Lake Okeechobee Watershed Construction Project

Phase II Technical Plan

DEPARTMENT OF ENVIRONMENTAL PROTECTION
FLORIDA

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Florida Department of Agriculture and Consumer Services

SOUTH FLORIDA WATER MANAGEMENT DISTRICT
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Phase II Technical Plan

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Prepared by:

South Florida Water Management District

Florida Department of Environmental Protection

Florida Department of Agriculture and Consumer Services

TABLE OF CONTENTS

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LIST OF ABBREVIATIONS

ac	Acre
ac-ft	Acre-feet
APAFR	Avon Park Air Force Range
ASR	Aquifer Storage and Recovery
ATS	Algal Turf Scrubber
AWSF	Alternative Water Storage Facility
BAT	Best Available Technology
BMAP	Basin Management Action Plan
BMP	Best Management Practice
BOD	Biological Oxygen Demand
BODR	Basis of Design Report
BWCD	Barron Water Control District
C&SF	Central and Southern Florida
CAPT	Coordinating Agency Planning Team
CBIR	Community Budget Issue Request
CE	Caloosahatchee Estuary
CELCP	Coastal and Estuarine Land Conservation Program
CERP	Comprehensive Everglades Restoration Plan
CFS	Cubic Feet per Second
CRW	Caloosahatchee River Watershed
CZMA	Coastal Zone Management Act
DMSTA	Dynamic Model for Stormwater Treatments Areas
DO	Dissolved Oxygen
DOI	Department of Interior
EAA	Everglades Agricultural Area
ECP	Everglades Construction Project
EMCT	Environmental Monitoring Coordination Team
EPA	Environmental Protection Agency
ERP	Environmental Resource Permit
ESA	Endangered Species Act
ET	Evapotranspiration
ETF	Everglades Trust Fund
EVS	Ecological Value Score
FAA	Federal Aviation Authority
F.A.C.	Florida Administrative Code
FDACS	Florida Department of Agriculture and Consumer Services
FDCA	Florida Department of Community Affairs
FDEP	Florida Department of Environmental Protection
FDOT	Florida Department of Transportation
FEC	Fisheating Creek
FLUCCS	Florida Land Use, Covers, and Forms System
FP&L	Florida Power and Light
FRESP	Florida Ranchland Environmental Services Project
FRPP	Farm and Ranchland Protection Program

F.S.	Florida Statutes
FSQM	Field Sampling Quality Manual
ft	Feet
ha	Hectares
HHD	Herbert Hoover Dike
HWTT	Hybrid Wetland Treatment Technology™
ICGA	Indiantown Citrus Growers Association
IRL-S	Indian River Lagoon-South
JD	Jurisdictional Wetland
KBMOS	Kissimmee Basin Modeling and Operations Study
KCOL	Kissimmee Chain of Lakes
Km	Kilometer
KRHRP	Kissimmee River Headwaters Revitalization Project
KRRP	Kissimmee River Restoration Project
LECSA	Lower East Coast Service Area
LIW	Lake Istokpoga Watershed
LOER	Lake Okeechobee and Estuary Recovery
LOFT	Lake Okeechobee Fast-Track
LOK	Lake Okeechobee
LOOP	Lake Okeechobee Operating Permit
LOPA	Lake Okeechobee Protection Act
LOPP	Lake Okeechobee Protection Plan
LOSA	Lake Okeechobee Service Area
LOW	Lake Okeechobee Watershed
LOWCP	Lake Okeechobee Watershed Construction Project
LSM	Land Suitability Model
m	Meter
MAPS	Managed Aquatic Plant System
MFL	Minimum Flows and Levels
MGD	Million Gallons per Day
mi	Mile
MM	Management Measure
mt	Metric Tons
N	Nitrogen
NEEPP	Northern Everglades and Estuaries Protection Program
NEPA	National Environmental Policy Act
NERSM	Northern Everglades Regional Simulation Model
NETP	Northern Everglades Technical Plan
NGVD	National Geodetic Vertical Datum
NMFS	National Marine Fisheries Service
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
O&M	Operation and Maintenance
P	Phosphorus
P2TP	Phase II Technical Plan

PD&E	Project Development and Engineering
PIR	Project Implementation Report
PM	Performance Measure
POI	Public Outreach Initiative
POR	Period of Record
ppb	Parts per billion
ppt	Parts per thousand
QASR	Quality Assurance Systems Requirements
R&D	Research and Development
R&U	Risk and Uncertainty
RASTA	Reservoir-Assisted Stormwater Treatment Area
RECOVER	Restoration Coordination and Verification
RLSA	Rural Land Stewardship Areas
RSM	Regional Simulation Model
SAV	Submerged Aquatic Vegetation
SFER	South Florida Environmental Report
SFWMD	South Florida Water Management District
SFWMM	South Florida Water Management Model
SJRWMD	St. Johns River Water Management District
SLRW	St. Lucie River Watershed
STA	Stormwater Treatment Area
SWIM	Surface Water Improvement and Management Plan
T&E	Threatened and Endangered
TCNS	Taylor Creek/Nubbin Slough
TDS	Total Dissolved Solids
TMDL	Total Maximum Daily Load
TNC	The Nature Conservancy
TP	Total Phosphorus
TPL	Trust for Public Lands
UF	University of Florida
UF/IFAS	University of Florida Institute of Food and Agriculture Sciences
UKISSWIN	Upper Kissimmee Model
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USDA	United States Department of Agriculture
USGS	United States Geological Survey
UTF	Urban Turf Fertilizer
USSR	Unified Statewide Stormwater Rule
WCA	Water Conservation Area
WOD	Works of the District
WRAC	Water Resources Advisory Committee
WRDA	Water Resources Development Act
WSE	Water Supply and Environment
WWF	World Wildlife Fund
yr	Year

