Lake Apopka Sediment Dredging and Material Placement Projects Planning and Permitting, St. Johns River Water Management District, Lake & Orange County, Florida

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ABSTRACT: Lake Apopka, at the headwaters of the Ocklawaha Chain of Lakes, is the fourth largest lake in Florida (approximately 31,000 acres [125.45 km^2]). A history of long-term muck farming of the adjacent wetlands has led to high pesticide concentrations in those wetland soils and extreme subsidence of the farming areas (roughly 5 feet [1.5 m]). In addition, for years runoff enriched with nutrients was also discharged directly to Lake Apopka from the adjacent muck farming areas, which has created hyper-eutrophic conditions. These conditions resulted in decades of algal blooms in the lake. The final result is that much of the bottom of Lake Apopka is now being covered by an unconsolidated muck layer. This thick muck layer inhibits recovery efforts for submerged aquatic vegetation (SAV) in the lake, both a critical ecosystem component for water quality improvement and significant habitat for any significant fisheries restoration.

The objective of the project outlined in this document - estimated at over $200,000,000 in construction costs and the handling of millions of cubic yards of sediments - is to prepare design drawings and acquire permits for various targeted in lake dredging projects, which would remove millions of cubic yards of sediment from the lake and place them in the subsided former muck farming areas. These projects will aid in navigation and more importantly will enhance and recover SAV within Lake Apopka while minimizing risks to and improving the environmental condition of sediment placement areas. St. Johns River Water Management District (District) owned properties adjacent to Lake Apopka will be used for material handling and beneficial use of dredged material, which will be considered in the selection of material handling alternatives.

INTRODUCTION

Review of recent systematic water quality improvement efforts initiated within Lake Apopka and the adjoining former muck farms provide a valuable case study for future large-scale restoration of muck impaired lakes and subsided wetlands.

Lake Apopka lies mostly within the bounds of Orange County, although the western part of the lake lies within Lake County, Florida. The lake is located roughly fifteen (15) miles (24.1 km) northwest of Orlando in the rolling hills of central Florida. Apopka Spring (a natural spring located at the southwest corner of Lake Apopka), rainfall, and stormwater runoff all feed Lake Apopka. However, the primary source of lake water is direct rainfall on the lake's surface. Historically, water drained from Lake Apopka by sheet flow through the Double Run Swamp marshlands on the northwest side of Lake Apopka.

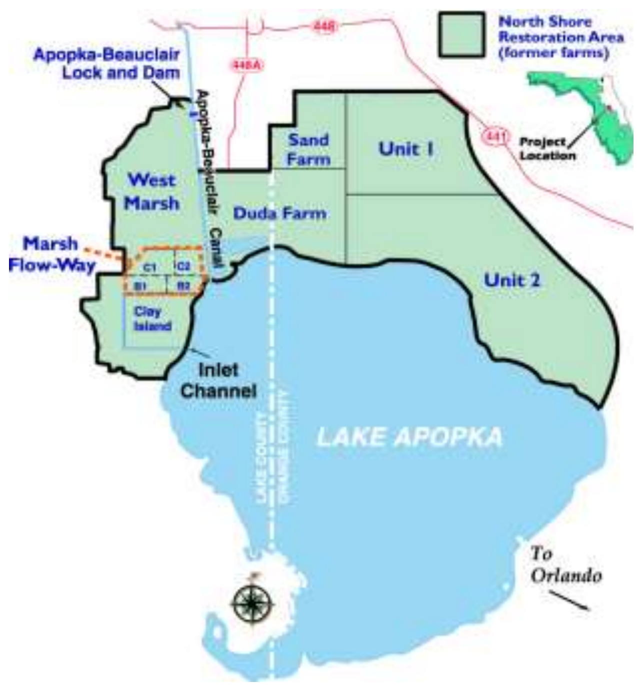

Figure 1. Lake Apopka Location Map (Courtesy Friends of Lake Apopka)

In 1893, the Apopka Canal Company constructed the Apopka-Beauclair Canal connecting Lake Apopka with Lake Beauclair downstream. The canal reduced Lake Apopka's water elevation by approximately 3 feet (0.9 m) and enhanced the farming ventures on the Lake Apopka North Shore (LANS) Restoration Area. Currently, water from Lake Apopka flows northward through the Apopka-Beauclair Canal Dam, into the Apopka-Beauclair Canal, then into Lakes Beauclair and Lake Dora. From Lake Dora, water flow continues into Lake Eustis, then into Lake Griffin and then northward into the Ocklawaha River, which subsequently flows into the St. Johns River.

