

Minimum Recommended Lake Levels: Lake Hampton, Florida

Water for Nature, Water for People

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Lake Hampton, Florida

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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

This report presents the Suwannee River Water Management District's (SRWMD's) recommended minimum flows and levels (MFLs) for Lake Hampton, Bradford County, Florida (Table 1). These MFLs are based on work performed by Greenman-Pederson, Inc. (GPI); Environmental Consulting and Technology, Inc. (ECT); and SRWMD staff using methodology developed by the St Johns River Water Management District (SJRWMD) and supported by methods developed by the Southwest Florida Water Management District (SWFWMD).

Recommended minimum surface water levels for Lake Hampton, Bradford County.

Minimum Level	Recommended Elevation (NAVD88)	Recommended Hydroperiod Categories	Recommended Duration (days)	Recommended Return Interval (years)
Minimum frequent high level (FH)	128.90	Seasonally flooded	30	2
Minimum frequent low level (FL)	126.24	Semi-permanently flooded	120	5

NAVD88 = feet North American Vertical Datum of 1988

The SJRWMD multiple MFLs method (SJRWMD 2006; Neubauer et al. 2008) is used to determine MFLs based on the evaluation of topography, vegetation, and soils associated with a water body. This method allows for the proposal of two MFLs for Lake Hampton, based upon separate hydroperiod categories, specifically the Minimum Frequent High (FH) and Minimum Frequent Low (FL). 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 Hampton is a stage elevation of 128.90 feet (ft.) NAVD88 and a hydroperiod category of seasonally flooded (Table 1). The minimum frequent high stage for a seasonally flooded hydroperiod represents the mean of the surface elevations surveyed in the cypress (*Taxodium* spp.) communities adjacent the lake.

The recommended FL for Lake Hampton is a stage elevation of 126.24 NAVD88 and a hydroperiod category of semipermanently flooded (Table 1). This elevation represents the average elevation of the landward extent of the deep marsh community adjacent the lake shoreline. This level provides sufficient water depths within the deep marsh communities to provide refuge and nesting habitat for fish and other aquatic species.

ECT utilized the Storm Water Management Model (SWMM) Version 5.1, developed by the U.S. Environmental Protection Agency (EPA), to formulate a water budget for Lake Hampton. The model was calibrated using hydrologic data collected between 2005 and 2014, using land use conditions and groundwater levels consistent with 2006 regional water use, as no significant development in

either condition has occurred since (ECT 2017). Based on subsequent model results using a long-term simulation period from 1983 through 2014, SRWMD concludes that the draft recommended MFLs for Lake Hampton are met under current conditions. To determine if changes in groundwater use allocations would cause lake levels to fall below the recommended MFLs for Lake Hampton, the existing Lake Hampton water budget model should be run using Floridan aquifer potentiometric level declines that reflect these changes in water use allocation.

1.0 INTRODUCTION

This report presents the Suwannee River Water Management District's (SRWMD's) evaluation of the minimum flows and levels (MFLs) determination for Lake Hampton, Bradford County, Florida. These MFLs are based on work performed by SRWMD staff; Greenman-Pederson, Inc. (GPI); and Environmental Consulting and Technology, Inc. (ECT) , using methodology developed by the St. Johns River Water Management District (SRWMD) and supported by methods developed by the Southwest Florida Water Management District (SWFWMD).

A hydrologic model for the lake was developed by Environmental Consulting and Technology, Inc. (ECT 2016, Appendix A), to provide a means of assessing whether compliance with MFLs is achieved under specific water use and land use conditions. This hydrologic model was calibrated for the period January 1, 2005 – December 31, 2014.

2.0 MFLS PROGRAM OVERVIEW

2.1 STATUATORY FRAMEWORK

The SRWMD MFLs program is based on the requirements of Section 373.042 and Section 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, MFLs 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 Section 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. MFLs 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 MFLs determinations are listed according to specific duration and return interval values in Table 2 (SJRWMD 2009a). "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
Semipermanently 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

SWFWMD methods use long-term hydrologic record to determine percentile rankings of water surface elevations (Rule 40D-8.624, F.A.C.) that form the basis for minimum recommended lake levels. Such levels may include the High Minimum Lake Level (HML) and the Minimum Lake Level (MLL). The former is a lake stage elevation that must be equaled or exceeded ten percent of the time (P10) on a long-term basis; and the MLL is the elevation that must be equaled or exceeded fifty percent of the time (P50) on a long-term basis.

MFLs apply to decisions affecting permit applications, declarations of water shortages, and assessments of water supply sources. Surface water and groundwater computer simulation models are used to evaluate existing and/or proposed consumptive uses and their likelihood to cause significant harm. 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(3), F.S.).

2.4 MANAGEMENT CONCERNS

Lake Hampton is located within the North Florida Regional Water Supply Partnership planning area (North Florida Regional Water Supply Partnership 2016). The Partnership is a collaborative effort between SRWMD, SJRWMD, the FL Department of Environmental Protection (FDEP), and local elected officials and stakeholders. 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

Lake Hampton is located in southern Bradford County near the intersection of State Roads 200 and 221 (US301 and CR18, respectively). The lake occupies approximately 823 acres (Mattson 1999, with a median water surface elevation of 128.79 feet (NAVD88, Figure 1, Table 3) from the available record. Lake Hampton is designated by the Florida Department of Environmental Protection (FDEP) as Class III waters. 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 9.8 feet (Canfield et al. 2002). It is mesotrophic, with average concentrations of total phosphorus: 10 ug-L^{-1}, total nitrogen: 464 ug-L^{-1}, chlorophyll a 5 ug-L^{-1}; and a secchi depth of 7.2 feet (Terrell et al. 2000). The lake basin covers approximately 4456.6 acres (ECT 2016). The majority of the land use in the basin is upland forests (40.1%), followed by wetlands (17.9%). Agricultural land use comprises 10.8% of the basin; while developed areas, including transportation and urban land use, combine for a total of 12.6% (ECT 2016). The lake drains directly to the Santa Fe River through a man-made canal in the lake's southwest corner. Available aerial imagery indicates that the outfall canal was constructed prior to photographic history (1938). The river is coincident with the County line located south of the lake and west of US301 (Figure 1).

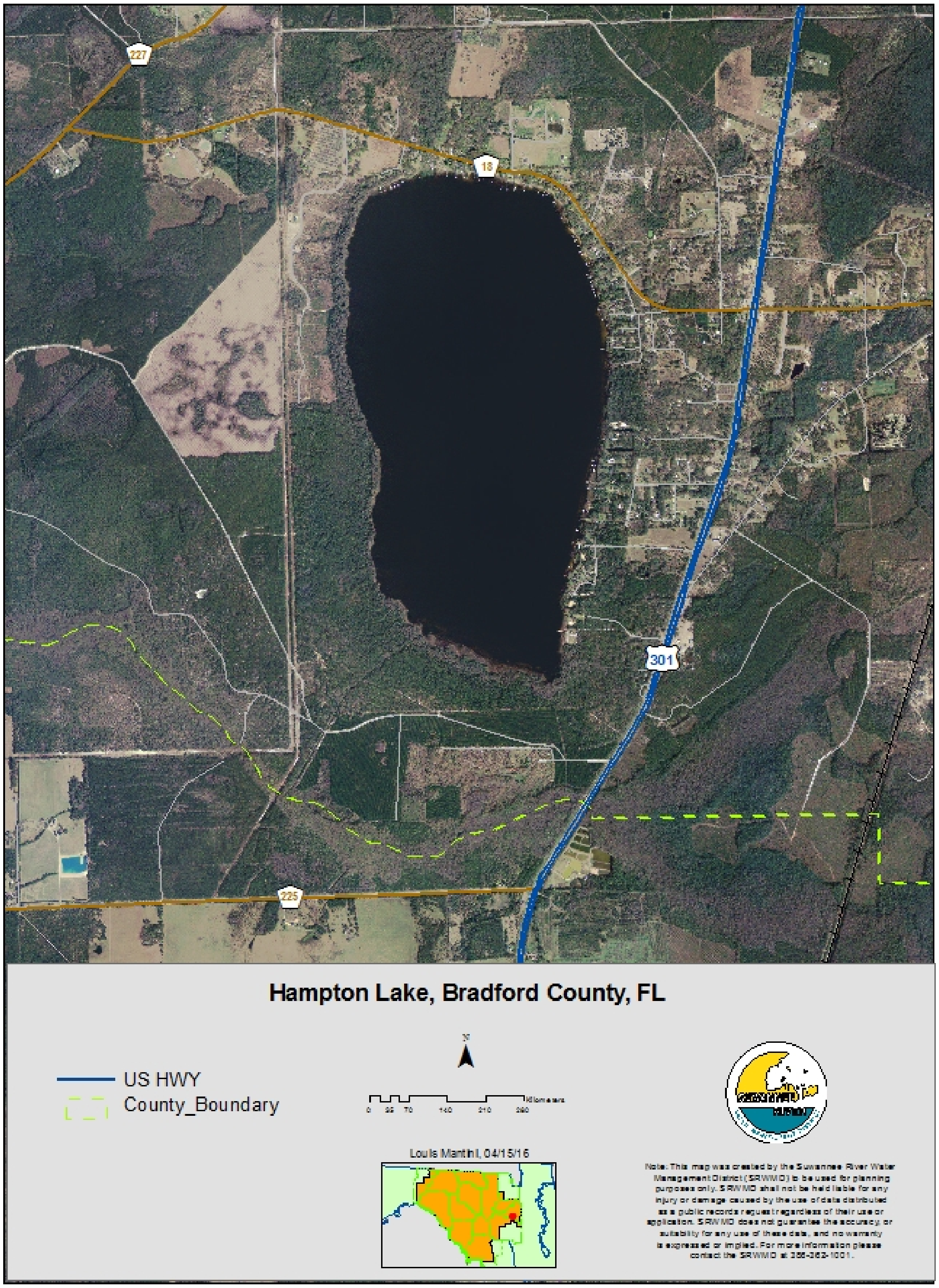

Figure 3-1 Location map of Lake Hampton.

3.1 BACKGROUND STAGE DATA

ECT, Inc. compiled and resampled lake stage data for calibration of a Lake Hampton water budget model (ECT 2016). This may also be referred to as subsampling or data thinning. The U.S. Geological Survey has a long-term stage gage, USGS 02320696 near Hampton, FL. This gage provides historical lake stage at various reporting frequencies from 1988 to present. The majority of the data were recorded on a weekly basis. Therefore, ECT resampled recently-recorded daily stage data (4/16/2013 to current), resulting in weekly stage data for the same period of record (POR). The resampling was done to eliminate any potential bias due to the different reporting frequencies in the raw data within the model simulation span. Percentiles describing stage frequencies were calculated using the resampled data for the entire POR, extending from water years 1988 to 2015 (Table 3). Note that the canal construction precedes the lake stage POR, so its effects upon lake hydrology cannot be unequivocally determined.

Table 3-1 Weekly stage frequency percentages for Lake Hampton (n=1843).

Percentile	Weekly readings for the POR (NAVD88)
P10	129.73
P50	128.79
P90	126.34

Note: See definitions below.

DEFINITIONS

- "P10" means the elevation of the water surface of a lake or wetland that is equaled or exceeded 10% of the time as determined from a long-term stage frequency analysis.
- "P50" means the elevation of the water surface of a lake or wetland that is equaled or exceeded 50% of the time as determined from a long-term stage frequency analysis.
- "P90" means the elevation of the water surface of a lake or wetland that is equaled or exceeded 90% of the time as determined from a long-term stage frequency analysis.

