Madrid Engineering Group, Inc.

LAKE HANCOCK DREDGING FEASIBILITY STUDY FINAL REPORT

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Prepared for:

POLK COUNTY NATURAL RESOURCES DIVISION

Prepared by:

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Project No. 4261
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CERTIFICATIONS

Engineering Certification

I hereby certify that I am a registered professional engineer in the state of Florida practicing with Madrid Engineering Group, Inc. under license number EB 0006509 issued by the Florida Department of Business and Professional Regulation and the Board of Professional Engineers. I certify that I, or others under my direct supervision have prepared the geotechnical engineering evaluations, findings, opinions and conclusions represented in this report.

Lake Hancock Dredging Feasibility Study
Final Report
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EXECUTIVE SUMMARY

This study was completed by Madrid Engineering Group, Inc. (MEG) for Polk County Natural Resources Division to provide an updated, engineered plan for dredging sediments from Lake Hancock, a 4,550-acre lake north of Bartow, Florida. The study included a review of previous engineering studies; a field program consisting of thickness determinations and sediment sampling within the lake, and an environmental/geotechnical evaluation of potential sites for use as confined disposal facilities (CDFs); laboratory testing of sediment samples to determine physical and chemical characteristics for dredging and storage purposes; analysis of dredging technologies to determine the most economical/feasible method to dredge; and process engineering to optimize consolidation of the sediments.

It was determined that the lake now has 26.1 million cubic yards of organic sediments, and that the sediments average 15% solids content *in situ* of which 23% is organic, the remainder being inorganic silt and very fine sand. Based on previous volume estimates, it appears that the sediments are accumulating at a relatively high rate. The average water depth is about 2 feet to the top of the sediment, and the average thickness of the sediment is 3.54 feet, but is up to 8 feet thick in places.

Hydraulic dredging is considered the most advantageous method for this lake. A dredging program can be completed in 5- to 7-year period using continuous operation mode, with two dredges operating at 3650 gpm. However, it was determined that the disposal volume requirement would be too high to dredge without the use of polymers, resulting in an inordinate storage requirement. It was determined that the most advantageous processing and storage program involves pumping to a treatment plant, injecting polymer and processing using clarifiers and centrifuges to drive off water from the sediment. This technology can result in a final solids content of about 50%, which reduces the storage capacity requirement to 6.2 million cubic yards. From a physical standpoint, this volume can be stored on the Old Florida Plantation site; however, this property is owned by the Southwest Florida Water Management District. The environmental evaluation of this study found that the positive impacts outweigh the negative impacts.

This program has a considerable expense. The engineering estimate includes three main components: $45 million for dredging, $29 million for chemical processing, and $32 million for the polymer. The total program cost ranges from $107 to $128 million. In order to offset these costs, two alternative approaches have been put forth.

- The first, recommended by Hayes-Bosworth, is the possibility of further drying and then selling the sediment as an organic fertilizer.

- The second alternative method, recommended by MEG and Clean Water Technologies, LLC involves: drawdown and dewatering of the lake to dry the sediments; exposing a 1000-acre area within the lake; removing up to 10 million CY of "hard bottom" for use at the adjacent Polk County Landfill; physical movement of the thickened sediments into the "hole"; and capping the sediments prior to refilling the lake.

Both of these alternatives have the opportunity to greatly offset the costs and deserve further consideration.

1.0 INTRODUCTION

Lake Hancock is a 4550-acre lake in central Polk County, just north of Bartow **(Figure 1)**. It is characterized by poor water quality and an accumulation of sediments. Lake Hancock is an important water body because of its size and its location as a major contributor of flow to the upper Peace River. Most freshwater lakes provide habitat for native flora and fauna; replenish drinking water supplies; store and filter stormwater; provide recreational facilities; and is aesthetically appealing. Lake Hancock's water quality is extremely poor, and contributes to downstream surface water degradation. Although it stores water from several inputs, it does not effectively filter stormwater. Its recreational use is extremely limited due to a poor sports fish population and limited access for boaters, and finally, the lake is not aesthetically pleasing due to very high algal concentration and/or high turbidity when wind churns up the lake sediments. For these reasons, Lake Hancock has been the subject of numerous studies since the 1960's when its problems became of regional interest.

1.1 The Basis for and Objectives of this Study

If the sediments were removed from contact with lake water, it is believed that lake water quality, and subsequently downstream water quality discharged from the lake, would significantly improve. The magnitude of the improvement, however, is the subject of much debate, due to the fact that the lake is nitrogen limited and can fix atmospheric nitrogen regardless of the amount of sediment in the lake. Further, it is difficult to model or predict water quality behavior in the event of sediment removal due to the fact that current conditions in the lake are much worse than other lakes in Florida for which computer models are calibrated. Previous water quality modeling has indicated that water quality would improve by removal of the sediments (ERD, 1999).

However, another issue is the accumulation of sediments, and the consequence of not removing the sediment. The study by Zellars-Williams in 1987 included measurement of the muck thickness, and indicated that the volume of sediments in the lake was 19.6 million CY. If the volume is divided by the lake area, the average thickness of sediments was 2.64 feet. The current study, less than 20 years later, indicates that the volume of sediments in Lake Hancock is 26.1 million CY, which equates to an average thickness of 3.54 feet. If the average thickness measurements are accurate, then the lake has accumulated 0.9 feet of sediment, on average, over an 18-year period. Similar, or increasingly higher deposition rates over time, would result in the lake being covered with sediment in less than 100 years at the current water levels (which are subject to change in the near future).

Improvements in sports fisheries are not anticipated to occur unless at least some of the sediment is removed. Bass need a hard lake bottom for spawning, according to the Florida Fish and Wildlife Conservation Commission, and very loose, flocculent sediment prevents spawning. And finally, the aesthetics and recreational use of the lake are not likely to be improved without removal of sediments, as is the case with numerous other lakes in Florida. Lake Hancock, in its present condition, is an underutilized resource of Polk County.

It is therefore the objective of this study to determine an updated, accurate cost of dredging; the most likely dredging equipment and methodology that would be used in Lake Hancock; the recommended means to process the sediments for settlement, drying, desiccation, and long-term storage; and to determine the time frame for a dredging project.

1.2 Previous Engineering Studies on Lake Hancock

Previous engineering studies have been made on Lake Hancock, and have provided background information that has been germane to this study. A partial listing is included below along with some of the important information:

Zellars-Williams Report (December 1987). This report, also known as the Jacobs Engineering report (Z-W was a division of Jacobs Engineering Group, Inc.), presented the findings of a Lake Hancock restoration study, historical and current information regarding the lake, concerns for the future of the lake, criteria for restoration and water budgets for the lake. Specifically, the water budget took into account all aspects of surface water, meteorological factors, groundwater and was summarized all the data by performing water budget calculations. This report also addressed the issue of water quality for Lake Hancock, both historical and current as well as characterizing the sediments of the lake. The report studied restoration efforts by the following methods: no action; mining for phosphate beneath the lake and reclamation; dredging; drawdown and desiccation of the sediments; and a combination of dredging and drawdown. The recommended method of restoration at that time was dredging of the sediments.

IMC-Agrico Report (December 1999). Twelve years after the Z-W report, this report presented sediment characterization data obtained by IMC-Agrico used to evaluate mining of the phosphate beneath the lake, and in doing so, to remove the in-lake sediment. The mining company decided not to pursue mining of the lake for various environmental and economic reasons, and soon thereafter closed its nearby Clear Springs mine in Bartow, Florida.

Lake Hancock Water and Nutrient Budget and Water Quality Improvement Project – Final Report (ERD, 1999). This report provided an excellent historical summary of Lake Hancock; determined existing (at that time) water quality conditions; estimated seepage rates, hydrologic and hydraulic inputs and outputs; and provided a predictive model for water quality. Based on this model, it was determined that sediment removal is likely to provide the highest improvement to in-lake water quality as compared to other actions.

Lake Hancock Restoration Management Plan (CDM, 2002). This report evaluated various goals and objectives of environmental restoration, determined preliminary costs and benefits associated with various alternatives, and ranked the alternatives based on a weighted scale.

In January 2005, Madrid Engineering Group, Inc. was selected by Polk County Department of Natural Resources to complete an engineering study to assist in determining, to a higher degree of detail than previous studies, the feasibility and recommended methodology of dredging the sediments in Lake Hancock. For this study, Madrid Engineering Group, Inc. (MEG) obtained sediment samples and measured the thickness of sediments at numerous locations within the lake. Using geographic information systems (GIS) technology, the sediment thickness contours were mapped and the current volume of sediment was calculated. Laboratory tests were completed to determine the solids content of various samples, as well as the percent organics and other physical and chemical characteristics of the sediment. These data were used to economically evaluate several potential methods to dredge the lake and treat the sediments, with cost projections made on the most likely or advantageous methods. The results are presented in this report.

Members of URS Corporation (subconsultant), Mr. Robert Hayes (Hayes-Bosworth, Inc.), and Mr. Don Luke, P.E. (independent consultant) assisted Madrid Engineering Group, Inc. in this evaluation.

2.0 DATA COLLECTION

2.1 Measuring Sediment Thickness

A sampling grid layout was determined by MEG personnel and approved by Polk County, based on available resources, using regularly spaced sampling locations. The total number of thickness probe locations was 177, and the total number of sampling locations was 30, with an average of 3 samples obtained at each location (top, middle, bottom of sediment). The approximate spacing of the grid system was 1040 feet on center. **Figure 2** shows the location of the sampling/probing locations.

MEG and URS worked together to check the depth to the top of the sediment in Lake Hancock. URS provided global positioning satellite (GPS) services while MEG provided the watercraft and personnel to measure to the top of the sediment. Each day, MEG and URS determined the water elevation from the Southwest Florida Water Management District's water elevation gage and entered that data into the handheld GPS unit.

The team went to each desired location, based on a real-time location map on the hand-held GPS unit. Upon arriving at the desired location, to within +/- about 10 feet, MEG personnel dropped anchor to remain at the desired location. To measure to the top of the sediment, MEG utilized a 2-inch diameter by 10-feet long, clear Schedule 40 PVC pipe with an outer beveled edge. The clear pipe was placed vertically into the water and pushed approximately 1-foot into the sediment to create a bottom plug. Before raising the tubing out of the water, a locking cap was applied to the top of the clear tubing to create suction on the water and hold the sediment in the pipe. Once the water column sample was removed from the lake, MEG personnel were able to visually see and measure the depth from the top of the water to the top of the sediment in the clear PVC. Based on trial and error, this method has been determined to provide the best measurement of the depth of sediments in shallow lakes. The measurements to the top of the sediment was read aloud by MEG personnel and recorded by URS personnel in a field book and entered into the GPS unit at the desired location. **Figure 3** shows the elevation of the top of sediment as determined by this method.

Upon completion of determining the depth to the top of the sediment, MEG used a 1-inch diameter Schedule 80 PVC probe rod to determine the total depth from the water surface to the hard bottom of the lake. When the probe encountered the hard bottom of the lake, MEG personnel read aloud the total length of probe below the water surface, to the nearest inch, and the depth was recorded by URS personnel in a field book and entered into the GPS unit. The total thickness of the sediment at each location was then calculated by subtracting the depth to the top of the sediment from the total depth to hard bottom at each desired location. The hard bottom contour map is shown on **Figure 4**.

The information was downloaded into a computer with ArcGIS software by ESRI, Inc. and processed to provide the elevation contours shown on the figures. In addition, the program was able to calculate the thickness of the sediment at each location, and to provide thickness contours as shown in **Figure 5**. Finally, the volume of the sediment was calculated using this technique, and hand checked to using two methods to assure accuracy of the results that are presented below.

2.2 Sediment Sampling Procedure

Having previously determined the thickness of the sediment, MEG personnel could determine the appropriate depth(s) at which to obtain sediment samples. MEG and URS worked together to sample the sediment in Lake Hancock. URS provided global positioning satellite (GPS) services while MEG provided the watercraft and personnel to obtain sediment samples. Sediment samples were removed from the lake and placed in sealed plastic containers and returned to MEG's geotechnical laboratory for further classification and laboratory testing characterization.