Before Lake Apopka's decline, it was one of Central Florida's main attractions well into the 1940s. Anglers trekked from throughout the United States to fish for trophy-sized bass in Lake Apopka, and as many as 21 fish camps lined the lake's shoreline. By 1967, nine fish camps were still open. By 1976, only four survived. Today, none exist.

HISTORICAL IMPACTS AND EFFORTS

Lake Apopka has a history of more than 125 years of human alteration, beginning with the construction of the Apopka-Beauclair Canal in 1893. The District has traced the acceleration of Lake Apopka's deterioration to the decision, in the 1940s, to construct a system of levees around 20,000 acres (80.94 km^2) of shallow marshes for year-round vegetable farming. The discharge of water back to Lake Apopka, rich in nutrients from agricultural and other non-point sources, produced conditions that created a chronic algal bloom and resulted in the loss of the lake's recreational value and game fish populations well into the 1990s.

Historically, this shallow lake, roughly 4.3 feet (1.3 m) mean depth at a minimal lake elevation of 65 feet (19.8 m) North American Vertical Datum, 1988 (NAVD 88), received a tremendous amount of nutrient and sediment loading through the drainage of adjacent farms (mainly vegetables and citrus), sewage effluent discharge, and nitrogen and carbon biological fixation. Consequently, Lake Apopka shifted in approximately 1947 from a clear water state dominated by rooted macrophytes to a turbid hypereutrophic state dominated by phytoplankton.

The first recorded lake-wide algal bloom occurred that same year, 1947. Photographic evidence and historical accounts suggest that the increase in phytoplankton and the further decline in macrophytes occurred over a several-year period from 1947 to 1951. Since the 1950s, the lake has had high levels of phosphorous and nitrogen and high turbidity caused by algae and resuspended sediments.

Figure 2. Lake Apopka Bathymetric Survey (Aerial)

A significant factor in the Lake Apopka limnology is a layer of unconsolidated flocculent sediments (UCF) that covers most of the consolidated flocculent (CF) sediments that make up the lakebed. Wind-driven waves and boater disturbance frequently suspends this muck layer. Historical evaluation of this sediment layer indicates that it is roughly 98% water, contains 65% organic matter, and meets the definition of fluid mud in that the individual particles are in suspension rather than supported by the particles below. The layer has increased in thickness from about 10 cm in 1968 to 45 cm by 1997.

