TECHNICAL PUBLICATION SJ2009-4

MINIMUM LEVELS REEVALUATION: LAKE ASHBY, VOLUSIA COUNTY, FLORIDA

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT

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MINIMUM LEVELS REEVALUATION: LAKE ASHBY, VOLUSIA COUNTY, FLORIDA

by

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Palatka, Florida

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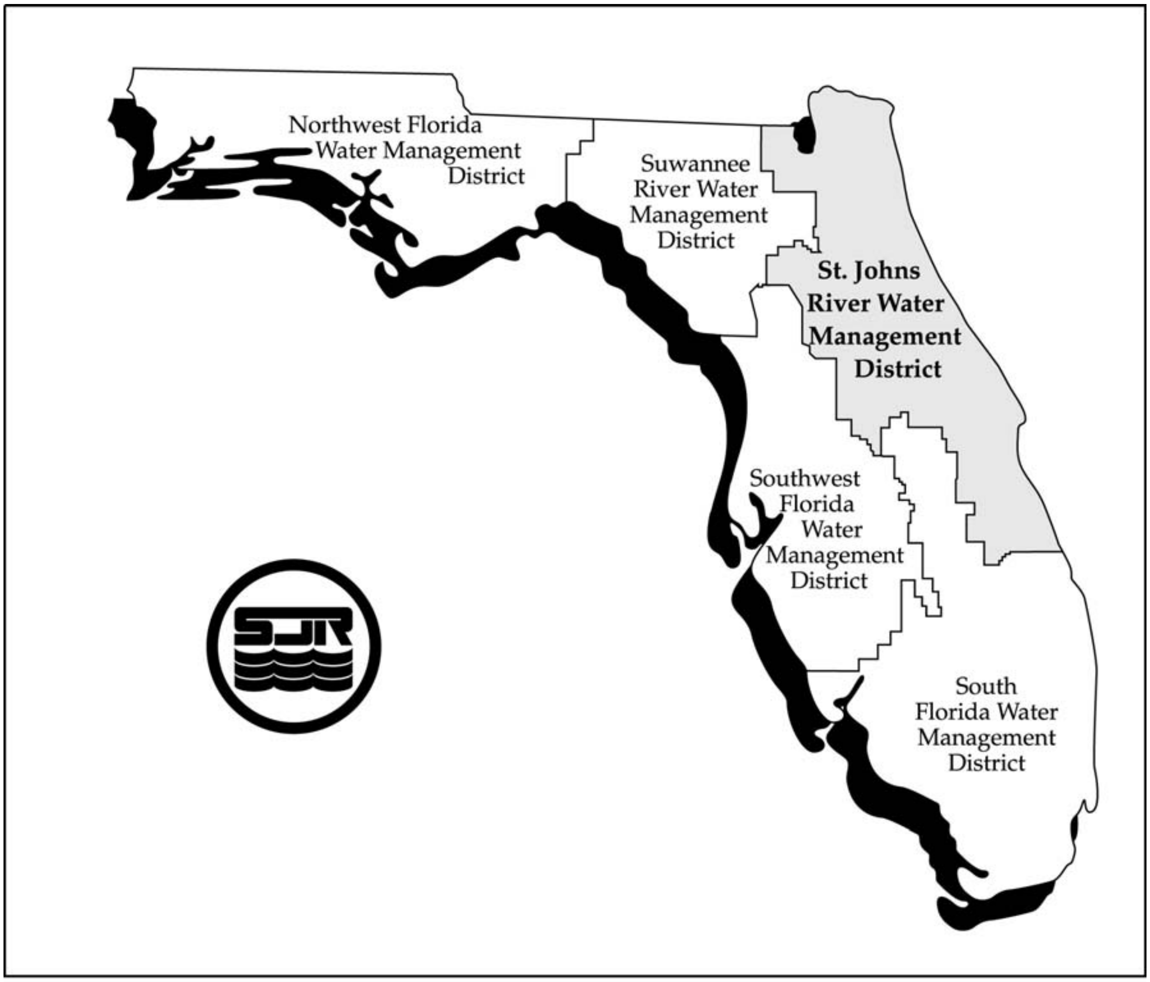

The St. Johns River Water Management District (SJRWMD) was created by the Florida Legislature in 1972 to be one of five water management districts in Florida. It includes all or part of 18 counties in northeast Florida. The mission of SJRWMD is to ensure the sustainable use and protection of water resources for the benefit of the people of the District and the state of Florida. SJRWMD accomplishes its mission through regulation; applied research; assistance to federal, state, and local governments; operation and maintenance of water control works; and land acquisition and management.

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EXECUTIVE SUMMARY

This report presents the St. Johns River Water Management District's (SJRWMD's) reevaluation of the minimum flows and levels (MFLs) determination for Lake Ashby, Volusia County (Table ES-1), Florida. The established MFLs were adopted in 1998 based on work performed by Valentine-Darby (1997, Appendix A).

The levels established in 1998 have been reevaluated in light of a hydrologic model (CDM 2003) that was not available then, when current levels were adopted. The model results indicate that the minimum frequent high and minimum average levels established in 1998 are not set correctly.

Table ES-1. Adopted and recommended minimum surface water levels for Lake Ashby, Volusia County

Minimum Level	Adopted Elevation (ft NGVD)	Adopted Hydroperiod Categories	Recommended Elevation (ft NGVD)	Recommended Hydroperiod Categories	Recommended Duration	Recommended Return Interval
Minimum frequent high level (FH)	13.8	Temporarily flooded	12.3	Seasonally flooded	60 days	2 years
Minimum average (MA)	12.1	Typically saturated	N/A	—	—	—
Minimum frequent low level (FL)	11.1	Semi-permanently flooded	11.1	Semi-permanently flooded	120 days	5 years

ft NGVD = feet National Geodetic Vertical Datum

The SJRWMD multiple MFLs method (SJRWMD 2006a; Neubauer et al. 2008) was used to determine the recommended minimum lake levels. SJRWMD determines recommended MFLs based on the evaluation of topography and soils as well as data collected from vegetation within plant communities associated with the water body. Hydroperiod categories, which describe the seasonal and cyclical patterns of water in a wetland, are defined from adaptations of water regime modifiers developed by Cowardin et al. (1979). Results presented in this report are considered recommended until the MFLs are adopted by the water management district's Governing Board as rule, in accordance with Chapter 40C-8, *Florida Administrative Code (F.A.C.).*

The recommended minimum frequent low level for Lake Ashby is a stage elevation of 11.1 feet (ft) National Geodetic Vertical Datum (NGVD) and a hydroperiod category of semipermanently flooded (Table ES-1). This elevation represents the upper limit of the deep marsh community and is the same as the adopted level recorded in the previous determination (Valentine-Darby 1997). This level provides sufficient water depths within the deep marsh communities to provide refugia and nesting habitat for fish and other aquatic species.

No minimum average is proposed for Lake Ashby because the lake spends little time at an elevation range relevant to the minimum average; this is on account of drainage canals that have created a cyclical hydrologic regime of rapid rise during storm events followed by rapid decline.

The recommended minimum frequent high level for Lake Ashby is a stage elevation of 12.3 ft NGVD and a hydroperiod category of seasonally flooded (Table ES-1). The minimum frequent high stage elevation of 12.3 ft NGVD for a seasonally flooded hydroperiod represents the grand mean of the mean surface community elevations in the hardwood swamps. The difference in the adopted and recommended minimum frequent high levels is a result of using a hydroperiod category of seasonally flooded, which is more appropriate than temporarily flooded for a lake with a cyclical hydrologic regime of rapid rise during storm events followed by rapid decline.

The hydrologic model for Lake Ashby was calibrated for 2002 conditions. These conditions included the most recent land use information and groundwater levels consistent with 2002 regional water use. Based on hydrologic model results, SJRWMD concludes that the recommended MFLs for Lake Ashby are protected under 2002 conditions. To determine if changes in groundwater use allocations subsequent to 2002 would cause lake levels to fall below the recommended MFLs for Lake Ashby, the existing Lake Ashby hydrologic model should be run using Floridan aquifer potentiometric level declines that reflect these changes in water use allocation.

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INTRODUCTION

This report presents the St. Johns River Water Management District's (SJRWMD's) reevaluation of the minimum flows and levels (MFLs) determination for Lake Ashby, Volusia County, Florida. The existing MFLs were adopted in 1998 based on work performed by Valentine-Darby (1997, Appendix A).

At the time of determination of the existing MFLs, a hydrologic model was not available to assess whether water levels in Lake Ashby were meeting these MFLs. Subsequently a hydrologic model for the lake was developed (CDM 2003). Application of the model indicated that the water level of Lake Ashby was below the established MFLs. Therefore, SJRWMD commenced reevaluation of the MFLs to determine if they were correctly set based on current, best available information.

MFLS PROGRAM OVERVIEW

The SJRWMD minimum flows and levels program, based on the requirements of Section 373.042 and Section 373.0421, *Florida Statutes* (F.S.), develops recommended MFLs for lakes, streams and rivers, wetlands, springs, and aquifers. Furthermore, the MFLs program is subject to the provisions of Chapter 40C-8, *Florida Administrative Code* (*F.A.C.*), and provides technical support to SJRWMD's regional water supply planning process (Section 373.0361, F.S.), and the consumptive use permitting (Chapter 40C-2, *F.A.C.*) and the environmental resource permitting (Chapter 40C-4, *F.A.C.*) programs.

Based on the provisions of Rule 40C-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.*).

Factors to Be Considered When Determining MFLs

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, nonconsumptive uses, and environmental values associated with coastal, estuarine, riverine, spring, aquatic, and wetlands ecology, including:

- Recreation in and on the water (Rule 62.40.473(1)(a), *F.A.C.*)

- Fish and wildlife habitats and the passage of fish (Rule 62.40.473(1)(b), *F.A.C.*)
- Estuarine resources (Rule 62.40.473(1)(c), *F.A.C.*)
- Transfer of detrital material (Rule 62.40.473(1)(d), *F.A.C.*)
- Maintenance of freshwater storage and supply (Rule 62.40.473(1)(e), *F.A.C.*)
- Aesthetic and scenic attributes (Rule 62.40.473(1)(f), *F.A.C.*)
- Filtration and absorption of nutrients and other pollutants (Rule 62.40.473(1)(g), *F.A.C.*)
- Sediment loads (Rule 62.40.473(1)(h), *F.A.C.*)
- Water quality (Rule 62.40.473(1)(i), *F.A.C.*)
- Navigation (Rule 62.40.473(1)(j), *F.A.C.*)

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.”

Hydrology

MFLs designate an environmentally protective hydrologic regime (i.e., hydrologic conditions that prevent significant ecological 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 criteria, and indicators that prevent significant harm to aquatic and wetland habitats. Three MFLs are usually defined for each system—minimum frequent high, minimum average, and minimum frequent low—flows and/or water levels. If deemed necessary, minimum infrequent high and/or minimum infrequent low flows and/or water levels also are defined. 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). SJRWMD has historically synthesized the continuous duration and frequency components of the MFLs into seven discrete hydroperiod categories to facilitate MFLs determinations for lakes and wetlands. However, for MFLs associated with reevaluations of established MFLs and MFLs for water bodies for which MFLs have not been previously established, these hydroperiod categories are now being replaced with specific duration and return interval values (Table 1).

Table 1. MFL hydroperiod categories and 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

MFLs are water levels and/or flows that primarily serve as hydrologic constraints for water supply development, but they may also apply in environmental resource permitting (Figure 1). MFLs take into account the ability of wetlands and aquatic communities to adjust to changes in the return intervals of high and low water events. Therefore, MFLs allow for an acceptable level of change to occur relative to the existing hydrologic conditions (gray-shaded area, Figure 1). However, when use of water resources shifts the hydrologic conditions below that defined by the MFLs, significant ecological harm occurs (Figure 1).

As it applies to wetland and aquatic communities, significant harm is a function of changes in the frequencies of water level and/or flow events of defined duration, causing impairment or loss of ecological structures and functions. Significant harm can be prevented if water withdrawals do not cumulatively alter the hydrology beyond the minimum hydrologic regime defined by the MFLs.

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 the likelihood they might cause significant harm. Actual or projected instances where water levels fall below established MFLs may require the SJRWMD 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.).

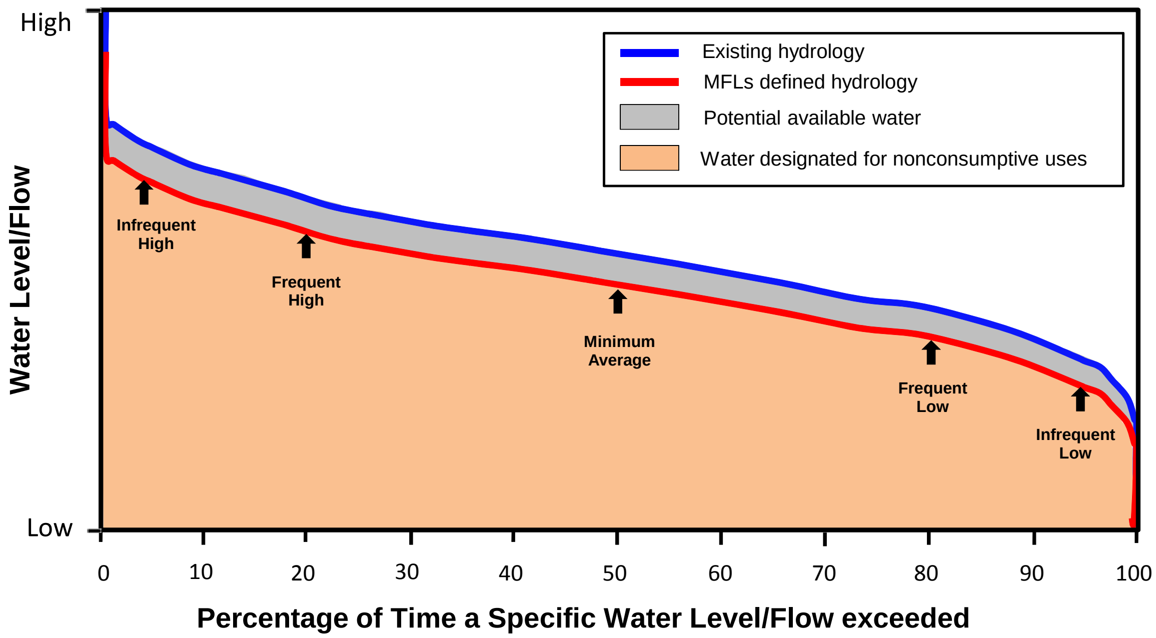

Figure 1. Hypothetical percentage exceedence curves for existing and MFLs-defined hydrologic conditions

MANAGEMENT CONCERNS

Lake Ashby is within the priority water resource caution area designated by SJRWMD in the 1998 *District Water Supply Assessment* (Vergara 1998). Further, according to groundwater model projections in *Water Supply Assessment, 2003* (SJRWMD 2006b), the surficial aquifer at Lake Ashby may be affected by a decline of 0.35 ft to 1.0 ft below existing long-term conditions by the year 2025, if the proposed water supply plans of major users are implemented. Management consideration should also be given to the protection of surface water quality (Rule 40C-8.011(4), *F.A.C.*), because the lake has a trophic status index (TSI) of good (FDEP 2000).

LAKE HYDROLOGY

Lake Ashby is located about 5 miles northeast of Osteen (Figure 2) in the Deep Creek Unit (4B) of the Middle St. Johns River Basin (Adamus et al. 1997) and the St. Johns Wet Prairie Physiographic Division (1d) of the Eastern Flatwoods District (Brooks 1982). A technical memorandum, prepared for SJRWMD by consultant Camp

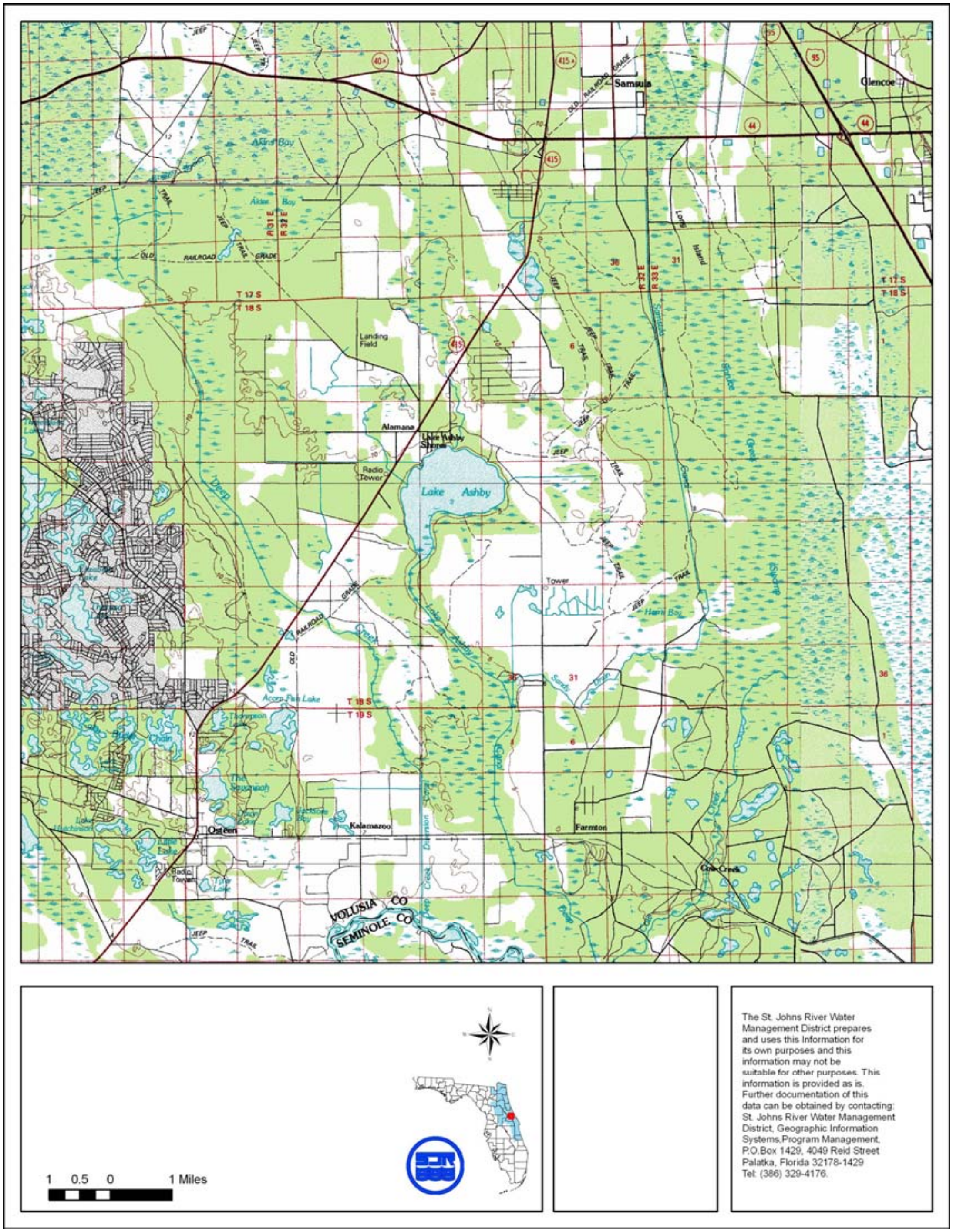

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Figure 2. Lake Ashby, Volusia County, Florida

Dresser and McKee Inc., summarizes lake hydrology and basin characteristics (CDM 2003). The open water area of the lake is approximately 872 acres at a lake stage of 11 ft NGVD. The watershed area for the lake is approximately 16,309 acres; eight canals drain the tributary area to the lake. The largest canal has an approximately 5.7-mile primary channel with 9.3 miles of tributaries that extend over nearly one-half of the drainage basin. The lake discharges through a canal and Deep Creek 10.5 miles to the St. Johns River. Hydrologic simulations from 1963 through 2002 provide the long-term hydrologic behavior of the lake under existing conditions. Lake stage ranges from a maximum of 16 ft NGVD to a minimum of 10.2 ft NGVD, with an annual fluctuation of about 5 ft (Figures 3.1 and 3.2). The wide-ranging stage fluctuation is typical of a lake with both high stormwater flow and low base flow coupled with a lowered outfall.

Interaction with groundwater varies from discharge near the lake to moderately high recharge (Boniol et al. 1993; Figure 4). Recharge is greatest in the sand hills of the southern extent of the Crescent City–DeLand Ridge that forms the northeastern border of the tributary basin (see CDM 2003; Figure 2). The extensive canal drainage carries storm water quickly out of the basin, reducing the potential for recharge.

SOILS

The Soil Conservation Service of the U.S. Department of Agriculture (USDA–SCS 1980) has delineated six types of hydric soils adjacent to Lake Ashby. As reported in Valentine-Darby (1997) and field soil observations here, however, there is poor correspondence with the mapped soils.