Upon arriving at a desired location, MEG personnel dropped anchor to hold the position. After completing the determination of the depth from the water surface to the top of sediment, and the depth to the hard bottom of the lake, MEG personnel obtained sediment samples from the top, middle and bottom of the sediment where possible. Due to the top of the sediment being in a very loose, semi-suspended state, MEG personnel sampled approximately 6 inches below the extreme top of the sediment to prevent the sample from becoming diluted from excess lake water. Similarly, while sampling the bottom of the sediment MEG personnel used extreme caution to stay above the hard bottom to avoid contaminating the sediment with additional sand from the bottom of the lake. The middle sample was obtained from the approximate midpoint of the sediment deposit at a particular location.

The initial sediment sampling took place over a one-week period and was completed using a 1.25 inside diameter by 1-foot long piston tube sampler attached to 5-foot rods, with additional rods added as needed depending on the total depth. The piston tube sampler was placed into the water and allowed to slowly drop until the top of the sampler tube encountered the top of the sediments. The sampler was then pushed 6 inches beyond the extreme top of the sediment and a sample then collected by activating the piston. The sampler device was then lifted from the sediment brought up to the watercraft deck, and the piston action was then reversed, ejecting the sediment sample into the plastic jars. This methodology was repeated for samples collected at the middle and bottom of the sediment, and repeated again at each sampling location.

After the initial sampling program, additional samples were obtained for bulk testing. Samples were obtained using a 3.5-inch diameter piston tube sampler capable of obtaining samples, each over a 3- to 4-foot depth interval. Thus, a larger amount of sediment could be collected with each sample, and the bulk sediments were placed in 5-gallon buckets.

3.0 LABORATORY TESTING PROGRAM

A series of laboratory tests were conducted on selected samples for natural water content (i.e., also solids content), Atterberg Limits determination, column-settling rates, percent passing the No. 200 mesh sieve, organic content, and water quality. The laboratory-testing program was used to further characterize the sediment samples in addition to visual classification in the field. Laboratory test results are included in **Appendix 1**. Individual testing procedures are presented below.

3.1 Atterberg Limits Determination (ASTM) D-4318.

Atterberg Limits testing was performed on a selected sample obtained from the sediment layer in Lake Hancock for determining if the sediments exhibit any plasticity properties that may be problematic in determining an applicable sediment removal plan. Tests were run in accordance with the American Society for Testing of Materials standard method.

- The test results for plasticity indicate the sediment samples obtained from Lake Hancock are non-plastic.

3.2 Minus No. 200 Sieve Analysis (ASTM D1140)

A number of minus No. 200 sieve tests were performed on select samples including some on the extreme top and bottom in addition to the ideal top and bottom sediments. The minus No. 200 sieve analysis was performed to further characterize the sediments obtained from Lake Hancock.

- The test results for lab tests conducted on samples including the extreme tops and bottoms have a percent passing the No. 200 sieve ranging from 1.4 to 78 percent for the top, 3.7 to 41.9 percent for the middle, and 10.0 to 69.3 percent for the bottom.

- The test results for lab tests conducted on samples including ideal tops and bottoms have a percent passing the No. 200 sieve ranging from 3.2 to 38.5 percent for the top and 7.5 to 63.2 percent for the bottom.

3.3 Organic Content (ASTM D2974)

A number of organic content tests were performed on select samples as part of the laboratory-testing program. The organic content analysis was performed to further characterize the sediments obtained from Lake Hancock.

- In general, the average organic content was 23 percent and ranged from 2.2 to 44 percent.

3.4 Sediment Chemistry Analysis (NELAC and EPA Test Methods)

General chemistry and metals testing was performed on select sediment samples as part of the laboratory-testing program. The testing was performed by Jupiter Environmental Laboratories, Inc. (JEL) to determine if there are any potentially contaminating leachates and/or nutrients that would be returned to Lake Hancock as a part of the remediation program. Specifically, JEL performed tests to determine Total Nitrogen, Total Phosphorus and OrthoP, and eight RCRA metals on samples prepared by the Toxicity Characteristic Leaching Procedure (TCLP). The testing was completed in accordance with the most current NELAC standards available. Nitrogen and phosphorus were tested by Method SW-846 9056. The TCLP was completed on a metals suite consisting of chromium, arsenic, selenium, silver, cadmium, barium, mercury, and lead. The results of the analytical testing are included in **Appendix B**.

In general, of the eight RCRA metals tested for all composite sediment samples collected, only Barium (Ba) was measured above the detection level. However, the detected concentration of Ba is well below the maximum contamination level and does not present a problem. All other constituents were below detectible levels.

4.0 SEDIMENT CHARACTERISTICS

4.1 In-Lake Sediment Characteristics

The lake sediments can be summarized as follows: sediments are typical black to dark brown, organic muck lake bottom sediments. They are loose at the top, and increase in thickness with depth. There is an increasing content of very fine sand with depth. The sediments have almost no shell content, but traces were found. The sediments were high in nitrogen and phosphorus. Based on laboratory testing, metals will not leach upon dredging.

Volume = 26 million cubic yards
Average thickness of sediment = 3.8 feet
Area of Lake = 4550 acres

Average solids content (top 6 inches) = 7%
Average solids content (from 6 inches to 12 inches) = 10.1%
Average solids content (middle 2 feet) = 16 %
Average solids content (6 inches to 1 ft up from bottom) = 17.3%
Average solids content (bottom 6 inches) = 42% (includes sand lenses)

Overall Average Solids Content = 15%
Plasticity = non-plastic
Average Organic Content = 23%

Based on the above and physical observations of the sediment, the material is in fact the consistency of pudding, having extremely low strength. The solids content indicates that the very top 6 inches is thinner and runny, while the remainder is thicker. The higher solids content at the bottom of the sediments is due at least in part to a higher sand content from trapped very fine sand that has settled through the more flocculent sediment above, but the majority of the sediment is organic silt with little to no strength. From that standpoint, the sediments are relatively uniform and in our opinion, partial dredging does not appear to be a viable option.

Hard sand and stiff clays and clayey sand underlie the sediments.

4.2 Sediment Settling and Consolidation Testing and Evaluation

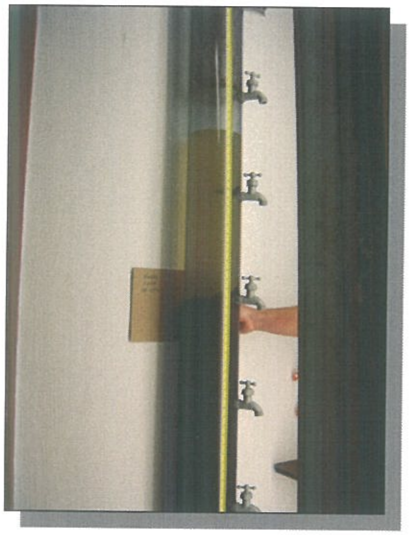
Bulk sediment samples were collected from the lake at mid-depth of the sediments, at locations shown on **Figure 6**. The samples were recovered using a 6-inch diameter piston tube sampler to provide a representative sample of a dredge effluent. Because of the low percentage of total solids by weight in the sediments (6%- 20%), the piston tube sampler provided the best method of capture. The collected sediment samples were placed in sealed 5-gallon buckets and transported to Madrid Engineering Group's (MEG's), geotechnical laboratory in Bartow for temporary storage prior to testing.

To evaluate the sediment settling and de-watering properties, two testing procedures were performed: 1) modified large diameter column settling test and 2) hanging bag tests. The large diameter column test was performed to evaluate the rate at which solids would settle in an upland confined disposal facility under quiescent conditions. The hanging bag tests were performed to determine the feasibility of utilizing geotubes as an alternative dewatering and upland disposal option.

4.3 Large Diameter Column Test

For bench scale testing purposes, a modified version of the large diameter column testing procedures, as described in the United States Army Corps of Engineers (USACOE), Engineering Manual for Confined Disposal of Dredge Material (EM 1110-2-5027), was performed to evaluate the self weight consolidation properties of these sediments. The testing procedure was modified to incorporate use of a 6-diameter column versus an 8-diameter column.

To create a representative dredge effluent slurry, lake sediments, previously collected and sealed in 5-gallon buckets were placed in a 55-gallon drum and mixed with lake water to dilute the sediments to a 5% solids mixture (as measured on a weight basis). The 5% solid mixture was determined to be the most representative mixture based on similar removal rates of this type of lake sediment using hydraulic dredging methodologies.



The large diameter column-settling test was run using an apparatus similar to the US Army Corps of Engineers test method, using a 6-inch diameter by 10 feet long, clear PVC pipe with sample ports installed at one-foot depth intervals. The sample ports to allowed collection of sediments and water at various time intervals to determine solids content profiles and settling rates. Upon thorough mixing, the sediments were poured into the large diameter column settling tube and the date and time were recorded to document the starting time of the test. The settling test was allowed to run for 11 days in which total thickness readings were recorded in the AM and in the PM on most days. Additionally, supernatant water was collected and tested for Total Suspended Solids and Turbidity. The large diameter column-settling test was conducted to determine the rate at which the sediments would settle if dredging were used as a means of removing the sediments from Lake Hancock.

- The initial average solids content of the 5-gallon bulk samples used in the settling test was 12.2 percent, as collected from the lake.

- MEG personnel diluted the bulk sediment to approximately 5 to 6 percent solids content, to simulate as-dredged solids content.

- After 30 hours elapsed time, a solids content of 4.5 percent was measured at 4 feet from the bottom, 7.0 percent was obtained at 3 feet from the bottom, 7.9 percent was obtained at 2 feet from the bottom and 9.4 percent was obtained at 1 foot from the bottom of the column. The supernatant water sample had the following results: Total Suspended Solids was 75 mg/l and Turbidity was 46.6 NTU.

- After 11 days elapsed time, the solids content in the large diameter settling tube reached 6 percent at 3 feet, 10.0 percent at 2 feet and 10.5 percent at 1 foot above the bottom of the column. The supernatant water had the following results: Total Suspended Solids was 10 mg/l and Turbidity was 7.85 NTU.

4.4 Hanging Bag Tests

To evaluate the feasibility of dewatering and storing a hydraulic dredge effluent in geotubes, hanging bag tests were conducted by placing a mock dredge effluent into a test bag (4-ft by 2-ft) composed of the geotube textile fabric. The tests were conducted outside, behind the MEG geotechnical laboratory in Bartow, Florida.
In a similar fashion to how the mock dredge effluent was created for the large diameter column test, the lake sediment samples (previously collected and sealed in 5-gallon buckets) were diluted to create a mock dredge effluent for the hanging bag tests. Three mock dredge slurries, containing initial solids concentrations of 5%, 2.7% and 1%.

The 5% solids mock dredge slurry was placed directly into a hanging bag with no chemical additions to establish baseline conditions of the sediments in the geotube. As previously discussed, the 5% solids mock dredge effluent slurry was determine to be the most representative solids concentration that would be produce from hydraulic dredging sediments from this lake.

A polymer (T-polymer) was added to both the 2.7% and 1% solids mixture to better understand the effects and volume of T-polymer that would be required. An outline of the three hanging bag tests performed is summarized below.

4.5 Percent Solids Prior to Test

Hanging Bag Test #1	5% solids dredge effluent with no polymers added.
Hanging Bag Test #2	1% solids dredge effluent with 1-pound/T-polymer.
Hanging Bag Test #3	2.7% solids dredge effluent with 4-pounds/T-Polymer (actual solids content was intended to 5%, but due to field mixing conditions, more water was added and the mock effluent was diluted to 2.7% which resulted in more polymer being added during the test then originally intended).

Each test was conducted by placing the mock dredge effluent into a hanging bag and measuring the volume of water discharged from the bag over time. Test results indicated that the 5% solids mock dredge effluent mixture with no polymer addition appeared clogged after 37-minutes and discharged only 8.6% of water by volume (approximately 2-gallons) after 61 minutes. Test results from the two mock dredge effluent samples in which a polymer was added to the mixture prior to placement in the hanging bag, showed significantly more aggressive dewatering. The 2.7% solids mixture discharged 78.5% of water by volume after 120 minutes and the 1% solids mixture discharged 88.5% of water by volume after 159 minutes.

Sediment samples were subsequently taken from each of the hanging bags after 24 hours to determine the percent solids by weight. The sediment samples were collected by cutting the side of the bag open and reaching in with a sediment-sampling spoon. Test results are summarized below. Test results are provided in **Appendix B**.

