Rainbow Lake

LAKE HABITAT ASSESSMENT, LAKE VEGETATION IDEX, SUBMERGED
VEGETATION SURVEY AND WATER QUALITY

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Methods

STUDY AREA ANALYISIS

The watershed containing the Rainbow Lake was analyzed using ESRI ArcGIS Pro. Using this software with 2022 ESRI Basemaps aerial, 2017 Land Use/ Land Cover (LULC), Landscape Development Intensity (LDI) Index values were calculated for the 100 meter buffer surrounding the lake following the procedures of FDEP (https://floridadep.gov/dear/bioassessment/content/bioassessment-ldi-hdg-bcg). "The Landscape Development Intensity index (LDI) is an estimate of how much humans have altered an area of interest around a waterbody. Various land use types (low density residential, row crops, industrial, natural) are assigned coefficients of land use intensity based on estimates of the amount of human energy that is put into those land use types. The LDI is calculated by multiplying each land use coefficient by the percentage of the area of interest occupied by that land use, and then summing the results. The Florida Department of Environmental Protection (DEP) uses the LDI as a tool to estimate potential land use impacts on streams, lakes, and wetlands. For streams and rivers, DEP typically uses a LDI calculated for the 100 m buffer of the waterbody for 10 km upstream of the point of interest. For lakes and isolated wetlands, DEP typically uses a LDI calculated for the 100 m buffer around the waterbody. LDI values less than two (≤2) can be considered minimally disturbed."

LAKE BATHYMETRY AND MORPHOLOGICAL CHARACTERISTICS ASSESSMENT

The Bathymetric Map[1] provides the lake's morphologic parameters in various units. The bottom of the lake was mapped using a Lowrance Elite 7 Ti Wide Area Augmentation System (WAAS)[2] enabled Global Positioning System (GPS) with Totalscan transducer (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. 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.

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[1] 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.

[2] 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. For more information, see end note 2.

LAKE VEGETATION INDEX ASSESSMENT

Hillsborough County requested the implementation of the Florida Department of Environmental Protection methods for Lake Vegetation Index (LVI 1000) (http://www.dep.state.fl.us/water/sas/sop/sops.htm) using forms FD 9000-03 (Physical/Chemical Characterization), FD 9000-06 (Lake Habitat Assessment) FD 9000-27 (LVI Field Sheet) and FD 9000-31 (Lake Observation Field Sheet).

The Lake Vegetation Index (LVI) is a rapid assessment protocol in which selected sections of a lake are assessed for the presence or absence of vegetation through visual observation and through the use of a submerged vegetation sampling tool called a Frodus. The assessment results provide a list of species presents and the dominant and where appropriate co-dominant species that are found in each segment. These results are then entered into a scoring table and a final LVI score is determined. LVI scores provide an estimate of the vegetative health of a lake. Our assessment team was trained and qualified by FDEP to conduct these assessment as an independent team and must prequalify each year prior to conducting additional assessments. The LVI method consists of dividing the lake into twelve pie-shaped segments (see diagram below) and selecting a set of four segments from the twelve to include in the LVI. The assessment team then travels across the segment and identifies all unique species of aquatic plant present in the segment. Additionally, a Frodus is thrown at several points on a single five-meter belt transect that is established in the center of the segment from a point along the shore to a point beyond the submerged vegetation zone. For scoring, the threshold score for impairment is 43.

Four metrics are utilized in the Lake Vegetation Index Survey; Dominant Coefficient of Conservatism (CoC), Percent Florida Exotic Pest Plant Council Type 1 (% FLEPPC), Percent Native Taxa, Percent Sensitive Taxa.

The Dominant Coefficient of Conservatism (CoC) metric for the dominant or co-dominate species in each section. The CoC applies a score of 0-10 to each species based on its ecological tolerances and fidelity to pre-settlement conditions. Species with higher scores show a high fidelity to native, undisturbed habitats and are typically sensitive to alterations. Available CoC scores can be obtained from LT 7000 from the Florida Department of Environmental Protection at: http://www.dep.state.fl.us/water/sas/sop/sops.htm.

The percent FLEPPC (Florida Exotic Pest Plant Council) Category 1 invasive exotic taxa in a single sampling unit (pie slice) by dividing the number of FLEPPC Category I taxa by the total number of taxa in that sampling unit. Multiply result times 100. Refer to Appendix LVI 1000-1 to determine which plants are on the FLEPPC Category 1 list. Note that not all exotic taxa should be included in this metric, only those listed in Appendix LVI 1000-1 as Category 1 FLEPPC. If the FLEPPC updates their list of Category 1 exotics, those updates shall not be reflected in this calculation until they are included in Appendix LVI 1000-1.

