-FINAL-

LAKE SEMINOLE WATERSHED MANAGEMENT PLAN

Prepared For :

Pinellas County Public Works Department
Planning and Programming
Surface Water Management
440 Court Street
Clearwater, FL 33756

Prepared By:

PBS&J
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September 2001

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ACKNOWLEDGMENTS

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EXECUTIVE SUMMARY

Lake Seminole, located in west central Pinellas County, Florida, was created in the late 1940s by the impoundment of an arm of Long Bayou, a brackish water segment of Boca Ciega Bay. In the late 1970s, in response to flood concerns, drainage from approximately 11 square miles of the Lake Seminole watershed was diverted around the lake and directly into Long Bayou by the construction of the Seminole Bypass Canal. With a surface area of 684 acres, Lake Seminole is the second largest lake in Pinellas County. With the exception of the County-owned Lake Seminole Park located along the southeast shore, virtually the entire remaining 3,480 acre watershed is urbanized, composed of both old and new residential and commercial development. The lake has historically supported heavy recreational use including boating, skiing, and fishing. Over the past decade, however, water clarity and sport fish stocks (primarily largemouth bass and bluegill) have declined significantly, and nuisance aquatic vegetation has proliferated. The available data indicate a trend of rapidly increasing eutrophication in Lake Seminole.

In response to public concerns over declining water clarity and the proliferation of nuisance aquatic vegetation, including cattails and hydrilla, the Pinellas County Board of County Commissioners passed a resolution in January 1989 (Resolution 89-13) urging the joint development of an effective long term lake management program through the cooperative efforts of the public, lake users, and state and local agencies with responsibilities on the lake. These agencies included Pinellas County, the Southwest Florida Water Management District, the Florida Department of Natural Resources, the Florida Department of Environmental Regulation, the Florida Game and Fresh Water Fish Commission, and the Cities of Largo and Seminole. Representatives from these agencies, as well as from affected homeowner and business interests, were subsequently assembled as the Lake Seminole Advisory Committee (LSAC).

Policy 1.4.5 of the Surface Water Management Element of the Pinellas County Comprehensive Plan states:

> *In the development of specific watershed/waterbody management plans, Pinellas County shall give priority to those water bodies whose water is known, or suspected, to be impaired, and to those high quality waterbodies whose quality may be in danger of impairment, as identified by the Departments of Public Works and Environmental Management through such means as the watershed ranking process.*

As part of the County's on-going work to develop comprehensive watershed management plans for priority basins within their jurisdiction, and to provide a focus to the activities of the LSAC, the County selected PBS&J in late 1996 to assist in the preparation of the Lake Seminole Watershed Management Plan (Plan). This document - *The Lake Seminole Watershed Management Plan* - represents the culmination of a decade of diagnostic feasibility and resource planning activities undertaken by numerous governmental agencies and consulting scientists and engineers.

The purpose of the Plan is to provide implementation guidance for the Pinellas County Growth Management Plan with respect to lake, wetland, and upland management issues in the Lake Seminole watershed. The Plan presents a comprehensive yet specific framework for action aimed at both improving and maintaining the natural resource functions and levels-of-service. As such, the Plan includes recommended management actions including structural and/or capital projects, non-structural best management practices (BMPs), and regulatory and policy guidelines, addressing the following objectives:

- reduce pollutant and nutrient loadings from both external and internal sources;
- improve lake water quality (e.g., reduce TSI and meet state water quality standards);
- increase watershed and in-lake habitat quality and diversity;
- control nuisance and exotic aquatic vegetation;
- sustain or enhance a balanced assemblage of endemic sport fisheries and wildlife;
- provide for public flood protection;
- maintain or enhance the aesthetic and recreational attributes of the lake; and
- maximize and balance recreational opportunities for all user groups.

In addressing the above listed management objectives, the Plan presents the development and prioritization of a set of recommended management actions in an integrated manner. In addition to the evaluation of structural BMPs in the watershed, and in-lake remediative measures, the Plan further addresses the project objectives through a variety of legal, regulatory, and policy guidelines that will serve to control future growth and redevelopment in the watershed.

Seven priority management issues have been identified for Lake Seminole and its watershed, and specific goals have been adopted by the LSAC to address each. The seven management issues and their corresponding goals are listed below.

Issue 1 - Water Quality

- *Goal 1* - The lake and its watershed shall be managed such that good water quality, according to Class-III State standards, is achieved and maintained in the lake

Issue 2 - Aquatic Vegetation

- *Goal 2* - Aquatic vegetation shall be managed such that nuisance and exotic plants are maintained at the lowest feasible levels while encouraging the establishment of a balanced and diverse assemblage of desirable native plants

Issue 3 - Fisheries

- *Goal 3* - The lake and its fish populations shall be managed to provide sustained quality sport fishing opportunities

Issue 4 - Wildlife and Associated Habitat

- *Goal 4* - The lake and its watershed shall be managed to provide adequate habitat abundance, and to enhance habitat quality and diversity

- *Goal 5* - The lake and its watershed shall be managed to attract and maintain populations of endemic fish and wildlife species

Issue 5 - Recreation and Aesthetics

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- *Goal 7* - Use of the lake shall be managed such that the needs of the various user groups are balanced and optimized

Issue 6 - Flood Control

- *Goal 8* - The lake and its watershed shall be managed to minimize flood damage

Issue 7 - Public Education

- *Goal 9* - Education in matters related to and affecting the other goals of the Lake Seminole Watershed Management Plan shall be provided

The management actions recommended herein are based on the extensive knowledge gained from the scientific/engineering studies and monitoring programs conducted to date, and represent the most cost-effective means of attaining the adopted lake and watershed management goals. The recommended Lake Seminole Watershed Management Plan contains a total of 22 Plan components which address the seven identified lake management issues. The components of the Plan are listed below.

Structural Components (6)

- *Structural Component 1* - Construct Enhanced Regional Stormwater Treatment Facilities in Priority Sub-Basins

- *Structural Component 2* - Divert Seminole Bypass Canal Flows to Improve Lake Flushing and Dilution

- *Structural Component 3* - Excavate Organic Peat Sediments from Shoreline Areas

- *Structural Component 4* - Dredge Organic Silt Sediments from Submerged Areas
- *Structural Component 5* - Restore Priority Wetland and Upland Habitats
- *Structural Component 6* - Install Stage and Flow Measurement Instrumentation on the Lake Seminole Outfall Control Structure

Management Components (5)

- *Management Component 1* - Implement an Enhanced Lake Level Fluctuation Schedule
- *Management Component 2* - Inactivate Phosphorus through Whole Lake Alum Applications
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- *Management Component 4* - Biomanipulate Sport Fish Populations
- *Management Component 5* - Improve Treatment Efficiency of Existing Stormwater Facilities

Legal Components (3)

- *Legal Component 1* - Amend the Florida Statutes to Temporarily Exempt Lake Seminole from Aquatic Preserve and Outstanding Florida Water Regulatory Restrictions
- *Legal Component 2* - Adopt a Resolution Designating the Lake Seminole Watershed as a "Nutrient Sensitive Watershed"
- *Legal Component 3* - Strengthen and Standardize Local Ordinances for Regulating Stormwater Treatment for Redevelopment in the Lake Seminole Watershed

Policy Components (1)

- *Policy Component 1* - Establish a Lake Seminole Watershed Management Area (WMA) through Amendments to the Pinellas County, and Cities of Largo and Seminole Comprehensive Plans

Compliance and Enforcement Components (2)

- *Compliance and Enforcement Component 1* - Expand and Enforce Restricted Speed Zones on Lake Seminole

- *Compliance and Enforcement Component 2* - Dedicate a Pinellas County Marine Unit Sheriff to Enforce Laws on Lake Seminole

Social and Recreational Components (2)

- *Social and Recreational Component 1* - Construct a Public Pedestrian Fishing Pier and Boardwalk in Lake Seminole County Park

- *Social and Recreational Component 2* - Establish and Protect Fishing Enhancement Zones in Lake Seminole

Public Education Components (2)

- *Public Education Component 1* - Develop and Implement a Comprehensive Public Involvement Program for the Lake Seminole Watershed

- *Public Education Component 2* - Develop and Implement a Local Citizens LakeWatch Program for Lake Seminole

Operation and Maintenance Components (1)

- *Operation and Maintenance Component 1* - Operate and Maintain Structural Facilities and Equipment Recommended in the Plan

It should be emphasized that the various components of the Plan are not all independent management actions that can be implemented without regard for the others. That is, among the various Plan components there are certain dependencies that need to be accommodated in the implementation schedule to ensure the most cost-effective results. In recognition of these dependencies, as well as potential financial constraints, it is recommended that the Plan be implemented in three phases.

- **Phase I** - The first phase of the Plan would focus initially on the design and permitting of the major structural components for which land acquisition, engineering design and regulatory permit approvals will be required. In addition, the primary focus of Phase I will be on watershed management activities that result in the reduction of external phosphorus loads to the lake (e.g., construction of enhanced regional stormwater treatment facilities). Land acquisition, engineering design, and environmental permitting activities in support of the major structural components of the Plan may require up to two years to complete and therefore should be initiated immediately. Phase I activities are projected to require a minimum of two years to complete, including construction. Therefore, Phase I would extend from October 2001 through at least September 2003.

- **Phase II** - The second phase of the Plan would focus primarily on in-lake restoration activities that build upon the watershed management projects completed under Phase I. These would include implementation of in-lake habitat restoration projects, as well as the removal of the flocculent deep sediments if monitoring results warrant this major project. Assuming that all land acquisition, design and permitting activities have been completed for the major structural components in Phase I, it is anticipated that the Phase II construction projects, and other non-structural components of the Plan, could be completed in two years. Therefore, Phase II would extend from October 2003 through September 2005.

- **Phase III** - The third phase of the Plan would focus primarily on following-up on in-lake restoration activities that build upon, or are dependent upon, the implementation of Phase I and Phase II projects. For example, assuming that adequate water quality improvement to support the proliferation of aquatic macrophytes in the lake has resulted from the implementation of the Phase I and II components, the aquatic weed harvesting program would be initiated during Phase III. Conversely, if the defined water quality targets have not been attained following implementation of the Phase I and II components, then sediment phosphorus inactivation would be implemented in Phase III. It should be noted that the majority of the Phase III projects are management or maintenance activities that will likely be conducted indefinitely on an ongoing basis. Therefore, Phase III would begin in October 2005 and extend indefinitely into the future.

The total construction cost of implementing the Plan is estimated at $14,480,000. This cost estimate assumes that all components of the Plan, including the most ambitious optional alternatives, are fully implemented as recommended. Therefore, this cost represents a maximum construction cost estimate. It should, however, be noted that the total estimated construction cost does not include design and permitting fees, or land acquisition costs. The total annual recurring cost of Plan implementation is estimated to be $537,000. This annual recurring cost estimate includes all ongoing operation and maintenance activities, and program administrative functions, to be conducted following implementation of the Plan. As with the total construction cost estimate, this cost estimate assumes that all components of the Plan, including the most ambitious optional alternatives, are fully implemented as recommended.

The total 10-year cost assumes that the construction of all structural components of the Plan will be completed within five years of initiation (e.g., by September 2006), and is estimated at $17,165,000. As such, the total 10-year cost includes the construction costs, plus 5-years of accrued annual recurring costs, for all components of the Plan. Therefore, this cost represents an estimate of the maximum total cost of Plan implementation over a 10-year planning and budgeting window (e.g., through September 2011). All cost estimates are figured in FY-2000 dollars and do not account for inflation.

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1.0 INTRODUCTION

1.1 Project Background

Lake Seminole, located in west central Pinellas County, Florida, was created in the late 1940s by the impoundment of an arm of Long Bayou, a brackish water segment of Boca Ciega Bay. In the late 1970s, in response to flood concerns, drainage from approximately 11 square miles of the Lake Seminole watershed was diverted around the lake and directly into Long Bayou by the construction of the Seminole Bypass Canal. With a surface area of 684 acres, Lake Seminole is the second largest lake in Pinellas County. With the exception of the County owned Lake Seminole Park located along the southeast shore, virtually the entire remaining 3,480 acre watershed is urbanized, composed of both old and new residential and commercial development. The lake has historically supported heavy recreational use including boating, skiing, and fishing. Over the past decade, however, water clarity and sport fish stocks (primarily largemouth bass and bluegill) have declined significantly, and nuisance aquatic vegetation has proliferated. The available data indicate a trend of rapidly increasing eutrophication in Lake Seminole.

In response to public concerns over declining water clarity and the proliferation of nuisance aquatic vegetation, including cattails and hydrilla, the Pinellas County Board of County Commissioners passed a resolution in January 1989 (Resolution 89-13) urging the joint development of an effective long term lake management program through the cooperative efforts of the public, lake users, and state and local agencies with responsibilities on the lake. These agencies included the Pinellas County, the Southwest Florida Water Management District, the Florida Department of Natural Resources, the Florida Department of Environmental Regulation, the Florida Game and Fresh Water Fish Commission, and the Cities of Largo and Seminole. Representatives from these agencies, as well as from affected homeowner and business interests, were subsequently assembled as the Lake Seminole Advisory Committee (LSAC).

As a result of a cooperative funding request by Pinellas County, the Southwest Florida Water Management District (SWFWMD), through the Pinellas-Anclote Basin Board, subsequently funded a diagnostic feasibility study of Lake Seminole in the early 1990s. The Lake Seminole Diagnostic Feasibility Study (SWFWMD, 1992) estimated potential pollutant loadings from the watershed, as well as the lake's ability to assimilate these pollutant loads. In support of this work a preliminary lake/watershed model was developed (Dames and Moore, 1992). This model was termed the Lake Seminole Management Model (LSMM). Other components of the diagnostic feasibility study included an assessment of plant and animal communities in the lake and watershed, as well as a characterization of lake water quality and sediments. This work was used as the basis for various lake and watershed management actions initiated by the County and other resource management agencies, however, a comprehensive lake and watershed management plan was never developed.

Since the completion of the diagnostic feasibility study, Pinellas County, with financial support from SWFWMD, initiated several projects aimed at reducing external nutrient loads to Lake Seminole, and improving in-lake habitats. These included the Dog Leg Pond and the Pond-6 Stormwater Rehabilitation Projects, and the construction of an improved outfall control structure to allow for greater lake level fluctuation. In addition, the County continued to sponsor periodic meetings of the LSAC to obtain input from represented local governments, regulatory and resource management agencies, and affected citizens and businesses regarding better management of the lake. To date, the primary functions of the LSAC have included: the identification of priority lake management issues and problems; the development of management goals and strategies; and, the provision of a general forum for the sharing of information and the discussion of ongoing and emerging lake management issues.

Policy 3.1.4 of the Conservation Element of the Pinellas County Comprehensive Plan calls for the systematic development of watershed/waterbody-specific management plans for all major drainage basins in the County on a priority basis. As part of the County's on-going work to develop comprehensive watershed management plans for all significant basins within their jurisdiction, and to provide a focus for the activities of the LSAC, the County selected PBS&J in late 1996 to assist in the preparation of the Lake Seminole Watershed Management Plan (Plan). This document - *The Lake Seminole Watershed Management Plan* - represents the culmination of a decade of diagnostic feasibility and resource planning activities undertaken by numerous governmental agencies and consulting scientists and engineers.

1.2 Purpose and Objectives of the Plan

The purpose of the Plan is to provide implementation guidance for the Pinellas County Growth Management Plan with respect to lake, wetland, and upland management issues in the Lake Seminole watershed. The Plan presents a comprehensive yet specific framework for action aimed at both improving and maintaining the natural resource functions and levels of service. As such, the Plan includes recommended management actions including structural and/or capital projects, non-structural best management practices (BMPs), and regulatory and policy guidelines, addressing the following objectives:

- reduce pollutant and nutrient loadings from both external and internal sources;
- improve lake water quality (e.g., reduce TSI and meet state water quality standards);
- improve watershed and in-lake habitat quality and diversity;
- control nuisance and exotic aquatic vegetation;
- sustain or enhance a balanced assemblage of endemic sport fisheries and wildlife;
- provide for public flood protection;
- maintain or enhance the aesthetic and recreational attributes of the lake; and
- maximize and balance recreational opportunities for all user groups.

In addressing the above listed management objectives, the Plan presents the development and prioritization of a set of recommended management actions in an integrated manner. In addition to the evaluation of structural BMPs in the watershed and in-lake remediative measures, the Plan further addresses the project objectives through a variety of legal, regulatory, and policy guidelines that will serve to control future growth and redevelopment in the watershed.

Because the driving force behind the development of the Plan was declining water quality and associated adverse impacts on living resources, a major aspect of the project was to conduct more extensive modeling of pollutant loadings to the lake, as well as the lake's response to these loadings. This modeling work also included an update of the County master drainage plan for the Lake Seminole basin to determine current and potential future flood prone areas. The ultimate application of the modeling work conducted in the planning process was to develop and prioritize a number of remediative and cost-effective management actions to reduce external and internal pollutant loadings to Lake Seminole, while maintaining public flood protection and improving recreational opportunities.

Using the evolving "watershed management" planning approach, the Plan addresses the interactions between water quality and quantity, and dependent living resources such as fish, wildlife and natural habitats. Furthermore, the Plan acknowledges that people are the dominant component of the Lake Seminole ecosystem. As such, the above listed management objectives need to be met while still allowing for reasonable and prudent growth and redevelopment within the Lake Seminole basin. Therefore, the Plan recognizes the socioeconomic benefits of the lake to Pinellas County, the Cities of Largo and Seminole, and affected homeowners and businesses, and accommodates the multiple uses of this valuable resource in a balanced manner. In this regard, it will serve to improve the effectiveness of existing resource management activities, and reduce the impact of future growth and redevelopment in the watershed.

1.3 Lake and Watershed Management Goals

Based on the decline in water quality and associated adverse impacts to habitat and sport fisheries observed in the early 1990s, the LSAC developed a list of priority lake and watershed management issues as well as a draft set of goals to address each issue. These draft goals were subsequently refined by PBS&J as part of the watershed planning process, and adopted by the LSAC. As a result of this work, seven priority management issues have been identified for Lake Seminole and its watershed, and specific goals have been adopted to address each. The seven management issues and their corresponding goals are listed below.

Issue 1 - Water Quality

Goal 1 — *The lake and its watershed shall be managed such that good water quality, according to Class-III State standards, is achieved and maintained in the lake.*

Issue 2 - Aquatic Vegetation

Goal 2 — *Aquatic vegetation shall be managed such that nuisance and exotic plants are maintained at the lowest feasible levels while encouraging the establishment of a balanced and diverse assemblage of desirable native plants.*

Issue 3 - Fisheries

Goal 3 — *The lake and its fish populations shall be managed to provide sustained quality sport fishing opportunities.*

Issue 4 - Wildlife and Associated Habitat

Goal 4 — *The lake and its watershed shall be managed to provide adequate habitat abundance, and to enhance habitat quality and diversity.*

Goal 5 — *The lake and its watershed shall be managed to attract and maintain populations of endemic fish and wildlife species.*

Issue 5 - Recreation and Aesthetics

Goal 6 — *The lake shall be managed in such a manner as to provide for safe recreational boating and skiing.*

Goal 7 — *Use of the lake shall be managed such that the needs of the various user groups are balanced and optimized.*

Issue 6 - Flood Control

Goal 8 — *The lake and its watershed shall be managed to minimize flood damage.*

Issue 7 - Public Education

Goal 9 — *Education in matters related to and affecting the other goals of the Lake Seminole Watershed Management Plan shall be provided.*

In addition to the above listed issues and goals, the following mission statement for the Lake Seminole Watershed Management Plan was subsequently adopted by the LSAC:

It is the goal of this Plan to improve water quality, enhance habitat and biodiversity, minimize flood damage, and optimize recreational opportunities and aesthetics in Lake Seminole and its watershed so that desirable conditions are maintained for future generations.

The management actions recommended herein are based on the extensive knowledge gained from the scientific/engineering studies and monitoring programs conducted to date, and represent the most cost-effective means of attaining the goals and mission statement adopted by the LSAC.

1.4 Document Organization

This document, the final *Lake Seminole Management Plan*, presents a synthesis of the various management recommendations developed and considered during the diagnostic/feasibility and planning processes, and provides an integrated summary of the preferred management options and alternatives. This document is organized as follows:

- Section 2.0 - Status and Trends. This section presents a summary of existing conditions in Lake Seminole and its watershed as they relate to the identified lake and watershed management issues.
- Section 3.0 - Alternatives Analysis. This section presents a discussion of the major management options and alternatives considered, and a summary of the findings of the watershed and waterbody modeling conducted to evaluate the efficacy of the various management options and alternatives.
- Section 4.0 - The Plan. This section presents the recommended Lake Seminole Watershed Management Plan, including a summary of the adopted lake and watershed management goals and level-of-service targets, and a detailed description of the various components of the Plan.
- Section 5.0 - Monitoring and Success Evaluation. This section presents a summary of the recommended monitoring and success evaluation program.
- Section 6.0 - Implementation Schedule. This section presents the recommended capital improvement program and Plan implementation schedule.
- Section 7.0 - Financing Requirements. This section presents a summary of the financing requirements of the Plan as well as various financing options.
- Section 8.0 - References. This section provides a listing of the references cited in this document.

- Section 9.0 - Appendices. This section contains key technical documents prepared as part of the planning process.

The Plan document has been prepared to provide a relatively succinct presentation of the documented problems in Lake Seminole and its watershed, as well as the recommended approach to addressing these problems. An attempt has been made to provide sufficient technical information in a format and level of detail that is understandable for laypersons. Readers seeking greater technical detail with regard to a particular issue are encouraged to review the individual Interim Task Reports prepared during the planning process. In addition to the detailed information provided in each of the Interim Task Reports, other ancillary project deliverables generated in the development of this Plan, including maps, surveys, model data and code, etc., are available from the Pinellas County Department of Public Works and Department of Environmental Management.

2.0 STATUS AND TRENDS

This section provides a brief history of Lake Seminole, an overview of historical trends in water quality and living resources, and a summary of existing conditions as they relate to the identified priority lake and watershed management issues. This information was derived primarily from work conducted as part of the Lake Seminole Diagnostic Feasibility Study (SWFWMD, 1992), as well as additional diagnostic feasibility studies performed in support of the development of this Plan.

2.1 History of Lake Seminole

Physical Modifications

Lake Seminole, located in west central Pinellas County, Florida, was created in the mid-1940s by the impoundment of an arm of Long Bayou, a brackish water segment of Boca Ciega Bay. On July 3, 1945, the Pinellas County Board of County Commissioners passed a resolution to create a freshwater lake in conjunction with the planned construction of Park Boulevard and a causeway across Long Bayou by the State Public Roads Administration. A secondary purpose for the creation of a freshwater lake was to provide a source of irrigation water for nearby citrus groves as well as to augment potable water supplies provided by the Pinellas County Water System (SWFWMD, 1992). Fresh water was contained in the lake through the construction of a fixed crest weir with an elevation of 6-feet NGVD at the south end of the lake. In the late 1960s, this structure was subsequently replaced with the fixed curvilinear weir that exists today. The fixed elevation of the existing weir is 5-feet NGVD.

Since the single fixed crest weir located at the south end of the lake had the potential to cause significant tailwater flooding upstream of the lake, a second weir was constructed at the north end of the lake in the late 1940s (SWFWMD, 1992). Water was then pumped from a dredged basin at the southern end of Long Creek (the original tributary which flowed to Long Bayou) over the north weir and into the lake via three lift pumps. This modification allowed the water level in Lake Seminole to be permanently maintained at elevation 6-feet NGVD. Between 1957 and 1965, Long Creek was channelized upstream of Lake Seminole to improve drainage conveyance in a rapidly urbanizing portion of Pinellas County.

During the mid to late 1970s, the Seminole Bypass Canal was constructed in response to flooding in the upper Long Creek basin, and to a perceived decrease in lake water quality thought to be caused by the pumping of Long Creek flows into the lake (SWFWMD, 1992). The construction of the Seminole Bypass Canal diverted runoff from approximately eleven square miles of the historic Long Creek basin, around Lake Seminole to the east and directly into Long Bayou. Subsequently, a fixed crest weir with an elevation of 3-feet NGVD was constructed at the southern terminus of the

Seminole Bypass Canal. Although this modification successfully reduced flooding potential in the upper Long Creek watershed, it essentially resulted in the hydrologic isolation of Lake Seminole, and substantially increased the residence time of the lake. Prior to this modification, the lake was discharging at or slightly above the 5-foot NGVD weir crest elevation a majority of the time. However, after the construction of the Seminole Bypass Canal and the dismantling of the pumps, discharge over the weir has been infrequent and of short duration (SWFWMD, 1992).

An additional small outfall was created during the 1960s with the construction of Lake Seminole Park. An 18-inch diameter outfall pipe with an invert elevation of 3.5-feet NGVD was constructed from the lake through a series of three interconnected ponds in the park. Water flows from the lake through this series of interconnected ponds and eventually discharges into the Seminole Bypass Canal over a weir slightly below elevation 5-feet NGVD. The purpose of this outfall was to provide relatively constant flow through the ponds to prevent stagnation and water quality problems.

Land Use

Since the construction of the Park Boulevard causeway and the impoundment of Long Bayou, land uses in the Lake Seminole watershed have changed from predominantly low density rural residential and agriculture (e.g., improved pasture and citrus) to high density urban residential and commercial. A review of historic aerial photography indicates that urbanization in the basin began in the 1950s, and was first evident along the western side of the lake where numerous waterfront residential developments were initiated. Many of these developments involved major dredge and fill activities to create canals and bulkheads.

From the early 1950s through the mid-1960s, urbanization continued to occur predominantly in the western portion of the watershed, along the Seminole Boulevard corridor. In the mid-1960s, land use changes in the eastern portion of the watershed began to occur. In 1967, Lake Seminole Park was constructed, and the park was subsequently expanded in 1976. Rapid infilling of urban land uses occurred throughout the watershed during the 1970s and 1980s, however, no new major dredge and fill activities in the lake were permitted during this time period. In the mid-1990s the 102nd Avenue Bridge was constructed over the central "narrows" portion of Lake Seminole. Figure 2-1 shows the boundaries of the Lake Seminole watershed and existing (1995) land use in the basin.

Causes of Current Problems

It should be emphasized at the outset that many of the problems facing Lake Seminole today were essentially predetermined by the physical origins of the lake, as well as the subsequent hydrologic modifications and land use changes that later occurred in the watershed. Long Bayou was historically a shallow tidal embayment which likely had been accumulating fine organic muck sediments in the poorly flushed backwaters for several centuries. When the lake was created by impounding Long Bayou, these sediments along with the riparian mangrove swamps were simply flooded by detained freshwater discharges from Long Creek. Today, these deposits of organic sediments constitute a lake

management problem that now, more than ever, needs to be addressed. In addition, the subsequent isolation of Long Creek flows from the lake via the construction of the Lake Seminole Bypass Canal substantially reduced lake circulation and flushing and increased the residence time of nutrients entering the lake. Combined with rapid urbanization with little or no stormwater treatment in the surrounding watershed, this hydrologic modification has likely significantly contributed to the persistent algae blooms and rapidly increasing cultural eutrophication observed in Lake Seminole.

When the original decision was made by the Pinellas County Board of County Commissioners to create Lake Seminole, these problems could scarcely have been anticipated. However, with the commitment to create the lake comes the obligation to manage the lake and its watershed in a manner consistent with the goals, objectives, and policies of the Pinellas County Comprehensive Plan. The Plan set forth herein provides the framework for remediating the historic problems described above, as well as for creating a new future for Lake Seminole.

2.2 Water Quality

This section discusses water quality status and trends in Lake Seminole in terms of: 1) trophic state; 2) water and nutrient budgets; and 3) pollutant loads.

2.2.1 Trophic State

The primary concern with regard to water quality in Lake Seminole is excessive cultural (human-induced) eutrophication. Other types of water quality problems can occur in lakes, such as high concentrations of toxics (e.g., heavy metals, pesticides, etc.) and pathogens (e.g., coliform bacteria), but these types of public health problems have not been observed in Lake Seminole to any significant degree. Rather, the major water quality concerns are: 1) the control of excessive nutrients entering the lake; and 2) the fate of the nutrients that do reach the lake (e.g., internal nutrient recycling).

The term *trophic state* can be loosely defined as the nutritional status of a lake (Huber et al, 1982). Like other plants, microscopic, single-celled algae, also referred to as phytoplankton, require nitrogen and phosphorus and other primary nutrients to grow and reproduce. However, if nutrients are available in the water column of lakes in concentrations that are too high, nuisance algae blooms occur. If these conditions persist for a prolonged period of time, many ecological changes begin to take place in the lake. First, the excessive algae concentrations increase turbidity in the water column and shade out the light that supports rooted plants, eventually resulting in the die-off of submerged aquatic vegetation. Second, the bacterial breakdown of the excessive amount of dead algal cells raining down on the lake bottom results in a depletion of oxygen in the water column which can result in fish kills. Third, when algae becomes the dominant source of primary production (photosynthesis) in the lake, this can result in a shift in the fish population structure from a predominance of carnivorous sport fish (e.g., largemouth bass) to a predominance of herbivorous rough fish (e.g., gizzard shad). This process is called *eutrophication*.

Lake eutrophication is a natural process resulting from the gradual accumulation of nutrients, increased productivity, and a slow filling in of the basin with accumulated sediments, silt and organic matter from the watershed. The classical lake succession sequence is usually depicted as a unidirectional progression through the following series of phases or trophic states including:

- *Oligotrophy* - nutrient-poor, biologically unproductive, low turbidity;
- *Mesotrophy* - intermediate nutrients and biological productivity, moderate turbidity;
- *Eutrophy* - nutrient-rich, high biological productivity, high turbidity;
- *Hypereutrophy* - pea soup conditions, the extreme end of the trophic continuum.

Although natural eutrophication could take tens of thousands of years to occur, a lake's lifespan can be drastically shortened by human-induced cultural eutrophication. Activities in the watershed such as forest clearing, road building, agricultural cultivation, residential and commercial development, stormwater runoff and wastewater discharges can all result in substantial increases in the discharge of nutrients, organic matter and sediments to the lake. Figure 2-2 illustrates the differences between natural and cultural, or human-induced, eutrophication.

The primary measure of the degree of eutrophication in a lake is the concentration of *chlorophyll-a* in the water column. Chlorophyll-a is an estimate of algal cell biomass, and may be directly related to the trophic state of the lake. In addition, the primary nutrients of concern with respect to controlling eutrophication are total nitrogen (TN) and total phosphorus (TP). Finally, the most commonly used measure of water transparency is the Secchi disk depth, or the maximum depth at which a disk suspended on a weighted line can be visually detected below the water surface.

The following summaries of the status and trends in water quality and pollutant loading sources focus on the parameters related to the trophic state of the lake, including chlorophyll-a, TN, TP, and Secchi disk depth. With respect to indicators of eutrophication, water quality in Lake Seminole has generally declined over the past decade. Figures 2-3 through 2-7 show plots of annual averages of monthly water quality data collected in Lake Seminole from 1991 through 1999.

Figure 2-3 shows trends in annual average chlorophyll-a concentrations. Chlorophyll-a is the most commonly used measure of lake trophic state, and is an indicator of algal biomass. Chlorophyll-a concentrations in Lake Seminole were generally stable from 1991 through 1998, but increased substantially in 1999. The mean annual chlorophyll-a concentration from 1991 through 1998 was 65 ug/l. In 1999, however, the mean monthly chlorophyll-a concentration increased to 118 ug/l, almost double the mean annual concentration over the previous eight years. This increase is alarming in light of the fact that rainfall in Pinellas County during 1999 was close to average for the 1990s (see Figure 2-7). In addition, no substantial changes in the lake or watershed that could significantly affect external pollutant loads or internal nutrient recycling were known to have occurred.

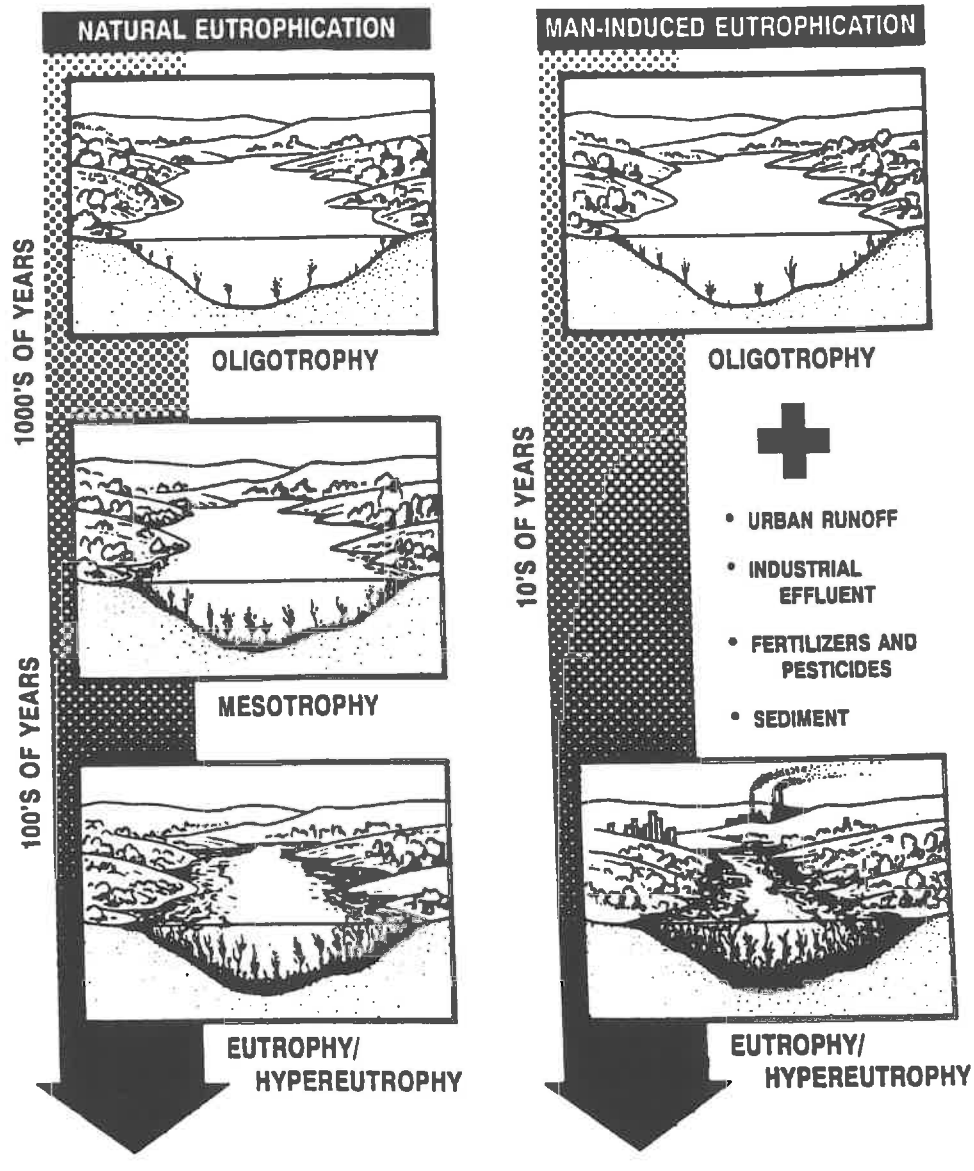


Figure 2-2. Natural vs. cultural (human-induced) eutrophication.

Figure 2-3. Trend in Lake Seminole annual average Chlorophyll-a concentrations.

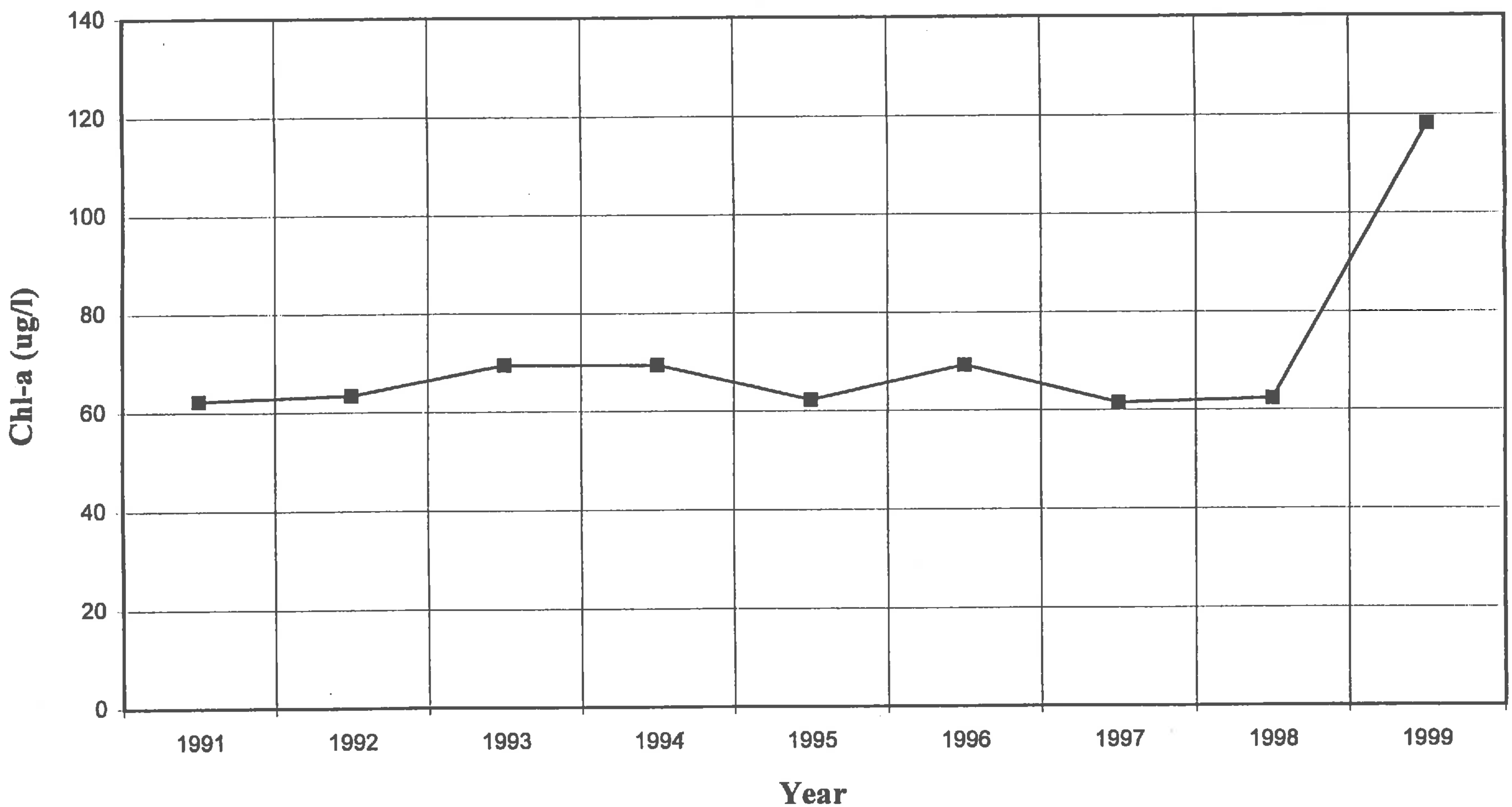


Figure 2-4. Trend in Lake Seminole annual average Total Nitrogen concentrations.

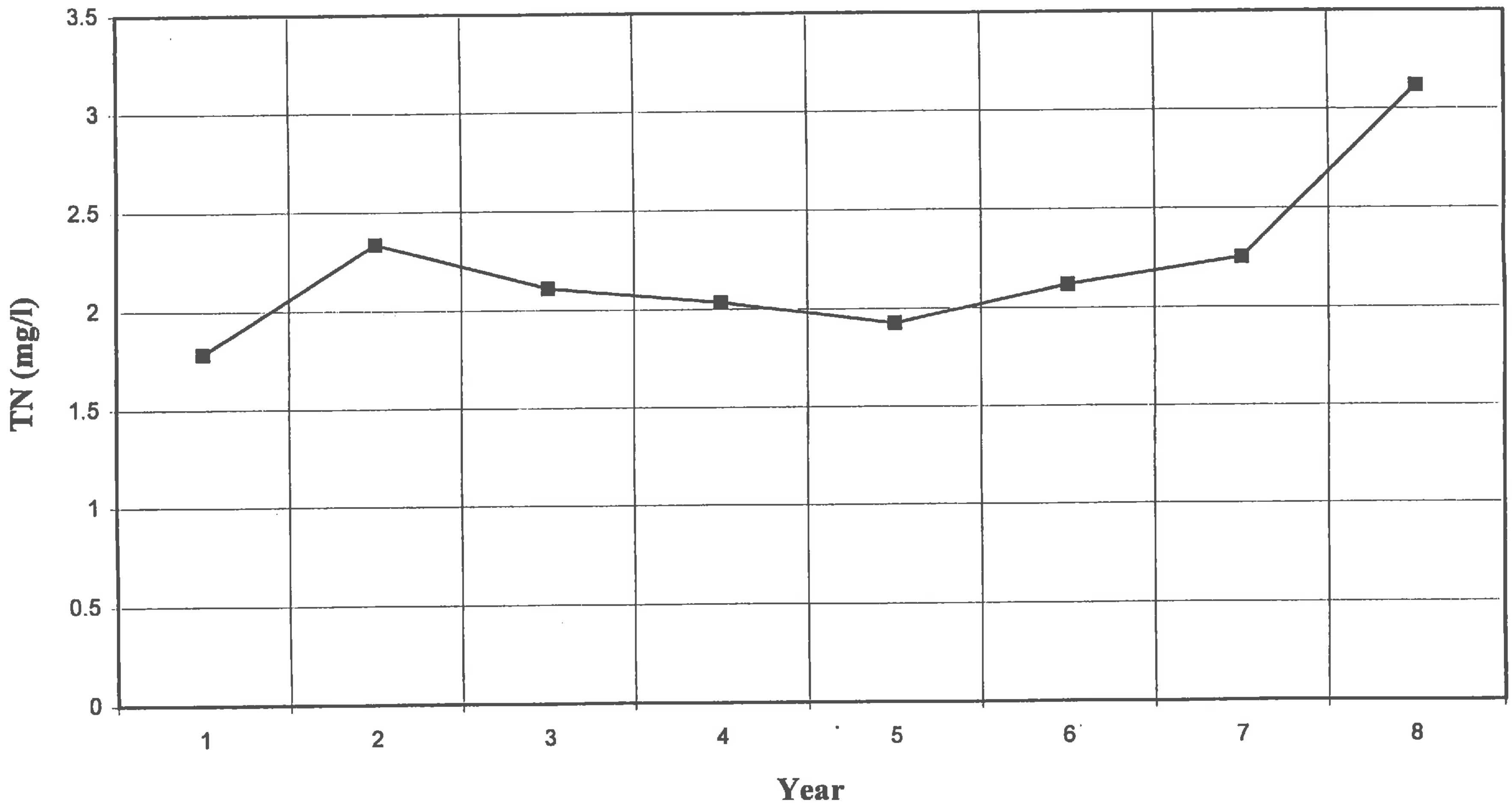


Figure 2-5. Trend in Lake Seminole annual average Total Phosphorus concentrations.

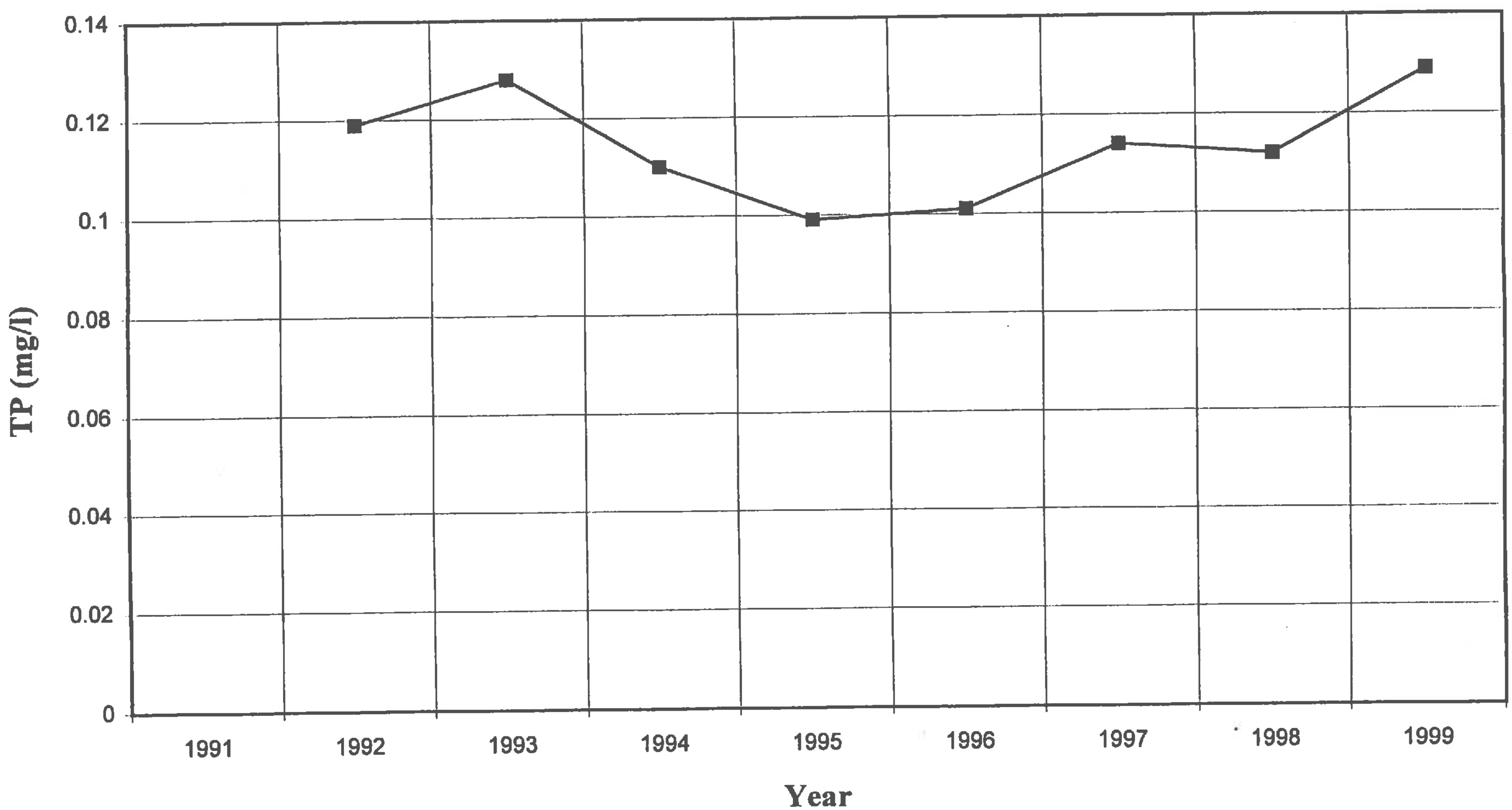


Figure 2-6. Trend in Lake Seminole annual average Secchi disk depths.

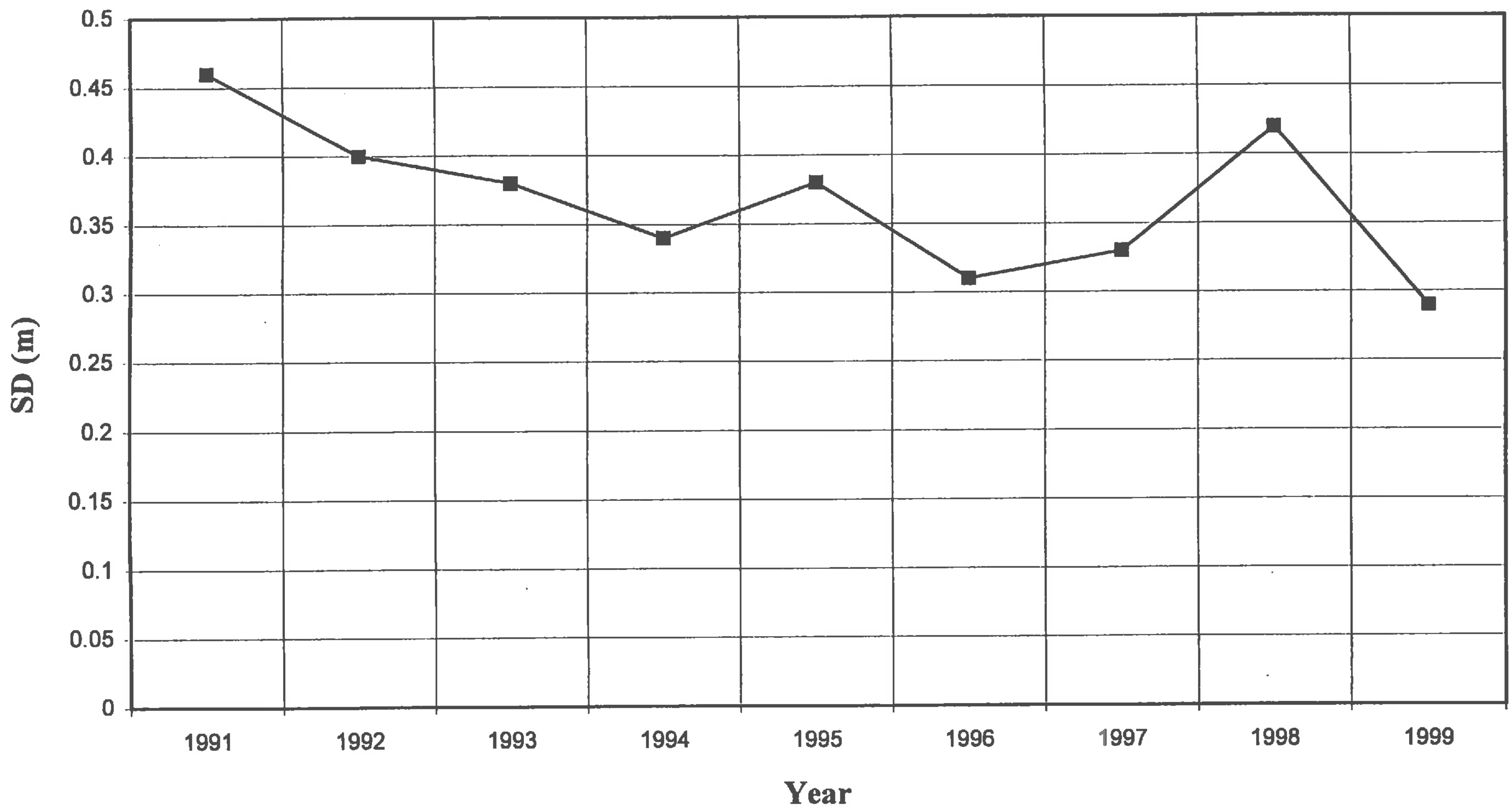


Figure 2-7. Trend in annual rainfall totals in the Lake Seminole watershed (Largo).

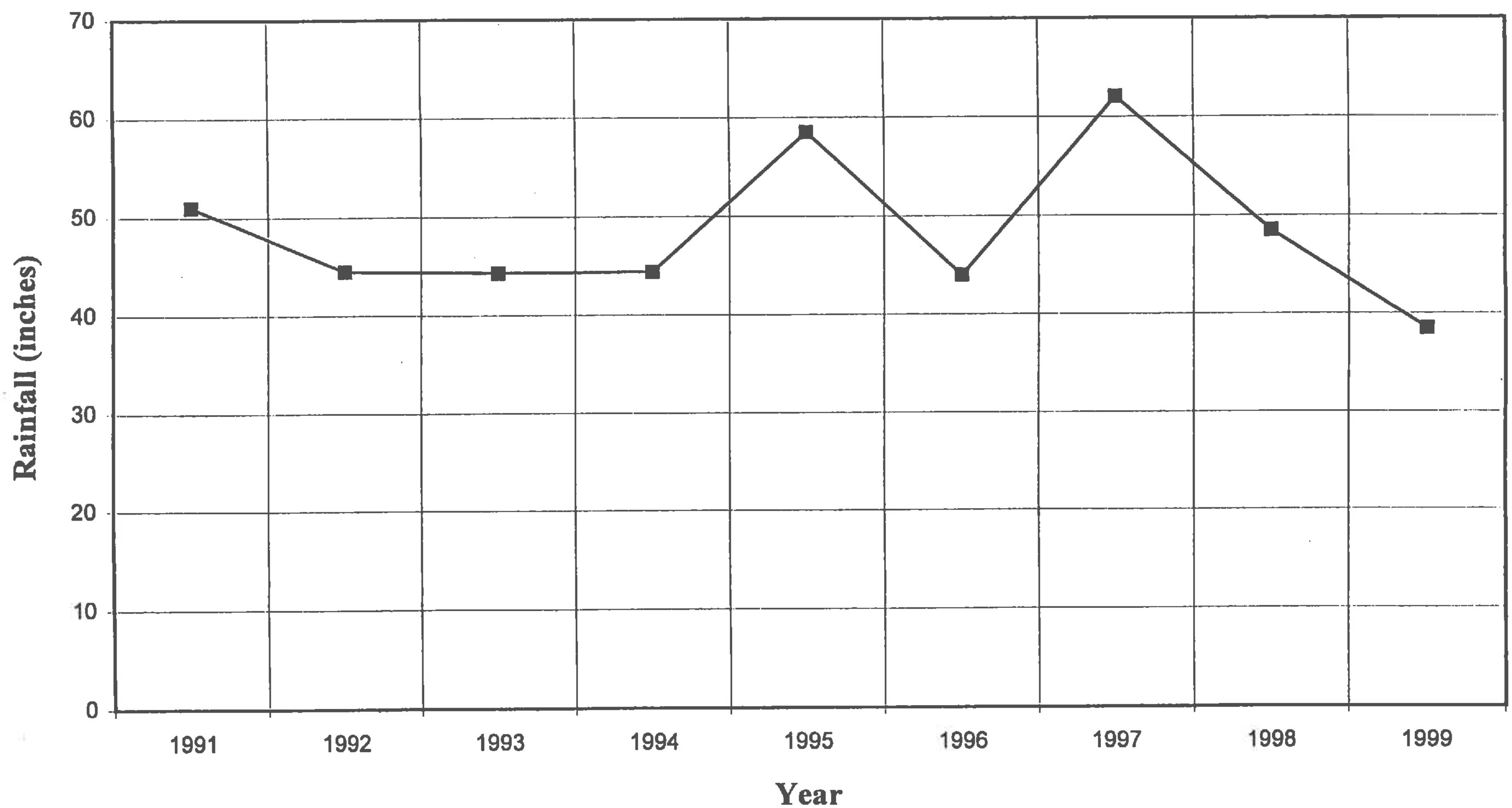


Figure 2-4 shows trends in annual average total nitrogen concentrations. Like chlorophyll-a, total nitrogen concentrations in Lake Seminole were relatively stable from 1991 through 1998, but increased substantially in 1999. As shown in Figure 2-5, total phosphorus concentrations decreased somewhat between 1993 and 1995, but have been on the increase since 1995.

Figure 2-6 shows trends in the annual average Secchi depth. Secchi depth in Lake Seminole has generally decreased since 1991. In 1999, the mean monthly Secchi depth was 0.29 meters, the lowest during the nine year reporting period. As an indicator of water transparency, Secchi depth values are generally inversely related to chlorophyll-a concentrations. Secchi depth values less than about 0.5 meters generally represent conditions that are severely light limiting for aquatic macrophytes, including desirable species such as eel grass.

Figure 2-7 shows trends in annual rainfall totals in the Lake Seminole area (Largo) for the period 1990-1999. As shown, 1995 and 1997 were the wettest years during this period of record, with 1997 being a documented "El-Nino" year during which most of the rainfall occurred during the winter months. Conversely, 1990 and 1999 were the driest years during this period. Given the lesser 1999 rainfall total, the observed increase in chlorophyll-a concentrations in 1999 cannot be readily explained in terms of increased external nutrient loads from stormwater runoff.

Although trophic state concepts have been in existence for some time, much controversy has existed over the terminology, the precise definition of various trophic state classes, and the development of an ecologically meaningful and widely accepted quantitative procedure for determining trophic state. In general, the most widely accepted trophic state index for Florida lakes is that developed by Huber et al. (1982). This index is unique in that it was developed specifically for Florida lakes, and thus recognizes and assimilates various characteristics (e.g. well-mixed, nitrogen limiting conditions) generally not accommodated in trophic state indices developed for temperate lakes. The Florida lakes index is calculated differently for nitrogen limited, phosphorus limited, and nutrient balanced lakes, and involves the calculation of separate sub-indices for total nitrogen, total phosphorus, chlorophyll-a, and Secchi depth. The overall trophic state index (TSI) for a lake is determined by combining the appropriate sub-indices to obtain an average for the physical, chemical, and biological features of the trophic state.

To determine the current trophic state of Lake Seminole, the most recent monitoring data available from Pinellas County, covering the period January through December 1999, were used. These most recent data corrected previous laboratory problems related to the lower detection limit which resulted in the skewing of monthly and annual TP means. The mean monthly concentrations of chlorophyll-a, TN, TP, and the mean monthly Secchi depth, for this time period are as follows:

- Chlorophyll-a (Chl-a) = 118.08 ug/l
- Total Nitrogen (TN) = 3.116 mg/l
- Total Phosphorus (TP) = 129.0 ug/l
- Secchi Depth (SD) = 0.29 m

As discussed by Huber et al. (1982), three classes of lakes can be described pursuant to the total nitrogen to total phosphorus ratio. They are as follows:

- Nitrogen-limited lakes = TN/TP < 10
- Nutrient-balanced lakes = 10 < TN/TP < 30
- Phosphorus-limited lakes = TN/TP > 30

Using the mean values shown above, the TN:TP ratio in Lake Seminole is **24.16**, making it a nutrient-balanced lake, at least under current conditions. Therefore, the TSI for nutrient balanced lakes is appropriate, and is defined as:

TSI(AVE) = 1/3 [TSI(Chl-a) + TSI(SD) + 0.5[TSI(TPB) + TSI(TNB)]]

Where TSI(Chl-a), TSI(SD), TSI(TPB), and TSI(TNB) are sub-indices for chlorophyll-a, Secchi depth, TN nutrient-balanced, and TP nutrient-balanced, respectively. These sub-indices are given and solved as follows:

- TSI(Chl-a) = 16.8 + (14.4 ln Chl-a) = **85.51**
- TSI(SD) = 10 [6.0 - (3.0 ln SD)] = **97.14**
- TSI(TNB) = 10 [5.6 + (1.98 ln TN)] = **78.50**
- TSI(TPB) = 10 [(1.89 ln TP) - 1.84] = **73.45**

With the values of all sub-indices known, TSI(AVE) for Lake Seminole can be solved as follows:

- TSI(AVE) = 1/3 [62.47 + 59.70 + 0.5 (57.15 + 52.24) = **86.21**

Therefore, the calculated current trophic state index for Lake Seminole for the period January through December 1999 is **86.21**. It should be noted that in other lakes where tannin colored waters are typical, investigators use modified versions of the above described trophic state index whereby water transparency (e.g., Secchi disk depth) is not considered. The integration of Secchi disk depth into the Lake Seminole TSI is appropriate, however, given the lack of tannin colored waters in the basin. The use of modified versions of the above described trophic state index, or other indices altogether, will yield different calculated TSI values which may lead to confusion with regard to the establishment of defensible resource management and pollutant load reduction goals. Therefore, it is recommended that the above described form of the Florida lakes TSI, as derived by Huber et al. (1982), be used for all comparative TSI calculations for Lake Seminole.

A primary issue regarding the application of the TSI to the classification of Florida lakes for management purposes is the selection of a critical TSI value, or a value above which the lake is considered to have trophic related problems. Based upon a review of data from 573 Florida lakes, and the subsequent classification of each, Huber et al. (1982) determined the TSI value of 60 to be a generally applicable critical value defining eutrophic conditions. Therefore, in consideration of the

Plan goals and objectives adopted by the Lake Seminole Advisory Committee, as well as a realistic understanding of the lake's urban setting, a TSI goal of 65 is considered appropriate for Lake Seminole.

Previous monitoring data from Lake Seminole collected during the 1990s have indicated that the lake has been consistently eutrophic, and has exhibited numerous trophic related problems, during the past decade. However, using the above described criteria with a calculated current TSI of 86.21, Lake Seminole can now be classified as severely hypereutrophic. Although it remains to be seen whether the recently observed hypereutrophic conditions will be maintained in the lake, it is likely that an aggressive program of both external and internal nutrient load reduction will be needed to meet a reasonable TSI target of 65.

2.2.2 Water and Nutrient Budgets

The first step in determining the pollutant loads to any lake is the establishment of a water budget. Flows carry pollutants into and out of lakes, and a meaningful analysis of lake eutrophication and most other water quality problems cannot be conducted without a quantitative understanding of lake hydrology. The basic water balance equation considers the following terms, typically expressed in units of acre-feet per year:

INFLOW + PRECIPITATION =
OUTFLOW + EVAPORATION + CHANGE IN STORAGE

For Lake Seminole, a storage volume of 3,420 acre-feet was calculated using an average depth of 5.0 feet and a surface area of 684 acres. Because the lake water level is currently managed within a relatively narrow range, this volume was assumed to be static for the purposes of this water budget analysis. Because the annual change in storage volume is considered to be zero, the water budget equation must be solved as follows:

INFLOWS + PRECIPITATION = OUTFLOWS + EVAPORATION

Figure 2-8 below graphically illustrates the water budget concept. The water budget calculated for Lake Seminole using 1997 data is summarized in Table 2-1.

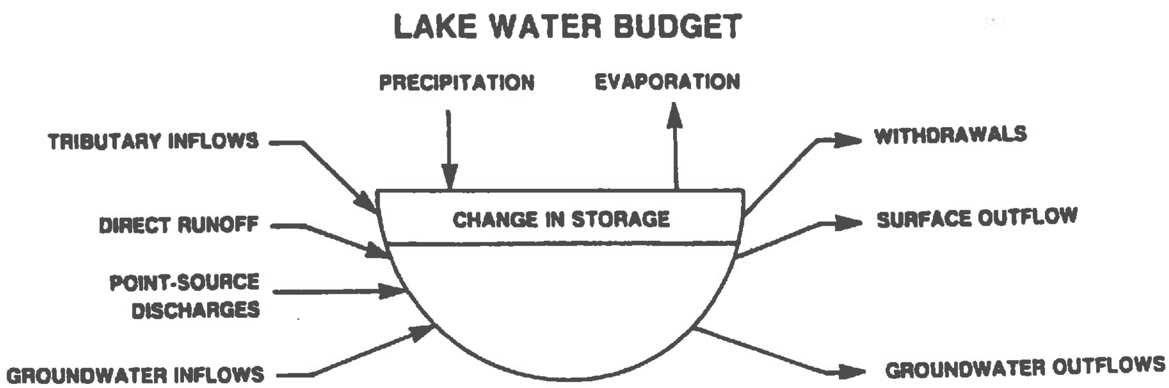


Figure 2-8. Graphical depiction of the lake water budget.

Table 2-1. Water budget for Lake Seminole calculated using 1997 data.

Inflows	cf	cfs	m^3	%
Direct Runoff (SWMM)	323,610,000	10.26	9,164,635	65.4%
Precipitation	168,013,404	5.33	4,758,140	33.9%
Surficial Aquifer	3,560,758	0.11	100,841	0.7%
TOTALS	**495,184,161**	**15.70**	**14,023,615**	**100.0%**
Outflows	**cf**	**cfs**	**m3**	**%**
Weir & Pipe Outflows	403,315,200	12.79	11,421,886	81.4%
Evapotranspiration	88,106,568	2.79	2,495,178	17.8%
Storage Loss	3,762,393	0.12	106,551	0.8%
TOTALS	**495,184,161**	**15.70**	**14,023,615**	**100%**
Lake Residence Time = 72 days				

Using the information developed in the water budget, lake nutrient budgets provide the cornerstone for evaluating lake eutrophication problems. The following terms are evaluated and are typically expressed in terms of tons or kilograms per year:

INFLOW LOADINGS =
OUTFLOW LOADING + NET SEDIMENTATION + CHANGE IN STORAGE

Nutrient budgets can be prepared for both nitrogen and phosphorus, although there are differences in some of the minor terms of the equation. The major components of inflow and outflow nutrient loads are essentially determined by multiplying appropriate nutrient concentration data with the respective inflow and outflow water volumes determined in the lake water budget.

The **net sedimentation** term defines the amount of nitrogen and phosphorus accumulated or retained in lake bottom sediments and/or the macrophyte standing crop. It reflects the net result of all physical, chemical, and biological processes causing vertical transfer of nutrients between the water column and the lake bottom.

For a given loading, lake water quality will generally improve as the magnitude of sedimentation increases because higher sedimentation leaves less available nutrients behind in the water column to stimulate algal growth. Because several complex processes are involved that vary spatially and

seasonally within a given lake, it is generally infeasible to measure net sedimentation directly. Accordingly, this term is usually calculated by obtaining the difference from the other terms, or estimated using empirical models; however, site specific data have been collected in Lake Seminole to enable a more direct estimate of net sedimentation of TN and TP (SWFWMD, 1992; PBS&J, 2000).

The **change in storage** term accounts for changes in the total mass of nitrogen and phosphorus stored in the lake water column between the beginning and end of the study period. Such changes would reflect changes in lake volume, average nutrient concentrations, or both.

As discussed above, there is no significant change in the volume of Lake Seminole on an annual average basis, and water quality monitoring has indicated relatively stable nutrient concentrations prior to 1999. Therefore, for the purposes of this analysis, the change in nutrient storage is considered to be close to zero allowing that the equation be solved as follows:

INFLOW LOADINGS = OUTFLOW LOADINGS + NET SEDIMENTATION

Figure 2-9 below graphically illustrates the nutrient budget concept with respect to phosphorus. The nutrient budgets calculated for Lake Seminole using 1997 data are summarized in Tables 2-2 and 2-3 for total nitrogen and total phosphorus, respectively.

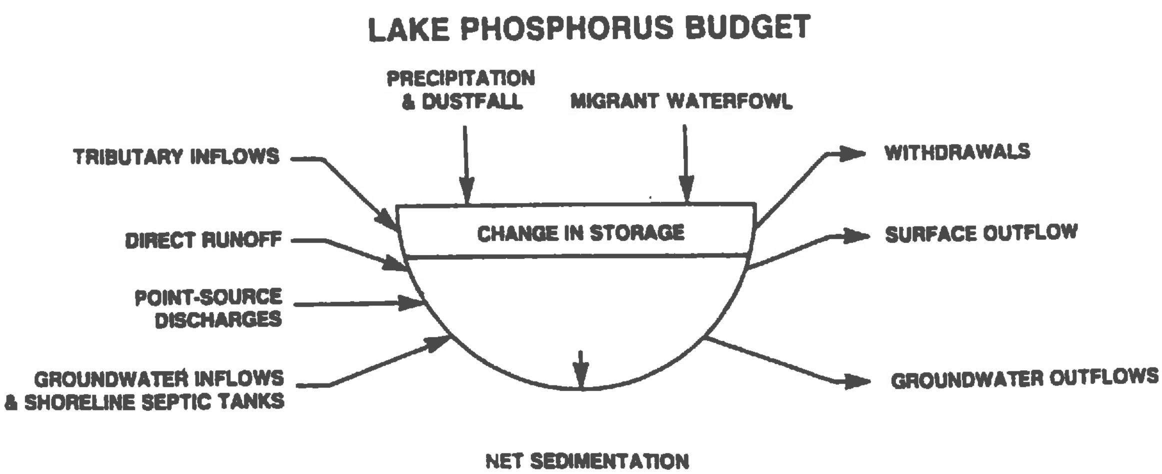


Figure 2-9. Graphical depiction of the lake phosphorus budget.

Table 2-2. Total nitrogen (TN) budget for Lake Seminole calculated using 1997 data.

Inflows	lbs.	tons	kg	%
Direct Runoff (SWMM)	31,168	15.58	14,135	36.8%
Precipitation	4,487	2.24	2,035	5.3%
Surficial Aquifer	131	0.07	60	0.2%
Undetermined Sources*	48,805	24.40	22,138	57.7%
TOTALS	**84,591**	**42.30**	**38,366**	**100.0%**
Outflows	**lbs.**	**tons**	**kg**	**%**
Weir & Pipe Outflows	55,820	27.91	25,315	66.0%
Sedimentation**	28,772	14.39	13,051	34.0%
TOTALS	**84,591**	**42.30**	**38,366**	**100.0%**

* Calculated undetermined N sources = (sum of N outflows) - (sum of N inflows from direct runoff, precipitation and surficial aquifer).

** Calculated N sedimentation = (calculated P sedimentation) x (measured sediment TN:TP ratio of 7.09).

Table 2-3. Total phosphorus (TP) budget for Lake Seminole calculated using 1997 data.

Inflows	lbs.	tons	kg	%
Direct Runoff (SWMM)	6,467	3.23	2,933	96.2%
Precipitation	248	0.12	112	3.7%
Surficial Aquifer	9	0.00	4	0.1%
TOTALS	**6,724**	**3.36**	**3,049**	**100.0%**
Outflows	**lbs.**	**tons**	**kg**	**%**
Weir & Pipe Outflows	2,666	1.33	1,209	39.6%
Sedimentation*	4,058	2.03	1,840	60.4%
TOTALS	**6,724**	**3.36**	**3,049**	**100%**

* Calculated P sedimentation = (sum of the P inflows) - (weir & pipe P outflows).

Based on the water and nutrient budgets summarized in Tables 2-1 through 2-3, the following conclusions can be made regarding the inflow and outflow of both water and the nutrients TN and TP in Lake Seminole.

- Direct runoff from the watershed land surface accounts for about 65.4% of the total annual hydrologic inflows. Direct precipitation on the lake water surface accounts for about 33.9% of the total annual hydrologic inflows. Groundwater seepage from the surficial aquifer accounts for the remaining 0.7%.

- Hydrologic discharges from the Lake Seminole weir structure and diversion pipe in the south lobe of the lake account for about 81.4% of the total annual hydrologic outflows. Evapotranspiration accounts for about 17.8% of the total annual hydrologic outflows. Storage loss due to sedimentation accounts for the remaining 0.8%.

- Direct runoff from the watershed land surface and direct precipitation on the lake water surface account for about 36.8% and 5.3% of the total annual TN inflows, respectively. Groundwater seepage from the surficial aquifer only accounts for about 0.2% of the total annual TN inflows.

- Approximately 57.7% of the total annual TN inflows are derived from undetermined sources. Internal nutrient recycling processes (e.g., sediment fluxes) could account for a substantial fraction of this TN mass. In addition, analyses of Lake Seminole phytoplankton populations conducted during the summer and fall of 2000 have revealed high concentrations of the nitrogen fixing blue-green alga *Cylindrospermopsis cuspis* (PCDEM, 2000). The observed dominance of nitrogen-fixing cyanobacteria indicates that the biological fixation of atmospheric nitrogen may be a major source of TN inflows to Lake Seminole.

- Other potential undetermined sources of nitrogen inflows could include illicit discharges to lake surface waters or the municipal drainage system, and sanitary sewer overflows or leaks. To date, however, no direct evidence of such nitrogen sources has been discovered in Lake Seminole.

- Hydrologic discharges from the Lake Seminole weir structure and diversion pipe in the south lobe of the lake account for about 66.0% of the total annual TN outflows. Sedimentation accounts for the remaining 34.0% of the total annual TN outflows.

- Direct runoff from the watershed land surface accounts for about 96.2% of the total annual TP inflows. Direct precipitation on the lake water surface accounts for about 3.7% of the total annual TP inflows. Groundwater seepage from the surficial aquifer accounts for the remaining 0.1%.

- Hydrologic discharges from the Lake Seminole weir structure and diversion pipe in the south lobe of the lake account for about 39.6% of the total annual TP outflows. Sedimentation accounts for the remaining 60.4% of the total annual TP outflows.

2.2.3 Pollutant Loads

It should be noted that there are no permitted point source discharges in the basin, and the entire Lake Seminole watershed is served by central sanitary sewer facilities. Therefore, the water and nutrient budgets presented above underscore two very important points with respect to potential pollutant load reduction strategies for Lake Seminole:

- **stormwater runoff** represents the single most important source of external phosphorus loads to Lake Seminole; and

- **internal nutrient recycling** - including nitrogen fixation by blue-green algae and sediment fluxes - constitutes a substantial cumulative nitrogen load to Lake Seminole surface waters.

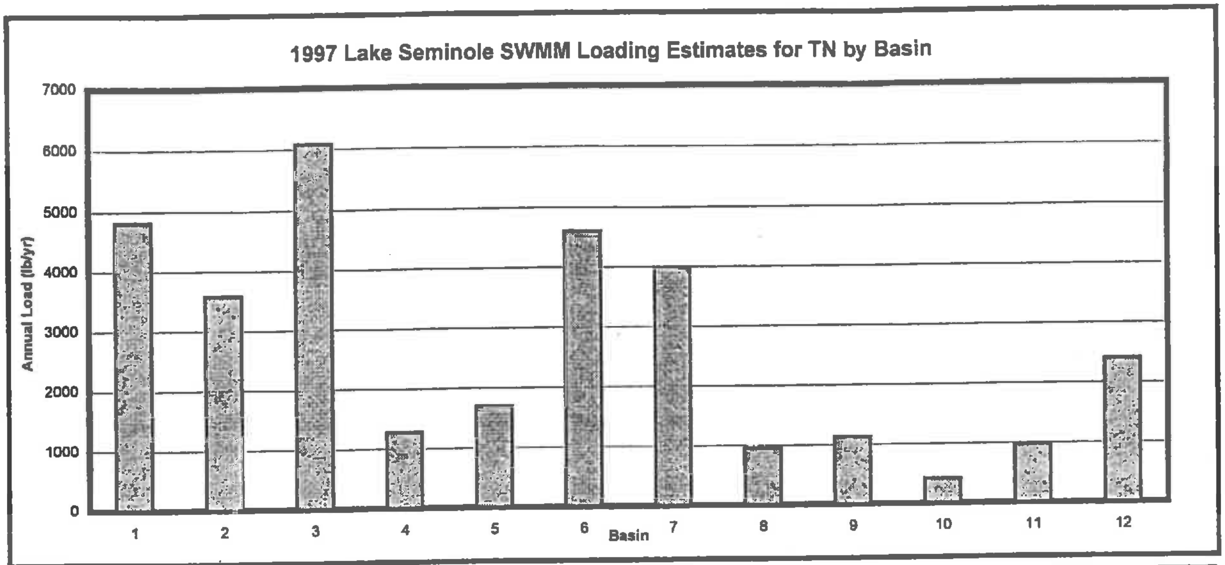
Stormwater Runoff

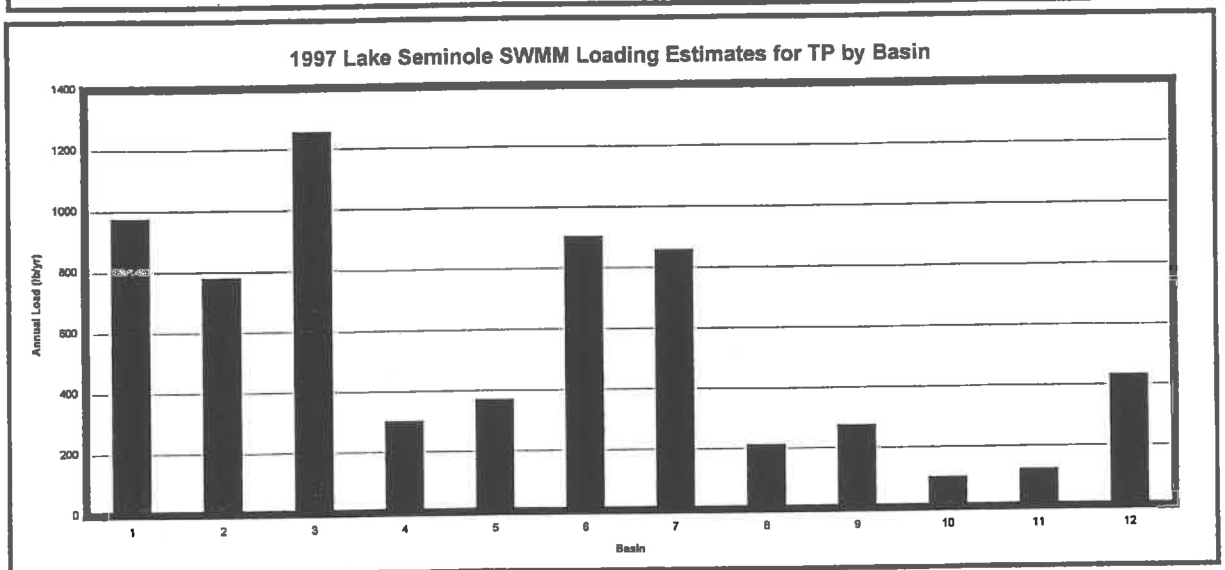
As part of the planning process, modeling of stormwater runoff using the SWMM model was conducted to determine those major sub-basins contributing the highest nonpoint source pollutant loads. The location of the major sub-basins in the Lake Seminole watershed are shown in Figure 2-10, whereas the modeled annual nonpoint source loads of TN, TP and total suspended solids (TSS) for each of the major sub-basins are summarized in Figure 2-11.

Using a ranking procedure which integrates modeled TN, TP, and TSS loads, the five priority major sub-basins, or those with the highest integrated nonpoint source pollutant loads, are listed below in Table 2-4 in order of decreasing priority.

Table 2-4. Major sub-basins with the highest integrated nonpoint source pollutant loads listed in order of decreasing priority.

Major Sub-basin	Drainage Area	%Total NPS Load	Priority Rank
3	654 acres	15%	1st
1	461 acres	14%	2nd
7	548 acres	12%	3rd
6	391 acres	12%	4th
2	478 acres	11%	5th





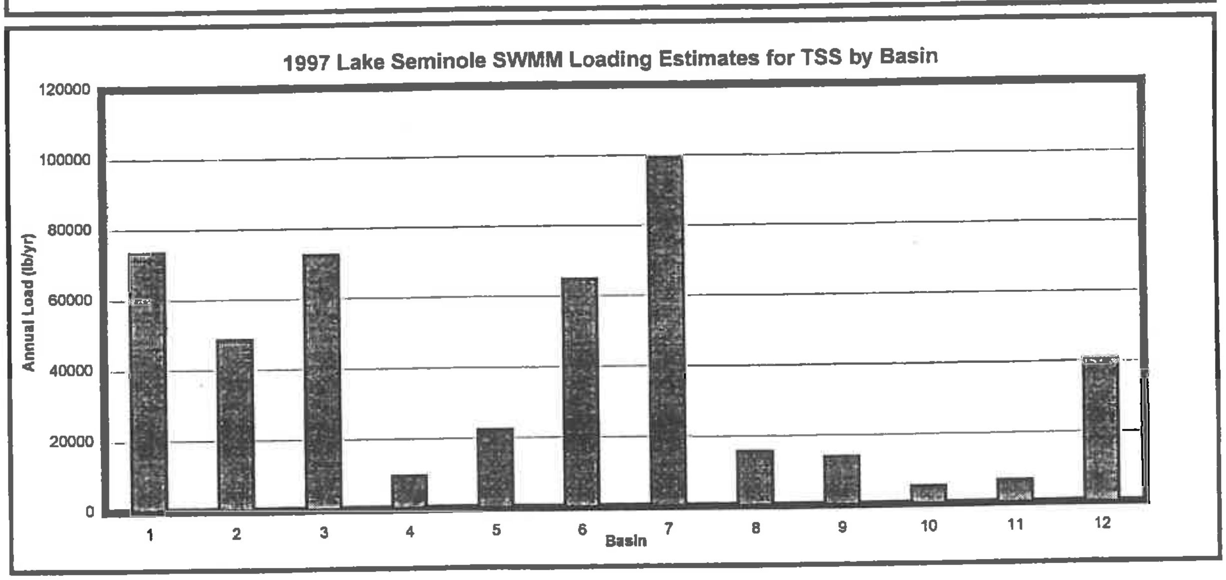


Figure 2-11. Pollutant load rankings of the major sub-basins.

Because high density urban land uses in the Lake Seminole basin are relatively ubiquitous, there are not significant differences in the unit area loads generated from each of the major sub-basins. Although there are minor differences in the age of the urban land uses in the various sub-basins, and whether or not on-site stormwater treatment is provided, these differences are generally not significant. Consequently, the major sub-basins with greatest contributing drainage area were generally the ones that ranked highest in terms of nonpoint source pollutant loads, as they deliver the greatest hydrologic and pollutant loads per unit rainfall.

Internal Nutrient Recycling

As shown in Table 2-2, it is estimated that undetermined sources accounted for approximately 24.40 tons, or about 57.7%, of the annual TN inflows to Lake Seminole in 1997. It should, however, be noted that the *undetermined sources* term was not measured but rather derived as the balancing term after accounting for modeled and measured inflows and outflows, and after accounting for an estimated sedimentation rate based on a measured sediment N:P ratio of 7.09. The estimated 24.40 tons of nitrogen from undetermined sources in Lake Seminole during 1997 equates to a rate of approximately 7.9 g $N/m^2/yr$. Under nitrogen limiting conditions, certain blue-green algae species (cyanobacteria) are capable of fixing atmospheric nitrogen to support their growth and reproduction. Measured nitrogen fixation rates in other hypereutrophic Florida lakes have ranged as high as 5.7 g $N/m^2/yr$, accounting for about 44% of the annual TN inflows, in Lake Tohopekaliga (Dierberg and Scheinkman, 1987). Therefore, based on the fact that nitrogen-fixing cyanobacteria are the dominant alga in Lake Seminole (SWFWMD, 1992; PCDEM, 2000), it is reasonable to assume that nitrogen fixation accounts for the majority of the undetermined sources of nitrogen inflows to Lake Seminole.

Upon a closer inspection of Tables 2-2 and 2-3 it can be seen that the TN:TP ratio of the measured and modeled inflows to Lake Seminole (excluding the calculated *undetermined sources* term in the nitrogen budget) is 5.32, whereas the TN:TP ratio for the measured outflows is 20.98. These findings indicate that the nutrient inflows should establish nitrogen limiting conditions, however, the outflows reflect nutrient balanced conditions. Since very little dissolved inorganic nitrogen (ammonia and nitrate/nitrite) or phosphorus (orthophosphate) is present in Lake Seminole surface waters, the measured TN:TP ratio in lake outflows represents that which has been assimilated in phytoplankton biomass. Therefore, the additional nitrogen assimilated by lake phytoplankton must be derived from internal sources which likely include both nitrogen fixation and sediment nitrogen fluxes.

It is also possible that some portion of the internally derived mass of nitrogen revealed in the lake nitrogen budget may actually represent an undocumented point source discharge to Lake Seminole. Such a discharge could include sanitary sewer leaks or overflows, or an illicit discharge(s) to lake surface waters or municipal storm sewer systems. It should be noted, however, that no direct evidence of an undocumented or illicit point source discharge has been discovered to date, and the presence of such an external pollutant source is not needed to explain the observed conditions and nutrient budgets. Nonetheless, Pinellas County should continue to investigate the possible existence of an undocumented point source discharge to Lake Seminole.

If subsequent investigations further confirm that the majority of the undetermined nitrogen inflows to Lake Seminole are attributable to internal nitrogen fixation, then the most effective approach to improving water quality and reducing the dominance of cyanobacteria will involve management actions that drive the lake towards phosphorus limitation and away from nitrogen limitation. Examples of such management actions include reduction of external phosphorus loads (e.g., enhanced stormwater treatment), and the removal or inactivation of sediment phosphorus stores (e.g., lake dredging). Other effective means of reducing the dominance of cyanobacteria include improving internal circulation and reducing residence time of lake surface waters.

It should also be noted that the nutrient budgets presented above indicate that a substantial mass of nitrogen, estimated at 27.91 tons per year for 1997, is discharged from Lake Seminole downstream to Boca Ciega Bay. Restoring the assimilative capacity of Lake Seminole would not only improve trophic conditions in the lake, but also in the downstream estuarine receiving waters of Boca Ciega Bay, a management segment of Tampa Bay.

2.3 Lake Sediments

As part of the planning process, a characterization study of Lake Seminole sediments was conducted (BCI, 1997). The final report from this effort is contained in Appendix 1 of this document.

Based on a bathymetric survey and laboratory analyses of sediment physical characteristics conducted as part of the planning process, Lake Seminole is estimated to contain a total of about 4.9 million cubic yards of unconsolidated sediments (PBS&J, 2000). Of this total, approximately 800,000 cubic yards is considered to be low density, organic silt (e.g., muck) which is located primarily in the north lobe and the "narrows" area, and in deeper isolated pockets of the south lobe, of the lake (PBS&J, 2000). These sediments are probably less than 100-150 years old (Schelske et al., 1991; in SWFWMD, 1992), and are composed predominantly of organic silts derived from the deposition of dead phytoplankton cells accumulated since the creation of Lake Seminole in the mid-1940s.

In addition to these low density flocculent muck sediments, this work also confirmed the presence of another approximate 130,000 cubic yards of highly organic, fibrous sediments located along the periphery of the lake (PBS&J, 2000). The majority of this material is on the east shore of the lake, but several large isolated pockets also occur along the west shore. These sediments are also relatively young in origin, and were originally derived from the accumulation of organic detritus in the historic mangrove swamps that were flooded with the construction of the lake. Since the lake was constructed, additional fibrous organic sediments have developed along the same shoreline areas through the accumulation of organic detritus from the decomposition of nuisance aquatic vegetation, predominantly cattails and primrose willow. The remaining unconsolidated sediment mass is primarily fine grained sands. Clays make up a very small fraction of the sediment mass in Lake Seminole (PBS&J, 2000). Chemical testing has indicated that Lake Seminole sediments do not contain toxic concentrations of heavy metals or anthropogenically derived organic compounds (PBS&J, 2000).

Figure 2-12 shows a bathymetric map of Lake Seminole indicating the depth of the water column. Figure 2-13 shows a map of the sediment thickness contours, or the difference between the sediment surface and the lake hard bottom. Figure 2-14 shows the muck thickness contours, or the difference between the sediment surface and the bottom of the muck layer, as well as the deposits of highly organic fibrous sediments along the shoreline of the lake. This latter figure essentially indicates the location of the problematic sediments potentially targeted for removal from Lake Seminole.

Both the low density flocculent sediments and the highly organic fibrous sediments are potentially problematic in Lake Seminole. Due to the shallowness of Lake Seminole, the low density flocculent sediments are easily resuspended by turbulent wave energy, especially those located in the "narrows" between the north and south lobes. This is demonstrated by a lack of reliable stratigraphy in sediment cores taken from this area (Schelske, 1991; in SWFWMD, 1992). Organic deposits in the north and south lobes show more reliable stratigraphy and are probably less prone to resuspension (Schelske et al., 1991; in SWFWMD, 1992).

The resuspension of low density flocculent sediments due to turbulent wave energy (e.g., generated by wind or powerboat wakes) has the potential to cause reduced water transparency and compromised recreational experiences, at least in localized areas. Although the direct contribution of sediment resuspension to reduced water clarity has not been quantified, there is strong anecdotal evidence that it contributes significantly to the very poor transparency observed in Lake Seminole during and following periods of high wind.

The low density flocculent sediments are also likely to be a major periodic source of water column nutrient enrichment, especially during the summer months when high bacterial respiration and high water temperatures can lead to low dissolved oxygen or hypoxia at the sediment/water column interface. Hypoxia at the sediment/water column interface, in turn, can cause chemical changes in the surface layer of the sediments which may facilitate the release of elemental phosphorus into the overlaying water column.

Schelske et al. (1991; in SWFWMD, 1992) concluded that nutrient release rates from Lake Seminole sediments may be a significant factor in the nutrient budgets of the lake. They measured nitrogen and phosphorus release rates from *in-vitro* sediment cores and found that N release rates ranged from 0.117 to 7.698 g/m2/yr ($\bar{x}$ = 3.705), and P release rates ranged from 0.360 to 2.218 g/m2/yr ($\bar{x}$ = 0.824). They compared these experimentally derived rates to "dangerous external loading rates" published by Vollenweider (1968) for lakes with a <5m mean depth and found the N release rate to be up to 6 times higher, and the P release rate to be up to 17 times higher, than the "safe" release rates for shallow lakes. The authors caution that the experimentally derived sediment nutrient release rates may represent maximum release rates caused in part by the removal of the sediment column from the lake bottom, and recommend that these rates be verified using alternative methods such as a nutrient loading model.

Figure 2-12. Bathymetric contours in Lake Seminole. (GIS map)

Figure 2-13. Sediment thickness contours in Lake Seminole. (GIS map)

Figure 2-14. Muck thickness contours in Lake Seminole. (GIS map)

Using the mean N and P sediment release rates published by Schelske et al. (1991; in SWFWMD, 1992), the annual N and P fluxes to the lake surface waters are calculated to be 10,374 kg N/yr, and 2,307 kg P/yr, respectively. Compared to the nutrient budgets summarized in Tables 2-2 and 2-3, it can be seen that the measured sediment N flux of 10,374 kg N/yr could account for as much as 47% of the calculated N load attributed to the *undetermined sources* balancing term in the Lake Seminole nitrogen budget. Similarly, the measured sediment P flux of 2,307 kg P/yr could account for as much as 75% of total calculated P load. In addition, waterbody modeling using WASP5 conducted as part of the planning process (see Chapter 3) indicated that sediment N and P fluxes in these orders of magnitude are needed to calibrate the model so that the observed water quality conditions in Lake Seminole are accurately simulated.

Schelske et al. (1991; in SWFWMD, 1992) point out that their measured sediment nutrient release rates were highly variable depending upon the sediment type, and that lakewide estimates of sediment nutrient fluxes should be based on an assessment of proportional areal coverages of organic versus sandy sediments. Nonetheless, these findings clearly suggest that sediment nutrient fluxes potentially constitute a very significant component in the lake nutrient budgets.

In addition to contributing to water quality problems, the substrate provided by these low density flocculent sediments is generally not conducive to the establishment and proliferation of desirable submerged aquatic vegetation. Similarly, the highly organic fibrous shoreline sediments preclude the establishment and proliferation of desirable emergent aquatic vegetation. More importantly, thick accumulations of these sediments in the lake littoral zone severely limit the shallow bottom area available for sport fish spawning. Although there is no evidence that the highly organic fibrous shoreline sediments contribute to water quality problems in the lake, they do compromise shoreline recreational uses and aesthetics through the combined effect of sustaining extensive stands of nuisance aquatic vegetation as well as limiting sport fish spawning.

In summary, the sediments in Lake Seminole constitute both a water quality problem and a habitat problem. At least a partial removal of the more problematic sediment types in the lake is indicated by the available data to meet the defined lake and watershed management goals.

2.4 Aquatic Vegetation

As discussed in Section 2.1, the mangrove and tidal marsh vegetation that originally existed in Long Bayou was flooded with the creation of Lake Seminole. Therefore, the aquatic vegetation communities of Lake Seminole began with conversion of tidal wetlands to freshwater emergent and submerged aquatic vegetation.

The earliest documented survey of aquatic vegetation in Lake Seminole was conducted in 1988 by the Florida Department of Environmental Protection (FDEP). The FDEP conducted follow-up surveys in 1990, 1992, 1993, 1994, and 1995. These surveys were semi-quantitative in nature, and

were conducted to estimate the relative cover of major desirable and nuisance species in the lake. The results of these surveys are summarized in Tables 2-5 and 2-6. The FDEP has not conducted any additional aquatic plant surveys on Lake Seminole since 1995.

As part of the planning process, an assessment of in-lake and watershed habitats was conducted. Figure 2-15 below shows the current distribution of major plant communities in Lake Seminole and its watershed.

Table 2-5. Estimated coverages of major nuisance and desirable species in Lake Seminole, as reported by FDEP for the years 1988-1995.

Year	Cattails acres	*Hydrilla* acres	*Vallisneria* acres
1988	68	86	28.0
1990	107	277	4.1
1992	110	0.5	13.2
1993	85	0.0	No Survey
1994	76	0.1	7.1
1995	61	0.0	4.2

The coverage and density of the exotic *Hydrilla* was a major concern in Lake Seminole during the late 1980s. As shown in Table 2-5, the coverage of *Hydrilla* rapidly expanded from 86 acres in 1988 to 277 acres in 1990. In response to this concern, the Florida Game and Freshwater Fish Commission released approximately 7,800 triploid grass carp into the lake between 1988 and 1991 with the objective of controlling the continued expansion of *Hydrilla*. Since then, the coverage and density of *Hydrilla* has declined to the point where its presence has been almost completely eradicated.

The subsequent harvesting of the *Hydrilla* crop by grass carp in the early 1990s clearly had a significant impact on the trophic state of Lake Seminole. This can be seen in the elevated TN, TP, and Chlorophyll-a concentrations that occurred in the lake during 1993, and the declining Secchi disk depths beginning in 1991 (see Figures 2-3 through 2-6). It can be assumed that a significant portion of the nutrient mass contained in approximate 277 acres of *Hydrilla* present when the carp were introduced was converted to carp waste, and subsequently to inorganic forms of N and P available for algal uptake. Huber et al. (1982) note that in many Florida lakes an inverse relationship generally exists between macrophyte coverage and phytoplankton (expressed as chlorophyll-a). Although phytoplankton were certainly a major source of primary production in Lake Seminole prior to 1991, the introduction of carp likely precipitated a major trophic shift from a macrophyte dominated system towards the algal dominated system that is present today.

Table 2-6. Results of the 1995 FDEP aquatic plant survey of Lake Seminole.

Scientific Name	Common Name	Acres
Alternanthera philoxeroides	alligator weed	0.1
Bacopa monnieri	smooth water-hyssop	0.1
Brachiaria mutica	para grass	0.6
Colocasia esculenta	wild taro	1.1
Cyperus spp.	sedge	0.1
Echinochloa spp.	barnyard grass	0.1
Eichornia crassipes	water hyacinth	0.2
Eleocharis interstincta	giant spikerush	0.1
Hibiscus spp.	hibiscus	0.2
Hydrocotyle spp.	pennywort	0.3
Lemna spp.	duckweed	0.1
Ludwigia peruviana	primrose willow	5.4
Nuphar luteum	spatterdock	0.1
Nymphaea odorata	fragrant water-lilly	0.6
Panicum repens	torpedo grass	1.2
Polygonum hydropiperoides	smartweed	0.2
Pontederia cordata	pickerelweed	0.3
Sagittaria lancifolia	lanceleaf arrowhead	0.4
Sagittaria latifolia	common arrowhead	0.1
Salix caroliniana	willow	3.5
Salvinia minima	water fern	0.1
Scirpus cubensis	burhead sedge	0.1
Scirpus californicus	giant bulrush	0.2
Typha spp.	cattail	61.4
Vallisneria americana	eel grass	4.2

During the mid-1990s, Pinellas County launched an ongoing mechanical harvesting program to remove cattails (*Typha spp.*) from the lake shoreline. The density of cattails had been determined to be excessive to the extent that waterfront views and shoreline recreational opportunities were being precluded. The harvesting program has been effective at removing dense problematic cattail stands in certain strategic locations around the lake.

Today, diverse populations of desirable native aquatic vegetation, both emergent and submergent, are essentially lacking in Lake Seminole, largely as a result of grass carp and mechanical harvesting of macrophytes, shoreline hardening, and the light limiting environment caused by excessive algal growth in the water column. In addition to these stressors, the maintenance of static water elevations in the lake by the existing weir outfall structure has contributed substantially to the proliferation of monotypic stands of cattails, primrose willow, and carolina willow; and has led to substantially reduced plant diversity in the lake littoral zone. Furthermore, accumulated flocculent sediments in many portions of the lake preclude the establishment of rooted macrophytes due to substrate limitations.

2.5 Fisheries

The freshwater sport fisheries in Lake Seminole developed slowly following the creation of the lake in the mid-1940s. In 1963 Lake Seminole was designated by the Florida Game and Freshwater Fish Commission (FGFWFC) as an official Fish Management Area which obligated this agency to conduct periodic monitoring of the sport fisheries as well as perform various fisheries management activities.

The main source of information about the early biological record of Lake Seminole is from the files and reports prepared by the FGFWFC. Records date back to the 1960s and concentrate mainly on the health of the lake fishery, although recommendations were made regarding the general improvement of the lake ecosystem.

During the late summer and early fall of 1960 through 1963, Lake Seminole was treated with rotenone for species control of threadfin shad, whose numbers were considered too high for healthy sport fish community balance. In 1965, the primary catches by commercial fisherman were brown bullhead and channel catfish (Phillipy, 1965). In addition, the largemouth bass population was rated as excellent and Lake Seminole had one of the highest standing crops per acre in west central Florida (Ware, 1965). By 1968, however, bass fishing success had declined, coinciding with another increase in the shad population (FGFWFC, 1968).

The FGFWFC (1968) also discussed the probability of Lake Seminole becoming highly eutrophic and degraded, and comparisons with nearby Lake Maggiore were made. Recommendations were made for remedial measures to prevent further water quality degradation including the elimination of domestic sewage discharges to the lake, and the preservation of existing aquatic vegetation to help retard the eutrophication process. The sewage effluent involved was from a secondary treatment

plant operated by the City of Largo which discharged into a drainage ditch and flowed into the channelized portion of Long Creek north of the lake. From there, effluent was pumped into the lake along with Long Creek flows. The plant is believed to have been shut down and replaced with a new treatment plant outside the watershed in 1971 (SWFWMD, 1992).

A few years later, the FGFWFC (1970) recommended that an extreme drawdown be conducted on the lake to reduce the organic muck on the lake bottom and to control shad populations. Control of the shad population using drawdowns appeared to have merit since the environment, rather than just the fish population, would be manipulated. However, the recommended extreme drawdown was never performed (SWFWMD, 1992). In 1982, in another attempt to further control shad populations, the FGFWFC stocked Lake Seminole with sunshine bass at a density of 10 fish per acre. (SWFWMD, 1992).

As discussed in Section 2.4 above, the proliferation of *Hydrilla* became an issue in Lake Seminole in the late 1980s. To control rapidly spreading *Hydrilla*, the FGFWFC stocked the lake with 350 triploid (reproductively sterile) grass carp (*Ctenopharyngodon idella*) in May 1987. An additional 350 carp were stocked in November 1988, and 2,100 more carp were added in October of 1989. In the spring of 1991, a second series of carp stockings were initiated with 2,000 fish added to the lake in February, and 3,000 more in March. By the summer of 1991, a total 7,800 grass carp had been introduced into Lake Seminole.

Later in 1991, the FGFWFC concluded that poor habitat seriously limits largemouth bass recruitment and sport fish quality in that it creates insufficient production of forage food items required by young bass, and reduces recruitment. In 1991, the total fish biomass averaged 306 kg/ha; however, largemouth bass standing crop was well below the carrying capacity of 23 kg/ha for this species (Champeau et al., 1991). In response to these findings, the FGFWFC recommended that a habitat restoration plan be implemented which included: 1) redesign of the outfall structure; 2) an extended lake drawdown to expose 50% of the bottom; 3) removal of organic sediments that cover the littoral shelf; and, 4) revegetation of the cleared areas with desirable macrophytes. In the early 1990s, Pinellas County initiated a redesign of the outfall structure.

Although the FGFWFC continued to assert that habitat restoration was the best long term solution to improving sport fishing in Lake Seminole, an innovative technique was attempted in 1995 to improve fishery quality. This technique involved the stocking of hatchery-produced adult sized bass that could immediately prey on the existing forage base. In September 1995 the FGFWFC first determined the relative abundance and species composition of the forage base using seines and gill nets. The abundance of forage of required size appeared sufficient to support stocked adult largemouth bass. The forage species collected included:

- gizzard shad;
- seminole killifish;
- small bluegill;

- threadfin shad;
- golden shiner;
- rio grande cichlid;
- black crappie; and
- brook silverside.

In November 1995, a total of 12,430 largemouth bass were stocked in Lake Seminole at a density of 43 fish/ha. Three months after stocking, the stocked bass density was only 0.11 fish/ha. The native bass population was also determined to be low at 8 fish/ha. It was concluded that handling stress accounted for most of the mortality of stocked largemouth bass; however, predatory birds and the inability of stocked bass to effectively forage probably claimed most of the surviving bass. Again, structural habitat in the form of emergent and submerged aquatic vegetation was considered to be critical to improving fishery quality in Lake Seminole.

In summary, the sport fishery in Lake Seminole has declined substantially since the mid-1960s when it was considered one of the most productive bass fishing lakes in west central Florida. The fish population structure has shifted from a dominance of carnivorous sport fish (e.g., largemouth bass, bluegill) to a dominance of planktivorous rough fish (e.g., gizzard and threadfin shad) in response to advancing eutrophication that has occurred over the past three decades. During the past decade, the decline of the sport fishery has been further exacerbated by the loss of submerged aquatic vegetation, and the structural habitat that it provides, due to the introduction of grass carp in Lake Seminole. In addition, the conversion by grass carp of the nutrient mass contained in macrophytes into inorganic forms available to phytoplankton has significantly contributed to the recent hypereutrophication of Lake Seminole.

2.6 Wildlife and Associated Habitat

This section provides an overview of the physical and geological features of the Lake Seminole watershed, and a discussion of the remaining vegetation communities and wildlife habitats that still exist within the basin.

2.6.1 Geology and Soils

Pinellas County is a peninsula, situated between the Gulf of Mexico and Tampa Bay. The peninsula lies within the larger physiographic province called the Gulf Coast Lowlands, an extensive coastal formation that includes much of the west coast of Florida (SWFWMD, 1988). Within Pinellas County these lowlands are generally characterized by relatively flat, often swampy lowlands along the coastal areas. Elevations generally range from sea level to 97 feet (Pinellas County Soil Survey, 1972). The Gulf Coast Lowlands typically have coastal barrier islands separated from the mainlands by bays and lagoons. These barrier islands were formed by erosion of headlands and sediment transport by longshore drift at the current sea level elevations. Pinellas County also exhibits gently

sloping marine terraces which were developed during periods of higher sea levels of the Pleistocene epoch. These marine terraces are generally referred to by the corresponding interglacial episodes and the respective sea level elevations above NGVD. Within Pinellas County these terraces are the Wicomico (100 feet), Penholoway (70 feet), and the Pamlico (25 feet). The Pinellas Ridge is one such marine terrace that extends from Seminole to Palm Harbor and reaches a maximum elevation of 97 feet (SWFWMD, 1988).

The geology of the Gulf Coast Lowlands is characterized by marine deposited sands and shelly sands of variable thickness overlaying Cretaceous and Tertiary carbonates, clays and evaporites deposited during times of higher sea level. The underlying geology of the Pinellas peninsula is sandy clays and marls of the Hawthorn Formation and the Tampa Limestone of the middle to early Miocene. These sandy clays and marls comprise the upper confining layers of the Floridan aquifer system and vary in depths from less than 25 feet in the north to areas with depths greater than 150 feet in southern Pinellas. These thick deposits in the south effectively restrict vertical movement of water between the surficial sands and the Floridan aquifer system (SWFWMD, 1988). The northern portion of the Pinellas Ridge exhibits Karst characteristics with sinkholes and a lack of surface drainage features. Karst features are largely absent from the southern extent of the Pinellas Ridge in the vicinity of the Lake Seminole watershed due to the underlying geology.

The western portion of the Lake Seminole watershed is defined by the Pinellas Ridge, an undulating, gently sloping, well drained sandy ridge of marine origin with poorly defined surface drainage features, which reaches an elevation of 55 to 70 feet. The eastern watershed is low, nearly level, poorly drained sandy soils of marine origin with a range of topographic elevation of between 5 and 15 feet. Topographic contours in the Lake Seminole watershed are shown in Figure 2-16.

Two dominant soil associations exist within the Lake Seminole watershed. These include the Astatula-Adamsville Associations in the western ridge area, and the Myakka-Immokalee-Pomello Associations predominantly in the eastern watershed areas. The distributions of major soil types in the Lake Seminole watershed are also shown in Figure 2-16.

Astatula soils are excessively well drained sandy soils that occur mostly on upland ridges within the western portion of the watershed. These soils have very rapid permeability, very low available water capacity, low organic content, and low natural fertility. The water table in this soil series is generally at a depth of more than 60 inches. The natural vegetative communities occurring in these soils typically are: sand and slash pine, scrub oak, saw palmetto, and various scrubs and grasses. These soils are favored for citrus and improved pasture and are less suitable for more intense agriculture because of the low availability of water and low fertility. These soils can produce crops, ornamentals and grasses with adequate amounts of fertilizer and irrigation. Urbanization of these areas began in the 1920s and continues today, partly because of the well drained soils and lack of flooding. Also, these areas were prime for development because they were relatively large tracts of land that had been consolidated into citrus and improved pastures and were readily available for development.

Adamsville soils occur predominantly near the base of the sloping ridge, consisting of nearly level, poorly drained sandy soils that formed in thick deposits of acid marine origin. As with the Astatula series, these sandy soils have rapid permeability, very low water holding capacity, low organic content and low natural fertility. Water tables vary seasonally between 10 to 40 inches in depth. Some areas exhibit seepage during seasonally high rainfall. The natural vegetative regime occurring in this soil series includes pine, oak, palmetto, scrubs and grasses. As with the Astatula series, these soils were favored for citrus production and have experienced urbanization.

The soils of the Myakka-Immokalee-Pomello Association are characterized by broad flats between sloughs, low ridges and knolls within the eastern watershed. These areas have small natural drainage ways and shallow grassy ponds in their natural setting. These soils are generally poorly drained with moderate to low permeability, with a water table within 10 to 30 inches of the surface. Natural vegetation consists of saw-palmetto, scattered stands of slash pine, gallberry, oak and grasses. Water tolerant hardwood trees, scrubs and grasses grow in lower elevations. The seasonally high water table is the main limiting factor in urbanization. While the high water table is a restraint to development activities, improved drainage has allowed for extensive development in these soils (Pinellas County Soil Survey, 1972). Soils classifications in the Lake Seminole watershed are also shown in Figure 2-16 above.

2.6.2 Vegetation Communities

Historic Habitats

A review of Pinellas County aerial photographs dating back to March 1926 indicates that the natural vegetative communities within the watershed area had already been extensively impacted by agricultural (citrus groves and pasture) activities. These aerial photographs show extensive citrus grove activity along the Pinellas Ridge area, as well as cleared lands with drainage improvements where shallow ephemeral ponds in natural pine flatwoods were being ditched and drained to create improved pasture. Prior to agricultural development, these upland areas supported pine flatwoods with slash, sand, and longleaf pine, scrub oaks, saw palmetto and a variety of scrubs and grasses typical of coastal ridge communities of the Gulf Coast Lowlands.

Areas with undisturbed native upland vegetative communities were widely distributed across the watershed in the 1926 aerial photographs. Remnants and/or second growth native vegetation still exists on County-owned lands east of the lake and where native trees remain within residential subdivisions. Remnants of the old growth citrus trees, dating from this early period, can be found in the residential subdivisions west of the lake.

The native vegetation in what is now Lake Seminole, prior to the impoundment that created the lake in the 1940s, was a narrow strip of red, white and black mangrove fringe in the southern lake area, and salt barrens with myrtle fringes adjacent to the upland pine flatwoods. This shallow estuarine system would have been similar to the existing vegetative and estuarine communities within Long

Bayou south of Park Boulevard in the vicinity of the lake. No evidence of these estuarine communities currently exists within or adjacent to Lake Seminole today because of the transition to a freshwater environment. The pine flatwoods community existing east of the lake within Lake Seminole County Park is second growth on improved pasture.

The 1926 and 1957 historical aerial photographs showed several poorly defined drainage features in the western portion of the watershed. These drainage features appeared to be shallow seasonal stream beds with narrow vegetated floodplains, many of which had been channelized as part of the agricultural improvements in the areas. These drainage features have since been incorporated into the urban stormwater management system and are not evident on current (1994) aerial photographs.

Existing Habitats

As part of the planning process, existing vegetation communities within the watershed were assessed with respect to habitat function and quality. The characterization of upland and wetland habitats recognized that the watershed was highly urbanized and that the remaining habitat units were diverse in nature, widely distributed throughout the watershed, and consisted of small isolated remnants of historical vegetative communities that existed prior to the development of the area. The methodology developed to perform the evaluation included both research of historical conditions and field inspection of each habitat area to determine existing conditions. A total of 121 habitat units were evaluated in the watershed. The resulting habitat classifications in the Lake Seminole watershed are shown in Figure 2-15 above using a modified Level-III of the Florida Land Use Cover and Classification System (FLUCCS). Table 2-7 provides a summary of the acreage of the various habitats types in the watershed.

As shown in Table 2-7, two of the most dominant species within the watershed are Brazilian pepper, *(Schinus terebinthifolius)* and cattails *(Typha spp).* Brazilian pepper is pervasive throughout the watershed, in that it is present in almost all vegetative communities and exists as a monoculture in many areas. Cattails are present in almost all shallow open water areas within Lake Seminole and isolated wetland systems within the watershed. Other nuisance species observed within various vegetative communities included Australian pine *(Casuarina equisetifolia)*, melaleuca *(Melaleuca quinquenervia)*, air potato *(Dioscorea bulbifera)*, jacaranda *(Jacaranda mimosifolia)* and mimosa *(Albizia julibrisson)* trees.

In general, all remaining habitats in the watershed have been impacted by past or present land use activities. The typical impacts sustained were hydraulic improvements in the vicinity of the habitat including drainage activities, roads, or filling and grading activities for adjacent land uses. The dominant type of physical alterations observed was the deposition of spoil materials and rubbish and the clearing of native vegetation. Chemical impacts on both upland and wetland communities were evident in portions of the watershed. Habitats adjacent to roads or drainage features were receiving chemicals from urban stormwater runoff while certain wetland communities appeared to have been treated with herbicides to eradicate cattails.

Table 2-7. Summary of habitat classifications in the Lake Seminole watershed.

