APPENDIX C— ENVIRONMENTAL DATA

Environmental Analyses

Field Data Collection

The field-data-collection procedure for determining MFLs typically involves gathering information and sampling elevation, soils, and vegetation data along fixed transects, across a hydrologic gradient. Upon selection of a transect site, a measuring tape is laid out along the length of the transect. Elevation measurements are recorded at various intervals (i.e.,1 ft, 5 ft, 10 ft) to adequately characterize topography and transect features. Additional elevations are often measured at obvious elevation breaks, vegetation features, plant community changes, soil changes, and high-water marks. Latitude and longitude data are also collected with a global positioning system (GPS) receiver at selected points along the length of transects. These data accurately locate specific features along each transect and facilitate future recovery of transect locations.

Soil Sampling Procedures

The primary soil criteria considered in the MFLs determinations are the presence and depth of organic soils, as well as the extent of hydric soils and hydric soil indicators (HI) observed along the field transects. Soil borings (up to a depth of 6 ft) were taken at various points on the transect lines to sample all significant geomorphic features, landscape positions, and plant communities. Permanently flooded areas such as deep marshes were generally not sampled. Soil profile descriptions followed NRCS guidelines (Schoeneberger et al. 2002). Soil descriptions included the horizon depth, texture, color, redoximorphic features, and consistence of soil materials. Additional soil sampling procedures are documented in SJRWMD's Minimum Flows and Levels Methods Manual (SJRWMD 2006).

Vegetation Sampling Procedures

Plant communities and transition zones were delineated along a specialized line transect called a belt transect. A belt transect is a line transect with width (belt width) 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 1). The belt transect width will vary depending upon the type of plant community to be sampled (SJRWMD 2006). 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 represent a forested community adequately.

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.

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 2006). Percent cover was estimated visually using cover classes (ranges of percent cover). The cover class and percent cover ranges are a variant of the Daubenmire method (Mueller-Dombois and Ellenberg 1974) and summarized in SJRWMD's (draft) Minimum Flows and Levels Methods Manual (SJRWMD 2006).

Accurate estimates of vegetation composition are necessary in order to characterize plant species distribution and to delineate plant communities. Various attributes may be used to characterize vegetation (Bonham, 1989). Vegetation cover is the vertical projection of vegetation parts onto the ground and approximates the area over which a plant exerts its influence on the ecosystem (Daubenmire, 1959). Vegetation cover may be expressed in absolute or relative terms. Due to the contributions of overlapping layers, absolute vegetation cover often exceeds 100 percent. Relative cover in which the cover of each species is a percent of the total vegetation sums to 100 percent. Relevé and line-intercept are two methods used in the MFL program to measure plant cover along transects. The data are then used in two different approaches to delineating plant community boundaries.

The relevé method involves first delineating the boundaries of plant communities in the field based on the observer's judgement of areas having uniform vegetation characteristics. Changes in dominant plant species, indicator plant species, soil characteristics, land slope, and elevation may all be used to determine community boundaries. Transition zones or ecotones where vegetation characteristics change rapidly are identified separately from uniform vegetation zones. Vegetation community names are assigned to different portions of the belt based on a SJRWMD classification system developed by Kinser (1996). Ocular estimates of cover for each species are assigned to broad cover classes. Broad classes are preferable because results are more likely to be consistent between observers. The cover classes are based on the Braun-Blanquet cover abundance scale, as follows: 5: >75% cover, 4: 50-75% cover, 3: 25-50% cover, 2: 10-25 % cover, 1: 1-10% cover, 0: <1 % cover. Belt width varies depending on the type of plant community being sampled. For an herbaceous community, belt width may be as little as 10 feet in width but for forested systems, a 50-foot wide belt is used (SJRWMD, 2006).

Line-intercept is the second technique used in the MFL program to measure plant cover. It is a quantitative method that involves measuring by plant species the lengths of vegetation that overlap the transect line. Cover intervals are measured to the nearest foot. Annuals, vines, and floating species, which are not reliable indicators of site hydrology, are excluded. Cover interval data are converted to cover abundance data for use in plant community delineation.

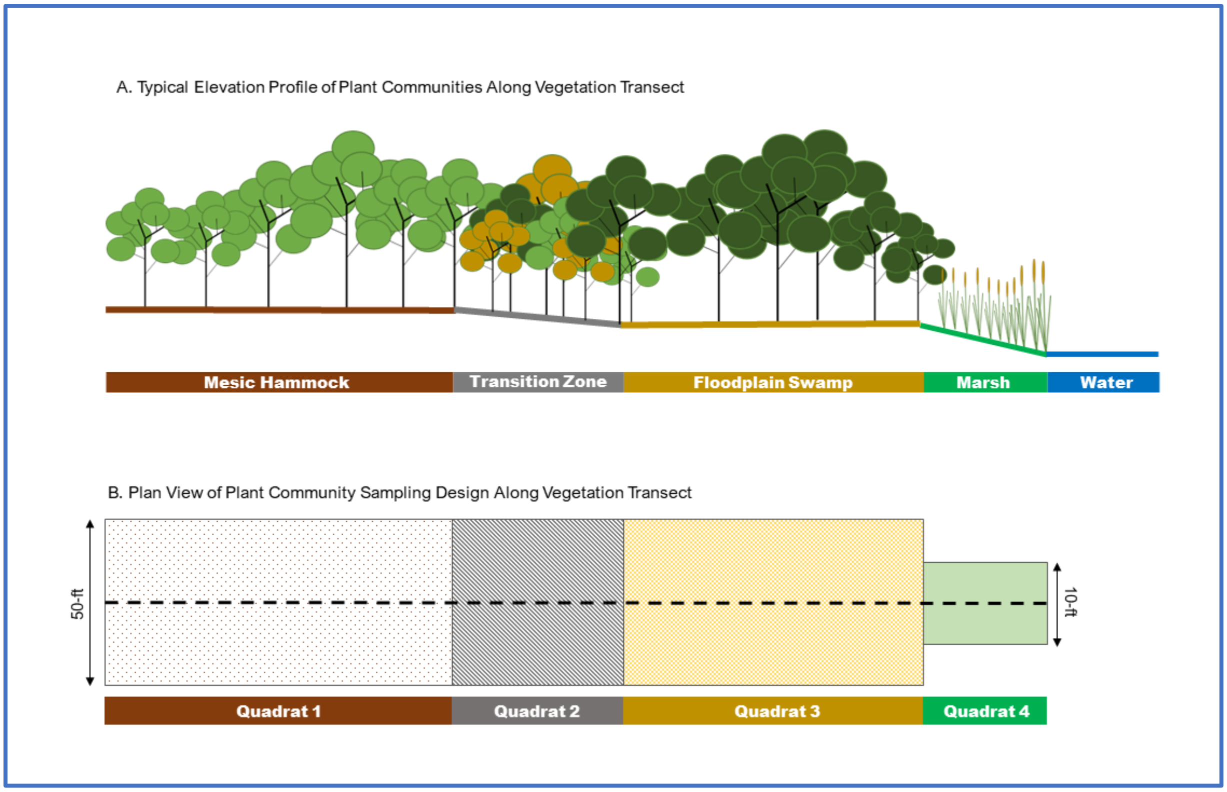

Figure 1. Example of belt transect within forested and herbaceous plant communities.

FIELD DATA

Two transect sites were selected after reviewing topographic, soil (Figure 3), and wetland maps. Transects 1 and 2 were established in April 2010 (Figure 4). SJRWMD staff collected vegetation and soils data at from 4/9/2010 to 4/16/2010. Staff collected elevation data at on 4/13/2010 when the lake level was at 82.03 ft NAVD88. The water level in the pond adjacent to Lake Apshawa at Transect 2 was at 82.83 ft NAVD88 at that time. Thirteen soundings from Lake Apshawa were collected on 2/18/2011 and numerous soundings were collected with an Acoustic Doppler Profiler on 3/19/2019. A staff gauge, located on the east shore of Apshawa Lake South, off East Apshawa Road (datum 75.33 ft NAVD), was verified with reference to benchmark IDs 03-12-614-0, 03-12-614-1, and 03-12-614-2.

TRANSECT 1

Transect 1 started in an upland area and extended 595 feet to the south ending at the open water of the lake (Table 1). At approximately 30 feet, the transect crossed a trail where minor topographic modifications may have been made. Elevations drop sharply from 40 to 70 feet marking a transition to the lake floodplain. The transect crossed a rise in the floodplain from 260 to 360 feet and then sloped gradually to the lake (Figure 2).