The percent native taxa in a single sampling unit (pie slice) is calculated by dividing the number of native taxa by the total number of taxa in that sampling unit. Multiply result times 100. Nativity status is determined by the Plant Atlas from the Institute for Systematic Botany, and is listed in Appendix LVI 1000-1. For informational purposes, visit the website

http://www.florida.plantatlas.usf.edu/. Taxa that are native according to the Plant Atlas from the Institute for Systematic Botany but are not on the list in Appendix LVI 1000-1 may be included in this metric calculation, but inclusion of these additional taxa is not required.

The percent sensitive taxa in a single sampling unit by summing the number of taxa with a C of C (Coefficient of Conservatism) score >= 7 and then dividing by the total number of taxa in that sampling unit. Multiply result times 100. Refer to Appendix LVI 1000-1 for a list of C of C scores.

The collected bathymetric data is analyzed for submerged aquatic vegetation (SAV) calculations including the percentage of the surface area of the lake inhabited by SAV as well as an estimate of the percent volume of the lake inhabited by SAV. SAV is an important component to a lakes nutrient cycling as well as chlorophyll concentrations due to the SAV and phytoplankton competing for available nutrients in the water column. In addition SAV serves a vital role as habitat for many species of macroinvertebrates and fish as well as substrate for epiphytic algae.

WATER QUALITY ASSESSMENT

Physical water quality samples were taken using a Eureka Manta Sub-2 multiprobe pre and post calibrated on the day of the assessment. Measurements taken with this device include: depth, conductivity, pH, Dissolved Oxygen (mg/l and % Saturation) and salinity. Chemical water parameters were collected and preserved on ice by USF Water Institute staff and analyzed at the Hillsborough County Public Utilities Laboratory Analysis include; Chlorophyll (a, b, c, t and corrected), Alkalinity, Color, E Coli, Enterococci, Ammonia, Nitrates/Nitrites, Total Phosphorous, Kjeldahl Nitrogen and Total Nitrogen. The results of the water quality sampling effort will be discussed in the framework of the FDEP Numeric Nutrient Criteria. Due to the lack of public access to the majority of lakes in Hillsborough County, the majority of available water quality samples are from the resident volunteer LAKEWATCH program. This data is being included in the analysis of Hillsborough County lakes.

Study Area

Rainbow Lake is located in the Coastal Old Tampa Bay Watershed in north-western Hillsborough County, Florida. The Landscape Development Intensity Index of the 100 meter buffer around Rainbow Lake is dominated by residential (67%) and natural (32.7%) land uses. The resulting LDI value for the 100 meter buffer around Rainbow Lake is 5.43.

FIGURE 1: 2023 RAINBOW LAKE ASSESSMENT STUDY AREA MAP

Rainbow Lake
WBID 1493X

Sample Date - July 12, 2023
Surface Area - 49.5 acres (2,157,465 sqft)
100m Landscape Development
    Intensity - 5.43
Dominant Land Use 100m Buffer -
    Residential (67%)
    Natural (32.7%)
Lake Vegetation Index - 52
Water Clarity - 2.13m (7.0ft)
Submerged Aquatic Vegetation
    Percent Area Covered - 32.7%
    Percent Volume Inhabited - 1.7%
    SAV Volume - 294,860 cubic feet
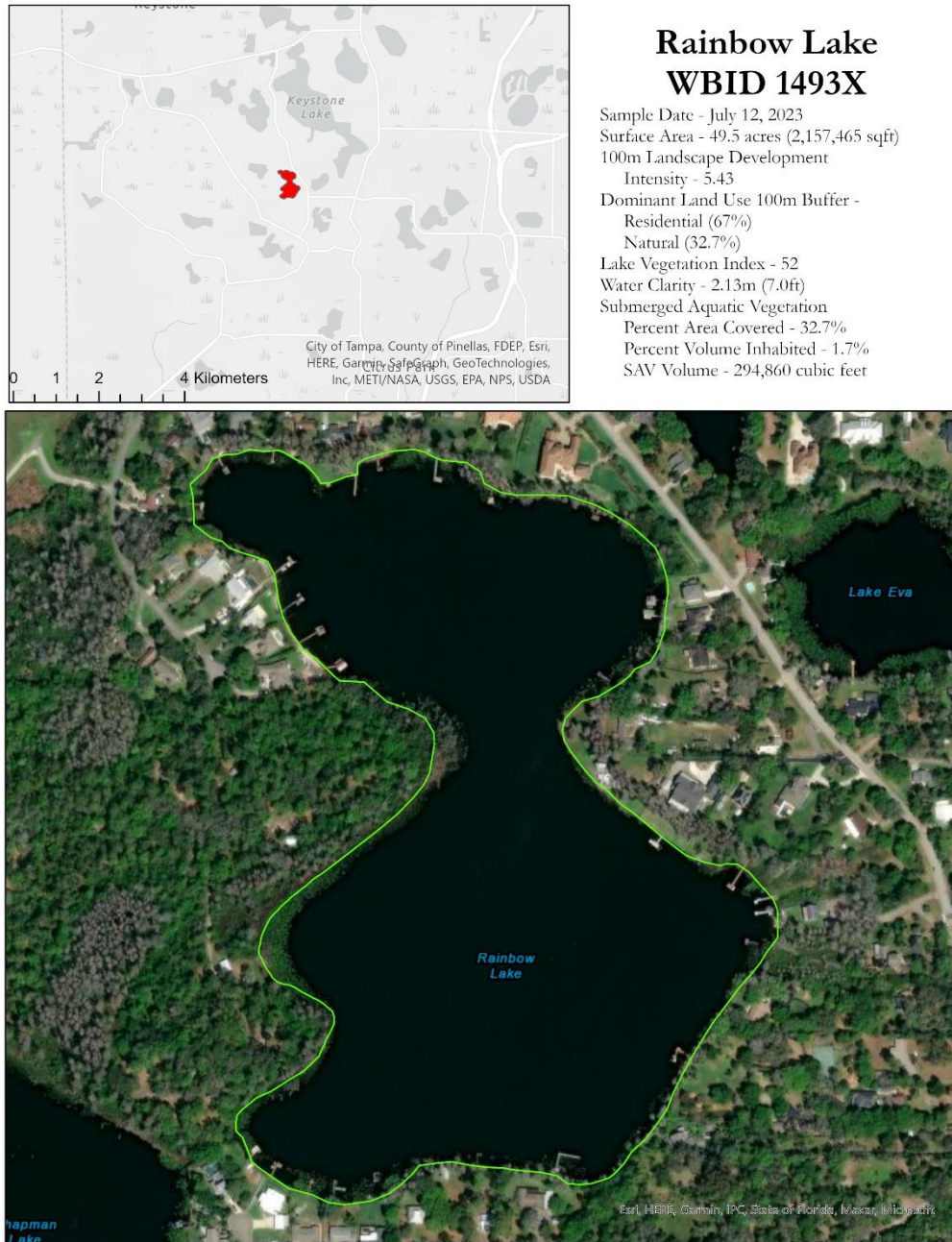
Lake Bathymetry and Morphological Characterization