Habitat Type	FLUCCS Code	Associations	Frequency of Occurrence	Acreage
Parklands	185		3	41.297
Open Lands	190		7	44.036
Improved Pasture	211		1	1.483
Citrus Groves	221		2	42.661
Tree Nurseries	241		1	2.606
Shrub and Brushland	320		1	0.871
Pine Flatwoods	411		6	70.888
Longleaf Pine	412		1	5.449
Pine Mesic Oak	414		5	19.165
Brazilian Pepper	422	212, 425, 429, 439	22	49.944
Oak-Pine	423		3	6.238
Live Oak	427		11	18.488
Cabbage Palm	428		1	0.465
Wax Myrtle	429	422	17	50.634
Australian Pine	437		1	0.742
Mixed Hardwood	438		5	13.431
Streams and Waterways	510		1	0.437
Open Water Greater than 500 Acres	521		1	639.912
Open Water Less than 10 Acres	524		39	39.083
Wetland Forested Mixed	630		1	12.061
Vegetated Non-Forested Wetlands	640	422, 429	1	2.224
Freshwater Marsh	641		1	9.967
Disturbed Lands	740		1	0.213
Baseball Fields	1861		1	16.988
Field Nursery	2412		3	2.971
Cattail	6412		30	60.236
Spatterdock	6442		1	2.788

As depicted in Figure 2-15, the urbanization of the watershed, especially the western portion, has left relatively small remnants of the native upland and wetland vegetative communities among the urban mix of land uses. Larger habitat segments within the watershed include Lake Seminole County Park and associated County owned lands to the north of the park. These habitats are predominantly pine flatwoods with a wetland fringe of carolina willow and cattails on Lake Seminole.

The St. Petersburg Junior College (SPJC) site is an approximately 100 acre tract located west of 113th Street. Dominant habitats on this tract include a remnant pine and bay wetland community along with successional vegetative growth in upland portions of the site where agricultural old fields and orange groves once dominated. This site is currently planned for development as a new Seminole Campus of SPJC. The conceptual development plan appears sensitive to the remnant wetland community on site.

Pinellas County also owns the narrow strip of land on the northeastern portion of the lake between the lake and Seminole Bypass Canal. The vegetative communities in this area are impacted remnants of pine flatwoods to the south and an oak dominant community farther to the north. The remaining habitats are impacted ruderal communities dominated by Brazilian pepper, elderberry, dog fennel, and castor bean. A review of the historical aerial photographs indicated that this area was probably unimproved pasture with scattered pines and a remnant wetland drainage feature that has been severed by pasture ditching and the construction of the Seminole Bypass Canal.

The Pinellas County Sheriff's Complex on Ulmerton Road contains approximately 20 acres of habitat, predominantly maintained grass training areas. Portions of this site support a remnant pine flatwoods surrounding an old borrow pit that serves as a stormwater management facility for the adjacent land uses including stormwater runoff from Ulmerton Road. Both the pine flatwoods and the areas surrounding the pond have various levels of Brazilian pepper encroachment ranging from a few individual plants on the fringe of the pine flatwood areas to extensive monoculture within the open fields and surrounding the pond.

As part of the planning process, habitat distribution and disturbance patterns were evaluated to determine the potential for special habitat management sites or habitats suitable for enhancement or restoration. The general findings from this evaluation were that the urbanized nature of the watershed does not provide notable opportunity for wildlife corridors or dispersal areas. The remnant habitats in the watershed are small and fragmented to the point where an opportunity for a unifying ecological corridor is no longer viable. Some opportunities do, however, exist for recreational corridor connections between Lake Seminole County Park and the Pinellas Trail that extends north-south along the western watershed boundary.

Of the approximately 120 habitat units evaluated, a high percentage exhibit nuisance species invasion in varying degrees. Therefore, nuisance species removal coupled with the enhancement and restoration of the habitats within the watershed as a whole is a needed and important activity. It should be noted that the habitat coverage by one of the nuisance species - Brazilian pepper - is high

throughout the watershed. Because this species displaces viable native habitat, it should be controlled or removed so that habitats can ultimately be restored to their natural condition.

2.6.3 Wildlife

Table 2-8 provides a compilation of species observed during the field surveys plus species reported from various sources to occur within the area. This list probably represents a partial listing of wildlife in the Lake Seminole watershed, since common species and migratory waterfowl are not extensively identified. The dominant types of wildlife observed within the watershed were wading birds and waterfowl. In addition, numerous coastal and sea birds frequent the lake due to the proximity to the tidal waters of Boca Ciega Bay and the Gulf of Mexico.

As may be anticipated within a freshwater lake system the size of Lake Seminole, certain of the indigenous wildlife are listed species and require varying levels of protection. In total, eight (8) species are listed as species of special concern (SSC), two as threatened (T) and one as endangered (E) by the Florida Game and Fresh Water Fish Commission. The U.S. Fish and Wildlife Service identifies one species as endangered (E). The primary listed species within the watershed in terms of the level of protection afforded by the various listings is the southern bald eagle.

Two active bald eagle nesting sites exist within the watershed: one on the fenced parcel of County owned lands north of Lake Seminole County Park; and a second on the St. Petersburg Junior College tract west of 113th Street. The U.S. Fish and Wildlife Service's Southern Bald Eagle Guidelines typically require a 750 foot primary zone where no human activities can occur during nesting season from October through March yearly and a secondary zone of an additional 750 feet where certain restricted activities can occur.

Table 2-8. Wildlife species observed or reported to occur within the Lake Seminole watershed.

Common Name	Scientific Name	GFC	FDA	USFWS	CITES	Observed, or Reported
Snowy Egret	*Egretta thula*	SSC				R
Tricolored Heron	*Egretta tricolor*	SSC				R
Green Heron	*Butorides striatus*					O
Yellow Crowned Night Heron	*Nyctanassa violacea*					O
Great Egret*	*Casmerodius albus*					O
Great Blue Heron	*Ardea herodias*					O
Cattle Egret	*Bubulcus ibis*					O
White Ibis	*Eudocimus albus*	SSC				O
Sandhill Crane	*Grus canadensis pratensis*	T				R
Mallard	*Anas platyrhynchos*					O
Purple Martin	*Progne subis*					O
Roseate Spoonbill	*Ajaia ajaja*	SSC				R
Common Moorhen	*Gallinula chloropus*					O
Osprey	*Pandion haliaetus*				II	R
Little Blue Heron	*Egretta caerulea*	SSC				O
Southern Bald Eagle	*Haliaeetus leucocephalus*	T		E	I	O
Turkey Vulture	*Cathartes aura*					O
Wood Stork	*Mycteria americana*	E	E			R
Limpkin	*Aramus guarauna*	SSC				O
Boat-Tailed Grackle	*Quiscalus major*					O

Common Name	Scientific Name	GFC	FDA	USFWS	CITES	Observed, or Reported
Red Wing Black Bird	*Agelaius phoeniceus*					O
Mourning Dove	*Zenaida macroura*					O
Anhinga	*Anhinga anhinga*					O
Double-Crested Cormorant	*Phalacrocorax auritus*					O
Pileated Woodpecker	*Dryocopus pileated*					O
Downy Woodpecker	*Picoides pubescens*					O
Red-bellied Woodpecker	*Melanerpes carolinus*					O
Brown Pelican	*Pelecanus occidentialis*	SSC				O
Common Tern	*Sterna hirundo*					O
American Alligator	*Alligatoridae mississippiensis*					O
Southern Black Racer	*Coluber priapus*					O
Corn Snake	*Elaphe guttata*					O
Red Eared Slider	*Trachemys elegans*					O
Largemouth Bass	*Micropterus salmoides*					O
Bream	*Lepomis sp.*					R
Blue Gill	*Lepomis macrochirus*					R
Redear Sunfish	*Lepomis microlophus*					R
Channel Catfish**	*Ictalurus punctatus*					R

Common Name	Scientific Name	GFC	FDA	USFWS	CITES	Observed, or Reported
Sunshine Bass	*Morone saxatilis x M. chrysops*					R
Triploid Grass Carp	*Ctenopharygodon idella*					R
Tilapia	*Tilapia mossambica*					O
Gray Squirrel	*Sciurus carolinensis*					O
Marsh Rabbit	*Sylvilagus palustris*					O
Armadillo	*Dasypus novemcinctus*					O
Raccoon	*Procyon lotor*					O
Opossum	*Didelphis virginiana*					O

Notes:

GFC = Florida Game and Fresh Water Fish Commission
FDA = Florida Department of Agriculture and Consumer Affairs
USFWS = United States Fish and Wildlife Service
Cites = Convention on International Trade in Endangered Species of Wild Fauna and Flora
E = Endangered
SSC = Species of Special Concern
A = Anticipated to occur on site
O = Observed on site
R = Reported - incidental sighting by Pinellas County Park, PCDEM, or FGFWFC staff over extended observation period.
II = Appendix II Species (CITES)
C2 = A candidate for federal listing with some evidence of vulnerability, but for which not enough information exists to justify listing.
* Great Egret - formerly known as the "American Egret," and/or "Common Egret," this bird's official name in North America is now Great Egret.
* FGFWFC records indicate that Lake Seminole was stocked with channel catfish *(Ictalurus punctarus)* in 1966 and natural reproduction was documented two years later. Brown Bullhead *(Ictalurus nebulosus)* may also be present in the lake, but are not listed on current FGFWFC survey reports.

2.7 Recreation, Aesthetics, and Economic Valuation

The economic value of Lake Seminole to Pinellas County can be estimated by evaluating two interdependent variables - recreational use and aesthetic attributes. Recreational activities include the boating and fishing activities conducted on the lake as well as recreational visits to Lake Seminole County Park. Aesthetic attributes, on the other hand, can perhaps be best represented in increased property values for those residential and commercial properties located on the lake.

2.7.1 Recreation

The levels of use, potential areas of conflict, and the projected economic value of recreational activities have been assessed using three sources including the November 1992 Pinellas County Recreational Survey, the 1990-91 recreational survey by the Florida Game and Freshwater Fish Commission, and the historical visitor levels at Lake Seminole County Park.

The Pinellas County Department of Environmental Management conducted a user survey of Lake Seminole in November, 1992. The purpose of this survey was to evaluate the type of recreational activities being performed on the lake and the users' insight and preferences regarding the lake as a recreational resource. In total, 147 individuals participated in the survey over a 15 day period. The survey included both weekday and weekend visitors. The responses to this survey indicated that fishing is the primary activity with 62 responses, followed by boating (30 responses), jet skiing (21 responses), skiing (5 responses), and no specific water activities (29 responses). The individuals surveyed indicated that Lake Seminole was a primary recreational resource that they used an average of 61 days a year. The average number of hours spent on the lake during a typical day was estimated at 4.4 hours. The type of equipment used to pursue the recreational boating activities included an average boat length of 16.5 feet with a 98 horsepower engine.

The majority of lake users (91 percent) felt safe on the lake, however, a number of user conflicts were noted including problems with: jet skis (62 percent); water skiers (30 percent); fishermen (9 percent); boaters (2 percent); and non specified conflicts (9 percent). A total of 92 percent of user conflicts (jet skis 62 percent and water skiers 30 percent) were associated with the speed of the watercrafts. The problems created by boat speed include safety of operation and avoidance of accidents, wakes, and associated noise. In part, because of these user conflicts, 39 percent of the respondents felt that a speed limit or restricted speed zones are needed on the lake. The speed limit desired based on the survey was 29 miles per hour.

The fishermen using the lake indicated that bass was the primary species pursued (79 percent), followed by other types of fish (18 percent), and crappie (4 percent). A total of 55 percent of the fishermen surveyed felt that the fishing was good (21 percent) or fair (34 percent), while 45 percent, the largest single response group, felt that fishing was poor.

The FGFWFC also conducted a recreational user survey in 1990-91. The findings of this survey indicated that the type and relative popularity of recreational uses supported by Lake Seminole were: fishing (59 percent); boating (29 percent); skiing (9 percent); personal watercraft (2 percent); and sailing (1 percent). The total number of boats observed on the lake during the survey ranged from 0 to 46, with an average of 13 boats per survey. The highest number of boats observed on the lake during the survey was on weekends.

Sportfishing was the primary recreational use of the lake during the survey period, however, considering the size and urban location, angling pressure was lower than expected (210 hours/ha/year). The economic impact of the Lake Seminole fishery was estimated by FGFWFC at $520,000 per year. Bass anglers comprised 76 percent of the total fishing effort and had a poor success rate of 0.19 bass/hour. Annual catch rate was estimated at 17 bass/ha/year. Most anglers did not practice catch-and-release; 64 percent of all bass caught were kept, and only 23 percent of quality-size bass were recycled (FGFWFC, 1991).

Since these surveys were taken in the early to mid 1990s, perceived changes in lake recreational uses have become apparent. These include a significant increase in the number of personal watercraft and ultra-light aircraft on the lake during weekends and holidays, and a decline in fishing pressure. These changes may eventually cause conflicts with the more traditional uses due to the congestion and noise. This may be especially true with the projected increases in aesthetics and recreational potential once lake water quality and habitats have been restored through the actions recommended in this Plan. Frequent recreational surveys would be necessary to determine any increases in recreational conflicts resulting from these changes in use.

2.7.2 Aesthetics and Economic Valuation

As part of the planning process, an estimate of the economic value of Lake Seminole was made, with consideration of both direct and indirect economic benefits.

The economic value of Lake Seminole is largely recreation based. Pursuit of recreational activities results in expenditures for gas, food, beverages, bait and tackle. The cost of a recreational visit to Lake Seminole County Park is estimated at $3.50 per day, while the cost of a boating trip on the lake is estimated at $35.00 per trip. By applying these cost estimates to the number of recreational visits and boating trips, the total annual expenditures within the local economy accruing from recreational uses of Lake Seminole is estimated at $5,264,887. Sales and gas tax revenues from these recreational expenditures are estimated at $632,855 to state and local government (PBS&J, 1998).

The aesthetic value of the lake was calculated by estimating the increased property values of residents with views on the lake versus comparable properties within the watershed with no views. The increased property values for lands surrounding Lake Seminole, including the potential value of existing public lands if these were in private ownership, is $10,560,000. This increased

property value would contribute an estimated $224,000 annually in ad valorem taxes (PBS&J, 1998).

This analysis places the overall economic value of Lake Seminole at $16,123,000. This is an annualized figure that generates an estimated $856,855 in yearly taxes to state and local governments.

2.8 Flood Control

Section 2.1 above provides a brief history of Lake Seminole and the Seminole Bypass Canal. Following the creation of the lake in the mid-1940s, periodic flooding problems were experienced upstream of the lake, in the historic Long Creek basin. However, because the lake was hydrologically isolated from Long Creek flows, except for water pumped from the creek into the lake, flooding problems in the Lake Seminole basin were limited to small areas in the watershed where the local drainage infrastructure was inadequate.

As urbanization in the Lake Seminole area advanced during the 1960s and 1970s flooding problems became more frequent and severe in the upper Long Creek basin. By the mid-1970s, flooding concerns had become so great that construction of the Seminole Bypass Canal became a necessity. Since the construction of the Seminole Bypass Canal, flooding problems in the historic Long Creek basin have essentially been eliminated, and no additional flooding problems have been created in the Lake Seminole basin.

As part of the planning process, a review and update of the Pinellas County Master Drainage Plan for the Lake Seminole basin was conducted. Today, only minor flooding problems periodically occur in the Lake Seminole basin. These problems are limited to small areas where the local drainage infrastructure is inadequate. Figure 2-17 shows the location of identified flooding problem areas within the basin for the 25-year and 100-year flood. It should also be noted that the existing outfall structure at the south end of the lake is a fixed crest weir with an elevation of 5-feet NGVD. In the case of a coastal flood event, rising tidal waters and storm surges could overflow the structure and cause severe flooding in the low lying areas around the perimeter of the lake. These areas are, however, not depicted in Figure 2-17 due to the unpredictable elevation of a coastal storm surge.

Independent of the planning process, the Pinellas County Department of Public Works has initiated the design and permitting of a new outfall structure to replace the existing fixed crest weir. The new structure will be a slot gate design that will allow for lake levels to be fluctuated within an approximate range of 3-feet (e.g., between elevation 2.0 and 5.0, NGVD). This new outfall structure design was considered in the planning process as a means of controlling water levels for lake management purposes.

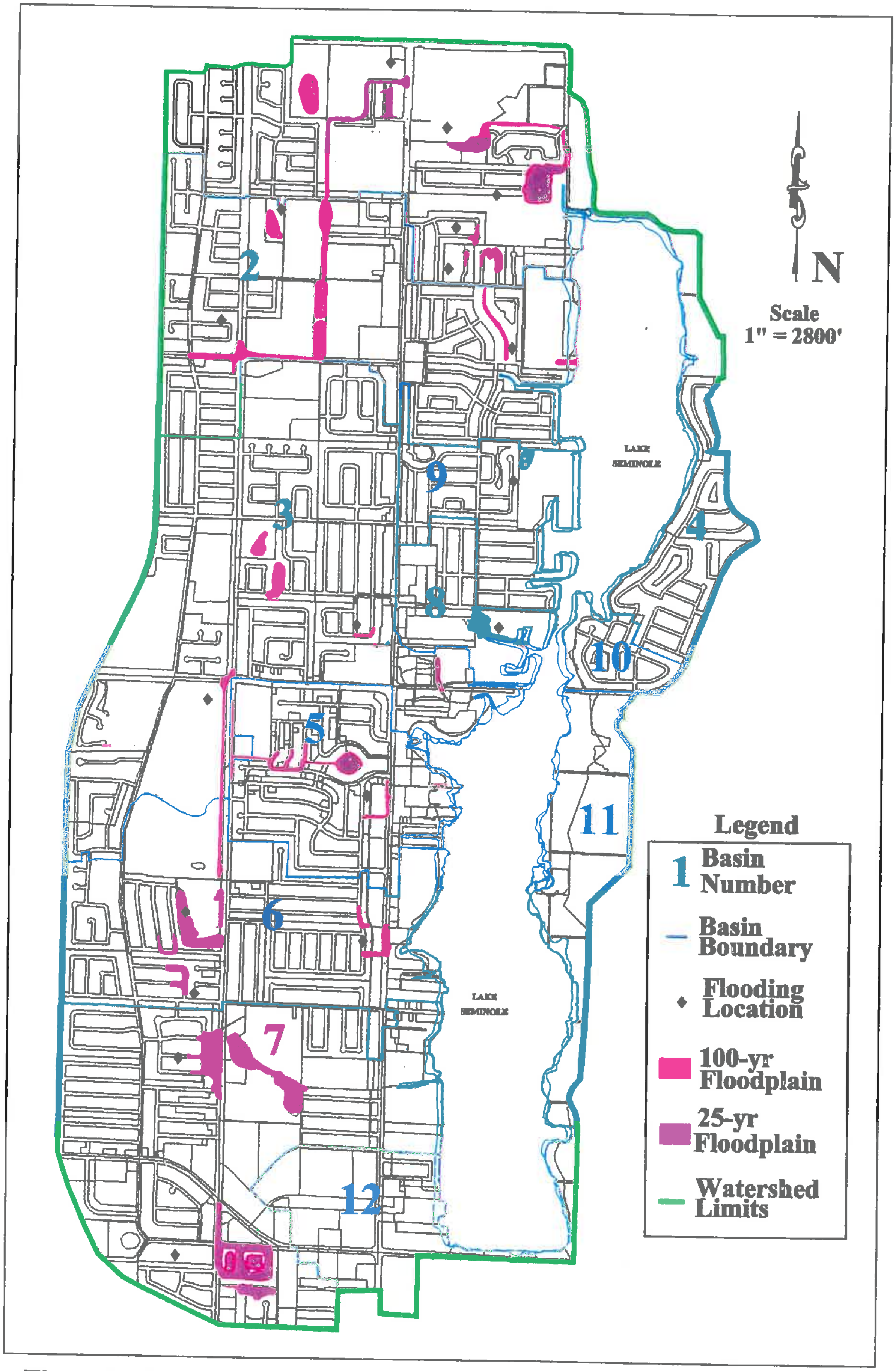


Figure 2-17 Existing flood prone areas in the Lake Seminole Watershed.

2.9 Public Education

No surveys of lakefront homeowners or recreational users of the lake have been conducted to specifically ascertain the level of public education on matters related to the ecology of Lake Seminole, or the watershed management process. The Pinellas County Department of Environmental Management has made attempts to improve public awareness of the lake and watershed management issues. These activities have included storm drain painting (e.g., "Dump No Waste - Drains to Lake") and the posting of signs along roadways indicating that drivers are entering the Lake Seminole Watershed Management Area. In addition, sign kiosks located in Lake Seminole Park have been used to display water quality data and other notices related to the lake and watershed management activities. Full implementation of the Plan recommended herein will require a more intense public education effort to solicit public support, cooperation, and involvement in the lake and watershed restoration and management activities.

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Lake Seminole Watershed Management Plan

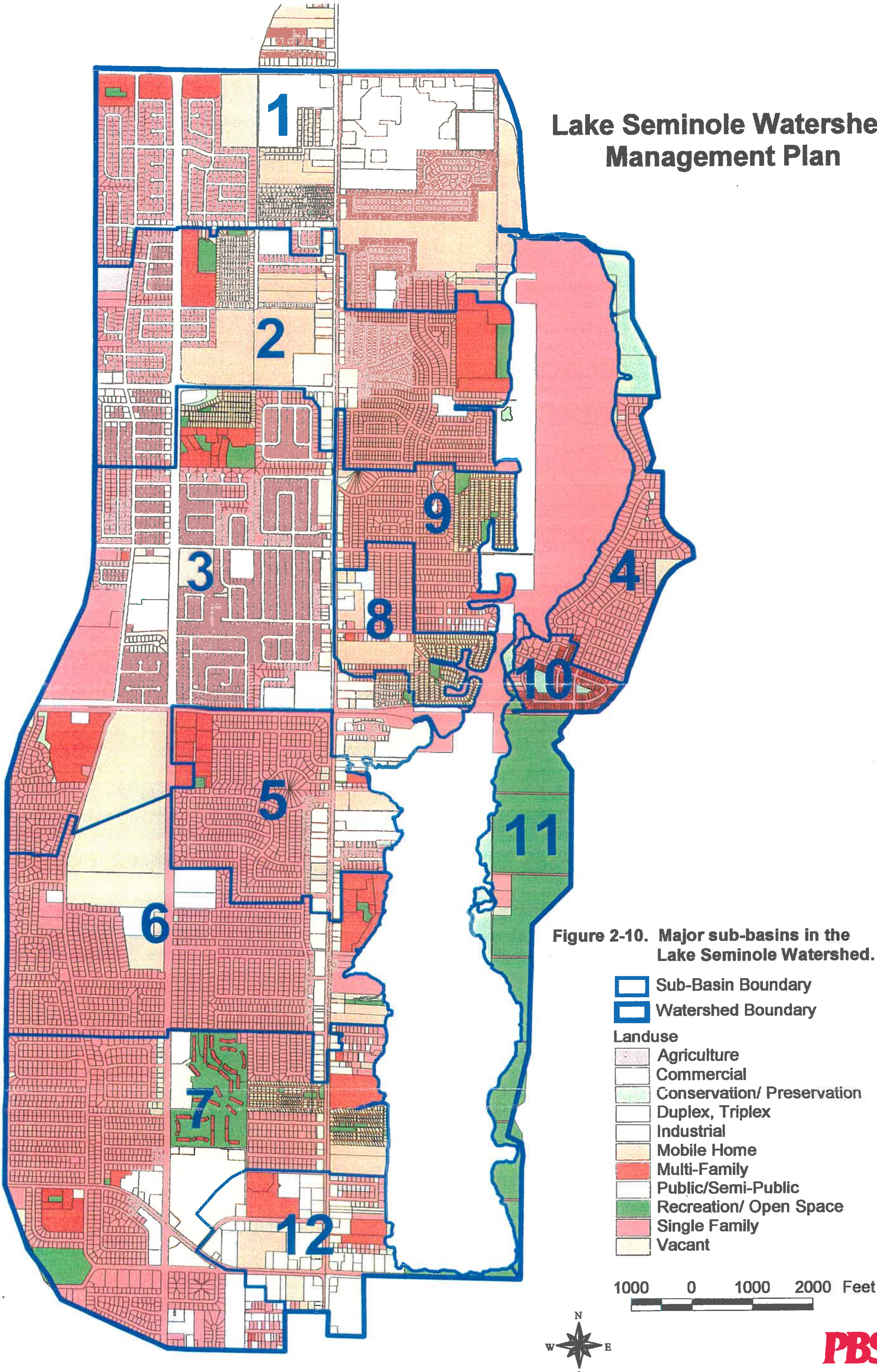


Figure 2-10. Major sub-basins in the Lake Seminole Watershed.

PBSJ

Lake Seminole Watershed Management Plan

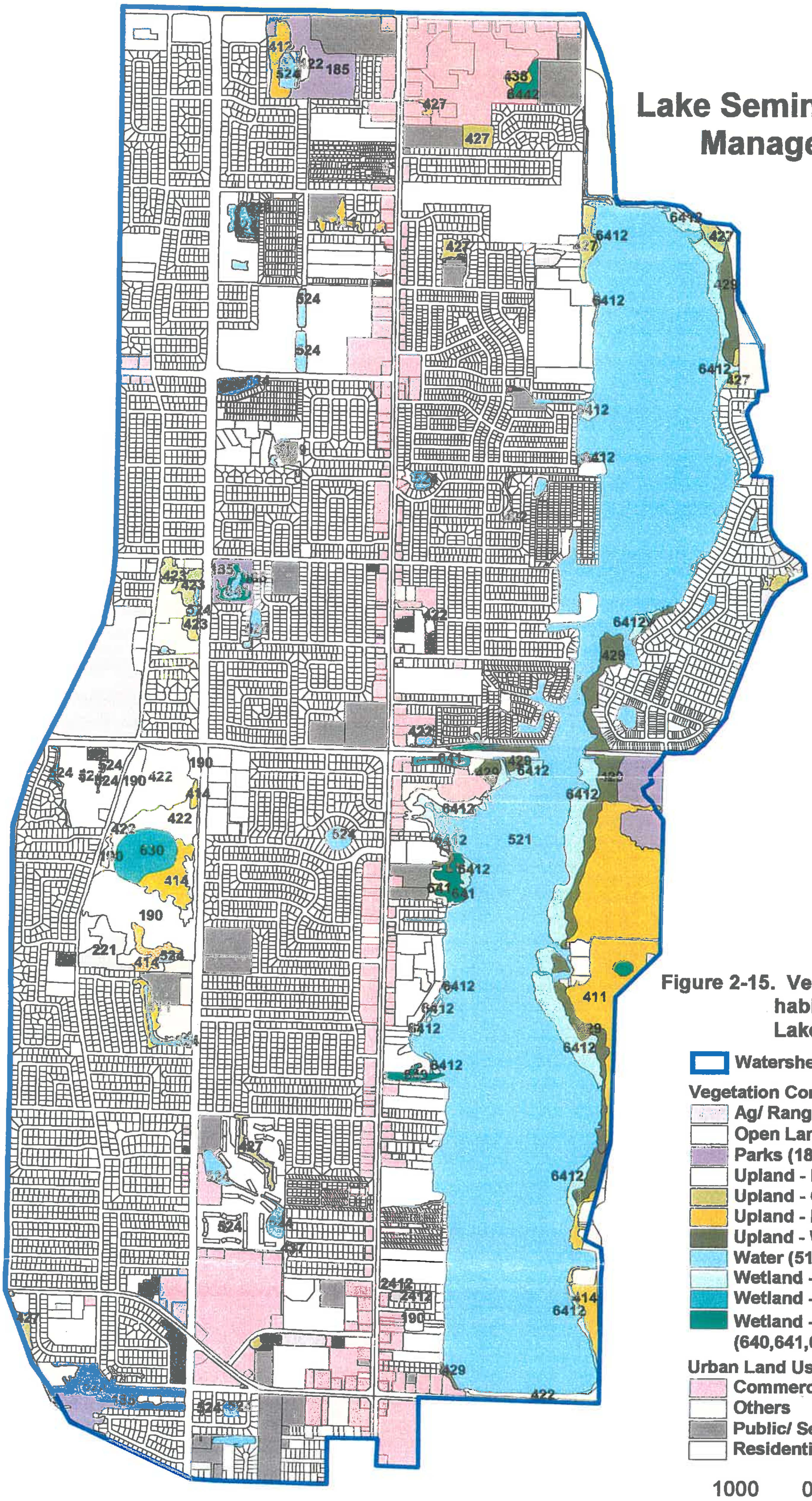


Figure 2-15. Vegetation communities and habitat classfications in the Lake Seminole Watershed.

Watershed Boundary

Vegetation Communities
- Ag/ Rangeland (211,221,241,320,2412)
- Open Land (190, 740)
- Parks (185,1861)
- Upland - Exotics (422,437)
- Upland - Oak (423,427,428,438)
- Upland - Pine (411,412,414)
- Upland - Wax Myrtle, Willow (429)
- Water (510,521,524)
- Wetland - Cattail (6412)
- Wetland - Forested Mix (630)
- Wetland - Vegetated Non-Forested (640,641,6442)

Urban Land Use
- Commercial/ Industrial
- Others
- Public/ Semi-Public
- Residential

1000 0 1000 2000 Feet

N W E S

PBSJ

Lake Seminole Watershed Management Plan

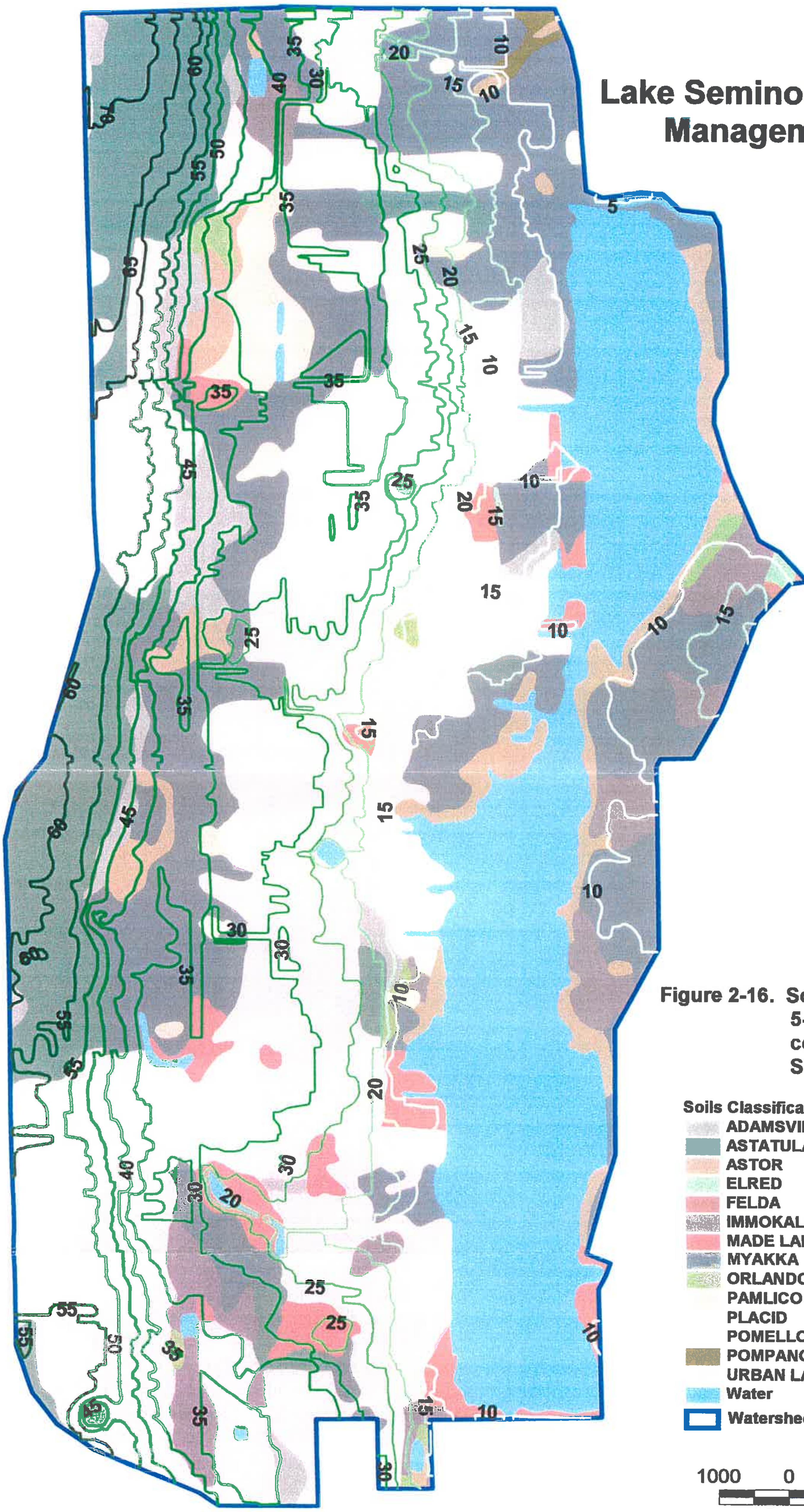


Figure 2-16. Soils classifications and 5-foot topographic contours in the Lake Seminole Watershed.

3.0 ALTERNATIVES ANALYSIS

This section provides a summary of predictive watershed and waterbody modeling conducted to evaluate the efficacy of key potential management actions proposed to address priority management issues for Lake Seminole and its watershed. Priority lake and watershed management issues include:

- water quality degradation and eutrophication (Issue 1 - Water Quality);
- loss of desirable aquatic vegetation (Issue 2 - Aquatic Vegetation); and
- sport fishery decline (Issue 3 - Fisheries).

Because these three lake management issues are very much interrelated, the proposed management actions addressed herein were developed and evaluated in a holistic manner which considers their individual and cumulative impact on the trophic state of the lake. While other identified lake management issues (e.g., watershed habitat restoration, recreational user conflicts, etc.) are addressed in the Plan, predictive modeling was only conducted on those management actions aimed at addressing the priority issues listed above.

3.1 Selection of Management Alternatives

Four key management actions potentially applicable to Lake Seminole, and a range of alternatives for each, were evaluated using predictive modeling techniques. With regard to the effective trophic management of lakes, three management actions are considered to be axiomatic (Wetzel, 1983):

- reduce external phosphorus loadings;
- reduce internal nutrient recycling; and
- reduce lake hydrologic residence time.

Therefore, three management actions, each addressing one of the three actions above, were developed for evaluation with respect to water quality improvements in Lake Seminole, including:

- enhanced stormwater treatment facilities in priority sub-basins;
- sediment removal; and,
- diversion of Seminole Bypass Canal flows into Lake Seminole.

With regard to the effective management of aquatic vegetation and sport fisheries in lakes, the fluctuation of lake levels has been shown to be very effective. Periodic lake level drawdowns elicit vegetation responses whereby the coverage of desirable emergent and submerged macrophytes is increased. In addition, this positive vegetation response provides improved cover and spawning habitat for carnivorous fishes such as largemouth bass and bluegill, leading to the overall

improvement of sports fisheries, especially in Florida lakes where the year round growing season can lead to problematic accumulations of littoral vegetation (Greening and Doyon, 1990). Therefore, to address the issues of Aquatic Vegetation and Fisheries, one management action was developed: enhanced lake level fluctuation. Table 3-1 below summarizes the four management actions selected for evaluation, and their respective mode of improvement.

Table 3-1. Summary of management actions proposed for model evaluation.

Management Action	Mode of Improvement
Enhanced stormwater treatment facilities in priority sub-basins	Reduces external phosphorus loadings
Sediment removal	Reduces internal nutrient recycling
Diversion of Seminole Bypass Canal flow into Lake Seminole	Reduces lake hydrologic residence time
Enhanced lake level fluctuation	Increases cover of submerged aquatic vegetation

As stated above, various alternatives for these management actions, and combinations of alternatives were evaluated in a series of model runs. The objective of the predictive modeling work was to determine the most effective management actions, or combinations of management actions, for improving the trophic state of Lake Seminole.

3.2 Model Description

An EPA model, the Water Quality Simulation Package, version 5 (WASP5) was selected as a receiving waterbody model for the Lake Seminole project. WASP is a dynamic compartmentalized modeling system that is one of the most detailed available for the simulation of water quality, and was used to address eutrophication impacts. The objective was to be able to assess impacts of changes in pollutant loadings to the lake, in particular, the interaction of nutrients with aquatic vegetation and dissolved oxygen. Data requirements for WASP can be quite extensive, but vary according to each application. This objective was accomplished through a twofold approach, whereby: 1) hydrodynamics of the lake were simulated using the stand-alone model DYNHYD which incorporated tributary inflows and outflows; and 2) in-lake water quality resulting from the hydrodynamics, environmental conditions, and pollutant loadings were simulated using the EUTRO routine within WASP.

DYNHYD is a hydrodynamic program used to simulate the movement of water and is a derivation of the Dynamic Estuary Model developed in 1970. User specified flow conditions must be defined

for each segment in terms of hydraulic discharge coefficients which define the relationship between velocity, depth, and flow. This one-dimensional hydrodynamic model solves equations for continuity and momentum. Momentum equations are used to predict water velocities and flows whenever the continuity equation is used to predict heads and volumes. Wind stress is also accounted for, as well as precipitation and evaporation. DYNHYD was used to provide flow characteristics to WASP, through a hydrodynamic interface file. Pollutant loading and flows were available from the SWMM modeling of land segments and channels that are tributary to the lake. These loads were also supplied to the WASP simulations through external pollutant loading interface files (*.nps).

WASP can be further subdivided into two submodels: 1) EUTRO and 2) TOXI. EUTRO simulates kinetics of conventional pollutants while TOXI simulates the kinetics of toxic pollution. TOXI simulations were not performed for Lake Seminole. Eutrophication processes are simulated in great detail in WASP by the EUTRO sub-model as nitrogen and phosphorus cycles, with phytoplankton, DO, and sediment interactions. Three phosphorus variables are modeled under the phosphorus cycle: phytoplankton phosphorus, organic phosphorus, and inorganic (orthophosphate) phosphorus. Both organic and inorganic phosphorus are divided into particulate and dissolved fractions. Various sources and sinks are simulated including phytoplankton uptake, respiration, death, mineralization, adsorption-desorption, settling, and benthic fluxes. Four nitrogen variables are modeled: phytoplankton nitrogen, organic nitrogen, ammonia, and nitrate. A number of sources and sinks are simulated including phytoplankton uptake, respiration, death, bacterial decomposition, nitrification, denitrification, settling and benthic fluxes.

All major biological processes in WASP are simulated in EUTRO through phytoplankton kinetics. Phytoplankton kinetics assume a central role in the eutrophication algorithms and affect all other systems The basic driving equation for the kinetic structure relates phytoplankton carbon fluxes to growth, decay, and settling. Ammonia, phosphorus, and nitrate are the major state variables affecting phytoplankton mass. Effects from light and dissolved oxygen are also considered. For calibration and verification purposes, chlorophyll-a is used as the direct measure of phytoplankton biomass. However, internally, EUTRO4 uses phytoplankton carbon as a measure of biomass. Although zooplankton are not simulated, a phytoplankton grazing rate can be specified by the user to account for the herbivorous zooplankton population. To summarize, the phytoplankton kinetics are governed by growth, decay, and settling with algorithms accounting for light (photosynthesis) interactions, temperature, nutrient limitations, and grazing.

The proposed management actions and alternatives for Lake Seminole were evaluated using the Linked Watershed-Waterbody Model (LWWM) developed for the Southwest Florida Water Management District by AscI, Inc. This water quality model provides a post-processing linkage between the watershed model SWMM, a public domain software program also developed by EPA, and the waterbody model WASP5. An external hydrodynamic file was also required for LWWM simulations which contained model segment flows, and was developed using an Excel spreadsheet and a fortran routine.

For application on Lake Seminole, DYNHYD and WASP models were calibrated using a 484 day simulation from 1/1/97 through 4/30/98. The entire calibrated Linked Watershed-Waterbody Model was verified using a 365 day simulation containing 1994 rainfall and existing conditions land use data. A baseline conditions model was then developed using 1994 rainfall and future land use conditions data, including load reductions anticipated from three planned BMPs. Finally, numerous simulations were performed which included various management actions, and combinations of alternatives, all of which were compared to the baseline conditions model to predict effectiveness of each management action. This linked model was therefore a tool for assessing the impacts of various management actions on the lake, and included the simulation of phosphorus, nitrogen, chlorophyll-a, dissolved oxygen, and biological oxygen demand (BOD).

Existing conditions within the Lake Seminole watershed were simulated during model calibration performed for 1996, 1997 and 1998. Following model calibration, each proposed management action was evaluated individually, and in all possible combinations with other proposed management actions (alternatives). In total, more than 35 separate LWWM simulations were performed to evaluate existing and future land use conditions within the watershed and prioritize management alternatives. The results of these simulations of the waterbody response to remedial actions and projected future changes in loadings are detailed below. Efforts to construct and calibrate this Linked Watershed-Waterbody Model for the Lake Seminole watershed are also summarized.

3.3 Model Components

As stated above, the SWFWMD Linked Watershed-Waterbody Model (LWWM) version 2.0 was used for all model simulations. This provided an interface between the SWMM and WASP models by properly formatting pollutant time series loads (*.nps), and served as a post-processor. Through the LWWM user interface, an input file can be selected, and modified or edited if necessary.

Each LWWM simulation was comprised of three separate components or input data files. A WASP5 input file (*.inp) is required which specifies initial volumes, point source loads, sediment fluxes and other kinetic variable terms necessary for a eutrophication model simulation. During execution of the WASP5 model, two other data files are called: a hydrodynamic file (*.hyd) contains time-varying flow data for model segments; and a non-point source load file (*.nps) contains time-varying non-point source pollutant load data. LWWM model simulations of receiving water lake response are performed using EPA's Water Analysis Simulation Program (WASP) version 5. The EUTRO5 submodel is called to perform eutrophication routines, and was used to simulate in-lake conditions under existing land use conditions for calibration runs, and future land use conditions for management alternative runs.

Daily records for pan evaporation and rainfall were used in conjunction with SWMM modeled estimates of runoff volume to establish daily model segment flows for each simulation. A level pool routing technique was developed in an Excel spreadsheet, and was used to determine outflow from

the system through a fixed 5-feet NGVD elevation weir and submerged pipe. A fortran routine was then used to convert these daily flows into a 0.1 day time step, and properly format an external hydrodynamic file (*.hyd) for each calibration simulation. For management evaluations, level pool routing spreadsheets were modified to account for weir modifications or canal diversion inflows. EPA's Surface Water Management Model (SWMM) version 4.30 was used to estimate pollutant loadings from each sub-basin within the watershed and route these loads to Lake Seminole. A SWMM model previously developed and calibrated for floodplain mapping and flood profile development (Task 3.2.4 of this project) was modified for these water quality simulations. Hydrologic water quality pollutant loads were added to the RUNOFF Block, and TRANSPORT was used instead of EXTRAN to route flows and loads from the watershed to Lake Seminole. TRANSPORT output data were then post-processed by the LWWM to produce an external non-point source file (*.nps) containing a time series of runoff pollutant loads.

3.4 Model Calibration Simulations

3.4.1 Existing Land Use Conditions

Model input data sets were developed for existing conditions within the Lake Seminole watershed, and continuous simulations were performed for 1996, 1997 and 1998. Each of the three LWWM model components were calibrated individually, using runoff water quality sample results, lake gauge data, and in-lake water quality data collected during these periods by Pinellas County DEM, USGS and PBS&J.

The SWMM watershed water quality model was first calibrated to measure field runoff water quality data collected during late 1997. Rainfall, stage, and velocity data were used to develop stage-discharge relationships at the sampling sites, and to construct runoff hydrographs for each recorded storm event. Modifications were made to the input loading rates of modeled pollutants by land use within the revised water quality portions of the SWMM model to bring predicted event mean concentrations (EMCs) at each sample location into closer agreement with laboratory results. Once these EMCs were optimized, they were retained for all simulations, including future land use and management alternative evaluations. Results of SWMM surface water quality simulations were then used to predict pollutant loads within the watershed during continuous simulations using 1996, 1997 and 1998 rainfall. Using the LWWM post-processor, three separate non-point source files (1996.nps, 1997.nps and 1998.nps) were created which were used as input for waterbody calibration simulations.

External hydrodynamic (*.hyd) input files were then developed and calibrated. Daily average runoff flow estimates from the calibrated SWMM model and daily precipitation records were added as total daily inflow. This value was then reduced by total daily outflow. Daily outflow consisted of evaporation records and weir and pipe outflow from the lake. A level pool routing technique to determine head, coupled with standard weir and submerged pipe hydraulic equations, was used to calculate daily average outflow for the only two outfalls at the south end of the lake.

All calculations were performed in a spreadsheet, which also provided daily lake level fluctuations based on the volume change due to total inflow minus total outflow. These daily lake level fluctuations were compared to USGS, PCDEM, and PBS&J gauge records for 1996, 1997 and 1998. Weir equation coefficients and pipe frictional loss values were then manipulated to obtain a good fit on predicted lake level fluctuations plotted against recorded lake level data. Once these variables were established, they were retained for all simulations, including future land use and management alternative evaluations. Using a fortran routine, three separate hydrodynamic files (1996.hyd, 1997.hyd and 1998.hyd) were created and then used as input for waterbody calibration simulations.

Calibrated non-point source (*.nps) and hydrodynamic files for 1996, 1997, and 1998 were then used as input for calibration of the third component of each LWWM simulation, the WASP5 EUTRO input data file. Eutrophication modeling relies on mathematical equations from which in-lake nutrient and algal concentrations are determined. Input required includes physical parameters such as temperature and length of daylight, along with kinetic reaction rates and constants describing the nutrient transformation processes within the waterbody.

Parameters affecting water quality may be spatially and/or temporally variable. WASP simulates the temporal variability of these parameters by allowing the user to specify different parameter values such as sediment flux for different model simulation times. Calibration of the WASP5 EUTRO simulations involved optimizing these values, as well as manipulation of the kinetic rates and constants. All of these parameters were optimized to obtain a good fit of simulated in-lake conditions to measured parameters for 1996, 1997 and 1998 while remaining within literature ranges of values.

Final calibration plots for the existing conditions calibration simulations are provided in Figures 3-1 through 3-3. Measured parameter values were obtained from PCDEM and PBS&J in-lake water quality data. A reasonable fit of measured parameter values to simulated predictions was obtained for the three calibration year simulations: 1996; 1997; and 1998.

3.4.2 Future Land Use Conditions

Future land use conditions were also modeled to predict non-point source pollutant loads (*.nps) in the Lake Seminole watershed under a projected ultimate build-out land use scenario. Although some differences in land use are anticipated under future land use conditions, the watershed is currently nearly 100% built out, resulting in little predicted difference in pollutant loads for future land use SWMM simulations. These simulations also accounted for three stormwater projects which are currently permitted and/or under construction within the watershed:

- the St. Petersburg Junior College site stormwater master plan;
- the Pinellas County Dog Leg Pond; and
- the Pinellas County Pond 6.

Figure 3-1. 1996 Calibration Simulation Results vs. Recorded Conditions.

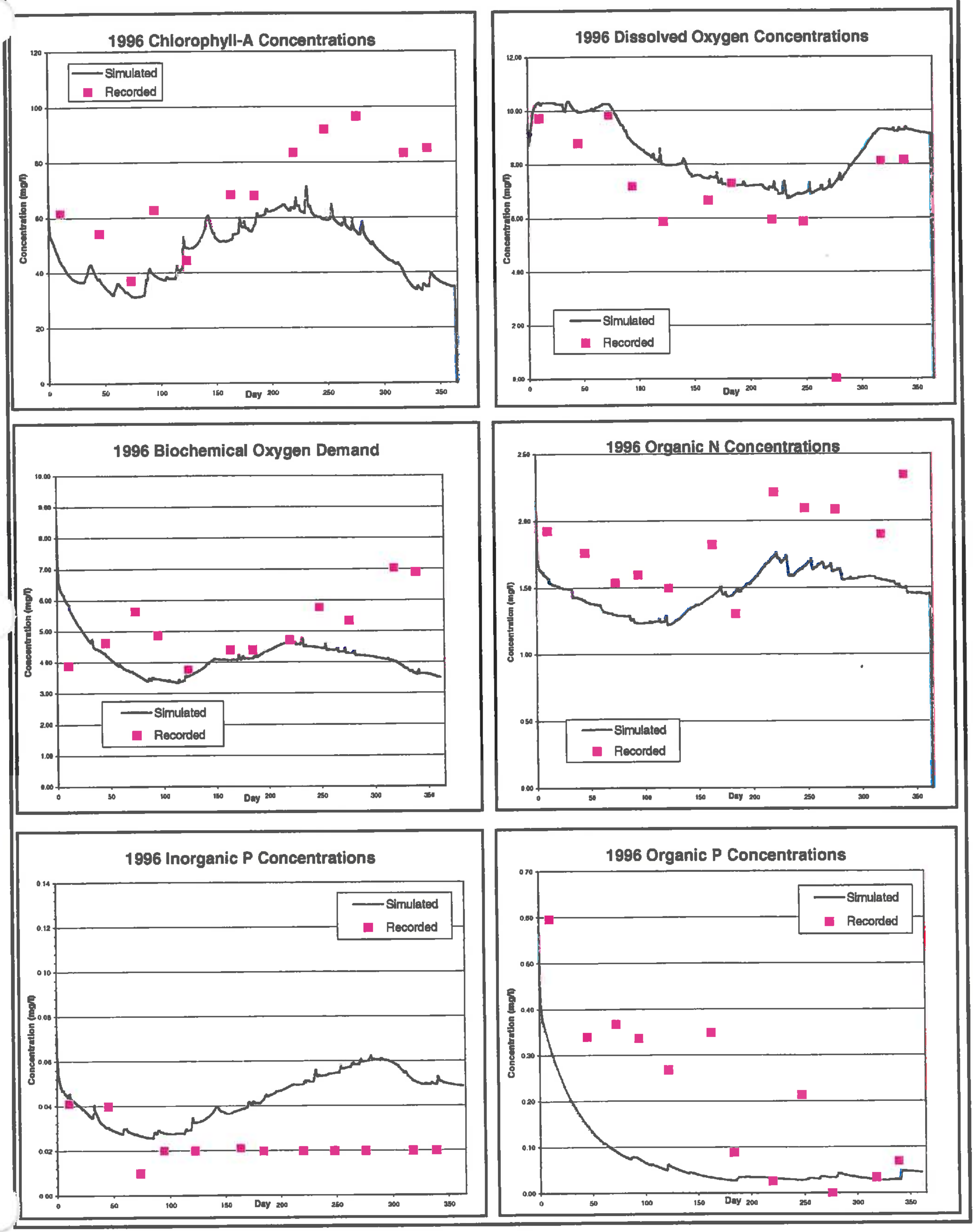


Figure 3-2. 1997 Calibration Simulation Results vs. Recorded Conditions.

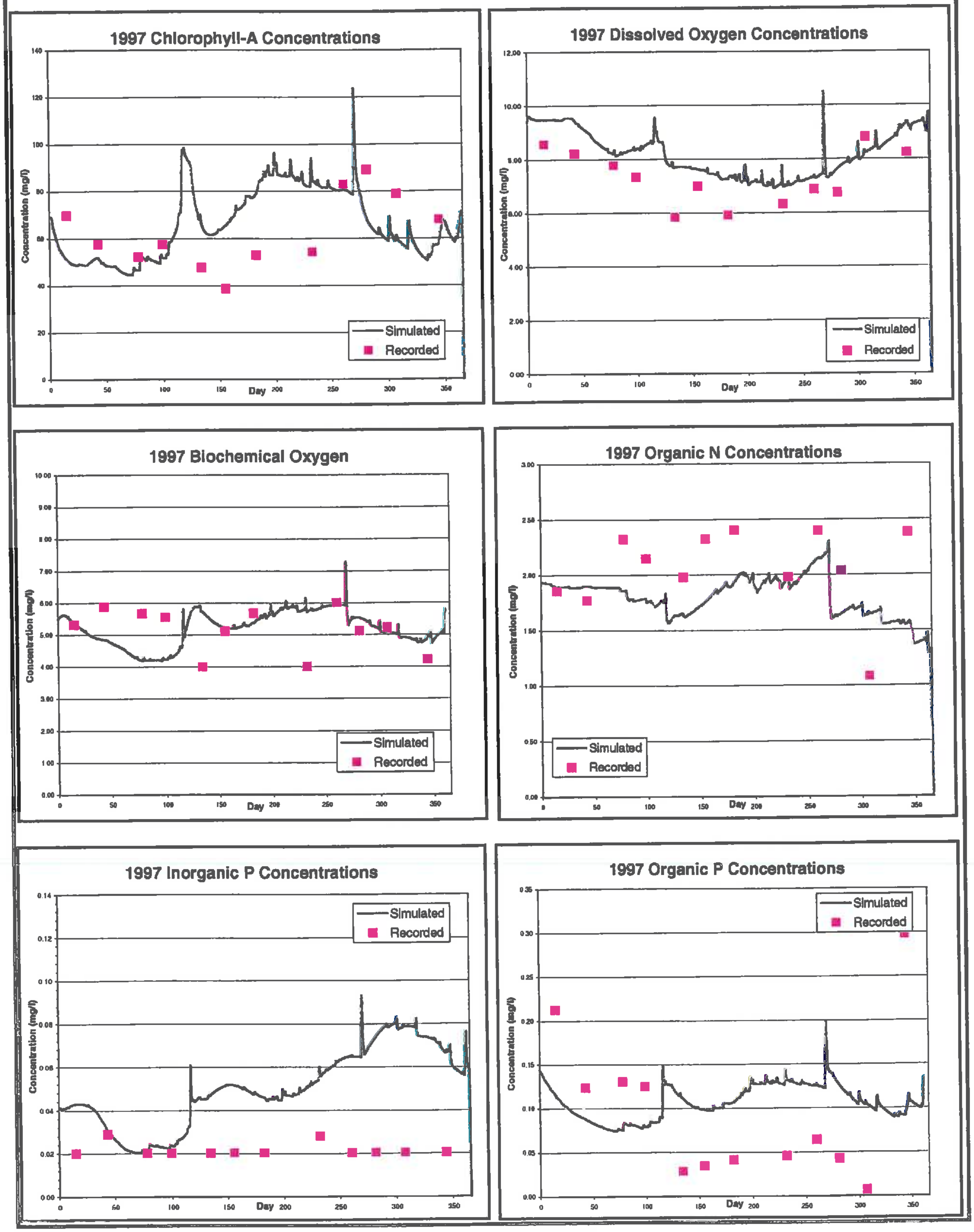
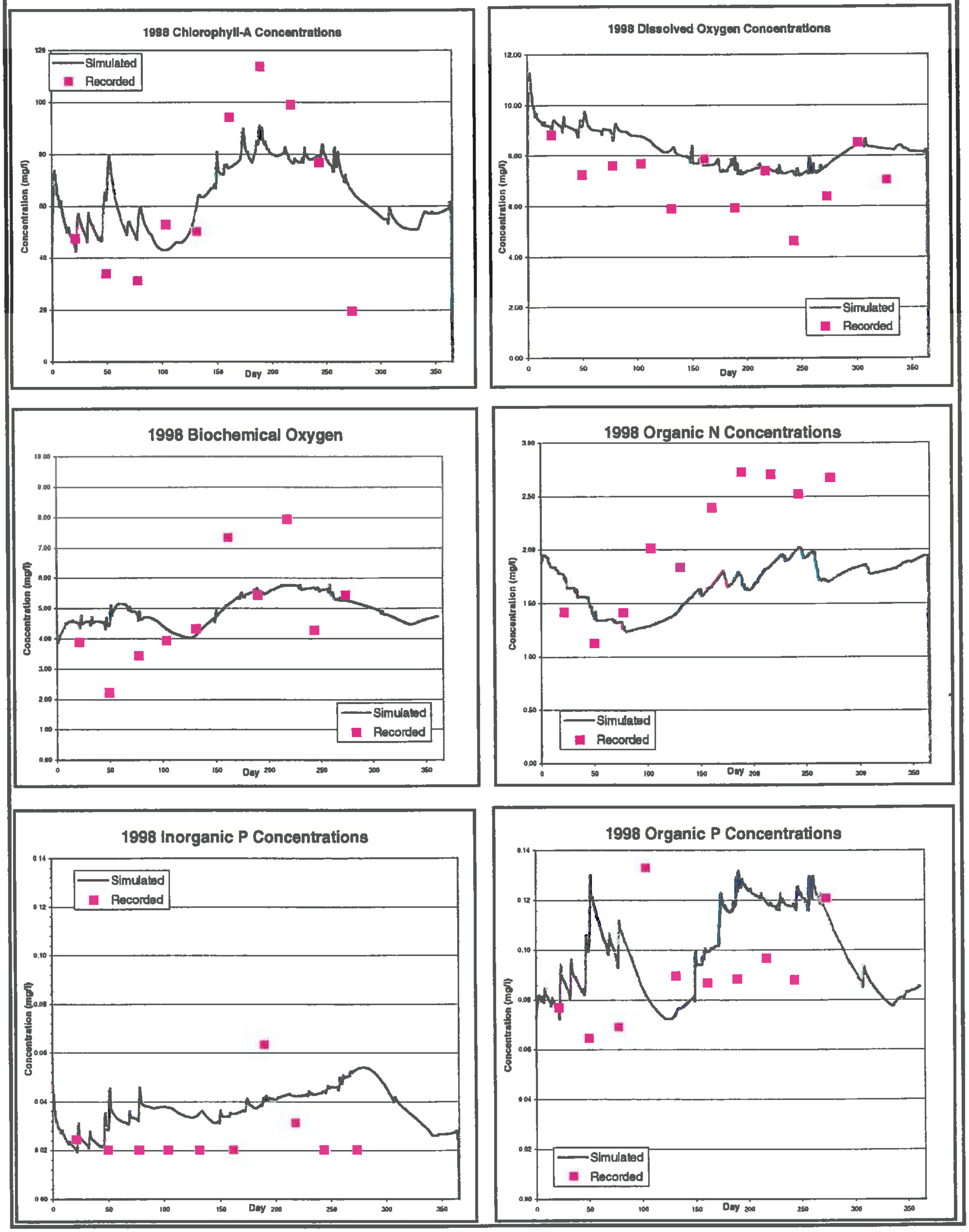


Figure 3-3. 1998 Calibration Simulation Results vs. Recorded Conditions.



The hydraulic network was modified to represent these ponds, and pollutant loads were reduced by estimating the treatment efficiencies of the completed projects with the corresponding wet detention treatment efficiencies shown in Table 3-2 applied to pollutant loads passing through the facilities.

Table 3-2. Wet detention treatment pollutant removal efficiencies (from Harper and Livingston, 1999).

Pollutant	Estimated Removal Efficiency
Total Nitrogen (TN)	30%
Total Phosphorus (TP)	70%
Biological Oxygen Demand (BOD)	55%

A continuous simulation was then performed using 1998 rainfall to create a non-point source input file (98F.nps) which was used for the baseline future land use condition simulations. An external hydrodynamic file for future land use conditions using 1998 rainfall (98F.hyd) was also prepared using these SWMM calculated inflows to Lake Seminole by applying the spreadsheet and fortran routines described above. A WASP5 simulation for future land use conditions using 1998 rainfall was then performed, which used the hydrodynamic and non-point source input files described above. These simulation results were used as a baseline condition for the evaluation of potential management alternatives. Results were similar to the existing conditions 1998 calibration simulation results, and are provided as a baseline for comparison purposes in Figures 3-4 through 3-8 below.

An independent review of the LWMM model construct and calibration simulations was conducted by Dr. James Martin, one of the original authors of the WASP5 model code. This review is provided in Appendix 2 of this document.

3.5 Management Action Simulations

3.5.1 Management Action #1 - Regional Stormwater Treatment Facilities (BMPs)

Basins within the Lake Seminole watershed were ranked according to SWMM pollutant loading estimates. These rankings were used to develop locations for potential stormwater treatment facilities within sub-basins 1, 2, 3 and 7. Because several stormwater rehabilitation projects are currently under design or construction in sub-basin 6, and these projects were included in the future land use baseline simulation, no additional facilities were modeled for this sub-basin.

Limited potential exists within the Lake Seminole watershed for stormwater retrofit using conventional wet detention treatment systems due to the lack of vacant land. All regional stormwater treatment facilities modeled for Management Action #1 were therefore assumed to be alum injection systems, with the corresponding alum treatment efficiencies shown in Table 3-3 applied to pollutant loads passing through the facilities.

Table 3-3. Pollutant removal efficiencies for alum treatment systems (from Harper and Livingston, 1999).

Pollutant	Estimated Removal Efficiency
Total Nitrogen (TN)	50%
Total Phosphorus (TP)	90%
Biological Oxygen Demand (BOD)	75%

It should also be noted that due to the high pollutant removal efficiency and minimal land area requirements, the cost per pound of nutrients removed is substantially lower than a wet detention system. Based on current information provided by SWFWMD (Mike Holtkamp-SWFWMD, personal communication), typical costs per pound of TN removed by wet detention systems ranges between $3,846 and $1,108; whereas typical costs per pound of TN removed by alum treatment systems ranges between $338 and $120. Because they provide pollutant removal efficiencies per dollar that are an order of magnitude better than wet detention systems, alum treatment facilities were selected as the design alternative of choice for Lake Seminole.

Separate non-point source input files were prepared for all possible combinations of potential alum injection treatment facilities within the watershed. Fifteen (15) separate simulations were performed using the various non-point source input files to evaluate the effect of reduced non-point source loads on average annual chlorophyll-a levels. All stormwater best management practice (BMP) management simulations used the same WASP input file (BMP.inp) and hydrodynamic file (98F.hyd). Only the non-point source file was changed for different combinations of potential watershed BMPs.

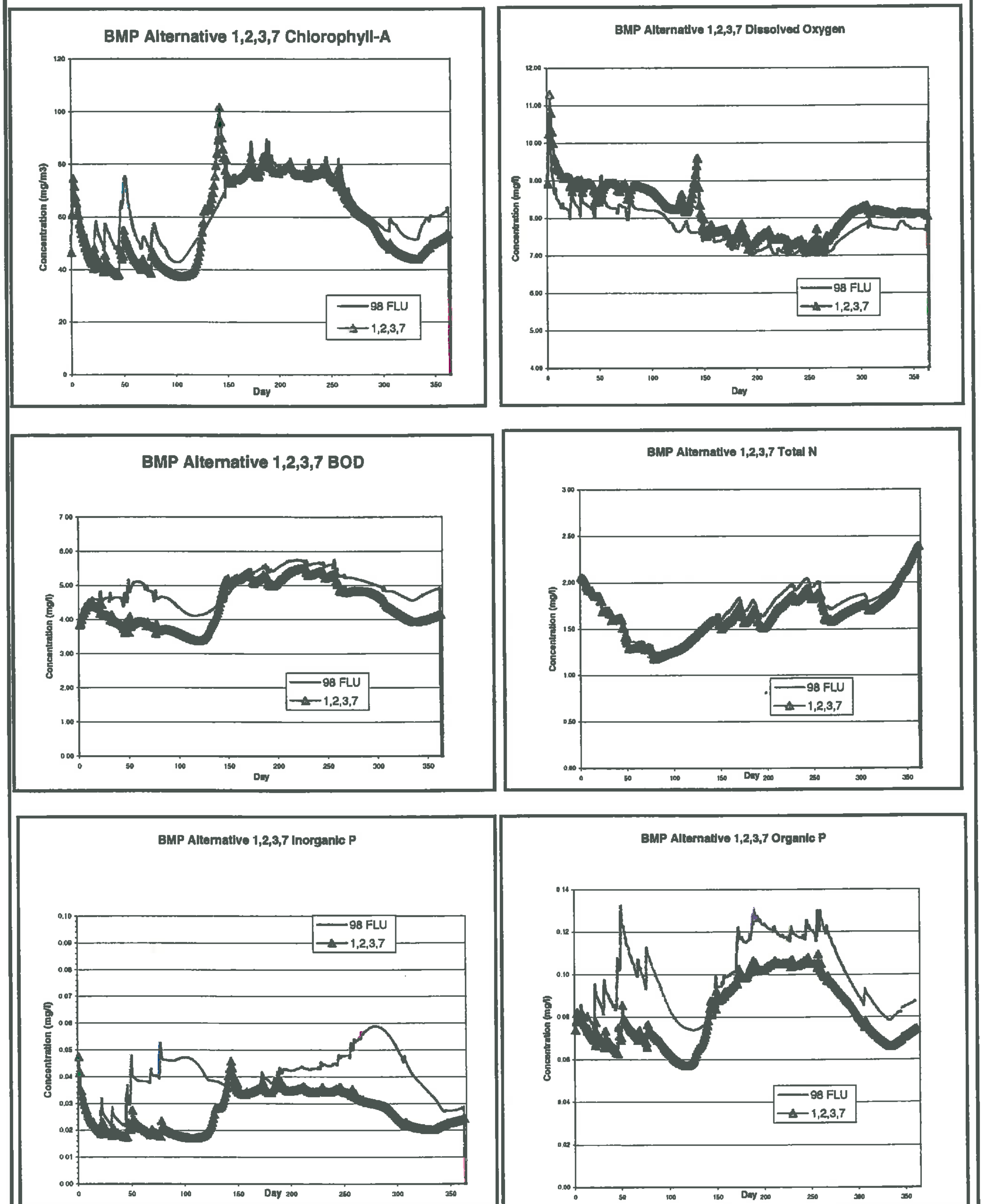
A summary of these results for all possible stormwater treatment project combinations is provided in Table 3-4 along with the effective reduction in total non-point source load. The numeric designations for BMP combinations in Table 3-4 refer to the sub-basins in which enhanced regional stormwater treatment facilities were simulated in the model runs. LWWM predictions for nutrient and chlorophyll-a concentrations within Lake Seminole resulting from implementation of all proposed watershed BMP facilities are provided in Figure 3-4.

These results indicate that the most effective alternative of regional stormwater treatment facilities is the combination of facilities located in sub-basins 1, 2, 3, and 7. The implementation of four regional alum treatment facilities at the outfall of these sub-basins is predicted to reduced in-lake chlorophyll-a concentrations by 4.4 ug/l, or about a 7% from baseline future land use conditions using 1998 rainfall. These results are not expected since external pollutant load reduction from regional stormwater treatment facilities should yield cumulative benefits determined by the percentage of the inflows being treated.

Table 3-4. LWWM simulation results for Management Action #1 - Regional Stormwater Treatment Facilities (BMPs).

BMP Combination (Sub-Basins)	NPS-TN Load Reduction (%)	NPS-TP Load Reduction (%)	NPS-BOD Load Reduction (%)	LWWM Modeled Chl A Reduction (mg/m^3)	LWWM Modeled Chl A Reduction (%)
1	5.65	11.97	6.19	0.9	1.43
2	3.93	8.96	4.33	0.6	1.00
3	7.04	17.32	8.54	1.6	2.52
7	2.43	7.19	3.35	0.4	0.58
1+2	9.57	20.93	10.53	2.0	3.17
1+3	12.69	29.29	14.73	2.8	4.44
1+7	8.08	19.17	9.54	1.8	2.81
2+3	10.97	26.27	12.88	2.4	3.87
2+7	6.36	16.15	7.68	1.4	2.28
3+7	9.47	24.51	11.89	2.3	3.58
1+2+3	16.61	38.25	19.07	3.8	6.06
1+2+7	12.01	28.13	13.88	2.7	4.29
1+3+7	15.12	36.48	18.08	3.5	5.58
2+3+7	13.40	33.47	16.23	3.2	5.02
1+2+3+7	19.05	45.44	22.42	4.4	7.04

Figure 3-4. BMP Alternative #1237 Simulation Results vs. 1998 Future Land Use Baseline Conditions.



3.5.2 Management Action #2 - Lake Level Fluctuation

A variable lake level fluctuation schedule was proposed primarily for littoral habitat improvement within Lake Seminole. Both inter-annual and intra-annual variation are achieved with the proposed monthly lake level fluctuation schedule. In order to assess the potential impact of this management action on in-lake nutrient and chlorophyll-a levels, the hydrodynamic file for 1998 rainfall and future land use conditions was modified to account for monthly variable weir crest elevations. Schedule A was used for management simulations, which provides the greatest range of fluctuation in the 4-year repeating schedule (see *Management Component 1* in Chapter 4 below for details on the proposed enhanced lake level fluctuation schedule). Only the hydrodynamic file reference in the WASP input file was changed from the 1998 future land use conditions simulation, and the same baseline non-point source file (98F.nps) was used for the weir management action simulation.

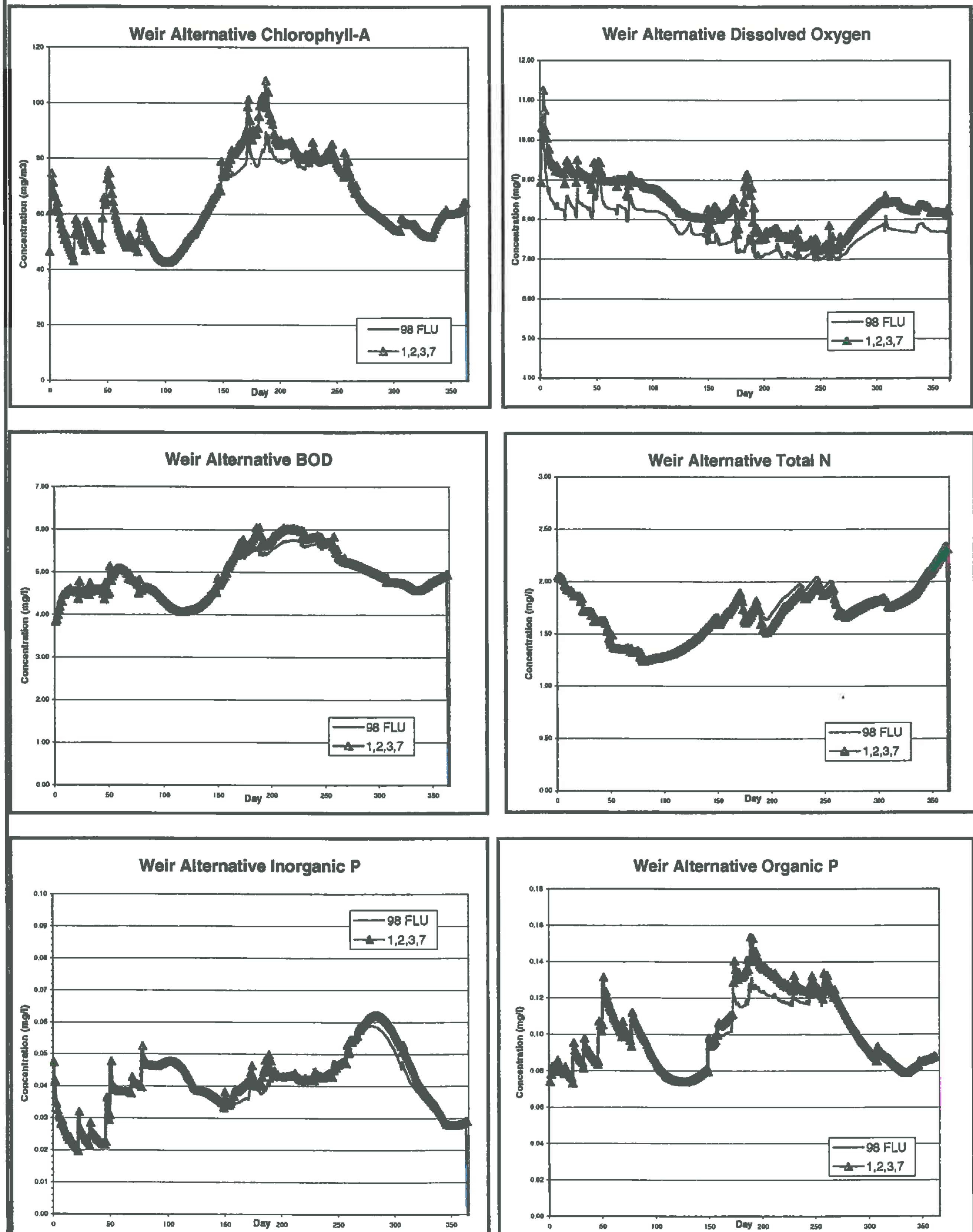
LWWM predictions for nutrient and chlorophyll-a concentrations within Lake Seminole resulting from implementation of the weir fluctuation schedule is provided in Figure 3-5. The simulation results for this management action actually show a slight increase in chlorophyll-a-a concentrations of 1.9 mg/m^3 (3.03% increase over baseline conditions). This predicted increase is most likely due to a decreased in-lake volume during the early and mid-summer, the period when algal productivity is greatest. It is interesting to note that Greening and Doyon (1990) cite several case histories where lake drawdowns have led to a slight temporary degradation of water quality, which they attribute to a phosphorus release from decaying macrophytes exposed to oxidation. Although this management action apparently has the potential to cause a slight degradation in water quality, the beneficial effects of enhanced lake level fluctuation on aquatic vegetation and fisheries habitat probably justify its implementation.

3.5.3 Management Action #3 - Canal Diversion

An important factor affecting receiving water quality is the amount of time is takes to completely exchange in-lake volume, often referred to as residence time. Potential Management Action #3 is designed to reduce residence time within Lake Seminole by pumping water from the adjacent Seminole Bypass Canal into the northern lobe of the lake. Four separate simulations were performed to evaluate the lake response to various pumping rates and treatment alternatives for canal diversion water. Canal baseflow and stormwater volume and nutrient concentration estimates were based on hydrological evaluations of the Starkey Basin performed by ERD, and summarized in a December 15, 1998 SWFWMD letter to PBS&J.

Alternative 3A was simulated by creating a hydrodynamic file containing a constant pumping rate of 10.42 cfs from the bypass canal into the northern lobe of Lake Seminole (3A.hyd). This flow represents a diversion of 80% of the annual baseflow within the canal. Nutrient loads were adjusted in the WASP5 input data file to account for TN, TP and BOD loads contained within the diverted canal water.

Figure 3-5. Weir Alternative Simulation Results vs. 1998 Future Land Use Baseline Conditions.



Alternative 3A1 used the same hydrodynamic file as above which accounted for an 80% diversion of canal baseflow into the northern lobe of Lake Seminole (3A.hyd). Alum treatment of this constant 10.42 cfs canal diversion flow was simulated prior to discharge into Lake Seminole for this alternative. Nutrient loads calculated in Alternative 3A were reduced by the alum treatment efficiencies contained in Table 3-3 prior to entry into the WASP5 input data file.

Alternative 3B was simulated by creating a hydrodynamic file (3B.hyd) containing higher pumping rates for canal diversion flow during July (11.40 cfs), August (11.60 cfs) and September (11.39 cfs). These increased pumping rates represent an 80% diversion of stormwater runoff flows expected during these months, in addition to the constant 10.42 cfs baseflow pumping rate. Stormwater flows routed during July, August and September would contain greater nutrient concentrations than a baseflow diversion only. Nutrient loads were therefore adjusted in the WASP5 input data file to account for these increased pollutant loads contained within the diverted stormwater flow in addition to baseflow.

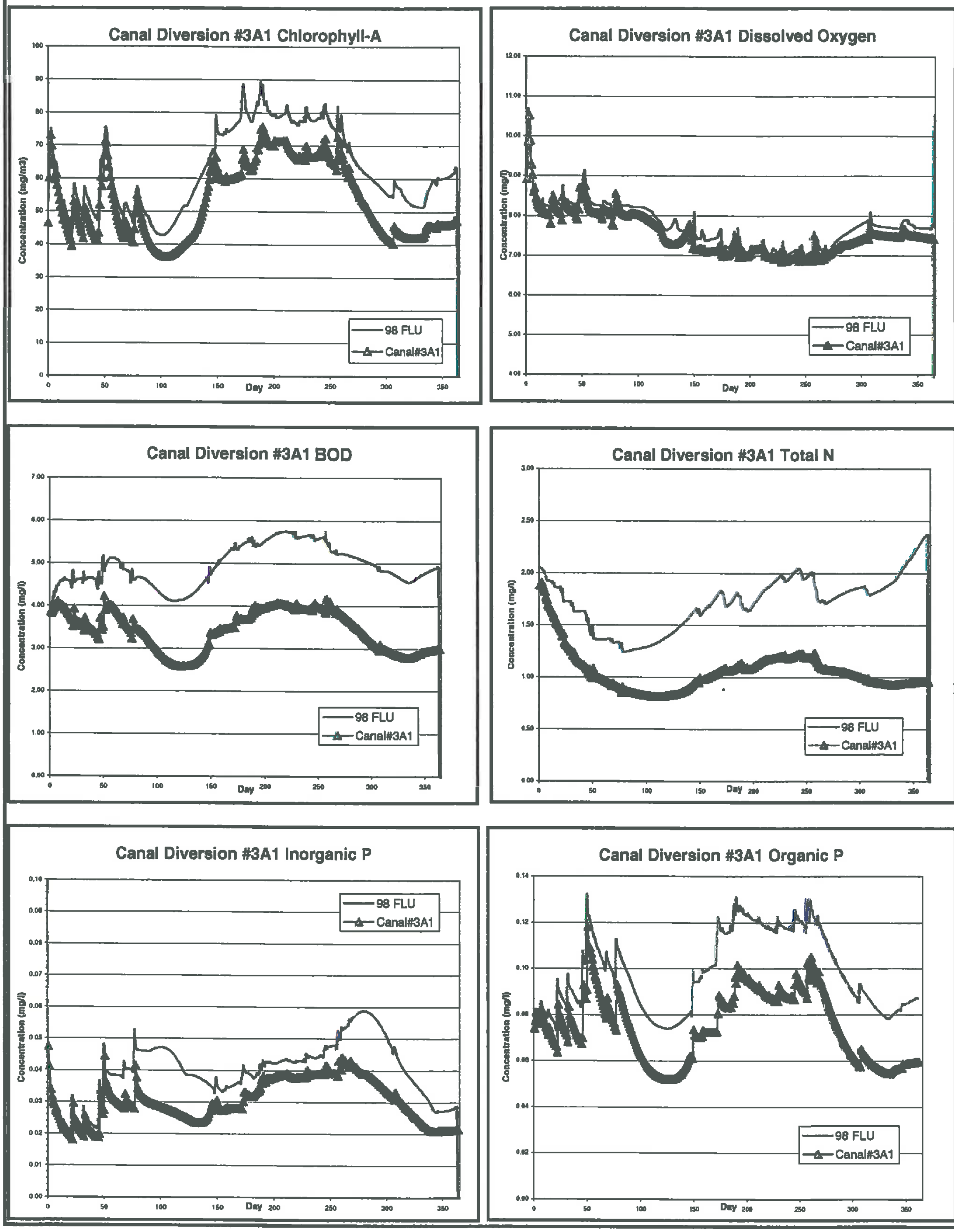
Alternative 3B1 used the same hydrodynamic file as above (3B.hyd), but considered alum treatment of diverted canal baseflow and stormwater flow. Nutrient loads calculated in Alternative 3B were reduced by the alum treatment efficiencies contained in Table 3-3 prior to entry into the WASP5 input data file for this alternative. The same baseline non-point source file (98F.nps) was used for all canal diversion management action simulations described above.

LWWM predictions for nutrient and chlorophyll-a concentrations within Lake Seminole resulting from implementation of canal diversion Alternative 3A1 are provided in Figure 3-6. Table 3-5 contains a summary of input files used for the evaluation of Management Action #3 and resulting predicted chlorophyll-a concentration reductions.

Table 3-5. LWWM simulation components and results for Management Action #3 - Canal Diversion.

Management Action #3 Alternative	WASP Input File	Hydro-dynamic File	Non-point Source File	LWWM Modeled Chl A Reduction (mg/m^3)	LWWM Modeled Chl A Reduction (%)
3A	CanalA.inp	CanalA.hyd	98F.nps	4.7	7.44
3A1	CanalA1.inp	CanalA.hyd	98F.nps	9.6	15.2
3B	CanalB.inp	CanalB.hyd	98F.nps	0.3	0.46
3B1	CanalB1.inp	CanalB.hyd	98F.nps	8.8	13.98

Figure 3-6. Canal Diversion Alternative #3A1 Simulation Results vs. 1998 Future Land Use Baseline Conditions.



The results of these LWWM simulations indicate that the greatest reduction in chlorophyll-a concentrations in Lake Seminole can be expected from a constant diversion of treated canal baseflow only (Alternative 3A1). This alternative yields a substantial predicted decrease in chlorophyll-a concentrations of 9.6 ug/l or about a 15% reduction over baseline conditions. Diversion of treated stormwater flows (Alternative 3B1) does not appear to be as effective, as the increased pollutant loads contained in this runoff effectively negate any reductions in chlorophyll-a concentrations achieved through a decrease in residence time.

3.5.4 Management Action #4 - Sediment Removal

Sediment removal as a lake management action is expected to result in improved water quality through two primary modes of action: 1) increased lake water volume; and 2) reduced sediment nutrient flux rates. The increase in lake water volume resulting from sediment removal can easily be quantified, being approximately equal to the wet volume of sediments removed. However, reductions in sediment nutrient fluxes resulting from sediment removal cannot be accurately quantified with the existing information from Lake Seminole. Many variables affect sediment nutrient exchange rates, and empirical data from Lake Seminole are currently not available.

During the calibration simulations, sediment nutrient fluxes were included in the variables which were manipulated to obtain the best fit of predicted parameter concentrations to recorded values. Initial sediment fluxes for N and P were set at rates with the same order of magnitude as those determined empirically for Lake Seminole sediments by Schelske et al. (1991; in SWFWMD, 1992). These calibrated flux rates were reduced incrementally in the dredging simulations described below to gain an understanding of the sensitivity of LWWM simulations to manipulation of this parameter.

Initial lake water volumes contained in the WASP5 input data file were increased to reflect the removal of 1 million cubic yards of sediment from the lake bottom, or about 100% of the estimated volume of unconsolidated organic sediments in the lake. In the simulations 36% of the increased lake water volume was applied to the northern lobe, while the remaining 64% was applied to the southern lobe. An updated hydrodynamic file was also created to reflect these increased volumes.

Table 3-6 contains a summary of input files used for the evaluation of Management Action #4, and the resulting predicted reductions in chlorophyll-a concentrations associated with a 20% (Alternative 4A), 35% (Alternative 4B), and 50% (Alternative 4C) reduction in sediment nutrient fluxes. It should be noted that all three simulations included 100% removal of the unconsolidated organic sediment mass, but applied different sediment nutrient flux rates resulting from the sediment mass removal. LWWM predictions for nutrient and chlorophyll-a concentrations in Lake Seminole resulting from implementation of dredging Alternative 4C are provided in Figure 3-7.

Figure 3-7. Dredging Alternative #4C Simulation Results vs. 1998 Future Land Use Baseline Conditions.

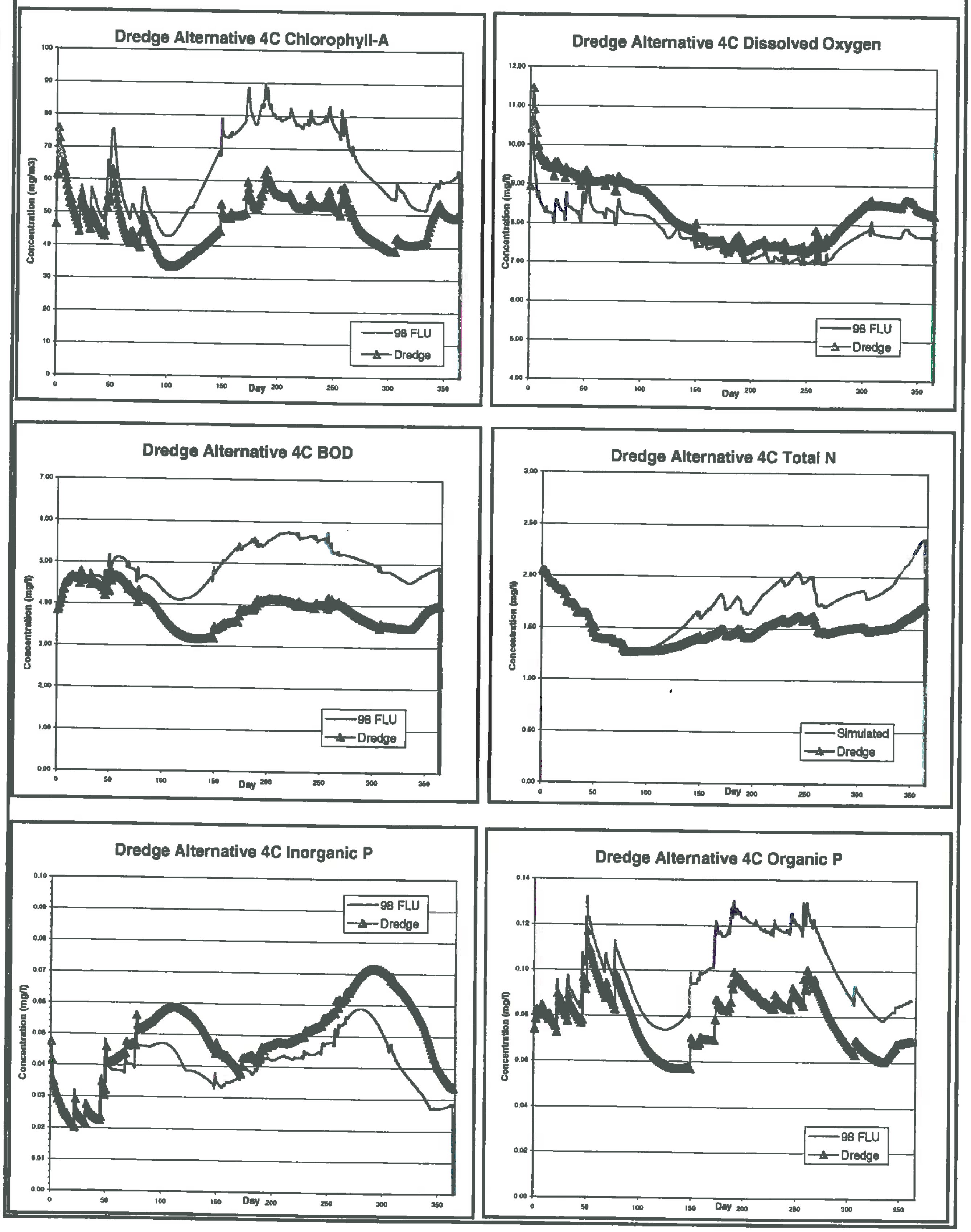


Table 3-6. LWWM simulation components and results for Management Action #4 - Sediment Removal.

Management Action #4 Alternative	WASP Input File	Hydro-dynamic File	Non-point Source File	LWWM Modeled Chl A Reduction (mg/m^3)	LWWM Modeled Chl A Reduction (%)
4A	DredgeA.inp	Dredge.hyd	98F.nps	1.0	1.57
4B	DredgeB.inp	Dredge.hyd	98F.nps	8.2	13.01
4C	DredgeC.inp	Dredge.hyd	98F.nps	15.3	24.40

The simulation results for the sediment removal alternatives indicate that the model is extremely sensitive to the reduction of sediment nutrient fluxes. With a 50% reduction in sediment nutrient flux rates (Alternative 4C), the model predicts a very substantial reduction in chlorophyll-a concentrations of 15.3 ug/l, or about 24% below baseline conditions.

The proposed removal of approximately 1 million cubic yards of unconsolidated organic sediments from Lake Seminole, including both the fibrous shoreline sediments and the flocculent deep sediments, is expected to reduce sediment nutrient flux rates significantly based on the sediment characterization study. Unfortunately, an accurate estimate of the percent reduction in nutrient flux rates resulting from sediment removal cannot be made with the information currently available. It seems reasonable, however, to assume that complete removal of the unconsolidated organic sediments in Lake Seminole could lead to a 50% reduction in sediment nutrient flux rates. With this conservative 50% reduction, significant water quality improvements in Lake Seminole are predicted.

3.6 Management Action Combinations

Model simulations were performed for all possible combinations of each of the four selected management action alternatives described above. In many cases, new WASP5 input data files were developed in order to combine all modifications made in the individual management scenario alternatives described above. In addition, updated hydrodynamic files were created for these simulations where required.

Figure 3-8 shows in-lake chlorophyll-a, DO, BOD, and nutrient concentrations resulting from a combination of all modeled management scenarios combined. Table 3-7 below contains a summary of input files used for the 15 LWWM simulations required for this optimization analysis, and predicted reductions in chlorophyll-a concentrations.

Figure 3-8. Combination of All Management Actions Simulation Results vs. 1998 FLU Baseline Conditions.

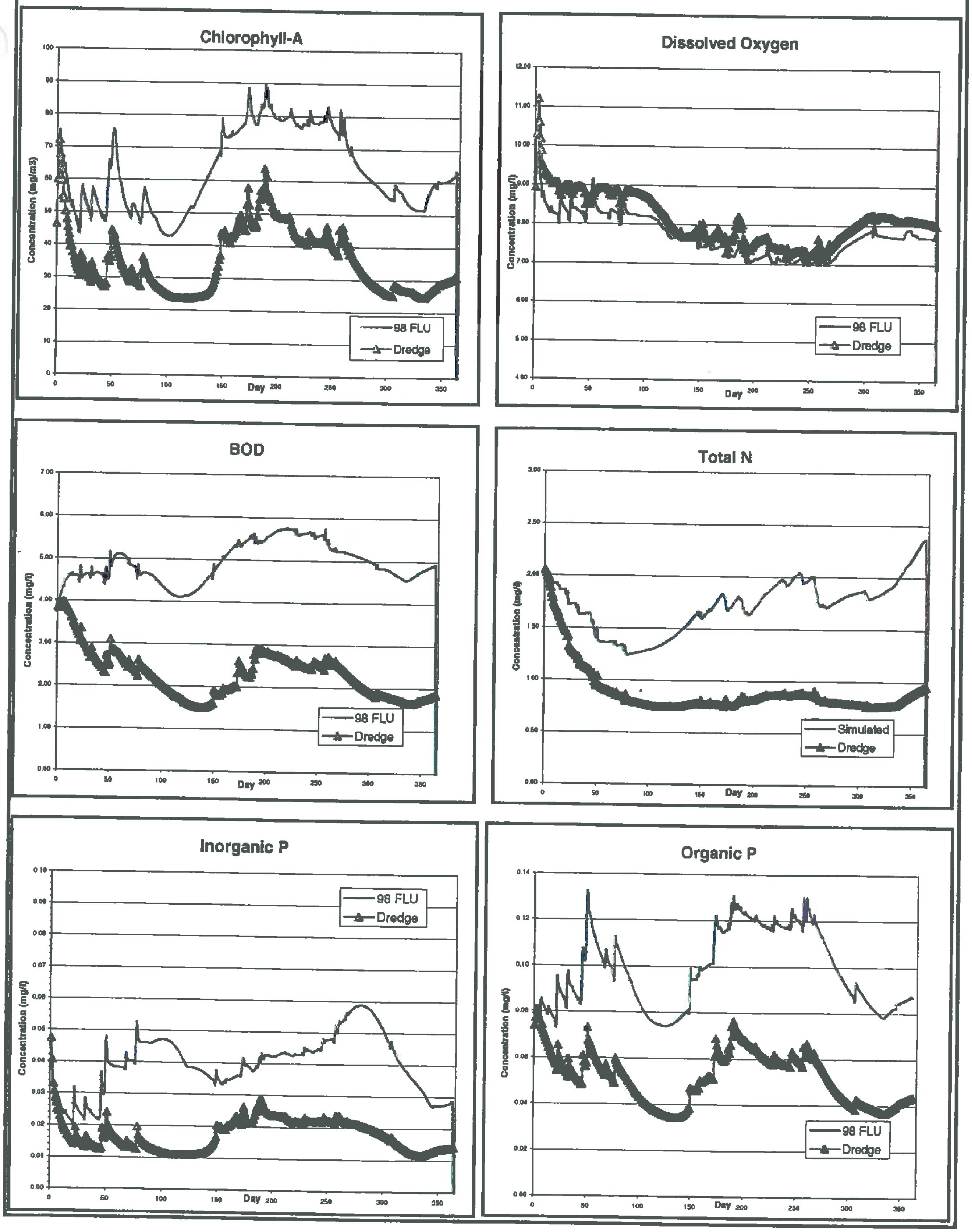


Table 3-7. LWWM simulation components and results for Management Action combinations.

Management Action Combination	WASP Input File	Hydro-dynamic File	Non-point Source File	LWWM Modeled Chl A Reduction (mg/m^3)	LWWM Modeled Chl A Reduction (%)
1	BMP1237.inp	98F.hyd	BMP1237.nps	4.4	7.04
2	Weir.inp	Weir.hyd	98F.nps	-1.9	-3.03
3	CanalA1.inp	CanalA.hyd	98F.nps	9.6	15.26
4	DredgeC.inp	Dredge.hyd	98F.nps	15.3	24.40
1+2	Mgt12.inp	Weir.hyd	BMP1237.nps	2.7	4.24
1+3	Mgt13.inp	CanalA.hyd	BMP1237.nps	12.7	20.19
1+4	Mgt14.inp	Dredge.hyd	BMP1237.nps	19.1	30.38
2+3	Mgt23.inp	Mgt23.hyd	98F.nps	7.6	12.08
2+4	Mgt24.inp	Mgt24.hyd	98F.nps	19.4	30.83
3+4	Mgt34.inp	Mgt34.hyd	98F.nps	25.3	40.22
1+2+3	Mgt123.inp	Mgt23.hyd	BMP1237.nps	10.7	17.01
1+2+4	Mgt124.inp	Mgt24.hyd	BMP1237.nps	23.7	37.75
1+3+4	Mgt134.inp	Mgt34.hyd	BMP1237.nps	28.5	45.31
2+3+4	Mgt234.inp	Mgt234.hyd	98F.nps	24.2	38.47
1+2+3+4	Mgt1234.inp	Mgt234.hyd	BMP1237.nps	27.4	43.56

Simulation results for the various combinations of management action alternatives presented in Table 3-7 above indicate that the most effective combination of alternatives includes the following:

- regional stormwater treatment facilities located in priority sub-basins 1, 2, 3, and 7;
- diversion of treated baseflows from the Seminole Bypass Canal into the lake; and
- removal of 1 million cubic yards of unconsolidated organic sediments.

The predicted reduction in chlorophyll-a concentration resulting from the implementation of this suite of management alternatives is 28.5 ug/l, or about a 45% reduction from baseline conditions. The second most effective combination of alternatives includes the three listed above plus the implementation of an enhanced lake level fluctuation schedule (Management Action #2). As discussed in Section 3.7 above, the proposed enhanced lake level fluctuation schedule is predicted to result in a slight increase in chlorophyll-a concentrations. However, the habitat benefits to be derived from this management action probably justify its inclusion in the recommended Plan.

Based on the above described model predictions, implementation of the most comprehensive suite of management action alternatives (Management Action Combination 1+2+3+4 from Table 3-7 above) will yield the greatest overall improvement in both water quality and habitat conditions. Using the predicted reductions in chlorophyll-a associated with this suite of management action alternatives, it appears feasible to make very substantial improvements in the water quality and trophic state of Lake Seminole. The predicted 27.4 ug/l reduction in chlorophyll-a concentrations (44% reduction of modeled baseline conditions) associated with this suite of management action alternatives indicates that a mean annual chlorophyll-a concentration target of 30 ug/l is both technically feasible and justifiable with respect to the adopted lake and watershed management goals. This target equates to a chlorophyll-a TSI value of 65.

The model predictions summarized in Table 3-7 also indicate that simultaneous implementation of the selected management action alternatives in many cases results in synergistic improvements in water quality and trophic state.

4.0 THE PLAN

4.1 Management Goals and Level-of-Service Targets

The keystone of any planning process is the establishment of goals. For each established goal, there must also be defined criteria by which degree of attainment of that goal can be measured. In comprehensive planning jargon these measures are commonly referred to as "level-of-service targets." Throughout this Plan the abbreviated term of "targets" will be used to represent the same. Targets are therefore defined as specific units of measure that define progress towards a particular management goal.

This section provides a summary of the final lake and watershed management goals adopted by the Lake Seminole Advisory Committee. In addition, the recommended targets associated with each of the adopted goals, and a brief discussion of the rationale for each, is presented for each of the priority lake and watershed management issues.

4.1.1 Water Quality

A single management goal addressing the issue of Water Quality has been adopted for Lake Seminole:

> ***The lake and its watershed shall be managed such that good water quality, according to Class-III State standards, is achieved and maintained in the lake.***

The following six targets are recommended to support the adopted Water Quality management goal.

1. Attain a mean annual chlorophyll-a concentration of 30 ug/l or less.

2. Attain a mean annual multi-parametric TSI value of 65 or less.

3. Reduce current annual TP loads from external sources by 50%.

4. Annually calculate current water and nutrient budgets for Lake Seminole.

5. Maintain Class-III water quality standards for dissolved oxygen, pH, specific conductance and chlorides.

6. Attain an 80% TSS load reduction for all permitted MSSW facilities within the basin.

The rationale for each of the above recommended targets is briefly discussed below.

Target 1: Attain a mean annual chlorophyll-a concentration of 30 ug/l or less.

Rationale: The target mean annual chlorophyll-a concentration of 30 ug/l is based on the desired beneficial uses of the lake with respect to aquatic vegetation and fisheries, and is consistent with the attainment of a chlorophyll-a TSI target of 65. In addition, waterbody modeling conducted as part of the planning process predicts that this target is attainable if all major components of the Plan are implemented.

Target 2: Attain a mean annual multi-parametric TSI value of 65 or less.

Rationale: The target mean annual multi-parametric TSI value of 65 is based on the desired beneficial uses of the lake with respect to aquatic vegetation and fisheries, and is consistent with the attainment of a mean annual chlorophyll-a target of 30 ug/l.

Target 3: Reduce current annual TP loads from external sources by 50%.

Rationale: An analysis of pollutant loading sources to the lake has indicated that it is feasible to reduce current annual TP loads from stormwater runoff by 55.7% through the construction of enhanced regional stormwater treatment facilities in the basin. This load reduction equates to about 53.7% of the current annual TP load from all external sources.

Target 4: Annually calculate current water and nutrient budgets for Lake Seminole.

Rationale: One of the lake manager's most important tools is an accurate water/nutrient budget. This inflow/outflow analysis of both the sources and sinks of water and nutrients provides information critical to making management decisions. And since a lake's hydrologic and chemical character can change over time in response to changes in the watershed, water and nutrient budgets should be updated annually so that management strategies can be properly adjusted, and management actions re-prioritized.

Target 5: Maintain Class-III water quality standards for dissolved oxygen, pH, specific conductance and chlorides.

Rationale: Maintenance of Class-III State water quality standards, as defined in 62-302 of the Florida Administrative Code, is technically required by law. Although toxics such as metals and organic compounds are not considered to be problems in Lake Seminole, compliance monitoring with respect to dissolved oxygen (DO), pH, specific conductance and chlorides is relevant due to

various management concerns. Both DO and pH are closely related to the management of living resources, whereas specific conductance and chloride concentrations may be used as indicators of saltwater intrusion.

Target 6: Attain an 80% TSS load reduction for all permitted MSSW facilities within the basin.

Rationale: There is a rebuttable presumption that State design criteria for Management and Storage of Surface Water (MSSW) facilities achieve an 80% pollutant load reduction. Furthermore, because Lake Seminole is an Outstanding Florida Water, a 95% pollutant load reduction is technically required for those MSSW facilities discharging directly into the lake. Although the statutes do not specify which pollutants are targeted by the State design criteria, they are generally interpreted to address total suspended solids (TSS) and biological oxygen demand. Attainment of these performance standards is rarely verified or enforced due to the complexities in monitoring individual MSSW facilities; however, available data indicate that most MSSW facilities are substantially deficient if not properly maintained. State law allows for stringent enforcement of these performance standards where it can be demonstrated that State water quality standards are being violated. It can be reasonably argued that nonpoint source pollutant loads to Lake Seminole are violating the State water quality standard for nutrients (e.g., must not cause an ecological imbalance). Assuming that MSSW facilities meeting the 80% TSS load reduction standard also provide adequate nutrient removal, strict enforcement of this minimal performance standard throughout the watershed is justified.

4.1.2 Aquatic Vegetation

A single management goal addressing the issue of Aquatic Vegetation has been adopted for Lake Seminole:

Aquatic vegetation shall be managed such that nuisance and exotic plants are maintained at the lowest feasible levels while encouraging the establishment of a balanced and diverse assemblage of desirable native plants.

Implicit in this goal is the need to manage exotic vegetation such that a favorable balance is achieved between: public access to the lake; safe boating/skiing/swimming; a productive fishery; and desirable aesthetics without water quality degradation. The following four targets are recommended to support the adopted Aquatic Vegetation management goal.

1. Increase and maintain the areal coverage of desirable, endemic submerged aquatic vegetation (SAV) at 170 acres or more (25% of the lake bottom area).

2. Limit the areal coverage of hydrilla to 35 acres or less (<5% of the lake bottom area; <20% of the SAV areal coverage target).

3. Increase and maintain the areal coverage of desirable, endemic emergent aquatic vegetation (EAV) at 60 acres or more.

4. Limit the areal coverage of cattails to 20 acres or less (<33% of the EAV areal coverage target).

The rationale for each of the above recommended targets is briefly discussed below.

Target 1: Increase and maintain the areal coverage of desirable, endemic submerged aquatic vegetation (SAV) at 170 acres or more (25% of the lake bottom area).

Rationale: Due to high grass carp densities and poor water transparency, very limited coverages of SAV exist in Lake Seminole. Desirable, endemic submerged aquatic species such as eel grass (*Vallisneria americana*) provide substantial ecological benefits by stabilizing lake sediments, uptaking sediment and water column nutrients, and providing habitat for invertebrates and sport fish. Eel grass historically existed in Lake Seminole, and a remnant population still exists. Although the exotic hydrilla also provides some of these benefits, it has the potential to outcompete endemic species and severely limit recreational uses. An analysis of available lake bathymetric data has indicated that approximately 25% of the lake bottom area is 3 feet deep or shallower, exclusive of residential canals. With the attainment of the Water Quality targets, it is reasonable to assume that sufficient water transparency will exist to support SAV growth and reproduction in these shallow areas.

Target 2: Limit the areal coverage of hydrilla to 35 acres or less (<5% of the lake bottom area; <20% of the SAV areal coverage target).

Rationale: *Hydrilla verticillata*, or hydrilla, has historically been the most problematic exotic species in Lake Seminole. Currently, little or no hydrilla exists in the lake due to high grass carp densities and very poor water transparency. Hydrilla is capable of expanding its coverage very rapidly, and becomes a management problem when it restricts recreational use primarily by fouling boat propellers. Paradoxically, hydrilla also provides some ecological benefits by serving as sport fish habitat and by binding sediments and reducing sediment nutrient fluxes. While the mission of the FDEP Aquatic Plant

Management Section is to manage hydrilla and other exotic species to their "lowest feasible levels," the complete exclusion of hydrilla from Lake Seminole is probably not feasible, and may not be desirable unless its niche is replaced by endemic species such as Eel grass. From a resource and recreational management standpoint, however, it is recommended that the coverage of hydrilla never be allowed to exceed 35 acres, or approximately 5% of the lake bottom area. Combined with Target 1 above, this target implicitly states that hydrilla should be managed so as to account for no more than 20% of the minimal target SAV areal coverage target of 170 acres. It should further be noted that the management range for hydrilla is *zero* to 100 acres, and that the upper limit of 35 acres of condensed coverage represents a threshold which requires immediate action.

Target 3: **Increase and maintain the areal coverage of desirable, endemic emergent aquatic vegetation (EAV) at 60 acres or more.**

Rationale: A survey of emergent aquatic vegetation performed in 1997 as part of the planning process indicated that approximately 70 acres of emergent herbaceous wetlands occurred in Lake Seminole at that time (PBS&J, 1997). These areas were predominantly covered by cattails and willows. Dredging of organic shoreline sediments combined with increased lake level fluctuation and assisted revegetation projects will enhance the majority of these areas such that a dominance of desirable species (e.g., bulrush) is attained.

Target 4: **Limit the areal coverage of cattails to 20 acres or less (<33% of the EAV areal coverage target).**

Rationale: While cattails (*Typha spp.*) are endemic and beneficial emergent aquatic species, they tend to outcompete other desirable species and dominate the littoral zone. Due to their height and density, large monotypic stands often constitute an impediment to waterfront vistas and public access to the shoreline. In addition, excessively dense cattail stands limit fish spawning areas and provide relatively little food and habitat value for other wildlife species compared to more diverse emergent plant assemblages. Reducing the coverage of cattail in the littoral zone will allow for a greater diversity of desirable, endemic plant species to occupy the shoreline, and will provide for improved fish and wildlife habitat, especially if assisted revegetation efforts are employed. Combined with Target 3 above, this target implicitly states that cattails should be managed so as to account for no more than 20 acres (or about 33%) of the minimal EAV areal coverage target of 60 acres.

4.1.3 Fisheries

A single management goal addressing the issue of Fisheries has been adopted for Lake Seminole:

> ***The lake and its fish populations shall be managed to provide sustained quality sport fishing opportunities.***

The following five targets are recommended to support the adopted Fisheries management goal.

1. Attain a fish community balance of F/C=3.0-6.0 (e.g., the ratio of forage fish biomass to carnivorous fish biomass).
2. Attain indices of Relative Stock Density (RSD) for major sport fish species of: 20-40% >14 inches for largemouth bass and 40-60% >6 inches for bluegill.
3. Attain a 100% angler catch and release rate for largemouth bass.
4. Attain fishing effort in Lake Seminole at ≥150 hours of fishing per acre per year.
5. Attain angler success rates of: >0.30 fish/hour for largemouth bass; and >3.0 fish/hour for panfish (bluegill, redear sunfish, crappie, and catfish).

The rationale for each of the above recommended targets is briefly discussed below.

Target 1: Attain a fish community balance of F/C=3.0-6.0 (e.g., the ratio of forage fish biomass to carnivorous fish biomass).

Rationale: The F/C ratio is a commonly used measure of fish community balance which can also serve as an indicator of lake trophic state as well. An F/C ratio ranging between 3.0 and 6.0 is typically correlated with good sport fishing opportunities as well as mesotrophic conditions. An alternative, and richer, measure of fish community balance is the Fishery Quality Index used by the Florida Fish and Wildlife Conservation Commission which integrates the F/C ratio with other parameters to estimate the condition of sport fish populations.

Target 2: Maintain indices of Relative Stock Density (RSD) for major sport fish species of: 20-40% >14 inches for largemouth bass and 40-60% >6 inches for bluegill.

Rationale: The index of Relative Stock Density provides a numerical expression of population size structure, and provides another quantitative measure of the population balance of major sport fish species.

Target 3: Attain a 100% angler catch and release rate for largemouth bass.

Rationale: Angler catch and release of sport fish - primarily largemouth bass - promotes desirable F/C ratios and maintains a healthy sport fishery. Furthermore, catch and release of carnivorous fishes constitutes an effective means of biomanipulating the fish community such that trophic state of the lake may be reduced. It is unlikely that the proposed catch and release rate of 100% would be attained voluntarily. Therefore, a rule change, as well as more stringent enforcement by the Florida Fish and Wildlife Conservation Commission, would likely be required.

Target 4: Maintain the fishing effort on Lake Seminole at ≥150 hours per acre per year.

Rationale: The sport fishery of Lake Seminole is potentially one of the lake's most important economic benefits to the region. A fishing effort of ≥150 hours per acre per year has been determined by the FFWCC to be an appropriate indicator that this urban lake is providing the expected recreational sport fishing value to anglers.

Target 5: Maintain angler success rates of: >0.30 fish/hour for largemouth bass; and >3.0 fish/hour panfish (bluegill, redear sunfish, black crappie, and catfish).

Rationale: Angler success rates are both a measure of fish abundance, as well as fishing pressure, catch per unit effort and general angler satisfaction. Catch rates of 0.25-0.50/hr for largemouth bass and 1.5-3.0/hr for panfish have been observed by the FFWCC in Lake Seminole, and form the basis for the recommended targets.

4.1.4 Wildlife and Associated Habitat

Two management goals addressing the issue of Wildlife and Associated Habitat have been adopted for Lake Seminole:

The lake and its watershed shall be managed to provide adequate habitat abundance, and to enhance habitat quality and diversity.

The lake and its watershed shall be managed to attract and maintain populations of endemic fish and wildlife species.

The following three targets are recommended to support the adopted Wildlife and Associated Habitat management goals.

1. Substantially reduce or eliminate the coverage of exotic upland species in Lake Seminole Park and other County-owned properties in the watershed.

2. Maintain or increase the number of eagle territories in the Lake Seminole watershed.

3. Maintain or increase the species richness and abundance of endemic bird populations in the Lake Seminole watershed.

The rationale for each of the above recommended targets is briefly discussed below.

Target 1: Substantially reduce or eliminate the coverage of exotic and nuisance upland species in Lake Seminole Park and other County-owned properties in the watershed.

Rationale: An inventory of habitat quality conducted as part of the planning process has indicated that virtually all remaining native plant communities within the Lake Seminole watershed have been adversely impacted by the invasion and proliferation of exotic and nuisance species. The greatest contiguous area of undeveloped land in the watershed occurs in Lake Seminole Park and other adjacent County-owned lands along the eastern shore of the lake. Although vegetation on these lands is virtually all second growth, the remnant native plant communities have been severely impacted by the exotics Brazilian pepper and air potato. The greatest potential for effective habitat restoration and enhancement in the watershed exists on these publicly-owned lands through an aggressive program to substantially reduce or eliminate the coverage of these exotics.

Target 2: Maintain or increase the number of bald eagle territories in the Lake Seminole watershed.

Rationale: The bald eagle is currently listed as a threatened species by both the U.S. Fish and Wildlife Service (USFWS) and the Florida Fish and Wildlife Conservation Commission (FFWCC). The Lake Seminole watershed provides excellent habitat for nesting eagles in that it is a large waterbody with an abundant fish population surrounded by extensive stands of mature pine trees in close proximity. At least two breeding pairs of eagles have nested within the basin boundaries, and the resource potential to support more breeding pairs exists. Habitat and wildlife management techniques should be employed to encourage other bald eagle pairs to nest in the watershed.

Target 3: Maintain or increase the species richness of endemic bird populations in the Lake Seminole watershed.

Rationale: In Florida, many endemic bird species are gradually being displaced by exotic birds. Endemic species provide natural insect control, transport native plant seed for distribution, and are enjoyed by numerous bird enthusiasts. The Lake Seminole area also provides important wintering habitat for a number of seasonal migrants. Minor habitat improvements, predominantly on publicly-owned lands, could be made to increase the species richness and abundance of endemic bird populations.

