Lake Jesup Interagency Restoration Strategy

DRAFT
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Participants listed below have demonstrated scientific, financial, and political support for this strategy and are committed to moving forward. Project details were developed in close cooperation with local governments in the Lake Jesup watershed and the Friends of Lake Jesup. : Seminole County Soil and Water Conservation Service, Sierra Club Central Florida Chapter (Cecilia Height, Vice Chair), Friends of Jesup (Robert King, President), Seminole County, Orange County, City of Winter Springs, City of Oviedo, City of Sanford, City of Winter Park, City of Orlando, City of Maitland, City of Lake Mary, City of Casselberry, City of Longwood, City of Altamonte Springs.

LAKE JESUP INTERAGENCY RESTORATION STRATEGY

Lake Jesup is a hydrologically complex system with a large urbanized watershed and a long history of abuse and neglect. A multi-faceted and well-organized strategy is needed to address the multitude of restoration issues associated with Lake Jesup. This document outlines that strategy. With the right projects in the right places in the right order, Lake Jesup can meet Class III water quality standards and support a healthy, self-sustaining fish and wildlife population.

This detailed interagency action strategy is fully endorsed by the Florida Department of Environmental Protection (FDEP), the Florida Fish and Wildlife Conservation Commission (FFWCC), and the St. Johns River Water Management District (SJRWMD). The strategy has been designed to meet restoration goals, provide a timetable for implementation, specify agency responsibilities, and identify specific restoration milestones.

The general restoration goal is to meet or exceed all Class III water quality standards and re-establish a healthy aquatic ecosystem in Lake Jesup. This goal will be achieved through implementation of seven basic steps that will occur in two sequential phases. Phase 1 activities are required components of the restoration strategy. Phase 2 activities will be implemented on an as-needed basis, depending on the results of Phase 1 activities.

Phase 1

1. Develop the BMAP
2. Reduce external nutrient loads
3. Remove nutrients stored in the lake water column

Phase 2

4. If necessary, implement projects to further improve water clarity
5. If necessary, implement projects to increase native vegetation and control exotic species
6. If necessary, implement projects to enhance sport fish populations

Throughout the Restoration Process

7. Monitor water quality

This approach facilitates the use of adaptive management in restoring Lake Jesup. Adaptive management is application of scientific principles to implement a course of action, test assumptions, learn from this experience, and use that learning to hone a sharper direction for the future. This approach facilitates wise use of resources and application of ever-improving science in the restoration process. When best applied, adaptive management is not a trial-and-error process. In the case of Lake Jesup, a significant body of work exists upon which this restoration strategy has been built, and although new information is emerging even after years of study, enough knowledge exists to begin restoration. Monitoring will occur throughout the process, providing a sound basis for adaptive management changes in the Jesup restoration process. Monitoring will also help track success of the restoration strategy.

As a result of strategy implementation, participants expect to see the following changes in Lake Jesup:

1) Reduced external nutrient loads (nitrogen and phosphorus)
2) Reduced water column phosphorus concentrations
3) Increased water clarity through reduction in phytoplankton density and turbidity
4) Increased coverage of native submerged and emergent vegetation
5) Increased sport fish populations

Trends in these five measurable elements will be used to establish criteria for evaluating the success of the Lake Jesup Interagency Restoration Strategy.

Need for the Interagency Restoration Strategy

A Total Maximum Daily Load (TMDL) has been established for Jesup, and the Basin Management Action Plan (BMAP) process is underway to identify pollutant sources and define nutrient load allocations over the next year. At the same time, competition for lands needed for treatment processes is increasing, available local government revenue for stormwater management is decreasing, and access to restoration funds through state agencies is becoming more competitive. This strategy will help state agencies and local governments pool their resources to do more with less.

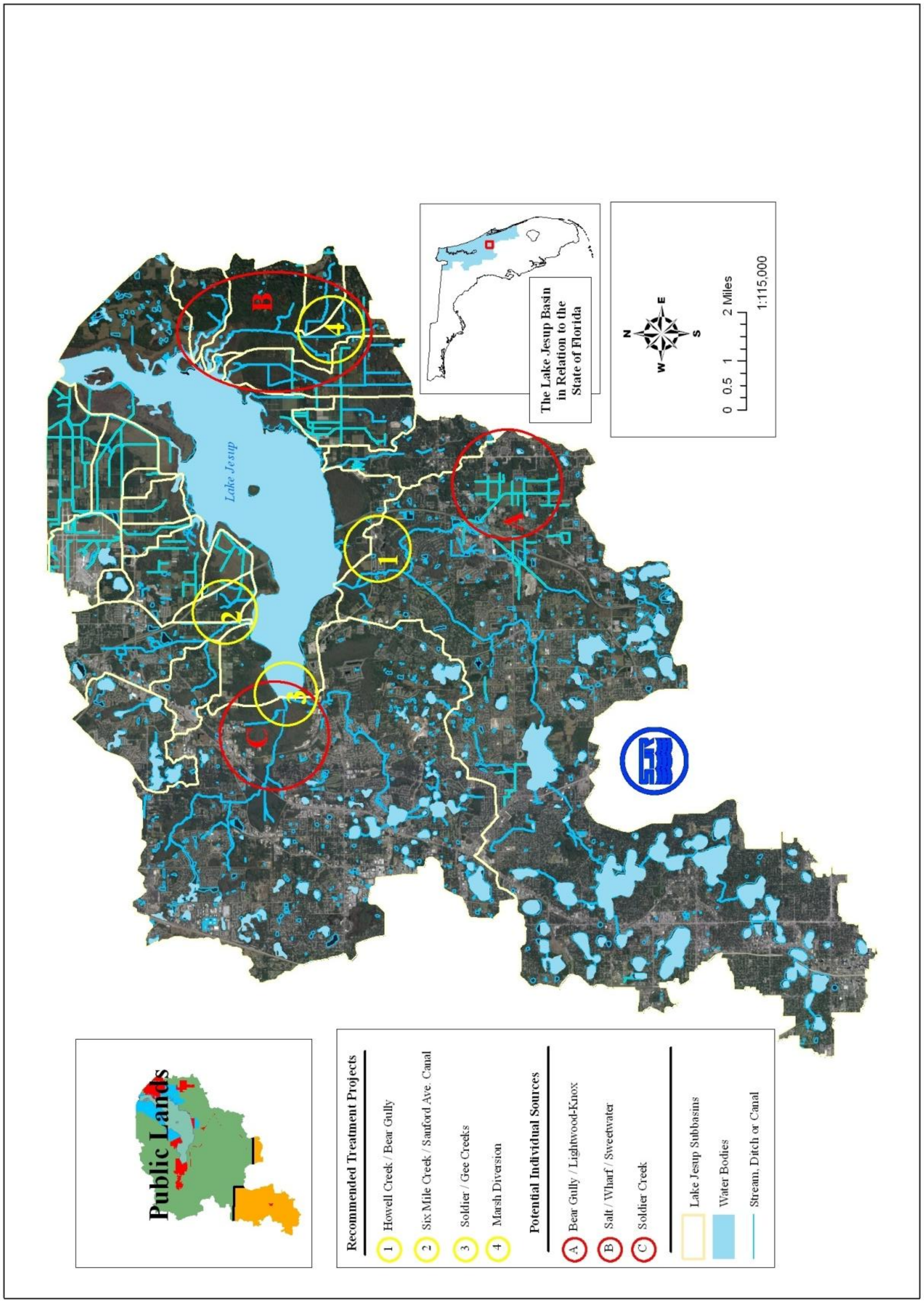
A quantitative measure of this fiscal responsibility is calculation of the cost per pound of phosphorus removed from the Lake Jesup basin. Calculations provided in this strategy demonstrate significant cost efficiency that can be gained through implementation of cooperative projects.