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SECTION 1

EXECUTIVE SUMMARY

TABLE OF CONTENTS

The Northern Everglades and Estuaries Protection Program requires the development of a detailed technical plan for Phase II of the Lake Okeechobee Watershed Construction Project by February 2008. In response, this preferred Plan was developed by the South Florida Water Management District in coordination with the Florida Department of Environmental Protection and the Florida Department of Agriculture and Consumer Services – and with extensive input from stakeholders throughout its development. Subject to ratification by the Florida Legislature, the preferred Plan builds upon and dovetails with on-going restoration activities and successfully consolidates many previous Lake Okeechobee restoration efforts into a broader, Northern Everglades-focused approach.

1.0 EXECUTIVE SUMMARY

Passed by the Florida Legislature and signed into law by Governor Charlie Crist in 2007, the landmark "Northern Everglades and Estuaries Protection Program" promotes a comprehensive, interconnected watershed approach to protecting Lake Okeechobee and the Caloosahatchee and St. Lucie rivers and estuaries. By expanding the Lake Okeechobee Protection Act, the Florida Legislature recognized the importance and connectivity of the entire ecosystem – from the Kissimmee Chain of Lakes south to Florida Bay.

The primary goal of the legislation is to restore and protect surface water resources by addressing not only the water quality but also the quantity, timing and distribution of water to the natural system. State agencies are working in partnership with those local governments whose economy and quality of life depend on the health of Lake Okeechobee and the coastal estuaries to develop and implement comprehensive plans to restore and protect these water bodies.

The preferred Lake Okeechobee Watershed Construction Project Phase II Technical Plan was developed by the South Florida Water Management District (SFWMD) in coordination with the Florida Department of Environmental Protection (FDEP) and the Florida Department of Agriculture and Consumer Services (FDACS) – and with extensive input from stakeholders throughout its development.

To achieve the restoration goals, the coordinating agencies evaluated various alternatives using best available technology and scientific information, and included significant public involvement and review throughout the process. The resulting preferred Plan identifies construction projects, along with on-site measures that prevent or reduce pollution at its source such as agricultural and urban best management practices (BMPs), needed to achieve water quality targets for the lake. In addition, it includes other projects for increasing water storage north of Lake Okeechobee to achieve healthier lake levels and reduce harmful discharges to the Caloosahatchee and St. Lucie estuaries.

Components of the multi-phase preferred Plan include:

- Implementing agricultural management practices on more than 1.7 million acres of farmland;
- Adopting new regulations that will reduce the impacts of development on water quality and flow;
- Building treatment wetlands to clean water flowing into the lake;

- Using other innovative "green" nutrient control technologies to reduce phosphorus loads from the watershed; and
- Creating between 900,000 and 1.3 million acre-feet of water storage north of the lake through a combination of above-ground reservoirs, underground storage and alternative water storage projects on public and private lands.

Comprised of local and regional projects, the preferred Plan consolidates, builds upon and dovetails with many on-going restoration activities. In addition to augmenting and enhancing efforts under way in the remnant Everglades south of Lake Okeechobee, it builds upon environmental improvements currently being implemented north of the lake as a part of the state-federal Comprehensive Everglades Restoration Plan (CERP). It also consolidates the numerous initiatives currently under way through Florida's Lake Okeechobee Protection Plan (LOPP) and Lake Okeechobee and Estuary Recovery Plan (LOER).

The proposed implementation schedule calls for a phased approach – designed to provide progressive water quality and quantity improvements to benefit the lake and downstream estuaries. Initial measures outlined by the preferred Plan call for an additional investment of up to $320 million beyond the State's 50 percent cost-share for land acquisition and construction projects as part of CERP. While the cost of non-CERP features will be primarily borne by the South Florida Water Management District and the State, CERP investments are eligible for up to a fifty percent cost share with the federal government.