4.1.5 Recreation and Aesthetics

Two management goals addressing the issue of Recreation and Aesthetics have been adopted for Lake Seminole:

The lake shall be managed in such a manner as to provide for safe recreational boating and skiing.

Use of the lake shall be managed such that the needs of the various user groups are balanced and optimized.

The following four targets are recommended to support the adopted Recreation and Aesthetics management goals.

1. Prevent boating and personal water craft accidents (0 accidents).

2. Maintain Class-III water quality standards for total and fecal coliform bacteria.

3. Attain 90% positive responses on recreational user and lakefront resident opinion surveys.

4. Maintain or increase recreational usage of the lake while still maintaining 90% user satisfaction.

The rationale for each of the above recommended targets is briefly discussed below.

Target 1: Prevent boating and personal water craft accidents (0 accidents).

Rationale: Public safety is a primary concern on any recreation waterbody. A zero tolerance for reckless boating is an appropriate level-of-service given the heavy recreational use that Lake Seminole receives.

Target 2: Maintain Class-III water quality standards for total and fecal coliform bacteria.

Rationale: Past measurements of total and fecal coliform bacteria concentrations in Lake Seminole have indicated the possible presence of human pathogens. Water contact sports such as swimming and water skiing can be severely limited by excessive concentrations of human pathogens. To be safe for human water contact recreation, State water quality standards for coliform bacteria must be maintained.

Target 3: Attain 90% positive responses on recreational user and lakefront resident opinion surveys.

Rationale: The most cost-effective and statistically comparable means by which to measure trends in subjective and qualitative factors such recreational and aesthetic satisfaction is through the use of public opinion surveys. The 90% positive response target is arbitrary and highly dependent on the questionnaire format, however, it should be a relatively good measure of public satisfaction.

Target 4: Maintain or increase recreational usage of the lake while still maintaining 90% user satisfaction.

Rationale: No data exist to meaningfully determine the recreational carrying capacity of Lake Seminole. Therefore, recreational use should be allowed to increase provided that user satisfaction and other lake management goals are not compromised.

4.1.6 Flood Control

A single management goal addressing the issue of Flood Control has been adopted for Lake Seminole:

The lake and watershed shall be managed to minimize flood damage.

The following two targets are recommended to support the Flood Control management goal.

1. Prevent flood damage ($0) to all properties within the Lake Seminole watershed.

2. Manage lake levels to improve water quality and aquatic vegetation conditions while maintaining maximum flood protection.

The rationale for the each of above recommended targets is briefly discussed below.

Target 1: Prevent flood damage ($0) to all properties in the Lake Seminole watershed.

Rationale: Flooding in the Lake Seminole watershed was effectively addressed through the construction of the Seminole Bypass Canal and lake outfall control structure. Since the construction of those facilities, only minor flooding has been reported in the basin. The implementation of other lake management actions should not be allowed to reduce this current level-of-service.

Target 2: Manage lake levels to improve aquatic vegetation conditions while maintaining maximum flood protection.

Rationale: The proper management of Lake Seminole water levels is a potentially very cost-effective management action addressing undesirable aquatic vegetation conditions. An enhanced lake level fluctuation control schedule which falls within the flood control management range of the structure has been proposed to improve the diversity and coverage of desirable aquatic vegetation.

4.1.7 Public Education

A single management goal addressing the issue of Public Education has been adopted for Lake Seminole:

Education in matters related to and affecting the other goals of the Lake Seminole Watershed Management Plan shall be provided.

The provision of an adequate level-of-service for public education can be measured in two ways: 1) as a function of the number and quality of public education events conducted and/or media products distributed; and 2) as a function of general public *understanding* of lake management issues, goals and objectives, as well as *participation* in the lake management process.

The following two targets are recommended to support the adopted Public Education management goal.

1. Annually provide for a minimum of two (2) public education/media events.

2. Attain 90% positive responses on recreational user and lakefront resident public opinion and knowledge surveys.

The rationale for each of the above recommended targets is briefly discussed below.

Target 1: Annually provide for a minimum of two (2) public education/media events.

Rationale: It is recommended that public education/media events be provided for approximately every six months. These events could include such activities as the annual Lake Seminole Day festival, closed circuit television broadcasts, park displays, and brochure/newsletter mailouts.

Target 2: Attain 90% positive responses on recreational user and lakefront resident public opinion and knowledge surveys.

Rationale: It is recommended that public education be assessed in a semi-quantitative manner through the implementation of biannual recreational user and lakefront resident surveys. In addition to public opinion questions discussed above, it is recommended that these surveys also include questions designed to determine pubic understanding of lake management issues, goals, and objectives, as well as public willingness to participate in the lake management process. The 90% positive response should be a relative measure of success.

Table 4-1 below presents a summary of the adopted goals and recommended targets for each of the identified priority lake and watershed management issue.

Table 4-1. Summary of adopted goals and recommended targets for each of the priority lake and watershed management issues.

Management Issue	Goals	Targets
Water Quality	The lake and its watershed shall be managed such that good water quality, according to Class-III State standards, is achieved and maintained in the lake.	1. Attain a mean annual chlorophyll-a concentration of 30 ug/l or less. 2. Attain a mean annual multi-parametric TSI value of 65 or less. 3. Reduce current annual TP loads from external sources by 50%. 4. Annually calculate current water and nutrient budgets for Lake Seminole. 5. Maintain Class-III water quality standards for dissolved oxygen, pH, specific conductance and chlorides. 6. Attain an 80% TSS load reduction for all permitted MSSW facilities within the basin.
Aquatic Vegetation	Aquatic vegetation shall be managed such that nuisance and exotic plants are maintained at the lowest feasible levels while encouraging the establishment of a balanced and diverse assemblage of desirable native plants.	1. Increase and maintain the areal coverage of desirable, endemic submerged aquatic vegetation (SAV) at 170 acres or more (25% of the lake bottom area). 2. Limit the areal coverage of hydrilla to 35 acres or less (<5% of the lake bottom area; <20% of the SAV areal coverage target). 3. Increase and maintain the areal coverage of desirable, endemic emergent aquatic vegetation (EAV) at 60 acres or more. 4. Limit the areal coverage of cattails to 20 acres or less (<33% of the EAV areal coverage target).
Fisheries	The lake and its fish populations shall be managed to provide sustained quality sport fishing opportunities.	1. Attain a fish community balance of F/C=3.0-6.0 (e.g., the ratio of forage fish biomass to carnivorous fish biomass). 2. Attain indices of Relative Stock Density (RSD) for major sport fish species of: 20-40% >14 inches for largemouth bass, and 40-60% >6 inches for bluegill. 3. Attain a 100% angler catch and release rate for largemouth bass. 4. Attain a fishing effort in Lake Seminole of $\geq$150 hours of fishing per acre per year. 5. Attain angler success rates of: >0.30 fish/hour for largemouth bass; and >3.0 fish/hour for panfish (bluegill, redear sunfish, crappie, and catfish).
Wildlife and Associated Habitat	The lake and its watershed shall be managed to provide adequate habitat abundance, and to enhance habitat quality and diversity. The lake and its watershed shall be managed to attract and maintain populations of endemic fish and wildlife species.	1. Substantially reduce or eliminate the coverage of exotic and nuisance upland species in Lake Seminole Park and other County-owned properties in the watershed. 2. Maintain or increase the number of eagle territories in the Lake Seminole watershed. 3. Maintain or increase the species richness and abundance of endemic bird populations in the Lake Seminole watershed.

Management Issue	Goals	Targets
Recreation and Aesthetics	The lake shall be managed in such a manner as to provide for safe recreational boating and skiing. Use of the lake shall be managed such that the needs of the various user groups are balanced and optimized.	1. Prevent boating and personal water craft accidents (0 accidents). 2. Maintain Class-III water quality standards for total and fecal coliform bacteria. 3. Attain 90% positive responses on recreational user and lakefront resident opinion surveys. 4. Maintain or increase recreational usage of the lake while still maintaining 90% user satisfaction.
Flood Control	The lake and watershed shall be managed to minimize flood damage.	1. Prevent flood damage ($0) to all properties within the Lake Seminole watershed. 2. Manage lake levels to improve aquatic vegetation conditions while maintaining maximum flood protection.
Public Education	Education in matters related to and affecting the other goals of the Lake Seminole Management Plan shall be provided.	1. Annually provide for a minimum of two (2) public education/media events. 2. Attain 90% positive responses on recreational user and lakefront resident public opinion and knowledge surveys.

Sections 4.2 through 4.9 below describe the various components of the Lake Seminole Watershed Management Plan. The Plan is broken into nine types of management actions, projects or programs including:

1. Structural Components (Section 4.2);
2. Management Components (Section 4.3);
3. Legal Components (Section 4.4);
4. Policy Components (Section 4.5);
5. Compliance and Enforcement Components (Section 4.6);
6. Social and Recreational Components (Section 4.7);
7. Public Education Components (Section 4.8); and
8. Operation and Maintenance Components (Section 4.9).

Success evaluation of the various recommended management actions is also an important component of the Plan. Focused, objective-oriented monitoring of key indicators is needed to determine progress towards the recommended goals of the Plan. The Monitoring Components of the Plan are presented separately in Chapter 5.

4.2 Structural Components

This section provides a description of the *Structural Components* of the Lake Seminole Watershed Management Plan. Structural components are those management actions that involve the construction of, or a structural or physical modification to, a facility or resource. As such, the structural components of the Plan are typically the most costly, and need to be properly budgeted for and funded through the annual Capital Improvement Plan.

The structural components of the Plan include the following:

- *Structural Component 1* - Construct Enhanced Regional Stormwater Treatment Facilities in Priority Sub-Basins
- *Structural Component 2* - Divert Seminole Bypass Canal Flows to Improve Lake Flushing and Dilution
- *Structural Component 3* - Excavate Organic Peat Sediments from Shoreline Areas
- *Structural Component 4* - Dredge Organic Silt Sediments from Submerged Areas
- *Structural Component 5* - Restore Priority Wetland and Upland Habitats
- *Structural Component 6* - Install Stage and Flow Measurement Instrumentation on the Lake Seminole Outfall Control Structure

For each of the described structural components of the Plan, the following information is provided:

- a description of the recommended management action;
- a discussion of the rationale and justification for the action;
- a summary of the expected benefits of the action;
- identification of the responsible entities; and
- the estimated cost of the action.

STRUCTURAL COMPONENT 1

CONSTRUCT ENHANCED REGIONAL STORMWATER TREATMENT FACILITIES IN PRIORITY SUB-BASINS

Description

This management action involves the construction and maintenance of enhanced stormwater treatment facilities at or near the outfall of selected priority sub-basins as identified in the watershed modeling work. The location of the sub-basins in the Lake Seminole watershed is shown in Figure 4-1 below. Based on SWMM modeled pollutant loading estimates, the priority sub-basins listed in order of decreasing pollutant load are: 3, 1,7, 6, and 2.

Given the virtual lack of available vacant lands for wet detention pond construction and/or expansion, and the potentially very high cost of purchasing and converting existing land uses for this purpose, the use of enhanced treatment systems such as alum injection represents a far more cost-effective approach per unit land area. Alum treatment systems are capable of achieving substantially greater treatment efficiencies than wet detention ponds, on the order of 40% removal for TN and 90% removal for TP and TSS (ERD, 1995). Alum injection with off-line floc settling basins is the approach most commonly applied. This approach is typically preferred by regulatory agencies in that the floc buildup is confined to isolated ponds or basins which can be periodically maintenance dredged to restore the settling volume capacity. In addition, the potentially toxic effects of alum floc buildup can be isolated to these smaller man-made ponds. Although the alum injection infrastructure requires very little land area (e.g., typically less than 0.25 acres), additional land area on the order of a few acres is typically required for floc settling ponds.

A less land-intensive, and thus more cost effective, alternative to this approach is alum injection with in-lake floc settling. While this alternative eliminates the need for additional land area for floc settling ponds, floc buildup in the lake and subsequent resuspension may constitute future water quality problems. In addition, the potential toxicity of alum floc to benthic invertebrates has also been raised as a concern (WAR, 1999). These problems, however, could at least be partially mitigated by the dredging of deeper floc settling basins in the lake bottom at the outfall point for each alum injection facility. The creation of in-lake settling basins would at least partially isolate the floc buildup into a smaller bottom area, and would allow removal of floc material via periodic maintenance dredging.

Preliminary discussions with the Florida Department of Environmental Protection (FDEP) have indicated that alum injection with off-line settling ponds would likely be a permittable approach on Lake Seminole. The FDEP has, however, raised concerns regarding the potential toxicity of alum floc buildup associated with in-lake floc settling. On the other hand, the Southwest Florida Water Management District, who has permitting authority for such facilities, has indicated that they could permit in-lake floc settling in Lake Seminole provided that appropriate monitoring is conducted. Further discussions with both agencies are recommended to discern all of the potential permitting

obstacles associated with alum injection. Based on what is known as of this writing, a cost-effective, technically defensible, and permittable compromise between upland off-line floc settling ponds and in-lake floc settling basins may involve the use of existing hydrologic features near the outfall point for each targeted sub-basin, such as existing ponds and canals, as floc settling basins. Where such features do not exist, the dredging of in-lake settling basins on the lake bottom at the outfall point of each alum injection facility would be the next best alternative.

Again, given the virtual lack of available vacant lands in the lower portions of the Lake Seminole watershed, and the high cost of displacing existing urban land uses, wet detention as a means of achieving regional stormwater treatment is not considered to be feasible. Furthermore, due to the potential for public relations problems, major displacement of existing land uses is not considered to be an option for any BMP applications. Therefore, alum injection with floc settling basins is the recommended technology to be applied in the Lake Seminole watershed. In addition to this technology, BMPs which also incorporate habitat improvements via the construction or enhancement of wetland treatment areas should be pursued wherever feasible.

As part of the planning process, potential BMP locations within each of the priority sub-basins were evaluated with respect to location in the basin (e.g., upstream or downstream), proximity to vacant lands and existing hydrologic features (e.g., existing ponds, canals and wetlands), and engineering design issues (e.g., re-routing of the drainage network, utility impacts, etc.). A total of nine potential BMP locations, plus three projects currently planned for implementation, were identified. These projects are described for each of the five priority sub-basins below. For each sub-basin with multiple alternatives, the first alternative listed (e.g., Alternative 3A) is the preferred alternative.

Sub-Basin 3

- **Alternative 3A - Alum injection with floc settling in an existing wet detention pond and/or an existing ditch/canal.** This BMP alternative would involve the construction of an alum injection facility between 102nd and 104th Avenues immediately east of Seminole Boulevard. Alum would be injected into flows at this point, and the floc would be allowed to settle in two existing wet detention ponds that would need to be modified for this purpose. Alternatively, the alum floc could be allowed to settle in an existing drainage ditch/canal that outfalls to Lake Seminole. This ditch/canal would likely need to be deepened to provide the necessary floc settling storage capacity. A third option would be to use both the existing ponds and the canal for floc settling. This alternative would treat runoff from 619 acres or about 95% of the basin land area.

- **Alternative 3B - Re-routing of drainage under 102nd Avenue; alum injection with floc settling in an existing pond/mitigation area; supplemental wetland treatment.** This BMP alternative would involve the diversion of flows from Sub-Basin 3 southward under 102nd Avenue. Alum would be injected into the flow stream and floc settling would occur in a pond created from the excavation of an existing wetland mitigation area. Discharges

from the floc settling pond would be allowed to flow through existing wetlands (proposed for habitat restoration activities) prior to entering the lake. This alternative would provide enhanced chemical treatment combined with supplement wetland treatment for runoff from 630 acres, or about 96% of the basin land area. However, this alternative would likely preclude riparian access to the lake by several homeowners. In addition, since it would involve converting an existing mitigation area into a floc settling pond, it may be difficult to obtain regulatory permits for this alternative.

Sub-Basin 1

- **Alternative 1A - Alum injection with floc settling in an existing ditch/canal.** This BMP alternative would involve the construction of an alum injection facility at the southern terminus of 101st Avenue, along the existing ditch/canal that outfalls to the north end of Lake Seminole. Alum would be injected into the flows at this point, and the floc would be allowed to settle in the existing drainage ditch/canal. This ditch/canal would likely need to be deepened to provide the necessary floc settling storage capacity. This alternative would treat runoff from 376 acres, or about 80% of the basin land area.

- **Alternative 1B - Alum injection with floc settling in an existing pond.** This BMP alternative would involve the construction of an alum injection facility at the western end of an existing pond located immediately south of Largo Mall. The pond is a permitted facility that treats runoff from the mall. An existing ditch immediately south of the pond carries upstream flows from Sub-Basin 1. Flows from this ditch would need to be redirected into the pond and treated with injected alum, and the floc would be allowed to settle in the pond. The treated flows would then be discharged over another structure back to the existing ditch which ultimately outfalls into the north end of Lake Seminole. The existing pond is shallow, and would need to be dredged to create the necessary floc settling storage capacity. This alternative would treat runoff from approximately 276 acres, or about 60% of the basin area.

Sub-Basin 7

- **Alternative 7A - Alum injection with floc settling in an existing ditch/canal.** This BMP alternative would involve the construction of an alum injection facility east of Seminole Boulevard and north of Skipper Drive, at the outfall of the box culvert draining Sub-Basin 7. Alum would be injected into the flows at this point, and the floc would be allowed to settle in an existing drainage ditch/canal that outfalls to Lake Seminole. This ditch/canal would likely need to be deepened to provide the necessary floc settling storage capacity. This alternative would treat runoff from 495 acres, or about 90% of the basin land area.

- **Alternative 7B - Alum injection with floc settling in two existing ponds.** This BMP alternative would involve the construction of an alum injection facility near the southeast corner of the intersection of 113th Street and 86th Avenue, at the inflow to the westernmost

existing pond located in the Seminole Gardens Apartment complex. Inflows from a box culvert would be treated at this point, and the alum floc would be allowed to settle in both the existing western and eastern ponds of the apartment complex prior to discharge over an existing weir structure. The existing ponds are shallow, and would need to be dredged to create the necessary floc settling storage capacity. This alternative would treat runoff from approximately 429 acres, or about 78% of the basin land area.

Sub-Basin 6

It should be noted that three stormwater rehabilitation projects have been planned, or are currently under construction, in Sub-Basin 6. These include:

- **St. Petersburg Junior College MSSW facility.** This facility will treat runoff from both the St. Petersburg Junior College Campus site as well as offsite runoff from some upstream areas. This facility will meet SWFWMD design standards for wet detention, and will treat runoff from approximately 85 acres, or about 22% of the basin land area

- **Pinellas County Dog Leg Pond project.** This project is primarily a habitat restoration project for an existing regional treatment pond, however, the treatment capacity of the pond has been enhanced by the modifications. The Dog Leg Pond facility treats runoff from approximately 33 acres, or about 8% of the basin land area.

- **Pinellas County Pond 6 project.** This project has been designed to provide both stormwater treatment and habitat restoration benefits. This facility will exceed SWFWMD design standards for wet detention, and will provide 14-day residence time treatment for drainage inflows. In addition, environmental education facilities are planned for this location. The Pond 6 facility will treat approximately 67 acres, or about 17% of the basin land area.

Both the St. Petersburg Junior College MSSW facility and the Pinellas County Dog Leg Pond project are BMPs that are located fairly high in the basin. Therefore, the percentage of the annual flows from Sub-Basin 6 treated by these projects is relatively small. In addition, although the Pond 6 project is located low in the basin, it will treat runoff from only about 17% of the basin land area due to the segregated routing of the drainage network in this basin. In addition to these three existing or planned projects, two other potential BMP alternatives are proposed as discussed below.

- **Alternative 6A - Alum injection with floc settling in an existing ditch/canal.** This BMP alternative would involve the construction of an alum injection facility immediately east of Seminole Boulevard, at the headwall of a box culvert that discharges to an existing ditch/canal that outfalls to Lake Seminole just north of the Pond 6 site. This box culvert drains the remainder of Sub-Basin 6 that does not flow to the Pond 6 site. Alum would be injected into the flows at this point, and the floc would be allowed to settle in the existing drainage ditch/canal. This ditch/canal would likely need to be deepened to provide the necessary floc

settling storage capacity. This alternative would treat runoff from approximately 282 acres, or about 72% of the basin land area.

- **Alternative 6B - Re-routing of drainage to Pond 6 site with combined alum and wetland treatment.** This BMP alternative would involve re-routing the drainage network such that all flows discharging from Sub-Basin 6 could be treated on the Pond 6 site. This would require the re-construction of the drainage network along Seminole Boulevard whereby the flows discharging from the north box culvert discussed above would be re-routed to the south. This would require permitting coordination with FDOT. On the Pond 6 site, the combined basin flows could be treated either with the planned wet detention approach, or with some combination of alum injection and wetland treatment. Given the land area available on the Pond 6 site, it may be feasible to accommodate an alum injection facility with a small floc settling pond that would discharge treated stormwater into a wetland habitat restoration area for water quality polishing prior to discharge to Lake Seminole. This alternative would treat runoff from approximately 365 acres, or about 93% of the basin land area, however, the cost and permitting complexity of rerouting the drainage network may make it non-viable.

<u>Sub-Basin 2</u>

- **Alternative 2A - Alum injection with floc settling in an existing ditch/canal.** This BMP alternative would involve the construction of an alum injection facility on the Orange Lake Civic Center property, located at the eastern terminus of 118th Avenue. The facility would be located near the headwall of a box culvert that discharges flows from Sub-Basin 2 into an existing ditch/canal that outfalls to Lake Seminole. Alum would be injected into the flows at this point, and the floc would be allowed to settle in the existing drainage ditch/canal. This ditch/canal would likely need to be deepened to provide the necessary floc settling storage capacity. This alternative would treat runoff 420 acres, or about 88% of the basin land area. No other viable alternatives were identified for this sub-basin.

The above described potential and planned BMP projects are summarized in Table 4-2, and the location of each is shown in Figure 4-1, below.

Rationale and Justification

Because of the diffuse nature of non-point source pollution, the effective reduction of pollutant loads from stormwater runoff in built-out urban watersheds is usually a difficult and costly problem. As such, implementation of structural BMPs in strategically located areas (e.g., near the outfall point) offers the best opportunity for direct reduction of the stormwater runoff component of external pollutant loads. Although source reduction through public education can also be effective, the attenuation of nutrient loads from nonpoint sources offers potentially the most effective external pollutant load reduction strategy available for Lake Seminole.

Expected Benefits

The five priority sub-basins cumulatively generate approximately 72.30% of the total annual TN, 72.68% of the total annual TP, and 76.03% of the total annual TSS loads to the lake from stormwater runoff. Furthermore, stormwater runoff accounts for about 96.2% of the total external phosphorus inflows to the lake. Assuming a maximum effectiveness of 40% TN removal and 90% TP and TSS removal for enhanced stormwater treatment technology such as alum injection with floc settling basins, the construction of alum injection facilities at the outfall point of the five priority sub-basins could potentially result in the removal of approximately 1.82 tons of phosphorus annually, or about 55.66% of the total annual phosphorus inflows from stormwater runoff. This accounts for about 53.69% of the total external phosphorus load. Although this estimate likely represents a maximum effectiveness, enhanced stormwater treatment facilities strategically implemented in a small watershed like that of Lake Seminole could be very effective at reducing external pollutant loads, particularly for TP and TSS. In a lake that is at least periodically nitrogen limited with respect to inorganic N and P, this management action could be very effective at driving Lake Seminole more towards the desired state of phosphorus limitation.

Responsible Entities

It is anticipated that the construction of enhanced stormwater treatment facilities would be funded by Southwest Florida Water Management District and FDEP with matching funds from Pinellas County and possibly the Cities of Seminole and Largo. The responsibility for property acquisition, design, permitting, and construction would fall primarily with Pinellas County.

Estimated Cost

Costs for installation, operation, and maintenance of alum injection systems with floc settling basins for the five priority basins (e.g., a total of five treatment facilities) have been estimated using unit costs listed for similar systems (ERD, 1994). The capital construction cost for the five alum injection treatment facilities with floc settling basins is estimated at $2.0 million, not including land acquisition costs. The recurring operation and maintenance costs for the five alum treatment facilities is estimated to be approximately $30,000 per year per facility, or a total of about $150,000 per year.

Table 4-2. Potential stormwater BMP locations in the priority sub-basins.

Sub-Basin No.	Sub-Basin Area	Potential BMP Projects	Comments
3	654 acres	Alternative 3A - Alum injection with floc settling in an existing wet detention pond and/or an existing ditch/canal	Would treat 95% of basin land area; off-line or in-lake floc settling basins.
		Alternative 3B - Re-routing of drainage under 102nd Avenue; alum injection with floc settling in an existing pond/mitigation area; supplemental wetland treatment.	Would treat 96% of basin land area; will impact existing mitigation area; may preclude riparian access of homeowners.
7	548 acres	Alternative 7A - Alum injection with floc settling in an existing ditch/canal	Would treat 90% of basin land area; in-lake floc settling basin.
		Alternative 7B - Alum injection with floc settling in two existing ponds	Would treat 78% of basin land area; would require modification of existing private ponds.
1	461 acres	Alternative 1A - Alum injection with floc settling in an existing ditch/canal	Would treat 80% of basin land area; in-lake floc settling basin.
		Alternative 1B - Alum injection with floc settling in an existing pond	Would treat 60% of basin land area; would require modification of a permitted private facility.
2	478 acres	Alternative 2A - Alum injection with floc settling in an existing ditch/canal	Would treat 88% of basin land area; in-lake floc settling basin.
6	391 acres	St. Petersburg Junior College MSSW facility	Recently completed; treats about 22% of basin land area.
		Pinellas County Dog Leg Pond project	Recently completed; primarily a habitat restoration project.
		Pinellas County Pond 6 project	Design complete; will treat only 17% of basin land area; includes habitat restoration component.
		Alternative 6A - Alum injection with floc settling in an existing ditch/canal	Would treat 72% of the basin land area; in-lake floc settling basin.
		Alternative 6B - Re-routing of drainage to Pond 6 site with combined alum and wetland treatment	Would treat 93% of basin land area; potentially costly modifications to drainage network; FDOT permit coordination required.

STRUCTURAL COMPONENT 2

DIVERT SEMINOLE BYPASS CANAL FLOWS TO IMPROVE LAKE FLUSHING AND DILUTION

Description

This management action would involve the diversion of some portion of surface water flows from the Seminole Bypass Canal into the north end of Lake Seminole to improve flushing and dilution of the lake. Water quality monitoring conducted by Pinellas County in the Seminole Bypass Canal indicates that canal water quality is similar to, or slightly better than, that of Lake Seminole with respect to trophic related parameters, especially during high flow periods. In addition, the Southwest Florida Water Management District is in the process of developing an enhanced regional stormwater treatment facility in the upper Seminole Bypass Canal, just south of East Bay Drive. This facility will provide for alum injection and floc settling ponds and is expected to significantly improve downstream water quality in the canal.

As envisioned, this management action would involve the diversion of some portion of the baseflows and/or high flows from the Seminole Bypass Canal into the northern end of Lake Seminole. Because there is a 2-foot elevational difference between Lake Seminole (e.g., weir elevation of 5.0 feet NGVD) and the Seminole Bypass Canal (e.g., weir elevation of 3.0 feet NGVD) the transfer of water from the canal to the lake would need to be facilitated using pumps. The hydrologic and engineering details of this management action would need to be determined in the design phase of the project. However, it should be noted that when Lake Seminole was first created in the mid-1940s, flows from historic Long Creek were diverted into the lake via three pumps that were later removed when the Seminole Bypass Canal was constructed in the mid-1970s.

The effect of this diversion would be to reduce lake residence time, improve flushing and circulation, and potentially provide for some dilution of the nutrient mass in the lake water column. The effectiveness of this management action could be substantially enhanced by further treating the diverted flows prior to discharge into the lake. This enhanced alternative would include the construction of an alum injection facility in association with the pump station such that diverted Seminole Bypass Canal flows would be treated prior to being discharged into Lake Seminole. Under this alternative, an in-lake settling basin would be dredged at the point of discharge to contain the accumulated alum floc. Depending on the diverted volumes, this enhanced alternative could provide for significant dilution of in-lake nutrient concentrations.

Rationale and Justification

Flushing and dilution is a well-documented lake management technique that involves increasing the rate at which the nutrient mass is flushed from the lake combined with the use of higher quality dilution water to reduce in-lake concentrations of nutrients and algae (NYSDEC, 1990). Flushing

and dilution serve to reduce the concentration of nutrients, and the period of time that aquatic vegetation is exposed to these nutrients. The reduced nutrient concentrations and residence time should lead to reduced algal biomass and increased water column transparency due to lower algal cell concentrations and, to a lesser extent, the addition of more transparent water to the lake volume. Increased transparency, in turn, should lead to the proliferation of desirable rooted aquatic plants.

Flushing and dilution as a management technique is most effective when an external supply of dilution water is used. The dilution water does not necessarily have to be of significantly higher water quality than the receiving waterbody; rather, it simply has to be equal to, or slightly lower, in nutrient concentrations to be effective (NYSDEC, 1990). Historically, the external sources of water used for this technique have been nearby rivers, water supplies, or other waterbodies. River and stream flows have been diverted from their natural watercourses into lakes; however, where domestic water supplies have been used, the construction of a pumping and piping system has usually been required (NYSDEC, 1990).

Algal cell concentrations may be reduced by flushing alone (e.g., the discharge of lake water). Increasing the water inflow will decrease the retention time and increase the flushing rate. If the flushing rate is greater than the algae growth rate, algal cells may be washed out of the lake system. Effective control of algae blooms can be achieved by a flushing rate of approximately 10-15% of the lake volume per day (NYSDEC, 1990). If flushing alone can be used to decrease algae concentration through washout, then lower quality water can be used, provided that the increases in the algal growth rate resulting from the higher nutrient concentrations are not sufficient to exceed the increased flushing rate. However, dilution water with nutrient concentrations significantly higher than those in the lake may exacerbate existing water quality problems.

If higher inflow nutrient concentrations result in algal growth rates that exceed the increased flushing rate, then algal concentrations in the lake could actually increase. For these reasons, it is imperative that a comparable or better quality source of dilution water be used in Lake Seminole. Fortunately, given the available external supply of dilution water provided by the Seminole Bypass Canal, flushing rates approaching 10-15% (342 to 513 acre feet) per day may be achievable during the wet season. In addition, water quality improvements expected to result from the SWFWMD regional stormwater treatment facility should ensure that suitable conditions exist to make this action viable.

Expected Benefits

Theoretically, the combined effects of dilution of water column nutrient concentrations, and reduced lake residence times, should produce substantial improvements in lake water quality on a seasonal and annual average basis. Simulations of this management action conducted using the WASP5 model indicate that it could reduce in-lake chlorophyll-a concentration by as much as 14%. Water quality improvements will, in turn, lead to improved conditions for aquatic vegetation and fisheries.

In addition to the water quality benefits, the availability of a dependable source of replacement water for lake water discharged during the implementation of an enhanced lake level fluctuation schedule (see *Management Component 1* below) provides a mechanism for restoring and maintaining target lake levels in the case of drought. Without a dependable source of replacement water, there is some risk that drought following a lake level drawdown will result in an extended period of low lake levels which may adversely impact recreational uses of the lake. This management action provides some insurance against that risk and allows for greater control over lake levels during drought conditions.

Finally, it should be noted that the Seminole Bypass Canal currently discharges largely untreated baseflows and stormwater runoff into Boca Ciega Bay. By diverting and treating baseflows from the canal, and then routing them through Lake Seminole, a significant reduction in nutrient loads from canal discharges to Boca Ciega Bay can be expected. It can be reasonably assumed that the magnitude of this load reduction would be roughly equal to the mass of TN and TP removed from the diverted canal baseflows. Assuming a baseflow of 10.42 cfs from the canal, and TN and TP concentrations of 3.116 mg/l and 0.129 mg/l, respectively, the existing annual nutrient loads to Boca Ciega Bay from untreated canal baseflows are approximately 31.9 tons of TN, and 1.3 tons of TP. Applying the treatment efficiencies for alum injection facilities shown in Table 3-3, this load would be reduced by at least 50% for TN, and by 90% for TP, assuming that the treated baseflows diverted to Lake Seminole would eventually be discharged from the lake outfall structure and into Boca Ciega Bay. Therefore, this management action is conservatively estimated to result in annual nutrient load reductions to Boca Ciega Bay of 16.0 tons for TN, and 1.2 tons for TP.

Responsible Entities

The Pinellas County Department of Public Works would likely take the lead in the design, construction and management of the pump systems that will be required to implement this management action. Permit approval from the Southwest Florida Water Management District will also likely be required, especially if an alum injection facility is incorporated into the design.

Estimated Cost

The costs associated with this component could vary somewhat depending on the infrastructure required to transfer the dilution water from the canal to the lake. Assuming that the alum treatment alternative is pursued, the estimated construction cost for the necessary pumps and infrastructure is approximately $500,000. Additional recurring costs of about $35,000 per year will be required for chemical supplies, and routine operation and maintenance of the alum injection facility and pumps.

STRUCTURAL COMPONENT 3

EXCAVATE ORGANIC PEAT SEDIMENTS FROM SHORELINE AREAS

Description

Approximately 130,000 cubic yards of organic peat sediments are located along the periphery of the lake. This material is composed predominantly of accumulated plant fragments, and poorly decomposed plant tissue, primarily cattails. These organic peat sediments do not resuspend easily, and likely do not contribute significantly to water quality problems; but they do preclude sport fish spawning in the littoral zone, as well as compromise shoreline recreational uses and aesthetics. This management action involves the physical removal of all or part of the estimated 130,000 cubic yards of organic peat sediments from priority segments along the lake shoreline.

There are four major shoreline segments in Lake Seminole where large accumulations of organic peat sediments have become a problem, and the majority of the 130,000 cubic yards of fibrous decayed plant matter identified as problem sediments are contained in these four segments. The four major shoreline segments with problem sediments are shown on Figure 4-2, and described below.

- **Segment 1** - a 44-acre area along the east shoreline of the lake, from the Lake Seminole County Park boat ramp northward to the 102nd Avenue bridge;
- **Segment 2** - a 13-acre area along the west shoreline of the lake, from 94th Place northward to the 102nd Avenue bridge;
- **Segment 3** - a 12-acre area east shoreline of the lake, from the 102nd Avenue bridge northward along Lake Seminole Drive; and
- **Segment 4** - a 16-acre area along the northeast shoreline of the lake, from Harborside Circle northward to the north end of the lake.

It is recommended that mechanical excavation of organic peat sediments from the priority shoreline segments be conducted in multiple phases. Each phase would begin by mobilizing earthmoving equipment to a staging area located along the shoreline segment targeted for sediment removal. Next, the lake level would be lowered to approximately 3.0 feet NGVD via gravity discharge through the new adjustable Lake Seminole outfall structure to be constructed at the south end of the lake. There would be no need for pumping to attain or maintain low lake levels. Using only gravity discharge, the target low lake level could be attained within a few days. Once the 3.0-foot lake level was attained, the affected shoreline segment would be inspected to determine if further adjustments in the lake level would be necessary to fully expose the problem sediments.

When the exposed sediments were sufficiently dessicated, the affected shoreline areas would be cleared and scraped down to a clean sand bottom using earthmoving equipment such as a front end loader or a crane-mounted dragline. The organic peat material would be scraped from the waters edge landward, and then stockpiled at the staging site for further drying. When sufficiently dry, the stockpiled material would then transported by truck to the offsite disposal area. It is anticipated that the excavated material would have a sufficiently high solids content to allow for efficient stacking and truck transport without the need for additional dewatering or treatment. Once all of the excavated material was removed, the affected shoreline would be properly graded and planted with desirable aquatic vegetation, as appropriate. The staging site would then be restored and the earthmoving equipment would be demobilized. Following completion of all associated earthwork, the outfall control structure would be adjusted and the lake would be allowed to naturally refill back up to the normal or controlled high water elevation. Phasing the mechanical excavation of shoreline sediments in this manner would result in minimal disruptions to riparian access and recreational uses of the lake. With the existing fixed-crest weir outfall structure in place, lake levels have periodically dropped as low as 3.0 feet NGVD during periods of drought without major disruptions to recreational uses and lake-dependent commercial operations. Another benefit of mechanical excavation of organic sediments in these areas is that the restored shoreline could be properly graded and planted for appropriate shoreline revegetation and habitat restoration efforts.

Because the four priority shoreline segments targeted for sediment removal are not contiguous, separate staging areas would likely be required for each. Each staging site would need to provide adequate area for the stockpiling of excavated sediments, storage of construction equipment, a temporary construction office facility (e.g., mobile home), and employee parking. In addition, staging sites would need to allow for efficient vehicular access between the lake shoreline and a roadway suitable for truck traffic. Landside access to Segments 2 and 3 is very limited. Although public right-of-way exists along the northern portion of Segment 2, no public access to Segment 3 currently exists. Therefore, the excavation of organic sediments from Segment 2 may only be feasible along the northern portions accessible from the right-of-way; whereas, excavation of sediments from Segment 3 may not be feasible at all. Therefore, it is recommended that the mechanical excavation of organic sediments from Segments 1, 2, and 4 be conducted in three separate phases. Due to limited landside access, the removal of organic peat sediments from Segment 3 and the southern reaches of Segment 2 would need to be conducted using a hydraulic dredge with an appropriate cutterhead. The hydraulic dredging of these areas is discussed further below under *Structural Component 4*.

It is estimated that the total time necessary to complete each of the three phases would range between 2-4 months, depending on the amount of material to be excavated from each of the priority shoreline segments. It is recommended that each phase be conducted during the dry season, during the months of March through June. During this time period lake levels are naturally lower, rainfall is minimal and dessication via solar radiation and air exposure would be maximized. In addition, lower lake levels during this time period are consistent with the recommended enhanced lake level fluctuation schedule.

The organic shoreline sediments would be excavated down to the underlying sand base to create open littoral areas more conducive to sport fish spawning activities. The restored shoreline areas could be allowed to recruit naturally with littoral vegetation, or pilot planting projects could be implemented to establish a seed source for desirable aquatic vegetation. Desirable species composition and appropriate plant densities in the restored littoral vegetation communities would be maintained with followup chemical treatments and mechanical harvesting. Specific habitat restoration projects in priority shoreline segments targeted for peat sediment removal are discussed under *Structural Component 5* below.

Rationale and Justification

The objective of this management action is improvement of aquatic vegetation communities and fishery habitat, and improved shoreline recreational and aesthetic attributes. According to fishery biologists from the Florida Fish and Wildlife Conservation Commission, sport fish spawning habitat is limited in Lake Seminole. This management action would directly increase the shallow littoral bottom area available to sport fish for spawning.

Expected Benefits

The expected benefits of this management action are improved sport fish reproductive success and increased biodiversity in the littoral plant communities of Lake Seminole. Combined with the proposed enhanced lake level fluctuation schedule, this action is expected to result in substantially improved shoreline habitat quality.

Responsible Entities

The Pinellas County Department of Public Works would be responsible for designing, permitting and contracting the sediment removal project. An Environmental Resource Permit (ERP) and a 404 permit would be required from the Southwest Florida Water Management District and the U.S. Army Corps of Engineers, respectively. The current Outstanding Florida Water designation of Lake Seminole may, however, present substantial permitting obstacles. The Florida Fish and Wildlife Conservation Commission should be retained in an advisory role to prioritize shoreline areas in most need of restoration and in monitoring the reproductive success of key sport fish species.

Estimated Cost

Using a conservative unit cost of $10 per cubic yard, the estimated cost to mechanically excavate the approximate 130,000 cubic yards of organic silt is $1,600,000. It is estimated that about 100,000 cubic yards of this material would need to be transported to the disposal site. Using a conservative unit cost of $3 per cubic yard, truck transport of 100,000 cubic yards would result in an additional cost of $300,000. Therefore, the total cost of this management action is estimated to be $1,600,000.

STRUCTURAL COMPONENT 4

DREDGE ORGANIC SILT SEDIMENTS FROM SUBMERGED AREAS

Description

Based on a bathymetric survey and laboratory analyses of sediment physical characteristics conducted as part of the planning process, Lake Seminole is estimated to contain a total of about 4.9 million cubic yards of unconsolidated sediments. The vast majority of this unconsolidated sediment mass is native fine to medium grained sand. Overlying the native sand material is approximately 800,000 cubic yards of low density organic silts which have accumulated predominantly in the north lobe and the "narrows" portion of the lake, as well as in deeper isolated pockets in the south lobe of the lake. The general distribution of the flocculent organic silt sediments is shown on Figure 4-2 above.

Due to the shallowness of Lake Seminole, the low density organic silts are easily resuspended by turbulent wave energy causing reduced water transparency and compromised recreational opportunites. In addition, these sediments are likely a major periodic source of water column nutrient enrichment during periods of bottom hypoxia. Furthermore, the substrate provided by these flocculent sediments is generally not conducive to the establishment and proliferation of desirable submerged aquatic vegetation.

This management action would involve the removal of the approximate 800,000 cubic yards of low density, organic silts which are located primarily in deeper isolated pockets of the lake. The removal of this sediment mass would be conducted using a hydraulic dredging approach. Hydraulic dredges typically use a cutterhead to loosen the sediment material and mix it with ambient water to create a spoil "slurry." The spoil slurry is then hydraulically pumped to a disposal site. Because the spoil slurry is about 95 percent water, the disposal site must have sufficient storage to accommodate both the volume of the dredged sediments plus the volume of the ambient water contained in the spoil slurry. If the disposal site does not have adequate storage volume, the spoil slurry must be dewatered to separate the solids from the fluid medium.

The Lake Seminole watershed is highly urbanized, and there are no large vacant tracts of land close to the lake that are suitable for sediment dewatering ponds and drying areas. Therefore, a rapid dewatering process such as polymer injection will be required to dewater the hydraulically dredge spoil slurry. A rapid dewatering facility must be able to separate the sediment solids from the spoil slurry at a rate compatible with the dredge operation. The spoil slurry must be dewatered to a minimum of 20-40 percent solids to facilitate truck transport to a final disposal area(s). Depending on the efficiency of the rapid dewatering technology employed, additional contiguous land area may be required to facilitate further air drying of the dewatered spoil prior to final disposal of the material. Several publicly-owned tracts of sufficient size to accommodate a spoil rapid dewatering operation within three miles of the lake were identified during the planning process. In consideration of several evaluation criteria, the four sites considered most suitable include:

- **Site A** - This MOL 60-acre site is located approximately 1.5 miles north of the lake, east of the Seminole Bypass Canal, and south of East Bay Drive. The site is owned by the City of Largo and was previously used as a municipal landfill; however, the landfill operations were ceased over a decade ago and the City has fulfilled all requirements of their FDEP approved landfill closure plan. The site is currently vacant uplands, with some disturbed wetlands on the north portion, and is used by the City only for the temporary stockpiling of fill dirt and other construction materials (e.g., gravel, concrete pipe). A remote control model airplane landing strip is also located near the entrance and is leased from the City by a local club.

- **Site B** - This MOL 15-acre site is located approximately 300 feet from northeast corner of Lake Seminole, immediately east of the Seminole Bypass Canal. The site is owned by Pinellas County and is currently vacant uplands. The site appears to have been an old spoil disposal site filled during the construction of the Seminole Bypass Canal.

- **Site C** - This MOL 20-acre site is located approximately 500 feet from the east side of Lake Seminole, immediately west of 98th Street, and south of 102nd Avenue and the Cross Bayou Little League baseball fields. The site is owned by Pinellas County and was also previously used as a baseball field. Currently, however, the site is vacant uplands.

- **Site D** - This MOL 15-acre County-owned site located approximately 500 feet from the east side of Lake Seminole, immediately west of 98th Street, and east of Lake Seminole County Park. The site is owned by Pinellas County, and currently in use as a nursery/mulch facility.

Figure 4-2 above shows the location of these four publicly-owned tracts in the vicinity of the lake that have the best potential for use as temporary spoil rapid dewatering sites. The closed City of Largo landfill site is the preferred sediment treatment site due to its large size, accessibility via truck and hydraulic pipeline, vacant land use, public ownership, and reclamation potential. The other three sites (Sites B, C, and D), are all substantially smaller in size than Site A, and would not easily accommodate additional land area for land spreading and air drying of dewatered sediments. However, depending on the effectiveness of the spoil rapid dewatering technology employed, substantial additional land area for air drying of dewatered sediments may not be necessary. In addition, these alternatives sites are all closer in proximity to Lake Seminole than Site A, and all have adequate vehicular access to Ulmerton Road or Seminole Boulevard to accommodate truck transport of dewatered spoil to the ultimate spoil disposal site(s).

Of the three alternative sites to the closed City of Largo landfill, Site B appears to offer the best potential in that it:

- is owned by Pinellas County;
- is currently cleared and maintained as pervious open space;
- contains no jurisdictional wetlands or sensitive upland habitats;
- contains no documented hazardous materials;

- is readily accessible to and from Ulmerton Road;
- could be easily buffered to minimize noise, dust, and visual exposure;
- is adequately sized to accommodate the RDS treatment facility and sediment stockpiling;
- would facilitate the discharge of recovered water to the Seminole Bypass Canal; and
- would provide physical access to shoreline Segment 4 for mechanical excavation of the organic peat sediments, and habitat restoration of the north County-owned tract.

If approval cannot be reasonably obtained from the City of Largo to use their closed landfill site as a spoil treatment and handling area, then it is recommended that Site B be pursued as the second alternative sediment treatment site. Site B is approximately 15 acres in size and would easily accommodate a spoil rapid dewatering facility. In addition, sufficient land area would be available to facilitate pile management activities as well as construct small polishing ponds for the treatment of recovered water. Finally, the location of the Site B would allow for the convenient discharge of recovered water into the Seminole Bypass Canal rather than Lake Seminole itself, an attribute that has important regulatory ramifications.

Permanent spoil disposal sites are anticipated to be available on one or more publicly-owned lands within a 10 mile radius of the lake. Of these sites, the Toy Town Landfill site is considered to be most feasible for ultimate spoil disposal due to its large size, documented need for fill material for future recreational development, and public ownership, and access via major highways. The only feasible means of transporting treated dewatered sediments from the dewateing site to the disposal site is by truck. The number of truck trips required to remove the material from dewatering site would depend on a number of variables including the percent solids content of the treated sediments, the total volume of treated sediments to be transported, and the capacity of the trucks used. The most direct access routes from Lake Seminole to the Toy Town Landfill site are via Ulmerton Road or Park Boulevard. Providing truck access to and from these roadways with minimal neighborhood and traffic impacts, will be a critical factor in gaining public support for the project.

Rationale and Justification

There is strong anecdotal evidence that the flocculent organic silts in Lake Seminole are easily and frequently resuspended by turbulent wave energy leading to reduced water transparency. In addition, modeling simulation indicate that the mass of organic silt sediments in the lake are contributing to nuisance algae blooms and degraded water quality. The removal of the flocculent organic silts would increase lake depth and volume, decrease sediment resuspension and associated turbidity, and create a more suitable substrate for the establishment and proliferation of desirable submerged aquatic vegetation. While it is the single most costly management action contained in the Plan, it has the greatest potential to both restore the natural assimilative capacity of the lake, as well as improve the recreational benefits provided to lake users.

Expected Benefits

The removal of up to 800,000 cubic yards of unconsolidated flocculant sediments from Lake Seminole would result in direct improvements to waterborne recreation, submerged aquatic vegetation, sport fisheries, and water quality through the physical deepening of the lake. Waterbody modeling using WASP5 has indicated that the removal of the deep organic flocculent sediments could result in significant water quality improvements, with a predicted chlorophyll-a reduction of as much as 24.4%. This is the single most effective management action considered in the waterbody modeling work. The modes of water quality improvement would include: 1) increased lake depth to reduce sediment resuspension; 2) increased lake volume to dilute nutrient concentrations and limit algae growth; and 3) decreased sediment nutrient fluxes to the overlying water column.

Responsible Entities

The Pinellas County Department of Public Works would be responsible for the design, permitting and contracting of the sediment removal project. An Environmental Resource Permit (ERP) and a 404 permit would be required from the Southwest Florida Water Management District and ACOE, respectively. The current Outstanding Florida Water designation of Lake Seminole may, however, present substantial permitting obstacles.

Estimated Cost

Using a conservative unit cost of $8 per cubic yard, the estimated cost to hydraulically dredge and dewater the approximate 800,000 cubic yards of organic silt is $6,400,000. Assuming a 50 percent volume shrinkage, approximately 400,000 cubic yards of this dewatered sediments will need to be transported to the disposal site. Using a conservative unit cost of $3 per cubic yard, truck transport of 400,000 cubic yards would result in an additional cost of $1,200,000. Therefore, the total cost of this management action is estimated to be $7,600,000. This cost does not include any costs associated with land acquisition or leasing, or with the reclamation of the spoil dewatering and treatment site. Those costs will be dependent on the site selected.

STRUCTURAL COMPONENT 5

RESTORE PRIORITY WETLAND AND UPLAND HABITATS

Description

This management action involves the restoration and/or creation of diverse, native aquatic vegetation communities in, and around the perimeter of, Lake Seminole. In addition, this action would include the restoration of priority remnant upland vegetative communities in the watershed.

As part of the watershed planning process, habitat distribution and disturbance patterns were evaluated to determine the potential for special habitat management sites or habitats suitable for enhancement or restoration. The general findings from this evaluation were that the urbanized nature of the watershed does not provide justifiable opportunities for the creation or re-establishment of wildlife corridors or dispersal areas. The remnant habitats in the lake and watershed are small and fragmented to the point where an opportunity for a unifying ecological corridor is no longer viable. Opportunities do, however, exist for recreational corridor connections between Lake Seminole County Park and the Pinellas Trail that extends north-south along the western watershed boundary.

Of the approximately 120 habitat units evaluated within the lake and watershed, a high percentage exhibit nuisance and/or exotic species invasion in varying degrees. Therefore, nuisance species removal coupled with the enhancement and restoration of diverse, native vegetation communities and habitats in both the lake and the watershed is a critical component to the Plan. It should be noted that the habitat coverage by the exotic upland species Brazilian pepper (*Schinus terebinthifolius*) and air potato (*Dioscorea bulbifera*) is very high throughout the watershed. Because these species displace both native upland and wetland species, they should be controlled or removed so that habitats can ultimately be restored to their natural condition. In addition, the native aquatics cattails (*Typha spp.*) and carolina willow (*Salix caroliniana*) have become nuisance species in Lake Seminole largely because of the static water levels that have been maintained for decades. Like Brazilian pepper, these species tend to grow as thick monocultures that exclude the establishment of other native species that may provide better fish and wildlife habitat. Cattails, in particular, occur so densely in Lake Seminole that the excessive growth and decomposition has resulted in the buildup of a layer of highly organic fibrous sediments around the perimeter littoral zone of the lake. These fibrous organic shoreline sediments further preclude spawning by desirable sport fish species.

Seven specific restoration sites were selected in conjunction with Pinellas County staff based on the restoration needs stated above as well as the size, ownership and proximity of the sites to one another and to Lake Seminole. In addition, watershed-wide and lake-wide habitat restoration and nuisance species controls are specified. Table 4-3 lists the sites and their respective existing habitat and restoration/enhancement projects, while Figure 4-3 identifies the location of each site. Appendix 4 contains a more detailed description and cost breakdown of the recommended habitat restoration projects, as well as a discussion of habitat restoration priorities in the Lake Seminole watershed.

Table 4-3. Summary of recommended habitat restorations sites and projects in Lake Seminole and its watershed.

Site	Existing Habitat	Restoration/Enhancement Projects
Park Boulevard Site*	Oak and willow fringe with Brazilian pepper between the road and Lake Seminole	Remove Brazilian pepper, improve views to lake, extend existing shoreline and create a 6 to 1 littoral shelf, vegetate shoreline and littoral habitat in the lake.
Cross Bayou Little League Tract	Brazilian pepper fringe	Remove Brazilian pepper fringe, replant with appropriate vegetation.
Northern County-Owned Tract*	Brazilian pepper dominated areas, disturbed areas with castor bean and elderberry dominant cover, willow marsh along old creek	Remove Brazilian pepper and plant appropriate vegetation, clear and plant pines in central area, clear cattails and willows along creek and plant aquatic vegetation in littoral area. Controlled burn of pine flatwoods area.
Pinellas County Sheriff's Complex	Brazilian pepper dominated areas, drainage pond, and mature pine flatwoods	Remove Brazilian pepper and fill material, plant appropriate vegetation, improve pond to provide for treatment of stormwater, controlled burn in pine flatwoods.
102nd Avenue Bridge Area*	Willow dominant wetland area with jacaranda and Brazilian pepper	Remove exotic species and diversify the habitat with mixed hardwood plantings.
Eagles' Nest Tract	Pine flatwoods	Recommend a controlled burn to revitalize pine flatwoods ecosystem and removal of Brazilian pepper from south property line.
Lake Seminole County Park Pine Flatwoods Restoration	Air potato and grape vine within pine flatwoods	Develop and implement emergency control program in response to prolific growth of these two species in recent years.
Watershed-wide	Brazilian pepper	A cooperative program to remove Brazilian pepper from public and private property throughout the watershed.
Lake-wide*	Cattails and carolina willow	An ongoing cooperative program to establish more diverse, native aquatic vegetation communities in the lake littoral zone.

* In-lake habitat restoration projects.

Rationale and Justification

The specific restoration sites that border Lake Seminole have incorporated a littoral shelf planting program that is designed to provide improved diversity, cover and forage for fish and wildlife. In their Annual Performance Report for Lake Seminole, 1990-91, the Florida Game and Fresh Water Fish Commission (FGFWFC) referenced the significant loss of littoral and submerged fish habitat due to the density of cattails along the eastern side of the lake and a reduction in the acreage of hydrilla. This loss in aquatic habitat has contributed significantly to the decline of the sport fisheries in Lake Seminole.

The FGFWFC recommended that macrophyte diversity and coverage be restored and enhanced through the implementation of littoral zone planting projects.. Recommended species included bulrush *(Scirpus californicus)* and pickerelweed *(Pontederia cordata)*. Other desirable species would include: eel grass (*Vallisneria americana*); maidencane (*Panicum hemitomon*); and arrowhead (*Sagittaria latifolia*).

Expected Benefits

A healthy and diverse community of native aquatic vegetation is an important component of all lake ecosystems. Emergent and submerged aquatic vegetation provides numerous ecological functions in lake systems including:

- food and shelter for fish and wildlife;
- stabilization of unconsolidated sediments; and
- nutrient uptake and stabilization of water quality.

It has been noted in Florida lakes that an inverse relationship generally exists between aquatic macrophyte coverage and algal biomass, as measured by chlorophyll-a concentrations (Huber et al., 1982). That is, lakes tend to either be macrophyte or algal dominated with respect to primary productivity. One of the net benefits derived from the above listed functions is improved water clarity. The improved water clarity and enhanced habitat complexity provided by aquatic macrophytes generally lead to improved sport fisheries and more satisfying recreational experiences and aesthetics.

Responsible Entities

The Pinellas County Department of Environmental Management would have the primary responsibility for implementing the specific in-lake habitat restoration projects. However, extensive coordination with the Florida Fish and Wildlife Conservation Commission is recommended for general lake-wide littoral zone plantings to optimize fish and wildlife habitat.

Estimated Cost

The estimated cost for implementing the three specific in-lake habitat restoration/enhancement projects listed in Table 4-2 - including all nuisance species removal, earthwork, and plantings - is summarized as follows:

- Park Boulevard Site - $314,000
- Northern County-Owned Tract - $592,500
- 102nd Avenue Bridge Site - $33,500

In addition to the above listed specific projects, an additional $60,000 is recommended for pilot littoral zone planting projects. Therefore, the total estimated capital cost for in-lake habitat restoration is approximately $1,000,000 if each project was conducted independently. It is estimated that approximately half of this cost would be associated with the clearing and removal of existing nuisance vegetation and accumulated organic soils in these locations. Therefore, if *Structural Component 3* (Excavation of Organic Peat Sediments from Shoreline Areas) was conducted in coordination with the planting efforts, the cost of the in-lake projects could be reduced to $500,000.

The estimated cost for implementing the five specific upland habitat restoration/enhancement projects listed in Table 4-2 - including all nuisance species removal, earthwork, herbicides, controlled burning, and plantings - is summarized as follows:

- Cross Bayou Little League Tract - $10,000
- Pinellas County Sheriff's Complex - $60,000
- Eagles' Nest Tract - $10,000
- Lake Seminole County Park Pine Flatwoods Restoration - $450,000

The total estimated capital cost for the watershed upland habitat restoration projects is approximately $530,000, with the vast majority of these costs being associated with the Lake Seminole County Park Pine Flatwoods Restoration project.

It should also be noted that the cost estimates provided for each restoration/enhancement project are for capital improvements only and do not include any long-term maintenance or monitoring activities that may be required to successfully complete the individual projects. All cattail removal required for the restoration/enhancement projects is assumed to be conducted by Pinellas County as part of the recommended cattail harvesting program.

STRUCTURAL COMPONENT 6

INSTALL STAGE AND FLOW MEASUREMENT INSTRUMENTATION ON THE LAKE SEMINOLE OUTFALL CONTROL STRUCTURE

Description

This management action involves the installation of instrumentation for accurately measuring lake stage and flow volumes at the Lake Seminole outfall control structure. In addition, this action involves the proper acquisition, storage, reduction and reporting of lake stage and flow volume data using accepted data management protocols.

Rationale and Justification

The Lake Seminole outfall control structure provides a convenient location for measuring flow and collecting water samples; however, instrumentation for accurately measuring and recording stage and flow volumes is not currently in place. Installation of state-of-the-art instrumentation is needed to address the defined monitoring objective of calculating annual water and nutrient budgets for Lake Seminole. Estimates of external loadings from nonpoint sources, atmospheric deposition and groundwater can be measured or modeled, and are addressed in separate monitoring objectives. To balance a water/nutrient budget, the direct measurements of outflows from the lake are needed and can be related to mean annual chlorophyll-a concentrations and TSI values. Annual estimates of loads leaving the lake will enable the calculation of loadings to Long Bayou, and allow for a demonstration of downstream load reduction following full implementation of the Plan.

Expected Benefits

The expected benefits of this management action include the acquisition of previously unavailable data essential to the support of various recommended management actions and monitoring programs, and to the justification of any potential modifications to the Plan in the future.

Responsible Entities

Pinellas County with logistical assistance from Southwest Florida Water Management District

Estimated Cost

Preliminary cost estimates for the installation of state-of-the-art stage and flow measurement and recording devices at the outfall structure range between $15,000 and $20,000. Approximately $2,000 in labor and equipment costs would be associated with the annual operation and maintenance of this instrumentation.

4.3 Management Components

This section provides a description of the *Management Components* of the Lake Seminole Watershed Management Plan. Management components are those management alternatives that involve non-structural modifications to the function, operation and/or maintenance of a facility or resource. In some instances the distinction between structural and management components is not clear, such as in the case of mechanical harvesting which involves physical alterations to aquatic vegetation. The distinction made herein is that if the activity involves minor modifications to an existing facility or resource, and does not involve the construction of any new facilities, it is a management activity.

The Management Components of the Plan include the following:

- *Management Component 1* - Implement an Enhanced Lake Level Fluctuation Schedule

- *Management Component 2* - Inactivate Phosphorus through Whole Lake Alum Applications

- *Management Component 3* - Mechanically Harvest Nuisance Aquatic Vegetation

- *Management Component 4* - Biomanipulate Sport Fish Populations

- *Management Component 5* - Improve Treatment Efficiency of Existing Stormwater Facilities

For each of the described management components of the Plan, the following information is provided:

- a description of the recommended management action;
- a discussion of the rationale and justification for the action;
- a summary of the expected benefits of the action;
- identification of the responsible entities; and
- the estimated cost of the action.

MANAGEMENT COMPONENT 1

IMPLEMENT AN ENHANCED LAKE LEVEL FLUCTUATION SCHEDULE

Description

This management action involves establishing an operational schedule for the proposed new Lake Seminole outfall control structure so as to provide for greater intra-annual lake level fluctuation and inter-annual variability. Since Long Bayou was severed to create Lake Seminole, static lake levels have been maintained at the approximate elevation of 5.0 feet NGVD. A lake level fluctuation schedule has never been formally adopted or implemented on Lake Seminole, and the maintenance of static levels has adversely affected both the aquatic vegetation communities and water quality by reducing plant diversity and increasing lake residence time.

The recommended enhanced lake level fluctuation schedule is shown in Figure 4-4. The enhanced schedule reestablishes a more natural pattern of seasonal and inter-annual variation in lake levels which are to be repeated every four years. The recommended four-year cycle is composed of three different annual lake level fluctuation schedules - A, B, and C. All three schedules have a high elevation of 5.0 feet NGVD. Schedule A has the greatest range with a low of 3.2 feet NGVD. Schedule B has a more moderate range with a low of 3.4 feet NGVD. Schedule C is the most conservative with a low of 3.8 feet NGVD. The four-year cycle involves a repeating pattern of the three schedules as follows: A, C, B, C, A, C . . . etc. Table 4-4 provides a tabular summary of the target monthly lake level elevations for proposed Schedules A, B and C.

Schedules A, B, and C all call for both spring and fall low lake levels. The spring low lake level under Schedule A is more exaggerated than that for Schedule B, whereas the fall low lake level in Schedule B is more pronounced than that for schedule A. Schedules A and B are repeated every four years, whereas Schedule C is repeated every two years. Theoretically, the spring discharge should result in the flushing and dilution of accumulated in-lake nutrient concentrations prior to the summer growing season, whereas the fall discharge is intended to flush nutrient-rich runoff accumulated from the summer rainy season. All three schedules call for high lake levels of 5.0 feet NGVD during both the winter and summer months. These lake level highs are intended to flood littoral vegetation and control the expansion and proliferation of nuisance species, predominantly cattails and willows.

The recommended four-year enhanced lake level fluctuation schedule is intended to better simulate the natural hydrologic regime while still maintaining consistency with the operational range established by Pinellas County for flood control. It should, however, be noted that the recommended four-year enhanced lake level fluctuation schedule is not meant to be implemented rigidly, but rather it is to serve as a guideline for improved lake management. For example, the recommended low water elevation of 3.2 feet NGVD called for in Schedule A should clearly not be attained if extended drought and exceptionally low water table conditions exist.

Figure 4-4. Recommended Four-Year Enhanced Lake Level Fluctuation Schedule for Lake Seminole

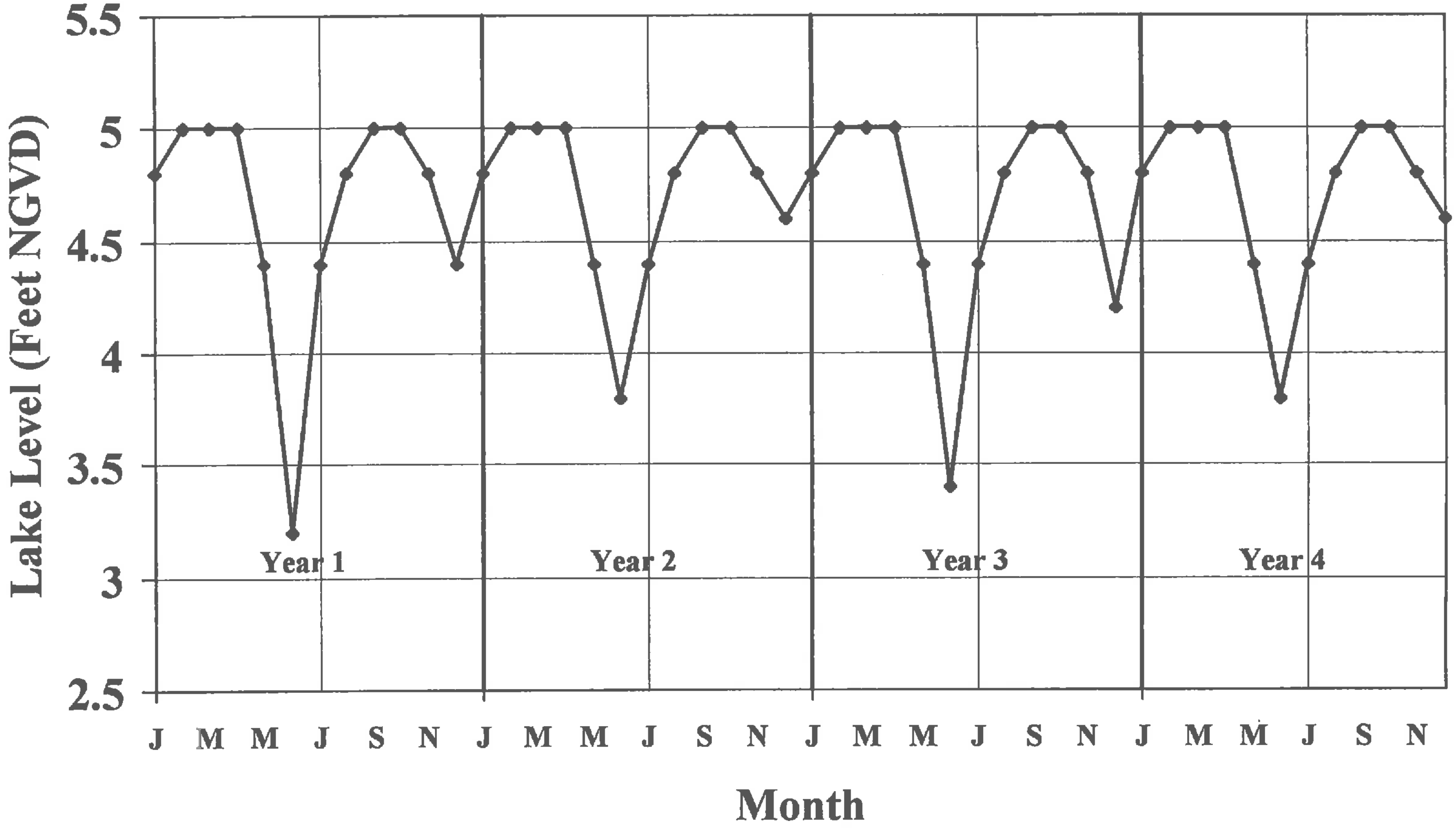


Table 4-4. Tabular summary of target monthly lake levels under the recommended enhanced lake level fluctuation schedule.

Month	Target Lake Levels		
	Schedule A	Schedule B	Schedule C
January	4.8	4.8	4.8
February	5.0	5.0	5.0
March	5.0	5.0	5.0
April	5.0	5.0	5.0
May	4.4	4.4	4.4
June	3.2	3.4	3.8
July	4.4	4.4	4.4
August	4.8	4.8	4.8
September	5.0	5.0	5.0
October	5.0	5.0	5.0
November	4.8	4.8	4.8
December	4.4	4.2	4.6

Notes:

1. All elevations are given in feet NGVD.

2. Target lake level indicates the recommended water elevation to be attained on the first day of each month.

3. The proposed modified four-year lake level fluctuation schedule involves the sequential implementation of Schedules A,C,B,C... on a repeating four-year cycle.

4. Shaded rows indicate the months during which the three schedules differ.

Rationale and Justification

Water level manipulation is one of the most common lake management techniques, used not only for the control of nuisance aquatic vegetation but also for water quality management via flushing and dilution (EPA, 1990). The design and capabilities of the proposed new Lake Seminole outfall control structure will allow for maximum flexibility in the management of lake levels. Unfortunately, the existing outfall structure was conservatively constructed solely for the purpose of flood control, and did not allow for any controlled water level fluctuation. The built-in flexibility of the proposed new structure should be properly utilized and applied in the achievement of other lake management goals including aquatic plant management and water quality improvement.

The recommended low lake levels of 3.2, 3.4 and 3.8 feet NGVD should not present major riparian access or navigational problems. A cursory inventory of nearshore areas and residential canals has been performed and indicates that no significant adverse impacts on recreational navigation will be caused by these low lake levels which periodically occur naturally during drought conditions.

Expected Benefits

The greater range of water level fluctuation will effectively create a more conducive environment for the expansion of a variety of desirable native emergent and submergent species such as bulrush and Eel grass, and will reduce the competitive advantage of cattails. The lowering of lake levels for short periods of time (e.g., weeks to months) almost always elicits a positive vegetation response whereby desirable submerged species such as Eel grass extend their coverage into deeper areas that are more exposed to light. This has the beneficial effect of oxidizing sediment organic matter and binding lake sediments. In addition, raising the water level elevation to, or slightly above, 5.0 NGVD for short periods of time will reduce the competitive advantage of nuisance littoral species such as cattails. Combined with site-specific revegetation projects, the primary benefit of this management action will be substantial improvements in the diversity of the littoral plant community in Lake Seminole, and an overall increase in macrophyte biomass.

A more varied water level fluctuation schedule will also improve sport fishing through the provision of better spawning habitat. Given the low cost of implementation, this component will likely be very cost-effective when compared to large scale habitat restoration projects. Finally, this component will create the opportunity for shoreline residents to remove exposed trash, debris and undesirable vegetation during low lake level periods. Combined with public education, this component should contribute to improved visual aesthetics along the lake shoreline.

It is difficult to quantify the water quality benefits of periodic lake flushing because of the complex biological, hydrogeological and chemical interactions. Using mean annual TN and TP concentrations from 1999 in-lake water quality data, it is estimated that the discharge of 1.0 foot of water from Lake Seminole (e.g., from elevation 5.0 to 4.0 NGVD) would result in a nutrient mass discharge of 5,598 lbs. of TN and 233 lbs. of TP. Although most of this nutrient mass will be replaced by inflowing

precipitation, runoff and groundwater, effective dilution would occur if the cumulative nutrient concentrations in the inflow waters were even slightly lower than in-lake concentrations. Following the implementation of the proposed watershed management actions to reduce external nutrient loads to the lake, greater nutrient dilution can be expected. In addition, the diversion of water from the Seminole Bypass Canal through Lake Seminole (see Structural Component 2 above), will provide for both increased flushing and dilution and reduced residence time, and will potentially constitute a reserve source of water to maintain target lake levels during periods of drought.

Waterbody modeling using the WASP5 model has, however, indicated that the implementation of the recommended enhanced lake level fluctuation schedule alone will result in a slight increase in mean annual chlorophyll-a concentration of 1.9 ug/l or 3%. The interpretation of these model predictions is that the lesser lake volume during the early summer creates conditions more favorable for algal growth. When combined with other management actions (e.g., diversion of Seminole Bypass Canal flows), this negative effect is essentially negated. Despite the predicted slight degradation in water quality, this management action is strongly recommended for the other benefits to living resource that it will produce.

Responsible Entities

Regulatory approval to implement the proposed lake level fluctuation schedule must be obtained from the U.S. Army Corps of Engineers and the Southwest Florida Water Management District. Permit approval is likely given the ecological benefits to be derived from this management action; however, both agencies have expressed concerns about potential downstream water quality impacts to Long Bayou. The Pinellas County Department of Public Works would be responsible for the operation and maintenance of the structure, and would be accountable for achieving the target monthly lake levels.

Estimated Cost

The cost of implementing this management action is considered to be nominal given that Pinellas County has completed the design of the new structure, and that construction costs are already approved in the Capital Improvement Plan. However, some recurring costs associated with staff time to monitor and manage lake levels is anticipated. Costs for these activities are not anticipated to exceed $5,000 per year.

MANAGEMENT COMPONENT 2

INACTIVATE PHOSPHORUS THROUGH WHOLE LAKE ALUM APPLICATIONS

Description

This management action involves whole lake applications of aluminum sulfate (alum) to the surface waters of Lake Seminole. Good candidate lakes for this procedure are typically those that have had nutrient diversion and have been shown through diagnostic-feasibility studies to have a high internal phosphorus release. The release of phosphorus stored in lake sediments can be so extensive in some lakes and reservoirs that algal blooms persist even after incoming phosphorus has been significantly lowered (EPA, 1990). Treatments of lakes with low doses of alum may effectively remove phosphorus (called phosphorus precipitation) but may be inadequate to provide long-term control of phosphorus release from lake sediments (phosphorus inactivation). Phosphorus precipitation removes phosphorus from the water column. Phosphorus inactivation, on the other hand, is a technique to achieve long-term control of phosphorus release from lake sediments by adding as much aluminum sulfate to the lake as possible within the limits dictated by environmental safety.

Iron, calcium, and aluminum have salts that can combine with (or sorb) inorganic phosphorus or remove phosphorus-containing particulate matter from the water column as part of a floc. Of these elements, aluminum is most often chosen because phosphorus binds tightly to its salts over a wide range of ecological conditions, including low or zero dissolved oxygen. In practice, aluminum sulfate (alum) or sodium aluminate is added to the water, and pin-point, colloidal aggregates of aluminum hydroxide are formed. These aggregates rapidly grow into a visible, brownish floc, a precipitate that settles to the sediments in a few hours or days, carrying phosphorus sorbed to its surface and bits of organic and inorganic particulate matter in the floc (EPA, 1990).

After the floc settles to the sediment surface, the water will be very clear. If enough alum is added, a layer of 1 to 2 inches of aluminum hydroxide will cover the sediments and significantly retard the release of phosphorus into the water column as an "internal load." In many lakes, assuming sufficient diversion of external nutrient loading, this will mean that algal cells will become starved for this essential nutrient. In contrast, some untreated lakes, even with adequate diversion of nutrients, will continue to have algal blooms that are sustained by sediment nutrient release (EPA, 1990).

Due to the shallowness of Lake Seminole, and the presence of flocculent sediments that are subject to frequent resuspension, phosphorus inactivation via whole lake alum applications is not recommended until a significant portion of the flocculent sediments have been removed from the lake. The long-term effectiveness of whole lake alum applications for phosphorus inactivation is significantly reduced in lakes where the reactive sediment surface is frequently reworked by turbulent resuspension or other forces (EPA, 1990). Therefore, it is recommended that this management action only be pursued as warranted following the removal of the flocculent deep sediments.

Rationale and Justification

Both empirically derived nutrient budgets and waterbody modeling using WASP5 indicate that internal nutrient recycling in Lake Seminole may be a very significant source of water column phosphorus. In addition, Lake Seminole is dominated by blue-green algal species which have the capability of fixing nitrogen in nitrogen limiting conditions. This management action would strongly drive the lake towards phosphorus limitation, thus reducing the dominance and impact of the persistent blue-green algae blooms that periodically plague Lake Seminole.

Expected Benefits

Phosphorus inactivation has been highly effective and long-lasting in deeper, thermally stratified lakes, especially where an adequate dose has been given to the sediments and where sufficient attenuation of external nutrient loads has occurred. The effectiveness of this phosphorus inactivation has been less impressive in shallow lakes where sediment resuspension is a problem, or where high flows may wash the floc out or quickly cover it with another layer of nutrient-rich silt. Treatment longevity has extended beyond 10 years in some cases and to 5 years in many (EPA, 1990). Shallow, non-stratified lakes appear to have shorter periods of treatment effectiveness than stratified lakes. In those cases where the treatment effectiveness has been short-lived, the phosphorus-sorbing floc layer has usually become covered with new, phosphorus-rich sediments (EPA, 1990). Typical lake responses to alum treatment include:

- sharply lowered phosphorus concentrations;
- greatly increased transparency resulting in improved conditions for desirable aquatic vegetation; and
- algal blooms of much reduced intensity and duration.

It should also be noted that the addition of aluminum salts to lakes has the potential for serious negative impacts, and care must therefore be exercised with regard to dosage. The potential for toxicity problems is directly related to the alkalinity and pH of the lake water. The seasonal ranges of pH and alkalinity must be determined by monitoring before conducting alum treatments. When alum is added, aluminum hydroxide is readily formed in water at pH 6 to 8. This compound is the visible precipitate or floc described earlier. However, pH and alkalinity of the water will fall during alum addition at a rate dictated by the initial alkalinity or buffering capacity of the water. In soft water, only very small doses of alum can be added before alkalinity is exhausted and the pH level falls below 6. At pH 6 and below, $Al(OH)_2$ and dissolved elemental aluminum (Al^{+3}) become the dominant forms. Both can be toxic to aquatic animal species. Well-buffered, hard water lakes are therefore good candidates for this type of lake treatment because a large dose can be given to the lake without fear of creating toxic forms of aluminum. Soft water lakes must be buffered, either with sodium

aluminate or carbonate-type salts, to prevent the undesirable pH shift and to generate enough $Al(OH)_3$ to control phosphorus release. Therefore, dosage is very lake-specific (EPA, 1990).

Responsible Entities

The Pinellas County Department of Environmental Management would be responsible for conducting the necessary water quality monitoring and chemical analyses, and for coordinating the procurement of qualified contractors to conduct the alum applications. Technical assistance from Southwest Florida Water Management District would be highly recommended. A variance from the Florida Department of Environmental Protection may be required, and monitoring to ensure compliance with State water quality standards will be necessary.

Estimated Cost

The cost of whole lake alum applications can vary substantially depending on the area of the lake, the nature of the sediments, and the mode of application. Based on initial discussions with a local alum applicator, it is estimated that 272 lbs. of alum are required to treat each acre-foot of volume to precipitate water column phosphorus and to create an effective floc barrier at the sediment interface in a typical eutrophic Florida lake. The chemical and labor costs associated with the application of 272 lbs. of alum to each acre-foot of lake volume is approximately $416. Using an estimated volume of 3,300 acre-feet for Lake Seminole, the total estimated cost to conduct a single whole lake alum treatment for the lake in its current undredged condition is approximately $1,372,800. It should be noted that this estimate probably represents a maximum cost for this management action. The actual cost may be substantially less, however, depending on the depth of the sediment mass to be inactivated. The cost-effectiveness and longevity of chemical phosphorus inactivation would be substantially greater if the submerged organic silt sediments in Lake Seminole were removed prior to the alum application. Therefore, if the majority of the submerged organic silts in Lake Seminole are dredged, it is reasonable to assume that an effective single whole lake alum application could be conducted for approximately $700,000, or about half the cost of an application in the lake's current condition.

MANAGEMENT COMPONENT 3

MECHANICALLY HARVEST NUISANCE AQUATIC VEGETATION

Description

This management action involves the permanent dedication of one mechanical harvester and transport barge, and a full-time operating crew, to Lake Seminole for the harvesting of cattails on a continual basis. When *Hydrilla* again becomes a component of the Lake Seminole flora, as it will when grass carp are removed and water transparency is improved, the program should be refocused to control this species as a means of controlling both the proliferation of this aggressive exotic as well as nutrient enrichment. The Pinellas County Highway Department (PCHD - Mosquito Control) would be responsible for the operation and maintenance of the harvester units. Drying and processing of the harvested plant matter would take place on publicly-owned property such as the Lake Seminole County Park. Elements of this management action include the following.

- Pinellas County should develop and implement a Lake Seminole Aquatic Weed Management Plan every two years. The plan should be cooperatively developed by the LSAC and technical representatives from PCDPW, PCDEM, SWFWMD, FDEP, FFWCC, and PCHD. The purpose of this plan should be to clearly articulate the two year aquatic weed management goals and priority areas, each agency's responsibilities in meeting the goals, and a two year schedule for aquatic plant management activities on the lake. This plan should be based on the technical information generated from biannual submergent and emergent vegetative surveys.

- A target annual harvest goal for cattails of 10 acres/year should be adopted. Cattails should be harvested from priority areas identified in the biannual Lake Seminole Aquatic Weed Management Plan.

- A target annual harvest goal for *Hydrilla* of 35 acres/year (inclusive of chemically treated senescent tissue) should be adopted. *Hydrilla* should be harvested opportunistically from areas of heavy concentration on a continual basis. The highest priority use of the harvester should be to remove senescent and decomposing *Hydrilla* mats following effective chemical treatment of infested areas. In this manner, mechanical harvesting of an annual biomass target would complement existing chemical treatment programs in controlling the coverage of nuisance aquatics while also resulting in the removal of a mass of stored nutrients thus reducing the potential for nutrient recycling.

- FDEP and SWFWMD should continue to have the primary responsibility for the management of submergent and floating nuisance aquatics in Lake Seminole under the existing Cooperative Aquatic Plant Control Program. A stable and adequate long-term funding source should be pursued so that interruption in maintenance activities is avoided in the future. Consideration

should be given to the use of Pinellas-Anclote Basin Board funds for this purpose. Pinellas County should assume primary control of emergent nuisance aquatics.

- A maximum chemical treatment area limitation of 100 acres per year should be established for *Hydrilla* control. Chemical treatment of *Hydrilla* should be performed on a more frequent and regular basis to maintain the coverage within the proposed target range and to avoid the need for major treatment events on large coverage areas.

- Assisted revegetation of the cattail harvest areas with desirable endemic species should be performed at a target rate of approximately 5 acres/year. It is anticipated that the proposed increased range in the lake level fluctuation schedule will stimulate the natural recruitment and proliferation of a more diverse assemblage of desirable emergent species. Assisted revegetation, either implemented through publicly funded habitat restoration projects or required as conditions of permits, should be limited to commonly available, desirable endemic species.

Rationale and Justification

This management action not only addresses the control of nuisance aquatic vegetation, but it also addresses water quality problems related to eutrophication as well. Macrophytes are widely employed for nutrient removal in wastewater treatment facilities. Reddy and DeBusk (1987) present a summary of the application of aquatic plants to the treatment of wastewater. The assimilation of nutrients into macrophyte biomass is used to fix water column nutrients and provide a means for their eventual removal from the aquatic system. Physical removal (i.e., harvesting) of the plant biomass is required to prevent the return of the assimilated nutrients to the water column or sediments as the plants senesce and decompose. Until relatively recently, however, experience with the use of macrophytes to remove nutrients from eutrophic surface waters has been limited in both the extent and scope. The principles of nutrient assimilation are the same in treating natural surface waters as in treating wastewater streams, but the relative concentrations of nutrients in the water column are much lower. The same species that have been employed in wastewater treatment, especially water hyacinth (*Eichhornia crassipes*), have been used in removing nutrients from surface waters (Reddy and DeBusk, 1987).

Interest in the use of aquatic plants for eutrophication management has increased sharply in the past few years, accompanied by an emphasis on the use of naturally occurring rooted macrophytes for removing both water column and sediment nutrients. There have been several reports published on the successful application of mechanical harvesting of rooted aquatic plants to the mitigation of eutrophication (Souza, et. al., 1988). This is an area of aquatic management that is expected to be developing rapidly over the next few years.

This management action should not be considered contradictory with existing FDEP and SWFWMD policy which essentially states that *Hydrilla* and other exotic nuisance aquatic plants should be

managed at their lowest feasible levels. Rather, mechanical harvesting of an annual biomass target would complement existing chemical treatment programs in controlling the coverage of nuisance aquatics while also resulting in the removal of a mass of stored nutrients thus reducing the potential for nutrient recycling. This is especially true with regard to the harvesting of senescing plant tissue following chemical treatment, which should be the primary objective of the harvesting program.

Expected Benefits

This management action will directly reduce the coverage of both submergent and emergent nuisance aquatic vegetation. In addition, it will contribute to the removal of nutrients from the lake ecosystem. Using cattail tissue analysis data from Lake Tarpon (Dames & Moore, 1992), the harvesting of 10 acres per year of cattails would result in the removal of approximately 170 tons of dry weight organic matter, and 0.3 tons of TP, from the system. Based on available harvesting data from Lake Okeechobee (Gremillion et al., 1988), it is estimated that the controlled harvest of approximately 35 acres of *Hydrilla* in Lake Seminole could result in the annual removal of approximately 4.0 tons of TN and 0.5 tons of TP per year. If this mass of plant tissue were to senesce and decompose simultaneously, as would be the case after a large scale chemical treatment, the harvesting of this material would result in a very substantial internal load reduction.

Responsible Entities

The primary responsibility for the implementation of the harvesting program will rest with Pinellas County. The agencies represented on the Lake Seminole Advisory Committee, including the Florida Department of Environmental Protection, the Southwest Florida Water Management District and the Florida Fish and Wildlife Conservation Commission should cooperate in the development and coordinated implementation of the Lake Seminole Aquatic Weed Management Plan.

Estimated Cost

Pinellas County currently owns the harvester and transport barge, and has operated it on Lake Seminole for several years. Therefore, only operation and maintenance costs would be involved. The annual O&M costs associated with conducting full-time harvesting for cattails and hydrilla in Lake Seminole are estimated to range between $160,000 and $200,000. To provide comparability with other nutrient reduction strategies, harvesting rate criteria must be based on cost per pound of nutrients removed. Based on a preliminary assessment of approximately $34 to $38 per pound of TP removed from the system, as reported by Gremillion et al. (1988), this action has the potential to be very cost-effective when compared to other watershed management actions.

MANAGEMENT COMPONENT 4

BIOMANIPULATE SPORT FISH POPULATIONS

Description

While there are a wide variety of ecological control mechanisms that generally fall under the category of "biomanipulation," this management action would primarily involve manipulation of the lake fisheries to improve water quality conditions and modify the fish population structure such that sport fish species become dominant. This primarily involves the selected harvesting of herbivorous rough fish from Lake Seminole, including grass carp and gizzard shad. In addition, this action would include stocking of sport fish species, and the adoption and aggressive enforcement of a catch and release rule for select sport fish species in Lake Seminole.

It is anticipated that these activities would be phased to coincide with habitat and water quality improvements associated with other components of the Plan. Phase I activities would involve removal of the grass carp via electrofishing and haul seines. The removal of grass carp is considered critical to habitat restoration efforts aimed at increasing the coverage of submerged aquatic vegetation in the lake. Phase I activities would also include haul seine removal of gizzard and threadfin shad as a means of removing phosphorus from the lake and reducing zooplankton predation, which in turn is expected to reduce chlorophyll-a concentrations. Phase II activities would involve continued shad harvesting as well as stocking the lake with young carnivorous sport fish, including largemouth bass and bluegill. Phase III activities would involve continued stocking of sport fish as deemed necessary, as well as the adoption and strict enforcement of a 100% catch and release rule for largemouth bass. The catch and release rule could be relaxed after several years if monitoring data indicate the establishment of a healthy sustained sport fish population.

Rationale and Justification

One of the priority goals of the Lake Seminole Watershed Management Plan is to restore and maintain a healthy sport fishery in the lake. In addition, Lake Seminole is a designated Fish Management Area, meaning that the Florida Fish and Wildlife Conservation Commission has a commitment to optimally manage the sport fishery in the lake. Although the sport fishery in Lake Seminole would likely recover on its own over time following the implementation of the other management actions discussed above, direct manipulation of the sport fishery to accelerate the recovery is warranted.

Expected Benefits

The expected benefits of this management action would be a shift in the fish population structure and an improved sport fishery. In addition, the removal of rough fish would also result in an ancillary improvement in water quality conditions.

Responsible Entities

The Florida Fish and Wildlife Conservation Commission (FFWCC) would have the primary responsibility for implementing this action. It is anticipated that this work would be conducted under a cooperative agreement between Pinellas County and the FFWCC.

Estimated Cost

A detailed cost estimate for this management action would need to be developed by the Florida Fish and Wildlife Conservation Commission. It is, however, estimated that the cost of a two to three year cooperative agreement with the FFWCC to facilitate rough fish removal and sport fish stocking over a three year period would likely not exceed $100,000 per year, or a total contract amount of $300,000.

MANAGEMENT COMPONENT 5

IMPROVE TREATMENT EFFICIENCY OF EXISTING STORMWATER FACILITIES

Description

This management action involves the development and implementation of a comprehensive local program to improve compliance monitoring and enforcement of permitted surface water management (MSSW) facilities in the basin. This program would essentially be an enhanced version of the Adopt-a-Pond program implemented in several local governments in Florida, including Hillsborough County. This action would involve the following steps:

1. Perform an inventory of all existing permitted MSSW facilities in the basin, as permitted by SWFWMD since 1985. Identify target MSSW facilities for inspection and potential monitoring. Monitoring candidates should be targeted based on the size of the service area and whether significant changes in contributing land uses have occurred since the facility was permitted. Develop a priority list of MSSW facilities to be inspected.

2. Inspect and monitor the priority MSSW facilities identified in Step 1 above. The facility should be inspected for compliance with the permitted design. In addition, stormwater entering and discharging from the facility following a storm event should be sampled for TSS, TN and TP.

3. If the facility is determined to be out of compliance with permitted design or water quality standards, the owner should be informed of the problems and the need to correct them. Florida Statutes require an 80% pollutant (TSS) removal efficiency and the attainment of Class-III water quality standards at the end of the discharge pipe.

4. Working cooperatively with the owners, develop a site-specific improvement plan for each target MSSW facility. The improvement plans could include such modifications as changing the water level control elevations or planting a littoral shelf. In addition, facility improvement plans should incorporate habitat improvement elements wherever feasible.

5. Provide financial assistance and technical guidance to owners, as appropriate, to implement the facility improvement plans.

Although facilities constructed prior to 1985 are legally vested from meeting water quality standards, the second level of priority under this program would be these older stormwater ponds. An attempt should be made to get owners of pre-1985 facilities to voluntarily participate in the program through financial incentives and/or assistance.

Rationale and Justification

There is a rebuttable presumption that State design criteria for Management and Storage of Surface Water (MSSW) facilities achieve an 80% pollutant load reduction. Furthermore, because Lake Seminole is an Outstanding Florida Water, a 95% pollutant load reduction is technically required for those MSSW facilities discharging directly into the lake. Although the statutes do not specify which pollutants are targeted by the State design criteria, they are generally interpreted to address total suspended solids (TSS) and biological oxygen demand (BOD). Attainment of these performance standards is rarely verified or enforced due to the complexities in monitoring individual MSSW facilities; however, available data indicate that most MSSW facilities are substantially deficient if not properly maintained.

State law allows for stringent enforcement of these performance standards where it can be demonstrated that State water quality standards are being violated. It can be reasonably argued that nonpoint source pollutant loads to Lake Seminole are violating the State water quality standard for nutrients (e.g., must not cause an ecological imbalance). Assuming that MSSW facilities meeting the 80% TSS load reduction standard also provide adequate nutrient removal, strict enforcement of this minimal performance standard throughout the watershed is justified.

The intense level of existing urban development in the Lake Seminole basin limits the potential effectiveness of implementing more stringent regulations for new development. Many stormwater facilities exist within the watershed but may not be functioning at their intended level-of-service. Therefore, measures to bring these facilities into compliance with current or basin-specific performance standards are likely to be cost-effective management actions, especially in those major basins where regional treatment facilities are not being proposed.

There is currently a rebuttable presumption in the law that existing surface water management facilities that meet State design criteria also comply with State water quality standards. This rebuttable presumption can be, and has been, legally challenged where the need for strict compliance can be clearly demonstrated. Since Lake Seminole is an Outstanding Florida Water (OFW) the applicable water quality standard for nutrients is concentrations which "cause degradation of water quality" downstream of the discharge. Therefore, under existing regulations, it is possible to develop and enforce a higher basin-specific performance standard for existing stormwater management systems.

Expected Benefits

The pollutant load reduction associated with improving the performance of existing stormwater treatment systems is potentially significant given the level of development in the study area, especially in the western portions of the watershed. It is not possible to accurately quantify this potential load reduction, however, until an inventory of existing facilities is completed.

Another benefit of documenting the stringent enforcement of existing regulations would be an improved basis for State authorization of Clean Water Act, Article 319, grant applications for eligible Lake Seminole projects.

Responsible Entities

The Pinellas County Departments of Environmental Management and Public Works would have the primary responsibility for implementing this management action. Coordination with the Southwest Florida Water Management District would also be required for accessing and reviewing old permit files and monitoring reports.

Estimated Cost

It is estimated that the effective implementation of this program would require one environmental specialist and one engineer on a full-time basis. In addition to the administrative costs associated with these staffing needs, a means of providing financial assistance to facility owners through a matching funds approach would be needed. It is anticipated that this program could be completed within two years following implementation. With an estimated annual cost of $100,000 per year, the total cost of this program is not expected to exceed $200,000.

4.4 Legal Components

This section provides a description of the *Legal Components* of the Lake Seminole Watershed Management Plan. Legal components are those management actions that involve the promulgation and adoption of new laws, rules and regulations; or the amendment of existing laws, rules or regulations.

The Legal Components of the Plan include the following:

- *Legal Component 1* - Amend the Florida Statutes to Temporarily Exempt Lake Seminole from Aquatic Preserve And Outstanding Florida Water Regulatory Restrictions

- *Legal Component 2* - Adopt a Resolution Designating the Lake Seminole Watershed as a "Nutrient Sensitive Watershed"

- *Legal Component 3* - Strengthen and Standardize Local Ordinances for Regulating Stormwater Treatment for Redevelopment in the Lake Seminole Watershed

For each of the described legal components of the Plan, the following information is provided:

- a description of the recommended management action;
- a discussion of the rationale and justification for the action;
- a summary of the expected benefits of the action;
- identification of the responsible entities; and
- the estimated cost of the action.

LEGAL COMPONENT 1

AMEND THE FLORIDA STATUTES TO TEMPORARILY EXEMPT LAKE SEMINOLE FROM AQUATIC PRESERVE AND OUTSTANDING FLORIDA WATER REGULATORY RESTRICTIONS

Description

Under current law, Lake Seminole is designated as part of the Pinellas County Aquatic Preserve, and as such is an Outstanding Florida Water (OFW). This management action would involve a legal amendment to the Florida Statutes resulting in the temporary exemption of Lake Seminole from certain regulatory restrictions applied to designated Aquatic Preserves and OFWs. The purpose of this management action would be to allow the implementation of the more disruptive lake restoration activities proposed in this Plan (e.g., sediment removal) without undue and inappropriate regulatory burdens.

As proposed, this management action would entail the preparation of legal language that would be incorporated into the Florida Statutes by amendment. This language would either: 1) temporarily suspend the inclusion of Lake Seminole in the Pinellas County Aquatic Preserve, and remove the OFW designation; or, 2) specifically allow for the implementation of all lake management activities outlined in this Plan under non-OFW permitting rules. If the first alternative is pursued, the temporary suspension of the Lake Seminole OFW designation would automatically sunset after a finite period of time (e.g., 5 years) adequate to complete the major lake restoration and management components.

Amendment of the statutes would require legislative action sponsored by local representatives. Appropriate provisions should be crafted to recognize the natural resource management needs of urban lakes and support activities necessary to restore Lake Seminole. Such an amendment would recognize the need for, and allow for the streamlined permitting of, appropriate dredge and fill activities for water quality improvement and habitat restoration, and other water quality treatment activities (e.g., whole lake alum applications) that may be necessary for the ecological restoration and recreational enhancement of the lake and its living resources.

Rationale and Justification

Under existing law there are legal restrictions relating to allowable activities in both Aquatic Preserves and Outstanding Florida Waters. The legislative intent behind these designations is to protect water quality and sovereign submerged lands in areas which have exceptional biological, aesthetic and scientific value in order to preserve these areas for future generations. These waterbodies are to be preserved insofar as possible, in an essentially natural condition. However,

because Lake Seminole is an impounded waterbody that is highly disturbed and hypereutrophic, these rules do not seem to readily apply.

Specific lake management activities allowable within OFW waterbodies are not well defined in the rules resulting in potentially significant permitting problems during restoration efforts. For example, the dredging of Lake Seminole, which will cause temporary localized degradation of water quality and the disturbance of sovereign submerged lands, would be extremely difficult to permit under OFW rules.

Chapter 72-663, Laws of Florida (Section 1) states that "the submerged lands included within the boundaries of Pinellas County, as described in Section 7.52, Florida Statutes, are hereby declared to be an Aquatic Preserve..." Since Lake Seminole is within the County the submerged lands within the lake are considered as part of the Aquatic Preserve. Section 2 of 72-668, Laws of Florida, and Chapter 258.39 of the Florida Statutes state that these Aquatic Preserves are also Outstanding Florida Waters. Restrictions specifically stated in the rules pertaining to Aquatic Preserves and Outstanding Florida Waters include:

- Section 72-668.(2)(a) - No further dredging or filling of submerged lands shall be approved or tolerated by the Trustees except:

    (1) Such minimum dredging and spoiling as may be authorized for public navigation projects; and

    (2) Such other alterations of physical conditions as may, in the opinion of the Trustees, be necessary to enhance the quality or utility of the preserve or the public health generally.

        (b) There shall in no case be any dredging seaward of a bulkhead line for the sole purpose or primary purpose of providing fill for any area landward of a bulkhead line.

    (3) The Trustees shall not approve the seaward relocation or setting of bulkhead lines seaward of the mean high-water mark within the preserve.

- Rule 62-4.242 (2) Florida Administrative Code establishes certain water quality standards for Outstanding Florida Waters. This section states that "... no Department permit or water quality certification shall be issued for any proposed activities or discharge within an Outstanding Florida Waters that significantly degrades water quality."

The restrictions embodied in existing law will likely constitute substantial legal obstacles to obtaining regulatory permits for the major lake restoration activities proposed in this Plan, and

there is recent local precedent for these problems. The City of St. Petersburg's efforts to dredge Lake Maggiore (also a highly degraded OFW) as a component of a lake restoration plan was delayed for several years due to conflicts between the existing statutory language and the proposed restoration activities.

Expected Benefits

The primary benefit expected from this management action would be streamlined regulatory permit approval for the various lake restoration activities proposed in the Plan. Temporarily exempting Lake Seminole from Aquatic Preserve and OFW regulatory restrictions will likely improve the receptiveness of the applicable regulatory agencies to permitting the major physical and chemical alterations deemed necessary to restore and enhance the functions of the lake. Once these major alterations are completed the Aquatic Preserve and OFW designations can be reinstated to ensure long-term preservation of the restored natural systems.

Responsible Entities

Pinellas County legal staff, and local representatives of the Florida legislature.

Estimated Cost

Costs for this management action would be limited to labor hours associated with preparation and implementation of a legislative amendment by the Pinellas County legal department and legislative staff.

LEGAL COMPONENT 2

ADOPT A RESOLUTION DESIGNATING THE LAKE SEMINOLE WATERSHED AS A "NUTRIENT SENSITIVE WATERSHED"

Description

This management action would involve the adoption of a resolution by the Pinellas County Board of County Commissioners and the Cities of Largo and Seminole designating the Lake Seminole basin as a "Nutrient Sensitive Watershed." The resolution would reference the Lake Seminole Watershed Management Plan as the controlling planning document, and would identify the need for, and public commitment to, developing specific voluntary guidelines for the following:

- regular street sweeping within the basin;
- proper disposal of lawn cuttings and brush clippings to prevent the dumping of organic debris into the lake;
- proper removal of pet droppings along public and private shoreline areas of the lake to prevent pet waste runoff into the lake;
- fertilizer application rates for both residential and commercial land uses (e.g., number of pounds per acre per month) to prevent overapplication and excessive runoff and seepage to the lake;
- reclaimed wastewater effluent application rates for both residential and commercial land uses (e.g., limited number of inches per acre per day) to prevent overapplication and excessive runoff and seepage to the lake; and
- optional control measures for reclaimed wastewater effluent application within the basin (e.g., automatic rain shut-off valves) to prevent runoff during storm events.

Rationale and Justification

Long-term monitoring data indicate that Lake Seminole has been eutrophic virtually since its creation in the mid-1940s. More recent data from the 1990s indicate that the rate of eutrophication is increasing rapidly. Since there are no point source discharges to the lake, and external sources of nutrients to the lake are generally diffuse in nature (e.g., stormwater runoff), the problem of reducing external nutrient loads to the lake must be attacked on many fronts. The predominantly residential and commercial land uses within the basin probably contribute a cumulatively substantial portion of the total nutrient load to the lake through sheetflow runoff, the dumping of lawn cuttings into the lake, pet waste runoff, and seepage of excessive applications of lawn fertilizers and reclaimed

irrigation water. This may be especially true for golf courses and heavily landscaped residential areas within the basin. Formal legal recognition of the nutrient sensitivity of the Lake Seminole watershed, as well as measures to reduce these diffuse loads, are needed as part of the overall management strategy.

Expected Benefits

The expected benefits from this management action include the reduction of diffuse nutrient loads from residential and commercial land uses within the basin. While the Plan includes recommendations for capital projects that address the primary manageable sources of external nutrient loads (e.g., direct runoff), this management action, combined with improved public education, is aimed at addressing the more diffuse yet cumulatively substantial nutrient loads associated with typical urban landscape management practices.

Responsible Entities

Pinellas County Board of County Commissioners and the Cities of Largo and Seminole.

Estimated Cost

Costs associated with this action would be limited to labor by existing County and City legal and planning staff.

LEGAL COMPONENT 3

STRENGTHEN AND STANDARDIZE LOCAL ORDINANCES FOR REGULATING STORMWATER TREATMENT FOR REDEVELOPMENT IN THE LAKE SEMINOLE WATERSHED

Description

This management action involves the cooperative development and adoption of a consistent ordinance, between Pinellas County and the Cities of Largo and Seminole, defining special thresholds, rules, and conditions for stormwater rehabilitation through redevelopment within the Lake Seminole watershed. The ordinance should address the retrofitting of pre-1985 stormwater treatment and/or flood attenuation systems with systems that meet current standards for Outstanding Florida Waters. It is recommended that the ordinance establish the following criteria for redevelopment activities specifically within the Lake Seminole watershed.

- All residential, commercial, and industrial parcels undergoing redevelopment shall meet current State stormwater treatment standards for Outstanding Florida Waters (e.g., treat the first 1.5 inches of runoff) for the entire parcel area.

- Redevelopment shall be defined as any demolition and reconstruction or repaving activity that affects 1,500 square feet or more of area, or 10% or more of the total parcel area, whichever is less. Single family residential lots shall be exempted from this provision.

- Payment in lieu of constructing stormwater treatment facilities shall be an allowable relief mechanism for all parcels falling under the above provisions. The fee shall be based on the estimated costs associated with the construction of said stormwater treatment facilities.

- Fees collected from payments made in lieu of constructing stormwater treatment facilities shall be placed in the Lake Seminole Watershed Management Trust Fund, and shall be used exclusively for the construction, operation and maintenance of regional stormwater treatment facilities constructed pursuant to the Lake Seminole Watershed Management Plan. All fees collected under this ordinance shall be expended within the governmental jurisdiction from which they were collected.

As described above, the recommended ordinance would establish a Lake Seminole Watershed Management Trust Fund for fees collected from payments made in lieu of constructing stormwater treatment facilities on constrained parcels. The trust fund would be managed by Pinellas County, and would be used exclusively to finance ongoing operation and maintenance of the regional enhanced stormwater treatment facilities recommended above in *Structural Component 1*.

The recommended ordinance should clearly acknowledge the fact that no net gain in water quality within the watershed can be achieved if redevelopment projects do not make some provisions for improved stormwater management and treatment. This is especially true in the Lake Seminole watershed where the majority of the basin was developed with numerous high density residential and commercial projects prior to the State's adoption of Chapter 17-25 F.A.C. These older developments typically have no stormwater treatment systems incorporated into the original design. Because of the age of the developments in the Lake Seminole watershed, redevelopment is expected to occur at an increasing pace over the next decade. It is imperative for the restoration of the lake that some gains are made with respect to improving the level of stormwater treatment on older developed parcels in the watershed, especially those located directly on the lake.

Rationale and Justification

One of the most notable examples of regulatory inconsistencies between the State and local governments with jurisdiction in the watershed involves rules governing stormwater treatment for redevelopment activities. Under current conditions, SWFWMD, Pinellas County, and the Cities of Largo and Seminole all deal with stormwater requirements on redeveloped parcels somewhat differently. These differences are summarized below.

- **SWFWMD:** On parcels developed prior to 1985 which are undergoing redevelopment, stormwater treatment is required only for the additional new impervious surface area resulting from the redevelopment activity. Such treatment must be consistent with current SWFWMD surface water quality discharge standards. The pre-existing impervious surface is exempt from stormwater treatment requirements.

- **Pinellas County:** Requires that all redevelopment which adds or exceeds a cumulative total of 3,000 square feet of additional impervious development, or 25% of the lot or parcel area, meet current SWFWMD stormwater treatment requirements for the entire site. Also, if a site is completely razed, then current surface water management standard requirements apply for the entire site.

- **City of Largo:** Adopts the SWFWMD requirements for redevelopment. The City of Largo does, however, specify that for sites that are completely razed, and remain vacant for one year or longer, the entire site must meet State stormwater treatment requirements when it is redeveloped, regardless of pre-existing impervious surface. In addition, the City of Largo specifically allows for payment in lieu of constructing stormwater treatment facilities in their urban downtown district.

- **City of Seminole:** Adopts the SWFWMD minimal requirements for redevelopment. The City of Seminole also has provisions for payment in lieu of constructing stormwater treatment facilities for constrained sites.

These differences have likely resulted in a great deal of variability with regard to the approach and ultimate effectiveness of stormwater rehabilitation on redeveloped parcels in the watershed. Given the level of older development in the basin, stormwater rehabilitation through redevelopment could be critical to the long term reduction of pollutant loadings to the lake, or at least to holding the line on existing loadings. Therefore, a more consistent and effective approach is needed.

It is recommended that this management action be coordinated and facilitated in combination with the *Legal Component 2* above (Adopt a Resolution Designating the Lake Seminole Watershed as a "Nutrient Sensitive Watershed"), and *Policy Component 1* below (Establish a Lake Watershed Management Area (WMA) Through Amendments to the Pinellas County, and Cities of Largo and Seminole Comprehensive Plans). Taken together, these three management actions establish a legal and policy framework for efficient intergovernmental coordination for the holistic management of Lake Seminole and its watershed as a singular resource.

Expected Benefits

The expected benefits from this management action would include reduced nonpoint source pollutant loadings to Lake Seminole as the watershed undergoes redevelopment. The percent load reduction cannot be quantitatively predicted, as it will be totally dependent on the level of redevelopment that ultimately occurs.

Responsible Entities

Pinellas County and the Cities of Largo and Seminole.

Estimated Cost

No additional staffing costs are anticipated through the implementation of this action. Existing site plan review and code enforcement staff should be sufficient. Improved efficiency and coordination between Pinellas County and the Cities of Largo and Seminole could reduce staffing needs.

4.5 Policy Components

This section provides a description of the *Policy Components* of the Lake Seminole Watershed Management Plan. Policy components are those management alternatives that involve the adoption of new policies and planning guidelines, or the amendment of existing policies and planning guidelines contained in State and local policy guidance documents.

One Policy Component is included in the Plan:

- *Policy Component 1* - Establish a Lake Seminole Watershed Management Area (WMA) through Amendments to the Pinellas County, and Cities of Largo and Seminole Comprehensive Plans

For the single described policy component of the Plan, the following information is provided:

- a description of the recommended management action;
- a discussion of the rationale and justification for the action;
- a summary of the expected benefits of the action;
- identification of the responsible entities; and
- the estimated cost of the action.

POLICY COMPONENT 1

ESTABLISH A LAKE SEMINOLE WATERSHED MANAGEMENT AREA (WMA) THROUGH AMENDMENTS TO THE PINELLAS COUNTY, AND CITIES OF LARGO AND SEMINOLE COMPREHENSIVE PLANS

Description

This management action involves the establishment of a Lake Seminole Watershed Management Area (WMA), via amendments to the Pinellas County, and Cities of Largo and Seminole Comprehensive Plans. The WMA would formally establish a special planning and management district for the Lake Seminole watershed within the growth management framework.

The purpose of the WMA designation would be to focus the adopted goals of the Lake Seminole Advisory Committee within a defined tri-jurisdictional geographic area, and to better coordinate and consolidate the decision making processes for regulatory and management activities conducted by Pinellas County and the Cities of Largo and Seminole within the Lake Seminole watershed. The WMA in concept would be a "planning" district, rather than a taxing district, that would cover the entire Lake Seminole watershed and place specific policy provisions in place for certain activities and land uses in both the unincorporated and incorporated areas of the basin.

As part of this action, Pinellas County and the Cities of Largo and Seminole should also adopt specific goals, objectives and policies for the Lake Seminole Watershed Management Area. At a minimum, the goals adopted by the Lake Seminole Advisory Committee should be embodied in the Comprehensive Plans of the County and the Cities. In addition, existing goals, objectives and policies as well as basin-specific level-of-service targets (e.g., stormwater treatment and O&M commitments) found elsewhere in the Pinellas County and City Comprehensive Plans should be consolidated under the Lake Seminole Watershed Management Area sections. Examples of such policies include:

- The requirement of OFW-level of stormwater treatment for all new development in the Lake Seminole WMA.
- The consistent application of local stormwater treatment requirements for redevelopment within the Lake Seminole WMA that exceeds the requirements of SWFWMD.
- Payment in lieu of stormwater treatment for exempted parcels.
- The consistent application of land development codes and regulations, as well as voluntary guidelines for management activities such as fertilizer and wastewater reuse application rates, within Lake Seminole WMA.

Rationale and Justification

Numerous policy inconsistencies exist between the Pinellas County and Cities of Largo and Seminole Comprehensive Plans regarding issues that affect the Lake Seminole Watershed Management Plan. The designation of the Lake Seminole Watershed Management Area, and the adoption of a consistent set of policy guidelines and level-of-service targets between both local government Comprehensive Plans will facilitate a common approach to resource management of the Lake Seminole watershed.

Expected Benefits

The primary expected benefit of this management action is improved intergovernmental coordination between Pinellas County and Cities of Largo and Seminole with regard to watershed management issues in the basin.

Responsible Entities

Pinellas County Board of County Commissioners and the Cities of Largo and Seminole.

Estimated Cost

Costs associated with this action would be limited to labor by existing County and City legal and planning staff.

4.6 Compliance and Enforcement Components

This section provides a description of the *Compliance and Enforcement Components* of the Lake Seminole Watershed Management Plan. Compliance and Enforcement components are those management alternatives that involve measures to improve compliance with all enacted laws, rules and regulations applicable to the Plan. Improved compliance is usually achieved through more effective enforcement activities, however, other types of incentives (e.g., property tax credits) and disincentives should be explored.

The Compliance and Enforcement Components of the Plan include:

- *Compliance and Enforcement Component 1* - Expand and Enforce Restricted Speed Zones on Lake Seminole

- *Compliance and Enforcement Component 2* - Dedicate a Pinellas County Marine Unit Sheriff to Enforce Laws on Lake Seminole

For each of the described compliance and enforcement components of the Plan, the following information is provided:

- a description of the recommended management action;
- a discussion of the rationale and justification for the action;
- a summary of the expected benefits of the action;
- identification of the responsible entities; and
- the estimated cost of the action.

