the North American Datum of 1988 (NAVD88) and a hydroperiod category of seasonally flooded (Summary Table). This FH level for a seasonally flooded hydroperiod with a return interval of at least once in 2 years represents the maximum of the mean surface elevations surveyed in the cypress (*Taxodium* spp.) communities contiguous with the lake. The intent of the recommended FH is for stage to achieve the level at least every 2 years for a 30-consecutive day period for the purposes of preserving the location, structure, and function of seasonally flooded forested wetlands (i.e., cypress-dominated and hardwood swamps), including provisioning of fish and wildlife values in the seasonally expanded inundated area. This defining hydrologic event for the FH was based on specific wetland inundation and dewatering signatures (SWIDS) analysis for Lake Santa Fe, supported by the methods developed and applied by SJRWMD (Neubauer et al. 2004 & 2007, Sutherland et al. 2017).

The recommended MA for Lake Santa Fe is a stage elevation of 137.89 ft NAVD88 and a hydroperiod category of typically saturated (Summary Table). This MA stage for a typically saturated hydroperiod represents a level near the mean elevation of thick organic soils in the cypress and hardwood swamp wetlands adjacent to the lake (i.e., 0.3 foot below the mean). Thick organic soils

include those described as Histosols (greater than or equal to 16 inches of thick surface organics) as well as those with a histic epipedon (8 to 16 inches of thick surface organics). The intent of the recommended MA is for the stage to only go below the level for 180 consecutive days no more frequently than every 1.7 years for the purposes of preventing excessive oxidation of the thick organic soils in the wetlands contiguous with the lake as well as provide soil saturation and shallow ponded water in the shallow marshes around the lake.

The recommended FL for Lake Santa Fe is a stage elevation of 136.52 ft NAVD88 and a hydroperiod category of semi-permanently flooded (Summary Table). This FL elevation represents a level 20 inches below the mean elevation of thick organic soils in the cypress and hardwood swamp wetlands adjacent to the lake (i.e., 1.67 feet below the mean). The intent of the recommended FL is for the stage to only go below the level for 120 consecutive days no more frequently than every 5 years for the purposes of preserving the near permanent inundation of the deep marsh community (and lake littoral zone) while allowing infrequent, beneficial dewatering of the other wetland communities contiguous with the lake. Dewatering has ecological benefits in the form of sediment consolidation and biochemical processes as well as allowing seed germination for wetland plants requiring exposed soils.

Assessment of the current MFLs status for Lake Santa Fe will be presented in a separate document.

1.0 Introduction

Under task work assignments (TWAs): 19/20-061.005 and 19/20-061.009, Environmental Consulting and Technology, Inc. (ECT) was authorized by the Suwannee River Water Management District (SRWMD or District) to prepare a report titled Minimum Recommended Lake Levels: Lake Santa Fe, Florida.

This report presents the SRWMD's evaluation of the minimum flows and levels (MFLs) determination for Lake Santa Fe, Alachua County, Florida. These MFLs are based on work performed by SRWMD staff, Greenman-Pedersen, Inc. (GPI), and ECT, using methods developed by the St. Johns River Water Management District (SJRWMD).

2.0 MFLs Program Overview

2.1 Statutory Framework

The SRWMD MFLs program is based on the requirements of Sections 373.042 and 373.0421, Florida Statutes (F.S.), and is subject to the provisions of Chapter 40B-8, Florida Administrative Code (F.A.C.). The MFLs program provides technical support to the SRWMD regional water supply planning process (Section 373.0361, F.S.), consumptive use permitting (Chapter 40B-2, F.A.C.), and environmental resource permitting (Chapter 40B-4, F.A.C.) programs.

Based on the provisions of Rule 40B-8.011(3), F.A.C., "... the Governing Board shall use the best information and methods available to establish limits which prevent significant harm to the water resources or ecology." Significant harm is prohibited by Section 373.042(1), F.S. Additionally, "Minimum flows and levels should be expressed as multiple flows or levels defining a minimum hydrologic regime to the extent practical and necessary to establish the limit beyond which further withdrawals would be significantly harmful to the water resources or the ecology of the area..." (Rule 62-40.473(2), F.A.C.).

2.2 Water Resource Values

According to Rule 62-40.473(1), F.A.C., in establishing MFLs pursuant to Section 373.042 and 373.0421, F.S., consideration shall be given to natural seasonal fluctuations in water flows or levels, non-consumptive uses, and environmental values associated with coastal, estuarine, riverine, spring, aquatic, and wetlands ecology. These environmental values, also referred to as water resource values (WRVs) are listed below with their respective working definitions. All of these items were qualitatively reviewed, but fish and wildlife habitat and the passage of fish (Value #2) was quantitatively evaluated, because it was considered most appropriate for this lake and would maintain other relevant values. WRVs are listed as follows:

- Recreation in and on the water;
- Fish and wildlife habitats and the passage of fish;
- Estuarine resources;
- Transfer of detrital material;
- Maintenance of freshwater storage and supply;
- Aesthetic and scenic attributes;
- Filtration and absorption of nutrients and other pollutants;
- Sediment loads;
- Water quality; and
- Navigation.

In addition to these factors, based on Section 373.0421(1), F.S., the following considerations are also required:

"When establishing minimum flows and levels pursuant to Section 373.042, the department or Governing Board shall consider changes and structural alterations to watersheds, surface waters, and aquifers and the effects such changes or alterations have had, and the constraints such changes or alterations have placed, on the hydrology of an affected watershed, surface water, or

aquifer, provided that nothing in this paragraph shall allow significant harm as provided by Section 373.042(1) caused by withdrawals.”

2.3 Hydrologic Regime

MFLs designate an environmentally protective hydrologic regime (i.e., hydrologic conditions that prevent significant harm) and identify levels and/or flows above which water may be available for reasonable–beneficial use. The SJRWMD event-based MFLs methods define the frequency and duration of high, average, and low water events necessary to protect relevant water resource values and prevent significant harm to aquatic and wetland habitats. Three types of events that are routinely used by the SJRWMD are referred to as minimum frequent high, minimum average, and minimum frequent low flows and/or water levels (SJRWMD 2006, Neubauer et al. 2008). The MFLs represent hydrologic statistics composed of three components: a magnitude (a water level and/or flow), duration (days), and a frequency or return interval (years). Discrete hydroperiod categories to facilitate MFL determinations are listed according to specific duration and return interval values in Table 2-1 (SJRWMD 2009). “High” approximate frequencies refer to high stage/flow events that occur for a minimum approximate duration. “Low” approximate frequencies refer to low stage/flow events occurring for a maximum approximate duration (i.e., a low stage event occurring every two years and not exceeding six months).

Table 2-1. MFLs Hydroperiod categories with approximate frequencies and durations

Hydroperiod Category	Approximate Frequency	Approximate Duration
Intermittently flooded	Once every 10 years high	Weeks to months
Temporarily flooded	Once every 5 years high	Weeks to months
Seasonally flooded	Once every 2 years high	Weeks to months
Typically saturated	Once every 2 years low	Months
Semi-permanently flooded	Once every 5 to 10 years low	Months
Intermittently exposed	Once every 20 years low	Weeks to months
Permanently flooded	More extreme drought	Days to weeks

MFLs apply to decisions affecting permit applications, declarations of water shortages, and assessments of water supply sources. Actual or projected instances where water levels fall below established MFLs may require the SRWMD Governing Board to develop recovery or prevention strategies (Section 373.0421(2), F.S.). MFLs are to be reviewed periodically and revised as needed (Section 373.0421(5), F.S.).

2.4 Management Stakeholders

Lake Santa Fe is located within the North Florida Regional Water Supply Partnership planning area (North Florida Regional Water Supply Partnership 2021). The Partnership is a collaborative effort between SRWMD, SJRWMD, the FL Department of Environmental Protection (FDEP), local governments, concerned citizens, and other stakeholders throughout the region. The Partnership’s mission is to protect the shared resources of the Floridan aquifer system through collaborative planning, scientific-tool development, and other efforts.

3.0 Setting and Description

3.1 Lake and Basin Morphometry

Lake Santa Fe forms the northeastern boundary of Alachua County (with adjacent counties Bradford and Putnam) and is located near the intersection of State Roads 26 and 21 (Figure 3-1). The lake occupies approximately 5,856 acres, including 4,721 acres for the larger southern lobe and 1,135 for the smaller northern basin (Dickinson et al. 1982). The smaller northern lobe is also referred to as Little Lake Santa Fe and is separated from the larger southern portion of Lake Santa Fe by a pass less than 1,000 feet (ft) wide and approximately 10 ft deep. Lake Santa Fe is connected through a man-made canal, called the Santa Fe Canal, to Lake Alto. The Santa Fe Canal is an historic canal that connects Lake Santa Fe to Lake Alto (Alachua County 2014). It was constructed in the late 1870s, along with the Waldo Canal, to connect Melrose on Lake Santa Fe to the train depot in Waldo, which was an important stop for rail traffic to and from Jacksonville. The canal was utilized to transport agricultural products, mail, supplies, and tourists. It was abandoned as a primary means of transportation by the early 1900s (Lauter 1950 as cited in Alachua County 2010).

Lake Santa Fe is designated by FDEP as an Outstanding Florida Water, meaning it is “worthy of special protection”. The lake is not designated as impaired under the Impaired Waters Rule (Chapter 62-303, F.A.C.). The lake has a mean depth of 19.7 ft (Canfield et al. 2002). It is mesotrophic, with an average total phosphorus concentration of 10 $\mu\text{g L}^{-1}$, total nitrogen concentration of 419 $\mu\text{g L}^{-1}$, chlorophyll-a concentration of 8 $\mu\text{g L}^{-1}$; and a Secchi depth of 7.5 feet (ft) based on data collected between 1996 to 1997 (Terrell et al. 2000). The combined Lake Santa Fe and Lake Alto basin covers 37,483.8 acres (ECT 2022). The majority of the land use in the basin is described as “rural with limited developed land (residential, transportation, etc.), most of which is located surrounding the lakes and along the U.S. Hwy 301 corridor” (ECT 2022). The top land uses in the lake watershed were identified as upland forests (31.1 percent), wetlands (25.7 percent), and waters (15.6 percent).

The 7,046-acre Santa Fe Swamp at the north end of the lake, is considered the headwaters of the Santa Fe River, the largest tributary of the Suwannee River. At high water levels, Lake Santa Fe overflows into the Santa Fe Swamp and ultimately into the river (Pirkle and Brooks 1959). Water levels in Lake Santa Fe have been characterized as stable relative to other nearby Florida lakes due to underlying relatively impermeable materials (Pirkle and Brooks 1959).

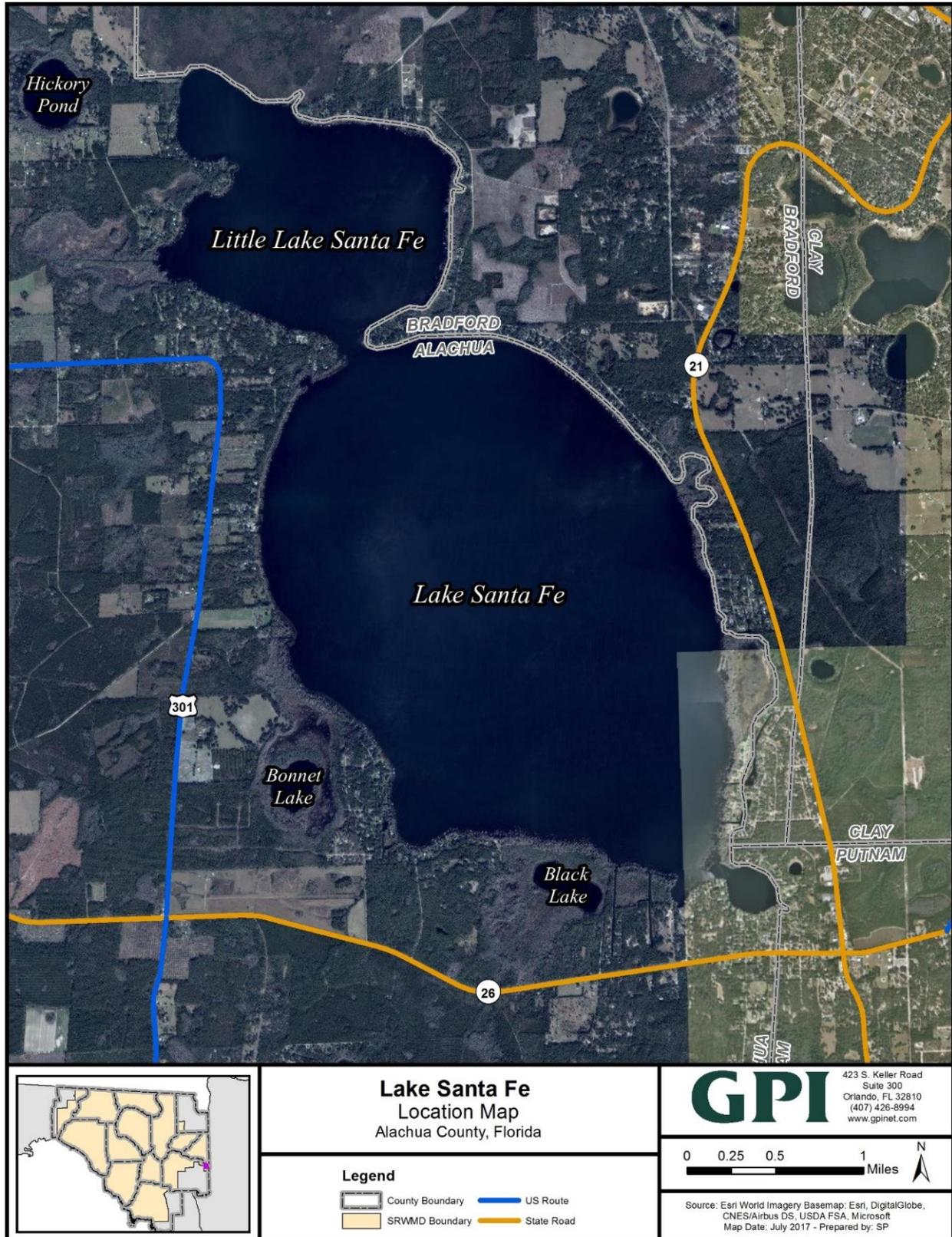


Figure 3-1. Lake Santa Fe location map (from GPI 2018)

3.2 Hydrologic Record

The U.S. Geological Survey (USGS) had a stage gage, USGS 02320630 at Lake Alto at Waldo, Florida located at the west end of the Waldo Canal (ECT 2022). This District-operated lake stage station provides the long-term historical lake stage values in a variety of frequencies from 1976 to present (ECT 2022).

A USGS/District-operated long-term stage station USGS 02320601 Lake Santa Fe near Earleton, FL is located on the west lakeshore of Lake Santa Fe (ECT 2022). This USGS/District-operated lake stage station provides the long-term historical lake stage values in a variety of frequencies from 7/11/1957 to present by USGS and the District. Lake stage values from 4/27/2006 to current were provided on a daily basis at this station. The historical stage data prior to 1/1/1990 was transferred from an inactive USGS station 02320600 by adding a correction factor of -0.48 ft due to a more accurate gage datum survey.

For Little Lake Santa Fe, a USGS/District-operated long-term stage station USGS 02320611 Little Santa Fe Lake was located on the west lake shore. Weekly stage data were manually measured from 2/15/1989 to 06/27/1994 by USGS and from 8/28/2000 to present by the District at this stage station.

As shown in Figure 3-2, the lake stage data collected at Little Lake Santa Fe has a big data gap in 1990's and the historical lake stage data at Lake Santa Fe was provided in a variety of frequencies.

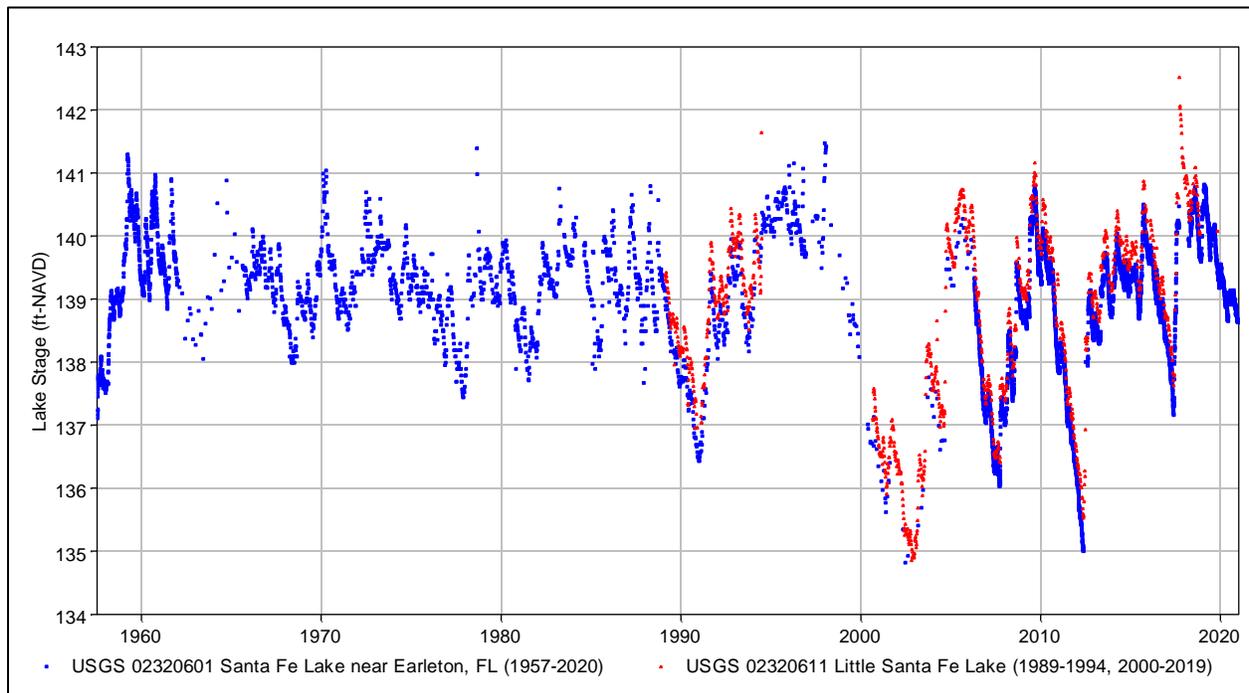


Figure 3-2. Observed Lake Stage Hydrographs at Lake Santa Fe (1957-2020).

To better represent the Historic conditions in the absence of groundwater withdrawals, the calibrated Lake Alto and Lake Santa Fe water budget model was used to run long-term simulations for an extended period of 55.7 years from April 25, 1960, to December 31, 2015. Based on the reference timeframe (RTF) analysis results provided by the District, the groundwater level data set for the no-pumping scenario was created using the “measured” groundwater data set estimated at Lake Santa Fe. This “measured” groundwater dataset was estimated using data collected at the USGS Melrose station (USGS ID: 294313082024601 / SRWMD ID: S092307001) and the SJRWMD Lake Brooklyn Wells near Keystone Heights (SJRWMD ID: 70078104). The term RTF data set is referred to as the “no-pumping” groundwater levels, which was created by adding the time-varying RTF adjustment factors to the “measured” groundwater level data set (ECT 2022).

A technical memorandum “Development of a Reference Timeframe Flow (RTF) Regime for the Minimum Flows and Minimum Water Levels (MFLs) Re-Evaluation of the Lower Santa Fe and Ichetucknee Rivers and Priority Springs” was developed by the District in 2019 and published as Appendix D of a recent MFL report “Minimum Flows and Minimum Water Levels Re-Evaluation for the Lower Santa Fe and Ichetucknee Rivers and Priority Springs” (HSW 2021). This memo outlines the process used to develop reference timeframe flow and/or groundwater-head (head) time-series (e.g., “no-pumping” condition) at groundwater monitoring locations, springs and/or stream gage locations using observed and modeled data and an estimated time series of historic groundwater withdrawals. The model used in this analysis is the North Florida Southeast Georgia Groundwater Model, (NFSEG 1.1) (Durden et al. 2019).

The groundwater level data set developed for the no-pumping scenario was implemented in the long-term model simulations to estimate the groundwater loss from the lake for the Historic conditions. It was assumed that the 55.7-year simulated lake stage data set for the Historic (no-pumping) scenario is a statistically realistic representation of the hydrology, absent significant climatological changes, over the next 55.7 years (ECT 2022). This approach was considered appropriate for extending the period of record (POR) for lake stage values in developing Historic lake stage exceedance percentiles.

Based on the daily model simulated lake stage data set for the no-pumping scenario (Figure 3-3), a stage exceedance graph was developed for Lake Santa Fe (Figure 3-4).

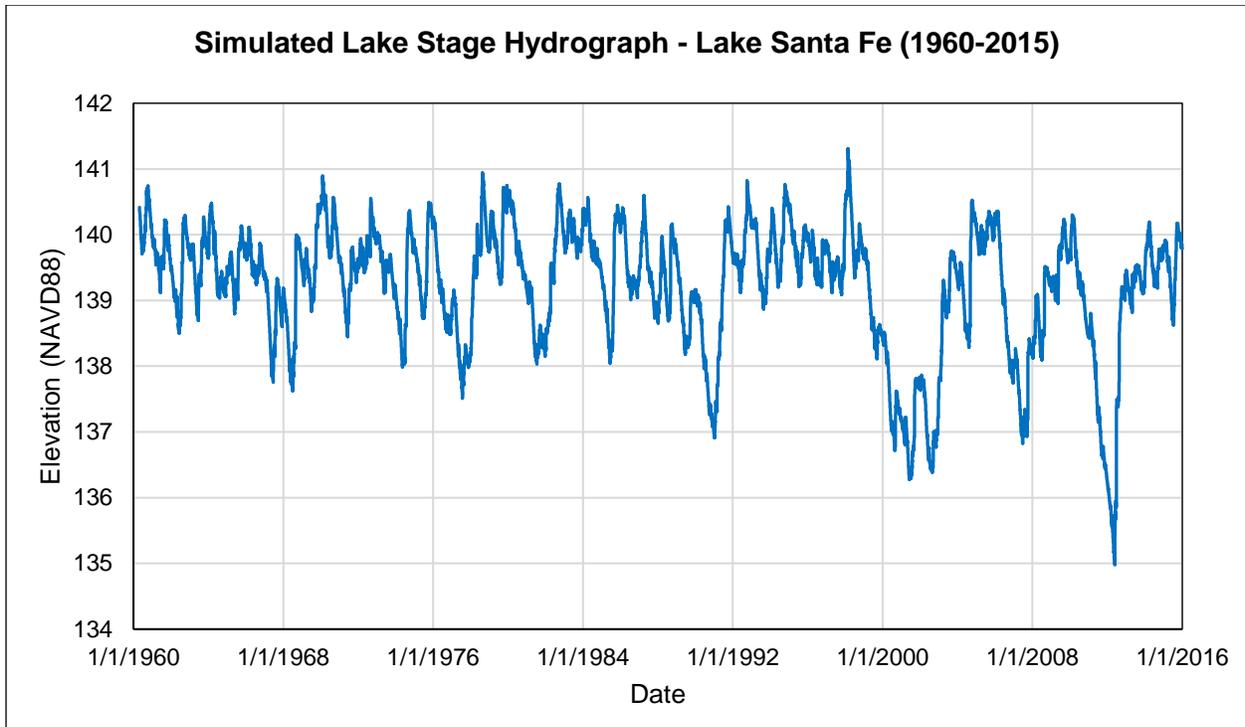


Figure 3-3. Hydrograph for Lake Santa Fe model simulated stage data for no-pumping scenario from 4/25/1960 to 12/31/2015.

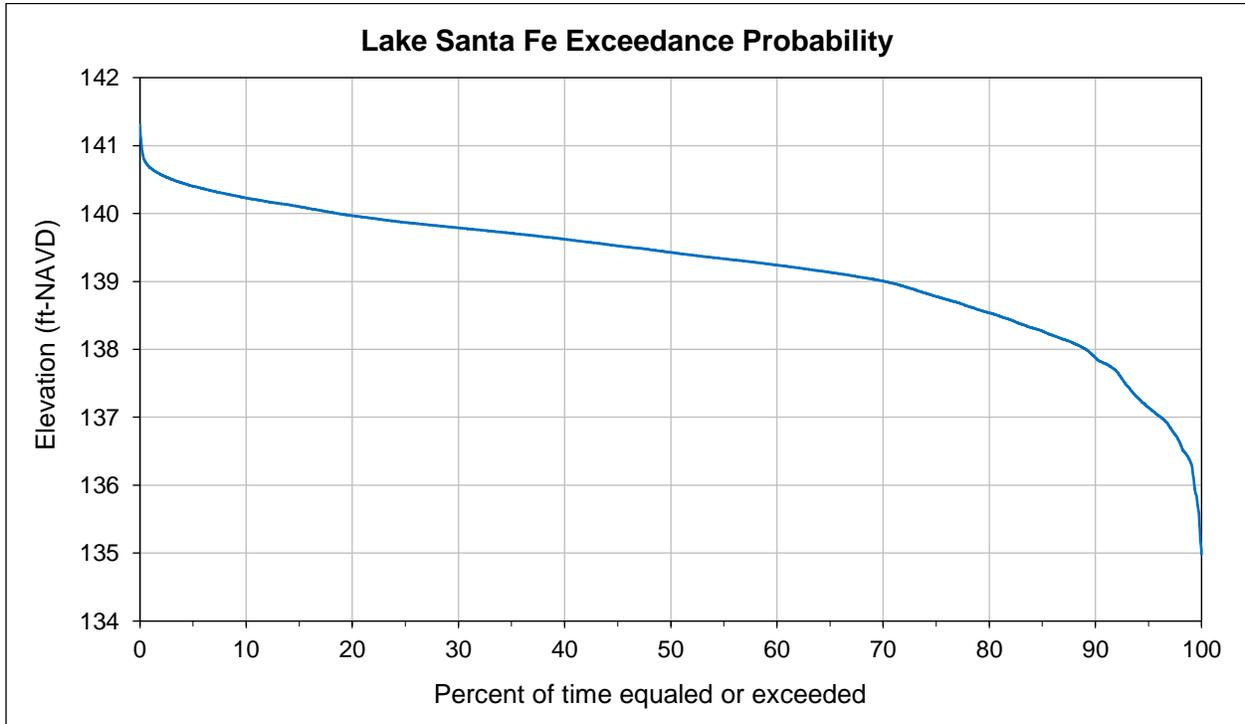


Figure 3-4. Stage Exceedance Graph for Lake Santa Fe model simulated stage data for no-pumping scenario from 4/25/1960 to 12/31/2015.

3.3 Wetlands

The diversity of natural wetland types that are either contiguous or hydrologically connected to Lake Santa Fe, using data produced by the US Fish and Wildlife Service National Wetlands Inventory (NWI), are shown in Figure 3-5. These geospatial data were developed for the purpose of mapping and tracking the status of wetlands and deepwater habitats in the United States and its territories. The NWI classifies wetlands by a hierarchical structure (FGDC 2013). In the case of Lake Santa Fe, wetland classification is based mainly upon dominant vegetation type and hydrologic regime. It is cautionary to note that the NWI hydrologic regimes are descriptive; whereas other hydrologic regimes used in determining MFLs in Florida are defined by specific events (Neubauer et al. 2008), often using identical nomenclature.

Wetlands that are contiguous to Lake Santa Fe include a variety of palustrine wetland types, with a few instances of lacustrine aquatic beds and lacustrine unconsolidated bottom surrounding the lake. The narrow band of wetlands surrounding Lake Santa Fe are composed of mostly forested wetlands according to the NWI data, with the emergent wetlands generally situated between the forested wetlands and the uplands. Lake Santa Fe has a large contiguous wetland to the north named the Santa Fe Swamp that connects to the Santa Fe River. The Santa Fe Swamp is over 7,000 acres in size and, along with the lake, serves as headwaters of the Santa Fe River. Lake Santa Fe is also hydrologically connected to Bonnet Lake (to the southwest) and Black Lake (to the south) via contiguous forested and emergent wetlands. The surrounding wetlands were mostly mapped as mixed wetland subclasses, meaning a combination of evergreen and deciduous trees; they also included a diversity of water regimes, from temporarily to permanently flooded.

The many types of forested wetlands presented as shades of green in Figure 3-5 characterize vegetation communities with deciduous trees represented by swamp tupelo (*Nyssa sylvatica* var. *biflora*), pond cypress (*Taxodium ascendens*), and red maple (*Acer rubrum*). Evergreens include loblolly bay (*Gordonia lasianthus*) and sweetbay magnolia (*Magnolia virginiana*). Darker shades in Figure 3-5 generally represent wetter water regimes. The wettest systems occur adjacent to the lake and also in some deeper basins in the backwater areas.

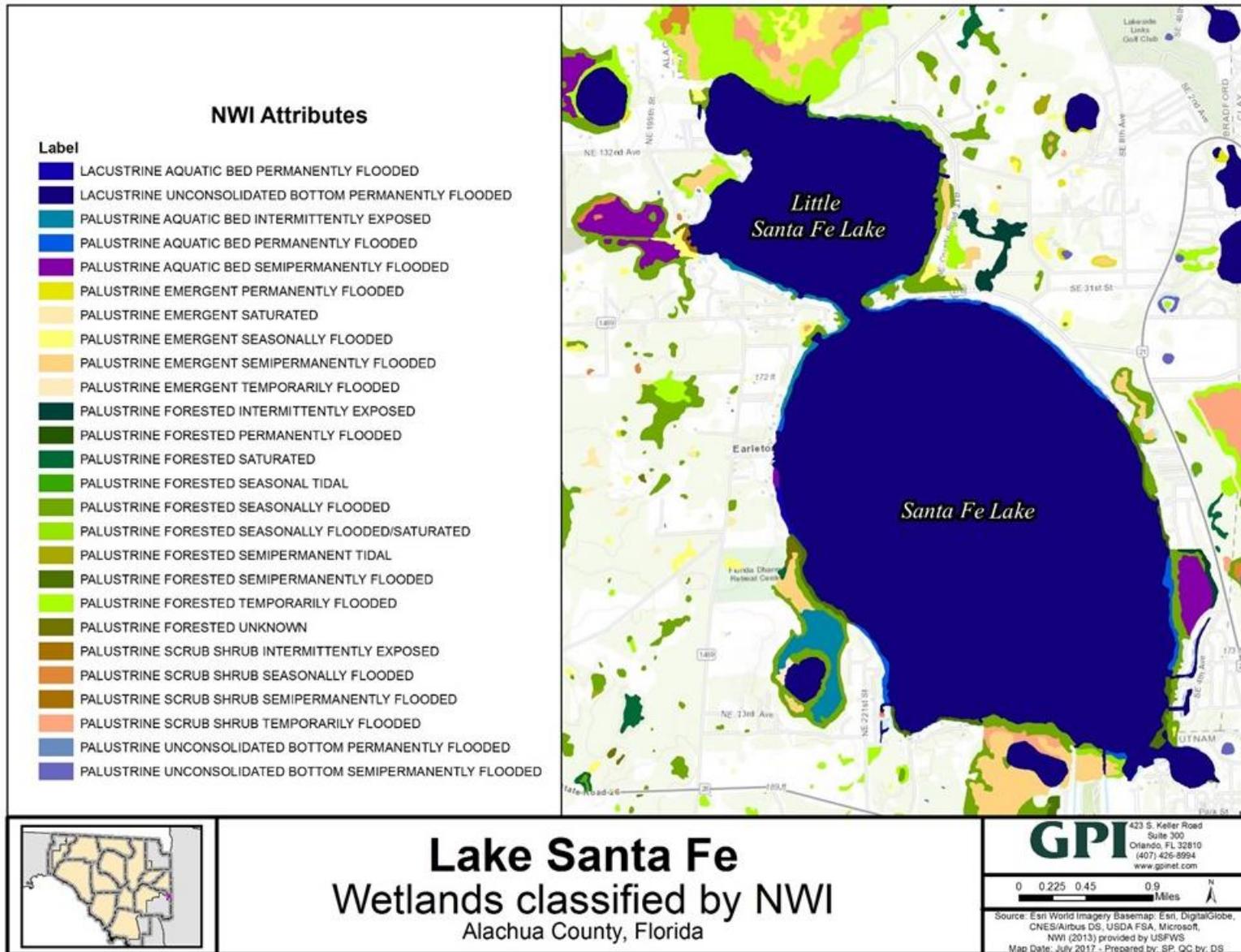


Figure 3-5. Wetlands classified by NWI near Lake Santa Fe (from GPI 2018).

3.4 Soils

Figure 3-6 depicts the hydric soils in proximity to Lake Santa Fe as designated by the USDA-NRCS Soil Survey Geographic database (SSURGO; Soil Survey Staff 2016). Individual map units are described in the legend according to texture, organic matter content, hydrologic regime, and relative elevation. The USDA-NRCS criteria for hydric soils are used in Florida State Standards under Rule 62-340.550, F.A.C. Under Florida State methodology, wetland hydrology is met when soils are inundated for a period of seven consecutive days and/or saturated for at least 20 consecutive days, during conditions which represent long-term hydrologic conditions. As defined, hydric soils are soils that are saturated, flooded, or ponded long enough during the growing season to develop anaerobic conditions in the upper part of the soil profile (Rule 62-340, F.A.C.). These soils support a prevalence of vegetation typically adapted for life in saturated environments.