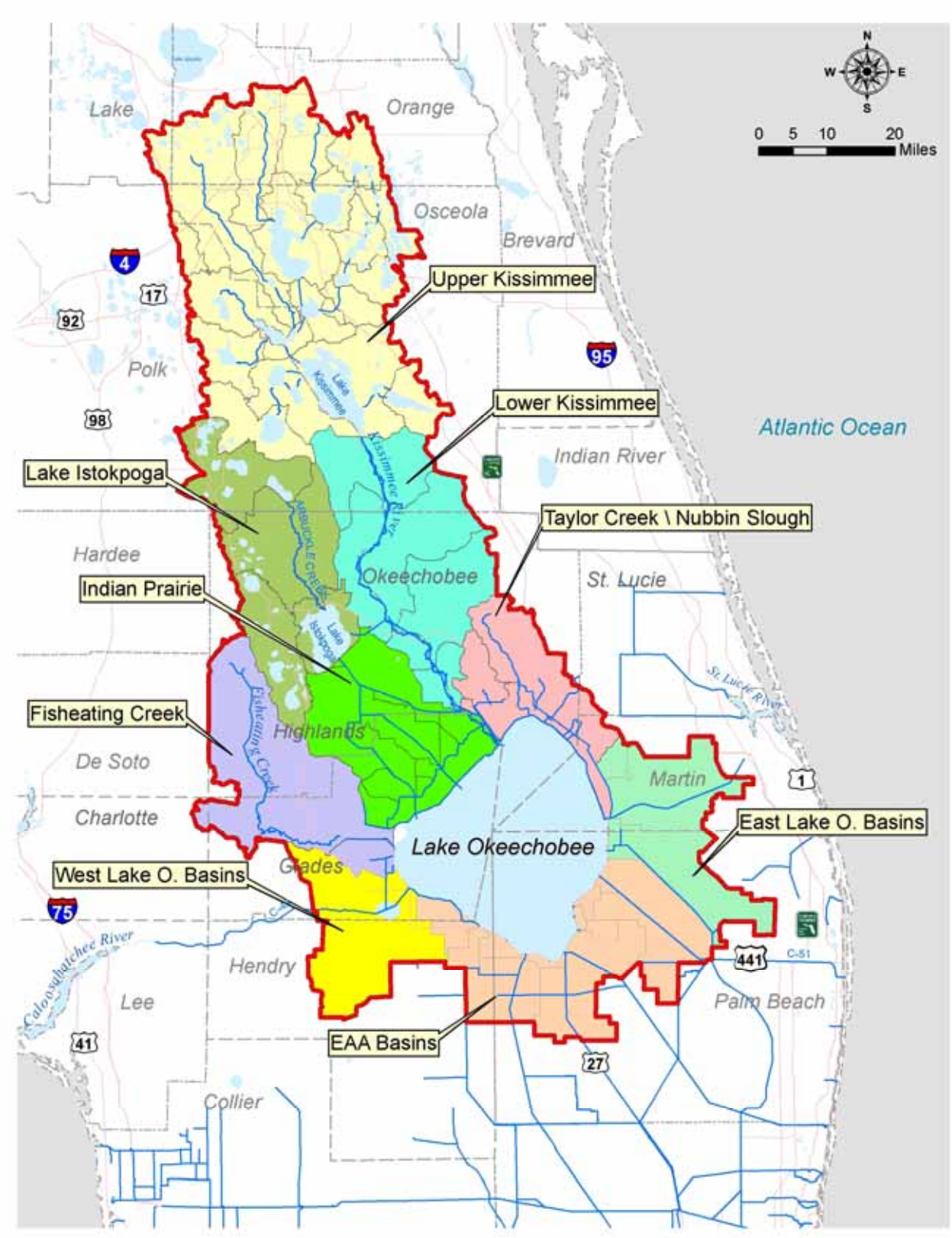
Completion of the Lake Okeechobee Watershed Construction Project Phase II Technical Plan is a critical step in the state's Northern Everglades initiative to protect and improve Lake Okeechobee and downstream receiving waters. The preferred Plan achieves the legislative requirement by outlining the steps needed to reduce pollution and improve the storage in the watershed north of the lake necessary to clean water flowing into Lake Okeechobee.

1.1 Background

Lake Okeechobee is the "liquid heart" of South Florida's interconnected aquatic ecosystem and holds the distinction of being the largest freshwater body in the southeastern United States. The 730 square-mile lake provides a number of values and benefits to the state's population, economy and environment, including environmental, public and agricultural water supply; flood protection; a sport and commercial fishery; navigation/recreation; and natural habitat for a variety of endangered and threatened animal and plant species.

Today, the lake's ecological health is adversely affected by three major influences: (1) excessive nutrient loading; (2) extreme high and low water levels in the lake; and (3) the proliferation of exotic species.

In addition to direct rainfall, the massive lake receives tributary inflows from a number of sources. The Lake Okeechobee watershed encompasses a drainage area of over 3.5 million acres (5,500 square miles), spanning 10 Florida counties, and is dominated by agricultural land uses that account for just over 50 percent of the total area. Based on hydrologic and geographic boundaries, the watershed includes nine sub-watersheds.