COMPLIANCE AND ENFORCEMENT COMPONENT 1

EXPAND AND ENFORCE RESTRICTED SPEED ZONES ON LAKE SEMINOLE

Description

This management action involves the adoption of an ordinance formally establishing new restricted speed zones in Lake Seminole, as well as the installation and maintenance of buoy markers that clearly define the established "no wake" areas. Currently, restricted speed zones exist along the lake perimeter out to 100 feet from the shoreline, and in the "narrows" area of the lake. This management action would extend the perimeter restricted speed zone out to 200 feet from the shoreline around the entire perimeter of the lake, and would establish restricted speed zones for the recommended "Enhanced Fishing Zones" described in *Social and Recreational Components 1 and 2* below.

It is recommended that any existing buoy markers be removed and replaced with new, more visible marker buoys installed approximately every 500 feet along the perimeter of the lake, 200 feet offshore of the true shoreline (e.g., the landward edge exclusive of vegetation). The locations of the recommended restricted speed zones are shown in Figure 4-6.

This action also includes improved means of communicating to the public the limits, purpose, and intended benefits (e.g., erosion control, noise abatement, segregation of incompatible recreational uses) of the restricted speed zones, as well as allowable activities and speeds within these zones. It is recommended that improved signage and instructional information be located at all public boat ramp kiosks clarifying the appropriate speeds allowed within restricted speed zone (e.g., clear definitions of no wake, idle speed, slow speed, etc.).

Rationale and Justification

The most common complaints registered in surveys of recreational users of the lake involved excessive speed by power boats and water skiers, personal watercraft, and ultralight aircraft, and violation of the existing posted no wake zones in the lake. The lack of clearly marked restricted speed zones in nearshore areas, and limited enforcement of existing restricted speed zones, were consistently cited as problems on Lake Seminole. In addition, there was a lack of awareness of the limits, purpose and allowable speeds within the existing restricted speed zones. Finally, excessive watercraft speed and turbulence in the shallow "narrows" and perimeter portions of the lake contributes to sediment resuspension and associated turbidity and water quality problems.

It should be noted that the potentially fatal collision of high speed motorboats, personal watercraft, and even ultralight aircraft taking off and landing in the non-restricted speed zones of the lake is a difficult problem to address. While additional regulations may prevent the rare accident, such regulations are also likely to significantly infringe upon the public's enjoyment of the multi-use recreational attributes of Lake Seminole. If additional regulations are deemed necessary to protect

public health, safety, and welfare from high speed watercraft and/or aircraft collisions, then it is recommended that they be developed outside the scope of this Watershed Management Plan.

Expected Benefits

The primary benefits of this action would be improved public safety and enjoyment of the lake, as well as reduced user conflicts. In addition, water quality may be improved through reduced wake and wave turbulence in shallow portions of the lake susceptible to sediment resuspension.

Responsible Entities

Pinellas County Department of Environmental Management and Parks Department.

Estimated Cost

The estimated non-recurring cost for purchasing and installing the recommended marker buoys, as well as improved signage and instructional information, is $100,000.

COMPLIANCE AND ENFORCEMENT COMPONENT 2

DEDICATE A PINELLAS COUNTY MARINE UNIT SHERIFF TO ENFORCE LAWS ON LAKE SEMINOLE

Description

This management action involves the assignment of a Pinellas County Sheriff's Department Marine Unit Deputy to enforce the recommended restricted speed zones in Lake Seminole (see *Enforcement and Compliance Component 1* above). This should be a full-time position dedicated to enforcing restricted speed zones and other applicable resource management laws on the two major lakes in Pinellas County - Lake Seminole and Lake Tarpon. As such, this Sheriff would split the full-time assignment between the two lakes and thus would be present on Lake Seminole approximately 20-hours per week.

Marine Unit Sheriff's presence on Lake Seminole should reduce user conflicts, and allow for more enjoyable passive recreational uses of the lake through improved enforcement of the existing noise ordinance (wildlife viewing, canoeing etc.). With crossover training by the Florida Fish and Wildlife Conservation Commission, increased Sheriffs Marine Unit presence will also further other goals related to natural resource protection especially with regard to enforcing the recommended catch and release rules for largemouth bass. As an alternative, Pinellas County Sheriff's Department could enter into an agreement with the Florida Fish and Wildlife Conservation Commission such that this position is filled by a FFWCC or Marine Patrol law enforcement officer.

In addition to the assignment of the full-time Sheriff, this action also involves improved and coordinated record keeping procedures of complaints, violations and accidents on the lake. It is recommended that the Pinellas County Department of Environmental Management, the Pinellas County Sheriffs Department and the Florida Fish and Wildlife Conservation Commission record and report quarterly summaries of complaints, violations, accidents, and other relevant incidents occurring on Lake Seminole.

Rationale and Justification

The most common complaints registered in surveys of recreational users of the lake involve excessive speed by power boaters, water skiers, and personal watercraft users, and the violation of the existing posted no wake zones on the lake. The lack of enforcement of these restricted speed zones was consistently cited as the problem. There is a lack of awareness of the management goals adopted for Lake Seminole within the Pinellas County Sheriffs Department, at both the staff implementation and policy level. It is evident that this lack of policy coordination has negatively impacted budgetary commitment and enforcement orientation. Furthermore, it was determined during the preparation of the Plan that no organized records of complaints, violations, accidents, and other relevant

incidents are maintained by the Sheriff's Department. Therefore, it is not possible to accurately assess the frequency of such problems under the current record keeping approach.

Expected Benefits

The expected benefits include improved enforcement of restricted speed zones, aesthetic standards (e.g., the noise ordinance) and fish and wildlife rules and regulations. In addition, reduced user conflicts should result.

Responsible Entities

Pinellas County Sheriff's Department with crossover training assistance from the Florida Fish and Wildlife Conservation Commission.

Estimated Cost

This management action involves the assignment of one full-time Marine Unit Sheriff to Lake Seminole, with the splitting of this time on Lake Tarpon. The costs of this action include: salary; equipment, including a boat and a truck and trailer; and equipment maintenance. Annual recurring costs are estimated at $100,000.

4.7 Social and Recreational Components

This section provides a description of the *Social and Recreational Components* of the Lake Seminole Watershed Management Plan. Social and recreational components are those management alternatives that involve strategies and non-enforcement related measures to reduce recreational user conflicts and improve the recreational and aesthetic enjoyment of the lake.

The Social and Recreational Components of the Plan include the following:

- *Social and Recreational Component 1* - Construct a Public Pedestrian Fishing Pier and Boardwalk in Lake Seminole County Park

- *Social and Recreational Component 2* - Establish and Protect Fishing Enhancement Zones on Lake Seminole

For each of the described social and recreational components of the Plan, the following information is provided:

- a description of the recommended management action;
- a discussion of the rationale and justification for the action;
- a summary of the expected benefits of the action;
- identification of the responsible entities; and
- the estimated cost of the action.

SOCIAL AND RECREATIONAL COMPONENT 1

CONSTRUCT A PUBLIC PEDESTRIAN FISHING PIER AND BOARDWALK IN LAKE SEMINOLE COUNTY PARK

Description

This management action involves the construction of a public pedestrian fishing pier and boardwalk in Lake Seminole County Park. Additional shoreline recreational facilities, such as a fishing pier, an observation tower, and boardwalks along the shoreline would substantially enhance the recreational opportunities currently available to park visitors. These shoreline recreational facilities would be complemented by the removal of the cattail and carolina willow fringe vegetation along the shoreline of the park, and the dredging of deeper pockets and construction of lime rock rip-rap fish havens (see *Social and Recreational Component 2* below). Figures 4-5A and 4-5B show two possible design alternatives, with Alternative B being the preferred, but also the most costly alternative.

Rationale and Justification

Lake Seminole County Park is the primary recreational access point to Lake Seminole. Lake Seminole County Park accommodates over 1,200,000 visitors annually and is the third most visited County park after Fort DeSoto and Fred Howard County Parks. Most recreational visitors to the park arrive by automobile and have limited access to the lake. Currently, water related recreational facilities within the park include the boat launching ramp with 80 boat trailer parking spaces and a hand launch ramp. The park also provides grassed open space and picnic shelters with views across the lake. Recreational activities conducted on the lake are currently limited to boating and water sports including ultra-light aircraft, skiing, pleasure boating, personal water craft, sailing, canoeing, and fishing via boat.

Increased shoreline access to water related activities on Lake Seminole would further diversify recreational opportunities within the park and assist in meeting the recreational demands of users. These recreational facilities are recommended to include enhanced shoreline fishing, a nature boardwalk and observation tower, and increased trail access to the lake waterfront. Shoreline improvements such as the removal of nuisance vegetation, dredging and construction of fish havens and habitat enhancement zones along the shoreline of the park, and the installation of docks and boardwalks would provide increased recreational access to the non-boating public.

Expected Benefits

Improved health of the lake together with shoreline recreational improvements will further diversify water related recreational opportunities for park visitors. These shoreline improvements

will complement the existing recreational facilities at the park and provide visitors with increased opportunities for water related recreational activities.

Responsible Entities

The Pinellas County Parks Department would have the primary responsibility for designing, permitting and constructing the recommended recreational improvements. Assistance in the design of the fishing pier and boardwalk should be provided by the FFWCC and SWFWMD.

Estimated Cost

Alternative A assumes a 185-foot "T" fishing pier 12-foot wide ($37,000) and 750 feet of 8-foot wide boardwalk both for an estimated cost of $150,000. Alternative B includes the pier and 2,370 feet of boardwalk at an estimated cost of $392,500. The removal of nuisance shoreline vegetation and restoration of aquatic plant communities along the park shoreline would add an additional $3,000 per acre to the cost of Alternative B, making the total cost of the project approximately $400,000.

SOCIAL AND RECREATIONAL COMPONENT 2

ESTABLISH AND PROTECT FISHING ENHANCEMENT ZONES ON LAKE SEMINOLE

Description

This management action involves the creation of two "fishing enhancement zones" in the lake, one each in the north and south lobes. The fishing enhancement zones are segments of the lake shoreline where the bottom would be dredged to create an undulating series of deeper pockets (e.g., 8-feet deep) separated by shallower areas. The shallow areas would be planted with desirable emergent vegetation such as bulrush; whereas in the deeper pockets structural cover such as lime rock rip-rap fish havens or tree stumps would be placed. The variable depths, combined with soft and hard substrate and structural elements, would be designed to optimize sport fish spawning and feeding activities, as well as provide shelter for larval and juvenile fish to enhance recruitment.

As proposed, one fishing enhancement zone would be constructed adjacent to the public pedestrian fishing pier and boardwalk located in Lake Seminole County Park, as discussed in *Social and Recreational Component 1* above. The second fishing enhancement zone would be constructed immediately offshore of the north County-owned tract proposed for habitat restoration. Figure 4-6 shows the location of the north and south fishing enhancement zones. In addition to the structural habitat creation, these segments of the lake shoreline would be designated as no wake zones, and marked accordingly with floating buoy markers. The intended recreational use for these areas would be limited to fishing and passive recreation, whereas water skiing and personal watercraft use would be restricted.

Rationale and Justification

Quality fishing opportunities are currently lacking in Lake Seminole. Anglers have to share the lake with more active watersports enthusiasts including water skiers, personal watercraft and ultra-light aircraft. These latter activities tend to conflict with fishing due to the associated noise and wave turbulence. There is a documented need to establish restricted access areas where only fishing and other passive recreational uses (e.g., canoeing) are allowed. In addition, the south fishing enhancement zone provides quality bank fishing opportunities that currently do not exist anywhere on the lake for the non-boating public.

Expected Benefits

The expected benefits of this management action include improved fishing quality and reduced user conflicts. The provision of structural fishery habitat improvements in protected segments of the lake is anticipated to improve the sport fishery as well as increase fishing effort and angler success rates in Lake Seminole.

Responsible Entities

The Florida Fish and Wildlife Conservation Commission should have the primary responsibility for designing and constructing the recommended recreational improvements under a cooperative agreement with Pinellas County. The Pinellas County Parks Department would be the permit applicant. Coordination with, and assistance from, the Pinellas County Department of Environmental Management is recommended.

Estimated Cost

The costs associated with dredging the deeper pockets could easily be incorporated into the shoreline dredging project discussed in *Structural Component 3* above. Therefore, construction costs for the two fishing enhancement zones would be limited to the emergent plantings and the creation of the rock rip-rap fish havens. It is estimated that the construction cost for these features would not exceed a total of $30,000 for both the north and south fishing enhancement zones.

4.8 Public Education Components

This section provides a description of the *Public Education Components* of the Lake Seminole Watershed Management Plan. The public education components are those management alternatives that involve strategies to improve public knowledge of lake and watershed management issues, problems and solutions; and to increase public interest and involvement in the lake management process and implementation of the Plan.

The Public Education Components of the Plan include the following:

- *Public Education Component 1* - Develop and Implement a Comprehensive Public Involvement Program for the Lake Seminole Watershed

- *Public Education Component 2* - Develop and Implement a Local Citizens LakeWatch Program for Lake Seminole

For each of the described public education components of the Plan, the following information is provided:

- a description of the recommended management action;
- a discussion of the rationale and justification for the action;
- a summary of the expected benefits of the action;
- identification of the responsible entities; and
- the estimated cost of the action.

PUBLIC EDUCATION COMPONENT 1

DEVELOP AND IMPLEMENT A COMPREHENSIVE PUBLIC INVOLVEMENT PROGRAM FOR THE LAKE SEMINOLE WATERSHED

Description

This management action involves the development and implementation of a comprehensive public involvement program for the Lake Seminole watershed. The program would include a number of elements including the following:

- Preparation of a semi-annual newsletter (e.g., twice per year) to be mailed to residents and businesses in the basin informing the public of the various components of the Plan as well as findings, trends, and upcoming activities.

- Production and airing of a government access television presentation on Lake Seminole, with updates to the program to be made on an annual basis. A video tape of this presentation should be made available to citizens upon request.

- Update and improve the "Help Save Lake Seminole" brochure. The improved brochure should be distributed to all residents and businesses in the watershed.

- Establish a speakers bureau for homeowners association meetings and other public functions. Members of the Lake Seminole Management Committee should be recruited for this purpose.

- Establish an information clearinghouse for technical reports, monitoring data, and other information related to Lake Seminole.

- Implement Lake Seminole Day as an annual function. Sponsorship for this event should be actively solicited from local businesses.

- Installation of "Dump No Waste - Drains to Lake" plaques on storm drains throughout the watershed.

- Installation of additional roadway signs indicating the boundaries of the Lake Seminole Watershed Management Area.

Due to the cost involved in large scale mailouts, it is recommended that mailings be focused only to residents and businesses within the Lake Seminole basin, exclusive of the Seminole Bypass Canal drainage basin. As an alternative, a subset mailing list could be developed for only those residents and businesses located within 1,000 feet of the lake.

Rationale and Justification

Public apathy regarding lake and watershed management is a common pattern until obvious problems such as nuisance algae blooms and aquatic weed infestations become apparent. The public response to such problems is typically quite negative and unproductive. Improved public understanding of the causes of lake management problems, and the role that individuals can play in managing and improving the quality of the lake and watershed will contribute significantly to furthering the goals of the Plan. In addition, increased public involvement as stakeholders in the ownership and implementation of the Plan should reduce unproductive and excessive public criticism of the responsible governmental agencies, and improve the overall lake and watershed management effort.

Expected Benefits

Improved public understanding of lake management problems and solutions; increased pubic involvement and participation in the Plan implementation process.

Responsible Entities

Pinellas County Public Information Department and Department of Environmental Management.

Estimated Cost

Cost estimates for the various elements of the public involvement program need to be developed. It is anticipated that total annual costs, exclusive of staff time, would not exceed $10,000.

PUBLIC EDUCATION COMPONENT 2

DEVELOP AND IMPLEMENT A LOCAL CITIZENS LAKEWATCH PROGRAM FOR LAKE SEMINOLE

Description

This management action involves the recruitment of interested local citizens to participate in the collection of supplemental monitoring data from Lake Seminole and its watershed. Local citizen involvement in monitoring activities would be implemented through a coordinated network of lakefront homeowners and other interested citizens. The recruitment and training of interested citizens would follow the protocols established by the Florida LakeWatch program, which has implemented similar programs on numerous central Florida lakes.

Rationale and Justification

A variety of data needs are identified in Section 5.0 of the Plan below, several of which are currently not being address by Pinellas County or other agencies. Interested citizens should be recruited to assist in the collection of such data wherever feasible. Local citizen LakeWatch programs have been very successful in central Florida, where numerous lake associations are actively involved in monitoring and data collection on their lakes. This type of public "ownership" in the resource could greatly improve public interest and involvement in the restoration and management of Lake Seminole.

Expected Benefits

Improved public interest and involvement in the lake and watershed management process, and assistance in the collection of supplemental monitoring data.

Responsible Entities

The Pinellas County Department of Environmental Management working with the central Florida LakeWatch organization.

Estimated Cost

The only costs associated with this management action would be labor by existing PCDEM staff in coordinating and supporting the activities of a local LakeWatch group. Additional financial support may be available from the Florida Department of Environmental Protection via EPA 319 grants.

4.9 Operation and Maintenance

In order to function properly, adequate manpower and financial resources must be directed to the continued operation and maintenance (O&M) of the structures, facilities, and other capital equipment constructed and/or dedicated as part of the Plan implementation. O&M activities are primarily associated with the structural components of the Plan, and those management components that involve facilities and equipment dedicated to the restoration and management of Lake Seminole. Although individual O&M activities are not considered to be stand-alone management actions, the cumulative O&M effort needed to support the recommended structures, facilities, and capital equipment constitutes and important component of the Plan. Therefore, a single Plan component for all applicable operation and maintenance activities is proposed as follows:

***Operation and Maintenance Component 1* - Operate and Maintain Structural Facilities and Equipment Recommended in the Plan**

O&M cost estimates for the key recommended structural and management components of the Plan were prepared through consultation with County staff and other readily available information sources. Annual O&M costs associated with these components are summarized in Table 4-5 below.

Table 4-5. Summary of estimated annual operation and maintenance costs rounded to the nearest $1,000.

Plan Component	O&M Activity	Estimated Annual O&M Cost
Structural Component 1 - Construct Enhanced Regional Stormwater Treatment Facilities in Priority Sub-Basins	Maintain alum injection facilities; chemical supplies.	$150,000 (@$30,000 per facility)
Structural Component 2 - Divert Seminole Bypass Canal Flows to Improve Lake Flushing and Dilution	Maintain pumps and alum injection facility; chemical supplies.	$35,000
Structural Component 6 - Install Stage and Flow Measurement Instrumentation on the Lake Seminole Outfall Control Structure	Operate and maintain outfall control structure; data downloads; maintain recording instrumentation.	$2,000
Management Component 3 - Mechanically Harvest Nuisance Aquatic Vegetation	Continued operation and maintenance of a single dedicated aquatic weed harvester	$200,000
Total Annual O&M Costs		**$387,000**

4.10 Summary of Plan Components

In summary, the recommended Lake Seminole Watershed Management Plan contains a total of 22 Plan components which address the seven identified lake management issues. The components of the Plan are listed below.

Structural Components (6)

- *Structural Component 1* - Construct Enhanced Regional Stormwater Treatment Facilities in Priority Sub-Basins
- *Structural Component 2* - Divert Seminole Bypass Canal Flows to Improve Lake Flushing and Dilution
- *Structural Component 3* - Excavate Organic Peat Sediments from Shoreline Areas
- *Structural Component 4* - Dredge Organic Silt Sediments from Submerged Areas
- *Structural Component 5* - Restore Priority Wetland and Upland Habitats
- *Structural Component 6* - Install Stage and Flow Measurement Instrumentation on the Lake Seminole Outfall Control Structure

Management Components (5)

- *Management Component 1* - Implement an Enhanced Lake Level Fluctuation Schedule
- *Management Component 2* - Inactivate Phosphorus through Whole Lake Alum Applications
- *Management Component 3* - Mechanically Harvest Nuisance Aquatic Vegetation
- *Management Component 4* - Biomanipulate Sport Fish Populations
- *Management Component 5* - Improve Treatment Efficiency of Existing Stormwater Facilities

Legal Components (3)

- *Legal Component 1* - Amend the Florida Statutes to Temporarily Exempt Lake Seminole from Aquatic Preserve and Outstanding Florida Water Regulatory Restrictions
- *Legal Component 2* - Adopt a Resolution Designating the Lake Seminole Watershed as a "Nutrient Sensitive Watershed"

- *Legal Component 3* - Strengthen and Standardize Local Ordinances for Regulating Stormwater Treatment for Redevelopment in the Lake Seminole Watershed

Policy Components (1)

- *Policy Component 1* - Establish a Lake Seminole Watershed Management Area (WMA) through Amendments to the Pinellas County, and Cities of Largo and Seminole Comprehensive Plans

Compliance and Enforcement Components (2)

- *Compliance and Enforcement Component 1* - Expand and Enforce Restricted Speed Zones on Lake Seminole

- *Compliance and Enforcement Component 2* - Dedicate a Pinellas County Marine Unit Sheriff to Enforce Laws on Lake Seminole

Social and Recreational Components (2)

- *Social and Recreational Component 1* - Construct a Public Pedestrian Fishing Pier and Boardwalk in Lake Seminole County Park

- *Social and Recreational Component 2* - Establish and Protect Fishing Enhancement Zones on Lake Seminole

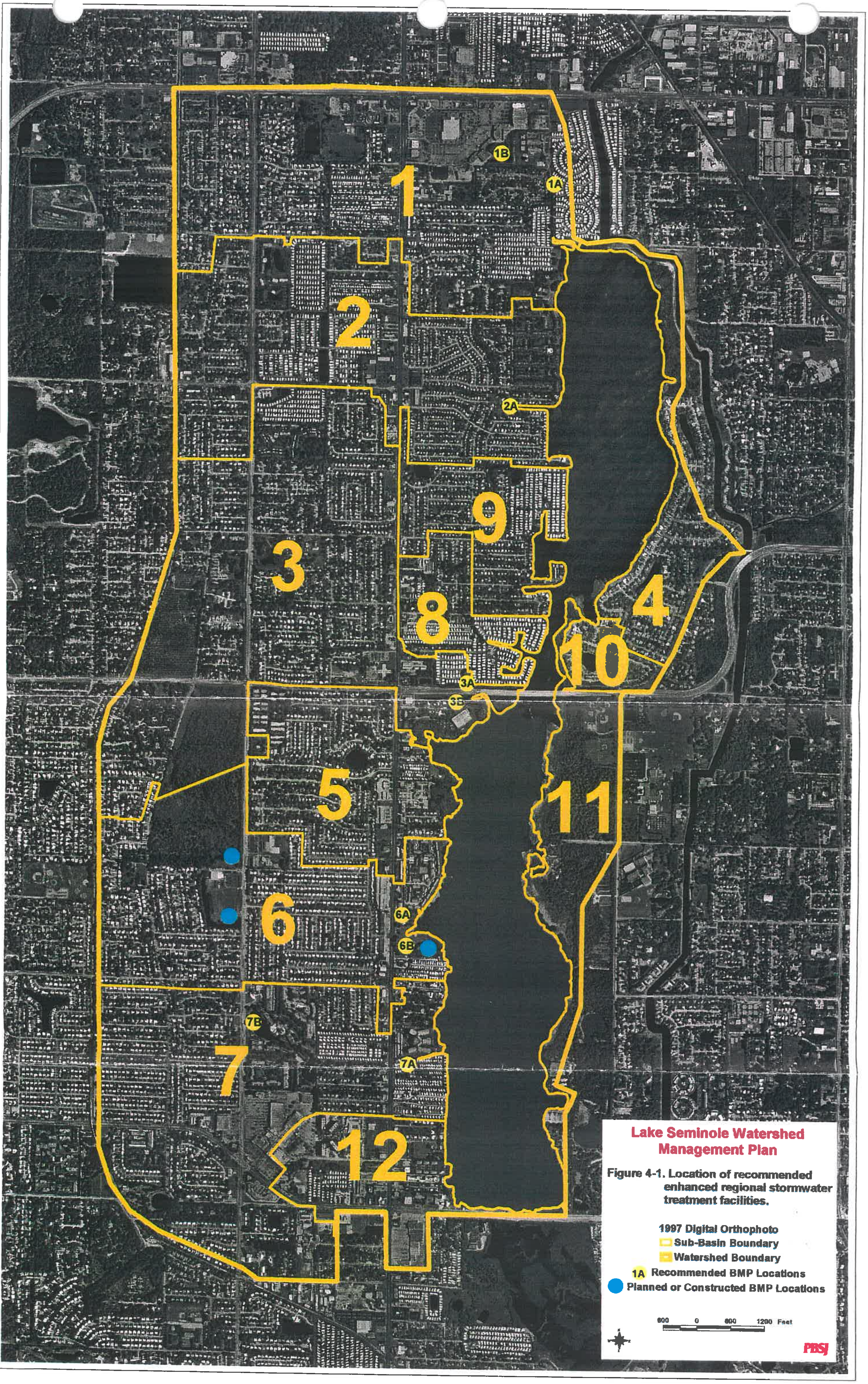
Public Education Components (2)

- *Public Education Component 1* - Develop and Implement a Comprehensive Public Involvement Program for the Lake Seminole Watershed

- *Public Education Component 2* - Develop and Implement a Local Citizens LakeWatch Program for Lake Seminole

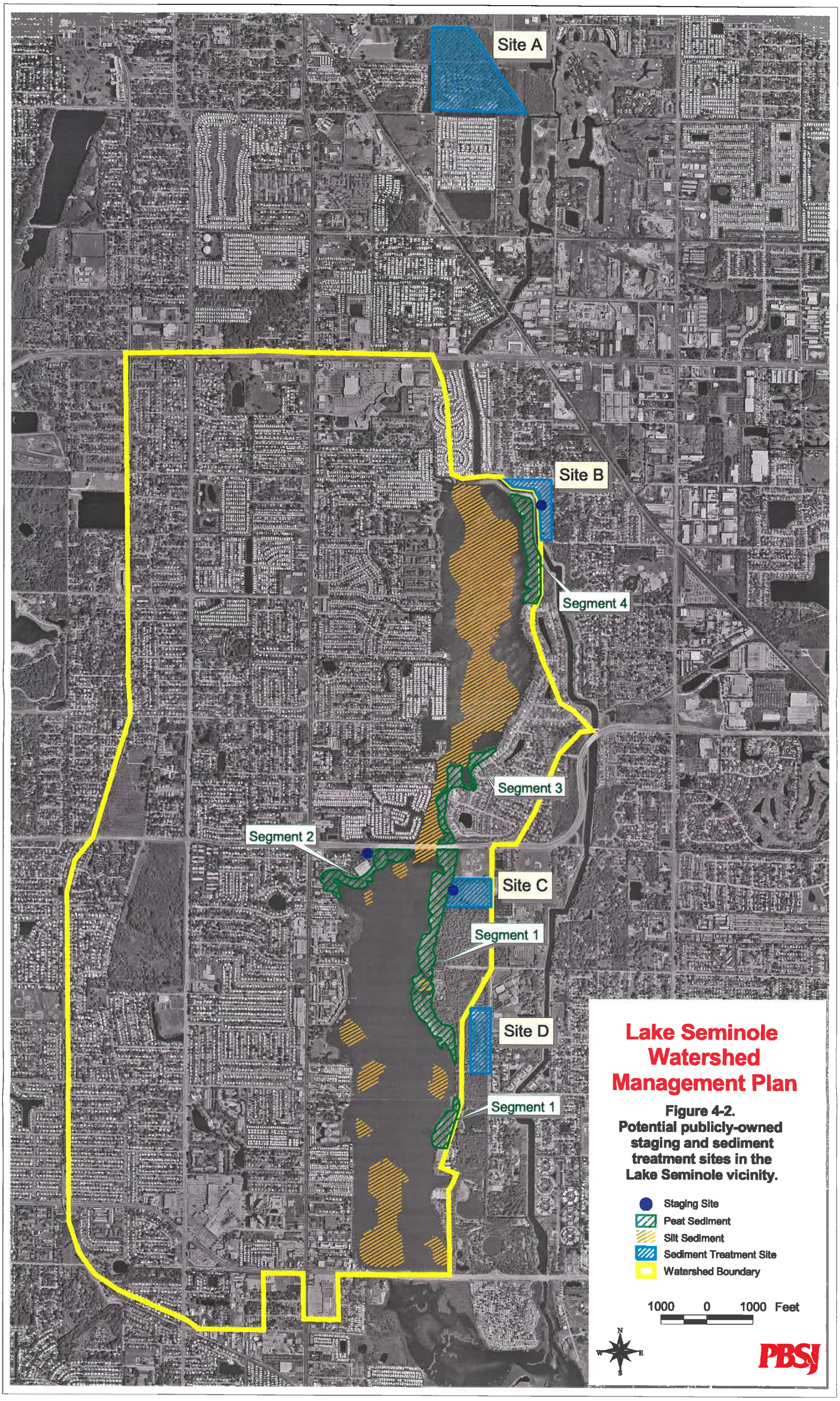
Operation and Maintenance Components (1)

- *Operation and Maintenance Component 1* - Operate and Maintain Structural Facilities and Equipment Recommended in the Plan



Lake Seminole Watershed Management Plan

Figure 4-1. Location of recommended enhanced regional stormwater treatment facilities.



Site A
Site B
Segment 4
Segment 3
Segment 2
Site C
Segment 1
Site D
Segment 1
Lake Seminole Watershed Management Plan
Figure 4-2.
Potential publicly-owned staging and sediment treatment sites in the Lake Seminole vicinity.
Staging Site
Peat Sediment
Silt Sediment
Sediment Treatment Site
Watershed Boundary
1000 0 1000 Feet
N
W
E
S
PBSJ

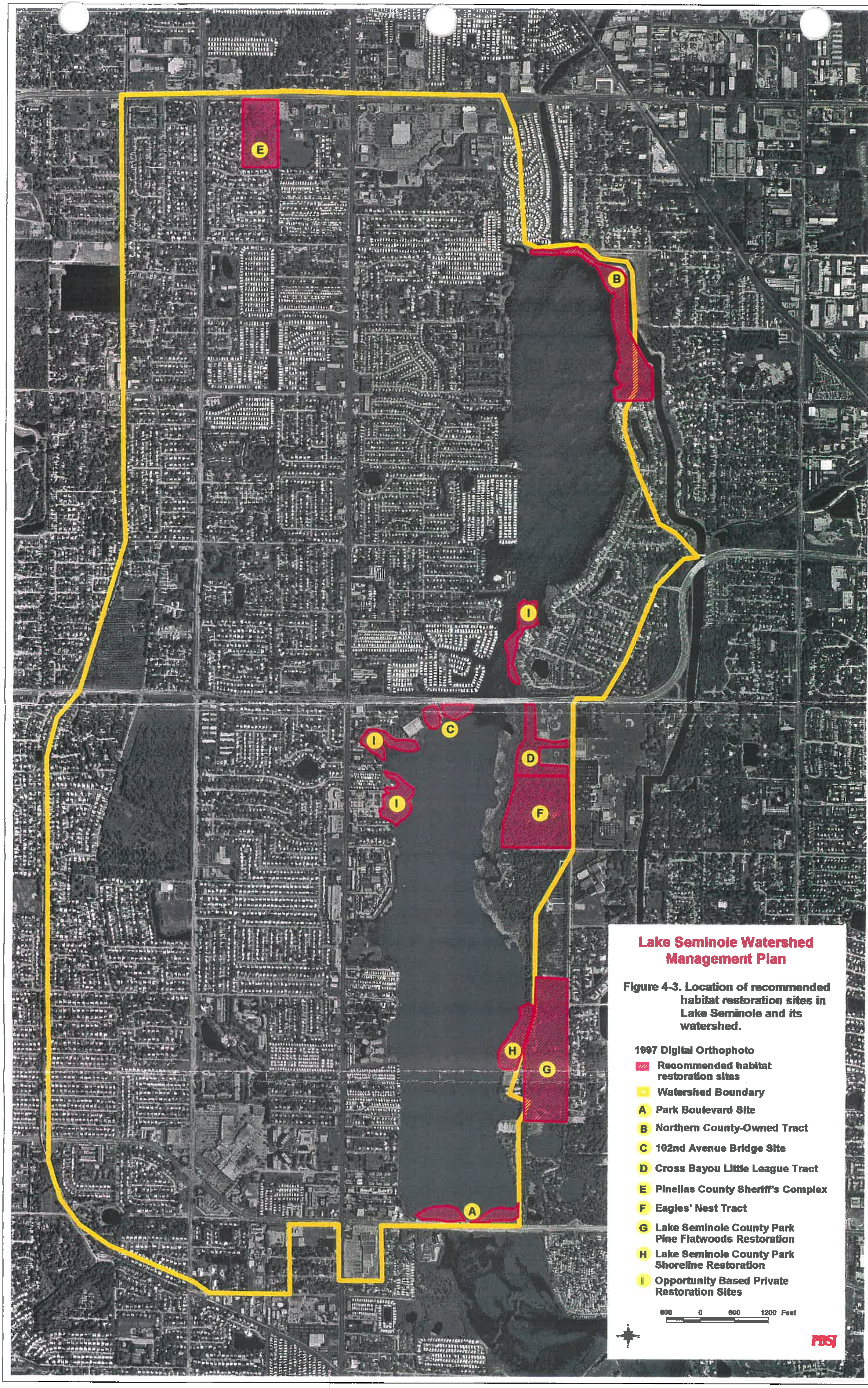
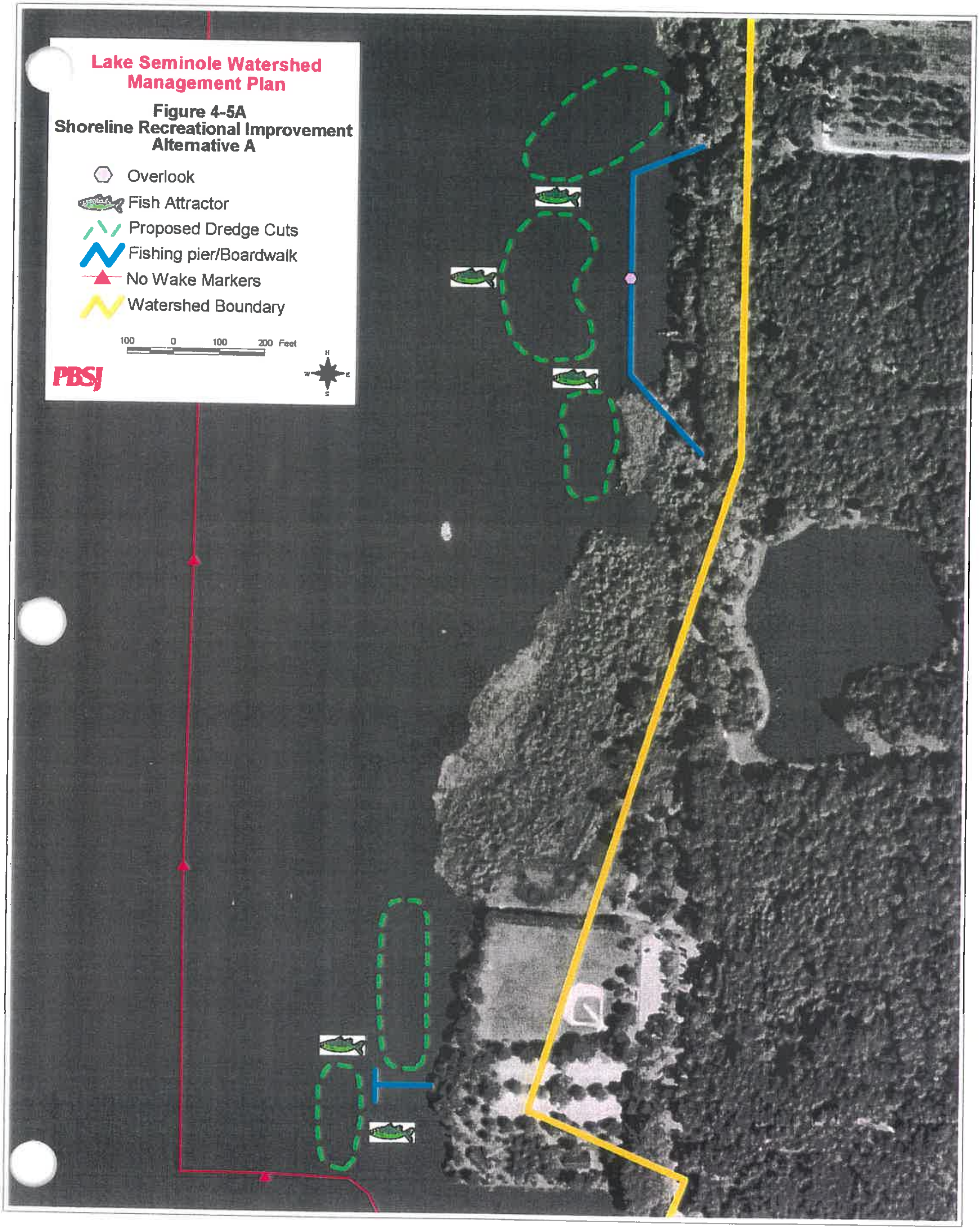
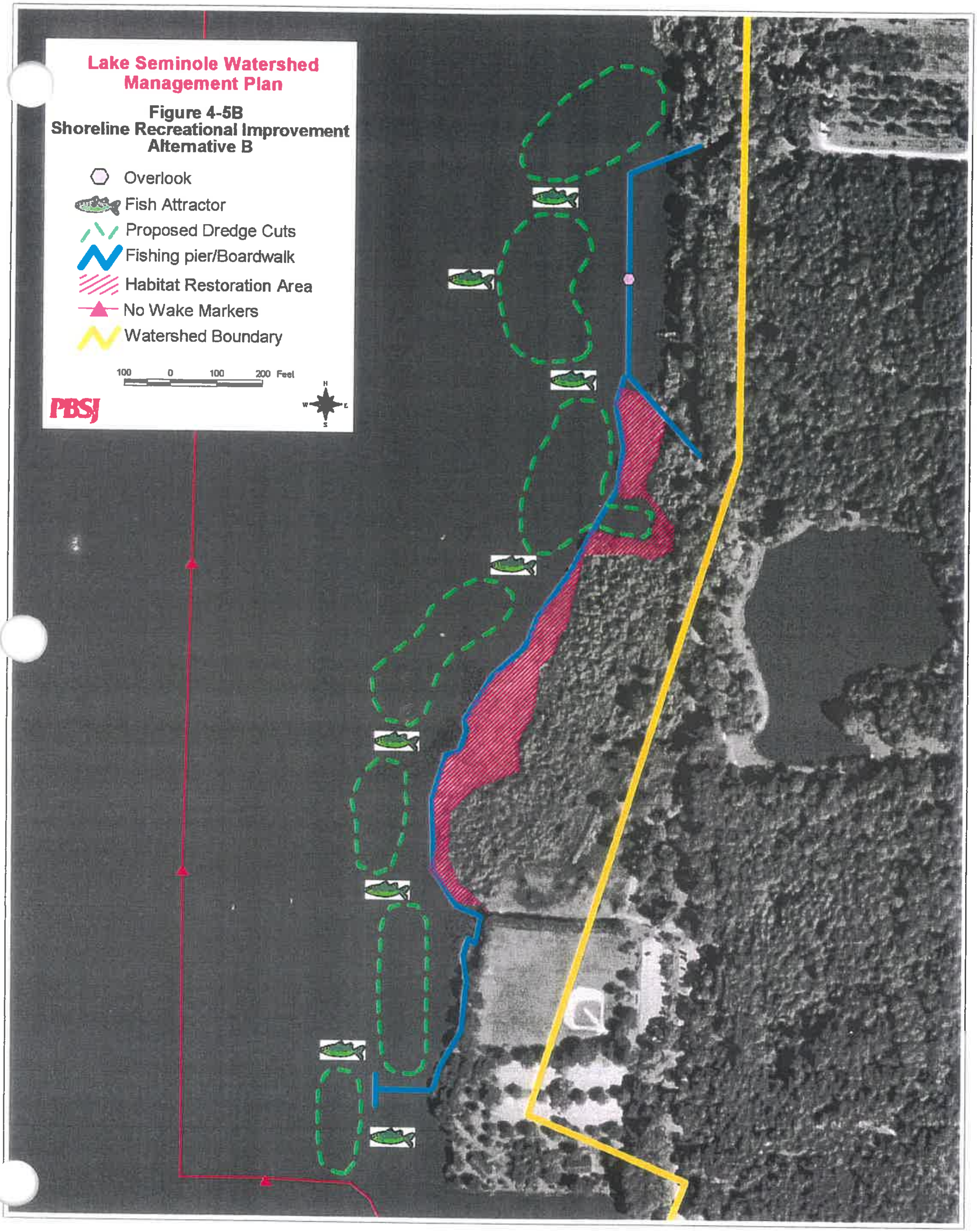
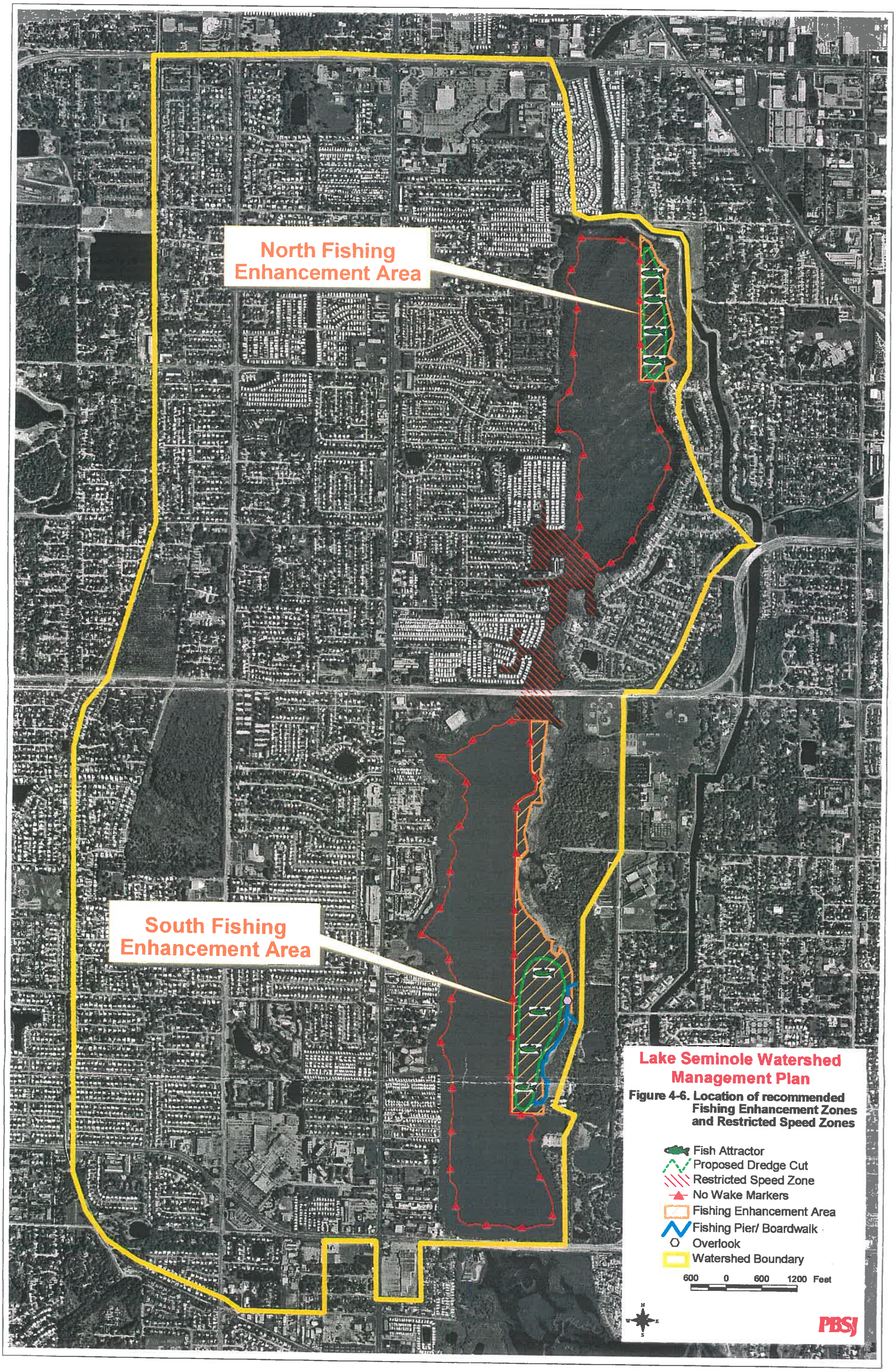


Figure 4-3. Location of recommended habitat restoration sites in Lake Seminole and its watershed.


Lake Seminole Watershed
Management Plan
Figure 4-5A
Shoreline Recreational Improvement
Alternative A
Overlook
Fish Attractor
Proposed Dredge Cuts
Fishing pier/Boardwalk
No Wake Markers
Watershed Boundary
100 0 100 200 Feet
PBSJ



Lake Seminole Watershed Management Plan
Figure 4-5B
Shoreline Recreational Improvement Alternative B
Overlook
Fish Attractor
Proposed Dredge Cuts
Fishing pier/Boardwalk
Habitat Restoration Area
No Wake Markers
Watershed Boundary
100 0 100 200 Feet
PBSJ
N
W
E
S


North Fishing Enhancement Area
South Fishing Enhancement Area
Lake Seminole Watershed Management Plan
Figure 4-6. Location of recommended Fishing Enhancement Zones and Restricted Speed Zones
Fish Attractor
Proposed Dredge Cut
Restricted Speed Zone
No Wake Markers
Fishing Enhancement Area
Fishing Pier/ Boardwalk
Overlook
Watershed Boundary
600 0 600 1200 Feet
PBSJ

5.0 MONITORING AND SUCCESS EVALUATION

5.1 Purpose and Importance of Monitoring

The results of environmental monitoring programs are important to a wide range of interests associated with Lake Seminole - fishermen and recreational user groups, lakefront residents, resource managers, scientists and engineers, politicians and private citizens. Examples of information needs met by monitoring are listed below (National Research Council, 1990).

- Monitoring provides the information needed to evaluate the effectiveness of, and to appropriately adjust, pollution abatement and resource management actions.

- Monitoring information can provide an early warning system, allowing for lower-cost solutions to environmental problems.

- Monitoring contributes to the knowledge of lake ecosystems and how they are affected by human activity. Such knowledge allows for the establishment of priorities for environmental protection and for the assessment of status and trends.

- Monitoring information helps answer layperson questions such as "is it safe to swim in, or eat fish from, the lake."

- Monitoring information is essential to the construction, adjustment, and verification of quantitative predictive models, which are an important basis for evaluating, developing, and selecting environmental management strategies.

- Monitoring information provides resource managers the scientific rationale for setting environmental quality standards.

- Monitoring determines legal compliance with established environmental standards and conditions as set forth in regulatory programs.

Many environmental monitoring programs lack a clearly articulated purpose and objective. This lack of focus often results in less than cost-effective use of available funds as well as data gaps and unanswered questions. Monitoring programs need to be properly designed, and monitoring methods appropriately applied, if they are to meet the multiple expectations of all those who rely on the information generated. Although most monitoring programs are technically sound, it is their overall design and institutional context that limits the usefulness of the information that results. Therefore, sound program design and implementation often depend on the following factors (National Research Council, 1990).

- The goals and objectives of the monitoring program need to be clearly articulated in terms that pose questions that are meaningful to the public and that provide the basis for scientific investigation.

- Not only must data be gathered, but attention must also be paid to their management, synthesis, interpretation, and analysis.

- Procedures for quality assurance are needed, including scientific peer review.

- Because a well-designed monitoring program results in unanswered questions about environmental processes or human impacts, supportive research should be provided.

- Adequate resources are needed not only for data collection but also for detailed analysis and evaluation over the long term.

- Programs should be sufficiently flexible to allow for their modification where changes in conditions or new information suggests the need.

- Provisions should be made to ensure that monitoring information is made available to all interested parties in a form that is useful to them.

In order to accurately gauge the effectiveness of the Plan over time, there must be a linkage between the established level-of-service targets and the monitoring and success evaluation components of the Plan. The remainder of Section 5.0 discusses the development of appropriate and achievable monitoring objectives which support the success evaluation of the Lake Seminole Watershed Management Plan. The detailed protocols for each of the recommended monitoring programs associated with each of the key management issues facing Lake Seminole are described in the Task 3.2.11 Report.

5.2 Monitoring Objectives

In developing specific monitoring objectives, it is critical to establish a hierarchical structure to the planning and program development process. The development of appropriate and achievable monitoring objectives for Lake Seminole must be clearly linked to, and driven by, the defined management issues and the adopted lake and watershed management goals. For each of the adopted goals, there must also be defined criteria by which attainment of a given goal can be measured. These measures are herein referred to as "targets," as discussed in Section 4.1 above. Since targets are specific units of measure that define progress towards a management goal, all targets must be linked to, and supported by, one or more monitoring objectives. Conversely, all

monitoring objectives must clearly support a target. The planning hierarchy of the monitoring program development process can be summarized as follows:

Management Issue
↓
Management Goal(s)
↓
Level-of-Service Target(s)
↓
Monitoring Objective(s)
↓
Monitoring Program

In the sub-sections that follow, specific targets and monitoring objectives addressing the adopted management goals are proposed, and the rationale for each is discussed.

5.2.1 Water Quality

Under the targets developed for the Water Quality issue twelve specific monitoring objectives are proposed, with some targets being associated with more than one monitoring objective. The rationale for each proposed monitoring objective is discussed below.

Target 1: **Attain a mean annual chlorophyll-a concentration of 30 ug/l or less.**

Objective 1: **Measure monthly in-lake chlorophyll-a concentrations.**

Rationale: The amount of phytoplankton biomass, measured as chlorophyll-a, serves as an integrator and indicator of lake trophic conditions. High mean annual chlorophyll-a concentrations usually indicate excessive algal growth. With regard to available and comparable water quality data, the best continuous record exists for the parameter of chlorophyll-a. Furthermore, the collection and measurement of chlorophyll-a samples are already programmed into the existing PCDEM monitoring program.

Target 2: **Attain a mean annual multi-parametric TSI value of 65 or less.**

Objective 2A: **Measure monthly in-lake TN and TP concentrations.**

Rationale: Nitrogen (N) and phosphorus (P) are the primary nutrients required by plants for growth and reproduction. In excessive concentrations, N and P can cause nuisance algae blooms. The measure of all chemical forms of

these nutrients (total N and P, or TN and TP) in the water column is a measure of the algal growth potential, and thus is an important indicator of trophic state. TN and TP concentrations are two of four parameters used to calculate a multi-parametric TSI value, with chlorophyll-a and Secchi disk depth being the other two. While the collection and measurement of TN and TP samples are programmed into the existing monitoring program, PCDEM nutrient data collected prior to 1995 are of limited value due to problems with laboratory detection limits and other analytical problems. This situation has, however, been corrected by Pinellas County.

Objective 2B: **Measure monthly in-lake Secchi disk depths.**

Rationale: Secchi disk depth serves as a simple measure of lake water clarity. The degree of water transparency is one of the most important attributes of water. Water transparency allows the penetration of light, which supports life through the photosynthetic process. The degree of water transparency has a direct impact on the growth and distribution of submerged aquatic vegetation. Water transparency also allows organisms with visual organs to see in order to search for food and shelter. Water transparency can be affected by suspended organic (e.g., algae) and inorganic (e.g., silt) matter in the water column, as well as tannins and dissolved substances. Secchi disk depth is one of four parameters used to calculate a multi-parametric TSI value.

Target 3: **Reduce current annual TP loads from external sources by 50%.**

Objective 3A: **Estimate mean annual nonpoint source TP loads to Lake Seminole from priority sub-basins.**

Rationale: It is possible to estimate external TP loads from nonpoint source runoff through direct measurement at points of discharge to the lake. Since nonpoint source runoff represents approximately 96% of the total annual external TP load, and since this load is both measurable and manageable to a large extent, long term trends in these loading sources should be monitored to evaluate the effectiveness of load reduction strategies. TN loads should also be estimated to allow for the development of annual nutrient budgets.

Objective 3B: **Estimate mean annual loads of TP to Lake Seminole from groundwater seepage.**

Rationale: Few site-specific data exist regarding the magnitude and timing of groundwater inputs to Lake Seminole. Using limited groundwater quality data collected by SWFWMD along the western perimeter of the lake, modeling techniques were applied to estimate groundwater loadings to the lake during wet and dry seasons. The results indicate that groundwater seepage contributes less than 1% of the total annual TP load to the lake. This estimate should be confirmed by direct field measurements using seepage meters or similar methods. TN loads should also be estimated to allow for the development of annual nutrient budgets. The SWFWMD wells should also be monitored every two years, and similar modeling techniques should be applied using these data, to determine potential long-term trends in this loading source. Monitoring of groundwater seepage is warranted due to the fact that the recommended enhanced lake level fluctuation schedule has the potential to alter seepage rates by increasing the head difference between the lake level and the water table.

Objective 3C: **Estimate mean monthly loads of TP to Lake Seminole from atmospheric deposition.**

Rationale: It is possible to estimate external TP loads from atmospheric deposition through direct measurement. Based on measurements taken from sites in the Tampa Bay region, it is estimated that atmospheric deposition accounts for only about 3.7% of the total annual external TP loads to the lake. Wet and dryfall measurements from samples collected in the Lake Seminole basin are needed to better estimate local conditions and loading rates. TN loads should also be estimated to allow for the development of annual nutrient budgets. Although this loading source is not considered to be significant or directly manageable at this time, long term trends should be monitored to determine the relative importance of this source, as well as the effectiveness of regional air quality programs.

Target 4: **Annually calculate current water and nutrient budgets for Lake Seminole.**

Objective 4: **Estimate the mean monthly mass of TN, TP and water volume discharged from Lake Seminole.**

Rationale: The estimation of mean annual TN, TP, and hydrologic loads discharged from the lake combined with estimates of mean annual loads entering the lake are needed to calculate lake water and nutrient budgets. Estimates of external loadings from nonpoint sources, atmospheric deposition and groundwater are measurable and are addressed in separate monitoring

objectives above. To balance a water/nutrient budget, direct measurements of outflows from the lake are needed. Annual estimates of loads leaving the lake will enable the calculation of net loadings into the lake, loads which should be related to mean annual in-lake chlorophyll-a concentrations and TSI values. The Lake Seminole outfall structure provides a convenient location for measuring flow and collecting water samples; however, instrumentation for accurately measuring stage and flow volumes need to be installed to meet this monitoring objective.

Target 5: **Maintain Class-III water quality standards for dissolved oxygen, pH, specific conductance and chlorides.**

Objective 5A: **Estimate the monthly frequency, duration, and magnitude of bottom dissolved oxygen concentrations in Lake Seminole that fall below regulatory minima of 5.0 mg/l.**

Rationale: In addition to phytoplankton biomass, the concentration of dissolved oxygen in the deepest portions of the lake is often a good indicator of overall lake water quality. Any dissolved oxygen concentrations below 5 mg/l are in exceedance of Class-III State water quality standards, and may result in fish kills and other adverse impacts on biota.

Objective 5B: **Estimate for Lake Seminole: 1) the monthly trend in pH; and 2) the frequency, duration, and magnitude that monthly pH varies by more than one unit above or below natural background levels.**

Rationale: A rapid or large change in lake pH may have severe adverse effects on lake biota. Although Lake Seminole monitoring data indicate that the lake is fairly stable with respect to pH, it will be critical to maintain normal pH ranges in the lake to ensure the success of the proposed alum injection and whole lake alum applications. Ongoing monitoring is needed to determine pH trends in Lake Seminole.

Objective 5C: **Estimate for Lake Seminole: 1) the monthly trend in chloride concentration; and 2) the frequency, duration, and magnitude that monthly chloride concentrations exceed background levels by 10% or more.**

Rationale: A rise in mean chloride concentrations above existing and historical levels (between about 200-250 mg/l) may have adverse effects on lake biota. Although mean annual lake chloride levels have remained fairly constant,

future increases of in-lake chloride concentrations are possible due to the proximity of the lake to saltwater and the proposed enhanced lake level fluctuation schedule. Increasing chlorides could potentially lead to substantial degradation of existing lake flora and fauna.

Objective 5D: **Estimate for Lake Seminole: 1) the monthly trend in specific conductance; and 2) the frequency, duration, and magnitude that monthly specific conductance exceeds 1,275 μmhos/cm.**

Rationale: Increases in specific conductance, like chlorides and pH, may adversely affect in-lake biota. Measurements of specific conductance may be used as a correlate to chloride measurements, and may be potentially used to explain trends in both chlorides and pH.

Target 6: **Attain an 80% TSS load reduction for all permitted MSSW facilities within the Lake Seminole watershed.**

Objective 6: **Determine the number of permitted MSSW facilities in the Lake Seminole watershed attaining an 80% TSS load reduction.**

Rationale: Site plans and design specifications should exist for all permitted MSSW facilities in the Lake Seminole watershed. Therefore, a detailed inventory of these facilities and an assessment of their compliance with the required performance standards could feasibly be completed over a period of time. Retroactive enforcement should be based on this information.

The goals, targets and monitoring objectives related to the Water Quality management issue are summarized in Table 5-1 below.

Table 5-1. Goals, targets and monitoring objectives for the Water Quality issue.

Goal(s)	Target(s)	Monitoring Objective(s)
The lake and its watershed shall be managed such that good water quality, according to Class-III State standards, is achieved and maintained in the lake	1. Attain a mean annual chlorophyll-a concentration of 30 ug/l or less.	1. Measure monthly in-lake chlorophyll-a concentrations.
	2. Attain a mean annual multi-parametric TSI value of 65 or less.	2A. Measure monthly in-lake TN and TP concentrations. 2B. Measure monthly in-lake Secchi disk depths.
	3. Reduce current annual TP loads from external sources by 50%.	3A. Estimate mean annual loads of TP to Lake Seminole from priority sub-basins. 3B. Estimate mean annual loads of TP to Lake Seminole from groundwater seepage. 3C. Estimate mean annual loads of TP to Lake Seminole from atmospheric deposition.
	4. Annually calculate current water and nutrient budgets for Lake Seminole.	4. Estimate the mean monthly mass of TN, TP, and water volume discharged from Lake Seminole.
	5. Maintain Class-III water quality standards for dissolved oxygen, pH, specific conductance and chlorides.	5A. Estimate the monthly frequency, duration, and magnitude of bottom dissolved oxygen concentrations in Lake Seminole that fall below the regulatory minima of 5.0 mg/l. 5B. Estimate for Lake Seminole: 1) the monthly trend in pH units; and 2) the frequency, duration, and magnitude that monthly pH varies by more than one unit above or below natural background levels. 5C. Estimate for Lake Seminole: 1) the monthly chloride concentration; and 2) the frequency, duration, and magnitude that monthly chloride concentrations exceed the background level by 10% or more. 5D. Estimate for Lake Seminole: 1) the monthly trends in specific conductance; and 2) the frequency, duration, and magnitude that monthly specific conductance exceeds 1,275 μmhos/cm.
	6. Attain an 80% TSS load reduction for all permitted MSSW facilities within the Lake Seminole watershed.	6. Determine the number of permitted MSSW facilities in the Lake Seminole watershed attaining an 80% TSS load reduction.

5.2.2 Aquatic Vegetation

Under the targets developed for the Aquatic Vegetation issue four specific monitoring objectives are proposed. The rationale for each proposed monitoring objective is discussed below.

Target 1: **Increase and maintain the areal coverage of desirable, endemic submerged aquatic vegetation (SAV) at 170 acres or more (>25% of the lake bottom area).**

Objective 1: **Estimate the status and trends in areal coverage, spatial distribution, and species composition of desirable, endemic submerged aquatic vegetation every two years.**

Rationale: No quantitative survey of the coverage of submerged aquatic vegetation has ever been performed in Lake Seminole. Given the importance of submerged aquatic vegetation to the overall ecology of the lake, quantitative monitoring is needed to assess status and trends in areal coverage, spatial distribution, and species composition at least every two years. A key management principle for Lake Seminole will be to drive the system away from phytoplankton dominance, and towards macrophyte dominance, with respect to primary production. Monitoring the status and trends in desirable, endemic submerged aquatic species is warranted to determine progress towards this overall management goal.

Target 2: **Limit the areal coverage of hydrilla to 35 acres or less (<5% of the lake bottom area; <20% of the SAV areal coverage target).**

Objective 2: **Estimate the status and trends in areal coverage and spatial distribution of hydrilla every two years.**

Rationale: Currently, the FDEP and SWFWMD qualitatively monitor the coverage of hydrilla on an as-needed basis for the purposes of defining herbicide application needs. The methods used are not statistically valid, and therefore the results are not suitable for accurately quantifying trends or relating trends to other ecological conditions (e.g., water quality). Given the potential and observed impact of hydrilla and its treatment on lake water quality and fisheries, there is a need to quantify trends in the areal coverage and spatial distribution of this aggressive species at least every two years following the implementation of Plan components aimed at improving water quality and transparency.

Target 3: **Increase and maintain the areal coverage of desirable, emergent aquatic vegetation (EAV) at 60 acres or more.**

Objective 3: **Estimate the status and trends in areal coverage, spatial distribution, and species composition of desirable, endemic emergent aquatic vegetation every two years.**

Rationale: Currently no quantitative monitoring of emergent aquatic vegetation is being performed in Lake Seminole on a regular basis. Given the importance of emergent aquatic vegetation as fish and wildlife habitat, as well as the potential for rapid changes in areal coverage, there is a need to assess the status and trends in areal coverage, species composition and spatial distribution of EAV at least every two years.

Target 4: **Limit the areal coverage of cattail to 20 acres or less (<33% of the total EAV areal coverage target).**

Objective 4: **Estimate the status and trends in areal coverage and spatial distribution of cattail every two years.**

Rationale: The dominance of cattail negatively impacts local fish and wildlife utilization, impedes human recreational usage, and detracts from visual aesthetics. Other than special diagnostic/feasibility studies, no quantitative monitoring of emergent aquatic vegetation in Lake Seminole is conducted on a regular basis. Areal coverage and spatial distribution of cattail should be monitored every two years so that deviations from the target coverage will be recognized, and appropriate management actions implemented.

The goals, targets and monitoring objectives related to the Aquatic Vegetation management issue are summarized in Table 5-2 below.

Table 5-2. Goals, targets and monitoring objectives for the Aquatic Vegetation issue.

Goal(s)	Target(s)	Monitoring Objective(s)
Aquatic vegetation shall be managed such that nuisance and exotic plants are maintained at the lowest feasible levels while encouraging the establishment of a balanced and diverse assemblage of desirable native plants.	1. Increase and maintain the areal coverage of desirable, endemic submerged aquatic vegetation (SAV) at 170 acres or more (>25% of the lake bottom area).	1. Estimate the status and trends in areal coverage, spatial distribution, and species composition of desirable, endemic submerged aquatic vegetation every two years.
	2. Limit the areal coverage of hydrilla to 35 acres or less (<5% of the lake bottom area; <20% of the SAV areal coverage target).	2. Estimate the status and trends in areal coverage and spatial distribution of hydrilla every two years.
	3. Increase and maintain the areal coverage of desirable, endemic emergent aquatic vegetation (EAV) at 60 acres or more.	3. Estimate the status and trends in areal coverage, spatial distribution, and species composition of desirable, endemic emergent aquatic vegetation every two years.
	4. Limit the areal coverage of cattail to 20 acres or less (<33% of the total EAV areal coverage target).	4. Estimate the status and trends in areal coverage and spatial distribution of cattail every two years.

5.2.3 Fisheries

Under the targets developed for the Fisheries issue five specific monitoring objectives are proposed. The rationale for each proposed monitoring objective is discussed below.

Target 1: **Attain a fish community balance of F/C=3.0-6.0 (e.g., the ratio of forage fish biomass to carnivorous fish biomass).**

Objective 1: **Estimate the F/C ratio and the Fishery Quality Index (FQI) in Lake Seminole every two years.**

Rationale: The F/C ratio and the FQI are measures of fish community balance which can also serve as an indicator of lake trophic state. The F/C ratio and the FQI are calculated through quantitative sampling techniques typically using a stratified random design with block net and rotenone fish collection. The Florida Game and Freshwater Fish Commission (FGFWFC) has conducted population studies for estimating the F/C ratio and FQI in Lake Seminole on an irregular basis, approximately every five years. It is recommended that this quantitative sampling program continue on a regular basis, every two years at a minimum, to be coordinated with the sequencing of other monitoring programs.

Target 2: **Attain indices of Relative Stock Density (RSD) for major sport fish species of: 20-40% >14 inches for largemouth bass, and 40-60% >6 inches for bluegill.**

Objective 2: **Estimate the indices of Relative Stock Density (RSD) for major sport fish species in Lake Seminole every two years.**

Rationale: The Relative Stock Density index provides a numerical expression of population size structure, and is another quantitative measure of the population balance of major sport fish species. RSDs are determined through quantitative sampling techniques typically using a stratified random design with block net and rotenone fish collection. The FGFWFC has conducted population studies for estimating RSDs in Lake Seminole on an irregular basis, approximately every five years. It is recommended that this quantitative sampling program continue on a regular basis, every two years at a minimum, to be coordinated with Objective 1 above as well as the sequencing of other monitoring programs.

Target 3: **Attain a 100% angler catch and release rate for largemouth bass.**

Objective 3: **Estimate the angler catch and release rate for largemouth bass in Lake Seminole every four years.**

Rationale: Voluntary angler catch and release of sport fish - primarily largemouth bass - promotes desirable F/C ratios and maintains a healthy sport fishery. Angler catch and release rates can be assessed relatively easily through various types of creel survey techniques. Given the rapidity by which lake water quality and the fish community structure can change, it is recommended that voluntary angler catch and release rates be assessed as a component of a comprehensive recreational fishery assessment to be performed every four years, in conjunction with the quantitative sport fish population assessments recommended for Objectives 1 and 2 above.

Target 4: **Attain a fishing effort in Lake Seminole of ≥150 hours of fishing per acre per year.**

Objective 4: **Estimate fishing effort in Lake Seminole every four years.**

Rationale: Fishing effort, or the number of hours fished per acre per year, can be assessed through various types of creel and recreational survey techniques. The measure of fishing effort forms the basis for calculating angler success rates. In combination with Objective 3 above, it is recommended that

fishing effort be assessed as a component of a comprehensive recreational fishery assessment to be performed every four years.

Target 5: **Attain angler success rates of: >0.30 fish/hour for largemouth bass; and >3.0 fish/hour for panfish (bluegill, redear sunfish, crappie, and catfish).**

Objective 5: **Estimate the angler success rates for largemouth bass and panfish in Lake Seminole every four years.**

Rationale: Angler success rates are a function of both fish population structure and fishing pressure; and they are a direct measure of the recreational value of the sport fishery. Angler success rates, or catch per unit effort, can be assessed relatively easily through creel surveys. In combination with Objective 3 and 4 above, it is recommended that angler success rates be assessed as a component of a comprehensive recreational fishery assessment to be performed every four years.

The goals, targets and monitoring objectives related to the Fisheries management issue are summarized in Table 5-3 below.

Table 5-3. Goals, targets and monitoring objectives for the Fisheries issue.

Goal(s)	Target(s)	Monitoring Objective(s)
The lake and its fish populations shall be managed to provide sustained quality sport fishing opportunities.	1. Attain a fish community balance of F/C=3.0-6.0 (e.g., the ratio of forage fish biomass to carnivorous fish biomass).	1. Estimate the F/C ratio and the Fishery Quality Index (FQI) in Lake Seminole every two years.
	2. Attain indices of Relative Stock Density (RSD) for major sport fish species of: 20-40% >14 inches for largemouth bass, and 40-60% >6 inches for bluegill.	2. Estimate the indices of Relative Stock Density (RSD) for major sport fish species in Lake Seminole every two years.
	3. Attain a 100% angler catch and release rate for largemouth bass.	3. Estimate the voluntary angler catch and release rate for largemouth bass in Lake Seminole every four years.
	4. Attain a fishing effort in Lake Seminole of ≥150 hours of fishing per acre per year.	4. Estimate fishing effort in Lake Seminole every four years.
	5. Attain angler success rates of: >0.30 fish/hour for largemouth bass; and >3.0 fish/hour for panfish (bluegill, redear sunfish, crappie, and catfish).	5. Estimate the angler success rates for largemouth bass and panfish in Lake Seminole every four years.

5.2.4 Wildlife and Associated Habitat

Under the targets developed for the Wildlife and Associated Habitat issue three specific monitoring objectives are proposed. The rationale for each proposed monitoring objective is discussed below.

Target 1: **Substantially reduce or eliminate the coverage of exotic and nuisance upland species in Lake Seminole Park and other County-owned properties in the watershed.**

Objective 1: **Estimate the status and trends in areal coverage of nuisance and exotic upland species in Lake Seminole Park and other County-owned parcels in the watershed every two years.**

Rationale: Currently no quantitative monitoring of exotic and nuisance upland vegetation is being performed in the Lake Seminole watershed on a regular basis. Given the already dominant presence of air potato and Brazilian pepper in Lake Seminole Park, and the potential for these species to rapidly expand their coverages, there is a need to assess the status and trends in areal coverage of these and other problematic species at least every two years such that control and maintenance measures can be properly focused.

Target 2: **Maintain or increase the number of bald eagle territories in the Lake Seminole watershed.**

Objective 2: **Annually determine the number of nesting eagle pairs in the Lake Seminole watershed.**

Rationale: Nesting eagle pairs have been documented in the Lake Seminole basin for many years. A decline in eagle territories may indicate that adjacent or proximate land uses are interfering with eagle nesting activity, or that an associated ecological stress, exhibited by a decline in the health of the lake or abundance of the fish population, has occurred. The occurrence of nesting eagles should be determined in coordination with the FFWCC annual eagle census program.

Target 3: **Maintain or increase the species richness of endemic bird populations in the Lake Seminole watershed.**

Objective 3: **Annually estimate the species richness and abundance of endemic bird populations in the Lake Seminole watershed.**

Rationale: Endemic birds possess habitat and life cycle requirements corresponding to the historic ecological succession of Lake Seminole. A decline in the presence or abundance of native species may indicate increasing ecological or human-induced stress. In addition, the presence and abundance of exotic birds results in interference with natural ecological processes such as competition and predation and increased nest parasitism. Conversely, the ecological improvements expected in the lake associated with the implementation of the Plan have the potential to increase the species richness and abundance of native birds in the watershed. It is recommended that bird species richness in the basin be estimated annually from summer and winter bird counts through coordination with the local Audubon Society Chapter and the FFWCC.

The goals, targets and monitoring objectives related to the Wildlife and Associated Habitat management issue are summarized in Table 5-4 below.

Table 5-4. Goals, targets and monitoring objectives for the Wildlife and Associated Habitat issue.

Goal(s)	Target(s)	Monitoring Objective(s)
The lake and its watershed shall be managed to provide adequate habitat abundance, and to enhance habitat quality and diversity.	1. Substantially reduce or eliminate the coverage of exotic and nuisance upland species in Lake Seminole Park and other County-owned properties in the watershed.	1. Estimate the status and trends in areal coverage of nuisance and exotic upland species in Lake Seminole Park and other County-owned parcels in the watershed every two years.
The lake and its watershed shall be managed to attract and maintain populations of endemic fish and wildlife species.	2. Maintain or increase the number of bald eagle territories in the Lake Seminole watershed.	2. Annually determine the number of nesting eagle pairs in the Lake Seminole watershed.
	3. Maintain or increase the species richness and abundance of endemic bird populations in the Lake Seminole watershed.	3. Annually estimate the species richness and abundance of endemic bird populations in the Lake Seminole watershed.

5.2.5 Recreation and Aesthetics

Under the targets developed for the Recreation and Aesthetics issue four specific monitoring objectives are proposed. The rationale for each proposed monitoring objective is discussed below.

Target 1: Prevent boating and personal water craft accidents (0 accidents).

Objective 1: Annually determine the number of boating and personal water craft accidents occurring on Lake Seminole.

Rationale: The total annual number of boating and personal watercraft accidents reported on Lake Seminole is the most direct measure of public safety and

enforcement effectiveness. Monitoring of ultra-light aircraft accidents should also be conducted.

Target 2: **Maintain Class-III water quality standards for total and fecal coliform bacteria.**

Objective 2: **Estimate for Lake Seminole: 1) the monthly trends in coliform bacteria; and 2) the frequency, duration, and magnitude that monthly total and fecal coliform concentrations exceed 2,400/100 ml and 800/100 ml, respectively.**

Rationale: Previous water quality surveys have indicated that coliform concentrations in Lake Seminole periodically exceed State water quality standards, however, routine measurements are currently not being performed. Monthly measurement of coliform bacteria concentrations in Lake Seminole should be performed to ensure continued public health and safety with respect to water contact recreation. It should be noted that some uncertainty currently exists within the regulatory community as to the validity of coliform testing as an indicator of contamination. Statewide investigations are in progress to develop more meaningful water quality standards with regard to the public health risks of water contact recreation. Consideration should be given to delaying the implementation of coliform monitoring until the findings of these investigations are published.

Target 3: **Attain 90% positive responses on recreational user and lakefront resident opinion surveys.**

Objective 3: **Assess recreational user and lakefront resident satisfaction every four years.**

Rationale: Pinellas County and the FGFWFC have periodically conducted recreational user surveys, and Pinellas County has completed a comprehensive lakefront resident survey on Lake Tarpon. The survey format should be refined and implemented on Lake Seminole every four years to assess trends in public opinion.

Target 4: **Maintain or increase recreational usage of the lake while still maintaining 90% user satisfaction.**

Objective 4: **Annually estimate the number of recreational users visiting the lake.**

Rationale: Lake Seminole County Park keeps daily records of user trips, and the use generated from this park probably represents over 50% of the total lake user population at any given time. Park user data, and other available recreational user data (e.g., ski clubs, fishing guides, etc.) should be summed annually to estimate the total number of recreational users annually visiting the lake. This objective must also incorporate the user satisfaction data collected under Objective 3 above.

The goals, targets and monitoring objectives related to the Recreation and Aesthetics management issue are summarized in Table 5-5 below.

Table 5-5. Goals, targets and monitoring objectives for the Recreation and Aesthetics issue.

Goal(s)	Target(s)	Monitoring Objective(s)
The lake should be managed in such a manner as to provide for safe recreational boating and skiing. Use of the lake shall be managed such that the needs of the various user groups are balanced and optimized.	1. Prevent boating and personal water craft accidents (0 accidents).	1. Annually determine the number of boating and personal water craft accidents occurring on Lake Seminole.
	2. Maintain Class-III water quality standards for total and fecal coliform bacteria.	2. Estimate for Lake Seminole: 1) the monthly trends in coliform bacteria; and 2) the frequency, duration, and magnitude that monthly total and fecal coliform concentrations exceed 2,400/100 ml and 800/100 ml, respectively.
	3. Attain 90% positive responses on recreational user and lakefront resident opinion surveys.	3. Assess recreational user and lakefront resident satisfaction every four years.
	4. Maintain or increase recreational usage of the lake while still maintaining 90% user satisfaction.	4. Annually estimate the number of recreational users visiting the lake.

5.2.6 Flood Control

Under the targets developed for the Flood Control issue two specific monitoring objectives are proposed. The rationale for each proposed monitoring objective is discussed below.

Target 1: Prevent flood damage ($0) to all properties within the Lake Seminole watershed.

Objective 1: Annually assess flood damage (dollars) to all properties within the Lake Seminole watershed.

Rationale: The aggregate sum of property damage (in dollars) from flooding in the Lake Seminole watershed should be assessed and reported annually to monitor the possible impacts of other lake management actions (e.g., water level fluctuations) on flood protection.

Target 2: **Manage lake levels to improve water quality and aquatic vegetation conditions while maintaining maximum flood protection.**

Objective 2: **Estimate monthly compliance with the recommended Lake Seminole enhanced lake level fluctuation schedule.**

Rationale: Strict compliance with the recommended enhanced lake level fluctuation schedule will allow lake managers to assess the effectiveness of altering water levels as a means of improving water quality and aquatic vegetation conditions. Average daily water level records from the Lake Seminole outfall control structure are needed to assess monthly compliance with the prescribed schedule.

The goals, targets and monitoring objectives related to the Flood Control management issue are summarized in Table 5-6 below.

Table 5-6. Goals, targets and monitoring objectives for the Flood Control issue.

Goal(s)	Target(s)	Monitoring Objective(s)
The lake and watershed shall be managed to minimize flood damage.	1. Prevent flood damage ($0) to all properties within the Lake Seminole watershed.	1. Annually assess flood damage (dollars) to all properties within the Lake Seminole watershed.
	2. Manage lake levels to improve water quality and aquatic vegetation conditions while maintaining maximum flood protection.	2. Estimate monthly compliance with the recommended Lake Seminole enhanced lake level fluctuation schedule.

5.2.7 Public Education

Under the targets developed for the Public Education issue two specific monitoring objectives are proposed. The rationale for each proposed monitoring objective is discussed below.

Target 1: **Annually provide for a minimum of two (2) public education/media events.**

Objective 1: **Annually determine the number of public education/media events conducted.**

Rationale: A simple accounting of the number of public education/media events should be recorded annually to track attainment with the target.

Target 2: Attain 90% positive responses on recreational user and lakefront resident public opinion and knowledge surveys.

Objective 2: Assess recreational user and lakefront resident public knowledge of the lake management plan every four years.

Rationale: It is recommended that the public education survey be combined with the recreational user and lakefront resident satisfaction surveys discussed above. Due to the demand on staff resources, surveys conducted at a frequency greater than every four years are not recommended.

The goals, targets and monitoring objectives related to the Public Education management issue are summarized in Table 5-7 below.

Table 5-7. Goals, targets and monitoring objectives for the Public Education issue.

Goal(s)	Target(s)	Monitoring Objective(s)
Education in matters related to and affecting the other goals of the Lake Seminole Management Plan shall be provided.	1. Annually provide for a minimum of two (2) public education/media events.	1. Annually determine the number of public education/media events conducted.
	2. Attain 90% positive responses on recreational user and lakefront resident public opinion and knowledge surveys.	2. Assess recreational user and lakefront resident public knowledge of the lake management plan every four years.

5.3 Summary of the Recommended Monitoring Programs

The existing monitoring programs currently being implemented by the various responsible agencies only partially address the data needs of the comprehensive Lake Seminole Watershed Management Plan. Many data gaps exist which must be addressed through the modification of existing monitoring programs, as well as the implementation of new monitoring programs. In addition, the existing monitoring programs in most cases lack clearly articulated monitoring objectives which are logically linked to management goals and level-of-service targets. This lack of focus has resulted in a less than cost-effective expenditure of available funding resources for monitoring activities.

A total of 13 monitoring program elements have been identified to fill data needs with respect to the implementation of the Lake Seminole Watershed Management Plan. Table 5-8 below summarizes

the monitoring objectives addressed, the sampling frequency, and the recommended agency responsibility(s) for each monitoring element. Key differences between the existing monitoring activities and the proposed comprehensive Lake Seminole Monitoring Program are summarized below:

- The existing ambient in-lake water quality monitoring program implemented by PCDEM is the most rigorous program currently in effect. The number and distribution of sampling stations are defensible, and continuation of the monthly sampling frequency is recommended.

- Additional sampling programs are recommended to assess nutrient loadings from: 1) nonpoint sources; 2) groundwater; and 3) atmospheric deposition. These monitoring elements combined with the ongoing measurement of nutrient concentrations in water discharged from the lake outfall structure will allow for the calculation of current annual water and nutrient budgets.

- An additional sampling program is recommended for assessing in-lake dissolved oxygen minima and compliance with other applicable State water quality standards.

- Additional sampling programs are recommended for assessing the status and trends in the coverage and composition of submerged and emergent aquatic vegetation.

- The frequency of the regular FGFWFC (now the Florida Fish & Wildlife Conservation Commission) sport fish population assessments is recommended to be changed from approximately every five years to every two years through 2010; and then every four years thereafter, at a minimum.

- Coordination of bird census data obtained by volunteers from the local chapter of the Audubon Society is recommended for regularly assessing bird populations.

- An additional monitoring program is recommended for assessing the status and trends of upland and wetland habitats in the watershed.

- Modification and improvement of the recreational user and lakefront resident surveys currently employed by PCDEM are recommended to expand the utility and statistical validity of these tools for assessing public opinion and responsiveness with regard to recreational, aesthetic and environmental education issues.

- Numerous other accounting measures are recommended for assessing progress towards the full implementation of the Lake Seminole Watershed Management Plan.

- Financial and logistical responsibility for the Lake Seminole Monitoring Program should rest primarily with Pinellas County Department of Environmental Management at the local level.

However, the SWFWMD and FFWCC should continue or expand their financial and logistical support with regard to certain monitoring components. The following specific intergovernmental coordination measures are recommended.

- Cost-sharing for laboratory analyses between Pinellas County and SWFWMD should be considered, with SWFWMD providing laboratory analyses associated with the nonpoint source and groundwater loading monitoring programs. For consistency with historic data, it is recommended that Pinellas County continue to provide laboratory analyses for all in-lake samples.

- Because of their extensive in-house expertise in groundwater monitoring, as well as their specific diagnostic work on the Lake Seminole groundwater system, it is recommended that SWFWMD be responsible for the installation and maintenance of, and collection of samples from, the recommended groundwater seepage meters.

- Because of their extensive in-house expertise and experience in fishery biology, as well as their history in monitoring trends in the Lake Seminole sport fishery, it is recommended that the FFWCC continue to be responsible for the quantitative assessment of fish populations. It is, however, also recommended that the collection of angler use data be delegated to PCDEM and incorporated into a comprehensive recreational use and lakefront resident survey program to be conducted every four years.

• The PCDEM should publish an annual State-of-the-Lake report which summarizes all of the monitoring data collected during the previous calendar year. In addition to monitoring data summaries, the annual report should include at a minimum:

  - Calculated water and nutrient budget for the previous calendar year; and

  - An assessment of compliance with each of the established level-of-service targets.

• The Pinellas County Department of Environmental Management (PCDEM) should designate a Lake Seminole Data Manager who serves as the point of contact for coordinating the collection, management and reporting of all monitoring data associated with the Lake Seminole Watershed Management Plan. Furthermore, PCDEM should serve as a depository of all monitoring data associated with the Plan.

• The Pinellas County Department of Public Works, and the Pinellas County Utilities Department, should continue to investigate potential leaks in the sanitary sewer system infrastructure within the watershed. As discussed in Section 2.2 above, lake nutrient budgets indicate an apparent excess of nitrogen in lake waters that cannot be accounted for by measured or modeled external nutrient loads. Although this excess can be feasibly explained

by internal nutrient recycling processes, the magnitude of the excess suggests the potential for an undocumented point source discharge of untreated waste into the lake. Visual inspection (e.g., using remote television cameras) of all sewer mains and pump stations that could potentially discharge waste to the lake should be conducted. In addition, monitoring of groundwater for appropriate sewage tracer compounds (e.g., caffeine) near suspected leaks should be performed to verify the presence of any waste discharges. If sewer system leaks are discovered, immediate action should be taken to repair the defective infrastructure and to eliminate any waste discharges to the lake. It should be noted, however, that the positive determination of a sewer system leak in the watershed would likely not effect any of the recommended components of the Plan, nor the phasing of the various components.

The detailed sampling protocols for each of the recommended monitoring elements are provided in the Task 3.2.11 Report. Full implementation of all recommended monitoring programs is considered to be essential in meeting the success evaluation requirements of the Plan.

Table 5-8. Summary of recommended monitoring program elements.

Monitoring Element	Objectives Addressed	Sampling Frequency	Responsible Entities
In-Lake Water Quality	Water Quality: 1, 2A, 2B, 4, 5B, 5C, and 5D Recreation and Aesthetics: 2	Monthly	PCDEM - field sampling and laboratory analysis
Nonpoint Source Loadings	Water Quality: 3A	Monthly	PCDEM - field sampling SWFWMD - laboratory analysis
Groundwater Loadings	Water Quality: 3B	Semi-annual (wet and dry season)	SWFWMD - field sampling and laboratory analysis
Atmospheric Deposition Loadings	Water Quality: 3C	Daily	PCDEM - field sampling and laboratory analysis
Dissolved Oxygen Minima	Water Quality: 5A	1-3 days/month during index period of July-September	PCDEM - field sampling and laboratory analysis
MSSW Inventory	Water Quality: 6	Ongoing	PCDEM with logistical support from SWFWMD.
Submerged Aquatic Vegetation	Aquatic Vegetation: 1 and 2	Every 2 years	PCDEM with logistical support from SWFWMD and FDEP
Emergent Aquatic Vegetation	Aquatic Vegetation: 3 and 4	Every 2 years	PCDEM with logistical support from SWFWMD and FDEP
Fish Populations	Fisheries: 1 and 2	Every 2 years	FFWCC with logistical support from PCDEM
Bird Populations	Wildlife and Associated Habitat: 2 and 3	Semi-annual (summer and winter)	PCDEM - coordination only - with logistical support by Audubon Society and FFWCC
Upland Habitats	Wildlife and Associated Habitat: 1	Every 2 years	PCDEM in coordination with Pinellas County Parks Department
Recreational User and Lakefront Resident Survey	Fisheries: 3, 4, and 5 Recreation and Aesthetics: 3 Public Education: 2	Every 4 years	PCDEM with logistical support from FFWCC for angler use data
Miscellaneous Accounting	Wildlife and Associated Habitat: 1 Recreation and Aesthetics: 1 and 4 Flood Control: 1 and 2 Public Education: 1	Annual	PCDEM

6.0 CAPITAL IMPROVEMENT AND IMPLEMENTATION SCHEDULE

This section presents a summary of the recommended implementation schedule for the major capital components of the Plan. In the schedule presented below, it assumed that the Plan will be adopted during FY-2001, and that implementation will be initiated in early FY-2002 (October 2001).

Phasing of Plan Components

It should be emphasized that the various components of the Plan are not all independent management actions that can be implemented without regard for the others. That is, among the various Plan components there are certain dependencies that need to be accommodated in the implementation schedule to ensure the most cost-effective results. For example, the recommended in-lake habitat restoration projects clearly should not be implemented prior to the dredging of the organic fibrous shoreline sediments that preclude the natural recruitment of desirable aquatic vegetation, or the removal of herbivorous grass carp which would effectively harvest planted macrophytes. Similarly, aquatic weed harvesting clearly should not be initiated until there is a substantial enough crop of macrophytes to effectively harvest.

The implementation of other management actions should be based on the measured effectiveness of preceding management actions. For example, it is recommended that the removal of the flocculent deep sediments in the lake not be initiated until the effectiveness of external phosphorus removal has been evaluated through water quality monitoring. If monitoring indicates that expected progress towards meeting the defined water quality targets is not being met through the reduction of external phosphorus loads, then the implementation of the dredging project would be justified. Similarly, sediment phosphorus inactivation through whole lake alum applications should not be initiated until the flocculent sediments have been removed and monitoring results still indicate insufficient progress towards meeting water quality targets.

In recognition of these dependencies, as well as potential financial constraints, it is recommended that the Plan be implemented in three phases, as described below.

- **Phase I** - The first phase of the Plan would focus initially on the design and permitting of the major structural components for which land acquisition, engineering design and regulatory permit approvals will be required. In addition, the primary focus of Phase I will be on watershed management activities that result in the reduction of external phosphorus loads to the lake (e.g., construction of enhanced regional stormwater treatment facilities). Land acquisition, engineering design, and environmental permitting activities in support of the major structural components of the Plan may require up to two years to complete and therefore should be initiated immediately. Phase I activities are projected to require a minimum of two years to complete, including construction. Therefore, Phase I would extend from October 2001 through at least September 2003.

- **Phase II** - The second phase of the Plan would focus primarily on in-lake restoration activities that build upon the watershed management projects completed under Phase I. These would include implementation of in-lake habitat restoration projects, as well as the removal of the flocculent deep sediments if monitoring results warrant this major project. Assuming that all land acquisition, design and permitting activities have been completed for the major structural components in Phase I, it is anticipated that the Phase II construction projects, and other non-structural components of the Plan, could be completed in two years. Therefore, Phase II would extend from October 2003 through September 2005.

- **Phase III** - The third phase of the Plan would focus primarily on following-up on in-lake restoration activities that build upon, or are dependent upon, the implementation of Phase I and Phase II projects. For example, assuming that adequate water quality improvement to support the proliferation of aquatic macrophytes in the lake has resulted from the implementation of the Phase I and II components, the aquatic weed harvesting program would be initiated during Phase III. Conversely, if the defined water quality targets have not been attained following implementation of the Phase I and II components, then sediment phosphorus inactivation would be implemented in Phase III. It should be noted that the majority of the Phase III projects are management or maintenance activities that will likely be conducted indefinitely on an ongoing basis. Therefore, Phase III would begin in October 2005 and extend indefinitely into the future.

Table 6-1 below summarizes the recommended capital improvement and implementation schedule for the Plan. This table embodies the logical sequencing and dependencies of the various Plan components discussed above. In addition to the components of the Plan, the recommended monitoring and success evaluation program presented in Chapter 5 should be implemented in Phase I to document existing baseline conditions, and to track progress throughout Plan implementation.

Table 6-1. Recommended capital improvement and Plan implementation schedule.

Priority Issue	Phase I Components FY-2002 through FY-2003	Phase II Components FY-2004 through FY-2005	Phase III Components FY-2006 and Beyond
Water Quality	*Structural Component 1* - Construct Enhanced Regional Stormwater Treatment Facilities in Priority Sub-Basins	*Structural Component 4* - Dredge Organic Silt Sediments from Submerged Areas	*Management Component 2* - Inactivate Phosphorus through Whole Lake Alum Applications (if warranted by monitoring results)
	Structural Component 2 - Divert Seminole Bypass Canal Flows to Improve Lake Flushing and Dilution	*Management Component 5* - Improve Treatment Efficiency of Existing Stormwater Facilities	
	Structural Component 6 - Install Stage and Flow Measurement Instrumentation on the Lake Seminole Outfall Control Structure	*Legal Component 3* - Strengthen and Standardize Local Ordinances for Regulating Stormwater Treatment for Redevelopment in the Lake Seminole Watershed	
	Legal Component 1 - Amend the Florida Statutes to Temporarily Exempt Lake Seminole from Aquatic Preserve and Outstanding Florida Water Regulatory Restrictions		
	Legal Component 2 - Adopt a Resolution Designating the Lake Seminole Watershed as a "Nutrient Sensitive Watershed"		
	Policy Component 1 - Establish a Lake Seminole Watershed Management Area (WMA) through Amendments to the Pinellas County, and Cities of Largo and Seminole Comprehensive Plans		

Priority Issue	Phase I Components FY-2002 through FY-2003	Phase II Components FY-2004 through FY-2005	Phase III Components FY-2006 and Beyond
Aquatic Vegetation	*Structural Component 3* - Excavate Organic Peat Sediments from Shoreline Areas	*Structural Component 5* - Restore Priority Upland and Wetland Habitats (In-Lake Habitat Restoration and Enhancement)	*Management Component 3* - Mechanically Harvest Nuisance Aquatic Vegetation
	Management Component 1 - Implement an Enhanced Lake Level Fluctuation Schedule		
Fisheries	*Management Component 4* - Biomanipulate Sport Fish Populations - Phase I (Rough Fish Removal)	*Management Component 4* - Biomanipulate Sport Fish Populations - Phase II (Sport Fish Stocking)	*Management Component 4* - Biomanipulate Sport Fish Populations - Phase III (Enforce Catch & Release)
Wildlife and Associated Habitat		*Structural Component 5* - Restore Priority Upland and Wetland Habitats (Upland Habitat Restoration and Enhancement)	
Recreation and Aesthetics	*Compliance and Enforcement Component 1* - Expand and Enforce Restricted Speed Zones on Lake Seminole	*Social and Recreational Component 1* - Construct a Public Pedestrian Fishing Pier and Boardwalk in Lake Seminole County Park	
	Compliance and Enforcement Component 2 - Dedicate a Pinellas County Marine Unit Sheriff to Enforce Laws on Lake Seminole	*Social and Recreational Component 2* - Establish and Protect Fishing Enhancement Zones on Lake Seminole	
Flood Control	*Structural Component 6* - Install Stage and Flow Measurement Instrumentation on the Lake Seminole Outfall Control Structure		*Operation and Maintenance Component 1* - Operate and Maintain Structural Facilities and Equipment Recommended in the Plan
Public Education	*Public Education Component 1* - Develop and Implement a Comprehensive Public Involvement Program for the Lake Seminole Watershed	*Public Education Component 2* - Develop and Implement a Local Citizens LakeWatch Program for Lake Seminole	

7.0 FINANCING REQUIREMENTS AND OPTIONS

7.1 Funding Requirements

The total cost for implementing the Plan can be broken down into the following line items: engineering design and environmental permitting fees; land acquisition costs; construction costs; and annual recurring costs for ongoing operation and maintenance activities, and program administrative functions. For most watershed management projects, the costs associated with land acquisition and construction are typically the greatest. Because the recommended Plan does not include management actions that require substantial land acquisition, construction costs by far constitute the greatest single line item associated with the implementation of the Plan. Table 7-1 shows a breakdown of construction cost by phase, whereas Table 7-2 shows a detailed breakdown of construction costs, annual recurring costs, and 10-year total costs for each component of the Plan.

Table 7-1. Construction cost breakdown by Plan implementation phase.

Plan Implementation Phase	Construction Cost
Phase I (FY-2002 through 2003)	$4,420,000
Phase II (FY-2004 through 2005)	$9,310,000
Phase III (FY-2006 and beyond)	$750,000
Total Construction Cost	**$14,480,000**

The total construction cost of implementing the Plan is estimated at $14,980,000. This cost estimate assumes that all components of the Plan, including the most ambitious optional alternatives, are fully implemented as recommended. Therefore, this cost represents a maximum construction cost estimate. It should, however, be noted that the total estimated construction cost does not include design and permitting fees, or land acquisition costs.

The total annual recurring cost of Plan implementation is estimated to be $537,000. This annual recurring cost estimate includes all ongoing operation and maintenance activities, and program administrative functions. As with the total construction cost estimate, this cost estimate assumes that all components of the Plan, including the most ambitious optional alternatives, are fully implemented as recommended. Therefore, this cost represents a maximum annual recurring cost estimate.

The total 10-year cost assumes that the construction of all structural components of the Plan will be completed within five years of initiation (e.g., by September 2006), and is estimated at $17,665,000. As such, the total 10-year cost includes the construction costs, and 5-years of accrued annual

recurring costs, for all components of the Plan. Therefore, this cost represents an estimate of the maximum total cost of Plan implementation over a 10-year planning and budgeting window (e.g., through September 2011). All cost estimates are figured in FY-2001 dollars and do not account for inflation.

Although the above cost estimate was prepared using the best available information to date, it should be noted that it is only a rough approximation of the total costs to implement the Plan. Design plans and specifications have not been prepared for the major structural components of the Plan, and market-driven unit costs (e.g., land, materials, labor, etc.) can vary significantly due to many factors (e.g., inflation, competition). More detailed and accurate cost estimates for each component of the Plan can only be developed based on designs, specifications, programs, and economic conditions in place at the time of implementation.

7.2 Funding Options

Several state and federal matching-fund and grant programs have been identified to help defray the local government costs of Plan implementation. Based on the information obtained during this study, the following conclusions and recommendations can be made regarding funding options for the Plan.

Federal Programs

- Federal grants under the EPA 319 program, administered by the Florida Department of Environmental Protection, should be pursued to generate funding for the proposed stormwater rehabilitation projects.

- Funding available from the EPA Clean Lakes Program has been under-utilized in Florida in past years, and current funding cuts now threaten the viability of the entire program. Political support of the Clean Lakes Program by Pinellas County is recommended.

State Programs

- Cooperative funding support from the Pinellas-Anclote River Basin Board should continue to be sought to the greatest extent feasible. This funding source, being generated by ad valorem taxes, represents perhaps the single most stable and predictable funding source for water resource and lake management initiatives in Pinellas County.

- Currently, the funding of District SWIM programs is dependent upon a yearly appropriation from the Florida Legislature. Funds generated by FDOT contributions to the Ecosystem Management Trust Fund for mitigation purposes are being evaluated as a potential long-term funding source for the District SWIM programs. Such funds are to be used for aquatic weed control programs, habitat restoration planting programs, and other remediative programs

associated with eutrophication. Pinellas County should continue to closely track the rule making for this legislation to determine if such funds will be available through District cooperative funding programs in the future.

- The Florida Forever Act passed by the Florida Legislature in 1999 will generate approximately $5.2 million per year for fishery enhancement projects statewide, for a total of 10 years. This program is to be administered by the Florida Fish and Wildlife Conservation Commission, and funds from this program should be pursued for fishery management and in-lake habitat restoration projects.

- Funds generated from the Florida Forever Act will also be directed to the Florida Department of Environmental Protection, Aquatic Plant Management Program. Funds from this program should be pursued for aquatic weed harvesting and in-lake habitat restoration projects.

Local Funding Options

- Pinellas County should pursue cooperative funding from the National Fish and Wildlife Foundation. Funds from this private foundation can be used to finance habitat restoration and fishing enhancement projects, as well as other nature-based recreational improvements.

- Pinellas County should consider the creation of a stormwater utility to provide a long-term, stable funding source for drainage and water quality improvement projects. In addition to the "Penny for Pinellas" sales tax, a stormwater utility could provide the County with a long-term and stable source of needed funding for continuing the watershed management initiatives already underway.

- Pinellas County should undertake a survey of lakefront and watershed property owners to determine if a Municipal Service Taxing Unit (MSTU) would be supported. If initial support is indicated, Pinellas County should give strong consideration to this management option in lieu of general revenues or a stormwater utility.

- A local boat registration fee is considered to be the most cost-effective and equitable approach to collecting user fees; however additional manpower will be needed to administer and enforce such a program.

Table 7-2 below provides a cost summary of the various components of the Plan and list potential funding sources for each.

Table 7-1. Cost summary for components of the Lake Seminole Watershed Management Plan, and potential funding sources for each.

Plan Component	Construction Cost*	Annual Recurring Costs**	Total 10-year Cost***	Potential Funding Sources
Structural Component 1 - Construct Enhanced Regional Stormwater Treatment Facilities in Priority Sub-Basins	$2,000,000	$150,000	$2,750,000	SWFWMD Basin Board Funds; EPA 319 Grants
Structural Component 2 - Divert Seminole Bypass Canal Flows to Improve Lake Flushing and Dilution	$500,000	$35,000	$675,000	SWFWMD Basin Board Funds; EPA 319 Grants
Structural Component 3 - Excavate Organic Peat Sediments from Shoreline Areas	$1,600,000	N/A	$1,600,000	SWFWMD Basin Board Funds; EPA Clean Lakes Funds
Structural Component 4 - Dredge Organic Silt Sediments from Submerged Areas	$7,600,000	N/A	$7,600,000	SWFWMD Basin Board Funds; EPA Clean Lakes Funds
Structural Component 5 - Restore Priority Upland and Wetland Habitats	$500,000 for In-Lake Projects $530,000 for Upland Projects	$5,000 $10,000	$525,000 $580,000	SWFWMD Basin Board Funds Florida Forever Act Funds
Structural Component 6 - Install Stage and Flow Measurement Instrumentation on the Lake Seminole Outfall Control Structure	$20,000	$2,000	$30,000	SWFWMD Basin Board Funds
Management Component 1 - Implement an Enhanced Lake Level Fluctuation Schedule	New Outfall Structure is Already Funded	$5,000	$25,000	County General Administrative Funds
Management Component 2 - Inactivate Phosphorus through Whole Lake Alum Applications	$700,000 per application	N/A	$700,000	SWFWMD Basin Board Funds
Management Component 3 - Mechanically Harvest Nuisance Aquatic Vegetation	Pinellas County Already Owns a Harvester	$200,000	$1,000,000	Florida Forever Act Funds
Management Component 4 - Biomanipulate Sport Fish Populations	$300,000 for Phase I-III Activities	N/A	$300,000	Florida Forever Act Funds
Management Component 5 - Improve Treatment Efficiency of Existing Stormwater Facilities	$200,000 for Program Implementation	N/A	$200,000	SWFWMD Basin Board Funds; EPA 319 Grants
Legal Component 1 -Amend the Florida Statutes to Temporarily Exempt Lake Seminole from Aquatic Preserve And Outstanding Florida Water Regulatory Restrictions	Implement with Existing Staff and Resources	N/A	$0	County General Administrative Funds

Plan Component	Construction Cost*	Annual Recurring Costs**	Total 10-year Cost***	Potential Funding Sources
Legal Component 2 - Adopt a Resolution Designating the Lake Seminole Watershed as a "Nutrient Sensitive Watershed"	Implement with Existing Staff and Resources	N/A	$0	County General Administrative Funds
Legal Component 3 - Strengthen and Standardize Local Ordinances for Regulating Stormwater Treatment for Redevelopment in the Lake Seminole Watershed	Implement with Existing Staff and Resources	N/A	$0	County and City General Administrative Funds
Policy Component 1 - Establish a Lake Seminole Watershed Management Area (WMA) through Amendments to the Pinellas County, and Cities of Largo and Seminole Comprehensive Plans	Implement with Existing Staff and Resources	N/A	$0	County and City General Administrative Funds
Compliance and Enforcement Component 1 - Expand and Enforce Restricted Speed Zones on Lake Seminole	$100,000	N/A	$100,000	County General Administrative Funds
Compliance and Enforcement Component 2 - Dedicate a Pinellas County Marine Unit Sheriff to Enforce Laws on Lake Seminole	N/A	$100,000	$500,000	County General Administrative Funds
Social and Recreational Component 1 - Construct a Public Pedestrian Fishing Pier and Boardwalk in Lake Seminole County Park	$400,000 for Alternative B	N/A	$400,000	National Fish and Wildlife Foundation Funds
Social and Recreational Component 2 - Establish and Protect Fishing Enhancement Zones on Lake Seminole	$30,000	N/A	$30,000	Florida Forever Act Funds; National Fish & Wildlife Foundation Funds
Public Education Component 1 - Develop and Implement a Comprehensive Public Involvement Program for the Lake Seminole Watershed	N/A	$10,000	$50,000	County General Administrative Funds
Public Education Component 2 - Develop and Implement a Local Citizens LakeWatch Program for Lake Seminole	Implement with Existing Staff and Resources	N/A	$0	County General Administrative Funds
Monitoring and Success Evaluation	Implement with Existing Staff and Resources	$20,000 over current County monitoring programs	$100,000	County General Administrative Funds
Total Costs	**$14,480,000**	**$537,000**	**$17,165,000**	—

* Construction costs are exclusive of design, permitting and land acquisition costs.

** Annual recurring costs include ongoing O&M and other expenditures for staff labor and equipment.

*** Total 10-year costs include construction costs plus 5-years of accrued annual recurring costs. Assumes that all components of the Plan are fully implemented.

8.0 REFERENCES

The following technical references and information sources are cited in the above sections of this document.

Champeau, T.R. 1991. South Regional Fisheries Management Annual Performance Report. Florida Game and Freshwater Fish Commission. Lakeland, FL.

Champeau, T.R. 1996. South Regional Fisheries Management Annual Performance Report. Florida Game and Freshwater Fish Commission. Lakeland, FL.

Dames & Moore, Inc. 1992. Lake Tarpon aquatic weed harvesting and revegetation project. Final report submitted to the Southwest Florida Water Management District, Tampa, Florida.

Environmental Research & Design (ERD). 1994. Lake Maggiore restoration stormwater pre-treatment ponds/ alum treatment systems. Final report submitted to the City of St. Petersburg and the Southwest Florida Water Management District.

Harper, H.H., and E.H. Livingston. 1999. Everything you always wanted to know about stormwater management practices but were afraid to ask, or stormwater BMPs, the good, the bad, and the ugly. Syllabus prepared for the Southwest Florida Water Management District Biennial Stormwater Research Conference, September 14, 1999. Tampa, FL.

Greening, H. and S. Doyon. 1990. Environmental and ecological effects of drawdown and enhanced fluctuation for Lake Apopka, Florida. Final report prepared for the St. Johns River Water Management District. Dames & Moore, Inc.

Gremillion, P.T., C.E. Mericas and H.S. Greening. 1988. Lake Okeechobee aquatic weed harvesting demonstration project. Final report prepared for the South Florida Water Management District, West Palm Beach, Florida.

Huber, W.C., P.L. Brezonik, J.P. Heany, R.E. Dickinson, S.D. Preston, D.S. Dwornik, and M.A. DeMaio. 1982. A classification of Florida lakes. University of Florida Water Resources Research Center. Publication No. 72. Gainesville, Florida.

National Research Council, 1990. Managing Troubled Waters. Washington, D.C; National Academy Press, Wash. D.C., 125 pp.

New York State Department of Environmental Conservation (NYSDEC). 1990. Diet for a small lake - a New Yorker's guide to lake management. Albany, NY.

Reddy, K.R. and T.A. DeBusk. 1987. State-of-the-art utilization of aquatic plants in water pollution control. Wat. Sci. Tech. 19(10): 61-79.

Schelske, C.L., M. Brenner, and T.J. Whitmore. Lake Seminole Sediment Characterization and Analysis. Final report prepared for the Southwest Florida Water Management District. University of Florida Department of Fisheries and Aquaculture. Gainesville, Fl.

Southwest Florida Water Management District. 1990. Lake Seminole Diagnostic Feasibility Study. Final report prepared for the Pinellas-Anclote River Basin Board. Brooksville, Fl.

Souza, S.J., J.D. Koppen, and R. Conner. 1988. Aquatic weed harvesting: a cost-effective means of improving the recreational, aesthetic and water quality conditions of Lake Hopatcong. Lake and Reservoir Management Vol. IV, North American Lake Management Society, Washington, D.C.

U.S. Environmental Protection Agency (EPA). 1990. Lake and Reservoir Guidance Manual. Second Edition 440/5-88-002. Washington, D.C.

Vollenweider, R.A. 1968. Scientific fundamentals of the eutrophication of lakes and flowing waters, with particular reference to nitrogen and phosphorus as factors in eutrophication. OECD Report No. DAS/CSI/68.27.

Water & Air Research (WAR), Inc. 1999. Investigation of Biological Effects of Alum Treatment. Final report prepared for the St. Johns River Water Management District. Gainesville, Fl.

Ware, F.J. 1965. Lake Seminole Fishery Management Area, Fishery Improvement Project Report. Florida Game and Freshwater Fish Commission. Lakeland, Fl.

Wetzel, R.G., 1983. Limnology. Second Edition. Saunders College Publishing.

APPENDIX 1

LAKE SEMINOLE WATERSHED MANAGEMENT PLAN

Sediment Characterization Study

Prepared for:

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Planning and Programing
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October 1997

LAKE SEMINOLE
SEDIMENT CHARACTERIZATION STUDY

Prepared for:

Coastal Environmental
A Division of Post, Buckley, Schuh & Jernigan, Inc.

Pinellas County, Florida

Prepared by:

BCI
ENGINEERS & SCIENTISTS, INC

BCI Project No. 959214

October 1997

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EXECUTIVE SUMMARY

BCI was engaged by Coastal Environmental, a division of Post, Buckley, Schuh & Jernigan, Inc., to provide engineering services related to the feasibility of dredging Lake Seminole sediments. Specific work tasks undertaken and reported upon within this report are:

- Determination of Lake Sediment Physical and Chemical Characteristics
- Determination of Lake Bathymetry
- Development of a Sediment Volume Estimate
- Preliminary Evaluation of Dredge Alternatives

Physical Characterization

Physical characterization of Lake Seminole sediments revealed two distinct classifications of sediments within the lake. Loose, high-density sands were the dominant sediment type in the southern lobe of the lake where the water depth averaged 5.5 feet. The low density, organic silts were present in the canals and northern lobe of the lake where the water depth averaged 4.1 feet. The average physical characteristics of the low density, organic silts are shown below:

Average Low Density, Organic Silt Physical Characteristics

Solids Content	15%
Organic Content	28%
Percent Passing #200 Sieve	80%
Specific Gravity	2.3
Plasticity Index	124

Sediment Volume Estimates

Calculations based on lake bathymetry, probing and sampling determined Lake Seminole currently has an estimated total volume of 4.9 million cubic yards (c.y.) of sediments. Of this, 800,000 c.y. is considered to be low density, organic silts, which may need to be removed to improve water quality within the lake. These low density sediments are confined mostly to the canals, northern lobe, and a few isolated pockets of the southern lobe. Not included with the 800,000 c.y. is an additional 130,000 c.y. of highly organic, decayed vegetation along the periphery of the lake.

Chemical Characterization

Chemical characterization was performed on Lake Seminole sediments, water, and elutriate for metals (antimony, arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, thallium, and zinc) and nutrients (total kjeldahl nitrogen, total phosphorus, orthophosphate, nitrate and nitrite combined, sodium and chloride). The sediments were also analyzed for potential for metal toxicity as defined by the Toxicity Characteristic Leaching Procedure (TCLP). The analysis revealed the following:

Sediments

- Sediments do not qualify as hazardous material based on the metal concentrations detected in the TCLP leachate produced.
- All metals, except mercury and thallium, were detected; however, chromium, copper, lead, and zinc were detected at concentrations ranging from about 5 to 60 mg/kg dry weight.

Water

- Arsenic, chromium, copper, lead, nickel, selenium, silver, and zinc were detected in the lake water; however, only lead and silver concentrations exceeded the Florida Class III freshwater quality standards.

- Soluble parameters demonstrate concentrations of 0.429 mg/L for nitrate and nitrite combined and 0.151 mg/L for orthophosphate. Total kjeldahl nitrogen and phosphorus in the water was 3.47 mg/L and 0.346 mg/L, respectively.
- Sodium and chloride were present at approximately 100 mg/L. These two elements are dominant in saline waters and when this value is converted to the standard measure of salinity in parts per thousand (ppt), the resulting value of 0.1 ppt is indicative of freshwater.

Elutriate

The sediment elutriate test procedure is a methodology developed by the U.S. Army Corps of Engineers to simulate the potential water quality impacts associated with dredging submerged sediments. In essence, the elutriate procedure is designed to approximate the concentration of sediment constituents that are released into the water column in a soluble form as a result of sediment agitation and resuspension. The elutriate analytical results are typically compared to the appropriate surface water regulatory standards.