All hydric soils adjacent to the lake experience frequent ponding, flooding, or both. Ponding is defined as standing water in a closed depression. The water is removed only by deep percolation, transpiration, evaporation, or by a combination of these processes; whereas, flooding is the temporary inundation of an area caused by overflowing streams or runoff from adjacent slopes. Water standing for short periods after rainfall is not considered flooding, and water standing in swamps and marshes is considered ponding rather than flooding.

About 34 percent of the soils within a 1,000-ft lake buffer are considered hydric soils. Very poorly drained hydric soils were common around Little Lake Santa Fe, and to the west and south of Lake Santa Fe. These soils formed in the floodplains and depressions include Dorovan muck, frequently flooded; Samsula muck; Terra Ceia muck; and Pamlico and Croatan mucks, depressional. Six very poorly drained muck soil map units comprise over 31 percent of the buffer area. The dominant soil in the Santa Fe Swamp adjacent to the northern edge of Little Lake Santa Fe is mapped as Dorovan muck, frequently flooded, covering about 26 percent of the buffer area. Found in densely forested floodplains, hardwood swamps, and depressions, Dorovan soils have organic muck layers 51 to 80 inches thick. Formed in highly decomposed acid-organic material, these soils have a water table at or above the soil surface during the wet season and frequently experience flooding and ponded water. The organic matter content of the surface horizons in the Dorovan muck soils can be 70 percent or more. Horizons with less than 20 to 35 percent organic matter by weight have properties more similar to mineral soils (USDA-NRCS 2014).

The USDA-NRCS mapped most areas adjacent to Lake Santa Fe as upland soils (not shown on Figure 3-6). There are over 83 soil map units within a one-mile buffer of the lake. The somewhat poorly drained Lochloosa fine sand and excessively drained Penny sand and Penny fine sand make up about one third of these upland soils. They formed on nearly level to sloping landscapes in thick beds of eolian or marine deposits on knolls and terraces above the lake. About 21 percent of land area within the 1,000-ft lake buffer is dominated by Lochloosa fine sand. These upland soils are somewhat poorly drained mineral soils. Sapelo sands covering over 12 percent of the lake buffer are mineral soils that range from poorly drained to somewhat poorly drained. These two soils have a seasonal high saturation ranging from 6 to 18 inches below ground surface and are not considered hydric, with organic matter content of the surface horizons typically 5 percent or less.

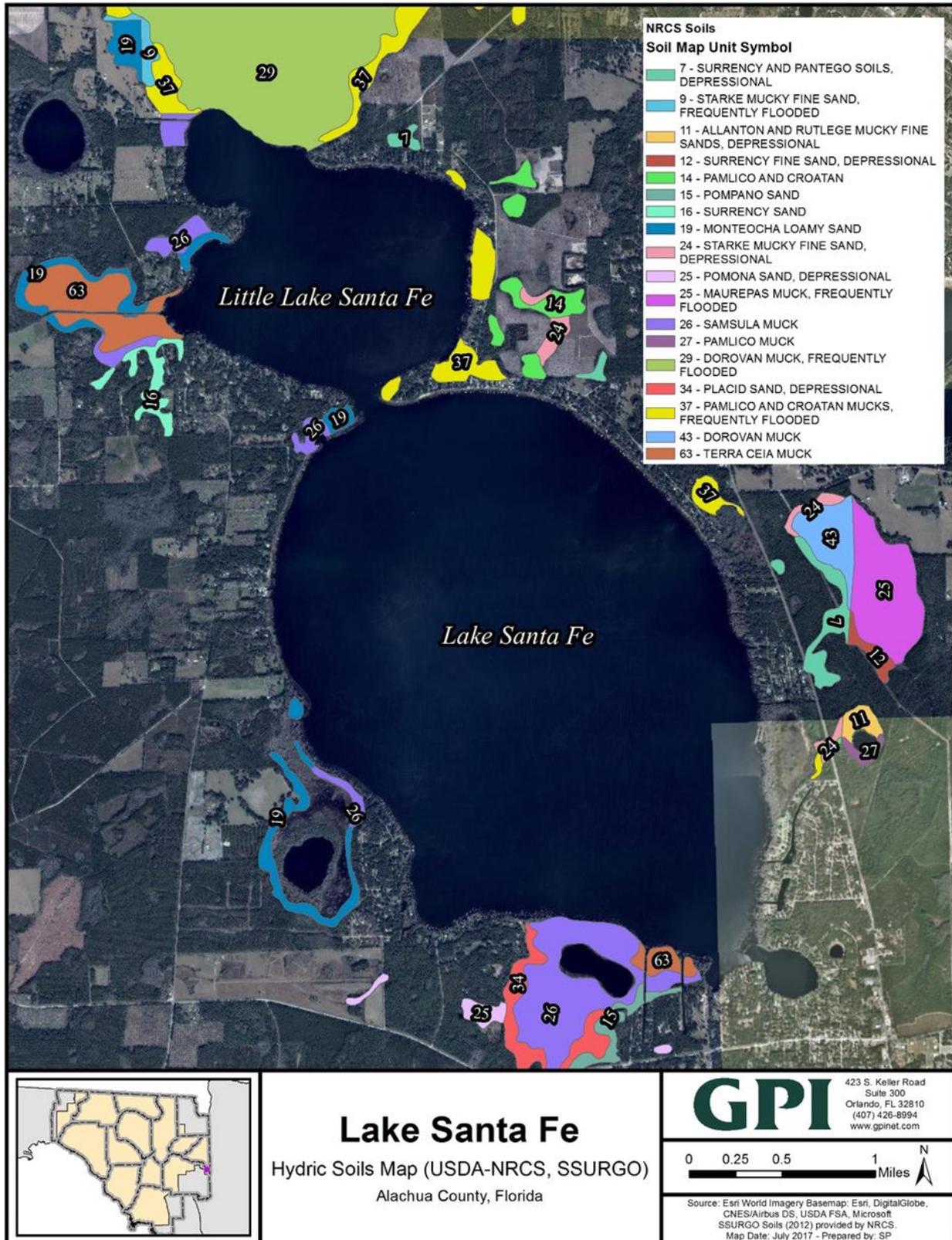


Figure 3-6. NRCS mapped soils near Lake Santa Fe (from GPI 2018).

4.0 MFLs Methodology

This section provides an overview of the methods and assumptions used in the minimum levels development process for Lake Santa Fe, including field procedures such as site selection, field data collection, data analyses, and levels determination criteria. Detailed methods are provided in respective appendices of this report. The event-based methodology is described more completely in the SJRWMD Minimum Flows and Levels Methods Manual (SJRWMD 2006).

The field data collection procedure included gathering detailed elevations, vegetation, and soils data along fixed transects. In addition to sampling procedures presented for field data collection, aerial imagery, maps, and other reliable information were obtained and reviewed for planning purposes, and they were studied for evidence of alterations that may have occurred within the lake and its drainage basin. All ground survey field operations took place from August 21, 2014 through December 05, 2014 and from January 27 through January 28, 2015. All field surveys for vegetation and soils were conducted on October 14 through 29, 2014.

4.1 Site Selection

Using aerial imagery, the NWI, and soil maps as guides, eight transects were considered representative for further investigation from which four were determined suitable. As part of the evaluation process, the suitability of each potential transect was based on four major criteria:

- Fair representation of plant communities and soils types surrounding the lake;
- Accessibility in terms of land ownership;
- Total transect length; and
- Ease of access.

Lake Santa Fe transects were fixed routes, extending from open water to uplands. Elevation, vegetation, and soils data were sampled along the transects to characterize the influence of surface water flooding on the distribution of plant communities and soils. Figure 4-1 illustrates transect locations, each oriented perpendicular to the lake shoreline and extending from the open water to the uplands.

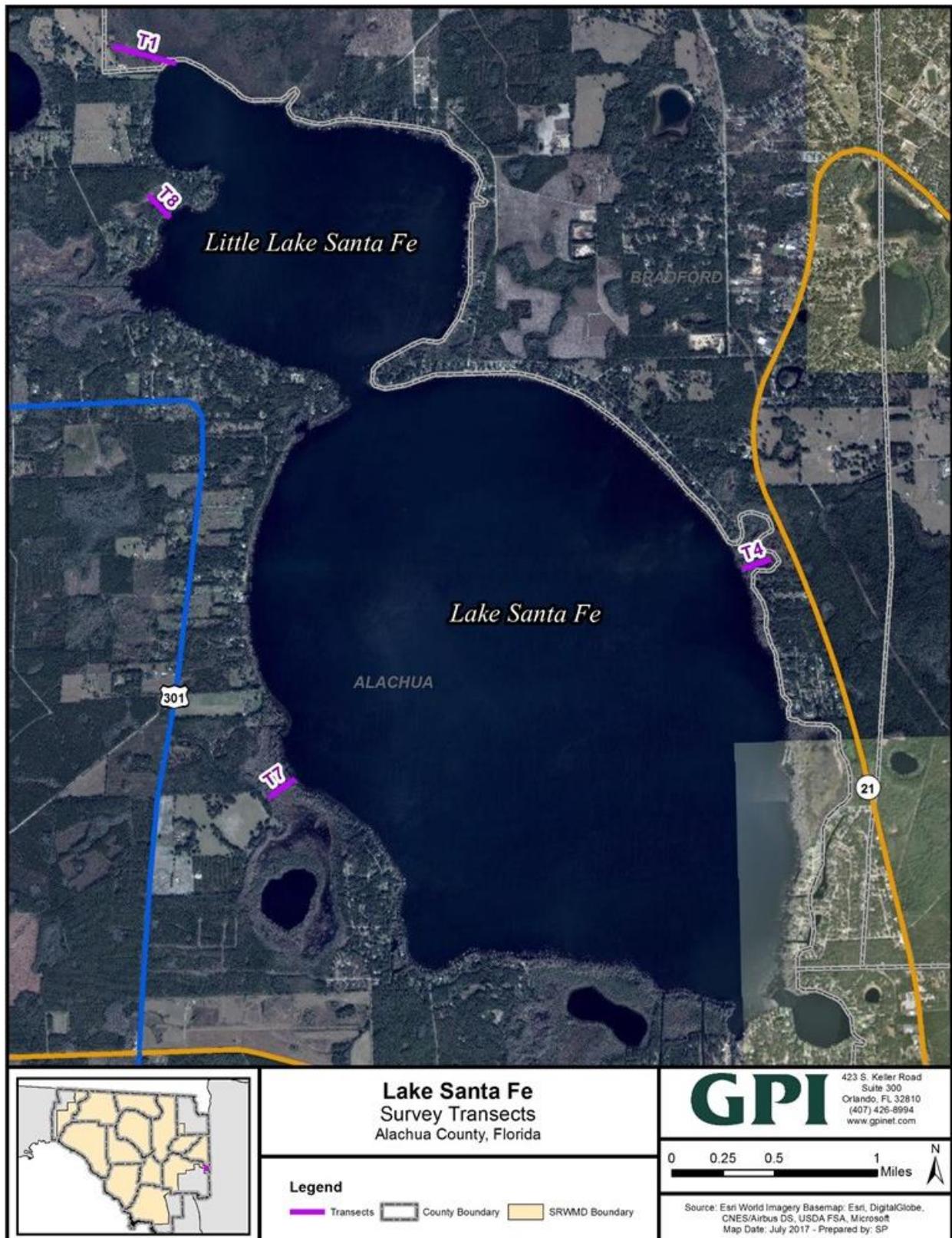


Figure 4-1. Lake Santa Fe sampling transect locations (from GPI 2018).

4.2 Site Survey

In order to relate relevant benchmarks to existing hydrologic data, a detailed elevation survey was conducted by a Florida-licensed Professional Surveyor and Mapper (PSM). Detailed procedures are presented in Appendix A. Surveying tasks included:

- Establishment of a standard elevation datum;
- Preparation of sampling transects;
- Gathering elevation data for vegetation communities and soil attributes along the transects;
- Gathering elevation data of natural and man-made drainage features; and
- Gathering elevation data of residential and recreational infrastructure.

4.3 Vegetation Sampling Procedures

The main objective of this sampling was to qualitatively describe vegetative communities and collect data used in determining the elevations of specific vegetation communities surrounding the lake, as described in the Florida Natural Areas Inventory, Guide to the Natural Communities of Florida (FNAI 2010). This was done so the minimum frequent high (FH) lake level could be set according to event-based methods (SJRWMD 2006, Neubauer et al. 2008). Detailed procedures are presented in Appendix B of this report, and sampling focused upon the following tasks:

- Field identification of plant communities along sampling transects (Figure 4-2) using descriptions provided by Kinser (1996) and the FNAI Guide to the Natural Communities of Florida (FNAI 2010);
- Field determination of the boundaries of all plant communities identified along sampling transects; and
- Field collection of plant community data using quadrats (Figure 4-2), belt transects, and the point-centered quarter method (Cottam and Curtis 1956) in order to describe species composition of the plant communities.



Figure 4-2. Transect 1: Herbaceous vegetation cover determination in a one-meter square quadrat. Survey stakes and measuring tape mark the transect centerline.

4.4 Soil Sampling Procedures

Detailed soil sampling procedures are presented in Appendix C of this report. Soil profiles were excavated along transects according to methods from the USDA-NRCS Field Book for Describing and Sampling Soils (Schoeneberger et al. 2012). This sampling effort targeted highly-organic soils that may be used in setting minimum average (MA) and minimum frequent low (FL) lake levels, according to event-based methods (SJRWMD 2006, Neubauer et al. 2008). These soils are classified as Histosols or exhibit the presence of a histic epipedon (USDA-NRCS 2016), and they were sampled from the wetlands using either a soil auger or probe to sufficient depth below soil surface for taxonomic confirmation (Figure 4-3). Sampling also was used to identify the landward extent of muck and the landward extent of hydric soils along the transect.



Figure 4-3. Transect 1: Soil characterization using an auger.

5.0 Data Analyses

Statistical data analyses and graphs were prepared using the following software programs: Microsoft Excel, R Studio (R Core Team 2014), and Statistica (StatSoft 2004). Statistical analyses were performed on surveyed elevation data after joining elevation data to specific plant communities or soil characteristics. The maximum ground elevations of the cypress plant community and the mean elevation of the thick organic soils were most important for determining minimum levels for Lake Santa Fe. Detailed procedures are provided for vegetation and soils in Appendices B and C, respectively.

6.0 Consideration of Basin Alterations

Based on the provisions of Section 373.0421(1)(a), F.S., when establishing MFLs, SRWMD considers changes and structural alterations to watersheds, surface waters, and aquifers and the effects such changes or alterations have had, and the constraints such changes and alterations have placed, on the hydrology of an affected watershed, surface water, or aquifer. However, when considering such changes and alterations, SRWMD cannot allow significant harm caused by withdrawals. To accomplish this, SRWMD reviews and evaluates available information, and makes site visits to ascertain the following information concerning the subject watershed, surface water body, or aquifer:

- The nature of changes and structural alterations that have occurred.
- The effects the identified changes and alterations have had.
- The constraints the changes and alterations have placed on the hydrology.

As noted in Section 3.1, the Santa Fe Canal is a historic canal that connects Lake Santa Fe to Lake Alto. It was constructed in the late 1870s along with the Waldo Canal to connect Melrose on Lake Santa Fe to the train depot in Waldo, Florida. Depending on the lake levels in these two lakes, Lake Santa Fe may discharge into or receive surface water from Lake Alto. As this canal is not currently used for navigation purposes, vegetation overgrowth and siltation were observed at some shallow canal segments during a field trip conducted by ECT and SRWMD staff in December 2016 (ECT 2022).

SRWMD has developed hydrologic models (ECT 2022), which address existing structural features, and has used these models to consider the effects these changes have had on the long-term hydrology of water bodies for which recommended MFLs are being developed.

SRWMD considered that the existing hydrologic condition, which was used to calibrate and verify the models, reflected the changes and structural alterations that have occurred in addition to changes that are the result of groundwater and surface water withdrawals existing at the time of model development. This consideration may also apply to vegetation and soils conditions if the changes, structural alterations, and water withdrawals have been sufficiently large to affect vegetation and soils and have been in place for a sufficiently long period to allow vegetation and soils to respond to the altered hydrology. However, the condition of vegetation and soils may not reflect the long-term existing hydrologic condition if the changes, structural alterations, and water withdrawals are relatively recent. This is because vegetation and soil conditions do not respond to all hydrologic changes nor respond rapidly to changes in hydrology that are sufficiently large to cause such change. SRWMD typically develops recommended MFLs based on vegetation and soils conditions that exist at the time fieldwork is being performed to support the development of these recommended MFLs.

7.0 Results and Discussion

Detailed results of the analyses of vegetation and soils data may be found in their respective appendices (Appendices B and C).

7.1 Lake Santa Fe Vegetation

Natural communities occurring in the Lake Santa Fe study area were classified in accordance with descriptions developed by Kinser (1996) and the Florida Natural Areas Inventory (FNAI 2010). These included bayhead, cypress, deep marsh, hardwood swamp, pond, shallow marsh, shrub bog, shrub swamp, and wet prairie (Table 7-1).

Table 7-1. Community elevations combined from Transects 1, 4, 7, and 8 survey data (ft NAVD88).

Community	N	Mean Elevation	Standard Deviation (ft)	Minimum Elevation	Maximum Elevation
Bayhead	139	138.52	0.45	137.06	139.29
Cypress	82	137.86	1.09	135.37	140.06
Deep Marsh	73	134.40	2.17	128.16	137.53
Hardwood Swamp	40	138.08	0.48	136.75	139.12
Pond	6	138.54	0.21	138.32	138.85
Shallow Marsh	88	138.25	0.53	137.35	139.46
Shrub Bog	40	137.52	0.50	136.60	138.75
Shrub Swamp	50	137.95	0.24	137.48	138.58
Upland	36	141.35	1.15	139.35	143.45
Wet Prairie	7	139.82	0.12	139.61	139.96

The lowest elevations sampled along the transects occurred in the deep marsh community, since those samples extended out into the lake in areas with emergent vegetation. The highest elevations were those landward ends of the transects described as upland. The rest of the wetland community types occurred between these extremes (Table 7-1 and Figure 7-1). There was very little overlap in elevation between upland areas and wetland areas as shown by the lack of overlap of the interquartile range of the upland samples over any of the wetland communities. As expected, wet prairie was the highest, and therefore driest, wetland community, which is generally “inundated for a relatively short duration each year” (Kinser 1996). The remaining wetland community types had partially overlapping elevational ranges, occurring mostly in a band between 137 and 139 ft NAVD88 (Figure 7-1). The deep mash community showed the widest elevation range, followed by the cypress community which had some large diameter cypress trees occurring in relatively deep water in the emergent zone of the lake and others occurring at elevations that were considered upland on some transects.

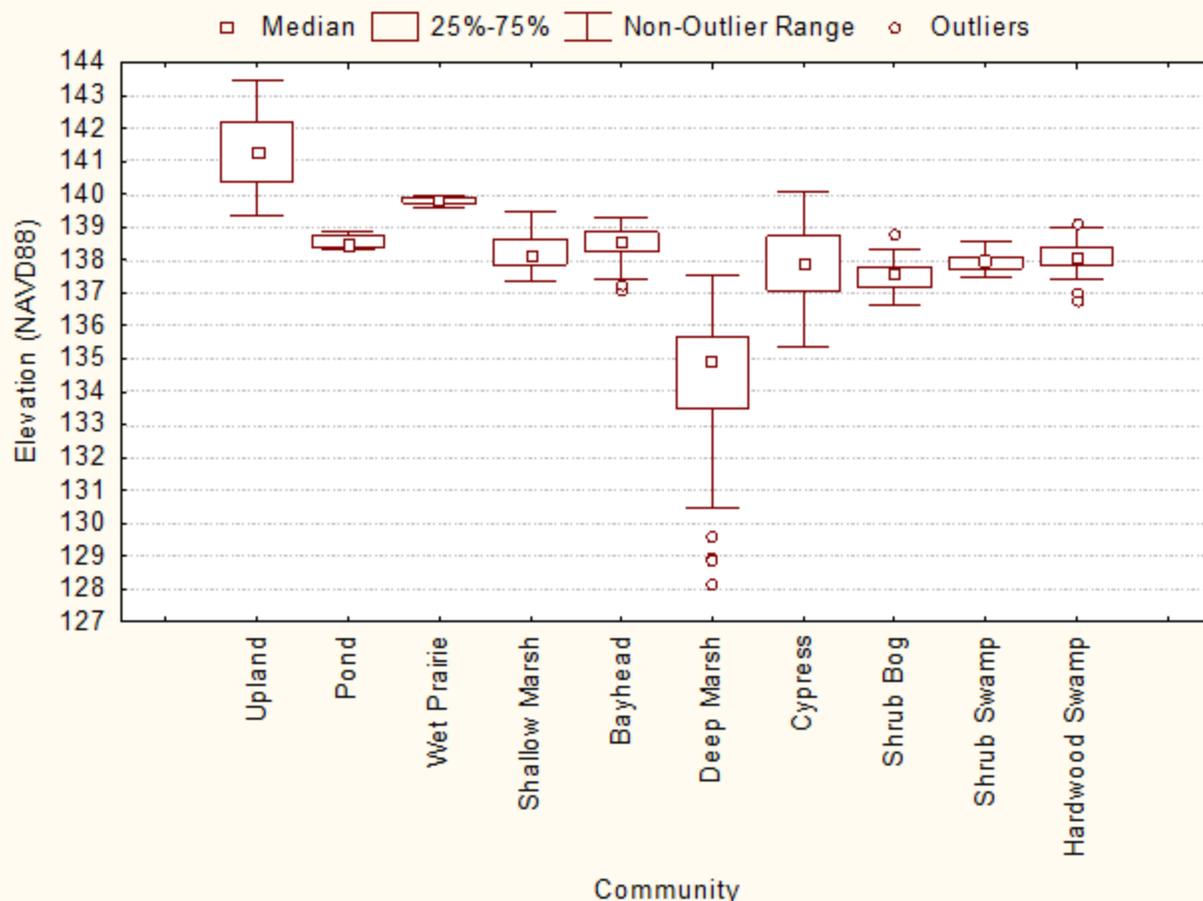


Figure 7-1. Distribution of elevations surveyed in Lake Santa Fe by community.

Maintenance of the hydrologic regime for the cypress community was most important in determining the high minimum level for Lake Santa Fe. The cypress community is a forested wetland dominated by bald cypress or pond cypress (*Taxodium distichum* or *T. ascendens*), flooded annually for periods of long duration—typically 4 to 8 months in any given year. It includes cypress dome, strand, and lakeshore variants (Kinser 1996). The maximum of the mean surface elevations of the cypress communities was used to set the FH level on Lake Santa Fe, ensuring the maintenance of flooding events with a minimum 30-day duration at a return interval of at least once in 2 years for seasonally flooded communities adjacent to the lake. A total of six cypress communities were observed on three of the four sampled transects (Transects 4, 7, and 8). The mean surface elevations of the cypress communities (CY1 through CY6) are summarized in Table 7-2 and the maximum of the mean surface elevations is 139.10 ft NAVD88 estimated at cypress community CY1.

Table 7-2. Mean surface elevation in cypress communities (ft NAVD88).

Cypress Community ID	Transect ID	Transect Stations	N	Mean Elevation	Standard Deviation (ft)	Minimum Elevation	Maximum Elevation
CY1	4	0+60 - 0+71	3	139.10	0.30	138.78	139.37
CY2	4	5+00 - 6+90	25	136.93	0.56	135.40	138.07
CY3	4	8+20 - 9+00	12	137.33	1.23	135.37	138.85
CY4	7	0+40 - 1+11	11	138.99	0.59	138.21	140.06
CY5	7	6+60 - 7+90	19	138.21	0.54	137.18	138.98
CY6	8	8+60 - 9+30	12	138.45	1.09	136.20	139.71

7.2 Lake Santa Fe Soils

Information gathered from vegetative communities was used to recommend the FH. The MA and FL are levels typically recommended based upon offsets from the mean elevation of highly organic soils from seasonally flooded vegetation communities, specifically Histosols and soils with a histic epipedon (Schoeneberger et al. 2012; SJRWMD 2006). The hydrologic regime protected by the MA relates to soils that experience dewatering for a maximum duration of 180 days and a maximum recurrence interval of 1.7 years. The intent of the MA is to minimize the oxidation of the thick organic soils that is known to occur if a wetland system is dewatered for a sustained period of time. The MA is calculated as a 0.3-ft offset (below) the mean elevation of the thick organics (SJRWMD 2006). The FL is a lower minimum level that is planned to occur less frequently (e.g., no more often than every five years) allowing a relatively short duration dry down (e.g., not more than 120 days) that will allow ecological processes necessary to the maintenance of the system (e.g., decomposition and compaction of organic sediments and cypress seedling germination) without causing excessive organic soil loss. The FL is frequently calculated as a 20-inch offset (below) the thick organics.

Of the 107 soil borings performed at Lake Santa Fe, 77% were found to have thick organics present. Five of the communities sampled showed all their samples to have thick organics: deep marsh, bayhead, hardwood swamp, shrub swamp, and shrub bog. As presented in Appendix C, the thick organics were more frequently found at lower elevations along the transect, reflecting the longer hydroperiods and longer periods of saturation occurring at lower elevations, promoting the development and maintenance of thick organic soils. A few low elevation samples lacked thick organics, but these represented subaqueous soils occurring in the emergent zone of the lake itself (i.e., deep marsh community).

An overall mean elevation of thick organic soils was calculated using only samples from the cypress and hardwood swamp communities (Table 7-3). This overall mean based on 26 samples was 138.19 ft NAVD88, making the MA equal to 137.89 ft NAVD88 (0.3-ft offset) and FL equal to 136.52 ft NAVD88 (20-inch offset). The rationale for excluding other community types from the mean calculation was the concern that organic soils in some wetland communities may form partially or completely due to groundwater seepage (SJRWMD 2015). The formation of organic soils in bayheads through seepage effects is of particular concern. We restricted the mean calculation to the cypress and hardwood swamp areas given the likelihood that the thick organic soils in those locations is maintained primarily from periodic inundation and saturation driven by lake levels.

Table 7-3. Mean elevation of thick organic soils in cypress and hardwood swamp communities (ft NAVD88).

Community	N	Mean Elevation	Standard Deviation (ft)	Minimum Elevation	Maximum Elevation
Cypress	16	138.14	0.71	136.92	139.33
Hardwood Swamp	10	138.27	0.37	137.80	139.12
All Groups	26	138.19	0.60	136.92	139.33

8.0 Conclusions and Recommendations

Event-based MFLs methods (SJRWMD 2006; Neubauer et al. 2008) were utilized to determine the minimum lake levels for Lake Santa Fe. MFLs determination is based on the evaluation of topography, soils, and vegetation data collected from plant communities associated with the water body. The recommended levels relate to hydroperiod categories and definitions adapted from water regime modifiers developed by Cowardin et al. (1979). The recommended MFLs for Lake Santa Fe are summarized in Table 8-1.

Table 8-1. Minimum recommended lake levels for Lake Santa Fe.

Designated Level	Elevation Benchmarks	Elevation (ft NAVD88)	Defining event or hydrologic criteria
Minimum Frequent High (FH)	Maximum of mean surface elevations of seasonally flooded cypress wetlands	139.10	30-day inundation/ 2-yr return interval
Minimum Average (MA)	Mean elevation of thick organic soils sampled in cypress and hardwood swamp minus 0.3 foot	137.89	180-day exposure/ 1.7-yr return interval
Minimum Frequent Low (FL)	Mean elevation of thick organic soils sampled in cypress and hardwood swamp minus 20 inches	136.52	120-day exposure/ 5-yr return interval

Each designated level is defined by rule in Florida’s Administrative Code (40C-8.021). The FH level is set in order to provide protection of seasonally flooded wetland communities that typically experience flooding events with a duration of at least 30 days occurring every 2 years. This defining hydrologic event for the FH was based on specific wetland inundation and dewatering signatures (SWIDS) analysis for Lake Santa Fe, supported by the methods developed and applied by SJRWMD (Neubauer et al. 2004 & 2007, Sutherland et al. 2017). The FH level is expected to maintain structure and function of hydrophytic vegetation communities surrounding the lake, particularly the cypress wetlands. In addition, the FH level will provide occasional increased aquatic habitat for fish and wildlife to utilize the lake floodplain.

The MA level is set in order to provide a surface water level necessary over a long period to maintain the integrity of hydric soils and wetland plant communities. The goal of the recommended MA is to prevent excessive oxidation and subsidence from degrading the thick organic layer occurring in the seasonally flooded wetlands, particularly the hardwood swamp and cypress communities. At the MA level, soils around Lake Santa Fe may be exposed during non-flooding periods of typical years, but the substrate remains saturated in many of the seasonally flooded areas, thus preserving the anoxic conditions which promote organic soil maintenance.

The FL level is set to protect the integrity of the semi-permanently flooded deep marsh communities that typically experience dewatering rarely (e.g., a duration of 120 days occurring every five years) due to periods of sustained reduced rainfall. This level is intended to prevent deleterious changes in the composition and structure of floodplain soils, the species composition and structure of floodplain and instream biotic communities, and the linkage of aquatic and floodplain food webs. Low water events not more severe than the FL are expected to have benefits for the system such as allowing

seed germination and growth of wetland plants, compaction of flocculent sediments, and release of nutrients (SJRWMD 2015).

Assessment of the current MFLs status for Lake Santa Fe will be presented in a separate document.

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Appendix A: Site Survey

Datum Reference and Final Coordinates

All ground Survey field operations took place between August 21, 2014 through December 05, 2014 and between January 27 through January 28, 2015 by GPI. GPS coordinates shown herein are based on the North American Datum of 1983 (2011), Florida State Plane Coordinate (SPC) system, North Zone, U.S. Survey Feet.

Control elevations are based on the North American Vertical Datum of 1988 (NAVD88), U.S. Survey Feet, utilizing differential leveling techniques and the following National Geodetic Survey benchmarks: A040AZMK (elevation 145.17 feet), A039 (elevation 159.50 feet), H510 (elevation 150.18 feet), and BH63 (elevation 143.08 feet).

GPS-derived elevations were used for some of the non-control locations. These GPS elevations were computed from the GPS-derived ellipsoid heights and geoid heights obtained from the GEOID12A geoid model published by the National Geodetic Survey and were verified through redundant ties to the project control benchmarks.

Methodology

Horizontal Control

The horizontal control point established consists of 5/8-inch rebar 18 inches in length with a plastic cap marked “LB 7560” and was observed with Leica survey grade dual frequency GPS receivers. Redundant observations at various GPS epochs were taken at the horizontal control point, operating in Real Time Kinematic (RTK) mode on Florida Department of Transportation’s (FDOT) Florida Permanent Reference Network (FPRN). To find out more about the FDOT FPRN go to: <https://www.fdot.gov/geospatial/fprn.shtm>

Vertical Control

The benchmarks established consist of either a 5/8-inch rebar 18 inches in length with plastic caps marked “LB 7560” or a nail with disk marked “G.P.I. LB 7560” and were established utilizing differential leveling techniques and ties to two National Geodetic Survey benchmarks (listed above).

Transects

Transect end points (waterward) were staked with 2-inch PVC pipe and located with Leica survey grade dual frequency GPS receivers, operating in RTK mode on FDOT FPRN. The transect lines were manually cut using machetes. Stationing and indicator locations were performed using both RTK GPS and a survey tape starting from the beginning point (upland) and extending to the waterward end. The beginning points were monumented with a rebar and cap marked “LB 7560” and located with RTK GPS observations. Transect elevations were established using a combination of RTK GPS observations, trigonometric total station observations, and water soundings and/or differential leveling with station/offset locations, depending on the transect location and visibility conditions.

Locations

Dock, house, and boat ramp locations were performed with RTK GPS observations. Elevations were variously obtained through a combination of RTK GPS observations, water soundings and/or differential leveling, depending on the location and visibility conditions.

Appendix B: Vegetation Sampling Methods, Analyses, and Results

Vegetation Sampling Methods

Vegetation sampling closely followed the methods described in SJRWMD (2006). Four belt transects were used to characterize plant communities and soils for Lake Santa Fe. Each transect extended from the waterward edge of the lake emergent vegetation zone through the forested wetland adjacent to the lake and ended in uplands (Figure B-1). Along each transect, the beginning and ending locations of recognized vegetation community types were marked, using the key provided in Kinser (1996). Habitat types not supported by Kinser (1996), including terrestrial (upland) plant community types, were modified from the Florida Natural Areas Inventory classification (FNAI 2010). A minimum of five natural ground elevation samples were surveyed per habitat type, and ground-shots were surveyed at 10-foot intervals by convention (or more frequently in areas of rapid elevation change). Hydrologic indicators were also marked for subsequent location and elevation surveys by Florida Licensed Professional surveyors (Appendix A).

Vegetation data were collected by GPI between October 14th and October 29th, 2014 along belt transects that were 10 feet wide. Belt transects are designed as long rectangular plots where organisms may be counted and measured, allowing the use of computational procedures of plot sampling (Brower et al. 1998). The belts were divided into zones of different vegetation communities, each representing a unique plot.

Three different methods were used to characterize the vegetation within the plant community zones. First, an overall cover estimate was recorded for all species observed with the belt transect, regardless of their height, using a modified cover scale as described below. Within each habitat type, plants were identified and the percent cover of each species was estimated. Percent cover was defined as the vertical projection of the crown or shoot area of a plant to the ground surface expressed as a percentage of the belt transect area with the plant community type. Percent cover as a measure of plant distribution is often considered as being of greater ecological significance than density, largely because percent cover gives a better measure of plant biomass than does the number of individuals. The canopies of the plants inside the quadrat often overlapped each other, so the total percent cover of plants in a single habitat type may add up to more than 100%. Percent cover was estimated visually using the Braun-Blanquet cover scales (Kent and Coker 1992).