At the time of the assessment, Rainbow Lake was experiencing normal water levels (35.39 feet NAVD88 on staff gauge) resulting in a 49.5 acre water body. Rainbow Lake at the time of the assessment had a mean water depth of 8.1 feet and a maximum observed depth of 21.47 feet. The volume at this time was approximately 130,585,845 gallons. Figure 2 shows the resulting bathymetric contour map for Rainbow Lake from data collected on July 12, 2023. The collected data has been overlain the 2022 ESRI Basemap aerials.

Table 1: Morphological Calculations for Rainbow Lake

Parameter	Feet	Meters	Acres	Acre-Ft	Gallons
Surface Area (sq)	2,157,465	200,433	49.5		
Mean Depth	8.1	2.47			
Maximum Depth	21.47	6.54			
Volume (cubic)	17,456,667	494,313		400.8	130,585,845
Gauge (NAVD 88)	35.39	10.79			

Figure 2: 2023 2-Foot Bathymetric Contour Map for Rainbow Lake

Rainbow Lake

Legend:
- Perimeter
- Contour
- 2
- 4
- 6
- 8
- 10
- 12
- 14
- 16
- 18
- 20

EXPLANATION:
Survey Date: July 12, 2023
Water level was 35.39 NAVD88
at the time of the assessment.
Contours are expressed in absolute
depth below this level.

LAKE MORPHOLOGY:
Perimeter 8,014 ft;
Area 49.5 Acres;
    (2,157,465 Sqft)
Mean Depth 8.1 ft;
Volume 400.8 Acre-ft,
    (130,585,845 gallons);
Deepest point 21.47 ft

DATA SOURCES:
2022 aerial photography provided by
ESRI.
Lake perimeter digitized from Hillsborough
County 2022 aerial photographs.
All contours generated by the USF Water
Institute from survey data collected by
USF Water Institute Lake and Stream
Assessment Program.

DISCLAIMER:
This map is for illustrative purposes only,
and should not be used for lake navigation.