- Several metals were detected in the elutriate water. However, of those detected, only arsenic, copper, and silver concentrations in the elutriate water exceeded Florida Class III standards. Arsenic and copper concentrations did not exceed the standards by much; however, silver was significantly higher and will need to be evaluated further.
- Soluble parameters demonstrate concentrations of 0.05 mg/L for nitrate and nitrite and a range of 0.4 to 1.5 mg/L for orthophosphate. Total kjeldahl nitrogen ranged from 8 to 14 mg/L, whereas total phosphorus ranges from 0.5 to 1.9 mg/L.

Conclusions

Results of this preliminary analysis indicate physical characteristics of Lake Seminole low density, organic silt sediments are similar to comparable sediments of Lake Maggiore. Fur-

thermore, the chemical analysis indicate that most metals are within Florida Class III freshwater standards even after being subjected to the elutriate procedure. However, silver concentration was not detected in one sample, but was significantly higher in another and warrants further evaluation. Although no standards exist for sediment disposal on land, a comparison with Environmental Protection Agency limits for sewage sludge disposal on land shows the sediments are well below the limits and should not pose any land disposal concerns. With regard to nutrients, the results of the elutriate tests indicate that short term eutrophication may be a concern during dredging. It should, however, be noted that the sediment analyses indicate a substantial reservoir of nutrients bound to the sediments, and that the purpose of the Lake Seminole restoration project is to remove the internal nutrient source.

1.0 INTRODUCTION

Lake Seminole, encompassing some 684 acres, is the second largest lake located in Pinellas County, Florida. It is a freshwater water body consisting of two large lobes on a north-south axis connected by a narrow channel. The lake's entire watershed (3,480 acres) and shoreline are highly developed with old and new commercial and residential development, with the exception of the county-owned Lake Seminole Park, located on the southeast shore of the lake. The land use in the watershed is comprised of residential, commercial, office space, and open space.

In the past years, state and local agencies and Pinellas County have received complaints about Lake Seminole's water quality. Therefore, the Pinellas County Board of County Commissioners initiated development of a long-term management plan to improve water quality with the cooperation of the public, lake users, and state and local agencies with responsibilities on the lake. These agencies included Pinellas County, the Southwest Florida Water Management District (SWFWMD), the Florida Department of Natural Resources, the Florida Department of Environmental Regulation, the Florida Game and Fresh Water Fish Commission, and the Cities of Seminole and Largo.

Previous cooperative watershed assessment work by the SWFWMD and the University of Florida (1991) identified 131 stormwater pipes discharging to the lake or its tributaries, mostly on the west side of the lake. No wastewater treatment facilities were located within the watershed. The trophic state index for the lake was determined to be 74.7 in 1991, placing the lake in eutrophic classification for Florida lakes. This earlier work by the SWFWMD included sediment characterization, which indicated organic surface deposits being confined to near-shore sites with the central locations of both the north and south lobes possessing sandy surface sediments (less than or equal to 2.0% organic content). However, isolated pockets of organic surface deposits were found along the north-south axis close to the north shore, in the constriction between the two lobes, and near the southern outflow.

Currently, the lake discharges over a weir structure constructed in the 1940s. The weir is located in the southern lobe of the lake, and water flows into the remnant of what was once the Long Bayou estuary, and ultimately into Boca Ciega Bay.

The information contained in this report was completed by BCI for Coastal Environmental, a division of Post, Buckley, Schuh & Jernigan, Inc., to determine the possibility of dredging sediments from Lake Seminole. This report presents the results of physical and chemical characterization, lake bathymetry, and volumetric calculations of Lake Seminole sediments.

2.0 PHYSICAL CHARACTERIZATION

2.1 Sampling and Evaluation of Lake Components

As part of the Lake Seminole sediment removal feasibility, lake bottom sediments were collected and returned to the BCI laboratory for physical characterization and additional laboratory testing including 30-day settling tests and flocculation testing designed to better define the sediments dewatering properties.

BCI collected lake bottom sediments from 11 locations in Lake Seminole between February 26 and February 28, 1997. Samples were collected from various locations and depths within the lake to a maximum depth of 13 feet below the water surface, utilizing a piston tube sampler. After collection, samples were placed in sealed, labeled jars and transported to BCI's laboratory. Table 1 summarizes the locations at which sediment samples were collected and the corresponding depth of water to the sediment interface. The sampling locations are shown in Figure 1.

In addition to the sediment sampling, 40 additional locations were probed using a 3/8-inch diameter rod to determine the sediment thickness from the water/sediment interface. A hand held Global Positioning Survey Unit (GPS) recorded each probing and sampling location. At all locations the depth of water to the sediment interface and the total depth probed was recorded. At the time of probing the water elevation was 4.9 feet NGVD on a staff gauge. The bathymetry of Lake Seminole was determined by continuous recording of the sediment/water interface by a graphic chart recorder along 22 transects in north-south and east-west directions across the lake.

Table 1
Lake Seminole Sample Locations

Sample #	Location	Water Depth (ft)
SP-4	N 27 50.549 W 82 46.984	7.5′
SP-11	N 27 50.882 W 82 46.850	6.5′
SP-16	N 27 51.206 W 82 47.067	5.5′
SP-19	N 27 51.402 W 82 46.818	4.0′
SP-26	N 27 51.696 W 82 46.888	5.0′
SP-31	N 27 52.035 W 82 46.765	7.0′
SP-34	N 27 52.397 W 82 46.381	3.5′
SP-38	N 27 52.630 W 82 46.541	4.5′
SP-42	N 27 52.797 W 82 46.658	4.0′
SP-44	N 27 52.921 W 82 46.543	5.0′
SP-46	N 27 52.979 W 82 46.416	4.0′

2.2 General Sediment Description

Lake bottom sediments were described in the field and classified in two categories. Much of the sediment from the south lobe of the lake was classified as loose, high-density sands. These sands were easily penetrated by a 3/8-inch diameter probe rod to depths of up to about 20 feet below the water surface. Sediments from the canal areas and the north lobe of the lake were classified as loose, low density, organic silts.

2.3 Laboratory Testing and Results

Laboratory tests were performed in accordance with applicable American Society for Testing and Materials (ASTM) standards to determine the physical characteristics of the sediments. These tests included:

- Solids Content
- Organic Content
- Percent Passing #200 Sieve
- Grain Size Distribution
- Specific Gravity
- Atterberg Limits
- 30-day Settling Tests
- Flocculant Testing

Table 2 presents a summary of quantities of physical testing performed on lake sediments collected during February 1997.

Table 2

Physical Testing Summary

Type of Test	North Lobe No. of Tests	South Lobe No. of Tests	Composite No. of Tests	Total Tests
Moisture/ - 200	15	8	2	25
Total Organic Content	15	8	2	25
Atterberg Limits	2	0	2	4
Specific Gravity	1	1	2	4
30-Day Settling	1	1	2	4
Grain Size Distribution	1	1	1	3

Solids Content

The solids content is the ratio of dry solids to total sample weight. The solids content of the lake sediments as a whole ranged from 5.5 to 79.7 percent. Individually, the solids content of the sediments described as loose, high-density sands (including the composite sample) ranged from 56.1 to 79.7. This data represents a high density, granular sediment containing relatively low amounts of water. The solids content of those sediments described as loose, organic silts ranged from 5.5 to 28 percent. This data describes a low-density sediment containing high amounts of water.

Physical Property	High Density Sands	Low Density Silts
Solids Content (%)	76.3	15.0

Percent Passing the #200 Sieve

The percentage of material passing the #200 mesh sieve is used to aid in classifying a soil or sediment sample. The material retained on the sieve is classified as sand/shell (coarser grained) and the material that passes the sieve is classified as clay/silt (fine-grained). The percent material passing the #200 sieve in sediments classified as high density sands ranged from 0.6 to 14.8, whereas the percent material passing the #200 sieve in the low-density silts ranged from 30.5 to 91.1.

Physical Property	High Density Sands	Low Density Silts
-200 Sieve (%)	7.3	80.5

A stack sieve analysis was completed for three sandy samples from each of the two lobes and the central channel to determine the grain size distribution. The distributions were fairly consistent with each sample having approximately 90% of material between the #40 (0.425mm) and #200 (0.075mm) sieve. This material retained above the #200 sieve is classified as a poorly

graded fine sand. The remaining 10% passed the No.200 mesh sieve and is classified as fine-grained silt. The sand is typically considered "select" for use as a fill material.

Atterberg Limits

An Atterberg limits test determines the plasticity of a soil or sediment. The moisture content over which a soil or sediment exhibits plastic behavior is termed the plasticity index (PI). The Atterberg limits test defines the following three parameters:

- Liquid Limit (LL): The water content above which a soil behaves as a liquid and below which it behaves as a plastic material.
- Plastic Limit (PL): The water content above which a soil behaves as a plastic material and below which it behaves as a semi-solid.
- Plasticity Index (PI): The numerical value of the liquid limit minus the plastic limit (PI = LL – PL).

Atterberg limits tests were completed on three samples of sediment obtained from the lake. An Atterberg was not completed on the sand sample. Generally, the higher the PI the more poorly a sediment will consolidate, i.e., dewater. Sample P31 (11-12 ft) has a very high percent passing the #200 sieve of 94% and a PI of 212. The other samples, P46 (6-7 ft) and Bulk Muck have a lower percent passing the #200 sieve, 30.5 and 51.8, respectively, and lower PIs of 62 and 99. On average, the PI will increase with increasing percent of fine-grained material. Based upon these results and the low average solids content of 15 percent, the fine-grained and organic Lake Seminole sediments should behave as a liquid and dewater very poorly by self-weight consolidation.

Physical Property	P31	Bulk Muck and P46 Avg
Atterberg Limits		
Plasticity Index	212	80
Liquid Limit	325	140
Plastic Limit	113	60

Specific Gravity

A specific gravity test determines the dry density of a material. Typical mineral sediments containing predominantly sands, silts and clays will have a specific gravity in the 2.6 to 2.7 range (162 to 168 pounds per cubic foot). Highly organic sediments typically have specific gravities ranging from 1.8 to 2.2 or greater, depending on their organic content. Specific gravity determinations for Lake Seminole organic silts averaged 2.3 and determinations for the sands averaged 2.6.

Physical Property	Sands	Organic Silts
Specific Gravity	2.6	2.3

Organic Content

The organic content is the amount of organic matter contained in a soil or sediment, generally determined by subjecting a dry soil/sediment sample to a temperature of 550°C for several hours. The loss in weight is considered to be the organic content. The organic content of the sands ranged from 0.7 to 2.2 percent with an average of 1.2. The organic content of the silts ranged from 15.7 to 46.1 percent with an average of approximately 28 percent.

Physical Property	High Density Sands	Low Density Silts
Organic Content (%)	1.2	28.2

Comparison With Lake Maggiore Low Density Sediments

Table 3 summarizes and compares the Lake Seminole physical characterization data with Lake Maggiore low-density sediment data (BCI, 1995). The comparison shows a remarkable similarity of the low-density sediments from the two lakes. Much of the Lake Seminole low-density sediment occurs in the north lobe and the channel between the north and south lobes of the lake. Our findings are fairly consistent with earlier work (SWFWMD, 1991), except for identification of additional isolated pockets of low-density material in the south lobe of the lake.

Table 3
Summary of Physical Data - Lake Seminole Sediments

Physical Property	Lake Seminole	Lake Maggiore
Solids Content (%)	15	14
-200 Sieve (%)	78.3	65
Organic Content (%)	27.5	39
Specific Gravity	2.3	2.3*
Atterberg Limits		
Plasticity Index	124	113
Liquid Limit	189	311
Plastic Limit	71	198

*Average for all sediments in Lake Maggiore

Settling Tests

Settling tests allow determination of how quickly sediment will fall out or settle from dilute slurries at very low solids contents. Four settling tests were performed on Lake Seminole sediments at initial solids contents of approximately two to eight percent, values indicative of dredged slurry material. The settling test data are presented in Appendix A. Table 4 shows an incremental breakdown of each settling test. Table 5 shows the physical characteristics of the sediment samples used in the settling tests.

The sediment samples for the settling test were selected to cover the range of characteristics of the sediments from the low-density silts to the high-density sand samples. The silt sample (P31 – 9 to 10 feet) was tested at a low solids content of approximately two percent. Settlement of the sediment was extremely slow resulting in a final solids content of approximately seven percent. The majority of the sediment settled out in one to two days. No further consolidation took place within the next 28-day period, i.e., the material did not consolidate (dewater) much beyond seven percent. This is consistent with the fact that this material:

- is extremely fine-grained
- has a low in-situ solids content
- has high organic content
- exhibits low specific gravity
- is extremely plastic

Settling tests were also performed on the high density sand samples (P38 – 7 to 8 feet) and bulk sand at low solids contents of approximately seven percent. These test samples settled very rapidly, reaching solids content of 25 to 35 percent within one day. The samples continued to consolidate (dewater) throughout the entire duration of the test attaining a final 30-day solids content near 40 percent. This behavior is consistent with the fact that this material is non-plastic and contains a small percentage of organic material.

Table 4
Settling Test Summary

Sample No. and Depth	Initial Solids Content (%)	1 Day	5 Day	10 Day	15 Day	30 Day
P31 – 9 to 10'	2.1	7.0	7.2	7.3	7.3	7.4
P38 – 7 to 8'	2.2	25.0	28.8	28.8	31.1	31.1
Bulk Sand	7.3	36.5	40.3	41.5	42.1	44.2
Bulk Muck	6.5	14	16.8	17.5	17.7	18.6

Table 5
Physical Characteristics of Settling Test Sediment Samples

Sample No.	In-Situ Solids	% <#200	% Organic
P31 - 9-10'	15.5	80.3	24
P38 – 7-8'	76.8	8.3	1.7
Bulk Sand	76.5	7.3	0.9
Bulk Muck	19.4	51.8	15.7

The fourth settling test was performed on a composite mix (Bulk Muck). The physical properties of the composite sample fell between the silt and sand properties and would represent mixing of the sediments during the dredging process. The sample was tested at an initial solids content of approximately seven percent. The sample settled to a solids content of 15 percent after one day and continued to consolidate to approximately 18 percent after 30 days. The composite or average properties of this sample yielded test results between the silt and sand results.

Visual observations of material in the 30-day settling test showed a distinct sand layer at the bottom within the first minute for the high density sand samples and some separation also in the bulk muck sample. At the end of the test it was quite evident that the sediment segregated

into two distinct layers: a dark brown layer of fine material over a light tan layer of sand. This type of separation, however, was not evident for the low-density silt sample.

Flocculation Testing

Due to the poor submerged/natural dewatering characteristics of the low density organic silts in Lake Seminole, an initial testing of an advanced dewatering process was completed. Tests were completed by Dr. Hassan El-Shall of Global Consulting Co. and a copy of his report is contained in Appendix B.

Test results indicate that the low density organic silt sediments, at five percent solids, readily flocculates with a relatively low dosage of several flocculants. Generally, the best result was achieved using durable flocculants, which achieved formation or large strong flocs and clear return water after screening.

The solids content increased to seven percent after treatment with the flocs and dewatering. Further testing is recommended to determine ways to increase the dewatering to minimize the requirement of a large disposal area. One possible approach may be to separate the sand and the silt/organic fraction using hydrocycloning. The hydrocycloning technique will be utilized in the Lake Maggiore sediment removal project.

3.0 SEDIMENT VOLUME ESTIMATES

Based on the lake survey and laboratory physical characterization data generated, Lake Seminole is estimated to contain a total of 4.9 million c.y. of sediments. Figure 2 shows the lake bathymetry (water/sediment surface interface), whereas Figure 3 shows the lake "hard" bottom contour. The difference between the top of the sediments and the lake "hard" bottom is shown in Figure 4 as sediment thickness.

Of the 4.9 million c.y., approximately 800,000 c.y. is considered to be low density, organic silt material that may need to be removed to improve water quality within the lake. Figure 5 shows the bottom contour of the low density/organic (muck) sediments. The difference between the lake bathymetry (Figure 2) and the muck bottom is shown in Figure 6 as the muck depth.

This survey (Figure 6) indicates sediments that may be considered for removal to occur in the lake periphery as was indicated in the earlier survey (SWFWMD, 1991). However, considerable low density sediments exist in isolated areas in the center of the north lobe, the cannel between the north and south lobes, and isolated pockets in the south lobe. Approximately 130,000 c.y. of highly organic, decayed cattails and other aquatic vegetation are located along the shorelines of Lake Seminole. The majority of this material is along the east shore of the lake, with several isolated pockets along the west shore.

Table 6
Total and Low Density, Organic Silt Sediment Distribution

Region	Total Volume (c.y.)	Low Density, Organic Silt Volume (c.y.)
North Lobe	1,679,000	411,000
Channel	192,000	55,000
South Lobe	2,969,000	334,000
Region Perimeter	130,000	130,000*
Total	4,970,000	800,000

*Not included in total. Based on Lake Seminole Habitat Classifications (Figure 1), Coastal Environmental, Inc., Map Publication No. 59796503 and Pinellas County Engineering Department Gross Drawdown Sediment Removal Estimates.

4.0 CHEMICAL CHARACTERIZATION

BCI contracted Brevard Teaching and Research Laboratories (BTRL) in Palm Bay, Florida to conduct chemical analyses of low density, organic silt sediments and water collected from Lake Seminole. Sediment samples were collected as composites from locations SP-16 (south lobe) at a depth of four feet and SP-31 (canal) to a depth of one foot from the surface of the sediments. Prior to sediment sampling, a water sample was collected from beneath the water surface (0 to 1 foot) close to location SP-16 (150 feet south of SP-16). All samples were labeled and placed in iced coolers for transport to the laboratory. Analytical methodology for all sediment and water analyses followed USEPA or other protocols as described in BTRL's CompQAP #930169. Laboratory results from BTRL are included in Appendix D.

4.1 Low Density, Organic Silt Sediment Analysis

Low density sediment homogenates were analyzed for bulk elemental composition and also potential for toxicity hazard as defined by the Toxicity Characteristic Leaching Procedure (TCLP). Table 7 summarizes the results of metal and TCLP sediment analyses. Metal concentrations detected in the TCLP leachates were uniformly lower than regulatory limits. Only arsenic, barium, cadmium, chromium, lead, mercury, sodium, and silver are considered as TCLP metals. With the exception of barium and sodium in Table 7, all other metals are considered to be priority metal pollutants. The low density sediment samples from the lobes and channel do not qualify as a hazardous material based on expected toxicity of leachate produced. All metals except mercury were detected at some level in the bulk sediment samples. There are no regulatory standards for bulk sediment quality, therefore the results can only be interpreted comparatively. Chromium, copper, lead, and zinc were the most abundant of the analytes, appearing in all samples from approximately five to about 60 mg/kg dry weight. Comparing the concentration of these metals to those of Lake Maggiore sediments shows that only lead appears to be much higher in the Lake Seminole sediments. Table 7 also shows the ceiling concentration for sewage sludge disposal on land by the USEPA (1993). A comparison of the sediment concentration to these

limits show sediment concentrations are well below the EPA limits and should not pose a problem for land disposal/application.

Table 7
Lake Seminole Low Density Organic Silt Sediment Chemical Analysis

Parameter	SP-16 (South Lobe)		SP-31 (Canal)			
Metals	TCLP (Leachate) (ug/L)	Sediment (mg/kg dry)	TCLP (Leachate) (ug/L)	Sediment (mg/kg dry)	TCLP Limits (ug/L)	EPA Ceiling Concentration (mg/kg)
Antimony	1.01	0.03	BDL	0.10	NSE	NSE
Arsenic*	28.9	1.60	18.5	1.97	5,000	75
Barium*	773	NT	295	NT	100,000	NSE
Beryllium	BDL	0.23	BDL	0.19	NSE	NSE
Cadmium*	BDL	0.24	BDL	0.31	1,000	85
Chromium*	57.1	7.86	12.0	11.7	5,000	3,000
Copper	35.3	4.45	42.3	19.5	NSE	4,300
Lead*	123	30.3	13.3	59.7	5,000	840
Mercury*	BDL	BDL	BDL	BDL	200	57
Nickel	43.0	2.28	2.72	2.72	NSE	420
Selenium*	2.89	0.54	1.14	0.69	1,000	100
Silver*	BDL	0.01	BDL	0.18	5,000	NSE
Sodium	14,900	285	14,200	521	NSE	NSE
Thallium	BDL	0.05	BDL	BDL	NSE	NSE
Zinc	1,000	20.9	150	41.3	NSE	7,500

BDL-Below Detection Limit
*TCLP Metals – Remaining metals were analyzed as TCLP, but are not considered in the TCLP metal list.
NSE – No Standard Established

Sodium concentration in the sediment ranged from about 250 to 520 mg/kg dry weight, whereas chloride ranged from 50 to 130 mg/kg dry weight. These concentrations, again, are much lower than Lake Maggiore as expected; Lake Seminole being a freshwater system whereas Lake Maggiore has salt water intrusion. Comparing Lake Maggiore sediment nutrients with

those from Lake Seminole (Table 8) shows total phosphorus and total kjeldahl nitrogen (TKN) to be significantly lower in Lake Seminole, but the soluble phosphorus (orthophosphorus) is slightly higher. The average soluble phosphorus was 8.7 mg/kg with a maximum concentration of 23 mg/kg in Lake Maggiore.

Table 8
Comparison between Lake Seminole and Lake Maggiore Low Density, Organic Silt Sediment Nutrient Concentrations

Nutrients	Sediment (mg/kg dry)	Sediment (mg/kg dry)	Lake Maggiore Average (mg/kg)
Ortho-P	40.6	17.9	8.7
Total-P	54.9	25.8	13.93
TKN	323	593	3823
Nutrients	**Sediment (mg/kg dry)**	**Sediment (mg/kg dry)**	
Nitrate + Nitrite	403	87.8	NT
Chloride	129	55.1	2158

NT = Not Tested

4.2 Site Water Analysis

Most metal analytes were detected in the lake water samples collected south of location SP-16. Table 9 summarizes the results of metal and nutrient concentrations in the lake water sample. In particular, arsenic, chromium, copper, lead, nickel, selenium, and zinc were well represented. The concentrations of lead and silver exceeded the Florida Class III freshwater quality standards.

Table 10 shows a comparison between the nutrients in the water of Lake Seminole and Lake Maggiore. Total kjeldahl nitrogen and total phosphorus concentrations were 3.47 and 0.346

mg/L, respectively. These values were very similar to those for Lake Maggiore. However, the soluble phosphorus is two-fold higher (0.151 mg/L) than in Lake Maggiore. Sodium and chloride were present at approximately 100 mg/L in the site water. This value converted to parts per thousand, the standard measure of salinity, indicates 0.1 ppt, freshwater as expected for this lake.

Table 9

Lake Seminole Water Metal Analysis

Metal	Concentration (ug/L)	Class III Fresh WQS (ug/L)
Antimony	BDL	4300
Arsenic	3.49	50
Beryllium	BDL	0.13
Cadmium	BDL	9.3
Chromium	2.03	11
Copper	2.05	2.9
Lead	6.28	5.6
Mercury	BDL	0.012
Nickel	2.19	8.3
Selenium	2.37	5
Silver	1.49	0.07
Sodium	93,300	40.0
Thallium	BDL	48
Zinc	5.67	86

BDL – Below Detection Limit

Table 10

Comparison between Lake Seminole and Lake Maggiore

Water Nutrient Concentrations

Nutrient	Concentration (mg/L)	Lake Maggiore Average (mg/L)
Ortho-P	0.151	0.060
Total-P	0.346	0.473
TKN	3.47	3.43
Nitrate + Nitrite	0.429	NT
Chloride	108	NT

NT – Not Tested

4.3 Elutriate Water Analysis

The sediment elutriate test procedure is a methodology developed by the U.S. Army Corps of Engineers to simulate the potential water quality impacts associated with dredging submerged sediments. In essence, the elutriate procedure is designed to approximate the concentration of sediment constituents that are released into the water column in a soluble form as a result of sediment agitation and resuspension. The elutriate analytical results are typically compared to the Class III freshwater regulatory standards.

Concentrations of several metals were not detected in the elutriate samples. Table 11 summarizes the results for the metal concentrations in the elutriate water. Of the metals detected, arsenic, copper, and silver concentrations exceeded Florida Class III standards. Silver, however, is significantly higher and will require further evaluation. As expected, the concentrations of most metals increased in the water; however, a decrease in lead concentration to below Class III freshwater quality standard was observed.

Water quality standards do not exist for nutrients as indicated previously. Salinity as sodium and chloride demonstrated no increase between the site water and the elutriate samples. It is expected that increased salinity should not be a result of dredging activities.

Soluble parameters (Table 12) demonstrated concentrations of about 0.06 mg/L for nitrite and nitrate and a range of 0.40 to 1.5 mg/L for orthophosphorus. Total kjeldahl nitrogen in the elutriate samples ranged from 8 to 14 mg/L, whereas total phosphorus ranged from 0.4 to 1.9 mg/L. The elutriate water nutrient concentrations are similar for both lakes, particularly for the phosphorus fractions, but TKN is lower for Lake Seminole.

The Florida Criteria for Water Quality Classifications for Class III waters indicates that "In no case shall nutrient concentrations of a body of water be altered so as to cause an imbalance in natural populations of aquatic flora or fauna." Data generated demonstrate that elutriate samples are enriched by a factor of two to ten for both total phosphorus and nitrogen as well as dissolved phosphorus. Dissolved nitrogen was not significantly enriched in the elutriate samples; however, the enrichment of the other analytes could potentially lead to algal blooms and other phenomena typically related to nutrient surplus.

Results of this preliminary analysis indicate physical characteristics of Lake Seminole low density (muck) sediments are similar to comparable sediments of Lake Maggiore. Furthermore, the chemical analysis indicate that most metals are within Florida Class III freshwater standards even after being subjected to the elutriate procedure. However, silver concentration was not detected in one sample, but significantly higher in another and warrants further evaluation.

Although no standards exist for sediment disposal on land, a comparison with Environmental Protection Agency limits for sewage sludge disposal on land shows the sediments are well below the limits and should not pose any land disposal concerns. With regard to nutrients, the results of the elutriate tests indicate that short term eutrophication may be a concern during dredging. It should, however, be noted that the sediment analyses indicate a substantial reservoir of nutrients bound to the sediments, and that the purpose of the Lake Seminole restoration project is to remove the internal nutrient source.

Table 11
Lake Seminole Elutriate Water Metal Analysis

Metal	P-16 (ug/L)	P-31 (ug/L)	Class III Fresh WQS (ug/L)
Antimony	2.49	1.58	4300
Arsenic	55.0	19.3	50
Beryllium	BDL	BDL	0.13
Cadmium	BDL	BDL	9.3
Chromium	3.55	BDL	11
Copper	5.84	3.75	2.9
Lead	2.39	BDL	5.6
Mercury	BDL	BDL	0.012
Nickel	3.34	2.52	8.3
Selenium	4.36	2.25	5
Silver	BDL	2.43	0.07
Sodium	91,900	82,700	NSE
Thallium	BDL	BDL	48
Zinc	3.12	BDL	86

BDL - Below Detection Limits

NSE - No Standard Established

Table 12
Comparison of Lake Seminole and Lake Maggiore
Elutriate Water Nutrient Concentrations

Nutrients	P-16 (mg/L)	P-31 (mg/L)	Lake Maggiore Average (mg/L)
Ortho-P	1.474	0.367	.945
Total-P	1.871	0.467	.987
TKN	14.26	8.668	21.38
Nitrite + Nitrate	0.058	0.044	
Chloride	92.4	128	

5.0 SEDIMENT REMOVAL ALTERNATIVES

There are three major components of a sediment removal project: Removal, Treatment, and Disposal. The following is a description of the project components.

Removal

As its name denotes, removal deals with how sediment is physically removed from a system. Selection of the type of removal method used for a project is dependent upon the projects' physical setting, disposal requirements, physical and chemical nature of the sediment, transportation and quantity of the sediment, schedule requirements and budget considerations.

Treatment

Treatment of sediment primarily focuses on how to handle it from the time of removal until disposal. The treatment can range from doing nothing (pumping only) to processing the sediment through a dewatering plant. The required degree of treatment is a function of the sediment dewatering characteristics, availability of a disposal area, time and money constraints, and impacts to the surrounding environment.

Disposal

Disposal deals with where the sediment is placed after removal and treatment. The disposal aspects of a project are driven by the sediment quantity, physical and chemical characteristics. The ability to locate and provide sufficient disposal areas for a project is a primary controlling factor in designing a sediment removal project.

The remainder of this section discusses three sediment removal concepts that may be feasible for implementation on Lake Seminole sediments.

1. "Mechanical removal" (with and without a drawdown of Lake Seminole)
2. Conventional "Dredge and Dispose" (with or without discharge)
3. "Hydraulic dredging" utilizing dredged material dewatering methods

Mechanical Removal – Option 1

The sediments to be removed from Lake Seminole currently have an average in situ solids content of about 15 percent (by weight). Sediments with low solids contents typically behave more as a semi-fluid rather than a solid material. This presents several potential difficulties for a mechanical or earthmoving equipment removal option. First, a lake drawdown would be implemented and maintained long enough for the sediments to dry out and achieve a consistency, which would allow heavy equipment to operate on the lake bottom.

As a drawdown is maintained during the removal activities, the exposed sediments will be subject to erosion from stormwater runoff which will likely cause highly turbid water. Disposal/treatment of turbid water may be difficult due to environmental and permit constraints.

Another consideration concerning the mechanical removal of Lake Seminole sediments is the added traffic inherent with trucking of dredged materials, provided the sediments can be dried long enough to achieve a "truckable" solids content. If the sediments are trucked wet, leakage and/or spillage on public roads is a potential problem.

Another alternative to earthmoving excavation would involve barge-mounted equipment using a backhoe and/or dragline. The excavator would place the sediments on or in a flat barge that would subsequently be transferred to the shoreline. The muck sediments would then be removed by a loader or similar piece of equipment to trucks, which would haul the material to a disposal site. Because the trucked material would be saturated and very soft, leakage or spillage from the trucks may occur unless specially lined trucks are used. Though feasible, this alternative will not be considered further due to the intensive material handling, minimal work area for material handling along the shoreline of the lake, the potential for leaks or spills from the trucks, potential for high in-lake turbidity around the dredge equipment, and the shallow depth of parts of the lake that could limit equipment access.

Hydraulic Dredge, Dispose and Discharge – Option 2

During a typical dredging operation the sediment is diluted (bulked) to a solids content ranging between two and eight percent. In order to have sufficient storage volume in a dredge disposal area, a volume of about two to three times the in-situ volume will probably be needed to handle the sediment and turbid decant water. This would result in an increase in dredge volume from 800,000 c.y. to between 1,600,000 and 2,400,000 c.y. for Lake Seminole sediments.

Based on recent experience with cutterhead hydraulic dredging and disposal of muck (organic rich) sediments from the Leslie Heifner Canal in eastern Citrus County, the majority of the dredged slurried material being deposited in the disposal area will settle within a few days. However, fine-grained particles of silt, clay and organic fibers will probably stay in suspension for several days. This suspended material usually causes turbidity readings well in excess of 29 NTUs (nepholometric turbidity units) above the background of the receiving waters, which will make discharge of the decant waters difficult without a turbidity treatment system.

Because the fine grained dredged materials tend to "line" or seal the disposal area, significant infiltration of the decant water does not occur during the duration of the removal project, thus excess water will need to be managed.

An alternative to the rotating cutterhead type hydraulic dredges is mud cat or "Versi dredge" equipment. Provided the horizontal cutter/auger head is covered with two or three feet of sediment, this type of dredge can excavate and pump the dredged material at a solids content close to the in situ solids content. This feature helps reduce the amount of storage volume needed in the disposal area and the quantity of turbid water. These dredges, however, are generally smaller in size, have a low production rate/day, have smaller pumps and may need booster pumps to move material more than a few thousand feet.

Hydraulic Dredging and Advanced Dewatering – Option 3

The alternative to conventional hydraulic dredging (Option 2) is to combine it with sediment dewatering processes. In the early 1990s the Florida Institute of Phosphate Research (FIPR) patented a rapid dewatering process for fine-grained materials. Dr. Hassan El-Shall, an expert in separation of fine-grained solids, developed FIPR's process for dewatering phosphatic clays which is called the FIPR-DIPR process. Utilizing recycled paper pulp with polymer flocculants, followed by screening, fine-grained materials can be thickened instantaneously to solids contents ranging from 10 to 20 percent. Working closely with Dr. El-Shall and FIPR, BCI has pioneered the use of the FIPR-DIPR process by applying it to lake restoration and dredged organic sediments. This technology has been modified for use with organic rich lake bottom sediments.

Based upon our preliminary settling tests, it appears that addition of polymer flocculant accelerates the settling rate of the sediments which in turn generates a clearer decant water. However, the use of polymers will require the use of some specialized mixing equipment. Further, there are some special handling requirements of the chemicals to prevent spills or high dosages that might impact the environment. Site specific toxicity testing will have to be done, if polymer addition is deemed the preferred sediment handling method for the Lake Seminole materials.

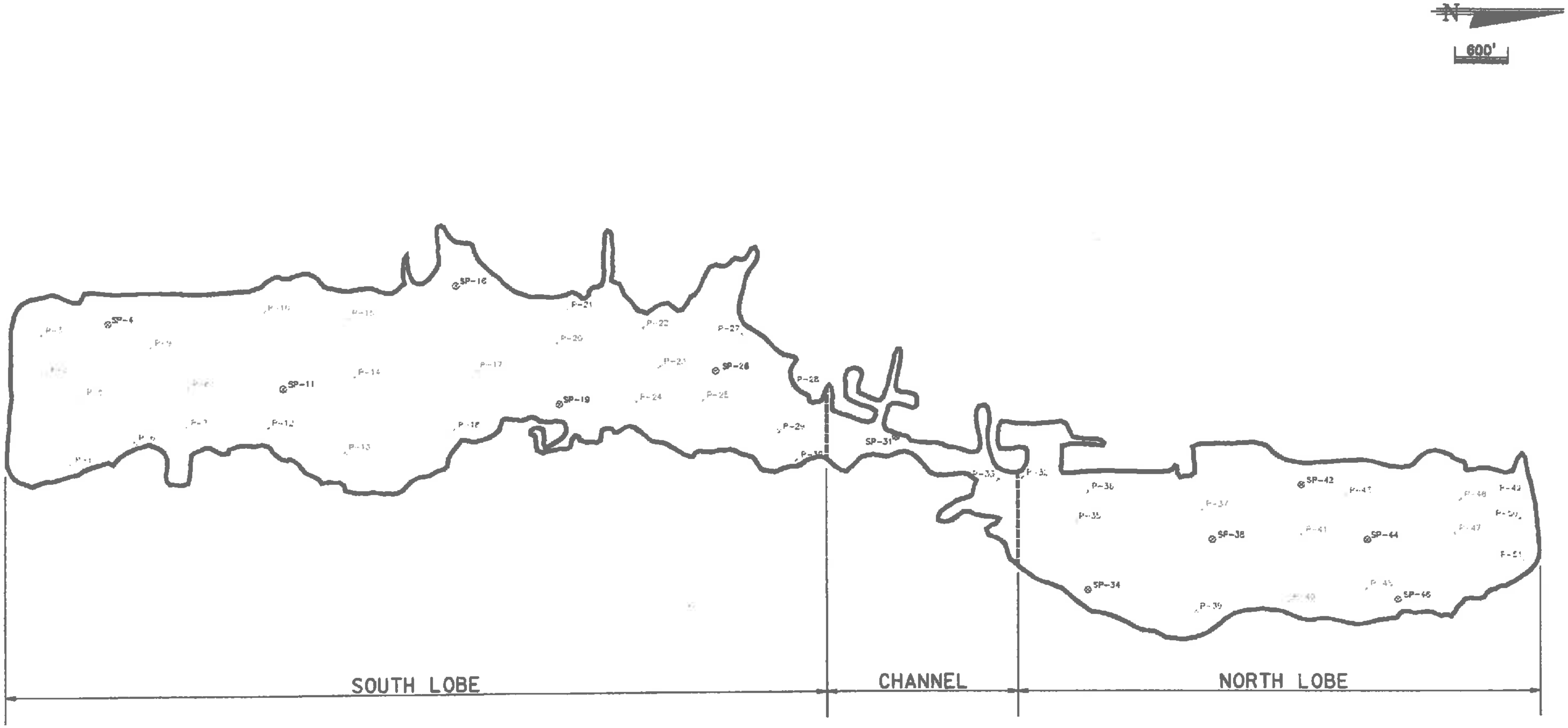
6.0 REFERENCES

BCI, 1995. Lake Maggiore Restoration Dredge Feasibility Study. Prepared for City of St. Petersburg.

Southwest Florida Water Management District, 1991. Lake Seminole Diagnostic Feasibility Study. University of Florida. Prepared for Southwest Florida Water Management District/Pinellas-Anclote River Basin Board.

DATE PLOTTED: 6/5/97

BCI PROJ. NO.	SHEET NO.
959214	



SP-46 SAMPLING LOCATIONS

P-46 PROBE LOCATIONS

FIGURE 1

REVISIONS								
DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION

BCI ENGINEERS & SCIENTISTS, INC.
2000 E. EDGEWOOD DRIVE, LAKELAND, FL 33803
PHONE: (941) 937-2340

	NAME	DATE		NAME	DATE
DESIGNED BY	NAME	3/97	DRAWN BY	NAME	3/97
CHECKED BY	NAME	3/97	CHECKED BY	NAME	5/97
SUPERVISED BY:					

LAKE SEMINOLE

APPROVED BY: DATE:

BCI NO.: 0481

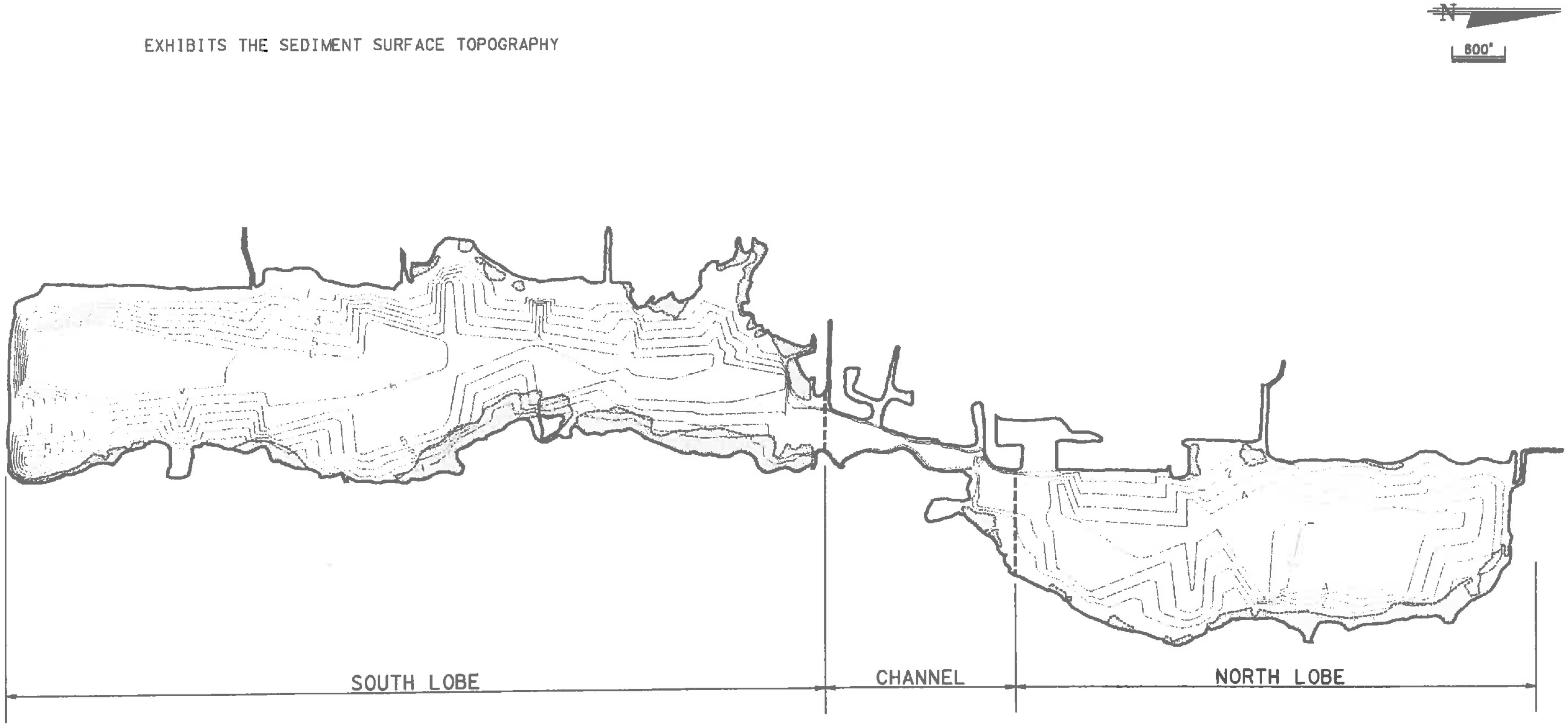
PROBE LOCATIONS

N:\9214\9214PROB.DWG (PLAN-600)

DATE PLOTTED: 9/17/97

BCI PROJ. NO.	SHEET NO.
959214	

EXHIBITS THE SEDIMENT SURFACE TOPOGRAPHY



WETLAND - CATTAIL

NOTE: WATER ELEVATION = 0.0

FIGURE 2

REVISIONS								
DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION

BCI ENGINEERS & SCIENTISTS, INC.
2000 E. EDGEWOOD DRIVE, LAKELAND, FL 33803
PHONE: (941) 667-2345

	NAME	DATE		NAME	DATE
DESIGNED BY	NAME	3/97	DRAWN BY	NAME	3/97
CHECKED BY	NAME	3/97	CHECKED BY	NAME	5/97
SUPERVISED BY:					

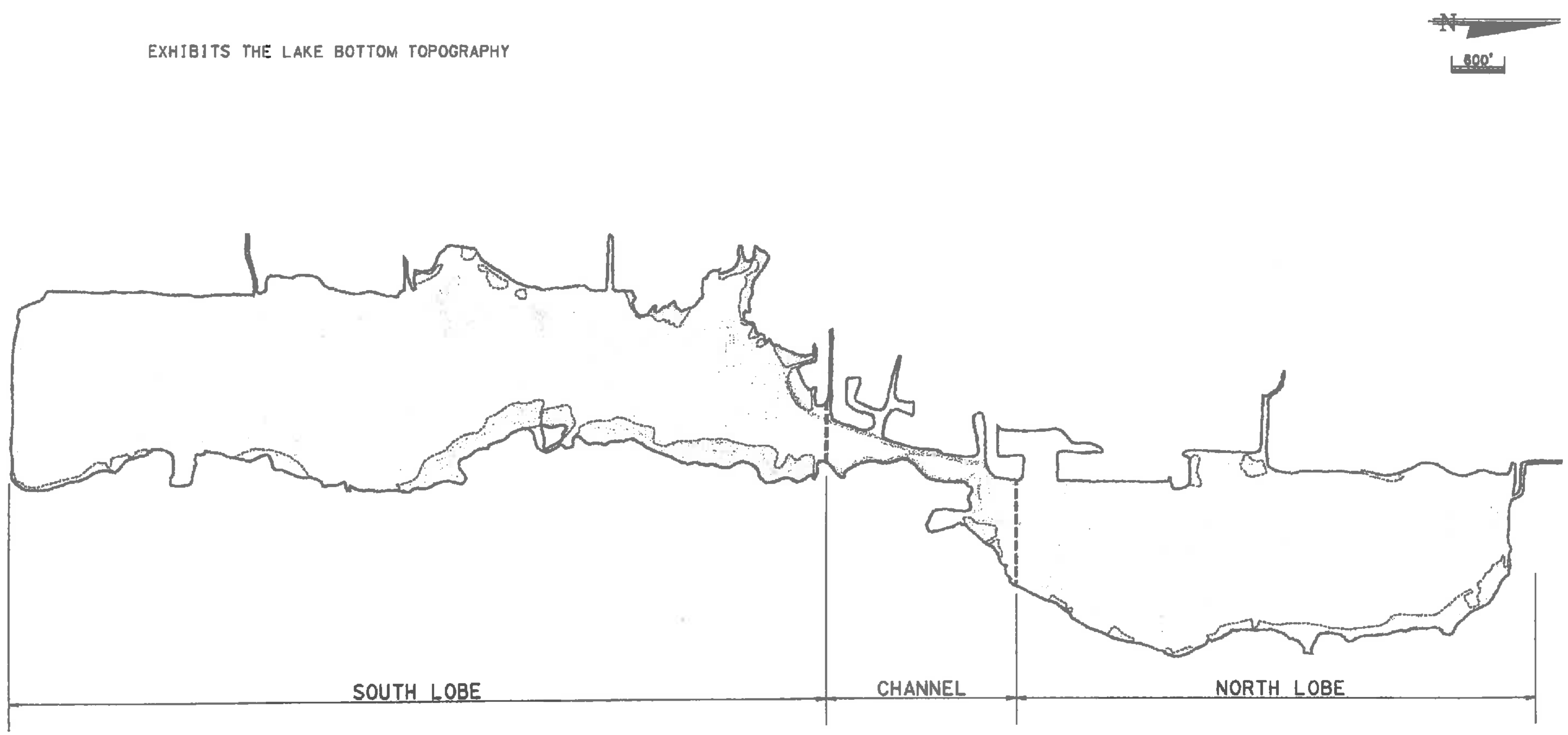
LAKE SEMINOLE

APPROVED BY: DATE:

BCI NO.: 0478

TOP OF SEDIMENT CONTOURS

N: \9214\9214SITA.DWG (TOS-600)



BCI PROJ. NO. 959214 | SHEET NO.

DATE PLOTTED: 9/17/97

FIGURE 3

DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION

REVISIONS

BCI ENGINEERS & SCIENTISTS, INC.

	NAME	DATE		NAME	DATE
DESIGNED BY	NAME	3/97	DRAWN BY	NAME	3/97
CHECKED BY	NAME	3/97	CHECKED BY	NAME	5/97
SUPERVISED BY:					

LAKE SEMINOLE

APPROVED BY: DATE:

BCI NO.: 0479

BOTTOM OF SEDIMENT CONTOURS

N:9214\9214SITA.DWG (80S-600)

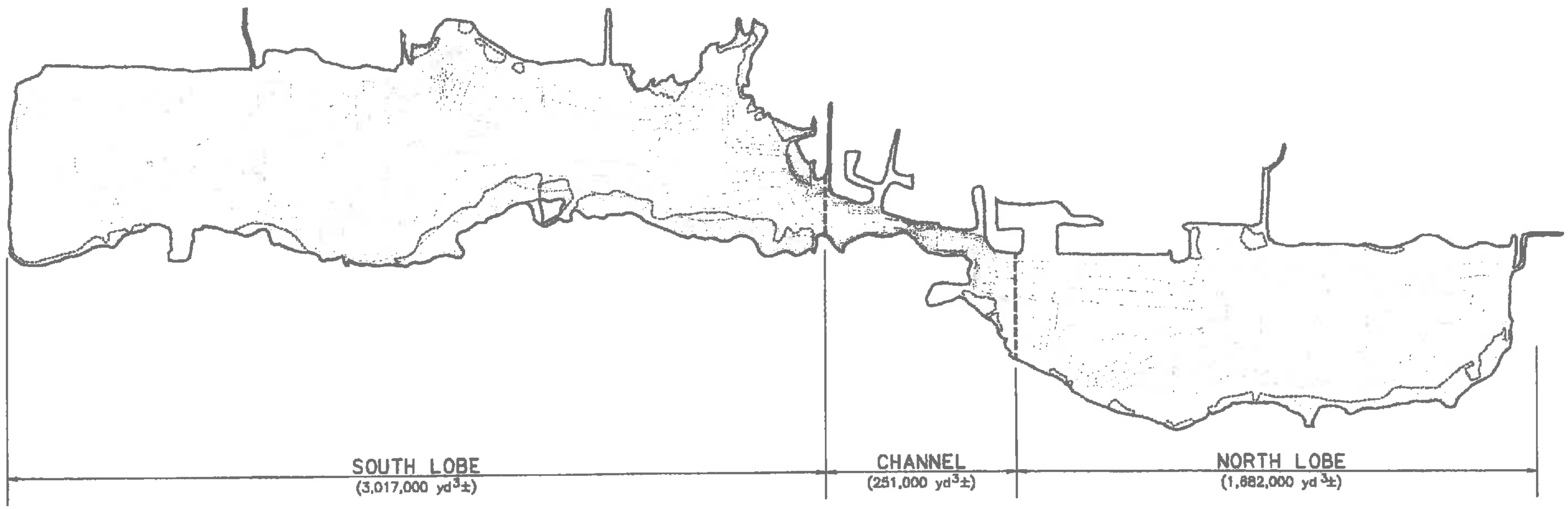
DATE PLOTTED: 9/18/97

BCI PROJ. NO.	SHEET NO.
959214	

N

600'

EXHIBITS DIFFERENCE BETWEEN SEDIMENT SURFACE
AND LAKE HARD BOTTOM TOPOGRPAHY



WETLAND - CATTAIL

NOTE: WATER ELEVATION - 0.0

TOTAL SEDIMENT VOLUME = 4,950,000 yd^3±

FIGURE 4

N:\9214\9214SITA.DWG (SED-600)

REVISIONS								
DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION

BCI ENGINEERS & SCIENTISTS, INC.
2000 E. EDGEWOOD DRIVE, LAKELAND, FL 33803
PHONE: (941) 667-2345

	NAME	DATE		NAME	DATE
DESIGNED BY	NAME	3/97	DRAWN BY	NAME	3/97
CHECKED BY	NAME	3/97	CHECKED BY	NAME	5/97
SUPERVISED BY:					

LAKE SEMINOLE

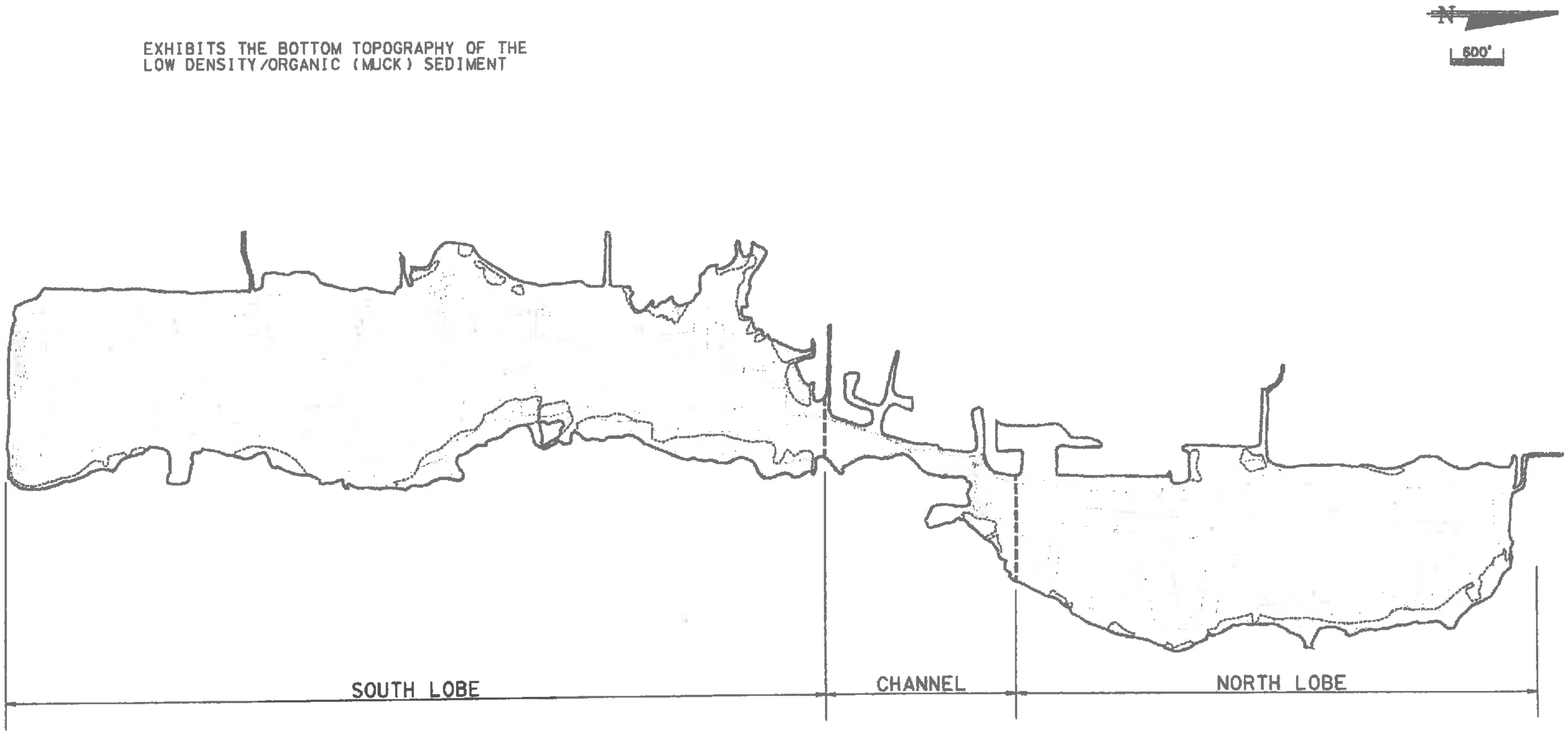
APPROVED BY: DATE:

BCI NO.: 0480

SEDIMENT THICKNESS CONTOURS

BCI PROJ. NO. 959214 | SHEET NO.

EXHIBITS THE BOTTOM TOPOGRAPHY OF THE
LOW DENSITY/ORGANIC (MUCK) SEDIMENT



WETLAND - CATTAIL

NOTE: WATER ELEVATION - 0.0

FIGURE 5

REVISIONS								
DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION

BCI ENGINEERS & SCIENTISTS, INC.
2080 E. EDGEWOOD DRIVE, LAKELAND, FL 33803
PHONE: (941) 667-2345

	NAME	DATE		NAME	DATE
DESIGNED BY	NAME	3/97	DRAWN BY	NAME	3/97
CHECKED BY	NAME	3/97	CHECKED BY	NAME	5/97
SUPERVISED BY:					

LAKE SEMINOLE
APPROVED BY: DATE:
BCI NO.: 0479

BOTTOM OF MUCK CONTOURS

DATE PLOTTED: 9/17/97

N:\9214\9214SITA.DWG (BOM-600)

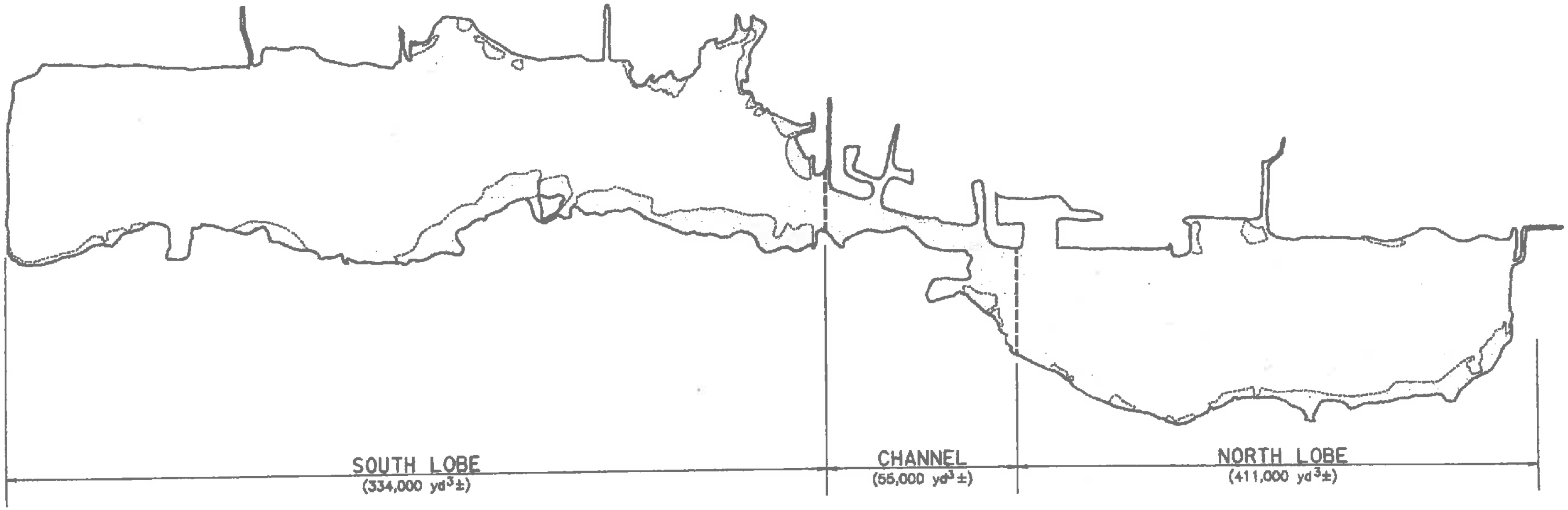
DATE PLOTTED: 9/17/97

BCI PROJ. NO.	SHEET NO.
959214	

EXHIBITS DIFFERENCE BETWEEN SEDIMENT SURFACE
AND MUCK BOTTOM TOPOGRAPHY

N

600'



WETLAND - CATTAIL

NOTE: WATER ELEVATION = 0.0

TOTAL MUCK VOLUME = 800,000 yd^3±

FIGURE 6

REVISIONS								
DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION

BCI ENGINEERS & SCIENTISTS, INC.
2000 E. EDGEWOOD DRIVE, LAKELAND, FL 33803
PHONE: (941) 667-2345

	NAME	DATE		NAME	DATE
DESIGNED BY	NAME	3/97	DRAWN BY	NAME	3/97
CHECKED BY	NAME	3/97	CHECKED BY	NAME	5/97
SUPERVISED BY:					

LAKE SEMINOLE
APPROVED BY: DATE:
BCI NO.: 0482

MUCK THICKNESS CONTOURS

N:\9214\9214SITA.DWG (MUCK-600)

Appendix A

Laboratory Data Sheets

Lake Seminole
Physical Characterization Data Summary
BCI Project No. 959214.1

SAMPLE I.D.	DEPTH (ft) from Surface	%SOLIDS	%FINER 200.0	%TOTAL ORGANICS	SPECIFIC GRAVITY	ATTERBERG		
						LL	PL	PI
BULK (sand)		76.5	7.3	0.9	2.66	16	NP	NP
BULK (muck)		19.4	51.8	15.7	2.33	153	54	99
P-4	8-9	79.1	10.8	1.4				
P-4	12-13	75.9	6.3	0.9				
P-11	7-8	80.3	4.0	0.6				
P-11	8-9	80.6	3.7	0.4				
P-16	5.5-6.5	6.5	85.4	33.6				
P-16	6.5-7.5	13.0	72.7	20.1				
P-16	7.5-8.5	18.1	87.9	17.6				
P-16	8.5-9.5	56.1	0.6	1.1				
P-16	9.5-10.5	75.5	7.2	0.8	2.62			
P-19	4-5	77.7	9.3	0.8				
P-19	5-6	77.4	8.9	0.7				
P-19	6-7	79.7	13.2	1.0				
P-26	5-6	73.6	2.1	0.8				
P-31	7-8	5.5	85.0	40.8				
P-31	8-9	10.0	86.9	31.6				
P-31	9-10	15.1	80.3	24.0				
P-31	10-11	13.6	82.0	23.6	2.28			
P-31	11-12	16.0	94.0	24.1		325	113	212
P-31	12-13	19.8	91.1	21.1				
P-34	4-5	10.6	88.5	34.4				
P-34	5-6	17.8	89.1	27.9				
P-34	6-7	18.0	90.2	27.9				
P-38	5-6	16.9	85.9	24.5				
P-38	6-7	78.0	14.8	2.2				
P-38	7-8	76.8	8.3	1.7				
P-38	8-9	79.1	9.0	1.0				
P-42	4-5	28.0	46.4	46.1				
P-42	5-6	77.7	10.8	3.7				
P-44	5-6	74.0	2.9	0.7				
P-44	6-7	78.1	7.2	1.8				
P-46	4-5	11.1	80.5	29.4				
P-46	5-6	20.6	92.8	31.5				
P-46	6-7	13.3	30.5	20.8		127	65	62
P-46	7-8	78.4	4.8	3.5				
	AVERAGE	45.8	43.1	14.4	2.5	202	77	124

NP - Non-Plastic

LABSUM

ATTERBERG LIMITS TEST

Sample No.: P31
Location: Lake Seminole
Depth: 11 to 12'
Boring No.:

Project No.: 959214.1
Date: 3/15/97
Tested By: DBP
Reviewed By MPK

Liquid Limit

No. of Blows	Wt. Cont. + Wet Soil (g)	Wt. Cont. + Dry Soil (g)	Wt. Cont. (g)	Water Content (%)
37	9.54	3.41	1.30	290.5
24	10.43	3.43	1.29	327.1
17	11.60	3.52	1.29	362.3

Plastic Limit

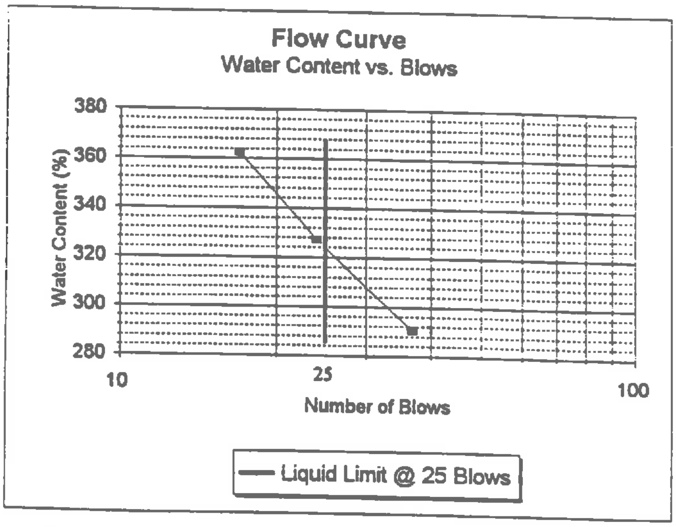
Wt. Cont. + Wet Soil (g)	Wt. Cont. + Dry Soil (g)	Wt. Cont. (g)	Water Content (%)
7.81	4.35	1.29	113.1
7.81	4.35	1.29	113.1

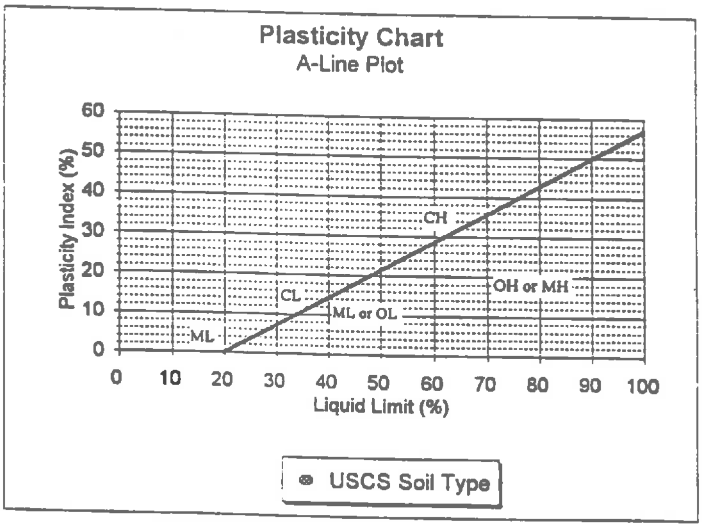
Results Summary

Liquid Limit 325

Plastic Limit 113

Plasticity Index 212





ATTERBERG LIMITS TEST

Sample No.: P46
Location: Lake Seminole
Depth: 6 to 7'
Boring No.:

Project No.: 959214.1
Date: 3/15/97
Tested By: DBP
Reviewed By MPK

Liquid Limit

No. of Blows	Wt. Cont. + Wet Soil (g)	Wt. Cont. + Dry Soil (g)	Wt. Cont. (g)	Water Content (%)
39	9.42	5.14	1.3	111.5
25	10.05	5.11	1.31	130.0
12	11.2	5.36	1.33	144.9

Plastic Limit

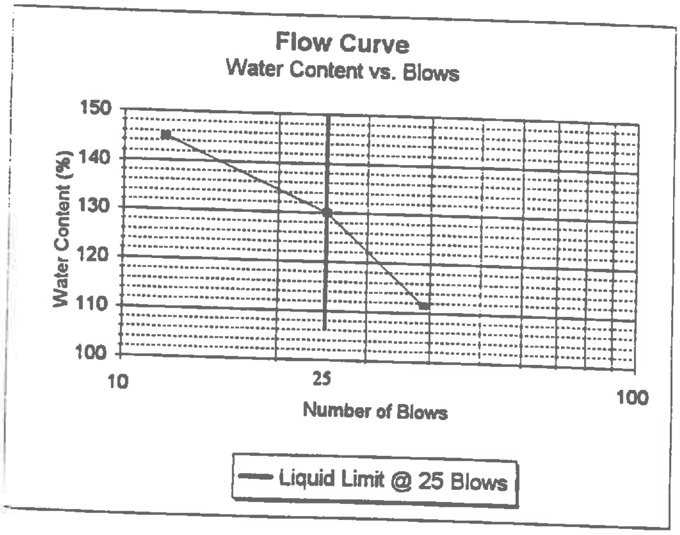
Wt. Cont. + Wet Soil (g)	Wt. Cont. + Dry Soil (g)	Wt. Cont. (g)	Water Content (%)
7.95	5.32	1.31	65.6
7.95	5.34	1.31	64.8

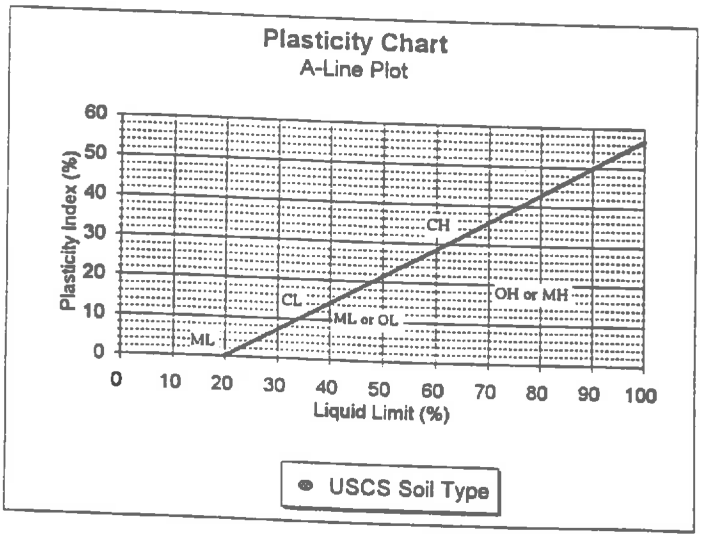
Results Summary

Liquid Limit 128

Plastic Limit 65

Plasticity Index 63





T:\ACTIVE\959214\ATTERB3.WB2

05/14/97

ATTERBERG LIMITS TEST

Sample No.: Bulk Muck
Location: Lake Seminole
Depth:
Boring No.:

Project No.: 959214.1
Date: 3/15/97
Tested By: DBP
Reviewed By MPK

Liquid Limit

No. of Blows	Wt. Cont. + Wet Soil (g)	Wt. Cont. + Dry Soil (g)	Wt. Cont. (g)	Water Content (%)
38	9.96	4.84	1.29	144.2
25	10.93	5.09	1.29	153.7
13	12.09	5.40	1.31	163.6

Pla[illegible] Limit

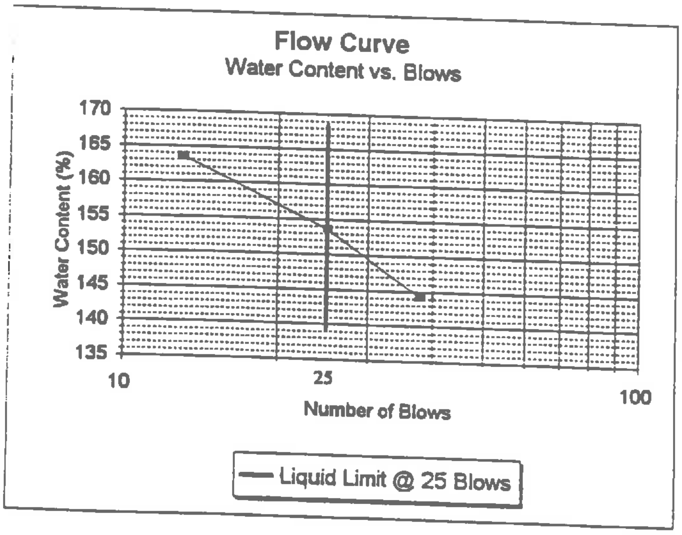
Wt. Cont. + Wet Soil (g)	Wt. Cont. + Dry Soil (g)	Wt. Cont. (g)	Water Content (%)
7.58	5.37	1.29	54.2
7.59	5.37	1.29	54.4

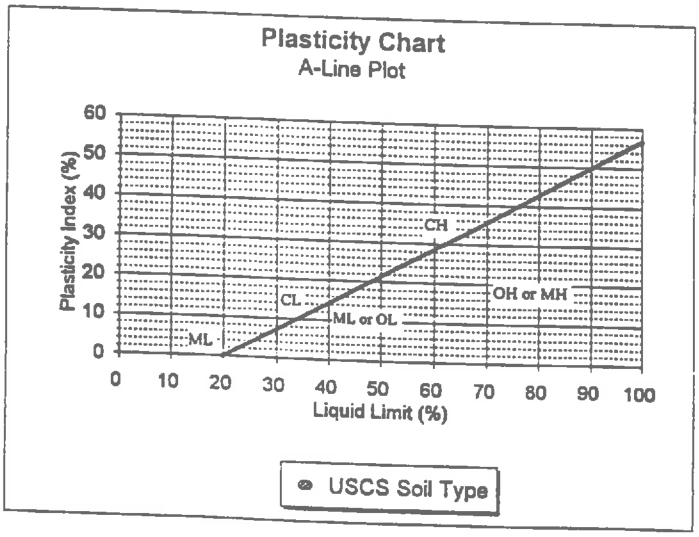
Results Summary

Liquid Limit 153

Plastic Limit 54

Plasticity Index 99





T:\ACTIVE\959214\ATTERB2.WB2

05/14/97

ATTERBERG LIMITS TEST

Sample No.: Bulk Sand
Location: Lake Seminole
Depth:
Boring No.:

Project No.: 959214.1
Date: 3/15/97
Tested By: DBP
Reviewed By MPK

Liquid Limit

No. of Blows	Wt. Cont. + Wet Soil (g)	Wt. Cont. + Dry Soil (g)	Wt. Cont. (g)	Water Content (%)
34	10.45	9.44	1.32	12.4
21	11.44	9.86	1.32	18.5
11	12.52	10.50	1.32	22.0

Plastic Limit

Wt. Cont. + Wet Soil (g)	Wt. Cont. + Dry Soil (g)	Wt. Cont. (g)	Water Content (%)
			NP
			NP

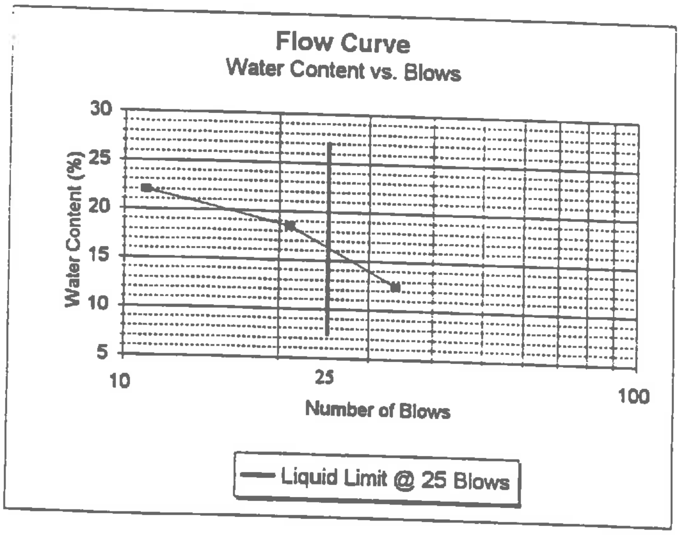
NP - Non-Plastic

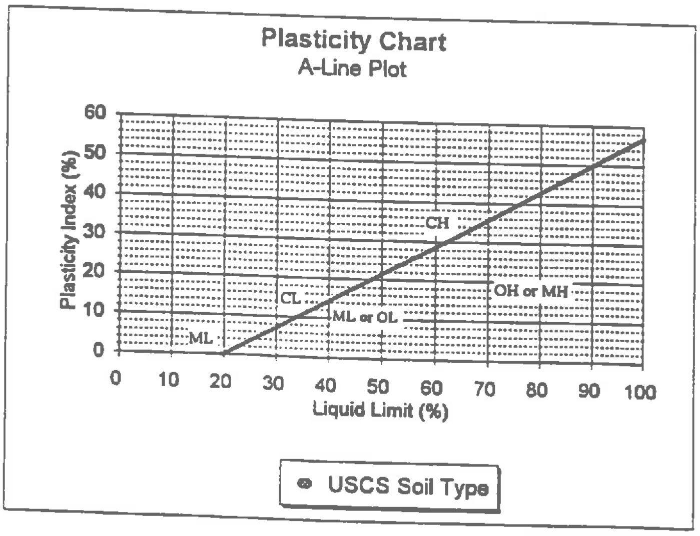
Results Summary

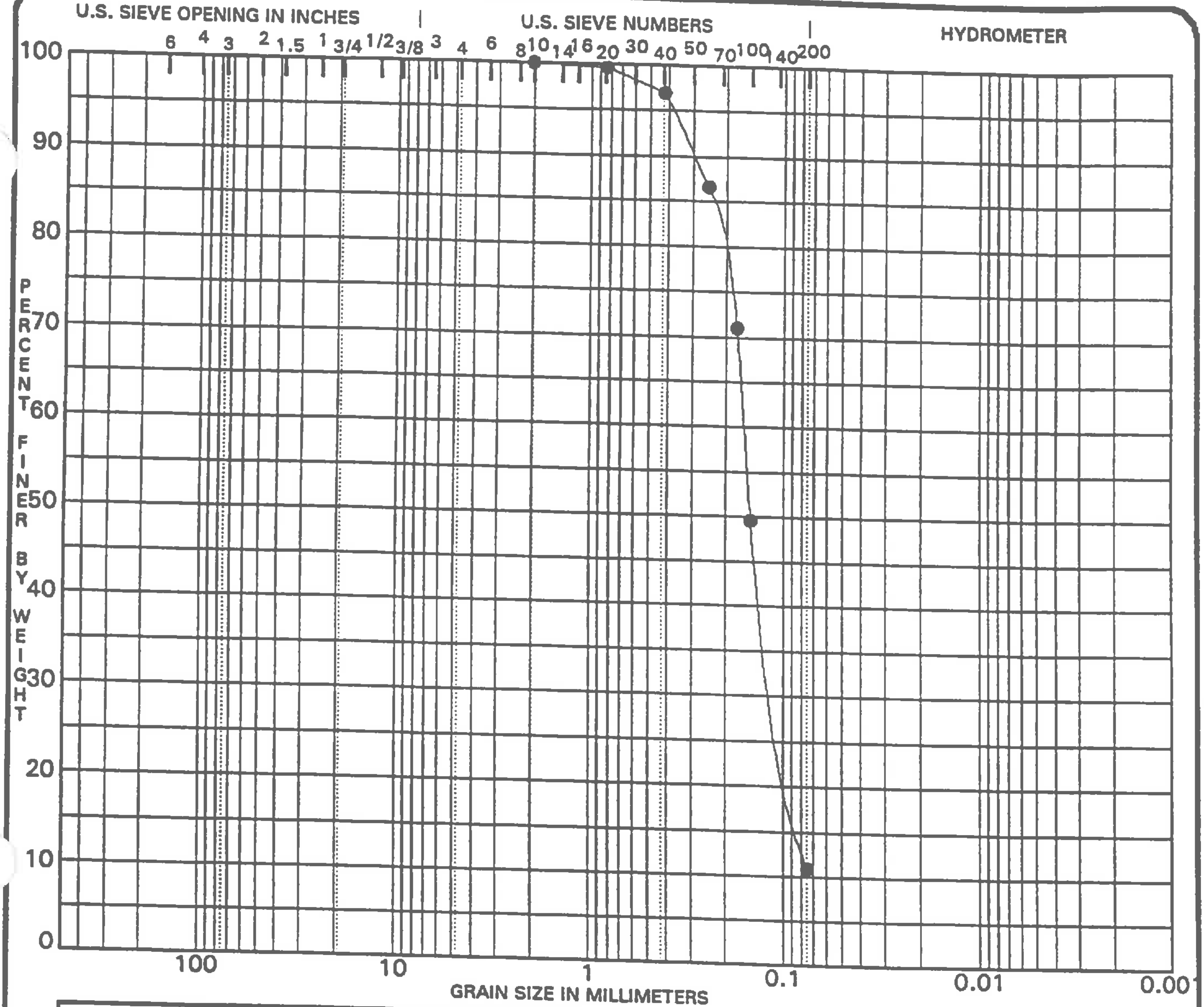
Liquid Limit 16

Plastic Limit

Plasticity Index NP







COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
●	BULKSAND 0.0	Dark brown fine sand with silt					0.98	2.3

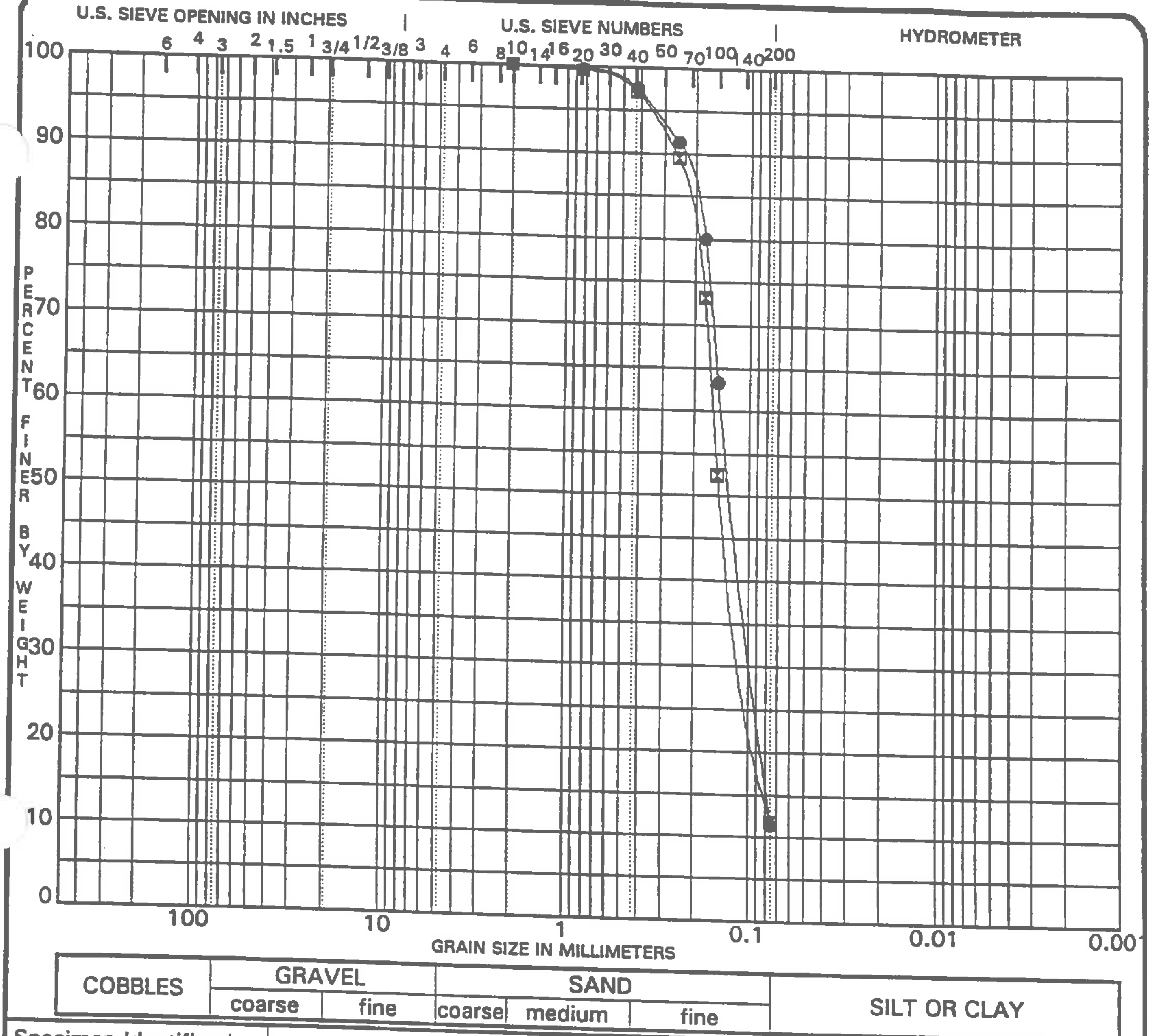
	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	BULKSAND 0.0	2.00	0.16	0.105		0.0	89.1	10.9	

PROJECT Lake Seminole - St. Petersburg, FL

JOB NO. 959214
DATE 6/25/97

GRADATION CURVES

BCI
Lakeland, FL



Specimen Identification			Classification	MC%	LL	PL	PI	Cc	Cu
●	P16	10.0	Dark brown fine sand with silt					0.92	2.0
⊠	P38	8.0	Dark brown fine sand with silt					0.94	2.3

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	P16	10.0	2.00	0.14	0.096		0.0	88.6	11.4	
⊠	P38	8.0	2.00	0.16	0.102		0.0	88.2	11.8	

PROJECT Lake Seminole - St. Petersburg, FL

JOB NO. 959214
DATE 6/25/97

GRADATION CURVES

BCI
Lakeland, FL

Appendix B

Settling Test Data

PROJECT NAME: Lake Seminole
SAMPLE NO: Bulk Sand
INIT. SOLIDS: 7.3
SP. GRAVITY: 2.7

PROJECT #: 959214.1
TIME REQ'D: 30 Days
ANALYSIS BY: MC

DATE	TIME	ELAPSED TIME (min)	SAMPLE HEIGHT (mm)	VOID RATIO (e)	SOLIDS CONTENT (%)
03/14/97	08:45	0.0	360.0	34.29	7.30
03/14/97	08:46	1.0	356.0	33.89	7.38
03/14/97	08:47	2.0	355.0	33.80	7.40
03/14/97	08:49	4.0	355.0	33.80	7.40
03/14/97	08:53	8.0	351.0	33.40	7.48
03/14/97	09:00	15.0	346.0	32.91	7.58
03/14/97	09:15	30.0	190.0	17.62	13.29
03/14/97	09:45	60.0	100.0	8.80	23.47
03/14/97	10:45	120.0	86.0	7.43	26.65
03/14/97	11:45	180.0	80.0	6.84	28.30
03/14/97	12:45	240.0	76.0	6.45	29.51
03/14/97	18:45	600.0	65.0	5.37	33.45
03/14/97	21:25	760.0	63.0	5.18	34.29
03/15/97	10:17	1532.0	58.0	4.69	36.56
03/15/97	17:05	1940.0	56.0	4.49	37.56
03/17/97	08:45	4320.0	52.0	4.10	39.72
03/17/97	20:00	4995.0	52.0	4.10	39.72
03/18/97	10:00	5835.0	51.0	4.00	40.31
03/18/97	17:20	6275.0	51.0	4.00	40.31
03/19/97	17:45	7740.0	51.0	4.00	40.31
03/20/97	19:40	9295.0	50.0	3.90	40.90
03/21/97	20:10	10765.0	50.0	3.90	40.90
03/22/97	17:00	12015.0	50.0	3.90	40.90
03/23/97	12:40	13195.0	50.0	3.90	40.90
03/24/97	17:00	14895.0	49.0	3.80	41.52
03/25/97	09:45	15900.0	49.0	3.80	41.52
03/27/97	11:10	18865.0	49.0	3.80	41.52
03/31/97	09:20	24515.0	48.0	3.70	42.16
04/04/97	09:00	30255.0	48.0	3.70	42.16
04/07/97	08:00	34515.0	47.0	3.61	42.81
04/14/97	07:00	44535.0	47.0	3.61	42.81
04/17/97	10:00	49035.0	45.0	3.41	44.18

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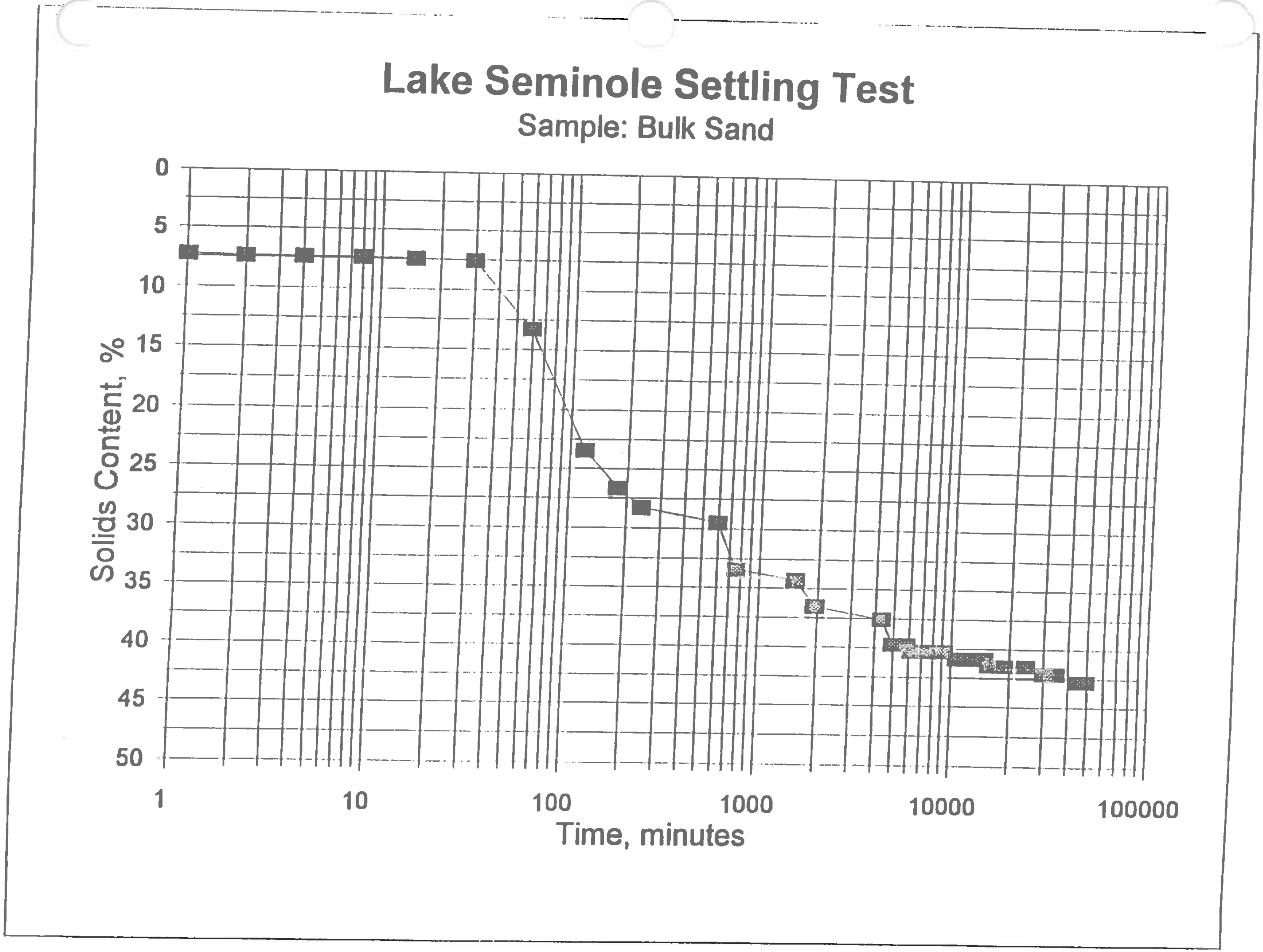
06/11/97

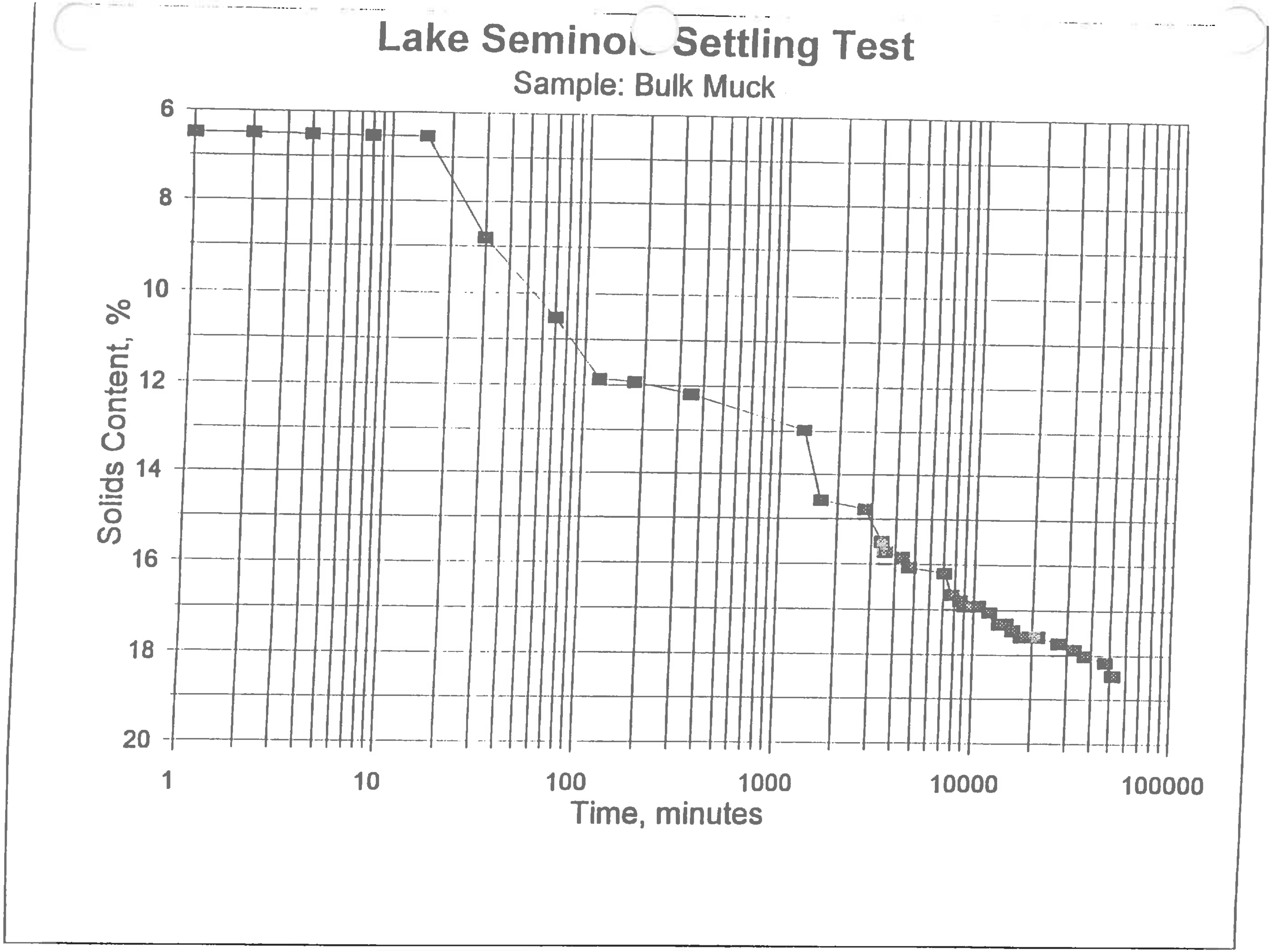


Lake Seminole Settling Test
Sample: Bulk Sand
Solids Content, %
0
5
10
15
20
25
30
35
40
45
50
1
10
100
1000
10000
100000
Time, minutes

PR[illegible]CT NAME: Lake Seminole
SA[illegible]E NO: Bulk Muck
INIT. SOLIDS: 6.5
SP. GRAVITY: 2.3

PROJECT #: 959214.1
TIME REQ'D: 30 Days
ANALYSIS BY: MC

DATE	TIME	ELAPSED TIME (min)	SAMPLE HEIGHT (mm)	VOID RATIO (e)	SOLIDS CONTENT (%)
03/12/97	10:05	0.0	330.0	33.08	6.50
03/12/97	10:06	1.0	330.0	33.08	6.50
03/12/97	10:07	2.0	329.0	32.98	6.52
03/12/97	10:09	4.0	328.0	32.88	6.54
03/12/97	10:13	8.0	328.0	32.88	6.54
03/12/97	10:20	15.0	240.0	23.79	8.82
03/12/97	10:35	30.0	199.0	19.55	10.52
03/12/97	11:15	70.0	175.0	17.08	11.87
03/12/97	12:05	120.0	174.0	16.97	11.93
03/12/97	13:05	180.0	170.0	16.56	12.20
03/12/97	15:52	347.0	159.0	15.42	12.98
03/13/97	08:06	1321.0	140.0	13.46	14.59
03/13/97	13:30	1645.0	138.0	13.25	14.79
03/14/97	08:06	2761.0	131.0	12.53	15.51
03/14/97	18:45	3400.0	129.0	12.32	15.73
03/14/97	21:25	3560.0	128.0	12.22	15.84
03/15/97	10:17	4332.0	126.0	12.01	16.07
[illegible]/97	17:05	4740.0	125.0	11.91	16.18
[illegible]/97	08:45	7120.0	121.0	11.50	16.67
03/17/97	20:00	7795.0	120.0	11.39	16.80
03/18/97	10:00	8635.0	119.0	11.29	16.92
03/18/97	17:20	9075.0	119.0	11.29	16.92
03/19/97	17:45	10540.0	118.0	11.19	17.05
03/20/97	19:40	12095.0	116.0	10.98	17.32
03/21/97	20:10	13565.0	116.0	10.98	17.32
03/22/97	17:00	14815.0	115.0	10.88	17.45
03/23/97	12:40	15995.0	114.0	10.77	17.59
03/24/97	17:00	17695.0	114.0	10.77	17.59
03/25/97	09:45	18700.0	114.0	10.77	17.59
03/27/97	11:10	21665.0	113.0	10.67	17.73
03/31/97	09:20	27315.0	112.0	10.57	17.87
04/04/97	09:00	33055.0	111.0	10.46	18.02
04/07/97	08:00	37315.0	110.0	10.36	18.17
04/14/97	07:00	47335.0	108.0	10.15	18.47
04/17/97	10:00	51835.0	107.0	10.05	18.62



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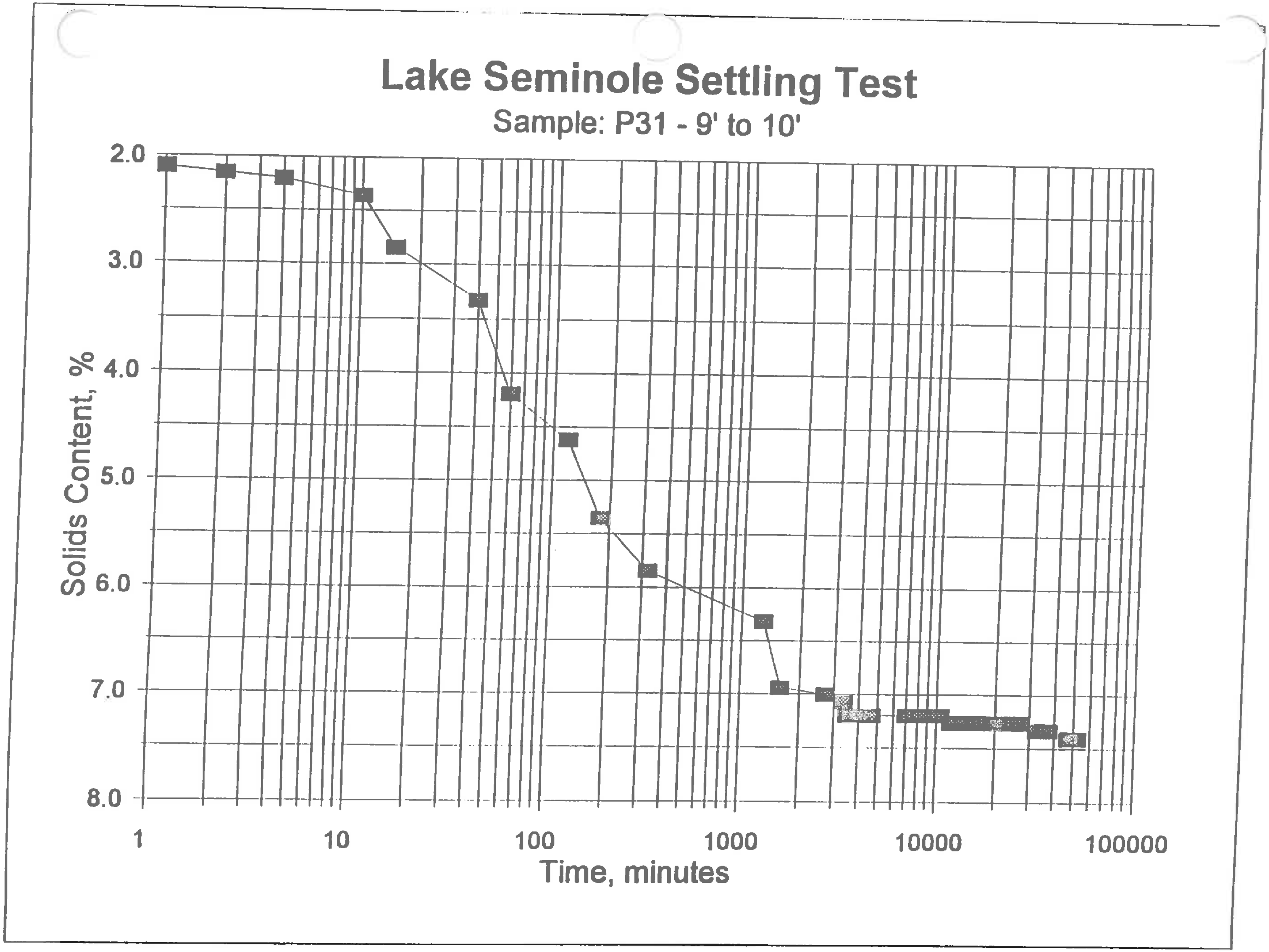
08/11/97

PR[illegible]ECT NAME: Lake Seminole
S[illegible]LE NO: P31 9' to 10'
INIT. SOLIDS: 2.1
SP. GRAVITY: 2.3

PROJECT #: 959214.1
TIME REQ'D: 30 Days
ANALYSIS BY: MC

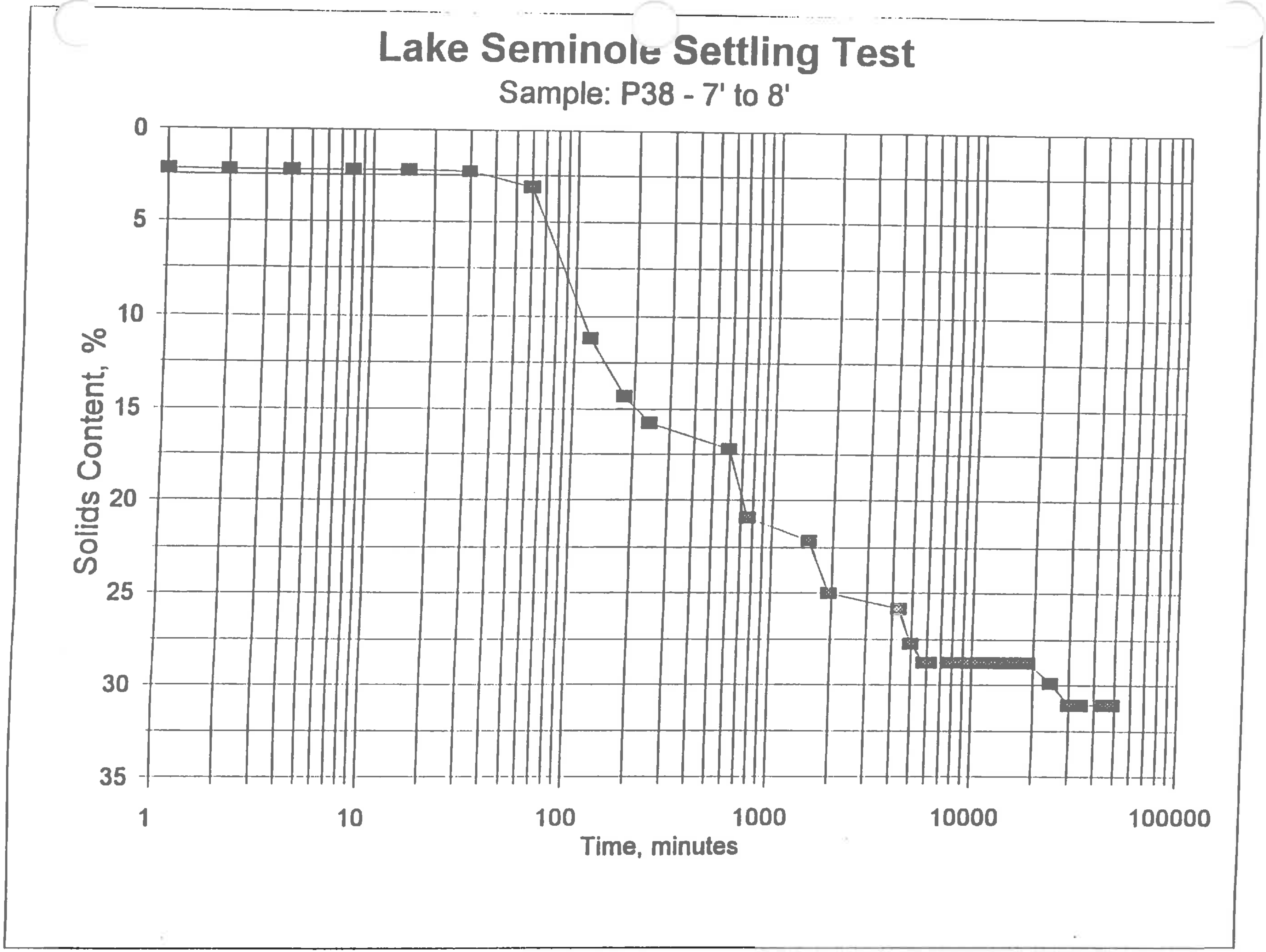
DATE	TIME	ELAPSED TIME (min)	SAMPLE HEIGHT (mm)	VOID RATIO (e)	SOLIDS CONTENT (%)
03/12/97	10:35	0.0	364.0	107.22	2.10
03/12/97	10:36	1.0	355.0	104.55	2.15
03/12/97	10:37	2.0	347.0	102.17	2.20
03/12/97	10:39	4.0	324.0	95.33	2.36
03/12/97	10:45	10.0	267.0	78.38	2.85
03/12/97	10:50	15.0	228.0	66.79	3.33
03/12/97	11:15	40.0	180.0	52.52	4.20
03/12/97	11:35	60.0	163.0	47.46	4.62
03/12/97	12:35	120.0	140.0	40.62	5.36
03/12/97	13:35	180.0	128.0	37.06	5.84
03/12/97	15:56	321.0	118.0	34.08	6.32
03/13/97	08:08	1293.0	107.0	30.81	6.95
03/13/97	13:30	1615.0	106.0	30.52	7.01
03/14/97	08:08	2733.0	105.0	30.22	7.07
03/14/97	18:46	3371.0	103.0	29.62	7.20
03/14/97	21:26	3531.0	103.0	29.62	7.20
03/15/97	10:18	4303.0	103.0	29.62	7.20
[illegible]5/97	17:06	4711.0	103.0	29.62	7.20
[illegible]7/97	08:45	7090.0	103.0	29.62	7.20
03/17/97	20:00	7765.0	103.0	29.62	7.20
03/18/97	10:00	8605.0	103.0	29.62	7.20
03/18/97	17:20	9045.0	103.0	29.62	7.20
03/19/97	17:45	10510.0	102.0	29.33	7.27
03/20/97	19:40	12065.0	102.0	29.33	7.27
03/21/97	20:10	13535.0	102.0	29.33	7.27
03/22/97	17:00	14785.0	102.0	29.33	7.27
03/23/97	12:40	15965.0	102.0	29.33	7.27
03/24/97	17:00	17665.0	102.0	29.33	7.27
03/25/97	09:45	18670.0	102.0	29.33	7.27
03/27/97	11:10	21635.0	102.0	29.33	7.27
03/31/97	09:20	27285.0	101.0	29.03	7.34
04/04/97	09:00	33025.0	101.0	29.03	7.34
04/07/97	08:00	37285.0	100.0	28.73	7.41
04/14/97	07:00	47305.0	100.0	28.73	7.41
04/17/97	10:00	51805.0	100.0	28.73	7.41


Lake Seminole Settling Test
Sample: P31 - 9' to 10'
Solids Content, %
2.0
3.0
4.0
5.0
6.0
7.0
8.0
1
10
100
1000
10000
100000
Time, minutes

PROJECT NAME: Lake Seminole
SAMPLE NO: P38 7' to 8'
INIT. SOLIDS: 2.2
SP. GRAVITY: 2.6

PROJECT #: 959214.1
TIME REQ'D: 30 Days
ANALYSIS BY: MC

DATE	TIME	ELAPSED TIME (min)	SAMPLE HEIGHT (mm)	VOID RATIO (e)	SOLIDS CONTENT (%)
03/14/97	08:46	0.0	345.0	115.58	2.20
03/14/97	08:47	1.0	343.0	114.91	2.21
03/14/97	08:48	2.0	342.0	114.57	2.22
03/14/97	08:50	4.0	342.0	114.57	2.22
03/14/97	08:54	8.0	341.0	114.23	2.23
03/14/97	09:01	15.0	335.0	112.20	2.26
03/14/97	09:16	30.0	240.0	80.10	3.14
03/14/97	09:46	60.0	64.0	20.63	11.19
03/14/97	10:46	120.0	49.0	15.56	14.32
03/14/97	11:46	180.0	44.0	13.87	15.79
03/14/97	12:46	240.0	40.0	12.52	17.20
03/14/97	18:46	600.0	32.0	9.81	20.95
03/14/97	21:26	760.0	30.0	9.14	22.15
03/15/97	10:18	1532.0	26.0	7.79	25.03
03/15/97	17:06	1940.0	25.0	7.45	25.88
03/17/97	08:45	4319.0	23.0	6.77	27.74
03/17/97	20:00	4994.0	22.0	6.43	28.78
[illegible]/97	10:00	5834.0	22.0	6.43	28.78
[illegible]3/97	17:20	6274.0	22.0	6.43	28.78
03/19/97	17:45	7739.0	22.0	6.43	28.78
03/20/97	19:40	9294.0	22.0	6.43	28.78
03/21/97	20:10	10764.0	22.0	6.43	28.78
03/22/97	17:00	12014.0	22.0	6.43	28.78
03/23/97	12:40	13194.0	22.0	6.43	28.78
03/24/97	17:00	14894.0	22.0	6.43	28.78
03/25/97	09:45	15899.0	22.0	6.43	28.78
03/27/97	11:10	18864.0	21.0	6.10	29.90
03/31/97	09:20	24514.0	20.0	5.76	31.11
04/04/97	09:00	30254.0	20.0	5.76	31.11
04/07/97	08:00	34514.0	20.0	5.76	31.11
04/14/97	07:00	44534.0	20.0	5.76	31.11
04/17/97	10:00	49034.0	20.0	5.76	31.11



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08/11/97

Appendix C

Flocculant Testing

Laboratory Testing of Polymer Flocculation of Seminole Lake Sediment

By

Global Consulting Co.

P O Box 15238

Gainesville, Fl. 32604

to

Bromwell and Carrier, Inc.

Lakeland, Florida

INTRODUCTION

Fine solids, largely consisting of vegetative matter in lake sediments is capable of forming a network structure and locking up considerable amount of water. The particulate suspension thus formed, can potentially occupy large tracts of lands which cannot be put to productive use and is deleterious to aquatic life. The separation of the solids would amount to recycling of the held up water as well as potential use of the solids as compost. Flocculation of the solids is investigated as a technique to achieve viable methods of clarification of the waste water sludge.

MATERIALS AND METHODS

Two 500 ml jars containing samples from Seminole lake sediment were received for screening of flocculants that can be used to dewater such sediment after dredging it from the bottom of the lake. Sample (P31) is composed of fine particles of mostly organic matter, the solids content by weight is determined to be about 16%. The second sample (P42) contains coarser particles including sand. The solids content by weight is determined to be about 22%. Several solid grade polymers were tested as possible flocculants for these samples. Polymers included nonionic, anionic, and cationic chemicals were tested in this program. The charged polymers (anionic and cationic were tested as a function of charge density on the polymer chain ie high, medium, or low charge. These polymers included Percol (351, 156, 335, 371, 455) all are products of Allied Colloids Inc. In addition Polyethylene Oxide (PEO) of Union carbide was also tested. In addition, Mixtures of these flocculants were studied to obtain the best dewatering possible.

1000 ppm solution of each polymer was made and stored in a measuring flask. Flocculation was carried out in a 250 ml beaker using 100 ml (5% solids by weight) prepared of well stirred suspension of the lake sediment. Agitation was carried out using a Lightnin Labmaster mixer (L1U08) with a high shear impeller (3.5 cm diameter) at 100 rpm.

Dewatering was done using a nylon mesh (a6 Mesh size) and press filtration, whenever used, was achieved manually by squeezing the water from the sediment through the mesh.