The occurrence of shrubs (woody plants greater than or equal to 50 cm in height with a diameter at breast height [dbh] measured at 1.4 meters of less than 2.54 cm and all palmettos) and trees (woody plants with a dbh of greater than or equal to 2.54 cm) were characterized using the Point-Centered Quarter (PCQ) method (Cottam and Curtis 1956). The PCQ method was implemented by selecting evenly spaced points after a random start location along the transect within each major vegetation community zone. The PCQ locations were marked using uniquely identified wooden laths. The individual points were generally spaced at least 50 feet apart to avoid overlap. At least five PCQ sampling locations were located within each vegetation zone (except where the zone was less than 200 feet in length). At each PCQ location, the nearest four shrubs and four trees were identified and measured for dbh in each of the four compass quadrants (i.e., four trees and four shrubs total per PCQ location). Distances to the sampled trees and shrubs from the PCQ location were also collected to provide an approximate estimate of density for the dominant species. In order to facilitate the

determination of PCQ metrics for trees, diameter at breast height (dbh) was measured at 1.4 meters for all tree species. For dbh measurements, conventions were necessary for defining “stems.” Multiple stems arising from a common root system were recorded separately if they branched below 1.4 meters. Branches arising above 1.4 meters were not counted separately, and only the main stem’s diameter was tallied. Density, frequency, basal area, and importance value (IV) were calculated for each tree species, by community. Only densities and frequencies were calculated for shrubs in each community.

Groundcover vegetation (i.e., less than 50 cm in height) by species also was estimated in one-meter square quadrats spaced two meters away from each PCQ location (in order to avoid the line cut by the surveyors).

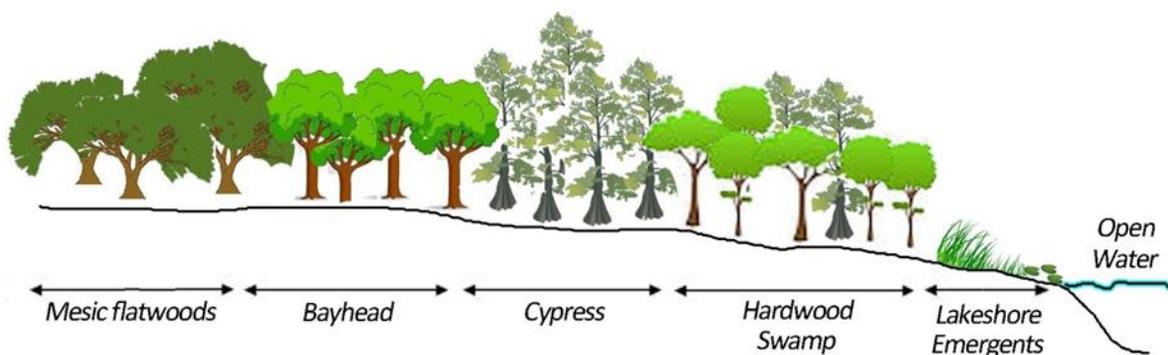


Figure B-1. Cross-section of a typical belt transect through forested and herbaceous plant communities described by Kinser (1996).

Vegetation Data Analyses

Transect elevation data were graphed using Microsoft Excel to illustrate the gradient from open water to uplands, and descriptive statistics were calculated for the elevations of individual vegetation communities. Descriptive statistics were calculated on all surveyed elevation data using STATISTICA Version 6.1 (StatSoft 2004) and R (R Core Team 2014). Importance Values, Relative Frequencies, and Relative Densities were calculated using Microsoft Excel and R (script by Mitchell 2015). In order to provide mean percent groundcover by community type, by species, on a relative scale, the following protocol was followed: 1) mean percent cover by species and community type was calculated using all quadrats from all transects; 2) the total of the mean covers of all species was determined for each community type; 3) the mean covers of respective species were then divided by the total for each community type to obtain their relative percentages within each community type.

Results and Discussion

Vegetation Community Descriptions

Table B-1 presents the Braun-Blanquet cover scale ranges in each community type for all the transects in this study. All species are presented, representing the canopy, mid-story and groundcover layers. Table B-2 presents importance values for tree species within each community type, based on an analysis of Point-Centered-Quarter (PCQ) data. The numbers of point locations sampled by community are as follows: bayhead (BH) = 9, cypress (CY) = 20, deep marsh (DM) = 14,

hardwood swamp (HS) = 10, shallow marsh (SM) = 16, shrub bog (SB) = 5, shrub swamp (SS) = 5, and wet prairie (WP) = 2. The IV is a metric combining relative basal area, relative density, and relative frequency of occurrence of individual woody plant species within each community. The sum of the IVs for each community equals 300. Since stem diameters were not measured for shrubs, IVs were not computed; but data were sufficient to estimate relative densities and frequencies of shrub species in each community (Table B-3). The groundcover quadrat data is summarized in Table B-4. As described above, mean percent cover by community type for each species was calculated as a percentage of the total mean cover of all species occurring in each community type. The quadrat data had detected 17 species not observed in the overall estimates and tended to capture species which were less visible at a distance, or which occurred in smaller numbers. Quadrat data tended to overestimate the cover of species which occurred in small amounts, but which were concentrated in clumps, i.e., if the quadrat happened to be placed within a clump. The overall cover estimate, on the other hand, detected 25 species not observed in the quadrats, which included many tree and shrub species that exceeded the 50 cm height criterion for inclusion in the quadrat sampling.

Table B-1. Percent cover estimate ranges for all transects by community.

Common Name	Plant Species Name	Wetland Status	Pond	Bayhead	Cypress	Deep Marsh	Hardwood Swamp	Shallow Marsh	Shrub Bog	Shrub Swamp	Wet Prairie
Red maple	<i>Acer rubrum</i>	FACW	-	-	1,2,3	2	3,4	2	1	2	-
Alligatorweed	<i>Alternanthera philoxeroides</i>	OBL	-	-	-	1,2	-	-	-	-	-
Purple bluestem	<i>Andropogon glomeratus</i> var. <i>glaucopsis</i>	FACW	-	-	-	-	-	2	-	-	4
American waterfern	<i>Azolla filiculoides</i>	N/A	-	-	-	-	-	3	-	-	-
Falsewillow	<i>Baccharis</i> sp.	FAC	-	-	1	-	-	-	-	-	-
Lemon bacopa	<i>Bacopa caroliniana</i>	OBL	-	-	-	-	-	-	-	1	-
Burmarigold	<i>Bidens laevis</i>	OBL	-	4	1	2	1	2,3	1	1	3
False nettle	<i>Boehmeria cylindrica</i>	OBL	-	-	1	-	-	-	-	-	-
Watershield	<i>Brasenia schreberi</i>	OBL	-	2	4	-	-	3,4	-	6	-
Awl-fruited sedge	<i>Carex stipata</i>	OBL	-	-	2	-	-	2,3	-	-	-
Spadeleaf	<i>Centella asiatica</i>	FACW	3	-	-	-	-	-	-	-	3
Common buttonbush	<i>Cephalanthus occidentalis</i>	OBL	-	-	3	1,2	2	2,3	1	2	-
Jamaica swamp sawgrass	<i>Cladium jamaicense</i>	OBL	-	2	2	-	2	2,3	1	5	-
Swamp loosestrife	<i>Decodon verticillatus</i>	OBL	-	3	1	2	3	2,3	4	-	-
Common water-hyacinth	<i>Eichhornia crassipes</i>	OBL	-	-	1	-	-	-	-	-	-
Viviparous spikerush	<i>Eleocharis vivipara</i>	OBL	-	-	-	3	-	2,4	-	-	3
Swamp doghobble	<i>Eubotrys racemosus</i>	FACW	-	-	2	-	2	-	-	-	-
Loblolly bay	<i>Gordonia lasianthus</i>	FACW	-	2,5	2	-	2	1	-	-	-
Marsh pennywort	<i>Hydrocotyle umbellata</i>	FACW	3	-	-	-	-	3,5	-	-	-
Dahoon	<i>Ilex cassine</i>	OBL	-	4	3,4	3	5	2	4	2	-
Myrtle dahoon	<i>Ilex cassine</i> var. <i>myrtifolia</i>	OBL	-	-	-	-	3	-	2	2	-
Virginia willow	<i>Itea virginica</i>	OBL	-	2	2	-	1,3	2	3	3	-
Soft rush	<i>Juncus effusus</i>	OBL	-	-	-	-	-	3	-	-	-
Lesser creeping rush	<i>Juncus repens</i>	OBL	1	-	-	-	-	-	-	-	-
Common duckweed	<i>Lemna minor</i>	NA	-	3	5	-	5	-	-	-	-
Sweetgum	<i>Liquidambar styraciflua</i>	FACW	-	-	2	-	-	-	-	-	-

Table B-1.—Continued.

Common Name	Plant Species Name	Wetland Status	Pond	Bayhead	Cypress	Deep Marsh	Hardwood Swamp	Shallow Marsh	Shrub Bog	Shrub Swamp	Wet Prairie
Narrowleaf primrosewillow	<i>Ludwigia linearis</i>	OBL	3	-	-	-	-	2	-	-	-
Mexican primrosewillow	<i>Ludwigia octovalvis</i>	OBL	-	-	-	2	-	-	-	-	-
Raven's primrosewillow	<i>Ludwigia ravenii</i>	OBL	-	-	-	-	-	-	-	1	-
Southern watergrass	<i>Luziola fluitans</i>	OBL	6	-	-	1,2	-	-	-	-	-
Taperleaf water horehound	<i>Lycopus rubellus</i>	OBL	-	-	1,2	-	-	-	-	1	-
Fetterbush	<i>Lyonia lucida</i>	FACW	-	-	-	-	2	-	-	-	-
Sweetbay	<i>Magnolia virginiana</i>	OBL	-	1	1,2	-	3	-	-	-	-
Climbing hempvine	<i>Mikania scandens</i>	NA	-	-	-	1,4	-	-	-	-	-
Southern bayberry	<i>Morella cerifera</i>	FAC	-	-	2	-	1,2	1	-	1	-
Spatterdock	<i>Nuphar advena</i>	OBL	-	-	-	3,5	-	1	-	-	-
American white waterlily	<i>Nymphaea odorata</i>	OBL	-	3	-	-	-	1,3	1	1	-
Swamp tupelo	<i>Nyssa sylvatica</i> var. <i>biflora</i>	OBL	-	1	1,2,3,4	1,2	2,4,5	2	2	1	-
Royal fern	<i>Osmunda regalis</i>	OBL	-	-	2,3	-	1,2	1	-	2	-
Maidencane	<i>Panicum hemitomon</i>	OBL	4	-	3	3,4	-	4,6	-	1	2
Green arrow arum	<i>Peltandra virginica</i>	OBL	-	3	1	-	2,3	1,2,6	-	2	-
Swamp bay	<i>Persea palustris</i>	OBL	-	-	1,2	-	1	-	-	-	-
Slash pine	<i>Pinus elliotii</i>	UPL	-	4	-	-	-	2	2	-	3
Dotted smartweed	<i>Persicaria punctatum</i>	OBL	-	2	-	-	-	2	-	-	-
Pickernelweed	<i>Pontederia cordata</i>	OBL	-	-	2	2	-	-	-	2	-
Pale meadow beauty	<i>Rhexia mariana</i>	FACW	-	-	-	-	-	-	-	-	3
Beaksedge	<i>Rhynchospora</i> spp.	FACW or OBL	-	-	-	-	-	-	-	-	4
Blackberry	<i>Rubus</i> sp.	FAC	-	-	2	-	-	-	-	-	-
American cupscale	<i>Sacciolepis striata</i>	FACW	-	-	-	3,6	-	-	-	-	-
Grassy arrowhead	<i>Sagittaria graminea</i>	OBL	-	-	-	-	-	-	-	-	-
Bulltongue arrowhead	<i>Sagittaria lancifolia</i>	OBL	-	-	-	-	-	3	-	-	-

Table B-1.—Continued.

Common Name	Plant Species Name	Wetland Status	Pond	Bayhead	Cypress	Deep Marsh	Hardwood Swamp	Shallow Marsh	Shrub Bog	Shrub Swamp	Wet Prairie
Water spangles	<i>Salvinia minima</i>	OBL	-	3,4	3,4,6	2,6	6	-	-	2	-
Elderberry	<i>Sambucus nigra</i> subsp. <i>canadensis</i>	FAC	-	-	-	2	-	-	-	-	-
Woolgrass	<i>Scirpus cyperinus</i>	OBL	-	2	-	-	-	-	-	-	-
Laurel greenbrier	<i>Smilax laurifolia</i>	NA	-	-	2	-	-	-	-	-	-
Pinebarren goldenrod	<i>Solidago fistulosa</i>	FACW	-	-	-	-	-	-	-	-	3
Pond-cypress	<i>Taxodium ascendens</i>	OBL	-	-	4,5,6	3	1,2	-	-	2	-
Eastern poison ivy	<i>Toxicodendron radicans</i>	NA	-	-	1,2	1	-	-	-	-	-
Virginia marsh St. John's-wort	<i>Hypericum virginicum</i>	OBL	-	-	2	2	-	-	-	-	-
Broadleaf cattail	<i>Typha latifolia</i>	OBL	-	4	-	-	-	-	-	-	-
Leafy bladderwort	<i>Utricularia foliosa</i>	OBL	-	-	-	-	-	-	-	3	-
Bladderwort	<i>Utricularia sp.</i>	OBL	-	2,3	-	-	3	3	-	-	-
Highbush blueberry	<i>Vaccinium corymbosum</i>	FACW	-	-	-	-	-	-	-	-	-
Muscadine	<i>Vitis rotundifolia</i>	NA	-	-	3	-	-	-	-	-	-
Netted chain fern	<i>Woodwardia areolata</i>	OBL	-	-	1,2	-	-	-	-	2	-
Virginia chain fern	<i>Woodwardia virginica</i>	FACW	-	3,5	1,2,4	-	1,3	4	1	1	-
Fringed yelloweyed grass	<i>Xyris fimbriata</i>	OBL	-	-	1	-	-	-	-	1	3

*Cover estimates: 1 = rare (<1%); 2 = Sparse (1-5%); 3 = Uncommon (6-25%); 4 = Common (26-50%); 5 = Abundant (51 – 75%); 6 = Dominant (76 – 100%), N/A=DEP wetland code is not applicable.

Table B-2. Importance Values for tree species for all surveyed communities.

Species	Bayhead	Cypress	Deep Marsh	Hardwood Swamp	Shallow Marsh	Shrub Bog	Shrub Swamp	Wet Prairie
<i>Acer rubrum</i>	-	13.84	25.89	58.20	56.92	19.47	159.67	-
<i>Cephalanthus occidentalis</i>	-	-	-	6.22	24.40	-	-	-
<i>Fraxinus caroliniana</i>	-	-	7.07	-	-	-	-	-
<i>Gordonia lasianthus</i>	128.05	3.59	-	6.59	-	-	-	-
<i>Ilex cassine</i>	91.48	69.40	12.95	126.71	40.88	258.40	-	-
<i>Ilex cassine</i> var. <i>myrtifolia</i>	-	-	-	23.96	-	-	61.79	-
<i>Lyonia lucida</i>	23.63	-	-	-	-	-	-	-
<i>Magnolia virginiana</i>	30.12	4.87	-	-	-	-	-	-
<i>Morella cerifera</i>	-	-	14.16	6.36	-	-	-	-
<i>Nyssa sylvatica</i> var. <i>biflora</i>	26.71	33.15	43.35	54.60	104.46	22.13	46.01	-
<i>Pinus elliotii</i>	-	-	-	-	50.02	-	-	300.00
<i>Salix caroliniana</i>	-	3.67	-	-	-	-	-	-
<i>Taxodium ascendens</i>	-	171.51	196.57	17.35	23.31	-	32.54	-

Table B-3. Shrub species Relative Density (RD) & Relative Frequency (RF) by community.

Species	Bayhead		Cypress		Deep Marsh		Hardwood Swamp		Shallow Marsh		Shrub Bog		Shrub Swamp		Wet Prairie	
	RD	RF	RD	RF	RD	RF	RD	RF	RD	RF	RD	RF	RD	RF	RD	RF
<i>Acer rubrum</i>	-	-	2.74	4.65	-	-	-	-	8.51	9.52	-	-	11.11	20.00	-	-
<i>Cephalanthus occidentalis</i>	-	-	16.44	16.28	33.33	31.25	10.00	10.34	12.77	14.29	-	-	44.44	40.00	-	-
<i>Decodon verticillatus</i>	12.50	6.25	-	-	-	-	15.00	10.34	27.66	28.57	15.00	12.50	-	-	-	-
<i>Eubotrys racemosus</i>	6.25	6.25	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Gordonia lasianthus</i>	34.38	25.00	-	-	-	-	10.00	10.34	-	-	-	-	-	-	-	-
<i>Ilex cassine</i>	3.13	6.25	36.99	32.56	29.63	25.00	20.00	17.24	2.13	4.76	20.00	37.50	5.56	10.00	-	-
<i>Ilex cassine</i> var. <i>myrtifolia</i>	-	-	-	-	-	-	2.50	3.45	-	-	-	-	-	-	-	-
<i>Itea virginica</i>	15.63	18.75	28.77	25.58	11.11	6.25	15.00	20.69	23.40	14.29	65.00	50.00	38.89	30.00	-	-
<i>Ludwigia octovalvis</i>	-	-	-	-	3.70	6.25	-	-	4.26	9.52	-	-	-	-	-	-
<i>Lyonia lucida</i>	9.38	6.25	-	-	-	-	12.50	6.90	-	-	-	-	-	-	-	-
<i>Magnolia virginiana</i>	9.38	12.50	-	-	14.81	18.75	2.50	3.45	-	-	-	-	-	-	-	-
<i>Morella cerifera</i>	6.25	12.50	6.85	9.30	-	-	10.00	13.79	-	-	-	-	-	-	-	-
<i>Nyssa sylvatica</i> var. <i>biflora</i>	3.13	6.25	4.11	4.65	3.70	6.25	-	-	2.13	4.76	-	-	-	-	-	-
<i>Persea palustris</i>	-	-	2.74	4.65	-	-	-	-	-	-	-	-	-	-	-	-
<i>Pinus elliotii</i>	-	-	-	-	-	-	-	-	19.15	14.29	-	-	-	-	87.50	66.67
<i>Sambucus nigra</i> subsp. <i>canadensis</i>	-	-	-	-	3.70	6.25	-	-	-	-	-	-	-	-	-	-
<i>Taxodium ascendens</i>	-	-	1.37	2.33	-	-	-	-	-	-	-	-	-	-	12.50	33.33
<i>Vaccinium corymbosum</i>	-	-	-	-	-	-	2.50	3.45	-	-	-	-	-	-	-	-

Table B-4. Relative percent cover of species in quadrats for all transects by community.

Common Name	Plant Species Name	Wetland Status	Pond	Bayhead	Cypress	Deep Marsh	Hardwood Swamp	Shallow Marsh	Shrub Bog	Shrub Swamp	Wet Prairie
Alligatorweed	<i>Alternanthera philoxeroides</i>	OBL	-	-	0.3	2	-	-	-	-	-
Purple bluestem	<i>Andropogon glomeratus</i> var. <i>glaucopsis</i>	FACW	-	-	-	-	-	0.2	-	-	17.9
Broomsedge bluestem	<i>Andropogon virginicus</i>	FAC	-	-	-	-	-	2.3	-	-	0.9
American waterfern	<i>Azolla filiculoides</i>	NA	-	-	-	-	-	2.3	-	-	-
NA	Bare Ground	FAC	-	3.6	19.9	-	6.5	2.2	39.0	-	11.2
Burmarigold	<i>Bidens laevis</i>	OBL	-	16.5	0.7	-	-	1.5	2.1	0.5	0.9
False nettle	<i>Boehmeria cylindrica</i>	OBL	-	-	0.7	-	0.5	-	-	-	-
Watershield	<i>Brasenia schreberi</i>	OBL	-	-	4.9	-	-	14.0	-	29.0	-
Awl-fruited sedge	<i>Carex stipata</i>	OBL	-	-	-	-	-	2.2	-	-	-
Spadeleaf	<i>Centella asiatica</i>	FACW	-	-	0.3	-	-	0.7	-	-	11.2
Common buttonbush	<i>Cephalanthus occidentalis</i>	OBL	-	-	0.3	1.2	-	-	-	-	-
Jamaica swamp sawgrass	<i>Cladium jamaicense</i>	OBL	-	16.2	-	-	-	4.9	4.1	8.5	-
Swamp loosestrife	<i>Decodon verticillatus</i>	OBL	-	-	-	7.8	-	1.1	-	-	-
Rough witchgrass	<i>Dichantherium leucothrix</i>	UPL	-	-	-	-	-	-	-	-	2.2
Carolina ponysfoot	<i>Dichondra carolinensis</i>	FAC	-	-	0.7	-	-	-	-	-	-
Threeway sedge	<i>Dulichium arundinaceum</i>	OBL	-	1.8	-	-	-	-	-	-	-
Common water-hyacinth	<i>Eichhornia crassipes</i>	OBL	-	-	6.6	-	-	-	-	-	-
Viviparous spikerush	<i>Eleocharis vivipara</i>	OBL	-	-	-	-	-	5.5	-	-	6.7
Coastal lovegrass	<i>Eragrostis virginica</i>	FAC	-	-	-	-	-	2.2	-	-	-
Dogfennel	<i>Eupatorium capillifolium</i>	FAC	-	-	-	-	-	0.9	-	-	-
Mohr's thoroughwort	<i>Eupatorium mohrii</i>	FAC	-	-	-	-	-	1.8	-	-	-
Slender flattop goldenrod	<i>Euthamia caroliniana</i>	FAC	-	-	-	-	-	0.7	-	-	-
Marsh pennywort	<i>Hydrocotyle umbellata</i>	FACW	5.0	0.5	-	-	-	2.4	-	-	-
Dahoon	<i>Ilex cassine</i>	OBL	-	-	0.3	-	-	-	-	-	-

Table B-4.—Continued.

Common Name	Plant Species Name	Wetland Status	Pond	Bayhead	Cypress	Deep Marsh	Hardwood Swamp	Shallow Marsh	Shrub Bog	Shrub Swamp	Wet Prairie
Virginia willow	<i>Itea virginica</i>	OBL	-	-	0.3	-	-	0.4	2.1	-	-
Lesser creeping rush	<i>Juncus repens</i>	OBL	20.0	-	-	-	-	-	-	-	-
Carolina redroot	<i>Lachnanthes carolina</i>	FAC	-	-	-	-	-	0.4	-	-	-
Common duckweed	<i>Lemna minor</i>	NA	-	9.0	13.5	-	22.0	-	39.0	-	-
American spongeplant	<i>Limnobium spongia</i>	OBL	-	-	-	-	-	1.2	-	-	-
Piedmont primrosewillow	<i>Ludwigia arcuata</i>	OBL	-	-	-	-	-	0.3	-	-	-
Narrowleaf primrosewillow	<i>Ludwigia linearis</i>	OBL	-	-	-	-	-	0.7	-	-	-
Hairy primrosewillow	<i>Ludwigia pilosa</i>	OBL	-	1.8	-	-	-	-	-	-	-
Southern watergrass	<i>Luziola fluitans</i>	OBL	60.0	-	0.7	0.6	-	-	-	-	-
Climbing hempvine	<i>Mikania scandens</i>	N/A	-	-	-	15.6	-	-	-	-	-
Southern bayberry	<i>Morella cerifera</i>	FAC	-	-	1.0	-	0.5	-	-	-	-
Spatterdock	<i>Nuphar advena</i>	OBL	-	-	-	10.3	-	-	-	-	-
American white waterlily	<i>Nymphaea odorata</i>	OBL	-	1.8	-	-	-	3.4	-	-	-
Clustered mille grains	<i>Edrastima uniflora</i>	FACW	-	-	-	-	-	-	-	-	0.9
N/A	Open Water	NA	12.0	10.1	20.0	28.5	6.1	3.7	12.6	-	-
Royal fern	<i>Osmunda regalis</i>	OBL	-	-	-	-	4.9	-	-	3	-
Maidencane	<i>Panicum hemitomon</i>	OBL	3.0	-	4.9	5.8	-	16.8	-	-	4.5
Virginia creeper	<i>Parthenocissus quinquefolia</i>	NA	-	-	0.3	-	-	-	-	-	-
Green arrow arum	<i>Peltandra virginica</i>	OBL	-	9.0	-	-	4.9	6.3	-	8.0	-
Dotted smartweed	<i>Persicaria punctatum</i>	OBL	-	0.9	-	-	-	0.6	-	-	-
Pale meadowbeauty	<i>Rhexia mariana</i>	FACW	-	-	-	-	-	-	-	-	4.0
Threadleaf beaksedge	<i>Rhynchospora filifolia.</i>	FACW	-	-	-	-	2.2	-	-	-	20.1
Bunched beaksedge	<i>Rhynchospora microcephala.</i>	FACW	-	-	-	-	-	-	-	-	4.5
American cupscale	<i>Sacciolepis striata</i>	FACW	-	1.8	-	11.7	-	-	-	-	-
Bulltongue arrowhead	<i>Sagittaria lancifolia</i>	OBL	-	-	-	-	-	2.2	-	-	-
Water spangles	<i>Salvinia minima</i>	OBL	-	11.7	14.1	16.6	42.5	1.5	-	40.1	-

Table B-4.—Continued.

Common Name	Plant Species Name	Wetland Status	Pond	Bayhead	Cypress	Deep Marsh	Hardwood Swamp	Shallow Marsh	Shrub Bog	Shrub Swamp	Wet Prairie
Woolgrass	<i>Scirpus cyperinus</i>	OBL	-	1.4	-	-	-	-	-	-	-
Laurel greenbrier	<i>Smilax laurifolia</i>	NA	-	-	1.0	-	-	-	-	-	-
Pinebarren goldenrod	<i>Solidago fistulosa</i>	FACW	-	3.5	-	-	-	7.0	-	-	2.0
Eastern poison ivy	<i>Toxicodendron radicans</i>	NA	-	-	1.3	-	-	-	-	-	-
Virginia marsh St. John's-wort	<i>Hypericum virginicum</i>	OBL	-	-	3.3	-	-	-	-	-	-
Broadleaf cattail	<i>Typha latifolia</i>	OBL	-	3.6	-	-	-	-	-	-	-
Bladderwort	<i>Utricularia sp.</i>	OBL	-	3.6	-	-	7.3	7.1	-	7.5	-
Netted chain fern	<i>Woodwardia areolata</i>	OBL	-	-	0.7	-	-	-	-	-	-
Virginia chain fern	<i>Woodwardia virginica</i>	FACW	-	5.4	4.0	-	4.7	5.3	1.2	4.8	-
Fringed yelloweyed grass	<i>Xyris fimbriata</i>	OBL	-	-	-	-	-	-	-	-	8.9
Richard's yelloweyed grass	<i>Xyris jupicai</i>	FACW	-	-	-	-	-	5.0	-	-	4.5

Bayhead

Kinser (1996) described the bayhead community as forested wetlands dominated by one or more species of broadleaved, evergreen bay trees (*Gordonia lasianthus*, *Persea palustris*, or *Magnolia virginica*). Dahoon holly (*Ilex cassine*) may occasionally be dominant. Soils are usually organic and nearly constantly saturated, or at least occasionally flooded. The canopy of some sites may be dominated by pines, but bays and other indicators will be prevalent in the subcanopy and understory.

The bayhead community was sampled along two transects in Lake Santa Fe (T1 and T8). As shown in Tables B-1 and B-2, the bayhead community canopy in Lake Santa Fe was dominated by loblolly bay (*Gordonia lasianthus*) and dahoon holly (*Ilex cassine*), with less frequent occurrences of fetterbush (*Lyonia lucida*), sweetbay (*Magnolia virginiana*), and blackgum (*Nyssa sylvatica* var. *biflora*). Juvenile loblolly bay were the most common shrub species (relative frequency of 25.00%, Table B-3); other mid-story and shrub species included Virginia willow (*Itea virginica*), juvenile sweetbay, and wax myrtle (*Morella cerifera*), with small amounts of swamp loosestrife (*Decodon verticillatus*), swamp doghobble (*Eubotrys racemosus*), juvenile dahoon holly, fetterbush, and juvenile blackgum. Tables B-1 and B-4 show that groundcover within the bayhead was very sparse, with burmarigold (*Bidens laevis*), Virginia chain fern (*Woodwardia virginica*) and broadleaf cattail (*Typha latifolia*) locally abundant in open areas, and the floating plant water spangles (*Salvinia minima*) was common in open areas with deeper standing water.



Figure B-2. Photo of bayhead habitat on Transect 1 in Lake Santa Fe.

Cypress

Kinser (1996) described the cypress community as forested wetlands dominated by bald cypress (*Taxodium distichum*) or pond cypress (*Taxodium ascendens*) and flooded annually for periods of

long duration, usually 4 to 8 months in any particular year. The cypress community type may occur as cypress domes, strands, and lakeshore variants.

The cypress community was sampled along three transects in Lake Santa Fe (T4, T7, and T8). The cypress community canopy in Lake Santa Fe was dominated by pond cypress (*Taxodium ascendens*), with less frequent occurrences of dahoon holly and blackgum, and a few scattered individuals of red maple (*Acer rubrum*), sweetbay, Carolina willow (*Salix caroliniana*), and loblolly bay (Tables B-1 and B-2). Juvenile dahoon holly and Virginia willow were the most common shrub species (relative frequencies of 32.56 percent and 25.58 percent, respectively, Table B-3); other mid-story and shrub species included common buttonbush (*Cephalanthus occidentalis*), wax myrtle, juvenile red maple, juvenile blackgum, juvenile swamp bay (*Persea palustris*), and juvenile pond cypress. Most of the cypress community was densely shaded and covered with standing water, with water spangles the most common understory plant (Table B-1). Table B-4 shows a mean cover of 20.0 percent for open water, 14.1 percent for water spangles, and 13.5 percent for duckweed (*Lemna minor*), a smaller floating plant that is less easily visible. Virginia chain fern was common on the higher hummocks, but at low cover (4.0 percent), with maidencane (*Panicum hemitomon*) throughout at 4.9 percent cover.



Figure B-3. Photo of cypress habitat on Transect 7 in Lake Santa Fe.

Deep Marsh

Kinsler (1996) described the deep marsh community as deepwater wetlands dominated by a mixture of water lilies and deepwater emergent species. The hydrologic regime is expected to be semi-

permanently to permanently flooded. Typical genera include: *Scirpus* (*Schoenoplectus*), *Nymphaea*, *Nuphar*, *Nelumbo*, *Brasenia* and *Nymphoides*.

The deep marsh community was sampled along all four transects in Lake Santa Fe. The deep marsh canopy in Lake Santa Fe generally included large dbh, widely-spaced pond cypress, with frequent occurrences of blackgum and red maple, and occasional dahoon holly, wax myrtle, and Carolina ash (*Fraxinus caroliniana*) (Tables B-1 and B-2). Common buttonbush was the most common shrub species (relative frequency of 31.25 percent, Table B-3); with juvenile dahoon holly and sweetbay almost as frequent. Other mid-story and shrub species included Virginia willow, Mexican primrosewillow (*Ludwigia octovalvis*), juvenile blackgum, and elderberry (*Sambucus nigra* subsp. *canadensis*). Common emergent aquatic or floating plants included American cupscale (*Sacciolepis striata*) at 11.7 percent cover, mixed with large patches of spatterdock (*Nuphar advena*) (10.3 percent cover), maidencane (5.8 percent cover) and water spangles (16.6 percent cover) (Tables B-1 and B-4). Climbing hempvine (*Mikania scandens*) was abundant on shrubs at the upper edge of the community (15.6 percent cover).



Figure B-4. Photo of deep marsh habitat on Transect 1 in Lake Santa Fe.

Hardwood Swamp

Kinser (1996) described the hardwood swamp community as forested wetlands dominated by one or more deciduous hardwood species, typically including black gum, red maple, Carolina ash, water elm, and willows. Cypress is often a significant component of this type. The hardwood swamp is known to be subject to annual, seasonal periods of prolonged flooding.

The hardwood swamp community was sampled along two transects in Lake Santa Fe (T7 and T8). The hardwood swamp canopy in Lake Santa Fe was largely dominated by dahoon holly, with moderate occurrences of red maple and blackgum, and less frequent occurrences of myrtle dahoon (*Ilex cassine* var. *myrtifolia*), pond cypress, loblolly bay, wax myrtle, and common buttonbush (Tables B-1 and B-2). Virginia willow and juvenile dahoon holly were the most common shrub species (relative frequencies of 20.69 percent and 17.24 percent, respectively, Table B-3). Other mid-story and shrub species included swamp loosestrife, wax myrtle, fetterbush, common buttonbush, juvenile loblolly bay, juvenile myrtle dahoon, juvenile sweetbay, and highbush blueberry (*Vaccinium corymbosum*). Groundcover was sparse except for the floating plants water spangles (42.5 percent cover), duckweed (22.0 percent cover) and bladderwort (*Utricularia* sp.) (7.8 percent cover). A few other emergents were present at less than 5 percent cover each (Tables B-1 and B-4).



Figure B-5. Photo of hardwood swamp habitat on Transect 7 in Lake Santa Fe.