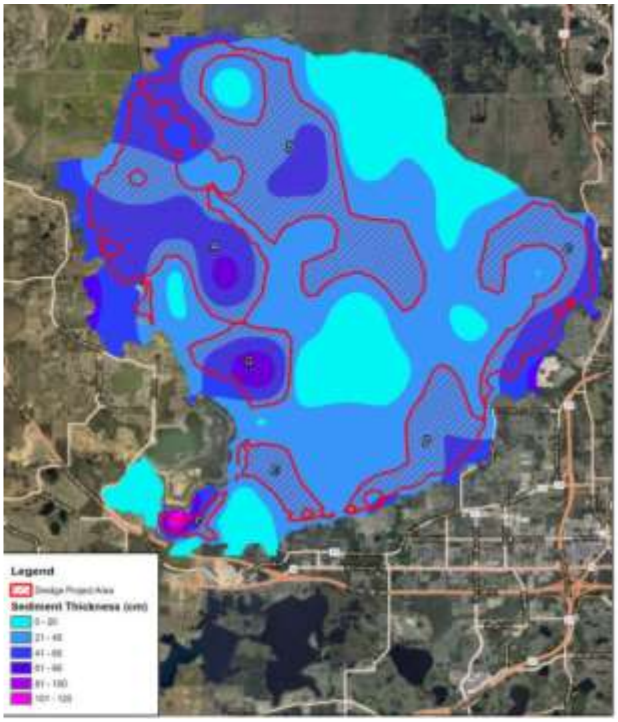

Figure 3. Lake Apopka UCF Thickness and Dredging Area Map

In 1987, the Florida Legislature created the Surface Water Improvement and Management (SWIM) Act to protect, restore, and maintain Florida's highly threatened surface water bodies. Under this act, the state's five water management districts identify a list of priority water bodies within their authority and implement plans to improve them. The District targeted Lake Apopka for clean-up under the SWIM.

In 1996, then-governor Lawton Chiles signed the Lake Apopka Restoration Act (Chapter 96-207, Florida Statutes), furthering the District's previous mandate to clean up the lake by providing funds to buy additional agricultural lands north of the lake. The shuttering of the farms allowed the District to begin plans to convert the fields back to the marsh area it had once been. Restoration of these farmlands to functioning wetlands is expediting clean-up efforts.

To date, major clean-up activities include marsh and floodplain restoration and creation of a marsh flow-way system that filters Lake Apopka’s waters by circulating lake water through restored wetlands. The primary goal of these previous efforts was to restore the lake's ecosystem was to reduce the amount of phosphorus going into Lake Apopka. Current and future efforts include removing phosphorus and other suspended sediments from the lake (by filtration through the Marsh Flow-Way and by mass removal of gizzard shad, improve the food-web structure by removing gizzard shad, and dredging); restoration of habitat through the restoration of the littoral zone shoreline; and restoration of the north shore farmlands to wetlands.

The Marsh Flow-Way, a constructed wetland, is located along the northwest shore of Lake Apopka and west of the Apopka-Beauclair Canal. It began operation in November 2003. The goal of the Marsh Flow-Way is to remove phosphorus and suspended material from Lake Apopka water. The system covers approximately 760 acres (3.08 km^2) and contains four individual wetland cells in addition to levees, canals, and ditches. The Marsh Flow-Way treats water (containing excessive amounts of phosphorus, algae, and suspended matter) pumped into it from Lake Apopka. The District

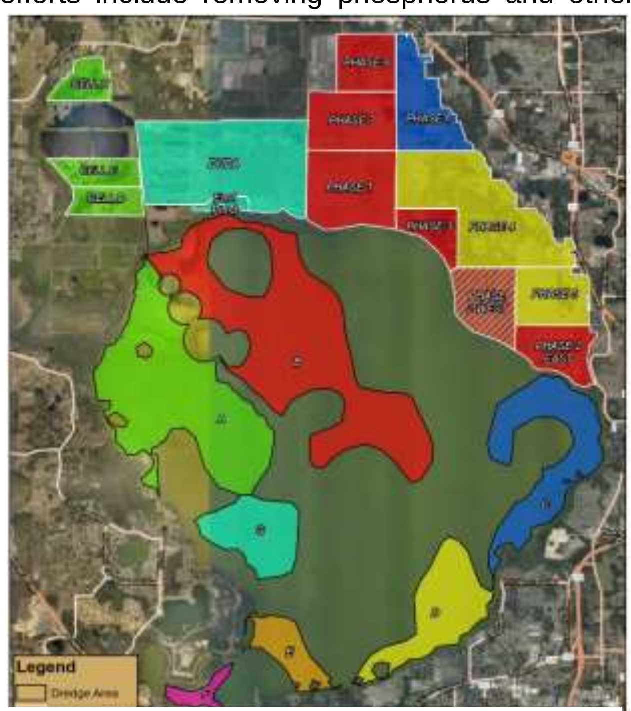

Figure 4. Lake Apopka Dredged Material Placement

manually controls water flow, within the cells, by a system of screw gates and riser boards in the individual cells. Most of the cleaner treated water returns to Lake Apopka, while the remaining water flows downstream toward Lake County Water Authority's nutrient removal facility (NuRF), where it is dosed with Alum, and then sent down the Apopka Beauclair Canal.