0   125 250   500
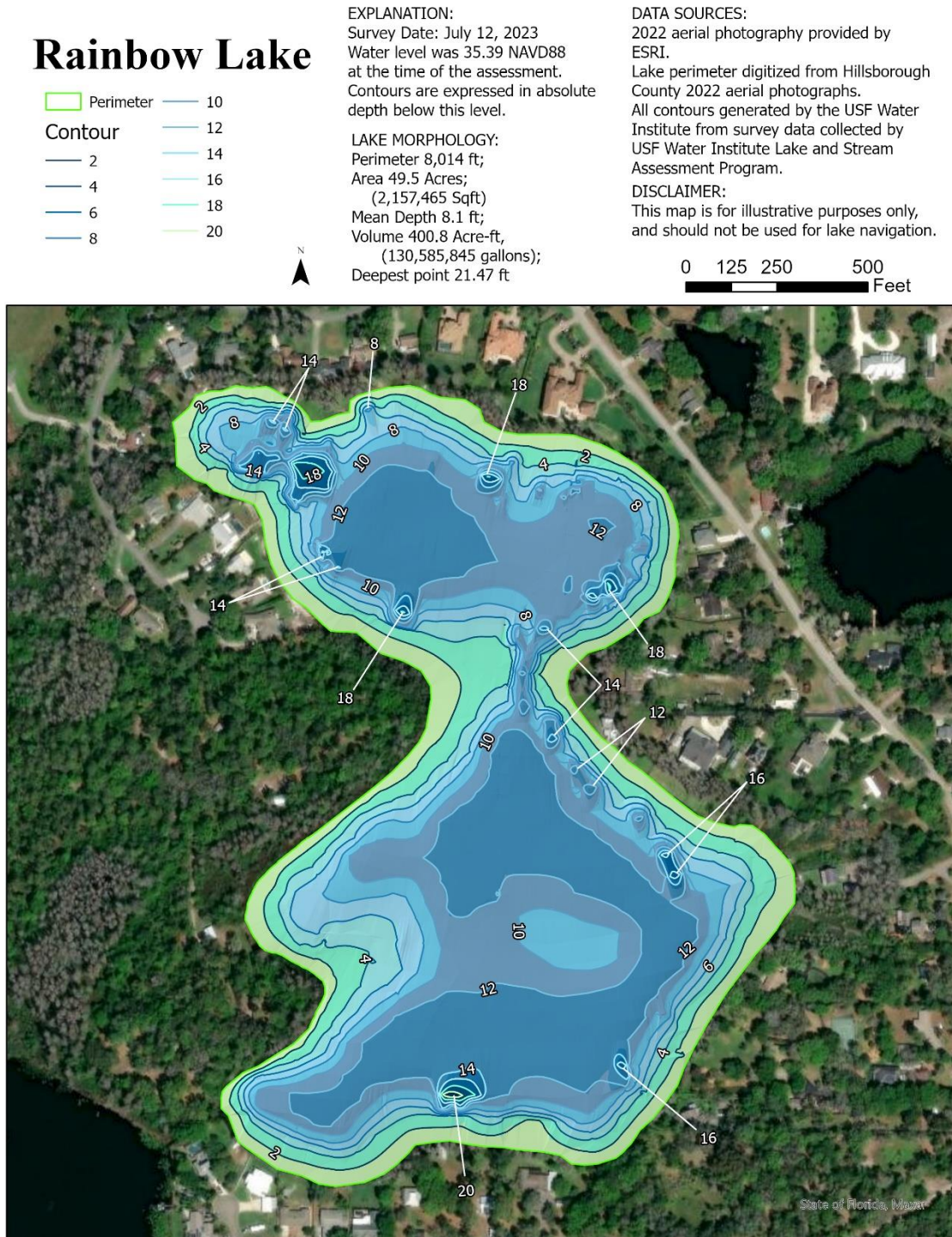   Feet

Figure 3 Overview photograph of Rainbow Lake showing the undeveloped portion of shoreline along region 7 of the Lake Vegetation Index.

Lake Habitat and Lake Vegetation Index Assessment

The lake assessment for Rainbow Lake was conducted on July 12, 2023. The water in Rainbow Lake was characterized as tannic with low turbid. The secchi disk depth was 2.13 meters allowing for an abundant submerged aquatic vegetation community. The vegetation quality of the plants in and buffering Rainbow Lake are predominantly native species with moderate growths of non-native invasive species such as *Melaleuca quiquenervia* and *Panicum repens*. The percentage of non-native FLEPPC 1 species ranged from 8% (region 10) to 20% (region 1). Stormwater reaches the lake predominately via sheet flow from surrounding residential land cover. The development along the shoreline has maintained the nearshore *Taxodium* however the shrub and native ground cover communities have largely been maintained for residential turf grasses. The bottom substrate quality was dominated by sandy/silt with coarse particulate organic matter near shore and submersed vegetation.

Figure 4 Nitella, Stonewort, was dominant in regions 4 and 7 and co-dominant in region 1 of the Lake Vegetation Index on Rainbow Lake

The Lake Vegetation Index identified 34 species of wetland vegetation growing in the four selected sections along Rainbow Lake. The majority of these species (27) are native species. The remaining 7 species (*shown in **bold** in Table 2*) are non- native or invasive to this region. The vegetation community along the shorelines of Rainbow Lake has been altered by lawn maintenance activities leaving a *Taxodium* canopy with a sparse shrub and ground cover community. The edges of the lake are dominated by species able to rapidly colonize following the frequent disturbance of mowing, such as *Panicum repens*. At the time of the assessment the water transparency was 2.13 m (7.0 ft). High annual average secchi disk depths allow for an extensive littoral zone with establishment of floating leaved and submerged aquatic vegetation. Six species of submersed aquatic vegetation were observed during the lake vegetation index. The macroalgaes *Nitella* and *Chara* were both co-dominant species in LVI regions. The floating leaved vegetation community had 4 species observed with both *Nuphar* and *Nymphaea odorata* being the most common in LVI regions.