4.6 Percent Solids - 24 Hours After Test

Hanging Bag Test #1 Consolidated from 5% to 9.9 % solids.

Hanging Bag Test #2 Consolidated from 1% to 20.9 %.

Hanging Bag Test #3 Consolidated from 2.7% to 22.1%.

The sediments samples at 20.9% and 22.1% solids (Bag #2 and Bag #3 respectively), appeared remarkably dense after a short time of dewatering and would be suitable for use below a sand cap. Use of these test results for conceptual design of a Confined Disposal Facility (CDF) is presented in Section 5.

5.0 DREDGING ALTERNATIVES

This section focuses on the concept on dredging approximately 26 million CY of sediment from Lake Hancock. While dredging operations are classified as either mechanical or hydraulically operated, both methods can be broken down into three basic steps: 1) Sediment Removal, 2) Dewatering, and 3) Disposal. Because each of these steps involves a wide variety of methodologies, dredging can become a very complex, challenging and costly undertaking. For the purposes of this report, the feasibility, practicality and cost reasonableness of dredging was evaluated based on the following assumptions;

- Step 1- Sediments would be removed using hydraulic dredging equipment versus mechanical.

- Step 2 – A confined disposal facility (CDF) or multiple CDFs could be constructed at the Old Florida Plantation (OFP) property; dredged sediments could be placed directly into the CDF(s); sediments would dewater under self-weight consolidation, and effluent water could be directed back to the lake without treatment.

- Step 3 - Upon completion of dredging operations, dredge material could remain on the OFP property in perpetuity.

Mechanical dredging was not considered feasible due to the low percentage of total solids in the sediments and therefore was not evaluated for its cost reasonableness. However an overview of both mechanical and hydraulic dredging approaches is provided below.

5.1 Mechanical Dredging

Mechanical dredging for the removal of sediments involves the physical excavation of sediments by use of equipment similar to the conventional equipment utilized for land excavation. For a project of this magnitude, in which the majority of the sediments contain organic muck with a low percentage of solids by weight (15% on average, i.e., 85% water), a high capacity self closing environmental "clam bucket" would be the most suitable to consider rather than the more conventional "drag-line bucket" type. However, even with an environmental self-closing clam bucket, the biggest problem associated with utilizing mechanical dredge equipment is their ability to effectively pick-up loose, low-solids sediment. Because the upper one-foot zone contains on average 7% total solids by weight, mechanical dredge equipment will have little impact in capturing these sediments and will cause these sediments to stay suspension during the dredging process, thus creating a turbidity problem. A possible solution to this problem would be to implement dewatering of the sediments first by lake drawdown to increase the solids content of the sediments prior to mechanical dredging and/or hydraulic dredging, at an additional expense.

In addition, the following other more standard limitations that apply to the conventional mechanical dredge equipment, including use of the self closing environmental clam bucket will also be a limitation in utilization this type of methodology for the removal of the organic muck sediments from Lake Hancock.

- Relatively low production rates,
- Re-suspension problems from the downward pressure wave from the descending bucket,
- Washing of sediments from external surfaces as the bucket is raised through the water column, etc.
- Over-dredging form "craters" left on the bottom from bucket,
- Need to transport the dredge material to an upland disposal area. Shallow areas in lake would restrict use of barges for transportation and would require use of a hydraulic slurry hopper and pipeline.

Based on these inherent limitations, mechanical dredging is not considered a feasible option for the removal of the nutrient rich organic muck sediments from Lake Hancock.

5.2 Hydraulic Dredging

Hydraulic dredging involves the physical removal of sediments by pumping. While there are several types of hydraulic dredge equipment available, all involve the basic principal of removing sediments by pumping a sediment-water mixture (dredge slurry) through a pipeline to a designated area for subsequent storage, dewatering and final placement and/or disposal. For Lake Hancock, this option would require the handling of an enormous volume of water, regardless of the specific type of cutter head and/or specialty hydraulic dredge equipment utilized.

Because of the low percentage range of in-situ solids in the sediments (15% average solids content, but including just 7% average solids content in the top 0.5 foot), it is anticipated that hydraulic dredging would produce an overall average dredge-slurry containing 5% total solids by weight. Based on 5%-solids dredge slurry, the total volume that would be generated from hydraulically dredging 26-million CY of sediments would exceed 16 billion gallons.

In addition to the physical removal of these sediments, this option would also require transportation of the sediments from the point of dredging to a designated upland confined disposal facility (CDF) location, via hydraulic pipeline.

For conceptual planning purposes, hydraulic dredging is considered a more feasible option than mechanical dredging for the removal the sediment from Lake Hancock.

5.3 Dredging Approach

For the purposes of this study, full scale hydraulic dredge operations were considered for the removal of the 26-million CY of nutrient rich organic sediments from Lake Hancock. A major consideration for full and complete removal of the sediments is the low solids content sediment at the top of the profile, which are fluid enough to move around and cover the bottom of the lake again if not removed, and the fact that the entire profile consists of organic sediments as opposed to the bottom sediments being just loose sand that could stay in place if it did not pose long term degradation to the lake. If that were the case, a dredge line, above the hard bottom, could be set and the volume of dredged sediments dredged would be reduced, along with the cost of the project. However, it is MEG's opinion, based on the data gathered in this study, that the entire profile of sediments should be removed in order to provide significant improvement to the lake. For instance, even though the bottom 6 inches of sediment has a significantly higher solids content (42%) than that above, it is still likely too soft to be used as a "hard bottom" for fish habitat in spawning areas. The full-scale dredging approach was evaluated based on the following forecasting assumptions:

5.4 Forecasting Assumptions

- Dredging can be completed within a 5- to 7-year period.
- Hydraulic dredge slurry will contain 5% total solids by weight.
- Dredge operations will be conducted 24 hours a day, 7 days a week with 25 to 28% downtime for maintenance.
- Dredge slurry can be stored long term in an unlined containment areas located on the OFP property.
- Sediments will settle significantly within 24 hours, based on the settling test results, will settle/consolidate to 8% solids within 48 hours and to 10% solids within two weeks, and can be returned to the lake without chemical treatment or directed offsite for alternative use. Based on testing, the supernatant water quality of 46 NTU's will be met at 30 hours (see column test results).

To complete the dredging operation within a 5-year period, two hydraulic dredge units operating at 3,650 gpm/each would be necessary. For an 8-year program, one hydraulic dredge, operating at 5,500 gpm, would be sufficient. While different size dredges would be necessary to accommodate the specific conditions of the lake (low water table areas), it is likely that full scale hydraulic dredges would range in size from 8 to 12 inches intake diameter. For the purposes of evaluating cost and schedule estimates, it is assumed that dredging would be conducted with two 10-inch hydraulic dredges. Estimates were based on the following projected volume quantities.

5.5 Projected Volume Quantities:

• Total Volume of Sediments in Lake	26 million CY
• Percent of Solids in Sediments	15% on average
• Total Volume of Dry Sediments	3.7 million CY
• Total Volume of Water in Sediments	4.8 billion gallons
• Additional Water Picked-up During Dredging	11.4 billion gallons

For this baseline evaluation, it was assumed that water collected in the dredge slurry could be directed back to the lake without chemical treatment of the return water. Using conventional hydraulic dredge equipment, it is assumed that the slurry will contain 5% solids and 95% water. Thus, the total volume of lake water needed to dilute the total solids concentration of the sediments from an average in-situ concentration of 15% to a dredge-slurry containing 5% total solids by weight would be an additional 8.1 billion gallons. The identification of a specific dredge head (dustpan, plain suction, cutter head, SEDCUT, etc.), were not evaluated as part of this feasibility study.

In our opinion, this dredging can be accomplished from a water balance standpoint, due to the large surface area of the lake and the pumping being spread out over several years for the length of the project. A very large quantity of water can be removed from the lake with just a few inches of drop in the elevation. For example, 2 inches on 4550 acres equates to 250 million gallons. Additionally, the sediment will be leaving the lake at 5% solids will consolidate quickly to 10% solids, so at least half of the dredged water will be returned to the lake over the life of the project, not counting water generated by long term consolidation of the sediments.

MEG and URS Corporation evaluated the use of an innovative dredging technology called the SEDCUT, which is a patented dredge head design that reduces the amount of water that can reach the suction pipe, thus increasing the solids content of the dredged sediment. The SEDCUT dredge was tested on Lake Okeechobee as part of the SFWMD Lake Okeechobee Dredge Feasibility Study (2002). Overall, this would improve the efficiency of the dredging operation. Initial production rates of SEDCUT revealed that this dredge-head could remove organic muck sediments at 90% of their in-situ percent solids concentration, or about 13% average solids content. Thus, the additional 8.1 billions gallons of lake water projected to be produced using conventional hydraulic dredges to dilute the dredge slurry to 5% total solids could be essentially eliminated, thus significantly reducing CDF disposal volume required.

5.6 Dredging Cost

Capital equipment investment, operating costs and mobilization and demobilization costs are the key components associated with pricing out dredging operations. But the most complex part of determining the dredging costs is the operating costs. Some of the major cost factors affecting the operating costs are summarized below.

- Fuel costs
- Dredge Crew
- Land Support Crew
- Routine Maintenance and repairs
- Production Rates
- Equipment depreciation

Based on other large scale dredging projects and discussions with dredging contractors regarding this specific project, hydraulic dredging costs are projected to range between $1.80 to $2.50 per CY, with the total project costs ranging between $46.8 million to $65 million. Costs for CDF construction, dewatering and final placement of dredge material are not included in the above rates, which have escalated within the past year due to rising fuel costs, but are discussed below.

6.0 CONFINED DISPOSAL FACILITIES (CDF)

A preliminary site suitability survey was conducted of the properties surrounding and nearby Lake Hancock to determine which properties could be used to store sediments dredged from the lake.

There are at least three possible confined disposal facilities (CDF) to the south and east of Lake Hancock. The Southwest Florida Water Management District (SWFWMD) owns the former Old Florida Plantation (OFP) property. CDF #1 is located on the sand tailings area in the northeast portion of the property. CDF #2 is located in the southeast portion of the parcel. CDF #3 is located on the southwest portion of the parcel. All sediment storage needs have been based on a final consolidated sediment volume of 13,000,000 CY assuming sediment reaching 21% solids. The figure below shows the location of these three possible CDFs. Additionally, the SWFWMD has recently purchased the Coscia property directly to the north of Old Florida Plantation, but the Coscia property was not included in this evaluation of disposal areas. The Coscia property consists largely of former mine pits that would be suitable for below-grade disposal that would likely require extensive dewatering prior to sediment placement.

CDF LOCATIONS

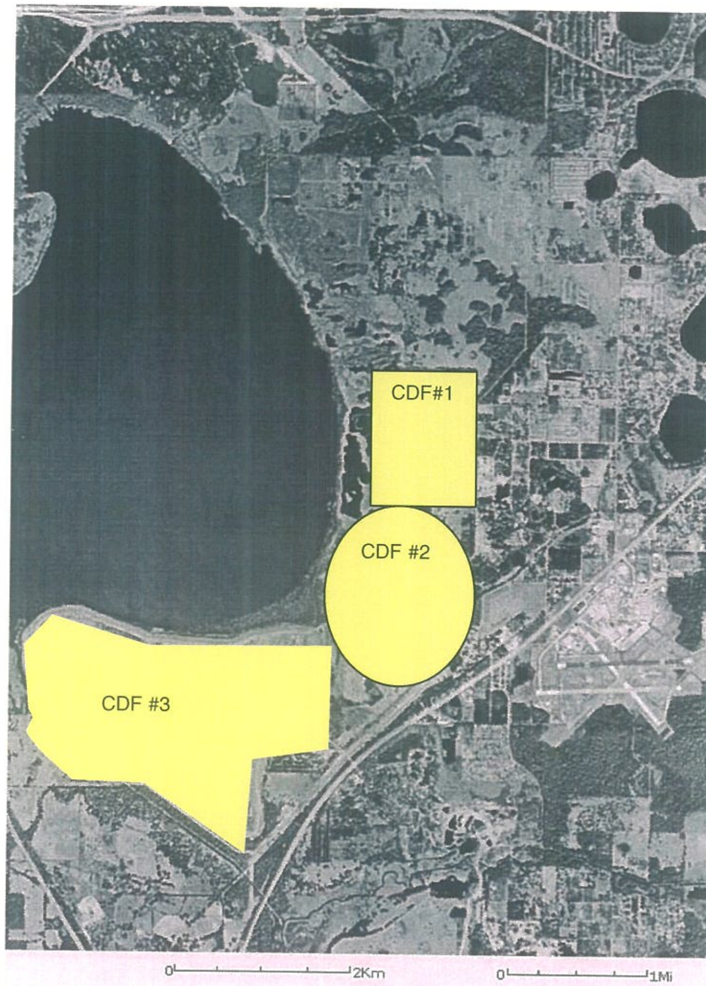


Image courtesy of the U.S. Geological Survey

6.1 Confined Disposal Facility #1

This potential confined disposal facility is located in the northeast portion of the SWFWMD/OFP parcel. This area has a large hill of tailings sand that would be useful to help dewater the dewatered sediment. The water from the pumped sediment would percolate down through the sand and assist in the dewatering of the sediment. The dry sediment could then be sold for topsoil or may have limited use at the Polk County North Central Landfill, located about 5 miles away, for daily cover material.