3.2 WETLANDS

Natural wetlands that are either contiguous or hydrologically connected to Lake Hampton using data produced by the US Fish and Wildlife Service, National Wetlands Inventory (NWI) are shown in Figure 2. This geospatial data were developed for the purpose of mapping and tracking the status of wetlands and deep water habitats in the United States and its territories. The NWI classifies wetlands by a hierarchical structure (Federal Geographic Data Committee 2013). In the case of Lake Hampton, 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 contiguous to the lake are shown in Figure 2 and classified accordingly:

- Deciduously vegetated, semi-permanently flooded (PFO6F);
- Evergreen or deciduous forests, semi-permanently-flooded (PFO7/O6F);
- Broad-leaved evergreen, temporarily flooded (PFO3/O4A);
- Broad-leaved evergreen and broad-leaved deciduous, seasonally flooded (PFO3/O1C);
- Deciduous, seasonally flooded wetlands (PFO6C) are hydrologically connected from the north of CR18 and located in the relict drain to the southeast nearest US301;
- One scrub-shrub, seasonally flooded wetland (PSS3C) is located landward of contiguous forested wetlands on the west side of the lake and chosen for study in determining this MFL. This community was located between station numbers 8+60.0 and 10+00.0;
- Needle-leaved and broad-leaved evergreen, temporarily flooded (PFO3/O4A);
- Broad-leaved evergreen, temporarily flooded (PFO3/O4A)

The many combinations of forested wetlands listed above characterize vegetation communities with deciduous trees represented by swamp tupelo (Nyssa sylvatica var. biflora), pond cypress (Taxodium ascendens), or red maple (Acer rubrum). Evergreens include loblolly bay (Gordonia lasianthus), and sweetbay magnolia (Magnolia virginiana). The water regimes in the preceding list are sorted from wettest to driest in the following order: semi-permanently flooded > seasonally flooded > temporarily flooded. The wettest system adjacent to the lake (cypress) is classified the same as the forested floodplain of the Santa Fe River, located south of the lake, which is semi-permanently flooded. Marshes located within the lake proper are not shown by the NWI polygons in Figure 2 but are described in the vegetation surveys in this report.

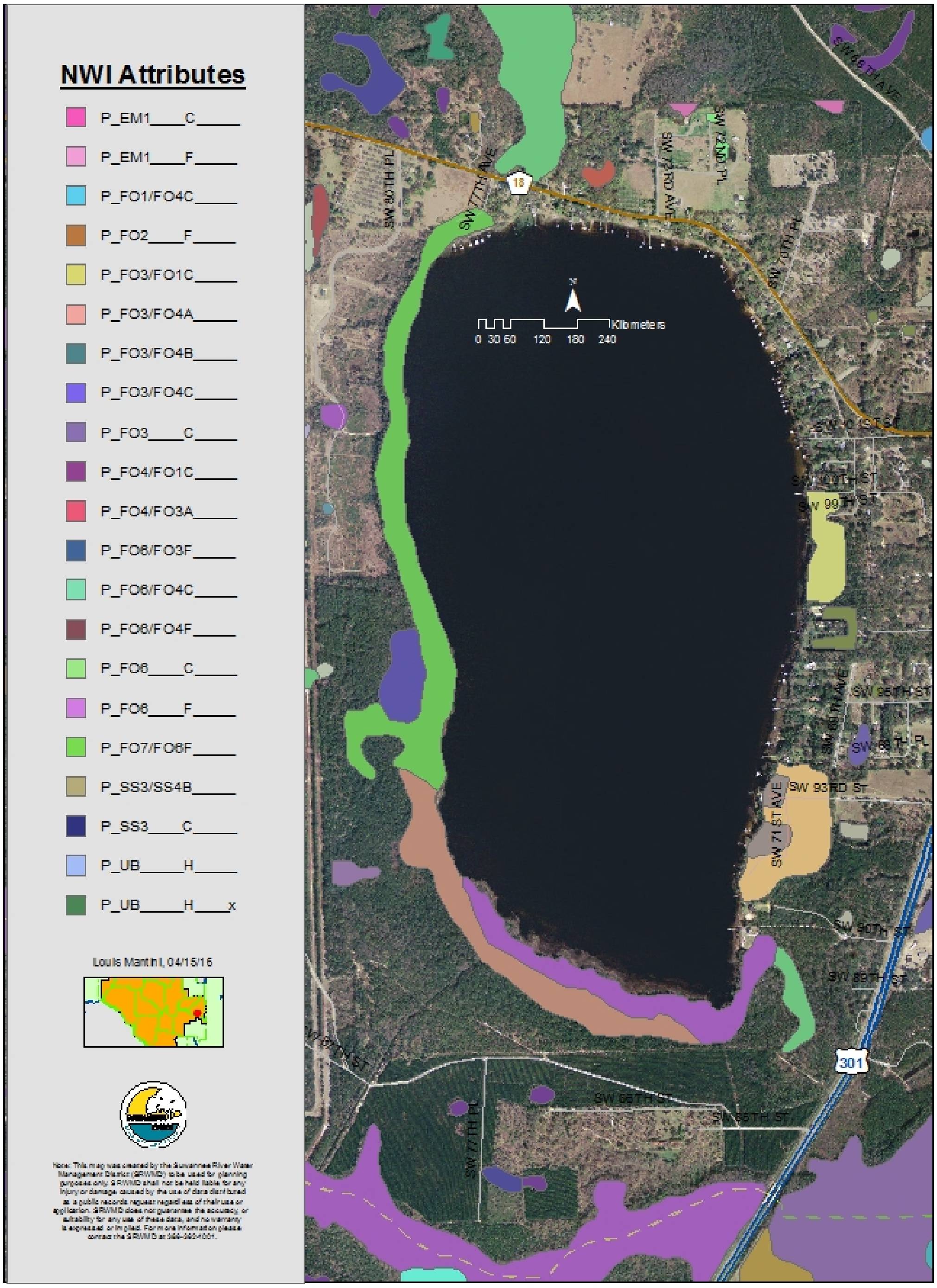

Figure 3-2 Wetlands classified by NWI.

3.3 SOILS

Figure 3 depicts the hydric soils in proximity to Lake Hampton as designated by the USDA-NRCS Soil Survey Geographic database (SSURGO; Soil Survey Staff 2016). Individual mapping units are described in the legend according to texture, organic matter content, hydrologic regime, and relative elevation. 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.

USDA-NRCS mapped most areas adjacent to the lake as Pamlico and Croatan mucks, Dorovan muck, Starke mucky fine sand, and Surrency and Pantego soils. Each of these soils is frequently flooded. The organic matter content of the surface horizons in the Pamlico and Croatan, and Dorovan muck soils range from 40% to 70%. The organic matter content of the surface horizons in the Starke mucky fine sand, and Surrency and Pantego soil components range from 10% to 15%. Horizons with less than about 20 to 35 percent organic matter, by weight, have properties more similar to mineral soils (USDA-NRCS 2014).

All hydric soils adjacent to the lake experience either 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. With the exception of the Pantego soil component, all soils have a seasonal zone of water saturation at 0 inches for at least five months throughout the year. The Pantego soil component has a seasonal zone of water saturation at 6 inches for nine consecutive months during a typical year.

The USDA-NRCS criteria for hydric soils are easily supported by State standards. According to §62-340.550, F.A.C., a wetland delineation using the State's methodology can be refuted by either reliable hydrologic records or site specific hydrologic data which indicate that neither inundation for at least seven consecutive days, nor saturation for at least twenty consecutive days, occurs during conditions which represent long-term hydrologic conditions.

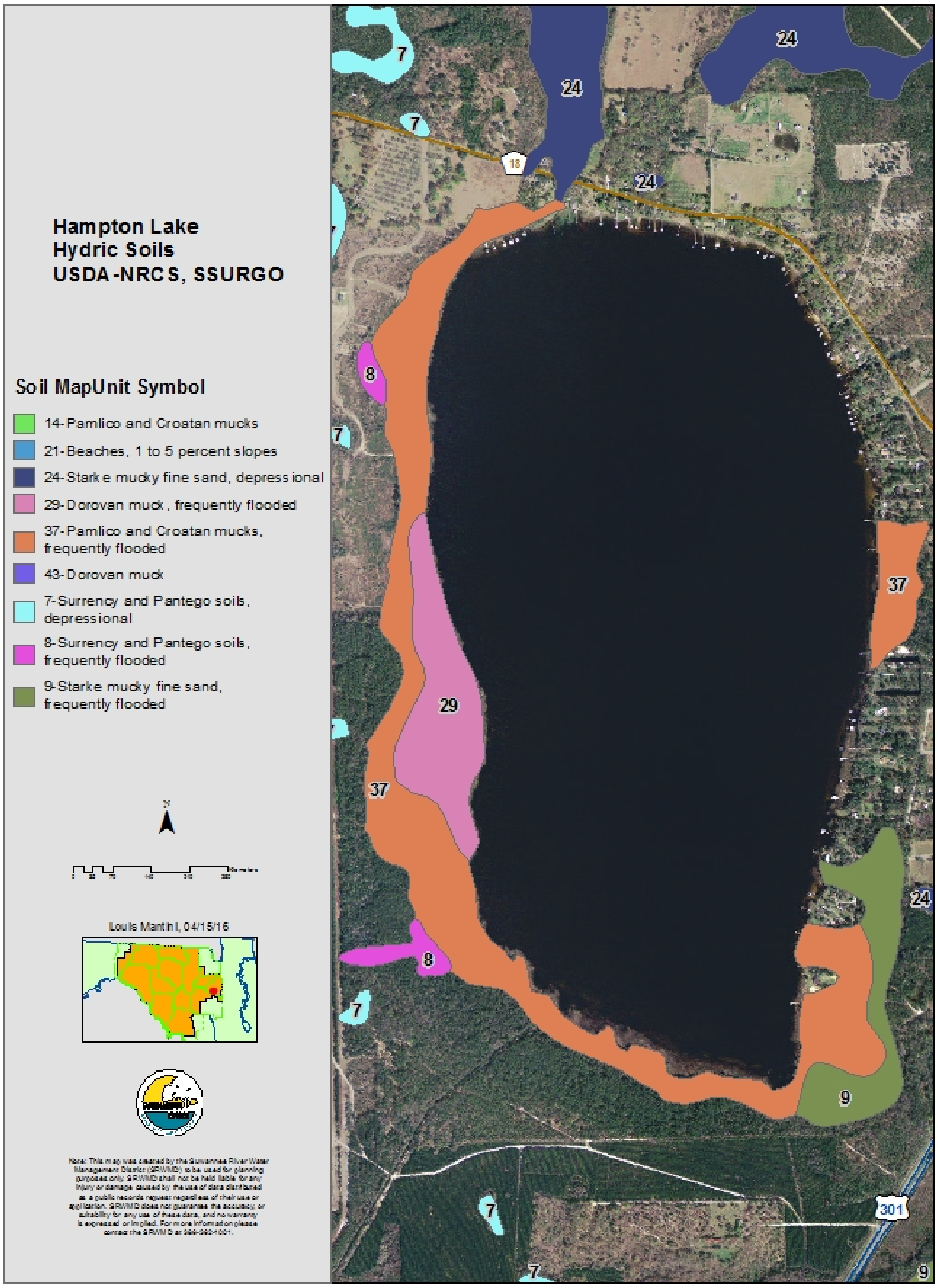
Hampton Lake
Hydric Soils
USDA-NRCS, SSURGO
Soil MapUnit Symbol
14-Pamlico and Croatan mucks
21-Beaches, 1 to 5 percent slopes
24-Starke mucky fine sand, depressional
29-Dorovan muck, frequently flooded
37-Pamlico and Croatan mucks, frequently flooded
43-Dorovan muck
7-Surrency and Pantego soils, depressional
8-Surrency and Pantego soils, frequently flooded
9-Starke mucky fine sand, frequently flooded
Louis Mantini, 04/15/16
7
24
18
37
29
8
9
301

Figure 3-3 Lake Hampton hydric soils.

4.0 MFLS METHODOLOGY

This section provides an overview of the methods and assumptions used in the minimum levels evaluation process for Lake Hampton, 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 SJRWMD methodology is described more completely in their Minimum Flows and Levels Methods Manual (SJRWMD 2006), and SWFWMD methods are detailed in Rule 40D-8.624, F.A.C.