Table 1. Apshawa Lake South transect locations

Transect	Latitude/Longitude
Transect 1 Station: 0	28°36'18.58"N/ 81°46'30.36"W
Transect 1 Station: 595	28°36'13.45"N/ 81°46'33.00"W
Transect 2 Station: 0	28°36'11.76"N/ 81°46'42.85"W
Transect 2 Station: 535	28°36'11.06"N/ 81°46'37.05"W

Figure 2. Transect 1 at station 100. Shallow marsh and wet prairie shown in photograph.

Soils Data

***Soil Survey Background*:** The Lake County Soil Survey Report (SCS-USDA, 1975) shows two soil map units at Transect 1. Astatula sand, 0 to 5 percent slopes (Hyperthermic, uncoated Typic

Quartzipsamments) was mapped in the uplands. This excessively-drained, rapidly permeable soil forms in eolian and marine sands. Astatula sand is non-hydric and depth to the seasonal high water table is greater than 120 inches. Placid and Myakka sands, 0 to 2 percent slopes (Sandy, siliceous, hyperthermic Typic Humaquepts and Aeric Alaquods) is a complex of poorly and very poorly drained soils that occurs in low, marshy depressions. This complex was mapped at lower elevations of the transect bordering the lake. This soil is considered hydric and the water table is at the surface for 4 to 6 months in most years.

On-site Investigations**:** Soil descriptions were collected at 18 stations. These soil descriptions are shown in Appendix C. The soil at stations 0 (91.55 ft. NAVD) and 80 (87.70 ft. NAVD) was Astatula sand. The soil at station 420 (83.06 ft. NAVD) was described as Sanibel muck (Sandy, siliceous, hyperthermic Histic Humaquept) but would be a variant on this series due to the presence of tight clay loam/ clay substrate at a depth of 46 to 55 inches.

Stripped matrix (S6) occurred at station 100 in wet prairie #1 and was the first hydric soil indicator observed. Mucky mineral (A7) occurred at stations 120 and 180 in the shallow marsh. S6 occurred again at station 295 in wet prairie #2 and was the highest elevation hydric soil indicator encountered on the transect. Muck presence (A8) occurred at station 390 in shallow marsh #2. Histic epipedon (A2) occurred at stations 395, 420 and 455, also in shallow marsh #2 at lower elevations than A8. A8 occurred again in the deep marsh at stations 490 and 510. Estimates of the extent of hydric soil indicators and soil summary statistics are provided in Table 2. Detailed soils description data are provided in Table 8.

Table 2 Transect 1 Soil summary statistics

HI map unit*	Borehole stations (ft.)	Map unit start - end (ft.)	mean	median	max	min
none	0, 20, 80, 90	0-100				84.24
S6	100	100-120	84.26	84.38	84.46	83.92
A7	120, 180	120-265	83.89	83.91	84.56	83.54
S6	295	265-365	84.5	84.62	84.76	83.95
A8	390	365-395	83.68	83.67	83.95	83.4
A2	395, 400, 420, 455	395-465	82.92	82.86	83.4	82.52
A8	490, 510	465-510	81.7	81.63	82.52	80.97
A7	520, 540, 565	510-565***			80.97	

Vegetation Data

Estimates of species composition and abundance for each community of Transect 1 are shown in Table 3. Summary statistics for elevations (ft NAVD) of each plant community are shown in Table 4. From 0 to 48 feet, the transect crosses an upland area dominated by bahiagrass (*Paspalum notatum*) in the understory and live oak (*Quercus virginiana*) in the canopy layer. A transition zone from 48 to 66 feet is dominated by upland species such as broomsedge (*Andropogon virginicus*) but also contains scattered wetland species such as blue maidencane (*Amphicarpum muhlenbergianum*) and spadeleaf (*Centella asiatica*). A wet prairie community occurs from 66 to 110 feet and is dominated by a mix of blue maidencane and broomsedge. A shallow marsh occurs from 110 to 265 feet and is dominated by blue maidencane. A second wet prairie dominated by broomsedge occurs from 265 to 365 feet. A second shallow marsh occurs from 365 to 485 feet, also dominated by blue maidencane. A deep marsh occurs from 485 to 595 consisting of a scattered stand of fringe rush (*Fuirena scirpoidea*) and torpedo grass (*Panicum repens*).

Table3. Lake Apshawa , Lake County, Florida, Transect 1: Vegetation cover data

		Communities**						
		UP	TZ	WP	SM	WP	SM	DM
		0	48	66	110	265	365	485
		48	66	110	265	365	485	595
Species	**Common name**							
Quercus virginiana	live oak	4						
Sida rhombifolia	fanpetals	0						
Urochloa sp.	signalgrass	1						
Paspalum notatum	bahia grass	1						
Euthamia caroliniana	slender goldenrod	0						
Lantana camara	lantana		0					
Rubus sp.	blackberry	0	0					
Passiflora incarnata	passionflower	0	0					
Baccharis halimifolia	groundsel tree		0		0			
Amphicarpum muhlenbergianum	blue maidencane		1	2	5	1	5	
Eupatorium sp.	dogfennel		0	0	0	1	0	
Andropogon virginicus	broomsedge		3	3	0	4		

Centella asiatica	spadeleaf		0	1	1	0		
Pluchea sp.	camphorweed				0	0		
Andropogon glomeratus	bushy bluestem						0	0
Solidago sp.	goldenrod				0		0	
Spartina bakeri	sand cordgrass					0		
Fuirena scirpoidea	fringe rush							1
Panicum repens	torpedo grass							1
Hydrocotyle sp.	marsh pennywort							0
Lachnanthes caroliniana	redroot						0	

Table 4. Transect 1 vegetation community elevation statistics

Vegetation community	Station Distance (ft)	Elevation (ft NAVD88)			
		Mean	Median	Minimum	Maximum
Upland	0 - 48			90.17	
Transition Zone	48 - 66	86.7	86.6	89.1	85.9
Wet Prairie #1	66 - 110	84.8	84.6	85.8	84.2
Shallow Marsh #1	110 - 265	83.9	83.9	84.6	83.5
Wet Prairie #2	265 - 365	84.5	84.6	84.8	84.0
Shallow Marsh #2	365 - 485	83.0	82.9	84.0	81.7
Deep Marsh	485 - 595	80.3	80.1	81.7	79.4

TRANSECT 2

Transect 2 started in an upland pasture and extended 595 feet to the east where it terminated at the waterward edge of the deep marsh. The first 100 feet of the transect slope at an eight percent grade into a depression which at low water levels is an isolated pond and at high water levels is connected to the lake. The depression extended an additional 200 feet and then merged with the lake floodplain, which extended an additional 180 feet. Topography then decreased gradually into the open water of the lake. Pictures from two stations are shown in Figure 3.

Figure 3. Transect 2 at Station 300 facing west across pond: shallow marshes in foreground; deep marsh, transitional shrub, and upland communities in background.

Soils Data

Soil Survey Background**:** The Lake County Soil Survey Report (NRCS, 1975) showed the same two soil map units previously described for Transect 1. Astatula sand occurs in the uplands and Placid - Myakka complex occur in the low areas bordering the lake.

On-site Investigations**:** Soil descriptions were collected at 26 stations. These soil descriptions are shown in Appendix C. Two holes were bored to a depth sufficient to determine soil series. The soil at station 20 (87.7 ft. NAVD) were Astatula sand and the soil at station 312 (83.5 ft. NAVD) was Placid sand.

No hydric soil indicators were observed in the upland community. The first hydric soil indicator was dark surface (S7) which occurred at station 60 in the transitional shrub community. Mucky mineral (A7) occurred at stations 65 and 75 and muck presence (A8) occurred at station 80, all of which were in the transitional shrub community. A8 also occurs in the shallow marsh at station 90. Histosol (A1) occurred at stations 100, 140, 240 in deep marshes #1 and 2. No borings were taken in the open water zone (station 150 to 237 feet) but it also appeared to be underlain by thick beds of muck. Histic epipedon (A2) occurred intermittently at station 120 in the first deep marsh and at station 250 in the second shallow marsh. A7 occurred at station 260 in the second shallow marsh. S7 occurred at station 280 in the third shallow marsh. Organic matter levels and depth increase progressively across the third shallow marsh with A8 occurring at stations 312 and 417. A2 occurs at stations 420 and 447 and A1 occurs at station 477. Organic matter levels diminish in the deep marsh bordering the lake and A7 at stations 492 and 500 was the only hydric indicator observed. Estimates of the extent of hydric soil indicators and soil summary statistics are provided in Table 5. Detailed soils description data are provided in Table 9.