By analyzing the collected sonar chart, submerged aquatic vegetation potentially covered approximately 32.69% of the surface area of Rainbow Lake. This submerged vegetation inhabits an estimated 1.69% of the water volume in Rainbow Lake. Figure 5 shows the results of the SAV analysis indicating the location and height of SAV estimated from collected sonar readings.

The calculated LVI score for Rainbow Lake was 52, above the impairment threshold of 43 indicating the vegetation community is showing evidence of being "Healthy". Figure 6 shows the map of Rainbow Lake detailing the LVI regions used for the assessment (Regions 1, 4, 7, 10). Table 2 details the species list results of the Lake Vegetation Index. Table 3 details the scoring result for the Lake Vegetation Index.
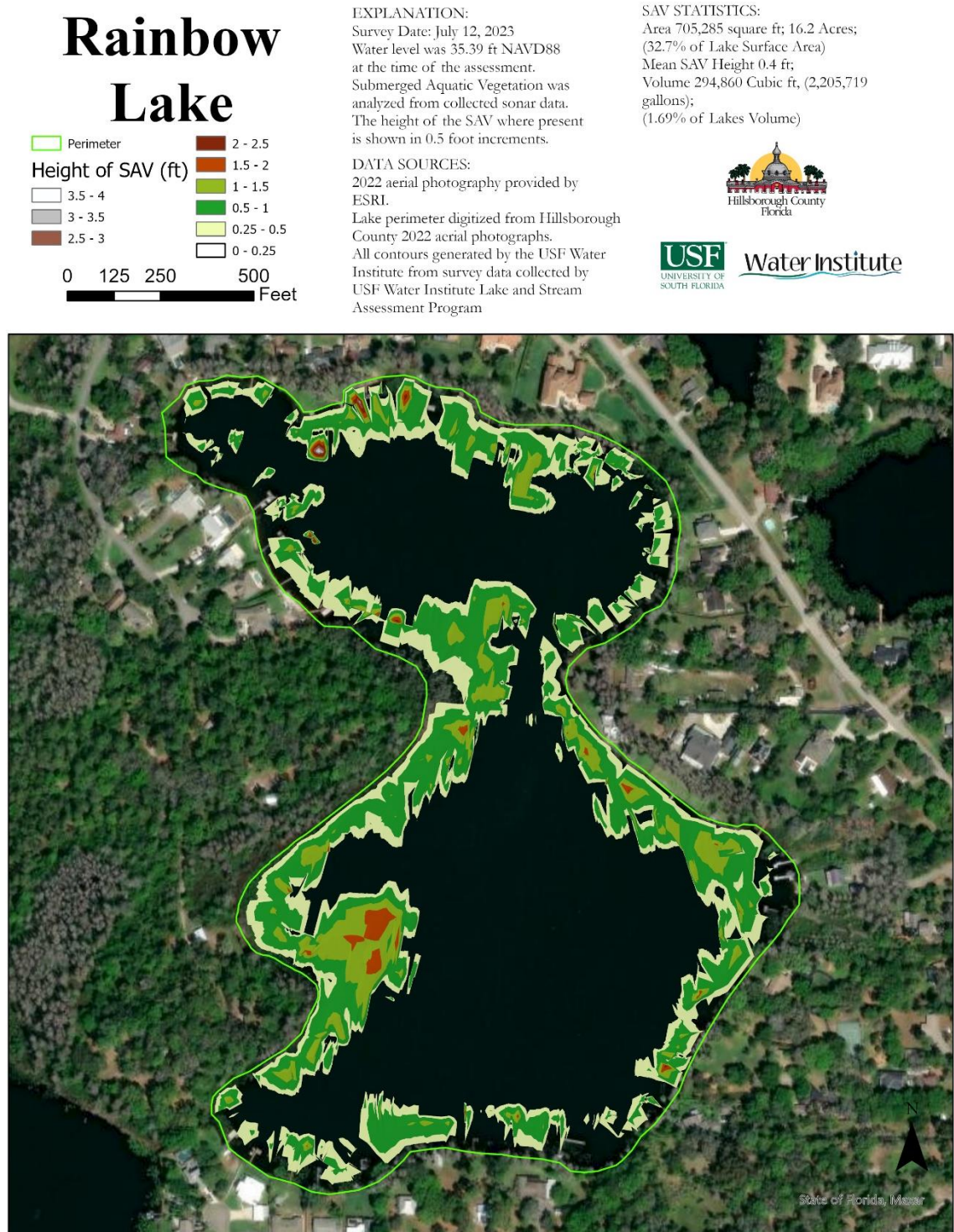
Rainbow Lake

Perimeter

Height of SAV (ft)

3.5 - 4	2 - 2.5
3 - 3.5	1.5 - 2
2.5 - 3	1 - 1.5
	0.5 - 1
	0.25 - 0.5
	0 - 0.25

0   125   250   500
Feet

EXPLANATION:
Survey Date: July 12, 2023
Water level was 35.39 ft NAVD88
at the time of the assessment.
Submerged Aquatic Vegetation was
analyzed from collected sonar data.
The height of the SAV where present
is shown in 0.5 foot increments.

