LAKE ASSESSMENT REPORT FOR LAKE ARMISTEAD IN HILLSBOROUGH COUNTY FLORIDA

Date Assessed: June 7, 2006
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Reviewed by: Jim Griffin

INTRODUCTION

This assessment was conducted to update existing physical and ecological data for Lake Armistead on the Hillsborough County Watershed Atlas (**http://www.hillsborough.wateratlas.usf.edu/**). The project is a collaborative effort between the University of South Florida's Center for Community Design and Research and Hillsborough County Stormwater Management Section. The project is funded by Hillsborough County and the Southwest Florida Water Management District's Northwest Hillsborough, Hillsborough River and Alafia River Basin Boards. The project has, as its primary goal, the rapid assessing of up to 150 lakes in Hillsborough County during a five year period. The product of these investigations will provide the County, lake property owners, and the general public a better understanding of the general health of Hillsborough County lakes, in terms of shoreline development, water quality, lake morphology (bottom contour, volume, area etc.) and the plant biomass and species diversity. These data are intended to assist the County and its citizens to better manage lakes and lake centered watersheds.

Figure 1. General Photo of Lake Armistead (6/7/2006).

The first section of the report provides the results of the overall morphological assessment of the lake. Primary data products include: a contour (bathymetric) map of the lake, area, volume and depth statistics, and the water level at the time of assessment. These data are useful for evaluating trends and for developing management actions such as plant management where depth and lake volume are needed.

The second section provides the results of the vegetation assessment conducted on the lake. These results can be used to better understand and manage vegetation in your lake. A list is provided with the different plant species found at various sites around the lake. Potentially invasive, exotic (non-native) species are identified in a plant list and the percent of exotics is presented in a summary table. Watershed values provide a means of reference and are derived from the lakes assessed during the 2006 lake assessment project in that watershed.

The third section provides the results of the water quality sampling of the lake. Both field data and laboratory data are presented. The trophic state index (TSI) [i] is used to develop a general lake health statement, which is calculated for both the water column with vegetation and the water column if vegetation were removed (adjusted TSI – Adj_TSI). These data are a combination of the water chemistry and vegetative submerged biomass assessments and are useful in understanding the results of certain lake vegetation management practices.

The intent of this assessment is to provide a starting point from which to track changes in your lake, and where previous comprehensive assessment data is available, to track changes in the lake's general health. These data can provide the information needed to determine changes and to monitor trends in physical condition and ecological health of the lake.