Since the area is presently a large pile of tailings sand, it does not lend itself to holding sediment in its current condition. Some of the sand could be excavated and used as embankment to provide sediment containment. The storage area is limited, but if the sand bottom does not severely clog, the sediment should dewater considerably faster than in the clay-bottomed settling areas in CDF #3 and allow for the removal of at least some consolidated sediment by mechanical means.

CDF #1 is approximately 5,000,000 ft^2 or 115 acres. For preliminary design purposes, we have assumed a freeboard of 5 feet will be required on any dams, in accordance with state regulations. If a sand tailings dam is pushed up to a height of 10 feet, that would allow 5 feet of storage or 927,000 CY. This would only handle about 4% of the total sediment needed to be stored. If the sand allows rapid dewatering, such that the final solids content is 4 times the as-dredged solids (i.e., 20%), the maximum sediment that could be stored would be 3,700,000 CY or 14% of the total sediment. The CDF #1 would therefore provide limited storage capacity, but would allow shorter pumping distances from the northern reaches of the lake.

According to the BMP for Non-Clay, Phosphate Mining and Reclamation Berms and Impoundments (Florida DEP Bureau of Mine Reclamation), when sand tailings are used for dam materials, the dam is required to have a minimum of a 10:1 hydraulic gradient, measured from the intersection of the high water level on the inside face of the dam to the outer toe elevation. This means that the dam would have to be 10 feet high, with a 25-foot wide top and inside and outside slopes of 2.5:1. This would allow 5 feet of storage and 5 feet of freeboard.

A total of 8,800 linear feet (LF) of dam would need to be constructed at 18.5 CY/LF; therefore 162,800 CY would be needed. We assume $2.80/CY for dam construction cost of $456,000 (using the on-site sand tailings). We assume that additional earthwork (motor grader, compaction, etc.) will be approximately $96,000. An emergency spillway would be needed at a cost of $50,000. The approximate total cost for CDF #1 construction would be $602,000.

6.2 Confined Disposal Facility #2

Confined disposal facility CDF #2 is located on reclaimed overburden and would have low to minimal percolation into the underlying soils. Of the three areas, this is the least optimum to be used for a CDF due to its lack of size, its impact to existing wetlands, the lack of elevation above groundwater, and poor soil permeability for percolation. It is, however, ideally located close to the lake for minimizing pumping distance.

CDF #2 is approximately 13,000,000 ft^2 or 298 acres. If an overburden dam were constructed to a height of 10 feet, this would allow 5 feet of storage or 2,407,000 CY of sediment. This would only handle about 9.1% of the total sediment needed to be stored. A total of 14,400 linear feet of dam would be needed to be constructed at 18.5

CY/LF or 266,400 CY. Based on $2.80/CY to build the dam, the cost would be $746,000. The figure for additional earthwork (motor grader, compaction, etc.) is $157,000. An emergency spillway would be needed for a cost of $50,000. The total approximate cost would be $953,000.

6.3 Confined Disposal Facility #3

This potential confined disposal facility is located on the three previously reclaimed settling areas directly south of Lake Hancock. These settling area were reclaimed in the early 1990's by pushing the existing cast dams in toward the interior of the dam and either capping or displacing the phosphatic clays. Just before the reclamation was initiated, the dams were 10 feet to 30 feet above the clays, so it was evident that none of the dams were totally filled, and that considerable consolidation had occurred in the waste phosphatic clays. The northeast dam was the most filled, with heavier fines forming a hill in the northeast corner. The northwest and the south dams had the least amount of clays pumped into them.

Presently, the phosphatic clays have considerably consolidated, resulting in elevations of the reclaimed dams 5 feet to 10 feet above the interior of the settling areas - we assume herein that the average height of the dams is 7 feet above the clays. The total area inside the settling area dams is approximately 1060 acres. If the sediment is flocculated and dewatered to 22% solids as indicated possible with the hanging bag tests, it has been determined that approximately 17,000,000 cubic yards or 10,500 acre-feet will have to be stored. This can be accomplished on this parcel with an average 10 feet thickness of sediment storage, which will require raising the existing dam crests.

In discussion with Steve Partney, P.E. and Jim Price of the Department of Environmental Protection (DEP), it is their conclusion that the use of these settling areas would not come under the 62-672 Minimum Requirements for Earthen Dams Used in Phosphate Mining and Beneficiation Operations and for Dikes Used in Phosphogypsum Stack System Impoundments since it is not for containing either phosphatic clays or phosphogypsum. It would be regulated under the Best Management Practices for Non-Clay, Phosphate Mining and Reclamation Berms and Impoundments. It is their suggestion that the existing reclaimed dams be bored to determine the soil conditions. It will be necessary to perform SPT's at least every 500 feet to determine the suitability for the soils as dam material. In the event that it is determined that a certain area has unsuitable soils, additional holes may need to be drilled and the unsuitable materials removed during construction of the dam.

The dam should be designed in accordance with the Design of Small Dams by the US Department of Interior. The existing dam need not be removed and rebuilt, but the additional height should be well keyed into the existing dam and the existing dam cleared and grubbed before adding the additional height. A minimum of 3 feet of freeboard must be maintained.

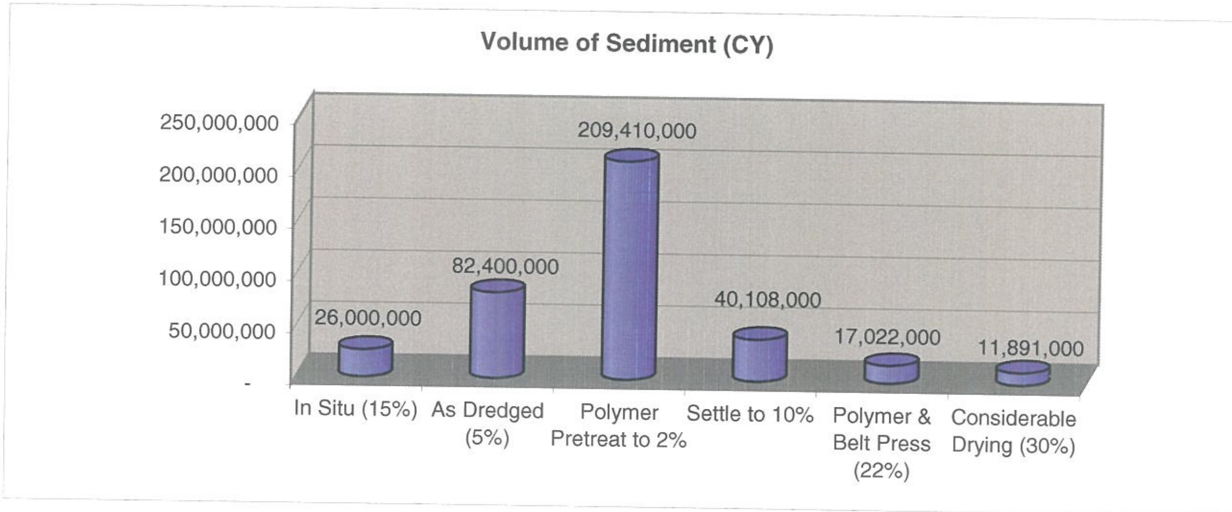
This would require a total of eight (8) feet to be added to the existing reclaimed dam height with the existing material available from the reclaimed dams. This would allow for three (3) feet of additional storage and five (5) feet of freeboard. We assume that the crest of dam will be 25 feet wide, with exterior and interior slopes at 2.5:1. This would necessitate the need for 13.3 cubic yards per foot of the above grade dam to be built. The total length of dam to be constructed would be 32,000 linear feet, so 425,600 CY would be needed for the entire dam. The dam would be built using dozers to push the present dam material and rollers to compact the dam in 6" lifts. Additionally, a key cut should be placed in the existing dam. This key cut would be 12 feet wide and 5 feet deep, compacted in 6" lifts. This would require an additional 71,111 CY to be removed and replaced in compacted lifts.

To determine the approximate costs, it was assumed that embankment material moved by bulldozer from the interior of the dams and would cost just $1.00 per cubic yard. Material moved by scraper would cost $2.80 per cubic yard. The above ground dam would cost approximately $500,000 to build and the "key" would cost approximately $200,000 to build. Additional earthwork (motor grader, compaction, etc.) is estimated to be $293,000. Also, at least one spillway would have to be installed at the cost of approximately $50,000. The spillway would be necessary to not only allow any decanted water from the sediment to flow back into Lake Hancock, but also to provide emergency runoff due to large rainstorms. The total cost estimate for CDF#3 is $1,043,000.

6.4 Conclusions Regarding CDF Construction

6.4.1 Volumetric Requirements

Volumes for various dredging and processing scenarios are presented below in graphical form. If the dredged sediment were to settle to 10% solids without the aid of chemical flocculants, the volume of storage requirement would be approximately 40.1 million CY. We have selected three settling areas, all on the Old Florida Plantation (OFP) property, totaling 1473 acres. If all three were used for the dredged sediments deposited 5 to 10 feet thick, the total storage volume would be 20.4 million CY, or about half of that required if no polymer or other similar flocculent is used to assist volume reduction after dredging. Thus, during the 5 to 8 years of active dredging, about 50 %



additional volume reduction (by consolidation, dewatering, drying, etc.) would have to occur during the dredging program to fit all the sediments into this area. Based on the characteristics of this sediment, this is highly unlikely to occur naturally, therefore handling the sediments with no physical or chemical processes other than natural dewatering appears to be unfeasible, unless considerably larger CDFs within OFP are used, or the dams are designed tall enough for 60% additional capacity above that described herein. For example, to store 40.1 million cubic yards of sediment at 10% solids on all 3500 acres of the OFP property, the average sediment thickness would be over 7 feet. This would increase the CDF construction price considerably.

6.4.2 Cost Effectiveness

Using the analysis, dimensions, and dam heights described above, the most cost efficient CDF to construct is CDF #3. The approximate costs to store the sediment are as follows:

CDF No.	Area (ac)	Sediment Thickness (ft)	Storage Volume (CY)	Cost ($) per MM CY Sediment
CDF #1	115	5.3	0.927 MM to 3.7 MM	$163,000 (a)
CDF #2	298	5	2,407,000	$397,000
CDF #3	1060	10	17,101,000	$61,000

Note (a) – assumes that the tailings sand allows additional consolidation of sediments.

Additional aspects to consider include 1) the cost to pump the sediment the additional distance to the south of the lake versus building a small settling area at the CDF #1 location, and 2) the possibility of recovering a portion of the sediment to sell as a mixture of sand and organics (topsoil).

7.0 DREDGE PROCESSING OPTIONS

Madrid Engineering Group, Inc. hired a local chemical engineer familiar with the Lake Hancock challenge, Mr. Bob Hayes (Hayes-Bosworth, Inc., Lakeland, Florida), to provide preliminary analysis and design for processing sediments using polymers and other process train options for separation and treatment of the materials, including centrifuges and belt presses. Mr. Hayes' analyses consisted of material balance, system analysis, process layout, and cost analysis (capital cost, operating cost, administration) for several Process Alternatives. Process diagrams for Mr. Hayes' analyses, as discussed below, are included as **Appendix C**. A summary of his findings is as follows:

Alternative I – OFP Dispersal – Treatment of the sediments with chemical flocculants and disposal on the OFP property. Hayes determined that flocculated sediments could reach 10 % solids, which would result in a required storage volume of 40 million CY. However, based on flocculent testing completed by Madrid Engineering Group on these sediments (as reported in Section 4.4), chemical flocculation should reach 15 to 20 percent solids within a few days time, and higher solids over time due to air drying and consolidation. If 22 percent solids could be reached over time, the required storage volume would be 17.0 million CY, which would fit into CDF #3 (Section 6 above).