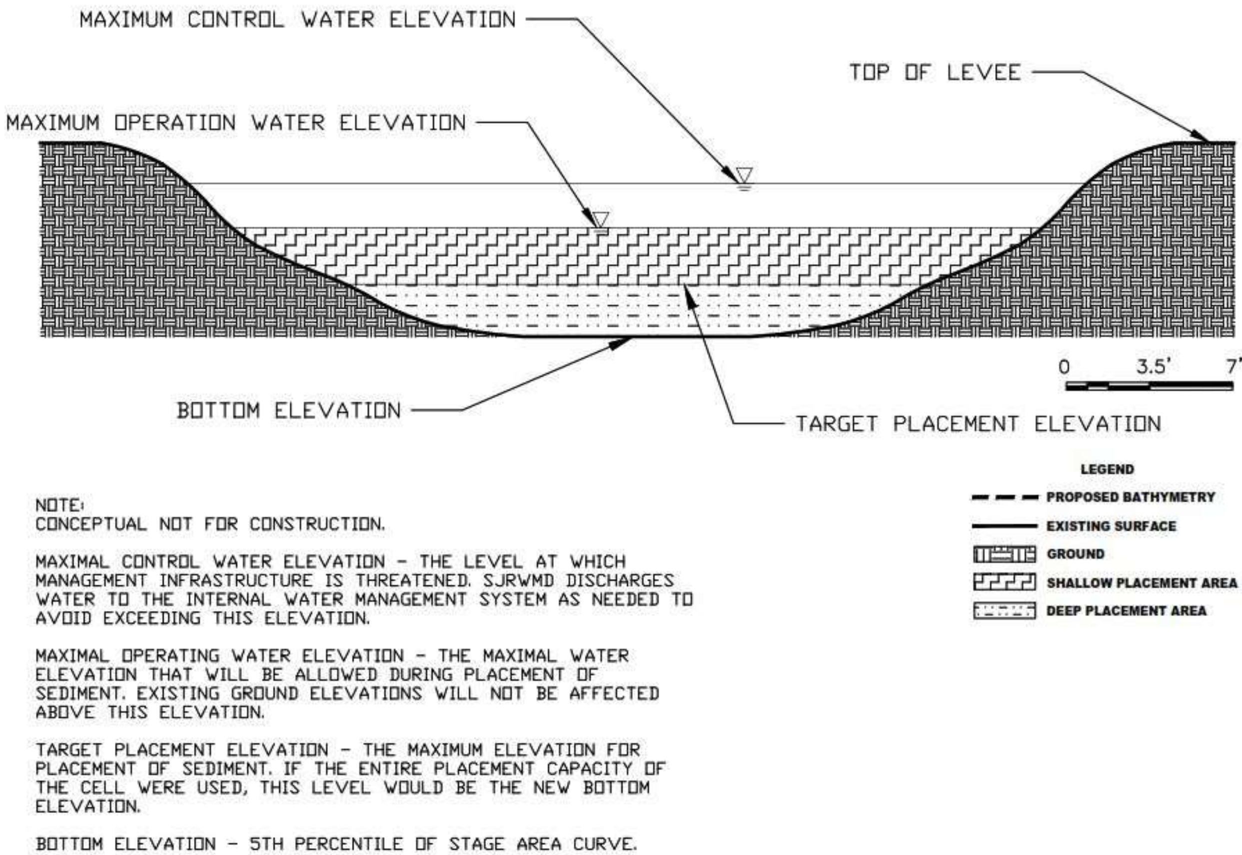

Figure 5. Lake Apopka Dredged Material Placement Map - Typical Cross Sections

In response to these historic District efforts, phosphorus levels in Lake Apopka are currently down by 62%, while water clarity has improved 68% over earlier conditions. In response to these improvements, native submersed plants have re-established at almost 200 locations around the lake.

METHODOLOGY

Numerous publications have documented the restoration of a number of hypereutrophic lakes throughout North America, Canada, and Europe. To a large degree, the success of dredging relates to the adequacy of pre-dredging studies to clearly define the magnitude of the problem and to accurately identify the desired post-dredging condition.