Document Organization

This Interagency Action Plan begins with a commitment to speed up the BMAP process for Lake Jesup and then provides recommendations for using multi-jurisdictional regional treatment projects that should more effectively reduce nutrient loading to Lake Jesup, both from a quantitative and easily monitored perspective as well as cost. This plan further commits to implementing in-lake projects to accelerate water clarity and revegetation once external loads are reduced, should in-lake responses be insufficient.

Details of the seven restoration steps are presented in the rest of this document. Each step is discussed conceptually with a brief description of the site-specific restoration recommended for implementing the step. A summary of recommendations, costs and timing are provided as tables following this narrative, and full details of the restoration strategies are provided in the appendices.

Figure 1. Areas of interest in the Lake Jesup basin, indicating general location of recommended treatment projects and potential individual sources of high nutrient concentration runoff.



PHASE I

1. *Develop the Basin Management Action Plan (BMAP).*

Lake Jesup is impaired by high levels of total nitrogen (TN), total phosphorus (TP), and unionized ammonia (FDEP, Verified Impaired Waters). The first step in restoration of the lake is the reduction of external loading rates (kg/y) of nitrogen and phosphorus. In order to restore water quality, FDEP has determined that the mean in-lake concentration of TP should not exceed 0.096 mg/L and the mean in-lake concentration of TN should not exceed 1.320 mg/L. Presently, mean concentrations are 0.167 mg/L and 2.400 mg/L for TP and TN, respectively. Reducing mean concentrations to the target levels will require substantial reductions in external loading rates of nitrogen and phosphorus. FDEP has determined that the Total Maximum Daily Load (TMDL) for phosphorus loading should not exceed 20,900 kg/yr and nitrogen loading should not exceed 272,400 kg/yr. A summary table of TMDL components is provided in Appendix 1. As part of the TMDL process, FDEP is working on the BMAP that will allocate the total allowable loads of nutrients among the concerned parties. The agencies party to this plan fully support this effort and agree that it is essential if we are to meet the restoration goal for the lake. The success of all other activities will depend on successfully reducing external excess nutrients loads.

The BMAP is currently under development. The Lake Jesup, Crane Strand, Crane Strand Drain, and Long Branch BMAP Working Group is developing the BMAP, with guidance from FDEP. The primary purpose of the BMAP is to document responsibilities for external load reductions (i.e. allocations) and projects that will be implemented to achieve those reductions. Projects include structural BMPs, non-structural BMPs, ordinances and policies and multi-jurisdictional efforts. The Working Group will make decisions regarding what projects to include, with support from DEP.

Key steps that have been completed to-date include technical analyses to refine TMDL calculations, compilation of project information from stakeholders, discussion of key programs that affect the BMAP (e.g. SJRWMD enhanced ERP rules), and initial discussions about allocation strategies. The Working Group began detailed discussions about allocation strategies in July 2007. Uncertainties regarding the role of in-lake processes in pollutant loading have had a significant impact on the BMAP process. It is highly unlikely that the science will be mature enough to provide resolution of these unknowns on the BMAP timeframe, but, while stakeholders are pursuing a consensus position regarding how to address in-lake processes in the BMAP, all agree on the need to control external loads, and consequently these uncertainties will not delay the first round of reduction allocations. A table completed by stakeholders with projects currently in place is provided in Appendix 1.

2. *Implement reduction of external total phosphorus (TP).*

Prior to 1983, Lake Jesup received marginally treated wastewater discharge from Lake Howell via Howell Creek and six other wastewater facilities. The average phosphorus concentration from 1966 to 1981 in Lake Jesup was 0.45 mg/l. Following the diversion of waste water treatment plant effluent in 1983 the in-lake TP declined and by 1985 averaged 0.17 mg/L, a concentration similar to the current conditions. Thus, the lake made rapid and substantial improvements to past load reductions indicating that Jesup responds favorably to nutrient reduction, despite being a shallow lake with high levels of soft sediment. However, ultimately these reductions were not large enough to drive the in-lake concentrations sufficiently low to restore the lake.

Reduction of the external phosphorus load is expected to cause a rapid decline in water column phosphorus concentrations. As phosphorus concentrations decline, so should the abundance of phytoplankton and suspended particulate matter. This reduction of particles in the water column will increase the transparency of the water and allow light to reach almost 65% of the bottom in this shallow lake. As light availability increases, submerged vegetation can colonize and increase in coverage. These plants play a vital role in providing desirable habitat for fish and wildlife and reducing the recycling of nutrients.

Phosphorus loading follows a variety of paths, some which are essentially unmanageable (for example rainfall directly onto the lake). However the majority of the loading to Lake Jesup occurs via routes and in forms that can be managed. Most of the excess nutrients loading comes from the surface water flowing into the lake from several tributaries. The largest excess nutrients loads come from Howell, Gee, and Soldier creeks, all of which flow into the western portion of Lake Jesup. Phosphorus cycles between a variety of chemical forms within the water column, which have differences in both their availability to algae and treatability. The majority of the phosphorus in the tributary loads is in the form of soluble reactive phosphorus (primarily phosphate [PO_4] from fertilizer), which is a form both highly available to algae and highly treatable. Thus, the largest portion of the manageable external load is in an easily treated form. The challenge is that this easily treated load is distributed between a variety of individual tributaries, most of which are flowing through urbanized areas where available land for treatment is scarce. In addition, the loading is the result of both highly variable flows and concentrations. The SJRWMD will investigate potential land acquisition and/or use agreements in key areas along tributaries where treatment sites might be constructed.

Because nitrogen fixation appears to be a significant percentage of nitrogen inputs to Lake Jesup, and because nitrogen fixation typically occurs in freshwater areas with high phosphorus concentrations, the primary focus for nutrient load reduction into Jesup will be, initially, phosphorus. Results from FDEP's watershed model, SJRWMD's HSPF watershed load model (Jia 2007) and water quality data indicate that between 18 and 20 MT TP/yr come into the lake from surface water runoff. The HSPF model also shows that even with all currently legislated BMPs for new development and retrofits for old development where possible, watershed nutrient loads will continue to increase. Consequently, innovative treatment techniques will need to be implemented where most effective, balancing cost and load reduction.

These recommended strategies are offered to stakeholders in the Jesup basin who have an obligation to reduce their loading by the allotment designated in the BMAP process (Step 1). The three agencies are using this document to demonstrate their commitment to significantly improve Lake Jesup's water quality and habitat, however, they do not own allocation obligations within this particular basin. Consequently, the municipalities and counties will ultimately need to choose and fund their reduction strategy. Regional treatment projects are often the best use of taxpayer's money because larger treatment facilities often provide the lowest per unit costs. Further, these recommended projects may receive higher consideration for competitive state and federal funding because of the larger number of stakeholders that will receive a benefit and the combined support of three state agencies.