DATA SOURCES:
2022 aerial photography provided by
ESRI.
Lake perimeter digitized from Hillsborough
County 2022 aerial photographs.
All contours generated by the USF Water
Institute from survey data collected by
USF Water Institute Lake and Stream
Assessment Program

SAV STATISTICS:
Area 705,285 square ft; 16.2 Acres;
(32.7% of Lake Surface Area)
Mean SAV Height 0.4 ft;
Volume 294,860 Cubic ft, (2,205,719
gallons);
(1.69% of Lakes Volume)

Hillsborough County
Florida

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Figure 5 Rainbow Lake Submerged Aquatic Vegetation Assessment Results
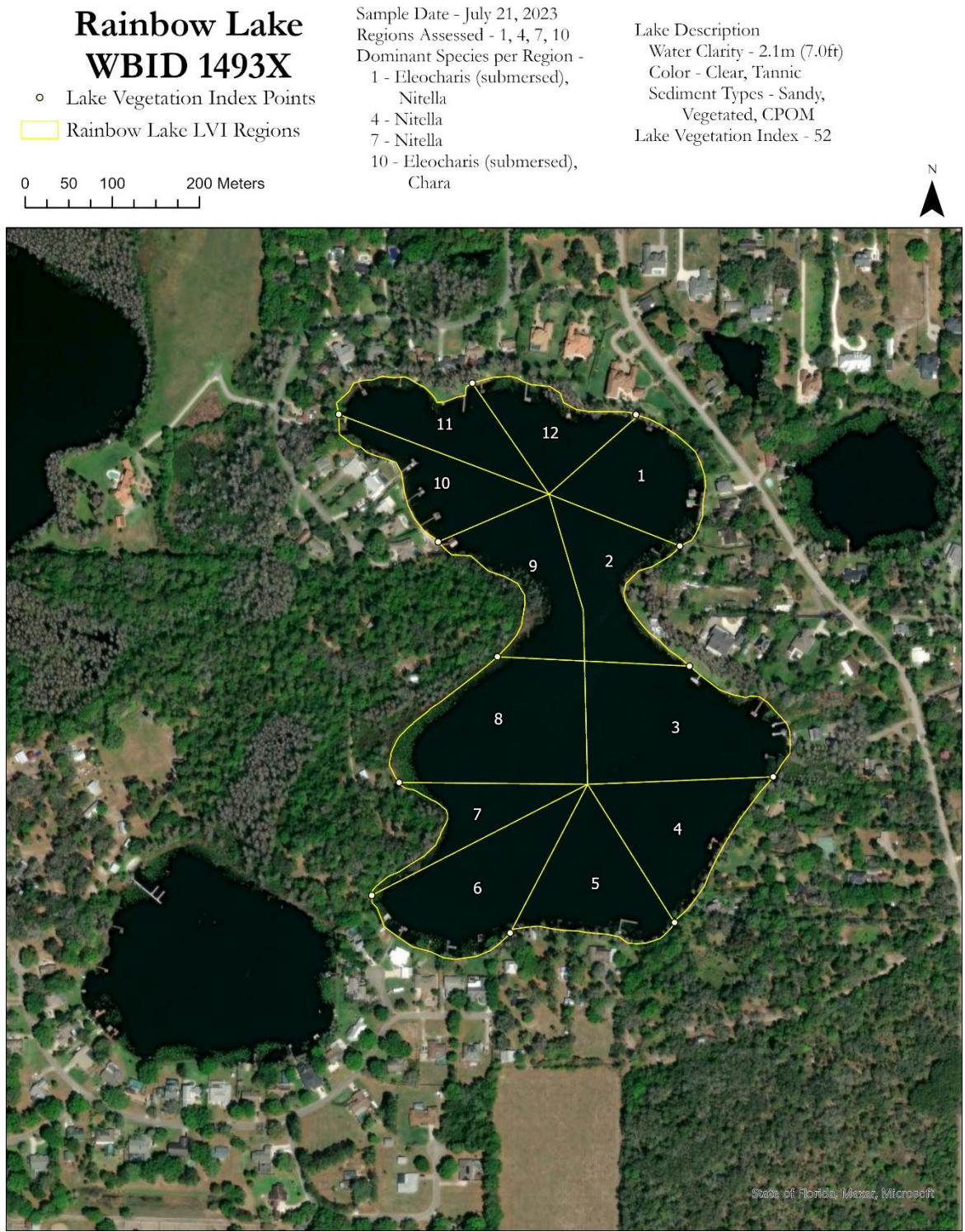
Figure 6: Lake Vegetation Index region map for Rainbow Lake

Table 2: Lake Vegetation Index results for Rainbow Lake July 12, 2023. In this table, "p" represents the taxa was present in the region while "c" and "d" denotes the taxa as being co-dominant or dominant in the vegetation region.