Shallow Marsh

Kinser (1996) described the shallow marsh community as herbaceous or graminoid communities dominated by species such as sawgrass (*Cladium jamaicense*), maidencane, cattails (*Typha* spp.), pickerelweed (*Pontederia cordata*), arrowhead (*Sagittaria* spp.), or other grasses and broad-leaved herbs. Shallow marsh is known to occur most often on organic soils that are subject to lengthy seasonal inundation in areas that are subject to occasional fire (Kinser 1996).

The shallow marsh community was sampled along three transects in Lake Santa Fe (T1, T4, and T8). The shallow marsh community of Lake Santa Fe had a very sparse cover of trees (less than 5

percent cover), which mostly consisted of red maple (Table B-1). Of the few trees present, blackgum, had the largest importance value (Table B-2). Smaller trees of red maple, slash pine (*Pinus elliottii*), and dahoon holly occurred around the fringes of the community, with scattered occurrences of common buttonbush and pond-cypress (Table B-2). Swamp loosestrife was the most common shrub species (relative frequency of 28.57 percent, Table B-3); other mid-story and shrub species included common buttonbush, Virginia willow, juvenile slash pine, juvenile red maple, Mexican primrosewillow, juvenile dahoon holly, and juvenile blackgum. The groundcover was very dense, with a mixture of plants. Green arrow arum (*Peltandra virginica*) was dominant along the transect that had recently experienced a severe fire, but it was at low cover on the other transects (6.3% cover overall). Other common plants were maidencane (16.8 percent cover), watershield (*Brasenia schreberi*) (14.0 percent cover), bladderwort (7.1 percent cover), pinebarren goldenrod (*Solidago fistulosa*) (7.0 percent cover), viviparous spikerush (*Eleocharis vivipara*) (5.5 percent cover), and Virginia chain fern (5.3 percent cover), with a variety of other emergents in smaller numbers and less than 5 percent cover each (Tables B-1 and B-4).



Figure B-6. Photo of shallow marsh habitat on transect 8 in Lake Santa Fe.

Shrub Bog

Kinser (1996) described the shrub bog community as dominated by shrubby vegetation occupying typical bayhead sites. The shrub bog is known to develop in bayheads destroyed by fire or other disturbance, and it shows a hydrology similar to that of bayhead communities.

The shrub bog community was sampled along only one transect in Lake Santa Fe (T4). The shrub bog canopy of Lake Santa Fe was largely dominated by a dense cover of small dahoon holly trees, with

much less frequent occurrences of blackgum and red maple (Tables B-1 and B-2). Virginia willow was the most common shrub species (relative frequency of 50 percent, Table B-3); other mid-story and shrub species included juvenile dahoon holly and swamp loosestrife. There was very little groundcover because of the dense shrubs and small trees. Duckweed occurred at 39.0 percent cover in the standing water underneath the shrubs (Tables B-1 and B-4).



Figure B-7. Photo of shrub bog habitat on Transect 4 in Lake Santa Fe.

Shrub Swamp

Kinser (1996) described the shrub swamp community as dominated by willows, buttonbush, or vegetation with similar growth forms. The shrub swamp hydrology is known to be similar to that of cypress, hardwood swamp, and shallow marsh communities.

The shrub swamp community was sampled along only one transect in Lake Santa Fe (T7). The shrub swamp canopy of Lake Santa Fe was largely dominated by many small widely-spaced red maple trees, with moderate occurrences of myrtle dahoon and blackgum, and less frequent occurrences of pond cypress (Tables B-1 and B-2). Common buttonbush was the most common shrub species (relative frequency of 40 percent, Table B-3); other mid-story and shrub species included Virginia willow, with smaller amounts of juvenile red maple, and juvenile dahoon holly. The emergent groundcover was dominated by watershield (29.0 percent cover) mixed with Jamaica swamp sawgrass (*Cladium jamaicense*) (8.5 percent cover) and green arrow arum (8.0 percent cover). The cover estimate for sawgrass was much lower in the quadrat data because the sawgrass was thin with many dead stalks. Water spangles grew densely underneath the thin sawgrass (40.1% cover) (Tables B-1 and B-4).



Figure B-8. Photo of shrub swamp habitat on Transect 7 in Lake Santa Fe.

Wet Prairie

Kinser (1996) described the wet prairie as communities of grasses, sedges, rushes, and herbs, typically dominated by sand cordgrass (*Spartina bakeri*), maidencane, or a mixture of species. The wet prairie usually occurs on mineral soils that are inundated for a relatively short duration each year, but with prolonged soil saturation. It is often subject to frequent fire.

The wetland prairie community was sampled along only one transect in Lake Santa Fe (T1). The only trees were slash pine at 5 to 25 percent cover, with large trees along the upper boundary, and juveniles further in the wetland. Slash pine was the most common shrub species (relative frequency of 66.67 percent, Table B-3), with juvenile pond cypress also present. The dense groundcover was dominated by beaksedge (*Rhynchospora* spp.) (24.6 percent cover) and purple bluestem (*Andropogon glomeratus* var. *glaucoptis*) (17.9 percent cover) and, along with a wide variety of herbs (Tables B-1 and B-4).



Figure B-9. Photo of wetland prairie habitat on Transect 1 in Lake Santa Fe.

Pond

Kinser (1996) described the pond (or more generally: water) community as unvegetated or sparsely vegetated sites subject to prolonged or semi-permanent flooding. The general water category includes lakes, streams, ponds, and other water bodies.

The pond community was sampled along only one transect in Lake Santa Fe (T1). There were no PCQ vegetation data collected for the pond community due to its very small size. Southern watergrass (*Luziola fluitans*) was the dominant species at 60 percent cover, with creeping rush (*Juncus repens*) at 20.0 percent cover, marsh pennywort at 5.0 percent cover, and maidencane at 3.0 percent cover (Table B-4). There were no trees or shrubs present.



Figure B-10. Photo of pond habitat on Transect 1 in Lake Santa Fe.

Vegetation at Transect 1

Transect 1 is located on the northwestern shore of Little Lake Santa Fe (Figure 4-1, Table B-5). Transect 1 was the longest transect sampled, traversing approximately 1,860 ft (Figure B-11). Transect 1 was surveyed from the uplands, through the pond, wet prairie and shallow marsh communities, and into the bayhead and deep marsh communities that surround Little Lake Santa Fe (Table B-6). Natural ground elevations were surveyed at a total of 206 points along the transect, ranging from 132.60 to 141.20 ft NAVD88 (Table B-6 and Figure B-11). Cover estimates for plant species in Transect 1 are provided in Table B-7.

Table B-5. Transect 1 location and fieldwork dates

Northing - Easting (Station 0; Upland)	Northing - Easting (Station 18+60; Deep Marsh)	Dates of Fieldwork
293425.49 - 2727052.03	292934.71 - 2728846.33	Little Lake Santa Fe, 10/16/2014

Table B-6. Lake Santa Fe Transect 1 vegetation community elevation statistics (ft NAVD88).

Vegetation Community	Stations	Mean Elevation	Standard Deviation (ft)	Median Elevation	Minimum Elevation	Maximum Elevation	N
Upland	0+00 - 0+47	140.40	0.72	140.34	139.35	141.20	6
Pond	0+60 - 1+00	138.54	0.21	138.47	138.32	138.85	6
Wet Prairie	1+11 - 1+49	139.82	0.12	139.80	139.61	139.96	7
Shallow Marsh	1+65 - 4+94	138.69	0.43	138.71	137.71	139.46	40
Bayhead	5+13 - 17+00	138.59	0.40	138.61	137.06	139.29	125
Deep Marsh	17+10 - 18+60	134.38	1.36	133.94	132.60	137.10	22

N = the number of elevations surveyed at each location

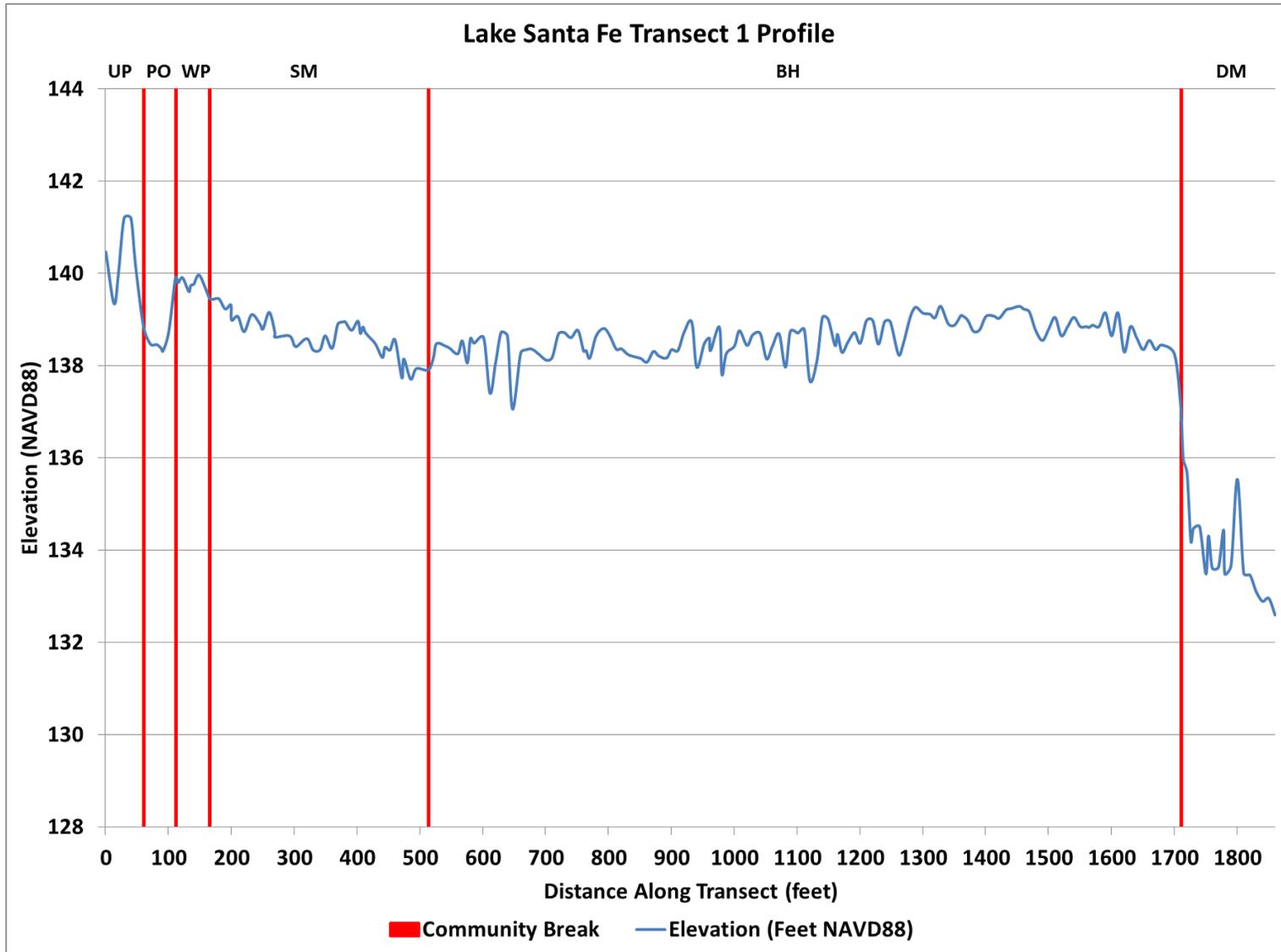


Figure B-11. Elevations along Transect 1, from the highest point surveyed in the uplands to the lowest point surveyed in the deep marsh.

Table B-7. Transect 1 plant species percent cover estimates².

Common Name	Plant Species Name	Wetland Status ¹ (DEP Code)	Pond Plant Species Cover	Wet Prairie Plant Species Cover	SM1-CY Species Cover	SM2 Species Cover	Bayhead Plant Species Cover	Deep Marsh Plant Species Cover
Alligatorweed	<i>Alternanthera philoxeroides</i>	OBL	-	-	-	-	-	2
Purple bluestem	<i>Andropogon glomeratus var. glaucopsis</i>	FACW	-	4	2	-	-	-
American waterfern	<i>Azolla filiculoides</i>	N/A-floating	-	-	3	-	-	-
Burmarigold	<i>Bidens laevis</i>	OBL	-	3	3	2	4	-
Watershield	<i>Brasenia schrederi</i>	OBL	-	-	4	3	2	-
Awl-fruited sedge	<i>Carex stipata</i>	OBL	-	-	2	3	-	-
Spadeleaf	<i>Centella asiatica</i>	FACW	3	3	-	-	-	-
Jamaica swamp sawgrass	<i>Cladium jamaicense</i>	OBL	-	-	-	2	2	-
Swamp Loosestrife	<i>Decodon verticillatus</i>	OBL	-	-	-	-	3	-
Viviparous spikerush	<i>Eleocharis vivipara</i>	OBL	-	3	4	2	-	3
Loblolly bay	<i>Gordonia lasianthus</i>	FACW	-	-	-	-	2	-
Marsh pennywort	<i>Hydrocotyle umbellata</i>	FACW	3	-	5	3	-	-
Virginia willow	<i>Itea virginica</i>	OBL	-	-	-	-	2	-
Soft rush	<i>Juncus effusus</i>	OBL	-	-	3	-	-	-
Lesser creeping rush	<i>Juncus repens</i>	OBL	4	-	-	-	-	-
Common duckweed	<i>Lemna minor</i>	NA-aquatic	-	-	-	-	3	-
Narrowleaf primrosewillow	<i>Ludwigia linearis</i>	OBL	3	-	2	-	-	-
Southern watergrass	<i>Luziola fluitans</i>	OBL	6	-	-	-	-	-
Sweetbay	<i>Magnolia virginiana</i>	OBL	-	-	-	-	1	-
Spatterdock	<i>Nuphar advena</i>	OBL	-	-	-	-	-	5
American white waterlily	<i>Nymphaea odorata</i>	OBL	-	-	-	3	3	-
Swamp tupelo	<i>Nyssa sylvatica var. biflora</i>	OBL	-	-	-	-	1	-
Maidencane	<i>Panicum hemitomon</i>	OBL	4	2	1	-	-	4
Green arrow arum	<i>Peltandra virginica</i>	OBL	-	-	1	6	3	-
Slash pine	<i>Pinus elliotii</i>	UPL	-	3	1	-	-	-
Dotted smartweed	<i>Persicaria punctatum</i>	OBL	-	-	3	2	2	-
Pale meadowbeauty	<i>Rhexia mariana</i>	FACW	-	3	1	-	-	-
Beaksedge	<i>Rhynchospora spp.</i>	FACW or OBL	-	4	2	-	-	-
Grassy arrowhead	<i>Sagittaria graminea</i>	OBL	-	-	-	-	3	-
Water spangles	<i>Salvinia minima</i>	OBL	-	-	2	-	-	-
Woolgrass	<i>Scirpus cyperinus</i>	OBL	-	-	-	-	2	-
Pinebarren goldenrod	<i>Solidago fistulosa</i>	FACW	-	3	2	-	-	-
Broadleaf cattail	<i>Typha latifolia</i>	OBL	-	-	-	-	4	-
Bladderwort	<i>Utricularia sp.</i>	OBL	-	-	-	3	3	-
Virginia chain fern	<i>Woodwardia virginica</i>	FACW	-	-	2	-	3	-
Fringed Yelloweyed grass	<i>Xyris fimbriata</i>	OBL	-	3	2	-	-	-

¹Wetland Status, DEP Code: *Delineation of the Landward Extent of Wetlands and Surface Waters* (Ch 62-340 F.A.C., 1994)

²Plant species cover estimates: Areal extent of vegetation species along transect within given community where 1 = <1% (rare); 2 = 1-5% (sparse); 3 = 6-25% (uncommon) 4 = 26-50% (common); 5 = 51-75% (abundant); 6 = greater than 75% (dominant)

Vegetation at Transect 4

Transect 4 was located east of Lake Santa Fe (Figure 4-1, Table B-8). Transect 4 was surveyed from the uplands, through a narrow band of cypress and then through shallow marsh, shrub bog, cypress, and deep marsh communities. Another band of cypress occurred just adjacent to the open water portion of the lake (Figure B-12). Natural ground elevations were surveyed at a total of 115 locations, ranging from 134.37 to 143.45 ft NAVD88 (Table B-9 and Figure B-12). Cover estimates for plant species in Transect 4 are provided in Table B-10.

Table B-8 Transect 4 location and fieldwork dates.

Northing - Easting (Station 0; Upland)	Northing - Easting (Station 9+22; Open Water)	Location and Dates of Fieldwork
280242.73 - 2744168.54	279951.08 - 2743293.89	Lake Santa Fe, 10/15/2014

Table B-9 Lake Santa Fe Transect 4 vegetation community elevation statistics (ft NAVD88).

Vegetation Community	Stations	Mean Elevation	Standard Deviation (ft)	Median Elevation	Minimum Elevation	Maximum Elevation	N
Upland	0+00 - 0+40	142.46	0.79	142.34	141.64	143.45	6
Cypress	0+60 - 0+71; 5+00 - 6+90; 8+20 - 9+00	137.21	0.97	137.12	135.37	139.37	40
Shallow Marsh	0+79 - 1+40	138.17	0.27	138.11	137.95	138.87	10
Shrub Bog	1+50 - 4+90	137.52	0.50	137.57	136.60	138.75	40
Deep Marsh	7+10 - 8+12	135.91	0.61	135.74	135.22	136.96	16
Water	9+12 - 9+30	134.70	0.42	134.57	134.37	135.17	3

N = the number of elevations surveyed at each location

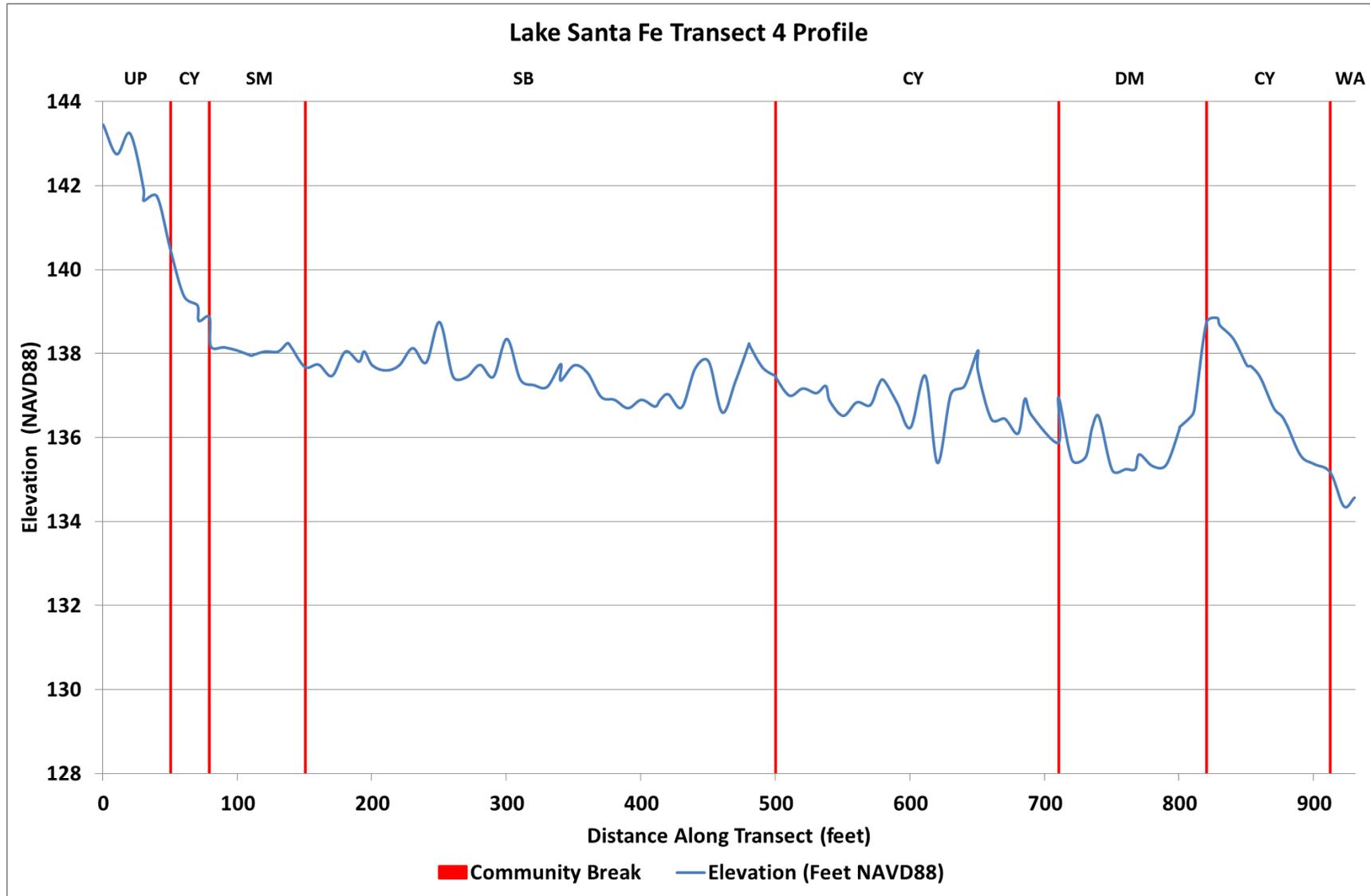


Figure B-12. Elevations along Transect 4, from the highest point surveyed in the uplands to the lowest point surveyed in the open water.

Table B-10 Transect 4 Plant Species Percent Cover Estimates².

Common Name	Plant Species Name	Wetland Status ¹ (DEP Code)	Cypress 1 Plant Species Cover	Deep Marsh Plant Species Cover	Cypress 2 Plant Species Cover	SB Plant Species Cover	SM Plant Species Cover	Cypress 3 Plant Species Cover
Pond-cypress	<i>Taxodium ascendens</i>	OBL	4	3	5	-	-	4
Swamp tupelo	<i>Nyssa sylvatica</i> var. <i>biflora</i>	OBL	3	2	4	2	2	3
Dahoon	<i>Ilex cassine</i>	OBL	3	3	3	4	2	3
Virginian chain fern	<i>Woodwardia virginica</i>	FACW	-	-	1	1	-	4
Muscadine	<i>Vitis rotundifolia</i>	N/A-vine	-	-	-	-	-	3
Fringed yelloweyed grass	<i>Xyris fimbriata</i>	OBL	-	-	-	-	-	4
Swamp doghobble	<i>Eubotrys racemosus</i>	FACW	-	-	-	-	-	2
Sweetgum	<i>Liquidambar styraciflua</i>	FACW	-	-	-	-	-	2
Laurel greenbrier	<i>Smilax laurifolia</i>	N/A-vine	-	-	-	-	-	2
Maidencane	<i>Panicum hemitomon</i>	OBL	3	-	-	-	6	-
Common bottonbush	<i>Cephalanthus occidentalis</i>	OBL	3	2	-	2	3	-
Jamaica swamp sawgrass	<i>Cladium jamaicense</i>	OBL	-	-	-	2	2	-
Swamp loosestrife	<i>Decodon verticillatus</i>	OBL	-	2	-	4	3	-
Green arrow arum	<i>Peltandra virginica</i>	OBL	-	-	-	-	1	-
Burmarigold	<i>Bidens laevis</i>	OBL	-	2	1	1	-	-
Virginia willow	<i>Itea virginica</i>	OBL	-	-	3	3	-	-
Slash pine	<i>Pinus elliotii</i>	UPL	-	-	-	2	-	-
American white waterlily	<i>Nymphaea odorata</i>	OBL	-	-	-	1	-	-
Myrtle dahoon	<i>Ilex cassine</i> var. <i>myrtifolia</i>	OBL	-	-	-	2	-	-
Red maple	<i>Acer rubrum</i>	FACW	2	2	3	1	-	-
Royal fern	<i>Osmunda regalis</i>	OBL	-	-	3	-	-	-
Common duckweed	<i>Lemna minor</i>	N/A-aquatic	-	-	5	-	-	-
Water spangles	<i>Salvinia minima</i>	OBL	3	6	4	-	-	-
Eastern poison ivy	<i>Toxicodendron radicans</i>	N/A-vine	2	-	2	-	-	-
Netted chain fern	<i>Woodwardia aerolata</i>	OBL	-	-	2	-	-	-
Sweetbay	<i>Magnolia virginiana</i>	OBL	-	-	2	-	-	-
Southern bayberry	<i>Morella cerifera</i>	FAC	2	-	-	-	-	-
Falsewillow	<i>Baccharis</i> sp.	FAC	1	-	-	-	-	-
American cupscale	<i>Sacciolepis striata</i>	FACW	-	6	-	-	-	-
Climbing hempvine	<i>Mikania scandens</i>	N/A-vine	-	4	-	-	-	-
Pickeralweed	<i>Pontederia cordata</i>	OBL	-	2	-	-	-	-
Alligatorweed	<i>Alternanthera philoxeroides</i>	OBL	-	2	-	-	-	-
Mexican primrosewillow	<i>Ludwigia octovalvis</i>	OBL	-	2	-	-	-	-
Elderberry	<i>Sambucus nigra</i> subsp. <i>Canadensis</i>	FAC	-	2	-	-	-	-
Virginia marsh St.John's-wort	<i>Hypericum virginicum</i>	OBL	-	2	-	-	-	-
Southern watergrass	<i>Luziola fluitans</i>	OBL	-	2	-	-	-	-

¹Wetland Status, DEP Code: *Delineation of the Landward Extent of Wetlands and Surface Waters* (Ch 62-340 F.A.C., 1994)

²Plant species cover estimates: Areal extent of vegetation species along transect within given community where 1 = <1% (rare); 2 = 1-5% (sparse); 3 = 6-25% (uncommon) 4 = 26-50% (common); 5 = 51-75% (abundant); 6 = greater than 75% (dominant)

Vegetation at Transect 7

Transect 7 was located west of Lake Santa Fe (Figure 4-1, Table B-11). Similar to Transect 4, Transect 7 had two separate occurrences of the cypress community. Transect 7 was surveyed from the uplands, through the cypress, shrub swamp and hardwood swamp communities, and through a second occurrence of cypress prior to entering the deep marsh bordering the lake. Natural ground elevations were surveyed at a total of 122 locations, ranging from 128.16 to 140.56 ft NAVD88 (Table B-12 and Figure B-13). Cover estimates for plant species in Transect 7 are provided in Table B-13.

Table B-11. Transect 7 location and fieldwork dates.

Northing – Easting (Station 0; Upland)	Northing – Easting (Station 9+80; Deep Marsh)	Location and Dates of Fieldwork
274058.78 – 2731083.71	274606.92 – 2731896.08	Lake Santa Fe, 10/14/2014

Table B-12 Lake Santa Fe Transect 7 vegetation community elevation statistics (ft NAVD88).

Vegetation Community	Stations	Mean Elevation	Standard Deviation (ft)	Median Elevation	Minimum Elevation	Maximum Elevation	N
Upland	0+00 - 0+30	140.16	0.27	140.06	139.92	140.56	5
Cypress	0+40 - 1+11; 6+60 - 7+90	138.50	0.67	138.48	137.18	140.06	30
Shrub Swamp	1+20 - 5+60	137.95	0.24	137.93	137.48	138.58	50
Hardwood Swamp	5+70 - 6+50	138.16	0.31	138.18	137.58	138.68	12
Deep Marsh	8+00 - 9+80	133.24	2.96	134.75	128.16	137.28	25

N = the number of elevations surveyed at each location

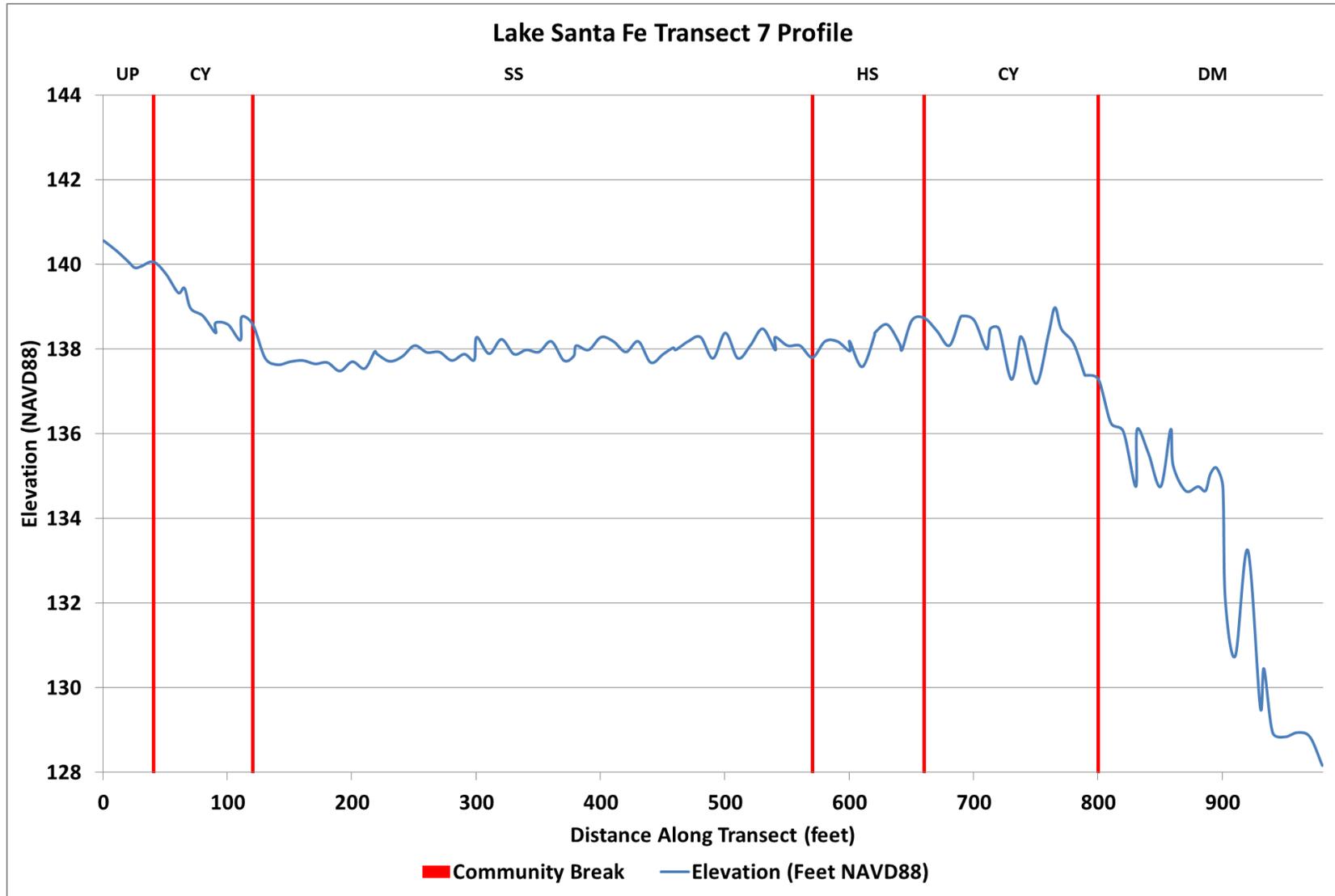


Figure B-13. Elevations along Transect 7, from the highest point surveyed in the uplands to the lowest point surveyed in the deep marsh.

Table B-13. Transect 7 Plant Species Percent Cover Estimates².

Common Name	Plant Species Name	Wetland Status ¹ (DEP Code)	Cypress 1 Plant Species Cover	Shrub Plant Species Cover	Hardwood Swamp Plant Species Cover	Cypress 2 Plant Species Cover	Deep Marsh Plant Species Cover
Red maple	<i>Acer rubrum</i>	FACW	-	2	-	1	-
Lemon bacopa	<i>Bacopa caroliniana</i>	OBL	-	1	-	-	-
Burmarigold	<i>Bidens laevis</i>	OBL	1	1	-	-	-
False nettle	<i>Boehmeria cylindrica</i>	OBL	-	-	-	1	-
Watershield	<i>Brasenia schreberi</i>	OBL	4	6	-	-	-
Awl-fruited sedge	<i>Carex stipata</i>	OBL	2	-	-	-	-
Common buttonbush	<i>Cephalanthus occidentalis</i>	OBL	-	2	-	-	-
Jamaica swamp sawgrass	<i>Cladium jamaicense</i>	OBL	2	5	-	-	-
Common water-hyacinth	<i>Eichhornia crassipes</i>	OBL	-	-	-	1	-
Dahoon	<i>Ilex cassine</i>	OBL	4	2	5	4	-
Myrtle dahoon	<i>Ilex cassine var. myrtifolia</i>	OBL	-	2	3	-	-
Virginia willow	<i>Itea virginica</i>	OBL	-	3	-	2	-
Raven's primrosewillow	<i>Ludwigia ravenii</i>	OBL	-	1	-	-	-
Taperleaf waterhorehound	<i>Lycopus rubellus</i>	OBL	2	1	-	1	-
Sweetbay	<i>Magnolia virginiana</i>	OBL	-	-	-	2	-
Southern bayberry	<i>Morella cerifera</i>	FAC	2	1	1	-	-
American white waterlily	<i>Nymphaea odorata</i>	OBL	-	1	-	-	-
Swamp tupelo	<i>Nyssa sylvatica var. biflora</i>	OBL	3	1	2	2	-
Royal fern	<i>Osmunda regalis</i>	OBL	-	2	2	2	-
Maidencane	<i>Panicum hemitomon</i>	OBL	-	1	-	-	3
Green arrow arum	<i>Peltandra virginica</i>	OBL	1	2	2	1	-
Swamp bay	<i>Persea palustris</i>	OBL	2	-	-	-	-
Pickeralweed	<i>Pontederia cordata</i>	OBL	2	2	-	-	-
Blackberry	<i>Rubus sp.</i>	FAC	2	-	-	-	-
Water spangles	<i>Salvinia minima</i>	OBL	-	2	6	6	2
Pond-cypress	<i>Taxodium ascendens</i>	OBL	5	2	1	5	3
Eastern poison ivy	<i>Toxicodendron radicans</i>	N/A-vine	1	-	-	2	-
Virginia marsh St. John's-wort	<i>Hypericum virginicum</i>	OBL	-	-	-	2	-
Leafy bladderwort	<i>Utricularia foliosa</i>	OBL	-	3	-	-	-
Netted chain fern	<i>Woodwardia areolata</i>	OBL	1	2	-	2	-
Virginia chain fern	<i>Woodwardia virginica</i>	FACW	2	1	1	2	-
Fringed yelloweyed grass	<i>Xyris fimbriata</i>	OBL	1	1	-	-	-

¹Wetland Status, DEP Code: *Delineation of the Landward Extent of Wetlands and Surface Waters* (Ch 62-340 F.A.C., 1994)

²Plant species cover estimates: Areal extent of vegetation species along transect within given community where 1 = <1% (rare); 2 = 1-5% (sparse); 3 = 6-25% (uncommon) 4 = 26-50% (common); 5 = 51-75% (abundant); 6 = greater than 75% (dominant)

Vegetation at Transect 8

Transect 8 was located west of Lake Santa Fe (Figure 4-1, Table B-14). Transect 8 was surveyed from the uplands, through hardwood swamp, shallow marsh, bayhead, a second occurrence of hardwood swamp, cypress, and finally deep marsh adjacent to the open water of the lake. Natural ground elevations were surveyed at a total of 123 locations, ranging from 132.77 to 143.36 ft NAVD88 (Table B-15 and Figure B-14). Cover estimates for plant species in Transect 8 are provided in Table B-16.