The field data collection procedure included gathering detailed elevations, vegetation, soils, and hydrologic indicator 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, and 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 07, 2014 through December 02, 2014 and from January 27 through January 28, 2015. All field surveys for vegetation, soils, and hydrologic indicators were conducted on September 30 through October 3, 2014 and January 27 through 28, 2015, with GPI. A return visit was cionducted with SJRWMD staff on March 24, 2016.

4.1 SITE SELECTION

Lake Hampton transects were fixed routes, extending from open water to uplands. Elevation, soils, vegetation, and hydrologic indicator data were sampled along the transects to characterize the influence of surface water flooding on the distribution of plant communities and soils. Using aerial imagery, the NWI, and soil maps as guides, two transects were chosen as representatives for further investigation. 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.

Figure 4 illustrates transect locations, each oriented perpendicular to the lake shoreline and extending from the uplands to open water (Figure 4). Supplementary elevation data were collected along four shoreline segments at the boundary of the lake's deep marsh community. These locations are also shown in the figure below.

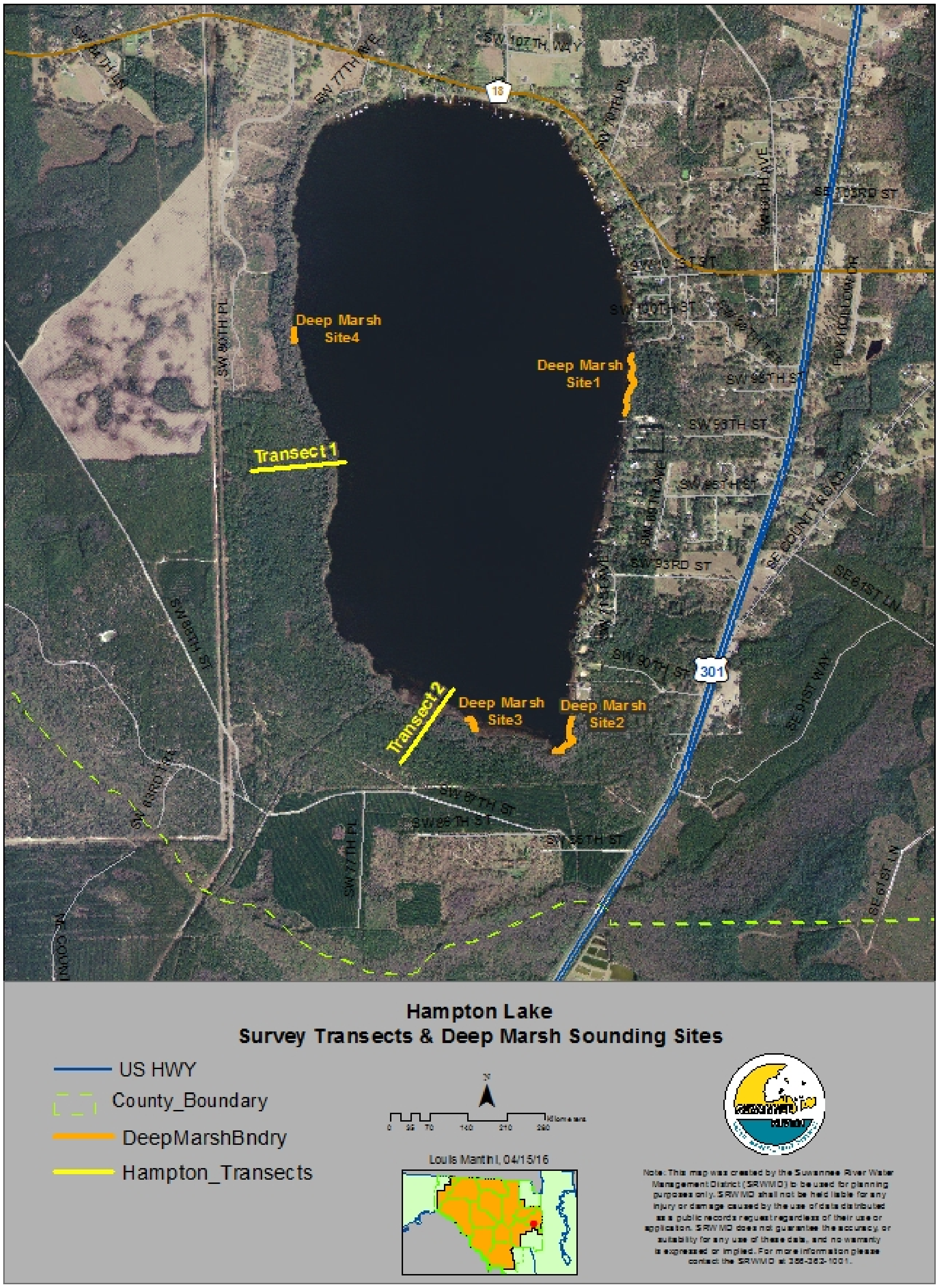

Figure 4-1 Lake Hampton sampling transect locations.

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 that are presented in Appendix B include:

- Establishment of a standard elevation datum;
- Preparation of sampling transects;
- Gathering elevation data for vegetation communities, soil attributes, and hydrologic indicators 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 average elevation of specific vegetation communities, so the minimum frequent high (FH) lake level could be set according to SJRWMD methods (SJRWMD 2006, Neubauer et al. 2008). Detailed procedures are presented in Appendix C of this report, and sampling focused upon the following tasks:

- Field identification of plant communities along sampling transects using descriptions provided by Kinser (1996) and the Florida Natural Areas Inventory, 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 the point-centered quarter method (Mitchell 2010) in order to describe species composition of the plant communities.

4.4 SOIL SAMPLING PROCEDURES

Detailed soil sampling procedures are presented in Appendix D 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., 2002). This effort targeted highly-organic soils that may be used in setting minimum average (MA) and minimum frequent low (FL) lake levels, according to SJRWMD methods (SJRWMD 2006, Neubauer et al. 2008). These soils are classified as Histosols, or exhibit the presence of a histic epipedon (USDA-NRCS 2014) and were sampled from the wetlands using either a soil auger or probe to sufficient depth below soil surface for taxonomic confirmation (Figure 5).

Figure 4-2 Transect 2: Survey stakes and measuring tape mark the transect centerline. Soil samples are being collected in the foreground, and the cypress community and lake are visible in the background.

4.5 HYDROLOGIC INDICATOR SAMPLING PROCEDURES

Detailed sampling procedures are presented in Appendix E of this report. Hydrologic indicators selected for this determination include cypress buttress inflection points, which may represent the normal pool of a lake, per SWFWMD methods (Rule 40D-8.624(8), F.A.C.). Other indicators of normal pool are illustrated in Figure 6 (Carr et al., 2006). These indicators identify boundaries where morphological plant adaptations occur in response to ponding or flooding. Such adaptations may occur above or below the waterline. Buttressing of tree bases, adventitious rooting, and moss collars are also morphological plant adaptations used in the delineating the landward extent of wetlands and other surface waters (Rule 62-340.500(9), F.A.C.).

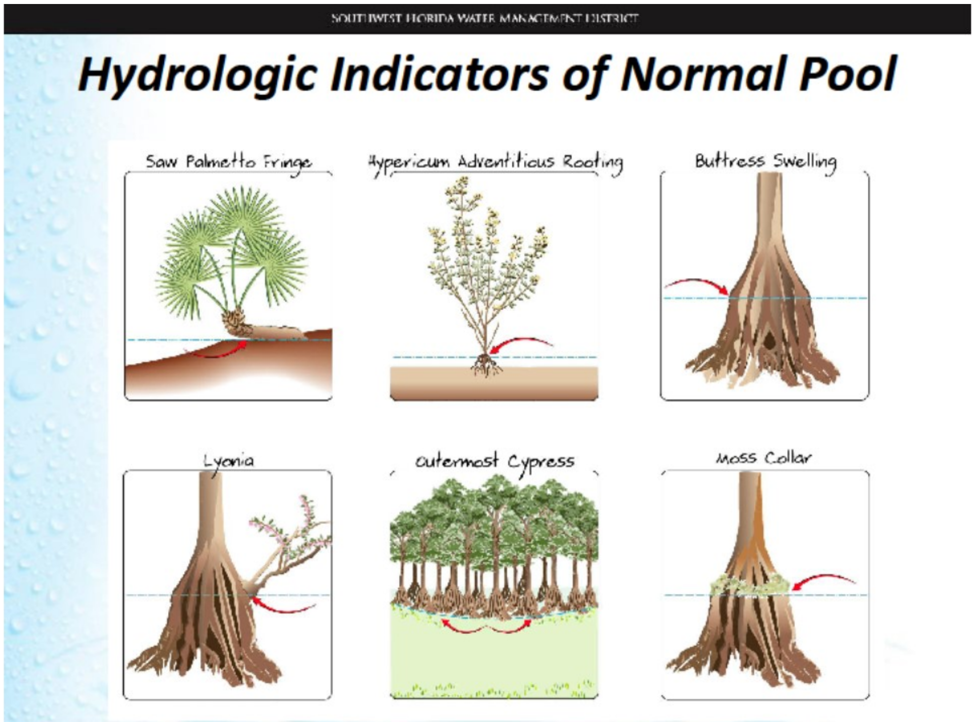

Figure 4-3 Hydrologic indicators of normal pool (Courtesy of Doug Leeper, SWFWMD). Adventitious roots occur on stems or trunks of certain plants when inundated; and *Lyonia* is a wetland shrub shown rooted above normal pool.

5.0 DATA ANALYSES

5.1 ANALYSIS OF VEGETATION, SOILS, AND HYDROLOGIC INDICATOR DATA

The primary data analysis consisted of using Microsoft Excel, Version 9.4 of the Statistical Analysis System (SAS), and the R Project for Statistical Computing (R Core Team 2014) to construct figures and perform statistical analyses on surveyed elevation data. The average ground elevation of seasonally-flooded plant communities, and the average elevation of the boundary between seasonally-flooded and semi-permanently flooded plant communities were most important in determining minimum levels for Lake Hampton. Detailed procedures are provided in respective Appendices C-E for vegetation, soils, and hydrologic indicators.

5.2 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.

SRWMD develops hydrologic models, which address existing structural features, and uses 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 considers that the existing hydrologic condition, which is used to calibrate and verify the models, reflects 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.

5.3 MFLS COMPLIANCE ASSESSMENT

A hydrologic (water budget) model for Lake Hampton was developed to provide a means of assessing whether compliance with MFLs is achieved under specific water use and land use conditions (ECT 2017). This hydrologic model was calibrated for the period January 1, 2005 – December 31, 2014, using land use conditions and groundwater levels consistent with 2006 regional water use, as no significant development in either condition has occurred since 2006 (ECT 2017).

The calibrated model was used to perform a long-term simulation for the period from January 1, 1983 through December 31, 2014, for the purpose of predicting a specific response in potentiometric elevation of the Florida aquifer to land and/or water use development. Hypothetical Floridan aquifer drawdown scenarios were subsequently tested to determine their relationship to the recommended Lake Hampton MFLs, and to determine the thresholds beyond which aquifer drawdowns would result in the draft recommended MFLs no longer being met.

An explanation of the use of this hydrologic model is presented in the Lake Hampton Water Budget Modeling Technical report (ECT 2017). A link to the report is provided in Appendix A.

6.0 RESULTS AND DISCUSSION

Detailed results of analysis of vegetation, soils, and hydrologic indicator data may be found in their respective appendices (Appendices B-E).

6.1 LAKE HAMPTON VEGETATION

Natural communities occurring in the Lake Hampton study site were classified in accordance with descriptions developed by the Florida Natural Areas Inventory (FNAI, 2010). These included wet flatwoods, baygall, cypress, and deep marsh. Maintenance of the hydrologic regime for the cypress and deep marsh communities were most important in determining minimum levels for Lake Hampton. 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 average elevation of the cypress community was used to set the minimum frequent high (FH) level on Lake Hampton, ensuring the maintenance of flooding events with a minimum 30-day duration at a minimum frequency of 2 years for seasonally-flooded communities adjacent the lake. Community elevation benchmarks are shown in Table 4. The mean elevation of the cypress community (CY) is 128.90 NAVD88.