Table 5 South Apshawa Lake, Lake County, Florida, Transect 2: Soil summary statistics.

HI map unit*	Borehole stations (ft.)	Map unit start - end (ft.)	mean	median	max	min
none	20, 50, 55	0-60				84.9
S7	60	60-65	84.6	84.6	84.9	84.4
A7	65, 75	65-80	83.6	83.6	84.4	82.9
A8	80, 90	80-96	82.4	82.4	82.9	81.8
A1/A2	100, 110, 120, 140, 240, 250	96-255	79.6	79.3	81.8	78.5
A7	260	255-275	81.4	81.3	82.2	80.8
S7	280	275-305	83.0	82.9	83.7	82.2
A8	312, 417	305-420	83.5	83.5	83.7	83.2
A1/A2	420, 447, 477	420-480	82.9	82.9	83.2	82.6
A7	492, 500	480-500	81.9	81.9	82.2	81.4
none	512	500-535			81.4	

Vegetation Data

Estimates of vegetation composition and percent cover for Transect 2 are shown in Tables 6 and 7. An upland community dominated by bahiagrass occurred from stations 0 to 42 feet. A transitional shrub community occurred from stations 42 to 85 feet dominated by broomsedge (*Andropogon virginicus*) and big carpetgrass (*Axonopus furcatus*) in the groundcover and groundsel tree (*Baccharis halimifolia*) in the shrub layer. The species dominating the transitional shrub community are listed as facultative by the Florida Department of Environmental Protection (Gilbert et al., 1995) and the community would therefore not qualify as wetland. The upper part of the transitional shrub community appeared to be regularly mowed. A shallow marsh dominated by dog fennel (*Eupatorium capillifolium*) and maidencane (*Panicum hemitomon*) occurred from stations 85 to 98 feet. A deep marsh, also dominated by maidencane, occurred from stations 98 to 150 feet. This deep marsh also contained cattail (*Typha domingensis*), algal bulrush (*Websteria confervoides*), and torpedo grass (*Panicum repens*). Open water occurred from stations 150 to 237 feet. A second deep marsh occurred from stations 237 to 258 feet with similar composition to the first deep marsh. A sawgrass-dominated shallow marsh occurred from stations 258 to 272 feet, followed by a big carpetgrass-dominated shallow marsh from stations 272 to 485 feet that was regularly mowed. Another sawgrass-dominated shallow marsh occurred from stations 485 to 499 feet, followed by a deep marsh that extends to station 535.

Table 6 . South Apshawa Lake, Lake County, Florida, Transect 2: Plant community statistics

Vegetation community	Station Distance (ft)	Elevation (ft NAVD88)			
		Mean	Median	Minimum	Maximum
Upland	0 - 42				86.2
Transitional Shrub	42 - 85	84.51	84.62	86.17	82.56
Shallow Marsh #1	85 - 98	81.98	82	82.56	81.35
Deep Marsh #1	98 - 150	80.19	80.18	81.35	79.48
Water	150 - 237	78.94	79.01	79.48	78.45
Deep Marsh #2	237 - 258	80.27	80.4	80.86	79.24
Shallow Marsh (#2- #4)	258 - 499	82.98	83.2	83.7	80.84
Shallow Marsh #2	258 - 272	81.27	81.25	81.94	80.84
Shallow Marsh #3	272 - 485	83.15	83.28	83.7	82.08
Shallow Marsh #4	485 - 499	81.78	81.8	82.08	81.45
Deep Marsh #3	499 - 535	80.48	80.28	81.45	79.66

Table 7. South Apshawa Lake, Lake County, Florida, Transect 2: Vegetation cover data

		Communities**									
		UP	**TS**	**SM**	**DM**	**W**	**DM**	**SM**	**SM**	**SM**	**DM**
		0	42	85	98	150	237	258	272	485	499
		42	85	98	150	237	258	272	485	499	535
Species	**Common name**										
Paspalum notatum	bahia grass	5									
Sabal palmetto	cabbage palm	1									
Lepidium virginicus	pepperweed	1									
Linaria canadensis	toadflax	1									
Axonopus furcatus	big carpetgrass		2						5		
Andropogon virginicus	broomsedge		2						1		
Eupatorium capillifolium	dogfennel		2	2							
Sapium sebiferum	Chinese tallow		0								
Baccharis halimifolia	groundsel tree		2	0	0			1		1	
Panicum hemitomon	maidencane		0	2	2		2				
Solidago sp.	goldenrod			1							
Panicum repens	torpedo grass				1						
Typha domingensis	cattail				1		1				
Juncus effusus	soft rush				0						

Websteria confervoides	algal bulrush				1						
Cladium jamaicense	sawgrass						1	5		2	
Lachnanthes caroliniana	redroot						0				
Andropogon glomeratus	bushy bluestem							1		1	0
Centella asiatica	spadeleaf								0		
Spartina bakeri	sand cordgrass								0		
Rubus sp.	blackberry									0	
Fuirena scirpoidea	fringe rush										1
Hydrocotyle sp.	marsh pennywort										1

Note:

* Braun-Blanquet cover abundance categories: 0 = less than 1 percent, 1 = 1 to 10 percent, 2 = 10 to 25 percent, 3 = 25 to 50 percent, 4 = 50 to 75 percent, 5 = greater than 75 percent.

** UP=upland, TS=transitional shrub, SM=shallow marsh, W=open water, DM=deep marsh.

Table 8. Detailed soil descriptions for Apshawa Lake South Transect 1

Lake Apshawa Transect 1

Station **0** Soil Series **Astatula**

Horizon	From	To	Texture	Hue	Value-Chroma	Soil_Description - Truncated
A	0	6	Sand (medium)	10YR	5/2	F1 Roots; Grd Bnd
C1	6	12	Sand (medium)	10YR	4/2	Grd Bnd
C2	12	21	Sand (medium)	10YR	5/3	Grd Bnd
C3	21	45	Sand (medium)	10YR	4/2	Grd Bnd
C4	45	50	Sand (medium)	10YR	6/2	Grd Bnd
C5	50	60	Sand (medium)	10YR	7/2	Grd Bnd
20						near trail, possible disturbed
A	0	5	Sand (medium)	10YR	5/2	F1 Roots
C	5	30	Sand (medium)	10YR	3/1	M1 10YR 4/2
80			**Astatula**			
A	0	7	Sand (medium)	10YR	4/1	1F GR
C1	7	10	Sand (medium)	10YR	3/2	1F GR; 20% CSG
C2	10	20	Sand (medium)	10YR	5/4	SG
C3	20	50	Sand (medium)	10YR	5/3	SG
90						
A	0	4	Sand (medium)	10YR	3/1	50% csg, c1 roots
E1	4	8	Sand (medium)	10YR	4/2	m1-2 10YR 3/1 shp bnd
E2	8	10	Sand (medium)	10YR	4/4	
100						
HI						S6 (stripped matrix)
	0	3	Sand (medium)	10YR	4/1	
	3	7	Sand (medium)	10YR	4/1	m1-2 10YR 5/2 stripping dif bnd
	7	12	Sand (medium)	10YR	3/3	
120						
HI						A7 5cm Mucky Mineral; S6 Stripped Matrix; S8 Polyvalue Below Dark Surface
A	0	4	Mucky sand	10YR	2/1	80% CSG
C	4	8	Sand (medium)	10YR	3/1	C2 10YR 4/1 stripping; C2 10YR 3/2
180						
HI						A7 5cm Mucky Mineral
A1	0	4	Mucky sand	10YR	2/1	80% CSG; M1-2 roots
A2	4	9	Sand (medium)	10YR	3/1	20% CSG; C1 10YR 4/1; F1 roots