WETLANDS

Field inspection and the SJRWMD 1995 map of wetlands vegetation for Lake Ashby indicate that wetland communities adjacent to the lake consist of cypress, hardwood swamp, bay heads, hydric hammocks, forested flatwoods depressions, wet prairie, mixed shrub swamps, shallow marshes, and deep marshes (Figure 5). Kinser (1996) describes the typical vegetative characteristics of equivalent wetlands and their associated hydrologic conditions. Deep marshes are deep-water wetlands dominated by a mixture of water lilies and deep-water emergent plant species. This community is semipermanently to permanently flooded. Shallow marshes are herbaceous or graminoid communities that occur most often on organic soils that are subject to lengthy seasonal inundation. Shrub swamps are dominated by broad-leaved deciduous shrubs, such as willows and buttonbush, and have soils that are subject to annual/seasonal periods of prolonged flooding. Hardwood swamps are forested wetlands dominated by one or more deciduous hardwood species (cypress is often a significant component) and soils are subject to annual/seasonal periods of prolonged

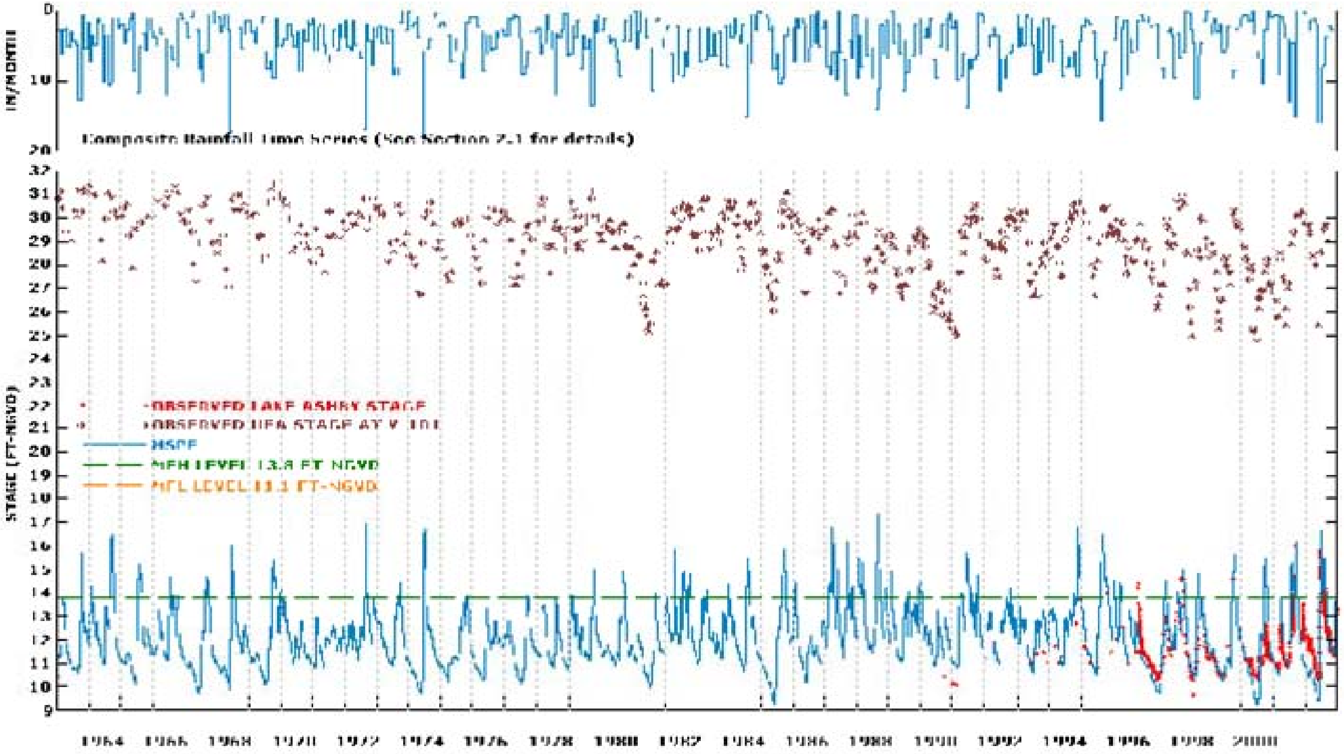

Figure 3.1. Long-term modeled hydrograph of Lake Ashby (CDM 2003)

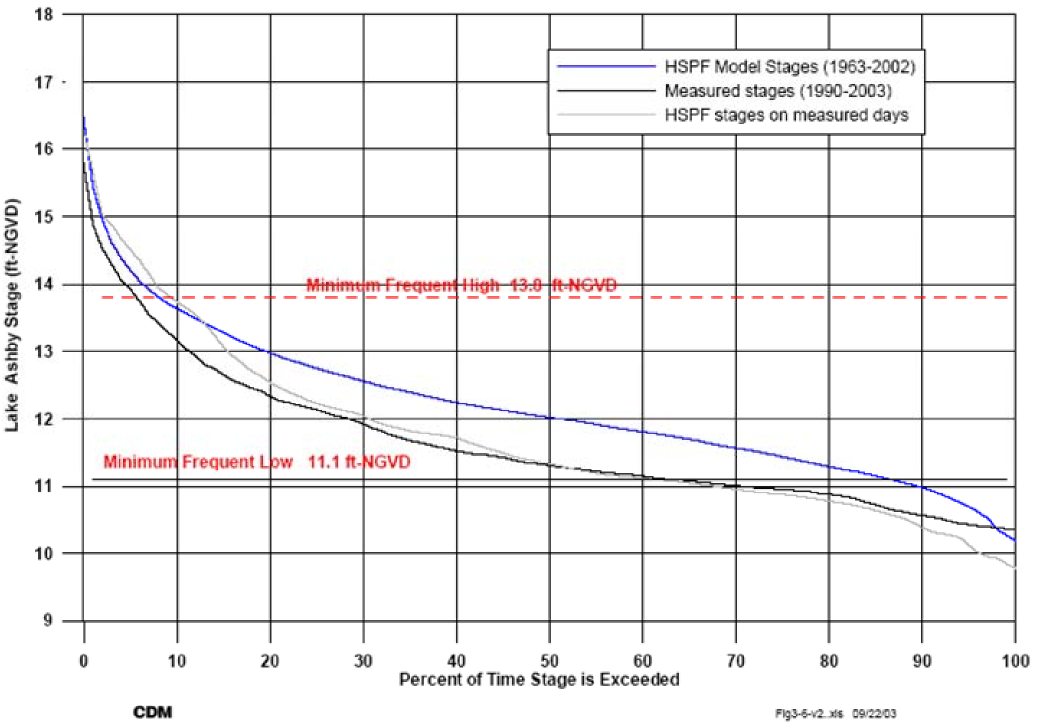

Figure 3.2. Stage duration curves for Lake Ashby (CDM 2003)

flooding. Hydric hammocks are forested systems dominated by a mixture of broadleaf evergreen and deciduous tree species. The soils are seldom inundated but are saturated during much of the year.

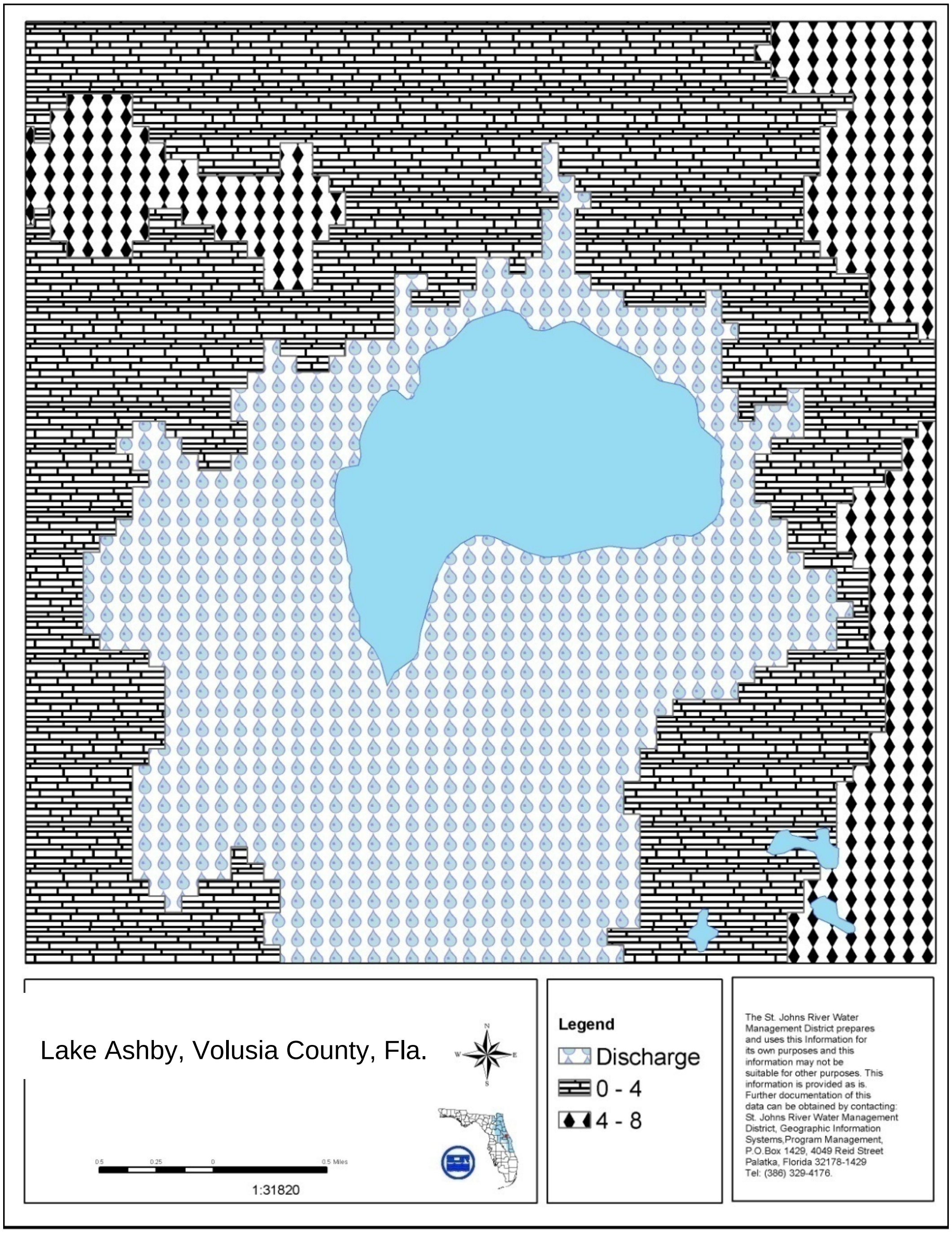

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Figure 4. Recharge map for Lake Ashby area, Volusia County, Florida
Data source: Recharge areas of the Floridan aquifer in the St. Johns River Water Management District *(www.sjrwmd.com)*

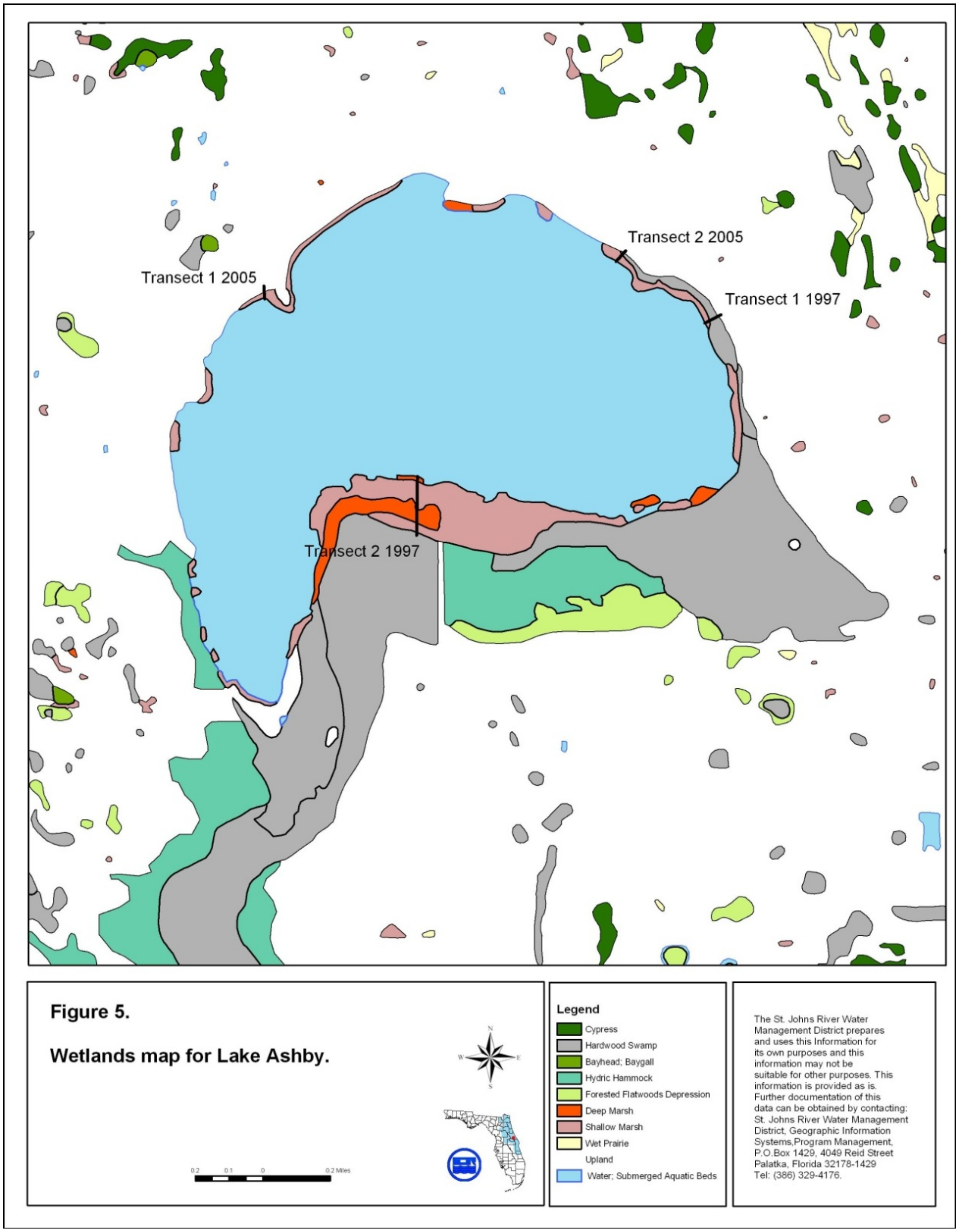

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Figure 5. Wetlands in Lake Ashby area, Volusia County, Florida
Data source: Wetlands vegetation and inventory, St. Johns River Water Management District (www.sjrwmd.com)

MFLS METHODOLOGY

Minimum flows and levels (MFLs) determinations incorporate biologic, soils, and topographic data collected in the field with information from the scientific literature to develop a recommended MFLs hydrologic regime. The MFLs methodology provides a process for incorporating these factors.

This section describes the MFLs methodology and assumptions used in the minimum levels reevaluation process for Lake Ashby, including field procedures such as site selection, field data collection, data analyses, and levels determination criteria. The SJRWMD general MFLs methodology is described more completely in the Minimum Flows and Levels Methods Manual (SJRWMD 2006a).

FIELD TRANSECT SITE SELECTION

Many factors are considered in the selection of field transect sites. Transects are fixed sample lines across a river, lake, or wetland floodplain. Transects usually extend from open water to uplands, along which elevation, soils, and vegetation are sampled to characterize the influence of surface water flooding on the distribution of soils and plant communities.

Field site selection begins with the implementation of a site history survey and data search. All available existing information is assembled, including:

- On-site and regional vegetation surveys and maps
- Aerial photography (existing and historical)
- Remote sensing (vegetation, land use, etc.) and topographic maps
- Soil surveys, maps and descriptions
- Hydrologic data (hydrographs and stage duration curves)
- Environmental, engineering, or hydrologic reports
- Topographic survey profiles
- Occurrence records of rare and endangered flora and fauna

These data were reviewed for Lake Ashby to familiarize the investigator with site characteristics and to locate important basin features that needed to be evaluated, as well as to assess prospective sampling locations. Copies of this information were organized and placed in permanent files for future reference and archiving.

Potential transect locations at Lake Ashby were initially identified from maps of wetlands, soils, and topography. Specific transect site selection goals included:

- Establishing transects at sites where multiple wetland communities of the most commonly occurring types were traversed.
- Selecting multiple transect locations with common wetland communities among them.
- Establishing transects that traverse unique wetland communities.

Transect characteristics were subsequently field-verified to ensure that the transect locations contained representative wetland communities, hydric soils, and reasonable upland access.

FIELD DATA COLLECTION

The field data collection procedure for determining MFLs involved gathering information and sampling elevation, soils, and vegetation data along fixed transects, across a hydrologic gradient. Transects were established in areas where there are changes in vegetation and soils, and the hydrologic gradient was marked (SJRWMD 2006a). The main purpose in using transects in these situations, where the change in vegetation and soils is clearly directional, was to describe maximum variations over the shortest distance in the minimum time (Martin and Coker 1992).

Site Survey

Upon selection of a transect site at Sylvan Lake, vegetation was trimmed to allow a line-of-sight along the length of the transect. A measuring tape was then laid out along the length of the transect. Elevation measurements were recorded at various length intervals (5 ft, 10 ft, and 20 ft) to adequately characterize the topography and transect features. Additional elevations were measured, including obvious elevation changes, vegetation community changes, soil changes, high water marks, and at bases of trees.

Latitude and longitude were collected with a global positioning system (GPS) receiver at selected points along the length of the Sylvan Lake transects. These data will be used to accurately locate specific features along each transect and facilitate recovering transect locations in the future.

Soil Sampling Procedures

Detailed soil profiles were described along each transect to gain an understanding of past and present hydrologic, geologic, and anthropogenic processes that have occurred, resulting in the observed transect soil features. Soil profiles were described following standard Natural Resources Conservation Service (NRCS) procedures

(USDA, NRCS 2002). Each soil horizon (unique layer) was generally described with respect to texture, thickness, Munsell color (Kollmorgen Corp. 1992), structure, consistency, boundary, and presence of roots.

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 2006a). 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, using the completed soil description, specifying which hydric soil indicators have been matched.
- Performing deeper examination of soil where field indicators are not easily seen within 20 in. of the surface. (It is always recommended that soils be excavated and described as deeply 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 1998).

Additional soil sampling procedures are documented in the Minimum Flows and Levels Methods Manual (SJRWMD 2006a).

Vegetation Sampling Procedures

SJRWMD has wetland maps developed from aerial photography utilizing a unique wetland vegetation classification system. SJRWMD’s Wetland Vegetation Classification System (Kinser 1996) was used to standardize the names of wetland plant communities sampled in MFLs fieldwork and in developing reports documenting the MFLs determination.

The spatial extent of plant communities or transition zones (i.e., ecotones) between plant communities was determined using reasonable scientific judgment. Reasonable scientific judgment involves the ability to collect and analyze information using technical knowledge, and personal skills and experience to serve as a basis for decision making (Gilbert et al. 1995). In this case, such judgment was based upon field observations of relative abundance of dominant plant species, occurrence and distribution of soils and hydric soil indicators, and changes in land slope or elevation along the hydrologic gradient. Plant communities and transition zones were delineated along a specialized line transect called a belt transect. A belt transect is a line to form a long, thin, rectangular plot divided into smaller sampling areas called quadrats that correspond to the spatial extent of plant communities or transitions between plant communities (Figure 9). The belt transect width will vary depending upon the type of plant community to be sampled (SJRWMD 2006a). For example, a belt width of 10 ft (5 ft on each side of the transect line) may suffice for sampling herbaceous plant communities of a floodplain marsh. However, a belt width of 50 ft (25 ft on each side of the line) may be required to adequately represent a forested community (e.g., hardwood swamp, Figure 9).

Plants were identified and the percent cover of plant species was estimated if they occurred within the established belt width for the plant community under evaluation (quadrat). Percent cover is defined as the vertical projection of the crown or shoot area of a plant to the ground surface and is expressed as a percentage of the quadrat area. 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 the number of individuals. The canopies of the plants inside the quadrat will often overlap each other, so the total percent cover of plants in a single quadrat will frequently sum to more than 100% (SJRWMD 2006a).

Percent cover was estimated visually using cover classes (ranges of percent cover). The cover class and percent cover ranges (Table 2) are a variant of the Daubenmire method (Mueller-Dombois and Ellenberg 1974) and are summarized in SJRWMD's Minimum Flows and Levels Methods Manual (SJRWMD 2006a). Plant species, plant communities, and percent cover data were recorded on field vegetation data sheets. The data sheets were formatted to facilitate data collection in the field and computer transcription.

Table 2. Summary of cover classes and percent cover ranges

Cover Class	Percentage Cover Range	Descriptor
0	< 1 %	Rare
1	1–10 %	Scattered
2	11–25 %	Numerous
3	26–50 %	Abundant
4	51–75 %	Co-dominant
5	> 75 %	Dominant

DATA ANALYSIS

The primary data analysis for information collected at Lake Ashby consisted of using a computer spreadsheet file to perform basic statistical analyses on the surveyed elevation data. Vegetation and soils information collected along transects were incorporated with the elevation data. Descriptive statistics were calculated for the elevations of the vegetation communities and specific hydric soil indicators.

Transect elevation data were also graphed to illustrate the elevation profile between the open water and upland communities. The locations of the vegetation communities along the transect together with a list of dominant species, statistical results, and soils information were labeled on the graph.

CONSIDERATION OF ENVIRONMENTAL VALUES IDENTIFIED IN RULE 62-40.473, *F.A.C.*

In establishing MFLs for water bodies pursuant to Section 373.042 and Section 373.0421, F.S., SJRWMD identifies the environmental value or values most sensitive to long-term changes in the hydrology of each water body/course. SJRWMD then typically defines the minimum number of flood events and maximum number of dewatering events that would still protect the most sensitive environmental value or values. For example, for water bodies/courses for which the most sensitive environmental values may be wetlands and organic substrates, recommended MFLs would reflect the number of flooding or dewatering events that allow for no net loss of wetlands and organic substrates. By protecting the most sensitive environmental value or values for each water body/course, the 10 environmental values identified in Rule 62-40.473, *F.A.C.*, are considered to be protected.

SJRWMD uses the following working definitions when considering these 10 environmental values:

1. Recreation in and on the water—The active use of water resources and associated natural systems for personal activity and enjoyment; these legal water sports and activities may include, but are not limited to swimming, scuba diving, water skiing, boating, fishing, and hunting.
2. Fish and wildlife habitat and the passage of fish—Aquatic and wetland environments required by fish and wildlife, including endangered, endemic, listed, regionally rare, recreationally or commercially important, or keystone species; to live, grow, and migrate; these environments include hydrologic magnitudes, frequencies, and durations sufficient to support the life cycles of wetland and wetland-dependent species.

3. Estuarine resources—Coastal systems and their associated natural resources that depend on the habitat where oceanic salt water meets freshwater; these highly productive aquatic systems have properties that usually fluctuate between those of marine and freshwater habitats.
4. Transfer of detrital material—The movement by surface water of loose organic material and associated biota.
5. Maintenance of freshwater storage and supply—The protection of an amount of freshwater supply for permitted users at the time of MFLs determinations.
6. Aesthetic and scenic attributes—Those features of a natural or modified waterscape usually associated with passive uses, such as bird-watching, sightseeing, hiking, photography, contemplation, painting and other forms of relaxation, that usually result in human emotional responses of well-being and contentment.
7. Filtration and absorption of nutrients and other pollutants—The reduction in concentration of nutrients and other pollutants through the process of filtration and absorption (i.e., removal of suspended and dissolved materials) as these substances move through the water column, soil or substrate, and associated organisms.
8. Sediment loads—The transport of inorganic material, suspended in water, which may settle or rise; these processes are often dependent upon the volume and velocity of surface water moving through the system.
9. Water quality—The chemical and physical properties of the aqueous phase (i.e., water) of a water body (lentic) or a watercourse (lotic) not included in definition number 7 (i.e., nutrients and other pollutants).
10. Navigation—The safe passage of watercraft (e.g., boats and ships), which is dependent upon adequate water depth and width.

CONSIDERATION OF BASIN ALTERATIONS IN ESTABLISHING MFLS

Based on the provisions of Section 373.0421(1)(a), F.S., when establishing MFLs, SJRWMD 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, SJRWMD cannot allow harm caused by withdrawals. To accomplish this, SJRWMD 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.

SJRWMD 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.

SJRWMD 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 instantaneously to changes in hydrology that are sufficiently large to cause such change. SJRWMD 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.

SJRWMD also provides for the collection and evaluation of additional data subsequent to the establishment of MFLs. SJRWMD uses this data collection and evaluation as the basis of determining if the MFLs are protecting the water resources or if the MFLs are appropriately set. If SJRWMD determines, based on modeling and this data collection and evaluation process, that MFLs have not been appropriately set, SJRWMD can establish revised MFLs.

If SJRWMD determines that recommended MFLs cannot be met under post-change hydrologic conditions due to existing structural alterations, SJRWMD may consider whether feasible structural or nonstructural changes, such as changes in the operating schedules of water control structures, can be accomplished such that the recommended MFLs can be met. In such cases, SJRWMD may identify a recovery strategy that includes feasible structural or nonstructural changes.

MFLS COMPLIANCE ASSESSMENT

A hydrologic model for Lake Ashby was developed to provide a means of assessing whether compliance with MFLs is achieved under specific water use and land use conditions (CDM 2003). This hydrologic model was calibrated for 2002 conditions.

These conditions included the most recent land use information and groundwater levels consistent with 2002 regional water use.

An explanation of the use of this hydrologic model and the applicable SJRWMD regional groundwater flow model to assess whether water levels are likely to fall below MFLs under specific water use and land use conditions is presented in Appendix A. This appendix also includes an introduction to the use of hydrologic statistics in the SJRWMD MFLs program.