Taxon	CofC Score	FLEPPC Status	Wetland Status	Nativity	Region 1	Region 4	Region 7	Region 10	Occurrence
Eleocharis submersed viviparous (species unknown)	3.00	-	OBL	Native	c	p	p	c	4
Nuphar	3.50	-	OBL	Native	p	p	p	p	4
Nymphaea odorata	5.00	-	OBL	Native	p	p	p	p	4
Panicum repens	0.00	Category 1	FACW	Exotic	p	p	p	p	4
Pontederia cordata	5.38	-	OBL	Native	p	p	p	p	4
Utricularia gibba	6.37	-	OBL	Native	p	p	p	p	4
Cephalanthus occidentalis	5.00	-	OBL	Native	p	p	p	-	3
Chara	3.90	-	OBL	Native	p	-	p	c	3
Hydrocotyle	2.00	-	FACW	Native	p	p	-	p	3
Melaleuca quinquenervia	0.00	Category 1	FAC	Exotic	p	p	p	-	3
Myrica cerifera	2.00	-	FAC	Native	p	p	p	-	3
Nitella	6.00	-	OBL	Native	c	d	d	-	3
Taxodium	7.00	-	OBL	Native	p	p	p	-	3
Typha	1.00	-	OBL	Native	p	p	p	-	3
Vitis rotundifolia	1.18	-	-	Native	p	p	p	-	3
Acer rubrum	4.65	-	FACW	Native	-	p	p	-	2
Blechnum serrulatum	5.50	-	FACW	Native	-	p	p	-	2
Boehmeria cylindrica	5.00	-	OBL	Native	p	p	-	-	2
Colocasia esculenta	0.00	Category 1	OBL	Exotic	p	-	p	-	2
Eleocharis baldwinii	2.82	-	OBL	Native	p	-	-	p	2
Ilex cassine	6.00	-	OBL	Native	-	p	p	-	2
Mikania scandens	1.95	-	-	Native	p	p	-	-	2
Nymphoides aquatica	6.09	-	OBL	Native	-	p	-	p	2
Sagittaria lancifolia	3.00	-	OBL	Native	p	p	-	-	2
Salix caroliniana	2.95	-	OBL	Native	p	-	p	-	2
Sphagneticola trilobata	0.00	Category 2	FACW	Exotic	-	p	p	-	2
Alternanthera philoxeroides	0.00	Category 2	OBL	Exotic	-	-	-	p	1
Bacopa caroliniana	4.50	-	OBL	Native	-	-	-	p	1
Ludwigia erecta	2.55	-	OBL	Native	-	-	-	p	1
Najas guadalupensis	5.07	-	OBL	Native	p	-	-	-	1
Panicum hemitomon	5.82	-	OBL	Native	-	p	-	-	1
Sagittaria graminea	5.53	-	OBL	Native	p	-	-	-	1
Sapium sebiferum	0.00	Category 1	FAC	Exotic	p	-	-	-	1
Schinus terebinthifolius	0.00	Category 1	FAC	Exotic	p	-	-	-	1

Table 3: Scoring Summary for the Lake Vegetation Index

LVI Sample Result:				52
Region	**South**			
Metric / Section	**1**	**4**	**7**	**10**
Total # Taxa	25	23	20	13
% Native Taxa	80%	87%	80%	85%
% FLEPPC 1 Taxa	20%	9%	15%	8%
% Sensitive Taxa	4%	4%	5%	0%
Dom Taxa Count	2	1	1	2
CofC Dom Taxa	4.50	6.00	6.00	3.45
Section LVI	42	64	53	48

Water Quality Assessment

Limited long-term water quality data is available for Rainbow Lake. The available data was collected by Lakewatch, Southwest Florida Water Management District, Florida Department of Environmental Protection and Hillsborough County Environmental Services. Table 4 provides a summary of the Physical/Chemical conditions recorded at the middle of the Rainbow Lake during the assessment in 2023.