Lake Apshawa Transect 1

Station			Soil Series			
Horizon	From	To	Texture	Hue	Value-Chroma	Soil_Description - Truncated
A3	9	12	Sand (medium)	10YR	2/1	
C1	12	24	Sand (medium)	10YR	4/2	
C2	24	30	Sand (medium)	10YR	4/3	
295						
HI						S6 Stripped Matrix
A	0	2	Sand (medium)	10YR	3/1	
C	2	12	Sand (medium)	10YR	5/1	C1 10YR 4/1 stripping; F1 10YR 3/1
390						
HI						A8 Muck Presence
Oa	0	6	Muck (Sapric)	10YR	2/1	M1 roots
A	6	10	Mucky sand	10YR	2/1	C1 roots
C	10	12	Sand (medium)	10YR	5/1	
395						
HI	0	9	Muck (Sapric)	10YR	2/1	A2 (histic epipedon)
400						
HI						A2 (histic epipedon)
Oa	9	9	Muck (Sapric)	10YR	2/1	
A	9	10	Sand (medium)	10YR	2/1	
420			Sanibel			Sanibel taxadjunct - clayey substrate
HI						A2 (Histic epipedon)
Oa	0	9	Muck (Sapric)	10YR	2/1	
A	9	11	Sand (medium)	10YR	3/1	
E1	11	20	Sand (medium)	10YR	5/2	m2 10YR 4/1
E2	20	33	Sand (medium)	10YR	4/2	
E3	33	46	Sand (medium)	10YR	5/3	
2C1	46	52	Sandy clay loam	10YR	4/3	
2C2	52	55	Sandy clay	10YR	4/3	c2 2.5Y 6/2, m3 2.5Y 6/3, v. firm, plastic
455						
HI						A2 Histic Epipedon
Oa	0	13	Muck (Sapric)	10YR	2/1	C1-2 roots

Lake Apshawa Transect 1

Station			Soil Series			
Horizon	From	To	Texture	Hue	Value-Chroma	Soil_Description - Truncated
A	13	17	Mucky sand	10YR	2/1	
C	17	25	Sand (medium)	10YR	5/1	
490						
HI						A8 Muck Presence
Oa	0	3	Muck (Sapric)	10YR	2/1	
C	3	10	Silt	10YR	5/4	appears depositional
Ab	10	14	Sand (medium)	10YR	2/1	
Cb	14	15	Sand (medium)	10YR	5/2	
510						
HI						A8 Muck Presence
Oa	0	2	Muck (Sapric)	10YR	2/1	
A	2	5	Mucky sand	10YR	2/1	
C	5	8	Sand (medium)	10YR	5/2	
520						
HI						A7 (mucky mineral), S6 (stripped matrix); similar to station 540
540						
HI						A7 (mucky mineral), S6 (stripped matrix)
A	0	2	Mucky sand	10YR	2/1	
C	2	8	Sand (medium)	10YR	4/1	c2 10YR 3/1 diff bnd
565						
HI						A7(mucky mineral)
A	0	2	Mucky sand	10YR	2/1	
C	2	5	Sand (medium)	10YR	4/1	c1 10 YR 3/1 streaks

Table 9. Detailed soil descriptions for Apshawa Lake South Transect 2

Lake Apshawa Transect 2

20			Astatula			
A1	0	12	Sand (medium)	10YR	4/1	
A2	12	24	Sand (medium)	10YR	3/1	20% CSG
C1	24	33	Sand (medium)	10YR	5/2	
C2	33	50	Sand (medium)	10YR	5/3	
50						
A1	0	2	Sand (medium)	10YR	3/1	30% CSG
A2	2	18	Sand (medium)	10YR	2/1	60% CSG
C	18	25	Sand (medium)	10YR	4/2	
55						
A	0	8	Sand (medium)	10YR	2/1	60% CSG
60						Edge of Mowed Area
HI						S7 Dark Surface
A1	0	5	Sand (medium)	10YR	2/1	C1 roots; 70% CSG
A2	5	10	Sand (medium)	10YR	2/1	F1 roots; 60% CSG
65						
HI						A7 5cm Muck Mineral; S7 Dark Surface
A1	0	2	Mucky sand	10YR	2/1	M1 roots; 80% CSG
A2	2	10	Sand (medium)	10YR	2/1	70% CSG
75						
HI						A7 5cm Mucky Mineral
A1	0	6	Mucky sand	10YR	2/1	
A2	6	12	Sand (medium)	10YR	2/1	
80						
HI						A8 Muck Presence
Oa	0	2	Muck (Sapric)	10YR	2/1	
A1	2	4	Mucky sand	10YR	2/1	
A2	4	10	Sand (medium)	10YR	2/1	
90						
HI						A8 Muck Presence
Oa	0	6	Muck (Sapric)	10YR	2/1	
A	6	12	Mucky sand	10YR	2/1	
C	12	14	Sand (medium)	10YR	3/1	

Lake Apshawa Transect 2

Station			Soil Series			
Horizon	From	To	Texture	Hue	Value-Chroma	Soil_Description - Truncated
100						A1 Histosol estimated to start @ 96'
HI						A1 Histosol
Oa	0	18	Muck (Sapric)	10YR	2/1	
A	18	20	Mucky sand	10YR	2/1	
110						
HI						A1 Histosol
Oa	0	17	Muck (Sapric)	10YR	2/1	
A	17	22	Mucky sand	10YR	2//1	
C	22	25	Sand (medium)	10YR	3/1	
120						
HI						A2 Histic Epipedon
Oa	0	10	Muck (Sapric)	10YR	2/1	
A	10	14	Mucky sand	10YR	2/1	
C	14	20	Sand (medium)	10YR	3/1	
140						
HI						A1 Histosol
Oa	0	23	Muck (Sapric)	10YR	2/1	
A	23	26	Sand (medium)	10YR	3/1	
240						
HI						A1 Histosol
Oa	0	24	Muck (Sapric)	10YR	2/1	
A	24	26	Sand (medium)	10YR	3/1	
250						
HI						A2 Histic Epipedon
Oa	0	11	Muck (Sapric)	10YR	2/1	
A	11	14	Mucky sand	10YR	2/1	
C	14	20	Sand (medium)	10YR	3/1	

Lake Apshawa Transect 2

Station / Horizon	From	To	Soil Series / Texture	Hue	Value-Chroma	Soil_Description - Truncated
260						
HI						A7 5cm Mucky Mineral
A	0	4	Mucky sand	10YR	2/1	
C	4	8	Sand (medium)	10YR	3/1	
280						
HI						S7 Dark Surface
A1	0	1	Mucky sand	10YR	2/1	90% CSG; 10% roots
A2	1	8	Sand (medium)	10YR	2/1	80% CSG; M1 roots
C	8	12	Sand (medium)	10YR	3/1	
312			**Placid**			
HI						A8 Muck Presence
Oa	0	1	Muck (Sapric)	10YR	2/1	
A1	1	6	Mucky sand	10YR	2/1	thin layer of 10YR 4/6 silt @ 4"
A2	6	9	Sand (medium)	10YR	2/1	
C1	9	16	Sand (medium)	10YR	3/1	
C2	16	21	Sand (medium)	10YR	2/2	
C3	21	35	Sand (medium)	10YR	3/3	
C4	35	45	Sand (medium)	10YR	4/3	
400						
HI	0	6	Muck (Sapric)	10YR	2/1	A8 (muck presence)
410						
HI						A8 (muck presence)
Oa	0	7.5	Muck (Sapric)	10YR	2/1	
A	7.5	10	Sand (medium)	10YR	4/1	
417						
HI						A8 Muck Presence
Oa	0	6	Muck (Sapric)	10YR	2/1	
A1	6	8	Mucky sand	10YR	2/1	
A2	8	10	Sand (medium)	10YR	2/1	

Lake Apshawa Transect 2

Station / Horizon	From	To	Soil Series / Texture	Hue	Value-Chroma	Soil_Description - Truncated
420						
HI						A2 (histic epipedon)
Oa	0	8	Muck (Sapric)	10YR	2/1	
A	8	10	Sand (medium)	10YR	4/1	c1 10YR 3/1
447						
HI						A2 Histic Epipedon
Oa	0	9	Muck (Sapric)	10YR	2/1	
A1	9	11	Mucky sand	10YR	2/1	
A2	11	13	Sand (medium)	10YR	2/1	
C	13	14	Sand (medium)	10YR	5/2	
477						
HI						A1 Histosol
Oa	0	16	Muck (Sapric)	10YR	2/1	
A	16	21	Sand (medium)	10YR	2/1	
492						
HI						A7 5cm Mucky Mineral
A1	0	6	Sand (medium)	10YR	3/1	
A2	6	12	Mucky sand	10YR	2/1	
C	12	0	Sand (medium)	10YR	3/1	
500						
HI		0		10YR		A7 (mucky mineral)
A	0	2	Mucky sand	10YR	2/1	
512						No HI (lakebed)
A1	0	8	Sand (medium)	10YR	3/1	
A2	8	16	Sand (medium)	10YR	3/2	

Organic Soil Verification and LOI

2018

High water levels persisted following Hurricane Irma in 2017, making a detailed verification of observations made in 2010 difficult. Attempts were made in 2018 to probe the submerged soils (Table 10). Thick, recently submerged, vegetation prevented access to the landward elevations on transect 2 in 2018. Conclusions regarding changes in elevation and depth could not be made from the probing data, however, organic soils observed in 2018 were found in roughly the same locations described by SJRWMD staff in 2010.