<u>Recommended strategies:</u>

1. Pursue fertilizer regulation and build an outreach program to provide information on this regulation, its benefits and alternatives to fertilizer applications. Include components

related to the nutrient content of reclaimed water and how excess use and use with additional fertilizer leads to excess nutrients runoff. Present these in a multi-faceted outreach program reemphasizing other BMPs for residential and commercial lawn care. Eliminating phosphorus use from residential areas would reduce TP loading from three to six MT/yr. A TV and school campaign targeted at the Jesup basin population would cost about $400,000/yr (see Appendix 2), or about $30/lb of phosphorus not entering the lake.

2. Identify nutrient loading coming from a single identifiable source. Five tributaries to Lake Jesup exhibit steep increases in TP loading from side canals or creeks at junctions close to the lake. If this increased load is coming from individual sources, FDEP and SJRWMD should collaborate with the appropriate MS4 permittees to assist these polluters with increasing their onsite treatment prior to design and construction of regional treatment projects.
3. Pursue large-scale regional treatment projects where phosphorus removal is most cost effective. Rather than individual municipalities attempting to initiate expensive treatment projects on small scales with questionable benefits to Lake Jesup, funding and planning efforts should be optimized by allowing interested stakeholders to contribute to regional treatment projects regardless of their location in the basin. After consideration of Lake Jesup's specific loading attributes, the following four site-specific recommendations are considered to be the most effective load reduction projects.

Acquire land in the Howell Creek basin near or on the shore of Lake Jesup and install an enhanced natural treatment system. Howell Creek delivers about 45% of the total watershed phosphorus load (Jia 2007). Treatment in this area (See Figure 1) would reduce TP loading from four to six MT/yr and cost between $70 and $150 per pound of phosphorus load reduction.

Install an alum system on Soldier creek near Lake Jesup if a single identifiable source is not located. Treatment at this location would remove between one and two MT TP/yr at an estimated cost between $220 and $50K per pound of phosphorus load reduction, depending upon alum costs over the next twenty years.

Acquire land in the Six-Mile Creek basin and install an enhanced natural treatment system. Potential removal of phosphorus is estimated at 1 MT/yr and the estimated cost per pound phosphorus removed per year is between $70 and $400.

Acquire land on the Potential Acquisition List near Salt and Sweetwater Creeks and construct a serpentine marsh diversion if a single source cannot be identified. This marsh diversion would remove between one and two MT TP/yr and would cost between $60 and $160 per pound phosphorus removed.

3. Remove nutrients stored in the lake water column.

Full achievement of load reductions will take years and, following external load reductions, it could take years for the lake to meet water quality, habitat and fish goals. In order to hasten restoration of water quality, the agencies support implementation of projects to remove phosphorus that is recycled in the water column. Although there is a large store of phosphorus in the lake sediments, most of this phosphorus is not readily recycled in the water column. This sedimentary phosphorus does not appreciably contribute to the high density of phytoplankton and water column turbidity. Thus, the agencies will be testing means for removal of water column phosphorus. Some options that may be tested include the installation of floating treatment wetlands, harvesting of plants from the lake, and other phosphorus removal technologies. At average lake stage and using the 10-year phosphorus concentration average, Lake Jesup has about 18MT phosphorus in the water column. As external loads are reduced, water column phosphorus will also decrease, and these in-lake treatment facilities should be considered temporary.

Recommended strategies:

1. Complete preliminary studies and pilot projects that can lead to rapid implementation of in-lake nutrient reduction following external load reduction.
    - SJRWMD will conduct a sediment nutrient cycling study to quantify annual sediment nutrient budget.
    - Assess efficacy of SJRWMD pilot Pay-For-performance project in reduction of water column phosphorus. The District has already committed to funding a pilot project to test removal of phosphorus with a biological filter. Two and a half million dollars are presently allocated for this project. A project description is provided in Appendix 3.

2. Fund temporary in-lake installations such as floating wetlands. These systems operate similarly to the Marsh Flowway in that nutrient enriched water is pumped into a treatment area then recirculated back to the lake as treated water. However, these are smaller scale, harvested and operated using solar power. Recommended locations within the lake are indicated on Figure 1 and additional information about options is in Appendix 3. Current estimates indicate that removal of four MT/yr of phosphorus would cost between $300 and $400 per pound and would cover about 0.2% (22 acres) of the lake.

3. Complete a feasibility study on harvesting *Phragmites* sp. as a phosphorus removal mechanism. Rough estimates of aerial extent indicate that between one and two MT/yr of phosphorus could be removed through plant uptake and aboveground harvest at a cost between $50 and $100 per pound.

PHASE 2

4. If necessary, implement projects to further improve water clarity

If monitoring data indicate that water clarity does not respond to excess nutrients load reductions sufficiently, other measures should be taken to enhance water clarity. Depending upon the basis for persistent turbidity, these activities could include treatment of the water column with alum to substantially reduce the phosphorus concentration and to remove suspended particles. Floating wetland filters could also be used to remove suspended particles. Dredging of surficial sediments and SAV planting may also play a role in increasing water clarity if monitoring data indicate that resuspension of sediments maintains high levels of suspended particles in the water column.

Recommended strategies:

1. Study feasibility of using floating wetlands as suspended solids filter devices (see Step 3 above).
2. Support targeted dredging in areas not responding to load reductions, but dewater the sediment and transport off-site as dredging occurs to avoid the negative impacts of impoundments in and

near wetlands. Initial sediment analysis indicates there are no contaminant issues and sediments are therefore candidates for any land application, including agriculture, as a soil amendment. One rapid dewatering vendor claims that 15M yd^3 of soft sediment could be removed over four to five years for about $105M.

3. Support redirection of reuse water from Sanford's Site 10 to other sites outside the basin currently using potable water for irrigation.

4. Purchase Site 10 currently used by the City of Sanford for disposal of excess reuse water and sludge for use as temporary holding area for dewatered sediment and for habitat restoration.

5. If necessary, implement projects to increase native vegetation and control exotic species

If water clarity improves but native vegetation fails to expand, then projects should be implemented to increase recolonization of the lake by native plants. Dredging of sediments may be necessary to provide a better substrate for vegetation. Planting of native species also may be necessary. Increased water clarity could also cause an expansion of undesirable exotic species, such as hydrilla. It will be essential to monitor exotic species as water clarity improves. If these species begin to colonize, control activities should be implemented immediately.

Because this action step is several years in the future and not expected to be necessary, no detailed plan is recommended at this time.

6. If necessary, implement projects to enhance sport fish populations

If native vegetation has expanded and habitat has become suitable for sport fish yet the response of sport fish populations has been insubstantial, then other fish management actions may be necessary. These actions could include stocking of species known to have high value as sport fish. Other sport fish management techniques may also be implemented.

PHASE 1 and 2

7. Monitor water quality, vegetation, and fish populations.

Successful implementation of this action plan will require monitoring of the lake throughout the life of the restoration effort. Adjustments will be made if the water quality, vegetation and fisheries fail to respond as expected to restoration activities. Additional monitoring data may be required to address the source(s) of in-lake nutrients should their concentrations persist following external load reductions. Additionally, sources of turbidity or suspended solids may be require identification should water clarity fail to improve.

Recommended strategies:

1. Complete District sediment study measuring nutrient recycle in three Middle and Lower Basin lakes. This multi-year study will begin sampling in December 2007 and will cost about $350K for three lakes.

2. Continue current water quality monitoring. Both ambient and storm event water quality monitoring in Lake Jesup and several tributaries are ongoing, long-term projects conducted by both SJRWMD and Seminole County. Seminole County also has two continuous YSI data loggers at either end of the lake measuring DO, turbidity, conductance and chlorophyll every half-hour.