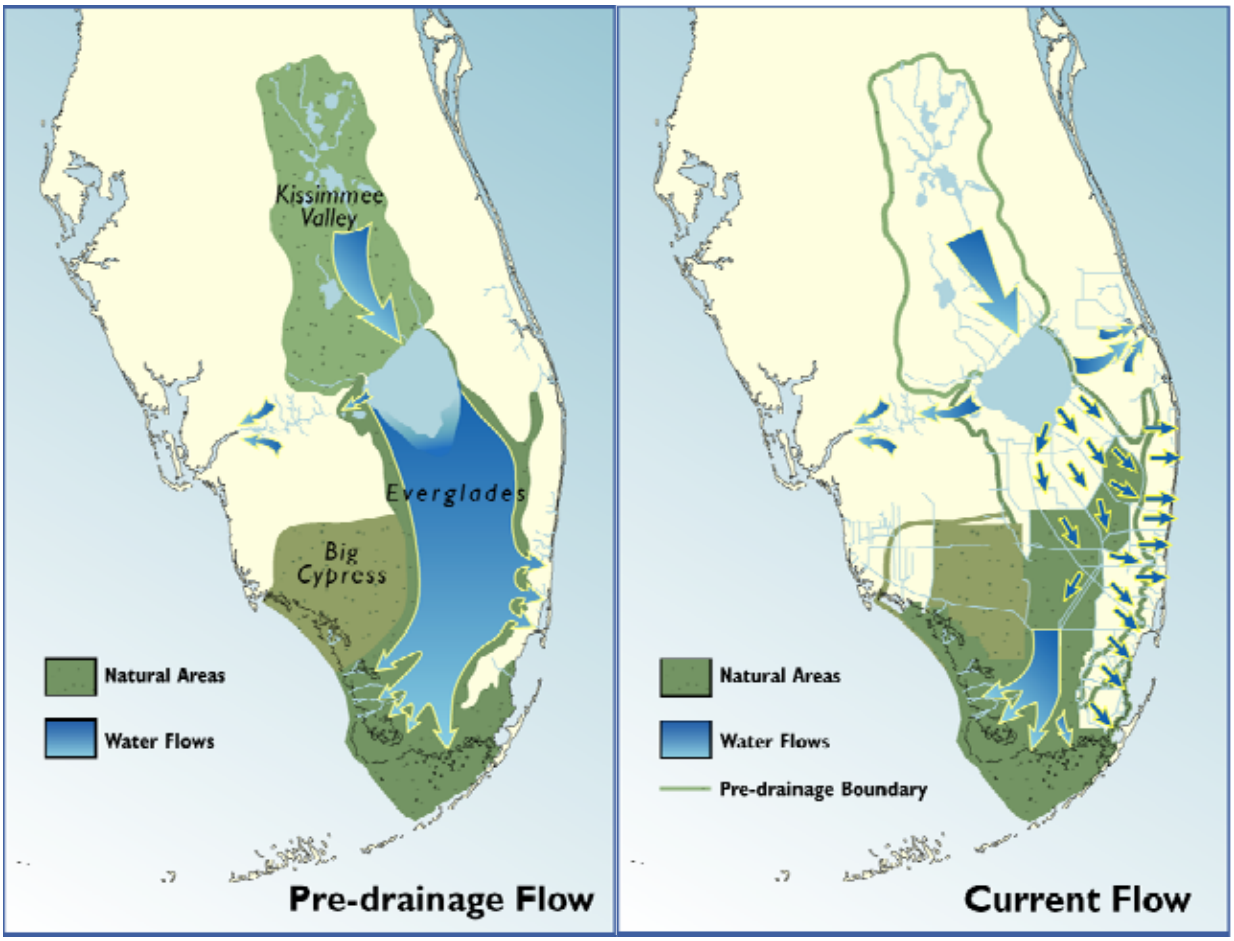
Phase II Technical Plan Boundary and Sub-Watersheds

Over the last century, a number of factors have led to adverse changes in the hydrology and water quality of Lake Okeechobee – as well as to the Caloosahatchee and St. Lucie rivers and estuaries. These include changes in land use within the upstream Kissimmee River basin; the construction of the regional water management network for flood control (the Central and Southern Florida public works project built by the U. S. Army Corps of Engineers); loss of available surface water storage; and the subsequent flow of nutrient-enriched local runoff into the water bodies.

The impacts have been significant: Channelization of the Kissimmee River removed regional storage upstream of Lake Okeechobee while making way for growth. As nutrient-enriched runoff from agricultural and urban activities within the watershed flowed into the lake, its water quality suffered. In recognition of increasing phosphorus impacts in the lake, in 2001 the State established a stringent restoration target known as a Total Maximum Daily Load (TMDL) for Lake Okeechobee. The TMDL establishes the maximum amount of phosphorus that Lake Okeechobee can assimilate without causing exceedences of water quality standards. The amount of phosphorus entering the lake has significantly exceeded the TMDL over the past three decades.

In addition, construction of the Herbert Hoover Dike greatly reduced the extent of the lake's natural littoral or shoreline marsh areas, reducing overall lake surface area by a third and, thereby, significantly reducing the lake's available and historical storage capacity. Construction of the protective levee system along with drainage and development efforts to the south, reduced the natural expanse of the Florida Everglades' wetland area by 50 percent, constraining flow south from Lake Okeechobee.