Table B-14 Transect 8 location and fieldwork dates.

Northing - Easting (Station 0; Upland)	Northing - Easting (Station 10+00; Deep Marsh)	Location and Dates of Fieldwork
289712.60 - 2727915.73	288987.14 - 2728614.55	Lake Santa Fe, 10/14/2014

Table B-15 Lake Santa Fe Transect 8 vegetation community elevation statistics (ft NAVD88).

Vegetation Community	Stations	Mean Elevation	Standard Deviation (ft)	Median Elevation	Minimum Elevation	Maximum Elevation	N
Upland	0+00 - 1+60	141.61	1.02	141.50	139.38	143.36	19
Hardwood Swamp	1+70 - 2+06; 7+00 - 8+50	138.04	0.54	138.05	136.75	139.12	28
Shallow Marsh	2+20 - 5+63	137.84	0.25	137.85	137.35	138.25	39
Bayhead	5+80 - 6+80	137.86	0.30	137.90	137.25	138.25	14
Cypress	8+60 - 9+30	138.45	1.09	138.64	136.20	139.71	12
Deep Marsh	9+40 - 10+07.3	135.06	1.14	135.08	132.77	137.53	11

N = the number of elevations surveyed at each location

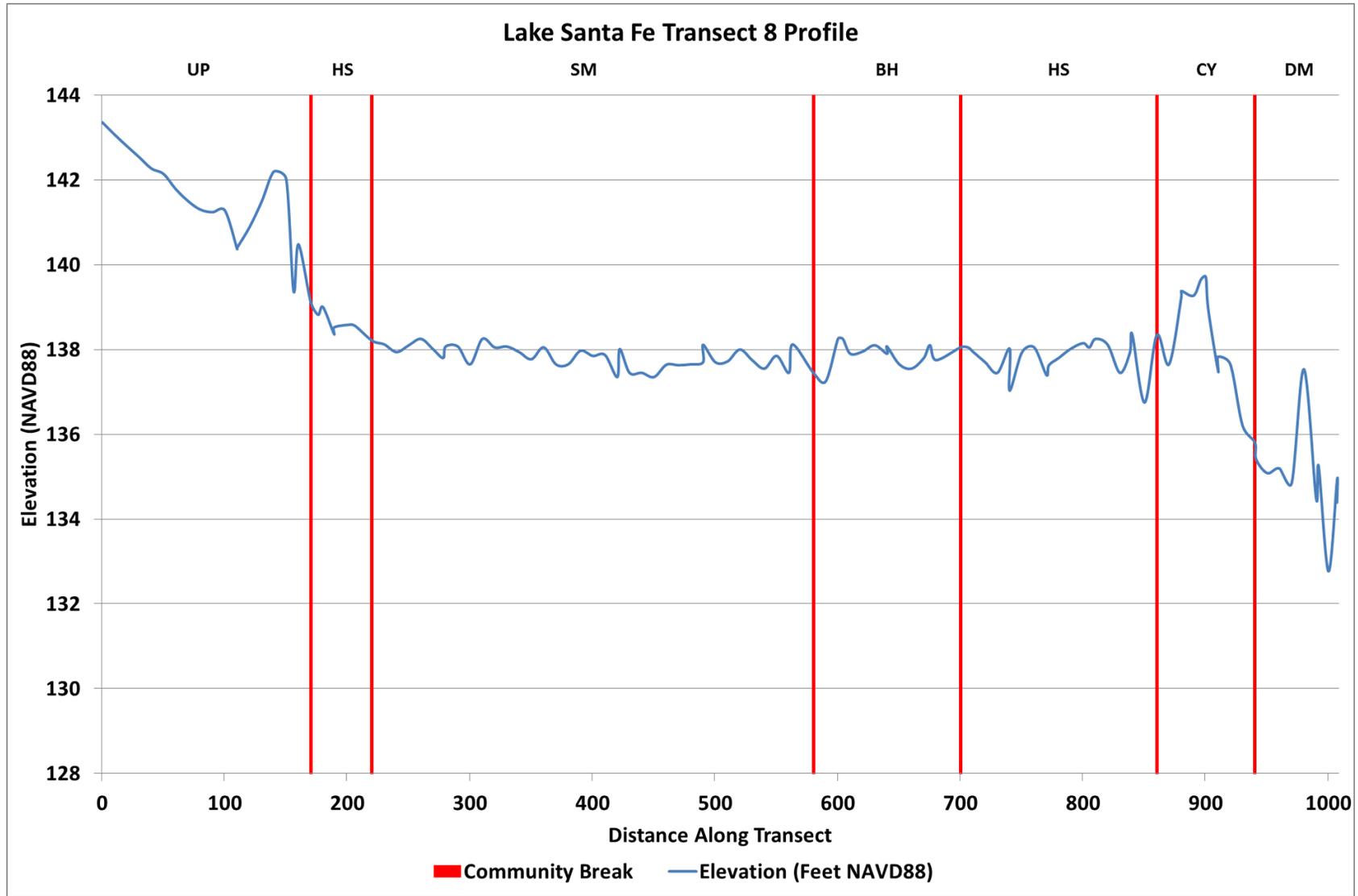


Figure B-14. Elevations along Transect 8, from the highest point surveyed in the uplands to the lowest point surveyed in the deep marsh.

Table B-16. Transect 8 Plant Species Percent Cover Estimates².

Common Name	Plant Species Name	Wetland Status ¹ (DEP Code)	Deep Marsh Plant Species Cover	Cypress Plant Species Cover	Hardwood Swamp 1 Plant Species Cover	Bayhead Plant Species Cover	SM Plant Species Cover	Hardwood Swamp 2 Plant Species Cover
Red maple	<i>Acer rubrum</i>	FACW	-	3	3	-	2	-
Alligatorweed	<i>Alternanthera philoxeroides</i>	OBL	1	-	-	-	-	-
Burmarigold	<i>Bidens laevis</i>	OBL	-	-	-	-	2	-
Common buttonbush	<i>Cephalanthus occidentalis</i>	OBL	1	-	-	-	2	-
Jamaica swamp sawgrass	<i>Cladium jamaicense</i>	OBL	-	-	-	2	3	-
Swamp loosestrife	<i>Decodon verticillatus</i>	OBL	-	1	3	-	2	-
Fetterbush	<i>Eubotrys racemosus</i>		-	-	2	-	-	-
Loblolly bay	<i>Gordonia lasianthus</i>	FACW	-	2	2	5	1	-
Dahoon	<i>Ilex cassine</i>	OBL	-	3	3	4	2	-
Virginia willow	<i>Itea virginica</i>	OBL	-	2	3	-	2	-
Common duckweed	<i>Lemna minor</i>	NA-aquatic	-	-	-	-	-	-
Southern watergrass	<i>Luziola fluitans</i>	OBL	1	-	-	-	-	-
Fetterbush	<i>Lyonia lucida</i>	FACW	-	-	2	-	-	-
Sweetbay	<i>Magnolia virginiana</i>	OBL	-	1	3	-	-	-
Climbing hempvine	<i>Mikania scandens</i>	NA-vine	1	-	-	-	-	-
Southern bayberry	<i>Morella cerifera</i>	FAC	-	-	2	-	1	-
Spatterdock	<i>Nuphar advena</i>	OBL	3	-	-	-	1	-
American white waterlily	<i>Nymphaea odorata</i>	OBL	-	-	-	-	1	-
Swamp tupelo	<i>Nyssa sylvatica var. biflora</i>	OBL	1	1	4	-	2	-
Royal fern	<i>Osmunda regalis</i>	OBL	-	2	1	-	1	-
Maidencane	<i>Panicum hemitomon</i>	OBL	3	-	-	-	4	-
Green arrow arum	<i>Peltandra virginica</i>	OBL	-	-	2	3	2	-
Swamp bay	<i>Persea palustris</i>	OBL	-	1	1	-	-	-
Slash pine	<i>Pinus elliotii</i>	UPL	-	-	-	4	2	-
American cupscale	<i>Sacciolepis striata</i>	FACW	3	-	-	-	-	-
Bulltongue arrowhead	<i>Sagittaria lancifolia</i>	OBL	-	-	-	-	3	-
Water spangles	<i>Salvinia minima</i>	OBL	-	3	6	4	-	-
Pond-cypress	<i>Taxodium ascendens</i>	OBL	-	6	2	-	-	-
Eastern poison ivy	<i>Toxicodendron radicans</i>	NA-vine	1	-	-	-	-	-
Bladderwort	<i>Utricularia sp.</i>	OBL	-	-	3	2	3	-
Highbush blueberry	<i>Vaccinium corymbosum</i>	FACW	-	-	-	-	-	-
Virginia chain fern	<i>Woodwardia virginica</i>	FACW	-	4	3	5	4	-

¹Wetland Status, DEP Code: *Delineation of the Landward Extent of Wetlands and Surface Waters* (Ch 62-340 F.A.C., 1994)

²Plant species cover estimates: Areal extent of vegetation species along transect within given community where 1 = <1% (rare); 2 = 1-5% (sparse); 3 = 6-25% (uncommon) 4 = 26-50% (common); 5 = 51-75% (abundant); 6 = greater than 75% (dominant)

Summary of Vegetation Communities Across Transects

The overall distribution of community types relative to elevations—pooled across transects—is presented in the main body of the report (Section 7.1 Lake Santa Fe Vegetation). Here we provide some additional information about the elevational distribution of the cypress community type, given its importance in the establishment of the FH level.

As shown in Figures B-12, B-13, and B-14, a total of six cypress communities was observed on three of the four studied transects. The mean ground surface elevations of the cypress communities (CY1 through CY6) are summarized in Table 7-2 in Section 7.1. The distribution of surface elevations in these cypress communities is shown in Figure B-15. Two of the six cypress communities are immediately adjacent to upland areas (Figures B-12 and B-13) with similar mean ground elevations of 139.10 ft NAVD88 (CY1) and 138.99 ft NAVD88 (CY4), which are relatively higher than other four cypress communities that are closer to the lake shoreline. Note that cypress communities adjacent to upland areas could be potentially influenced by the groundwater baseflow from their upland contributing areas.

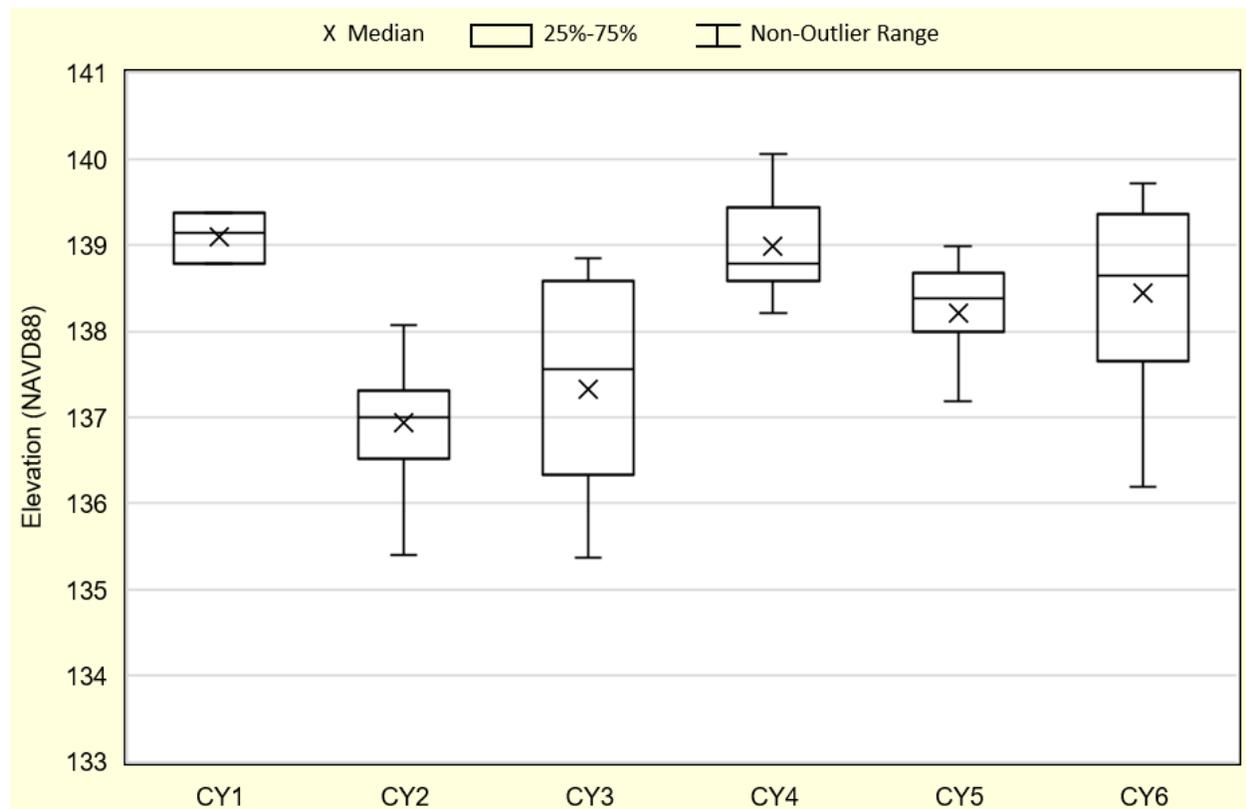


Figure B-15. Boxplot of surface elevations by cypress community.

Appendix C: Soil Sampling Methods, Analyses, and Results

This appendix contains detailed methods and results of the soil sampling effort for minimum levels establishment for Lake Santa Fe. In addition, extensive background information on the mapped soils of the area as well as transect-specific results are provided.

Soil Sampling Methods

The primary soil criteria considered in the MFLs determination are the presence and depth of organic soils, as well as the extent of hydric soils observed along the field transects (SJRWMD 2006). The procedure to document hydric soils included:

- Removing all loose leaf-matter, needles, bark, and other easily-identified plant parts to expose the soil surface; digging a hole, and describing the soil profile to a depth of at least 20 inches and, with the use of the completed soil description, specifying which hydric soil indicators have been matched.
- Performing deeper examination of the soil where field indicators are not easily seen within 20 inches of the surface (e.g., when examining depth to seasonal high saturation in higher areas or examination of soil layering to look for past flooding events). It is always recommended that soils be excavated and described as deep as necessary to make reliable interpretations and classification.
- Paying particular attention to changes in microtopography over short distances, since small elevation changes may result in repetitive sequences of hydric/nonhydric soils and the delineation of individual areas of hydric and nonhydric soils may be difficult (USDA-NRCS 2010, superseded by USDA-NRCS 2017b).

Detailed soil profiles were observed and described by a Certified Soil Scientist at selected stations along each of the four transect lines. A minimum of three locations per each vegetation community type were sampled per transect. Soil profiles were described following standard Natural Resources Conservation Service (NRCS) procedures (Schoeneberger et al. 2012). Each soil horizon (unique layer) was described with respect to texture, thickness, Munsell color, structure, consistency, boundary, and presence of roots.

Soil sampling intervals varied, as sampling locations along each transect were selected to reflect the general characteristics of the vegetation habitat type, avoiding unusual micro-topography that was not representative of the general area.

The following soil features, if present, were identified and the locations marked along the transect line so soil surface elevations could be determined for the following features:

- Landward extent of hydric soils.
- Landward extent of surface organics.
- Landward extent of histic epipedon (surface organic horizon 8-16 in. thick) (USDA-NRCS 2016).
- Landward extent of Histosols (>16-in. thick surface organic horizon).
- Thickness of organic surface horizon.
- Presence of soil flooding indicators such as changes in soil texture from coarse to fine sand or buried surface soil layers or stratification of soils.

- Soil indications of change in hydroperiod indicated by presence of relict soil features or other indicators such as changes in soil structure or map unit composition.

Soil data were collected in the field on standard datasheets. A list of soil markers deployed for survey was prepared and provided to project surveyors. All soil data sheets were reviewed for completeness, then scanned and provided as a deliverable to the SRWMD in PDF format. In addition, soils data were entered into Excel format and joined to survey data in ArcGIS for further analyses.

Overall Results

Elevations of the soil surface were obtained for a total of 107 soil borings at Lake Santa Fe. The critical data element from each sample was whether thick organic soils occurred or not. Thick organic soils were defined as either a Histosol or soils having a histic epipedon. In other words, at least 8 inches of muck had to occur near the surface of the soil to be classified as a thick organic. Of the 107 soil borings among the four transects, 82 (77 percent) were found to have thick organics present (Table C-1). Five of the communities sampled showed all samples to have thick organics: deep marsh, bayhead, hardwood swamp, shrub swamp, and shrub bog (Table C-1). Two of the communities had no thick organic samples: wet prairie and pond (although these only had one or two samples each). The remaining communities had either a relatively high proportion of thick organic samples (cypress and shallow marsh) or a very low proportion of thick organic samples (upland).

Table C-1. Distribution of soil borings with thick organics by community.

Community	Thick Organics Not Present	Thick Organics Present	Totals	Percentage with Thick Organics
Cypress	6	16	22	73%
Shallow Marsh	8	13	21	62%
Deep Marsh	0	16	16	100%
Bayhead	0	15	15	100%
Hardwood Swamp	0	10	10	100%
Upland	8	1	9	11%
Shrub Swamp	0	6	6	100%
Shrub Bog	0	5	5	100%
Wet Prairie	2	0	2	0%
Pond	1	0	1	0%
All Groups	25	82	107	77%

Note: Communities sorted descending by number of soil borings

Considering all samples, there was some minor overlap in the elevations of samples with and without thick organics (Figure C-1). However, the difference in elevation of the two groups was statistically significant (Mann-Whitney U, $p < 0.001$); the median of the elevations with thick organics (138.04 ft NAVD88, $n=82$) was less than the median of the soil borings lacking thick organics (139.45 ft NAVD88, $n=25$). Some of the overlap was caused by the occurrence of a small number of samples in the cypress community on Transect 4 which were subaqueous soils occurring close to the open water of the lake that were very sandy and lacked significant organic accumulation.

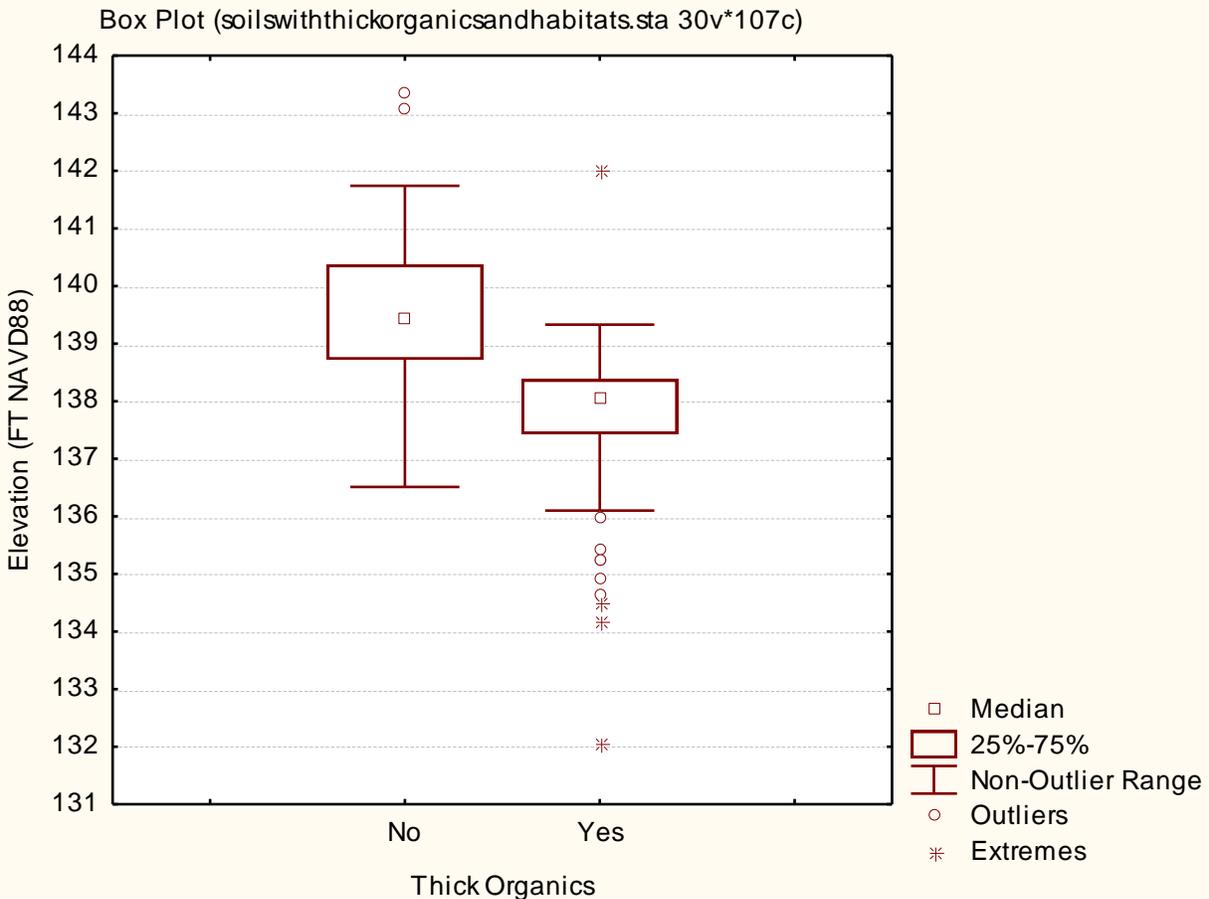


Figure C-1. Elevational distribution of soil borings with thick organics.

Figure C-2 documents the distribution of soil elevations for soil borings with and without thick organics by transect. The elevations of soils lacking thick organics varied by transect, but generally occurred at higher elevations than the soils with thick organics that were more uniform in their elevational distributions (Figure C-2). With the exception of a single outlier on Transect 8 at 142.02 ft NAVD88 (an upland community sample that was noted as the landward extent of histic epipedon), no soil borings with thick organics occurred higher than elevation 139.33 ft NAVD88.

The SJRWMD MFL approaches for establishing the Minimum Average level and the Frequent Low level typically rely on offsets from the mean elevation of “muck” soils, i.e., those having thick organics present (Neubauer et al. 2008). We propose similar approaches in the present study. It is important to properly address the issue of outliers in the dataset to have a representative mean elevation. Three of the four transects (1, 7, and 8) had “outlier” or “extreme” low elevation values (Figure C-2). Outliers represent points that lay more than 1.5 interquartile ranges away from the median and extreme values lay more than 3 interquartile ranges away. These extreme values tend to bias the mean downwards away from the median. Also, as noted previously, there was one high elevation muck soil extreme value occurring in the Uplands community of T8. This bias effect is observed in the summary statistics of Table C-2 where it may be observed that for the 82 soil borings with thick organics, the mean elevation was 137.68 ft NAVD88, and the median was 138.04 ft NAVD88.

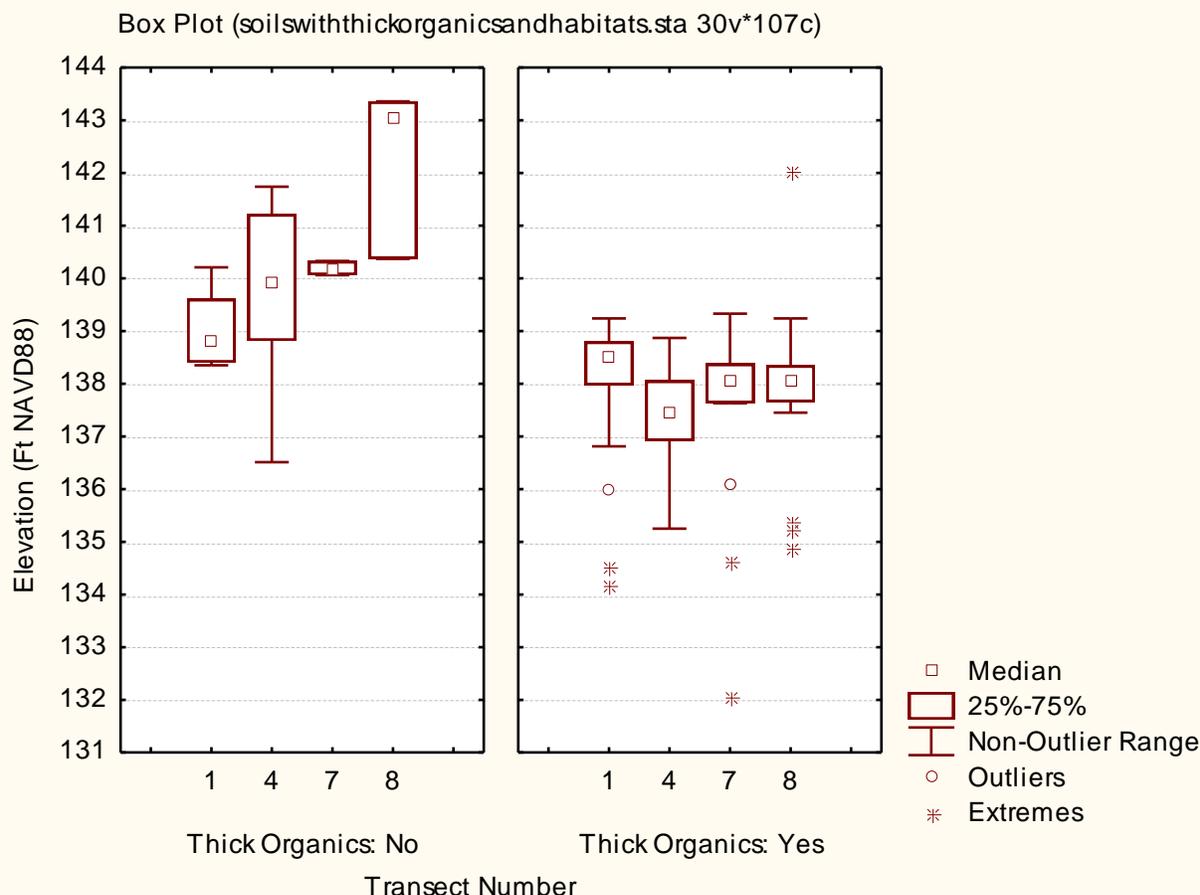


Figure C-2. Elevational distribution by transect of soil borings with thick organics.

Table C-2. Summary statistics for soil borings with and without thick organics present (ft NAVD88).

Thick Organics Present	N	Standard Deviation (ft)	Min	Q25	Mean	Median	Q75	Max
No	25	1.55	136.51	138.72	139.74	139.45	140.37	143.36
Yes	82	1.38	132.05	137.43	137.68	138.04	138.38	142.02
All Groups	107	1.66	132.05	137.60	138.16	138.18	138.85	143.36

Why do occasional extreme low values occur in the dataset? Nearly all of the points below 136.0 ft NAVD88 represent those soil borings at the lakeward end of the transects in subaqueous soils, located in the deep marsh community (with the exception of one deep hole on T4). Since the deepest portions of the deep marsh tend to occur at lower elevations than the other community types, additional samples in those areas could be expected to bias the outcome of a mean elevation of thick organics. By using the median, instead of the mean, we avoid overemphasizing this unusually deep community type which is expected to be semi-permanently to permanently flooded. The median represents the middle measurement of a set of data and is known to be an unbiased estimator of the mean for normal distributions and represents a better estimator of central tendency for data with skewed distributions or outliers (Quinn and Keough 2002).

Background

Lake Santa Fe Soils

Lake Santa Fe covers about 5,580-acres. While it is entirely in Alachua County, Florida, it borders Bradford County and the project transects on the north and east side of the lake are predominantly in Bradford County.

Before going to the field, the USDA published Soil Survey was reviewed to determine how the soils were mapped and to help identify potential transect areas. In addition to reviewing published Soil Survey manuscripts, soil maps of the areas around Lake Santa Fe and transect locations were downloaded from the Web Soil Survey (WSS) which provides soil data and information produced by the National Cooperative Soil Survey program and is operated by the USDA Natural Resources Conservation Service (USDA-NRCS 2017a).

Soil information obtained from these documents includes soil map units described during the course of the soil survey. Major field work was completed in 1982 in Alachua County and 1987 in Bradford County. While WSS is convenient to use, and may provide some updated soil information, it lacks detailed descriptions, geologic and land use data, and other information in the manuscript relevant to soil conditions taken at the time of mapping necessary to making complete analyses. Soils were mapped at a specific scale and as stated in the Soil Surveys, enlargements of these maps do not show small areas of contrasting soils that may be found through on-site investigations. However, these maps are very accurate at the scale of mapping and critical to the planning of field exercises and site assessment.

Soil areas are first described in a larger context to depict conditions and landform influences surrounding Lake Santa Fe. Due to the complexity of soil map units surrounding Lake Santa Fe, soil maps were split into a north section covering Little Lake Santa Fe comprising Transects T1 and T8, and a south section of soils around the larger Lake Santa Fe comprising Transects T4 and T7.

General Soil Map of the Area

The General Soil Map of Bradford County (Figure C-3) includes General Soil Map Unit 5 as "Soils in the Flatwoods, on Slight Knolls, and in Transitional Areas between Uplands and Flatwoods." These soils have a distinct pattern of relief and drainage in a unique natural landscape.

Bradford County General Soil Map Unit 5, Plummer-Sapelo, located on the east side of the lake represent nearly level, poorly drained sands that have loamy material between 40 to 80 inches of the surface. Upslope to the northeast General Soil Map Unit 2, Penny-Blanton-Troup, described in the landform "Soils on Sand Ridges", consist of nearly level to strongly sloping, excessively drained, moderately well drained, and well drained soils that are sandy in the upper part and have lamellae or loamy material at depth of 40 to 80 inches. These excessively drained soils appear to be recharge areas to the Plummer-Sapelo soils formed on a lower landscape along the lake.

Soils on the west side of the lake in Alachua County (Figure C-4) also include General Soil Map Units 7 and 10 as "Soils in the Flatwoods, on Slight Knolls, and in Transitional Areas between Uplands and Flatwoods." General Soil Map Unit 7, Millhopper-Lochloosa-Sparr, represent nearly level to gently sloping, moderately well-drained, and somewhat poorly drained soils; some have sandy surface horizons to a depth of 20 to 40 inches and others have deeper sands of 40 to 80 inches, both with loamy layers below. Soil unit 10, Pomona-Wachula-Newnan soils, are nearly level, poorly drained,

and somewhat poorly drained soils that have a sandy, organic coated subsoil at depths of less than 30 inches and a loamy subsoil within 28 to 80 inches of the soil surface. Based on these maps it is anticipated that a higher percent of organics may occur on the western portions of the lake.

Located west and south of Lake Santa Fe, General Soil Map Units 11 and 13 are very poorly drained soils described as "Soils on Wet Prairies and in Marshes, Swamps, and Flood Plains". These soils differ in degree, frequency, and duration of wetness from the better drained soil areas listed above. General Soil Map Unit 11, Montechoa-Surrency are nearly level, very poorly drained soils; some are sandy to depths of 40 to 80 inches, with an organic coated subsoil at depths of less than 30 inches and loamy texture below; and some are sandy to a depth of 40 inches and overlying a loamy textured horizon. South of Lake Santa Fe, General Soil Map Unit 13 Shenks-Terra Ceia-Okeechobee includes very poorly drained non- mineral soils which differ from other areas on the General Soil Map. Some soils have organic material 16 to 50 inches deep to clayey material, and some soils have organic material more than 51 inches thick.

In general, soils along the eastern and southern portions of the lake had higher landforms of excessively drained soils within 1/4 mile or less of their western boundaries which may discharge large amounts of water towards the lake. Areas around the lake were very poorly to somewhat poorly drained and with subaqueous conditions along the Ordinary High Water Line (OHWL) of the lake.