3. Continue monitoring submerged aquatic vegetation populations (SAV) every 2 years, quantifying changes from baseline study conducted in July 2007 with Seminole County as the lead agency partnering with FWC, FDEP and SJRWMD.

4. Continue current yearly monitoring of fish population by FWC.

Other Projects

Dredging Prior to River Reconnection at State Road 46

This plan recognizes the significant contribution of other projects that will result in improvements to Lake Jesup. These efforts include a project already planned by the Florida Department of Transportation to re-engineer the connection of the lake with the St. Johns River in conjunction with replacing the State Road 46 causeway. This project would be implemented to both replace the causeway and enhance exchange between the river and lake. This work is being done in conjunction with the US Army Corps of Engineers and their 1135 restoration project examining the opportunity to reduce the environmental impacts from changes made to the historic river channel decades ago. Strategic dredging in the northern neck of the lake may be required for navigation during periods of low water, to reduce downstream export of resuspended sediments and improve sediment conditions for SAV.

PROJECT SUMMARY AND COSTS

INITIAL ESTIMATES – Engineering SJRWMD is reviewing

Table 1: Reduce External Nutrient Loading - Project Framework for Lake Jesup Phosphorus Reduction

Project	Estimated Cost/lb TP Removed[+]	Potential MT TP Removed per year	Capital; O&M	Estimated Time to Start-up
Fertilizer and reclaimed water use outreach	$30 and up	3 - 6*	No Capital; $250K – 500K (not done every year)	18 months
Howell Creek/Bear Gully, ATT	$70 - 150	4 - 5	$9M – 24M; $115K – 154K	2 years after land purchase
Soldier/Gee Creek, chemical	$220-55K^	1 - 2	$500K – 900K; $490K – 600K	2 years
6-Mile Creek/Sanford Canal, ATT	$70 - 400	0.5 – 1.5	$2.1M – 3M; $37K – 50K	2 years after land purchase
Salt/Wharf/Sweetwater, Marsh diversion	$60 - $160	1 - 2	$5.1M – 13.4M; No O&M	1 month after land acquisition and permitting
Total potential reduction in external loading		8 - 12		

+ Amortized over 20 yr Project Life

* When this rule is implemented, potential reductions in other projects will be lower than presented in this table

^ Highly dependent upon alum costs

Table 2: Reduce Nutrients Stored in the Lake

Project	Estimated Cost/lb TP Removed[+]	Potential MT TP Removed per year	Capital and O&M	Estimated Time to Start-up
Study: Nutrient Cycling in Sediments	NA	NA	$350K; NA	Early 2008
Pilot Pay-for-Performance Project	$227**	1 and up	NA**	Fall 2008
Floating wetlands, 0.2% lake surface area coverage	$300 - 400	2 and up	$2.5M – 4M; $250K – 500K	3 months after permitting
Phragmites Harvest	$50 - 100	1 - 2	$0; $420 - 600K	Immediately

** Reflects price negotiated in Pay-for-Performance contract (five years), but might not reflect 20 year cost or removal rate

ATT – Alternative Treatment Technology; STA – Stormwater Treatment Area

TIMELINE FOR ACTION PLAN

Milestone	BMAP allocations; projects prioritized	Fertilizer Rule; Land purchase; Project design; Permitting	Construction begins	External load reduced by 9 MT/yr	In-lake TP reduced to 0.094 mg/l	TMDL revisited in 2nd round; TP reduced another 5MT/yr	In-lake TP reduced to <0.07 mg/l	In-lake TDS < 250 mg/l	SAV > 15%	SAV > 40%
Action Step	**FY08**	**FY09**	**FY10**	**FY11**	**FY12**	**FY13**	**FY14**	**FY15**	**FY16**	**FY17**
Develop the Basin Management Action Plan (BMAP)	X	X								
Reduce external PHOSPHORUS loads		X	X	X	X	X	X	X	X	X
Remove nutrients stored in the lake						X	X	X	X	X
If necessary, implement projects to further improve water clarity								X	X	X
If necessary, implement projects to increase native vegetation, control exotic species and enhance sport fish populations										X
Monitor water quality, vegetation, and fish populations	WQ, F, V	WQ, F	WQ, F	WQ, F	WQ, F, V	WQ, V, F	WQ, F, V	WQ, F, V	WQ, F, V	WQ, F, V

RESPONSIBILITY

Action Step	FDEP	FWC	SJRWMD
Develop the Basin Management Action Plan (BMAP)	X		
Reduce external phosphorus loads	X		X
Remove nutrients (phosphorus and nitrogen) stored in the lake water column	X		X
If necessary, implement projects to further improve water clarity	X		X
If necessary, implement projects to increase native vegetation and control exotic species	X	X	X
If necessary, implement projects to enhance sport fish populations		X	
Monitor water quality, vegetation, and fish populations	X	X	X

APPENDICES

Appendix 1. Develop the Basin Management Action Plan (BMAP)

Table 1A.1 Summary of loads used to determine the annual Total Maximum Daily Loads (TMDLs) and reduction goals for Lake Jesup (FDEP 2006).

FDEP TMDL Report	Loads in metric tons		1995-2003					
	TN: Target Concentration 1.32 mg/l				TP: Target Concentration 0.094 mg/l			
	Current	Background	TMDL (annual)	Reduction	Current	Background	TMDL (annual)	Reduction
Surface	129.9	121.1	99.7	30.2	14	5.6	7.5	6.5
Baseflow	10.4	14.3	10.4	0	3.3	4.6	3.3	0
Septic Tanks	19.7		12	7.7	2.7		1.2	1.5
Groundwater	3.4	3.4	3.4	0	0.6	0.6	0.6	0
Atmospheric	39	39	39	0	3.1	3	3.1	0
River	99.9	68.8	68.8	31.1	5.1	3.5	3	2.1
N2 Fixation	270.8		14	256.8				
Reported Total	**553.9**	**246.6**	**247.3**	**306.6**	**28.8**	**16.9**	**19**	**9.8**
Actual Total	**573.1**			**325.8**				

The project sheet will be included via Jennifer

Appendix 2.   Implement reduction of external total phosphorus (TP) loads

Support for pursuing external phosphorus reduction without similar TN reductions:
Substantial nitrogen fixation indicated by single event sampling in Jesup, August 2006 (Tomasko, PBS&J, Seminole County Contract) and follow-up testing in progress since then (Scinto, FIU, SJRWMD Contract SK42812). These studies are supported by water quality data indicating dominance of Cyanophyta genus known to be nitrogen fixers.

Recommended strategies:

1. Pursue fertilizer regulation and build an outreach program to provide information on this regulation, its benefits and alternatives to fertilizer applications. Include components related to the nutrient content of reclaimed water and how excess use and use with additional fertilizer leads to excess nutrients runoff. Present these in a multi-faceted outreach program reemphasizing other BMPs for residential and commercial lawn care.

A new rule eliminating phosphorus in typical lawn fertilizer will soon be passed in the state, and a reduction of phosphates in residential fertilizer applications will result in a load reduction of approximately 6 MT TP/yr into Lake Jesup. At a cost of about $400,000/yr for an advertising campaign targeted at the Jesup basin population (Table 2A.1), the cost per pound of phosphorus not entering the system would be about $30 per year. Further, this cost is short-term, only needed until the population has changed their fertilizer habits or used up their old stock.