Because the volume of water coming from the upstream basin has remained relatively constant (approximately 3.5 million acre-feet per year, on average, equivalent to about 7.5 feet over the lake surface area), lake inflows have often exceeded its limited present-day storage capacity. With discharge capacity to the southern part of the Everglades ecosystem reduced because of constructed changes to the natural system, along with legal and environmental operating constraints, the need to discharge water from the lake to the east (via the St. Lucie River and Estuary) and west (via the Caloosahatchee River and Estuary) has increased. These coastal discharges of excess lake water – driven by the need to maintain safe lake levels in accordance with federal regulations and the U.S. Army Corps of Engineers' operating schedule for Lake Okeechobee – can cause detrimental ecological fluctuations for the delicate estuarine environments in the St. Lucie and Caloosahatchee Estuaries.



1.2 Previous Restoration Efforts

A number of lake and estuary improvement plans and actions have been developed and implemented over the years, primarily aimed at reducing pollution and the flow of excess phosphorus into the lake. Some early protection efforts began in the 1970s and, by the late 1980s, a mandatory program to control phosphorus discharges from dairy operations north of Lake Okeechobee was implemented. That program resulted in the implementation of an initial suite of best management practices on 30 farms and the buy-out of 18 dairies.

Recognizing that construction of the federally-built water management system resulted in unintended consequences on the natural system, Congress authorized the Restudy of the Central and South Florida Project in the early 1990s to assess the measures necessary to restore the south Florida ecosystem. During this time, a number of "Critical Restoration Projects" were determined to provide immediate, substantial, and independent benefits to the Everglades and were specifically authorized by the 1996 Water Resources Development Act. These included projects to benefit the health of Lake Okeechobee.

The broader-scope Comprehensive Everglades Restoration Plan (CERP) was proposed in 1999 and was authorized in the Water Resources Development Act of 2000. The joint state-federal partnership of CERP provides a framework and guide to restore, protect and preserve the water

resources of central and southern Florida, including the Everglades. The overarching goal of CERP is to capture fresh water that now flows unused to the ocean and the gulf and redirect it to areas that need it most. The majority of the water will be devoted to environmental restoration. The remaining water will enhance urban and agricultural water supplies.

To better manage Lake Okeechobee and the coastal estuaries, CERP included a series of storage and water quality treatment facilities north of the lake, as well as Aquifer Storage and Recovery (ASR) in the vicinity of Lake Okeechobee. In addition, to improve flows to the Caloosahatchee and St. Lucie River watersheds, CERP includes water storage and water quality improvement projects such as the C-43 Reservoir, Indian River Lagoon South projects and the Everglades Agricultural Area Reservoir.

Also in 2000, Florida passed the Lake Okeechobee Protection Act establishing a phased, watershed-based protection program to restore the lake and its tributaries. As required by the Lake Okeechobee Protection Act, the South Florida Water Management District, the Florida Department of Agriculture and Consumer Services and the Florida Department of Environmental Protection developed the Lake Okeechobee Protection Plan, which details a suite of activities necessary for reducing pollutant loads in the watershed and achieving the established TMDL.

That Lake Okeechobee Protection Plan included Phase I of the Lake Okeechobee Watershed Construction Project (as described in the original Lake Okeechobee Protection Act), which identified a series of project features designed to obtain phosphorus load reductions through the construction of stormwater treatment facilities and isolated wetland restoration projects.

Through the implementation of the Lake Okeechobee Protection Plan, the State has achieved some notable accomplishments:

- Adopting a Lake Okeechobee TMDL for phosphorus of 140 metric tons to achieve an in-lake target phosphorus concentration of 40 parts per billion;
- Constructing the Taylor Creek and Nubbin Slough Stormwater Treatment Areas (a Congressionally-approved Critical Restoration Project) in partnership with the federal government;
- Completing conservation and nutrient-management plans on individual farms covering 550,000 acres to reduce phosphorus loads from agricultural land in the watershed;
- Completing a suite of individual projects to reduce phosphorus from dairy farms, restore isolated wetlands, treat urban stormwater run-off and enhance water storage and habitat on ranchlands;
- Implementing a comprehensive research and water quality monitoring program for the lake and watershed; and
- Treating more than 32,000 acres of exotic and invasive vegetation.

To help further accelerate progress, the $200 million Lake Okeechobee and Estuary Recovery (LOER) plan was launched in 2005 – a combination of capital projects and numerous interagency initiatives to increase water storage, expand and construct treatment marshes and expedite environmental management initiatives. In addition to expediting construction of a series of Lake Okeechobee Fast-Track projects, other components of the LOER plan include

alternative water storage, revisions to permit criteria, changes in fertilizer practices, revisions to the Lake Okeechobee regulation schedule and continued implementation of the Lake Okeechobee Protection Plan components.