In general, dredging is the most cost-effective in small lakes with organically rich sediment, low sedimentation rates, and long hydraulic residence times. Generally, with dredging large lakes, the economics become increasingly crucial as lake surface area increases. Cost increases in larger lakes are non-linear, reflecting not just associated increases in material dredged in larger lakes but also increased pumping costs due to increased pumping distance (reflecting head losses due to friction in the pipe conducting dredged material onshore) across larger lakes.

One of the largest lakes ever successfully dredged and restored is Vancouver Lake, Washington. By comparison, Lake Apopka is nearly twelve (12) times larger. The general objectives of lake dredging projects are incidental deepening that will benefit navigation, nutrient control, toxic substances removal, and macrophytes balance. While the proposed dredging of Lake Apopka would provide negligible navigation benefits, it would primarily promote all of the other listed objectives.

APPROACH/ACTIVITIES

The following types of projects will be included under this project:

1) Preparing a “programmatic” permit with a duration of up to 20 years to cover all anticipated dredging and material placement projects.
2) Prioritizing a list of suitable dredging locations to that enhance recovering SAV in Lake Apopka using available hydrodynamic data and other available data from Lake Apopka.
3) Prioritizing a list of sump locations based on areas of high deposition using available hydrodynamic data and other available data for Lake Apopka. Dredging of both the unconsolidated flocculent (UCF) and consolidated flocculent (CF) sediments from the bottom of Lake Apopka will be targeted.
4) Picking placement techniques appropriate for the conditions will be considered for beneficial use of dredged material. The purpose of this placement may include both the covering of residual pesticides within wetland soils and placing additional material in areas that have subsided as a result of historic farming operations.
5) Placing dredged material, for beneficial uses, within existing wetlands on adjacent District-owned lands.

PROGRESS TO DATE

As of the date of this paper, Wood has submitted on the District behalf local (Orange County), state (Florida Department of Environmental Protection), and federal (U.S. Army Corps of Engineers) programmatic permit application packages. Concurrently Wood has prioritized a list of suitable dredging areas, which will enhance recovering SAV in Lake Apopka. Also, Wood has ranked a list of appropriate sump dredging locations based on areas of high deposition within Lake Apopka. Currently, due to funding issues and the desire to not significantly increase the depth of Lake Apopka, primarily CF sediments from the bottom of Lake Apopka will be targeted. Finally, Wood has selected the maximum benefit placement locations along with the appropriate techniques for the conditions will be considered for the dredged material’s beneficial re-use. As noted above, the purpose of this placement may include both the covering of residual organochlorine pesticides within the wetland soils and placing additional material in areas that have subsided as a result of historic farming operations.

Following the receipt of permits, Wood will initiation the design and construction of the selected dredging locations within Lake Apopka and relocating the dredged material into the chosen placement areas within the existing LANS wetlands for beneficial uses.

CONCLUSIONS

Lake Apopka, once an icon of Florida’s vibrant ecology, has spent the last nearly eight (8) decades in a turbid hypereutrophic state dominated by phytoplankton, algal blooms, and poor water quality. While the discharge of nutrient-rich agricultural wastewater and other non-point sources were successfully eradicated nearly two (2) decades ago the lake is yet to experience but a fraction of its former productivity and health.

Wetland areas on the LANS potentially available for material placement consist of fourteen (14) parcels of varying size that total approximately 12,000 acres (4.86 km2). Current habitats in these District managed marsh areas include a mosaic of water levels and vegetation, ranging from shallow open water to dense areas of scrub/shrub wetlands. The proposed placement of sediment will be done as to not raise soil elevations to the point where wetlands are converted to uplands. The anticipated improvement (lift) from the proposed project is in the environmental community structure category for the benefits to fish and wildlife due to the burial of contaminated sediments. Through burial of the contaminated sediments, the organochlorine pesticides within the sediments are less bioavailable to fish and wildlife. It is anticipated that there may also be an additional improvement (lift) in the community structure score due to the conversion of some open water areas to emergent wetlands associated with an increase in the bottom elevation due to the sediment placement.

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CITATION

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