Table 2A.1.   2005 population in the Lake Jesup watershed and an estimated cost to complete a single year of education about the benefits of TP reduction in fertilizer (US Census 2000 and US Census Update 2005).

Population	Households	Mail Campaign[1]	School Program[2]	Cable TV Ads[3]	Total Cost
271034	104244	$104,244	$243,930	$16,200	$364K

1. $1/household;
2. 18% population school age, $5.00 per child;
3. $54/min; 1 month campaign January, 60 30-sec spots 2/night, 10 stations

A similar program should be directed at newer developments using reclaimed water for lawn irrigation. Reclaimed water has extremely high phosphorus concentrations (~0.5 to 5 mg/l TP) and is extensively used in some areas of the Jesup basin. Applications of one inch two times a week in areas with reclaimed water have a potential runoff of approximately 4 MT TP/yr (see Figure 2A.1 for reuse areas in Jesup's basin). Recommended applications should be reevaluated and consumers educated about potential overuse.

Table 2A.2 Estimate of amount of TP available for runoff into Lake Jesup using SJRWMD estimates of 2006 reuse areas

Reuse acres in Jesup basin	5942	acres
Recommended reuse application	1.5	inches/wk
Range applied TP	24 - 238	MT/yr
Range runoff TP, 20% runoff coefficient	5 - 50	MT/yr

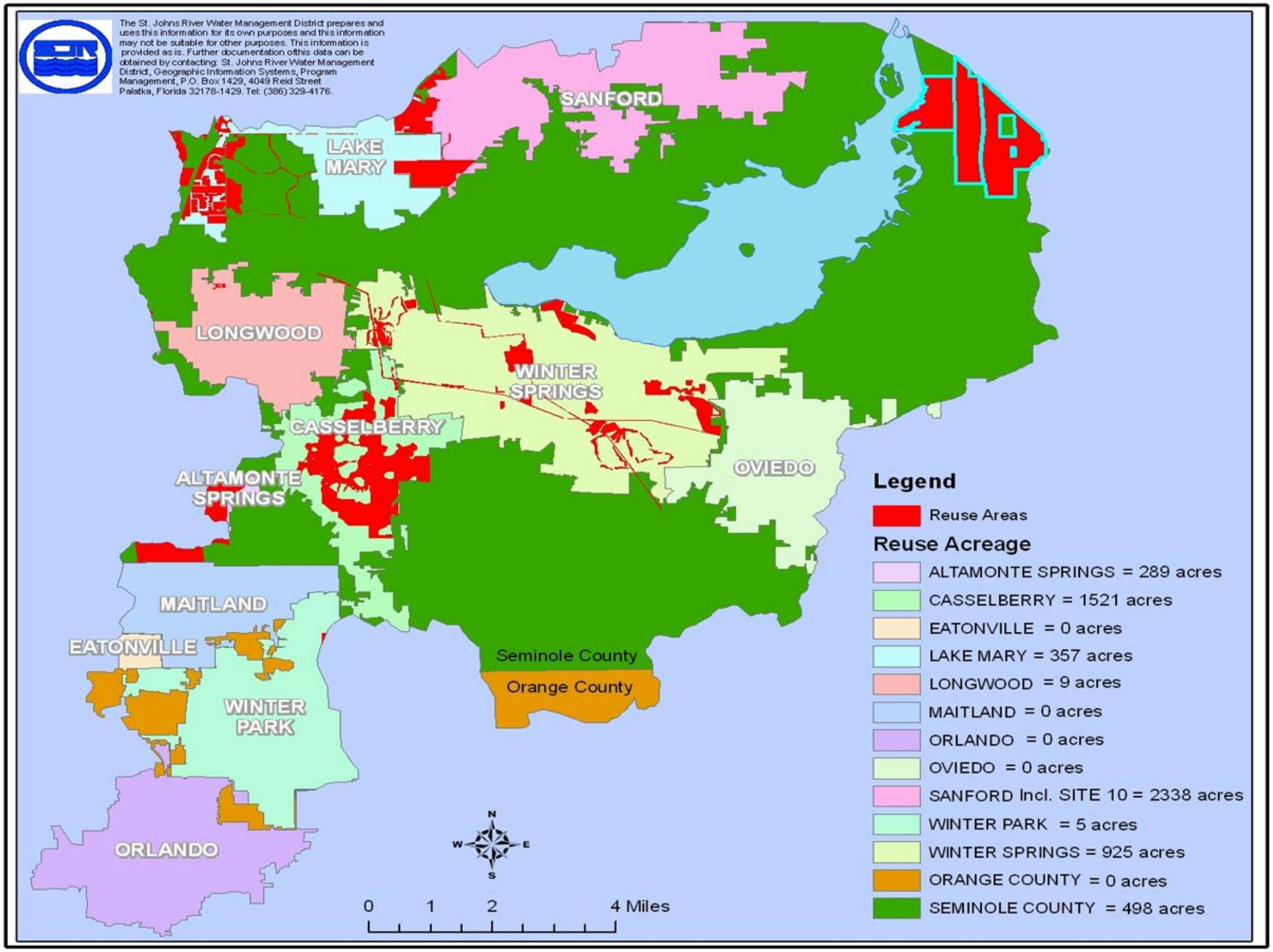


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Figure 2A.1. Acreage and location of reuse areas with the Lke Jesup basin (SJRWMD 2007). Allocations to individual entities determined using FGDL coverages from 2006.

These efforts should be combined with other proven outreach venues to create a comprehensive multi-faceted media program. The Seminole County Soil and Water Conservation District (SSWCD) would coordinate and develop a strategy to reduce water consumption and reduce activities, behaviors and lifestyles that contribute to higher nutrient loading. This strategy would include additional mail outs from the water utilities, educational spots in newspapers, public outreach booths at events to educate the public on reducing need for fertilizers through native plant use, nutrient alternatives (mulching, organics, safelawns.org, etc.), multimedia presentations and events. This coordinated effort would provide reductions that could be applied to allocations in the same way that larger scale tributary treatment projects serve as regional treatment projects.

2. Identify nutrient loading coming from a single identifiable source.

Five tributaries to Lake Jesup exhibit steep increases in TP loading from side canals or creeks at junctions close to the lake (Circles A,B and C on Figure 1). If this increased load is coming from individual sources, FDEP and SJRWMD should collaborate with FDACS and the appropriate MS4 permitees to assist these polluters to increase their onsite treatment prior to design and construction of regional treatment projects. Preliminary water quality monitoring demonstrates that almost 65% of the Howell Creek TP load comes from the Bear Gully Creek and Lightwood-Knox Canal. Similar increases occur in Soldier Creek somewhere between the Seminole County ball fields and the lake. Conduct a study to determine the source of extremely high concentrations in three ephemeral creeks on the southern shore: Sweetwater/Salt/Wharf Creeks; then recommend most feasible option: 1) chemically amend or physically remove excess nutrients from isolated sites, or 2) increase stormwater residence time by rechanneling flow through a constructed serpentine creek bed in the floodplains of one or more of the creeks. These tributaries flow through floodplain already owned by the District or on the potential acquisition list (see Figure 1 for location, Figure 2.2 in Appendix 2 for conceptual design and #3 below for description), but may require additional acquisition to insure the channels are above the 100 yr flood line. This marsh diversion would remove between two and three MT TP/yr and would cost between $60 and 160 per pound phosphorus removed.