Table 6-1 Community elevations combined from Transect 1 and 2, survey data.

Analysis Variable: NAVD88						
Community	N Obs	N	Mean	Std Dev	Minimum	Maximum
BG	31	31	129.92	0.26	129.58	130.45
CY	45	45	128.90	1.32	126.12	130.09
DM	117	117	126.24	0.29	125.52	126.92
WF	173	173	131.78	1.64	130.11	137.03

The cypress and wet flatwood communities (WF) are separated in elevation, albeit by a very narrow spread. The maximum elevation surveyed from the cypress community was 130.09 NAVD88, while the wet flatwoods minimum was 130.11 NAVD88. Since the frequency of fire is more important in maintenance of the wet flatwoods community (FNAI 2010), these two communities should be separated on the landscape, as demonstrated by the results of this study.

A similar separation in surveyed elevations cannot be shown between the cypress and baygall communities. The baygall community is typically located at the bases of sandy slopes and maintained by downslope seepage; soils in this community are organic and nearly constantly saturated but infrequently flooded (Kinser 1996).

The cypress and deep marsh (DM) communities also overlapped, conjoining the minimum elevation of the seasonally-flooded (cypress) hydrologic regime with the maximum elevation of the semi-permanently to permanently flooded (deep marsh) hydrologic regime (Kinser 1996). The average elevation of the landward extent of the deep marsh community (126.24 NAVD88) was used to set the minimum frequent low (FL) level, ensuring the maintenance of a hydrologic regime where dewatering occurs for a maximum duration of 120 days at a minimum frequency of five years (SJRWMD 2006).

The elevation data collected for vegetative communities in this study supports their use in setting minimum levels for Lake Hampton. A one-way nonparametric analysis of variance and accompanying Kruskal-Wallis test indicate that community type accounts for a significant portion of the variability in elevation, and the hypothesis that no difference in location (central value) for elevation among communities can be rejected (Appendix C).

The results of this study may be improved through the collection of additional and refined elevation data, particularly within the cypress community where potential impacts from drainage have occurred. Lack of symmetry is demonstrated in the elevation-distribution of the cypress community (Figure 7). This may be an artifact of soil subsidence in lake-fringing wetlands as a result of artificial drainage created by the outfall canal. Exaggerated hummocks and exposed roots surrounding cypress trees provide evidence of soil subsidence (Figure 8). It is possible the elevations centering on 129.5 and 130 NAVD88 may represent relict soil surfaces and not those currently influenced by seasonal flooding. By the same reasoning, dewatering may have resulted in baygall encroachment on the landward extent of the cypress community (SWFWMD 1998).

The longitudinal extent of the wet flatwoods was not established in this study, due to their extensive range into the surrounding landscape. This community does not have a specific hydrologic regime that minimum lake levels were designed to protect.

The deep marsh elevation soundings were represented by four well-balanced samples, and the maximum difference in their average depth was approximately 0.54 feet. Sample sites are illustrated in Figure 4.

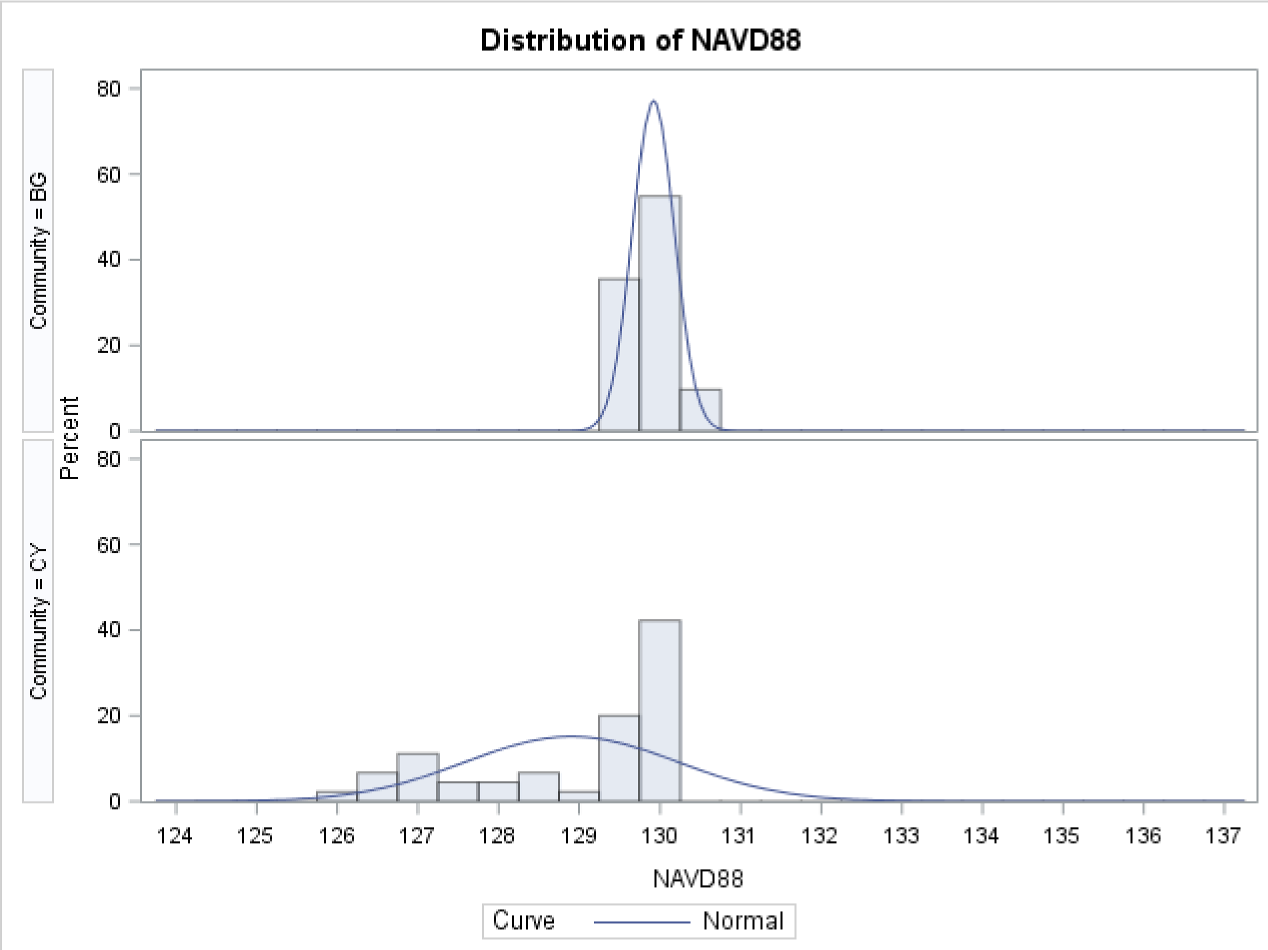

Figure 6-1 Distribution of elevations surveyed in Lake Hampton baygall (BG) and cypress (CY) communities.

Figure 6-2 Exposed roots surrounding a cypress tree on Transect 1

6.2 LAKE HAMPTON SOILS

Information gathered from vegetative communities was used to recommend the FH and FL. The minimum average (MA) is a third frequently-recommended level based upon the subtraction of 0.3 feet from the average elevation of highly organic soils from seasonally-flooded vegetation communities, namely Histosols and soils with a histic epipedon (Schoeneberger et al., 2002; SJRWMD 2006). The hydrologic regime protected by the MA relates to soils that experience dewatering for a maximum duration of 120 days and a maximum recurrence interval of 1.7 years. The SRWMD decided that it would be prudent to exclude recommendation of a MA due to the extreme extension of these soils into the wet flatwoods.

6.3 LAKE HAMPTON HYDROLOGIC INDICATORS

Elevations of hydrologic indicators were surveyed in anticipation of applying SWFWMD MFLs methods specified in rule 40D-8.624, Guidance and Minimum Levels for Lakes. Two MFLs typically-proposed by this methodology are the High Minimum Lake Level (HML) and the Minimum Lake Level (MLL). The HML is a stage that represents the elevation of the water surface equaled or exceeded 10 percent of the time as determined from a long-term stage frequency analysis. The MLL is a stage that represents the elevation of the water surface equaled or exceeded 50 percent of the time as determined from a long-term stage frequency analysis. These levels are also referred to as the P10 and P50, respectively.

According to the resampled stage data presented in Appendix A of this MFLs document, the Lake Hampton P10 and P50 determined for the period of record (POR) beginning 11/9/1988, and ending in 12/31/2014, were 129.87 and 128.36 NAVD88, respectively.

Hydrologic indicators are often utilized by SWFWMD methods to approximate both the P10 and P50. An inflection in the buttresses, located at the base of cypress trunks, may be utilized to approximate the P50 when sufficient hydrologic records do not exist: The average elevation of this inflection on Lake Hampton was 133.01 NAVD88, which represents a historic normal pool (HNP) elevation. According to the methodology, 1.8 feet may be subtracted from the HNP elevation to approximate a P50 of 131.21 NAVD88 for Lake Hampton (rule 40D-8.624(8), F.A.C.). Depending upon classification by the same methods, the P10 may be estimated by either subtracting 0.4 feet from the HNP or using a set (i.e., structurally-regulated) guidance level. The estimated P50 for Lake Hampton is considerably higher than that determined from long-term hydrologic record, beginning in 1988 (Figure 9). The potential reason for this discrepancy is that the cypress buttress inflections were shaped by hydrologic conditions prior to excavation of the outfall canal that has facilitated drainage of the lake.

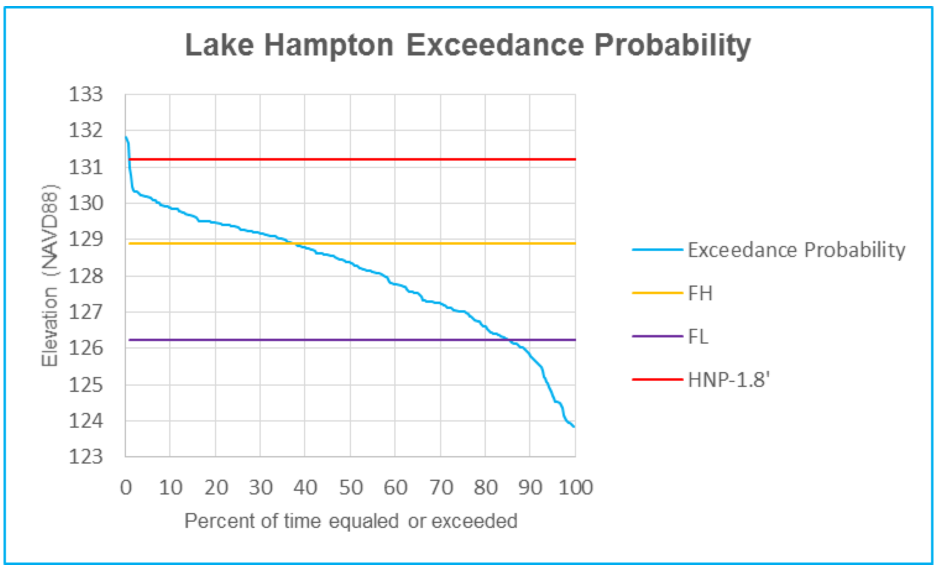

Figure 6-3 Exceedance probability chart, FH, FL, and estimated P50 (HNP) for the entire period of record (POR), extending from water years 1988 to 2015.

The average cypress buttress inflection elevation, and the apparent average elevation of the (historic) soil surface prior to subsidence (HSL), support the theory that the vegetative communities surrounding the lake have been historically dewatered. The latter elevation was determined to be 132.16 NAVD88 (Table 5).