To restore the health of the ecosystem upstream of Lake Okeechobee, portions of the channelized Kissimmee River are being backfilled in an effort to reestablish the lost floodplain. The $578 million Kissimmee River Restoration Project is among the largest ecosystem restoration projects in the world and is well under way. In 2006, the South Florida Water Management District completed acquisition of the 102,061 acres needed for construction of the project. The backfilling of 9.5 miles of flood control canal by the U.S. Army Corps of Engineers has already restored close to 20 miles of historic river channel and 6,500 acres of associated floodplain.

1.3 Preferred Technical Plan Key Objectives/Findings

To develop the preferred Lake Okeechobee Watershed Construction Project Phase II Technical Plan, the best available land use information, flow data and water quality data were used to identify existing flows and phosphorus loads from each sub-basin within the lake's watershed. An evaluation of current programs and projects was also conducted. Following these analyses, alternatives were identified to reduce harmful flows and phosphorus loads. Potential constraints were also identified to ensure compatibility with all ongoing or planned initiatives and legal mandates.

A set of four restoration alternatives were developed and reviewed, using established performance measures to assess how well each proposed alternative achieved the identified water quality and water quantity/storage objectives.

Water Quality: Meet the Lake Okeechobee Phosphorus TMDL

In 2001, the Florida Department of Environmental Protection established a TMDL of 140 metric tons per year of total phosphorus for Lake Okeechobee. This has been determined as the amount of total phosphorus that the lake can assimilate without causing significant ecological impacts within the lake. Of that limit, 35 metric tons per year are estimated to naturally reach the lake directly through atmospheric deposition; therefore, no more than 105 metric tons per year of total phosphorus loading should enter the lake from the watershed.

Based on the initial 1991 to 2000 period of record, the average total phosphorus loading to the lake was reported to be 433 metric tons per year from the watershed. Projects and strategies were identified as part of the Lake Okeechobee Protection Plan (including Phase I of the Lake Okeechobee Construction Project) to meet the target load. It is important to note that the TMDL is based on a five-year rolling average and the load reduction required to achieve it will vary annually.

For development of the preferred Lake Okeechobee Watershed Construction Project Phase II Technical Plan, the period of record for inflow to Lake Okeechobee was updated through 2005 – which included the hurricane-driven extreme rainfall events in 2004 and 2005. This expanded period (1991-2005) raised the annual total phosphorus load to 514 metric tons per year,

necessitating additional phosphorus reduction measures to meet the total maximum daily load target.

Significant conclusions from the water quality analyses are:

- Existing water quality in the Lake Okeechobee watershed is significantly influenced by the various land use and land management practices within the individual sub-watersheds and drainage basins.

- In the future, implementation of Lake Okeechobee Protection Plan recommended best management practices (BMPs) and other total phosphorus reduction measures are expected to significantly reduce phosphorus loading. However, measured phosphorus reductions in the lake waters are likely to be substantially delayed because of the residual phosphorus in soils within the watershed (legacy phosphorus) and lake sediments.

- Implementation of BMPs in areas that contribute flows to Lake Istokpoga and Lakes Kissimmee, Cypress and Hatchineha are expected to reduce phosphorus loading to these lakes. While the load reductions to these upstream lakes are not expected to provide an immediate benefit to Lake Okeechobee, implementation of BMPs in these sub-watersheds is necessary to protect water quality in the lakes themselves and to ensure the long-term ability to assimilate phosphorus and protect Lake Okeechobee.

- The Indian Prairie, Taylor Creek/Nubbin Slough and Fisheating Creek sub-watersheds contribute disproportionately high phosphorus loads to Lake Okeechobee relative to their flow contributions. Therefore, these sub-watersheds were targeted for additional water quality measures.

Water Quantity/Storage: Manage Lake Okeechobee water levels within an ecologically-desirable range and manage flows to meet desirable salinity ranges for the St. Lucie and Caloosahatchee estuaries while meeting other water–related needs of the region, including water supply and flood protection.

The 2007 legislation also recognized the importance of managing the quantity, timing, and distribution of water from the watershed north of the lake to achieve integrated and comprehensive environmental restoration of Lake Okeechobee and the Caloosahatchee and St. Lucie estuaries. An analysis was conducted to determine the amount of water needed to be stored in the watershed to better manage water levels in Lake Okeechobee and reduce excess damaging freshwater releases to the estuaries. This analysis included an evaluation to ensure that the identified water quantity storage goal would not impact the ability to maintain existing water supply for Lake Okeechobee water users.

Key findings from the water quantity data analysis are:

- There is a breakpoint between 900,000 and 1.3 million acre-ft of storage above which additional increases in storage capacity would provide relatively small improvements in damaging releases to estuaries.

- Because a large portion of the inflows come from large rainfall events, it will be necessary to size, locate and design features with the operational flexibility to capture significant amounts of water during these large events.

- The Upper and Lower Kissimmee and Istokpoga sub-watersheds contribute close to three-quarters of the total average annual inflow to Lake Okeechobee. The Lower Kissimmee and Istokpoga sub-watersheds were targeted for storage projects.