3. Pursue large-scale regional treatment projects where phosphorus removal is most cost effective.

Lake Jesup has thirteen tributaries all of which have a relatively high orthophosphate (PO_4) concentration (see Table 2A.2). Capturing phosphorus loads at this level (>50% of phosphorus) is the easiest and most cost effective lake treatment because orthophosphates are more chemically and biologically available than organic phosphorus and treatable with simpler processes. Rather than individual municipalities attempting to initiate expensive treatment projects on small scales with questionable benefits to Lake Jesup, funding and planning efforts should be optimized by allowing interested stakeholders to contribute to regional treatment projects regardless of their location in the basin. After consideration of Lake Jesup's specific loading attributes, the following five site-specific recommendations are considered to be the most effective projects for load reductions at the lowest relative cost. Not all of these tributaries have significant flow year round which is an integral component in most treatment processes, but several have periods of high flow during which significant load reductions are possible. In addition, locating such facilities adjacent to the lake creates the opportunity to treat lake water during periods of low flow, thus reducing in-lake concentrations, this combination providing almost all of the phosphorus reduction required by the TMDL.

Table 2A.2. Estimated loads from Jesup's main tributaries, demonstrating that Howell, Soldier and Gee Creeks have the highest water and TP loads and that all the tributaries have a high percentage orthophosphate. Water quality data – ambient MSJRB network, SJRWMD; HSPF discharge estimates from Jia (2007)

Tributary	Avg TP mg/l Ambient Data	HSPF Estimates ac-ft	Calculated TP MT/yr	Percent PO_4
Howell Creek	0.138	57451	9.8	51
Soldier Creek	0.149	11237	2.1	72
Gee Creek	0.118	11873	1.7	62
Sanford Canal	0.179	5506	1.2	63
Solary Canal	0.500	1775	1.1	82
Salt Creek	0.229	3171	0.9	53
Sweetwater Creek	0.375	1809	0.8	77
Chub Creek	0.595	1012	0.7	0.47
Black Sweetwater Creek	0.364	1159	0.5	NA
Navy Creek	0.062	5506	0.4	NA

Land Acquisition and Pilot Projects: Howell Creek; Soldier/Gee Creek; Six-Mile Creek;

There are four tributaries to Lake Jesup that deliver enough phosphorus and stormwater/baseflow to warrant treatment systems. Unfortunately these systems are in urban areas where land is scarce and highly priced. Alternative Treatment Technologies (ATTs) optimize total phosphorus removal through innovative treatment trains (chemical and natural), typically require a smaller footprint than more traditional stormwater treatment areas (STAs) and can be customized for unique features of the specific water body. The savings in land costs from a smaller process footprint offset the added expense of a managed process in this basin where land costs more than $100,000/acre.

One of these tributaries, Howell Creek, delivers about 45% of the total watershed non-point source phosphorus load. The flood plain of this creek, next to the new city center for Winter Springs, is currently for sale but upland in the parcels is limited. Purchasing this floodplain, with both wetlands and sufficient upland for treatment sites, between Hwy 434 and the south side of the lake (Circle 1 on Figure 1), would keep future development from increasing the phosphorus loads and seeking permits to use wetlands, and would provide a base for an ATT. We estimate that treatment of 70% of Howell Creeks phosphorus load will require approximately 36 acres and will cost between $73 - $140/lb phosphorus removed (capital and land amortized over 20 years, see Table 2A.3).

Table 2A.3. Cost estimate for a harvested periphyton system to reduce TP in Howell Creek before it drains into Lake Jesup

Data for IFAS process sized for 0.150 mg/l TP influent, 100 MGD (Sano et al 2005)		
Capital costs for 56 acre facility	$6,730,883	
Replacement costs (required at 10 yrs)	$1,035,561	
Cost per acre without real estate (1.5% of capital)	$134,032	
O&M costs 50 years net present 2005	$8,974,847	
Cost per year per acre	$3,205	
Removal capacity per acre 50 year total	18242	lb TP
Per acre per year	365	lb TP
Costs projected for 6 MT/yr TP removed using IFAS numbers		
Howell Creek: 0.140 mg/l TP; 51 MGD; similar in concentration and flow, assume linear scale-up		
Minimum upland required for treatment area 6 MT	36	acres
6MT - Capital costs without land, with replacement costs	$4,825,134	
O&M costs for 20 year lifespan	$2,307,818	
Cost for 36 acres Jesup basin land	$3,960,000	
Total capital costs w/land @ $110,000	$8,785,134	
Total 20 yr costs	$11,092,952	
Cost per pound TP removed	$42	2005 $
Cost range for sample parcels in the sub-basin	$7,323450 - $19,200,000	
Cost range per pound TP removed, 2005 $	$42 - $120	2005 $
Cost range per pound TP removed, 2008 $	$73 - $134	2008 $

Bear Gully, a long stream stretch draining part of the Howell Creek basin, drains into Howell Creek just south of the lake. The Lightwood-Knox Canal is a tributary to Bear Gully. It has been investigated as a potential source to be treated separately prior to convergence with Howell Creek, and current water quality data provides evidence that part of the Bear Creek/ Lightwood-Knox Canal load is related to agriculture that could be managed better on-site.

Table 2A.4 Cost estimate for use of alum to treat Soldier Creek discharge into Lake Jesup

Soldier Creek			
Soldier Creek Data Highest storm event monitored 2.86" rain, 7,512,449 cubic feet discharge (CDM 2004)			
Average flow rate	11237	acre-ft/yr, HSPF model (Jia 2007)	
Alum Data			
Cost per gallon alum	$0.44	2006 cost[+]	
Dosing rate	0.00812	gpm alum per cfs influent, dosing rate of 1 mg/L [+]	
Alum, using 15mg/l dose[+]	1.89	gpm alum[+]	
O&M/yr [+]	$50,000		
Capital without excavation [+]	$500,000		
Holding Pond Data			
Weir	$50,000		
volume 1st inch rain	2626730	ft3/in	
detention area, 8 ft depth	328341	ft2	
	8	acres	
Excavation, no transport	$7	yd^3	
No increase in alum costs		**With increase in alum costs**	
with land lease		***with land lease***	
1 year land lease*	$8,291	1 year land lease*	$8,292
total project cost 20 yrs	$13,477,672	total project cost 20 yrs	$3,068,508,725
total TP removed, lb	60678	total TP removed, lb	60678
cost per pound TP	$222	cost per pound TP	$50,570
with land purchase		***with land purchase***	
land acquisition**	$829,145	land acquisition**	$829,145
total project cost 20 yrs	$13,456,446	total project cost 20 yrs	$3,068,491,026
total TP removed, lb	60678	total TP removed, lb	60678
cost per pound TP	$222	cost per pound TP	$50,570

[+] Nalway 2007, no jar tests completed for Lake Jesup, using information from Lake Apopka
* $1100/acre/yr   ** $110,000/acre

Two other tributaries would benefit from similar treatment: Soldier and Six-Mile creeks (Circle 3 and 4 respectively, Figure 1). Soldier Creek and another tributary, Gee Creek, converge in a forested floodplain on Seminole County property but there is not enough upland nearby to treat both creeks simultaneously. Soldier Creek has the higher phosphorus loading. Soldier creek, with limited acreage, will require chemical treatment rather than periphyton. Treatment at this location would remove about 1.5 MT TP/yr at an estimated cost of $220/lb while alum costs about $0.44/gallon. Alum costs increased almost 50% last year. If this level of increase persists, the cost per pound could reach $51K in 20 years (See Table 2A.4 for cost analysis).