Topographic map features derived from the Web Soil Survey are shown in Figure C-5. The large Santa Fe Swamp, north of the lake, can be seen sloping upland with sharp topographic breaks and low gradient marsh areas.

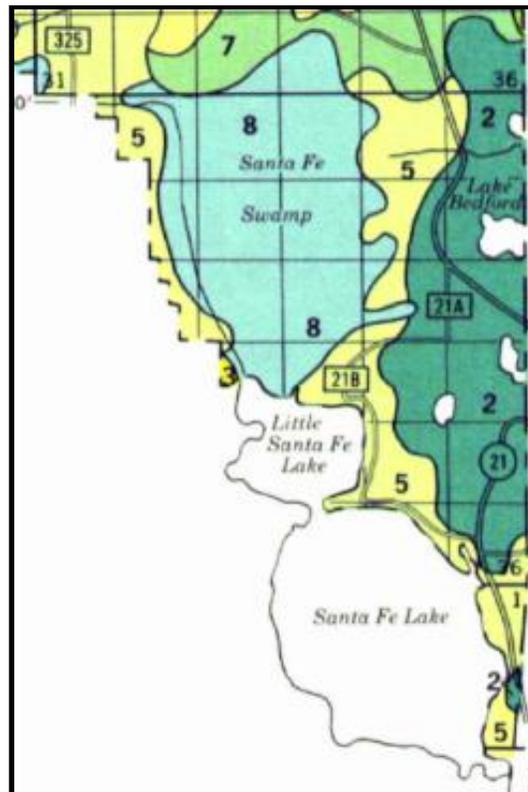


Figure C-3. General Soil Map Bradford County.

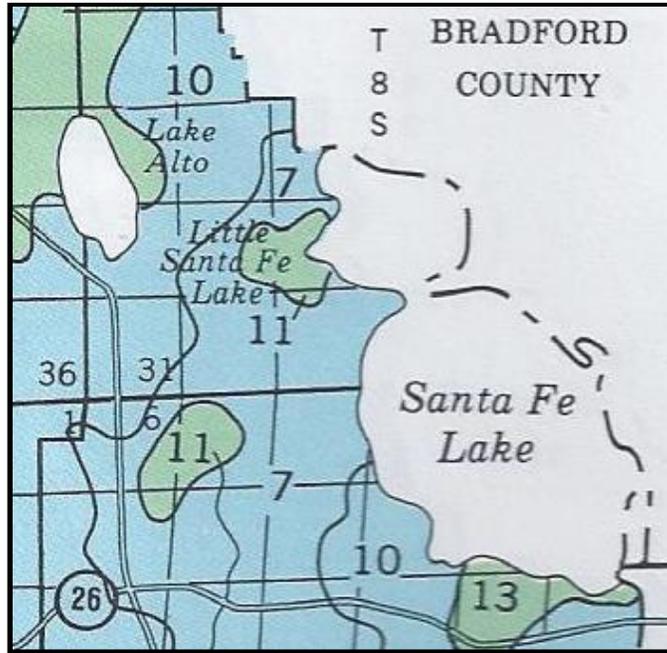


Figure C-4. General Soil Map Alachua County.

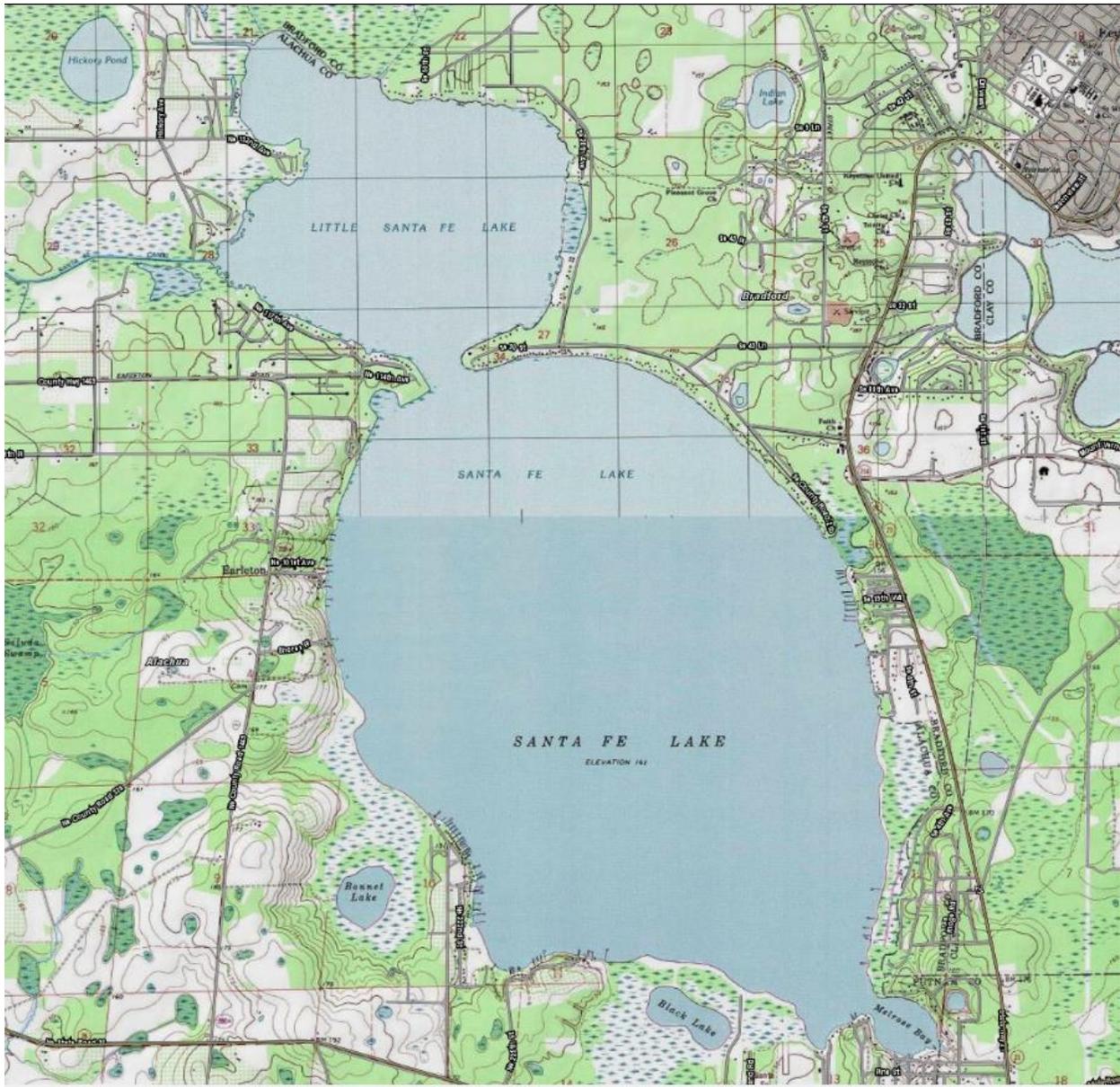


Figure C-5. Topographic Map.

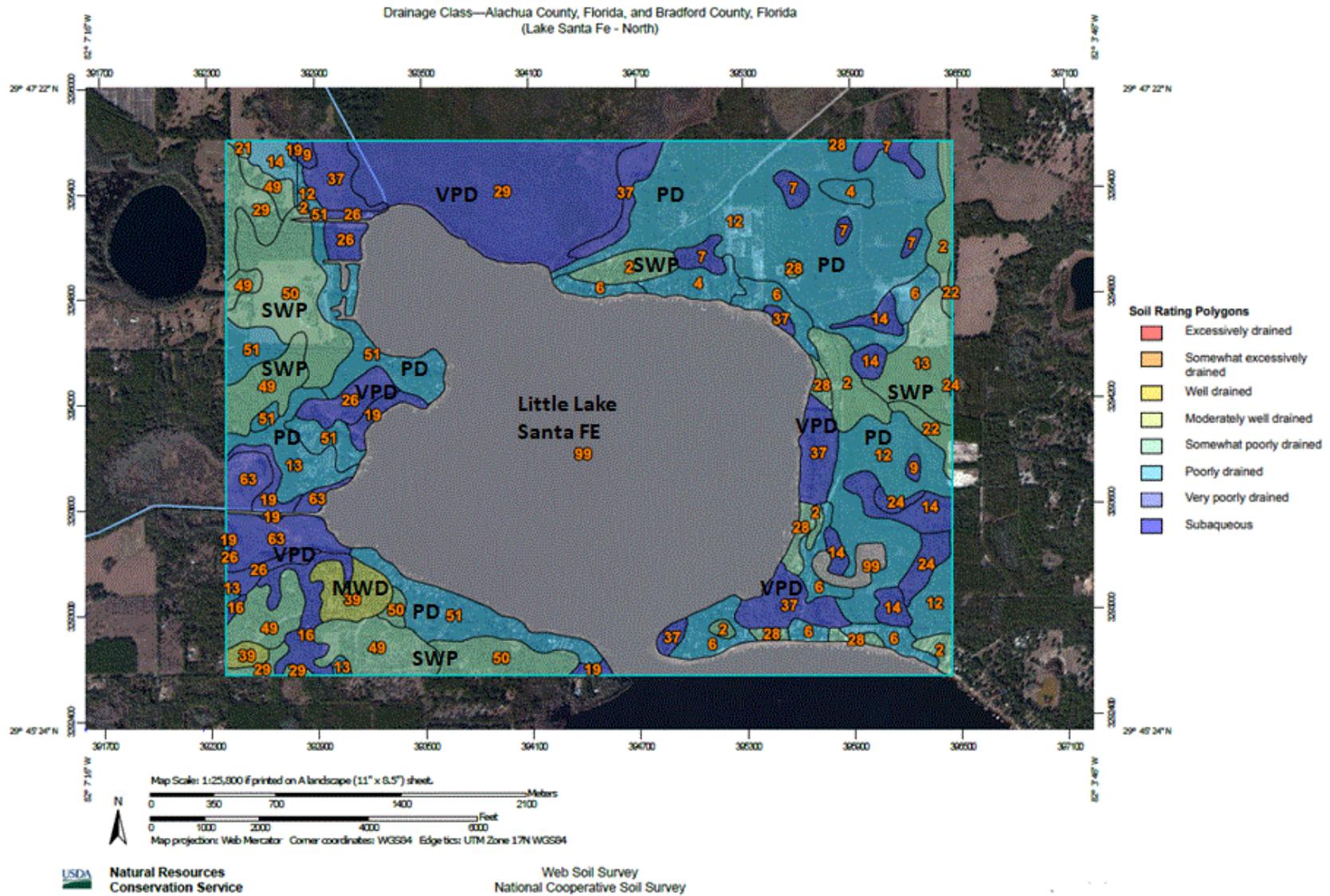


Figure C-6. Soils Map Units- (North) - Little Lake Santa Fe.

Twenty-six Soil Map Units (MU) and correlated drainage classes are shown in Figure C-6 which include areas around the northern portion of the project area and Little Lake Santa Fe. Table C-3 provides a listing of Little Lake Santa Fe soil map unit numbers and names. Soils of the largest extent were poorly drained Sapelo sand (MU 12) on a marine terrace position above the east side of the lake and Dorovan muck (MU 29) close to the lake. Dorovan muck soils are very poorly drained and frequently flooded. These soils were formed on floodplains of marine terraces and have Oa-horizons of muck layers 80 inches thick or more. Pamlico and Croatan mucks (MU 37) are located on the east side of the lake and are also very poorly drained and frequently flooded. They have Oa-horizons of muck layers typically 40 inches thick over sand mineral soil. Upslope, poorly drained Sapelo sand (MU 12) soils have Bh-horizons, which are spodic layer(s) below sandy surface layers and overlay finer textured argillic horizons. Plummer wet sands (MU 6) are also poorly drained mineral soils with finer textured subsoil but lack a spodic layer. Continuing upslope are somewhat poorly drained Albany fine sand, 0 to 5 percent slopes (MU 2) with loamy subsoil; and Hurricane sand, 0 to 5 percent slopes (MU 13) with deep Bh-spodic horizons. On the Alachua County side of the lake, poorly drained Plummer fine sand (MU 51) was most common. These soils have sandy surface layers over finer textured argillic horizons formed on flats on marine terraces.

Very poorly drained map units include Terra Ceia muck, frequently ponded, 0 to 1 percent slopes (MU 63), Samsula muck (MU 26) and Montechoa loamy sand (MU 19). Terra Ceia muck soils were formed in depressions on marine terraces and have Oa- horizons of muck layers 80 inches thick or more. Samsula muck on similar depressional landforms have muck layers about 36 inches over sand. Montechoa soils are mineral soils with spodic and argillic layers in the subsoil. Montechoa soils also form in depressions on marine terraces.

Hydric Soils located adjacent to Little Lake Santa Fe are shown in Figure C-7. Hydric soils are defined by the National Technical Committee for Hydric Soils (NTCHS) as soils that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part (Federal Register 1994).

The majority of hydric soils occur in the Santa Fe Swamp north of the lake and along the perimeter in both Alachua and Bradford Counties. Typical soils include frequently flooded or depressional map units, and mucks and loamy sands such as Montechoa (MU 19). Soils designated as 100 percent hydric comprise about 18 percent of the area and all are very poorly drained. Very poorly drained soils typically have water tables above the soil surface for more than a few weeks during the wet season. Other soils such as Sapelo sand (MU 12), which make up about 14 percent of the area shown in Figure C-7, have about 66 percentage of the map unit meeting hydric soil criteria. Other soils have a lesser percent of the map unit meeting hydric soil criteria or are non-hydric. All somewhat poorly drained soils and some poorly drained soils were listed as non-hydric.

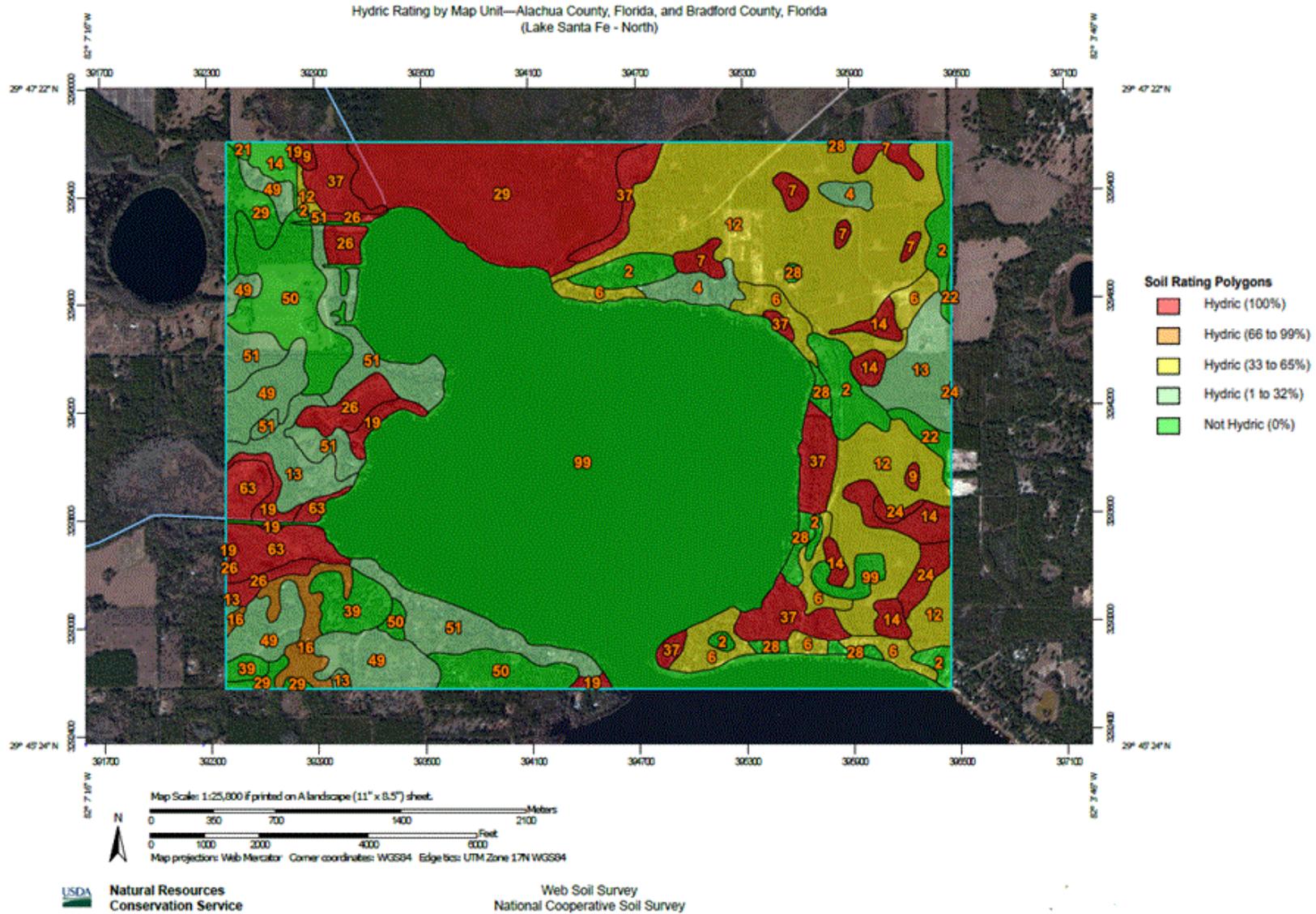


Figure C-7. Hydric Soils Little Lake Santa Fe.

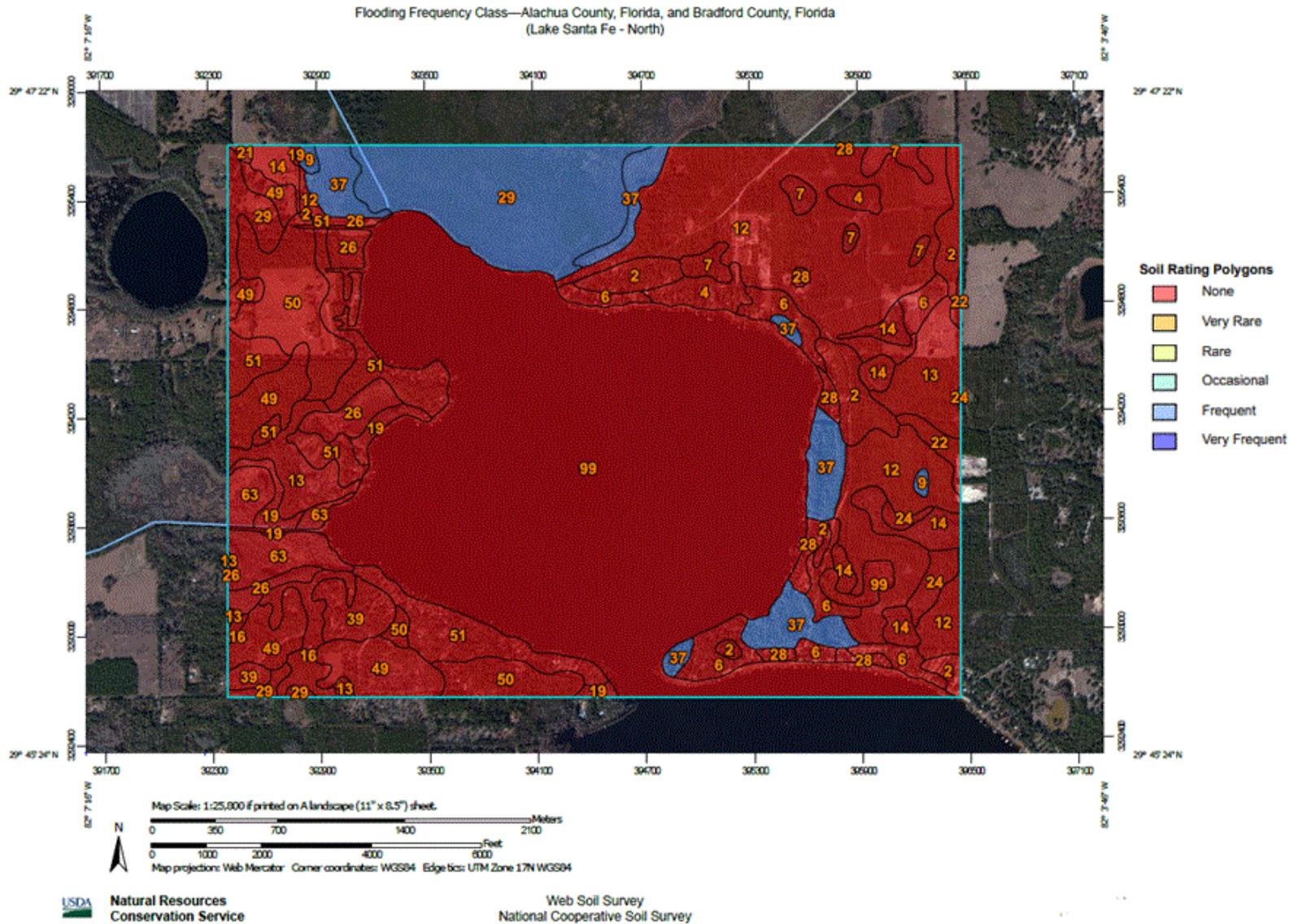


Figure C-8. Flooding Frequency Class.

Most soils in the vicinity do not flood with the notable exception of MU 29, Dorovan muck, frequently flooded, north of the project area in the Santa Fe Swamp (Figure C-8), which may be flooded due to backwater effects from the Santa Fe River; and MU 30, Pamlico and Croatan mucks, frequently flooded on the east side of Little Lake Santa Fe. Flooding is the temporary inundation of an area caused by overflowing streams such as the Santa Fe River or by runoff from adjacent slopes, the latter being the case of Zolfo sand (MU 37). Frequency is expressed as none, very rare, rare, occasional, frequent, and very frequent as shown in the legend. "None" means that flooding is not probable and the chance of flooding is nearly 0 percent in any year. Flooding occurs less than once in 500 years. "Very Frequent" indicates that flooding is expected to occur very often under normal weather conditions and the chance of flooding is more than 50 percent in all months of any year.

Ponding is defined as standing water not associated with overflowing streams but due to landscape position in closed concave depressional areas or flats. Water is removed only by deep percolation, transpiration, or evaporation or by a combination of these factors. As shown in Figure C-9, ponding occurs predominantly in areas surrounding the lake in muck soil map units. These include MU 29, Dorovan muck, frequently flooded; MU 37, Pamlico and Croatan mucks, frequently flooded; MU 63, Terra Ceia muck, frequently ponded, 0 to 1 percent slopes; MU 14, Pamlico and Croatan mucks; and MU 26, Samsula muck.

Figure C-10 illustrates the spatial distribution of soil surface texture adjacent to Little Lake Santa Fe. Depth of surface texture can vary depending on occurrence of subsurface layers. Fine sand and muck soils were more prevalent in Alachua County west of the lake, while sandy ridges occurred above the muck soils east of the lake in Bradford County.

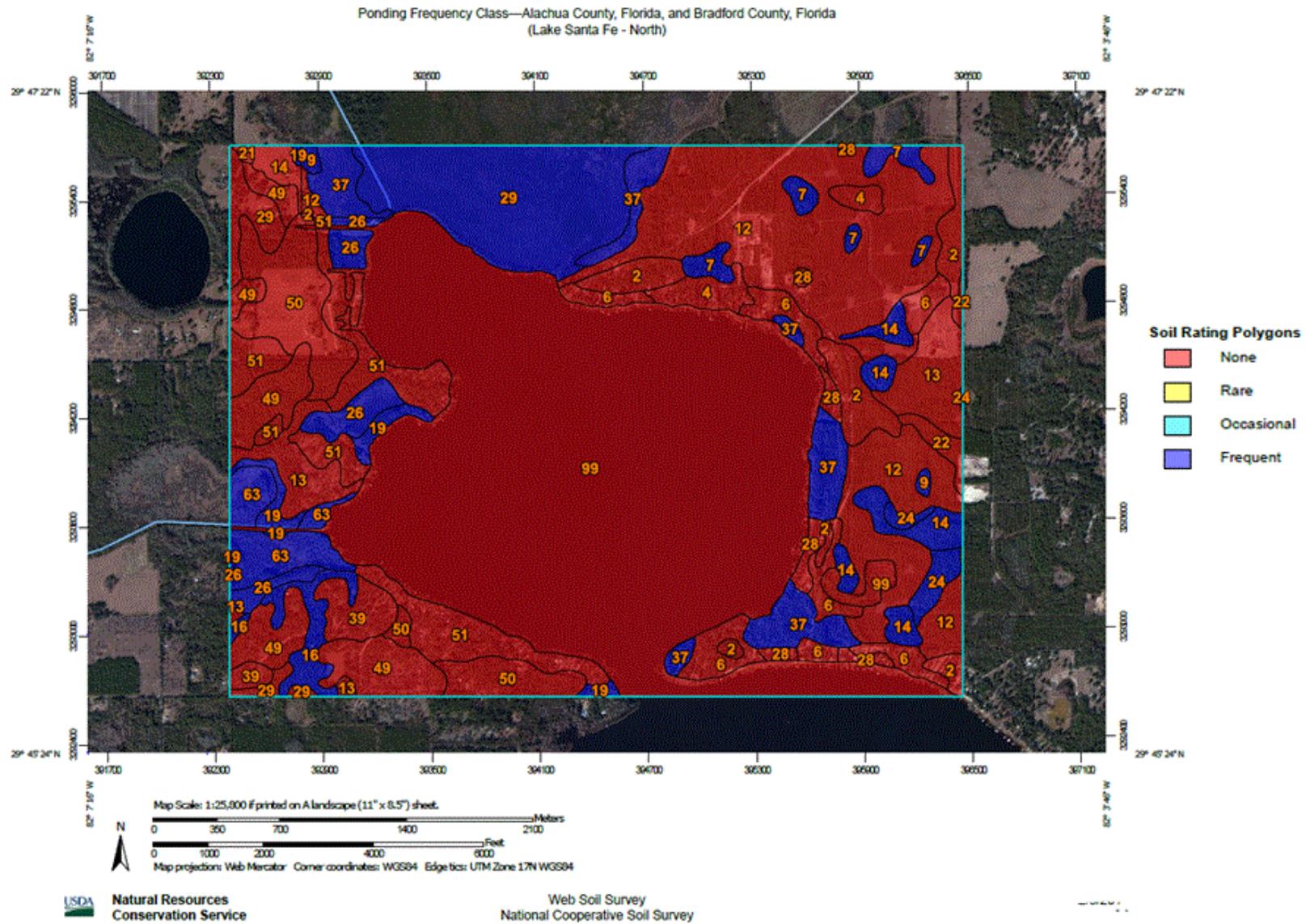


Figure C-9. Ponding Frequency Class.

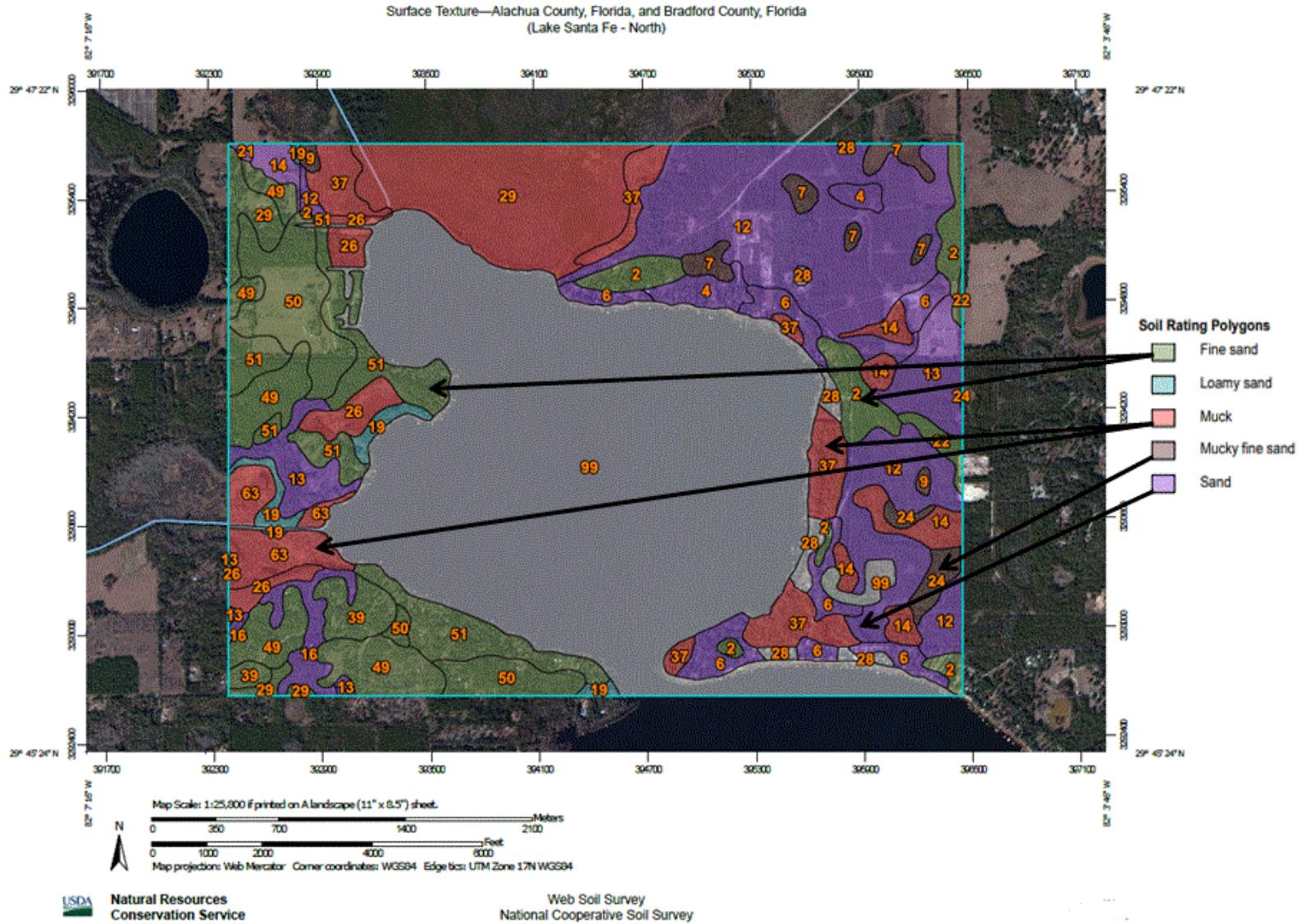


Figure C-10. Soil Surface Texture.

Table C-3. Little Lake Santa Fe Soil Map Unit Number and Name.

Alachua County	
13	Pelham sand
14	Pomona sand, 0 to 2 percent slopes
15	Surrency sand
19	Monteocha loamy sand
21	Newman sand
26	Samsula muck
29	Lochloosa fine sand, 2 to 5 percent slopes
39	Bonneau fine sand, 2 to 5 percent slopes
49	Lochloosa fine sand, 0 to 2 percent slopes
50	Sparr fine sand
51	Plummer fine sand
63	Terra Ceia muck, frequently ponded, 0 to 1 percent slopes
99	Water

Bradford County	
2	Albany fine sand, 0 to 5 percent slopes
4	Mascotte sand, 0 to 2 percent slopes
6	Plummer-Plummer wet, sands
7	Surrency and Pantego soils, depressional
9	Starke mucky fine sand, frequently flooded
12	Sapelo sand
13	Hurricane sand, 0 to 5 percent slopes
14	Pamlico and Croatan mucks
22	Chipley fine sand, 0 to 5 percent slopes
24	Starke mucky fine sand, depressional
28	Arents, moderately wet, 0 to 5 percent slopes
29	Dorovan muck, frequently flooded
37	Pamlico and Croatan mucks, frequently flooded
99	Water

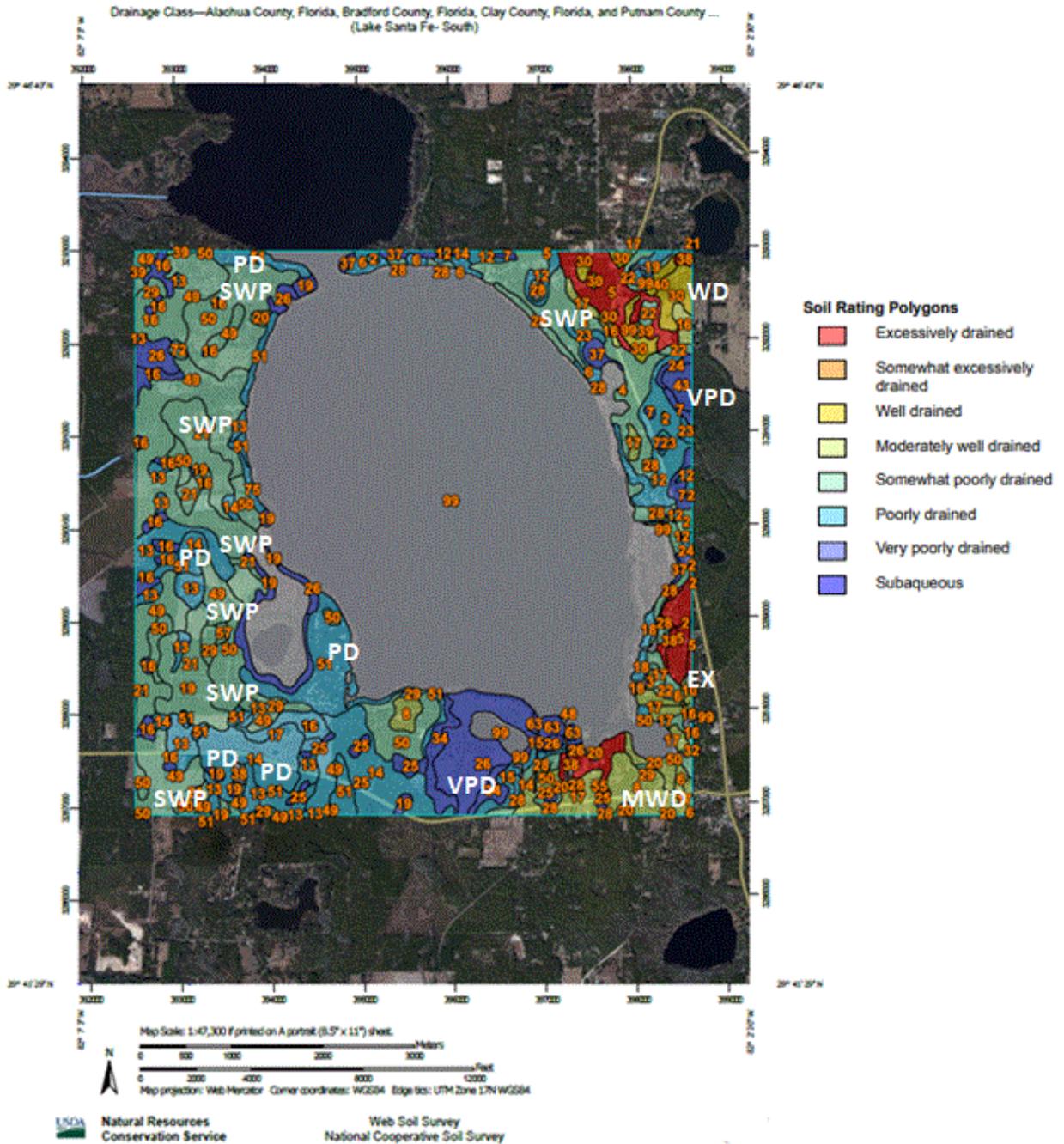


Figure C-11. Soils Map Units- (South) - Lake Santa Fe.