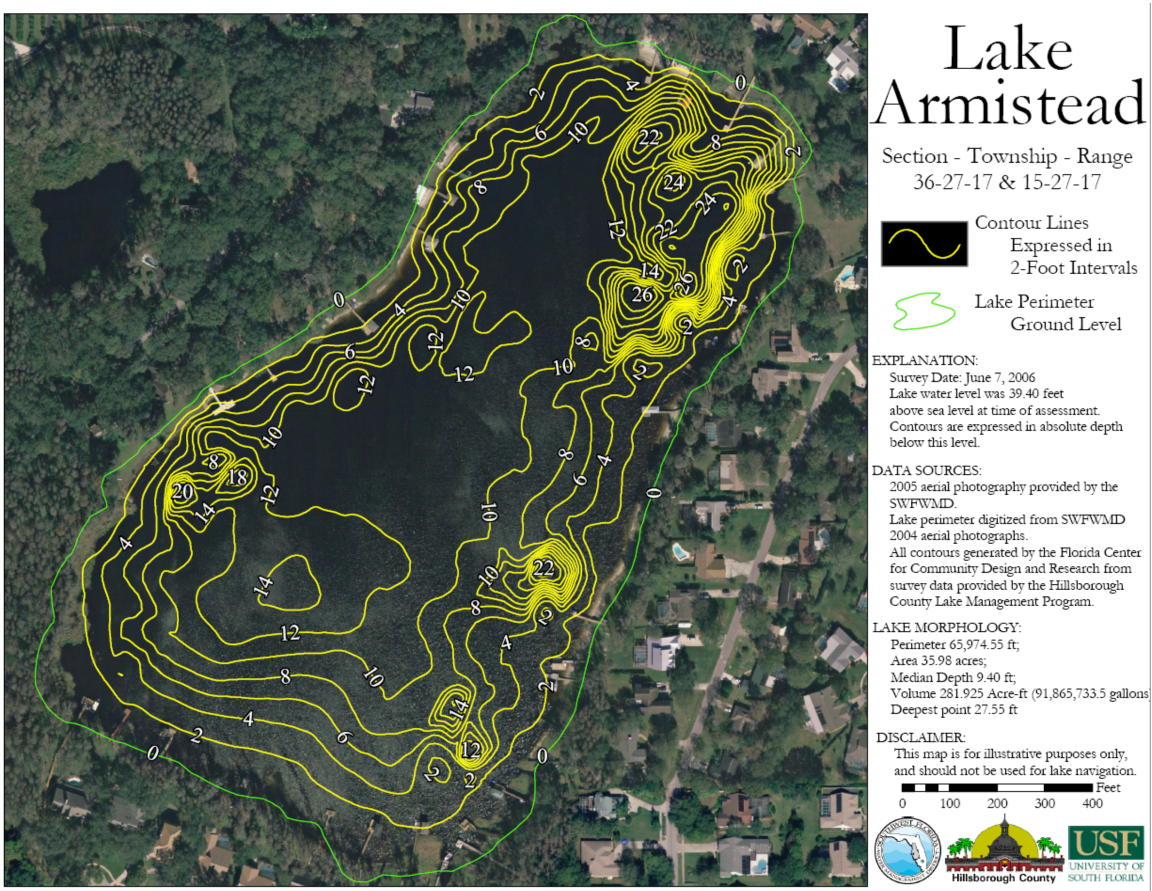
Section 1: Lake Morphology

Bathymetric Map[ii]. The bottom of the lake was mapped using a Lowrance LCX 26C HD Wide Area Augmentation System (WAAS)[iii] enabled Global Positioning System (WAAS-GPS) with fathometer (bottom sounder) to determine the boat's position, and bottom depth in a single measurement. The result is an estimate of the lake's area, mean and maximum depths, and volume and the creation of a bottom contour map (Figure 2). Besides pointing out the deeper fishing holes in the lake, the morphologic data derived from this part of the assessment can be valuable to overall management of the lake vegetation as well as providing flood storage data for flood models. Table 1 provides the lake's morphologic parameters in various units.

Table 1. Lake Area Depth and Volume

Parameter	Feet	Meters	Acres	Acre-ft	Gallons
Surface Area (sq)	1,548,981.51	143,906.80	35.56		
Mean Depth	9.40				
Maximum Depth	27.55				
Volume (cubic)	12,280,577.19	347,785.95		281.96	91,846,436.80

Figure 2. Contour map for Lake Armistead. The lake was mapped during the 2006 lake assessment project. A differential global positioning system and fathometer combination instrument was used to obtain simultaneous horizontal and vertical measurements.



Section 2: Lake Ecology (vegetation)

The lake's apparent vegetative cover and shoreline detail are evaluated using the aerial shown in Figure 3 and by use of GPS. Submerged vegetation is determined from evenly spaced contours sampled using a Lowrance 26c HD, combined DGPS/fathometer described earlier. Fifteen vegetation assessment sites were used for Lake Armistead (Figure 3) as dictated by the *Lake Assessment Protocol* (copy available on request) for a lake of this size. The site positions are set using a DGPS and then loaded into a GIS mapping program (ArcGIS) for display. Each site is field sampled in the three primary vegetative zones (emergent, submerged and floating). The latest aerials (2005, 6 inch resolution, SWFWMD aerials) are used to provide shore details (docks, structures, vegetation zones) and to calculate the extent of surface vegetation coverage. The primary indices of submerged vegetation cover and biomass for the lake, percent area coverage (PAC) and percent volume infestation (PVI), are determined by transiting the lake by boat and employing a fathometer to collect "hard and soft return" data. These data are later analyzed for presence and absence of vegetation and to determine the height of vegetation if present. The PAC index is determined from the presence and absence analysis of 100 sites in the lake and the PVI index is determined by measuring the difference between hard returns (lake bottom) and soft returns (top of vegetation) for sites (within the 100 analyzed sites) where plants are determined present.