RESULTS

All tested polymers were found to flocculate suspensions prepared from both received samples. However, flocs were small, fluffy and weak especially in the case of the fine sample (P31). Dewatering the flocculated material on the screen resulted in small amount of solids (about 5%) retained on the screen. In case of the double polymer treatment (156/371), flocs were larger and slightly stronger (about 40% retained) (see table I). Supernatant water was found to be clear in case of using 455, 371, and 156/371 polymers. Flocculation is found to start at a dosage of) 0.9 lb/dry ton of solids with no added benefit as the dosage increased.

In case of the second sample (P42), again all polymers are found to flocculate the suspension. In this case, the flocs were found to be slightly larger and slightly stronger (about 20% retainment of solids on the screen) than in the case of sample (P31). This is attributed to the coarser size distribution of the solids in the sample (P42) as compared to the first sample. In the case of using the dual treatment of 156/371 polymers, flocs were stronger and can be dewatered on the screen with

about 90% retained on the screen (see Table II). It should be remembered that addition of fiber may help in strengthening the flocs which can be dewatered further by pressing the solids on the screen.

Table I: Flocculation results of Sample (P31) using various flocculation schemes

S. No	Flocculant	Dosage (lb/ton)		% light* Transmitted in Filtrate	% solids retained on screen
		Anionic	Cationic		
1	Percol 156	0.9	-	15%, Turbid	5
2	Percol 336	0.9	-	81%, Turbid	5
3	Percol 371	-	0.9	92%, Clear	5
4	156 + 371	0.7	0.4	92%, Clear	40
5	336 + 371	0.7	0.4	92%, Clear	40
6	455	-	0.9	Clear	5

*% Light transmitted in lab water"100%

Table II: Flocculation results of Sample (P42) using various flocculation schemes

S. No	Flocculant	Dosage (lb/ton)		% light* Transmitted in Filtrate	% solids retained on screen
		Anionic	Cationic		
1	Percol 156	0.9	-	15%, Turbid	20
2	Percol 336	0.9	-	81%, Turbid	20
3	Percol 371	-	0.9	92%, Clear	15
4	156 + 371	0.7	0.4	92%, Clear	90
5	351 + 371	(Nonionic) 0.7	0.4	92%, Clear	90
6	455	-	0.9	Clear	20

*% Light transmitted in lab water"100%

As mentioned above, two nonionic polymers (Percol 351) and PEO were tested and the results are similar to the anionic polymers.

CONCLUSION

Even though it was easy to flocculate these samples by all types of polymers, the solids capture on the screen is not high. Also, the solid content in the dewatered solids are not high (increased from 5% to 7% after dewatering. Perhaps, the use of fiber may help in the dewatering as well as solids capture on the screen.

Appendix D

BTR Labs Chemical Analyses
of
Sediments in Seminole Lake, Florida
Seminole Lake, Florida

Sediment Analytical Data

Metals

Nutrients

Brevard Teaching & Research Laboratories, Inc.

Trace Metals Analysis
TCLP Sediment

Client: Bromwell Carrier, Inc.
Field Identification: P-16
Sampling Date: 02/28/97
Date Received: 02/28/97

CompQAP No.: 930169, 860106
Laboratory Identification: 3885-02T
Work Order/Report Number: 3885

Matrix: TCLP extract
Preservative: HNO_3

Data Released By: T. Price

Parameter	Method	Date Analyzed	Result (µg/l)	MDL (µg/l)
Antimony	EPA 200.8	03/29/97	1.01	0.99
Arsenic	EPA 200.8	03/29/97	28.9	1.19
Beryllium	EPA 200.8	03/29/97	BDL	1.06
Cadmium	EPA 200.8	03/29/97	BDL	1.14
Chromium	EPA 200.8	03/29/97	57.1	1.13
Copper	EPA 200.8	03/29/97	35.3	1.00
Lead	EPA 200.8	03/29/97	123	0.96
Mercury	EPA 245.1	03/13/97	BDL	0.10
Nickel	EPA 200.8	03/29/97	43.0	1.03
Selenium	EPA 200.8	03/29/97	2.89	1.02
Silver	EPA 200.8	03/29/97	BDL	1.13
Sodium	EPA 273.1	03/31/97	14,900	40.0
Thallium	EPA 200.8	03/29/97	BDL	1.07
Zinc	EPA 200.8	03/29/97	1000	1.20

MDL - Method Detection Limit
BDL - Below Detection Limit

Brevard Teaching & Research Laboratories, Inc.

Trace Metals Analysis
TCLP Sediment

Client: Bromwell Carrier, Inc.
Field Identification: P-31
Sampling Date: 02/28/97
Date Received: 02/28/97

CompQAP No.: 930169, 860106
Laboratory Identification: 3885-03T
Work Order/Report Number: 3885

Matrix: TCLP extract
Preservative: HNO_3

Data Released By: T. Price

Parameter	Method	Date Analyzed	Result (µg/l)	MDL (µg/l)
Antimony	EPA 200.8	03/29/97	BDL	0.99
Arsenic	EPA 200.8	03/29/97	18.5	1.19
Beryllium	EPA 200.8	03/29/97	BDL	1.06
Cadmium	EPA 200.8	03/29/97	BDL	1.14
Chromium	EPA 200.8	03/29/97	12.0	1.13
Copper	EPA 200.8	03/29/97	42.3	1.00
Lead	EPA 200.8	03/29/97	13.3	0.96
Mercury	EPA 245.1	03/13/97	BDL	0.10
Nickel	EPA 200.8	03/29/97	2.72	1.03
Selenium	EPA 200.8	03/29/97	1.14	1.02
Silver	EPA 200.8	03/29/97	BDL	1.13
Sodium	EPA 273.1	03/31/97	14,200	40.0
Thallium	EPA 200.8	03/29/97	BDL	1.07
Zinc	EPA 200.8	03/29/97	150	1.20

MDL - Method Detection Limit
BDL - Below Detection Limit

Brevard Teaching & Research Laboratories, Inc.

Trace Metals Analysis
TCLP Sediment

Client: Bromwell Carrier, Inc.
Field Identification: P-16
Sampling Date: 02/28/97
Date Received: 02/28/97

CompQAP No.: 930169, 860106
Laboratory Identification: 3885-02T
Work Order/Report Number: 3885

Matrix: TCLP extract
Preservative: HNO_3

Data Released By: T. Price

Parameter	Method	Date Analyzed	Result (ug/L)	TCLP limit	MDL (µg/l)
Arsenic	EPA 200.8	03/29/97	28.9	5000	1.19
Barium	EPA 200.8	03/29/97	733	100,000	0.15
Cadmium	EPA 200.8	03/29/97	0.73T	1000	1.14
Chromium	EPA 200.8	03/29/97	57.1	5000	1.13
Lead	EPA 200.8	03/29/97	123	5000	0.96
Mercury	EPA 245.1	03/13/97	1.68	200	0.10
Selenium	EPA 200.8	03/29/97	2.89	1000	1.02
Silver	EPA 200.8	03/29/97	0.45T	5000	1.13

T - Value reported is less than laboratory method detection limit. The value is reported for informational purposes.
MDL - Method Detection Limit
BDL - Below Detection Limit

Brevard Teaching & Research Laboratories, Inc.

Trace Metals Analysis
TCLP Sediment

Client: Bromwell Carrier, Inc.
Field Identification: P-31
Sampling Date: 02/28/97
Date Received: 02/28/97

CompQAP No.: 930169, 860106
Laboratory Identification: 3885-03T
Work Order/Report Number: 3885

Matrix: TCLP extract
Preservative: HNO_3

Data Released By: T. Price

Parameter	Method	Date Analyzed	Result (ug/L)	TCLP limit	MDL (µg/l)
Arsenic	EPA 200.8	03/29/97	18.5	5000	1.19
Barium	EPA 200.8	03/29/97	295	100,000	0.15
Cadmium	EPA 200.8	03/29/97	0.15 T	1000	1.14
Chromium	EPA 200.8	03/29/97	12.0	5000	1.13
Lead	EPA 200.8	03/29/97	13.3	5000	0.96
Mercury	EPA 245.1	03/13/97	0.10	200	0.10
Selenium	EPA 200.8	03/29/97	1.14	1000	1.02
Silver	EPA 200.8	03/29/97	0.07 T	5000	1.13

T - Value reported is less than laboratory method detection limit. The value is reported for informational purposes.
MDL - Method Detection Limit
BDL - Below Detection Limit

Brevard Teaching & Research Laboratories, Inc.

Trace Metals Analysis
Sediment

Client: Bromwell Carrier, Inc.
Field Identification: P-16
Sampling Date: 03/28/97
Date Received: 03/28/97

CompQAP No.: 930169, 860106
Laboratory Identification: 3885-02
Work Order/Report Number: 3885

Matrix: Sediment
Preservative: HNO_3

Data Released By: T. Price

Parameter	Method	Date Analyzed	Result (mg/kg dry)	MDL (mg/kg dry)
Antimony	EPA 200.8	03/29/97	0.03	0.02
Arsenic	EPA 200.8	03/29/97	1.60	0.7
Beryllium	EPA 200.8	03/29/97	0.23	0.02
Cadmium	EPA 200.8	03/29/97	0.24	0.02
Chromium	EPA 200.8	03/29/97	7.86	0.05
Copper	EPA 200.8	03/29/97	4.45	0.03
Lead	EPA 200.8	03/29/97	30.3	0.02
Mercury	EPA 7471	03/13/97	0.08 T	0.12
Nickel	EPA 200.8	03/29/97	2.28	0.02
Selenium	EPA 200.8	03/29/97	0.54	0.4
Silver	EPA 200.8	03/29/97	0.01 T	0.05
Sodium	EPA 7770	03/12/97	285	0.5
Thallium	EPA 200.8	03/29/97	0.05 T	0.2
Zinc	EPA 200.8	03/29/97	20.9	0.9

T - Value reported is less than laboratory method detection limit. The value is reported for informational purposes.
MDL - Method Detection Limit
BDL - Below Detection Limit

Brevard Teaching & Research Laboratories, Inc.

Trace Metals Analysis
Sediment

Client: Bromwell Carrier, Inc.
Field Identification: P-31
Sampling Date: 03/28/97
Date Received: 03/28/97

CompQAP No.: 930169, 860106
Laboratory Identification: 3885-03
Work Order/Report Number: 3885

Matrix: Sediment
Preservative: HNO_3

Data Released By: T. Price

Parameter	Method	Date Analyzed	Result (mg/kg dry)	MDL (mg/kg dry)
Antimony	EPA 200.8	03/29/97	0.10	0.02
Arsenic	EPA 200.8	03/29/97	1.97	0.7
Beryllium	EPA 200.8	03/29/97	0.19	0.02
Cadmium	EPA 200.8	03/29/97	0.31	0.02
Chromium	EPA 200.8	03/29/97	11.7	0.05
Copper	EPA 200.8	03/29/97	19.5	0.03
Lead	EPA 200.8	03/29/97	59.7	0.02
Mercury	EPA 7471	03/13/97	0.13 T	0.25
Nickel	EPA 200.8	03/29/97	2.72	0.02
Selenium	EPA 200.8	03/29/97	0.69	0.4
Silver	EPA 200.8	03/29/97	0.18	0.05
Sodium	EPA 7770	03/12/97	521	0.5
Thallium	EPA 200.8	03/29/97	0.05 T	0.2
Zinc	EPA 200.8	03/29/97	41.3	0.9

T - Value reported is less than laboratory method detection limit. The value is reported for informational purposes.
MDL - Method Detection Limit
BDL - Below Detection Limit

Brevard Teaching & Research Laboratories, Inc.

Nutrient Analysis
Sediment

Client:	Bromwell Carrier, Inc.
Field Identification:	P-16
Sampling Date:	02/28/97
Date Received:	02/28/97
Matrix:	Sediment
Preservative:	None or H_2SO_4
Analyst:	L. Fitzpatrick, J. Hatcher
Data Released By:	T. Price

CompQAP No.:	930169
Laboratory Identification:	3885-02s
Work Order/Report Number:	3885

Parameter Name	Method	Date Analyzed	Analysis Result (mg/Kg) Dry	MDL (mg/Kg) Dry
O-Phos	365.1	03/13/97	40.6	0.002
T-Phos	365.4	03/18/97	54.9	0.01
TKN	351.2	03/18/97	323	0.04
NO_x	353.2	03/13/97	403	0.001
Chloride	300.0	03/05/97	129	0.116

MDL - Method Detection Limit
BDL - Below Detection Limit

Brevard Teaching & Research Laboratories, Inc.

Nutrient Analysis
Sediment

Client: Bromwell Carrier, Inc.
Field Identification: P-31
Sampling Date: 02/28/97
Date Received: 02/28/97

CompQAP No.: 930169
Laboratory Identification: 3885-03s
Work Order/Report Number: 3885

Matrix: Sediment
Preservative: None or H_2SO_4

Analyst: L. Fitzpatrick, J. Hatcher
Data Released By: T. Price

Parameter Name	Method	Date Analyzed	Analysis Result (mg/Kg) Dry	MDL (mg/Kg) Dry
O-Phos	365.1	03/13/97	17.9	0.002
T-Phos	365.4	03/18/97	25.8	0.01
TKN	351.2	03/18/97	593	0.04
NO_x	353.2	03/13/97	87.8	0.001
Chloride	300.0	03/05/97	55.1	0.116

MDL - Method Detection Limit
BDL - Below Detection Limit

<u>Site Water Data</u>

Metals

Nutrients

Brevard Teaching & Research Laboratories, Inc.

Trace Metals Analysis
Surface Water

Client:	Bromwell Carrier, Inc.
Field Identification:	Surface Water
Sampling Date:	02/28/97
Date Received:	02/28/97
CompQAP No.:	930169, 860106
Laboratory Identification:	3885-01
Work Order/Report Number:	3885
Matrix:	Surface Water
Preservative:	HNO_3
Data Released By:	T. Price

Parameter	Method	Date Analyzed	Result (µg/l)	MDL (µg/l)
Antimony	EPA 200.8	03/29/97	0.44 T	0.99
Arsenic	EPA 200.8	03/29/97	3.49	1.19
Beryllium	EPA 200.8	03/29/97	0.08 T	1.06
Cadmium	EPA 200.8	03/29/97	0.11 T	1.14
hromium	EPA 200.8	03/29/97	2.03	1.13
Copper	EPA 200.8	03/29/97	2.05	1.00
Lead	EPA 200.8	03/29/97	6.29	0.96
Mercury	EPA 245.1	03/13/97	0.06 T	0.10
Nickel	EPA 200.8	03/29/97	2.19	1.03
Selenium	EPA 200.8	03/29/97	2.37	1.02
Silver	EPA 200.8	03/29/97	1.49	1.13
Sodium	EPA 273.1	03/12/97	93,300	40.0
Thallium	EPA 200.8	03/29/97	0.12 T	1.07
Zinc	EPA 200.8	03/29/97	5.67	1.20

T - Value reported is less than laboratory method detection limit. The value is reported for informational purposes.
MDL - Method Detection Limit
BDL - Below Detection Limit

Brevard Teaching & Research Laboratories, Inc.

Nutrient Analysis
Surface Water

Client: Bromwell Carrier, Inc.
Field Identification: Surface Water
Sampling Date: 02/28/97
Date Received: 02/28/97

CompQAP No.: 930169
Laboratory Identification: 3885-01
Work Order/Report Number: 3885

Matrix: Surface Water
Preservative: None or H_2SO_4

Analyst: L. Fitzpatrick. J. Hatcher
Data Released By: T. Price

Parameter Name	Method	Date Analyzed	Analysis Result (mg/L)	MDL (mg/L)
O-Phos	365.1	03/13/97	0.151	0.002
T-Phos	365.4	03/18/97	0.346	0.01
TKN	351.2	03/17/97	3.47	0.04
NO_x	353.2	03/13/97	0.429	0.001
Chloride	300.0	03/05/97	108	0.116

MDL - Method Detection Limit
BDL - Below Detection Limit

Elutriate Water Data

Metals

Nutrients

Brevard Teaching & Research Laboratories, Inc.

Trace Metals Analysis
Elutriate Water

Client: Bromwell Carrier, Inc.
Field Identification: P-16
Sampling Date: 02/28/97
Date Received: 02/28/97

CompQAP No.: 930169, 860106
Laboratory Identification: 3885-02E
Work Order/Report Number: 3885

Matrix: Elutriate Water
Preservative: HNO_3

Data Released By: T. Price

Parameter	Method	Date Analyzed	Result (µg/l)	MDL (µg/l)
Antimony	EPA 200.8	03/29/97	2.49	0.99
Arsenic	EPA 200.8	03/29/97	55.0	1.19
Beryllium	EPA 200.8	03/29/97	0.40 T	1.06
Cadmium	EPA 200.8	03/29/97	0.13 T	1.14
Chromium	EPA 200.8	03/29/97	3.55	1.13
Copper	EPA 200.8	03/29/97	5.84	1.00
Lead	EPA 200.8	03/29/97	2.39	0.96
Mercury	EPA 245.1	03/20/97	0.06 T	0.10
Nickel	EPA 200.8	03/29/97	3.34	1.03
Selenium	EPA 200.8	03/29/97	4.36	1.02
Silver	EPA 200.8	03/29/97	0.59 T	1.13
Sodium	EPA 273.1	03/12/97	91,900	40.0
Thallium	EPA 200.8	03/29/97	0.07 T	1.07
Zinc	EPA 200.8	03/29/97	3.12	1.20

T - Value reported is less than laboratory method detection limit. The value is reported for informational purposes.
MDL - Method Detection Limit
BDL - Below Detection Limit

Brevard Teaching & Research Laboratories, Inc.

Trace Metals Analysis
Elutriate Water

Client: Bromwell Carrier, Inc.
Field Identification: P-31
Sampling Date: 02/28/97
Date Received: 02/28/97

CompQAP No.: 930169, 860106
Laboratory Identification: 3885-03E
Work Order/Report Number: 3885

Matrix: Elutriate Water
Preservative: HNO_3

Data Released By: T. Price

Parameter	Method	Date Analyzed	Result (µg/l)	MDL (µg/l)
Antimony	EPA 200.8	03/29/97	1.58	0.99
Arsenic	EPA 200.8	03/29/97	19.3	1.19
Beryllium	EPA 200.8	03/29/97	0.03 T	1.06
Cadmium	EPA 200.8	03/29/97	0.13 T	1.14
Chromium	EPA 200.8	03/29/97	1.04 T	1.13
Copper	EPA 200.8	03/29/97	3.75	1.00
Lead	EPA 200.8	03/29/97	0.45 T	0.96
Mercury	EPA 245.1	03/20/97	0.11	0.10
Nickel	EPA 200.8	03/29/97	2.52	1.03
Selenium	EPA 200.8	03/29/97	2.25	1.02
Silver	EPA 200.8	03/29/97	2.43	1.13
Sodium	EPA 273.1	03/12/97	82,700	40.0
Thallium	EPA 200.8	03/29/97	0.15 T	1.07
Zinc	EPA 200.8	03/29/97	0.70 T	1.20

MDL - Method Detection Limit
BDL - Below Detection Limit

Brevard Teaching & Research Laboratories, Inc.

Nutrient Analysis
Elutriate Water

Client: Bromwell Carrier, Inc.
Field Identification: P-16
Sampling Date: 02/28/97
Date Received: 02/28/97

CompQAP No.: 930169
Laboratory Identification: 3885-02E
Work Order/Report Number: 3885

Matrix: Elutriate Water
Preservative: None or H_2SO_4

Analyst: L. Fitzpatrick, J. Hatcher
Data Released By: T. Price

Parameter Name	Method	Date Analyzed	Analysis Result (mg/L)	MDL (mg/L)
O-Phos	365.1	03/13/97	1.474	0.002
T-Phos	365.4	03/18/97	1.871	0.01
TKN	351.2	03/17/97	14.26	0.04
NO_x	353.2	03/14/97	0.058	0.001
Chloride	300.0	03/10/97	92.4	0.116

MDL - Method Detection Limit
BDL - Below Detection Limit

Brevard Teaching & Research Laboratories, Inc.

Nutrient Analysis
Elutriate Water

Client: Bromwell Carrier, Inc.
Field Identification: P-31
Sampling Date: 02/28/97
Date Received: 02/28/97

CompQAP No.: 930169
Laboratory Identification: 3885-03E
Work Order/Report Number: 3885

Matrix: Elutriate Water
Preservative: None or H_2SO_4

Analyst: L. Fitzpatrick, J. Hatcher
Data Released By: T. Price

Parameter Name	Method	Date Analyzed	Analysis Result (mg/L)	MDL (mg/L)
O-Phos	365.1	03/13/97	0.367	0.002
T-Phos	365.4	03/18/97	0.467	0.01
TKN	351.2	03/17/97	8.668	0.04
NO_x	353.2	03/14/97	0.044	0.001
Chloride	300.0	03/10/97	128	0.116

MDL - Method Detection Limit
BDL - Below Detection Limit

APPENDIX 2

LAKE SEMINOLE WATERSHED MANAGEMENT PLAN

Review and Recalibration of Lake Seminole WASP Model

Prepared for:

Pinellas County Public Works Department
Planning and Programing
Surface Water Management
440 Court Street
Clearwater, Florida 33756

Prepared by:

James L. Martin, Ph.D., P.E.
Martin Environmental Services
345 Marian Lane
Vicksburg, MS 39183

June 2000

Martin Environmental Services
Vicksburg, MS

Review and Recalibration of Lake Seminole WASP Model

Prepared for

Post, Buckley, Schuh and Jernigan, Inc.

5300 West Cypress Street, Suite 300

Tampa, Florida

by

James L. Martin, Ph.D., P.E.

Martin Environmental Services

345 Marian Lane

Vicksburg, MS 39183

June 25, 2000

Review and Recalibration of Lake Seminole WASP Model

Introduction

Lake Seminole is a 684-acre freshwater body located in southwest Pinellas County, Florida. In order to evaluate the potential impact of proposed watershed and lake management scenarios, Post, Buckley, Schuh and Jernigan, Inc. (PBS&J) developed and applied mathematical models to the lake and its watershed. EPA's Surface Water Management Model (SWMM) version 4.30 RUNOFF and TRANSPORT blocks were used to estimate pollutant loadings from each subbasin within the watershed and route these loads to Lake Seminole. EPA's Water Analysis and Simulation Program (WASP) version 5 was used to simulate the receiving water quality and the lake response to pollutant loads. The objectives of the application were to

- Characterize Lake Seminole and the associated contributing watershed,
- Identify and prioritize subbasins within the watershed with regard to the severity of flooding and pollutant loading, and
- Summarize water quality modeling results of proposed lake management scenarios.

Martin Environmental Services (MEnvS) was contracted by PBS&J to review the WASP5 model application and make necessary modifications to the model code and input data sets to improve model calibrations. MEnvS was also requested to review and test input data sets used in simulations of various management scenarios, as directed by PBS&J. This report summarizes the testing and recalibration of the WASP5 model as completed by MEnvS. Specific task completed by MEnvS included:

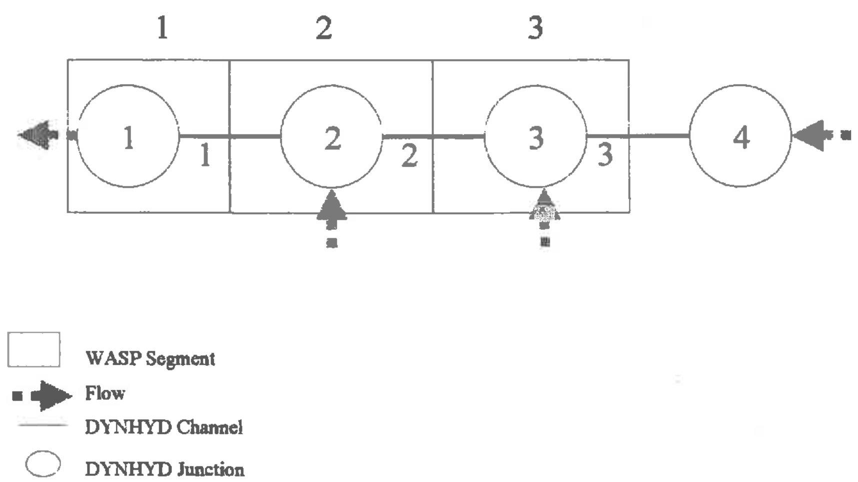
1. Preliminary review of the WASP model application and testing of input data sets,
2. Reformulation of the model and calibration to data from 1994 and 1997,
3. Recalibration of the model to data from data from 1996 to 1998, and

4. Testing of input data files used in evaluation of management scenarios

The tasks completed by MEnvS were restricted to the WASP5 model application using input and output data sets provided by PBS&J along with spreadsheets for comparing model predictions and observations. The tasks did not include a verification of the data included in the spreadsheets or evaluation of the SWMM model application used to develop flow and loading estimates for the Lake Seminole WASP model application.

Preliminary Review

In the initial application of WASP to Lake Seminole by PBS&J, the hydrodynamics of Lake Seminole were estimated using the DYNHYD5 hydrodynamic model. The model grid consisted of four junctions and three channels, with flows specified for each of the four junctions, as illustrated by Figure 1. Rates of precipitation were also specified. The DYNHYD model runs created hydrodynamic linkage files for use by the eutrophication sub-model to WASP (EUTRO5). The eutrophication model consisted of thee segments, as illustrated in Figure 1. The WASP model was configured for a full eutrophication simulation, with all eight state variables being simulated.



• Figure 1

The initial review of the EUTRO5 model application consisted of a) comparison of model predictions with those from the EPA's most recent release version of EUTRO5 (download from the CEAM web site), b) review of constants and kinetic rates in input data sets provided by PBS&J, c) review of model output, and d) a review of the hydrodynamic model application and WASP linkage.

The comparison of model results with those from the EPA latest release was conducted as a quality control check. Not differences in predictions were detected.

Review of input data sets suggested that, in general, rates and constants used in the initial application by PBS&J were reasonable. However several areas were identified for additional review and model refinement. These included refinement of specifications for rates of sediment oxygen demand and nutrient release, algal settling, and specification of light extinction coefficients. The review also suggested a reevaluation through additional calibration of constants affecting denitrification, algal growth and respiration, and mineralization of organic nitrogen.

The review of model output indicated significant mass balance errors. These mass balance errors were reported in the WASP mass balance file and resulted in spurious peaks in predicted concentrations. Test input data files were created treating the lake as a single volumetric element. Further investigation suggested that the cause of the mass balance errors was the hydrodynamic model linkage.

The initial review resulted in the recommendation that the hydrodynamic model set up be reevaluated prior to any further attempts to recalibrate the EUTRO5 model. Subsequent conversations with PBS&J resulted in the recommendation that the Lake be re-segmented into two segments (instead of the original three segments) and that flows between the two segments be recomputed from continuity rather than using the DYNHYD5 model.

Recalibration to 1994 and 1997

Subsequent to the preliminary review, the model segmentation was modified to two segments and new input data sets developed by PBS&J and MEnvS. The revised model was then recalibrated to data for 1994 and 1997. The recalibration included incorporation of algal settling, and rates for sediment oxygen demand, nutrient release, and light extinction. Minor modifications of other rate constants were incorporated. In general, the calibration appeared to reasonably mimic observed variations in field data, although predicted algal concentrations remained relatively constant over the period of simulation for the two years. This was consistent with observations for 1997, but resulted in an under-prediction of summertime peaks in 1994.

Recalibration to 1996 to 1998

Subsequent to the 1994 and 1997 recalibration, PBS&J developed data sets for the 1996 and 1998. Simulations for these years indicated that predictions using the recalibrated model were not consistent with observations. In particular, summertime peaks in chlorophyll-a were observed that were not captured by the

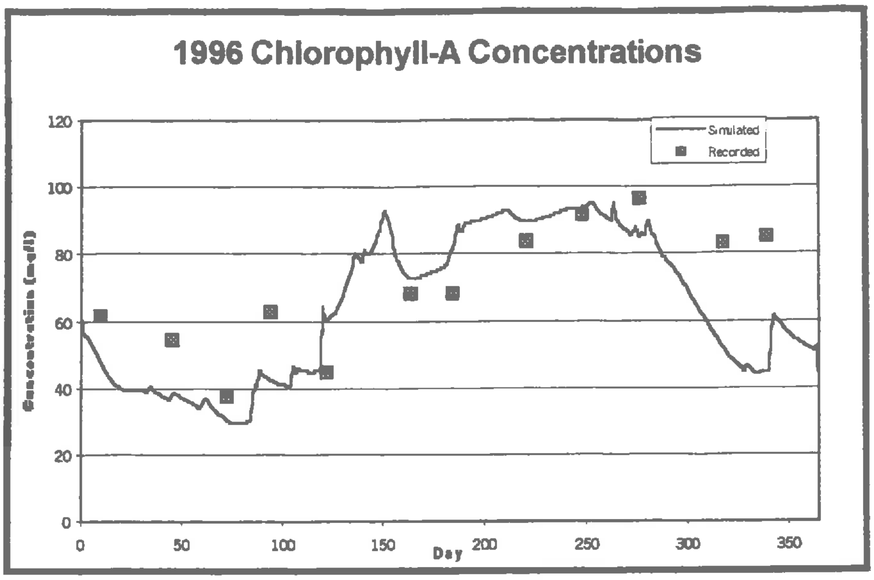
model. The model was then recalibrated to each of these years (1996 through 1998).

The recalibration included incorporation of methods to more accurately represent depths in the recalibrated model. When WASP is coupled with a hydrodynamic model, computed flows, depths, volumes and velocities are passed to WASP using a hydrodynamic linkage file. However, when WASP is not coupled to a hydrodynamic model, the depths are computed from $D=aQ^b$, where D is the depth, Q the flow rate, and a and b are coefficients. During the course of the recalibration, it was determined that these depths could not be adequately described by the aQ^b formulation typically used by WASP. In order to adequately represent the depths, the flows and depths and volumes were computed externally to WASP and specified to WASP in a linkage file. This modification allowed the depths to be accurately represented in simulations.

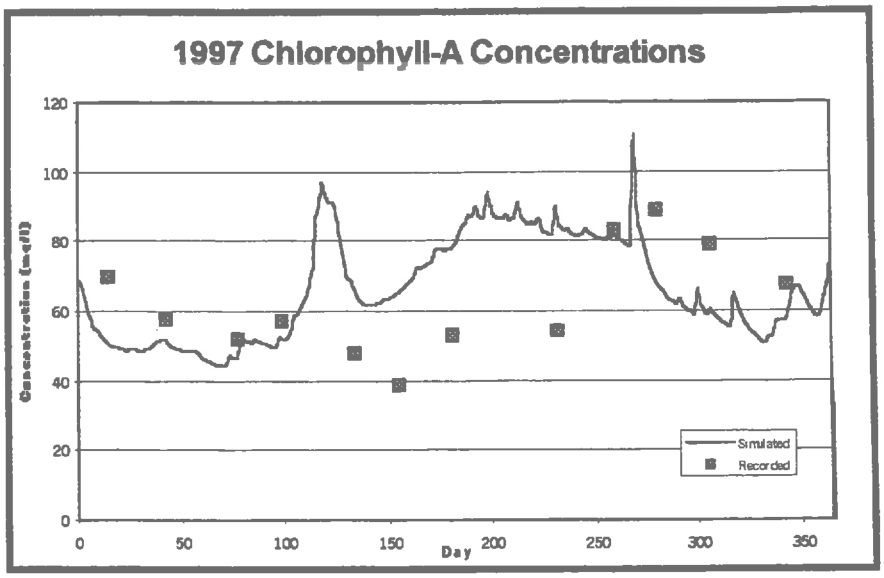
Other modifications in the recalibration to the years 1996-1998 included slight modifications to model parameters and kinetic rates. Seasonal variations in light extinction based upon observations were also included. Also included were time functions for sediment ammonia and phosphorus release. The release rates were computed from a constant value of 30 and 4 $mg/m^2/day$ for ammonia and phosphorus at 20^oC, respectively, adjusted by temperature using a theta of 1.1. A time function was also included for air temperature, assumed equal to the water temperature (it is used in the computation of reaeration). The results of the recalibration are provided below.

Chlorophyll-a

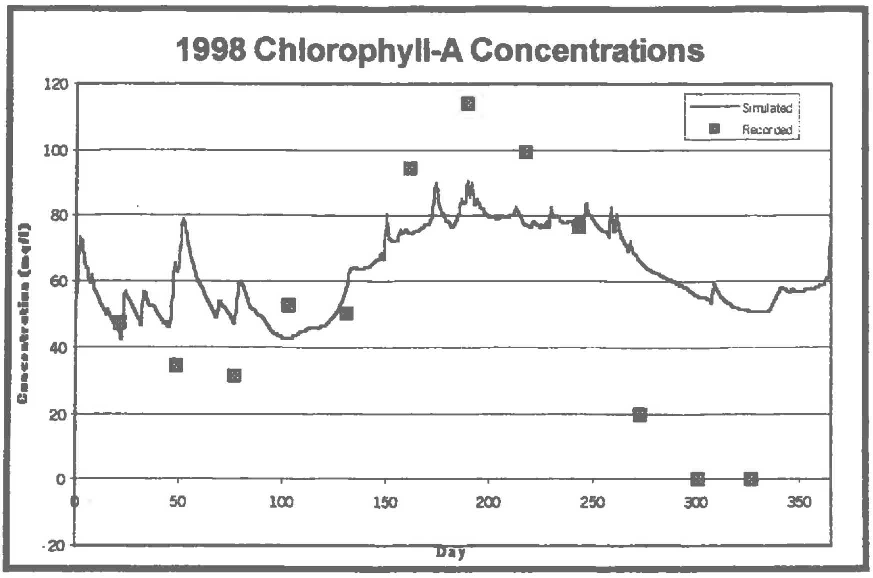
Comparisons of predicted and observed chlorophyll-a concentrations are provided in Figure 2 to Figure 4. The simulations adequately captured seasonal variations in chlorophyll-a for 1996, overestimated summertime concentrations for 1997 and slightly under-estimated peak concentrations for 1998. No consistent set of calibration values could be determined which allowed capturing the relatively constant chlorophyll-a values for 1997 while still capturing seasonal blooms for 1996 and 1998. Examination of all time-series input did not suggest a mechanism which would have prevented the lack of a summertime bloom during 1997. One possible mechanism, which is not included in the WASP simulations, which include a single algal group, could be a shift in algal species composition between the years.



• Figure 2. Comparison of predicted and observed chlorophyll-a concentrations for 1996.



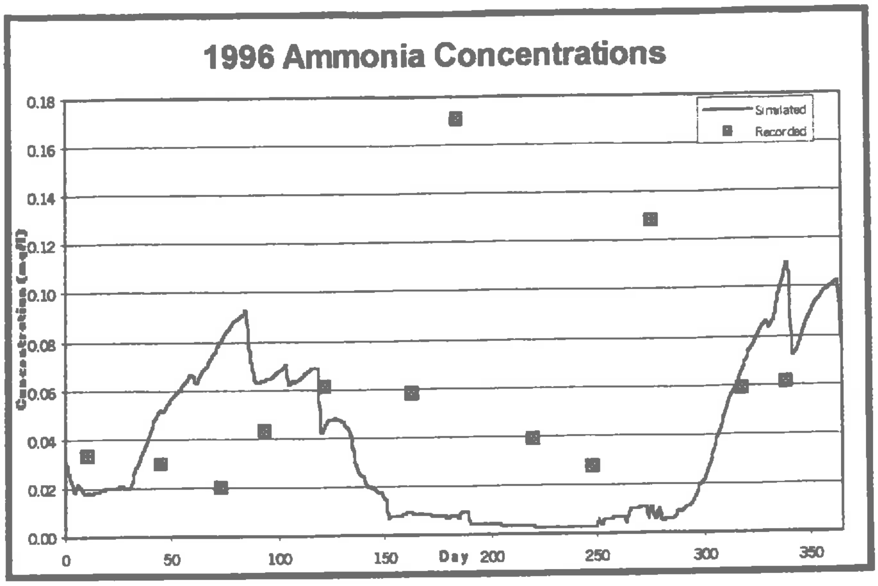
• Figure 3. Comparison of predicted and observed chlorophyll-a concentrations for 1997.



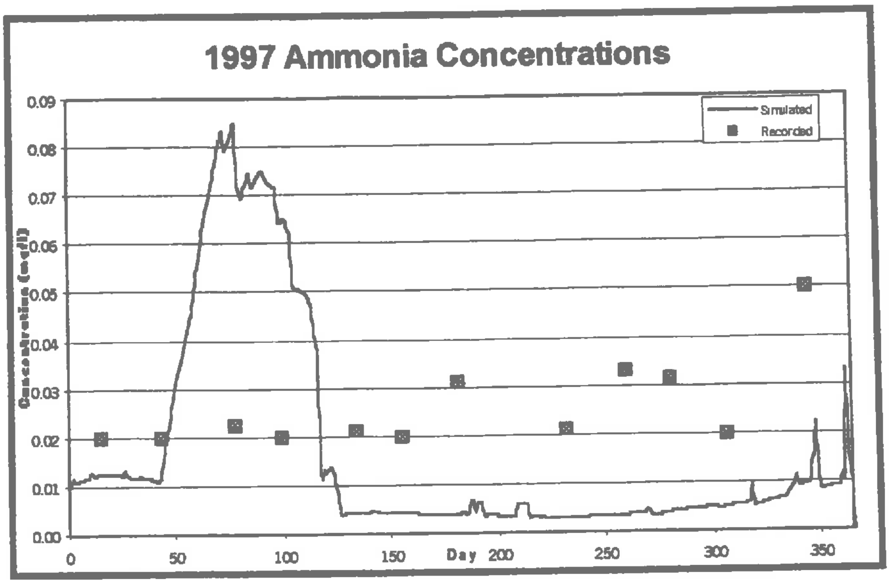
• Figure 4. Comparison of predicted and observed chlorophyll-a concentrations for 1998.

Ammonia-nitrogen

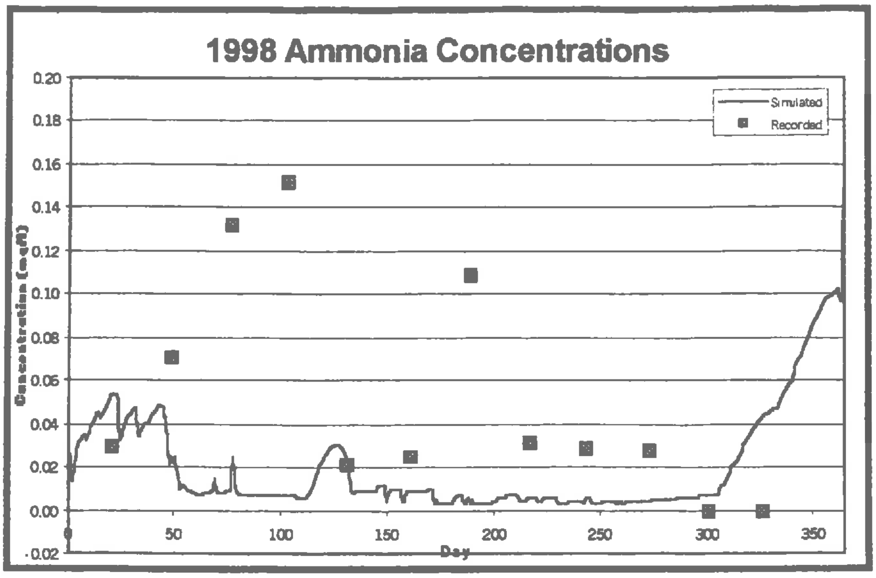
Predicted and observed ammonia-nitrogen concentrations are illustrated in Figure 5 to Figure 7. Predicted concentrations were generally within the range of observations. However, for 1997, a peak in concentrations was predicted which was not observed. For 1998, a peak was observed which was not predicted.



• Figure 5. Comparison of predicted and observed ammonia concentrations for 1996.



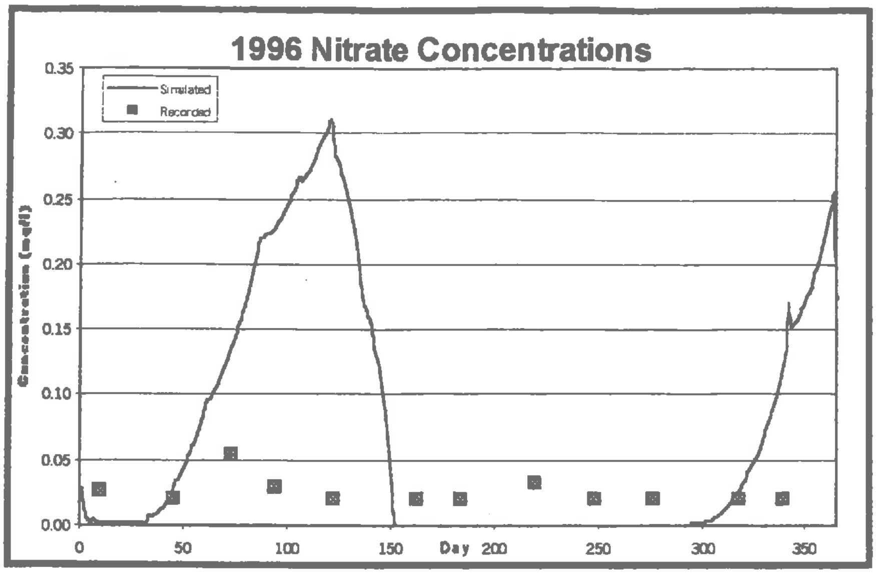
• Figure 6. Comparison of predicted and observed ammonia concentrations for 1997.



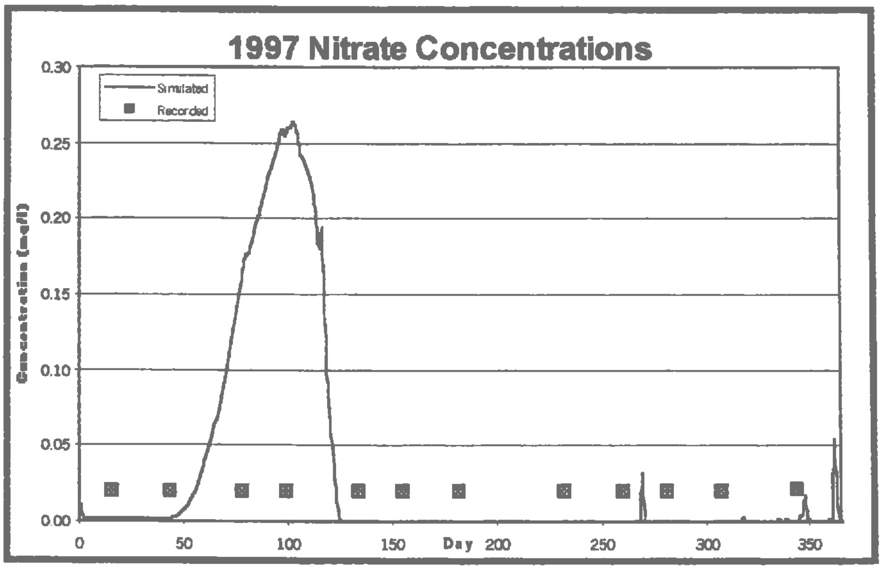
• Figure 7. Comparison of predicted and observed ammonia concentrations for 1998.

Nitrate-Nitrogen

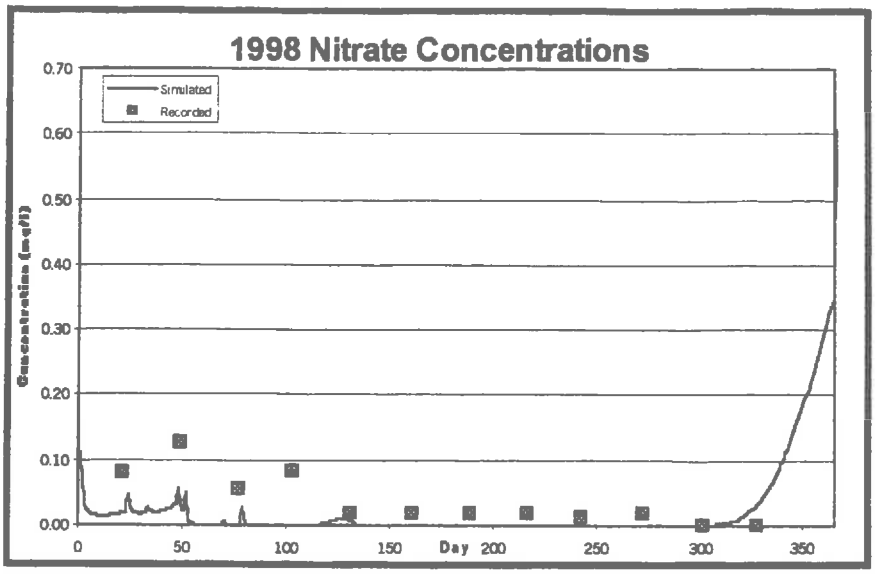
Predicted and observed nitrate-nitrogen concentrations are illustrated in Figure 8 through Figure 10. In general, model predictions were within the range of observations. However, a peak in concentrations was predicted in 1996 and 1997 that were not reflected in observations.



• Figure 8. Comparison of predicted and observed nitrate-nitrogen concentrations for 1996.



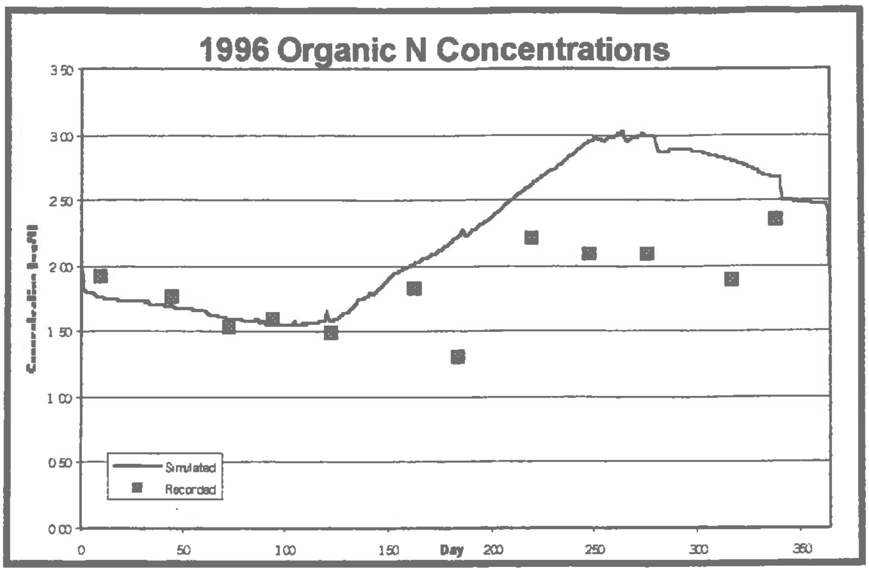
• Figure 9. Comparison of predicted and observed nitrate-nitrogen concentrations for 1997.



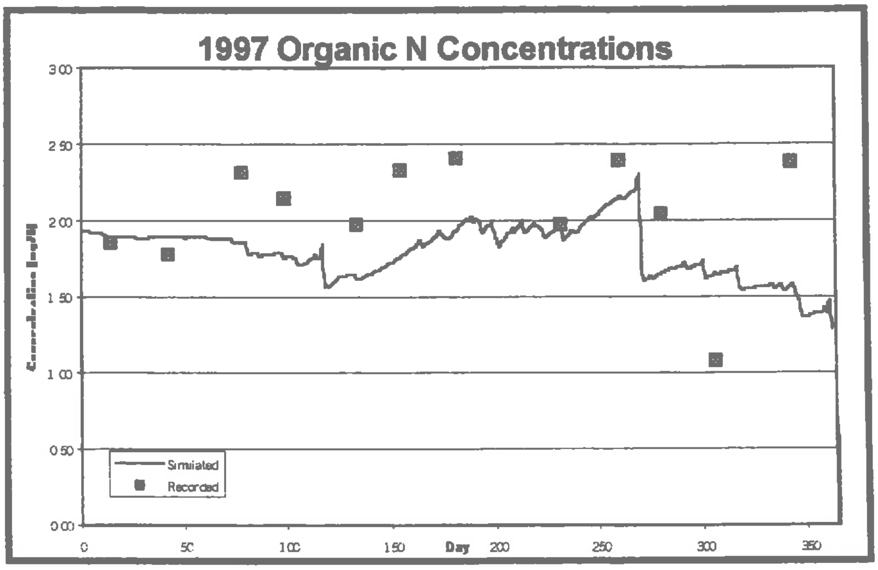
• Figure 10. Comparison of predicted and observed nitrate-nitrogen concentrations for 1998.

Organic Nitrogen

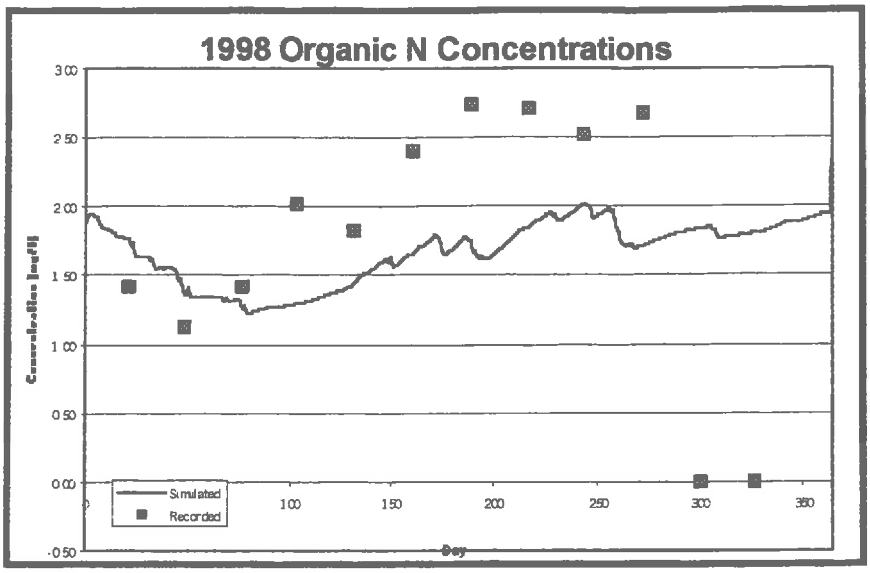
Predicted and observed organic nitrogen concentrations are illustrated in Figure 11 through Figure 13. Model predictions generally adequately captured seasonal variations in organic nitrogen concentrations.



• Figure 11. Comparison of predicted and observed organic nitrogen concentrations for 1996.



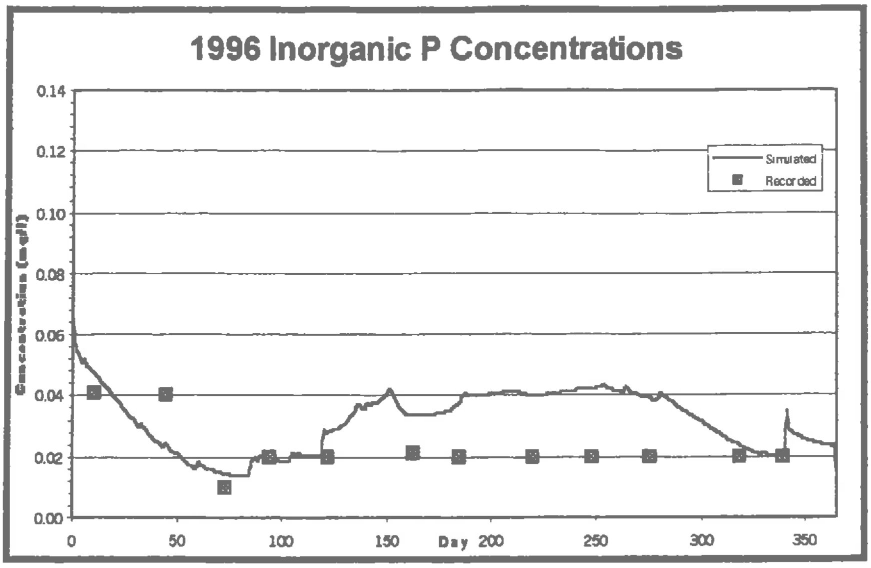
• Figure 12. Comparison of predicted and observed organic nitrogen concentrations for 1997.



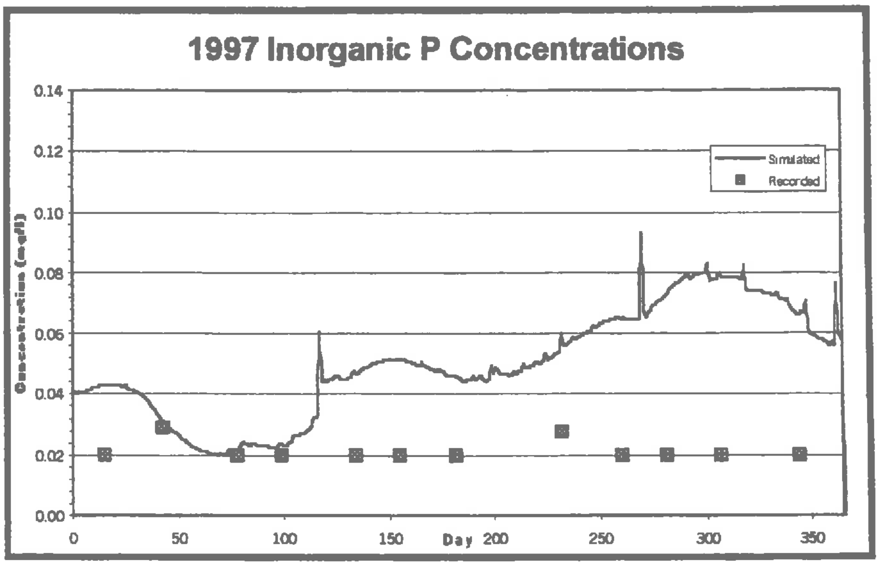
• Figure 13. Comparison of predicted and observed organic nitrogen concentrations for 1998.

Ortho-Phosphorus

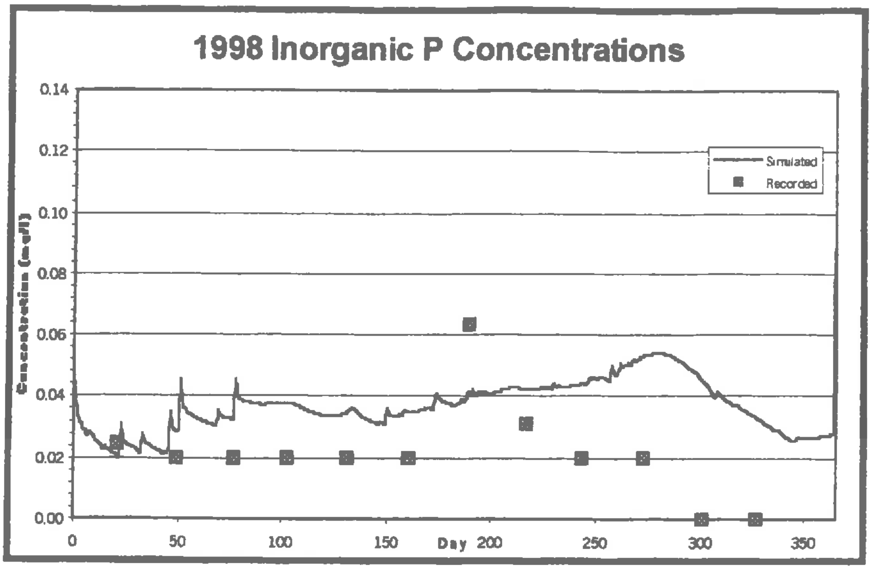
Predicted and observed ortho-phosphorus (available inorganic phosphorus) concentrations are illustrated in Figure 14 through Figure 16. Predicted concentrations were generally within the range of observed concentrations and adequately reproduced seasonal variations.



• Figure 14. Comparison of predicted and observed ortho-phosphorus concentrations for 1996.



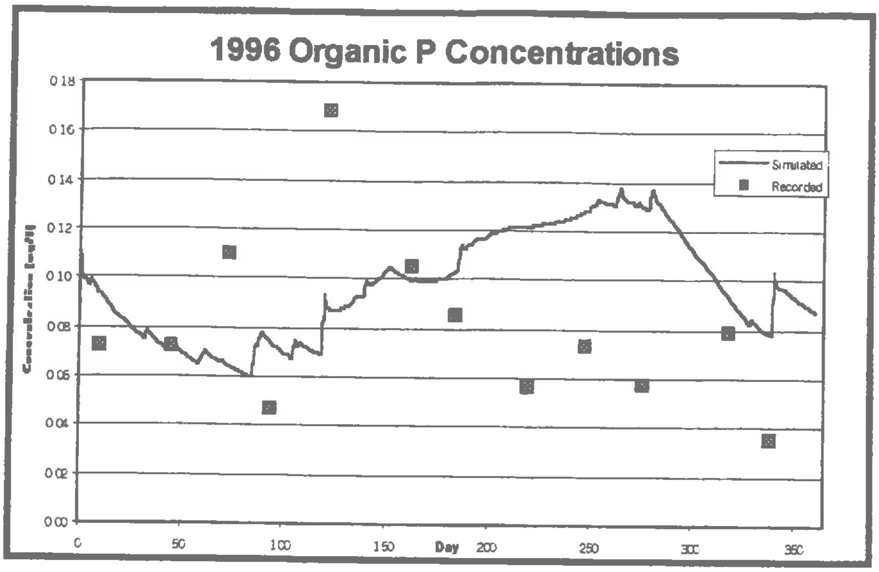
• Figure 15. Comparison of predicted and observed ortho-phosphorus concentrations for 1997.



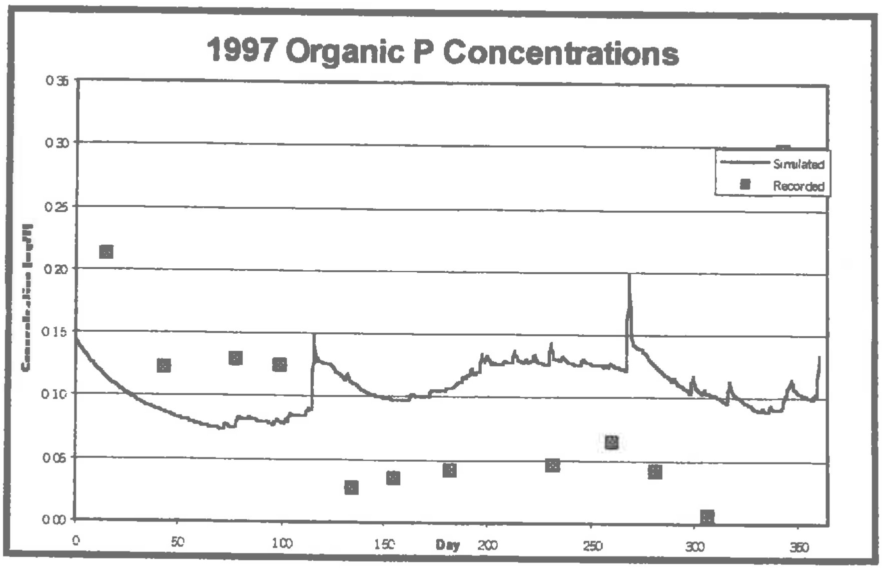
• Figure 16. Comparison of predicted and observed ortho-phosphorus concentrations for 1998.

Organic Phosphorus

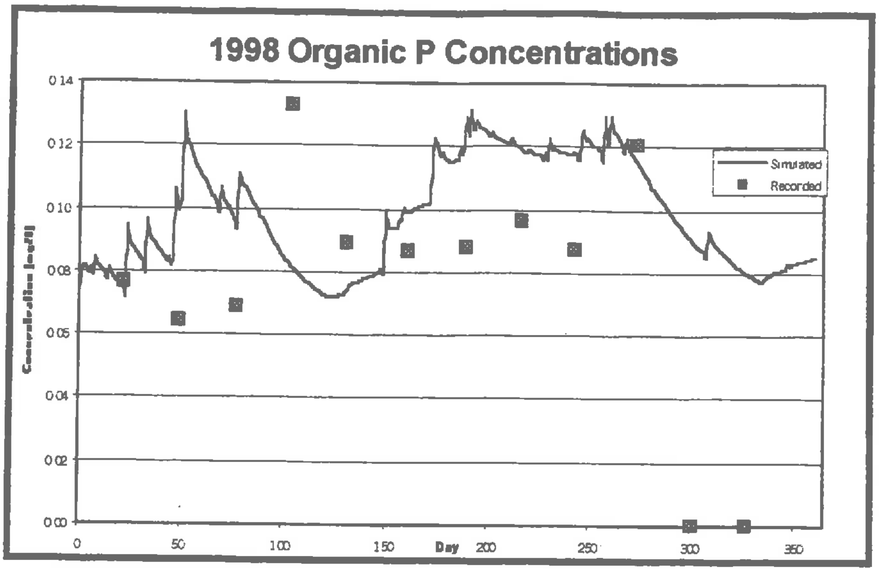
Predicted and observed organic phosphorus concentrations are illustrated in Figure 17 through Figure 19. Predicted concentrations were generally within the range of observed concentrations.



• Figure 17. Comparison of predicted and observed organic phosphorus concentrations for 1996.



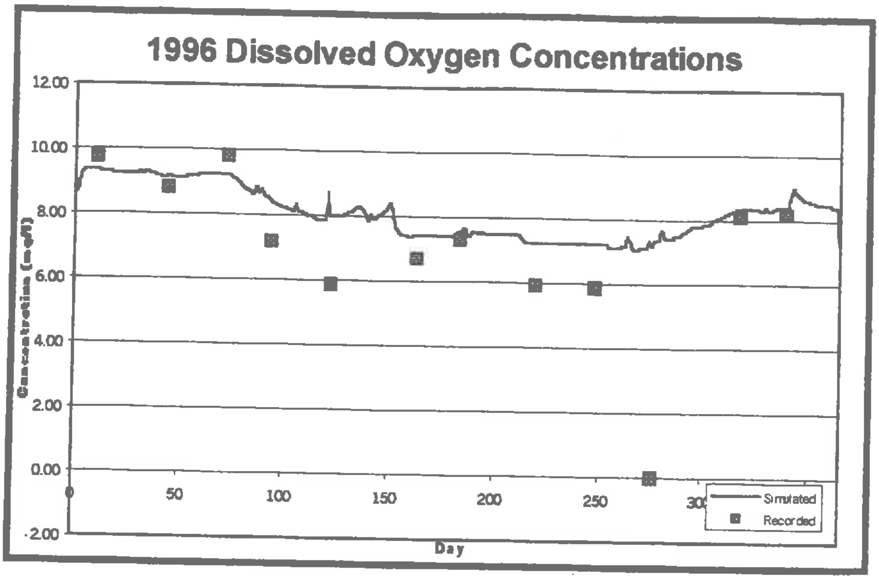
• Figure 18. Comparison of predicted and observed organic phosphorus concentrations for 1997.



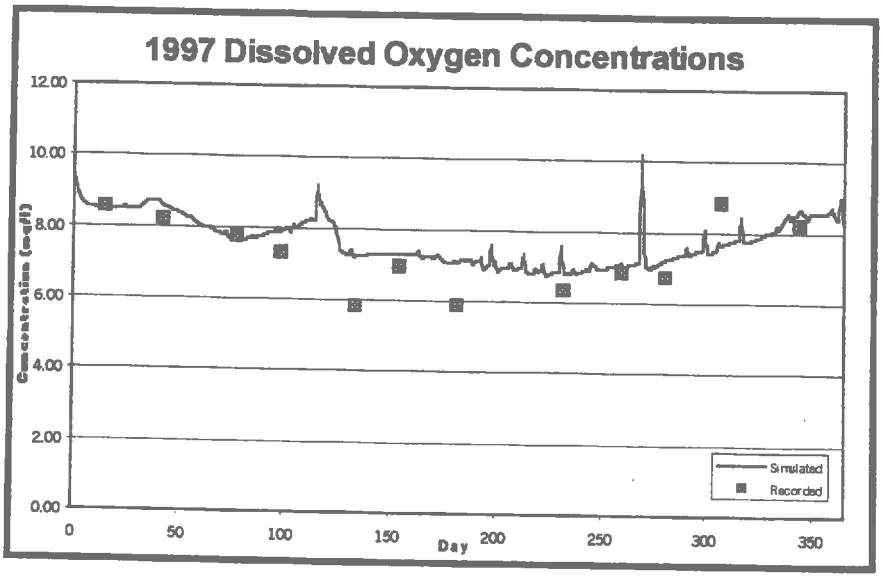
• Figure 19. Comparison of predicted and observed organic phosphorus concentrations for 1998.

Dissolved Oxygen

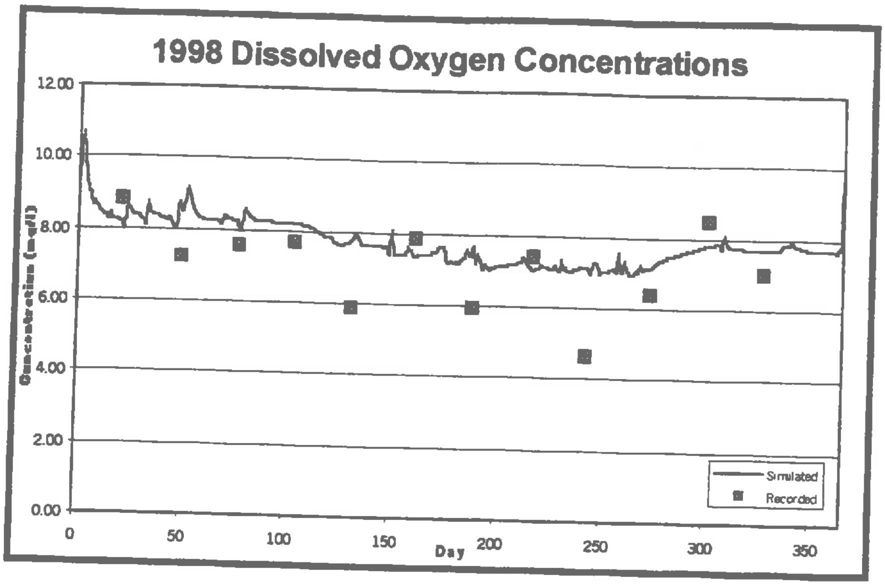
Predicted and observed dissolved oxygen concentrations are illustrated in Figure 20 through Figure 22. Predictions adequately captured observed seasonal variations in dissolved oxygen concentrations.



• Figure 20. Comparison of predicted and observed dissolved oxygen concentrations for 1996.



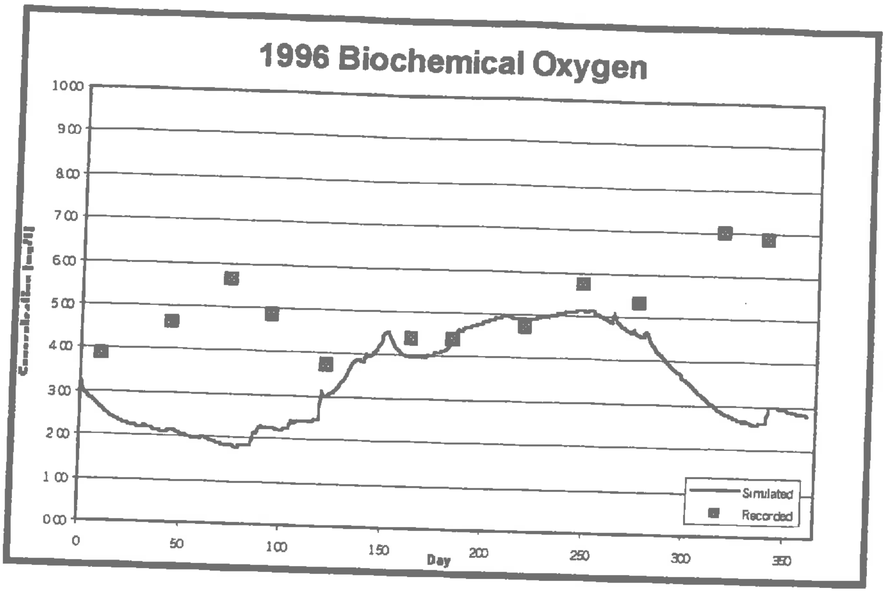
• Figure 21. Comparison of predicted and observed dissolved oxygen concentrations for 1997.



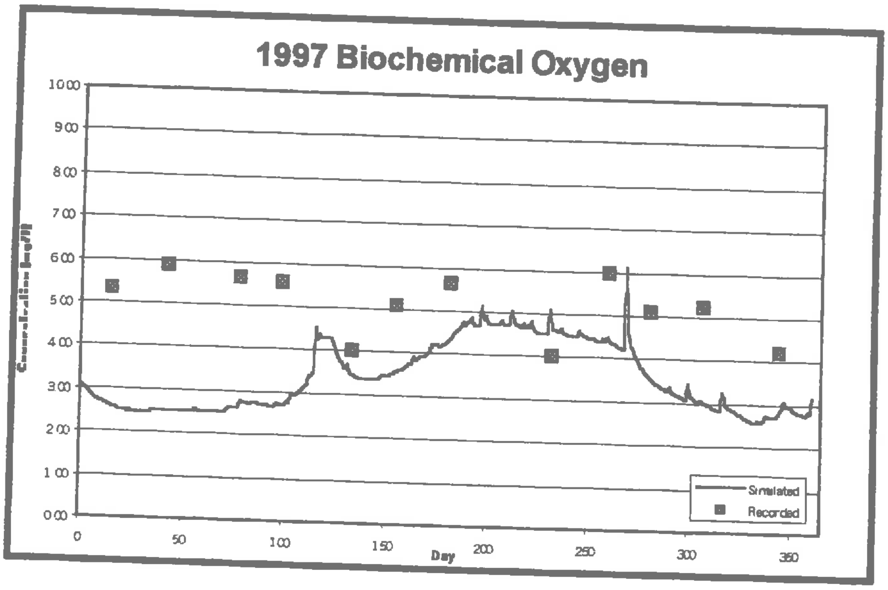
• Figure 22. Comparison of predicted and observed dissolved oxygen concentrations for 1998.

Five-Day Biochemical Oxygen Demand

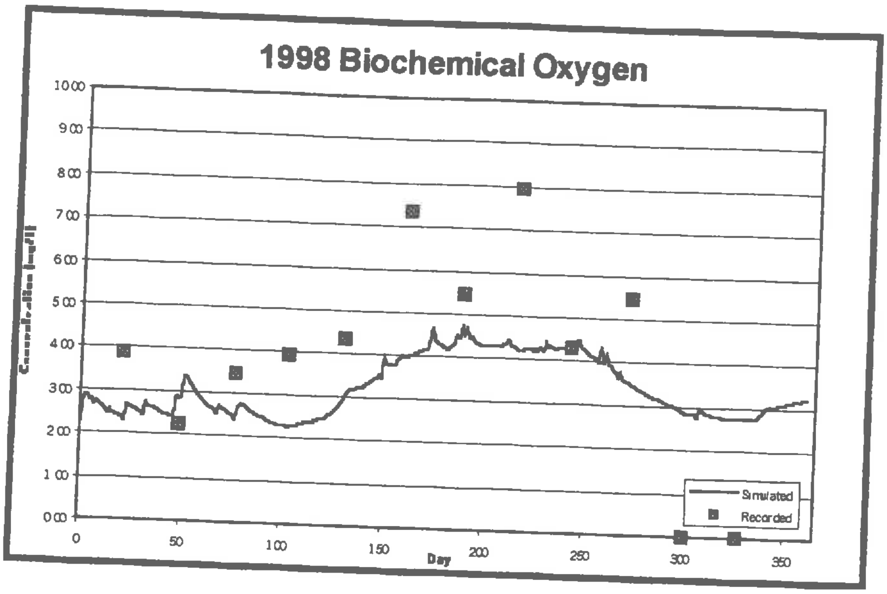
Predicted and observed 5-day Biochemical Oxygen Demand is illustrated in Figure 23 through Figure 25. Predictions generally mimicked seasonal variations in observed concentrations, although predicted concentrations were typically lower than those observed.



• Figure 23. Comparison of predicted and observed BOD_5 concentrations for 1996.



• Figure 24. Comparison of predicted and observed BOD_5 concentrations for 1997.



• Figure 25. Comparison of predicted and observed BOD_5 concentrations for 1998.

Summary of Model Calibration

The model calibration, as reported above, represents an improvement in both the physical and chemical characterization of the waterbody as well as in the predictive capability of the model over previous iterations. The calibration, while far from perfect, is considered reasonable for the available data and adequate for the relative assessment of management alternatives.

Evaluation of Management Scenarios

Following completion of the model calibration, input data sets were prepared by PBS&J for the comparison of management alternatives. MEnvS reviewed these input data sets. The files provided for review included the non-point source loading files, linkage files (with internal flows generated from continuity using a program developed for PBS&J and MEnvS), WASP input files, and a summary of the output in Excel spreadsheets. All results were plotted against the results for the 1998 Future Land Use Simulations – the baseline condition. In addition to each individual run of each management scenario, all were combined in an additional simulation. The scenarios evaluated included:

1. Management Scenario #1: Proposed ponds within the watershed result in a reduced nonpoint source.

2. Management Scenario #2: Proposed weir fluctuation results in lower water stages during the summer.

3. Management Scenario #3: Proposed canal diversion results in more flow and increased point source loads.

4. Management Scenario #4: Proposed dredging of sediments simulated by removal of sediment fluxes and addition of 1 million cubic yards of volume.

5. Combination of All Management Scenarios.

For each of the above scenarios, input data sets and model output were examined. Predicted volumes, depths, and mass balance checks were evaluated. In general, predictions seemed reasonable for the scenarios evaluated. Minor discrepancies in input data sets were noted and recommendations provided to PBS&J for incorporation into the final management simulations.

APPENDIX 3

LAKE SEMINOLE WATERSHED MANAGEMENT PLAN

Sediment Removal Feasibility Study

Prepared for:

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September 2001

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1.0 INTRODUCTION

Lake Seminole is a 684-acre freshwater lake located in west central Pinellas County, Florida. It was created by the impoundment of an arm of Long Bayou, an estuarine waterbody, in the 1940s. The Lake Seminole watershed encompasses approximately 3,500 acres, of which almost 90% is developed in urban uses. Much of the historical watershed of the lake has been diverted to the Seminole Bypass Canal, which intercepts surface runoff and conveys it east of the lake to Long Bayou. The lake currently supports heavy recreational use including boating, skiing, and fishing. In recent years, however, the sport fishery (primarily largemouth bass and bluegill) and water quality have declined. The available data indicate a trend of increasing eutrophication in Lake Seminole.

Unconsolidated sediments have been accumulating in Lake Seminole since its impoundment and creation in the 1940s. The accumulation of organic silts in lakes is often attributed to declining water quality and compromised recreational uses, and excessive accumulation of decaying vegetation along lake shorelines degrades sport fisheries as well as recreational uses and aesthetics (EPA, 1990). Although the shoreline of Lake Seminole has been altered by numerous dredge and fill activities, there has never been a large-scale sediment removal project implemented with the objective of improving lake water quality, fish and wildlife habitat, and recreational benefits for all waterfront homeowners and users of the lake. This report addresses the feasibility of removing accumulated sediments from Lake Seminole with these objectives in mind.

This report was specifically prepared to address the requirement of Task 3.2.16, Part B, of the Lake Seminole Watershed Management Plan scope of work. Based on the findings of Part A, *Lake Seminole Sediment Characterization Study* (Appendix 1 of the Lake Seminole Watershed Management Plan "the Plan") prepared by BCI in October 1997, this report provides an analysis of various sediment removal, treatment, and disposal alternatives for Lake Seminole. The objectives of this Sediment Removal Feasibility Study are as follows:

- summarize the characteristics and distribution of sediments in Lake Seminole;
- evaluate various sediment removal, treatment, transport, and disposal alternatives;
- assess potential staging sites, and spoil treatment and disposal areas;
- determine potential regulatory permitting constraints on sediment removal;
- recommend the most cost-effective approach to sediment removal from Lake Seminole;
- determine the optimum sediment removal/dewatering rate;
- assess potential sediment reuse options;
- estimate the cost of the recommended Lake Seminole sediment removal project;
- estimate the timeframe for the recommended Lake Seminole sediment removal project; and
- estimate public acceptance of the recommended Lake Seminole sediment removal project.

This report addresses the above objectives and presents results of the data and alternatives analyses conducted. In addition, a recommended approach to the Lake Seminole sediment removal project is discussed.

2.0 SEDIMENT DISTRIBUTION AND CHARACTERISTICS

2.1 Sediment Distribution

The spatial distribution and physical and chemical characteristics of sediments in Lake Seminole are described in detail in the *Lake Seminole Sediment Characterization Study* (BCI, 1997) provided in Appendix 1 of the Lake Seminole Watershed Management Plan. The information provided below has been summarized from this document.

The distribution and characterization of sediments in Lake Seminole were based on 40 sediment depth probes and sediment samples from 11 sites in the lake, collected by BCI in February 1997. These analyses revealed three distinct classifications of sediments in the lake:

- **Loose, high density sands** - The dominant sediment type in the southern lobe of the lake where the water depth averages 5.5 feet.
- **Flocculent, low density organic silts** - The dominant sediment type in the northern lobe, as well as the central "narrows" area connecting the north and south lobes, and in the drainage and navigational canals along the shoreline. The depth of these organic silts is 1 to 2 feet, however, patches of silt ranging from 4 to 8 feet in depth exist in certain areas.
- **Fibrous decayed plant matter** - The dominant sediment type along many portions of the lake perimeter formed by thick accumulations of decaying emergent aquatic vegetation (predominantly cattails). The depth of these organic peat sediments averages 1-2 feet, with deeper pockets in several areas along the shoreline.

Based on sediment depth probe and sample data, it is estimated that approximately 4.9 million cubic yards (yd^3) of unconsolidated sediments exist in Lake Seminole. Of this volume approximately 4.1 million yd^3 are loose, high density sands that overlay bedrock, whereas the remaining 800,000 yd^3 comprise a surficial veneer of flocculent, low density organic silts that can contribute to water quality problems in the lake. An additional 130,000 yd^3 of decayed plant matter or peat sediments exist along the lake shoreline in areas of heavy emergent aquatic vegetation. While these peat sediments likely do not contribute to water quality problems as much as the low density organic silts, they do substantially reduce the bottom area available for sport fish spawning and preclude the establishment of desirable submergent and emergent aquatic vegetation. Both the 800,000 yd^3 organic silt sediments from the submerged areas of the lake, and the 130,000 yd^3 of peat sediments in the shoreline areas, are considered to be problematic with respect to lake management objectives. Therefore, a total of 930,000 yd^3 of organic sediments are targeted for removal from Lake Seminole.

The relative volumes of all unconsolidated sediments, and the problematic sediments, in the three major segments of the lake are quantified in Table 1. As shown in this table, the 800,000 yd^3 of organic silts targeted for removal are predominantly located within the northern lobe of the lake and the central "narrows" between the north and south lobes, and in isolated pockets within the southern lobe. The north lobe contains an estimated 411,000 yd^3 within a fairly uniform distribution of a 1 to 2 feet thick sediment layer. The estimated 55,000 yd^3 of sediments within the central "narrows" area range from 2 to 4 feet in thickness and uniformly cover the area. The south lobe contains an estimated 334,000 yd^3 in isolated pockets of sediments that typically range from 1 to 2 feet in thickness. However, the deepest accumulation of sediments exists in the southwestern corner of the lake where the isolated pocket contains sediments of up to six feet in depth. The estimated 130,000 yd^3 of peat sediments exist predominantly in two areas on the east side of the lake: along the shoreline of Lake Seminole County Park (north of the boat ramp to the 102nd Avenue Bridge); and along the shoreline north of the Lake Park subdivision to the Lake Seminole control structure (e.g., the north end of the lake). Smaller segments of the peat sediments exist at various locations along the western shoreline of the lake.

Table 1. Distribution of organic sediments in Lake Seminole.

Region of Lake	Total Volume Unconsolidated Sediments (yd^3)*	Total Volume Organic Sediments (yd^3)*
North Lobe	1,679,000	411,000**
Central "Narrows"	192,000	55,000**
South Lobe	2,969,000	334,000**
Perimeter	130,000	130,000***
Total	**4,970,000**	**930,000**

* Wet volume.
** Flocculent, low density organic silts.
*** Fibrous, decayed plant matter.

The spatial distribution of the unconsolidated sediment mass can be mapped in terms of depth contours. Figure 1 shows the bathymetric contours in Lake Seminole, or the distance in feet from the water surface to the sediment surface. Figure 2 shows the organic sediment thickness contours, or the thickness of the muck sediment mass overlying unconsolidated sand or bedrock. Figures 1 and 2 also show the areas along the lake shoreline where nuisance aquatic vegetation, predominantly cattails, has formed accumulations of organic peat sediments composed of fibrous, decayed plant matter. Figure 3 shows a typical cross section through Lake Seminole, with the organic silt sediments or "muck" overlying sand and bedrock.

Figure 1
Lake Seminole Bathymetric Contours

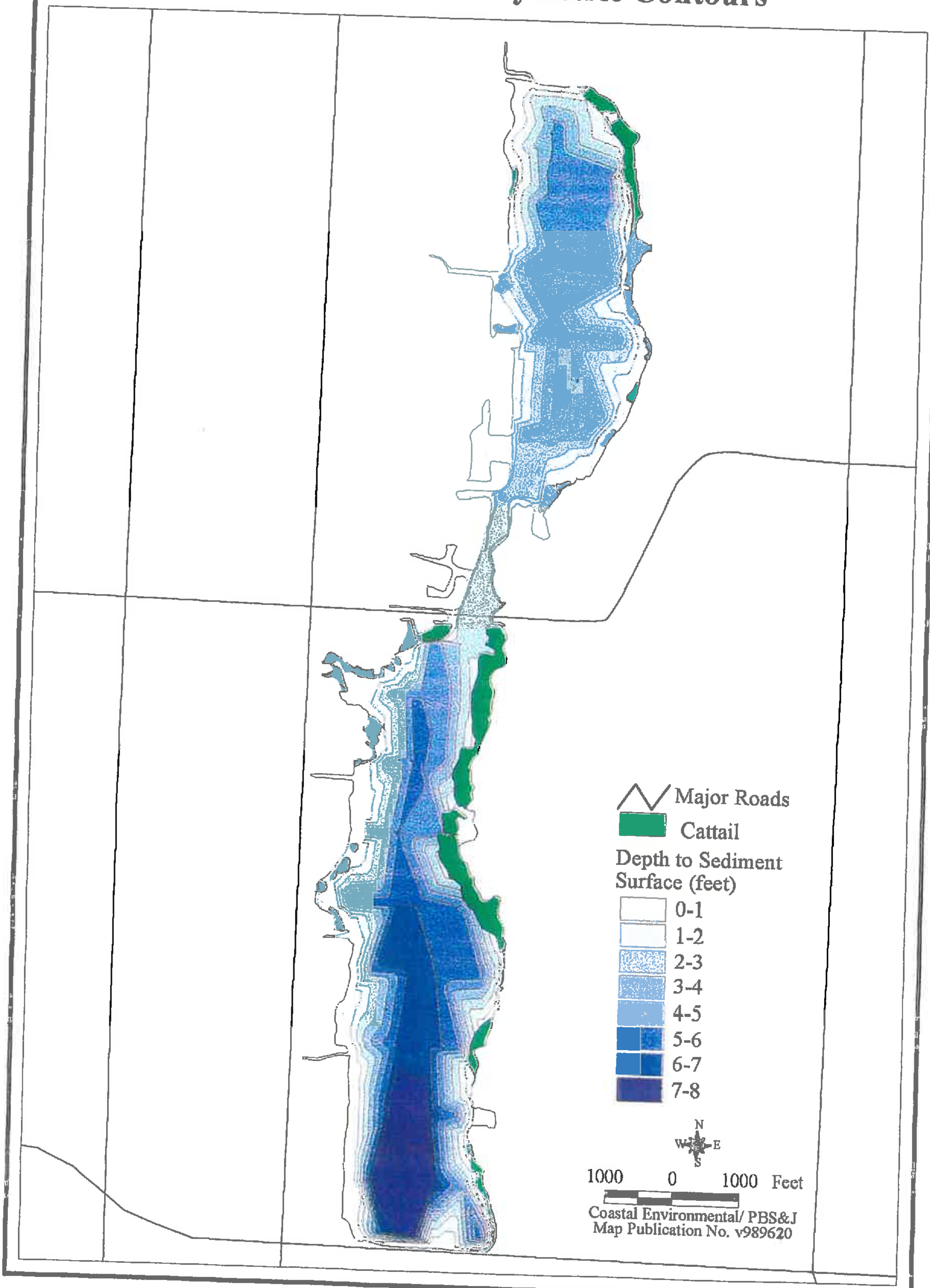


Figure 2
Organic Sediment Thickness Contours

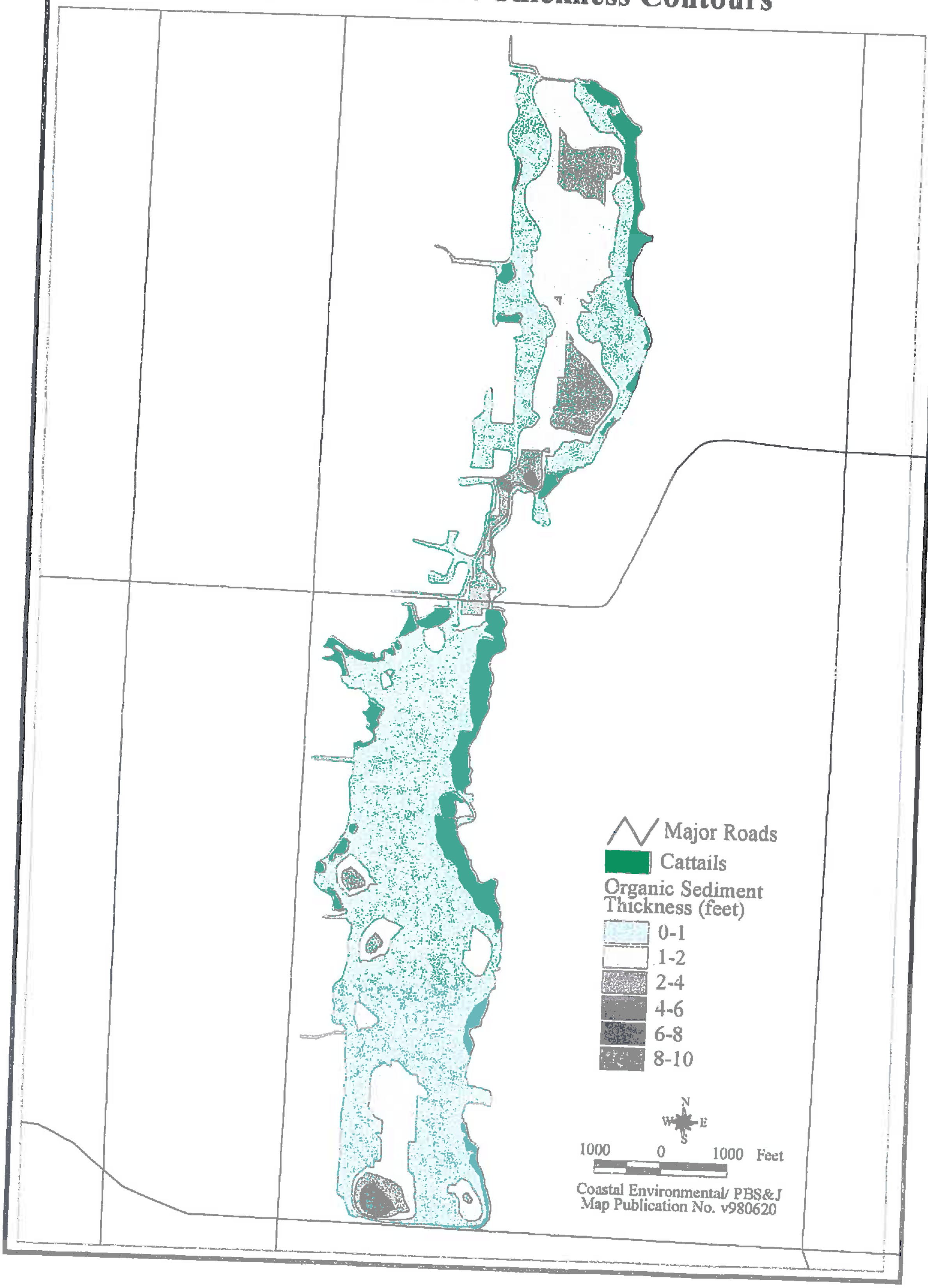
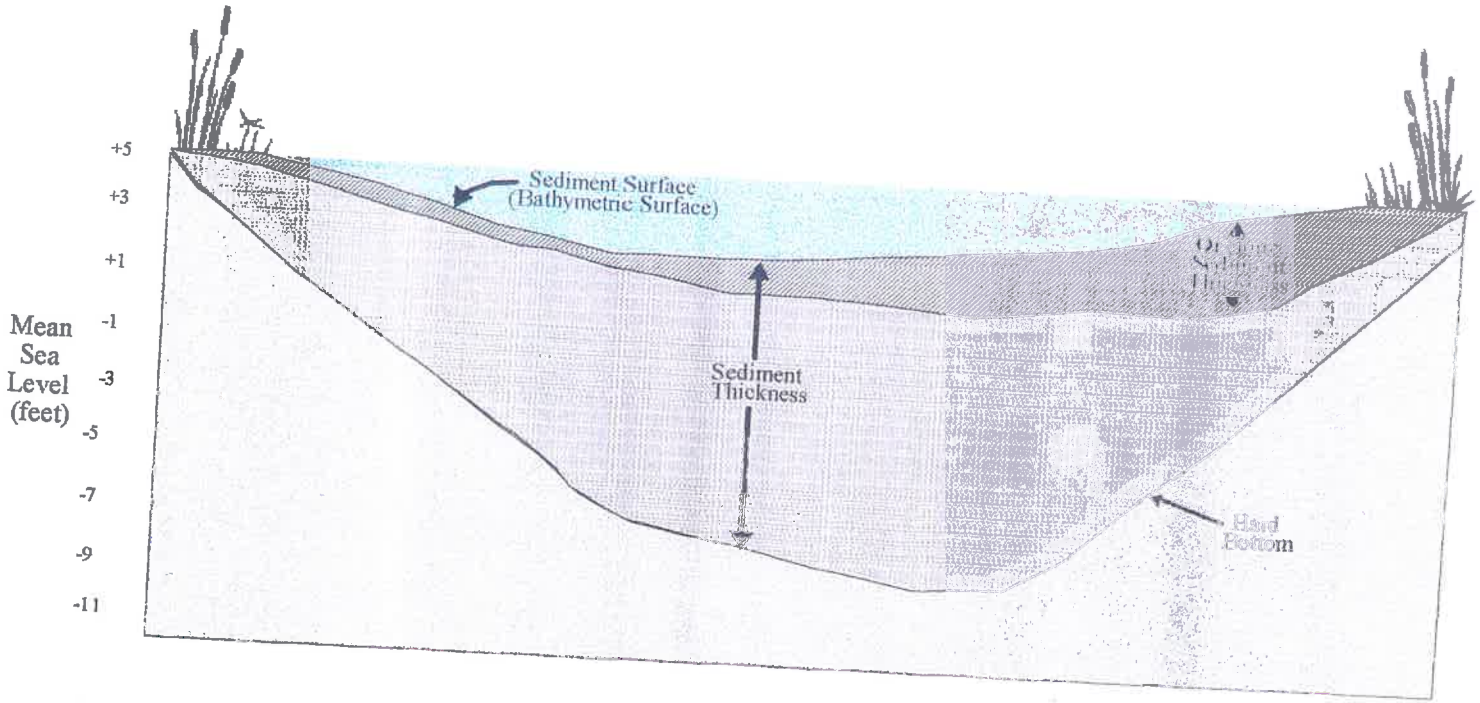


Figure 3
Typical Cross Section



2.2 Sediment Characteristics

This section presents a summary of Lake Seminole sediment characteristics based on laboratory analyses, and an assessment of the their general engineering properties.

2.2.1 Laboratory Analyses

Laboratory tests were performed on the sediments to determine the physical and chemical characteristics. The analytical data resulting from these tests are contained in the *Lake Seminole Sediment Characterization Study* (BCI, 1997) provided in Appendix 1 of the Plan. These tests included:

- solids content;
- organic content;
- percent by weight passing through a #200 sieve;
- grain size distribution;
- specific gravity;
- Atterberg limits;
- 30-day settling tests; and
- flocculation tests.

A summary of the sediment characteristics follows.

Solids Content

The solids content test is the ratio of dry solids to the total sample weight. The solids content was evaluated for two types of sediments found in the lake including the loose high density sands and the organic silts. The loose high density sands exhibited a range of solids content from 56.1 to 79.7 percent. The organic silts ranged between 5.5 to 28 percent solids content.

Organic Content

The organic content of the loose high density sands is relatively low at 0.7 to 2.2 percent with an average of 1.2 percent. The organic silts had an organic content of 15.7 to 46.1 percent with an average of approximately 28 percent.

Percent Passing Through a #200 Sieve

The material retained in the #200 sieve is classified as sands/shell and coarser materials found in the sediments, while the material that passes through the sieve is classified as clay/silt (fine grained). The percentage of the high-density sands that pass through the sieve ranged from 0.6 to 14.8, while the percentage of low-density silts ranged from 30.5 to 91.1.

Grain Size Distribution

Grain size analysis indicates variations between 2.0 millimeters in size for the high density sands found in the sediments to 0.096 millimeters for the organic silt. The range of grain sizes indicates that Lake Seminole sediments are generally classified as fine sands, to silt or clays.

Specific Gravity

A specific gravity test determines the dry density of a material. Typical mineral sediments containing predominately sands, silts, and clays will have a specific gravity in the 2.6 to 2.7 range. Highly organic sediments typically have specific gravities ranging from 1.8 to 2.2 or greater, depending on their organic content. Specific gravity determinations for the Lake Seminole organic silts averaged 2.3 and the loose high density sands averaged 2.6.

Atterberg Limits

The Atterberg limits test determines the plasticity of the sediments. Due to their obvious lack of plasticity, no Atterberg limits tests were performed on the high density sands. Based on their low average solids content of 15%, the fine grained materials and organic sediments would behave as a liquid and dewater very poorly by self-weight consolidation.

30-Day Settling Test

Settling tests indicate the speed at which sediments fall out or settle from diluted slurries. Variations in sediment type required that a number of settling tests be performed. These tests ranged between 7.4 to 44.2 percent solids after 30 days. As would be expected, the lower rates were for the highly organic silts, while the high settling occurred with the bulk medium to fine grained sands. A bulk muck sample that contained a composite mix was considered representative of the mixed sediments expected during dredging activities. This sample required 30 days to reach 18.6 percent solids.

Flocculation Test

Due to the slow rates of dewatering experienced in the settling test, an additional flocculation test was performed by mixing diluted sediment samples with a flocculent. Flocculates rapidly precipitate leaving clear decant water after screening. The test indicated that the low density organic silt sediment at five percent solids readily flocculated with a relatively low dosage of several flocculents.

If employed, the use of flocculents could reduce the requirements for land areas needed for the dewatering of sediments. The injection of flocculents, and screening and decanting of water, requires a treatment facility. A treatment facility of this nature is currently a new technology. One is currently in operation on the Lake Hollingsworth sediment removal program in the City of Lakeland. This technology has also been proposed for the Lake Maggoire Restoration in the City of St. Petersburg.

2.2.2 Sediment Toxicity

Lake Seminole sediments do not qualify as a hazardous material based on the metal concentrations detected in the Toxicity Characteristic Leaching Procedure (TCLP). The results of the TCLP testing showed that none of the sediments exceeded heavy metal standards for Clean Soil (see Appendix D of BCI, 1997). A comparison with USEPA limits for sewage sludge disposal shows that the sediments are well below applicable thresholds and should pose no limitations for land disposal. Since the sediment toxicity analyses were based on a relatively small number of samples, additional analysis should be anticipated during the sediment removal program.

With regard to nutrients, the results of the elutriate tests indicate that short-term eutrophication of surface waters may be a concern during dredging and sediment dewatering. Therefore, means to control sediment resuspension at the dredge site, and to treat decant water at the dewatering site, will need to be employed to maintain applicable surface water quality standards.

2.2.3 Engineering Properties

Engineering properties address the characteristics of the dewatered sediments that are to be transported to a disposal site(s). These properties indicate the range of uses that can be anticipated for the sediments. These uses may include topsoil, fill for construction sites, road fill, cover for landfill, plus characteristics relevant to use for embankments and drainage facilities.

Sediments are anticipated to be transported in a dry, semi-dry, or moist condition (less than 80 percent moisture by weight) to avoid dripping or spillage during transport. The percentage of material passing through the #200 sieve indicates that 0.6 to 14.8 percent are high density sands, whereas 30.5 to 91.1 percent are classified as low-density organic silts. A composite mix of these sediments would have poor engineering properties for construction and road fill materials.

The high percentage of organics indicates that the sediments are well suited for top soils and land cover type uses. The fill materials should be disposed of at minimal grade unless additional stabilizing materials are used. Separation of the sands from the organic silts may be performed in order to produce a "select" sand for use as a fill material that can serve as a construction fill or be blended with the organic materials to give the fill more manageable engineering properties relating to drainage and grading.

The Atterberg limits tests indicate that with a low average solids content of 15 percent, the fine grained and organic sediments would behave as a liquid and dewater very poorly by self weight consolidation. Conversely, dried sediments are anticipated to exhibit a high affinity for absorbing and holding water. This characteristic should be taken into consideration with any stockpiling on site, as well as the intended uses at the final disposal site. Fine grained sediments of this type also become suspended and entrained in water. Because of this characteristic, sediment disposal sites may erode if not subject to stabilization and/or revegetation.

2.3 Sediment Volume to be Removed

As discussed above, it is estimated that approximately 4.9 million cubic yards (yd^3) of unconsolidated sediments, including loose high density sands and low density organic silts, exist within Lake Seminole. Of this volume, approximately 800,000 yd^3 are considered to be the flocculent, low density organic silts that can contribute to water quality problems. In addition, 130,000 yd^3 of peat sediments exist along the lake shoreline in areas of heavy emergent aquatic vegetation. Therefore, a total of approximately 930,000 yd^3 of problematic sediments exist in Lake Seminole, and are targeted for removal to improve both water quality and habitat conditions.

It should be noted that Pinellas County initiated a cattail harvesting program in Lake Seminole during the mid-1990s with the objective of removing nuisance aquatic vegetation, predominantly cattails and primrose willow from priority shoreline segments. The harvester was not, however, capable of removing accumulations of peat sediments formed by decayed vegetation. Although the harvesting program has since ceased, 25-acres of the cattail dominated shoreline habitat were intended to be left in place along the Lake Seminole County Park as a habitat component. It is estimated that approximately 80,000 yd^3 of peat sediments underlies this 25-acre shoreline tract. If this area is not included in the sediment removal effort, it would reduce the volume of peat sediments to be removed to approximately 50,000 yd^3. Therefore, of the total 930,000 yd^3 of organic sediments in the lake, 850,000 yd^3 would be targeted for removal if the cattail marsh is not dredged.

In consideration of both the ecological and socio-economic objectives of the Lake Seminole Watershed Management Plan, the removal of the entire estimated 930,000 yd^3 of problematic organic sediments is recommended. Given the potential water quality, habitat, and recreational use benefits of removing the entire mass of organic sediments in the lake, conserving the existing cattail marsh along the County Park shoreline cannot be justified. Furthermore, it will likely be far more cost-effective to maximize the volume of problematic sediments removed in a single construction dredging project rather than to extend this effort out over several projects.

3.0 BENEFITS OF SEDIMENT REMOVAL

3.1 Water Quality Benefits

In lakes where nutrient loading from sediments is a major source of nuisance weed and algae growth, sediment removal may improve overall water quality (EPA, 1990). Dredging removes the top layer of sediment which contains the nutrients most readily available for biological processes, and is most important with respect to sediment-water column interactions and exchanges. In addition, if heavy metals and other toxic materials are present in bottom sediments, dredging these sediments can reduce the concentration of these hazardous substances in the sediments, and ultimately in the overlying water and organisms living in the sediment and water (EPA, 1990).

Both the flocculent organic silts and the organic peat sediments are potentially problematic in Lake Seminole. Due to the shallowness of Lake Seminole, the flocculent organic silts are easily resuspended by turbulent wave energy, especially those located in the "narrows" between the north and south lobes. This is demonstrated by a lack of reliable stratigraphy in sediment cores taken from this area (Schelske et al., 1991; in SWFWMD, 1992). Organic deposits in the north and south lobes show more reliable stratigraphy and are probably less prone to resuspension (Schelske et al., 1991; in SWFWMD, 1992).

The flocculent organic silts are also likely to be a major periodic source of water column nutrient enrichment, especially during the summer months when high bacterial respiration and high water temperatures can lead to low dissolved oxygen or hypoxia at the sediment/water column interface. Hypoxia at the sediment/water column interface, in turn, can cause chemical changes in the surface layer of the sediments which may facilitate the release of elemental phosphorus into the overlaying water column.

Schelske et al. (1991; in SWFWMD, 1992) concluded that nutrient release rates from Lake Seminole sediments may be a significant factor in the nutrient budgets of the lake. They measured nitrogen (N) and phosphorus (P) release rates from *in-vitro* sediment cores and found that N release rates ranged from 0.117 to 7.698 g/m2/yr (mean = 3.705), and P release rates ranged from 0.360 to 2.218 g/m2/yr (mean = 0.824). They compared these experimentally derived rates to "dangerous external loading rates" published by Vollenweider (1968) for lakes with a <5m mean depth and found the N release rate to be up to 6 times higher, and the P release rate to be up to 17 times higher, than the "safe" release rates for shallow lakes. The authors caution that the experimentally derived sediment nutrient release rates may represent maximum release rates caused in part by the removal of the sediment column from the lake bottom, and recommend that these rates be verified using alternative methods such as a nutrient loading model.

Using the mean N and P sediment release rates published by Schelske et al. (1991; in SWFWMD, 1992), the annual N and P fluxes to the lake surface waters are calculated to be 10,374 kg N/yr, and 2,307 kg P/yr, respectively. Compared to the calculated nutrient budgets for Lake Seminole the measured sediment N flux of 10,374 kg N/yr could account for as much as 47% of the calculated N load attributed to the *undetermined sources* balancing term in the Lake Seminole nitrogen budget. Similarly, the measured sediment P flux of 2,307 kg P/yr could account for as much as 75% of total calculated P load. Schelske et al. (1991; in SWFWMD, 1992) point out that their measured sediment nutrient release rates were highly variable depending upon the sediment type, and that lakewide estimates of sediment nutrient fluxes should be based on an assessment of proportional areal coverages of organic versus sandy sediments. Nonetheless, these findings clearly suggest that sediment nutrient fluxes potentially constitute a very significant component in the lake nutrient budgets.

In addition, water quality modeling using WASP5 indicated that sediment N and P fluxes in these orders of magnitude are needed to calibrate the model so that the observed water quality conditions in Lake Seminole are accurately simulated. Furthermore, WASP5 simulations using the calibrated model indicated that by removing the entire 930,000 yd^3 of organic sediments, and subsequently reducing the sediment nutrient fluxes by a very conservative 50%, the annual average lake chlorophyll-a concentrations would be reduced by 15.3 ug/l, or 24.4% below current levels.

Based on these analyses, it is concluded that the removal of the organic sediment mass in Lake Seminole will be very beneficial to lake water quality. Water quality benefits achieved through sediment removal are expected to include both: 1) the reduction of suspended material in the water column; and, 2) the removal of a potentially significant source of nitrogen and phosphorus from the lake surface waters.

3.2 Habitat Benefits

In addition to contributing to water quality problems, the substrate provided by the flocculent organic silts is generally not conducive to the establishment and proliferation of desirable submerged aquatic vegetation. Similarly, the peat sediments in the shoreline areas preclude the establishment and proliferation of desirable emergent aquatic vegetation. More importantly, thick accumulations of these sediments in the lake littoral zone severely limit the shallow bottom area available for sport fish spawning. Although there is no evidence that the shoreline peat sediments contribute to water quality problems in the lake, they do compromise shoreline recreational uses and aesthetics through the combined effect of sustaining extensive stands of nuisance aquatic vegetation as well as limiting sport fish spawning.

Sediment removal may aid in the control of aquatic weed growth in several ways (USEPA, 1990). Plants and the nutrients entrapped within the plant tissue are physically removed by the dredging process. The bottom sediment, which contains the root system of the plant and serves as a nutrient

reservoir for plant and algae growth, is also removed. In addition, dredging serves to reduce rooted vegetation growth by increasing the lake depth and reducing the amount of sunlight that reaches the sediment. Since plants require sunlight for growth, reducing the light levels will reduce the plant levels.

3.3 Recreational Benefits

Sediment removal is often used to deepen a lake for recreational and navigational purposes. Deepening a lake may be the only recourse when the lake has become too shallow for boat navigation, swimming, and fishing (NYSDEC, 1990). In addition, other control methods related to nutrient management, such as chemical treatment (e.g., alum), are of little use when water depths are simply too shallow for the lake's intended uses. When recreational uses are compromised by restricted navigability, or when aesthetics are adversely impacted by the turbulent resuspension of shallow lake sediments into the water column, sediment removal through dredging may be the only recourse (EPA, 1990).

Poor water clarity is frequently cited by lakefront homeowners and recreational users of lakes as a significant factor determining the aesthetic quality of their recreational experience (NYSDEC, 1990). The resuspension of flocculent organic silts due to turbulent wave energy (e.g., generated by wind or powerboat wakes) has the potential to cause reduced water transparency and compromised recreational experiences, at least in localized areas. Although the direct contribution of sediment resuspension to reduced water clarity has not been quantified, there is strong anecdotal evidence that it contributes significantly to the very poor transparency observed in Lake Seminole during and following periods of high wind.

Navigability is currently somewhat restricted in the "narrows" portion of Lake Seminole, and along certain shoreline areas, due to excessively shallow depths. In addition, water clarity is typically very poor in Lake Seminole, contributing to a generally poor recreational experience. Sediment removal is expected to substantially improve the recreational uses and natural aesthetics of Lake Seminole by improving both navigability and water clarity.

4.0 ALTERNATIVES ANALYSIS

4.1 Components of the Sediment Removal Project

With regard to the Lake Seminole Watershed Management Plan, the "sediment removal project" generally refers to a three step process whereby sediments are removed, treated (e.g., dewatered), and then permanently disposed of. Between each of these steps the sediment material must also be transported. As summarized in Section 2.0 above, Lake Seminole contains approximately 800,000 yd^3 of fine organic silts, herein referred to as "muck" sediments. These muck sediments have been identified as a potential source of water quality degradation in Lake Seminole. In addition, 130,000 yd^3 of decayed plant matter or peat sediments exist along the lake shoreline in areas of heavy emergent aquatic vegetation accumulation. These sediments preclude the establishment and proliferation of desirable emergent aquatic vegetation, and severely limit the shallow bottom area available for sport fish spawning.

The approach to removing problematic sediments from Lake Seminole will require a technically and economically viable combination of removal, treatment and disposal options, including the following:

Sediment Removal Alternatives

- lake drawdown with sediment compaction/oxidation;
- lake drawdown with mechanical excavation;
- lake drawdown with hydraulic dredging and mechanical excavation;
- hydraulic dredging; and
- mechanical dredging.

Sediment Treatment Alternatives

- percolation/evaporation (e.g., drying ponds to dewater and consolidate sediments);
- physical treatment (e.g., hydrocyclone technology);
- chemical treatment (e.g., polymer flocculation);
- process treatment (e.g., combination of physical and chemical treatment methods); and
- discharge to wastewater treatment plant.

Sediment Disposal Alternatives

- in-lake disposal;
- landfill disposal;
- landspreading; and
- distribution as topsoil.

In addition to sediment removal, treatment, and disposal alternatives, the transport of sediments is a major consideration that factors into the logistic and economic evaluation of various sediment removal project alternatives. Sediments must be transported from the extraction site to the treatment site, and then from the treatment site to the ultimate disposal site(s). Sediment transport options depend largely on the consistency and percent solids of the dredge spoil material, and typically include the following modes:

- barge;
- pipeline; and
- truck.

Each of the above listed options for sediment removal, treatment and disposal take into consideration certain constraints that exist for the anticipated sediment removal project in Lake Seminole. In addition to volume and physical/chemical characteristics of the sediments involved, these constraints include: the physical configuration and setting of the lake; the availability and location of staging, treatment and disposal sites; and regulatory controls under which these activities must be conducted. The physical configuration of the lake and its setting within a highly urbanized basin in particular present a number of constraints to the sediment removal project including: the long, linear configuration of the lake; the heterogeneous distribution of sediments throughout the linear lake bottom; and the limited number of vacant parcels along the shoreline for staging, and spoil treatment and disposal.

The regulatory coordination and permitting that will be required to facilitate the sediment removal program is another project constraint. It is anticipated that permits will be needed from the U.S. Army Corps of Engineers, Southwest Florida Water Management District, Florida Department of Environmental Protection, and Pinellas County. In addition, because Lake Seminole is part of the Pinellas County Aquatic Preserve and as such is classified as an Outstanding Florida Water (OFW), dredging is allowed only when demonstrated to be in the public interest. Approval by the Board of Trustees of the Internal Trust Fund of the State of Florida (e.g., the Governor and Cabinet) will likely be required in order to implement the sediment removal project, unless the regulatory status of Lake Seminole as an OFW is amended. Depending on the location and extent of other related facilities, permits or approvals may also be required from the cities of Seminole and Largo.

4.2 Sediment Removal Alternatives

Sediment removal projects typically involve the excavation or dredging of bottom sediment from a lake for the purposes of increasing depth, controlling nuisance aquatic vegetation, controlling nutrient release from sediments and water quality, and removing toxic substances. While sediment removal can be very effective in controlling algal blooms, it is used most often to deepen lakes and remove macrophytes (EPA, 1990).

Since dredging projects will not easily elicit the support of the local community, other management strategies should be considered first. Excessive rooted vegetation may be more simply controlled by mechanical harvesting or herbicide applications. In some lakes nutrient release from sediments can be controlled by phosphorus precipitation and inactivation, and toxic materials may be more easily contained with sand and bottom barriers or chemical inactivation. Unfortunately, however, there may not be any other feasible management alternative for increasing the lake depth and reducing the water quality impacts of sediment resuspension problems exhibited in Lake Seminole.