RESULTS AND DISCUSSION

The recommended minimum levels are derived from the topographic data for vegetative communities observed at four shoreline transects (Figure 6). Field data for Transects 1 and 2 were collected on July 6 and 13, 2005, respectively. Lake stage was determined by using staff gauge readings referenced to SJRWMD-surveyed benchmarks. Lake stage was 15.48 ft NGVD on July 6, 2005, and 15.11 ft NGVD on July 13, 2005. Transects 1 and 2 from the original fieldwork for vegetation, on August 27 and September 3, 1997 (Valentine-Darby 1997), are considered in this analysis.

Identification of wetland plant community types was based on Kinser (1996). Community transitions were based on shifts in species compositions and their hydrologic requirements (see Tobe et. al. 1998). Along the transect, the percent cover of each species occurring within a community was recorded and an auger survey of soils conducted. The soil survey identified the beginning points of occurrence for the following hydric soil indicators (USDA–NRCS 1998): stripped matrix, organic bodies, dark surface, mucky-mineral, muck, and histosol soil. A complete discussion of the field methods can be found in SJRWMD (2006a).

FIELD DATA COLLECTION—TRANSECT 1

Transect 1, in 2005, was located in forested wetlands on the northwestern shoreline (Figure 7). The point-of-beginning (POB) of the transect was 19.1 ft NGVD in disturbed uplands below a hard-surface road within the Lake Ashby Mobile Home Park. A live oak (*Quercus virginiana*) overstory characterized the uplands. A flatwoods depression extended from 17.2 ft to 14.3 ft NGVD. The presence of fresh-cut stumps indicated that, before the 2004 hurricane season, slash pine (*Pinus elliottii*) dominated the upland and flatwoods depression communities. A groundcover of ornamental and exotic species was found to characterize these communities after the pine trees were cleared (Table 3.1). A dirt-filled pathway at the lower edge of the depression was a permanent disturbance forming a shallow impoundment. Muck soils were found in the depression only. Soils in the remainder of the transect were mucky-mineral sand and dark-surface sand. A hydric hammock extends from 14.3 ft to 12.5 ft NGVD. The canopy was characterized by slash pine (*Pinus elliottii*), laurel oak (*Quercus laurifolia*), bald cypress (*Taxodium distichum*) and pond cypress (*Taxodium ascendens*) with a midstory of swamp dogwood (*Cornus foemina*) and wax myrtle (*Myrica cerifera*). The hardwood swamp terminated in open water and a shoreline sandbar, with a mean elevation of 13.6 ft NGVD and a delta. The hardwood swamp was dominated by bald cypress (*Taxodium distichum*) and pond cypress (*Taxodium ascendens*), with a midstory of swamp dogwood (*Cornus foemina*) and

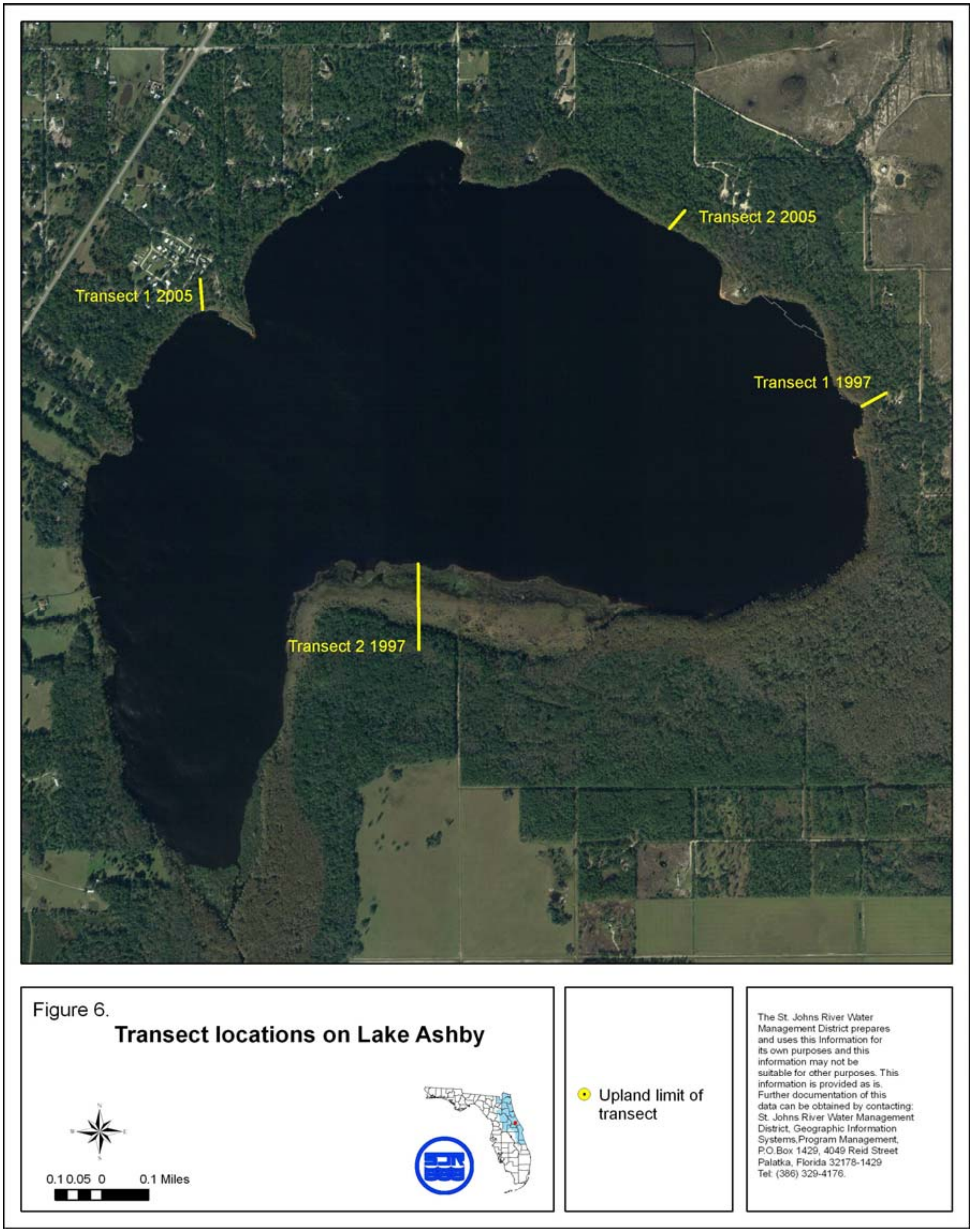


Figure 6. Transect locations on Lake Ashby

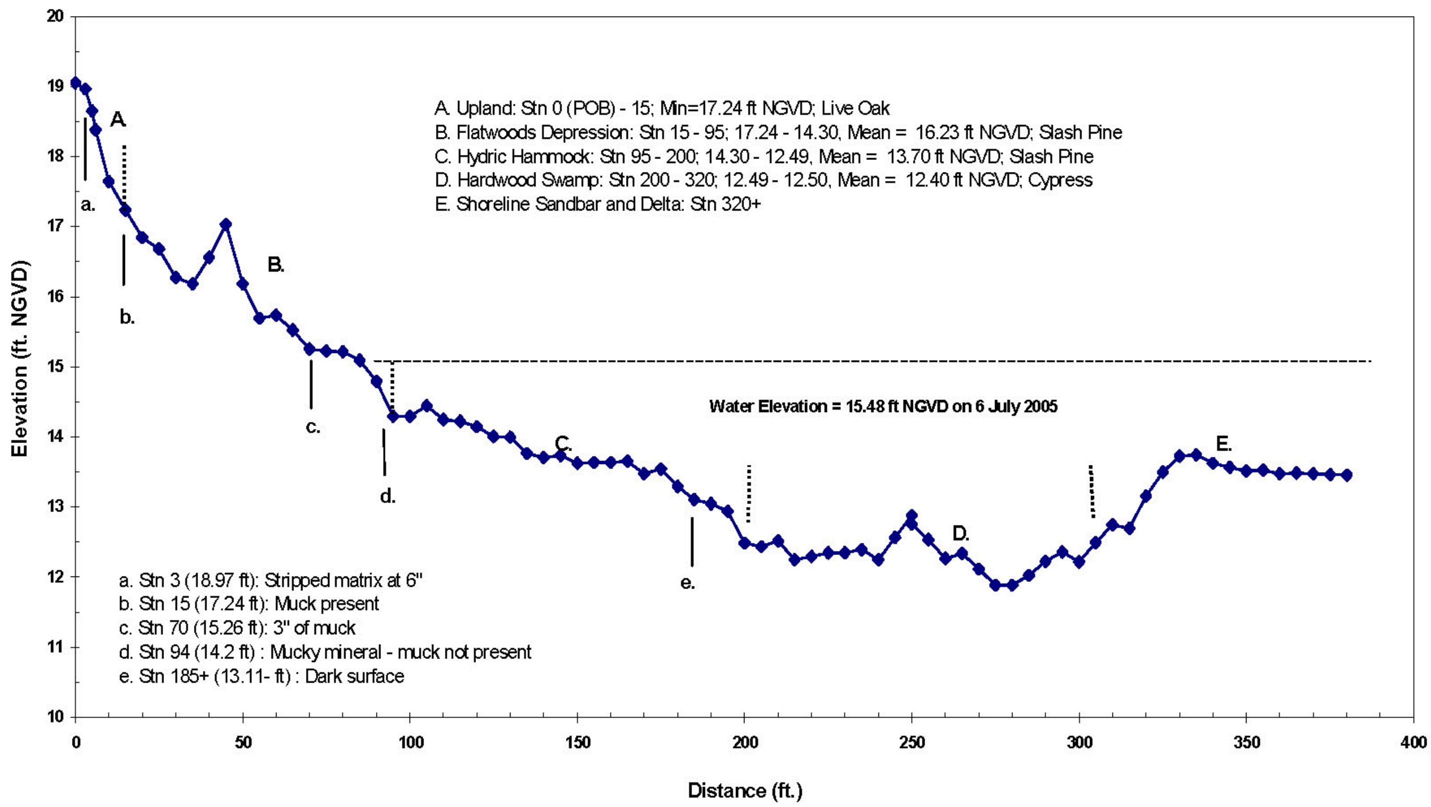


Figure 7. Lake Ashby vegetation and soil transect 1 (2005)

Table 3.1. Plant communities and associated species observed in Transect 1 (2005), Lake Ashby

Species	Hydric Designation	Upland POB–15	Forested Depression 15–45	Hydric Hammock 45–200	Hardwood Swamp 200–360
Red maple *Acer rubrum*	FACW			1	3
Pepper vine *Ampelopsis arborea*	UPL	1			
Groundnut *Apios americana*	UPL	0		0	
Marlberry *Ardisia crenata*	FAC	1			
Smallspike false-nettle *Boehmeria cylindrica*	OBL	0		0	
Caric sedge *Carex glaucescens*	FACW			0	
Hop sedge *Carex lupilina*	OBL			0	
Coinwort *Centella asiatica*	FACW		0		
Buttonbush *Cephalanthus occidentalis*	OBL			0	1
Swamp dogwood *Cornus foemina*	FACW			1	1
Split leaf philodendron *Philodenron selloum*	UPL	2			
Fireweed *Erechtites hieracifolia*	FAC		1	1	
Dog fennel *Eupatorium capillifolium*	FAC			0	
Elliott's milkpea *Galactia elliottii*	UPL		1	0	0
Bedsraw Galium *tinctorium*	FACW			0	
Dahoon holly *Ilex cassine*	OBL			0	
Virginia willow *Itea virginica*	OBL		1		
Shore rush *Juncus marginatus*	FACW			0	
Duckweed *Lemna sp.*	OBL			0	0
Sweetgum *Liquidambar styraciflua*	FACW		1		
Climbing hemp-weed *Mikania scandens*	UPL			0	0

Table 3.1—*Continued*

Species	Hydric Designation	Upland POB–15	Forested Depression 15–45	Hydric Hammock 45–200	Hardwood Swamp 200–360
Wax myrtle *Myrica cerifera*	FAC			1	1
Boston fern *Nephrolepis cordifolia*	FAC	1			
Tupelo, swamp *Nyssa sylvatica var. biflora*	OBL				0
Royal fern *Osmunda regalis*	OBL			0	0
Maidencane *Panicum hemitomon*	OBL			1	
Sour paspalum *Paspalum conjugatum*	FAC			0	
Golden polypody *Phlebodium aureum*	UPL			0	
Slash pine *Pinus elliottii*	UPL		3	2	
Braken fern Pteri*dium aquilinum*	UPL	0	1		
Mock bishop's weed *Ptilimnium capillaceum*	FACW		1	0	
Laurel oak *Quercus laurifolia*	FACW			1	1
Virginia live oak *Quercus virginiana*	UPL	3			0
Meadowbeauty *Rhexia sp.*			0		
Cabbage palm *Sabal palmetto*	FAC			0	0
Common salvinia *Salvinia minima*	OBL			1	1
Lizard tail *Saururus cernuus*	OBL		1		
Saw palmetto *Serenoa repens*	UPL	2	1		
Wild sarsaparilla Sm*ilax glauca*	UPL	0			
Bamboo-vine *Smilax laurifolia*	UPL	0		0	
Pond cypress *Taxodium ascendens*	OBL			1	2
Bald cypress *Taxodium distichum*	OBL			1	2

Table 3.1—*Continued*

Species	Hydric Designation	Upland POB–15	Forested Depression 15–45	Hydric Hammock 45–200	Hardwood Swamp 200–360
Poison ivy *Toxicodendron radicans*	UPL		1	1	
American elm *Ulmus americana*	FACW			0	
Caesar weed *Urena lobata*	UPL		0		
Muscadine grape *Vitis rotundifolia*	UPL	0	1		
Virginia chain fern *Woodwardia virginica*	FACW		0		

Note: Species hydric designations are taken from Chapter 62-340.450, *F.A.C.*

UPL = Upland
FAC = Facultative
FACW = Facultative wet
OBL = Obligate

Species not in the rule are assumed as upland (UPL), unless they are obvious aquatics; unlisted aquatic plants are designated as obligates (OBL); numbers refer to station distance (ft) from the transect point-of-beginning (POB)

Species abundance codes:

0 = <1%
1 = 1–10%
2 = 11–25%
3 = 26–50%
4 = 51–75%
5 = >75%

wax myrtle (*Myrica cerifera*) similar to that of the hydric hammock. The source of the sandbar was most likely sediment introduced into the lake through a drainage canal, located approximately 250 ft to the east.

FIELD DATA COLLECTION—TRANSECT 2

Transect 2, in 2005, was located in forested wetlands on the northeastern shoreline (Figure 8). The point-of-beginning (POB) was 17.9 ft NGVD in flatwoods depression. The flatwoods depression overstory was dominated by loblolly pine (*Pinus taeda*), water oak (*Quercus nigra*), laurel oak (*Quercus laurifolia*), cabbage palm (*Sabal palmetto*), and bald cypress (*Taxodium distichum*) (Table 3.2). Soils consisted of mucky-mineral sand and 1 inch (in.) to 6 in. of muck throughout this area of the transect and short segment of the hydric hammock. The organic soils in this

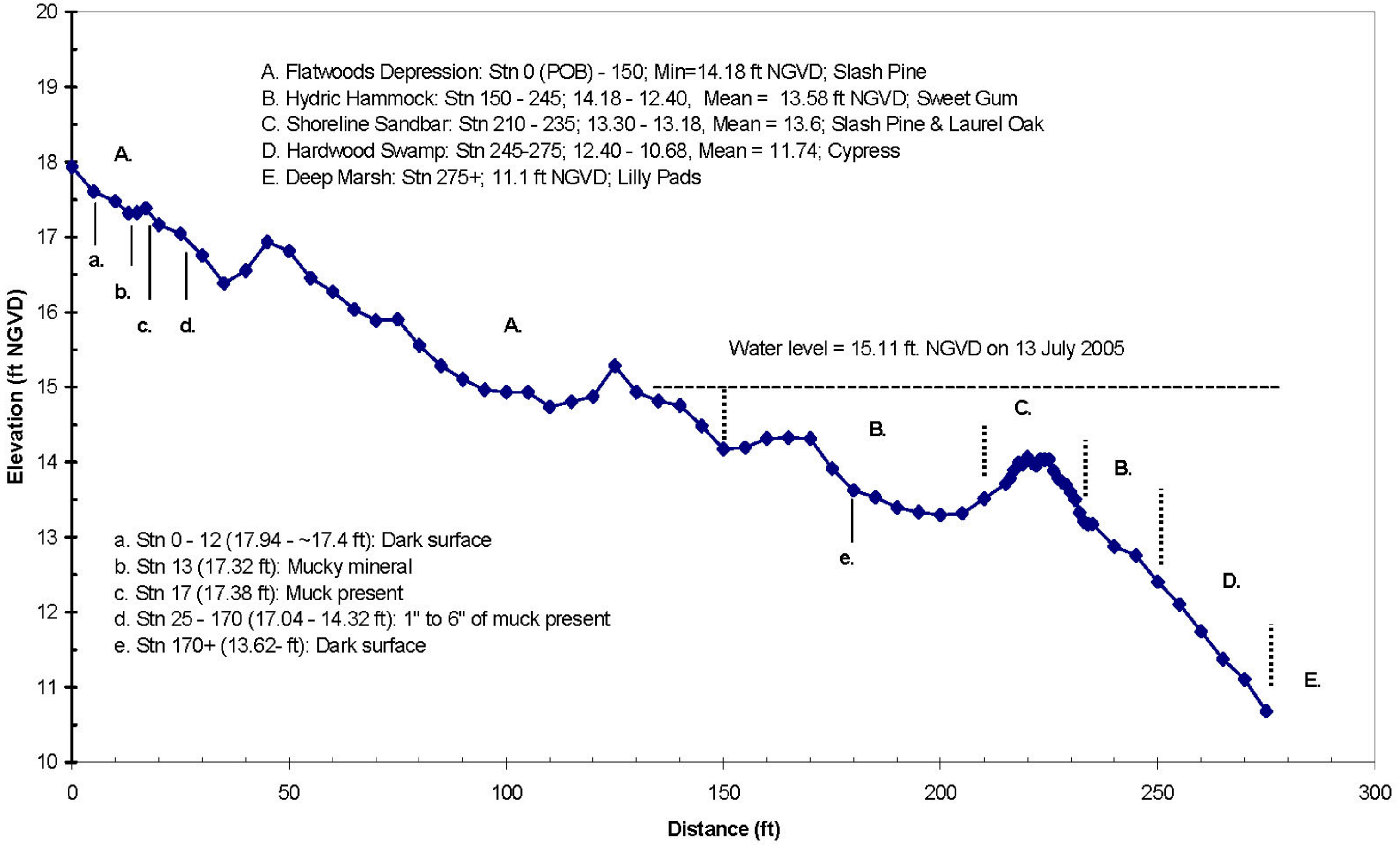


Figure 8. Lake Ashby vegetation and soil transect 2 (2005)

Table 3.2. Plant communities and associated species observed in Transect 2 (2005), Lake Ashby

Species	Hydric Designation	Forested Depression	Hydric Hammock Hardwood Swamp
Red maple *Acer rubrum*	FACW	1	1
Alligatorweed *Alternanthera philoxeroides*	OBL		0
Pepper vine *Ampelopsis arborea*	UPL	0	
Smallspike false-nettle *Boehmeria cylindrica*	OBL	0	
Buttonbush *Cephalanthus occidentalis*	OBL		1
Spanglegrass *Chasmanthium laxum*	FACW	0	
Swamp dogwood *Cornus foemina*	FACW		1
Dahoon holly *Ilex cassine*	OBL	0	
Virginia willow *Itea virginica*	OBL	0	
Sweetgum *Liquidambar styraciflua*	FACW	1	2
Climbing hemp-weed *Mikania scandens*	UPL		0
Wax myrtle *Myrica cerifera*	FAC	0	0
Royal fern *Osmunda regalis*	OBL	0	
Virginia creeper *Parthenocissus quinquefolia*	UPL	0	
Golden polypody *Phlebodium aureum*	UPL		0
Slash pine *Pinus elliottii*	UPL	1	1
Loblolly pine *Pinus taeda*	UPL	2	
Braken fern *Pteridium aquilinum*	UPL	0	
Laurel oak *Quercus laurifolia*	FACW	2	3
Water oak *Quercus nigra*	FACW	2	
Blackberry *Rubus sp.*	FAC	0	
Cabbage palm *Sabal palmetto*	FAC	2	1

Table 3.2—*Continued*

Species	Hydric Designation	Forested Depression	Hydric Hammock Hardwood Swamp
Arrowhead *Sagittaria lancifolia*	OBL	0	0
Coastal plain willow *Salix caroliniana*	OBL		0
Common salvinia *Salvinia minima*	OBL	0	
Bulrush *Scirpus sp.*	OBL		0
Greenbrier *Smilax bona-nox*	UPL	0	
Bamboo-vine *Smilax laurifolia*	UPL	0	
Pond cypress *Taxodium ascendens*	OBL		1
Bald cypress *Taxodium distichum*	OBL	1	1
Shield fern *Thelypteris palustris*	FACW	1	
Poison ivy *Toxicodendron radicans*	UPL	0	
American elm *Ulmus americana*	FACW	1	0
Deerberry *Vaccinium stamineum*	UPL	0	
Walter's viburnum *Viburnum obovatum*	FACW	0	
Muscadine grape *Vitis rotundifolia*	UPL	0	
Virginia chain fern *Woodwardia virginica*	FACW	1	

Note: Species hydric designations are taken from Rule 62-340.450, *F.A.C.*

UPL = Upland
FAC = Facultative
FACW = Facultative wet
OBL = Obligate

Species not in the rule are assumed as upland (UPL), unless they are obvious aquatics; unlisted aquatic plants are designated as obligates (OBL); numbers refer to station distance (ft) from the transect point-of-beginning (POB).

Species abundance codes:
0 = <1%
1 = 1–10%
2 = 11–25%
3 = 26–50%
4 = 51–75%
5 = >75%

portion of the transect appeared to have been maintained by storm water, pooling in relict shoreline swales, as well as the contribution of a small surface flow from an artesian well with a failed plug. The SJRWMD Division of Groundwater Programs was notified, and the plug has been reinstalled. The hydric hammock extended from 14.2 ft to 12.4 ft NGVD and was characterized by a sweet gum (*Liquidambar styraciflua*) and cabbage palm (*Sabal palmetto*) canopy with dark sand soils. Dark sand was present for the remainder of the transect. A prominent shoreline sandbar with a mean elevation of 13.6 ft NGVD occurred within the hammock. A deep marsh, dominated by lily pads (*Nuphar luteum*), began at 11.1 ft NGVD and extended beyond the end of the transect.

MINIMUM LEVELS DETERMINATION

Recommended minimum levels are based on consideration of the biological and soil features associated with long-term typical water levels. Two levels—minimum frequent high and minimum frequent low—are recommended for Lake Ashby, to define a long-term minimum hydrologic regime of high- and low water conditions. Each minimum level has an associated hydroperiod category that defines a minimum duration and recurrence interval. Together, these levels define a hydrologic threshold for water management decisions that should prevent significant harm to wetlands and aquatic habitats associated with Lake Ashby.

Minimum Frequent High Level

The minimum frequent high stage elevation is "… a chronically high surface water level … with an associated frequency and duration that allows for inundation of the floodplain at a depth and duration sufficient to maintain wetland functions." (Rule 40C-8.021(7), *F.A.C.).* As it affects the hardwood swamp community adjacent to Lake Ashby, the hydroperiod category of seasonally flooded means that "… surface water is present or the substrate is flooded for brief periods (weeks to months) approximately every two years." (Rule 40C-8.021(17), *F.A.C.).* The hydroperiod category has an approximate duration of several weeks and a return interval of approximately every 2 years for a long-term period of record (Rule 40C-8.021(17), *F.A.C.*).