The data collected during the site vegetation sampling include vegetation type, exotic vegetation, predominant plant species and submerged vegetation biomass. The total number of species from all sites is used to approximate the total diversity of aquatic plants and the total non-native plants on the lake (Table 2). The Watershed value in Table 2 only includes lakes sampled during the lake assessment project begun in May of 2006. These data will change as additional lakes are sampled. Tables 3 through 5 detail the results from the 2006 aquatic plant assessment for you lake. These data are determined from the 15 sites used for intensive vegetation surveys. The tables are divided into Floating Leaf, Emergent and Submerged plants and contain the plant code, species, common name and presence (1) or absence (blank) of species and the calculated percent occurrence (number sites species is found/number of sites) and type of plant (Native, Non-Native, Invasive, Pest). In the "Type" category, the term invasive indicates the plant is commonly considered invasive in this region of Florida and the term "Pest" indicates that the plant has a greater than 55% occurrence in your lake and is also considered a problem plant for this region of Florida, or in a non-native invasive that is or has the potential to be a problem plant in your lake and has at least 40% occurrence. These two terms are somewhat subjective; however, they are provided to give lake property owners some guidance in the management of plants on their property. Please remember that to remove or control plants in a wetland (lake shoreline) in Hillsborough County the property owner must secure an Application To Perform Miscellaneous Activities In Wetlands (http://www.epchc.org/forms_documents.htm) permit from the Environmental Protection Commission of Hillsborough and for management of in-lake vegetation outside the wetland fringe (for lakes with an area greater than 10 acres), the property owner must secure a Florida Department of Environmental Protection permit (http://www.dep.state.fl.us/lands/invaspec/).

Table 2 Total diversity, total Non-Native, and number of EPPC pest plants

Parameter	Lake	Watershed
Total Plant Diversity (# of Taxa)	49	84
Total Exotic or Invasive Plants	8	15
Total Pest Plant Species	3	6

Figure 3. 2005 six inch resolution aerial and vegetation assessment sites on Lake Armistead.