Duration of inundation periods have been estimated for other indicators: Carr et al. (2006) determined moss collars and cypress buttress swellings were inundated 2–3% of the time; and other indicators including lowest roots of *Serenoa repens* (palmetto), landward-most cypress, and the uppermost woody adventitious root of individual *Hypericum fasciculatum* (St John’s wort) were inundated 13–29% of the time; while hydric soils were inundated 38% of the time.

Table 6-2 Elevations of hydrologic indicators along Lake Hampton transects (NAVD88).

Analysis Variable: NAVD88					
Indicator	N	Mean	Std Dev	Minimum	Maximum
Adventitious roots	5	129.98	0.21	129.72	130.29
HNP	20	133.01	0.30	132.57	133.73
HSL	9	132.16	0.52	131.59	133.20
Lichen lines	5	130.73	0.08	130.60	130.81
Palmetto	5	135.89	0.25	135.47	136.11

Current regulatory benchmarks for Lake Hampton also indicate historic water levels may have been staged higher than present. Sovereign submerged lands (SSL) occur below the ordinary high water elevation (OHWL) of 131 (NGVD 1929), which is equal to approximately 130.12 NAVD88. The SSL are therefore located at an elevation that is slightly higher than the P10 for the entire period of record (POR), extending from water years 1988 to 2015 (Figure 9).

6.4 MFLS COMPLIANCE ASSESSMENT (HYDROLOGIC MODELING)

An assessment of the hydrologic model results indicated that a Florida aquifer drawdown of 10.0 feet beyond 2006 hydrologic conditions could be harmful to the fish and wildlife habitat of Lake Hampton, by lowering water levels in the lake proper and in the lake watershed. Such drawdown would result in lowering the levels set by the SJRWMD methodology in this study, specifically the FH and FL.

7.0 CONCLUSIONS AND RECOMMENDATIONS

The recommended MFLs for Lake Hampton are summarized in Table 6. Results presented in this report are considered recommendations until the minimum flows and levels are adopted by the SRWMD Governing Board as rule. SRWMD MFLs are listed in Chapter 40B-8, F.A.C.

The SJRWMD multiple MFLs method (SJRWMD 2006) was utilized to determine the minimum lake levels for Lake Hampton. MFLs determination is based on the evaluation of topography and vegetation data associated with the water body. The levels relate to hydroperiod categories and definitions adapted from water regime modifiers developed by Cowardin et al. (1979).

Table 7-1 Minimum recommended lake levels for Lake Hampton.

Designated Level	Elevation Benchmarks	Elevation (NAVD88)	Defining event or hydrologic criteria
Minimum frequent High (FH)	Mean elevation of seasonally-flooded wetlands	128.90	30-day inundation/ 2-yr return interval
Minimum Frequent Low (FL)	Mean elevation of the landward extent of the deep marsh	126.24	120-day exposure/ 5-yr return interval

Each designated level is defined by rule in Florida's Administrative Code. In the case of the minimum frequent high (FH) and minimum frequent low (FL), the definitions may be found in Rules 40C-8.021(7) and (10), F.A.C., respectively. The FH elevation is set in order to provide protection of seasonally-flooded wetland communities that typically experience flooding events with a duration of 30 days occurring every two years. The hydrology of the cypress community surrounding Lake Hampton is consistent with this flood duration and associated return interval. The FL elevation is set to protect the integrity of the semi-permanently-flooded deep marsh communities that typically experience dewatering with a duration of 120 days occurring every five years.

Results of the lake hydrologic model indicated the MFLs recommended for Lake Hampton are met under 2006 hydrologic conditions. It is assumed that these conditions are representative of current conditions, since there have been no significant land or water use developments in the Lake Hampton watershed since 2006 (ECT 2017). The model was subsequently used to assess hypothetical Floridan aquifer drawdowns and their effects upon the recommended MFLs and determined that with a maximum drawdown of 8.0 feet below 2006 hydrologic conditions, the recommended MFLs would no longer be met.

EPA SWMM model was chosen as the preferred water budget model for this MFLs study. However, all models operate upon assumptions; and those respective to the Lake Hampton model included groundwater loss rates, the control elevation of the outfall canal, applicability of calibration and long-term simulation periods, accuracy of data sources, and hypothetical water resource development in the assessment of allowable aquifer drawdowns.

In the future, water budget modeling efforts could be further improved with a more comprehensive integrated surface water and groundwater model and/or by recalibrating the model when additional data becomes available.

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APPENDIX A: LAKE WATER BUDGET MODELING

The Lake Hampton water budget modeling report (ECT 2016) may be accessed following the link below:
http://www.srwmd.state.fl.us/index.aspx?nid=440

These reports outline the development and long-term simulation of the Lake Hampton Water Budget Model.

Lake Stage Exceedance Percentiles

The following percentiles were determined using monthly average stage data generated from linearly-interpolated daily stage, coincident with the POR of the long-term simulation of the water budget model.

SWFWMD MFLs methods use categorical significant change standards to identify criteria sensitive to long-term changes in hydrology (Rule 40D-6.624, F.A.C.). The cypress standard was used to support Lake Hampton MFLs development, and methods are detailed in Appendix E: HYDROLOGIC INDICATOR SAMPLING, ANALYSES, AND RESULTS. Lake Hampton is classified as a Category 2 lake: one with fringing cypress wetlands that have been structurally altered such that lake water levels do not rise to levels expected to fully maintain the integrity of the wetlands. The two MFLs proposed by this methodology are the High Minimum lake Level (HML) and the Minimum Lake Level (MLL).

The recommended HML for Lake Hampton is a stage elevation of 129.87 ft. NAVD88; Table A1). This stage represents the elevation of the water surface of a lake or wetland that is equaled or exceeded 10 percent of the time as determined from a long-term stage frequency analysis. Data utilized for this analysis were the resampled data provided by ECT for the long-term simulation of the water budget model. Resampled data consisted of weekly measurements for the period of record (POR) beginning 11/9/1988, and ending in 12/31/2014.

The recommended MLL for Lake Hampton is a stage elevation of 128.36 ft. NAVD88. This stage represents the elevation of the water surface of a lake or wetland that is equaled or exceeded 50 percent of the time.

Table A1. Stage frequency percentages for Lake Hampton.

Percent Exceedance	Monthly readings, Period of Record
10%	129.87
50%	128.36
90%	125.86

Note: See definitions and footnotes, below.

DEFINITIONS
"10%" means the elevation of the water surface of a lake or wetland that is equaled or exceeded 10% of the time as determined from a long-term stage frequency analysis.
"50%" means the elevation of the water surface of a lake or wetland that is equaled or exceeded 50% of the time as determined from a long-term stage frequency analysis.
"90%" means the elevation of the water surface of a lake or wetland that is equaled or exceeded 90% of the time as determined from a long-term stage frequency analysis.

Literature Cited

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APPENDIX B: SITE SURVEY

Suwannee River Water Management District
Lake Hampton – Minimum Flows and Levels Project
Survey Report

Introduction

This report contains an outline of the Survey and Mapping Services that supported the Suwannee River Water Management District (SRWMD) Lake Hampton Minimum Flows and Levels Project in Bradford County, Florida; SRWMD Work Order 10/11-068.06; Greenman-Pedersen, Inc. (GPI) Project Number FTP-2013104.06.

Project Area

The project area encompasses Lake Hampton and bordering shores in Bradford County, Florida.

Purpose

The purpose of this survey was to:

1. Establish Horizontal and Vertical Control - set three bench marks
2. Establish elevation at “0” mark on existing manual read staff gauge near boat ramp
3. Stake and Station two transect lines
4. Locate hydrologic indicators, habitat zone breaks, and soil borings as marked by GPI environmental staff (and sub-consultants) along the two transect lines
5. Locate select docks, houses, and boat ramp
6. Provide three Cross-Sections along Santa Fe River outlet channel
7. Provide three Cross-Sections along and adjacent to the bridge crossing the Santa Fe River outlet channel
8. Provide two Cross-Sections along and adjacent upstream edge of dirt road crossing Santa Fe River at east edge of power line right-of-way

Date of Survey

All ground Survey field operations took place between August 07, 2014 through December 02, 2014, and between January 27 through January 28, 2015.

Datum Reference and Final Coordinates

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 National Geodetic Survey benchmarks J368 (elevation 140.19 feet) and G368 (elevation 136.71 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 points established consist of 5/8” rebar 18” in length with plastic caps marked “LB 7560” and were observed with Leica survey grade dual frequency GPS receivers. Redundant observations at various GPS epochs were taken at each 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: http://www.dot.state.fl.us/surveyingandmapping/FPRN.shtm

Vertical Control

The benchmarks established consist of 5/8” rebar 18” in length with plastic caps marked “LB 7560” and were established utilizing differential leveling techniques and ties to the two National Geodetic Survey benchmarks (listed above).

Transects

Transect end points (waterward) were staked with 1/2” PVC pipe and located with Leica survey grade dual frequency GPS receivers, operating in Real Time Kinematic (RTK) mode on Florida Department of Transportation’s (FDOT) Florida Permanent Reference Network (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 & 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.

Prepared By:

Greenman-Pedersen, Inc. (Licensed Business #7560)
328 NE 1st Avenue, Suite 200
Ocala, Florida 34470
Phone: (352) 368-5055
Fax: (352) 368-5063

Surveyor's Certification

I hereby certify that we have performed the surveying services listed herein, and that this survey conforms with the minimum technical standards as set forth by the Florida Board of Professional Surveyors and Mappers in chapter 5J-17, Florida Administrative Code, pursuant to Section 472.027, Florida Statutes.

____

James Hunter Blair, PSM
Professional Surveyor & Mapper #6917
State of Florida

Date Signed:____________________

APPENDIX C: VEGETATION SAMPLING METHODS, ANALYSES, AND RESULTS

Vegetation Sampling Methods

Vegetation sampling closely followed the methods described in SJRWMD (2006). Two belt transects were used to characterize lake plant communities and soils. Each transect extended from the edge of lake, through the forested wetland, and ended in uplands (Figure C1). Along each transect, the beginning and ending locations of recognized vegetation community types were marked, using the key provided in “The Wetlands Diagnostic Characteristics” (Kinser 1996). Habitat types not supported by Kinser (1996), including terrestrial (upland) plant community names, were modified from the Florida Natural Areas Inventory classification method (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. Hydrologic indicators were also marked for subsequent location and elevation surveys by Florida Licensed Professional surveyors (Appendices B & E).

Vegetation data were collected between September 30 and October 3, 2014; and January 27 and 28, 2015, 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 belt may be divided into zones of different vegetation communities, each representing a unique plot.

Plants were identified along the length of both transects. For the purpose of describing the species composition of each community, plants were placed into one of three main categories on the basis of stature: canopy, sub-canopy (mid-story), and groundcover, following the convention of Cowardin et al. (1979). Woody vegetation that was 6 m (20 feet) or taller was considered canopy vegetation. Mid-story species included true shrubs, young trees, and trees or shrubs that may be small or stunted because of environmental conditions. Shrubs are woody plants which generally exhibit several erect, spreading, or prostrate stems and have a bushy appearance. Groundcover included erect, rooted, herbaceous hydrophytes, excluding mosses and lichens; annual herbs and forbs; and low-growing, spreading plants other than climbing vines.

Sampling sites were located randomly in each plant community within individual transects; and the point-centered-quarter (PCQ) sampling method was used to characterize species composition (Mueller-Dombois and Ellenberg 1974, Kent and Coker 1992). With the exception of the deep marsh communities, a minimum of two sites from each community was sampled. Density, frequency, basal area, and importance value (IV) were calculated for each tree species, by transect and community. Only densities and frequencies were calculated for shrubs in each community.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 50 cm. Branches arising above 50 cm were not counted separately, only the main (largest) stem’s diameter were tallied. Canopy species were designated as measuring >2.54 cm dbh.