2021

Low water levels during 2021 provided an opportunity to access the exact locations of field work performed in 2010 and re-examine the deep organic soils. The verification method consisted of relocating the original transect locations and identifying the transects stations where deep organic soils were identified in 2010. These were staked out (Figure 9) and soil descriptions were made. Soil descriptions of the Oa (muck) horizon depth were made based on soil plugs dug with a sharpshooter shovel roughly every 10 ft within these areas (Figure 10).

Samples were also collected within areas where organic soils were located in 2010. Excavated soil samples were sent to the Extension Soils Testing Laboratory (ESTL) at the University of Florida for Loss-On-Ignition (LOI) organic matter content determination (Table 11). There were tracks observed in multiple locations from OHV usage. Some of these tracks coincided with station 430 on transect 2, leading to compaction and an Oa horizon below 8” of depth where ≥8” was observed in 2010. Without OHV compaction this location would have maintained ≥8” of Oa horizon, and therefore met the guidelines for A2, histic epipedon. Station 430 is thus included in the calculations for the MA. The verifications performed in 2018 and 2021 provide evidence that observations made in 2010 remain valid in 2021. Environmental field work conducted by SJRWMD staff in 2010 is therefore included as the basis for the MA for Apshawa Lake South.

Table 10. Data comparison from 2010 detailed soil descriptions and submerged organic soil probing in 2018

Transect	Landward elevation of organic soil (ft; NAVD88)
2010	
1	84.0
2	83.5
2018 / 2021	
1	84.5
2	NA*

see text for reason elevation was not determined

Figure 1. Transect 1: Station 0 (mature oak tree in the background) through Station 465 (the end of observed deep organic soils observed in 2010; stake in foreground).

Figure 2. Examination of the Oa horizon depth at Transect 1 Station 400

Table 11. Locations of LOI sampling along with Oa depth and % organic carbon.

Station	Oa depth (in)	Transect	Sample	LOI	%OC (>18% denotes muck)
395	8.75	1	1	45.5	26.5
400	9.5	1	2	52.5	30.5
410	13	1	3	47.3	27.5
440	9	1	4	54.1	31.5
450	15	1	5	52.7	30.6
430	7.5	2	6	36.1	21.0
440	8.5	2	7	38.6	22.5
450	9	2	8	58.2	33.8
460	8.5	2	9	54.8	31.8
470	9	2	10	54.0	31.4

Water Table Shape

To better understand the direction of subsurface seepage, and whether organic soils at Apshawa Lake South are the result of lake hydrology or surficial seepage flow, observations were made of the water table shape in proximity to the upland boundaries of transect 1 and 2. Evidence of seepage flow in the vegetation has largely been removed due to land clearing. However, the presence of seepage flow would influence organic matter accretion independently of lake hydrology. If seepage was present the water table would show a domed shape, increasing in elevation with distance from the edge of water (Figure 11).

If seepage is not present, then the water table should decline in elevation moving away from the edge of water (Figure 12). Boreholes were dug at 3 locations of increasing distance from the edge of water in November 2018 (Figure 13) and 4 locations in March 2019. The water table was measured after equilibration using a survey transit to establish elevation in ft NAVD88. The "waterward borehole" was roughly 15 feet from the edge of water for each location. These data suggest that water is moving from the lake towards the surrounding surficial aquifer (similar to Figure 12), and not into the lake via seepage from the surficial aquifer.

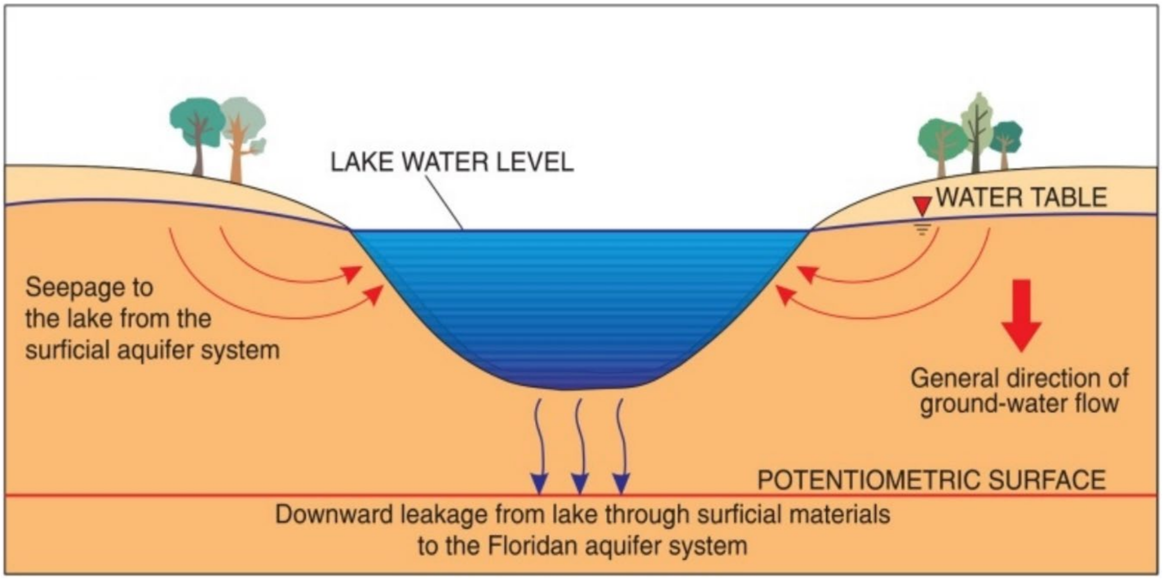

Figure 11. Conceptual diagram showing a lake connected to an underlying aquifer with the lake level below the water table, such that water flows from the shallow aquifer (seepage) into the lake (from Schiffer, 1998).

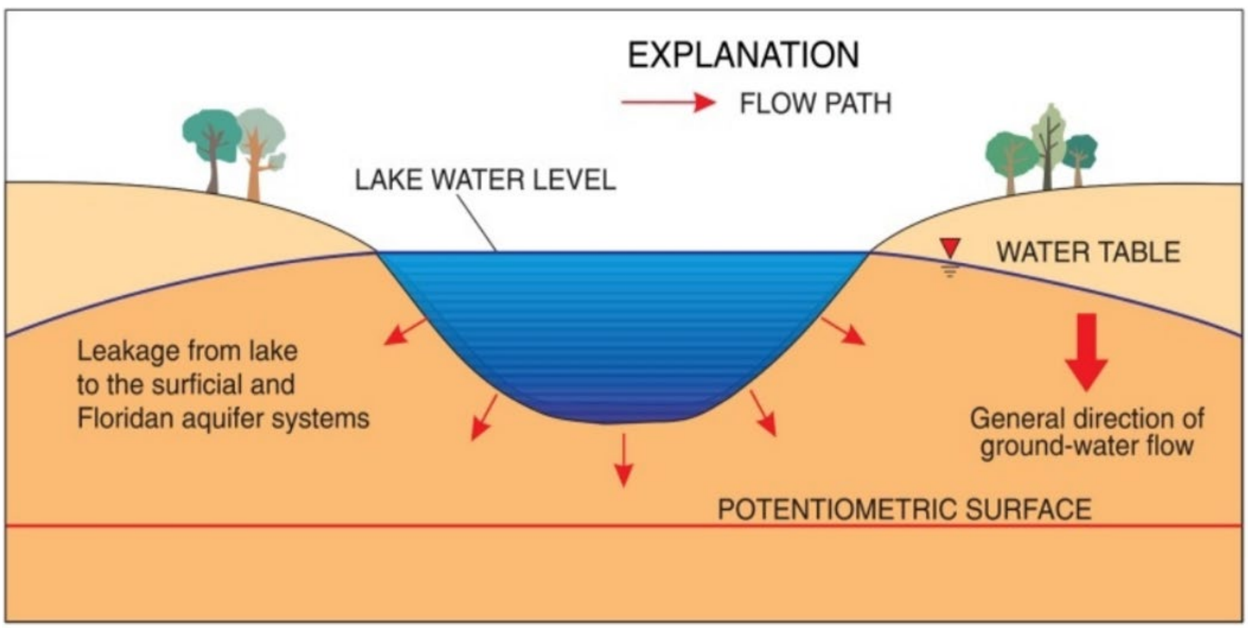

Figure 12. Conceptual diagram showing a lake connected to an underlying aquifer with the lake level above the water table, such that water flows to the shallow aquifer from the lake (from Schiffer, 1998).