Alternative II – Low Gravity LoG Dewatering – Treatment of sediments with polymer, with additional dewatering by belt press (i.e., low-gravity device), and disposal on OFP or off-site. Hayes estimates that with belt press, the sediments could reach 20% solids, which would result in a storage volume requirement of approximately 19 million CY. Using the same assumptions above, we believe that Hayes' estimate is conservative, and that at least 25% solids could be reached, resulting in a volume requirement of 14.7 million CY.

Alternative III – High-Gravity (HiG) Dewatering – Treatment of sediments with polymer, and additional dewatering using high gravity centrifuges to either reduce offsite trucking cost or OFP dispersal disposal cost. Hayes estimates that with high gravity centrifuges, the sediments could reach 50% solids, which would result in a storage volume requirement of just 6.2 million CY.

Alternative IV – High-Gravity (HiG) Dewatering plus Drying – This process includes polymer flocculation, dewatering with high gravity centrifuges, and drying the sediments using indirectly heated disk dryers, such that the final product is a saleable, organic fertilizer type product. With additional drying using this process train, the solids content could reach 75%, which is dry enough to bag and sell as a nutrient rich, organic fertilizer product. Mr. Hayes assumed in a cost analysis for Alternative IV that 50% of the sediment would be stored at OFP and 50% could be sold as a bagged fertilizer or soil amendment-type product.

It is important to note that the Hayes report recommends Alternative III, only because Alternative IV could not be substantiated by "hard" numbers by fertilizer companies, and would require a public-private agreement or partnership to accomplish the sale of fertilizer for profit. Alternative III has clear economic advantages over Alternatives I and II, and therefore was the recommended process. However, Hayes recommends that additional attention be given to Alternative IV, as it could substantially offset the costs of dredging or eliminate them altogether.

8.0 ENVIRONMENTAL CONSTRAINTS

8.1 Overview

URS Corporation was contracted by Madrid Engineering Group (MEG) to provide a characterization of the ecological communities within Lake Hancock and a tract of land adjacent to Lake Hancock known as the Old Florida Plantation (See **Figure 7** – Lake Hancock/OFP Location Map). This characterization will be used in assessing the feasibility of dredging Lake Hancock and depositing the removed sediment within Old Florida Plantation. Although the dredge methodology has not yet been selected, any methodology must take into consideration habitat protection, hydrologic impacts and potential presence of threatened and endangered species.

The assessment of the natural communities within the two-project study areas is based principally on March 9 and 15, 2005 site visits by URS staff and review of site-specific information. Information reviewed included:

- United States Geological Survey (USGS), Aerial Photograph (scale, 1" = 400') 2000,
- Florida Natural Areas Inventory (FNAI), Polk County Endangered Species Occurrence Summary (1997),

- Florida Fish and Wildlife Conservation Commission (FFWCC), Eagle Nest Locator website,
- U.S. Department of Agriculture (USDA), Natural Resource Conservation Service (NRCS), Soil Survey of Polk County, Florida (1982);
- Florida Association of Professional Soil Classifiers, "Hydric Soils of Florida Handbook" (Carlisle, 1995),
- U.S. Fish and Wildlife Service (USFWS), "Classification of Wetlands and Deepwater Habitats of the United States", (Cowardin, *et. al.* 1979),
- Florida Department of Transportation. "Florida Land Use, Cover, and Forms Classification System." Third edition (1999) (FLUCFCS),
- Southwest Florida Water Management District's (SWFWMD) Lake Hancock Lake Level Modification report, BCI Engineers and Scientist (January 2005), and
- Old Florida Plantation, LTD., Development of Regional Impact application (August 1, 1996).

The following is a brief description of each of the principle natural communities found in each study area.

8.2 Lake Hancock

Lake Hancock is a 4500-acre lake that serves as the headwaters to the Peace River. It is located within west-central Polk County near the geographic center of peninsular Florida. Lake Hancock receives inflow from three major tributaries: Saddle Creek entering from the north, Lake Lena Run entering from the northeast, and Banana Lake which enters through the Banana Lake Canal on the west side of the lake. The Lake outfalls on the south through Saddle Creek that flows to the Peace River and terminates in Charlotte Harbor. Lake Hancock has an average depth of 3 feet at mean historical water elevation of 98.2, with a muck layer ranging in thickness from 1 to 8 feet.

Currently, the lake is undeveloped with surrounding land use consisting of cattle farms, orange groves, reclaimed mining land, natural areas and a few small residential subdivisions (See **Figure 8**—Existing Land Use Map). The lake's shoreline is mostly comprised of bald cypress (*Taxodium distichum*), sweetbay (*Magnolia virginiana*) and red maple (*Acer rubrum*) dominated forested swamps. Submerged, floating and emergent nuisance species such as cattails (*Typha* sp.) and water hyacinth (*Eichornia crassipes*) occur throughout the lake. (BCI Engineers and Scientists, Inc, January 2005)

8.3 Old Florida Plantation

The Old Florida Plantation (OFP) property comprises approximately 3,347 acres of land located along the southern and eastern portion of Lake Hancock. In the late 1940's through the 1960's, the site was subject to phosphate mining. As a result of reclamation activities, the site now contains approximately 666 acres of wetlands and 2,681 acres of uplands.

The wetlands within OFP are comprised of three vegetative community types: Mixed Wetland Hardwoods (FLUCFCS- 617), Freshwater Marsh (FLUCFCS-641), and Mixed Cypress Hardwoods (FLUCFCS-630). The Mixed Wetland Hardwoods are generally located on the southern portion of the OFP parcel and are dominated by Florida elm (*Ulmus Americana* var. *floridana*), Brazilian pepper (*Schinus terebinthifolia*), laurel oak (*Quercus laurifolia*), red maple, Carolina willow (*Salix caroliniana*) and sweet gum (*Liquidambar styraciflua*). The Freshwater Marsh is located throughout the OFP parcel and is dominated by cattails (*Typha latifolia*), pickerelweed (*Pontedaria cordata*), fireflag (*Thalia geniculata*), rushes (Juncus sp.) and smartweed (*Polygonum punctatum*). The Mixed Cypress Hardwoods are generally located in the central portion of the OFP parcel and are dominated by bald cypress, red maple, Carolina willow, sweetbay (*Magnolia virginiana*), scattered redbay (*Persea borbonia*), and black gum (*Nyssa sylvatica*). See **Figure 8** - Existing Land Use Map for the approximate locations of each habitat type.

The uplands within the OFP are comprised of two dominant vegetative community types: Mixed Hardwoods (FLUCFCS- 438) and Improved pastures (FLUCFCS- 211). The Mixed Hardwoods are generally located in the southern portion of the OFP parcel and are dominated by red mulberry (*Morus rubra*), Florida elm, laurel oak, red maple, and dahoon holly (*Ilex cassine*). The Improved pasture is located throughout the OFP parcel and is dominated by bahia grass (*Paspalum notatum*), and cogon grass (*Imperata cylindrica*) with interspersed slash pine (*Pinus elliotti*). This area is currently being used for cattle grazing. The approximate location of each habitat type is shown in **Figure 8** - Existing Land Use Map.

8.4 Protected Species

In-office research and field reviews were conducted to assess potential occurrence of State and Federally listed protected species within both Lake Hancock and the OFP parcel. The results of that research revealed both parcels contained highly diverse fauna including one of Central Florida's largest wading bird rookeries and a large American alligator population.

The FFWCC element occurrence database provides data on element occurrences of rare species and natural occurrences in Florida. Review of the database indicate that there are several element occurrences mapped within the vicinity of the two project study areas, including bald eagle, little blue heron, tricolored heron (*Egretta tricolor*), woodstork, white ibis (*Eudocimus albus*), osprey and snowy egret. See **Figure 9** - Documented and Observed Occurrences of Wildlife Species Map for the locations of these occurrences.

Review of the FFWCC eagle nest locator website indicated that two bald eagle nests are located within one-mile of the project site (See **Figure 9** - Documented and Observed Occurrences Wildlife Species Map).

The wood stork is listed as an endangered species on both FFWCC and USFWS. The woodstork is known to utilize an 18.6-mile radius area as a primary foraging area. Review of the FFWCC wood stork rookery map indicated that there are four woodstork rookeries within 18.6 miles of the project study area (See **Figure 10** - Wood Stork Rookery Location Map).

Within the boundary of Lake Hancock, the American alligator (*Alligator mississippiensis*), the little blue heron (*Egretta caerulea*), snowy egret (*Egretta thula*), southern bald eagle (*Haliaeetus leucocephalus*), roseate spoonbill (*Ajaia ajaja*), wood stork (*Mycteria americana*), and osprey (*Pandion haliaetus*) were observed during the March 15 and 19, 2005 field reviews.

Within the OFP parcel, the American alligator (*Alligator mississippiensis*), adult and juvenile southern bald eagle (*Haliaeetus leucocephalus*), wood stork (*Mycteria americana*), osprey (*Pandion haliaetus*), and a Sherman's fox squirrel (*Sciurus niger shermani*) were observed during the March 19, 2005 field review.

8.5 Potential Permit Requirements

From review of the project study area, the following list of issues will need to be addressed during the design and permitting phase of the project.

- Water quality impacts resulting from the proposed dredge project,
- Water quantity impacts resulting from dredged material return water going back to the lake and the placement of dredge material within the Old Florida Plantation property and,
- Potential impacts to wetlands resulting from the dredge activities and placement of dredged material.

As a result of these issues, permits and/or approvals may be required from various state and federal regulatory agencies. The permits and approvals required may include:

• 404 Dredge and Fill Permit	US Army Corp of Engineers (ACOE)
• Environmental Resource Permit (ERP)	Southwest Florida Water Management District (SWFWMD)
• National Pollutant Discharge Elimination Systems (NPDES)	Florida Department of Environmental Protection (FDEP)

SWFWMD requires an Environmental Resource Permit (ERP) when construction of a project results in creation of a new or modification to an existing, surface water management system or if the construction of the project results in impacts to waters of the state or isolated wetlands. In addition, the ACOE requires a 404 dredge and fill permit if a project results in impacts to waters of the United States.

A National Pollution Discharge Elimination System (NPDES) permit is required for the discharge of storm water from construction activities that will result in the clearing of one or more acres of land. The NPDES permit requires development of a Storm Water Pollution Prevention Plan (SWPPP). The SWPPP identifies potential sources of pollution that may reasonably be expected to affect the quality of storm water discharges from the site and outlines methods to minimize impacts to the quality of storm water discharging from a project site.

The USFWS and FFWCC regulate activities that may adversely affect Federal and state protected animal species respectively. The Florida Department of Agriculture and Consumer Services (FDA) regulate protected plant species. Prior to construction, coordination with the Federal and state agencies will determine if consultation pursuant to Section 7 of the Federal Endangered Species Act and Chapter 372 of the State Endangered Species Act will be required for protected species that may occur within or adjacent to a proposed construction and/or disposal area.

9.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the findings of this study, dredging Lake Hancock is technically feasible, but costly. The estimated cost range for dredging, processing and disposing of 26 million CY of sediment are as follows:

ITEM	COST/CY	TOTAL COST ($ MILLION)
Hydraulic Dredging	$1.75 – 2.50	$45.5 - 65.0
Physical/Chemical Processing	$1.13	$29.3
Polymer Materials Supplied	$1.26	$32.8
Disposal Area #3 Construction	$0.04	$1.0
Total	**$4.18 – 4.93**	**$108.6 – 130.0**

The above estimates assume that the sediment is dredged. hydraulically at or near current prices in central Florida for similar types of dredging projects. It further assumes that chemical flocculation will be required to treat the sediments in accordance with the Hayes Alternative III High-Gravity Dewatering program, which involves clarifiers and centrifuges.