The recommended minimum frequent high (FH) level for Lake Ashby is a stage elevation of 12.3 ft NGVD and a hydroperiod category of seasonally flooded (Table 1; Figure 4-2, CDM 2003). The minimum frequent high stage elevation of 12.3 ft NGVD is derived as the grand mean of the mean surface community elevations from all four transects in the hardwood (Table 4; Figures 7 and 8) and lower swamps (Table 3.1 and Figure 7; Valentine-Darby 1997). The difference in the adopted and recommended minimum frequent high levels is a result of using a hydroperiod category of seasonally flooded, rather than temporarily flooded, which is the basis of the current, adopted MFLs. The hydroperiod category of seasonally flooded is more appropriate for a lake with a cyclical hydrologic regime of rapid rise during storm events followed by rapid decline. An adequate hydrologic model was not available to make this determination when current MFLs were adopted.

Table 4. Data summary for Lake Ashby, Volusia County, Florida

Location	Feature	N	Mean (ft. NGVD)	Median (ft. NGVD)	Max (ft. NGVD)	Min (ft. NGVD)
Vegetative Communities						
Transect 1 (2005)						
Stn 0 (POB)–15	Upland	6	18.32	18.52	19.06	17.24
Stn 15–95	Flatwoods depression	20	16.23	16.19	17.24	14.3
Stn 95–200	Hydric hammock	22	13.7	13.70	14.30	12.49
Stn 200–320	Hardwood swamp	26	12.4	12.35	12.50	12.49
Transect 2 (2005)						
Stn 0 (POB)–150	Flatwoods depression	33	15.97	15.91	17.94	14.18
Stn 150–245	Hydric hammock	16	13.58	13.91	14.18	12.4
Stn 245–275	Hardwood swamp	7	11.74	11.74	12.40	10.68
Stn 275+	Deep marsh	5	10.06	10.08	11.10	9.48
Soils						
Transect 1 (2005)						
Stn 3	Stripped matrix at 6 in.	1	18.97			
Stn 15	Muck present	1	17.24			
Stn 70	3 in. of muck	1	15.26			
Stn 94	Mucky-mineral	1	14.20			
Stn 185–360	Dark surface	11	12.75	12.35	13.48	13.11
Transect 2 (2005)						
Stn 0	Dark surface	1	17.94			
Stn 13	Mucky-mineral	1	17.32			
Stn 17	Muck present	1	17.38			
Stn 25–170	1 in. to 6 in. of muck	13	14.79	14.76	17.04	14.32
Stns 180 and 190	Dark surface	2	13.51		13.63	13.40

ft NGVD = feet National Geodetic Vertical Datum
N = the number of elevations surveyed at each location

For the stage elevation and hydroperiod category described, the recommended minimum frequent high level should provide inundation or saturation sufficient to support the association of obligate and facultative wet plant species within the transitional shrub communities. The level should protect the spatial extent and functions of the shallow marsh communities, allowing sufficient water depths for fish and other aquatic organisms to feed and spawn on the floodplains of the lake. The minimum frequent high stage elevation of 12.3 ft NGVD should provide about 2 ft of water over the observed mean elevation of the deep marshes.

Minimum Frequent Low Level

The minimum frequent low stage elevation is "… a chronically low surface water level … that generally occurs only during periods of reduced rainfall. This level is intended to prevent deleterious effects to the composition and structure of floodplain soils, the species composition and structure of floodplain biotic communities, and the linkage of aquatic and floodplain food webs" (Rule 40C-8.021(10), *F.A.C.*). As it affects the organic hydric soils within the lower emergent marshes of the lake, the hydroperiod category of semipermanently flooded means that inundation in these areas persists in most years. When surface water is absent during moderate droughts, the water table is near the surface. A return interval of 5–10 years for several or more months is expected (Rule 40C-8.021(16), *F.A.C.*). The minimum frequent low stage elevation combined with the hydroperiod category of semipermanently flooded has an expected exceedence of approximately 80% over the long-term period of record (Rule 40C-8.021(16), *F.A.C.).*

The recommended minimum frequent low (FL) level for Lake Ashby is a stage elevation of 11.1 ft NGVD and a hydroperiod category of semipermanently flooded (Table 1; CDM 2003 Figure 4-4). This elevation is derived as the upper limit of the deep marsh community in Transect 2, in 2005, and is the same as that recommended in the previous determination (Valentine-Darby 1997). This level maintains sufficient water depths within the deep marsh communities to provide refugia and nesting habitat for fish and other aquatic species. (An example of a belt transect through plant communities is shown in Figure 9.)

The recommended minimum frequent low level allows periodic drying within the hydric hammock, shallow marshes, and upper reaches of the littoral zone (deep marshes) while preventing permanent upland encroachment. During moderate droughts, this stage elevation would completely dewater the floodplain wetland communities and expose the lake bottom sediments within the upper deep marsh communities. This level also recognizes that occasional drawdown conditions are necessary for zones of wetland vegetation to experience soil decomposition, with associated nutrient release, as well as permit seed germination for many plant species

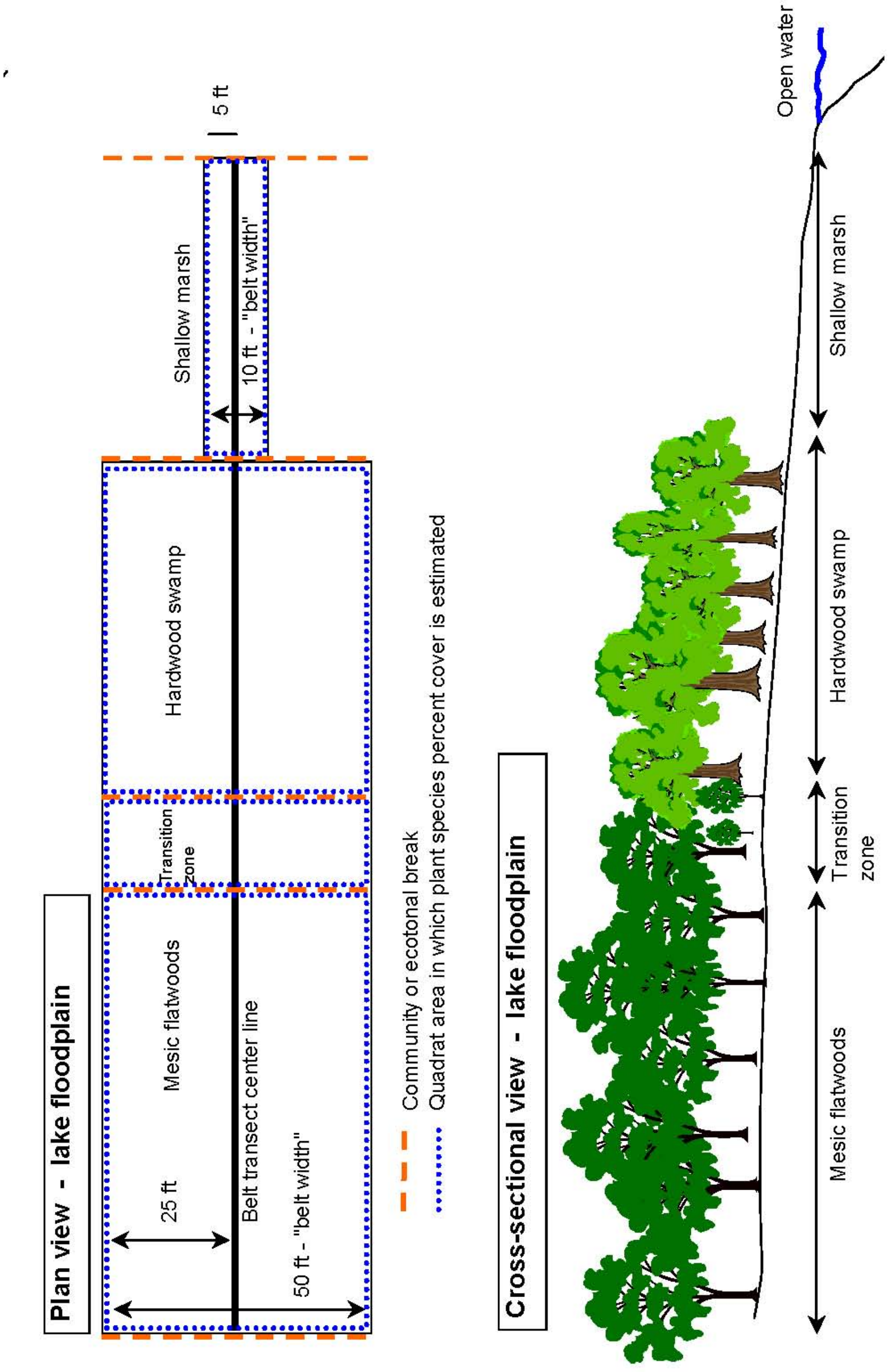


Figure 9. Example of belt transect through forested and herbaceous plant communities

that require exposed soil conditions (aerobic conditions). In addition, such low levels allow utilization of the lake floodplain by upland flora and fauna (Bancroft et al. 1990) while maintaining sufficient water depths within the deep marsh communities (littoral zone) to provide refugia and nesting habitat for fish and other aquatic species. The stage elevation was calculated as the upper limit of the deep marsh communities in all transects where recorded.

STRUCTURAL ALTERATIONS AND OTHER CHANGES

The Lake Ashby drainage basin has undergone some urbanization (Figure 2). The lake's drainage basin area is approximately 16,309 acres. Based upon the SJRWMD 1995 land use geographic information system (GIS) coverage, the watershed contains more than 65 percent of upland forest (6,326 acres) and wetlands (4,892 acres). The remaining basin area includes crops (2,667 acres), rangeland (1,532 acres), low-density residential (965 acres), and other (60 acres) (CDM 2003). The low-density residential development of the basin has likely had very little effect on the lake water levels, as compared to predevelopment conditions. However, eight canals have been constructed to drain the tributary area to Lake Ashby. The largest canal has an approximately 5.7-mile primary channel with 9.3 miles of tributaries that extend over nearly one-half of the drainage basin. The natural outlet of Lake Ashby has also undergone improvements, although the timing of these improvements is unknown. The lake discharges through a canal (Lake Ashby Canal) and Deep Creek, south to the St. Johns River. It is likely that the improvements made to the lake outlet drainage way, have lowered lake levels and altered the durations of flooding events.

Despite the changes in the lake basin, the conditions of soils and vegetation, observed at the time fieldwork was performed to support the development of recommended MFLs, did not appear to be in transition because of anthropogenic changes. Further, the water budget model developed for Lake Ashby shows that MFLs were protected under existing conditions, long-term hydrology.

CONCLUSIONS AND RECOMMENDATIONS

The adopted and recommended MFLs for Lake Ashby are summarized in Table 5. Results presented in this report are considered recommendations until the minimum flows and levels are adopted by the SJRWMD Governing Board as rule, as listed in Chapter 40C-8, *F.A.C.*

The SJRWMD multiple MFLs method (SJRWMD 2006a; Neubauer et al. 2006) was utilized to determine the minimum lake levels for Lake Ashby. MFLs determination is based on the evaluation of topography and soils, as well as data collected from vegetation within plant communities associated with the water body. Results presented in this report are considered recommended until the MFLs are adopted by the water management district's Governing Board as rule, in accordance with Chapter 40C-8, *F.A.C.* The levels are being reevaluated in light of a hydrologic model that was not available in 1998, when current levels were adopted. The model results indicate that the minimum frequent high and minimum average levels, established in 1998, are not set correctly based on new information. Hydroperiod categories and definitions are adapted from water regime modifiers developed by Cowardin et al. (1979).

The recommended minimum frequent low (FL) level for Lake Ashby is a stage elevation of 11.1 ft NGVD and a hydroperiod category of semipermanently flooded (Table 5). This elevation is derived as the upper limit of the deep marsh community and is the same as the adopted level recorded in the previous determination (Valentine-Darby 1997). This level maintains sufficient water depths within the deep marsh communities to provide refugia and nesting habitat for fish and other aquatic species.

No minimum average is proposed for Lake Ashby because the lake spends little time at an elevation range relevant to the minimum average; this is on account of drainage canals that have created a cyclical hydrologic regime of rapid rise during storm events followed by rapid decline.

The recommended minimum frequent high (FH) level for Lake Ashby is a stage elevation of 12.3 ft NGVD and a hydroperiod category of seasonally flooded (Table 5). The minimum frequent high stage elevation of 12.3 ft NGVD for a seasonally flooded hydroperiod is derived as the grand mean of the mean surface community elevations in the hardwood swamps. The difference in the adopted and

Table 5. Adopted and recommended minimum surface water levels for Lake Ashby, Volusia County, Florida

Minimum Level	Adopted Elevation (ft NGVD)	Adopted Hydroperiod Categories	Recommended Elevation (ft NGVD)	Recommended Hydroperiod Categories	Recomended Duration/ Return Interval	Recommended Return Interval
Minimum frequent high level	13.8	Temporarily flooded	12.3	Seasonally flooded	60 days	2 years
Minimum average	12.1	Typically saturated	N/A	—	—	—
Minimum frequent low level	11.1	Semipermanently flooded	11.1	Semipermanently flooded	120 days	5 years

ft NGVD = feet National Geodtic Vertical Datum recommended minimum frequent high levels is a result of using a hydroperiod category of seasonally flooded, which is more appropriate than temporarily flooded for a lake with a cyclical hydrologic regime of rapid rise during storm events followed by rapid decline.

The hydrologic model for Lake Ashby was calibrated for 2002 conditions. These conditions included the most recent land use information and groundwater levels consistent with 2002 regional water use (CDM 2003). Based on hydrologic model results, SJRWMD concludes that the recommended MFLs for Lake Ashby are protected under 2002 conditions. To determine if changes in groundwater use allocations subsequent to 2002 would cause lake levels to fall below the recommended MFLs for Lake Ashby, the existing Lake Ashby hydrologic model should be run using Floridan aquifer potentiometric level declines that reflect these changes in water use allocation. Information included in Appendix A concerning use of the hydrologic model and applicable SJRWMD regional groundwater flow model should be utilized to assess whether water levels are likely to fall below MFLs under specific water use and land use conditions.

Based on the model results, both the low and high levels are being met under 2002 conditions.

LITERATURE CITED

Adamus, C., D. Clapp, and S. Brown. 1997. *Surface Water Drainage Basin Boundaries St. Johns River Water Management District: A Reference Guide*. Technical pub. SJ97-1. Palatka, Fla.: St. Johns River Water Management District.

Bancroft, G.T., S.D. Jewell, and A.M. Strong. 1990. *Foraging and Nesting Ecology of Herons in the Lower Everglades Relative to Water Conditions*, p. 139. Final report to the South Florida Water Management District, Environmental Sciences Div., West Palm Beach, Fla.

Boniol, D., M. Williams, and D. Munch. 1993. *Mapping Recharge to the Floridan Aquifer Using a Geographic Information System*. Technical pub. SJ93-5. Palatka, Fla.: St. Johns River Water Management District.

Brooks, H.K. 1982. *Guide to the Physiographic Divisions of Florida*. Compendium to the map, Physiologic Divisions of Florida, 8-5M-82. Gainesville: Univ. of Florida, Cooperative Ext. Serv., Institute of Food and Agricultural Sciences.

[CDM] Camp Dresser and McKee Inc. 2003. Model Development for MFL Evaluation of Lake Ashby, Volusia County. Technical memorandum (unpublished). Prepared for the St. Johns River Water Management District, Palatka, Fla.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. *Classification of Wetlands and Deepwater Habitats of the United States*. Wash., D.C.: U.S. Fish and Wildlife Serv., Office of Biological Serv. FWS/OBS–79/31.

Florida Administrative Weekly. 2004. (30):5451.

[FDEP] Florida Dept. of Environmental Protection. 2000. *Florida Water Quality Assessment*. 305b Status Report. Accessed on the FDEP Web site at www.dep.state.fl.us/water/305b/index.htm.

Hall, G.B. 1987. *Establishment of Minimum Surface Water Requirements for the Greater Lake Washington Basin*. Technical pub. SJ87-3. Palatka, Fla.: St. Johns River Water Management District.

Kinser, P.D. 1996 (unpublished). Wetland Vegetation Classification System. Internal document. St. Johns River Water Management District, Palatka, Fla.

Martin, K., and P. Coker. 1992. *Vegetation Description and Analysis: A Practical Approach*, p. 363. Wiley.

Mueller–Dombois, D., and H. Ellenberg. 1974. *Aims and Methods of Vegetation Ecology*, p. 547. Wiley.

Neubauer, C.P., G.B. Hall, E.F. Lowe, C.P. Robison, R.B. Hupalo, and L.W. Keenan. 2006. *Minimum Flows and Levels Method of the St. Johns River Water Management District*. Palatka, Fla.: St. Johns River Water Management District.

[SJRWMD] St. Johns River Water Management District. 2006a. Minimum Flows and Levels Methods Manual. St. Johns River Water Management District, Palatka, Fla.

SJRWMD. 2006b. *Water Supply Assessment, 2003.* Technical pub. SJ2006-1. Palatka, Fla.: St. Johns River Water Management District.

[SFWMD] South Florida Water Management District. 1999. *Establishment of Minimum Levels in Palustrine Cypress Wetlands.* Final draft. (March 18, 1999.) West Palm Beach, Fla.: South Florida Water Management District.

Tobe, J.D., K.C. Burks, R.W. Cantrell, M.A. Garland, M.E. Sweeley, D.W. Hall, P. Wallace, G. Anglin, G. Nelson, J.R. Cooper, D. Bricknew, K. Gilbert, N. Aymond, K. Greenwood, and N. Raymond. 1998. *Florida Wetland Plants: An Identification Manual.* Tallahassee: Florida Dept. of Environmental Protection.

[USDA–NRCS] U.S. Dept. of Agriculture, National Resources Conservation Serv. 1998. *Field Indicators of Hydric Soils in the United States, vers. 4.0*. G.W. Hurt, P.M. Whited, and R.F. Pringle, eds., p. 30. Lincoln, Nebr.: U.S. Dept. of Agriculture, NRCS, in cooperation with the National Technical Committee for Hydric Soils, Fort Worth, Tex.

[USDA–SCS] U.S. Dept. of Agriculture, Soil Conservation Serv. 1980. *Soil Survey of Volusia County, Florida*. R. Baldwin, ed., p. 207. Wash., D.C.: U.S. Dept. of Agriculture, SCS, in cooperation with the Univ. of Florida, Soil and Water Science Dept., Gainesville, Fla.

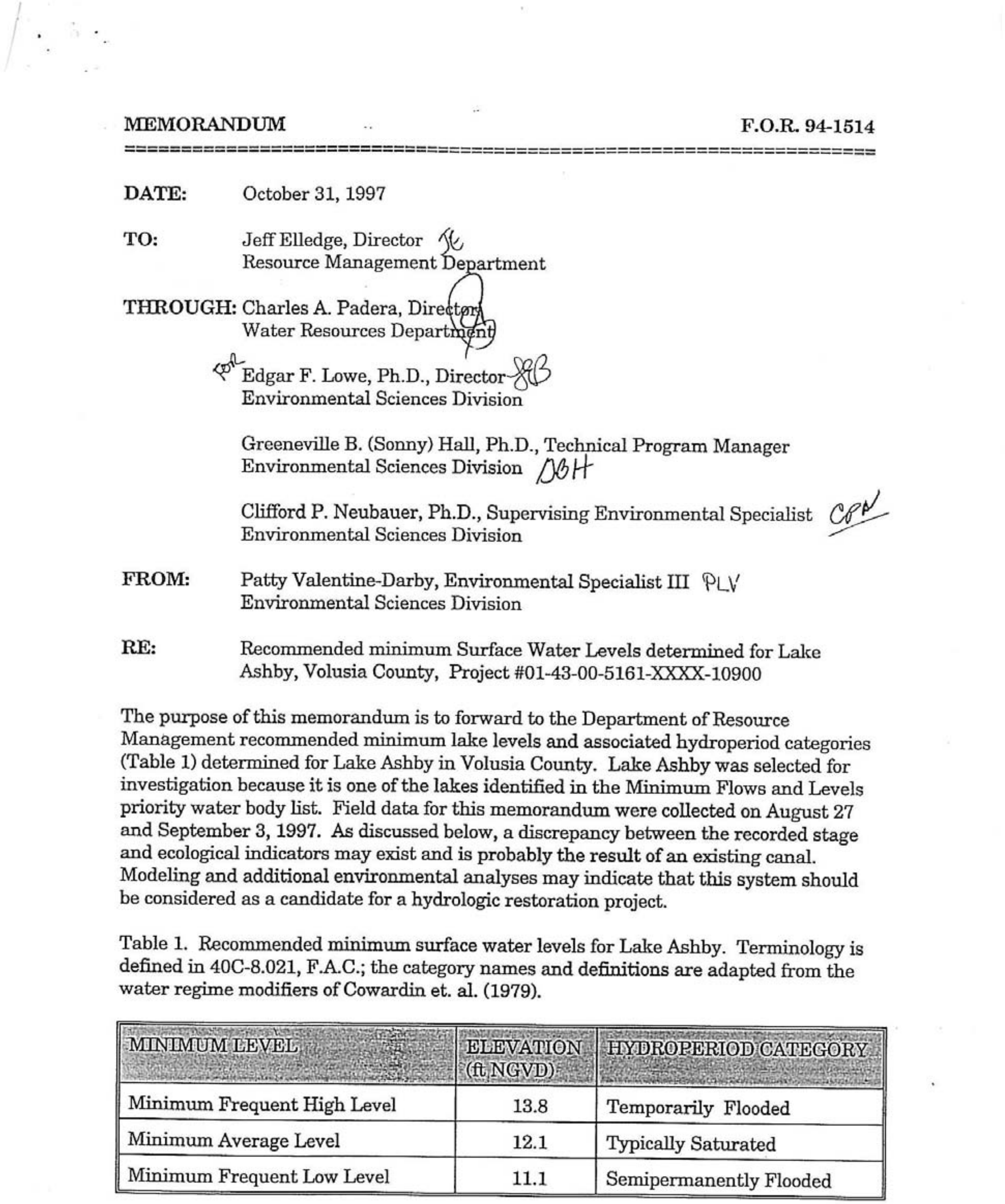
Vergara, B. 1998. *Water Supply Assessment 1998*. Technical pub. SJ98-2. Palatka, Fla.: St. Johns River Water Management District.

Valentine-Darby, P. 1997. Recommended Minimum Surface Water Levels for Lake Ashby, Volusia County. Memorandum 94-1514 (unpublished). Prepared for the St. Johns River Water Management District, Palatka, Fla.

Ware, C. 2002. *Ecological Summaries of Plants Commonly Encountered During Minimum Flows and Levels Determination.* Minimum flows and levels plant ecology series no. 7, *Sabal palmetto* (Cabbage palm). Palatka, Fla.: St. Johns River Water Management District.

Ware, C. 2003. *Ecological Summaries of Plants Commonly Encountered During Minimum Flows and Levels Determination*. Minimum flows and levels plant ecology series no. 10, *Taxodium distichum* (L.) (Bald cypress) and *Taxodium ascendens* (Pond cypress). Palatka, Fla.: St. Johns River Water Management District.