Fifty-five soil map units and correlated drainage classes are shown in Figure C-11, which include areas around the southern portion of the project area and Lake Santa Fe. Table C-4 provides a listing of (South) Lake Santa Fe soil map unit numbers and names. Soils of the largest extent are the somewhat poorly drained Lochloosa fine sand, 0 to 2 percent slopes (MU 49); and Sparr fine sand (MU 50) on flats and rises on marine terraces. Closer to the lake, flats that border Lake Santa Fe on the west in Alachua County are Plummer fine sand (MU 51) and Pelham sand (MU 13). Areas of very poorly drained Montechoa loamy sand (MU 19) were mapped on marine terrace depressions, also on the west side of the lake. Very poorly drained organic Samsula muck soils (MU 26) cover a large area on the south end of Lake Santa Fe. Except for Samsula muck, all of the above soils are mineral soils with sand or loamy sand surface layers and finer textured subsoils. Samsula muck in Alachua County is typically 35 inches thick, but the combined thickness of muck layers can be 16 to 51 inches based on the range of characteristics of the soil series.

Dorovan muck (MU 29) are very poorly drained soils and frequently flooded. These soils were formed on floodplains of marine terraces and exhibit Oa- horizons of muck layers 80 inches thick or more. On the east side of the lake, Pamlico and Croatan mucks (MU 37), also very poorly drained soils and frequently flooded, have Oa- horizons of muck layers typically 40 inches thick over sand mineral soil. Upslope, poorly drained Sapelo sand (MU 12) has Bh-horizons, or spodic layer(s), below sandy surface layers, that overlay finer textured argillic horizons. Plummer wet sands (MU 6) are also poorly drained mineral soils with a finer textured subsoil, but lack a spodic layer. Continuing upslope, somewhat poorly drained Albany fine sand, 0 to 5 percent slopes (MU 2) with loamy subsoil; and Hurricane sand, 0 to 5 percent slopes (MU 13) with deep Bh-spodic horizons are shown in Figure C-11. Poorly drained Plummer fine sand (MU 51) was most common on the Alachua County side of the lake. These soils have sandy surface layers over finer textured argillic horizons formed on flats on marine terraces.

Eleven of the 55 soil map units are rated as "frequent" ponding (Figure C-12) giving them a greater than 50% chance in a given year to have standing water above the soil surface. Dominant soils include. Samsula muck (MU 26), Montechoa loamy sand (MU 19), and Surrency sand (MU 16).

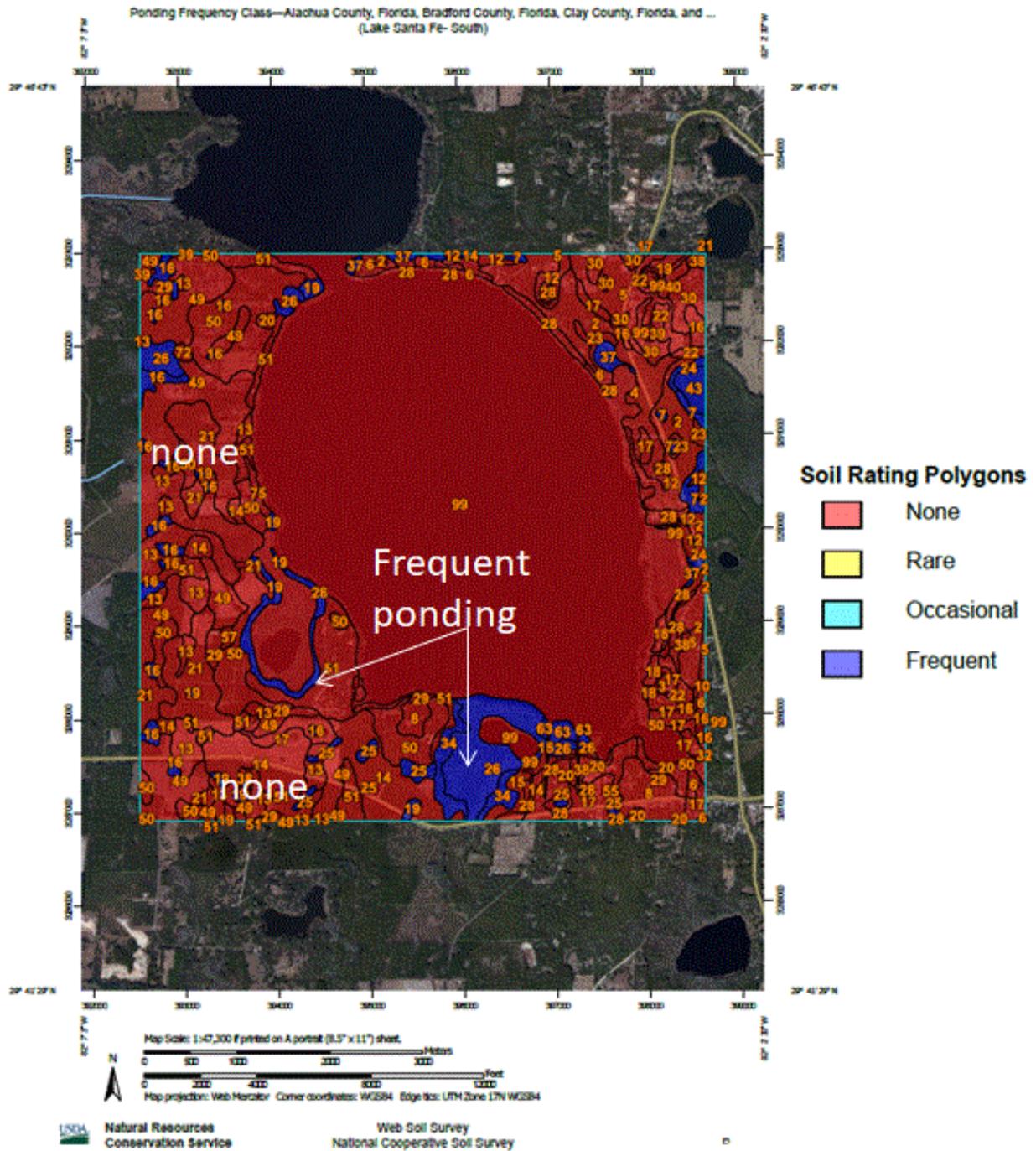


Figure C-12. Ponding Frequency.

Figure C-13 is a map of soil surface texture. Organic muck soils were most prevalent south of the lake and on the west in Bradford County.

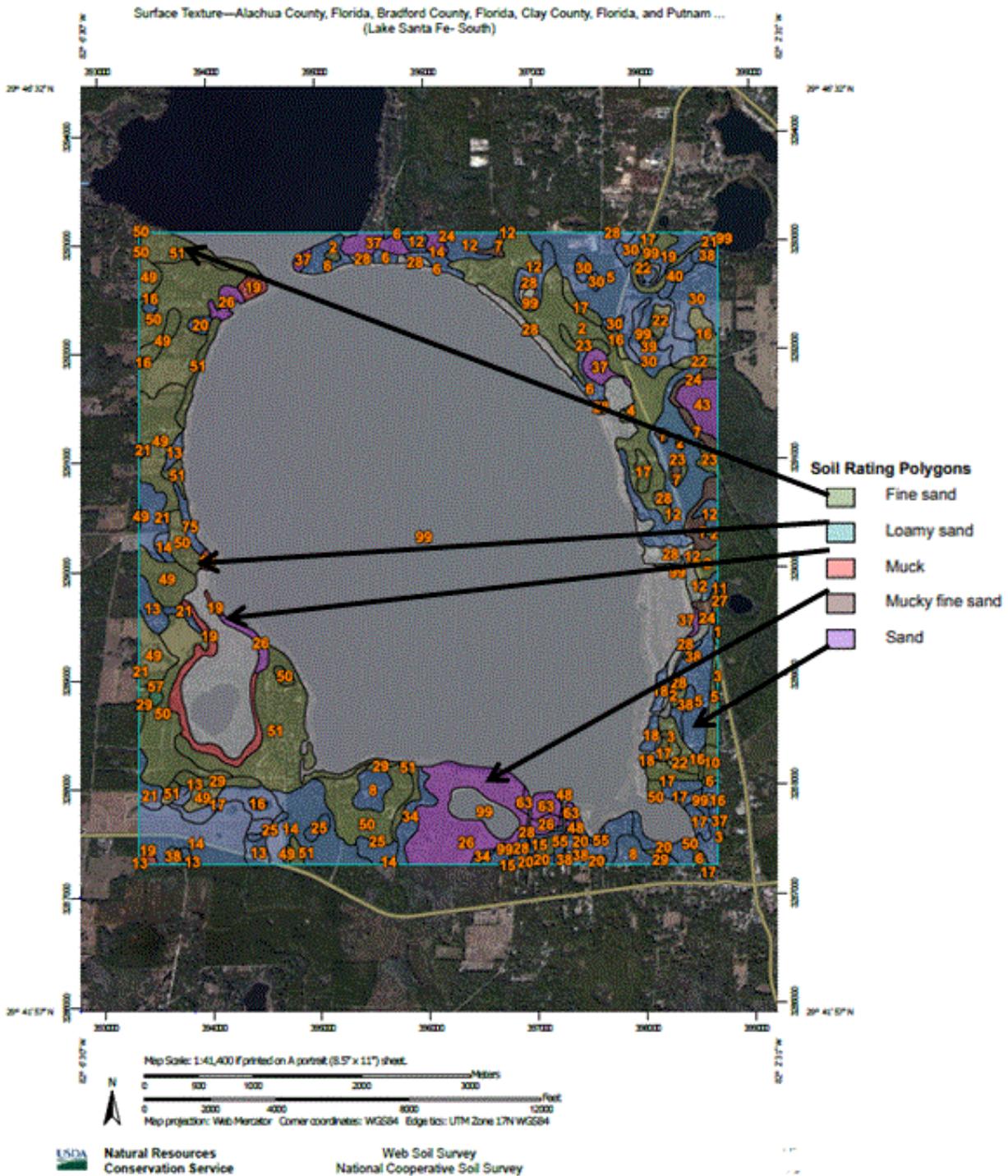


Figure C-13. Soil Surface Texture.

Table C-4. Lake Santa Fe Soil Map Unit Number and Name.

Alachua County		Bradford County		Clay County	
8	Millhopper sand, 0 to 5 percent slopes	2	Albany fine sand, 0 to 5 percent slopes	1	Albany fine sand 0 to 5 percent slopes
13	Pelham sand	3	Ocala fine sand 0 to 5 percent slopes	3	Hurricane fine sand, 0 to 5 percent slopes
14	Pomona sand, 0 to 2 percent slopes	4	Mascotte sand, 0 to 2 percent slopes	5	Penny fine sand, 0 to 5 percent slopes
15	Pompano sand	5	Penney sand, 0 to 5 percent slopes	10	Ortego fine sand, 0 to 5 percent slopes
16	Surrency sand	6	Plummer-Plummer wet, sands	11	Allanton and Rutlege mucky fine sands, depressional
17	Wauchula sand	7	Surrency and Pantego soils and depressions	27	Pamlico muck
18	Wauchula-Urban land complex	12	Sapelo sand		
19	Monteocha loamy sand	14	Pamlico and Croatan mucks		
20	Tavares sand, 0 to 5 percent slopes	16	Foxworth fine sand, 0 to 5 percent slopes		
21	Newman sand	17	Blanton fine sand, 0 to 5 percent slopes		
25	Pomona sand, depressional	19	Leon sand, 0 to 2 percent slopes		
26	Samsula muck	21	Beaches, 1 to 5 percent slopes		
28	Chipley sand	22	Chipley fine sands, 0 to 5 percent slopes		
29	Lochloosa fine sand, 2 to 5 percent slopes	23	Pelham complex, 0 to 2 percent slopes		
34	Placid sand, depressional	24	Starke mucky fine sand, depressional		
38	Pits and dumps	28	Arents, moderately wet 0 to 5 percent slopes		
48	Myakka-Myakka, wet, sands 0 to 2 percent slopes	30	Troup sand, 0 to 5 percent slopes		
49	Lochloosa fine sand, 0 to 2 percent slopes	37	Pamlico and Croatan mucks, frequently flooded		
50	Sparr fine sand	38	Penney sand, rolling		
51	Plummer fine sand	39	Blanton fine sand, 5 to 12 percent slopes		
55	Lake sand 0 to 5, percent slopes	40	Troup sand, rolling		
57	Micanopy loamy fine sand, 2 to 5 percent slopes	43	Dorovan muck		
63	Terra Ceia muck, frequently ponded, zero to 1 percent slopes	99	Water		
75	Blichton sand, 5 to 8 percent slopes				

Putnam County	
3	Myakka-Myakka wet, fine sands, 0 to 2 percent slopes
6	Tavares find sand, 0 to 5 percent slopes
16	Adamsville sand, 0 to 2 percent slopes
17	Millhopper sand 0 to 5 percent slopes
32	Sparr sand, 0 to 5 percent slopes
37	Ona-Ona, wet fine sand, 0 to 2 percent slopes
50	Wabasso fine sand

Soil Transects

Little Lake Santa Fe connects to the larger southern lobe of Lake Santa Fe at the pass. A canal was dug in the late 1800s to connect Lake Santa Fe to Lake Alto about 2 miles to the west. Lake Santa Fe is a surficial spring-fed lake that forms the headwaters of the Santa Fe River.

Soil sampling transect locations are provided in Figure C-14. Transects along the west side of Lake Santa Fe included T1 (Figure C-15) in the northwest corner, in Bradford County above the Santa Fe Canal and T8 in Alachua County. Transect T4 is located in Bradford County on the east shoreline of Lake Santa Fe, while T7 is located on the west of the lake in Alachua County.



Figure C-14. Transect Location Map.

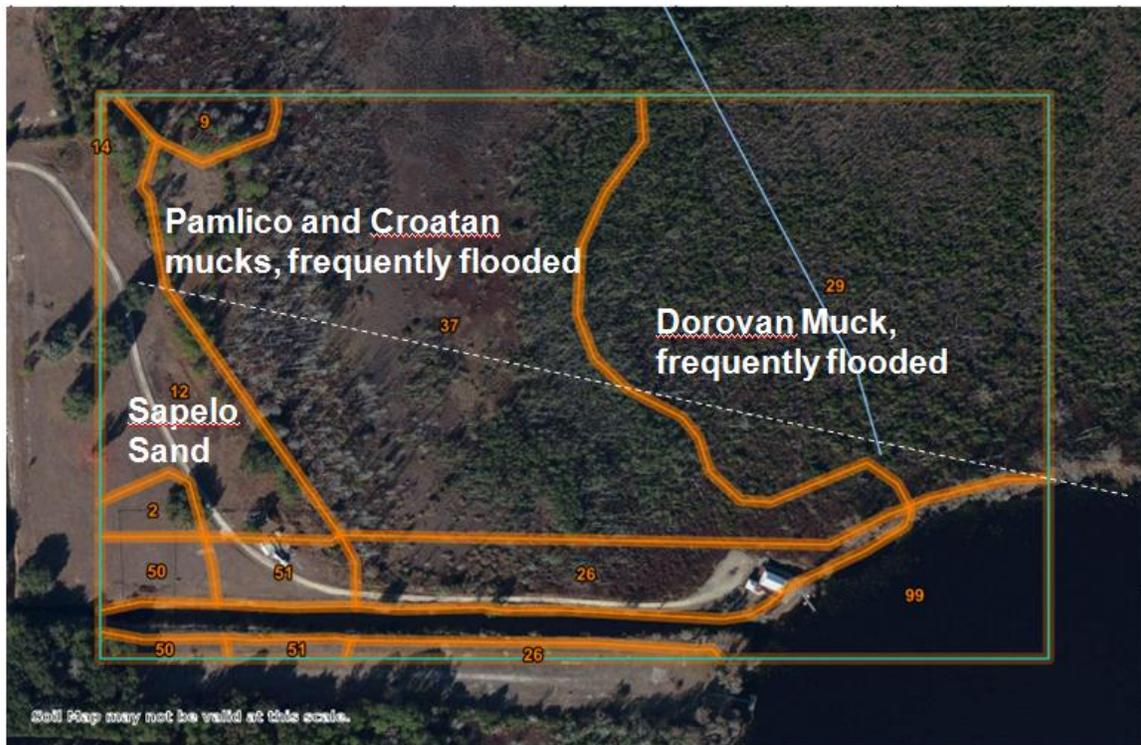


Figure C-15. Soil Map Units Across Transect T1.

Soils described on Transect T1 are shown in Figure C-15. Dorovan mucks (MU 29) are very poorly drained floodplain soils that experience frequent flooding and ponding. These soils have a seasonal high saturation (SHS) above the soil surface. They are muck soils typically 80-inches or more thick. They are Histosols and classified as Dysic, thermic Typic Haplosaprists. Seasonal High Saturation

(SHS) formerly termed seasonal high water table (SHWT) is characterized by zero or positive pressure in the soil-water, long enough to produce anaerobic conditions. A seasonal high water table (SHWT) is the shallowest depth to free water that stands in an unlined borehole or where the soil moisture tension is zero for a significant period (more than a few weeks; Watts and Hurt 1991).

Pamlico and Croatan mucks, frequently flooded (MU 37) to the west are also very poorly drained floodplain soils that frequently flood and pond water and have a SHS above the soil surface. They are muck soils about 48-inches thick over sand. They are Histosols and classified as Sandy or sandy-skeletal, siliceous, dysic, thermic Terric Haplosaprists.

Sapelo sands (MU12), located on the western end of the transect, are sandy soils on flats of mesic or hydric lowlands. These soils are poorly drained and do not frequently flood or pond water. They have a SHS at typically six to 18 inches below the soil surface. The surface layer in this series is described as having clean sand grains giving a salt and pepper appearance and no presence of muck. These soils have a spodic horizon over an argillic horizon in the subsoil with moderate permeability. Internal free water occurrence is very shallow and persistent. They are classified as Sandy, siliceous, thermic Ultic Alaquods. While the muck map units are typically 100% hydric, Sapelo soils are found to have only 40% of the map unit as meeting hydric criteria in Bradford County. This is because soil map units that are made up dominantly of nonhydric soils may have small areas of minor hydric components in the lower positions on the landform.

An interpretive map of hydric soil ratings along Transect T1 is provided in Figure C-16. Figures C-17 through C-19 map soil orders, organic soils (Histosols) and mineral soils (Spodosols); soil ecological site name, floodplains and flats; and soil organic matter content, expressed as a percentage typical for the soil map units in the area of interest.

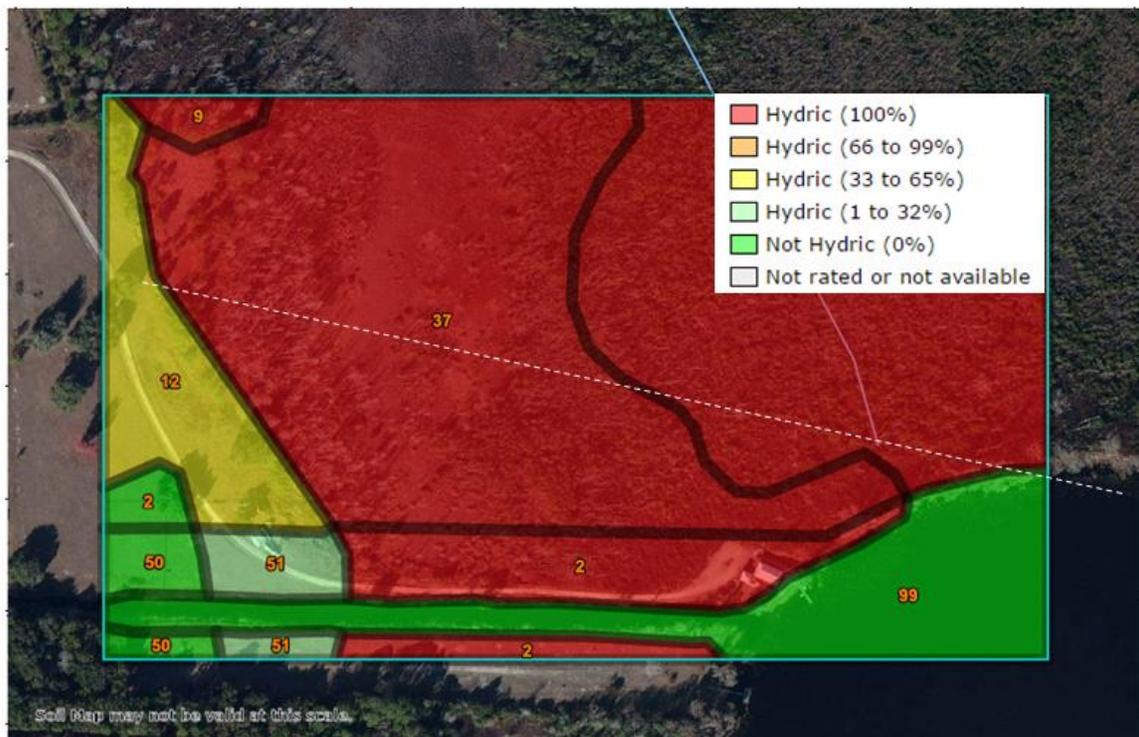


Figure C-16. Hydric Soils for Transect T1.

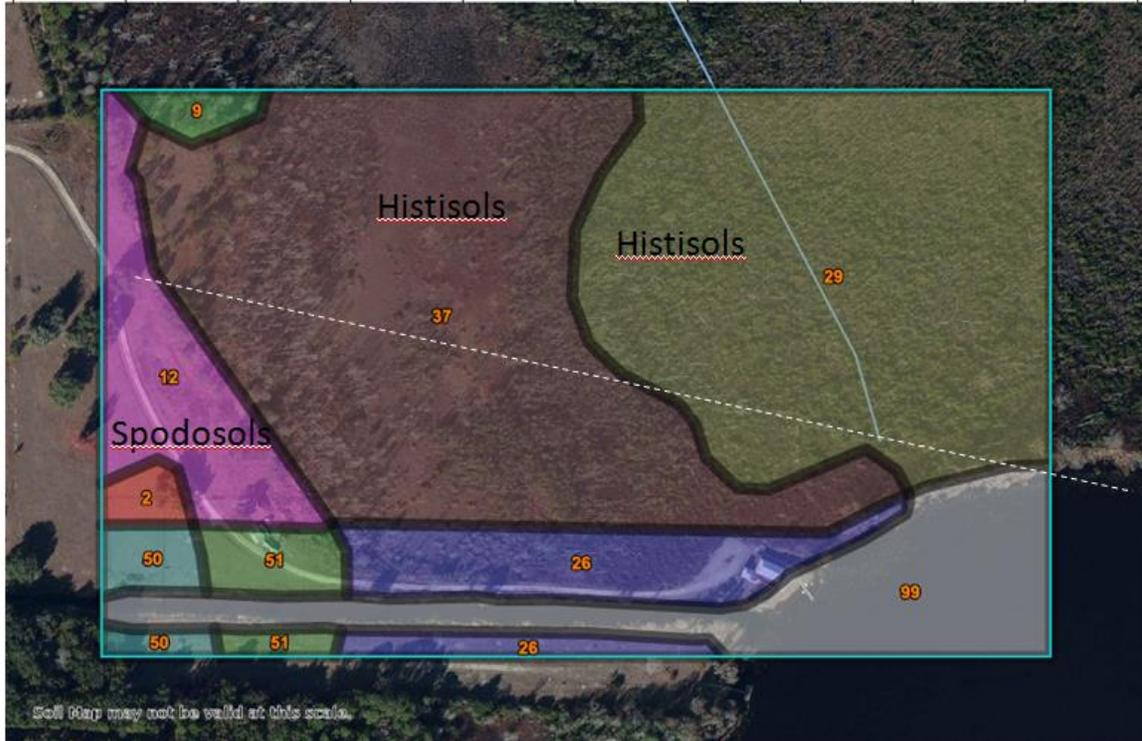


Figure C-17. Soil Orders for Transect T1.



Figure C-18. Soil Ecological Site Name for Transect T1.

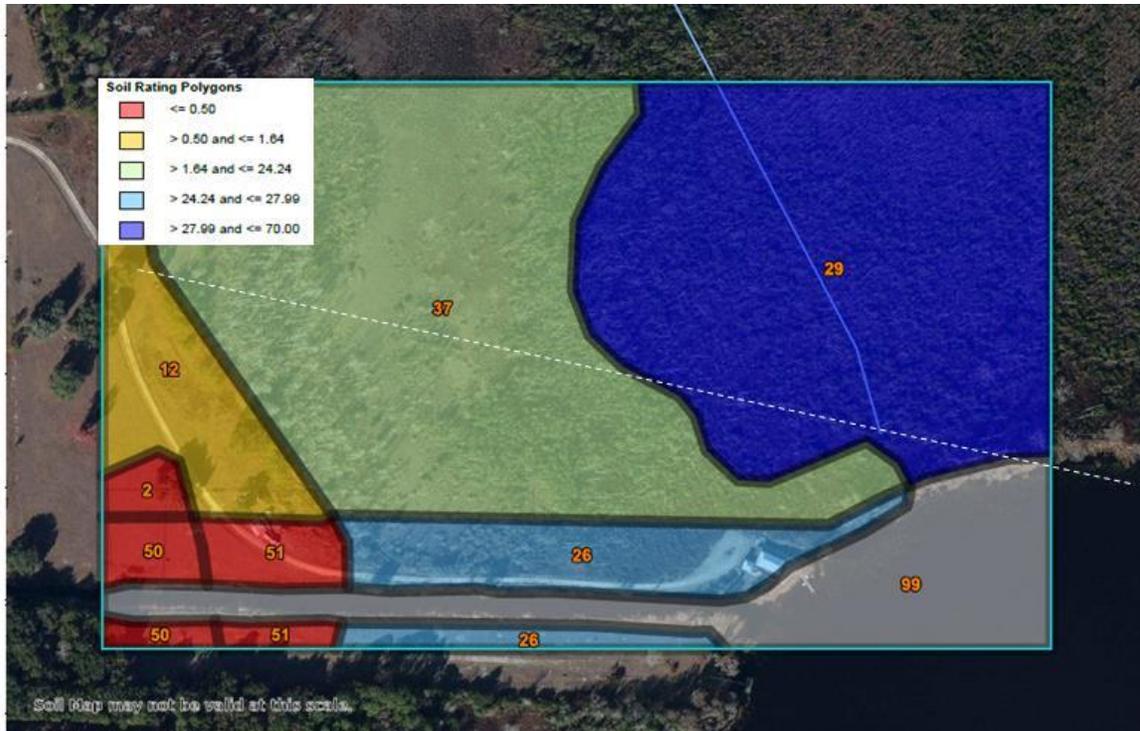


Figure C-19. Soil Organic Matter for Transect T1.

Soils described on Transect T4 are shown in Figure C-20. Due to the scale of mapping, the entire transect was mapped by the USDA-NRCS as MU 99 water. No ratings are given for hydric soils, nor ranks for other soil properties or ecological site assessment. Albany fine sand, 0-5 percent slope (MU 2) was mapped east of the transect which formed on marine terrace positions with clayey subsoil and sandy surface horizons. Albany soils are somewhat poorly drained and have no frequency of ponding or flooding. They have a typical SHS at 12-30 inches below the soil surface. Albany soils are Ultisols, classified as *Loamy, siliceous, subactive, thermic, Grossarenic Paleudults*

Figures C-20 through C-24 provide interpretive maps for Transect T4 and surrounding uplands depicting influential landscapes. Unlike the organic and sandy soils in the vicinity of Transect 1, the map of Soil Orders shows mineral soil with clayey subsoil (Ultisols) upslope of the transect. Other maps identify hydric soil ratings, soil ecological site name, and soil organic matter content typical for the soil map units.

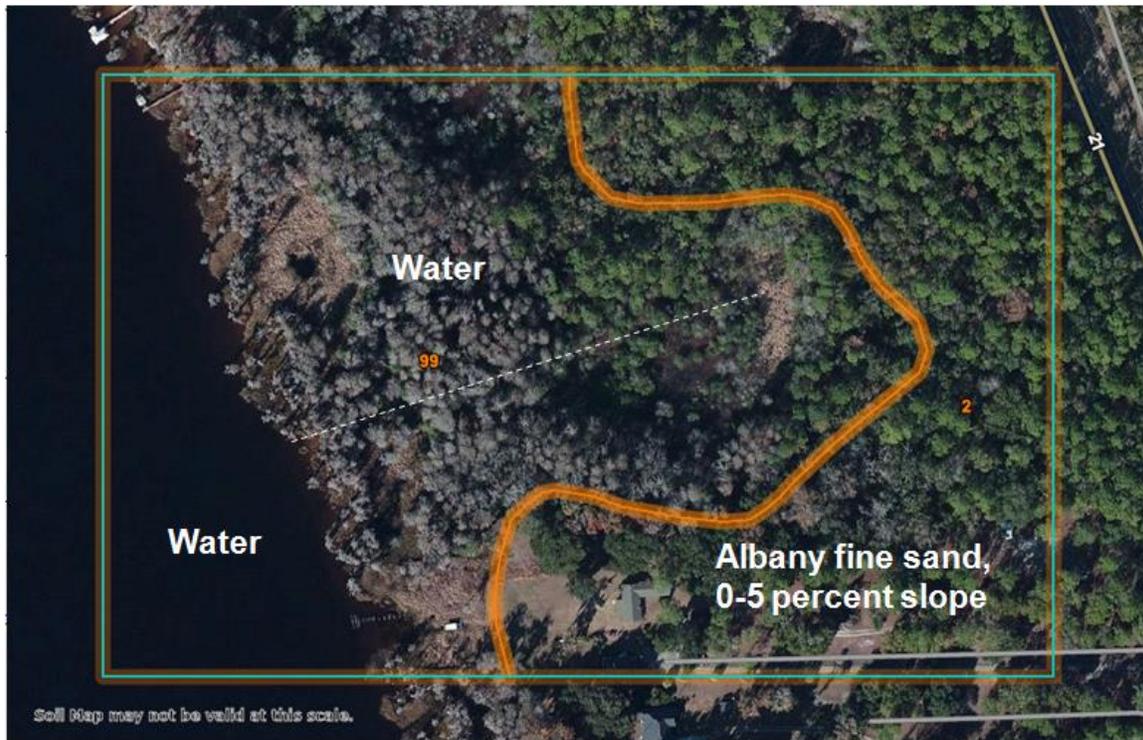


Figure C-20. Soil Map Units Across Transect T4.



Figure C-21. Hydric Soils for Transect T4.



Figure C-22. Soil Orders for Transect T4.