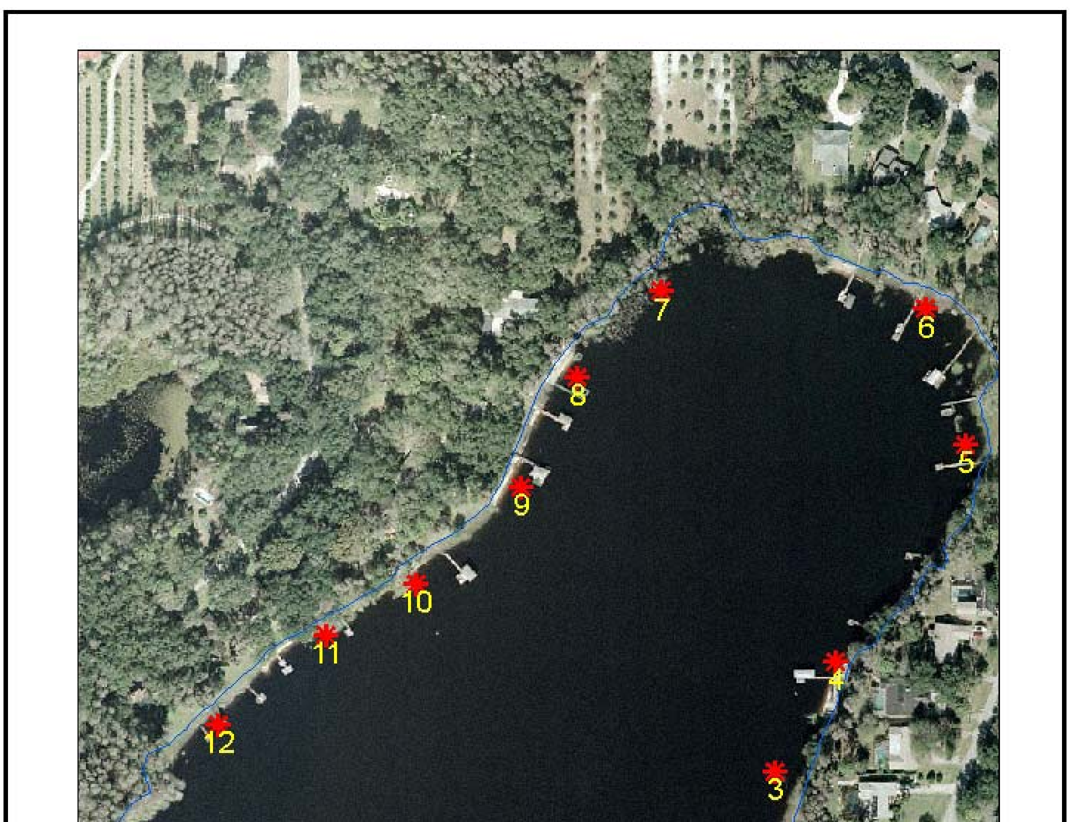


Table 3. List of Floating Leaf Zone Aquatic Plants Found in Lake Armistead

Code	Plant Species	Common Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	% Occurrence	Native (N), Non-Native(NN), Invasive (I), Pest (P)
HYE	Hydrocotyl umbellata	Manyflower Marshpennywort, Water Pennywort		1	1	1	1			1	1	1	1			1		60%	Native
PSS	Pistia stratoides	Water Lettuce	1				1			1		1				1		33.30%	NN-I
ECS	Eichornia crassipes	Water Hyacinth	1				1									1	1	26.70%	NN-I
NLM	Nuphar lutea var. advena	Spatterdock, Yellow pond lily					1								1			13.30%	Native
NNC	Nymphoides cristata	Crested banana lily											1					6.70%	NN-I
SMA	Salvinia minima	Water Spangles, Water Fern														1		6.70%	NN-I

Figure 4- Spadderdock, Yellow Pondlily, shown in Lake Armistead.

Table 4 List of Emergent Zone Aquatic Plants Found in Lake Armistead

Code	Plant Species	Common Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	% Occurrence	Native (N), Non-Native(NN), Invasive (I), Pest (P)
TDM	Taxodium distichum	Bald Cypress		1	1	1	1	1	1	1	1	1		1	1	1	1	86.67%	Native
APS	Alternanthera philoxeroides	Alligator Weed	1		1	1	1	1		1			1	1	1	1	1	73.33%	NN-I-P
BMA	Urochloa mutica	Para Grass	1		1		1	1			1	1	1		1	1		60%	NN-I-P
LOP	Ludwigia spp.	Water Primroses, Primrosewillow	1		1		1	1	1			1	1		1	1		60%	Native
ELE	Eleocharis spp.	Roadgrass, Spikerushes		1	1	1	1			1		1				1	1	53.33%	Native
MEL	Melaleuca quinquenervia	Punk Tree, Melaleuca			1				1	1	1			1	1	1		46.67%	NN-I-P
SCS	Scirpus cubensis	Burhead Sedge,Cuban Scirpus	1			1	1	1					1		1		1	46.67%	Native
COS	Cephalanthus occidentalis	Common Buttonbush					1		1	1					1	1	1	40%	Native
CAA	Centella asiatica	Asian Pennywort, Coinwort, Spadeleaf			1						1	1		1	1			33.33%	Native
MSS	Mikania scandens	Climbing Hempvine					1						1	1		1	1	33.33%	Native
POL	Polygonum spp.	Smartweed, Knotweed								1			1	1	1		1	33.33%	Native
RF	Osmunda regalis	Royal Fern					1			1				1	1	1		33.33%	Native
SAL	Salix spp.	Willow					1	1	1							1	1	33.33%	Native
TYP	Typha spp.	Cattails					1	1		1					1		1	33.33%	Native
PRS	Panicum repens	Torpedo Grass				1				1						1	1	26.67%	NN-I
BMI	Bacopa monnieri	Common Bacopa, Herb-Of-Grace										1	1	1			1	26.67%	Native
COM	Commelina spp.	Dayflower			1		1					1	1					26.67%	Native
BID	Bidens spp.	Bur Marigold								1				1		1		20%	Native
CCM	Cicuta maculata	Water Hemlock								1			1				1	20%	Native
CYO	Cyperus odoratus	Fragrant Flatsedge	1		1							1						20%	Native
PAN	Panicum spp.	Panic grasses					1	1			1							20%	Native
ACE	Acer rubrum var. trilobum	Southern Red Maple	1												1			13.33%	Native
BOC	Boehmeria cylindrica	Bog Hemp, False Nettle											1	1				13.33%	Native