APPENDIX A—RECOMMENDED MINIMUM SURFACE WATER LEVELS DETERMINED FOR LAKE ASHBY, OCT. 31, 1997



MEMORANDUM **F.O.R. 94-1514**

DATE: October 31, 1997

TO: Jeff Elledge, Director JE
Resource Management Department

THROUGH: Charles A. Padera, Director
Water Resources Department

for Edgar F. Lowe, Ph.D., Director
Environmental Sciences Division

Greeneville B. (Sonny) Hall, Ph.D., Technical Program Manager
Environmental Sciences Division GBH

Clifford P. Neubauer, Ph.D., Supervising Environmental Specialist CPN
Environmental Sciences Division

FROM: Patty Valentine-Darby, Environmental Specialist III PLV
Environmental Sciences Division

RE: Recommended minimum Surface Water Levels determined for Lake Ashby, Volusia County, Project #01-43-00-5161-XXXX-10900

The purpose of this memorandum is to forward to the Department of Resource Management recommended minimum lake levels and associated hydroperiod categories (Table 1) determined for Lake Ashby in Volusia County. Lake Ashby was selected for investigation because it is one of the lakes identified in the Minimum Flows and Levels priority water body list. Field data for this memorandum were collected on August 27 and September 3, 1997. As discussed below, a discrepancy between the recorded stage and ecological indicators may exist and is probably the result of an existing canal. Modeling and additional environmental analyses may indicate that this system should be considered as a candidate for a hydrologic restoration project.

Table 1. Recommended minimum surface water levels for Lake Ashby. Terminology is defined in 40C-8.021, F.A.C.; the category names and definitions are adapted from the water regime modifiers of Cowardin et. al. (1979).

MINIMUM LEVEL	ELEVATION (ft NGVD)	HYDROPERIOD CATEGORY
Minimum Frequent High Level	13.8	Temporarily Flooded
Minimum Average Level	12.1	Typically Saturated
Minimum Frequent Low Level	11.1	Semipermanently Flooded

Lake Ashby is an approximately 1,030-acre lake (at 11 ft. NGVD) located five miles east of Deltona in Volusia County (Figure 1). The USGS (1:24,000 scale) quadrangle (Figure 2) shows seven surface water inflows and one surface water outflow from Lake Ashby. The outflow, at the southwest tip of the lake, is called the Lake Ashby Canal; it flows into Deep Creek, which flows into the St. Johns River north of Lake Harney. Lake Ashby is located in a low recharge (0-4 inches per year) / discharge zone (Boniol et al. 1993); however, the regional nature of this map product precludes accurate site specific references concerning actual recharge/discharge.

The St. Johns Wet Prairie Physiographic Division (1d) of the Eastern Flatwoods District encompasses Lake Ashby. The Eastern Flatwoods District, in which elevations are generally less than 90 feet, arose as a sequence of barrier islands and lagoons during Plio-Pleistocene and Recent times (Brooks 1982). The St. Johns Wet Prairie Division (1d) consists of marshes and grass prairies with seasonally-flooded areas of cabbage palms and willow. Elevations are 6 to 12 feet above current sea level. The northern shore of Lake Ashby is separated from the Volusia Ridge Sets Division (1c) by a scarp (Brooks 1982 and related map), with elevations to the north of the scarp greater (e.g., 35 to 40 feet) than to the south (e.g., 20 feet).

HYDROLOGY

A stage record exists for Lake Ashby from July 16, 1986 to the present (Figure 3), although data prior to October 1990 cannot be verified and should be considered provisional. During the period of record, the lake has fluctuated 6.22 feet; the minimum water level was 10.23 ft. NGVD (March 1-3, 1991), and the maximum water level was 16.45 ft. NGVD (November 19, 1994). The mean and median stages were 11.84 and 11.66 ft. NGVD, respectively, for the eleven year period. A percent exceedence curve is presented in Figure 4.

A comparison between the stage data and the data collected during the two site visits (i.e., vegetation, soils, and elevation data) revealed discrepancies. Based on the forested wetland communities and muck soils observed at Transect-1, one would expect Lake Ashby to have experienced higher water levels than those that have occured over the eleven year period of record. For example, based on data from the transects only, we might recommend a minimum average level with the associated hydroperiod category of typically saturated of 13.1 (average elevation of organic soils at T-1 minus 0.25 ft.) to 13.2 ft. NGVD (average elevation of the mixed swamp at T-1). However, this level corresponds to the 10th percentile of exceedence on the stage-duration curve rather than to the 50-60th, which typically have corresponded to the minimum average water level. It appears that the hydrologic regime of the lake may have declined, but the forested wetlands and associated soils do not yet reflect the change.

It is likely that the presence of the Lake Ashby Canal (Figure 2) has resulted in lower lake levels. The lake levels needed to maintain the full extent of the wetlands observed at the transects are likely higher than the lake's present hydrology can provide. For this reason, the three minimum levels recommended in this memo may not be conservative, but they are more likely attainable under the current hydrology.

Open water depths were measured on August 27, 1997 at thirteen locations from south to north on the mid-western side of the lake. The range of depths was 5.0 ft. (8.0 ft. NGVD) to 9.7 ft. (3.3 ft. NGVD), with an average depth of 7.0 ft. (6.1 ft. NGVD).

No consumptive use permits (CUPs) exist for surface water withdrawals from Lake Ashby. However, two CUPs for groundwater withdrawals exist within a 2 mile radius of the lake (9 wells existing and 5 proposed, with a total maximum allocation of 774.5 MGY for agricultural purposes) (Mary McKinney, Resource Management, 9/8/97). An application for a third CUP within two miles of the lake is pending at this time.

HYDRIC SOILS

The SCS (1980) delineated six types of hydric soils adjacent to Lake Ashby (Figure 5). These soils were Basinger fine sand, depressional (Mapping Unit ID 8), Tequesta muck (MUID 64), Tomoka muck (MUID 66), Terra Ceia muck (MUID 65), Gator muck (MUID 25), and Samsula muck (MUID 56).

Basinger fine sand, depressional (MUID 8) lines the northern and northwestern portions of the lake. It is a poorly drained, nearly level sandy soil found primarily in depressions and in poorly defined drainageways in the sandhills and flatwoods (SCS 1980). The water table is above the soil surface for several months in most years; for the remainder of the year it is within 30 inches of the surface, except for during very dry periods. This soil type is low in organic matter and is naturally vegetated by water-tolerant grasses and pond pine.

Tequesta muck (MUID 64) is found on a southern portion of the lake. According to the Volusia County Soil Survey (SCS 1980), this soil type should have existed at Transect 2; however, as discussed in the next section, the soils at the transect were not mucky. Tequesta muck occurs on broad, low flats adjacent to natural bodies of water, and in freshwater swamps and marshes. This very poorly drained soil contains a moderate amount of organic matter. For 6 to 9 months, in most years, the water table is within 10 inches of the surface. It may rise 12 inches or more above the surface in wet seasons, but may drop to within 20 inches of the surface during extended dry seasons. The natural vegetation usually consists of hardwoods (e.g., red maple, bald cypress), shrubs (e.g., wax myrtle, fetterbush), and/or grasses and forbs (e.g., sawgrass, maidencane).

Tomoka muck (MUID 66), found along the southeastern portion of the lake, is a very poorly drained soil high in organic matter. The water table is at or above the surface for 6 to 9 months in most years, and may be as much as 2 feet above the surface during rainy seasons. This soil type occurs in swamps and freshwater marshes and is usually dominated by hardwoods (e.g., red maple) or marsh grasses (e.g., sawgrass).

The remaining three hydric soil types adjacent to the lake occured to a lesser extent. Samsula muck (MUID 56) is a very poorly drained, nearly level organic soil occurring in broad low flats, small depressions, freshwater marshes, and swamps. Except for during extended dry periods, the water table is at or above the soil surface. This is the soil type mapped at Transect 1. Gator muck (MUID 25) is a very poorly drained, nearly level, well decomposed organic soil which occurs in swamps, freshwater marshes, and on floodplains of lakes, rivers, and creeks. The water table is above or at the soil surface in spring, summer, and fall, and within 10 inches in winter. Terra Ceia muck (MUID 65) is also a poorly drained soil, high in organic material, that occurs in swamps, freshwater marshes, and small depressions. In this soil type, the water table is at or above the surface for 6 to 9 months in most years.

WETLANDS

The U.S. Fish and Wildlife Service's National Wetlands Inventory (Lake Ashby quadrangle, 1987) identified 13 classes of wetlands in and immediately surrounding the lake (Figure 6). The wetland classes are presented below in Table 2.

Table 2. Wetlands mapped at Lake Ashby by the U.S. Fish & Wildlife Service.

Wetland Id	Description
L1UBH	Lacustrine Limnetic Unconsolidated Bottom Permanently Flooded
L2AB3H	Lacustrine Littoral Aquatic Bed Rooted Vascular Permanently Flooded
L2UBG	Lacustrine Littoral Unconsolidated Bottom Intermittently Exposed
PEM1F	Palustrine Emergent Persistent Semipermanently Flooded
PEM1G	Palustrine Emergent Persistent Intermittently Exposed
PSS1F	Palustrine Scrub Shrub Broad-Leaved Deciduous Semipermanently Flooded
PSS1G	Palustrine Scrub Shrub Broad-Leaved Deciduous Intermittently Exposed
PFO1C	Palustrine Forested Broad-Leaved Deciduous Seasonally Flooded
PFO3C	Palustrine Forested Broad-Leaved Evergreen Seasonally Flooded
PFO6C	Palustrine Forested Deciduous Seasonally Flooded
PFO6F	Palustrine Forested Deciduous Semipermanently Flooded
PFO1/4A	Palustrine Forested Broad-Leaved Deciduous/Needle-Leaved Evergreen Temporarily Flooded
PFO1/4C	Palustrine Forested Broad-Leaved Deciduous/Needle-Leaved Evergreen Seasonally Flooded

Two elevation/vegetation transects (T-1 and T-2) were established around the lake shore. The locations of the transects are shown on Figure 6. A brief description of each transect follows.

Transect 1

Transect 1 traversed forested wetlands on the lake's eastern shore. The National Wetlands Inventory identified this area as PFO6C (Palustrine Forested Deciduous Seasonally Flooded). The hydric soil was mapped by SCS as Samsula muck. The 340-ft. transect traversed cypress swamp, mixed swamp, and hydric hammock communities. Dominant and codominant plant species for each community are listed on Figure 7. The cypress swamp ranged in elevation from 10.0 to 12.5 ft. NGVD. The soil consisted of greater than 2.8 ft. of peaty muck. The mixed swamp ranged in elevation from 12.3 to 13.8 ft. NGVD. This community's soil contained a minimum of

Table 3. Spot, mean, maximum and minimum elevations measured at Lake Ashby. Elevations are in feet NGVD.

LOCATION	FEATURE	SPOT	MEAN	MAX	MIN	N
Transect #1	Cypress Swamp		11.6	12.5	10.0	9
Transect #1	Cypress Swmp & lower Mixed Swmp		12.1	13.1	10.0	15
Transect #1	Mixed Swamp, lower (80-140 ft.)		12.8	13.1	12.3	7
Transect #1	Mixed Swamp, entire		13.2	13.8	12.3	13
Transect #1	Muck depth ≥ 0.5 ft.		13.3	16.5	10.0	29
Transect #1	Mixed Swamp, upper (140-200 ft.)		13.6	13.8	13.1	7
Transect #1	Mixed Swamp/Hydric Ham. Ecotone	13.8				
Transect #1	Hydric Hammock, lower (200-280 ft)		15.2	16.5	13.8	9
Transect #1	Hydric Hammock		16.0	18.0	13.8	14
Transect #1	Upland, palmetto line (330 ft.)	18.0				
Transect #2	Cattail Marsh		10.4	11.0	9.7	17
Transect #2	Aquatic bed		11.3	11.5	11.1	18
Transect #2	Marsh with bald cypress		11.7	12.1	11.4	19
Transect #2	Wet prairie		12.6	13.2	12.1	16
Transect #2	Hydric Hammock		13.4	14.2	13.2	11

Common and scientific names of plant species found along the transects at Lake Ashby are presented in Table 4. Three levels with corresponding hydroperiod categories are recommended. Short descriptions of the functions of each minimum level and the related data used in the determination are presented below.

MINIMUM FREQUENT HIGH LEVEL

The recommended Minimum Frequent High level (13.8 ft. NGVD) and the assigned hydroperiod category of Temporarily Flooded corresponds to the ecotone (at 200 ft.) of the mixed swamp (80-200 ft.) and hydric hammock (200-330 ft.) at Transect 1 (T-1). Waterward of the ecotone, the wetland soils consisted of at least 1.3 ft. of muck.

This minimum level results in the brief inundation of the mixed swamp at T-1. It also allows for approximately 2.2 ft. of water over the average elevation of the cypress swamp at T-1. At T-2, it would result in the brief, shallow inundation (0.4 ft. over the average elevation) of the lower elevations of the hydric hammock; the higher elevations of the hydric hammock were not surveyed. This minimum level would also allow for approximately 1.2 ft. of water over the average elevation of the wet prairie and 2.0 ft. of water over the average elevation of the emergent marsh/cypress zone.

The recommended minimum frequent high level allows for water levels of sufficient frequency and duration to 1) inhibit the invasion of wetland areas by upland plant species, and 2) allow fish and other aquatic species access to the wetlands associated with the lake. This recommended minimum water level is 2.7 feet below the maximum recorded water level (16.45 ft NGVD, November 1994), and 4.2 ft. below the palmetto line at T-1. This water level corresponds to the 5th percentile of exceedence on the stage-duration curve.

MINIMUM AVERAGE LEVEL

The recommended Minimum Average level (12.1 ft NGVD) with the assigned hydroperiod category of Typically Saturated corresponds to the average elevation of the cypress swamp and the lower portion of the mixed swamp (80 to 140 ft.) at Transect 1. This level is also the elevation of the ecotone of the wet prairie and emergent marsh with cypress at T-2.

This minimum average level results in the shallow inundation (0.5 ft. on average) of the cypress swamp and associated muck soils present at T-1, and in the inundation (0.3 ft. on average) of the emergent marsh with cypress at T-2. This minimum level protects the lower elevation muck soils from oxidation while allowing for wetland plant seed germination on the exposed soils present at higher elevations along the transects. At T-2, the minimum level would also inundate the aquatic bed with an average of 0.8 ft. of water and the cattail marsh with depths ranging from 1.1 to 2.4 ft.

This water level (i.e., 12.1) is similar to the average stage (11.8 ft. NGVD) for the eleven year period of record. The recommended minimum average level corresponds to the approximate 32nd percentile of exceedence on the stage-duration curve.

MINIMUM FREQUENT LOW LEVEL

The recommended Minimum Frequent Low level (11.1 ft NGVD) with the assigned hydroperiod category of Semipermanently Flooded corresponds to the average elevation of the lower mixed swamp (80 to 140 ft.) at Transect 1 minus 1.67 ft. (12.75 ft. NGVD - 1.67 = 11.08 ft. NGVD). The figure 1.67 ft. reflects a twenty inch reduction in the soil water table, which is considered reasonable for a moderate drought. Occasional drawdown conditions are necessary in wetlands to stimulate decomposition and promote new vegetative growth. This minimum level recognizes the benefits of low water conditions during periods of low rainfall.

This minimum frequent low level results in a drawdown of the majority of the cypress swamp at T-1, and it exposes the aquatic bed at T-2, which has an elevation range of 11.1 to 11.5 ft. NGVD. It also provides for an average of 0.7 ft. of water in the cattail marsh at T-2. This water level is equal to the 80th percentile of exceedence on the stage-duration curve for the period of record, and it is 0.9 ft. above the minimum recorded water level.

Please call me (ext. 2309), Cliff Neubauer (ext. 4343), or Jane Mace (4389) if you wish to discuss these minimum levels.

LITERATURE CITED

Boniol, D., M. Williams, and D. Munch. 1993. Mapping recharge to the Floridan Aquifer using a geographic information system. St. Johns River Water Management District Tech. Rept. SJ93-5, 41 pp.

Brooks, H.K. 1982. Guide to the Physiographic Divisions of Florida, Compendium to the map Physiographic Divisions of Florida, 8-5M-82. Cooperative Extension Service, University of Florida, Institute of Food and Agricultural Sciences, Gainesville, Florida.

Cowardin, L.M., F.C. Golet and E.T. LaRoe. 1979. Classification of Wetlands and Deepwater Habitats of the United States. FWS/OBS-79/31, U.S. Fish and Wildlife Service, Washington, DC p. 24.

National Wetland Inventory. 1987. Lake Ashby, FL, 1:24,000 scale quadrangles, National Wetland Inventory maps, U.S. Department of the Interior.

Reed, P.B. 1988. National list of plant species that occur in wetlands: Southeast (Region 2). U.S. Fish and Wildlife Service Biol. Rep. 88(26.2). 124 pp.

Soil Conservation Service. 1980. Soil Survey of Volusia County, Florida. U.S. Department of Agriculture. 207 pp. + 103 illus.

PLV:bs

attachments

c:				
	Kathryn Mennella	Hal Wilkening	Tommy Walters	Larry Battoe
	David Clapp	Ric Hupalo	Jane Mace	Larry Fayard
	Dwight Jenkins	Sandy McGee	Price Robison	Bob Freeman
	MFL-REG	David Watt	Eric Olsen	Dale Jones

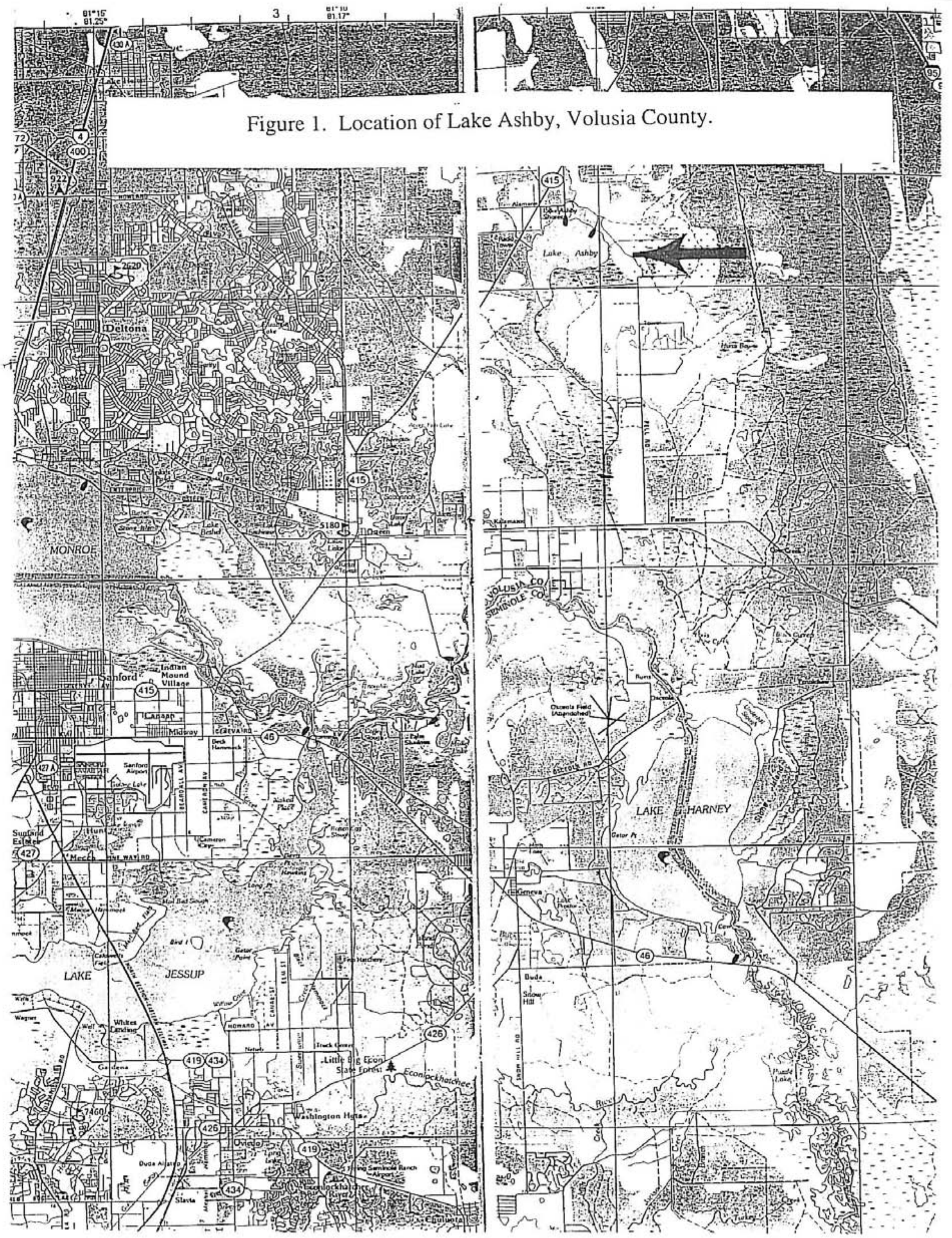


Figure 1. Location of Lake Ashby, Volusia County.

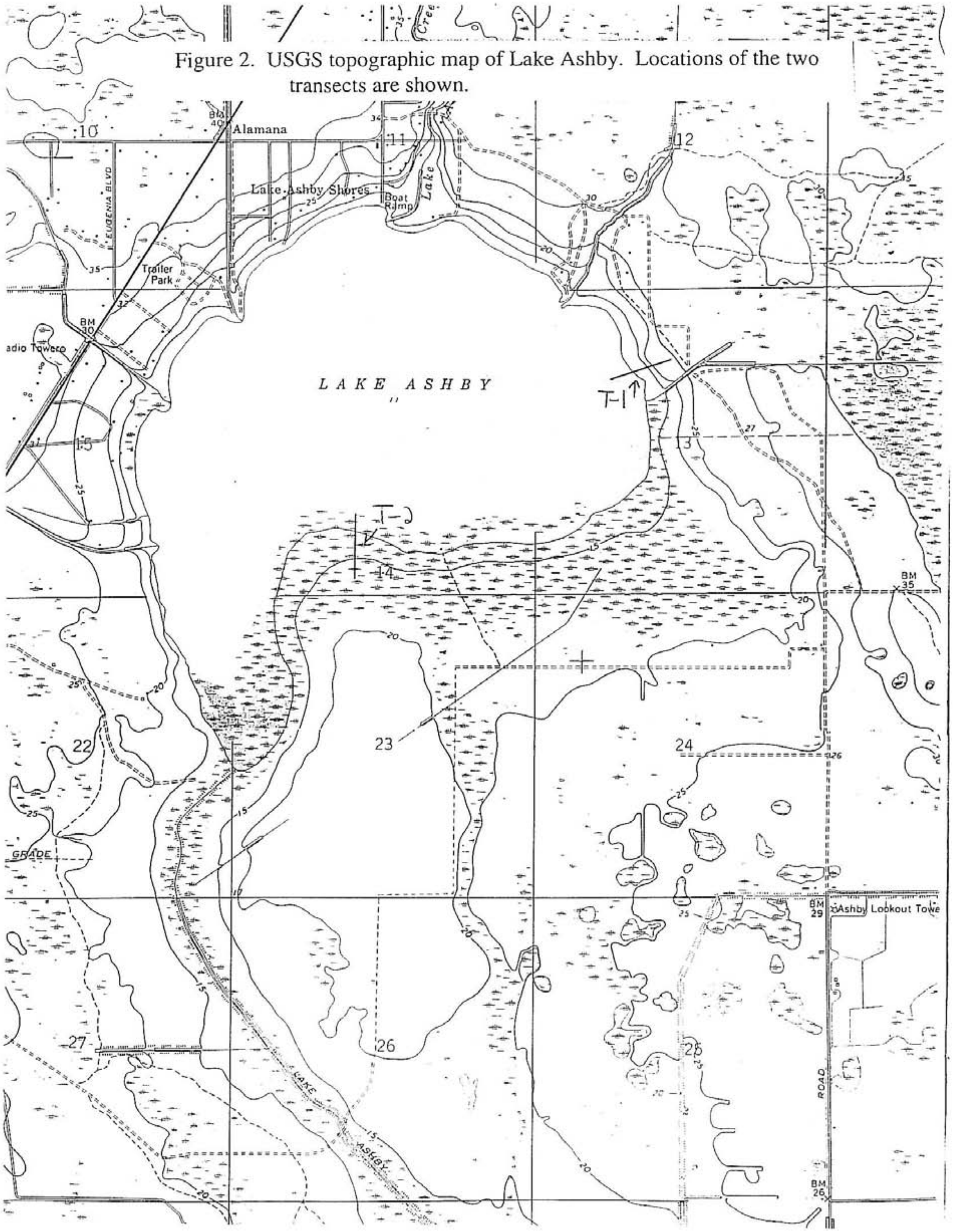


Figure 2. USGS topographic map of Lake Ashby. Locations of the two transects are shown.