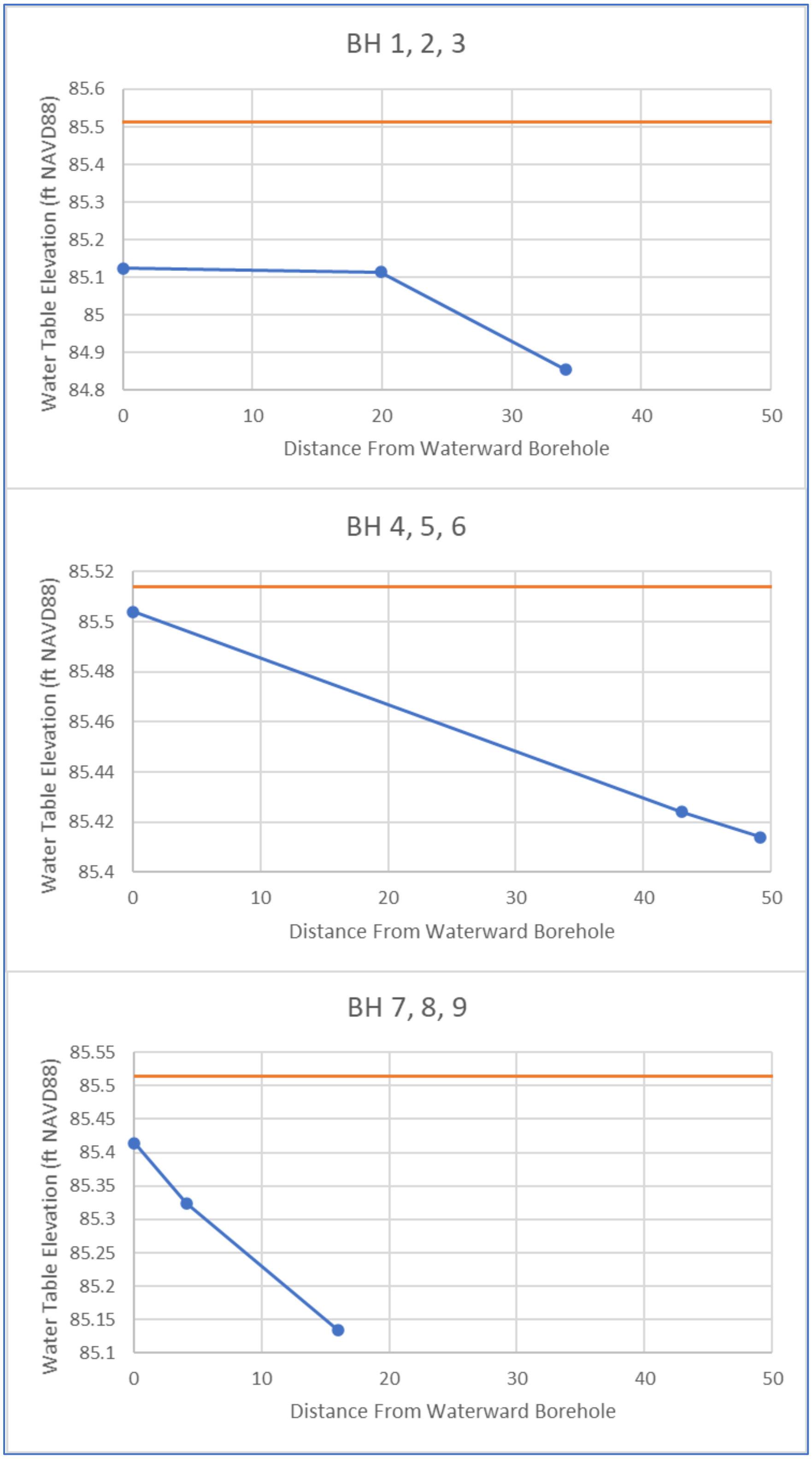

Figure 13. Shape of surficial aquifer adjacent to Apshawa Lake South based on water table measurements from boreholes in proximity to edge of water. Lake pool elevation at time of data collection is represented by orange line.

Surface Water Inundation/Dewatering Signatures (SWIDS)

SJRWMD event-based MFLs are composed of magnitude, duration, and return interval components. Magnitude and duration components define biologically relevant events. The return interval of events is the manageable component (Neubauer et al., 2008). For example, if a 30-day flooding event of a field elevation of interest (e.g., maximum elevation of shallow marsh) had an annual probability of exceedance of 33%, then the event is interpreted as occurring during 33 in 100 years or a 3-year return interval, on average.

Annual maximum and minimum series stage frequency analyses of long-term stage data or modeled stage data were utilized to provide probabilities (Gordon et al., 1992) of flooding/dewatering events for wetland plant communities and organic soil indicators at various locations within SJRWMD. Because ground elevations are transformed to durations and probabilities, comparisons of like plant communities or soils indicators from different systems at different landscape elevations resulted in quantitative hydrologic signatures called surface water inundation/dewatering signatures (SWIDS). The mean, minimum, and maximum elevations of vegetation communities and soil indicators were used for SWIDS analysis (Neubauer et al., 2004; Neubauer et al., 2008).

SWIDS of vegetation communities provide a hydrologic range for each community, with a transition to a drier community on one side of the range and a transition to a wetter community on the other side. These hydrologic signatures provide a target for MFLs determinations that are focused on vegetation community protection criteria, and provide an estimate of how much the return interval or probability of a flooding or dewatering can be shifted at a specified duration and still maintain a vegetation community within its observed hydrologic range.

Minimum Average

Return Interval

Protective event frequencies (i.e., recommended return intervals) are determined using hydrologic event probabilities called Surface Water Inundation and Dewatering Signatures (SWIDS; see above for general description of SWIDS). A primary assumption is that these hydrologic probabilities (i.e., signatures) are for a group of *similar water bodies* and thus provide an estimate of the shift in return interval of flooding or drying events that can occur before causing significant harm to the species or community in question. If water bodies used for this analysis (i.e., to determine an average return interval for a given event) are not similar it may result in a wide range of hydroperiods and inappropriate return interval for the test system. When all central Florida lakes with MA data (i.e., mean elevation of deep organics minus 0.3 ft offset) are used, the resulting range in return intervals for a 180-day non-exceedance event (i.e., the MA) is high (Figure 14).