Sediment removal is probably the most difficult lake restoration technique to successfully complete due to the scale and impacts of the dredging process. While the benefits of dredging can be more dramatic and persist for much longer than those of other techniques, the costs are much higher than virtually all other techniques, and the potential for negative impacts can be relatively high. In addition, most lake communities have not been willing to provide or secure the levels of funding necessary to implement a dredging project, or to endure the extensive environmental review and permitting process associated with dredging. Consequently, dredging projects can generally be implemented only where federal, state and/or local government participation in the funding, engineering, and permitting of the project are provided.

An alternative to sediment removal is lake drawdown with sediment compaction/oxidation. Although not technically a sediment removal technique, sediment compaction/oxidation can result in an effective decrease in the volume and chemical reactivity of organic materials contained in lake sediments.

This section presents a discussion and analysis of alternatives for removing sediments from Lake Seminole. As mentioned above, five sediment removal alternatives are considered:

- lake drawdown with sediment compaction/oxidation;
- lake drawdown with mechanical excavation;
- lake drawdown with hydraulic dredging and mechanical excavation;
- hydraulic dredging; and
- mechanical dredging.

Each of these alternatives are discussed below, followed by a comparison of the relative advantages and disadvantages associated with each.

4.2.1 Lake Drawdown with Sediment Compaction/Oxidation

Sediment compaction involves a drawdown of lake water levels for an extended period of time (e.g., six months or more) such that sufficient desiccation and oxidation of organic material can take place. As mentioned above, lake drawdown with sediment compaction/oxidation is technically not a sediment extraction technique, however, it can result in an effective decrease in the volume of reactive organic materials contained in lake sediments.

The benefits and impacts of lake drawdown as a lake management technique have been studied and summarized by Greening and Doyon (1990). With some exceptions, lake drawdown results in increased fish production and littoral zone habitat enhancement, increased macrophyte-associated macroinvertebrate populations, and short-term control of nuisance vegetation in cold climates. On the other hand, drawdown generally does not result in long-term water quality improvements (decreased TP, TN, or chlorophyll-a concentrations) or nuisance macrophyte control in warm climates (including Florida). In addition, significant sediment consolidation occurs only following long (>7 months) periods of desiccation. The following conclusions were reached by Greening and Doyon (1990) regarding the effectiveness of extended water level drawdown in Florida lakes.

- Lake drawdown is effective for improving sportfish populations (as total numbers, densities, and growth), primarily due to improved littoral zone habitat. Germination and growth of the littoral zone and terrestrial plant species on exposed sediments during water level drawdown provide food, spawning sites, and habitat for many species of fish and macroinvertebrates. Other factors include a concentration of forage fish in remaining water during drawdown, an increase in invertebrate littoral zone organisms, and an increase in suitable spawning sites after refill. Sport fish populations in Florida lakes may remain high for two to six years before returning to pre-drawdown levels.

- Due to increased littoral zone habitat, macrophyte-associated macroinvertebrates exhibit temporarily increased densities after lake refill. However, benthic species which inhabit lake sediments exposed during water level drawdown can suffer reduced densities or elimination during dewatering.

- Lake drawdown can result in temporary (<1 year) improvements in water quality (e.g., decreased TP, TN, and chlorophyll-a concentrations). However, all lakes in Florida reporting water quality information showed higher nutrient concentrations during and after drawdown when compared to periods prior to water level reduction. Increased nutrient concentrations during drawdown have been attributed to the release of nutrients from exposed sediments during exposure to oxygen and increased microbial activity. Upon reinundation, terrestrial plants which germinate on the exposed sediment are flooded and die, and can release additional nutrients into the water column.

- Lake drawdown is effective for annual control of some nuisance macrophyte species (especially pondweed, coontail, and milfoil) in cold climates. Winter drawdown in northern states results in exposure, desiccation, freezing and ice scour, causing temporary reductions in the populations of susceptible species. However, freeze-tolerant nuisance species can become established as a result of reduced competition for space.

- Lake drawdown alone does not appear to be successful for nuisance macrophyte control in Florida lakes. Several drawdowns have resulted in large growths of undesirable vegetation (especially cattail and water hyacinth) which must be controlled after refill. Drawdown on

Lake Ocklawaha (Rodman Reservoir) provided short-term control of coontail and hydrilla, but increased growth of water hyacinth and alligatorweed. The year-round growing season in Florida undoubtedly contributes to the difficulties in managing nuisance macrophytes. Lake drawdown combined with periodic high water levels may be more effective at controlling emergent nuisance macrophytes.

- Lake drawdown can be effective for sediment consolidation if the drawdown is for a sufficient length of time, and if the water level is lowered below the level of the unconsolidated sediments. In Florida lakes, it appears that sediments must be dewatered for at least seven months before significant sediment consolidation occurs. Periods of dewatering between three and seven months have resulted in the formation of a cap of consolidated sediments overlying unconsolidated muck, which becomes colonized with emergent or terrestrial vegetation during drawdown. Upon lake refill, this cap of consolidated sediment can become dislodged from the unconsolidated sediments below it and float to the surface, causing "floating islands" of vegetation.

- Sediment exposure as a result of lowered lake levels can result in increased release of orthophosphate due to more effective oxidation of the sediments. However, experimental desiccation and consolidation of sediments from Lake Apopka indicate that the effect of sediment drying on major nutrient forms appears to be minimal, and leads to only slight changes in nutrient leachability.

While lake drawdowns have been used successfully on many Florida lakes as a means to temporarily improve shoreline habitat and sports fisheries, it is concluded from the findings cited above that other lake management objectives such as sediment volume reduction and improved water quality would not be addressed by an extended drawdown in Lake Seminole. Therefore, this alternative was eliminated from further consideration.

4.2.2 Lake Drawdown with Sediment Removal via Mechanical Excavation

Sediment removal from lakes is usually accomplished by either: 1) drawdown of lake water levels followed by mechanical excavation; or, 2) in-lake dredging. In drawdown excavation, water must be pumped or drained from the lake basin, and the exposed sediments must be sufficiently dewatered to accommodate heavy earth-moving equipment. The exposed sediments can then be excavated. Where it is difficult or impossible to drain a lake, mechanical "bucket" dredges, and hydraulic "suction" dredges, have been used effectively to remove problematic sediments from lakes.

An extended lake drawdown followed by the mechanical excavation of organic shoreline sediments in Lake Seminole has been recommended by the Florida Game and Fresh Water Fish Commission (FGFWFC) as a means of improving the sport fishery of the lake (see Appendix A - 1996 letter from Tom Champeau to Will Davis). As recommended by the FGFWFC, lake levels would be dropped from the normal elevation of 5.0 feet NGVD to 1.0 feet NGVD for a period of at least six months,

and exposed shoreline areas would be scraped down using bulldozers to remove organic sediments. The organic sediments would be hauled away in dump trucks, and the lake would be allowed to refill.

It should be noted that the existing fixed-crest weir outfall structure at the south end of Lake Seminole does not allow for water level manipulation. Until the modified slot-gate outfall structure that has been designed and permitted for Lake Seminole is constructed, a lake drawdown would only be feasible by pumping water over the existing weir. Following completion of the new outfall structure, a lake drawdown could be accomplished by opening the slot-gates and discharging the lake water into Long Bayou. The new outfall structure has been designed to allow for controlled lake level fluctuation between elevations of 3.0 and 5.0 feet NGVD. Lowering of the lake level below 3.0 feet NGVD with the new outfall structure is possible, however, below about 1.0 foot NGVD, additional pumping would be required.

Figure 4 shows the portions of Lake Seminole that would be exposed through a one, two, and three foot drawdown of Lake Seminole below the normal lake elevation of 5.0 feet NGVD. Based on this analysis, a drawdown to elevation 3.0 feet NGVD (e.g., a 2-foot drawdown) would be adequate to expose the majority of the problematic shoreline sediments. The major problem areas are located in the central portion of the lake, on both the east and west shorelines south of the 102nd Avenue bridge. Therefore, if a drawdown was to be conducted only for the purposes of improving shoreline habitat and sport fisheries, it appears that sufficiently low water levels could be attained through the operation of the new control structure without the need for additional pumping.

Although this alternative could be used to effectively remove the organic peat sediments along the lake shoreline, it would not facilitate the removal of the majority of the flocculent organic silts in the deeper portions of the lake. It would not be possible to the lower the lake level sufficiently to expose the entire lake bottom using gravity alone to discharge water through the new outfall structure. To do so would require pumping to lower lake levels below the structure invert elevation of 3.0 feet NGVD. Because the lake is 7 feet deep (e.g., approximately -2.0 feet NGVD) in some places during normal water levels, it is likely that substantial pumping would be required to continuously remove groundwater seepage and expose sediments in the deeper portions of the lake.

In addition to removing surface water, the water table in the sediment would also need to be lowered to assist with the consolidation and desiccation process. Several intersecting water collection ditches would need to be excavated along the lake bottom to create a sump system at approximately two to three feet below the lowest sediment level. Water would then need to be continuously pumped out of the sump system, clarified, and discharged as necessary. Even with continuous pumping it is likely that the hydrophilic muck sediments would retain substantial moisture, making the operation of earthmoving equipment along the lake bottom extremely difficult.

To desiccate the organic silts sufficiently such that earthmoving equipment could be effectively operated along the lake bottom, it would likely be necessary to essentially lower the water table on the order of 8-10 feet below the existing lake level, or approximately 3-5 feet below sea level. This would likely require lowering the water table not only within the lake but also within the surficial aquifer contributing seepage to the lake. BCI (1995) estimated that up to 2.5 million gallons per day would need to be pumped from Lake Maggiore in St. Petersburg to lower the water table and maintain a sufficiently dry lake bottom to allow for mechanical sediment excavation. This estimate assumed all stormwater runoff from the adjacent watershed could be routed away from the lake bed. Given that Lake Seminole is almost twice as large as Lake Maggiore, it could be conservatively estimated that up to 5 million gallons per day would need to be pumped to maintain a dry lake bed. However, because there is a substantial ridge of well-drained sands in the western portion of the Lake Seminole watershed, actual groundwater seepage volumes discharging to the lake following a drawdown could be substantially greater, requiring even higher pumping rates.

The seasonal timing of this alternative would also be critical because the process is extremely weather dependent. Pumping, drying, and mechanical removal would need to be completed during the dry season in order for maximum desiccation to occur. Depending on the climatic conditions which are encountered during the project, stormwater inflows could cause a great deal of difficulty. It would be necessary to construct a highly reliable drainage and pumping system within the lake bed to maintain the water table below sea level. Failures of this system, or unusually high rainfall amounts, could result in potentially long project delays and unpredictable cost increases. Given that the entire process would need to be completed within the 8-month dry season, it may not be technically feasible. In addition to the hydraulic problems associated with sufficiently lowering lake levels to expose sediments in the deeper portions of the lake, an extended drawdown of Lake Seminole could potentially result in substantial adverse social and economic impacts resulting from the following:

- structural damage to seawalls, docks, and boat lifts;
- temporary curtailment of recreational uses of the lake; and
- odor from decaying vegetation and exposed anaerobic sediments.

As part of this Sediment Removal Feasibility Study, a preliminary structural assessment of the existing vertical seawalls in Lake Seminole was conducted (see Appendix B - 1997 memorandum from Morad Ghali to Roger Anderson). Based on this preliminary assessment, it was determined that there are several segments along the lake shoreline where the age of the existing vertical seawalls is advanced, and the condition rated as either *serious* (local failure is likely), *poor* (advanced wall deterioration), or *fair* (all primary wall elements are sound but may have minor deteriorations). In these segments, the existing vertical seawalls are at risk for physical damage or failure from a rapid lowering of lake water levels and/or an extended drawdown period. Based on this analysis, it is concluded that an extended lake level drawdown would likely expose Pinellas County to numerous liability claims for structural damage to existing vertical seawalls. Although the condition of existing docks and boat lifts was not inspected as part of this study, there would be similar liability risks with regard to these structures as well.

An extended drawdown of Lake Seminole, even to elevation 1.0-feet NGVD, would restrict virtually all recreational uses of the lake, effectively eliminating the two existing lake-dependent commercial operations, as well as severely curtailing the public use of Lake Seminole County Park. In addition, an extended lake drawdown would cause substantial indirect economic impacts to lakefront property owners by temporarily eliminating riparian access and recreational uses of the lake, degrading waterfront views and shoreline aesthetics, and creating odor problems from decaying vegetation and exposed anaerobic sediments. While it is difficult to quantitatively estimate the direct and indirect adverse socio-economic impacts associated with an extended lake drawdown, it is likely that legal claims for property damage and reduced property values would constitute a significant financial and administrative burden to Pinellas County during and after project completion.

Based on the concerns discussed above, it is concluded that *lake drawdown with sediment removal via mechanical excavation* is not a feasible sediment removal alternative in Lake Seminole. While this alternative could be used effectively to remove the organic peat sediments along the lake shoreline, it would not facilitate the removal of the majority of the flocculent organic silts in the deeper portions of the lake. Nonetheless, even if this approach was used to remove the problematic shoreline sediments and only a portion of the organic silts, many of the adverse socio-economic impacts discussed above would still be incurred. Given the dense urban land uses that surround Lake Seminole, and the intense recreational uses of the lake, an extended lake drawdown is not considered to be economically feasible, and may not even be technically feasible. Therefore, this alternative was eliminated from further consideration

4.2.3 Lake Drawdown with Sediment Removal via Hydraulic Dredging and Mechanical Excavation

This alternative would involve an abbreviated lake drawdown (e.g., 2-4 months), but only to elevation 3.0-feet NGVD, to allow for the exposure and mechanical excavation of the organic peat sediments along the lake shoreline. In addition, the flocculent organic silts in the deeper portions of the lake would be concurrently removed via a hydraulic suction dredge mounted on a floating barge. Because water levels would only need to be lowered to expose the problematic shoreline sediments, the lake drawdown could be entirely accomplished using gravity discharge through the new outfall structure. Furthermore, since the deeper central portions of the lake would remain inundated to float the hydraulic dredge, the need for supplemental pumping would be eliminated.

Although aforementioned concerns regarding an extended drawdown still apply to this alternative, the potential adverse impacts would likely be lessened because: 1) the lake level would only be lowered to approximately 3.0 feet NGVD as opposed 1.0 feet NGVD or lower; and 2) the time period of the drawdown would likely be shorter, on the order of 2-4 months as opposed to 7-9 months.

As envisioned, this alternative would involve mobilizing earthmoving equipment to a shoreline segment targeted for sediment removal, followed by the lowering of lake water level to 3.0-feet

NGVD. When the exposed sediments were sufficiently desiccated, they would be excavated using the earthmoving equipment, and then transported by truck to an off site disposal area. When the sediments were completely removed from the targeted shoreline segment, the lake levels would be allowed to rise back up to the ordinary high water elevation while the earthmoving equipment was being relocated to another targeted shoreline segment.

Phasing the mechanical excavation of shoreline sediments in this manner would result in minimal disruptions of lake recreational uses. Riparian access to the lake, and lake recreational uses, would not be severely restricted if water levels were maintained at or near 3.0-feet NGVD. With the existing fixed-crest weir outfall structure in place, lake levels have periodically dropped to within this range during periods of drought without major disruptions to recreational uses and lake-dependent commercial operations. Therefore, compared to the *lake drawdown with sediment removal via mechanical excavation*, this alternative would result in substantially reduced social and economic impacts.

It is estimated that the entire 130,000 yd^3 of organic peat sediments that exist along the lake shoreline in areas of heavy emergent aquatic vegetation could be removed using this approach. In addition, since the sediments would be excavated in a saturated but not inundated condition, it is likely that no additional dewatering or treatment would be necessary for truck transport and disposal. Another benefit of mechanical excavation of sediment in these areas is that the shoreline could be graded and prepared for appropriate shoreline revegetation efforts, an application that is not well suited for either a hydraulic or mechanical dredge.

While no sediment treatment is required with this alternative, it would require an upland access point and staging/stockpiling site adjacent to each of the targeted shoreline segments. The provision of an upland staging and stockpiling site on the east side of the lake, where Pinellas County owns most of the shoreline south of the 102nd Avenue Bridge, would likely not present a problem. On the west side of the lake, however, the purchase or lease of private property for this purpose may be required. It should also be noted that the hydraulic dredging of the flocculent organic silts from the deeper central portions of the lake would require a spoil treatment/handling site, and a permanent disposal site for the dewatered sediments. The hydraulic dredging process is described in Section 4.2.4, and various alternatives for treating the hydraulic dredge spoil material are discussed in detail in Section 4.3.

Although this alternative would present some of the operational difficulties associated with the *lake drawdown with sediment removal via mechanical excavation* alternative, these difficulties would be far more manageable due to the fact that water levels would only be lowered to 3.0-feet NGVD, and there would be no need for lowering the water table or for supplemental pumping. This alternative would, however, require the construction of a spoil treatment facility for dewatering the hydraulic dredge spoil, which is potentially the most costly component of the project. Nonetheless, this alternative is considered to be both technically and economically feasible.

4.2.4 Sediment Removal via Hydraulic Dredging

This alternative would involve the hydraulic dredging of both the organic peat sediments along the lake shoreline, and the flocculent organic silts in the deeper portions of the lake. All of the dredging would be conducted using a hydraulic cutterhead dredge mounted on a floating barge. The dredge spoil material would be pumped as a "slurry" to an upland treatment site where it would be dewatered, and then loaded into trucks and transported to a permanent disposal site. This alternative would not require an extended lake level drawdown, as all sediment removal could be conducted at the ordinary high water elevation of 5.0-feet NGVD. However, the construction of an upland treatment facility somewhere near the perimeter of the lake would be necessary.

Dredging has proven to be an effective control technique for many lakes for increasing mean depth, reducing excessive vegetation levels, controlling nutrient release from sediments, and reducing the concentrations of toxic substances and nutrients in sediments. It has been used for the entire lake basin in smaller lakes, or only a small portion of the basin for larger lakes. If dredging is not done properly, however, it can actually make lake conditions worse by causing excessive turbidity, fish kills and algal blooms (NYSDEC, 1990). The main problems occur when bottom sediments mix with lake water during the dredging process. This can happen while the sediments are being removed with a mechanical bucket dredge, or when return water from a hydraulic dredging settling basin is discharged back into the lake. As a result, nutrients, toxics and other contaminants may be reintroduced into the lake water column. Many of the water quality problems associated with dredging can, however, be minimized by the selection of the most appropriate dredge for the particular application, and the use of best management practices.

The type of dredge used (e.g., hydraulic vs. mechanical) will depend upon factors that include: time and financial constraints; land availability; the distance which the spoil material must be transported; and the physical and chemical characteristics of the dredge spoil material. The design of the disposal area will depend largely upon the amount of dredge spoils that must be contained. In addition, the sediment grain size and settling characteristics are important factors to consider if any decant water will be discharged from the disposal site.

Unlike mechanical bucket dredges, hydraulic dredges generally do not cause elevated turbidity levels or water quality problems at the dredge site. Any localized turbidity created by the cutterhead is usually sucked into the pipeline where ambient water is mixed with sediment to create the spoil slurry. Therefore, where maintenance of water quality standards within the waterbody to be dredged is a critical issue, hydraulic dredges are typically preferable over mechanical dredges. However, the discharge of the spoil slurry from hydraulic dredges must be carefully managed to avoid water quality problems at the treatment and/or disposal site.

Cutterhead hydraulic pipeline dredges are most commonly used to remove lake sediments (EPA, 1990). These dredges can operate anywhere on the lake, cutting to a depth of up to 18 meters. The system is operated from a floating steel hull, moved by raising and lowering vertical pipes ("spuds")

to "walk" the dredge forward. The cutterhead typically consists of three to six smooth or toothed conical blades, mounted on a movable steel boom or ladder at the bow of the platform. Different types of cutterheads have been designed to loosen and remove sand, silt, clay, stumps, vegetation, and even rock. When the cutterhead is lowered to the lake bottom and moved from side to side, the rotating blades loosen the sediments, which are transported to the pickup head by suction from the dredge pump. The sediment slurry (10-20% sediment and 90-80% water) is then pumped through a pipeline for discharge at the disposal site.

It is anticipated that a hydraulic dredge with a 12-inch diameter cutterhead and pipeline could be used on Lake Seminole. An appropriate cutterhead for removing stumps and vegetation would be used in the shoreline areas. A 12-inch hydraulic dredge could operate at a capacity of between 3,000 to 5,000 gallons per minute (gpm). Assuming a bulking factor of three (i.e., a dilution of the solids content of the dredged sediment to one third that of the *in-situ* volume), the dredge could have the capability to remove between approximately 2,268 and 3,785 yd^3 of sediments during a ten hour working day. This dredging rate would allow for the complete removal of the entire 930,000 yd^3 of sediments targeted for removal within a period of between 246 and 410 work days, not including mobilization, downtime, demobilization, and site reclamation.

Because there are limited vacant upland parcels along the lake perimeter or in the nearby watershed, this dredge operational rate would be dependent on the ability to efficiently dewater and transport the spoil material from a smaller treatment site to a permanent disposal site. If the treatment and disposal operations cannot keep pace with the 12-inch dredge, a lower volume dredge (e.g., 8 to 10-inch) operating over a longer period of time may better match the capacity of the landward facilities. Therefore, the rate of the hydraulic dredge operation would be potentially limited by the availability of land for spoil treatment facilities and disposal, and the efficiency of the spoil treatment system that is ultimately implemented. Land availability for treatment and disposal is discussed in detail below.

The *sediment removal via hydraulic dredging* alternative is considered to be both technically and economically feasible for Lake Seminole, provided that suitable spoil treatment and disposal sites are available, and that an efficient spoil treatment process can be developed and effectively implemented. Various spoil treatment alternatives are discussed in detail in Section 4.3 below. Both the peat sediments along the shoreline, and the flocculent organic silts in the deeper portions of the lake, could be effectively removed using a hydraulic dredge without the disruptions to riparian access and recreational uses associated with an extended lake level drawdown. In addition, water quality conditions in the lake would not be degraded during the dredging operation. Treatment of the spoil material would, however, be more difficult due to the variable mixture of decaying plant matter and the organic silts in the hydraulic slurry. A more heterogeneous spoil slurry may require the use of different polymers and/or other treatment process modifications depending on the nature of the sediments being dredged at any given time. The need to modify the spoil treatment process in response to variable concentrations of the two major sediment types in the hydraulic dredge slurry would likely result in reduced pumping rates and related project delays.

4.2.5 Sediment Removal via Mechanical Dredging

This alternative would involve the mechanical dredging of both the peat sediments along the lake shoreline, and the flocculent organic silts in the deeper portions of the lake. All of the dredging would be conducted using a mechanical bucket or "clamshell" dredge mounted on a floating barge. The dredge spoil material would be placed on hopper barges, dewatered, and transported to an upland site where it would be off loaded and stockpiled for further drying. Once the spoil was sufficiently dewatered, it would be loaded into trucks and transported to a permanent disposal site. This alternative would not require an extended lake level drawdown, as all sediment removal could be conducted at the ordinary high water elevation of 5.0-feet NGVD. However, the construction of an upland handling facility somewhere along the lake perimeter would be necessary.

Mechanical or grab-type bucket dredges are typically used in special situations, most commonly around docks, marinas and shoreline areas. As with hydraulic cutterheads, different types of buckets have been designed to loosen and remove sand, silt, clay and rock. They can be easily transported to different areas within a lake, and their performance is not hampered by stumps and other debris that may impede hydraulic cutterhead dredges. In addition, because the dredged sediments are not mixed with water and pumped, the solids content of the spoil material is typically much higher than the "slurry" created by a hydraulic dredge, often eliminating the need for additional treatment and dewatering.

Bucket dredges, however, have several disadvantages. First, the sediment must be dumped within the radius of the crane arm onto a barge or into a truck on shore, thus increasing the complexity of handling and transporting dredge spoil material. Second, because the rate of sediment removal is limited by the size of the bucket and the frequency of operation, bucket dredges are typically much less time-efficient than hydraulic dredges. Third, the use of a bucket dredge can leave the bottom "chewed up" and uneven, resulting in deeper holes and shallower areas. Finally, and most importantly, the process of lifting the filled bucket through the water column frequently creates extensive turbidity plumes and water quality problems at the dredge site, often requiring the use of turbidity barriers at the dredge site.

It is anticipated that a mechanical dredge could remove approximately 1,000 yd^3 of sediment during a ten hour working day, depending on the type of sediment being removed (Don Fletcher - personal communication). Comparatively, removal of the entire 930,000 yd^3 of problem sediments in Lake Seminole could be completed three to five times faster using a hydraulic dredge, assuming the implementation of an efficient treatment and disposal process for the hydraulic dredge spoil. In addition, the use of a mechanical dredge to remove the flocculent organic silts from the deeper portions of the lake may be especially inefficient due to their low solids content. Because of their "soupy" consistency, much of the sediment material may actually be washed out of the bucket as it is being drawn through the water column, or run off the hopper barge back into the lake surface waters. These sediment characteristics would likely reduce the actual operational rate of the mechanical dredge to far less than the estimated 1,000 yd^3 per day.

Perhaps the most serious problem with mechanical dredging is that the handling of the flocculent organic silts with a bucket dredge and hopper barge is expected to generate substantial turbidity, and cause other water quality problems within the lake during the dredging process. As mentioned above, turbidity plumes can adversely impact aquatic vegetation and fish populations, and the release of sediment nutrients into the water column can stimulate severe and persistent algae blooms and reduce dissolved oxygen concentrations below levels sufficient to maintain aquatic life. Although turbidity plumes can be somewhat contained using floating turbidity barriers, the other water quality problems are very difficult to control. Consequently, in-lake water quality degradation is likely to be a major obstacle in the regulatory permitting of a major mechanical dredge operation in Lake Seminole.

Mechanical dredging is generally considered to be less costly than hydraulic dredging, primarily because sediments are removed with a higher solids content and typically do not require additional treatment or dewatering prior to transport. However, given their hydrophilic nature, the flocculent organic silts in Lake Seminole would likely require additional treatment even if removed using a mechanical dredge. Handling the flocculent organic silts on a hopper barge may require the use of an on-board filtration system (e.g., sand filter bed) to contain barge runoff, and allow for some dewatering of the sediments to occur on the barge. Additional dewatering may be required in drying ponds at the upland handling site once the spoil is off loaded from the hopper barge. These complex handling issues are expected to substantially reduce any cost benefits associated with this alternative.

Finally, mechanical dredge operations are generally more intrusive and disruptive with respect to local aesthetics. The operation of the crane and hopper barge can cause major noise disturbances, and the associated turbidity plumes and odor can be very bothersome to lakefront homeowners and recreational users of the lake. In addition, movement of the hopper barge and support watercraft between the dredge site and the upland handling site can create navigational conflicts with local boat traffic. Comparatively, hydraulic dredge operations are quiet, and do not generate turbidity plumes or odors at the dredge site; and hydraulic dredges are moved very slowly to access new dredge areas.

Given the above cited problems, *sediment removal via mechanical dredging* is not considered to be a feasible sediment removal alternative for Lake Seminole. Although both the peat sediments along the shoreline and flocculent organic silts in the deeper portions of the lake could be removed using a mechanical dredge, in-lake water quality problems and aesthetic issues make this alternative unacceptable. Furthermore, the dredging rate and removal efficiency of the mechanical dredge would likely be substantially lower than the hydraulic dredge. Finally, because the flocculent organic silts may require additional treatment following removal by mechanical dredge, any potential cost benefits of mechanical dredging over hydraulic dredging would likely be substantially reduced. For these reasons, this alternative was eliminated from any further consideration.

4.2.6 Summary of Sediment Removal Alternatives

As discussed in the preceding sections, five sediment removal alternatives were evaluated with respect to potential application on the Lake Seminole sediment removal project. Table 2 below presents a

comparative summary of the advantages, disadvantages, and conclusions associated with each of the sediment removal alternatives considered.

Based on this analysis, only two sediment removal alternatives are considered to be both technically and economically feasible, and potentially applicable to the Lake Seminole sediment removal project, including: 1) *lake drawdown with hydraulic dredging and mechanical excavation*; and 2) *hydraulic dredging*. Of these two, *lake drawdown with hydraulic dredging and mechanical excavation* is recommended as the primary or preferred sediment removal approach. This alternative would involve the hydraulic dredging of the flocculent organic silts from the deeper portions of the lake, combined with the mechanical excavation of the decaying plant matter along degraded shoreline areas. This alternative is preferred for the following reasons.

- Limiting the hydraulic dredging operation to only the 800,000 yd^3 of flocculent organic silts would maintain a higher level of homogeneity in the spoil slurry, thus reducing the need to modify the treatment process in response to variability in the nature of the dredged material. A higher level of homogeneity in the spoil slurry would allow for maximum hydraulic pumping rates to be maintained, and would minimize the dredging timeframe and treatment costs.

- Mechanical excavation of the 130,000 yd^3 of decaying plant matter along the degraded shoreline areas could be feasibly accomplished with a limited lake level drawdown of 2-3 feet, thus minimizing the social and economic impacts associated with a more extensive lake level drawdown. In addition, the cost per cubic yard to mechanically excavate the shoreline organic sediments would be substantially less than the cost to hydraulically dredge the same material due to the need to treat the hydraulic dredge spoil.

- Mechanical excavation could be effectively coordinated with other aquatic habitat improvements requiring earthwork (e.g, wetland plantings, installation of fish havens, etc.), and would allow for greater flexibility in the scheduling of other lake management activities (e.g., enhanced lake level fluctuation).

In conclusion, *lake drawdown with hydraulic dredging and mechanical excavation* is the most cost effective sediment removal alternative for Lake Seminole. Although the *hydraulic dredging* alternative alone could provide for effective removal of both the organic silts from the submerged areas and the decayed vegetation from the shoreline areas, the additional costs and potential complications associated with treating the hydraulically dredged shoreline sediments could be substantial. In addition, high lake levels would need to be maintained throughout the dredging process to allow for barge accessibility to shoreline areas, thus potentially limiting other lake management activities.

Table 2. Comparative summary of sediment removal alternatives.

Alternative	Advantages	Disadvantages	Conclusions
Lake Drawdown with Sediment Compaction/ **Oxidation**	1. Low cost. 2. Temporary improvement of aquatic vegetation and fisheries habitat.	1. No removal of lake sediments. 2. Potential temporary water quality degradation following refilling of the lake. 3. Complete restriction of lake recreational uses. 4. High risk of structural damage to seawalls and docks.	This alternative would not address the primary objectives of the sediment removal project, and would result in substantial adverse social and economic impacts. This alternative is not considered to be feasible.
Lake Drawdown with Mechanical Excavation	1. Moderate cost. 2. Effective removal of decayed vegetation from shoreline areas. 3. Could be coordinated with other lake habitat improvements.	1. Ineffective removal of organic silts from submerged areas. 2. Requires intensive pumping to lower water table. 3. High risk of structural damage to seawalls and docks. 4. Complete restriction of lake recreational uses. 5. Noise from earthmoving equipment. 6. Odor from decaying vegetation.	Direct project costs would be relatively low, however, the potential adverse social and economic impacts could be extensive. Intensive pumping would be required to lower the water table, and organic silts in the submerged areas of the lake may not be effectively removed. This alternative is not considered to be feasible.
Lake Drawdown with Hydraulic Dredging and Mechanical Excavation	1. Effective removal of both decayed vegetation from shoreline areas and organic silts from submerged areas. 2. Moderate to high sediment removal rate. 3. No water quality degradation at the dredge site. 4. Minimal restriction of lake recreational activities. 5. Could be coordinated with other lake habitat improvements.	1. Moderate to high cost. 2. Spoil slurry would require dewatering and treatment. 3. Potential water quality degradation at the treatment site. 4. Moderate risk of structural damage to seawalls and docks. 5. Minor noise from earthmoving equipment. 6. Minor odor from decaying vegetation.	Would combine the technical efficiency of hydraulic dredging, and the cost benefits of mechanical excavation. Because mechanical excavation would be conducted with a minimal lake drawdown, the potential adverse social and economic impacts would be reduced. This alternative is considered to be feasible, and is recommended as the preferred sediment removal method.
Hydraulic Dredging	1. Effective removal of both decayed vegetation from shoreline areas and organic silts from submerged areas. 2. High sediment removal rate. 3. No water quality degradation at the dredge site. 4. No restriction of lake recreational activities. 5. No risk of structural damage to seawalls and docks.	1. High cost. 2. Spoil slurry would require dewatering and complex treatment. 3. Potential water quality degradation at the treatment site. 4. Requires maintenance of high water levels during dredging.	Would provide for effective sediment removal with minimal social and economic impacts. The need for treatment of variable sediment types could, however, result in substantial additional costs and delays. Nonetheless, this alternative is considered to be feasible, and is recommended as the alternative sediment removal method.
Mechanical Dredging	1. Low to moderate cost. 2. Effective removal of decayed vegetation from shoreline areas. 3. Spoil material would require minimal dewatering. 4. No restriction of lake recreational activities. 5. No risk of structural damage to seawalls and docks.	1. Ineffective removal of organic silts from submerged areas. 2. Low sediment removal rate. 3. Water quality degradation at the dredge site. 4. Potential navigational conflicts with boat traffic. 5. Noise from dredge and earthmoving equipment. 6. Odor from decaying vegetation.	This alternative would not provide for effective removal of organic silts from submerged areas, and the rate of sediment removal would be very slow. In addition, social impacts resulting from dredge equipment noise, odor, and navigational conflicts could be substantial. This alternative is not considered to be feasible.

4.3 Sediment Treatment Alternatives

In the context of a sediment removal project, the term *sediment treatment* generally refers to the physical and/or chemical processing of dredge spoil to remove sufficient water so as to produce a soil material that can be stacked and transported by truck without fluid spillage. In addition, if the dredge spoil contains excessive pollutants or contaminants, treatment would also involve the neutralization, removal, and/or containment of those substances such that subsequent disposal does not present a risk to the environment or public health. In most lake dredging projects, the primary objective with regard to sediment treatment is to achieve rapid fluid loss and sediment volume reduction to allow for cost-effective transport and disposal with minimal environmental and social impacts.

As discussed in Section 4.2 above, the two sediment removal alternatives considered to be feasible both involve the use of a hydraulic dredge to remove the flocculent organic silts from the deeper portions of the lake. Consequently, treatment of the resulting spoil slurry created by the hydraulic dredge will present a technical challenge that must be addressed for the sediment removal project to be successful. This section presents a discussion and analysis of alternatives for treating sediments removed from Lake Seminole via hydraulic dredging. As mentioned above, four sediment treatment alternatives are considered:

- percolation/evaporation (e.g., drying ponds to dewater and consolidate sediments);
- physical treatment (e.g., hydrocyclone technology);
- chemical treatment (e.g., polymer flocculation);
- process treatment (e.g., combination of physical and chemical treatment methods); and
- discharge to a wastewater treatment plant.

Each of these alternatives are discussed below, followed by a comparison of the relative advantages and disadvantages associated with each.

4.3.1 Percolation/Evaporation

This alternative would involve the direct discharge of dredge spoil slurry from the hydraulic pipeline into excavated drying pits. The spoil slurry would be allowed to settle, and moisture loss would be accomplished through percolation and evaporation. Once the spoil had attained a sufficient consistency to be stacked and transported by truck without excessive fluid loss, the dewatered spoil material would be excavated from the pits, and the pits would again be filled with more spoil slurry. Assuming a bulking factor of three resulting from the mixing of ambient water with *in-situ* sediments, it is estimated that the hydraulic dredging of the 800,000 yd^3 of organic silts will generate approximately 2,400,000 yd^3 of spoil slurry for the total project. In terms of a daily rate, with the dredge operating at a maximum volume of 5,000 gallons per minute, approximately 11,355 yd^3 of spoil slurry will be generated during each 10-hour work day. Therefore, approximately 11,355 yd^3, or about 9.20 ac/ft of drying pit storage would have to be made available every day for the hydraulic dredge to work continuously.

As part of the sediment characterization study (see Appendix 1 of the Plan) settling tests were performed on Lake Seminole sediments. Four settling tests were performed at initial solids contents of approximately two to eight percent, values that generally simulate dredged slurry material. Settlement of the sediments was extremely slow resulting in a final solids content of approximately seven percent. Although the majority of the sediment settled out in one to two days, the settled material did not consolidate or dewater much beyond the seven percent solids content. The poor settling and consolidation results are consistent with the fact that Lake Seminole sediments:

- are extremely fine grained;
- are low in *in-situ* solids content;
- have high organic content;
- exhibit low specific gravity; and
- have extremely low plasticity.

Given the poor settling and consolidation characteristics of Lake Seminole sediments, rapid turnover of dewatered sediments in drying pits will not be possible. Although it not possible with the available data to estimate the retention time necessary to sufficiently dewater the spoil slurry in open air drying pits, it is reasonable to assume that the percolation and evaporation processes could take weeks to months to achieve a solids content of greater than 20 percent to allow for stacking and truck transport. Assuming that the spoil slurry could be effectively dewatered in drying pits within 30 days, and that the dewatered spoil could be excavated from the pits and hauled off within this timeframe, it is estimated that approximately 340,650 yd^3 or 275.93 acre-feet of storage volume would need to be provided in order for the dredge to run continuously at the maximum production rate of 5,000 gpm. If the drying pits were excavated to create 4-feet of storage, reasonable for the high water table elevations in the project area, this scenario would require approximately 68 acres of drying pit area to accommodate the dredging operation at the maximum production rate.

While the dredging production rate could be scaled back to allow for percolation/evaporation to be accomplished on a smaller land area, the tradeoffs in the project schedule would be substantial. For example, if the maximum production rate was cut in half - from 5,000 to 2,500 gpm - approximately 34 acres of drying pit area would be required, assuming a 30-day dewatering period and 4 feet of storage. This reduced production rate reduction would, however, double the project timeframe to dredge the entire 930,000 yd^3 of sediments targeted for removal from approximately 246 days to 492 days, not including mobilization and demobilization. It should also be noted that the actual turnover time within the drying pits could be substantially longer than 30 days, especially during the wet season. A doubling of the turnover time, from 30 to 60 days, would in turn double the total project timeframe.

Vacant land in the Lake Seminole watershed is scarce. The only publicly-owned parcels in the watershed that are sufficiently sized to accommodate 68 acres of drying pits are forested uplands on the Lake Seminole County Park property. It is very likely that the clearing and conversion of 70+ acres of forested park lands to drying pits for dredge spoil treatment would be strongly opposed by

the local public. In addition, an impact of this magnitude to publicly-owned conservation lands may require an amendment to the Pinellas County Comprehensive Plan.

Although it is not located in the Lake Seminole watershed, the closed City of Largo landfill site located approximately 1.5 miles north of Lake Seminole is sufficiently sized to accommodate about 60 acres of drying pits, and can be reached with a hydraulic pipeline via the Seminole Bypass Canal. This site is indicated as "Site A" on Figure 7. This site appears to be the only publicly-owned site within the project area that provides the size, proximity, and access required for treating hydraulic dredge spoil using a percolation/evaporation approach. The City of Largo has, however, indicated preliminary opposition to the use of this site for spoil treatment on the basis that such use may threaten the environmental integrity of the closed landfill, and the treatment and disposal process will create unacceptable neighborhood impacts, including excessive noise, dust and odor (see Appendix C - 1999 letter from Thomas Feaster to Douglas Robison).

Spoil treatment using a percolation/evaporation approach appears to be a feasible alternative only if the closed City of Largo landfill site is made available for this use. No other publicly-owned properties within the project area are both large enough and reasonably accessible via a hydraulic dredge pipeline. Without adequate land area, at least 60 acres, percolation/evaporation is not a feasible alternative for the Lake Seminole sediment removal project.

4.3.2 Physical Treatment

Physical treatment of hydraulic dredge spoil slurry refers to the use of "hydrocyclone" technology to separate suspended solids particles from the liquid medium they are contained within. There are several different types of hydrocyclone devices used in hydraulic dredging operations (e.g., Krebs Engineers, Inc.), however, they all utilize the same general principal of liquid/solids separation. Typically, the hydraulic dredge slurry is pumped into a vortex chamber where it is subjected to a high tangential velocity and low internal turbulence. Centrifugal force causes the heavier solids particles in the slurry to accumulate along the outer portion of the chamber, while the liquid fraction is pumped out of the middle of the chamber and then discharged. The separated solids are forced into an outer chamber with lower internal pressures, and then allowed to fall out the bottom where they are stockpiled. Figure 5 shows a cutaway diagram of a typical hydrocyclone device.

Hydrocyclone technology generally works well for separating heavier sand particles from dredge slurry. The course sand/shell material discharged from the underflow of a hydrocyclone can be quickly dewatered to about 70 percent solids. However, this technology by itself has not been shown to be effective in removing silts, clays, and organics, which have much less mass and lower specific gravities than sand particles. Given that the majority of the problem sediments in Lake Seminole are low density flocculent organic silts, hydrocyclone technology would not be effective at dewatering the hydraulic dredge slurry. In addition, hydrocyclones generally operate most effectively at flow rates that are an order of magnitude less than the typical rate generated by a 10 to 12-inch dredge (e.g., 3,000 to 5,000 gpm).

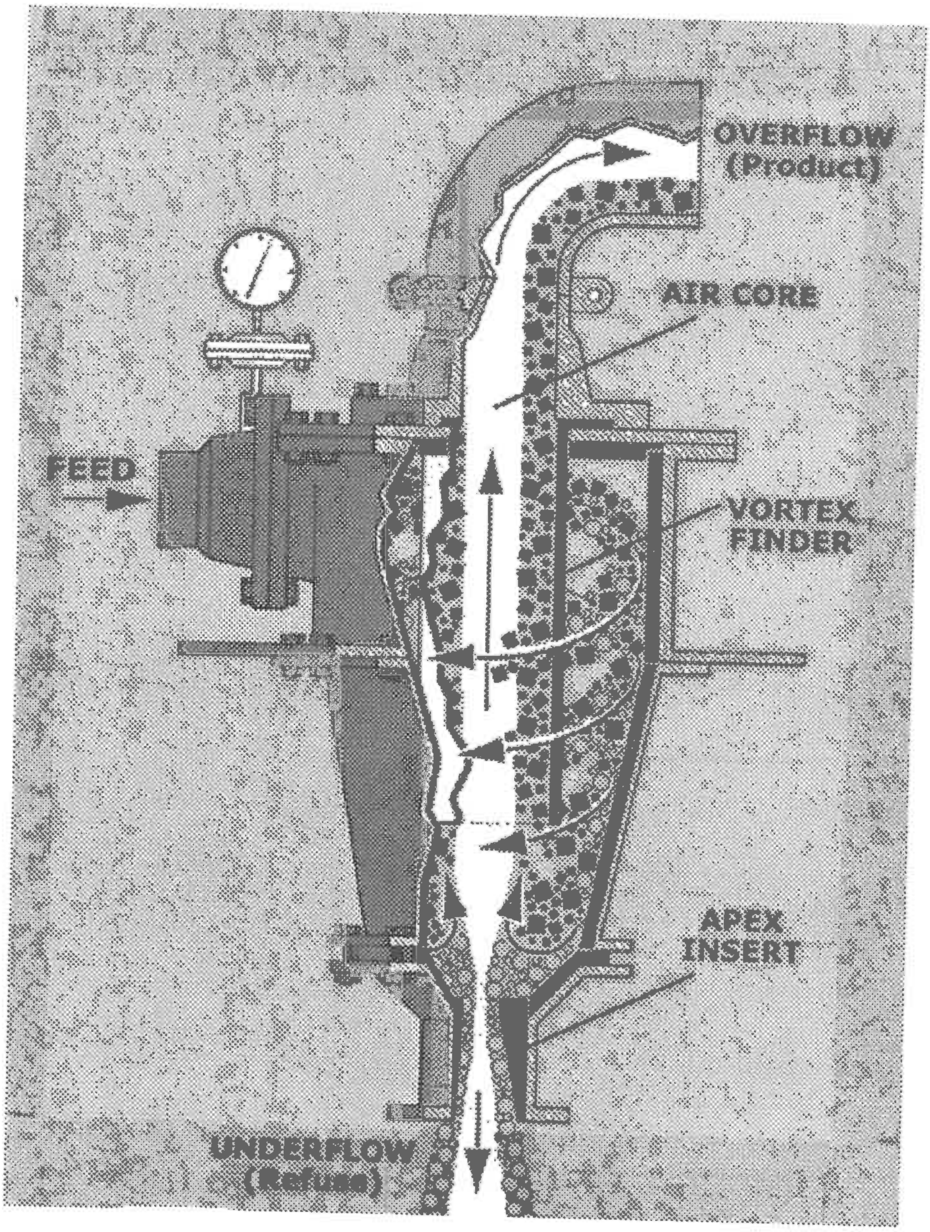


Figure 5. Cutaway diagram of a typical hydrocyclone device.

For the reasons cited above, hydrocyclone technology alone is not considered to be a feasible treatment alternative for Lake Seminole sediments. Hydrocyclone technology could, however, be used in combination with other treatment approaches to augment the separation of the larger and heavier solids from the spoil slurry.

4.3.3 Chemical Treatment

Chemical treatment of hydraulic dredge spoil slurry refers to the application of various chemical coagulants to facilitate the separation of solids particles from the liquid medium they are contained within. Coagulants are substances with ionically charged molecules that attract the solids particles contained within a slurry. Because the coagulated solids particles have a higher specific gravity than individual particles, the solids precipitate out of suspension more rapidly. In addition, the coagulated solids and organic particles tend to be less hydrophilic which further facilitates the sediment dewatering process. Chemical coagulants commonly used in spoil and effluent dewatering operations include liquid alum (e.g., aluminum sulfate) and a variety of anionic and cationic organic polymers. To improve the performance of the coagulants other fibrous organic material such as cellulose pulp can be also be added during the mixing process.

Typically, liquid coagulants are injected into the dredge spoil slurry and allowed to turbulently mix with the slurry within a mixing basin. The treated slurry is then pumped onto fine-mesh screens rotating on a conveyer belt. On the screens the coagulated solids are retained and the liquid fraction is allowed to flow through, where it is collected, treated via detention, and then discharged. The separated solids are then conveyed to another location for additional treatment or disposal. Chemically treated low density organic silts such as those found in Lake Seminole can typically be dewatered to about 10 to 15 percent solids. Therefore, additional treatment of some type is usually required to sufficiently dewater the coagulated solids to a point where they can be stacked and trucked to a permanent disposal site without excessive fluid spillage. Additional treatment typically involves percolation/evaporation in drying pits, although other physical treatment approaches such as belt presses and dessication ovens have been used.

Chemical treatment alone is not a feasible treatment alternative for Lake Seminole sediments. Based on information derived from other lake dredging projects conducted in Florida (e.g., Lake Hollingsworth in Polk County), low density organic silts cannot be adequately dewatered using chemical coagulants alone. Additional treatment is almost always required.

4.3.4 Process Treatment

Process treatment refers to the use of a combination of treatments, or a "treatment train" to dewater the hydraulic dredge spoil slurry. This approach would include a combination of physical and chemical treatment methodologies to rapidly achieve a solids content greater than 20 percent. As envisioned, treatment of the spoil slurry would be conducted in a series of sequential steps, as summarized below. Figure 6 shows a diagram of the example process treatment described below.

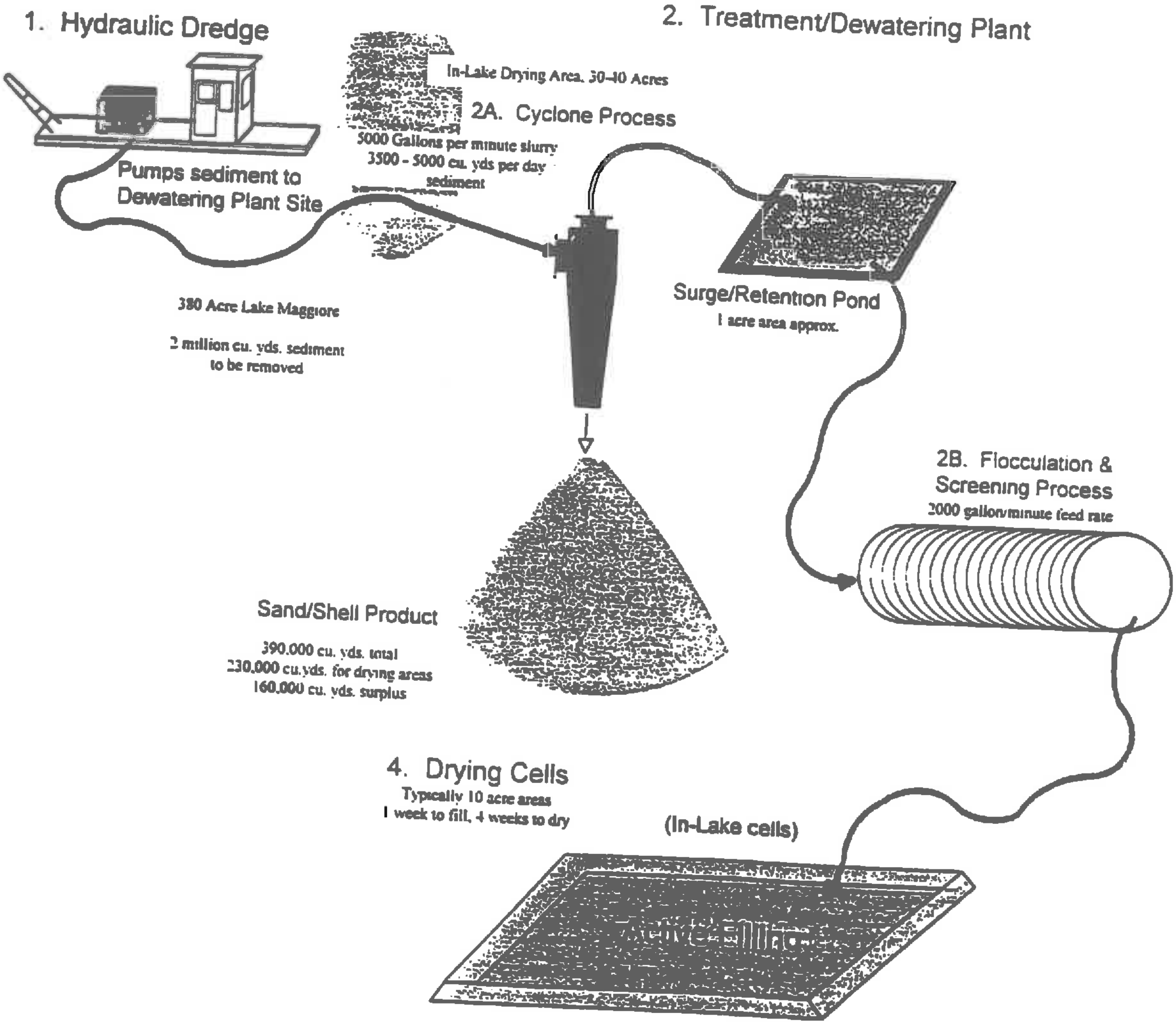


Figure 6. Example sediment dewatering process treatment system.

- **Step 1** - The hydraulic dredge slurry is pumped into a hydrocyclone to remove the course sand fraction. Sand separated in the underflow of the hydrocyclone is stockpiled on site.

- **Step 2** - Overflow from the hydrocyclone is pumped to a mixing chamber where it is injected with polymer coagulants to flocculate the organic silts.

- **Step 3** - The chemically treated slurry is pumped onto a rotating fine-mesh screen. The coagulated solids are retained and delivered to a conveyer belt, where they are then run through a belt press. The liquid fraction is allowed to flow through screens where it is collected and then conveyed to a central detention pond.

- **Step 4** - The belt press applies physical pressure to compress addition fluid out of the coagulated solids. The compressed solids are then conveyed to a stockpiling area where they are hauled away by trucks either to drying pits for additional dessication, or to the permanent disposal site(s). It is anticipated that following the belt press treatment, the compressed solids would have a sufficient solids content (e.g., 20-30% solids) to allow for safe truck transport. The additional liquid fraction removed in this step is collected and then conveyed to a central detention pond.

- **Step 5** - The liquid fraction in the central detention pond is again chemically treated, this time with alum, to further precipitate any remaining solids, and to reduce nutrient and pollutant concentrations. The chemically treated liquid fraction is then discharged back to ambient surface waters.

While there are many potential configurations of such a treatment process system, virtually all configurations will require the application of both physical and chemical treatment methodologies to effectively dewater the dredge spoil, and will require a staging site to allow for the stacking and pile management of the recovered solids as well as the detention of return water. If the physical and chemical treatment methodologies are effective, no drying pits would be necessary, and the land area required for the staging area could be as small as 5-10 acres in size. Even with this reduced land area requirement the availability of vacant publicly-owned parcels that are not environmentally sensitive, and are adjacent to the lake, or reasonably accessible via a hydraulic pipeline, are very limited.

Several publicly-owned tracts of sufficient size to accommodate a sediment process treatment system within three miles of the lake were identified in this study. In consideration of several evaluation criteria, four particular sites were considered most suitable. The locations of these sites are shown in Figure 7, and each site is described below.

- **Site A** - This MOL 60-acre site is located approximately 1.5 miles north of the lake, east of the Seminole Bypass Canal, and south of East Bay Drive. The site is owned by the City of Largo and was previously used as a municipal landfill; however, the landfill operations were ceased over a decade ago and the City has fulfilled all requirements of their FDEP approved

landfill closure plan. The site is currently vacant uplands, with some disturbed wetlands on the north portion, and is used by the City only for the temporary stockpiling of fill dirt and other construction materials (e.g., gravel, concrete pipe). A remote control model airplane landing strip is also located near the entrance and is leased from the City by a local club.

- **Site B** - This MOL 15-acre site is located approximately 300 feet from the northeast corner of Lake Seminole, immediately east of the Seminole Bypass Canal. The site is owned by Pinellas County and is currently vacant uplands. The site appears to have been an old spoil disposal site filled during the construction of the Seminole Bypass Canal.

- **Site C** - This MOL 20-acre site is located approximately 500 feet from the east side of Lake Seminole, immediately west of 98th Street, and south of 102nd Avenue and the Cross Bayou Little League baseball fields. The site is owned by Pinellas County and was also previously used as a baseball field. Currently, however, the site is vacant uplands.

- **Site D** - This MOL 15-acre County-owned site is located approximately 500 feet from the east side of Lake Seminole, immediately west of 98th Street, and east of Lake Seminole County Park. The site is currently in use as a nursery/mulch facility.

To overcome the problem of distance from the lake, the installation of a temporary hydraulic pipeline would be necessary to convey dredge materials to a suitably sized dewatering/treatment area, and to decant water back to the lake. The construction of a temporary hydraulic pipeline across developed uplands would likely involve extensive utility crossings and require numerous easements and rights-of-way. For this reason, all four sites are located adjacent to, or near Lake Seminole or the Seminole Bypass Canal.

The City of Largo landfill site (Site A) is the most suitably sized site to accommodate a spoil rapid dewatering operation as it has substantial additional land area for land spreading and air drying of dewatered sediments. In addition, hydraulic pipeline access to, and return water discharges from, the site could be provided via the Seminole Bypass Canal. As noted above, however, the City of Largo has initially declined to provide the use of this site for spoil dewatering on the basis of potential environmental problems with the landfill (e.g., leaching of hazardous materials), as well as noise, odor, and dust impacts on adjacent neighborhoods. Nonetheless, further communication and coordination with the City should continue as the closed landfill site offers the best combination of attributes for the proposed spoil dewatering operation, including:

- **Size** - This site is the largest single parcel in the vicinity of the lake that is not dedicated to preservation or conservation use. The MOL 60-acre site could easily accommodate a sediment process treatment operation, with substantial additional land area available for land spreading and air drying of dewatered sediments if necessary. The large size of the site would also allow for effective buffering of adjacent neighborhoods from potential noise, dust, and odor problems.

- **Access** - The site is readily accessible to a hydraulic pipeline which could easily be placed in the Seminole Bypass Canal. In addition, trucks can readily access the site from both Ulmerton Road and East Bay Drive to accommodate transport of dewatered spoil to the ultimate spoil disposal sites(s).

- **Land Use** - As a closed landfill, the site has been previously disturbed and is currently vacant ruderal land with few natural resources worthy of conservation or preservation. Due to its proximity to the Seminole Bypass Canal to the east, this site only abuts residential land uses on the south and west, thereby reducing the potential for neighborhood impacts. In addition, the site is currently isolated from the adjacent residential areas on the south and east by existing earthen berms and heavy vegetation.

- **Ownership** - This site is owned by the City of Largo, and is dedicated to public use in the City of Largo Comprehensive Plan.

- **Reclamation Potential** - Due to its degraded condition, excellent opportunities exist to reclaim this site to more beneficial public uses including a park or recreational ballfields.

The other three sites (Sites B, C, and D), are all substantially smaller in size than Site A, and likely could not accommodate additional land area for land spreading and air drying of dewatered sediments. However, depending on the effectiveness of the process treatment technology employed, the additional land area for air drying of dewatered sediments may not be necessary. In addition, these alternatives sites are all closer in proximity to Lake Seminole than Site A, and all have adequate vehicular access to Ulmerton Road or Seminole Boulevard to accommodate truck transport of dewatered spoil to the ultimate spoil disposal site(s).

Process treatment is considered to be a technically feasible treatment alternative for Lake Seminole sediments due to the relatively small land area requirement and the potentially high dewatering efficiency. It should be noted that the cost of polymer coagulants typically used on process treatment systems can add substantially to the overall cost of a sediment removal project, and chemical costs must often be weighed against land costs in evaluating the cost-effectiveness of project alternatives. For lake dredging projects where vacant land is simply not available, however, process treatment may be the only viable alternative.

4.3.5 Discharge to a Wastewater Treatment Plant

This alternative would involve treatment of the hydraulic dredge spoil at a municipal wastewater treatment plant. The dredge slurry would be discharged into a sanitary sewer main, or be pumped directly to the plant via a separate pipeline. The dredge spoil slurry would be blended and treated with inflowing raw sewage. Once in the plant, the organic sediments would be subjected to normal wastewater treatment processes including aerobic digestion, filtration, and clarification. The resulting solids would be disposed of as part of the sludge by-product of the wastewater treatment process.

The Lake Seminole watershed is served by the South Cross Bayou Wastewater Treatment Plant (SCBWWTP), a Pinellas County facility located north of 54th Street on Joe's Creek. The SCBWWTP has a permitted capacity of 27 million gallons per day (mgd), but is currently operating at an average capacity of 20 to 21 mgd. This leaves approximately 6 mgd of capacity at the plant. The SCBWWTP is designed as an advanced secondary treatment facility and is currently undergoing a modification (Phase 2-B) to bring the plant to an advanced wastewater treatment (AWT) standard. The objective of the Phase 2-B modification is to allow the plant to produce approximately 17 to 20 mgd of advanced treated wastewater suitable for use as reclaimed water. The surplus waters would continue to be discharged to surface water in Joe's Creek. The SCBWWTP is currently constrained by the physical size of the property, with little remaining space for expansion after completion of the Phase 2-B improvements.

Existing sanitary sewer transmission lines or existing reclaimed water distribution lines could be used to convey the hydraulic dredge spoil slurry to the plant. New pipelines have been installed in the vicinity of the lake to facilitate the distribution of reclaimed water to the west central portion of Pinellas County. A 20-inch reclaimed water line is currently stubbed out just south of 102nd Avenue on 98th Street, in the vicinity of the Cross Bayou Little League facilities east of Lake Seminole. This 20-inch pipeline is an extension of a network of transmission lines that extend from the SCBWWTP to central Pinellas County. As of this writing, the Five-Points Condominium is the only reclaimed water customer on the SCBWWTP pipeline. Theoretically, this underutilized pipeline could potentially be used to convey up to 5,000 yd^3 per day, or approximately 1.2 mgd, of dredge spoil slurry back to the SCBWWTP. In practice, however, the use of this reclaimed water line, or existing sanitary sewer lines, for conveying spoil slurry to the plant would require modifications to both the pipelines and the plant.

If reclaimed water lines were to be used, it is likely that the size of the lines would need to be increased in some segments, and that additional pump stations would need to be added. These problems would also apply to a lesser degree to existing sanitary sewer collector lines. In addition, the introduction of large amounts of sand and other non-digestible solids into reclaimed water or sanitary sewer pipelines could result in line and pump station blockages. The use of reclaimed water lines to convey dredge spoil slurry would at least temporarily preclude the intended use of these lines which is to distribute reclaimed water. For the duration of the sediment removal project, reclaimed water distribution to existing and future customers served by the affected lines would need to be suspended. Similarly, the use of existing sewer collector lines to convey dredge spoil slurry could overburden the existing infrastructure, potentially leading to sewage overflows.

Although organic sediments are somewhat similar in composition to raw sewage, the domestic wastewater treatment process, which depends on bacterial digestion of waste materials and clarification, may be poorly suited for the treatment of dredge spoil slurry. The introduction of large amounts of sand and other non-digestible solids into the treatment plant could result in an excessive accumulation of grit in the digestion tanks and clarifiers. Furthermore, the highly flocculent nature of the organic silts contained in lake sediments could substantially reduce the efficiency of the

clarifiers. Finally, assuming that the in-place volume of sediments will be reduced by approximately one-half following treatment, conveying the dredge spoil slurry to the SCBWWTP for treatment would result in the generation of up to 465,000 yd^3 of additional municipal sludge over the duration of the sediment removal project. As stated above, the SCBWWTP site is already constrained for space, and an increase in sludge volume of this magnitude would place an undue burden on existing facilities to handle and dispose the additional sludge volume.

The conveyance of dredge spoil slurry to the SCBWWTP for treatment does not appear to be a viable treatment alternative for Lake Seminole sediments. Although it may be technically feasible, the cost to modify conveyance lines, pump stations, and the wastewater treatment plant itself, likely make this alternative economically infeasible. Furthermore, the introduction of excessive sand and non-digestible solids into sanitary sewer lines and the wastewater treatment plant may cause significant disruptions to the capacity and efficiency of the existing infrastructure. The use of a municipal wastewater treatment plant to treat organic sediments in dredge spoil is unprecedented in Florida, and possibly in the U.S. Given the substantial unknowns involved, this alternative was eliminated from further consideration.

4.3.6 Summary of Sediment Treatment Alternatives

As discussed in the preceding sections, five sediment treatment alternatives were evaluated with respect to potential application on the Lake Seminole sediment removal project. Table 3 below presents a comparative summary of the advantages, disadvantages, and conclusions associated with each of the sediment treatment alternatives considered.

Based on this analysis, only two sediment treatment alternatives are considered to be both technically and economically feasible, and potentially applicable to the Lake Seminole sediment removal project, including: 1) *process treatment*; and, 2) *percolation/evaporation*. Of these two, *process treatment* is recommended as the primary or preferred sediment treatment approach. This alternative would combine various physical and chemical treatment methods to dewater organic silts on site to a level sufficient to allow for truck transport. This alternative is preferred for the following reasons.

- Process treatment could achieve rapid and effective separation of sand, and both mineral and organic silts, from the hydraulic dredge slurry. The resulting decant water would, however, likely require additional treatment to remove dissolved pollutants such as nutrients and metals.

- Process treatment would require minimal vacant land area, on the order of 5-10 acres. In addition, minimal odor and dust would be generated at the treatment site.

It should be noted that process treatment methodologies can vary considerably depending on the concentration of the solids and the nature of the organics that must be separated from the fluid medium in the hydraulic dredge slurry. Bench testing of various chemical flocculents and pilot studies of various treatment methodologies and rates would need to be conducted to optimize the approach.

Although *percolation/evaporation* would be a more cost-effective sediment treatment alternative, the scarcity of vacant publicly-owned lands in the Lake Seminole area limits the feasibility of this alternative. The only sufficiently sized parcel with potentially compatible land uses is the closed City of Largo landfill. Unless approval to use this site is granted by the City of Largo, this alternative is not considered to be feasible.

Table 3. Comparative summary of sediment treatment alternatives.

Alternative	Advantages	Disadvantages	Conclusions
Percolation/Evaporation	1. Low cost. 2. Effective separation of sand, and mineral and organic silts. 3. No additional treatment of decant water required.	1. Requires substantial vacant land area. 2. Very slow solids separation rate. 3. Odor and dust generated at the treatment site. 4. Percolation may result in hydrologic impacts.	This alternative would require approximately 60 acres of vacant land area for drying ponds, and is only feasible if the closed City of Largo landfill site is made available for this use. No other publicly-owned properties within the project area are both large enough and reasonably accessible via a hydraulic dredge pipeline.
Physical Treatment	1. Low cost. 2. Effective separation of sand. 3. Rapid solids separation rate. 4. Minimal vacant land area required. 5. No odor and dust generated at the treatment site.	1. Ineffective separation of mineral and organic silts. 2. Decant water requires additional treatment to remove silts and dissolved pollutants.	Physical treatment alone is not sufficient to effectively dewater the organic silt sediments in Lake Seminole. This alternative is not considered to be feasible.
Chemical Treatment	1. Effective separation of sand and mineral silts. 2. Rapid solids separation rate. 3. Minimal vacant land area required. 4. Minimal odor and dust generated at the treatment site.	1. Moderate to high cost. 2. Only partial separation of organic silts. 3. Decant water requires additional treatment to remove organic silts and dissolved pollutants. 4. Separated solids need to be transported to disposal site.	Although far more effective than physical treatment, chemical treatment alone is not sufficient to effectively dewater organic silts to a level sufficient to allow for truck transport. This alternative is not considered to be feasible for Lake Seminole sediments.
Process Treatment	1. Effective separation of sand, and mineral and organic silts. 2. Rapid solids separation rate. 3. Minimal vacant land area required. 4. Minimal odor and dust generated at the treatment site.	1. Moderate to high cost. 2. Decant water requires additional treatment to remove dissolved pollutants. 3. Separated solids need to be transported to disposal site.	This alternative would combine various physical and chemical treatment methods to dewater organic silts to a level sufficient to allow for truck transport. This alternative is considered to be feasible for Lake Seminole sediments, and is recommended as the preferred sediment treatment approach.
Discharge to a Wastewater Treatment Plant	1. Effective separation of sand, and mineral and organic silts. 2. Rapid solids separation rate. 3. No vacant land area required. 4. No additional treatment of decant water required. 5. Separated solids disposed with municipal sludge. 6. No odor and dust generated at the treatment site.	1. High cost. 2. Requires substantial modification to existing pipelines, pump stations, and treatment plant. 3. Could adversely impact public wastewater and reclaimed water infrastructure.	Although this alternative could effectively treat the organic silts in hydraulic dredge slurry, it would require substantial modification to existing pipelines, pump stations, and treatment plant. Because of the high costs involved and potential impacts to public infrastructure, this alternative is not considered to be feasible.

4.4 Sediment Disposal Alternatives

Where sufficient land area is available near the dredge site, it is most cost-effective to simply discharge dredge spoil material onto adjacent lands where it is allowed to dewater and remain in place. For dredging projects without land constraints, spoil disposal areas should be selected carefully. Because the muck material in dredge spoil slurry will blanket vegetation and can kill it, the disposal of organic silts is unsuitable in woodlands, floodplains or wetlands. A carefully engineered and diked upland area is typically the best option for hydraulic dredge spoil slurry. Any disposal site should be fenced to keep out people and animals. The Southwest Florida Water Management District successfully used such an approach to dredge Banana Lake in Polk County during the mid-1990s.

Vacant land in the vicinity of Lake Seminole is extremely scarce, and dense urban land uses in the watershed preclude the direct discharge and disposal of dredge spoil on adjacent lands. Therefore, in the context of the Lake Seminole sediment removal project, the term *sediment disposal* refers to the final disposal of the dewatered solids generated from sediment treatment process. Since the primary objective of the treatment process is to remove sufficient water to produce a soil material that can be stacked and handled using earthmoving equipment without excessive fluid spillage, the transport of treated sediments to the disposal site will most likely be conducted using trucks.

As discussed in Section 4.3 above, process treatment appears to be the only feasible treatment alternative for Lake Seminole sediments. Under this scenario, sediment solids produced at a dewatering site near the lake would require truck transport to another location for disposal. Potential disposal sites must be sufficiently sized and have suitable land uses to accommodate the potentially large volumes of fill material involved. In addition, land cover on and adjacent to potential disposal sites must not be environmentally sensitive. This section presents a discussion and analysis of alternatives for disposing treated sediments from Lake Seminole. As mentioned above, four sediment treatment alternatives are considered:

- in-lake disposal;
- landfill disposal;
- landspreading; and
- distribution as topsoil.

Each of these alternatives are discussed below, followed by a comparison of the relative advantages and disadvantages associated with each.

4.4.1 In-Lake Disposal

This alternative would involve the placement of appropriate dredge spoil material in Lake Seminole to create islands or littoral wetlands as part of the overall habitat restoration and enhancement strategy for the lake.

As discussed in Section 2.2 above, the fine grained and organic sediments in Lake Seminole have a low average in-place solids content of 15 percent or less, and are almost completely lacking in plasticity. Therefore, if moved from one portion of the lake and placed in another, these sediments would behave as a liquid and dewater very poorly by self-weight consolidation. Because of these physical properties, the fine grained organic sediments in Lake Seminole do not offer the potential for beneficial reuse with respect to the creation of recreational islands or the enhancement of shoreline habitats.

During the hydraulic dredging process, it is anticipated that a fair amount of sand will be entrained into the dredge along with the organic sediments. The sediment treatment process will be designed to efficiently separate the sand material from the organic sediments resulting in a stockpile of surplus sand at the treatment site. Unlike the organic sediments, this material does have good plasticity and could be beneficially reused to create recreational islands or enhance shoreline habitats. Unfortunately, due to the variability in the distribution of organic sediments in the lake, and in the hydraulic dredging process itself, it is difficult to predict with a high degree of certainty how much surplus sand will be generated in the sediment treatment process.

In-lake disposal for the construction of recreational islands is not considered to be feasible for three reasons, including:

- recreational island construction would likely require substantially more sand than what is expected to be available as surplus from the sediment treatment process;
- Lake Seminole is a relatively narrow waterbody, and the construction of recreational islands anywhere in the lake would likely restrict navigation and preclude existing recreational uses of the lake to some degree; and
- the placement of sand fill material on sovereign submerged lands to create new uplands would likely not be permittable under existing environmental regulations.

Even if sufficient surplus sand was generated, and there was strong public support for recreational island creation, it is highly unlikely that environmental permits could be obtained to convert submerged lands into new uplands. This activity would result in the loss of both jurisdictional wetlands and State owned submerged lands. Given that Lake Seminole is a designated Outstanding Florida Waters (OFW), and is part of the Pinellas County Aquatic Preserve, permit approval of the filling of lake bottom to create recreational islands is even more unlikely. As part of the Lake Maggiore dredging project in St. Petersburg, an unsuccessful attempt was made to obtain environmental permit approval for the filling of lake bottom to create a recreational beach. Lake Maggiore is also part of the Pinellas County Aquatic Preserve and is an OFW.

Unlike recreational island creation, the limited filling of lake bottom to create more productive wetland habitat (e.g., fringe cypress forest) as part of an overall habitat enhancement strategy is

considered to be a feasible disposal alternative for the surplus sand material generated in the sediment treatment process. The Park Boulevard habitat enhancement project discussed in Appendix 4 of the Lake Seminole Watershed Management Plan specifically requires surplus sand to construct a littoral shelf for wetland plantings. This project would require approximately 32,000 yd^3 of sand fill material. This material would be deposited along the existing shoreline, extending waterward a distance of from 50 to 75 feet. This fill activity would create a littoral area approximately 1-2 feet deep during normal lake levels that would be suitable for the planting of native wetland vegetation. The extended shoreline area would also create an open space amenity where none currently exists. Surplus sand from the sediment treatment site would likely need to be trucked to this location, and then deposited and graded using a barge mounted crane. In addition, floating turbidity barriers would also be required to control turbidity plumes during construction.

This beneficial reuse of the surplus sand product would not constitute a loss of jurisdiction wetlands or sovereign submerged lands, and would be in the public interest. Therefore, regulatory permit approval of this activity could likely be obtained. Regulatory permitting of the sediment removal project is discussed in greater detail in Section 6.0 below.

4.4.2 Landfill Disposal

This alternative would involve the disposal of treated sediments in a permitted solid waste landfill. Solid waste landfills have certain regulatory requirements for fill material. The material must not be toxic as defined by the Toxic Contaminant Leachate Procedure (TCLP) test, and must be of sufficient solids content so as to not cause substantial additional leaching. Based on the sediment quality testing conducted as part of the Lake Seminole Sediment Characterization Study, sediments in Lake Seminole are not considered to be toxic, as defined by the TCLP results. Therefore, no constraints other than solids content would prevent landfill disposal.

The typical guideline for the solids content of fill material placed in solid waste landfills is 70 percent solids. However, exceptions can be made to this guideline where it can be demonstrated that the material is clean and does not cause substantial additional leaching. It is anticipated that treated Lake Seminole sediments would qualify for an exception if sufficiently dewatered to at least 40 percent solids.

For planning purposes it is reasonable to assume that the final treated sediment volume will be approximately 50 percent of the in-place sediment volume. Therefore, for the Lake Seminole sediment removal project a conservative estimate of the final volume of treated sediments to be disposed of is 500,000 yd^3. Table 4 indicates the estimated land area required to accommodate 500,000 yd^3 of treated sediments at various fill depths. As shown in this table the 500,000 ^{3}yd constitutes about 310 acre-feet. In other words, if this volume of sediment material was piled 1-foot high and distributed evenly across the fill site, approximately 310 acres of land area would be required to contain the entire volume. The land area requirements are reduced proportionately as the depth of the fill is increased.

Table 4. Land area requirements for the disposal of treated sediments.

Volume of Material (Yd^{3})	Depth of Material (Feet)	Disposal Area Required (Acres)
500,000	1 foot	309.9 acres
500,000	2 feet	155.0 acres
500,000	3 feet	103.3 acres
500,000	4 feet	77.5 acres
500,000	5 feet	61.98 acres

The Toy Town Landfill is the only solid waste landfill in the vicinity of Lake Seminole sufficiently sized to accommodate this volume of treated sediments. The Toy Town Landfill is located between Park Boulevard and Ulmerton Road, east of 49th Street, and is owned and operated by the Pinellas County Utilities Department. Based on information provided by the Pinellas County Utilities Department, the landfill could easily accommodate the entire estimated 500,000 yd^3 of treated sediments, provided that the material meets the applicable toxicity requirements. The landfill is partially closed, and is expected to be fully closed by 2010. Solid waste in Pinellas County is now disposed of in the waste to energy incinerator plant adjacent to the landfill. Future reclamation plans for the landfill involve the development of a golf course and other recreational facilities. The treated sediment generated from the Lake Seminole sediment removal project would be high in organics, and if properly blended with other fill material would provide a nutrient rich soil for suitable for golf course landscaping and other non-structure bearing recreational uses.

Based on preliminary information provided by the Pinellas County Utilities Department, disposal of the entire estimated 500,000 yd^3 of treated organic sediments in the Toy Town Landfill is a feasible sediment disposal alternative. More than adequate storage volume exists, and the landfill site could be easily accessed by truck from Lake Seminole, via either Park Boulevard or Ulmerton Road. In addition, future reclamation plans for golf course development on the landfill site are consistent with the high organics content of the treated sediment fill material.

4.4.3 Landspreading

This alternative would involve the landspreading of treated sediments onto one or more large upland sites in the general vicinity of Lake Seminole. The treated sediments would be tilled into the ambient soils and then properly regraded. If spread out over a large area encompassing multiple sites, the estimated 500,000 yd^3 of treated organic sediments could be disposed of without adversely impacting any one particular site.

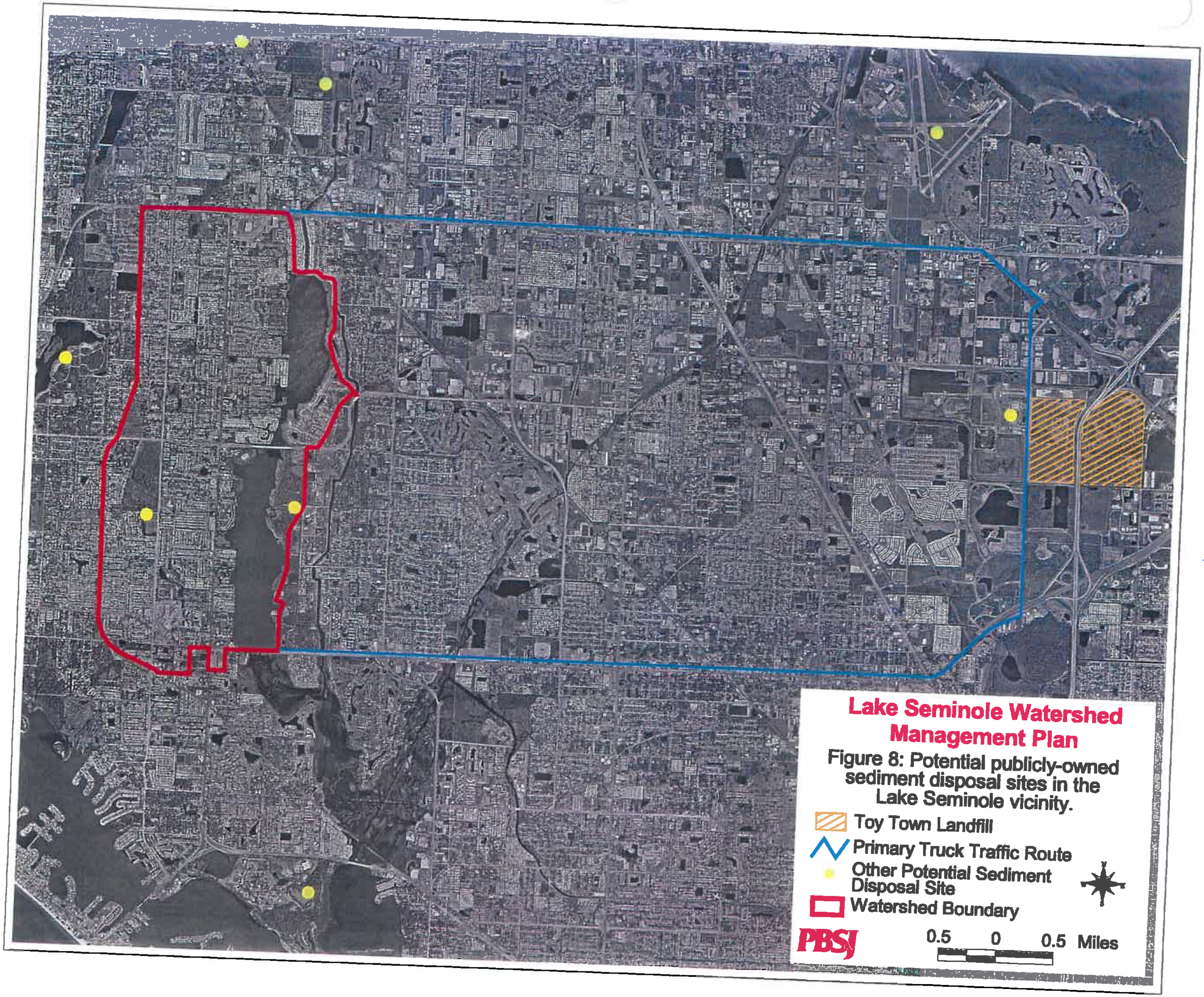
The provision of the highly organic treated sediments as a soil additive may be desirable on some park and golf course sites as a means of improving soil fertility. A program of county and municipal park facility improvements could be implemented to creatively utilize the treated sediments. These improvements would include placement of fill to create land contours, landscape features, amphitheaters, and/or other landscaping and habitat enhancement projects.

Securing one site to accommodate the remaining sediments is unlikely. It is anticipated that multiple large sites, each needing fill material for various reasons, would be required to adequately dispose of the sediments. Publicly-owned lands currently owned by Pinellas County and the municipalities of Seminole, Largo, Pinellas Park, and St. Petersburg offer the highest potential for disposal of the treated sediment material. In an effort to identify suitable sites for disposal, an information package could be prepared and forwarded to each governmental entity. The results of this survey would become the basis for the sediment disposal program. Potential upland disposal sites include:

- Pinellas County Solid Waste Incinerator site;
- St. Petersburg-Clearwater International Airport;
- Walsingham County Park;
- Lake Seminole County Park;
- War Memorial County Park;
- City of Largo closed landfill;
- City of Largo Central Park;
- City of Seminole Community Recreation Facility; and
- Public and private golf courses within a 10+ mile radius (10 courses).

Figure 8 shows the location of these potential sediment disposal sites in relationship to Lake Seminole. The ten mile radius band is shown for purposes of estimating distances to be traveled to potential disposal sites.

Although this alternative is technically feasible on a limited basis, it would involve a great deal of coordination to secure agreements from the various entities involved, and to manage transport operations to the various sites. Sediment removal from the treatment site to the ultimate point of disposal would most likely be conducted by truck. Truck transport could be accommodated by dump trucks with capacities ranging from 18 to 30 yd^3. The size of the truck and the number of trips required to remove the material from the treatment site would depend on a number of variables. Assuming the required disposal of 500,000 yd^3 of material using trucks with 18 yd^3 capacity, a total of 27,777 truck trips would be required over the time period of the sediment removal project. The coordination of truck trips to multiple disposal sites would likely result in excessive project schedule delays. If the disposal sites were not prepared to accept the fill material, treated sediments could accumulate to the point where the dredging and treatment processes would need to be shut down due to a limited amount of storage area at the treatment site. Schedule delays of this nature could substantially increase project costs. For these reasons, this alternative is considered to be provisionally feasible, pending further coordination with the owners of potential recipient sites.


Lake Seminole Watershed Management Plan
Figure 8: Potential publicly-owned sediment disposal sites in the Lake Seminole vicinity.
Toy Town Landfill
Primary Truck Traffic Route
Other Potential Sediment Disposal Site
Watershed Boundary
PBSJ
0.5 0 0.5 Miles

4.4.4 Distribution as Topsoil

This alternative would involve separation and stockpiling of the organic fraction of the treated sediments, as well as additional handling and processing, to create a topsoil additive product. In addition, the topsoil additive product would need to be transported and/or distributed to the final users of the product. Additional processing would include blending the treated sediments with mulch and/or sand to create a topsoil product that could be distributed to the public for free, or sold at a nominal cost, at local brush disposal and mulching sites. Another option would be to sell the separated organic fraction to commercial agricultural or horticultural interests.

This alternative appears to be feasible only if adequate vacant land area could be secured at the spoil treatment site to accommodate the stockpiling and blending of the various soil fractions, as well as the distribution of the final product. If adequate land area was not available at the spoil treatment site, treated sediments could accumulate to the point where the dredging and treatment processes would need to be shut down due to a limited amount of storage area at the treatment site. Schedule delays of this nature could substantially increase project costs. Although the costs associated with the additional handling and processing of the treated sediments could be partially covered by the sale of the topsoil product, such revenues may not be sufficient to offset the cost increases associated with the extended project timeframe. For these reasons, this alternative is considered to be provisionally feasible, pending further study.

Once the sediment treatment site and process treatment methodologies have been determined, it is recommended that an economic analysis be conducted to determine if: 1) there is adequate public and/or commercial demand for a topsoil additive product; and 2) if the revenues generated from the sale of such a product would be sufficient to offset the costs associated with the additional handling and processing of the treated sediments.

4.4.5 Summary of Sediment Disposal Alternatives

As discussed in the preceding sections, four sediment treatment alternatives were evaluated with respect to potential application on the Lake Seminole sediment removal project. Table 5 below presents a comparative summary of the advantages, disadvantages, and conclusions associated with each of the sediment disposal alternatives considered.

Based on this analysis only one sediment disposal alternative, *landfill disposal*, is considered to be both technically and economically feasible, and is recommended as the primary or preferred sediment disposal approach for the Lake Seminole sediment removal project. This alternative would involve truck transport of the dewatered sediments to the Toy Town landfill owned and operated by Pinellas County where it would be deposited as cap fill material, and blended with other on site soils for future recreational development. Two other alternatives, including *landspreading* and *distribution as topsoil* are considered to be provisionally feasible, pending further study and coordination. *Landfill disposal* is the preferred sediment disposal alternative for the following reasons.

- Minimal treatment, handling, and processing of the dredged sediments would be required to make them suitable for landfill disposal.

- There is a demonstrated need for fill material at the Toy Town landfill, and reclamation of the landfill is in the public interest.

- Minimal stockpiling of treated sediments at the treatment site would be required as truck transport to the landfill should be able to keep pace with the sediment treatment process.

Both the *landspreading* and *distribution as topsoil* alternatives would require substantial additional handling, processing, and coordination with other entities at the recipient or disposal site(s). If truck transport to the recipient or disposal site(s) was delayed for any reason, treated sediments could accumulate to the point where the dredging and treatment processes would need to be shut down due to a limited amount of storage area at the treatment site. Therefore, additional land area would likely be required for long term stockpiling, processing, and/or distribution.

Table 5. Comparative summary of sediment disposal alternatives.

Alternative	Advantages	Disadvantages	Conclusions
In-Lake Disposal	1. Low to moderate truck transport costs. 2. Creates new recreational opportunities.	1. Disposal of sand fraction only. 2. Results in loss of lake surface area and submerged habitats. 3. Likely not permittable.	Would only result in the disposal of the sand fraction of the treated sediments, and is likely not permittable. This alternative is not considered to be feasible.
Landfill Disposal	1. Disposal of both sand and organic silt fractions. 2. Minimal coordination with single recipient site owner. 3. Demonstrated need for fill material at Toy Town landfill. 4. Toy Town landfill can accommodate entire volume. 5. Improves soil fertility at reclaimed landfill sites.	1. Moderate to high truck transport costs.	The Toy Town landfill can accommodate the entire treated sediment volume, and a single recipient site owner would minimize truck transport costs and coordination requirements. This alternative is considered to be feasible and is recommended as the preferred sediment disposal approach.
Landspreading	1. Disposal of both sand and organic silt fractions. 2. Minimizes potential adverse impacts of sediment disposal on any one site. 3. Improves soil fertility at publicly-owned recipient sites.	1. High truck transport costs due to additional trips. 2. Requires coordination with numerous recipient site owners. 3. May require additional land area for stockpiling and handling. 4. May result in project delays.	Would require extensive coordination with numerous recipient site owners resulting in higher truck transport costs and potential project delays. This alternative is considered to be provisionally feasible, subject to further study.
Distribution as Topsoil	1. Disposal of both sand and organic silt fractions. 2. Revenues from topsoil sales could partially offset project costs.	1. High truck transport costs due to additional trips. 2. Requires coordination with the public and/or commercial interests. 3. May require additional land area for stockpiling, handling, and processing. 4. May result in project delays.	Would require extensive coordination with the public and/or commercial interests resulting in higher truck transport costs and potential project delays. This alternative is considered to be provisionally feasible, subject to further study.

5.0 RECOMMENDED SEDIMENT REMOVAL PROJECT

This section presents a description of the recommended approach to the Lake Seminole sediment removal project. As discussed in the preceding sections, the recommended sediment removal project involves a three step process whereby sediments are removed, treated (e.g., dewatered), and then permanently disposed of. Between each of these steps the sediment material must also be transported. The recommended approach to each of these steps is described below.

5.1 Sediment Removal

As presented in Section 4.2.6 above, the preferred sediment removal alternative is *lake drawdown with sediment removal via hydraulic dredging and mechanical excavation*. This alternative would involve two separate and distinct sediment removal operations or project components, including:

- removal of the organic peat sediments from degraded shoreline areas via mechanical excavation; and

- removal of the organic silt sediments from the submerged portions of the lake via hydraulic dredging.

With this alternative, only an abbreviated lake drawdown - approximately 2-4 months at elevation 3.0 feet NGVD - would be required to adequately expose the problematic shoreline sediments so that they could be mechanically excavated. Because the deeper central portions of the lake would remain inundated at the 3.0-foot lake level, hydraulic dredging of organic silts could occur concurrently with the mechanical excavation of the organic shoreline sediments. Therefore, the two sediment removal operations could be conducted independently. The two sediment removal operations are discussed separately below.

5.1.1 Mechanical Excavation of Organic Peat Sediments from Shoreline Areas

There are four major shoreline segments in Lake Seminole where large accumulations of organic peat sediments have become a problem. The majority of the 130,000 yd^3 of fibrous decayed plant matter identified as problem sediments are contained in these four segments which include:

- **Segment 1** - a 44-acre area along the east shoreline of the lake, from the Lake Seminole County Park boat ramp northward to the 102nd Avenue Bridge;

- **Segment 2** - a 13-acre area along the west shoreline of the lake, from 94th Place northward to the 102nd Avenue Bridge;

- **Segment 3** - a 12-acre area east shoreline of the lake, from the 102nd Avenue bridge northward along Lake Seminole Drive; and

- **Segment 4** - a 16-acre area along the northeast shoreline of the lake, from Harborside Circle northward to the north end of the lake.

These four major shoreline segments with problem sediments are shown on Figure 7 above.

Construction Approach

It is recommended that mechanical excavation of organic peat sediments from the priority shoreline segments be conducted in multiple phases. Each phase would begin by mobilizing earthmoving equipment to a staging area located along the shoreline segment targeted for sediment removal. Next, the lake level would be lowered to approximately 3.0 feet NGVD via gravity discharge through the new adjustable Lake Seminole outfall structure to be constructed at the south end of the lake. There would be no need for pumping to attain or maintain low lake levels. Using only gravity discharge, the target low lake level could be attained within a few days. Once the 3.0-foot lake level was attained, the affected shoreline segment would be inspected to determine if further adjustments in the lake level would be necessary to fully expose the problem sediments.

When the exposed sediments were sufficiently dessicated, the affected shoreline areas would be cleared and scraped down to a clean sand bottom using earthmoving equipment such as a front end loader or a crane-mounted dragline. The organic peat material would be scraped from the waters edge landward, and then stockpiled at the staging site for further drying. When sufficient dry, the stockpiled material would then transported by truck to the offsite disposal area. It is anticipated that the excavated material would have a sufficiently high solids content to allow for efficient stacking and truck transport without the need for additional dewatering or treatment. Once all of the excavated material was removed, the affected shoreline would be properly graded and planted with desirable aquatic vegetation, as appropriate. The staging site would then be restored and the earthmoving equipment would be demobilized. Following completion of all associated earthwork, the outfall control structure would be adjusted and the lake would be allowed to naturally refill back up to the normal or controlled high water elevation.

Phasing the mechanical excavation of shoreline sediments in this manner would result in minimal disruptions to riparian access and recreational uses of the lake. With the existing fixed-crest weir outfall structure in place, lake levels have periodically dropped as low as 3.0 feet NGVD during periods of drought without major disruptions to recreational uses and lake-dependent commercial operations. Another benefit of mechanical excavation of organic sediments in these areas is that the restored shoreline could be properly graded and planted for appropriate shoreline revegetation and habitat restoration efforts.

Landside Access and Staging Sites

Because the four priority shoreline segments targeted for sediment removal are not contiguous, separate staging areas would likely be required for each. Each staging site would need to provide adequate area for the stockpiling of excavated sediments, storage of construction equipment, a temporary construction office facility (e.g., mobile home), and employee parking. In addition, staging sites would need to allow for efficient vehicular access between the lake shoreline and a roadway suitable for truck traffic.

The problem segment with the greatest volume of material to be excavated is Segment 1 (east shoreline of the lake, from the Lake Seminole County Park boat ramp north to the 102nd Avenue Bridge). With the exception of one outparcel, Pinellas County owns the shoreline along this entire segment. Therefore, securing and preparing a staging area on County-owned for this phase of the project should not present a problem. Sites C and D as shown on Figure 7 are possible staging site locations, but there may be other more appropriate sites.

No large publicly-owned parcels abut Segment 2 (west shoreline of the lake, from 94th Place northward to the 102nd Avenue Bridge), therefore, securing a staging area for this segment may present a problem. It may be possible to use a portion of the public right-of-way along the south side of 102nd Avenue for this purpose, however, an existing stormwater pond and mitigation area could potentially be disturbed. Otherwise, it may be necessary to lease a portion of one or more privately-owned commercial and/or multi-family residential parcels to provide vehicular access between the lake shoreline and Seminole Boulevard. Due to the limited landside access to this shoreline segment, it may only be feasible to remove problem sediments from the northernmost areas that directly abut the public right-of-way.

Likewise, no major publicly-owned parcels abut the Segment 3 (east shoreline of the lake, from the 102nd Avenue Bridge northward along Lake Seminole Drive). Abutting land uses along this segment are limited to single family residential. Although there are two platted lots along this shoreline area that currently do not have structures on them, lease/purchase arrangements would need to be made with the owners of these lots to use them as temporary staging areas. Due to the very limited landside access to this shoreline segment, removal of problem sediments from this segment may not be feasible.

Segment 4 (northeast shoreline of the lake, from Harborside Circle northward to the north end of the lake) can be accessed either from the south via Harborside Circle or from the east via the County-owned parcel immediately to the east the Seminole Bypass Canal (Site D on Figure 7). Due to dense residential development in the Harborside subdivision, access from the east is the most feasible approach. Although a temporary construction bridge over the Seminole Bypass Canal would be required to access the affected shoreline area from the east, the Site D parcel would make an excellent staging site for proposed sediment removal and habitat restoration activities in this area.

Phasing Schedule

As mentioned above, landside access to Segments 2 and 3 is very limited. Although public right-of-way exists along the northern portion of Segment 2, no public access to Segment 3 currently exists. Therefore, the excavation of organic sediments from Segment 2 may only be feasible along the northern portions accessible from the right-of-way; whereas, excavation of sediments from Segment 3 may not be feasible at all. Assuming this is the case, it is recommended that the mechanical excavation of organic sediments from Segments 1, 2, and 4 be conducted in three separate phases.

It is estimated that the total time necessary to complete each of the three phases would range between 2-4 months, depending on the amount of material to be excavated from each of the priority shoreline segments. It is recommended that each phase be conducted during the dry season, during the months of March through June. During this time period lake levels are naturally lower, rainfall is minimal and desiccation via solar radiation and air exposure would be maximized. In addition, lower lake levels during this time period are consistent with the recommended enhanced lake level fluctuation schedule detailed in the Lake Seminole Watershed Management Plan.

Due to limited landside access, the removal of organic peat sediments from Segment 3 and the southern reaches of Segment 2 would need to be conducted using a hydraulic dredge with an appropriate cutterhead. The hydraulic dredging of these areas is discussed below.

5.1.2 Hydraulic Dredging of Flocculent Organic Silt Sediments from Submerged Areas

Approximately 800,000 yd^3 of flocculent organic silts exist throughout Lake Seminole, in the deeper submerged portions of both the north and south lobes, and in the "narrows" area of the lake. It is recommended that these organic silts be removed using a hydraulic dredge.

Construction Approach

It is recommended that the hydraulic dredging of organic silts from Lake Seminole be conducted in a single phase. The hydraulic dredging operation would involve two major components: 1) a barge-mounted dredge; and 2) the hydraulic pipeline from the dredge to the spoil treatment facility.

A barge-mounted hydraulic dredge would be mobilized and launched from the Lake Seminole County Park boat ramp. The barge-mounted dredge would be moved to the first area targeted for dredging via a small push boat, and then a hydraulic pipeline would then be laid from the dredge to the spoil treatment facility. The pipeline could either be floated on the lake surface or submerged along the lake bottom. The size (e.g., internal diameter) of the pipeline would likely range between 8 and 12 inches, and would depend on the optimal pumping rate determined during pilot testing of the treatment facility. Once the pipeline and treatment facility were properly constructed and tested, the dredge operator would sweep the cutterhead back and forth across the lake bottom in front of the dredge. When the overlying silts are adequately removed from the bottom area in front of the dredge,

the dredge would be "walked" forward with spuds to access the next undredged bottom area. The hydraulic pipeline would be appropriately adjusted with each movement of the dredge. In this manner, the dredge would remove organic silts in a series of overlapping strips across the lake bottom. As proposed, the hydraulic dredge would work continuous 10-hour days until the targeted volume of organic silts is sufficiently removed from the lake.

The rate at which the hydraulic dredge can remove the targeted organic silt volume will be dependent upon the dewatering efficiency of the sediment treatment facility, or the ability to quickly and effectively separate sediment solids from the liquid fraction in the spoil slurry. The recommended sediment treatment approach is discussed below.

5.2 Sediment Treatment

The organic peat sediments to be mechanically excavated from degraded shoreline areas are not anticipated to require any additional dewatering or treatment. Therefore, this section applies only to the treatment of the flocculent organic silts contained in the hydraulic dredge spoil. As presented in Section 4.3.6 above, the preferred sediment treatment alternative is *process treatment.* This alternative would involve combining various physical and chemical treatment methods to dewater organic silts on a relatively small (e.g., 5-10 acres) site in close proximity to the dredge to a solids content sufficient to allow for truck transport to the disposal area(s) without fluid spillage.

Treatment Technology

Based upon a preliminary assessment of available process treatment technologies, the proprietary Rapid Dewatering System (RDS) developed by the Black & Veatch Special Projects Corporation appears to offer the best potential. The RDS process is ideal for application on the Lake Seminole sediment removal project in that it:

- is a continuous process, not a batch process;
- removes very small particles, down to the 7-14 angstrom size range;
- can be located away from the dredge site;
- is a modular design that is easily mobilized and demobilized;
- has a small footprint of no more than 75 x 100 feet in area;
- requires no exposed pond bottoms or heavy earthmoving equipment;
- is discrete in operation, emitting minimal noise and odor; and
- recycles all recovered water back to the source, leaving behind dewatered sediment.

The Black & Veatch RDS, in its standard configuration, has a through-put rate of 3,000 gallons per minute (GPM), equal to the production rate of a 370 series Mudcat hydraulic dredge. The modular system can be configured for higher or lower through-put, depending upon operational needs. In operation, the system immediately separates all free water from sediment and returns the recovered

water back to the receiving water body. Coarse grain materials are separated and removed by a physical process, and then the fines are flocculated using a chemical process. The Black & Veatch RDS employs CIBA Specialty Chemicals to provide the polymers to aid in the flocculation of the finest particles. Once this is accomplished, the flocculated material passes through either a one or two step dewatering process, depending upon the degree of dewatering desired and the nature of the dredged material.

The heart of the RDS is the control module, a fully programmable and automated unit that monitors real-time changes in polymer demands. The control module meters the solids content of the inflowing slurry, and properly doses the polymer injection in response to changes in the solids content of the inflowing slurry. It assures proper polymer flow rates on a real-time basis to create an efficiently dewatered primary product. Polymer additives are typically the most costly portion of rapid dewatering systems, but the control module optimizes the polymer dosing process and eliminates polymer waste. The proper polymer dosage should be determined by the nature of the material. Highly inorganic material may require as little as one pound per bone dry ton (BDT) of sediment. At the other extreme, materials such as fine clays and organics may require as much as 16 pounds of polymer per BDT. The control module keeps project costs in line and optimizes the production rate for the primary and secondary dewatering steps. One control module unit provides a continuous flow rate of 300 to 400 GPM. Adding additional control module units increases the flow rate accordingly to meet through-put requirements.

From the control module, the polymerized dredged material is pumped to the primary dewatering unit, a proprietary engineered grid. As the polymerized dredged material flows down the engineered grid, the angle of repose allows free water to gravity drain, stripping it from the dredged material and leaving only capillary and intracellular water. The primary dewatered material typically has the consistency of scrambled eggs. Depending on the nature of the sediments, the solids content of the material coming out of the primary dewatering unit is typically 15-20% solids. If a drier consistency is required, the secondary dewatering step - a belt filter press module - is used. The belt filter press module collects the primary dewatered material and physically compresses it and squeezes out the free capillary water. Material coming off the belt press module contains only intracellular water, and has the appearance and consistency of moist soil. The primary dewatered material is considered ideal for optimal belt press efficiency.

Material exiting the belt press, or secondary dewatered material, is stackable and can be augured either to a pile management area or directly into transportation for off-site management. Organic peat sediments exiting the primary dewatering stage (control module and engineered grid) may contain only 25% solids by weight. Belt pressing can increase the solids content to as high as 40% solids by weight. Conversely, a high specific gravity inorganic sediment can reach 70% solids by weight in the primary dewatering stage and little additional moisture may be removed by processing through a belt press. Given the highly organic nature of Lake Seminole silts, the belt press second stage of the RDS will likely be required to effectively dewater the sediments to meet a 20-40% solids content suitable for truck transport.

It should be noted that process treatment methodologies can vary considerably depending on the concentration of the solids and the nature of the organics that must be separated from the fluid medium in the hydraulic dredge slurry. It is strongly recommended that bench testing of various chemical flocculents and pilot studies of various treatment methodologies and rates be conducted to optimize the process treatment approach.

Treatment Sites

Figure 7 above shows possible locations of sediment treatment sites in the vicinity of Lake Seminole. The closed City of Largo landfill site is the preferred sediment treatment site due to its large size, accessibility via truck and hydraulic pipeline, vacant land use, public ownership, and reclamation potential. The other three sites (Sites B, C, and D) are all substantially smaller in size than Site A, and would not easily accommodate additional land area for land spreading and air drying of dewatered sediments. However, depending on the effectiveness of the process treatment technology employed, substantial additional land area for air drying of dewatered sediments may not be necessary. In addition, these alternative sites are all closer in proximity to Lake Seminole than Site A, and all have adequate vehicular access to Ulmerton Road or Seminole Boulevard to accommodate truck transport of dewatered spoil to the ultimate spoil disposal site.

Of the three alternative sites to the closed City of Largo landfill, Site B appears to offer the best potential in that it:

- is owned by Pinellas County;
- is currently cleared and maintained as pervious open space;
- contains no jurisdictional wetlands or sensitive upland habitats;
- contains no documented hazardous materials;
- is readily accessible to and from Ulmerton Road;
- could be easily buffered to minimize noise, dust, and visual exposure;
- is adequately sized to accommodate the RDS treatment facility and sediment stockpiling;
- would facilitate the discharge of recovered water to the Seminole Bypass Canal; and
- would provide physical access to shoreline Segment 4 for mechanical excavation of the organic peat sediments, and habitat restoration of the north County-owned tract.

If approval cannot be reasonably obtained from the City of Largo to use their closed landfill site as a spoil treatment and handling area, then it is recommended that Site B be pursued as the second alternative sediment treatment site. Site B is approximately 15 acres in size and would easily accommodate a module process treatment plant such as the Black & Veatch RDS. In addition, sufficient land area would be available to facilitate pile management activities as well as to construct additional polishing ponds for the recovered water. Finally, the location of Site B would allow for the convenient discharge of recovered water into the Seminole Bypass Canal rather than Lake Seminole itself, an attribute that has important regulatory ramifications as discussed in more detail below.

5.3 Sediment Disposal

As presented in section 4.4.5 above, the preferred sediment disposal alternative for the Lake Seminole sediment removal project is *landfill disposal*. This alternative would involve truck transport of the dewatered sediments from the treatment site to the Toy Town landfill where it would be deposited as cap fill material and blended with other on site soils. The Toy Town Landfill is owned and operated by Pinellas County Utilities Department, but is being phased out over time. There is a demonstrated need for cap fill material suitable for future golf course development, and the high organic content of Lake Seminole sediments would facilitate the turf growth on reclaimed lands.

Truck transport would be accommodated by dump trucks with capacities ranging from 18 to 30 yd^3. It can reasonably be assumed that 500,000 yd^3 of treated material would need to be transported by truck to a disposal site as part of the overall sediment removal project. Using trucks with 18 yd^3 capacity, a total of 27,777 round trips would be required to transport this volume of material over the timeframe of the project. The production rate of the process treatment plant would likely determine both the hydraulic pumping rate as well as the number of truck trips required per unit time, assuming that the work is conducted over 410 working days, the project would generate approximately 67 truck trips per 10-hour day, or about 7 trips per hour at full capacity.

From either of the two recommended alternative treatment sites (Sites A and B), the most efficient truck traffic route to the Toy Town Landfill is via Ulmerton Road (State Road 688). Ulmerton Road is a major arterial divided highway with adequate capacity to handle the anticipated truck traffic. Therefore, development of a truck traffic route and management plan from the treatment site to Ulmerton Road that minimizes neighborhood impacts will be most critical to gaining local public approval of the project.

5.4 Permitting Requirements

The Lake Seminole sediment removal project will involve substantial dredging and minor filling of wetlands and submerged lake bottom. Despite the fact that the proposed sediment removal project would be conducted as part of an overall watershed management and restoration plan, these activities would still be subject to permit approval by federal and state environmental regulatory agencies. It is anticipated that the recommended sediment removal project will require the following permits:

- Federal 404/10 (dredge and fill) permit issued by the U.S. Army Corps of Engineers;
- State Environmental Resource Permit (ERP) issued by either the Florida Department of Environmental Protection or the Southwest Florida Water Management District; and
- Local Water & Navigation Control Authority Permit issued by Pinellas County.

5.4.1 Federal 404/10 Permit

The federal government's authority to regulate activities conducted in wetland and surface waters originates from the Clean Water Act of 1976. Section 404 establishes a special authority for the U.S. Army Corps of Engineers (ACOE) to issue permits for activities involving the discharge of dredge and fill materials into waters of the United States. Section 10 prohibits the creation of any obstruction, and prohibits excavation or filling, within the navigable waters of the U.S. without prior authorization from the ACOE. Under ACOE guidelines most wetlands, including submerged lands, constitute a productive and valuable public resource, the unnecessary alteration or destruction of which should be discouraged as contrary to the public interest.

Under federal rules some activities in wetlands and surface waters are exempt from permitting requirements while others require either a General Permit or an Individual Permit. General Permits are issued on a national or regional basis for categories of activities that are substantially similar in nature, and cause only minimal individual and cumulative environmental impacts. The most common type of General Permit is the Nationwide Permit. There are currently 43 types of activities covered by Nationwide Permits, and the categories and rules are frequently revised. Activities that quality for Nationwide Permits can be permitted relatively quickly (e.g., 30-60 days) without a detailed review of potential individual and/or cumulative impacts.

Individual Permits are issued on a case-by-case basis for activities that are typically variable in nature and scope, and are likely to have significant individual and/or cumulative impacts. Activities subject to Individual Permits require an extensive review of potential projects impacts, both individual and cumulative, and typically involve a process referred to as *sequencing* where the applicant must demonstrate that no practicable alternatives exist for the proposed wetland impacts, and that every effort has been made to avoid and minimize wetland impacts. If these points are adequately demonstrated in the permit review process a permit is issued, usually with requirements for mitigation or ecological compensation for the permitted impacts. Mitigation or compensation usually involves the on-site creation of new wetlands and/or the restoration/enhancement of existing wetlands. The review and permitting process for Individual Permits is typically lengthy (e.g., 120-360 days or longer).

Even though the recommended Lake Seminole sediment removal project would be conducted within the framework of an overall watershed management and restoration plan, the project involves activities at a large enough scale that would likely trigger the requirement for an Individual Permit. These activities include:

- excavation of organic sediments from the submerged lake bottom and shoreline areas;
- removal of nuisance aquatic vegetation (e.g., cattails and willows) from shoreline areas;
- discharge of recovered water from sediment treatment process back to surface waters; and
- placement of sand fill separated from the sediment treatment process on submerged lake bottom associated with habitat creation and restoration activities (optional).

A relatively new Nationwide Permit category for habitat restoration projects (NWP-27) has been established for stream and wetland restoration activities. Activities covered under this Nationwide Permit include the restoration and enhancement of degraded tidal and non-tidal wetlands and riparian areas, and the restoration and enhancement of non-tidal streams and non-tidal open waters. It may be possible to conduct the sediment removal project under a NWP-27 authorization, however, this Nationwide Permit has typically been used for projects involving relatively minor dredge and fill volumes.

The Lake Seminole sediment removal project involves dredge and fill volumes approaching 1,000,000 yd^3, which is about an order of magnitude greater than projects typically authorized under a NWP-27. It is recommended that a pre-application meeting be conducted with the U.S. Army Corps of Engineers to discuss potential authorization of the sediment removal project under a NWP-27. If this is not possible, the project is likely permittable as an Individual Permit with limited mitigation.

5.4.2 State Aquatic Preserve/Outstanding Florida Water Designation

As defined by Chapter 72-663, Laws of Florida, Lake Seminole is part of the Pinellas County Aquatic Preserve. Furthermore, as an Aquatic Preserve, all waters are also Outstanding Florida Waters (Section 62-302.700 (2) (f) Florida Administrative Code). The legislative intent behind the Florida Aquatic Preserve Act of 1975 (Section 258.35-258.394 and 258.40-258.46 Florida Statutes) is to protect state-owned submerged lands in areas which have exceptional biological, aesthetic, and scientific value in order to protect and preserve these areas for future generations. The Board of Trustees of the Internal Improvement Trust Fund is given authority to oversee the maintenance of these preserves (Chapter 258.42, F.S.).

As an Aquatic Preserve and Outstanding Florida Water, significant regulatory restrictions exist which must be taken into consideration while preparing and coordinating State permits for the Lake Seminole sediment removal project. These restrictions have the potential to substantially impact the State permitting process, and include the following.

- There shall in no case be any dredging seaward of a bulkhead line for the sole or primary purpose of providing fill for any area landward of a bulkhead line (Chapter 72-663. 3 Laws of Florida).

- No further dredging or filling of submerged lands shall be approved by the Trustees except the following activities may be authorized pursuant to a permit:

  - Such other alterations of physical conditions as may, in the opinion of the Trustees, be necessary to generally enhance the quality or utility of the preserve or the public health.

  - Such maintenance dredging as may be required for existing navigation channels.

The regulatory restrictions in Outstanding Florida Waters are stated in Chapter 62-4.32 Florida Administrative Code. This section states that:

- No Department permit or water quality certification shall be issued for any proposed activity or discharge within an Outstanding Florida Waters, which significantly degrades, either alone or in combination with other stationary installations, any Outstanding Florida Waters, unless the applicant affirmatively demonstrates that:
    - The proposed activity of discharge is clearly in the public interest. The Department recognizes that it may be necessary to permit limited activities or discharges in Outstanding Florida Waters to allow for, or enhance, public use;
    - Management practices and suitable technology approved by the Department are implemented for all stationary installations including those created for drainage, flood control, or by dredging or filling; and
    - There is no alternative to the proposed activity, including the alternative of not undertaking any change.