A follow-up visit was conducted with SJRWMD staff to adjust the landward boundaries of the cypress communities along vegetation sampling transects (Robert Freese, PhD., Andrew Sutherland, and Casey Harris, personal communication, March 10, 2016). SRWMD staff conducted lake-wide depth-soundings on March 24, 2016, to determine the landward elevation of the deep marsh community. Multiple soundings (n=117) were conducted along four separate segments of shoreline where an abrupt boundary occurred between emergent sawgrass (*Cladium jamaicense*) and floating-leaved cow lily (*Nuphar advena*).

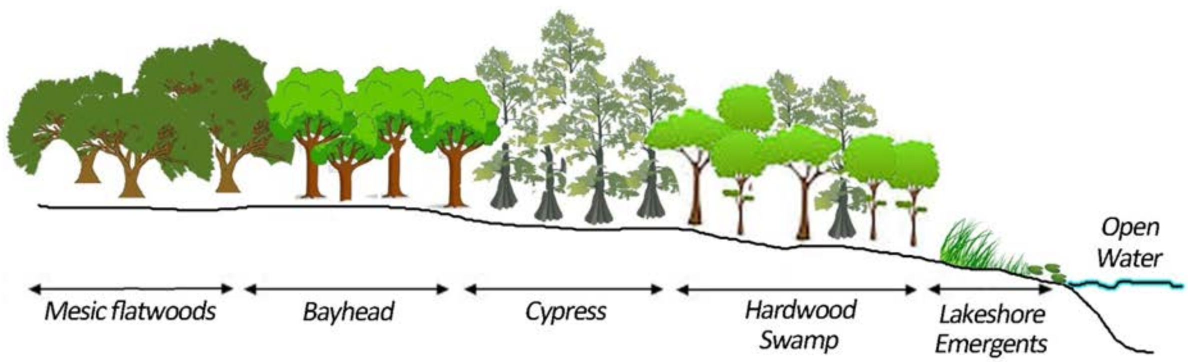

Figure C1**.** Cross-section of a typical belt transect through forested and herbaceous plant communities described by Kinser (1996).

Vegetation Data Analyses

Transect elevation data were graphed using Microsoft Excel to illustrate the gradient from open water and uplands, and descriptive statistics were calculated for the elevations of individual vegetation communities. Statistics were calculated on all surveyed elevation data using Version 9.4 of the Statistical Analysis System (SAS) Proc Univariate statement, specifying the Normal option for each community. The NPAR1WAY procedure was used to perform nonparametric tests for differences in location and scale between communities; and a comparison of elevations between individual communities was conducted using the Analysis of Variance (ANOVA) procedure with a post-hoc Tukey's Studentized Range (HSD) Test.

Descriptive statistics were determined for depth soundings collected on March 24, 2016, using R version 3.0.1. An ANOVA was performed for depth soundings between the four sites, as were tests for normality (Shapiro-Wilk), homoscedasticity (Bartlett’s), and a post-hoc multiple comparison (Tukey’s). Depths representing the definitive boundary separating emergent sawgrass and floating-leaved cow lily stands were combined between sites, averaged, subtracted from ambient lake stage (129.70 NGVD29) and converted to NAVD88.

Vegetation Results

Vegetation at Transect 1

Transect 1 is located on the western shore of Lake Hampton south of the Edith Ellen Estates Subdivision (**reference original transect location figure**). Transect 1 was the longest transect sampled, traversing approximately 1453 feet (Table C3).

Table C3. Transect 1 Location and Fieldwork Dates

Northing – Easting (Station 0; upland)	Northing – Easting (Station 1140.40; water's edge)	Dates of Fieldwork
319064.39 – 2704161.94	319206.53 – 2705547.93	10/2/2014; 3/10/2016, 3/10/2016

Transect 1 was surveyed from the interior of the deep marsh, through cypress and baygall, and into the interior of the wet flatwoods (Table C4). Natural ground elevations were surveyed at a total of 165 points along the transect, ranging from 125.84 to 132.41 NAVD88 (Table C4 and Figure C2). In Figure C2, the community with steepest slopes is the cypress community.

Table C4. Lake Hampton Transect 1 Vegetation Community Elevation Statistics

Vegetation Community	**Stations**	**Mean (NAVD88)**	**Std Dev**	**Median (NAVD88)**	**Min (NAVD88)**	**Max (NAVD88)**	**N**
Deep marsh	12+20.0 - 12+20.0	125.00	0.44	124.84	124.53	125.84	26
Cypress	12+10.0 – 11+00.0	129.01	1.43	129.75	126.12	130.02	14
Baygall	10+90.0 – 8+70.00	129.92	0.26	129.82	129.58	130.45	31
Wet flatwoods	8+60 – 0+00	130.91	0.56	130.75	130.17	132.41	94

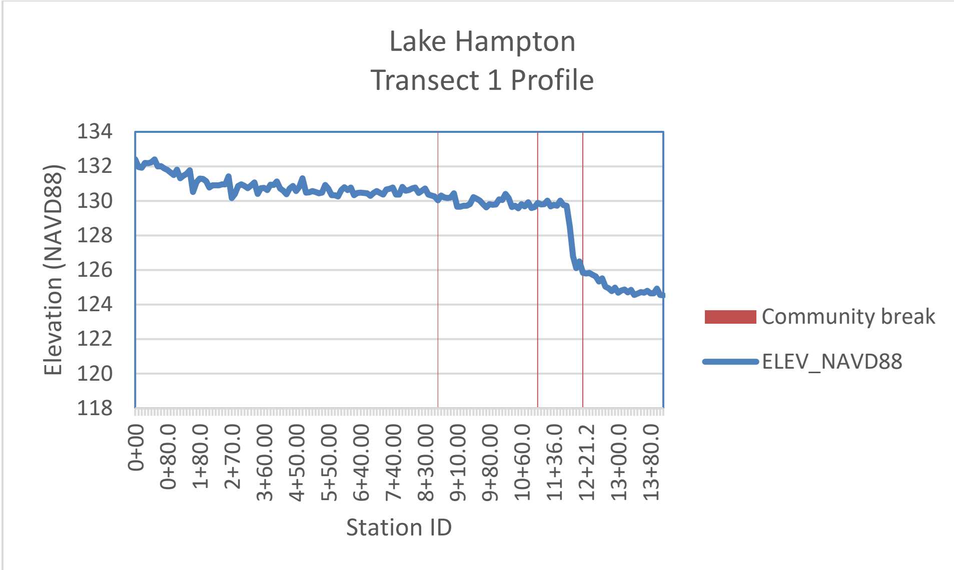

Figure C2. Elevations along Transect 1, from the highest point surveyed in the wet flatwoods to the lowest point surveyed in the deep marsh.

Kinser (1996) described the deep marsh community as deep water wetlands dominated by a mixture of water lilies and deep water emergent species. It is a community that experiences a semi-permanent to permanent flooding regime. Typical genera include: *Scirpus* (*Schoenoplectus*), *Nymphaea*, *Nuphar*, *Nelumbo*, *Brasenia* and *Nymphoides*.

The deep marsh community in Lake Hampton was composed mainly of native vegetation, with the minor exception of the invasive exoctic alligatorweed (*Alternanthera philoxeroides*). Deep-rooted, floating-leaved species of this community included banana lily (*Nymphoides aquatica*), fragrant water lily (*Nymphaea odorata*), and cow lily (*Nuphar advena*) (Figure C3). Floating vegetation included water fern (*Salvinia minima*). Submersed aquatic vegetation included red ludwigia (*Ludwigia repens*), southern naiad (*Najas guadalupensis*), and bladderwort (*Utricularia* sp.). Emergent vegetation that extended into deep water, greater than depths of three feet, included giant bulrush (*Schoenoplectus californicus*), maidencane (*Panicum hemitomon*), and jointed spikerush (ether *Eleocharus equisitoides* or *E. interstincta*). Shallow emergents were represented by pickerelweed (*Pontederia cordata*), American cupscale (*Sacciolepis striata*), and sawgrass (*Cladium jamaicense*).

Figure C3. View of the southeast corner of Lake Hampton where fragrant water lilies are shown adjacent the emergent sawgrass that fringe the Cypress communities in the background.

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. The Transect 1 cypress community was represented by a canopy of pond cypress (*Taxodium ascendens*), loblolly bay (*Gordonia lasianthus*), and swamp tupelo (*Nyssa sylvatica var. biflora*). Mid-story and groundcover plants included fetterbush (*Lyonia lucida*), wax myrtle (*Myrica cerifera*), Virginia willow (*Itea virginica*), and Virginia chain fern (*Woodwardia virginica*). Several plants fringing the shoreline included buttonbush (*Cephalanthus occidentalis*), sawgrass (*Cladium jamaicense*), Virginia marsh-St. John's-wort (*Triadenum virginicum*), titi (*Cyrilla racemiflora*), dahoon holly (*Ilex cassine*), and highbush blueberry (*Vaccinium corymbosum*).
The baygall community is a forested wetland typically dominated by one or more species of evergreen bay trees or less commonly by dahoon holly, deciduous hardwoods, or pine. It is often located at the bases of sandy slopes and maintained by downslope seepage. Soils are organic and nearly constantly saturated but infrequently flooded. The canopy of the Transect 1 baygall canopy included a mixture of loblolly bay, swamp tupelo, dahoon holly, and sweet bay magnolia (*Magnolia virginiana*). Mid-story and gruoundcover included swamp bay (*Persea palustris*) wax myrtle, Virginia willow, fetterbush, and Virginia chain fern.
Wet flatwoods are typically pine forests with a sparse or absent mid-story and a dense groundcover of hydrophytic grasses, herbs, and low shrubs. The Transect 1 wet flatwoods

canopy consisted mainly of tall slash pine (*Pinus elliottii*). The midstory was sparse and represented by red maple (*Acer rubrum*), pond cypress, dahoon holly, loblolly bay, water oak (*Quercus nigra*), red bay, and swamp tupelo. The mid-story and groundcover included galberry (*Ilex glabra*), fetterbush, highbush blueberry, Virginia chain fern, and cinnamon fern (*Osmunda cinnamomea*).

An analysis of Point-Centered-Quarter (PCQ) data rendered canopy species Importance Values (IVs) for each community (Table C6): deep marsh (DM), cypress (CY), baygall (BG), and wet flatwoods (WF). The number of sites sampled by community are as follows: DM (n=1), CY (n=2), BG (n=6), and WF (n=5). 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 should equal 300. These IVs indicate that pond cypress, loblolly bay, and slash pine provideprovide large relative contributions of area, density, and frequency in their respective communities. Although PCQ data are not utilized in delineating the landward extent of wetlands, the importance of slash pine in canopy of the wet flatwoods supports exclusion of this vegetative community as a wetland, per Rules 62-340.300 (2), (a) and (b), F.A.C.

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 C7). The shrubs represented in PCQ survey results indicate low species diversity in each community.

Table C6. Canopy species Importance Values (IV) by community for Transect 1.

Transect 1, Canopy Species Importance Values				
Species	IV_{DM}	IV_{CY}	IV_{BG}	IV_{WF}
Quercus laurifolia				42.07
Gordonia lasianthus		150.21	223.87	30.59
Vaccinium sp.				11.73
Ilex cassine				25.79
Myrica cerifera			18.44	28.98
Lyonia lucida			14.18	11.70
Pinus elliottii				120.30
Taxodium ascendens	300.00	149.79		12.83
Acer rubrum				16.00
Nyssa sylvatica (var. biflora)			43.52	

Table C7. Shrub Species Relative Density & Relative Frequency by community for Transect 1.

Transect 1, Shrub Species Relative Density & relative Frequency								
Species	RDDM	RFDM	RD_{CY}	RF_{CY}	RD_{BG}	RF_{BG}	RD_{WF}	RF_{WF}
Myrica cerifera	50.00	50.00						
Cephalanthus occidentalis	50.00	50.00						
Gordonia lasianthus			93.75	80.00	33.33	40.00	70.00	60.00
Itea virginica			6.25	20.00				
Lyonia lucida					66.67	60.00		
Ilex glabra							30.00	40.00

Vegetation at Transect 2

Transect 2 was located approximately 775 feet east of the outlet canal on the southern shoreline of Lake Hampton (Table C8). Transect 2 was surveyed from the interior of the deep marsh, through the cypress community, and into the interior of the wet flatwoods. Natural ground elevations were surveyed at a total of 157 locations, ranging from 124.30 to 137.03 NAVD88 (Table C9 and Figure C4).