Figure 3. Lake Ashby stage data from July 16, 1986 to present (SJRWMD data).

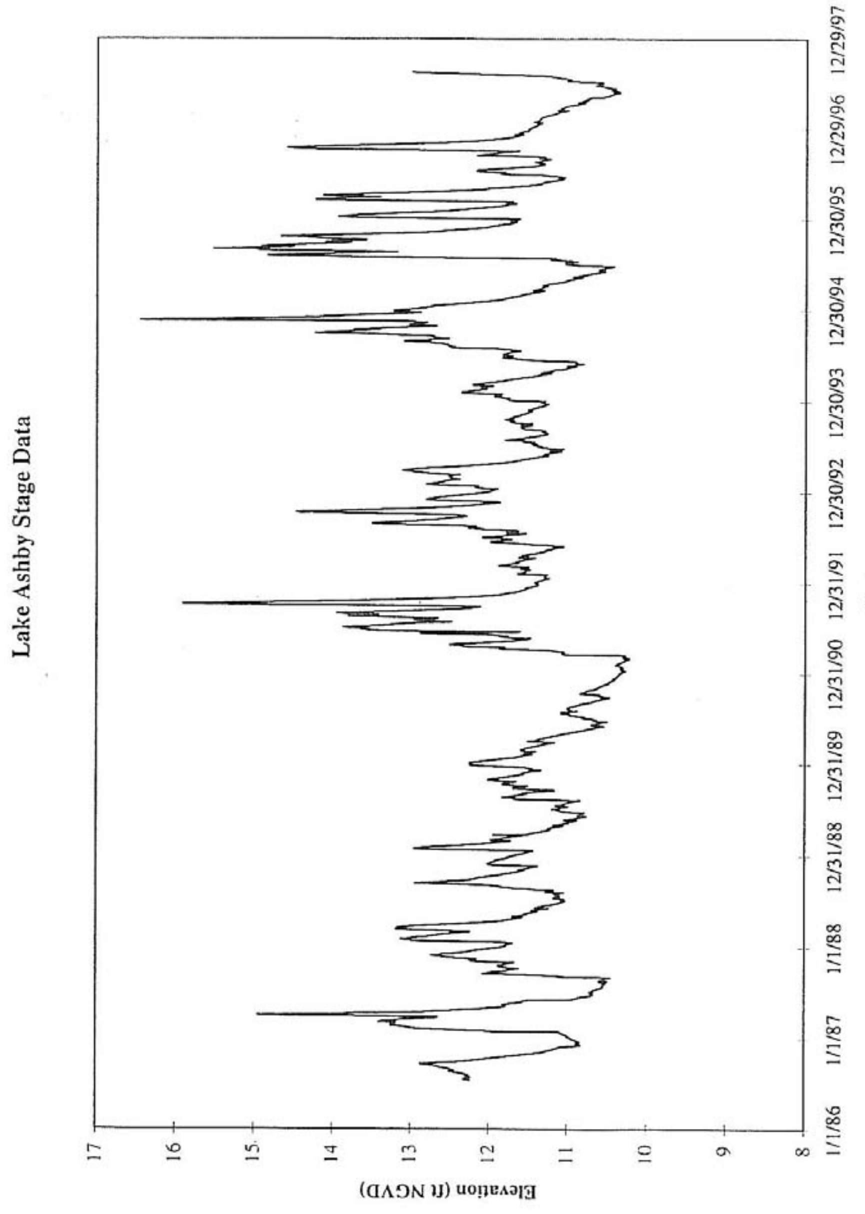
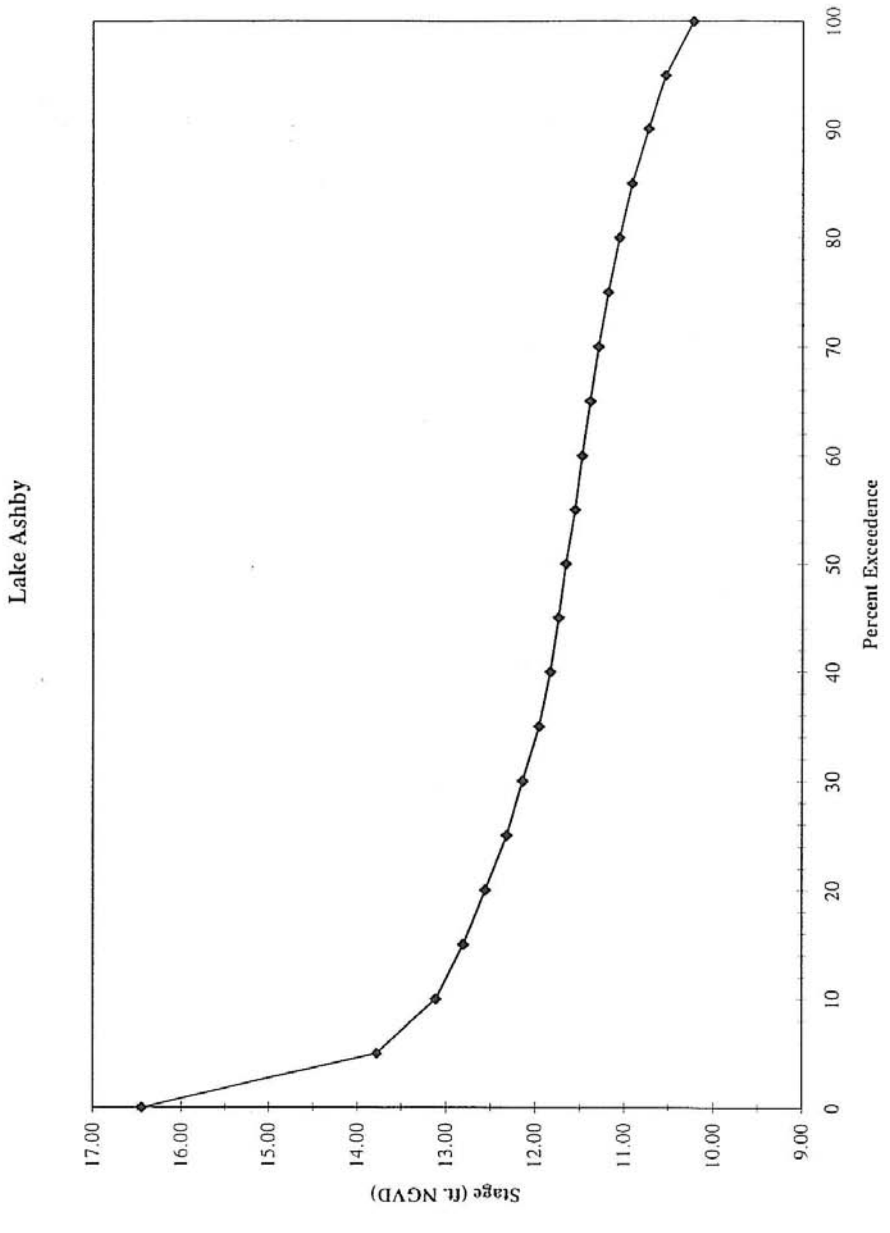


Figure 4. Percent exceedence curve for Lake Ashby (from SJRWMD data).



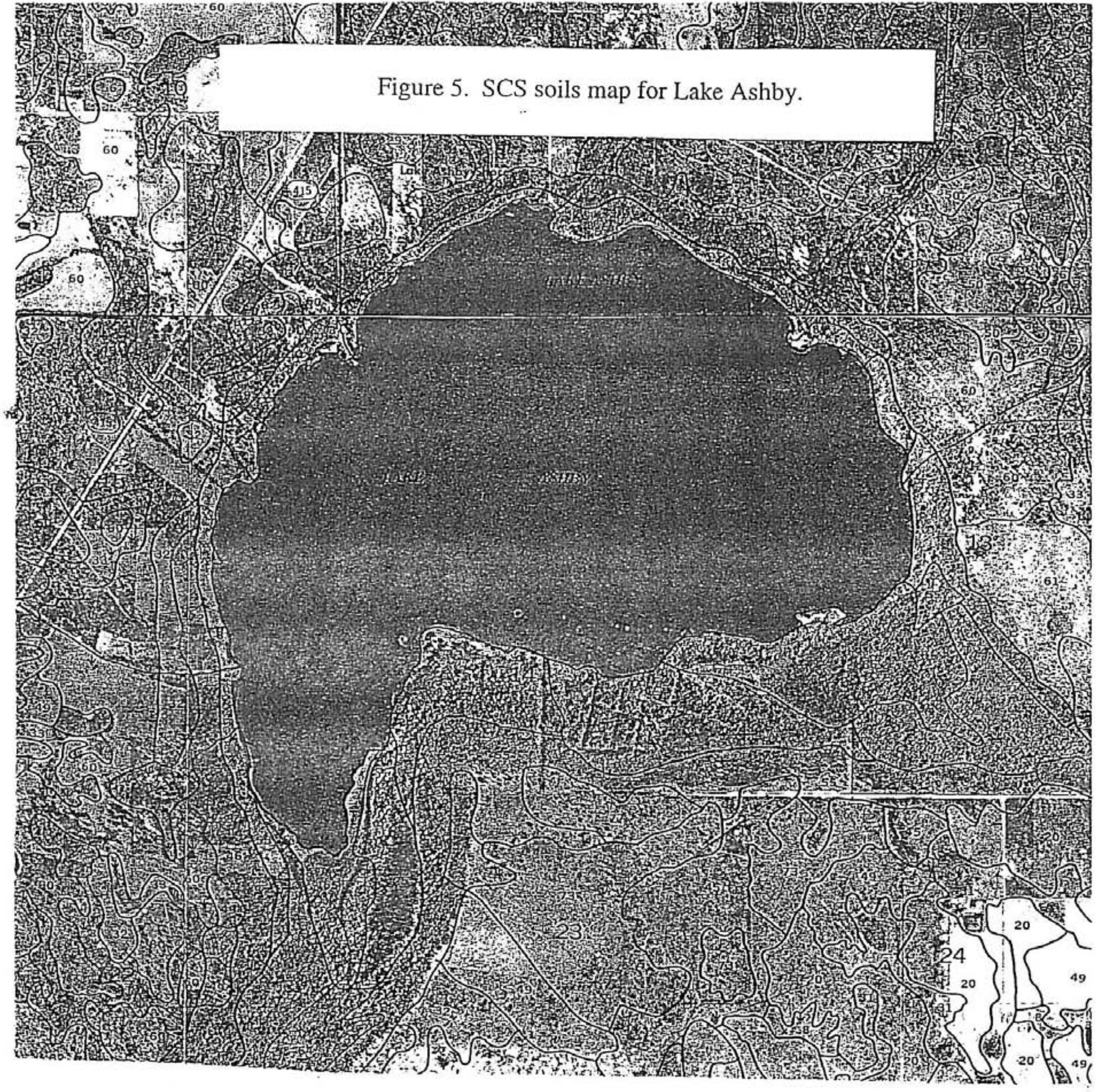


Figure 5. SCS soils map for Lake Ashby.

Figure 6. National Wetlands Inventory map of Lake Ashby. Locations of the two transects are shown.

Figure 7.

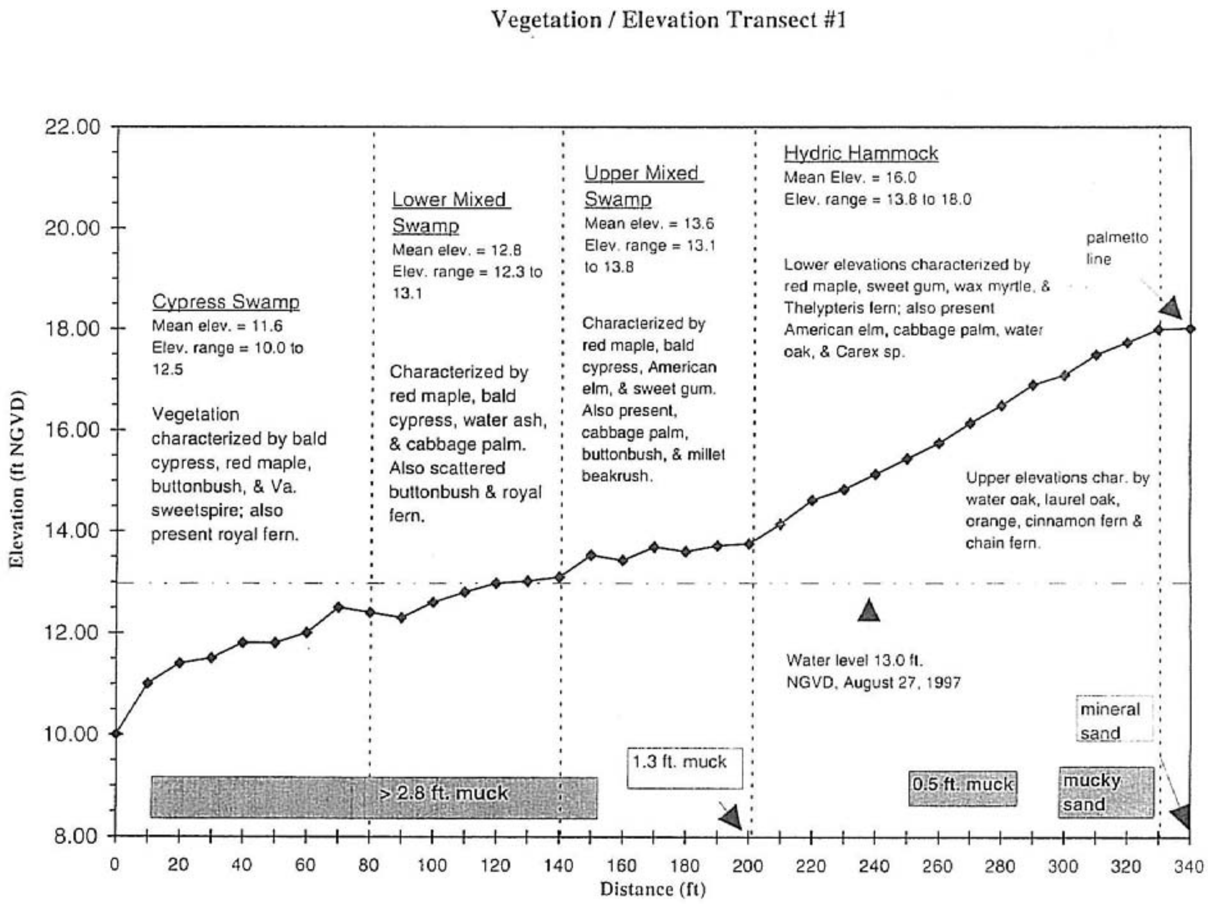
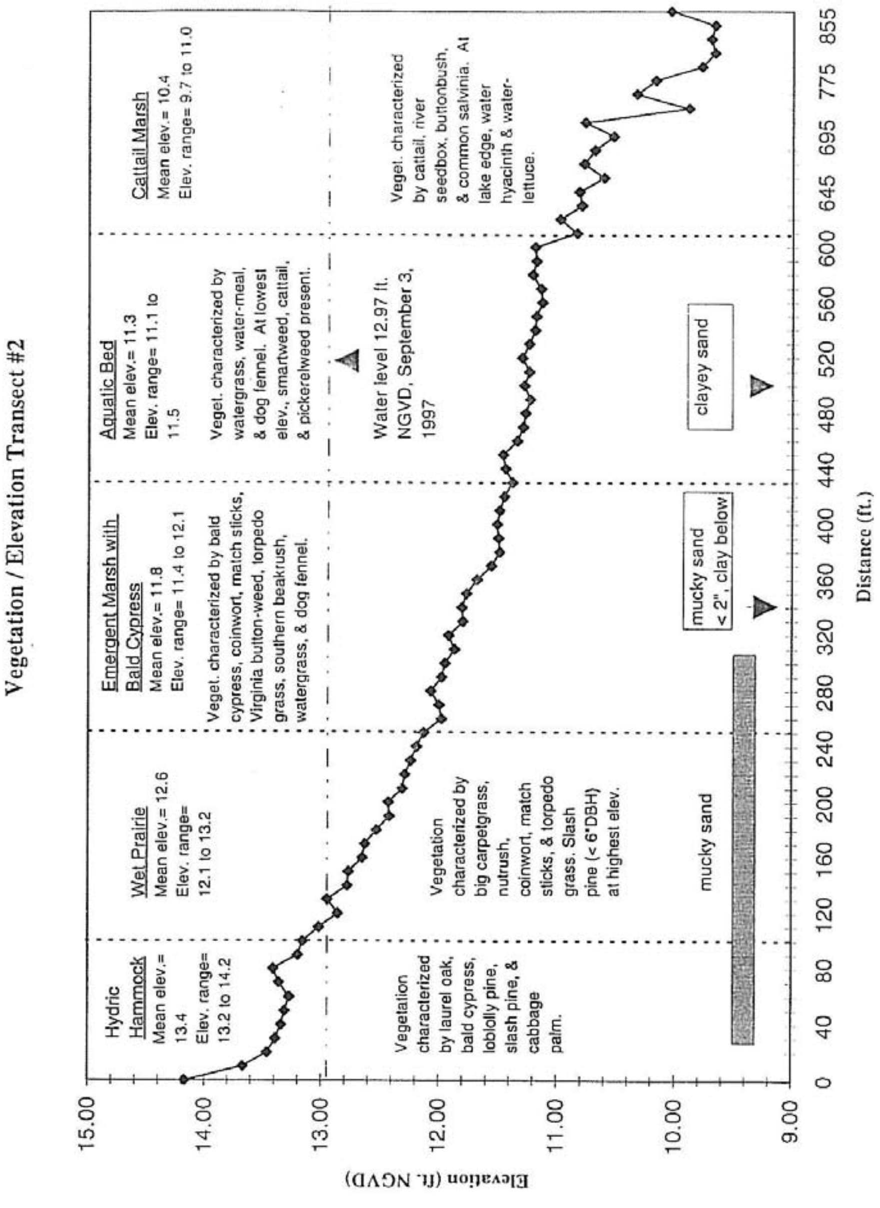

Vegetation / Elevation Transect #1
Elevation (ft NGVD)
22.00
20.00
18.00
16.00
14.00
12.00
10.00
8.00
Distance (ft)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
Cypress Swamp
Mean elev. = 11.6
Elev. range = 10.0 to 12.5
Vegetation characterized by bald cypress, red maple, buttonbush, & Va. sweetspire; also present royal fern.
Lower Mixed Swamp
Mean elev. = 12.8
Elev. range = 12.3 to 13.1
Characterized by red maple, bald cypress, water ash, & cabbage palm. Also scattered buttonbush & royal fern.
Upper Mixed Swamp
Mean elev. = 13.6
Elev. range = 13.1 to 13.8
Characterized by red maple, bald cypress, American elm, & sweet gum. Also present, cabbage palm, buttonbush, & millet beakrush.
Hydric Hammock
Mean Elev. = 16.0
Elev. range = 13.8 to 18.0
Lower elevations characterized by red maple, sweet gum, wax myrtle, & Thelypteris fern; also present American elm, cabbage palm, water oak, & Carex sp.
palmetto line
Upper elevations char. by water oak, laurel oak, orange, cinnamon fern & chain fern.
Water level 13.0 ft. NGVD, August 27, 1997
> 2.8 ft. muck
1.3 ft. muck
0.5 ft. muck
mineral sand
mucky sand

Figure 8.


Vegetation / Elevation Transect #2
Elevation (ft. NGVD)
15.00
14.00
13.00
12.00
11.00
10.00
9.00
Distance (ft.)
0
40
80
120
160
200
240
280
320
360
400
440
480
520
560
600
645
695
775
855
Hydric Hammock
Mean elev.= 13.4
Elev. range= 13.2 to 14.2
Vegetation characterized by laurel oak, bald cypress, loblolly pine, slash pine, & cabbage palm.
Wet Prairie
Mean elev.= 12.6
Elev. range= 12.1 to 13.2
Vegetation characterized by big carpetgrass, nutrush, coinwort, match sticks, & torpedo grass. Slash pine (< 6"DBH) at highest elev.
Emergent Marsh with Bald Cypress
Mean elev.= 11.8
Elev. range= 11.4 to 12.1
Vegel. characterized by bald cypress, coinwort, match sticks, Virginia button-weed, torpedo grass, southern beakrush, watergrass, & dog fennel.
Aquatic Bed
Mean elev.= 11.3
Elev. range= 11.1 to 11.5
Vegel. characterized by watergrass, water-meal, & dog fennel. At lowest elev., smartweed, cattail, & pickerelweed present.
Cattail Marsh
Mean elev.= 10.4
Elev. range= 9.7 to 11.0
Vegel. characterized by cattail, river seedbox, buttonbush, & common salvinia. At lake edge, water hyacinth & water-lettuce.
Water level 12.97 ft. NGVD, September 3, 1997
mucky sand
mucky sand < 2", clay below
clayey sand

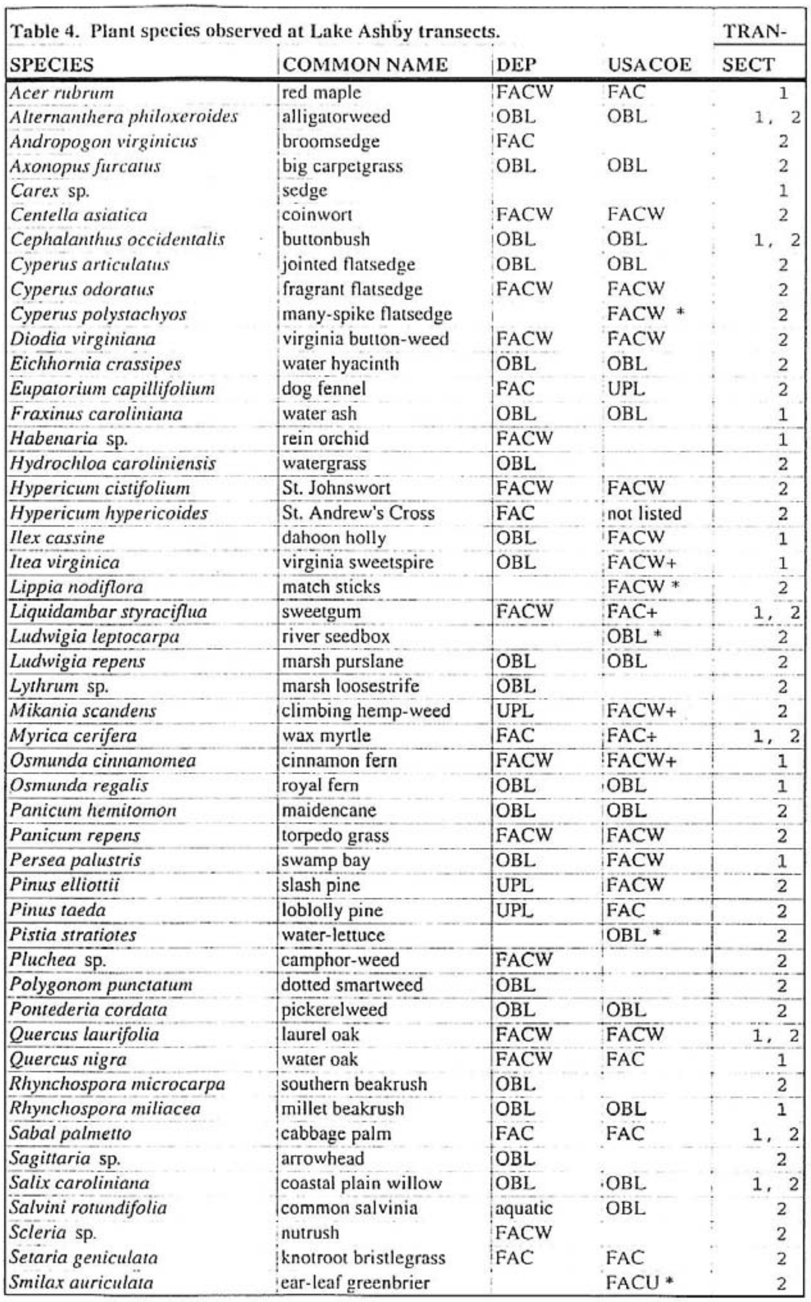
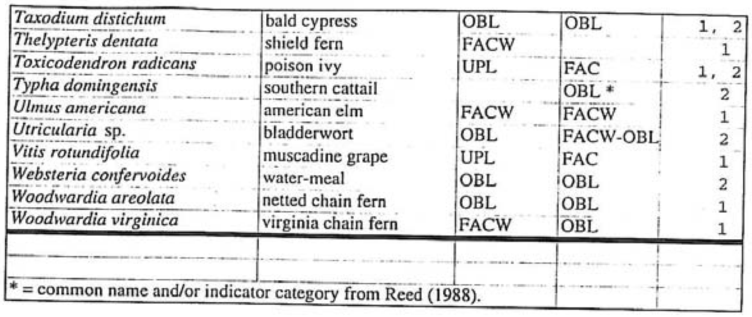


Table 4. Plant species observed at Lake Ashby transects.