Table 4: Rainbow Lake Water Quality 7/12/2023 (Field)

Meter Readings:	Depth (M)	Temp (°C)	pH (SU)	D.O (MG/L)	D.O Sat. (%)	Cond. (UMHO/CM)	Salinity (PPT)
Top:	0.2	31.7	7.77	6.67	90.5	146	0.07
Mid-Depth:	1.86	31.4	7.28	6.32	85.4	146	0.07
Bottom:	3.45	31.3	7.02	6.03	81.2	146	0.07

The chemical water quality analysis for Rainbow Lake is shown in Table 5 for the samples taken on 6/13/23 and 7/12/23. Table 6 includes this data in the numeric nutrient criteria framework where possible using the data from this assessment. The long term color data have a geometric mean value of 20 PCU, classifying it as a clear water lake (greater than or equal to 40 PCU). Total Alkalinity period of record geometric mean value is 13.1 mg/L. The NNC thresholds for a clear-soft water lake with insufficient data to calculate NNC (Previous three years with at least 4 samples per year in separate seasons) are 6 µg/L for Chlorophyll-a Corrected for Phaeophytin, 0.01 mg/L for Total Phosphorous and 0.51 mg/L for Total Nitrogen.

Geometric mean Chlorophyll-a corrected values for the past three years cannot be calculated due to insufficient data with 0 samples in 2021 and 2022 and 2 samples in 2023. Two sample geometric mean values was 4.6 µg/L (2023). Total Phosphorous geometric mean for the past three years cannot be calculated due to insufficient data with 2 samples in 2021, 0 samples in 2022 and 2 samples in 2023. The geometric mean value of available data is 0.015 mg/l (2021) and < 0.068 mg/L (2023). Total Nitrogen geometric mean for the past three years cannot be calculated due to insufficient data with 2 samples in 2021, 0 samples in 2022 and 2 samples in 2023. The geometric mean value of available data is 0.694 mg/l (2021) and 0.779 mg/L (2023).

Bacteria testing showed low levels of E. Coli (1.5 colonies/100ml) and Enterococci (4.6 colonies/100ml) below the rules set forth in FDEP 62-302.530 (https://www.flrules.org/gateway/RuleNo.asp?title=SURFACE%20WATER%20QUALITY%20STANDARDS&ID=62-302.500) "Most Probable Number (MPN) or Membrane Filter (MF) counts shall not exceed a monthly average of 200, nor exceed 400 in 10% of the samples, nor exceed 800 on any one day. Monthly averages shall be expressed as geometric means based on a minimum of 10 samples taken over a 30 day period."

Table 5: Rainbow Lake 2023 Hillsborough County Environmental Services Water Quality Results (Laboratory)

Parameter	6/13/2023	7/12/2023	POR Mean Value	Units
Alkalinity	13.0	13.2	13.1	mg/LCaCO3
Color			20	PCU
E Coli	1.0	2.0	1.5	#/100ml
Enterococci	4.1	5.1	7.5	#/100 ml
Chlorophyll a	5.4	3.9	3.1	ug/L
Chlorophyll b	2.5	2.5	2.5	ug/L
Chlorophyll c	2.5	2.5	2.5	ug/L
Chlorophyll a Corrected	5.6	4.0	5.2	ug/L
Ammonia	<0.073	<0.073	<0.073	mg/L
Nitrates/Nitrites	< 0.043	< 0.043	< 0.043	mg/L
Kjeldahl Nitrogen	0.823	0.743	0.783	mg/L
Total Nitrogen	0.820	0.740	0.471	mg/L
Total Phosphorus	<0.068	<0.068	0.010	mg/L

Table 6: Numeric Nutrient Criteria Framework

Parameter	Value
Geometric Mean Color (pcu)	20
Number of Samples	81
Geometric Mean Alkalinity (mg/L CACO3)	13.1
Number of Samples	2
Lake Type	Clear - soft

Year (# of Samples)	Geomean Chla Corrected (µg/L)	Chlorophyll a Criteria (µg/L)	Geomean Total Phosphorous (mg/L)	Total Phosphorous Criteria (mg/L)	Geomean Total Nitrogen (mg/L)	Total Nitrogen Criteria (mg/L)
2021 (2)	No data	< 6	0.15	< 0.01	0.694	< 0.51
2022 (0)	No data	< 6	No data	< 0.01	No data	< 0.51
2023 (2)	4.7	< 6	<0.068	< 0.01	0.779	< 0.51

Conclusion

Rainbow Lake is a predominately residential lake in the Coastal Old Tampa Bay Watershed of Hillsborough County, Florida. The results of the assessment of Rainbow Lake is inconclusive based on Chlorophyll-a, Total Nitrogen and Total Phosphorous concentrations according to the FDEP numeric nutrient criteria using a combination of Lakewatch, Southwest Florida Water Management District and Hillsborough County Environmental Services datasets due to insufficient data.

The system does show health in the vegetation communities according to the Lake Vegetation Index with abundant invasive species (7) and an overall LVI score of 52. The assessment also revealed a submerged aquatic vegetation community comprising 5 species occupying 32.69% of the surface area and 1.69% of the volume of Rainbow Lake.