CYP	Cyperus spp.	Sedge					1					1						13.33%	Native
LCA	Lachnanthes caroliniana	Carolina Redroot					1										1	13.33%	Native
OCA	Osmunda cinnamomea	Cinnamon Fern												1	1			13.33%	Native
PCA	Pontederia cordata	Pickerel Weed								1							1	13.33%	Native
BLS	Blechnum serrulatum	Swamp Fern														1		6.67%	Native
CRX	Carex spp.	Sedge	1															6.67%	Native
EBI	Eleocharis baldwinii	Baldwin's Spikerush, Roadgrass		1														6.67%	Native
ERB	Eryngium baldwinii	Baldwin's coyote thistle														1		6.67%	Native
HIC	Hibiscus coccineus	Marsh hibiscus															1	6.67%	Native
HYP	Hypericum spp.	St. John's Wort												1				6.67%	Native
HYA	Hyptis alata	Musky Mint														1		6.67%	Native
ICE	Ilex cassine	Dahoon Holly				1												6.67%	Native
PHN	Panicum hemitomon	Maidencane								1								6.67%	Native
PAT	Parietaria spp.	Pellitories								1								6.67%	Native
PHU	Phyllanthus urinaria	Leaf Flower												1				6.67%	Native
SLA	Sagittaria lancifolia	Bulltongue Arrowhead, Duck Potato	1															6.67%	Native
WAX	Myrica cerifera	Wax Myrtle					1											6.67%	Native

Figure 5- Lake Armistead shoreline vegetation showing Melaleuca (upper left), Red Maple (center background), Maidencane (foreground grass), and Primrose Willow (foreground shrubs).

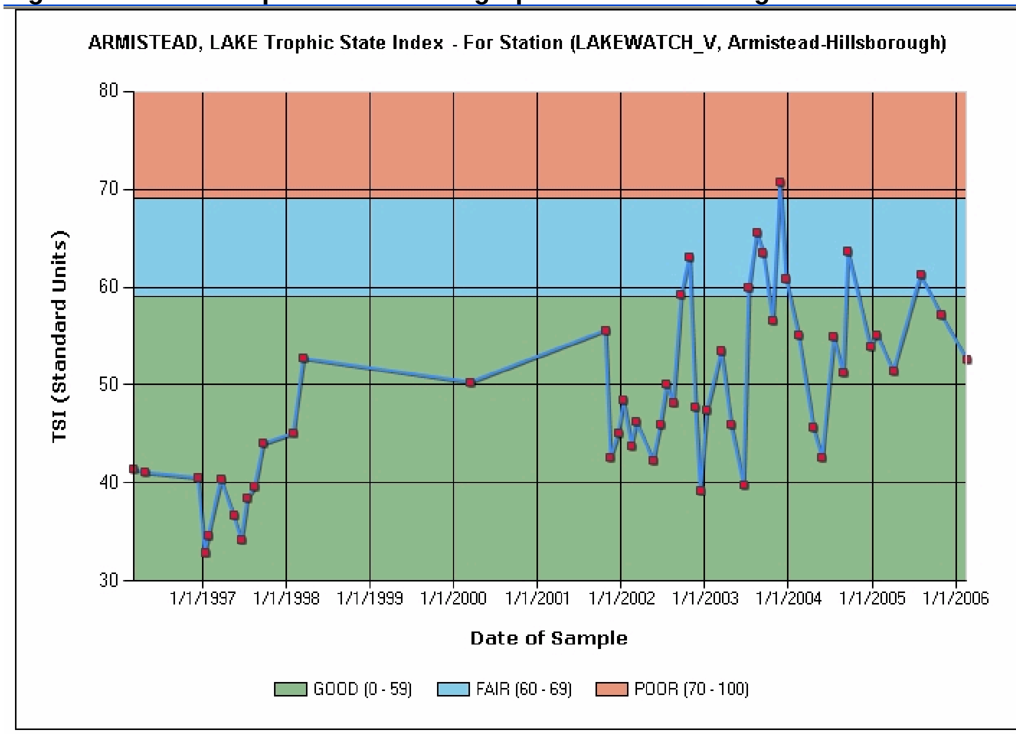
Table 5 List of Submerged Zone Aquatic Plants Found in Lake Armistead.