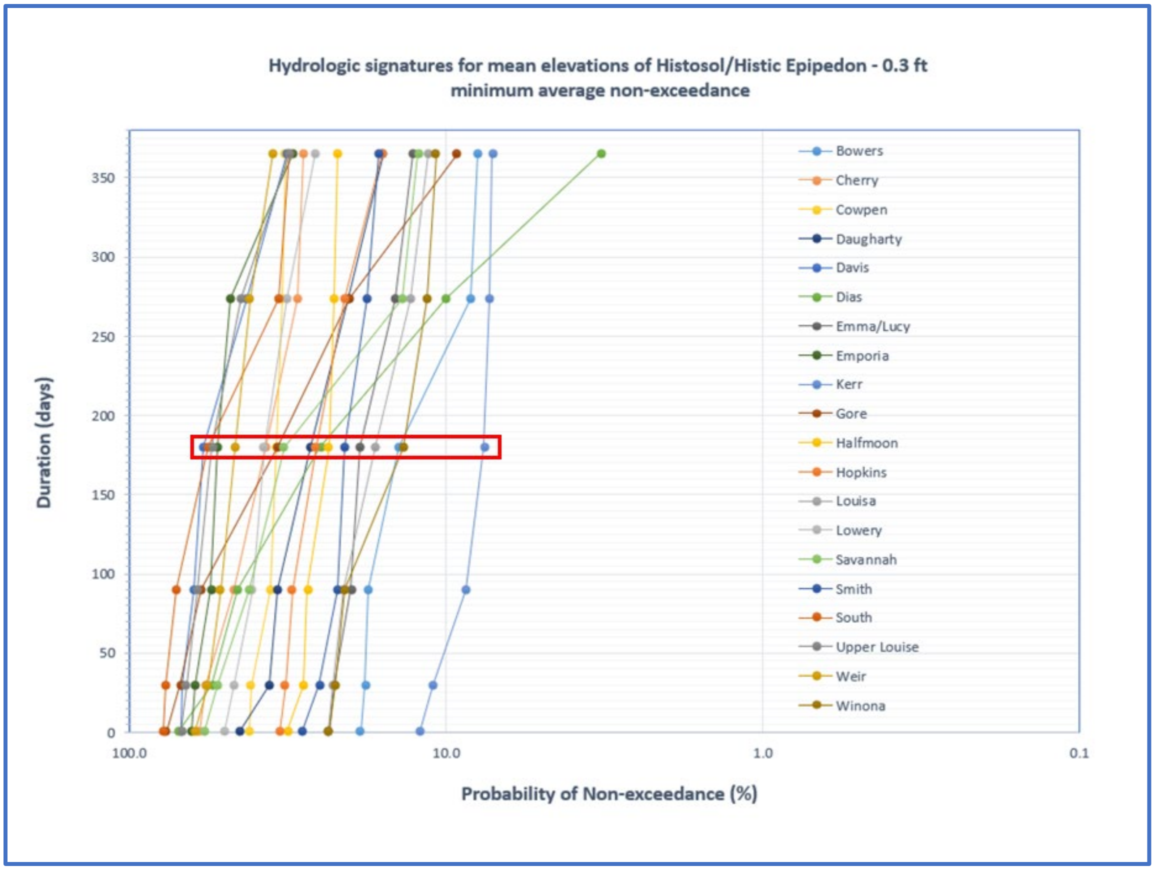

Figure 14. SWIDS plot showing distribution of hydrologic signatures for average non-exceedance elevations (of various durations) for mean elevations of deep organic soil elevations for 29 lakes in Central Florida.

To address this concern, two analyses were performed to identify lake groups with similar hydrological and landscape characteristics, in an effort to reduce uncertainty and base the Apshawa Lake South return interval on similar sites. The first was an ordination analysis aimed at determining whether hydrological and landscape factors could help explain variability among SWIDS sites. Principal components analysis (PCA) was conducted for twenty-nine central Florida lakes and based on fourteen hydrological and landscape variables (Table 12). A single parameter, water level range (P10 minus P90), explained the most variability among sites. Other parameters identified by the PCA were:

- water level symmetry: kurtosis of four-week stage elevation change;
- connection to the UFA: maximum cumulative fluctuation index value;
- depth to water table (NRCS data; annual minima);
- landscape drainage: percent of surrounding landscape with high drainage class ranking (NRCS data); and
- soil permeability: percentage of surrounding landscape with high soil permeability ranking (NRCS data).

Table 12. Parameters and values for twenty-nine central Florida lakes, used for cluster analysis to determine appropriate MA return interval. Skewness and kurtosis were calculated for 4-week lake stage change distribution. MCF (maximum cumulative fluctuation) index is a measure of connection to the UFA.

Site	Water Level Range			Water Level Symmetry		Landscape Drainage Class			UFA connection		Depth to Water Table (ft)	Soil Permeability		
	Lower (P80-P50) (ft)	Upper (P50-P20) (ft)	Total (P90-P10) (ft)	Skewness	Kurtosis	High	Medium	Low	Pearson's R	MCF		High	Moderate	Low
Apshawa	1.9	3.3	6.4	0.2	2.0	76.9	5.2	11.6	0.9	4.7	3.3	85.8	0.0	0.0
Banana	1.7	1.4	4.2	0.7	0.6	34.8	26.8	17.8	0.9	3.7	1.4	75.4	17.3	0.0
Bowers	2.1	0.9	4.5	0.2	0.9	52.9	13.9	18.8	0.9	2.6	2.0	75.3	3.2	0.0
Cherry	1.1	0.7	3.1	0.5	0.5	26.8	33.8	30.8	0.8	5.0	3.2	81.7	1.1	1.8
Como	2.1	1.5	4.6	0.6	0.5	50.1	21.1	22.7	0.9	3.9	1.4	81.9	13.3	0.0
Cowpen	1.3	1.9	6.4	1.9	9.0	22.5	47.4	20.2	0.9	5.7	3.1	80.6	0.0	0.0
Daugharty	1.8	1.3	5.7	1.6	4.7	15.4	33.2	19.8	0.9	5.8	1.4	36.4	7.1	0.0
Davis	2.5	1.4	5.6	0.8	2.3	2.7	64.3	29.0	0.8	5.9	1.2	92.3	4.8	0.0
Dias	0.4	0.3	1.1	1.0	2.6	27.0	33.3	37.3	0.9	1.3	1.2	78.9	14.3	0.0
Emma/Lucy	1.2	0.6	3.2	1.2	4.8	45.0	31.7	4.0	0.8	3.7	3.1	85.5	4.9	0.0
Emporia	2.8	2.2	6.4	0.9	1.6	17.2	64.3	17.4	0.8	6.8	1.4	93.9	0.0	0.0
Gore	1.0	0.4	2.2	1.1	1.8	0.0	2.8	95.3	0.7	2.0	0.7	80.1	15.8	0.0
Hires	1.3	1.8	6.0	-1.0	10.9	8.8	19.3	24.7	0.9	7.4	1.4	6.7	13.2	0.0
Hopkins	1.4	1.0	3.6	0.8	1.7	56.1	24.5	19.2	1.0	5.7	1.0	89.5	10.4	0.0
Kerr	1.7	1.2	4.0	0.5	1.4	62.1	14.2	18.7	0.8	4.4	0.9	88.6	0.7	0.0
L. Como	2.3	2.4	5.8	2.0	11.1	66.0	13.8	12.2	0.9	6.0	1.6	92.0	0.0	0.0
Louisa	1.1	0.9	2.9	1.1	1.8	46.3	2.7	48.0	0.9	5.6	3.4	56.9	15.7	0.0
Nicotoon	0.9	0.7	3.0	1.3	3.5	71.4	9.6	6.6	1.0	4.0	2.0	90.3	0.0	0.0
Purdom	1.7	0.5	3.1	0.7	2.0	2.3	51.7	32.5	0.9	2.4	1.2	52.8	37.0	0.0
Savannah	0.5	0.5	1.5	1.3	8.9	13.8	30.7	48.6	0.8	2.6	1.0	47.4	32.3	0.0
Smith	2.3	2.0	5.7	1.1	1.7	69.1	5.0	15.0	0.8	3.5	2.1	82.4	0.0	0.0
South	0.9	0.8	2.3	0.5	0.5	16.8	10.6	71.5	0.9	1.4	0.5	94.0	3.0	0.0
Swan	3.0	1.4	6.2	0.3	1.4	19.4	64.2	11.7	0.9	5.6	3.4	99.7	0.0	0.0
Sylvan	1.8	2.2	4.9	1.0	5.4	17.8	43.2	38.6	0.9	5.3	1.4	97.5	0.0	0.0
Tarhoe	3.4	2.1	8.0	2.3	11.1	22.0	29.2	39.2	0.9	6.8	1.3	87.2	2.3	0.0
Trone	2.8	1.7	5.7	0.9	1.0	38.8	33.9	15.5	0.9	4.7	1.4	97.6	0.0	0.0
Up. Louise	1.6	0.7	3.2	0.4	2.7	0.0	53.8	40.3	0.8	5.0	1.2	94.6	1.5	0.0
Weir	1.1	1.2	3.3	0.6	0.0	41.5	23.0	32.8	0.6	3.2	2.0	84.9	4.6	0.6
Winona	0.8	2.0	3.8	0.5	1.1	38.4	50.3	9.1	0.6	9.1	1.5	91.9	0.0	0.0

Next, a cluster analysis was performed, using the parameters listed above, to identify lake groups with similar hydrological and landscape characteristics. Ward's Method of hierarchical clustering was used, which minimizes variance between sites within a group while maximizing variance between groups. The resulting cluster of sites that included Apshawa Lake South was used for the preliminary SWIDS analysis (Figure 15). This analysis was conducted for the eight lakes in the Apshawa Lake South cluster for which there also exists corresponding MA (i.e., deep organic soils) data (Figure 16).