Table C8. Transect 2 Location and Fieldwork Dates

Northing – Easting (Station 0; upland)	Northing – Easting (Station 12+68.2; water's edge)	Location and Dates of Fieldwork
314880.52 – 2706306.24	315921.38 – 2707039.56	Southern shore of Lake Hampton October 1, 2014

Table C9. Lake Hampton Transect 2 Vegetation Community Elevation Statistics.

Vegetation Community	Stations Distance (ft.)	Mean (NAVD88)	Std Dev	Median (NAVD88)	Min (NAVD88)	Max (NAVD88)	N
Deep marsh	13+00 – 9+30	125.48	0.58	125.55	124.30	126.34	47
Cypress	9+27.7 – 7+07.0	128.85	1.29	129.54	126.57	130.09	31
Wet flatwoods	7+00.0 – 0+00.0	132.80	1.88	132.72	130.11	137.03	79

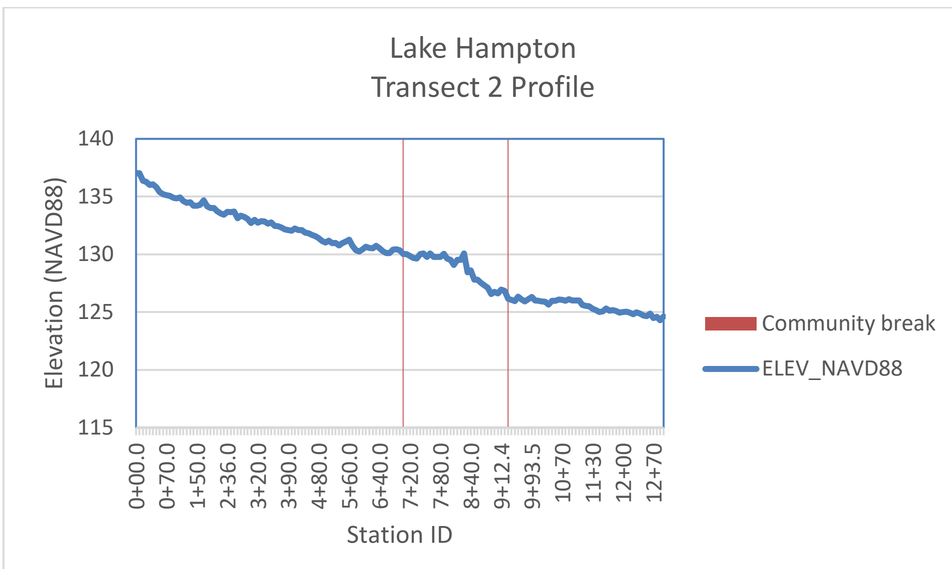

Figure C4. Elevations along Transect 2, from the highest point surveyed in the wet flatwoods to the lowest point surveyed in the deep marsh.

The plants found in the lake's deep marsh community are universal in terms of species composition, particularly the deep-rooted, floating-leaved, submersed aquatic, and deep-water emergent vegetation species listed in the preceding section. Shallow emergent plants unique to Transect 2 were represented by rush fuirena (*Fuirena scirpoidea*), swamp loosestrife (*Decodon verticillatus*), and sawgrass.

The cypress community included a canopy of pond cypress, loblolly bay, red maple, dahoon holly, and sweetbay magnolia. Mid-story species included wax myrtle, fetterbush, and red bay. Groundcover plants included Virginia chain fern, witchgrass (*Dichanthelium* sp.), and sawgrass. The wet flatwoods canopy consisted of loblolly pine (*Pinus taeda*), slash pine, red maple, laurel oak (*Quercus laurifolia*), water oak, and dahoon holly. The mid-story was represented by red bay, loblolly bay; and perennial shrubs and groundcover such as galberry, saw palmetto (*Serenoa repens*), fetterbush, and a species of *Vaccinium* with considerable basil area that was likely sparkleberry (*V. arboretum*). Virginia chain fern represented the groundcover.

PCQ data analyses rendered canopy species Importance Values (IVs) for cypress (CY) and wet flatwoods (WF) communities (Table C10). The number of sites sampled by community are as follows: DM (n=1), CY (n=2), BG (n=6), and WF (n=5). These IVs indicate that pond cypress, slash pine, and loblolly pine each make large relative contributions of area, density, and frequency in their respective communities.

Estimates of relative densities and frequencies of shrub species demonstrate a relatively greater diversity of species in each community of Transect 2 (Table C11).

Table C10. Canopy species Importance Values (IV) by community for Transect 2.

Transect 2, Species Importance Values		
Species	IV_{CY}	IV_{WF}
Quercus laurifolia		34.76
Quercus nigra		49.05
Gordonia lasianthus	22.30	14.18
Vaccinium sp.		
Ilex cassine	22.52	27.72
Myrica cerifera	29.78	
Lyonia lucida		
Pinus elliottii		82.16
Pinus taeda		61.47
Taxodium ascendens	152.53	
Acer rubrum	25.23	17.95
Nyssa sylvatica (var. biflora)		
Magnolia virginiana	16.30	
Vaccinium sp.		12.71

Table C11. Shrub Species Relative Density & Relative Frequency by community for Transect 2.

Transect 2, Shrub Species Relative Density & relative Frequency				
Species	RD_{CY}	RF_{CY}	RD_{WF}	RF_{WF}
Myrica cerifera				
Cephalanthus occidentalis	10.00	20.00		
Gordonia lasianthus			15.00	11.11
Itea virginica				
Lyonia lucida	10.00	20.00	15.00	22.22
Ilex glabra			40.00	33.33
Salix Carolineana	10.00	20.00		
Persea palustris	70.00	40.00	25.00	22.22
Vaccinium sp.			5.00	11.11

Boxplots representing natural ground elevations surveyed for individual communities are shown in Figure C5. The cypress and wet flatwoods communities are completely separated between respective maximum and minimum elevations. A nearly identical relationship exists between the cypress and deep marsh communities, where the minimum cypress elevation surveyed (Transect 1), is only 0.22 feet below the maximum elevation surveyed in the deep marsh on (Transect 2). It is apparent that most variability in the cypress survey data occurs near the boundary of the deep marsh communities (Figures C2 and C4). Overlap in the interquartile range (IQR) occurs between the baygall and two cypress communities with respective medians differing by 0.14 feet. Deep marsh elevations have a high level of agreement within and between transects, as their IQRs are relatively constricted. The highest elevations surveyed from wet flatwoods communities differed by nearly six feet; but this does not indicate skewness, as these transect endpoints did not represent community ecotones.
Results of both Shapiro-Wilk and Bartlett tests found the residuals of the data were not normally and independently distributed with mean zero and constant variance, so an ANOVA was not used to test for differences in mean elevation between communities (Montgomery 2001). However, results of a one-way nonparametric analysis of variance indicate that community type accounts for a significant portion of the variability in elevation ($p<0.0001$), and the accompanying Kruskal-Wallis test leads to rejection of the null hypothesis that there is no difference in location for elevation among communities ($p<0.0001$).

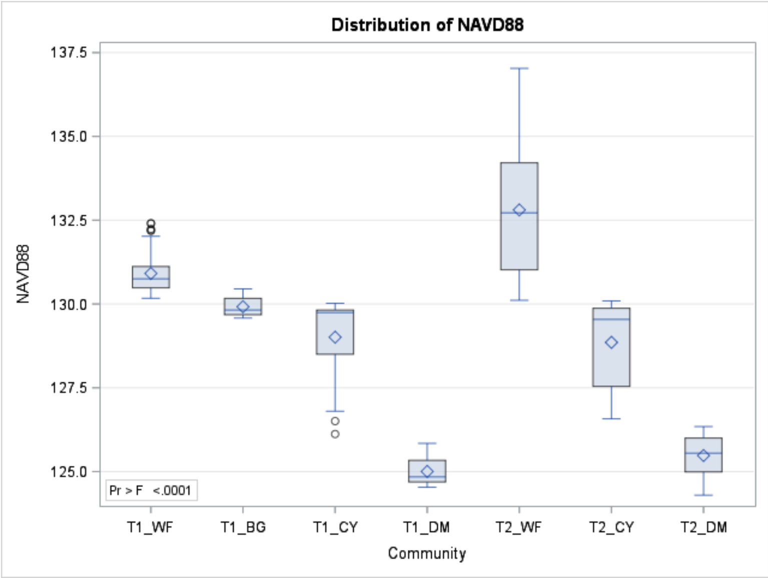

Figure C5. Boxplots representing natural ground elevations surveyed for individual communities from Transects 1 and 2.

Since minimum lake levels are established to protect specific types of communities, such as seasonally-flooded cypress, it is appropriate to combine survey data from the two transects by community (Table C12 and Figure C6). Similar to results taken separately according to transect, data combined by community did not conform to normality or homoscedasticity, and community type accounts for a significant portion of the variability in elevation ($p<0.0001$). It is important to note that the cypress and wet flatwoods did not exhibit an overlap in surveyed elevations. The minimum frequent high water level is based upon the mean of the cypress community (**128.90 NAVD88**)

Table C12. Community elevations combined from Transect 1 and 2, survey data.

Analysis Variable: NAVD88						
Community	N Obs	N	Mean	Std Dev	Minimum	Maximum
BG	31	31	129.91871	0.2586212	129.58	130.45
CY	45	45	128.90247	1.31815	126.12	130.09
DM	73	73	125.30887	0.580622	124.2951	126.343
WF	173	173	131.77653	1.6355497	130.11	137.03

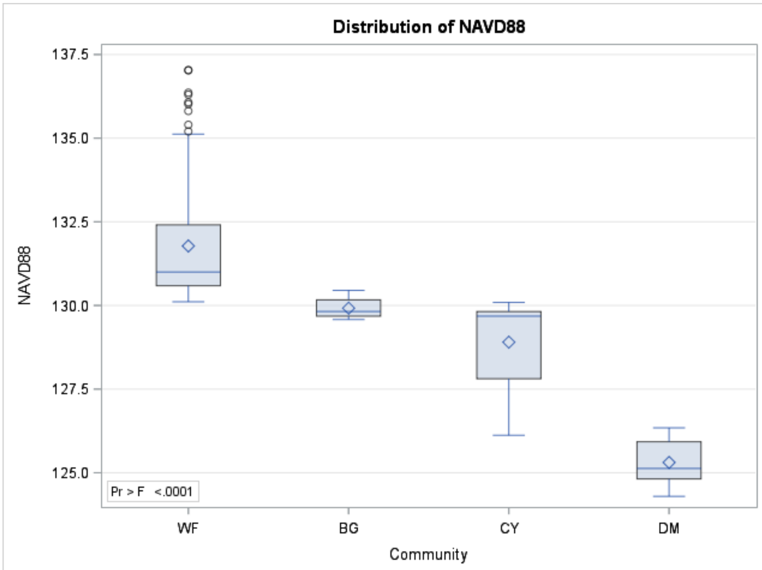

Figure C6. Boxplots representing natural ground elevations surveyed by community.

Deep Marsh Community Depth Soundings

Mean depth soundings of the boundary separating emergent sawgrass and floating-leaved cow lily stands are listed for individual sites in Table C13C13, and illustrated in Figure C5. This boundary represents the landward extent of the deep marsh community. Results of both Shapiro-Wilk and Bartlett tests found the residuals of the data normally and independently distributed with mean zero and constant variance, so an ANOVA was performed with a post-hoc Tukey test. Results indicated that significant differences existed in means from individual sites with the exception of Sites 1 and 2 ($p<0.05$).