Code	Plant Species	Common Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	% Occurrence	Comment
MGM	Micranthemum glomeratum	Manatee Mudflower, Baby's Tears	1	1	1	1	1	1			1	1	1	1		1	1	80%	Native
POT	Potamogeton spp.	Pond Weed							1			1		1				20%	Native
MUM	Micranthemum umbrosum	Shade Mudflower, Baby's Tears															1	6.70%	Native

Section 3: Lake Water Chemistry

A critical element in any lake assessment is the long-term water chemistry data set. The primary source of water quality trend data for Florida lakes is the Florida LAKEWATCH volunteer and the Florida LAKEWATCH water chemistry data. Hillsborough County is fortunate to have a large cadre of volunteers who have collected lake water samples for significant time period. These data are displayed and analyzed on the Water Atlas as shown in Figure 6 for Lake Armistead. Additional data, when available, is also included on the Water Atlas; however, the LAKEWATCH data remains the primary source. By the trend data shown in Figure 6, the lake may be considered fair health in terms of the trophic state index. Lake Armistead is a dark water lake and as such it must maintain a TSI of below 60 to not be considered impaired by the State of Florida guidelines[iv]. Lake Armistead's long term water quality data indicates enough violations of these criteria to be classified by Florida DEP as impaired. The more recent data indicate a possibly improving trend and if this continues the lake may be removed from the impaired waters list.

Figure 6 Recent Trophic State Index graph from Hillsborough Watershed Atlas.



Note: The graph above includes benchmarks for using verbal descriptors of "good", "fair" and "poor". The verbal descriptors for these benchmarks are based on an early determination by stakeholders of the generally acceptable and understood terms for describing the state of lakes. The same benchmarks are used for nutrient graphs (Nitrogen and Phosphorus), chlorophyll graphs and trophic state index (TSI) graphs. The TSI is a calculated index of lake condition based on nutrient and chlorophyll (a) concentrations (please see "Learn more about Trophic State Index"). The benchmarks are established based on the TSI range that relates to a specific descriptor. The source for the TSI concentration relationships is the Florida Water Quality Assessment, 1996, 305(b) (Table 2-8). For many lakes there is more than a single source of water quality data. You have the option with the "Select Data Source" drop down to select any available data source and create the graph using that source or you may select "All" to graph all available data. The graph header will also change to reflect the source used.