SPECIES	COMMON NAME	DEP	USACOE	TRANSECT
Acer rubrum	red maple	FACW	FAC	1
Alternanthera philoxeroides	alligatorweed	OBL	OBL	1, 2
Andropogon virginicus	broomsedge	FAC		2
Axonopus furcatus	big carpetgrass	OBL	OBL	2
Carex sp.	sedge			1
Centella asiatica	coinwort	FACW	FACW	2
Cephalanthus occidentalis	buttonbush	OBL	OBL	1, 2
Cyperus articulatus	jointed flatsedge	OBL	OBL	2
Cyperus odoratus	fragrant flatsedge	FACW	FACW	2
Cyperus polystachyos	many-spike flatsedge		FACW *	2
Diodia virginiana	virginia button-weed	FACW	FACW	2
Eichhornia crassipes	water hyacinth	OBL	OBL	2
Eupatorium capillifolium	dog fennel	FAC	UPL	2
Fraxinus caroliniana	water ash	OBL	OBL	1
Habenaria sp.	rein orchid	FACW		1
Hydrochloa caroliniensis	watergrass	OBL		2
Hypericum cistifolium	St. Johnswort	FACW	FACW	2
Hypericum hypericoides	St. Andrew's Cross	FAC	not listed	2
Ilex cassine	dahoon holly	OBL	FACW	1
Itea virginica	virginia sweetspire	OBL	FACW+	1
Lippia nodiflora	match sticks		FACW *	2
Liquidambar styraciflua	sweetgum	FACW	FAC+	1, 2
Ludwigia leptocarpa	river seedbox		OBL *	2
Ludwigia repens	marsh purslane	OBL	OBL	2
Lythrum sp.	marsh loosestrife	OBL		2
Mikania scandens	climbing hemp-weed	UPL	FACW+	2
Myrica cerifera	wax myrtle	FAC	FAC+	1, 2
Osmunda cinnamomea	cinnamon fern	FACW	FACW+	1
Osmunda regalis	royal fern	OBL	OBL	1
Panicum hemitomon	maidencane	OBL	OBL	2
Panicum repens	torpedo grass	FACW	FACW	2
Persea palustris	swamp bay	OBL	FACW	1
Pinus elliottii	slash pine	UPL	FACW	2
Pinus taeda	loblolly pine	UPL	FAC	2
Pistia stratiotes	water-lettuce		OBL *	2
Pluchea sp.	camphor-weed	FACW		2
Polygonom punctatum	dotted smartweed	OBL		2
Pontederia cordata	pickerelweed	OBL	OBL	2
Quercus laurifolia	laurel oak	FACW	FACW	1, 2
Quercus nigra	water oak	FACW	FAC	1
Rhynchospora microcarpa	southern beakrush	OBL		2
Rhynchospora miliacea	millet beakrush	OBL	OBL	1
Sabal palmetto	cabbage palm	FAC	FAC	1, 2
Sagittaria sp.	arrowhead	OBL		2
Salix caroliniana	coastal plain willow	OBL	OBL	1, 2
Salvini rotundifolia	common salvinia	aquatic	OBL	2
Scleria sp.	nutrush	FACW		2
Setaria geniculata	knotroot bristlegrass	FAC	FAC	2
Smilax auriculata	ear-leaf greenbrier		FACU *	2



Taxodium distichum	bald cypress	OBL	OBL	1, 2
Thelypteris dentata	shield fern	FACW		1
Toxicodendron radicans	poison ivy	UPL	FAC	1, 2
Typha domingensis	southern cattail		OBL *	2
Ulmus americana	american elm	FACW	FACW	1
Utricularia sp.	bladderwort	OBL	FACW-OBL	2
Vitis rotundifolia	muscadine grape	UPL	FAC	1
Websteria confervoides	water-meal	OBL	OBL	2
Woodwardia areolata	netted chain fern	OBL	OBL	1
Woodwardia virginica	virginia chain fern	FACW	OBL	1

* = common name and/or indicator category from Reed (1988).

APPENDIX B—IMPLEMENTATION OF MFLS FOR LAKE ASHBY

Prepared by
C. Price Robison, P.E., St. Johns River Water Management District (2007)

The objective of minimum flows and levels (MFLs) is to establish limits to allowable hydrologic change in a water body or watercourse, to prevent significant harm to the water resources or ecology of an area. Hydrologic changes within a water body or watercourse may result from an increase in the consumptive use of water or the alteration of basin characteristics, such as down-cutting outlet channels or constructing outflow structures.

MFLs define a series of minimum high- and low water levels and/or flows of differing frequencies and durations required to protect and maintain aquatic and wetland resources. MFLs take into account the ability of wetlands and aquatic communities to adjust to changes in hydrologic conditions. MFLs allow for an acceptable level of change to occur relative to existing hydrologic conditions, without incurring significant ecological harm to the aquatic system.

Before MFLs can be applied, the minimum hydrologic regime must be defined or characterized statistically. Resource management decisions can then be made predicated on maintaining at least these minimum hydrologic conditions as defined by the appropriate statistics.

One way to understand how changes within a watershed alter a hydrologic regime and, therefore, how the aquatic and wetland resources might be affected is by simulating the system with a hydrologic model. Significant harm can be avoided by regulating hydrologic changes based on the comparison of statistics of the system with and without changes.

MFLs determinations are based on a concept of maintaining the duration and return periods of selected, ecologically based stages and/or flows. Thus, a water body can fall below the selected stage and/or flow, but if it does so too often and/or for too long, then the MFLs would no longer be met.

Statistical analysis of model output provides a framework to summarize the hydrologic characteristics of a water body. The St. Johns River Water Management District (SJRWMD) MFLs program relies on a type of statistical analysis referred to as frequency analysis.

Frequency analysis

As discussed previously, aquatic resources are sustained by a certain hydrologic regime. Depending on the resource in question, a selected ground elevation, for example, might include the need to:

- Remain wet for a certain period of time with a certain frequency.
- Remain dry for a certain period of time with a certain frequency.
- Be under a given minimum depth of water for a certain period of time with a certain frequency.

Frequency analysis estimates how often, on average, a given event will occur. If annual series data are used to generate the statistics, frequency analysis estimates the probability of a given hydrologic event happening in any given year.

A simple example illustrates some of the concepts basic to frequency analysis. A frequently used statistic with respect to water level is the yearly peak stage of a water body. If a gauge has been monitored for 10 years, then there will be 10 yearly peaks—$S_1, S_2, \cdots, S_{10}$. Once sorted and ranked, these events can be written as $\hat{S}_1, \hat{S}_2, \cdots, \hat{S}_{10}$, with $\hat{S}_1$ being the highest peak. Based on this limited sample, the estimated probability of the yearly peak being greater than or equal to $\hat{S}_1$ would be

$$P(S \geq \hat{S}_1) = \frac{1}{n} = \frac{1}{10} = 0.1; \qquad \text{(B1)}$$

the probability of the 1-day peak stage in any year being greater than $\hat{S}_2$ would be

$$P(S \geq \hat{S}_2) = \frac{2}{10} = 0.2; \qquad \text{(B2)}$$

and so on. The probability of the stage equaling or exceeding $\hat{S}_{10}$ would be

$$P(S \geq \hat{S}_{10}) = \frac{10}{10} = 1.0. \qquad \text{(B3)}$$

Because this system of analysis precludes any peak stage from being lower than $\hat{S}_{10}$, the usual convention is to divide the stage continuum into 11 parts: nine between each of the 10 peaks, one above the highest peak, and one below the lowest peak ($n - 1 + 2 = n + 1 = 11$). This suggests what is known as the Weibull plotting position formula,

$$P(S \geq \hat{S}_m) = \frac{m}{n+1} \tag{B4}$$

where

$P(S \geq \hat{S}_m) =$ probability of S equaling or exceeding $\hat{S}_m$

$m =$ rank of the event.

Thus, in the example, the probability of the peak in any year equaling or exceeding $\hat{S}_1$ would be

$$P(S \geq \hat{S}_1) = \frac{1}{n+1} = \frac{1}{11} = 0.0909\ ; \tag{B5}$$

the probability of the 1-day peak stage in any year being greater than $\hat{S}_{10}$ would be

$$P(S \geq \hat{S}_{10}) = \frac{10}{11} = 0.9091\ ; \tag{B6}$$

and so on. The probability of the stage in any year is smaller than $\hat{S}_{10}$ would be

$$P(S < \hat{S}_{10}) = 1 - P(S \geq \hat{S}_{10}) = 1 - \frac{10}{11} = 1 - 0.9091 = 0.0909\ . \tag{B7}$$

The return period (in years) of an event, T, is defined as

$$T = \frac{1}{P} \tag{B8}$$

so the return period for $\hat{S}_1$ would be

$$T(\hat{S}_1) = \frac{1}{P(S \geq \hat{S}_1)} = \frac{1}{\frac{1}{11}} = 11\ . \tag{B9}$$

Said another way, $\hat{S}_1$ would be expected to be equaled or exceeded, on average, once every 11 years.

As the size of the sample increases, the probability of $\hat{S}_1$ being exceeded decreases. Thus, with n = 20,

$$P(S \geq \hat{S}_1) = \frac{1}{n+1} = \frac{1}{21} = 0.048 \qquad \text{(B10)}$$

and

$$T(\hat{S}_1) = \frac{1}{P(S \geq \hat{S}_1)} = 21 . \qquad \text{(B11)}$$

The stage or flow characteristics of a water body can be summarized using the Weibull plotting position formula and a frequency plot. For example, Figure B1 shows a flood frequency plot generated from annual peak flow data collected at the U.S. Geological Survey (USGS) gauge on the Wekiva River.

Minimum events are treated in much the same way as maximum events, except with minimums, the events are ranked from smallest to largest. Thus, $\hat{S}_1$ is the smallest or lowest event in a sampling. The minimum stage or flow characteristics of a gauge or water body can be summarized using the Weibull plotting position formula and a frequency plot. For example, Figure B2 shows a drought frequency plot generated from a hydrologic simulation of the middle St. Johns River.

One of the purposes of performing this process of sorting, ranking, and plotting events is to estimate probabilities and return periods for events larger than $\hat{S}_1$, smaller than $\hat{S}_n$, or any event between sample points. There are two methods of obtaining these probabilities and return periods. The first method is to use standard statistical methods to mathematically calculate these probabilities and return periods (Figure B3). This method is beyond the scope of this appendix; the reader is referred to a standard hydrology text (Ponce 1989, Linsley et al. 1982) or the standard flood frequency analysis text, USGS Bulletin 17B (1982).

With the second method, interpolated or extrapolated frequencies and return periods can also be obtained by the graphical method. Once the period-of-record or period-of-simulation events have been sorted and ranked, they are plotted on probability paper. Probabilities and return periods for events outside of the sampled events can be estimated by drawing a line through the points on the graph to obtain an estimated best fit (Figure B4).

Frequency analysis is also used to characterize hydrologic events of durations longer than 1 day. Frequency analysis encompasses four types of events: (1) maximum average stages or flows; (2) minimum average stages or flows; (3) maximum stages or flows continuously exceeded; and (4) minimum stages or flows continuously not exceeded.

Maximum average stages or flows. In this case, an event is defined as the maximum value for a mean stage or flow over a given number of days. For example, if the maximum yearly values for a 30-day average are of interest, the daily-value hydrograph is analyzed by using a moving 30-day average. Therefore, a 365-day hydrograph would have 336 (365 – 30 + 1 = 336) different values for a 30-day average. These 336 values are searched, and the highest is saved. After performing this analysis for each year of the period of record or period of simulation, the events are sorted and ranked. The analytical process is then the same as for the 1-day peaks.

Minimum average stages or flows. In this case, an event is defined as the minimum value for a mean stage or flow over a given number of days. For example, if the minimum yearly values for a 30-day average are of interest, the daily-value hydrograph is analyzed by using a moving 30-day average. Therefore, a 365-day hydrograph would have 336 (365 – 30 + 1 = 336) different values for a 30-day average. These 336 values are searched, and the lowest is saved. After performing this analysis for each year of the period of record or period of simulation, the events are sorted and ranked. The process is then the same as for the 1-day low stages.

Maximum stage or flow continuously exceeded. In this case, an event is defined as the stage or flow that is exceeded continuously for a set number of days. For example, if the maximum yearly ground elevation that continuously remains under water for 60 days is of interest, the stage hydrograph of each year is analyzed by taking successive 60-day periods and determining the stage that is continuously exceeded for that period. This is repeated for 306 (365 – 60 + 1 = 306) periods of 60 days. The maximum stage in those 306 values is saved. Once that operation is performed for all years of record or of simulation, the results are sorted and ranked as for the 1-day peaks.

Minimum stage or flow continuously not exceeded. In this case, an event is defined as the stage or flow that is not exceeded continuously for a set number of days. For example, if the minimum yearly ground elevation that continuously remains dry for 60 days is of interest, the stage hydrograph of each year is analyzed by taking successive 60-day periods and determining the stage that is continuously not exceeded for that period. This is repeated for 306 (365 – 60 + 1 = 306) periods of 60 days. The minimum stage in those 306 values is saved. Once that operation is performed for all years of record or of simulation, the results are sorted and ranked as for the 1-day low stages.

In frequency analysis, it is important to identify the most extreme events occurring in any given series of years. Because high surface water levels (stages) in Florida generally occur in summer and early fall, maximum value analysis is based on a year that runs from June 1 to May 31. Conversely, because low stages tend to occur in late spring, the year for minimum events runs from October 1 to September 30.

Hydrologic statistics and their relationships to the Lake Ashby MFLs

This section describes the process used to relate long-term hydrologic statistics to the establishment of MFLs. SJRWMD has adopted two MFLs for Lake Ashby: (1) a minimum frequent high (FH) level and (2) a minimum frequent low (FL) level. The FH level for this lake is used here to illustrate how long-term hydrologic statistics of a lake relate to MFLs.

Each of the two MFLs is tied to characteristic stage durations and return frequencies. For example, the ground elevation represented by the FH level is expected to remain wet continuously for a period of at least 60 days. This event is expected to occur, on average, at least once every 3 years.

A consultant developed a hydrologic model of Lake Ashby for SJRWMD (CDM 2003). At the time of model development, only land use data for 1995 was available. However, it is assumed that land use around Lake Ashby remained largely unchanged between 1995 and 2002, the last year of model simulation. Therefore, the model is assumed to represent 2002 conditions.

The standard stage frequency analysis described previously in this appendix was performed on stage data from lake model simulations of Lake Ashby (CDM 2003). In particular, stages continuously exceeded (ground elevations remaining wet) for 30 days were determined, sorted, ranked, and plotted (Figure B5). These stages were modeled assuming that long-term basin conditions were what they were in 2002. The ground elevation of the FH level can be superimposed on the plot (Figure B6) to demonstrate how the level is related to the pertinent hydrologic statistics. Finally, a box bounded by: (1) the FH level on the bottom; (2) a vertical line corresponding to a frequency of occurrence of once in every 3 years on the right; and (3) a vertical line corresponding to a frequency of occurrence of once in every 2 years on the left, is superimposed on the plot (Figure B7). Similar analysis was performed for the FL level (Figure B8). Both levels are being met under these conditions.

A summary of the adopted MFLs for Lake Ashby is shown in Table B1. Values in this table will be used as benchmarks for modeling outputs to determine if any basin changes will cause water levels to fall below MFLs.

Based on model calibration, there is no significant connection between Lake Ashby and the Floridan aquifer. Therefore, regional groundwater withdrawals will not significantly affect Lake Ashby stages.

Table B1. Summary of adopted MFLs for Lake Ashby

MFLs	Level (ft NGVD)	Duration	Series	Water Year	Statistical Type	Minimum Return Period	Maximum Return Period
Minimum frequent high (FH)	12.3	60 days	Annual	June 1–May 31	Maximum, continuously exceeded	NA	3 yrs
Minimum frequent low (FL)	11.1	120 days	Annual	Oct. 1–Sept. 30	Minimum, continuously not exceeded	5 yrs	NA

ft NGVD = feet National Geodetic Vertical Datum
NA = not applicable

References

[CDM] Camp, Dresser and McKee. 2003. *Model Development for MFL Evaluation of Lake Ashby, Volusia County*. Jacksonville, Florida.

Linsley, R.K., M.A. Kohler, and J.L.H. Paulhus. 1982. *Hydrology for Engineers*. 3d ed. New York: McGraw-Hill.

Ponce, V.M. 1989. *Engineering Hydrology: Principles and Practices*. Englewood Cliffs, N.J.: Prentice Hall.

[USGS] U.S. Geological Survey. 1982. *Guidelines for Determining Flood Flow Frequency*. Bulletin 17B. Reston, Va.: Interagency Advisory Committee on Water Data.

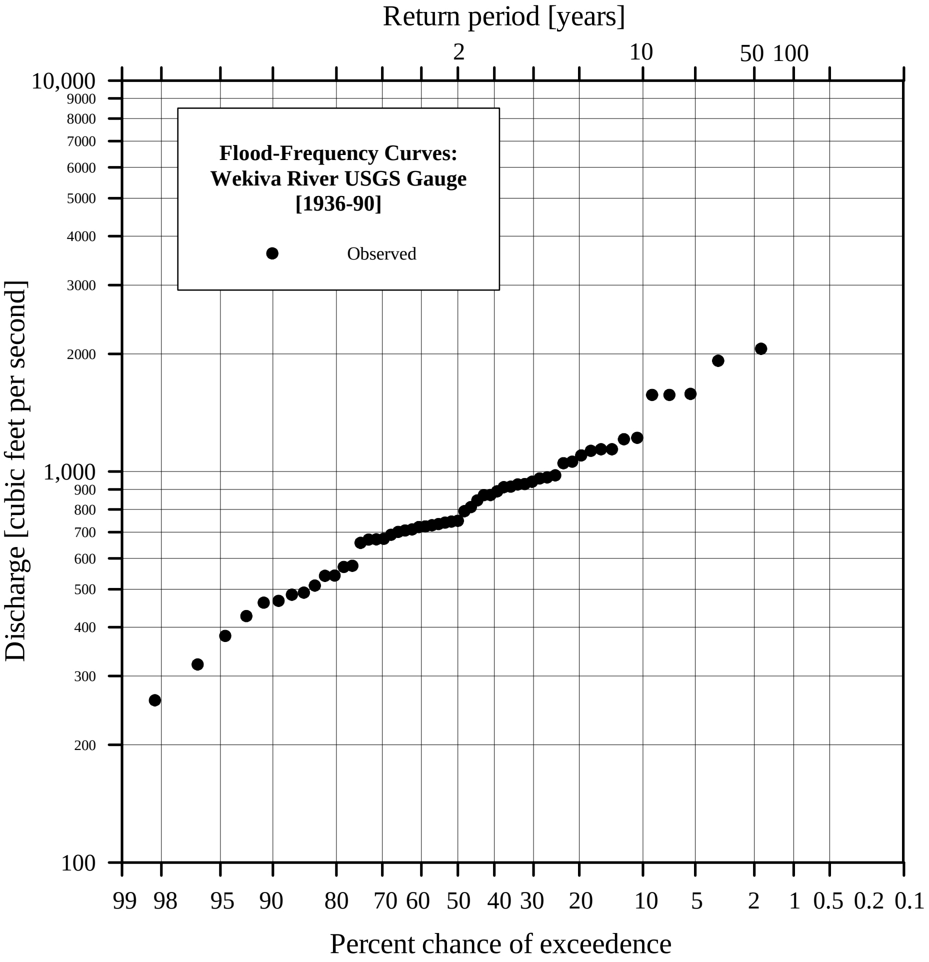


Figure B1. Flood frequencies for the Wekiva River at the USGS gauge near Sanford, Fla.; the 1-day peak flows have been sorted, ranked, and plotted according to the Weibull plotting position formula