Hayes' Alternative III is projected to result in dewatered sediments that reach 50% solids content, therefore the volumetric requirement for storage is significantly less than the 17 million CY that CDF #3 will hold. Cost savings on improving and using only a portion of CDF #3, which has three cells, is not a significant cost variance to that shown above. In addition, the material balance indicates that the separation operations will result in 517,000 CY of sand from the process, which can be sold commercially to offset the cost of the operations. This would generate some $2 million in revenue to offset costs, if it is used.

Therefore, the final cost estimate for dredging and disposal ranges from $107 million to $128 million.

The ability to pay for such an endeavor would require considerable cooperation, public awareness, and "buy-in" by interested and affected parties. This plan, for instance, involves the use of clay settling areas within Old Florida Plantation, which is owned by the Southwest Florida Water Management District, and assumes that this project can be done along side other uses they contemplate for this property. Although technically feasible, it may not be feasible from a cost standpoint. Therefore, alternative methods that could offset the cost have been studied by others, and/or are set forth herein, as follows:

9.1 Offset Dredging Cost by Mining Phosphate Ore from Soil Beneath the Sediment

This has been studied on and off for about 20 years. More recently, IMC completed a study in 1999 and concluded that it was not economically feasible to mine the lake, citing difficulties in controlling water quality discharged from the lake during the mining. Since 1999, the Clear Springs Mine, which was the nearest phosphate processing facility, has been closed, necessitating transport of the phosphate ore to another, more distant facility. Furthermore, rail service to transport phosphate ore from the OFP property to nearby currently active phosphate mining facilities was severed in 2003 during an upgrade of SR60 in Bartow, and the cost of trucking approximately 20 miles one way is extremely high, making the cost economically unattractive at current worldwide phosphate prices.

9.2 Offset Dredging Cost by Selling Sandy Soil Beneath the Sediment to the Polk County Landfill

Madrid Engineering Group, Inc. proposes an alternate plan, based on the fact that the Polk County North Central Landfill, located less than 1 mile north of the lake, requires over 10 million CY of fill in the coming years for expansion and operation projects. MEG believes that the soil beneath the sediments in Lake Hancock could be used to supply this need. We propose the following methodology:

- Construct a temporary berm to re-route surface inflows from Lake Lena Run, Saddle Creek, and Banana Creek, to the Peace Creek Canal along the west side of the lake.
- Temporarily dewater the lake naturally as much as possible, then with pumps, using a sump area to collect the water, treat with flocculants, and discharge downstream. Use internal ditches to maintain the water level at or below the "hard bottom" of the lake.
- Scrape sediments away over a 500- to 1000-acre area within the lake, exposing "hard bottom" soils.
- Mechanically excavate and remove hard bottom soils to a depth of 10 to 20 feet below "hard bottom" grade. Truck/transport to the North Central landfill for use as fill materials for future landfill cells and daily cover. Polk County Solid Waste to provide agreement to accept the fill and pay for it at a fixed cost that is advantageous to the County. Cost of fill offsets the cost to bury sediments.
- Place consolidated sediments into the excavated hole for burial.

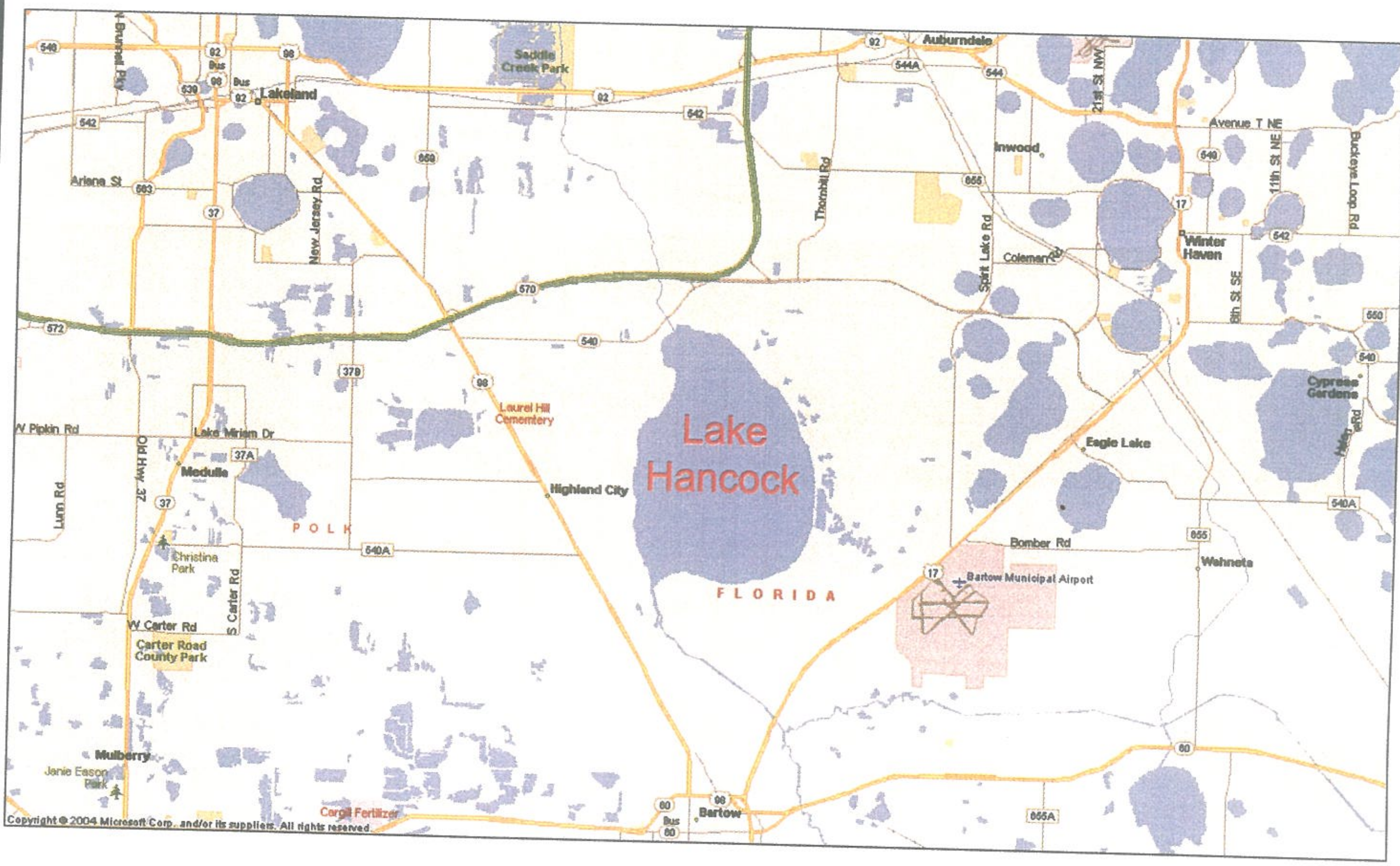
- Re-fill the lake and cover the sediments with several feet of soil from the deconstructed berm. This will entomb the sediments, preventing them from direct contact with the lake, and will cause the sediments to consolidate further under the load of the cover soils.

MEG estimates that the cost of this method is $40- to $50-million dollars, which would be offset by selling the fill materials ($30- to $40-million) to the landfill. The net cost would range from zero (break-even) to $10 million dollars. It is emphasized that the above cost analysis is preliminary. Nonetheless, the overall cost of $40- to 50-million is less than that for dredging, and if successful could be accomplished at no net cost to the County, along with a possible cost savings for fill materials at the landfill. The project would take 24 to 30 months to complete, and would require the sediments to reach an overall solids content of 20 to 23%, which should be feasible since the average in-place solids content is already 15%. Preliminary drying tests indicate that solids contents could reach 22 percent in about 2 months time after exposure of the top of sediment to allow solar/air drying, thereby meeting this technical requirement.

9.3 Offset Dredging and Drying Cost by Processing/Bagging/Selling as Fertilizer

As described in Alternative IV by Hayes-Bosworth, this alternative has the potential to generate enough profit to offset the cost of the project completely. In our opinion, implementation of this option would require a signed agreement with a major fertilizer company that would be willing to take the product for wholesale. If an agreement could be made to process and sell the sediment as a fertilizer product, thereby significantly offsetting or eliminating the cost of sediment removal to the general public, the County should research the conceptual plan.

FIGURES



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EB-0006509

Lake Hancock Sediment Study

FIGURE 1
Site Location Map
Lake Hancock
Polk County, Florida

DATE: October 2005	Revised:	Drawn By: PCF	Checked By: LDM	MEG Project No. 4261	nts