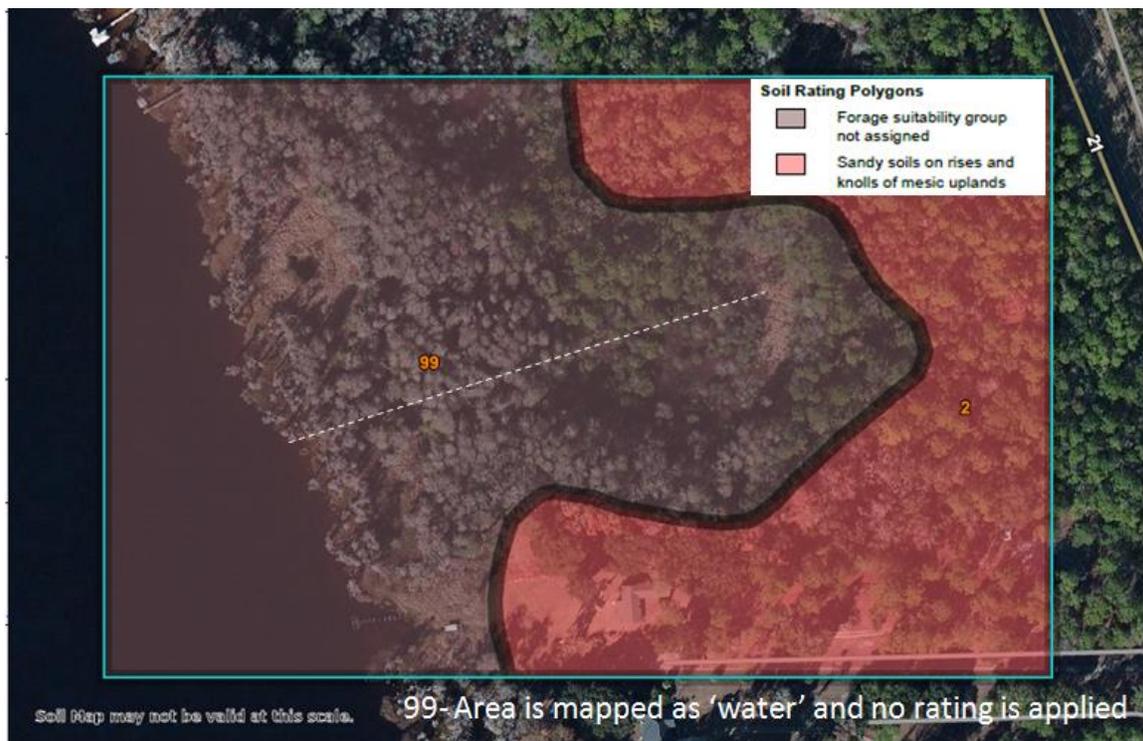


Figure C-23. Soil Ecological Site Name for Transect T4.



Figure C-24. Soil Organic Matter for Transect T4.

Soils described on Transect T7 are shown in Figure C-25. Soils mapped by the USDA show Monteccha loamy sand (MU 19) in a depressional terrace position above the water's edge close to the lake and rising again below the upland soils Newnan sand (MU 21) and Sparr fine sand (MU 50). Monteccha soils are very poorly drained and frequently pond water. Monteccha loamy sands are classified as sandy, siliceous, hyperthermic Ultic Alaquods. Samsula muck to the south (MU 26) are also very poorly drained soils that frequently pond water and have muck surface layers typically 35 inches thick over sand subsoil. They are Histisols and classified as Sandy or sandy-skeletal, siliceous, dysic, hyperthermic Terric Haplosaprists.

Below are interpretive maps of hydric soils mapped along the transect. Other maps show Soil Orders, organic soils (Histisols) and mineral soils (Spodosols); Soil Ecological Site Name, floodplains and flats; and Soil Organic Matter.

Figures C-26 through C-29 provide interpretive maps for Transect T7 and surrounding uplands depicting area influential landscapes. Monteccha soils are Spodosols with a dark rich organic subsoil, unlike the Samsula muck which is a Histisol. Other maps illustrate hydric soil ratings, soil ecological site name, and soil organic matter content typical for the soil map units.



Figure C-25. Soil Map Units Across Transect T7.

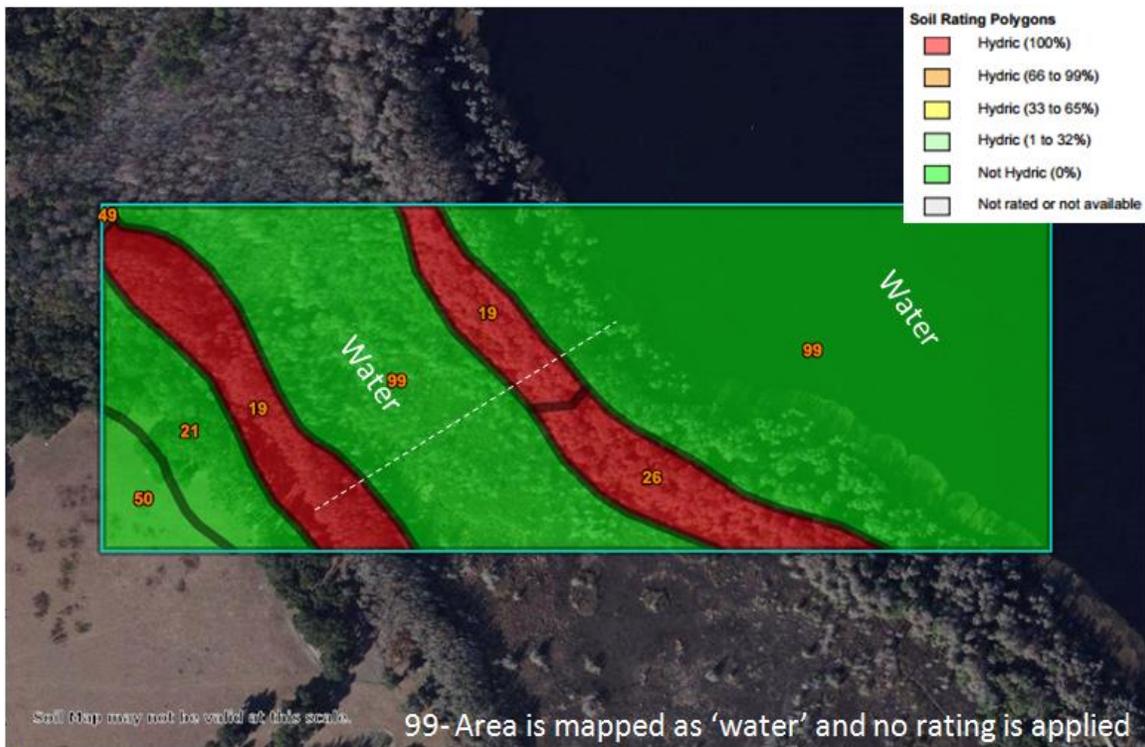


Figure C-26. Hydric Soils for Transect T7.



Figure C-27. Soil Orders for Transect T7.



Figure C-28. Soil Ecological Site Name for Transect T7.

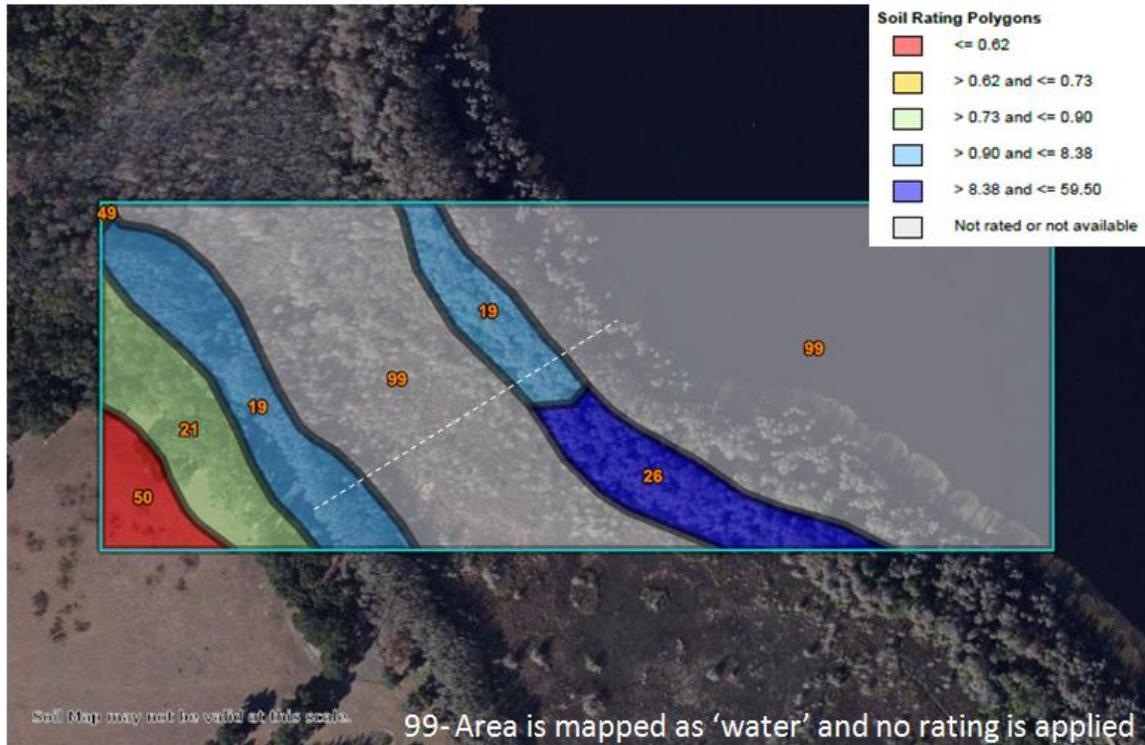


Figure C-29. Soil Organic Matter for Transect T7.

Soils described on Transect T8 are shown in Figure C-30. Soils mapped by the USDA show Montecocha loamy sand (MU 19) in a depressional terrace position above the water's edge close to the lake followed by a large expanse of Samsula muck (MU 26) rising slightly into Plummer sand (MU51) soils on flats found on marine terraces.

Montecocha soils are very poorly drained and frequently pond water and are classified as sandy, siliceous, hyperthermic Ultic Alaquods. Samsula muck soils to the west (MU 26) also are very poorly drained and frequently pond water and have muck surface layers typically 35 inches thick over sand subsoil. They are Histosols and classified as Sandy or sandy-skeletal, siliceous, dysic, hyperthermic Terric Haplosaprists. Plummer sand soils upslope on the flats are typically non-hydric with seasonal high saturation (SHS) at six to 18 inches below the soil surface. Plummer soils are classified as Loamy, siliceous, subactive, thermic Grossarenic Paleaquults.

Figures C-31 through C-34 provide interpretive maps for Transect T8 and surrounding uplands depicting area influential landscapes. These maps illustrate hydric soil ratings, soil ecological site name, and soil organic matter content typical for the soil map units.



Figure C-30. Soil Map Units Across Transect T8.

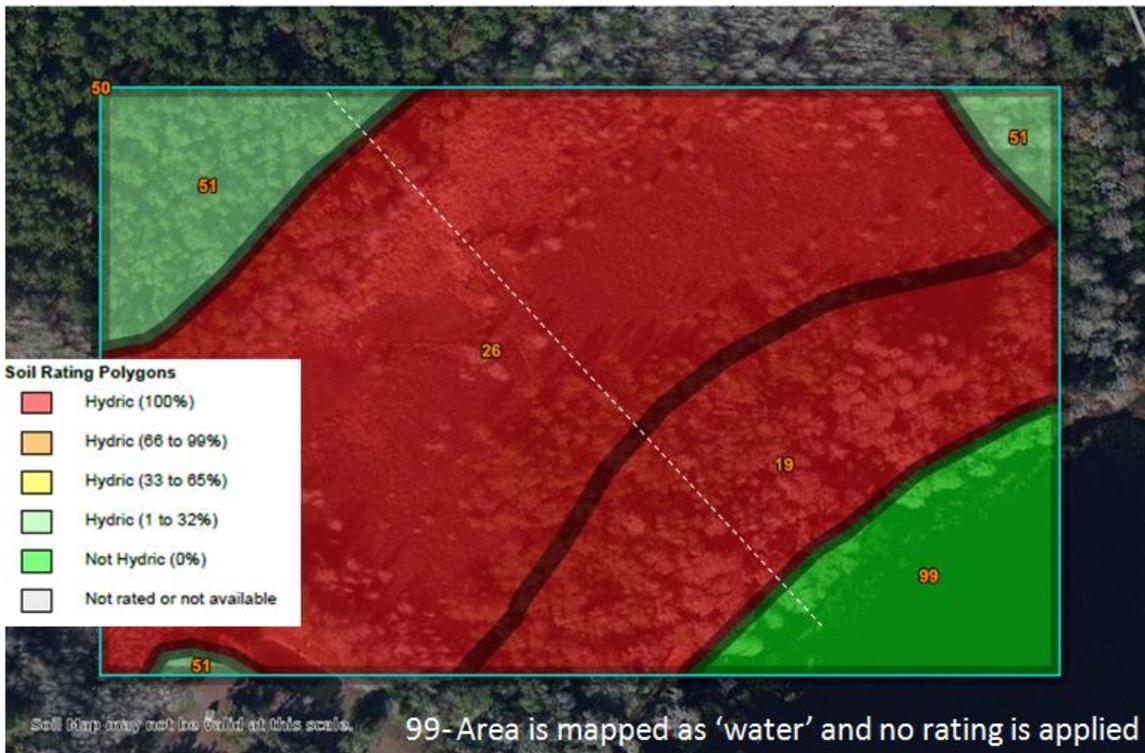


Figure C-31. Hydric Soils for Transect T8.



Figure C-32. Soil Orders for Transect T8.



Figure C-33. Soil Ecological Site Name for Transect T8.

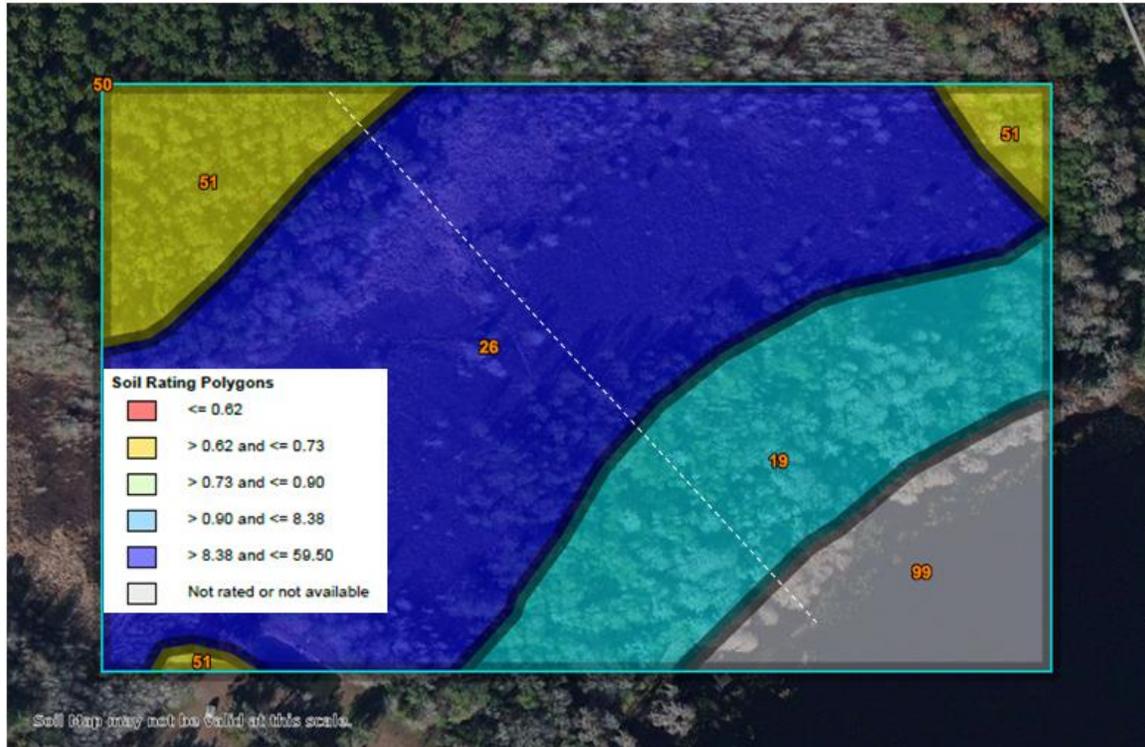


Figure C-34. Soil Organic Matter for Transect T8.

Detailed Transect Results

Lake Santa Fe Soils - Transect T1

Thirty soil borings were conducted along a soil-landscape catena from an upland spoil bank at soil boring station IDs SB-1 to SB-30 in a subaqueous position in the lake in about 5 feet of water. Transect T1 is shown in Figure C-35. The landward extent of Histosols were located at SB-14. On the day of sampling, October 16, 2014, the water table was observed at about 20 inches above the soil surface at SB-14. The dominant habitat included deep marsh and bayhead. The landward extent of the histic epipedon was located about 60 feet upslope at SB-12 where the observed water table was also about 20 inches above the soil surface. The dominant habitat at SB-12 was shallow marsh. The landward extent of muck ended at SB-6 in an area of former cypress in the shallow marsh where the water table was six inches above the soil surface. Hydric soils at SB-1, which was located near a borrow pit, were expressed by stripping (hydric soil indicator S-6, USDA-NRCS 2017b) occurring at about four inches from the soil surface. The observed water table at SB-1 was 12 inches below the soil surface, the depth to seasonal high saturation (SHS) was indicated at four inches, and the dominant habitat was wet prairie.

In contrast to the soil map of Transect T1, the landward extent of the Histosols was located at SB-14, about 400 feet east of the landward extent of Pamlico and Croatan mucks (Figures C-15 and C-35). Muck decreased in thickness from 16 inches, elevation 138.56 ft NAVD88, at SB-14 to four inches at SB-13, elevation 138.72 ft NAVD88. The elevation of Histosols at SB-30 was 134.51 ft NAVD88. The histic epipedon extended to an elevation of 138.97 ft NAVD88. Muck presence occurred another 160 feet west along the transect into the Wet Prairie to an elevation of 138.99 ft NAVD88. Hydric soils extended above elevation 140.21 ft NAVD88 with a SHS at four inches below the soil surface.

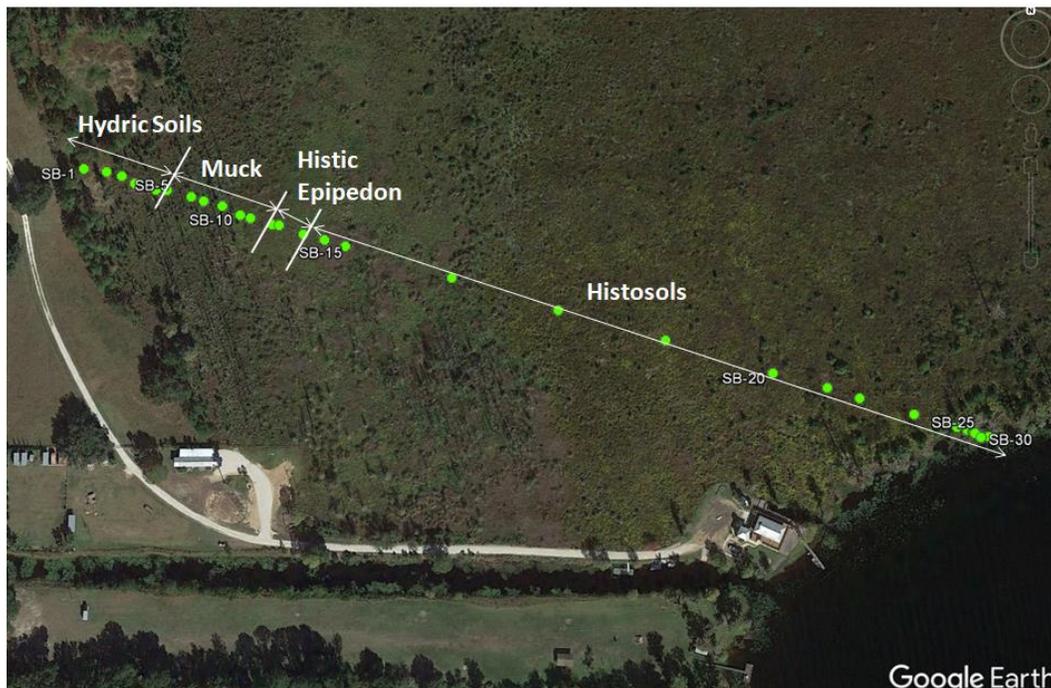


Figure C-35. Transect T1- Soil Boring Locations and Limits of Organic Soils.

Lake Santa Fe Soils - Transect T4

Twenty-eight soil borings were conducted along a soil-landscape catena from a subaqueous position at SB-1, at a depth of about three feet, to SB-28 on a terrace position about 10 feet above the hydric soil line about 20 feet east of the wetland edge (Figure C-36). Soil borings SB-1 to SB-4 were taken in subaqueous positions in the lake. Soils were stratified at SB-4 entering the deep marsh habitat adjacent the cypress, and the depth of water ranged from one to three feet. Organic soils were found at SB-4 with eight inches of muck present. Soil borings SB-1 to SB-3 had gray to black sandy surface layers over loamy subsoil. Continuing landward, SB-5 had 36 inches of muck over sandy subsoil. Organic soils 72 inches or more thick were found from SB-8 at elevation 136.96 ft NAVD88 to SB-13 at elevation 137.43 ft NAVD88, over a linear extent of 210+ feet under a cypress canopy. Thick organic soils continued, ranging from 42 to 72 inches or more in the shrub bog habitat, SB-14 through SB-18. Organic soil depths ranged from eight to 48 inches in the shallow marsh from SB-19 to SB-23. The landward extent of Histosols was located in the shallow marsh at SB-21 at a depth of 18 inches on the day of sampling, October 15, 2014. Histosols started in the deep marsh at an elevation of 136.25 ft NAVD88 and continued landward into the cypress, shrub bog, and shallow marsh to about 138.07 ft NAVD88. The landward extent of the histic epipedon was located about 21 feet upslope at SB-23 at elevation 138.87 ft NAVD88 at the edge of the shallow marsh with 18 inches of water above the soil surface. Upslope in the cypress, muck, mucky sand or peat was four inches thick or less. The landward extent of muck ended at SB-26, above the 140 ft NAVD88 elevation and 25 feet upslope of the histic epipedon. Hydric soils ended in the cypress at SB-27, elevation 141.74 ft NAVD88 where the SHS was at 4 inches below ground surface.

Soil boring SB-13 was located at the waterward edge of the shrub bog at an elevation of 137.43 ft NAVD88, and SB-18 was located in the shrub bog habitat at 137.72 ft NAVD88, where about 6 inches of hemic soil or mucky peat was found above the underlying muck. Mucky peat is considered an intermediate state of decomposition and has a rubbed fiber content of 17 to 40 percent by volume. Sapric material, muck, is highly decomposed and has less than 17 percent fiber. This is a common horizon sequence in some organic soils. At SB-19 (elevation 138.14 ft NAVD88) and SB 21 (elevation 138.07 ft NAVD88), both in the shallow marsh, a buried layer of mucky peat stratified between layers of muck was present. This is a common horizon sequence in some organic soils, possibly indicating differing extents of inundation or other factors such as different episodes of soil decomposition or soil formation.

In contrast to the soil map of Transect T4, Histosols and areas of muck were observed in what was mapped as 'water' as well as the landward extent of hydric soils (Figures C-22 and C-21). This may be due to the scale of the USDA soil maps.



Figure C-36. Transect T4 - Soil Boring Locations and Limits of Organic Soils.

Lake Santa Fe Soils - Transect T7

Twenty-five soil borings were conducted along a soil-landscape catena from subaqueous position at SB-1 in the deep marsh along the lake to the upland habitat starting at SB-24 area above the cypress. Transect T7 is shown in Figure C-37. The water table during the investigation was above the soil surface from SB-1 to SB-22 below the upland ridge. Soil borings SB-1 to SB-4 were taken in subaqueous positions in the deep marsh habitat of the lake. Soils sampled at SB-1 and SB-2 consisted of mucky peat to depths of two to three feet below the soil surface and averaging 6-feet deep below the water surface. Layers of mucky peat and muck about 6 feet thick were found at SB-3 to SB-5 in the deep marsh. Soils were sapric with muck thickness to a soil boring depth of 6 feet in the cypress at SB-6 through SB-10. In the hardwood swamp, at SB-11 and SB-12, 6 to 12 inches of mucky peat was found above the muck which extended to a soil boring depth of 6 feet or more. Contrasting layers of organic soils over muck continued into the shrub swap habitat at a maximum boring depth of 6 feet and to an elevation of 137.92 ft NAVD88. At SB-17, organic soils decreased to a thickness and depth of 48 inches overlaying sandy horizons. At SB-21, organic soils were less than 16 inches thick, thus defining the landward extent of Histosols. Soils with a histic epipedon continued landward to SB-22 under a cypress canopy about a foot higher in elevation at 139.33 ft NAVD88. A muck surface continued to the edge of the cypress at SB-23 and was about 4 inches thick. The landward extent of hydric soils at SB-24 was near the upland/wetland boundary at elevation 140.06 ft NAVD88.

In contrast to Figures C-27 and C-25, respectively, Histosols and areas of muck were observed throughout the depressional Monteocha loamy sand map unit. Soils were more typical of the Samsula muck map unit to the south but with generally thicker organics than the range of characteristics of the Samsula soil series. These discrepancies are due to the scale of the USDA soil maps which are important tools before a detailed site investigation.

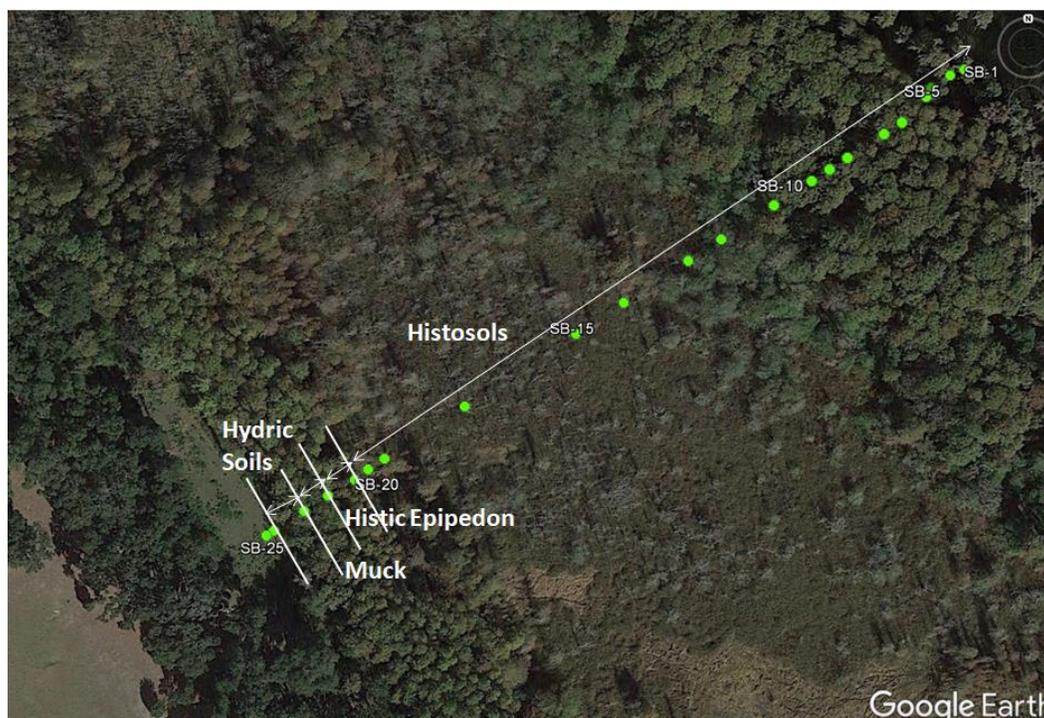


Figure C-37. Transect T7 - Soil Boring Locations and Limits of Organic Soils.

Lake Santa Fe Soils - Transect T8

Twenty-eight soil borings were conducted along a soil-landscape catena from a subaqueous position at SB-1 in the deep marsh to the upland habitat above the hardwood swamp at SB-29. Transect T8 is shown in Figure C-38. The water table during the investigation was ponded above the soil surface throughout most of the transect and dropped below the soil surface at SB-26, the landward extent of histic epipedon and the start of the upland habitat. Soil borings SB-1 to SB-4 were taken in subaqueous positions in the deep marsh community.

At SB-1 and SB-2, soils consisted of peat two to three and a half feet thick below the water column averaging 4-feet deep. At SB-3 and SB-4, two feet of mucky peat was found below the water column averaging two feet deep. Soil borings SB-5 to SB-7 were sapric with six feet or more of muck in the cypress area landward of the deep marsh. At the edge of the cypress and start of the hardwood swamp, SB-8 and SB-9 had 18 to 24 inches of muck mixed with mucky peat over lower tiers of muck to boring depths of six feet. Deep muck continued to boring depths of six feet at SB-10 and SB-11. At SB-12 continuing in the hardwood swamp soils, contrasting layers of organic soils with tiers of muck and mucky peat were found to six-foot boring depths and continued through the bayhead and into the shallow marsh. The hardwood swamp began at SB-23 where organic soils decreased in thickness on a gentle rise, with sand underlying about 30 inches of organic soils. The landward extent of Histosols ended near SB-25 at the edge of the hardwood swamp. Soils with a histic epipedon continued a short distance landward to a canal spoil bank near SB-26 as the land rose into the uplands. A thin layer of organic soil extended up into the upland terrace at soil boring SB-27 on a concave landscape position. Upslope dark-colored sandy hydric soils ended at soil boring SB-28, elevation 143.07 ft NAVD88.

In contrast to Figures C-30 through C-34, Histosols and areas of muck were observed throughout the depressional Monteocha loamy sand map unit and Samsula muck area; while organic muck surface layers and hydric soils ended near the edge of the Plummer sandy upland soils.

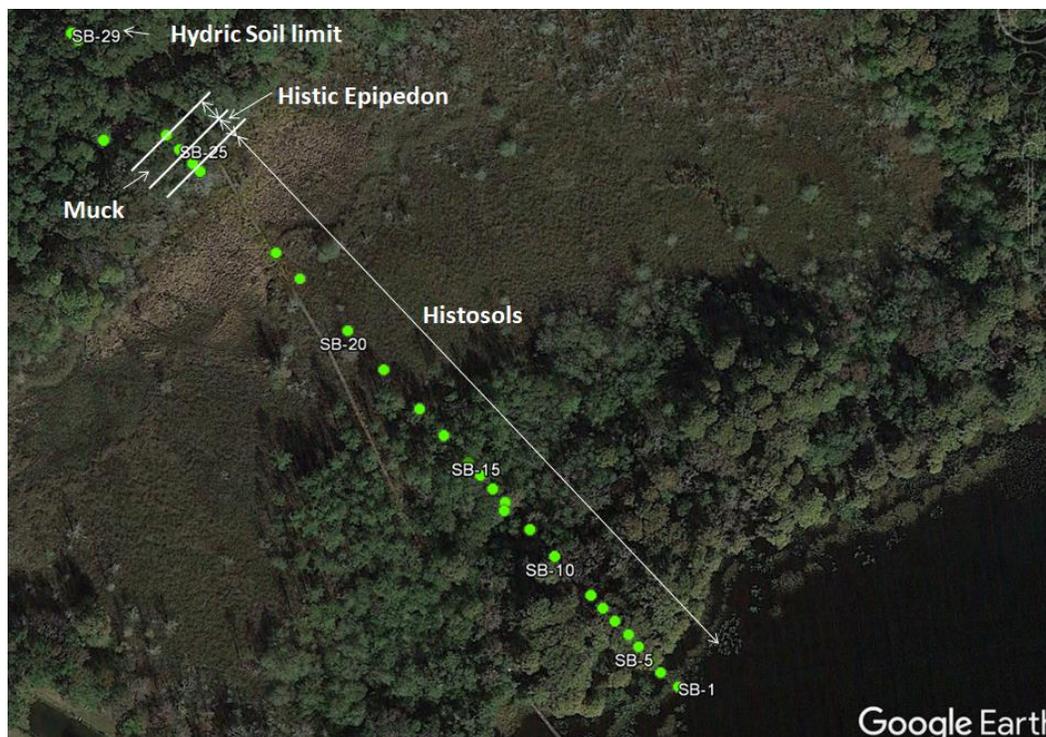


Figure C-38. Transect T8 - Soil Boring Locations and Limits of Organic Soils.

The table below shows the elevations of the landward extent of hydric soils, presence of muck, histic epipedon, and extent of Histosols for all four transects. The landward extent of Histosols ranged from elevation 138.07 ft NAVD88 at transect T4 in the cypress to elevation 139.12 ft NAVD88 at transect T8 in hardwood swamp. The landward extent of histic epipedons ranged from elevation 138.87 ft NAVD88 at transect T4 in the shallow marsh to elevation 142.02 ft NAVD88 at transect T8 in the uplands. The landward extent of muck presence ranged from elevation 138.99 ft NAVD88 at transect T1 in the shallow marsh to elevation 140.46 ft NAVD88 at transect T4 in the cypress habitat. The landward extent of hydric soil ranged from elevation 140.06 ft NAVD88 at Transect T7 to elevation 143.07 ft NAVD88 at transect T8, both in the upland habitat.

Table C-5 Elevations of the landward extent of hydric soils, presence of muck, histic epipedon, and extent of Histosols (ft NAVD88).

Landward extent of:	T1	Elevation	T4	Elevation	T7	Elevation	T8	Elevation
Hydric Soil	SB-1	140.21	SB-27	141.74	SB-24	140.06	SB-28	143.07
Muck	SB-6	138.99	SB-26	140.46	SB-23	140*	SB-27	140.37
Histic Epipedon	SB-12	138.97	SB-23	138.87	SB-22	139.33	SB-26	142.02
Histosols	SB-14	138.56	SB-21	138.07	SB-21	138.38	SB-25	139.12

* T7 SB-23 marker was lost in the field and was approximated at 140 based on adjacent SBs