Even though the recommended Lake Seminole sediment removal project would be conducted within the framework of an overall watershed management and restoration plan, it is not readily apparent whether the project would be permittable under the additional regulatory protections afforded Aquatic Preserves and Outstanding Florida Waters. Further legal interpretation and consultation with the Florida Department of Environmental Protection are recommended to discern what regulatory restrictions would apply to the sediment removal project.

If it is determined that the recommended sediment removal project would not be allowable under the current designation as an Aquatic Preserve and Outstanding Florida Water, one possible regulatory relief mechanism would be to amend the Florida Statutes to temporarily suspend the Aquatic Preserve and Outstanding Florida Water designation for Lake Seminole until the sediment removal project, and all associated dredge and fill activities, are completed. This relief mechanism would require action on the part of the Pinellas County legislative delegation.

5.4.3 Sovereign Lands

All tidally influenced waters to the mean high water line and navigable fresh water bodies to the ordinary high water line in existence when Florida became a state in 1845 are considered sovereign lands. These lands are held in trust by the State for all citizens. The trust is administered by the Board of Trustees of the Internal Improvement Trust Fund of the State of Florida. Any proposed activities occurring on or over sovereign lands - including dredging, filling, or dock construction - will require the approval of the Board of Trustees.

A sovereign submerged lands title determination from the Division of State Lands would be required to determine if Lake Seminole bottom lands are sovereign. Outstanding questions that affect the determination of sovereignty on Lake Seminole include the fact that the lake was created by impoundment in the 1940s. Prior to that date, Lake Seminole was a tidally influenced arm of Long Bayou with a mean high water line presumable much lower than the current lake elevation. In addition, there are currently a number of property owners whose property lines extend well into the lake.

Until a final determination is confirmed by the Division of State Lands, it should be assumed that the lake bottom or portions of the bottom are sovereign, and that the sediment removal and disposal will require the approval of the Board of Trustees.

5.4.4 State Environmental Resource Permit

An Environmental Resource Permit (ERP) must be obtained from the State of Florida before beginning any construction activity that will affect wetlands, alter surface water flows, or contribute to water pollution. An ERP is needed to regulate activities such as dredging and filling in wetlands, construction of drainage facilities, stormwater containment and treatment, construction of dams or reservoirs; and other activities affecting State waters. In an effort to streamline the permitting process, the Florida Legislature in 1993-94 combined the previously separate rules for wetland resources permitting and management and storage of surface waters permitting into a single set of rules which define the ERP permitting process. The Florida Department of Environmental Protection (FDEP) is the State agency with the administrative authority to issue ERPs, however, the FDEP has delegated this authority to four of the five State Water Management Districts. The Lake Seminole watershed in contained within the jurisdictional boundaries of the Southwest Florida Water Management District (SWFWMD) which has delegated authority to issue ERPs.

Three ERP categories have been defined in the SWFWMD rules including Individual, Standard General, and Noticed General permits. Similar to federal rules, both the Standard General and Noticed General ERPs are issued for categories of activities that are substantially similar in nature, cause only minimal individual and cumulative environmental impacts, and meet certain defined design criteria. Individual ERPs, on the other hand, are issued on a case-by-case basis for activities that are typically variable in nature and scope, and are likely to have significant individual and/or cumulative impacts. Even though the recommended Lake Seminole sediment removal project would be conducted within the framework of an overall watershed management and restoration plan, the project involves activities at a large enough scale that would likely trigger the requirement for an Individual ERP.

Chapter 40D-4 of the Florida Adminstrative Code sets forth rules for the review and processing of Individual ERP applications. Four types of Individual permits and determinations can be issued under Chapter 40D-4 including: 1) conceptual permit; 2) construction permit; 3) operations permit; and 4) formal determinations of wetland boundaries. The difference between a conceptual permit and the

other Individual ERPs is that a conceptual permit does not authorize any construction, operation, or maintenance of a surface water management system. In addition, a conceptual permit is valid for two years whereas the other Individual ERPs are valid for five years. A conceptual permit would, however, be an appropriate vehicle to permit a large project such as the Lake Seminole sediment removal project where the construction details are not yet developed. Once a conceptual permit is approved for a project, separate construction permits can be expeditiously approved for various phases if they are consistent with the conceptual permit for the overall project.

The recommended State permitting strategy for the Lake Seminole sediment removal project is to coordinate all ERP permitting activities through the SWFWMD. The SWFWMD is a financial and technical participant in the watershed planning process, and District staff is familiar with existing conditions in the lake and the objectives of the Lake Seminole Watershed Management Plan. A conceptual ERP approval for the overall project should be obtained, including all anticipated impacts to wetlands and submerged lands, as well as surface water management activities related to stormwater runoff from construction areas and the discharge of decant water recovered from the sediment treatment process. Once the conceptual ERP has been issued, three separate construction permits should be pursued for the following project components:

- a pilot field study to evaluate the efficacy of various approaches for process treatment of hydraulic dredge spoil;
- mechanical excavation of organic peat sediments from affected shoreline areas; and
- hydraulic dredging and treatment of organic silt sediments from submerged areas.

Detailed construction, operation, and maintenance plans would be developed for each of the three project components, and submitted as three separate permit applications. The detailed plans for each component would, however, be consistent with the overall project specifications permitted under the conceptual ERP.

5.4.5 Pinellas County Water and Navigation Authority

The Pinellas County Water and Navigation Control Authority has responsibilities to protect, through sound management and judicious issuance of permits, the aquatic natural resources of Pinellas County. The regulatory authority of the Pinellas County Water and Navigation Control Authority is defined in the Laws of Florida, and compiled in Chapter 2, Article VI, Division 4 of the Pinellas County Code. These rules are embodied to implement regulations set out in this article throughout the jurisdiction of the Authority.

Waters of Pinellas County include not only waters having a measurable salinity at some point during the tidal cycle and lying within the legal boundaries of the County, but also Lakes Tarpon, Seminole, St. George, Chautauqua, Salt, Leisure, Taylor and Walsingham. All areas which are inundated or

saturated by surface water or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation specifically adapted to life in saturated conditions, as listed in the Florida Administrative Code, are also considered waters of the County.

Several activities involved in the Lake Seminole sediment removal project will require permit approval from the Water and Navigation Control Authority. Section 166-356 of the County Code states that "No person shall undertake any dredging or filling in the Waters of the County without first obtaining a permit from the Authority." Any dredging within Lake Seminole will need to be approved by the County. The dredge and fill application would first be reviewed at the staff level, and then submitted for administrative approval. If recommended, the sediment removal project will be presented to the Board of County Commissioners for final approval. Approval from the municipal authorities (e.g, Cities of Seminole and Largo) will also be required.

5.5 Estimated Project Cost

Lake dredging projects are generally expensive to implement. Costs may vary widely depending upon site conditions, spoil volume, desired depth of excavation, access to dredge sites and staging areas, nature of the spoil material, transport and disposal logistics, and monitoring requirements. As reported by EPA (1990) lake dredging costs range from as low as $0.40/yd^3 to $23.35/yd^3, and found that costs from $2 to $3 (in 1988 dollars) were common and could be considered reasonable for a hydraulic dredging project. These costs, however, do not include spoil transport, disposal, and monitoring costs. Based on other lake dredging projects bid in west central Florida during the early and mid-1990s, the total cost of a lake hydraulic dredging project has typically ranged between $3 and $6 per cubic yard (BCI, 1995). To put this into perspective, the cost of dredging one acre of lake bottom to a depth of 3 feet below existing grade could range from $14,520 to $29,040 depending on the complexity of the project. The factors most directly contributing to the complexity of a lake dredging project include:

- sediments requiring extensive dewatering or treatment;
- lack of large areas of vacant land in close proximity to the dredging operation; and
- disposal site located a long distance from the dredging operation.

All three factors listed above apply to the Lake Seminole sediment removal project. First, the flocculent organic silts can only be effectively removed via a hydraulic dredge, and the resulting slurry will require extensive dewatering. Second, because there is very little vacant land in the immediate vicinity of the lake on which to conduct spoil dewatering, treatment, and handling operations, a process treatment system will need to be employed on a smaller tract(s) of vacant land that is available. Finally, the treated dredge spoil will need to be transported by truck to the disposal site, a distance of approximately 10 miles. All of these factors will significantly increase the cost of the Lake Seminole sediment removal project.

To develop a cost estimate for the Lake Seminole sediment removal project, the project can be broken down into five components including:

- Design and permitting;
- Hydraulic dredge pilot study;
- Mechanical excavation of organic peat sediments;
- Hydraulic dredging of organic silt sediments (including treatment); and
- Truck transport of dewatered sediments to the disposal site.

These project components are discussed briefly below.

5.5.1 Design and Permitting

As discussed in Section 5.4 above, regulatory permitting of the Lake Seminole sediment removal project would be a complex task involving interaction with numerous regulatory and management agencies. At the State level the proposed approach is to seek a conceptual Environmental Resource Permit for the entire project and then obtain separate construction permits for: 1) the hydraulic dredge pilot study; 2) mechanical excavation of organic peat sediments from the shoreline areas; and 3) hydraulic dredging of the organic silt sediments from the submerged areas. It is anticipated that the following professional services would be conducted:

- additional data collection;
- preliminary engineering;
- pilot dredging operations plan; and
- regulatory permitting.

The professional service fees associated with the above listed tasks are estimated to total approximately $150,000.

5.5.2 Hydraulic Dredge Pilot Study

The hydraulic dredge pilot study would involve both bench testing of various chemical polymers, and the field implementation of a scaled down demonstration project. The objective of the bench testing would be to determine the most effective polymer(s) for specifically dewatering Lake Seminole sediments. The objective of the demonstration project would be to determine the optimal treatment process and plant configuration on the available site(s), as well as the most feasible hydraulic pumping rate. Following completion of the pilot study, a final engineering study would be prepared including the findings of the pilot study and detailed recommendations regarding the optimal dredging and treatment approach, as well as revised cost estimates and schedules.

The professional service fees and construction costs associated with the hydraulic dredge pilot study are estimated to total approximately $200,000.

5.5.3 Mechanical Excavation of Organic Peat Sediments

Mechanical excavation of the organic peat sediments from the targeted shoreline segments would involve the following steps:

- adjustment of the outfall structure and lowering of lake levels to elevation 3.0 feet NGVD;
- mobilization of appropriate earthmoving equipment to the staging site(s);
- preparation of the staging site(s);
- excavation of organic peat sediments, and stockpiling material at the staging site(s);
- truck transport of stockpiled material from the staging site(s);
- reclamation of the staging site(s); and
- demobilization of the earthmoving equipment.

With the exception of truck transport of stockpiled peat material from the staging site to the disposal site(s), this component of the project would most likely be bid on a cost per cubic yard basis. Based on discussions with local contractors costs, could reasonably range from \$11 to \$13 per cubic yard of organic peat excavated. Truck transport costs are discussed separately in Section 5.5.5 below.

5.5.4 Hydraulic Dredging of Organic Silt Sediments

Hydraulic dredging of organic silt sediments from the targeted submerged portions of the lake segments would involve the following steps:

- mobilization of the hydraulic dredge and associated watercraft to the lake;
- preparation of the treatment site;
- assembly of the process treatment plant;
- construction of the hydraulic dredge pipeline;
- dredging of organic silt sediments and pipeline transport to the treatment site;
- dewatering and treatment of the hydraulic dredge slurry at the treatment site;
- stockpiling of treated sediment material at the treatment site;
- truck transport of stockpiled material from the treatment site;
- disassembly of the process treatment plant;
- reclamation of the treatment site; and
- demobilization of the hydraulic dredge and associated watercraft.

With the exception of truck transport of treated sediment material from the treatment site to the disposal site, this component of the project would most likely be bid on a cost per cubic yard basis. Based on discussions with local contractors, costs could reasonably range from \$7 to \$9 per cubic yard of dewatered organic silt produced at the treatment plant. The basis for payment would be the volume of treated material that meets or exceeds a minimal percent solids content. Truck transport costs are discussed separately in Section 5.5.5 below.

5.5.5 Truck Transport of Dewatered Sediments to the Disposal Site

The only feasible means of transporting treated dewatered sediments from the staging and treatment sites to the disposal site is by truck. The number of truck trips required to remove the material from the staging and treatment sites would depend on a number of variables including the percent solids content of the treated sediments, the total volume of treated sediments to be transported, and the capacity of the trucks used.

Truck transport would be accommodated by dump trucks with capacities ranging from 18 to 30 yd^3. It can reasonably be assumed that 500,000 yd^3 of treated material would need to be transported by truck to a disposal site as part of the overall sediment removal project. Using trucks with 18 yd^3 capacity, a total of 27,777 round trips would be required to transport this volume of material over the timeframe of the project. The production rate of the process treatment plant would likely determine both the hydraulic pumping rate as well as the number of truck trips required per unit time (e.g., per 10 hour work day).

The treated organic silts have some potential to be beneficially reused as a soil additive. Making some of the material available for pick up at the treatment site by the public or commercial interests could reduce the total volume of material to be transported from the treatment site, thus reducing trucking costs. In addition, it may be possible to burn some of the organic peat material on site using an air curtain or similar equipment, further reducing the volume of material to be trucked. The use of County-owned trucks could also reduce transportation costs.

Truck transport of the sediments to the disposal site is anticipated to be a costly element of the Lake Seminole sediment removal project due to the distance between the dredge and disposal sites. Typically, transport costs increase with the distance traveled from the point of origin. The distance between the treatment site(s) near Lake Seminole and the Toy Town Landfill disposal site is estimated to be about 10 miles. Based on discussions with local contractors, trucking costs could reasonably range between $40-60 per load for a mini-wheeler dump truck (18 yd^3 capacity). Using the mid-point of $50 per load, this equates to a unit cost of approximately $3 per cubic yard.

5.5.6 Cost Summary

Table 6 below summarizes the estimated costs associated with each of the components of the recommended Lake Seminole sediment removal project. As shown in this table, the most costly component of the project is the hydraulic dredging of organic silts. This component includes the hydraulic dredging as well as process treatment of the hydraulic dredge spoil. It should be noted that the cost shown in Table 6 for the hydraulic dredging component of the project is a rough estimate based on the anticipated performance of the process treatment system. Following completion of the hydraulic dredge pilot study, a more accurate and detailed cost estimate for this component of the project will be developed. The costs shown for the other components of the project are considered to be reasonably good estimates under current conditions, and are not expected to vary substantially

over the next several years. As with all construction cost estimates, however, the actual cost of the project may vary significantly based on market factors present at the time of the bid submittals.

Table 6. Cost summary for the recommended Lake Seminole sediment removal project.

Project Component	Volume of Material	Estimated Unit Cost	Estimated Total Cost
Design and Permitting	N/A	N/A	$250,000
Hydraulic Dredge Pilot Study	N/A	N/A	$250,000
Mechanical Excavation of Organic Peat Sediments from Shoreline Areas[1]	130,000 yd^3 (maximum)	$10.00/$yd^3$	$1,300,000
Hydraulic Dredging of Organic Silt Sediments from Submerged Areas[2]	800,000 yd^3 (estimated)	$8.00/$yd^3$	$6,400,000
Truck Transport to Disposal Site[3]	500,000 yd^3 (maximum)	$3.00/$yd^3$	$1,500,000
Total Project	---	---	**$9,700,000**

Notes:
[1] Includes mobilization, staging site preparation, demobilization, and staging site reclamation.
[2] Includes mobilization, treatment site preparation, demobilization, and treatment site reclamation.
[3] Assumes 18 yd^3 capacity trucks, a 10 mile one-way distance to the disposal site, and no tipping or disposal fee.

5.6 Estimated Project Schedule

The recommended Lake Seminole sediment removal project is a complex project that must be conducted in phases over a number of years. Because it is potentially a very costly project, the sequencing of the various components and phases of the project is critical to maximizing the benefits while minimizing the costs. There are a number of uncertainties, both technical and regulatory, that must be resolved prior to proceeding into construction activities. For this reason, it is critical that the design and permitting activities and the hydraulic dredge pilot study be initiated early in FY-2002. Uncertainties that must be resolved during these components of the project include the following.

- Do the existing Aquatic Preserve and Outstanding Florida Water designations for Lake Seminole seriously restrict the recommended sediment removal activities?
- What are the actual access and staging area requirements for the mechanical excavation of organic peat sediments from targeted shoreline segments?

- Can a process treatment system be developed to effectively dewater and treat Lake Seminole sediments?
- What are the actual land area requirements for the dewatering and treatment of hydraulically dredged organic silts?
- What is the highest feasible hydraulic dredge pumping rate for the process treatment system?
- How many truck trips per working day will be required to effectively transport treated sediments to the disposal area?

It is anticipated that many of these questions and other uncertainties will be addressed during the design and permitting phase and during the completion of the hydraulic dredge pilots study. Until then, the project schedule can only be estimated. For example, the hydraulic dredge pumping rate will be critical to the timeframe required for the dredging of organic silts from submerged areas. If the pilot study demonstrates that a rate of 2,000 yd^3 /day can be effectively treated, the timeframe of the hydraulic dredge component would be approximately 400 days following mobilization. If, however, a rate of 1,000 yd^3 /day can only be achieved, then the timeframe of this component would double to about 800 days. Table 7 below shows the estimated start and completion dates for the various project components based on available information. Following completion of the hydraulic dredge pilot study, a more accurate and detailed schedule for this component of the project will be developed.

Table 7. Estimated schedule for the recommended Lake Seminole sediment removal project.

Project Component	Initiation Date	Completion Date	Duration
Design and Permitting	October 2001	September 2002	12 months
Hydraulic Dredge Pilot Study	October 2002	September 2003	12 months
Mechanical Excavation of Organic Peat Sediments from Shoreline Areas[1]	October 2002	September 2005	36 months
Hydraulic Dredging of Organic Silt Sediments from Submerged Areas[2]	October 2003	September 2006	36 months
Truck Transport to Disposal Site[3]	October 2002	September 2006	48 months
Total Project	**October 2001**	**September 2006**	**60 months**

Notes:
[1] To be conducted in three separate one-year phases with each segment being excavated during the period March-June.
[2] Contingent upon hydraulic dredge pumping rate to be determined in the pilot study.
[3] Ongoing during both the mechanical excavation and hydraulic dredge components.

6.0 CONCLUSIONS AND RECOMMENDATIONS

This section summarizes the findings, conclusions, and recommendations of the Sediment Removal Feasibility Study as discussed in the preceding sections.

6.1 Findings and Conclusions

Sediment Distribution and Characteristics

- Based on sediment depth probe and sample data, it is estimated that approximately 4.9 million cubic yards (yd^3) of unconsolidated sediments exist in Lake Seminole. Of this volume approximately 4.1 million yd^3 are loose, high-density sands that overlay bedrock, whereas the remaining 800,000 yd^3 comprise a surficial veneer of flocculent, low density organic silts that can contribute to water quality problems in the lake.

- An additional 130,000 yd^3 of decayed plant matter or peat sediments exist along the lake shoreline in areas of heavy emergent aquatic vegetation. While these peat sediments likely do not contribute to water quality problems as much as the low density organic silts, they do substantially reduce the bottom area available for sport fish spawning and preclude the establishment of desirable submergent and emergent aquatic vegetation.

- Both the 800,000 yd^3 organic silt sediments from the submerged areas of the lake, and the 130,000 yd^3 of peat sediments in the shoreline areas, are considered to be problematic with respect to lake management objectives. Therefore, a total of 930,000 yd^3 of organic sediments are targeted for removal from Lake Seminole.

- The estimated 800,000 yd^3 of organic silts targeted for removal are predominantly located within the northern lobe of the lake and the central "narrows" between the north and south lobes, and in isolated pockets within the southern lobe.

- The estimated 130,000 yd^3 of organic peat sediments targeted for removal exist primarily in two areas on the east side of the lake: along the shoreline of Lake Seminole County Park, and along the shoreline north of the Lake Park subdivision to the north end of the lake. Smaller segments of peat sediments exist at various locations along the western shoreline of the lake.

- Lake Seminole sediments do not qualify as a hazardous material based on the metal concentrations detected in the Toxicity Characteristic Leaching Procedure (TCLP). In addition, a comparison with USEPA limits for sewage sludge disposal shows that the sediments are well below applicable thresholds and should pose no limitations for land disposal.

- The results of the elutriate tests indicate that short-term eutrophication of surface waters may be a concern during dredging and sediment dewatering. Therefore, means to control sediment resuspension at the dredge site, and to treat decant water at the dewatering site, will need to be employed to maintain applicable surface water quality standards.

- With a low average solids content of 15 percent, the organic silts would behave as a liquid and dewater very poorly by self weight consolidation. Conversely, dried sediments are anticipated to exhibit a high affinity for absorbing and holding water. This characteristic should be taken into consideration with any stockpiling on site, as well as the intended uses at the final disposal site.

- The high percentage of organics in the sediments targeted for removal indicates that the spoil material would be well suited for topsoils and land cover type uses; however, use for structural fill purposes would be precluded.

Benefits of Sediment Removal

- The removal of the organic sediments from Lake Seminole will be very beneficial to lake water quality. Water quality benefits achieved through sediment removal are expected to include both: 1) the reduction of suspended material in the water column; and, 2) the removal of a potentially significant source of nitrogen and phosphorus from the lake surface waters. Water quality modeling using WASP5 indicated that by removing the entire 930,000 yd^3 of organic sediments, and subsequently reducing the sediment nutrient fluxes by a conservative 50%, the annual average lake chlorophyll-a concentrations would be reduced by 15.3 ug/l, or 24.4% below current levels.

- The removal of organic sediments from Lake Seminole will also improve habitat conditions for desirable aquatic vegetation and sports fisheries. The substrate provided by the flocculent organic silts is generally not conducive to the establishment and proliferation of desirable submerged aquatic vegetation. Similarly, the peat sediments in the shoreline areas preclude the establishment and proliferation of desirable emergent aquatic vegetation, and severely limit the shallow bottom area available for sport fish spawning.

- Sediment removal is expected to substantially improve the recreational uses and natural aesthetics of Lake Seminole by improving both navigability and water clarity. Navigability is currently somewhat restricted in the "narrows" portion of Lake Seminole, and along certain shoreline areas, due to excessively shallow depths. In addition, water clarity is typically very poor in Lake Seminole, contributing to a generally poor recreational experience.

Alternatives Analysis

- Only two sediment removal alternatives are considered to be both technically and economically feasible, and potentially applicable to the Lake Seminole sediment removal project, including: 1) *lake drawdown with hydraulic dredging and mechanical excavation*; and 2) *hydraulic dredging*. Of these two, *lake drawdown with hydraulic dredging and mechanical excavation* is recommended as the primary or preferred sediment removal approach. This alternative would involve the hydraulic dredging of the organic silts from the deeper portions of the lake, combined with the mechanical excavation of the organic peat sediments along degraded shoreline areas. It is preferred for the following reasons.
  - Limiting the hydraulic dredging operation to only the 800,000 yd^3 of flocculent organic silts would maintain a higher level of homogeneity in the spoil slurry, thus reducing the need to modify the treatment process in response to variability in the nature of the dredged material. A higher level of homogeneity in the spoil slurry would allow for maximum hydraulic pumping rates to be maintained, and would minimize the dredging timeframe and treatment costs.
  - Mechanical excavation of the 130,000 yd^3 of decaying plant matter along the degraded shoreline areas could be feasibly accomplished with a limited lake level drawdown of 2-3 feet, thus minimizing the social and economic impacts associated with a more extensive lake level drawdown. In addition, the cost per cubic yard to mechanically excavate the shoreline organic sediments would be substantially less than the cost to hydraulically dredge the same material due to the need to treat the hydraulic dredge spoil.
  - Mechanical excavation could be effectively coordinated with other aquatic habitat improvements requiring earthwork (e.g, wetland plantings, installation of fish havens, etc.), and would allow for greater flexibility in the scheduling of other lake management activities (e.g., enhanced lake level fluctuation).
- The *lake drawdown with hydraulic dredging and mechanical excavation* alternative is the most cost effective sediment removal alternative for Lake Seminole. Although the *hydraulic dredging* alternative alone could provide for effective removal of both the organic silts from the submerged areas and the decayed vegetation from the shoreline areas, the additional costs and potential complications associated with treating the hydraulically dredged shoreline sediments could be substantial. In addition, high lake levels would need to be maintained throughout the dredging process to allow for barge accessibility to shoreline areas, thus potentially limiting other lake management activities.
- Only two sediment treatment alternatives are considered to be both technically and economically feasible, and potentially applicable to the Lake Seminole sediment removal

project, including: 1) *process treatment*; and, 2) *percolation/evaporation*. Of these two, *process treatment* is recommended as the primary or preferred sediment treatment approach. This alternative would combine various physical and chemical treatment methods to dewater organic silts on site to a level sufficient to allow for truck transport. This alternative is preferred for the following reasons.

- Process treatment could achieve rapid and effective separation of sand, and both mineral and organic silts, from the hydraulic dredge slurry. The resulting decant water would, however, likely require additional treatment to remove dissolved pollutants such as nutrients and metals.

- Process treatment would require minimal vacant land area, on the order of 5-10 acres. In addition, minimal odor and dust would be generated at the treatment site.

- Process treatment methodologies can vary considerably depending on the concentration of the solids and the nature of the organics that must be separated from the fluid medium in the hydraulic dredge slurry. Bench testing of various chemical flocculents and pilot studies of various treatment methodologies and rates would need to be conducted to optimize the treatment process.

- Although *percolation/evaporation* would be a more cost-effective sediment treatment alternative, the scarcity of vacant publicly-owned lands in the Lake Seminole area limits the feasibility of this alternative. The only sufficiently sized parcel with potentially compatible land uses is the closed City of Largo landfill. Unless approval to use this site is granted by the City of Largo, this alternative is not considered to be feasible.

- Only one sediment disposal alternative, *landfill disposal*, is considered to be both technically and economically feasible, and is recommended as the primary or preferred sediment disposal approach for the Lake Seminole sediment removal project. This alternative would involve truck transport of the dewatered sediments to the Toy Town landfill owned and operated by Pinellas County where it would be deposited as cap fill material, and blended with other on site soils for future recreational development. Two other alternatives, including *landspreading* and *distribution as topsoil* are considered to be provisionally feasible, pending further study and coordination. *Landfill disposal* is the preferred sediment disposal alternative for the following reasons.

    - Minimal treatment, handling, and processing of the dredged sediments would be required to make them suitable for landfill disposal.

    - There is a demonstrated need for fill material at the Toy Town landfill, and reclamation of the landfill is in the public interest.

- Minimal stockpiling of treated sediments at the treatment site would be required as truck transport to the landfill should be able to keep pace with the sediment treatment process.

- Both the *landspreading* and *distribution as topsoil* alternatives would require substantial additional handling, processing, and coordination with other entities at the recipient or disposal site(s). If truck transport to the recipient or disposal site(s) was delayed for any reason, treated sediments could accumulate to the point where the dredging and treatment processes would need to be shut down due to a limited amount of storage area at the treatment site. Therefore, additional land area would likely be required for long term stockpiling, processing, and/or distribution.

6.2 Recommended Sediment Removal Project

- The recommended sediment removal alternative is *lake drawdown with sediment removal via hydraulic dredging and mechanical excavation*. This alternative would involve two separate and distinct sediment removal operations or project components, including:

  - removal of the organic peat sediments from degraded shoreline areas via mechanical excavation; and

  - removal of the organic silt sediments from the submerged portions of the lake via hydraulic dredging.

- With this alternative, only an abbreviated lake drawdown - approximately 2-4 months at elevation 3.0 feet NGVD - would be required to adequately expose the problematic shoreline sediments so that they could be mechanically excavated. Because the deeper central portions of the lake would remain inundated at the 3.0-foot lake level, hydraulic dredging of organic silts could occur concurrently with the mechanical excavation of the organic shoreline sediments. Therefore, the two sediment removal operations could be conducted independently.

- It is recommended that the mechanical excavation of organic sediments from Segments 1, 2, and 4 be conducted in three separate phases. It is estimated that the total time necessary to complete each of the three phases would range between 2-4 months, depending on the amount of material to be excavated from each of the priority shoreline segments. It is recommended that each phase be conducted during the dry season, during the months of March through June. During this time period lake levels are naturally lower, rainfall is minimal and desiccation via solar radiation and air exposure would be maximized. In addition, lower lake levels during this time period are consistent with the recommended enhanced lake level fluctuation schedule.

- The organic peat sediments to be mechanically excavated from degraded shoreline areas are not anticipated to require any additional dewatering or treatment. Therefore, sediment treatment requirements only apply to the treatment of the flocculent organic silts contained in the hydraulic dredge spoil.

- Based upon a preliminary assessment of available process treatment technologies, the proprietary Rapid Dewatering System (RDS) developed by the Black & Veatch Special Projects Corporation appears to offer the best potential. The RDS process is ideal for application on the Lake Seminole sediment removal project in that it:

  - is a continuous process, not a batch process;
  - removes very small particles, down to the 7-14 angstrom size range;
  - can be located away from the dredge site;
  - is a modular design that is easily mobilized and demobilized;
  - has a small footprint of no more than 75 x 100 feet in area;
  - requires no exposed pond bottoms or heavy earthmoving equipment;
  - is discrete in operation, emitting minimal noise and odor; and
  - recycles all recovered water back to the source, leaving behind dewatered sediment.

- It should be noted that process treatment methodologies can vary considerably depending on the concentration of the solids and the nature of the organics that must be separated from the fluid medium in the hydraulic dredge slurry. It is strongly recommended that bench testing of various chemical flocculents and pilot studies of various treatment methodologies and rates be conducted to optimize the process treatment approach.

- The closed City of Largo landfill site (Site A) is the preferred sediment treatment site due to its large size, accessibility via truck and hydraulic pipeline, vacant land use, public ownership, and reclamation potential.

- If approval cannot be reasonably obtained from the City of Largo to use their closed landfill site as a spoil treatment and handling area, then it is recommended that the County-owned Site B be pursued as the second alternative sediment treatment site. Site B is approximately 15 acres in size and would easily accommodate a module process treatment plant such as the Black & Veatch RDS. In addition, sufficient land area would be available to facilitate pile management activities as well as to construct additional polishing ponds for the recovered water. Finally, the location of Site B would allow for the convenient discharge of recovered water into the Seminole Bypass Canal rather than Lake Seminole itself, an attribute that has important regulatory ramifications, as well as good accessibility via truck and hydraulic pipeline.

- The recommended sediment disposal alternative for the Lake Seminole sediment removal project is *landfill disposal*. This alternative would involve truck transport of the dewatered

sediments from the treatment site to the Toy Town landfill where it would be deposited as cap fill material and blended with other on site soils. The Toy Town Landfill is owned and operated by Pinellas County Utilities Department, but is being phased out over time. There is a demonstrated need for cap fill material suitable for future golf course development, and the high organic content of Lake Seminole sediments would facilitate the turf growth on reclaimed lands.

- Truck transport would be accommodated by dump trucks with capacities ranging from 18 to 30 yd^3. It can reasonably be assumed that 500,000 yd^3 of treated material would need to be transported by truck to a disposal site as part of the overall sediment removal project. Using trucks with 18 yd^3 capacity, a total of 27,777 round trips would be required to transport this volume of material over the timeframe of the project. The production rate of the process treatment plant would likely determine both the hydraulic pumping rate as well as the number of truck trips required per unit time, assuming that the work is conducted over 410 working days, the project would generate approximately 68 truck trips per 10-hour day, or about 7 trips per hour at full capacity.

- From either of the two recommended alternative treatment sites (Sites A and B), the most efficient truck traffic route to the Toy Town Landfill is via Ulmerton Road (State Road 688). Ulmerton Road is a major arterial divided highway with adequate capacity to handle the anticipated truck traffic. Therefore, development of a truck traffic route and management plan from the treatment site to Ulmerton Road that minimizes neighborhood impacts will be most critical to gaining local public approval of the project.

- The Lake Seminole sediment removal project involves dredge and fill volumes approaching 1,000,000 yd^3, which is about an order of magnitude greater than projects typically authorized under a Nationwide Permit No. 27 for waterway and habitat restoration projects. It is recommended that a pre-application meeting be conducted with the U.S. Army Corps of Engineers to discuss potential authorization of the sediment removal project under a NWP-27. If this is not possible, the project is likely permittable as an Individual Permit with limited mitigation.

- Lake Seminole is part of the Pinellas County Aquatic Preserve and is a designated Outstanding Florida Water. As an Aquatic Preserve and Outstanding Florida Water, significant regulatory restrictions exist which must be taken into consideration while preparing and coordinating State permits for the Lake Seminole sediment removal project. Even though the recommended Lake Seminole sediment removal project would be conducted within the framework of an overall watershed management and restoration plan, it is not readily apparent whether the project would be permittable under the additional regulatory protections afforded Aquatic Preserves and Outstanding Florida Waters. Further legal interpretation and consultation with the Florida Department of Environmental Protection are recommended to discern what regulatory restrictions would apply to the sediment removal project.

- If it is determined that the recommended sediment removal project would not be allowable under the current designation as an Aquatic Preserve and Outstanding Florida Water, one possible regulatory relief mechanism would be to amend the Florida Statutes to temporarily suspend the Aquatic Preserve and Outstanding Florida Water designation for Lake Seminole until the sediment removal project, and all associated dredge and fill activities, are completed. This relief mechanism would require action on the part of the Pinellas County legislative delegation.

- The recommended State permitting strategy for the Lake Seminole sediment removal project is to coordinate all ERP permitting activities through the SWFWMD. The SWFWMD is a financial and technical participant in the watershed planning process, and District staff is familiar with existing conditions in the lake and the objectives of the Lake Seminole Watershed Management Plan. A conceptual ERP approval for the overall project should be obtained, including all anticipated impacts to wetlands and submerged lands, as well as surface water management activities related to stormwater runoff from construction areas and the discharge of decant water recovered from the sediment treatment process.

- Once the conceptual ERP has been issued, three separate construction permits should be pursued for the following project components: 1) a pilot field study to evaluate the efficacy of various approaches for process treatment of hydraulic dredge spoil; 2) mechanical excavation of organic peat sediments from affected shoreline areas; and 3) hydraulic dredging and treatment of organic silt sediments from submerged areas. Detailed construction, operation, and maintenance plans would be developed for each of the three project components, and submitted as three separate permit applications. The detailed plans for each component would, however, be consistent with the overall project specifications permitted under the conceptual ERP.

- To develop a cost estimate for the Lake Seminole sediment removal project, the project can be broken down into five components including:

  - design and permitting;
  - hydraulic dredge pilot study;
  - mechanical excavation of organic peat sediments;
  - hydraulic dredging of organic silt sediments (including treatment); and
  - truck transport of dewatered sediments to the disposal site.

- Professional services and construction costs associated with the design and permitting tasks, and the hydraulic dredge pilot project, are anticipated to range from $400,000 to $600,000.

- The mechanical excavation component of the sediment removal project would most likely be bid on a cost per cubic yard basis. Based on discussions with local contractors, costs could reasonably range from $9 to $11 per cubic yard of organic peat excavated.

- The hydraulic dredging component of the sediment removal project would most likely be bid on a cost per cubic yard basis. Based on discussions with local contractors, costs could reasonably range from $7 to $9 per cubic yard of dewatered organic silt produced at the treatment plant. The basis for payment would be the volume of treated material that meets or exceeds a minimal percent solids content.

- Truck transport of the sediments to the disposal site is anticipated to be bid on a cost per truck load basis. Typically, transport costs increase with the distance traveled from the point of origin. The distance between the treatment site(s) near Lake Seminole and the Toy Town Landfill disposal site is approximately 10 miles. Based on discussions with local contractors, trucking costs could reasonably range between $40-60 per load for a mini-wheeler dump truck (18 yd^3 capacity). Using the approximate mid-point of this range, this equates to a unit cost of approximately $3 per cubic yard.

- The total estimated cost to complete all components of the Lake Seminole sediment removal project is approximately $9,700,000 in 2001 dollars.

- The total estimated timeframe necessary to complete all components of the Lake Seminole sediment removal project is approximately 60 months from the initiation of design and permitting. Following completion of the hydraulic dredge pilot study, a more accurate and detailed schedule can be developed which reflects the actual sediment removal rates achievable using the recommended process treatment system.

- Pinellas County should pursue federal and state cost share grant programs to augment available funds to conduct the Lake Seminole sediment removal project. Clean Lakes Program funds available from the U.S. Environmental Protection Agency and disbursed by the Florida Department of Environmental Protection are applicable to lake sediment removal projects.

7.0 REFERENCES

Bromwell Carrier, Inc. (BCI). 1997. Lake Seminole sediment characterization study. Final report prepared for PBS&J.

Bromwell Carrier, Inc. (BCI). 1995. Lake Maggiore restoration dredge feasibility study. Final report prepared for the City of St. Petersburg.

Greening, H. And S. Doyon. 1990. Environmental and ecological effects of drawdown and enhanced fluctuation for Lake Apopka, Florida. Final report prepared for the South Florida Water Management District, West Palm Beach, Florida.

New York State Department of Environmental Conservation (NYSDEC). 1990. Diet for a small lake - a New Yorker's guide to lake management. Albany, NY.

Schelske, C.L., M. Brenner, and T.J. Whitmore. 1991. Lake Seminole Sediment Characterization and Analysis. Final report prepared for the Southwest Florida Water Management District. University of Florida Department of Fisheries and Aquaculture. Gainesville, FL.

U.S. Environmental Protection Agency (EPA). 1990. Lake and Reservoir Guidance Manual. Second Edition 440/5-88-002. Washington, D.C.

Vollenweider, R.A. 1968. Scientific fundamentals of the eutrophication of lakes and flowing water, with particular reference to nitrogen and phosphorus as factors in eutrophication. OECD Report No. DAS/CSI/68.27.

APPENDIX 4

LAKE SEMINOLE WATERSHED MANAGEMENT PLAN

Habitat Restoration and Enhancement Strategies

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September 2001

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1.0 INTRODUCTION

This report was prepared to address the requirement of Task 3.2.2 of the Lake Seminole Watershed Management Plan scope of work. Habitat distribution and disturbance patterns were evaluated to determine the potential for special habitat management sites or habitats suitable for enhancement or restoration. The general findings from this evaluation were that the urbanized nature of the watershed does not provide notable opportunity for wildlife corridors or dispersal areas. The remnant habitats in the watershed are small and fragmented to the point where an opportunity for a unifying ecological corridor is no longer viable. Opportunities do exist for recreational corridor connections between Lake Seminole County Park and the Pinellas Trail that extends north-south along the western watershed boundary.

Of the approximately 120 habitat units evaluated, a high percentage exhibit nuisance species invasion in varying degrees. Therefore, nuisance species removal coupled with the enhancement and restoration of the habitats within the watershed as a whole is a needed and important activity. It should be noted that the habitat coverage by one of the nuisance species, namely Brazilian pepper (*Schinus terebinthifolius*), is high throughout the watershed. Because this species displaces viable native habitat, it should be controlled or removed so that habitats can ultimately be restored to their natural condition. Other restoration and enhancement considerations included: aesthetics, restoration of historical vegetative communities, benefits to water quality from vegetated littoral zones, habitat diversity, plus increasing cover and forage within the lake. Eight restoration sites have been selected in conjunction with Pinellas County staff based on the restoration needs stated above as well as the size, ownership and proximity of the sites to one another and to Lake Seminole. Table 1 lists the sites and their respective existing habitat and restoration/enhancement options. Figure 1, Lake Seminole Watershed Restoration/Enhancement Site Location Map, identifies the location of each site.

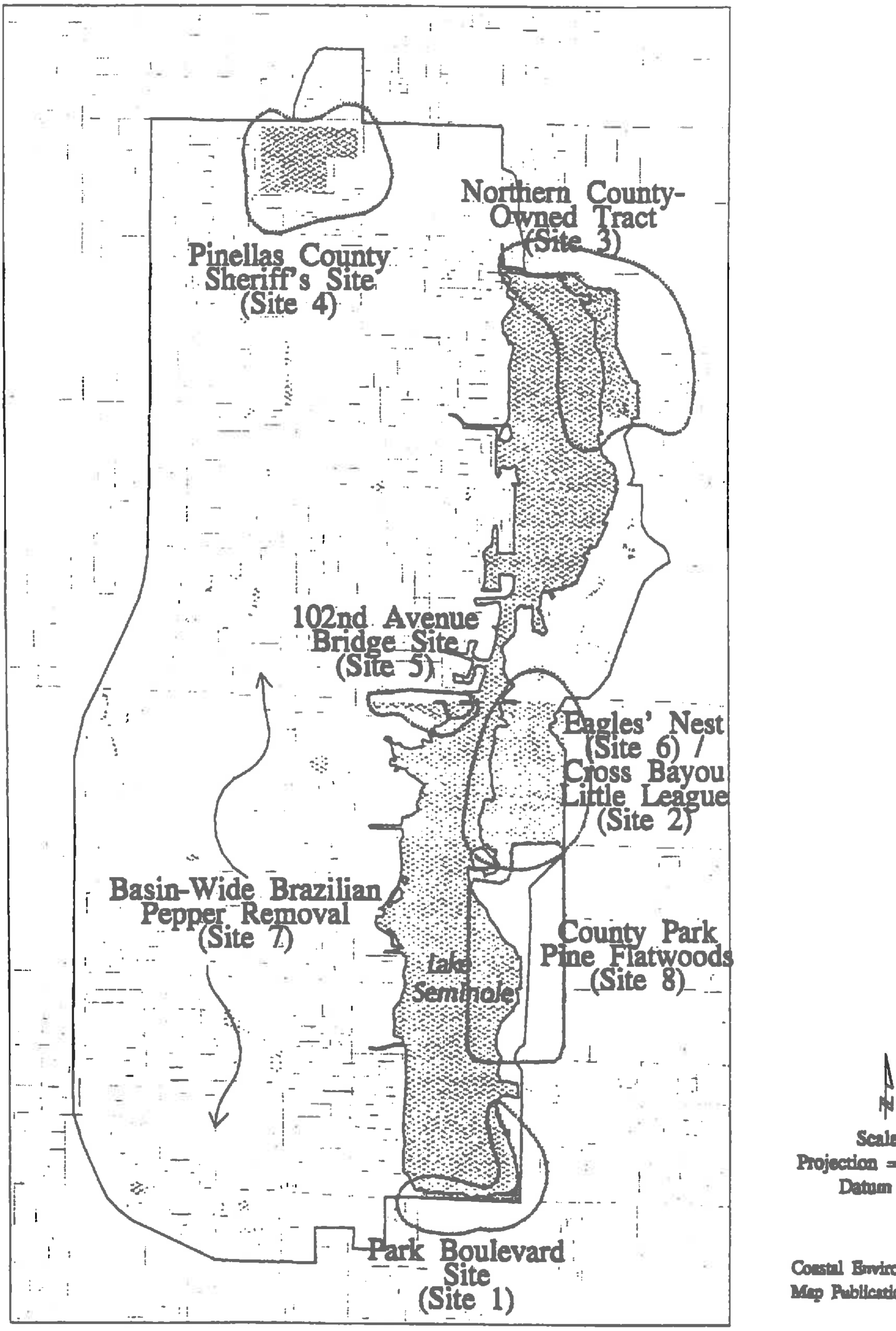
The restoration sites that border Lake Seminole have incorporated a littoral shelf planting program that is designed to provide diversity, cover and forage for fish and wildlife. This application is in response to recommendations made by the Florida Game and Fresh Water Fish Commission (FGFWFC) in the Annual Performance Report for Lake Seminole, 1990-91. This report referenced a loss of littoral habitat due to the density of cattails along the eastern side of the lake and the reduction in the acreage of hydrilla. FGFWFC recommended that increases of macrophyte diversity and restoration of littoral zones be implemented. This report further stated that littoral zone rehabilitation can be enhanced by the planting of desirable species such as bulrush *(Scirpus californicus)* and pickerelweed *(Pontederia cordata)*.

It should also be noted that the cost estimates provided for each restoration/enhancement project are for capital improvements only and do not include any long-term maintenance or monitoring activities that may be required to successfully complete the individual projects. All cattail removal required for the restoration/enhancement projects is assumed to be conducted by the County as part of the current cattail harvesting program.

Table 1. Potential habitat restoration sites in Lake Seminole and its watershed.

Site	Existing Habitat	Restoration/Enhancement Options
1. Park Boulevard	Oak and willow fringe with brazilian pepper between the road and Lake Seminole	Remove Brazilian pepper, improve views to lake, extend existing shoreline and create a 6:1 slope littoral shelf, vegetate shoreline and littoral habitat in the lake.
2. Cross Bayou Little League Tract	Brazilian pepper fringe	Remove Brazilian pepper fringe, replant with appropriate vegetation.
3. Northern County-owned Tract	Brazilian pepper dominated areas, disturbed areas with castor bean and elderberry dominant cover, willow marsh along old creek	Remove Brazilian pepper and plant appropriate vegetation, clear and plant pines in central area, clear cattails and willows along creek and plant aquatic vegetation in littoral area. Control burn of pine flatwoods area.
4. Pinellas County Sheriff's Complex	Brazilian pepper dominated areas, drainage pond, and mature pine flatwoods	Remove Brazilian pepper and fill material, plant appropriate vegetation, improve pond to provide for treatment of stormwater, control burn in pine flatwoods.
5. 102nd Avenue Bridge Area	Willow dominant wetland area with jacaranda and Brazilian pepper	Remove exotic species and diversify the habitat with mixed hardwood plantings.
6 Eagles' Nest Tract	Pine flatwoods	Recommend a controlled burn to revitalize pine flatwoods ecosystem and removal of Brazilian pepper from south property line.
7. Watershed-wide	Brazilian pepper	A cooperative program to remove Brazilian pepper from public and private property throughout the watershed.
8. Lake Seminole County Park Pine Flatwoods Restoration	Air potato and grape vine within pine flatwoods	Develop and implement emergency control program in response to prolific growth of these two species in the spring of 1997.

FIGURE 1
LAKE SEMINOLE WATERSHED HABITAT RESTORATION/ENHANCEMENT SITES LOCATION MAP



Scale 1:36,000
Projection = UTM, Zone 17
Datum = NAD 27

Coastal Environmental
Map Publication No: S9799401

2.0 RECOMMENDED RESTORATION/ENHANCEMENT PROJECTS

2.1 Park Boulevard Site

The Park Boulevard site is a narrow sloping strip of land between Park Boulevard and the south end of Lake Seminole. Figure 2 provides a concept plan for the recommended restoration of the Park Boulevard site. This area is predominantly within or immediately adjacent to the existing right-of-way for Park Boulevard and supports a linear strip of vegetation including live oak *(Quercus virginiana)*, carolina willow *(Salix caroliniana)*, Brazilian pepper (*Schinus terebinthifolius*), and wax myrtle *(Myrica cerifera)*. This vegetative canopy obscures the view of the lake from motorists traveling on Park Boulevard, a six-lane arterial. The recommended restoration activity in this area is a two-phased approach addressing the existing vegetative conditions and modifying the land form by depositing sediment dredged from the lake onto the shoreline. The upland shoreline would be extended from 50 to 75 feet waterward to provide a more natural lake shoreline. A littoral area would be formed at a 6' to 1' slope along the extended shoreline.

Phase one of this project includes the removal of nuisance species along the shoreline and thinning of the existing vegetation to provide visual access to the lake for passing motorists. Suitable fill materials (sands underlying high organic sediments) from the sediment removal program would be deposited along the existing shoreline in this area, extending the shoreline waterward for a varying distance of from 50 to 75 feet. This fill activity would require a coordinated permitting process with the U.S. Army Corps of Engineers, Florida Department of Environmental Protection, and the Southwest Florida Water Management District.

The second phase would entail planting both upland and aquatic plants along this area. The upland areas would be planted with cypress trees and/or mixed hardwoods in clusters along the extended shoreline to enhance the appearance of this visual access point. Selected aquatic plant materials including giant bulrush *(Scirpus californicus)*, pickerelweed *(Pontederia cordata)*, and arrowhead *(Sagittaria lancifolia)* would be planted along the recontoured littoral shelf to provide cover, foraging and nesting habitat for fish and wading birds, as well as to combat the regrowth of cattail on the littoral shelf. This would provide a more attractive lakefront while providing the opportunity to construct a meandering pedestrian sidewalk away from the Park Boulevard travel lanes. This restoration activity would provide an open space amenity for motorists and pedestrians while the cover and forage on the revegetated littoral shelf would benefit wading birds and fish. The pedestrian interconnection between the Pinellas Trail and Lake Seminole County Park will assist in meeting the objectives of multi-purpose recreational trail enhancement between the Park and the Trail. The introduction of this vegetated littoral area will provide for water quality improvements through the stabilization of the shoreline, reduction of erosion and sediment transport from wave action, plus nutrient uptake by the planted vegetation. The cost estimate for the Park Boulevard site restoration is provided in Table 2.

FIGURE 2
PARK BOULEVARD RESTORATION SITE

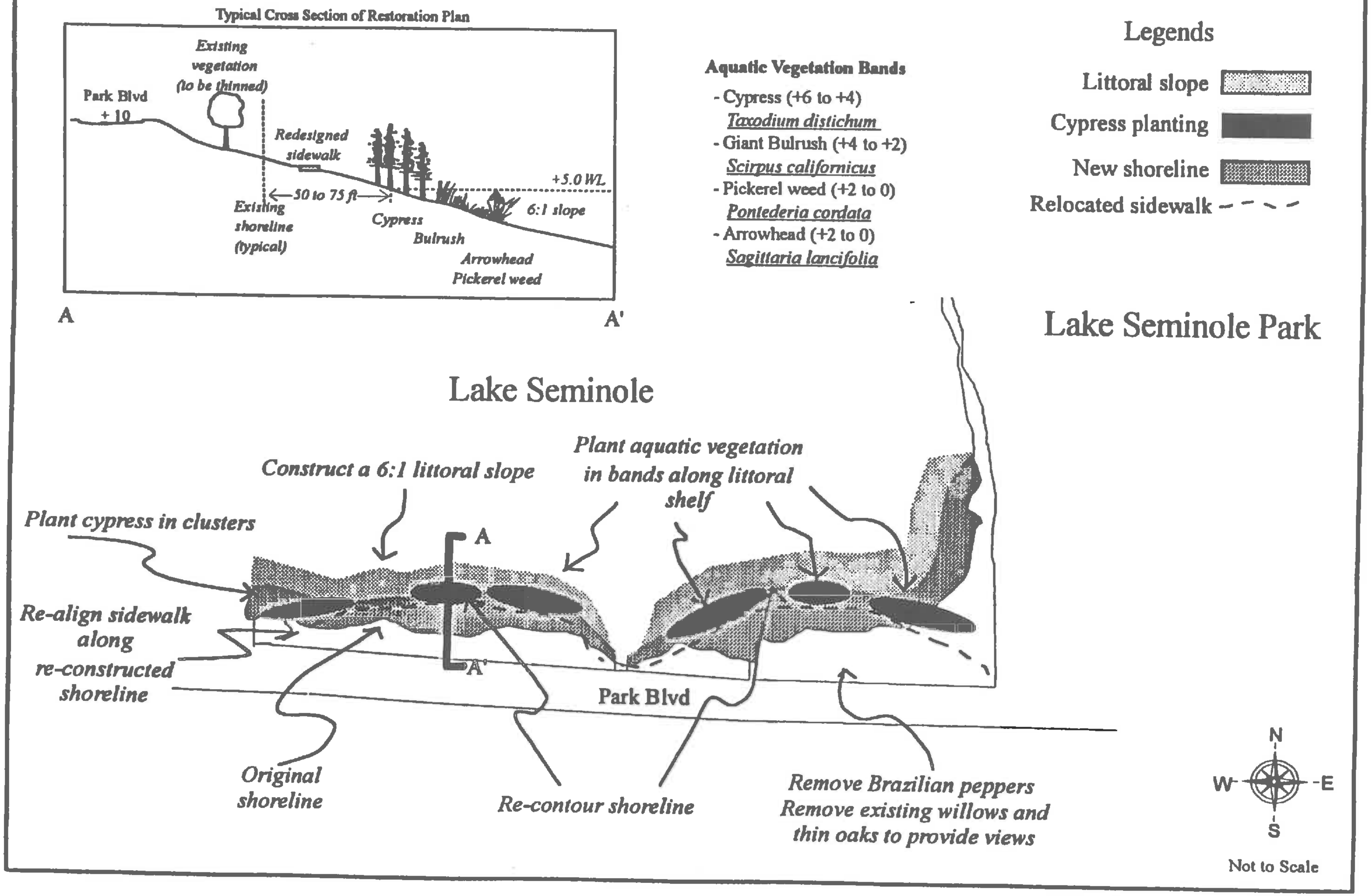


Table 2. Estimated quantities and costs for the Park Boulevard site restoration.

Item	Quantity	Unit/cost	Description	Estimated Cost
Phase I - Exotic Species Eradication				
Brazilian pepper	Scattered Brazilian pepper	5 days estimated at $600 per day per crew	Remove scattered Brazilian pepper from existing vegetated shoreline	$3,000
Mimosa	One	$500	Remove mimosa tree	$500
Carolina willow	Scattered carolina willow	4 days estimated at $600 per day per crew	Selectively remove carolina willow	$2,400
Total Phase One Cost				$5,900
Phase II - Expansion of Shoreline Habitat Area				
Engineering design			Prepare engineering plans to extend shoreline and associated littoral area waterward	$34,250 Est.
Permitting			FDEP, ACOE and SWFWMD permits required for proposed fill	$50,000 Est.
Construction				
Mobilization and utility coordination		Estimated based on the scale of the project		$15,000
Earthwork	26,000 cu. yd.	$6.00/cu. yd.		$156,000
Final grading	5,500 sq. yd.	$2.00/sq. yd.		$11,100
Planting				
Cypress	120 trees	$20.00 per ten gallon trees, 7 to 8 feet in height	Plant additional cypress trees in expanded shoreline area in clusters	$ 2,400
Aquatic vegetation	5,000 plants	$1.00 per plant installed	Littoral shelf planting	$ 5,000

Item	Quantity	Unit/cost	Description	Estimated Cost
Public Use Facilities				
Sidewalk	2,000 linear feet of 6' wide sidewalk	$16.00/linear foot	2,000 feet of new sidewalk along recontoured shoreline	$32,000
Benches	4 benches	$350 each	New benches	$1,400
Total Phase Two Cost				$307,150
Total Project Cost				**$313,050**

2.2 Eagles' Nest Tract

The Eagles' Nest Tract is located north of Lake Seminole County Park and includes the Cross Bayou Little League site. Figure 3 provides a concept plan for the recommended restoration of the Eagles' Nest Tract. The Eagles' Nest Tract is a County-owned tract that is a fenced mature pine flatwoods with a fringe of carolina willow and cattail along the tract's shoreline with Lake Seminole. The pine flatwoods is a mature habitat that has not been burned for at least 20 to 25 years. The area extends north of the Eagles' Nest Tract onto the Cross Bayou Little League site, which is an improved Little League baseball complex on lands leased from the County.

The recommended restoration activity proposed for this tract is controlled burning of the pine flatwoods to rejuvenate the existing habitat on the Eagles' Nest Tract, and removal of the Brazilian pepper encroachment on both sites. The seasonally high water table in the area and the existing species within the pine flatwoods indicate that slash pine *(Pinus elliottii)* should be planted in the areas where Brazilian peppers are removed. Natural recruitment of subcanopy and ground cover should occur from the surrounding areas if nuisance species are controlled. The cost estimate for the Eagles' Nest site restoration is provided in Table 3.

FIGURE 3
EAGLES' NEST TRACT

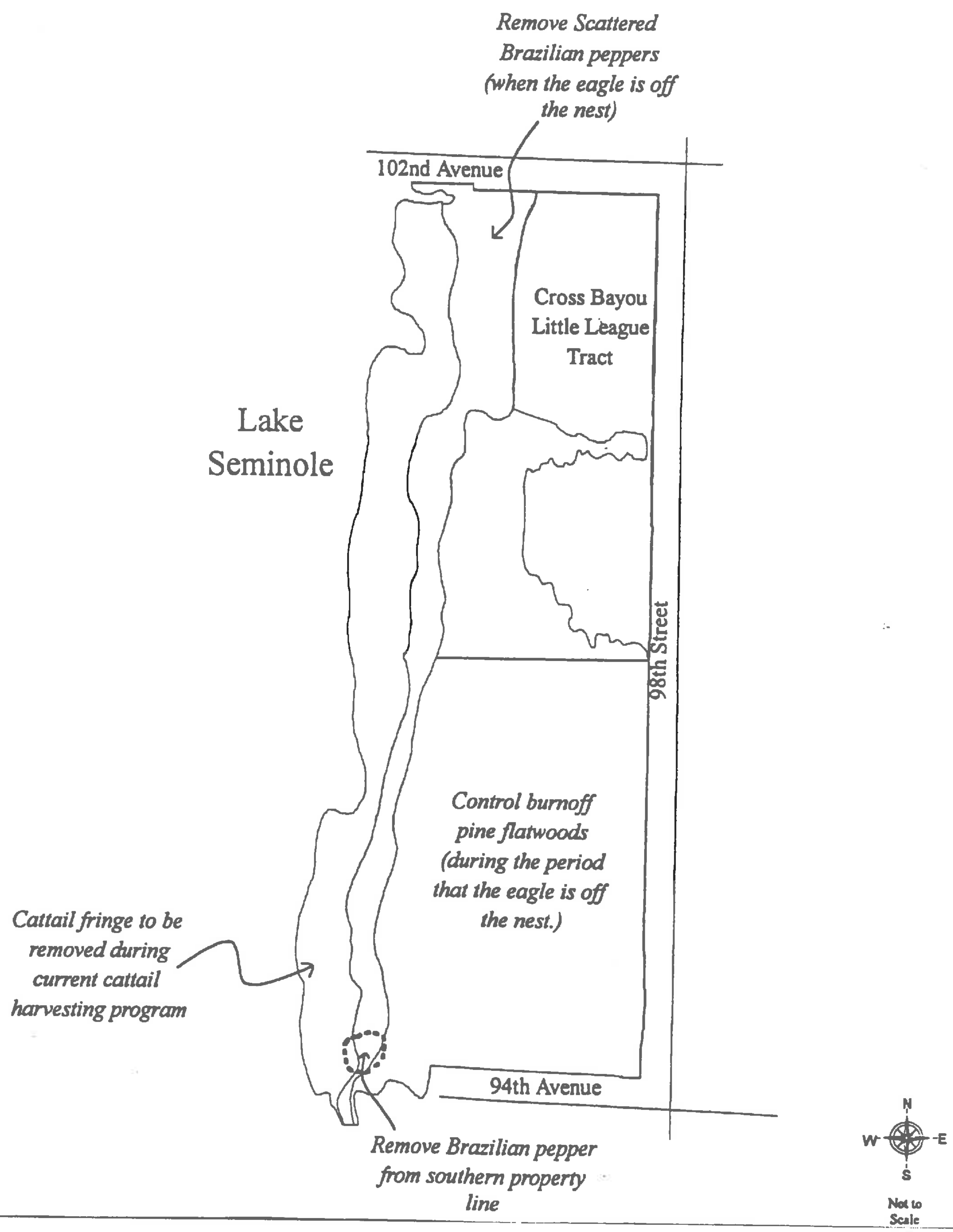


Table 3. Estimated quantities and costs for the Eagles' Nest Tract habitat restoration.

Item	Quantity	Unit Cost	Description	Estimated Cost
Control burn	40 acres	$150 per acre	Control burn 40 acre tract*	$6,000
Nuisance species removal	2 acre estimate	$600 per day per crew, 5 days estimate	Remove Brazilian pepper	$3,000
Permits	Burn permit		To be obtained from the Florida Forestry Service	NA
Planting	2 acres, 100 pine trees	$ 4.00 per three gallon tree	Replant pine *(Pinus elliottii)* in clusters within the cleared area	$400
Total Project Cost				**$ 9,400**

* Control burn to be performed when the eagles are not nesting.

2.3 Northern County-Owned Tract

The Northern County-Owned Tract is approximately 35 acres located between the lake and the Bypass Canal north of the Lake Park Subdivision. This disturbed tract has received fill material from the construction of the Bypass Canal, served as a disposal site for cattails, and has experienced long term changes in surficial water level since the construction of the Bypass Canal. The tract currently exists in a ruderal state with primrose willow, elderberry, castor bean, and grape vine being the dominant vegetative mix. Other areas in the north portion of this tract are dominated by Brazilian pepper *(Schinus terebinthifolius)* and in need of restoration. The shoreline of this tract supports a fringe of carolina willow and cattail, much of which is growing on a highly organic mat. This combination of vegetation communities precludes the growth of beneficial upland and aquatic vegetation that would provide cover and diversity of habitat for wildlife and fisheries.

The restoration activities on this tract should consider the upland portions as a first phase and restoration of the littoral areas as a long term objective of the Lake Seminole management planning process. The recommended restoration plan includes a controlled burn of the pine flatwood area. The ruderal area north of the pine flatwoods should be cleared of existing vegetation and replanted with pine *(Pinus elliottii)* to re-establish the historical community that existed prior to the construction of the Bypass Canal. The northern portion of this tract, in the vicinity of the Bypass Canal outfall structure, is dominated with Brazilian pepper. The recommended restoration plan for this area is to remove the Brazilian pepper and replant pine and oak trees in the upland areas and cypress on the shore of the lake and Bypass Canal. The remnant creek, on the southern portion of the tract, provides the opportunity for restoration as a viable herbaceous marsh system to provide cover and forage for waterfowl and fish. This restoration activity would require that the existing vegetation be cleared and the creek be replanted with appropriate vegetation to provide forage habitat and cover for wildlife and fish. The creation of this herbaceous marsh system will also provide for water quality improvements through improved circulation and nutrient uptake from the wetland vegetation.

The recommended restoration plan for the Northern County-owned tract should also include the lands east of the Bypass Canal. Although this area is outside of the Lake Seminole watershed, and is under consideration for use as a temporary spoil dewatering area in support of lake dredging, excellent restoration opportunities exist for this site which was used historically as a spoil deposition area during the construction of the Seminole Bypass Canal. The recommended restoration for this area is planting pine *(Pinus elliottii)* in clusters with cypress *(Taxodium distichum)* along the shoreline. Historical soil conditions (high water table) indicate that slash pine flatwoods were the most probable community within this Northern Tract. Since the construction of the Bypass Canal with a design water level two (2) feet lower than the lake, soil water levels have apparently declined, making the more easterly portions of this site suitable for longleaf pine *(Pinus palustris)*.

Figure 4 provides a concept plan for recommended Northern County-owned Tract restoration, while the estimated restoration costs for this tract are provided in Table 4.

Certain recreational improvements are also recommended for this tract. These recreational facilities are designed to meet the passive recreational needs of surrounding neighborhoods and provide a destination oriented feature for canoeing and kayaking on the Bypass Canal and Lake Seminole. A portage between these waterbodies would allow for canoes and kayaks to travel on the canal and portage to Lake Seminole for a return trip to Lake Seminole County Park. A canoe launch site on the Bypass Canal in the park would facilitate use of the canal by these non-motorized watercraft.

Neighborhood passive recreational usage can by facilitated by providing access and parking on the County-owned lands east of the Bypass Canal. A pedestrian bridge over the canal, along with a dock, gazebo, and/or observation tower could provide additional amenities for this neighborhood recreational park. Other facilities could include a multi-purpose trail connecting a pedestrian access gate at the southern property line with the bridge and dock facilities. Picnic shelters and one or more restroom facilities could be strategically located along this trail.

FIGURE 4
NORTHERN COUNTY OWNED TRACT

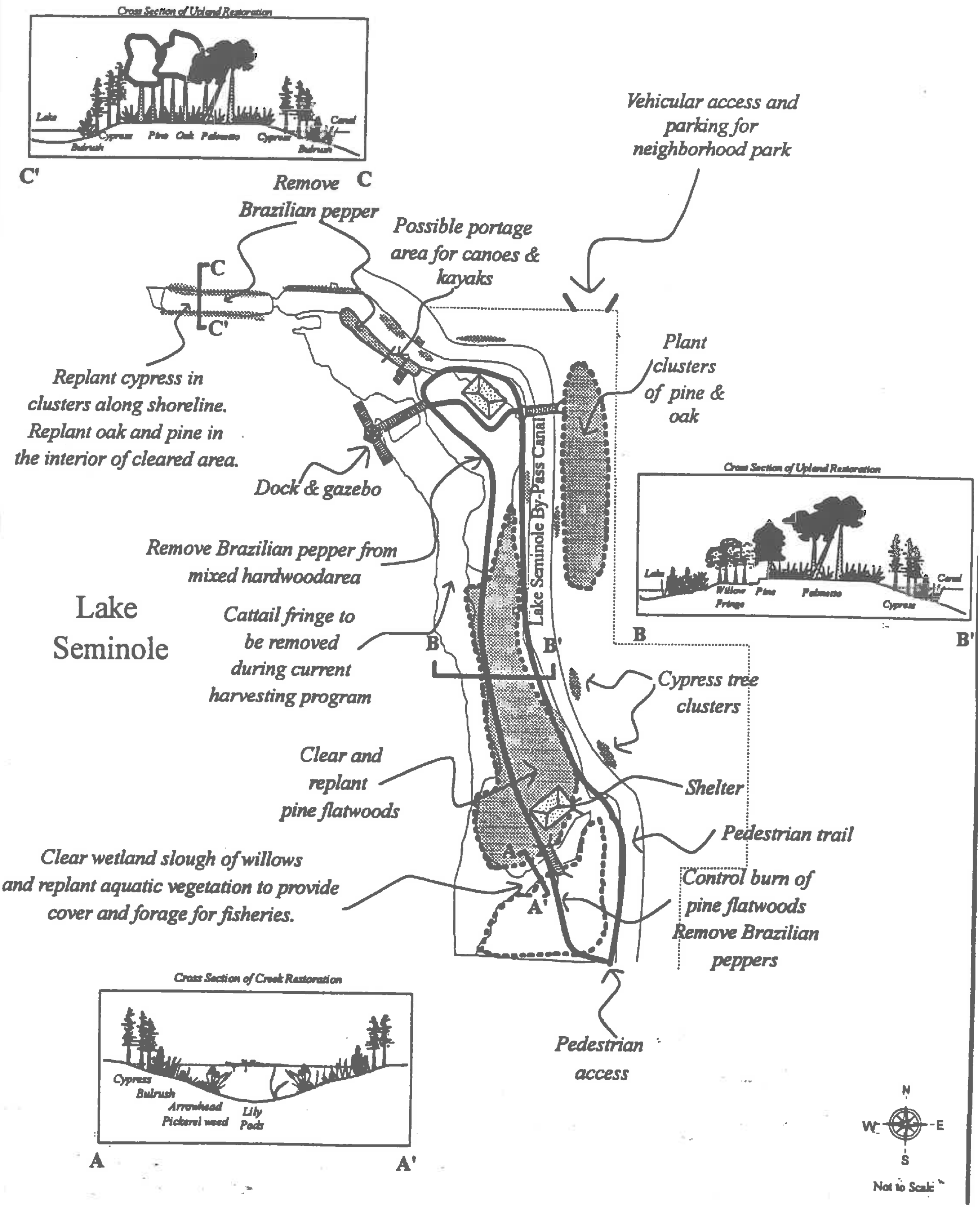


Table 4. Estimated quantities and costs for the Northern County-Owned Tract restoration.

Item	Quantity	Unit Cost	Description	Estimated Cost
Nuisance Species Removal				
Brazilian pepper	Approx. 4 acres of Brazilian pepper monoculture on the Tract	Estimated at $600 per day per crew. 5 days per acre	Remove Brazilian pepper monoculture from northern portion of the Tract	$12,000 estimate
Control Burn				
Control burn	30 acres	$150 per acre	Control burn 30 acre tract*	$4,500
Clearing				
Upland clearing	15 acres	$ 2,000 per acre	Clearing uplands	$30,000
Wetland clearing	3 acres	$ 5,000 per acre	Clear creek of cattail and carolina willows	$15,000
Permitting				
Permitting of wetland impacts, bridges and docks				$30,000 est.
Revegetation				
Replanting upland	15 acres	200 trees per acre at $4.00 per tree	Plant 3 gallon size pines on burned areas	$12,000
Replanting wetland	5 acre fringe area	100 trees per acre at $8.00 per three gallon trees	Replant live oak, cypress and wetland hardwoods in areas where carolina willows dominate	$4,000
Recreational Improvements				
Design of park facility				$25,000 est.
Bridge and dock	250 linear feet est.	$ 120. 00 per linear foot	8 foot wide treated lumber bridge & dock	$30,000
Multi-purpose trail	7,400 linear feet	$ 14.00 per linear foot	8 foot wide asphalt trail	$103,600
Shelters	Two shelters	$ 38.00 per sq. ft.	Two shelters each approx. 30' x 60' (1,800 sq. Ft.)	$140,000 ($ 70,000 each)*

Item	Quantity	Unit Cost	Description	Estimated Cost
Restrooms	Two restrooms	Pinellas County est.	Two male/female restroom facilities approx. 12' x 12'	$160,000, ($ 80,000 each)*
Access drive and parking	Parking for 30 vehicles, 200 feet of 24 ft. wide access drive	$ 12. 00 per sq. yd of pavement	532 cu. yds of asphalt pavement	$6,400
Fencing and gate	2,500 linear ft. of fence, 2 gates	$ 8.00 per linear foot	6 ft. chain link security fence, one vehicular gate, one pedestrian gate	$20,000
Total Project Cost				**$ 592,500**

* Cost estimate from the Pinellas County Parks Department for standard County park facilities.

2.4 Pinellas County Sheriff's Site

The Pinellas County Sheriff's site on Ulmerton Road supports approximately 20 acres of habitat, predominantly maintained grass training areas. Portions of this site support a remnant pine flatwood surrounding an old borrow pit that serves as a stormwater management facility for the surrounding land uses including stormwater runoff from Ulmerton Road. This pond is hydraulically connected to a major drainage ditch that discharges to the northern portion of Lake Seminole. The hydraulic improvement of this pond is a restoration activity that could provide water quality improvements within the urbanized north basin. Once the watershed model is complete, the hydraulic conditions of this pond should be reviewed to determine the potential for expanding this stormwater management facility.

Both the pine flatwoods and areas surrounding the pond have various levels of encroachment from Brazilian pepper ranging from a few individual plants on the fringe of the pine flatwood areas to extensive monoculture within the open fields and surrounding the pond. The areas surrounding the pond are spoil sites containing demolition debris that should be removed from the site as part of the restoration activities.

The Pinellas County Sheriff's Site conceptual restoration plan is provided on Figure 5, while the cost estimate for the restoration is provided in Table 5. The engineering and excavating costs for construction of an improved stormwater management facility are unknown at this time. Once the model has identified sub-basin conditions, the Sheriff's site may require increased stormwater storage and treatment capacity. If the model indicates that no additional stormwater management capacity is needed in this sub-basin, then the habitat improvements proposed for this site are debris and nuisance species removal only.

FIGURE 5
PINELLAS COUNTY SHERIFF'S TRACT

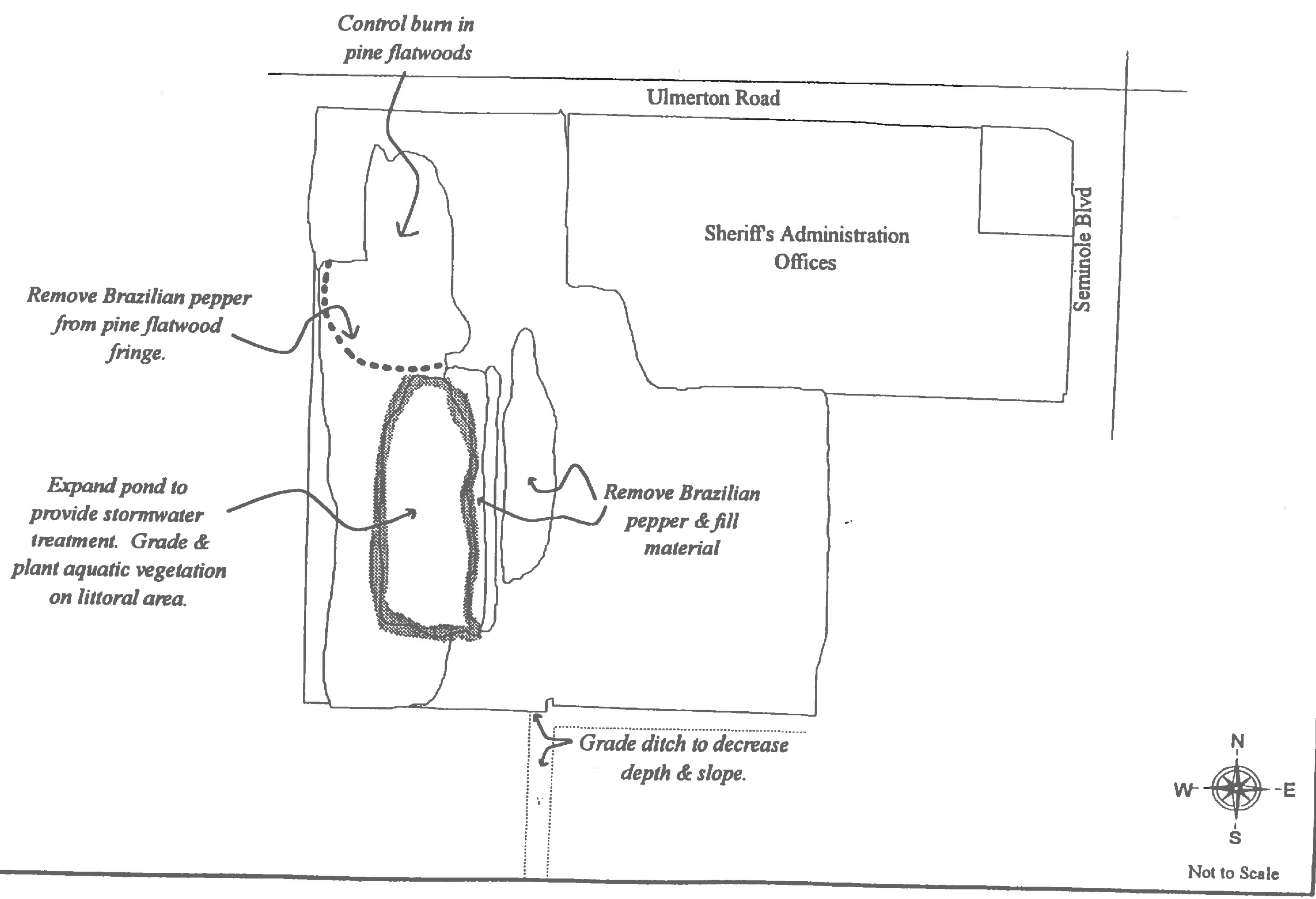


Table 5. Estimated quantities and costs for the Pinellas County Sheriff's Site restoration.

Item	Quantity	Unit Cost	Description	Estimated Cost
Nuisance Species Removal				
Brazilian pepper	Approx. 2 acres	Estimated at $600 per day per crew, 3 to 5 days per acre	Remove approx. two acres of Brazilian pepper	$ 6,000
Engineering & Permitting				
Engineering			Engineering of expanded stormwater pond	unknown
Permitting			Permitting of expanded stormwater pond	unknown
Excavation				
Spoil material	Approx. 5,500 cu. yds	$6.00 per cu. yd.	Remove spoil material to appropriate disposal site	$ 33,000
Pond expansion	Unknown	$6.00 per cu. yd.	Enlarge pond or remove sediments to increase attenuation and treatment	Unknown
Revegetation				
Revegetate cleared areas	Approx. 2 acres	$8.00 per three gallon tree, 300 per acre	Replant appropriate areas with pine and oak on 12 foot centers	$4,800
Total Project Cost				Undetermined

2.5 102nd Avenue Bridge Site

The 102nd Avenue Bridge site is an approximately 8 acre tract located south of the 102nd Avenue Bridge on the west side of Lake Seminole. The recommended 102nd Avenue Bridge site restoration is provided on Figure 6. This site is dominated by carolina willow, mimosa *(Jacaranda mimosifolia)* trees and Brazilian pepper *(Schinus terebinthifolius)*. The area west of this tract is an existing mitigation area for the wetlands impacted by the bridge construction. This mitigation area is connected to Lake Seminole by a canal that traverses the recommended restoration site. The recommended restoration activities for this site include removal of the Brazilian pepper and mimosa trees, along with removal of the spoil materials from the drainage improvements on the site. This area should be revegetated with mixed hardwood vegetation such as cypress, tupelo, and red maple. Improvements to the drainage canal (grading and planting of aquatic vegetation) on this tract would provide shallow nursery areas for fish and other aquatic wildlife, plus foraging areas for waterfowl. The cost estimate for the recommended 102nd Avenue Bridge site restoration is shown in Table 6.

FIGURE 6
102ND AVENUE TRACT

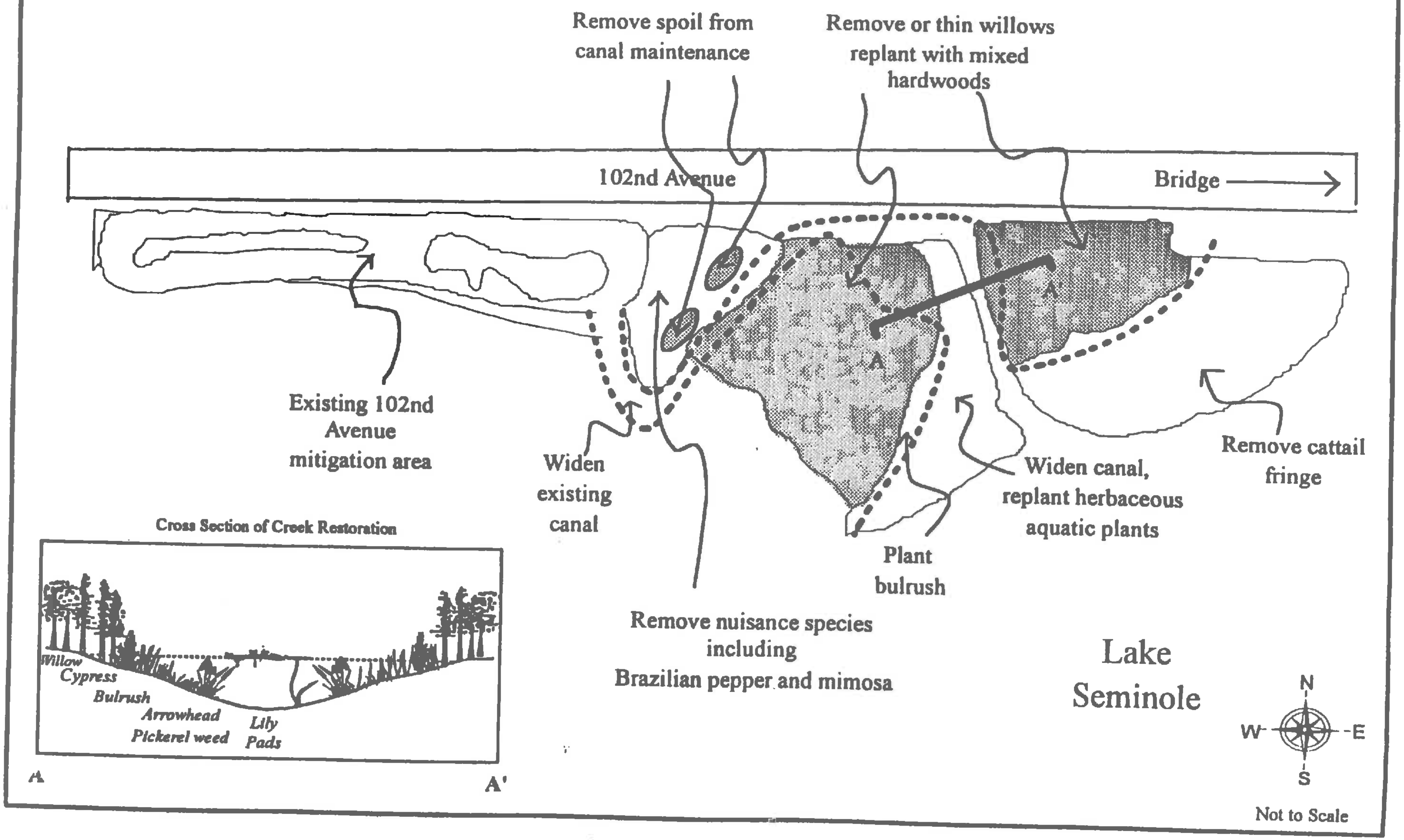


Table 6. Estimated quantities and costs for the 102nd Avenue Bridge site restoration.

Item	Quantity	Unit Cost	Description	Estimated Cost
Nuisance Species Removal				
Brazilian pepper	Less than one acre	Estimated at $600 per day per crew. 3 to 5 days per acre	Remove Brazilian pepper from habitat areas	$1,800
Mimosa trees	Estimated 12 trees	Estimated $200 per tree	Remove mimosa trees	$2,400
Carolina willow	Six acres	Estimated at $600 per day per crew, 3 to 5 days per acre	Remove 75 percent of the carolina willow from the area in preparation for planting of mixed hardwoods	$18,000
Excavation				
Spoil material	50 cu. yds.	$6.00 per cu. yd	Remove spoils from along existing canal	$300
Expansion of shallow drainage canal	1,300 cu. yds.	$6.00 per cu. yd.	Widen the existing drainage canal to 20 feet	$7,800
Revegetation				
Hardwoods	200 trees per acre	$8.00 per 3-gallon tree	Plant clumps (one acre) of hardwoods at strategic locations within the restoration area	$1,600
Herbaceous	2500 plants per acre	$2.00 per plant	Plant herbaceous species along widened canal, 0.27 acres	$1,350
Total Project Cost				**$33,550**

2.6 Watershed-Wide Brazilian Pepper Removal

The Lake Seminole watershed has a number of habitat areas where nuisance species exist as the dominant vegetation. These nuisance species include: Brazilian pepper *(Schinus terebinthifolius)*, melaleuca *(Melaleuca quinquenervia)*, australian pine *(Casarina equisetifolia)*, mimosa *(Jacaranda mimosifolia)*, and air potato *(Dioscorea bulbifera)*. Brazilian pepper, most prominant of these nuisance species, is present as monocultures or scattered among the native vegetation within the habitats in almost all of the habitat surveyed. The continued spread of Brazilian pepper through the watershed will reduce the viability of natural habitat on both public and private lands. This restoration option addresses a cooperative program designed to remove Brazilian pepper from the entire watershed.

This program will require a three step process. First, a contractor should be selected by the County to facilitate the actual Brazilian pepper removal process and to apply herbicides to the impacted areas. Secondly, the County should formulate an educational and advertising campaign targeting the removal of Brazilian pepper from private lands. Third, the County could provide neighborhood pickup and disposal of Brazilian pepper removed by property owners. These activities should be conducted while the County initiates an extensive Brazilian pepper removal program from County-owned property throughout the watershed. The educational program should identify or provide appropriate native vegetation to replace the Brazilian pepper and prevent regeneration in cleared areas.

The cost estimate for this recommended Watershed-Wide nuisance species removal program is provided on Table 7.

Table 7. Estimated quantities and costs for watershed-wide nuisance species removal.

Item	Quantity	Unit Cost	Description	Estimated Cost
Brazilian pepper	Estimate 300 acres of Brazilian pepper in the watershed	Estimated at $600 per day per crew, 3 to 5 days per acre	Remove Brazilian pepper from public and private property within the watershed	$ 900,000
Education/ advertising	Assume an advertising campaign targeting the Lake Seminole watershed. This campaign could include: cable access bulletins, local newspaper articles, specialty publications, mailouts, speeches to homeowners' associations, civic organizations, and local clubs.	Varies	Public education and advertising	$50,000 est.
Total Project Cost				**$950,000**

2.7 Lake Seminole County Park Pine Flatwoods Restoration

Problem Identification

The pine flatwoods community within the northern portion of Lake Seminole County Park has experienced some mortality of vegetation within the subcanopy and groundcover due to the presence of two weedy species, air potato *(Dioscorea bulbifera)*, and wild grape vine *(Vitis rotundifolia)*. The mortality has been light to moderate in past years, but has recently increased as the area of coverage has expanded and the density of the foliage increased. The spring growth in 1997 has been especially prolific and has raised increasing concern with the Lake Seminole County Park staff. If left unattended, these two species will cause extensive detrimental changes to the pine flatwoods community.

Wild grape vine is a species native to Florida and typically present in pine flatwood communities throughout the state. This vine uses the trunks and limbs of existing vegetation for support and elevation. Wild grape is naturally controlled by periodic fires within the pine flatwoods. In the absence of fire, the extent of the vine coverage increases, eventually shading out groundcover and subcanopy species causing mortality. In extreme circumstances wild grape has been known to entirely displace a pine flatwoods community.

Wild grape growth within the approximately 100 acre pine flatwoods community in the northern portion of Lake Seminole County Park is extensive. This coverage has reached the top of the pine canopy in some areas and has caused the mortality of old growth palmetto *(Serenoa repens)* and subcanopy species as well as young and mature pines. This extensive coverage of wild grape vine is attributed to the long term absence of natural fire within the park.

Air potato *(Dioscorea bulbifera)* is an exotic species with high climbing vines of up to 20 meters in length. This plant specie is a native of Asia and was imported to the U.S. as an exotic ornamental. As with other exotic nuisance species, air potato has escaped from cultivation and is present in wooded disturbed sites throughout Florida. Propagation of the species occurs from tubers that fall from the vines and root. Tubers may remain dormant prior to emerging as a growing vine. Growth of the vines during the spring and summer months is extensive. The vines become dormant during the winter months.

Air potato has been observed in Lake Seminole County Park for several years. The spring growth in 1997 was notably prolific both in coverage and density of the vegetation in affected areas. The extent of growth may be attributed in part to the efforts within the park to control Brazilian pepper *(Schinus terebinthifolia)*. This effort has left areas of the pine flatwoods in a disturbed state with extensive areas of soil exposed to light. The areal extent of air potato infestation has been further advanced by the tubers being thrown into the pine flatwoods by pedestrians on the multi-purpose trail through the park. New growth of air potato can be observed deep in the pine flatwoods away from the trail system because of human activities and natural recruitment. An additional extenuating

circumstance to the extensive growth in the pine flatwood areas appears to be caused by the air potatoes using the existing wild grape vines to accelerate vertical growth into the subcanopy and in some instances the upper canopy.

As with wild grape, air potato causes shading of existing vegetation and causes the death of all species that are extensively covered by the dense broadleaf vine. Areas of Lake Seminole County Park that have had extensive infestation of air potato in past growing seasons have stunted growth or killed ground cover and subcanopy species, leaving the areas in a thick mat of dead organic materials. The park staff has physically removed this organic mat in an effort to control the air potato, however much of the ground cover and subcanopy within these areas was found to be dead and was removed with the mat. The physical clearing of infected areas has resulted in almost total removal of the existing ground cover leaving bare ground under the pine canopy. In these cleared areas, air potato appears to be the first emergent vegetation. Selective herbicide applications have been moderately successful, however concerns for desirable species within the ground coverage have precluded large scale applications.

Because of the extent of coverage by these two weedy species as of the spring of 1997, an extensive emergency restoration program was developed and implemented prior to the next year's growth and development of propagules The restoration plan was developed in conjunction with the Pinellas County Parks Department in order to take advantage of their experience in the control of these species. Restoration options examined included: controlled burn of infected areas; physical removal of air potato from infected areas; application of selective herbicides; and/or all three combined into a master long term weed management plan.

Failure to act swiftly on this restoration effort would result in the extensive loss of pine flatwood communities within Lake Seminole County Park. A multi-discipline team approach to effect a long term management plan was imperative.

Recommendations for Habitat Restoration

This management effort began at a meeting at Lake Seminole County Park on June 24, 1997. The purpose of the meeting was to view areas of infestation and discuss the extent of the problem and various strategies for restoring the pine flatwoods to a more natural condition. This meeting was attended by representatives from the Pinellas County Parks Department, Public Works, Department of Environmental Management, plus outside specialist Dr. David Hall, and Butch Neal and Roger Anderson of PBS&J. The consensus reached at this meeting is summarized below.

- The infestation of air potato and wild grape is severe, resulting in extensive loss of habitat and diversity within the pine flatwoods.

- The pine flatwoods within the park are generally overgrown and in poor condition regardless of the extent of nuisance species infestation.

- A management plan is recommended to direct the multi-year activities needed to return the pine flatwoods to a more natural condition.

- This management plan would outline needed activities in terms of the physical removal of nuisance species, controlled burn of pine flatwoods, and herbicide applications.

Physical Removal of Nuisance Species

The physical removal of nuisance species from the pine flatwoods is an important first defense against the loss of habitat and diversity. Physical removal activities are anticipated to be labor intensive and will require the allocation of manpower and equipment to complement the current maintenance capabilities of the Lake Seminole County Park staff. Multiple labor crews, working under the supervision of the park staff, should remove air potato and wild grape vine from the existing groundcover and subcanopy using hand and power tools. The vegetative materials from this physical clearing process should be removed from the park and destroyed. The physical removal process is anticipated to require three to five years of effort to remove the seed source from the park. The source(s) of labor for this effort may include: County labor crews, contract labor, volunteers, or prison labor.

For planning purposes, Lake Seminole County Park maintenance crews conducted a demonstration project on one-eight of an acre of pine flatwoods where air potato was dominant. This demonstration effort required a total of 56 man-hours and resulted in the removal of approximately two tons of organic material from the infested area. Based on this demonstration effort, a minimum of 5,600 man-hours is estimated to physically remove an estimated twelve (12) acres of the worst air potato infestation from the one hundred acres of pine flatwoods within the park. It should be noted that this fast growing species has continued to spread until the air potato infestation at Lake Seminole County Park is estimated to have expanded to 20+ acres by September, 1997.

Two additional factors were evident during the demonstration project: the air potato was producing propagules, some of which were developing roots; and the secondary growth in the demonstration area after the removal effort was high, at an estimated one foot per week. The high manpower requirements for the physical removal efforts would require the initiation of all available labor sources during the current growing season. In addition, planning should be conducted to refine procedures for herbicide applications and controlled burns in order to reduce the need for the intense physical removal efforts in future growing seasons.

In response to this problem with air potato, Lake Seminole County Park instituted a volunteer program. This volunteer effort commenced with a "Volunteer Day" on September 13, 1997. Approximately 40 volunteers participated in the physical removal of approximately 12 tons of air potatoes on this day. An "Adopt a Plot" program was also initiated. This program allows volunteers to concentrate on individual 20 meter plots within the park over an extended period. Many volunteers have worked regularly on the individual plots to reduce the infestation of air potato vines

and are participating in the park-wide collection of air potato propogules that have fallen to the ground. The implementation of the volunteer program has significantly reduced the air potato infestation in the park and its continuation over several growing periods is anticipated to be a significant portion of the air potato control effort.

The success of the volunteer program has raised concern that the removal of dead groundcover and sub-canopy has exposed soil surface for the first time in many years. This condition may promote revegetation by ruderal species as opposed to desirable species native to pine flatwoods. To avoid this, a restoration effort intended to reintroduce the desirable specie should be developed and implemented. These desirable species should include wire grass and saw palmetto.

Herbicide Applications

Recently, the management plan defined the appropriate type of herbicides, application equipment, and techniques needed to control the nuisance species within the park. Herbicide applications were coordinated with the physical removal of nuisance species. Herbicide applications included direct foliar applications to leaves, since broadcast applications have caused mortality of other groundcover species. The current application of herbicides is showing favorable control of the species without the secondary loss of native vegetation. Three additional herbicide applications are anticipated for the next three growing seasons in an effort to control nuisance species. Consulting services from herbicide specialists were anticipated to be necessary to refine the most effective herbicide type(s), equipment, and application procedures.

Controlled Burns

A controlled burn of the pine flatwoods within the park was initiated in the fall of 2000 as a management tool, since these areas are currently overgrown and in poor condition. While the burn resulted in the loss of some mature pines, it should be continuously used . As implemented, these burns allow for regenerative growth within the pine flatwoods, resulting in improved habitat and diversity. A burn plan for the park should address control of public access to the existing recreational trail and protection of surrounding residential areas. The development of the burn plan for Lake Seminole County Park included certain capital improvements to the park, such as extension of a waterline to the northern end of the recreational trail, and/or the installation of an additional vehicular access gate within the northern portion of the trail.

Preliminary Cost Estimate

A preliminary cost estimate for the recommended restoration of the Lake Seminole County Park pine flatwoods is provided in Table 8. This cost estimate includes the management planning effort as the necessary first step of the implementation process. The plan will refine the procedure, approach, and cost of this multi-year program. The preliminary cost estimate assumes that labor and equipment will be provided by Pinellas County and that any necessary public relations, public notifications and/or development of a volunteer program will be performed by the Pinellas County Parks Department. The management plan will provide insight into the areas of public activities.

Table 8. **Estimated quantities and costs for the Lake Seminole County Park pine flatwoods restoration.**

Item	Quantity	Unit Cost	Description	Estimated Cost
Management Planning				
Management Plan	A management plan for 100 acre pine flatwoods area within Lake Seminole County Park	Varies with tract of land	Preparation of management plan for pine flatwoods area by consultant	\$25,000 to \$50,000
Physical Removal of Nuisance Species				
Labor (1)	2,100 man days over 3 years	\$250 per day for a labor crew of four	Labor crew consists of three laborers and one supervisor per team for nuisance species removal. Multiple labor crews may work simultaneously. Volunteer and community service labor included in manhour estimates but not cost	\$120,000 Labor costs estimates assume the use of volunteers and community service individuals at low cost to the project.
Equipment	Truck, dumpster, power & hand tools for labor crews	\$100 per day	Cost to operate necessary equipment during restoration activities	\$48,000
Supplies	Per day per labor crew	\$25.00 per day	Gas, oil, repairs, plus beverages for crew	\$12,000
Waste disposal	Per ton at County incinerator	37.50 per ton, assuming 5 tons per acre	Disposal of organic material from removal of air potato from the park	\$ 3,000
Controlled Burn				
Fire team (2)	200 days for preparation and burning over a three year period	\$500 per day estimate for the County fire team of five people	County burn team to initiate small plot (half acre) controlled burns in the pine flatwoods	\$100,000

Item	Quantity	Unit Cost	Description	Estimated Cost
Equipment and supplies	200 days for preparation and burning over a three year period	$250 per day during burn periods	Engines, hoses, power & hand tools, gas, oil, field supplies, etc.	$50,000
Herbicide [3]				
Labor	Application of appropriate herbicides up to three times per year on affected 15+ acres. Assume 360 hrs over 3 year period.	County Parks Department labor at $12 to $20 per hour for herbicide application	Application of appropriate herbicides on affected acres as prescribed by the Management Plan	$7,200 plus consulting at $6,000 Total estimated cost $13,200
Supplies	Assume one gallon of the selected herbicide application per acre, three applications per growing season	Varies with type and concentration of herbicide	Selected herbicides applied as defined by the Management Plan	Herbicide cost estimate: $18,500 Equipment: $3,000 Total estimated cost: $21,500
Monitoring				
Monitoring	6 days during the first year, 3 days second year, 2 days third year.	$1,800 per day for botanist, fire and herbicide specialists	Review and evaluation of the management program, field activities and preparation of monitoring letter report	$20,000
Total Project Cost				**$437,700**

Notes for Table 8:

(1) Labor - Cost of estimated labor for the physical removal of nuisance species assumes a contract labor crew of three at minimum wages and one supervisor at $12.00 per hour. No cost for volunteer and community service labor.

(2) Controlled burn cost estimate assumes use of County fire team. The use of Florida Division of Forestry teams will affect the cost estimates for controlled burns. Consulting services for controlled burns are available at $600.00 per day. Contract fire team and equipment available at an estimated $1,750 per day.

(3) Herbicide - Cost estimates for herbicide applications assume the cost of herbicides, equipment, and supplies, plus labor. All labor associated with herbicide applications to be provided by the County. Application assumes 360 labor hours over a three year period. Consulting services for herbicide application are available at an estimated $ 600.00 per day. Herbicide applications assume one gallon per acre for each application event. The cost for herbicides is based on a high estimated cost of herbicide of $337.00 per 2.5 gallon container.

3.0 RESTORATION PRIORITIES

Table 9 is a matrix of eight (8) recommended restoration sites and the disturbance levels determined from the habitat evaluations. The matrix provides a prioritization of the sites based on level of disturbance. Disturbance levels range from the leasted disturbed (1) to the highest disturbance (5) levels. As identified in Table 9, the habitats with the highest levels of disturbance are the: Northern County-owned Tract, Watershed-wide Brazilian Pepper, and the Pinellas County Sheriff's site. Three of the projects have wetland habitat creation on Lake Seminole as a part of the recommended restoration programs. These include: the Northern County-owned Tract, 102nd Avenue Bridge site, and the Park Boulevard project area. These three project sites have the highest potential for water quality improvements based on the creation of extensive vegetated littoral zones in Lake Seminole.

Two projects have the highest need for upland habitat restoration. These include the Lake Seminole County Park Pine Flatwoods Restoration and the Watershed-wide Brazilian Pepper Removal Program. The Lake Seminole County Park Pine Flatwoods Restoration should be considered an immediate action project because of the extensive infestation of air potato along with the general overgrown condition of the pine flatwoods and the prevalence of wild grape in the sub-canopy. Each of these species is causing loss of diversity within the pine flatwoods area that accommodates an active multi-purpose recreational trail system.

The Watershed-wide Brazilian Pepper Removal Program is proposed because of the presence of this single noxious species throughout the watershed. The habitat analysis indicates that this species exists as a monoculture in many areas and is present in many habitat units in the watershed. The extent of Brazilian pepper throughout the watershed is expected to increase unless a management control action can be initiated. The proposed restoration plan calls for a public/private effort to remove Brazilian pepper within the watershed.

Table 9. Restoration priorities matrix.

Habitat Unit	FLUCCS Classification	Levels of Disturbance				
		Hydrologic	Ecological	Chemical	Physical	Total
Northern County-owned Tract	422/427/429	5	5	0	4	14
Watershed-wide Brazilian Pepper Removal	422	5	5	1	3	14
Pinellas County Sheriff's Site	427	4	4	1	5	14
Lake Seminole County Park Pine Flatwoods Restoration	411	3	5	1	3	12
102nd Street Bridge Site	422/439	3	3	1	4	11
Cross Bayou Little League	1861	3	2	1	2	8
Park Boulevard	414/422	2	2	1	2	7
Eagles' Nest	411	1	2	0	2	5

Note: Disturbance levels range from 1 (least disturbed) to 5 (most disturbed).

4.0 CONCLUSIONS

The 3,500 acre Lake Seminole watershed, located in west central Pinellas County, is highly urbanized in nature with residential land uses and commercial nodes and strip development along arterial roadways. Lake Seminole was created in the 1940s when an arm of Long Bayou was impounded by the extension of Park Boulevard. Prior to this impoundment, the estuarine system supported a mangrove fringe and tidally influenced wetland habitat that transitioned into pine flatwoods. The lake has existed as a freshwater system for approximately 50+ years and is showing signs of eutrophication presumably caused by nutrient rich stormwater runoff from the urbanized watershed. Sports fishing is also exhibiting signs of stress with reduced catches and stunted fish populations.

The natural vegetative communities have been highly impacted by this urbanization and currently exist as scattered remnants of the historical communities. In total 121 habitat units were field surveyed within the watershed. The majority of the habitats were remnant or secondary growth pine flatwoods or oak dominated communities, plus fringe wetland systems on the shoreline of Lake Seminole and various ponds within the watershed. All habitat areas exhibit some degree of nuisance species encroachment, predominantly Brazilian pepper (*Schinus terebinthifolius*), melaleuca (*Melaleuca quinquenervia*), air potato *(Dioscorea bulbifera)*, australian pine *(Casuarina equisetifolia)* and cattail (*Typha spp*). This nuisance species encroachment ranges from slight to areas where nuisance species dominate. Approximately 135 acres of habitat within the watershed are monocultures of these nuisance species, including 85 acres of cattail along the shoreline of Lake Seminole. The County is currently conducting a cattail eradication program that will reduce the cattail habitats to approximately 25 acres. The largest contiguous vegetative community includes approximately 290 acres of pine flatwoods which exist in the Lake Seminole County Park and associated county lands extending north of the park to 102nd Avenue North.

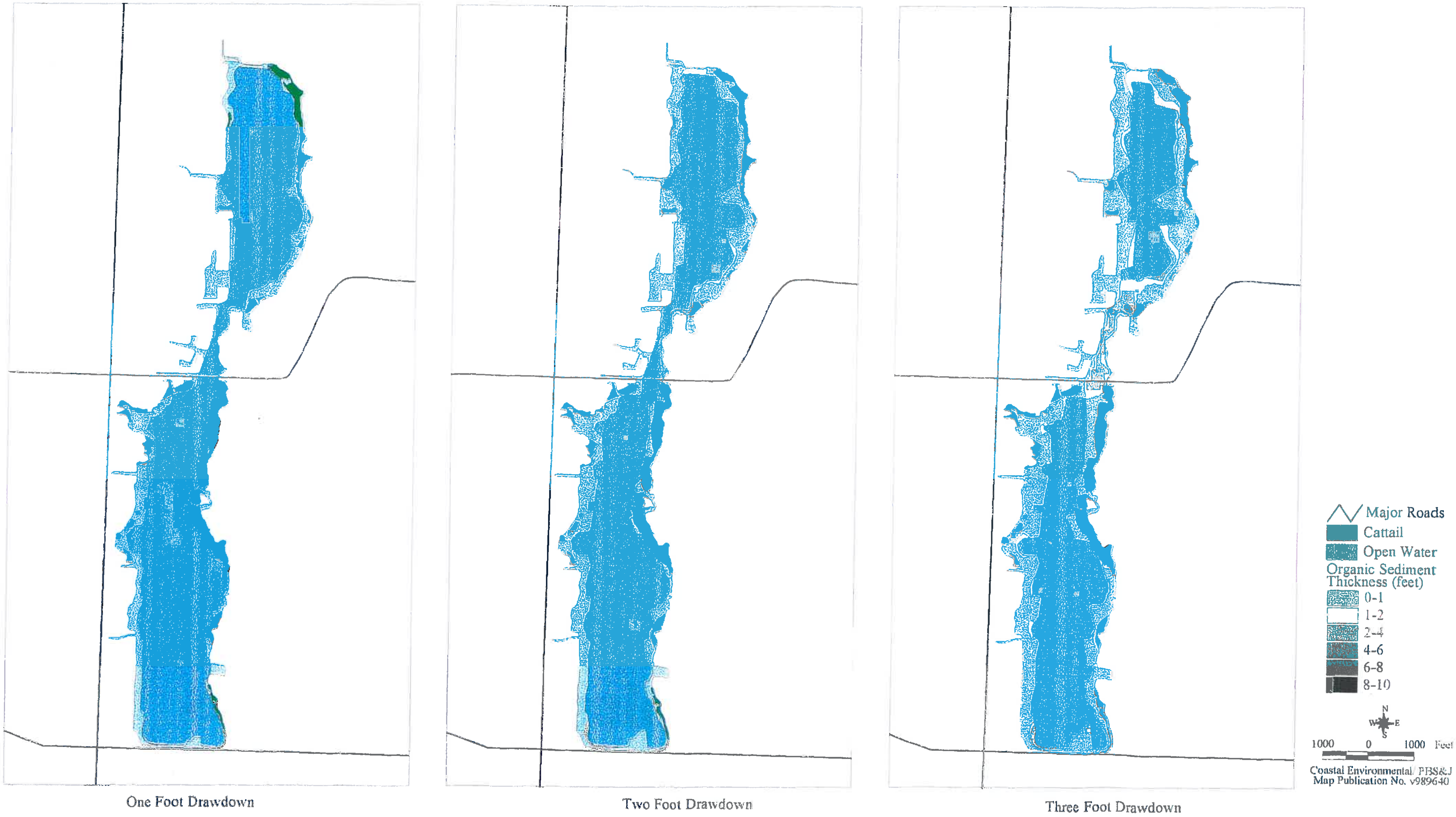
Despite its urbanized nature, the Lake Seminole watershed supports a variety of wildlife including eight (8) species that are listed as species of special concern (SSC), two as threatened (T), and one as endangered (E) by the Florida Game and Fresh Water Fish Commission. The U.S. Fish and Wildlife Service identifies one species as endangered (E). These listed species are primarily wading birds and waterfowl. The primary listed species within the watershed, in terms of the level of protection afforded by the various listings, is the Southern Bald Eagle. Two active nesting sites exist within the watershed: one on the fenced parcel of County-owned lands north of Lake Seminole County Park; and a second on the St. Petersburg Junior College tract west of 113th Street.

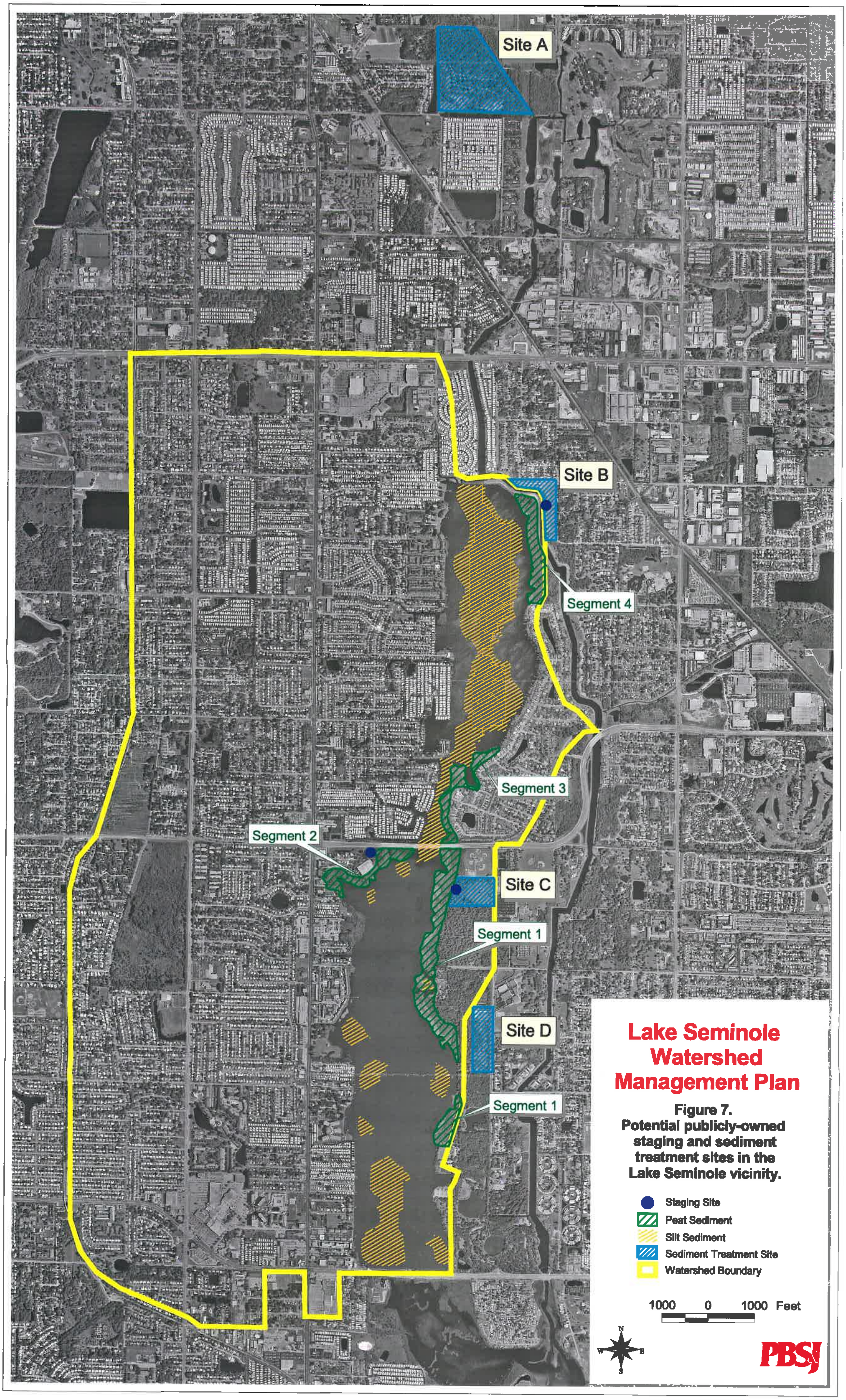
Suggested remediation and restoration projects within the watershed generally include the removal of nuisance species from the remaining habitat and restoration of the natural vegetative communities and habitat diversity. The suggested habitat restoration projects include both upland habitat restoration plus wetland and aquatic vegetation replantings to improve cover, forage, and nesting habitat for the game fish and waterfowl in the lake. All recommended restoration projects should be viewed in the context of the larger, yet to be defined, lake sediment removal project, since three of

the restoration sites are shoreline improvements that should be conducted concurrently with the lake sediment removal project. In addition, the restoration sites adjacent to the lake may be impacted by the staging for the dredge operation, sediment removal, and disposal process. Eight candidate sites have been identified for restoration. These include:

- Eagles' Nest Tract (approximately 40 acres controlled burn of a mature pine flatwoods);
- Cross Bayou Little League site (approximately 2 acres of Brazilian pepper removal);
- Northern County-owned Tract between Lake Seminole and the Bypass Canal (approximately 32 acres habitat restoration including Brazilian pepper removal and selected replanting of native vegetation);
- Sheriff's Complex (approximately 20 acres of Brazilian pepper and spoil material removal, and stormwater management improvements);
- 102nd Avenue Bridge site (approximately 5 acres of nuisance species control, and planting to diversify existing willow wetland system);
- Park Boulevard site (approximately 2,000 linear feet of lake shoreline adjacent to Park Boulevard, nuisance species removal, revegetate shoreline for habitat enhancement and appearance);
- Watershed-wide Brazilian pepper removal project (estimated 300 acres); and
- Lake Seminole County Park pine flatwoods restoration.

Figure 4
Lake Bottom Exposed Through Various Drawdown Scenarios





Lake Seminole Watershed Management Plan

Figure 7. Potential publicly-owned staging and sediment treatment sites in the Lake Seminole vicinity.