N W E S

0 750 1,500 Feet

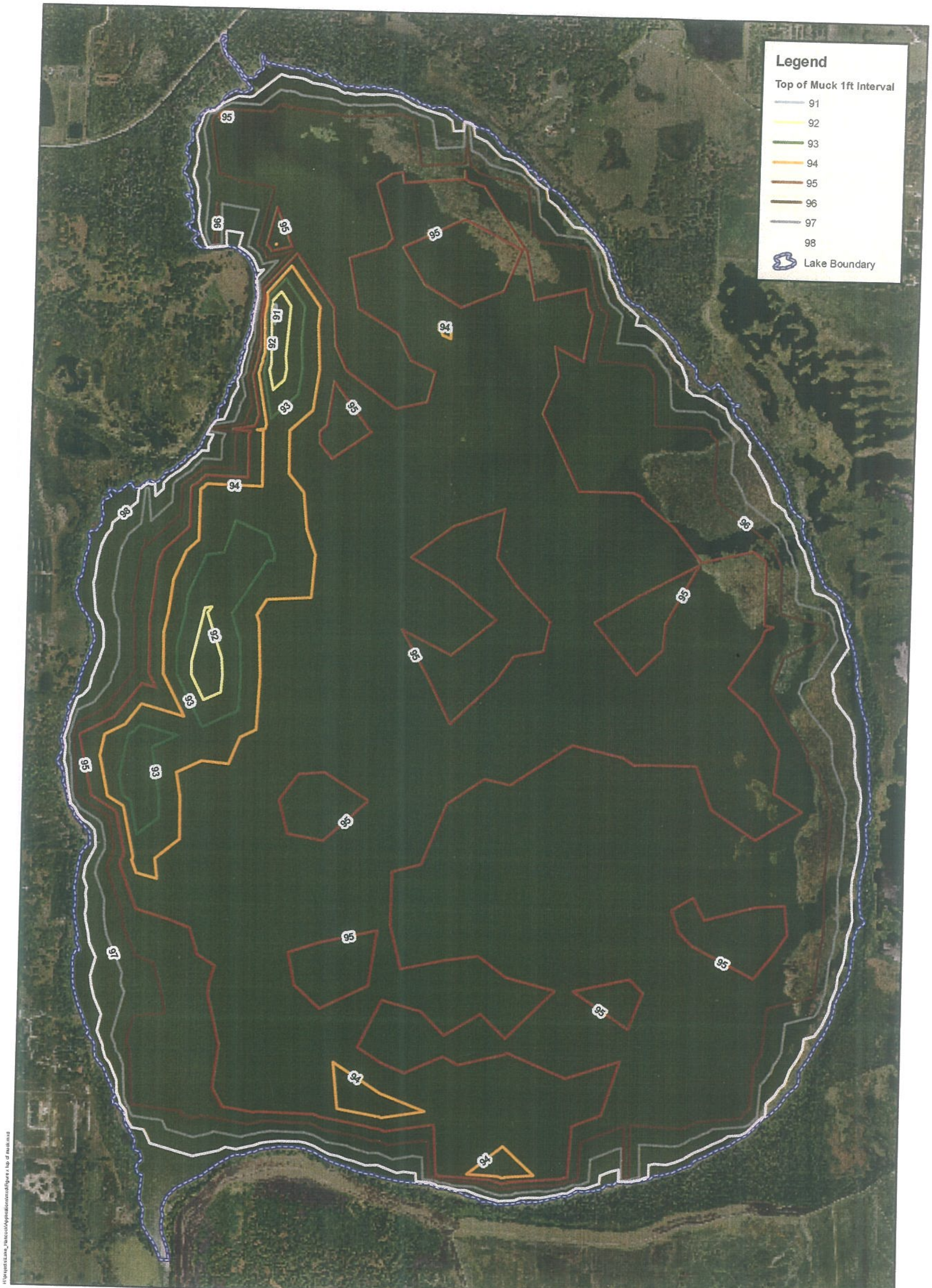
Lake Hancock Sediment Survey

Sampling Grid

MEG

URS

Figure 2



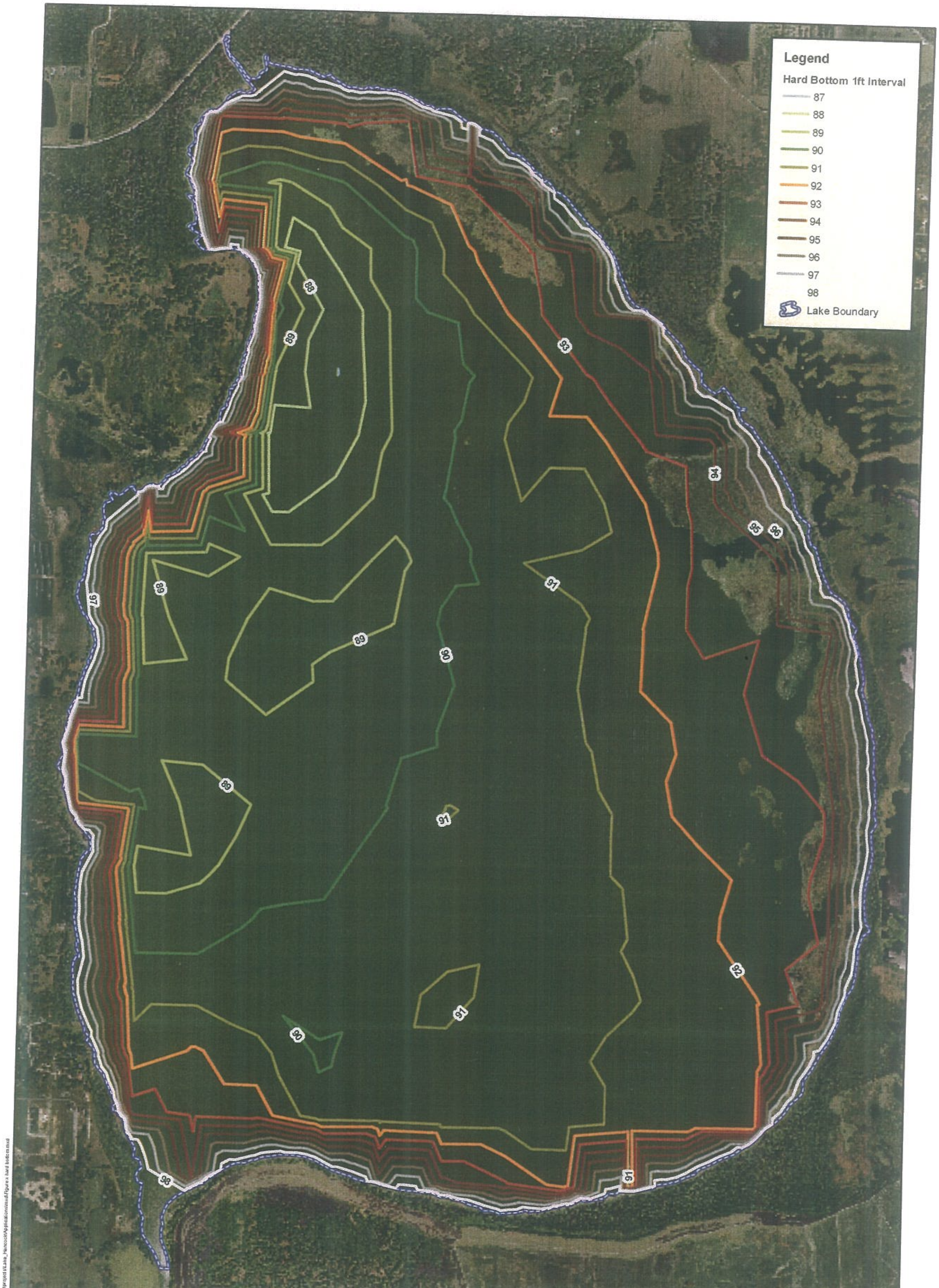
Lake Hancock Sediment Survey

Top of Muck Contour Map 1ft Interval

MEG

URS

Figure 3



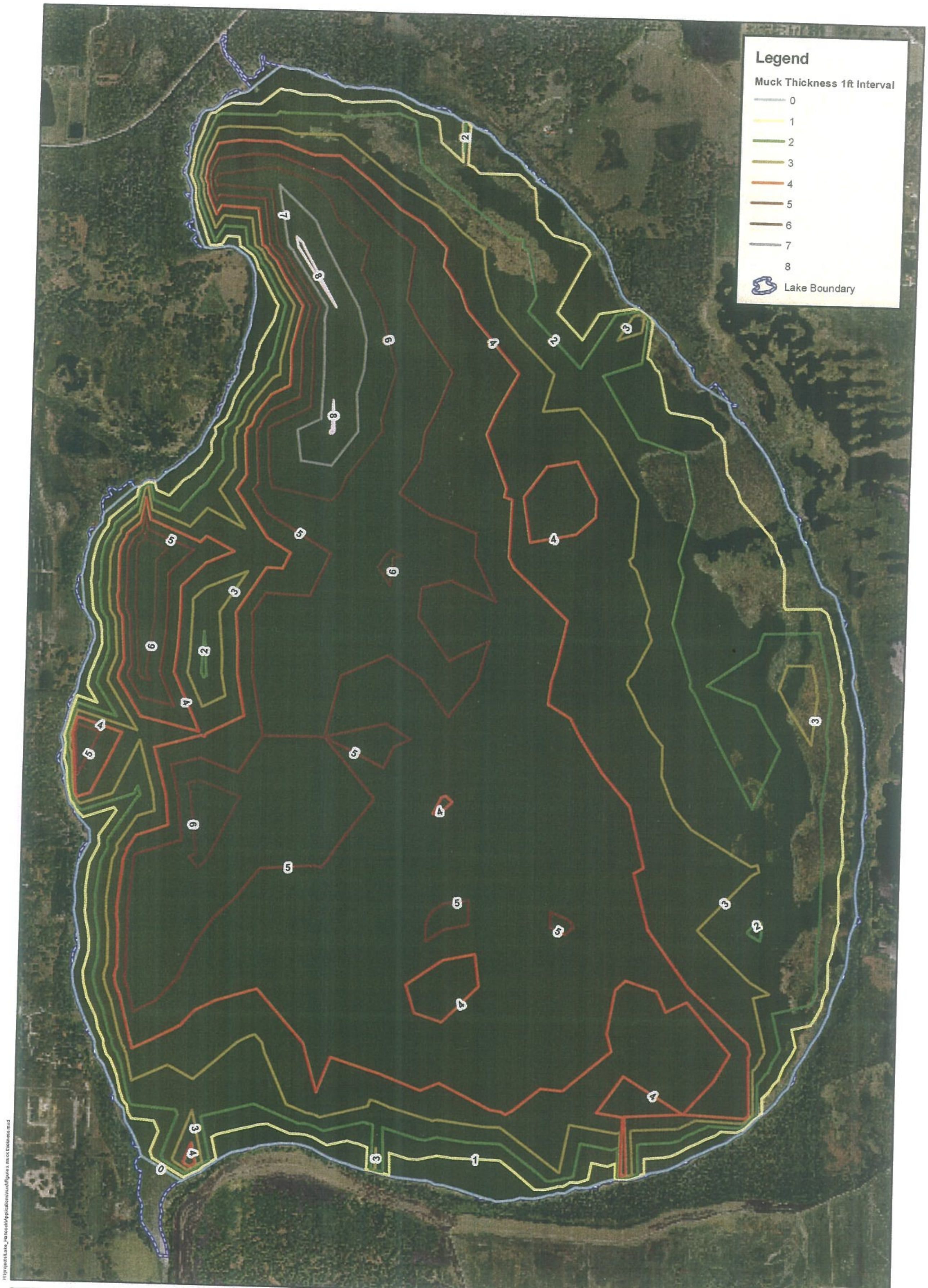
Lake Hancock Sediment Survey

Hard Bottom Contour Map 1ft Interval

MEG

URS

Figure 4



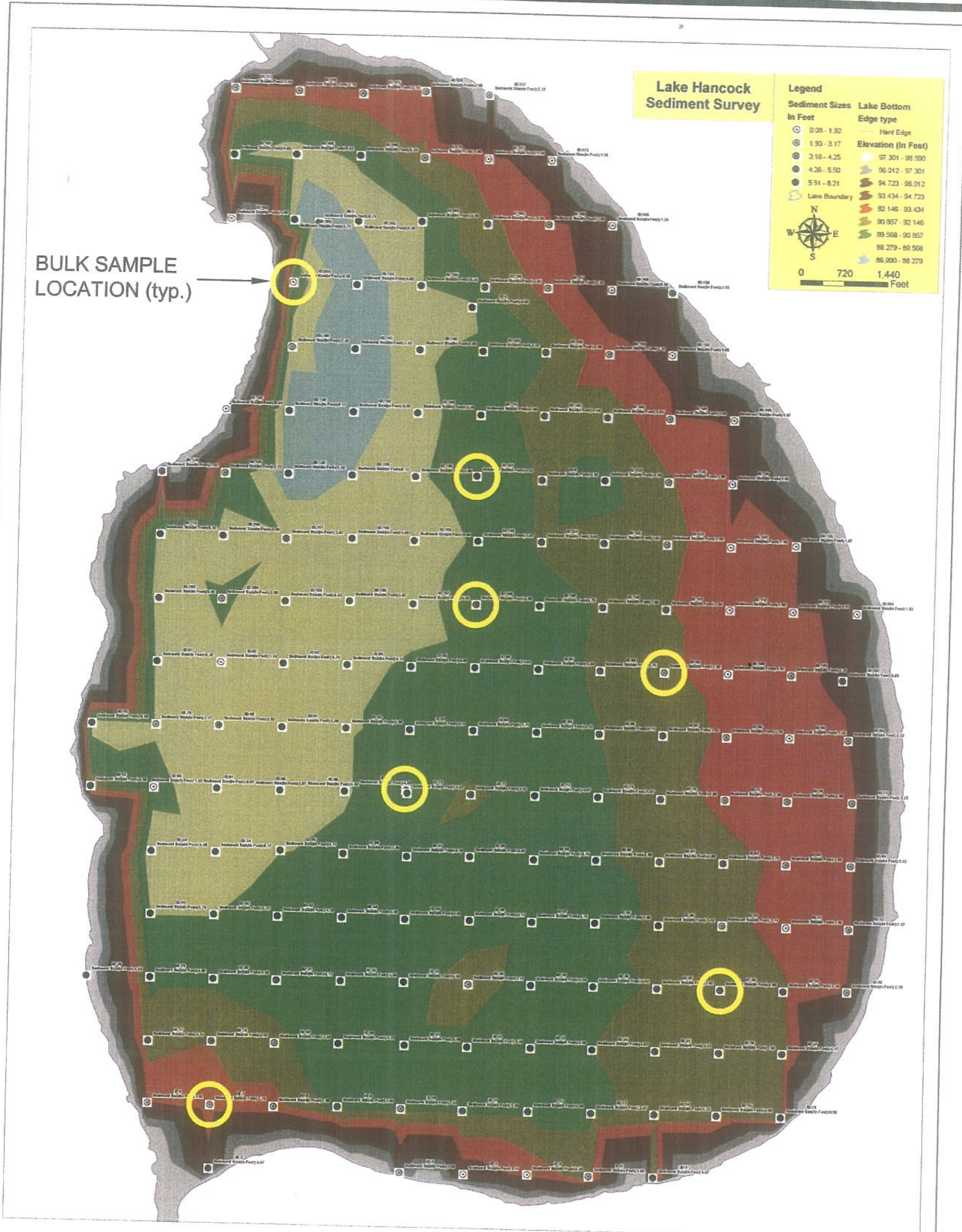
Lake Hancock Sediment Survey

Thickness of Muck Contour Map 1ft Interval

MEG

URS

Figure 5



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Lake Hancock Sediment Study

FIGURE 6
Bulk Sample Locations
Lake Hancock
Polk County, Florida

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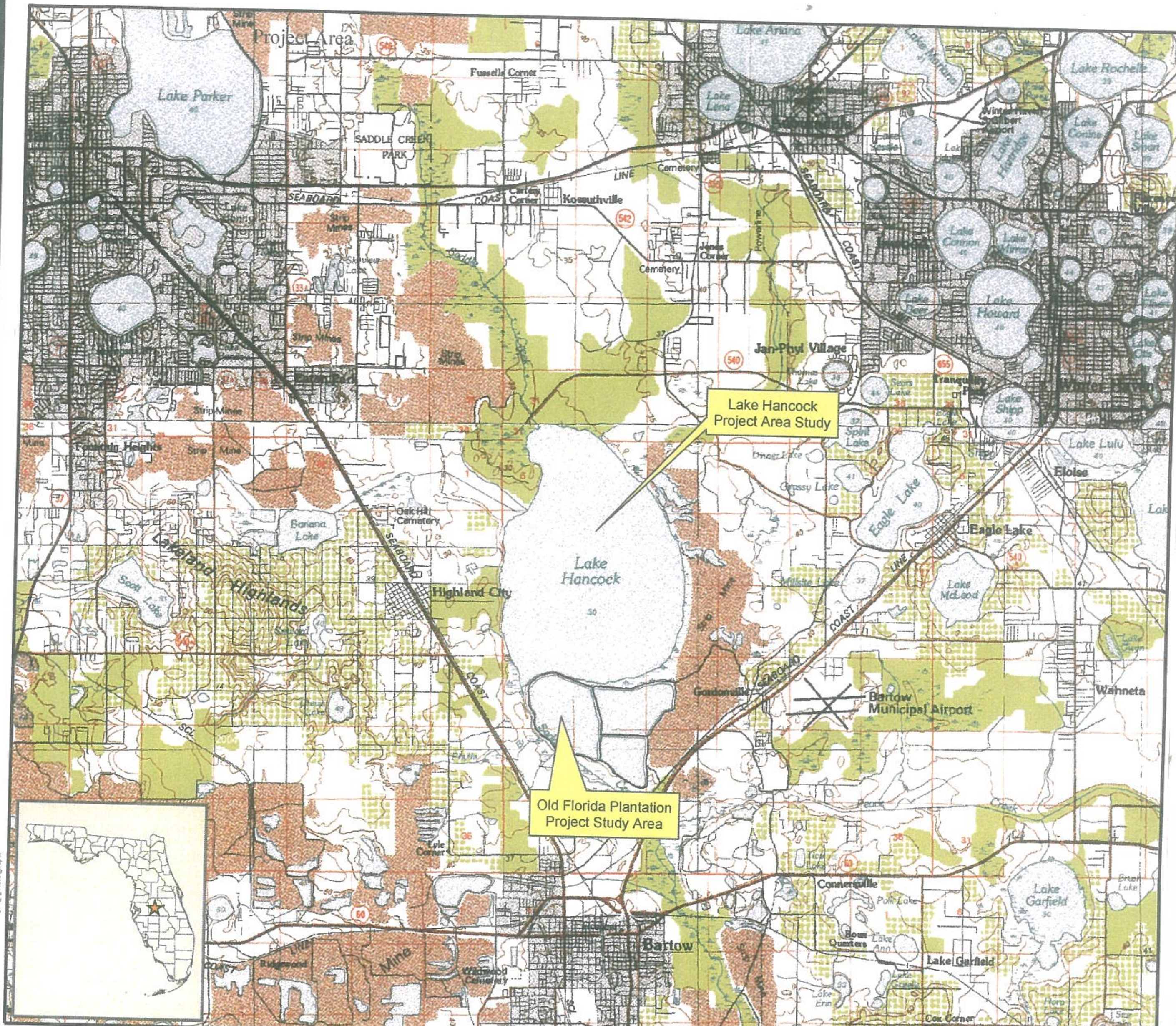

LAKE HANCOCK

General Location Map

N
W E
S

0 7,500 15,000 Feet

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Lake Hancock Sediment Study

FIGURE 7
General Location Map
Lake Hancock / OFP
Polk County, Florida

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LAKE HANCOCK