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As part of the lake assessment, the physical water quality and water chemistry of a lake are measured. These data only indicate a snap shot of the lakes water quality; however they are useful to comparing to the trend data. Table 6A contains the summary water quality data and index values and adjusted values calculated from these data. The total phosphorus (TP), total nitrogen (TN) and chlorophyll (a) water chemistry sample data are the results of chemical analysis of samples taken during the assessment and analyzed by the Hillsborough County Environmental Protection Commission laboratory. These data compare well with the mean data from the LAKEWATCH data set for the lake. The trophic state index (TSI) calculated from the sample data (57.95) is well within the values shown in Figure 6. Table 6B contains the field data taken in the center of the lake using a YSI Corporation – 6000 multi-probe which has the ability to directly measure the temperature, pH, dissolve oxygen (DO), percent DO (calculated from DO, temperature and conductivity) and Turbidity. These data are listed for three levels in the lake and twice for the surface measurement. The duplicate surface measurement was taken as a quality assurance check on measured data. The bottom data indicates a definite anoxic layer with low dissolved oxygen (DO) and high (low value) oxygen reduction potential. The second surface value indicates that the probe was not allowed to equilibrate and is not a good reading.

Table 6A. Water Quality Parameters

Summary Table for Water Quality		
Parameter	Value	Comment
TP ug/L	45.00	
TN mg/L	1.09	
Chla ug/L	21.30	
Chla TSI	60.85	
TP TSI	52.40	
TN TSI	57.72	
Secchi Disk (SD)	3' 5"	
TSI	57.95	Balanced
PAC	7%	
PVI	12%	
Adj TP ug/L	0.2187	P from Veg Added
Adj TN mg/L	0.0029	N from Veg Added
Adj Chla ug/L	0.0031	Chla from Veg Added
Adj TSI	57.99	With additional N and P

Table 6B. Water Quality Parameters (Field – YSI)

Sample	Sample Location	Time	Temp (oC)	Conductivity (mS/cm3)	Dissolved Oxygen (%)	DO (mg/L)	pH (SU)	ORP (ORP)	Tubidity (NTU)	Secchi Depth
1	Surface	13:12	30.61	0.194	96.1	7.18	7.36	261.6	2.6	
1	Mid	13:12	28.78	0.187	30.8	2.23	6.48	258.4	3.5	
1	Bottom	13:12	28.42	0.185	9.7	0.78	6.2	121.5	493.1	
1	Surface	13:12	30.77	0.194	91.9	6.87	7.3	121.2	2.6	
Mean			**29.645**	**0.19**	**57.125**	**4.265**	**6.835**	**190.675**	**125.45**	**3' 5"**

Table 6A also provides data derived from the vegetation assessment which is used to determine an adjusted TSI. This is accomplished by calculating the amount of phosphorus and nitrogen that could be released by existing submerged vegetation if this vegetation were treated with an herbicide or managed by the addition of Triploid Grass Carp (*Ctenopharyngodon idella*). While it would not be expected that all the vegetation would be turned into available phosphorus by these management methods, the data is useful when planning various management activities.

Approximately 7% of the lake has submerged vegetation present and this vegetation represents about 12% of the available lake volume. Because there is very little submerged vegetation in the lake, the amount of nutrient available from vegetation is low. The vegetation holds enough phosphorus to add about 0.219 μg/L of phosphorus and 0.003 mg/L of nitrogen to the water column. This is not enough to stimulate appreciable algae growth. One approach to manage the water quality of the lake would be to increase the percent of submerged vegetation. The additional vegetation would remove nutrient from the water column and thus reduce the lakes TSI.