- Although there is a large volume of flow to Lake Okeechobee from the Upper Kissimmee sub-watershed, further evaluation through the Upper Kissimmee Regional Water Supply Feasibility Study will determine if a portion of storage capacity currently identified for the Lower Kissimmee sub-watershed could be located in the Upper Kissimmee sub-watershed.

1.4 Alternatives Evaluation

The coordinating agencies evaluated four restoration alternatives as part of the development of the preferred Lake Okeechobee Watershed Construction Project Phase II Technical Plan. Extensive emphasis was also placed on providing opportunities for public comment and review through meetings, web postings and community briefings.

A set of restoration alternatives that addressed project objectives were formulated and evaluated by the coordinating agencies planning team. Below are brief descriptions of the alternatives and a comparison of their load reduction and storage capacities.

Alternative No.	**Alternative Characterization**	**Projected Average Load Reduction* (metric tons per year)** ***target reduction is 409 mt/yr**	**Shortfall in achieving goal (metric tons per year)**	**Projected Storage Capacity (acre-feet)**
1	Current, on-going, and planned projects	301	108	265,000
2	Maximizes storage capacity	316	93	1,300,000
3	Maximizes phosphorus load reduction	364	45	330,000
4	Integrates the most efficient and effective combination of storage capacity and phosphorus load reduction	360	49	900,000

Each alternative was evaluated for its performance at reducing phosphorus, improving Lake Okeechobee water levels, reducing damaging discharges to estuaries and maintaining water supply. It was clear that Alternative 1 on its own would not meet the water quality and water quantity objectives. Alternative 2 performed best at improving Lake Okeechobee water levels and reducing damaging discharges to the estuaries. Alternative 3 performed best at reducing phosphorus inputs to Lake Okeechobee. Alternative 4 performed the best when balancing the achievement of both water quality and water quantity objectives. It falls short, however, of meeting the TMDL by 49 metric tons per year. It also provides slightly lower water quantity

benefits for Lake Okeechobee and the estuaries than Alternative 2, which had a larger storage capacity.

Therefore, a modified version of Alternative 4 became the basis for the preferred Plan. Additional features were added to address the phosphorus reduction shortfall and to provide a storage range from 900,000 to 1.3 million acre feet for optimum water quantity performance. The development and comparisons of the four alternative restoration plans, with input from the public, ultimately identified the best science-based and technologically feasible options for improving lake and estuary health.

1.5 Preferred Technical Plan Features

An important aspect of the 2007 legislation that sets it apart from previous actions is the requirement to identify both the water quality treatment and water quantity storage needed to improve the health of Lake Okeechobee and the St. Lucie and Caloosahatchee estuaries. The preferred Lake Okeechobee Watershed Construction Project Phase II Technical Plan represents the best blueprint that current technology allows for achieving water quality standards while better managing lake levels.

To meet the water quality targets established for the lake, the preferred Plan includes local and regional treatment projects, along with ongoing and expanded implementation of on-site agricultural and urban best management practices. Based on a water budget analysis of the major sub-watersheds flowing into Lake Okeechobee, the preferred Plan also includes other projects and initiatives for increasing water storage north of Lake Okeechobee that will help achieve healthier lake levels and reduce harmful discharges to the Caloosahatchee and St. Lucie Estuaries.

It comprises local and regional project features that include both structural and non-structural components, and builds upon ongoing treatment and restoration projects that are in the planning, design or construction phases. Through interaction between the coordinating agencies and the public, the preferred Plan also promotes involvement of private landowners, local governments and other stakeholders as restoration partners.

Water Quality – The following types of water quality measures are designed to meet the 105 metric ton total phosphorus limit:

- Source control – Best Management Practices (BMPs) and changes in regulatory requirements
- Stormwater Treatment Areas (STAs)
- Deep injection wells
- Innovative nutrient control technologies

Cumulatively, the preferred Plan's construction projects and other measures are predicted to reduce total phosphorus loads to Lake Okeechobee by approximately 409 metric tons per year – the amount needed to meet the total maximum daily load based on the 1991-2005 period of record. In addition, implementation of the preferred Plan provides the capability to reduce in-lake total phosphorus loads by approximately 75 metric tons per year.

Water Storage – The following types of water quantity measures are designed to meet the 900,000 - 1,300,000 acre-feet of needed storage:

- Alternative water storage on public and private lands
- Above-ground reservoirs
- Aquifer Storage and Recovery (ASR) facilities

It is important to note that the water quantity storage goal of 900,000 to 1.3 million acre-feet is not in addition to existing or planned projects. It is an overall goal that may be met through a combination of existing or future projects and through a combination of storage methods such as alternative water storage on public and private lands, large above-ground reservoirs or aquifer storage and recovery facilities. Information from the Lake Okeechobee aquifer storage and recovery pilot projects and other regional pilot projects will help determine the best mix of surface and underground storage needed to achieve the overall goal.

NOTE: An overview of features, by project type, is included at the end of this executive summary. For more detailed information and descriptions, please refer to the entire preferred Lake Okeechobee Watershed Construction Project Phase II Technical Plan.