Florida Land Use Cover and Forms Classification System (FLUCCS) Map

N W E S

0 2,800 5,600 Feet

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FIGURE 8
FLUCCS Map
Lake Hancock / OFP
Polk County, Florida

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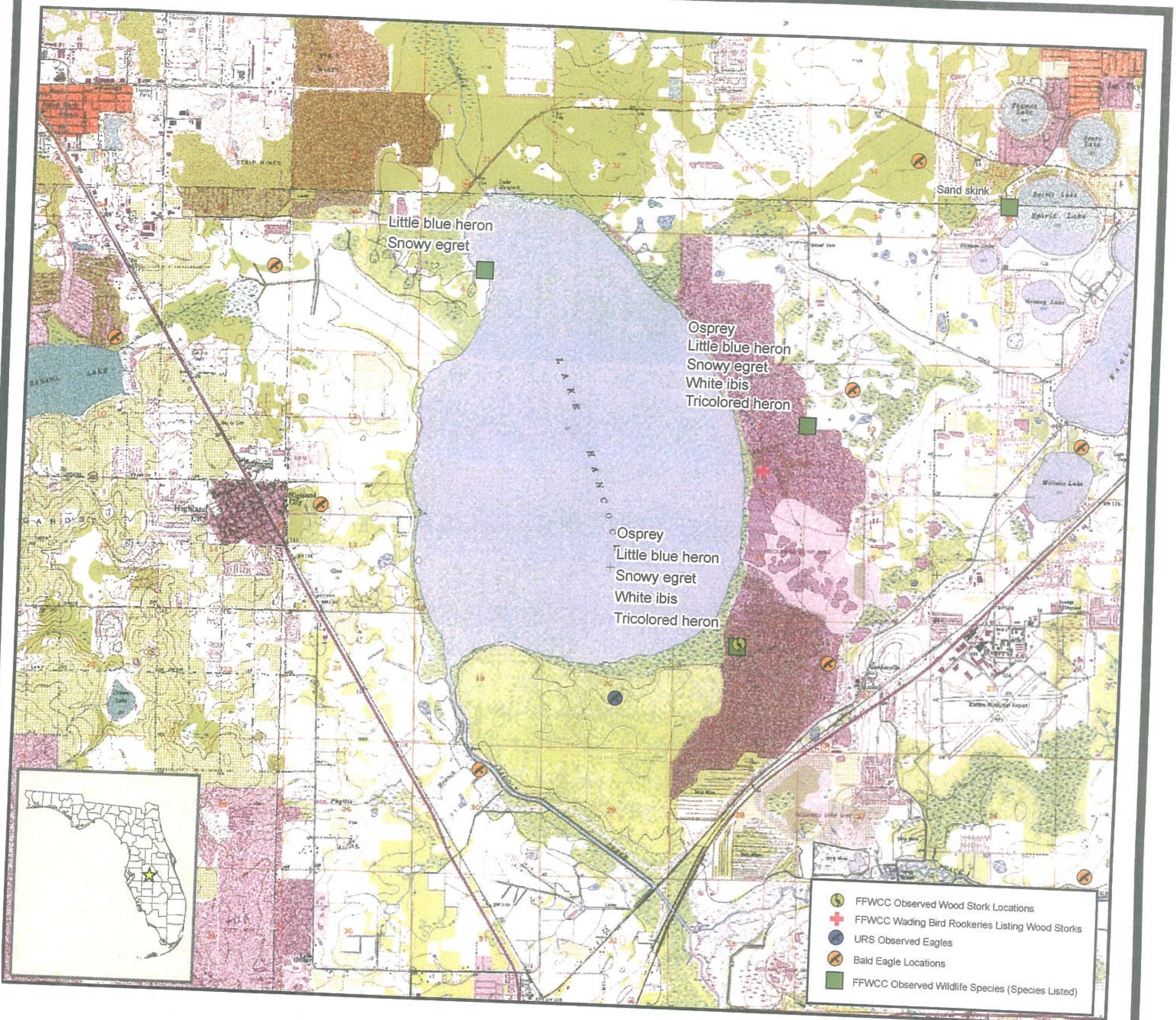

LAKE HANCOCK

Documented and Observed Occurrences
of Wildlife Species

N W E S

0 4,000 8,000 Feet

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FIGURE 9
Occurences of Wildlife Species
Lake Hancock / OFP
Polk County, Florida

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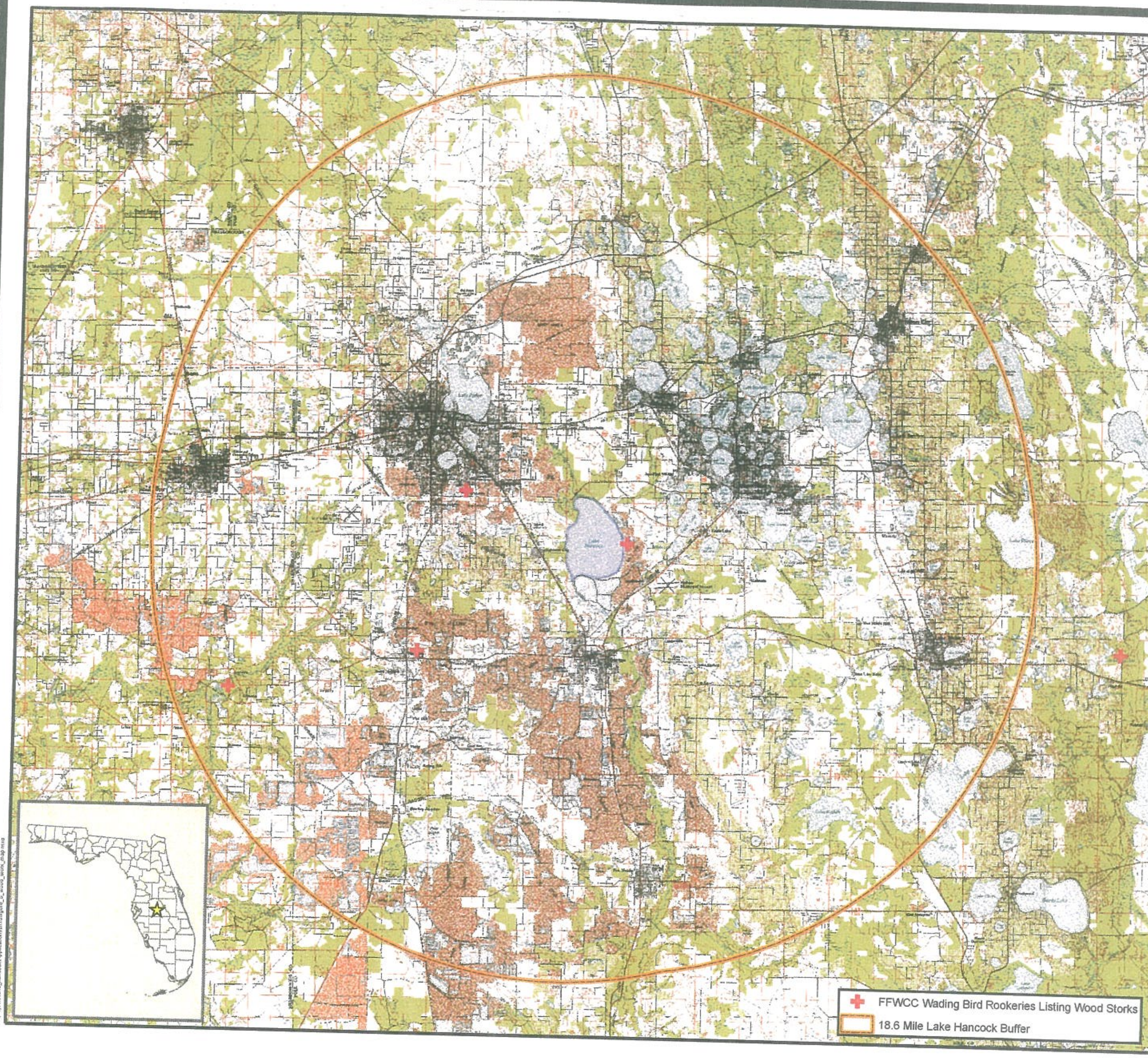

LAKE HANCOCK

FFWCC Wading Bird Rookeries
Showing Only Instances with Wood Stork Listings
Additionally Showing 18.6 Mile Lake Hancock Centered Buffer

N W E S

0 24,000 48,000 Feet

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FIGURE 10
FWCC Wood Stork Listings
Lake Hancock / OFP
Polk County, Florida

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