Six-Mile Creek drains a wetland used for disposal of sewage in the past, converges with Sanford Ave Canal and drains directly into the lake. More data need to be collected for this system, but the potential removal of phosphorus is estimated at 1 MT/yr and will require about 12 acres. The estimated cost per pound phosphorus removed per year is between $73 and $400. This project cost per pound TP removed will be higher than Howell Creek because the amount of available TP is lower.

Marsh Diversion: Sweetwater/Salt/Wharf Creeks

There are several tributaries on the southeast shore of Jesup that have high concentrations of phosphorus and loading that can be considerable during rain events, but are ephemeral or lake dominated the remainder of the year. Tributary systems with these characteristics are usually not candidates for cost-effective active treatment processes. However, these tributaries drain a large area of tree farms and ornamental nurseries, most with irrigation systems draining into roadside canals and swales leading into these tributaries and potential abandoned ag fields with residual fertilizer and contaminants. All of these tributaries flow through floodplain already owned by the District just prior to entering the lake.

Before recommending a treatment strategy, a study of potential sources should be completed evaluating nutrient concentrations from current agricultural operations and testing abandoned agriculture fields for residual phosphorus. Depending upon source identification, DACS could assist in identifying primary sources in the BMAP process and gain agreement from contributors to improve on-site retention. If residual phosphorus is the source, we recommend removal of nutrient rich soil or enhancing the treatment efficiency of these wetlands to increase their phosphorus removal rate. The current channels are straight and through wetlands. By rechanneling flow through a serpentine creek bed, increasing residence time and uptake (see Circle 2 on Figure 1 for location, Figure 2A.2 for conceptual design), 35 to 100 acres of the wetland would remove about 2MT TP/yr and would cost between $60 - 160/lb phosphorus removed assuming only excavation costs with no additional O&M costs. The channel would be considered a one-time construction project and allowed to fill in naturally as treatment requirements decrease.

Table 2A.5. Cost estimates for marsh diversion excavation

Ambient Creek Data			
Creek (subbasin # from Jia 2007)	Wharf (34)	Salt (35)	Sweetwater (36)
Water acre-ft/yr (Jia 2007)	800	3171	1809
TP concentration	0.6	0.229	0.375
annual load, kg	600	900	800
load kg/d	1.6	2.5	2.2
load kg/day assuming all in wet season 4 months	4.93	7.40	6.58
Estimated TP removal, kg/yr	550	703	693

Estimated Marsh Diversion Costs		
Estimate Treatment Area		
TP effluent concentration mg/l = 0.4083*kg TP/ha/day - 0.0504		
from TP efficiency curve generated by CH_2MHill (2007)		
Assume desired effluent concentration 0.05 mg/l		
Required area = 0.4083 (load TP kg/d)/(0.05*(1+.0504))		
Excavation Estimates		
Design load (seasonal load)	19	kg/day TP
Seasonal load area	106	acres
Cubic yards serpentine trench, 2 ft deep		
Seasonal load	340435	yd^3
Excavation @ $15/yd3 removed		
Seasonal load	$5,106,526	
Assume removal free due to urgent need in area for fill		
Assume natural recruitment (no planting costs)		
Potential mitigation costs		
106 acres impacted wetlands	$8,268,000	
Cost per pound TP removed		
20 yr TP removal	85763	lb
Cost/lb TP Seasonal load	$60	
Cost/lb TP Seasonal load w/mitigation	$156	

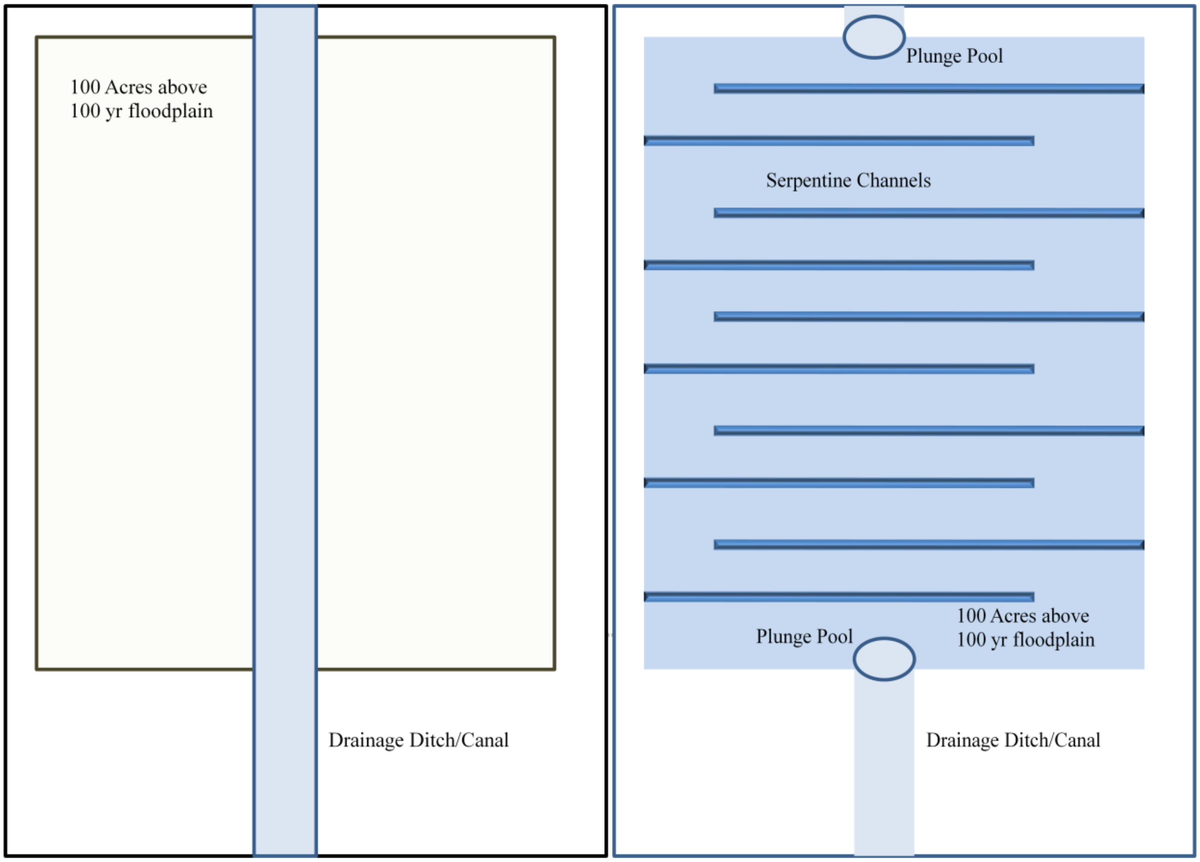

Figure 2A2. Conceptual diagram for marsh diversion project: serpentine berms are constructed to direct flow into a large area than the original straight drainage channel. Treatment is obtained through increased residence time

Appendix 3. Remove nutrients stored in the lake water column

Assess efficacy of SJRWMD pilot Pay-For-performance project in reduction of water column phosphorus.