The PCA and cluster analysis resulted in only a moderate reduction in the range of the MA return intervals (i.e., using eight lakes versus the original twenty lakes; Figures 14 versus 16). Further, the range of return intervals, for lakes in the Apshawa Lake South cluster exhibited a six-fold difference (from 2.2 years to 13.2 years). The central tendency (mean minus standard error) of these return intervals equaled 4.4 years, make this far more constraining than any

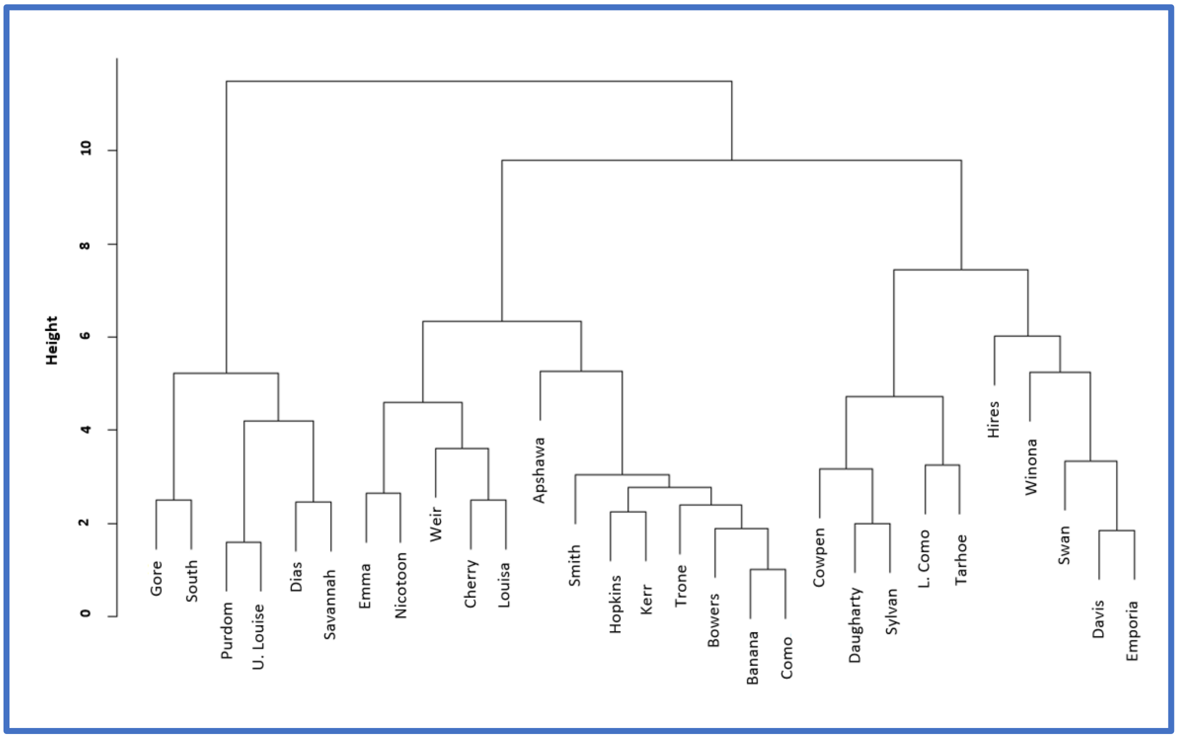

Figure 15. Cluster analysis plot used to determine SWIDS group for Apshawa Lake South

MA adopted in the past. For these reasons, instead of using the cluster analysis results, which yielded almost as high a range in values as using all sites, a different approach was pursued.

Since the most significant parameter identified in the PCA (and in earlier work by Epting et al., 2008) was water level range (P10 – P90), the next step was to investigate those sites (for which deep organic hydroperiods exist) with similar water level range. The result was five (of the original twenty) lakes, with deep organics data, that also have water level range (P10 – P90) similar to Apshawa Lake South. These lakes (Cowpen Lake, Lake Daugharty, Lake Davis, Lake Emporia and Smith Lake) have a mean (± SD) water level range of 6.0 ft (± 0.4

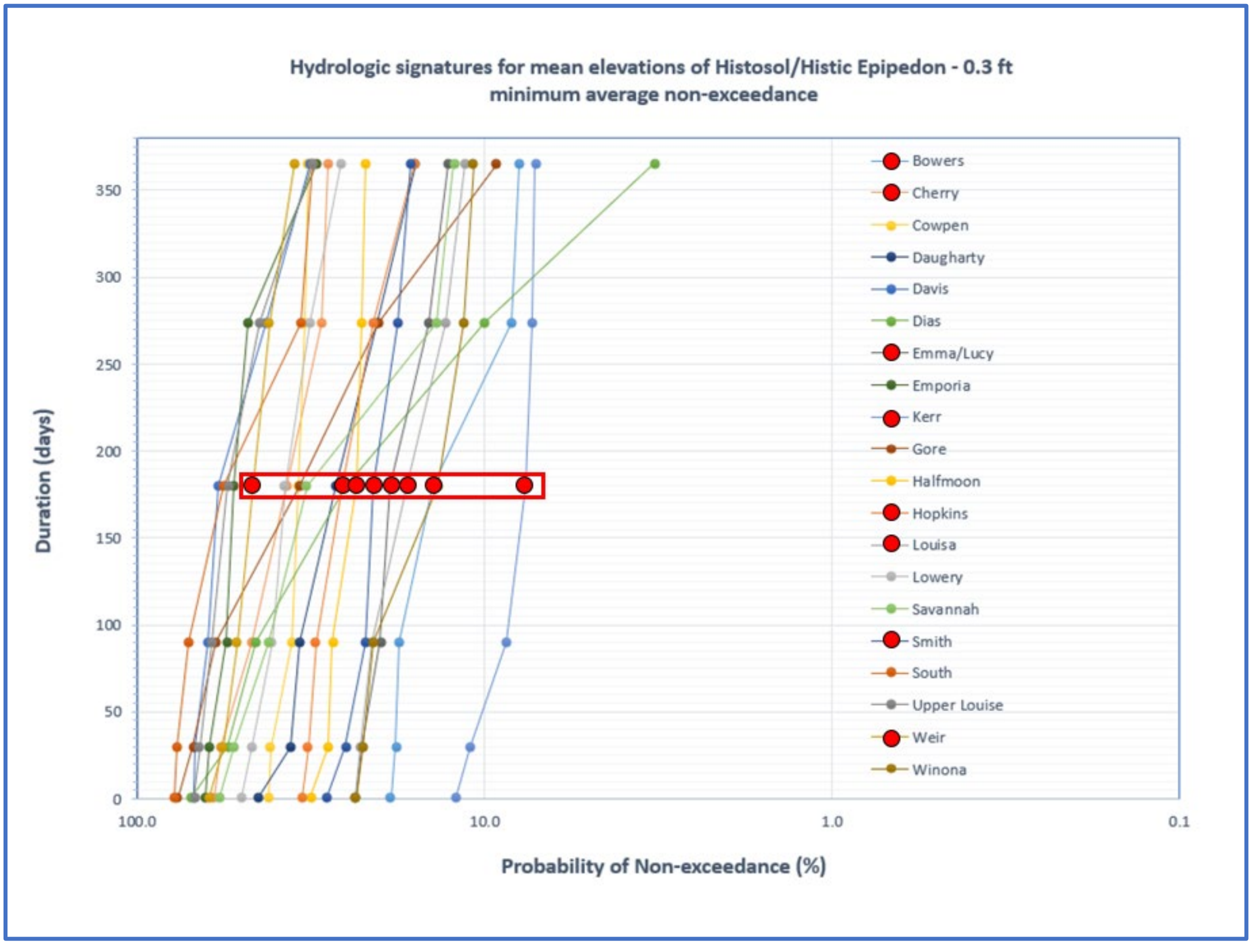

Figure 15. SWIDS plot showing distribution of hydrologic signatures for average non-exceedance elevations (of various durations) for mean elevations of deep organic soil elevations for 8 lakes in Central Florida, based on cluster analysis; red dots are lakes in the same cluster as Apshawa Lake South.

ft), whereas all sites have a mean (± SD) of 4.3 ft (± 1.8 ft). The former is much more similar to the water level range at Apshawa Lake South, which equals 6.4 feet.

The return interval central tendency (mean minus standard error) of these five lakes (i.e, those with similar range) was used for the Apshawa Lake South recommended MA return interval. Using these five lakes yielded a tighter return interval range (1.7 year to 4.8 years) than either all sites, or those based on the cluster analysis. It was deemed prudent to base the recommendation on sites that are similar in water level range, and that yield less uncertainty in the return interval range. Based on this analysis, the recommended return interval for the Apshawa Lake South MA is 2.4 years.