Section 4: Conclusion

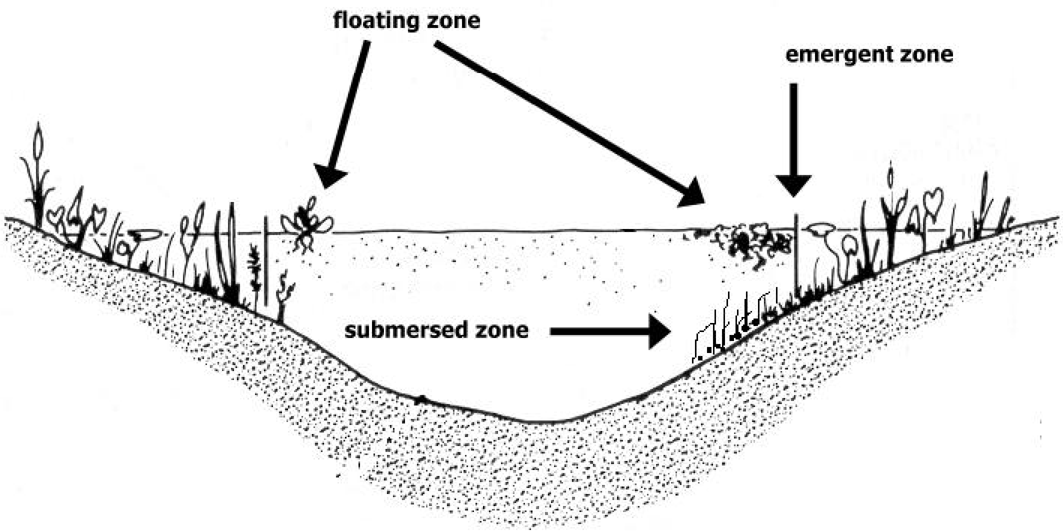
Armistead is a small sized (36 acre) lake that would be considered in the fair to good category of lakes based on water chemistry. It has a lower than normal concentration of aquatic vegetation. It is the last lake on the Rocky Creek chain of lakes and the water leaving this lake is the predominate source of water for the reaches of the creek below the lake. About 7% of the open water areas contain submerged vegetation. The lack of vegetation can contribute to elevated nutrients in the lake as well as poor fish habitat. The lake has many open water areas that support various types of recreation and has a fair diversity of plant species. The primary pest plants in the lake include Punk tree (Melaleuca), Hydrilla and Alligator weed. For more information and recent updates please see the Hillsborough Watershed Atlas (water atlas) website at: http://www.hillsborough.wateratlas.usf.edu/lake/default.asp?wbodyid=5144&wbodyatlas=lake

i "Trophic" means "relating to nutrition." The Trophic State Index (TSI) takes into account chlorophyll, nitrogen, and phosphorus, which are nutrients required by plant life. For more information please see *learn more* at:
http://www.hillsborough.wateratlas.usf.edu/lake/default.asp?wbodyid=5168&wbodyatlas=lake

[ii] A bathymetric map is a map that accurately depicts all of the various depths of a water body. An accurate bathymetric map is important for effective herbicide application and can be an important tool when deciding which form of management is most appropriate for a water body. Lake volumes, hydraulic retention time and carrying capacity are important parts of lake management that require the use of a bathymetric map.

[iii] WAAS is a form of differential GPS (DGPS) where data from 25 ground reference stations located in the United States receive GPS signals form GPS satellites in view and retransmit these data to a master control site and then to geostationary satellites. The geostationary satellites broadcast the information to all WAAS-capable GPS receivers. The receiver decodes the signal to provide real time correction of raw GPS satellite signals also received by the unit. WAAS enabled GPS is not as accurate as standard DGPS which employs close by ground stations for correction, however; it was shown to be a good substitute when used for this type of mapping application. Data comparisons were conducted with both types of DGPS employed simultaneously and the positional difference was determined to be well within the tolerance established for the project.

[iv] The three primary aquatic vegetation zones are shown below:



[v] A lake is impaired if " (2) For lakes with a mean color less than or equal to 40 platinum cobalt units, the annual mean TSI for the lake exceeds 40, unless paleolimnological information indicates the lake was naturally greater than 40, or
For any lake, data indicate that annual mean TSIs have increased over the assessment period, as indicated by a positive slope in the means plotted versus time, or the annual mean TSI has increased by more than10 units over historical values. When evaluating the slope of mean TSIs over time, the Department shall use a Mann's one-sided, upper-tail test for trend, as described in

Nonparametric Statistical Methods by M. Hollander and D. Wolfe (1999 ed.), pages 376 and 724 (which are incorporated by reference), with a 95% confidence level."

Excerpt from Impaired Water Rule (IWR). Please see: **http://www.dep.state.fl.us/water/tmdl/docs/AmendedIWR.pdf**