SJRWMD is pursuing evidence that advanced treatment technologies (ATT) such as biological filters and chemical amendments, alone or in combination, can cost-effectively remove TP and restore water quality in Lake Jesup. Results from ATT projects in Florida suggest that they can result in substantial improvements in water quality with minimum land requirements. However, these projects treated phosphorus concentrations higher than typical for Lake Jesup and its tributaries, and little data currently exists for successful operation of ATTs beyond one year. Operational problems have been reported in published pilot studies of biological ATTs, with corresponding drops in TP removal rate. Chemical amendments have also shown problems with long-term operation.

Because such technologies have not been successfully demonstrated on large hypereutrophic lakes such as Lake Jesup in highly developed basins, nor for extended time periods, SJRWMD is reluctant to expend funds for capital costs (including land) or technology development and refinement. The District is therefore offering an alternative method for funding of this project: Pay-for-Performance, and the pilot scale project has been awarded to AquaFiber, Inc., Winter Park, Florida.

The purpose of this project is to demonstrate that an ATT can effectively remove a minimum of one MT TP/yr for a minimum of five consecutive years using a process that can be scaled up for higher levels of removal using a footprint smaller than typical stormwater treatment areas while still being cost effective. Removal of TP is expected to begin by Fall 2008.

Fund temporary in-lake installations such as floating wetlands

Floating treatment plants were pioneered by John Todd with Ocean Arks International (now with John Todd Ecological Design, Inc.) and called Restorers[R] or floating Living Machines[R] (Figure 3A.1). These systems are similar to the principal behind the Lake Apopka flow way marsh, where water is pumped into a wetland or aquatic system, cleaned through natural removal processes, then returned to the lake with nutrients at an acceptable concentration for improved water quality. However, floating treatment areas are actively managed, do not require a land base and are powered by solar energy. Work on alternatives has been completed in Florida by DB Environmental, Inc. Several areas have been identified that would benefit from floating wetlands and an area of 25 acres would remove about 4 MT phosphorus from the water column at a cost of about $300/lb phosphorus removed. At average lake stage and using the 10-year phosphorus concentration average, Lake Jesup has about 18MT phosphorus in the water column, which will decrease in volume and concentration as external loads are reduced.

Figure 3A.1. Lake restoration systems from John Todd Ecological Design, Inc.

Complete a feasibility study on harvesting *Phragmites* sp. as phosphorus removal mechanism

Unlike other lakes in the Middle Basin, Jesup has an extensive stand of *Phragmites* sp. (Figure 3A.2) and the aerial extent appears to be increasing. While *Phragmites* is not the optimum emergent vegetation for use in treatment of nutrient rich water, they have been successfully used in many wastewater treatment wetlands in Europe and Africa and have been studied for nutrient uptake in eutrophic rivers and lakes (EPA 2000, Meuleman et al 2002, Kao et al 2003, Vymazal 2004). *Phragmites* grows at the boundary between marsh and lake and is the last treatment option for non-point source runoff into the lake from the watershed as well as a perimeter treatment of lake water. This native but invasive vegetation might be a feasible alternative for phosphorus removal, eliminating the need for spraying and the concomitant problems from the sudden organic load to the marsh and lake from decomposing biomass. Using the aerial extent in Jesup in 2004 and average uptake rates and harvest costs from the literature indicates that more than two MT TP/yr could be removed from Jesup non-point loads at a cost of less than $100/lb including disposal costs if no agricultural concern wants the feed supplement. Harvesting of *Phragmites* will open access to marsh areas during periods of high water increasing areas for fishing.

Figure 3A.2: Stand of *Phragmites* SP on Jesup's shore

Appendix 4. If necessary, implement projects to further improve water clarity

<u>Support dredging in areas not responding to load reductions, but use rapid dewatering and sludge removal over a period of several years rather than 20 to 25 year impoundment of high quality wetlands.</u>

Using data from a sediment-coring project completed by Cable et al. (1996), Dames & Moore (2000) estimated that the total volume of soft sediments in 1996 was about 100M cubic yards (Table 4A.1). Analysis of sediments completed by Battelle (200x) for SJRWMD found all excess nutrients concentrations to be far below regulations in Part 503 land application limits. Further, in excess of 100 repeated applications on a single area would be required to exceed cumulative excess nutrients load rates. Consequently, all of the lake sediments are therefore candidates for any land application, including agriculture, as a soil amendment.

This point is significant because it creates potential disposal areas that may not require impoundments in wetlands and that may be far enough from the lake to eliminate runoff without high transport costs (see map of useable disposal areas, Figure 4A.1). New dewatering technologies with improved drying times and increasing demand for lake sediments as soil amendments should be used to determine the rate at which targeted areas are dredged so that no wetlands are impacted, with this dredging viewed as ongoing long-term lake maintenance.

Table 4A.1: Estimated volumes of soft sediment in different areas of Lake Jesup

Soft Sediment Volumes, 1996	
Whole lake	1.02E+08 yd3
Top 35 cm	9.90E+06 yd3
Northern neck	1.58E+06 yd3
Southern central region	4.17E+06 yd3

(Dames & Moore, 2000 using Cable et al. 1996)

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Appendix 5. Letters of Support

SIERRA CLUB
FOUNDED 1892

CENTRAL FLORIDA GROUP
P.O. Box 941692, Maitland, FL 32794-1692

September 12, 2007

Dr. Sherry Brandt-Williams
Regina Lovings-Morse
St. John's River Water Management District
4047 Reid St.
Palatka, FL 32178-1429

RE: Lake Jesup Interagency Water Quality and Habitat
Restoration Strategy

Dear Dr. Brandt-Williams and Ms. Lovings-Morse

The Sierra Club, Central Florida Group, has been an active participant of the Friends of Lake Jesup for more than a decade. We are grateful for this opportunity to offer comments on this proposed restoration strategy document.

Sierra Club acknowledges the commitment of all the agencies and entities who pledged to come together to formulate a working plan for the improvement of the Lake Jesup Basin. We applaud the spirit of cooperation of all parties to protect and enhance water quality for a healthy and vibrant Lake Jesup Basin.

Sierra Club would like to offer our support for a number of key elements of the plan, including the following: active land acquisition plans within the basin, including but not limited to areas connected to Soldier Creek and Six Mile Creek; the proposed floating wetlands proposal; future dredging programs and <u>off-site removal of the sediment</u> that will benefit Jesup's lake bottom and water quality; the purchase of Site 10; aggressive reductions of the nutrient loadings into the Lake Jesup Basin, especially of phosphorus and nitrogen; increasing propagation of native vegetation and reduction of exotics and removal of the nutrients that flow into the Lake Jesup Basin.

While we are aware that there are a number of budgetary concerns that are under consideration, we respectfully support significant target level reductions of nutrient loadings at the earliest possible time period. We support efforts to actively engage all residents and all governmental entities in order to significantly reduce their contribution to the nutrient loading into and ecological degradation of the Lake Jesup Basin. We encourage a proactive and aggressive land acquisition program since it is one of the best strategies to help preserve the ecology of the Lake Jesup Basin while helping to implement this management plan.

On behalf of the Executive Committee of the Sierra Club of Central Florida, we wish to extend our approval of the vision of the Lake Jesup Interagency Water Quality and Habitat Restoration Strategy Plan. We welcome any communication with us should you have any questions or comments.

Sincerely,

Cecilia Height, Vice Chair, Lake Jesup Issue Chair (407) 657-9582

Marge Holt, Conservation Chair (407) 679-6759

Sierra Club, Central Florida Group