Collectively, the mean depth from all sites is equal to 2.58 feet. The lake stage was 129.70 (NGVD29) during time of the soundings. After subtracting the sounding depths and a correction factor of 0.88, the mean elevation of the landward extent of the deep marsh community is estimated as **126.24 NAVD88**, the proposed elevation of the minimum frequent low lake level.

Table C13. Descriptive statistics of the depth soundings at the boundary of the cow-lilies and sawgrass on Lake Hampton, 03/24/2016.

Deep Marsh Community Analysis Variable: Depth					
Site	N	Mean	Std Dev	Minimum	Maximum
Site1	25	2.6	0.2	2.2	3.1
Site2	22	2.7	0.2	2.2	3.1
Site3	57	2.4	0.2	1.9	3
Site4	13	3.0	0.2	2.6	3.3

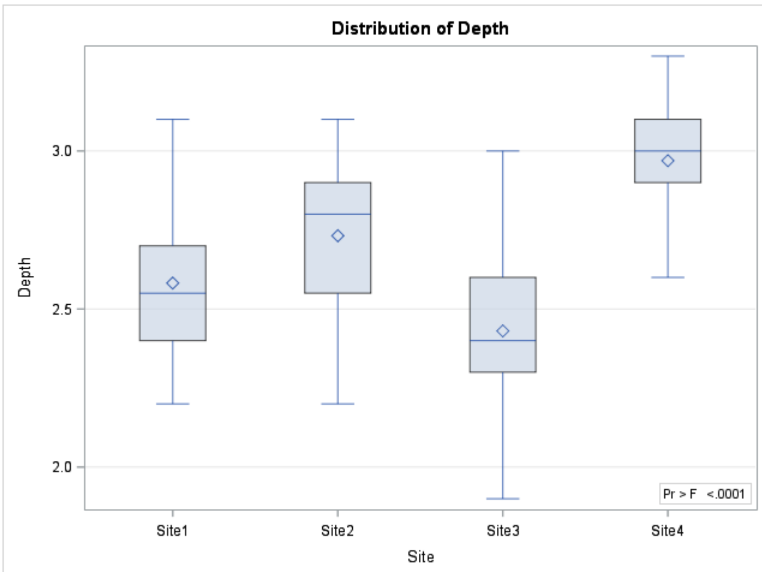

Figure C5. Boxplots constructed from depth soundings at the boundary of the cow-lilies and sawgrass on Lake Hampton, 03/24/2016.

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APPENDIX D: SOIL SAMPLING METHODS, ANALYSES, AND RESULTS

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 in. 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 in. 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).

Detailed soil profiles were observed and described by a Certified Soil Scientist at selected stations along each of the six 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 that 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 course 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 District in PDF format. In addition, soils data were entered into Excel format and joined to survey data in ArcGIS for further analyses.

Results

Tables D1 and D2 provide keys to the soil boring samples from Transects 1 and 2, respectively. These soil marker tables indicate the vegetative community where respective samples occurred: WF = wet flatwoods; BG = baygall; CY = cypress; and DM = deep marsh. Survey stations are also provided for cross-reference with elevation data; and comments are provided for reference to hydric/organic status of the soils sampled. The soil marker tables can also be cross-referenced with field data for individual samples. The occurrence of Histosols and soils with a histic epipedon extended far into the wet flatwoods communities of both transects. In Transect 1, this distance occurred 1080 feet from the boundary of the cypress community. In Transect 2, the distance extended approximately 357 feet from the cypress community boundary.

Table D1. Soil markers for Lake Hampton, Transect 1.

Soil Boring #	Habitat Type	Approximate Survey Station	Comments
SB-2	WF	0-45	Landward extent of hydric soils
SB-5	WF	0+20	Landward extent of surface organics
SB-6	WF	0+40	Landward extent of histic epipedon
SB-7	WF	1+60	Landward extent of histosols
SB-1	WF	0-60	
SB-2	WF	0-45	
SB-3	WF	0-37	
SB-4	WF	0+00	
SB-5	WF	0+20	
SB-6	WF	0+40	
SB-7	WF	2+00	
SB-8	WF	2+76	
SB-9	WF	3+40	
SB-10	WF	5+60	
SB-11	BG	8+82	
SB-12	BG	9+35	
SB-13	BG	9+80	
SB-14	BG	10+40	
Soil Boring #	**Habitat Type**	**Approximate Survey Station**	**Comments**
SB-15	BG	10+80	
SB-16	CY	11+20	
SB-17	CY	11+36	
SB-18	CY	11+60	
SB-19	DM	PCQ-5	
SB-20	DM	PCQ-4	
SB-21	DM	PCQ-3	
SB-22	DM	PCQ-2	
SB-23	DM	PCQ-1	

Table D2. Soil markers for Lake Hampton, Transect 2.

Soil Boring #	Habitat Type	Approximate Survey Station	Comments
SB-27	WF	0+08	Landward extent of hydric soils
SB-26	WF	0+80	Landward extent of surface organics
SB-22	WF	3+50	Landward extent of histic epipedon
SB-21	WF	3+85	Landward extent of histosols
SB-1	DM	0+68	
SB-2	DM	0+142	
SB-3	DM	10+91	
SB-4	DM	20+35	
SB-5	DM	9+93.5	
SB-6	CY	9+27.7	
SB-7	CY	8+64.4	
SB-8	CY	8+11	
SB-9	CY	7+60	
SB-10	CY	7+45	
SB-11	CY	7+35	
SB-12	CY	7+07	
SB-13	WF	6+60	
SB-14	WF	6+40	
SB-15	WF	6+20	
SB-16	WF	5+85	
SB-17	WF	5+80	
SB-18	WF	5+40	
SB-19	WF	4+80	
SB-20	WF	4+32	
Soil Boring #	**Habitat Type**	**Approximate Survey Station**	**Comments**
SB-21	WF	3+85	
SB-22	WF	3+40	
B-23	WF	2+80	
SB-24	WF	2+20	
SB-25	WF	1+40	
SB-26	WF	0+80	
SB-27	WF	0+08	
SB-28	WF	0+00	
SB-29	WF	0-55	

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APPENDIX E: HYDROLOGIC INDICATOR SAMPLING, ANALYSES, AND RESULTS

Hydrologic Indicator Sampling Methods

Important physical indicators of historical inundation were identified along Transects 1 and 2. These indicators included cypress buttress inflection elevations, historic soil lines, occurrence of saw palmetto (*Serenoa repens*) closest the lake, well-developed adventitious roots, lichen lines, and moss lines. With The exception of the saw palmetto edge, all of these indicators are listed in Rule 62-340.500 F.A.C. All indicators have known hydrologic associations. Locations of these hydrologic indicators were marked for subsequent elevation survey.

Hydrologic Indicator Data Analyses

Descriptive statistics (i.e., mean, median, min, max, and n [sample size]) were calculated for the elevations of specific hydrologic indicators using the Version 9.4 SAS Means procedure (SAS).

Hydrologic Indicator Results

The highest mean elevation recorded with these results was the saw palmetto edge in the vicinity of both transects (Table E1 and Figure E1). This elevation represents a definitive break between wetland and upland communities along the elevation gradient. The average elevation of all cypress buttress inflection points surveyed was **133.01 NAVD88**, abbreviated HNP ("High Normal Pool"). The average elevation of the historic soil line (HSL) is similar to the HNP, occurring relatively higher in elevation than the remaining indicators surveyed. Lichen lines (Lichen_M) and adventitious roots (AdvRoot) represent indicators of seasonal high water and associated morphological plant adaptations, respectively. Tight inter-quartile ranges of the lichen line and adventitious root elevation data demonstrate the consistency of each.

Table E1. Elevations of hydrologic indicators along Lake Hampton transects (NAVD88).

Analysis Variable: NAVD88					
HI_abbrev	N	Mean	Std Dev	Minimum	Maximum
AdvRoot	5	129.98	0.21	129.72	130.29
HNP	20	**133.01**	0.30	132.57	133.73
HSL	9	132.16	0.52	131.59	133.20
Lichen_M	5	130.73	0.08	130.60	130.81
Palmetto	5	135.89	0.25	135.47	136.11

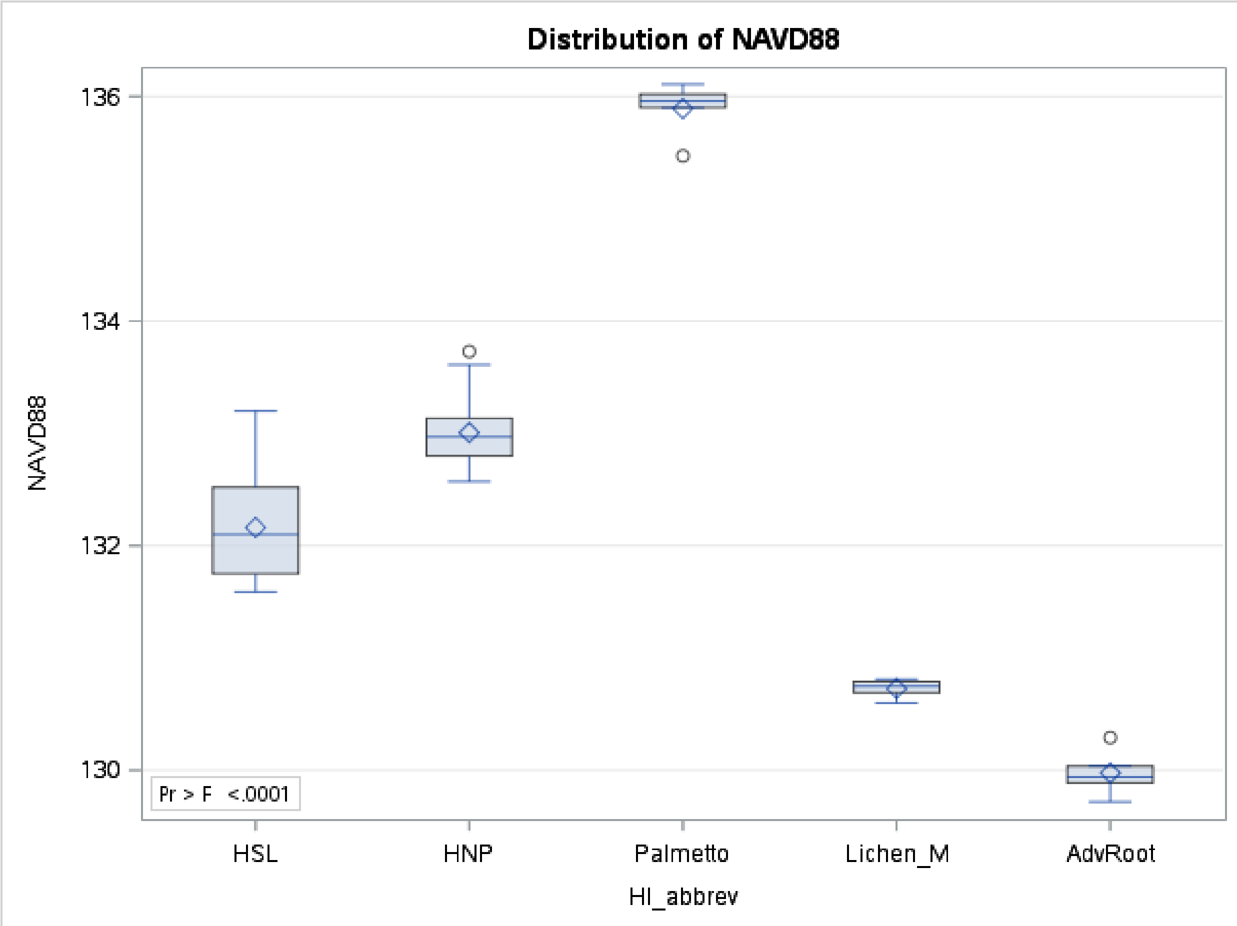

Figure E1. Distribution of elevations across Lake Hampton hydrologic indicators.

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