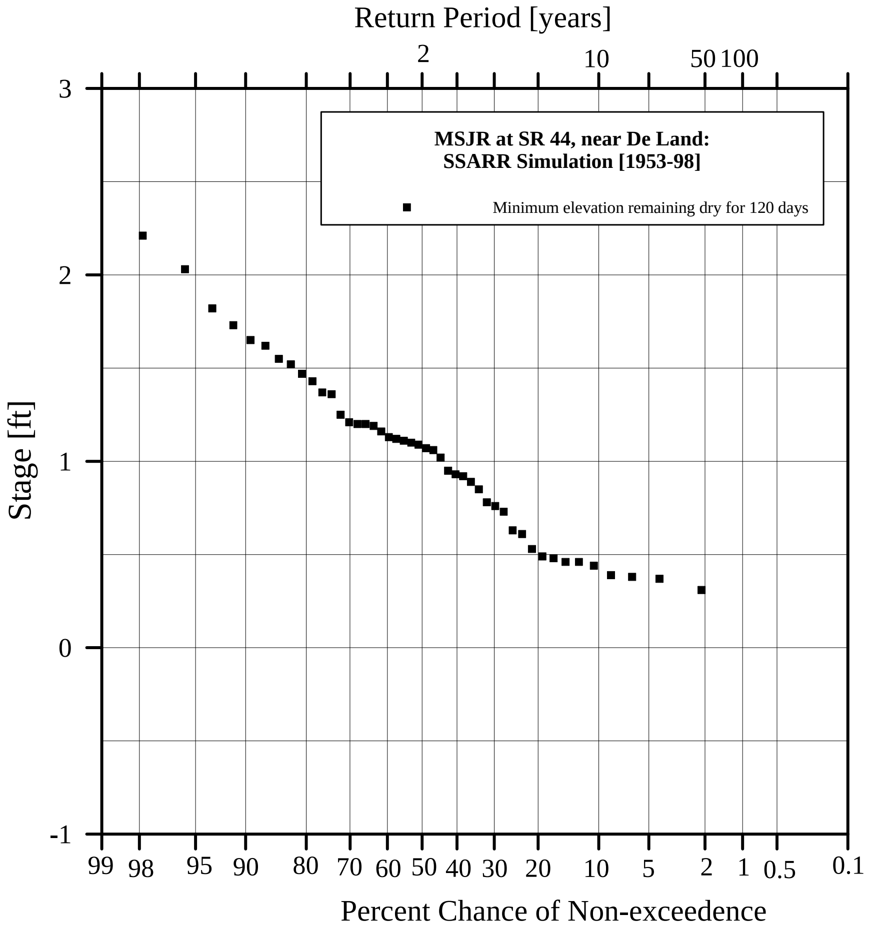


Figure B2. Drought frequencies computed using daily stages simulated by the MSJR SSARR model at SR 44, near DeLand; the minimum stages continuously not exceeded for 120 days have been sorted, ranked, and plotted according to the Weibull plotting position formula

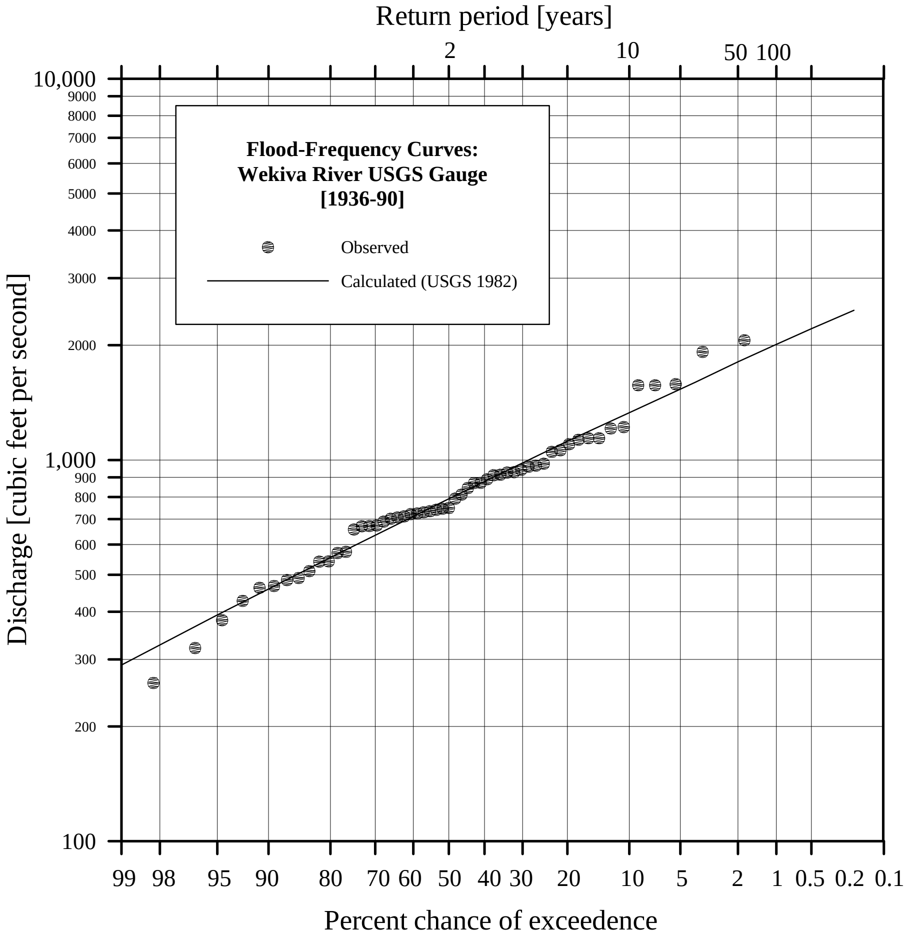


Figure B3. Flood frequencies for the Wekiva River at the USGS gauge near Sanford, Fla., fitted by standard mathematical procedure

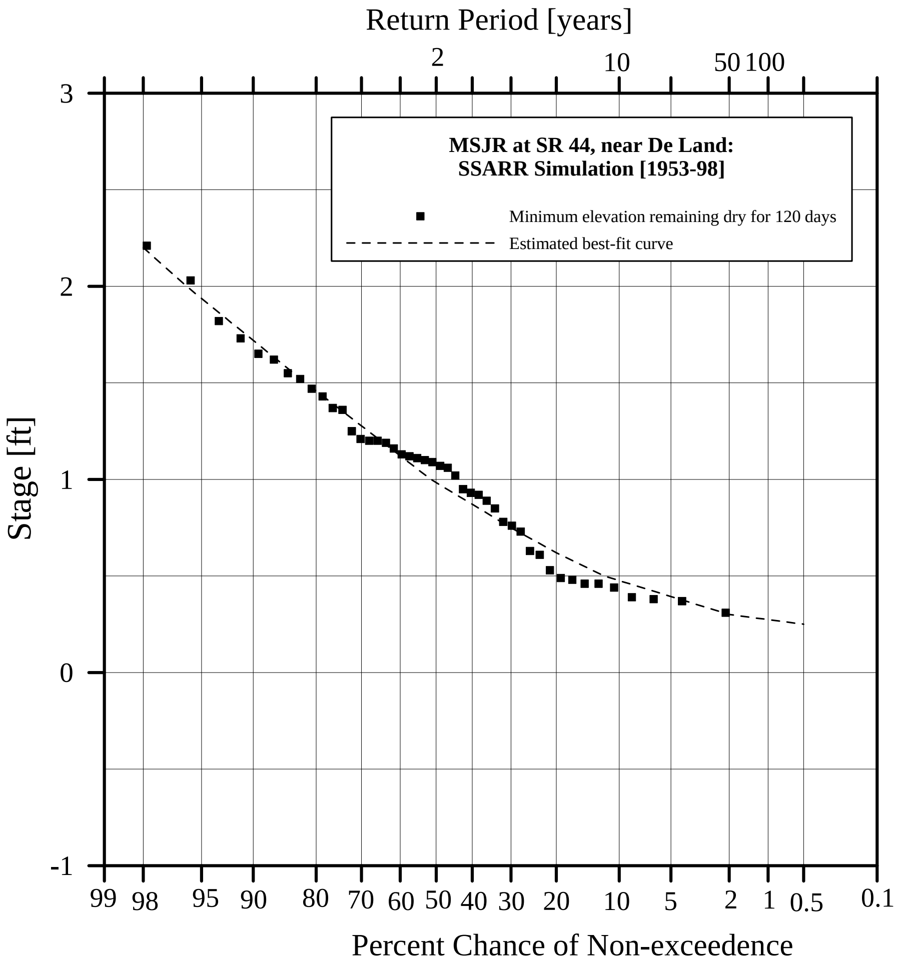


Figure B4. Drought frequencies computed using daily stages simulated by the MSJR SSARR model at SR 44, near DeLand, fitted by the graphical method

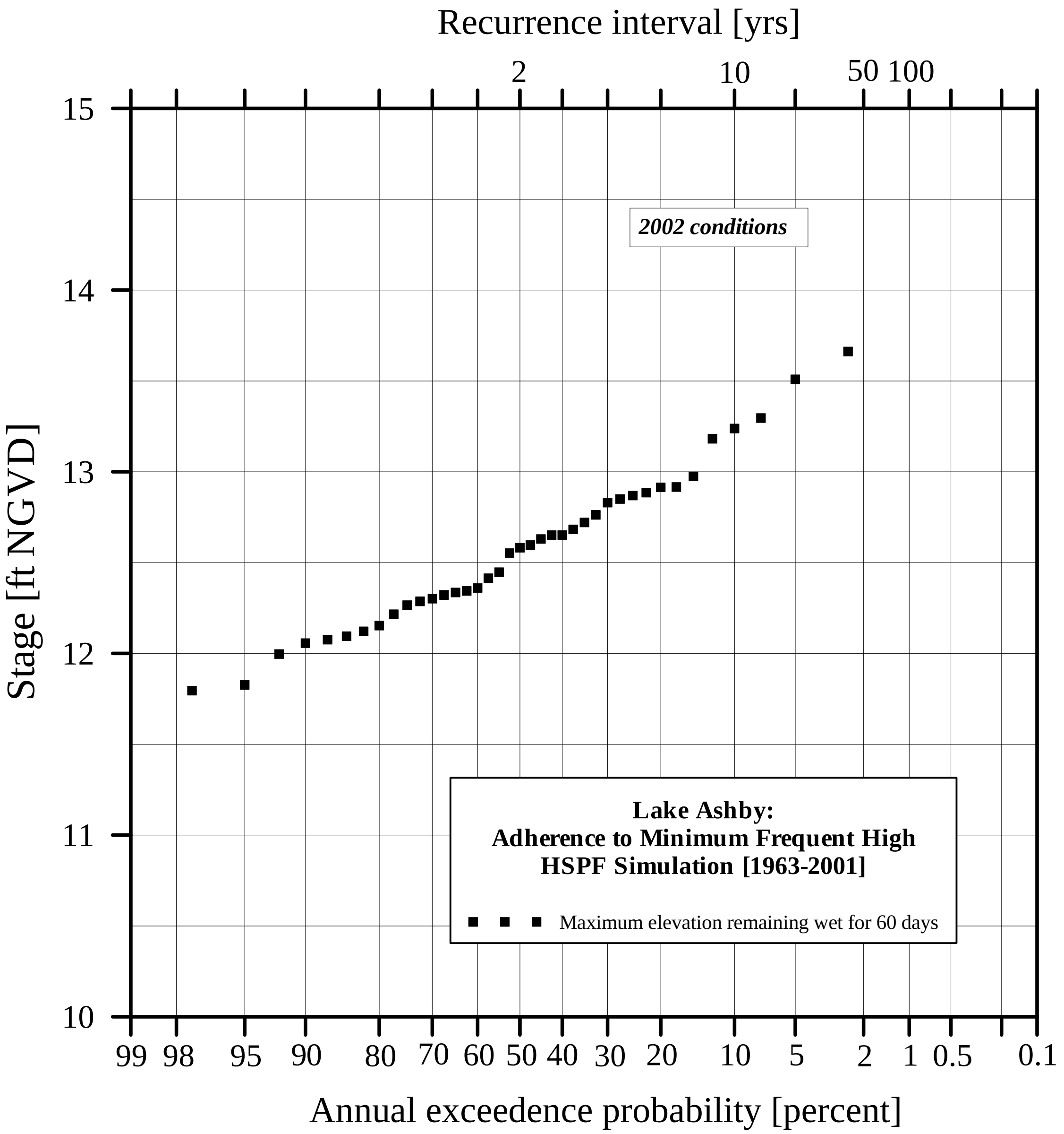


Figure B5. Flood frequencies computed using daily stages from model simulations of Lake Ashby, for elevations continuously wet for 60 days and 2002 conditions

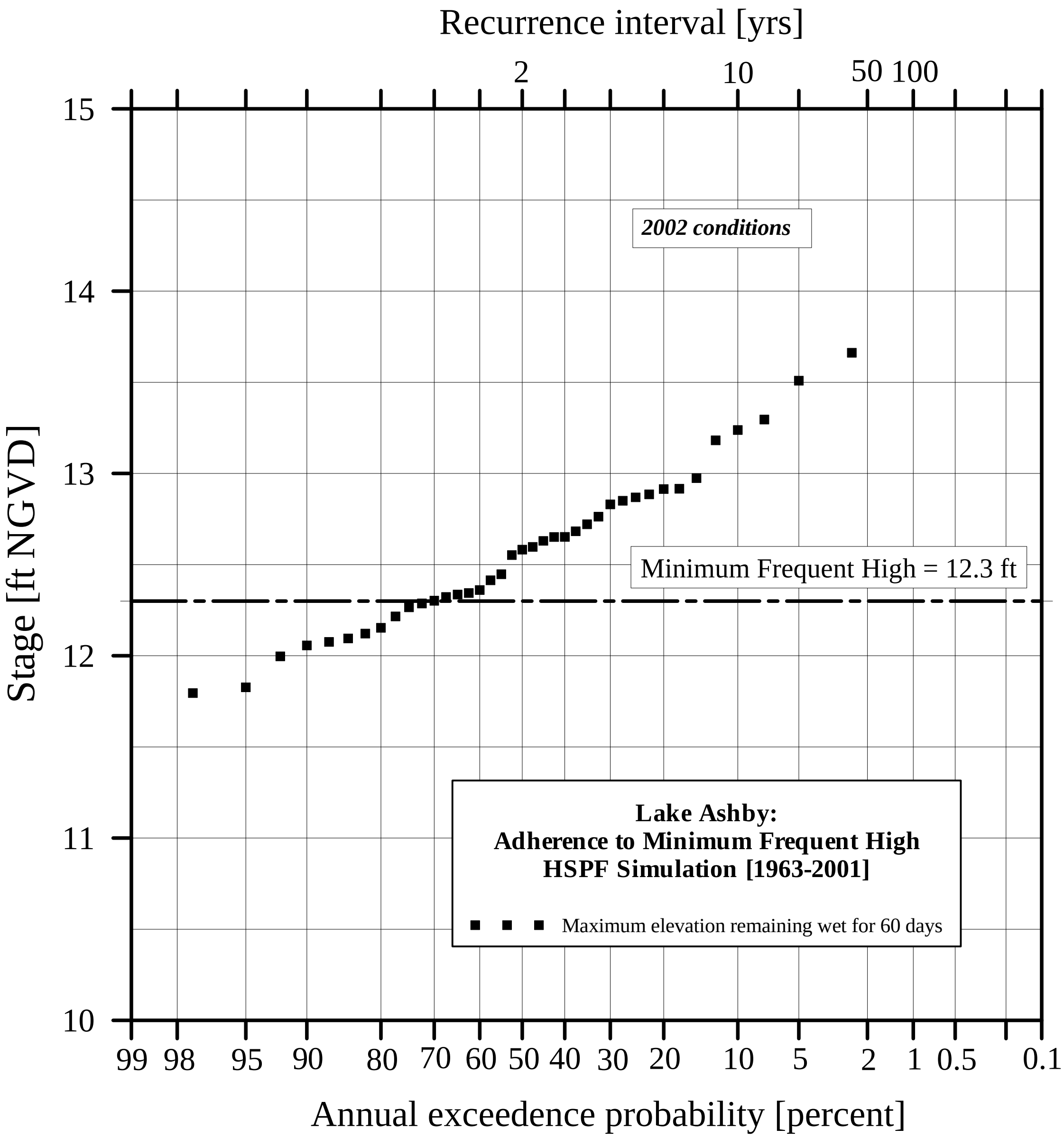


Figure B6. Flood frequencies computed using daily stages from model simulations of Lake Ashby, for elevations continuously wet for 60 days and 2002 conditions with the FH of 12.3 ft NGVD superimposed

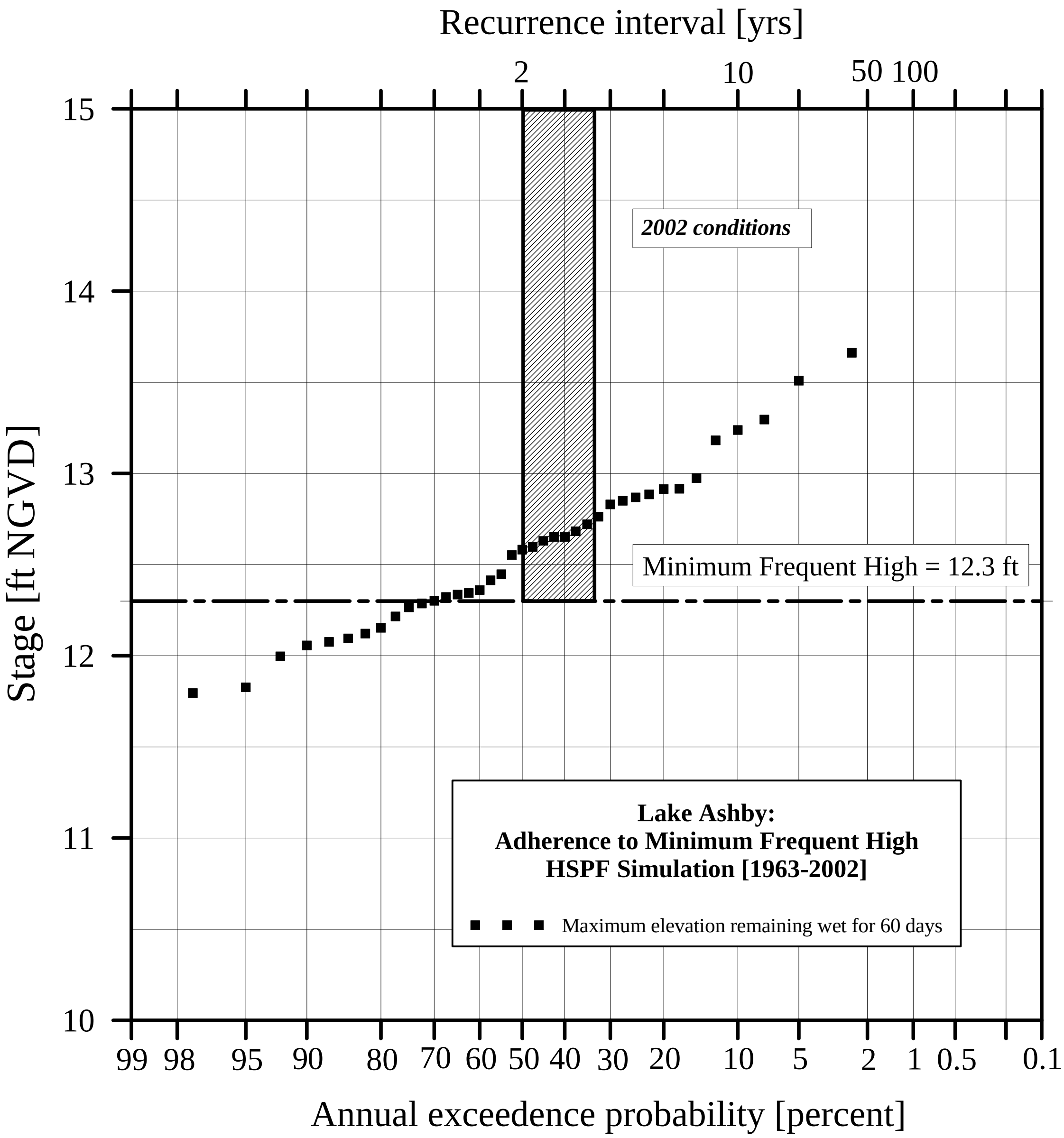


Figure B7. Flood frequencies computed using daily stages from model simulations of Lake Ashby, for elevations continuously wet for 60 days and 2002 conditions with a superimposed box bounded by: (1) the FH; (2) a vertical line corresponding to a return period of 2 years; and (3) a vertical line corresponding to a return period of 3 years

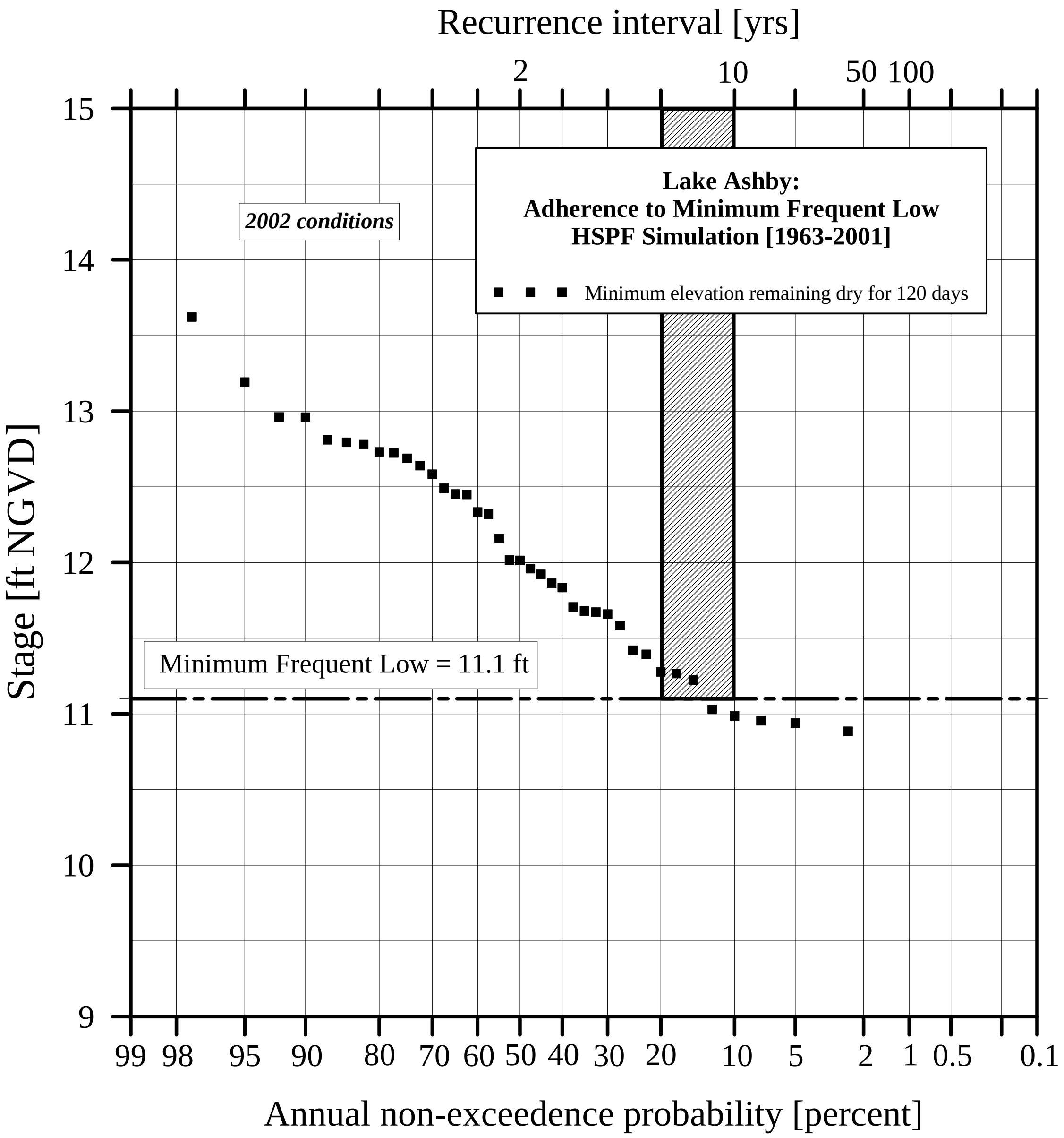


Figure B8. Drought frequencies computed using daily stages from model simulations of Lake Ashby, for the FL level and 2002 conditions