1.6 Phased Implementation

The preferred Lake Okeechobee Watershed Construction Project Phase II Technical Plan calls for an iterative, adaptive and phased implementation process, including an Initial Implementation Stage, Mid-Term Implementation Stage and Long-Term Implementation Stage. The first phase includes existing projects already under way and/or new features that will be initiated between 2008 and 2010.

Key expectations of the initial implementation stage include:

- Implementing Best Management Practices on 1.3 million acres of agricultural lands;
- Completing Environmental Resource Permit and Works of the District rule revisions;
- Initiating/completing implementation of approximately 100,000 acre-feet of long-term alternative water storage;
- Completing design and initiating construction of more than 2,600 acres of Stormwater Treatment Areas;
- Completing the initial suite of Lake Okeechobee Protection Plan phosphorus source control projects;
- Implementing eight Florida Ranchlands Environmental Services Projects;
- Completing cycle testing of CERP Aquifer Storage and Recovery pilot projects, the interim report, optimization analysis and Floridan Aquifer groundwater model;
- Implementing 65 million gallons per day of Aquifer Storage and Recovery storage;
- Restoring 4,470 acres of wetlands within the Lake Okeechobee watershed; and
- Reducing phosphorus loads to Lake Okeechobee by approximately 150 metric tons.

Initial Implementation Measures.

		Water Quality	Water Quantity
Projects	Agricultural and Urban BMPS and Regulatory Programs	✔	✓
	LOPP Phosphorus Source Control Projects	✔	✓
	Local Government Initiatives	✔	✔
	Florida Ranchlands and Environmental Services Projects	✔	✔
	LOER Alternative Water Storage Projects (Alternative water storage facilities, Paradise Run 10 Well ASR System, Seminole Brighton ASR Pilot, and Taylor Creek ASR Reactivation)	✓	✔
	LOER Stormwater Treatment Areas (Brady Ranch STA and Lemkin Creek Water Quality Treatment Facility)	✔	✓
	CERP ASR Pilots	✓	✔
	CERP Lake Okeechobee Watershed Project (Istokpoga STA, Lakeside Ranch STA, Taylor Creek Reservoir, and Paradise Run Wetland Restoration)	✔	✔
Technology and Model Refinement	BMP Research and Refinement	✔	✓
	Chemical Treatment Feasibility Study	✔	✓
	Water Quality Model Development	✔	✓
	ASR Feasibility- Pilot Cycle Testing, ASR Regional Study, ASR Optimization Analysis	✓	✔
	Hydrologic Model Refinement	✓	✔

✔ = Primary benefit ✓ = Ancillary benefit

Information from pilot projects and studies conducted during the initial stage will be used to determine the types of projects to be implemented in future stages.

Mid-term Implementation Measures.

		Water Quality	Water Quantity
Projects	Continued Implementation of Previous Measures	✓	✓
	Implementation of Additional Water Quality Measures as optimized by Technology and Model Refinement Studies	✓	✓
	Initiate Implementation of Appropriate Combination of Storage Methods based upon CERP ASR Feasibility Studies	✓	✓
Technology and Model Refinement	BMP Research and Refinement	✓	✓
	STA Integration and Refinement	✓	✓
	ASR Feasibility- Final Results of ASR Regional Study, Data from LOER ASR and Pilot Projects	✓	✓

✓ = Primary benefit ✓ = Ancillary benefit

Long-term Implementation Measures.

		Water Quality	Water Quantity
Projects	Continued Implementation of Previous Measures	✓	✓
	Continue Implementation of Storage (ASR/Surface Storage)	✓	✓
Technology and Model Refinement	Process Development and Engineering	✓	✓

✓ = Primary benefit ✓ = Ancillary benefit

1.7 Preliminary Cost Estimates

To provide a source of State funding for the continued restoration of the South Florida ecosystem, the 2007 Florida Legislature expanded the use of the Save Our Everglades Trust Fund to include Northern Everglades restoration and extended the State of Florida's commitment to Everglades restoration through the year 2020.

Cost estimates for the initial implementation stage of the preferred Lake Okeechobee Watershed Construction Project Phase II Technical Plan were broken out into two categories: Comprehensive Everglades Restoration Plan (CERP) features and non-CERP features.

- Estimate for Non-CERP features: $260-$320 million
- Estimate for CERP features: $1-$1.4 billion

The costs for non-CERP features will be primarily borne by the South Florida Water Management District and the State, while CERP costs are eligible for up to a fifty percent cost share with the federal government. It is anticipated that once the Lake Okeechobee Watershed Project – a component of the CERP state-federal partnership effort – is formally authorized by Congress, the federal government will provide its fifty percent cost sharing commitment on a

series of reservoirs and stormwater treatment areas in the Lake Okeechobee watershed. It is important to note that a portion of the estimated CERP cost is for projects that the South Florida Water Management District is expediting ahead of authorization to achieve environmental benefits earlier. Completion of these Lake Okeechobee Fast-Track projects, however, is dependent on continued State and SFWMD funding in advance of federal appropriation.

Costs for each subsequent stage of implementation will be developed as information from various pilot projects and studies are gathered. This information will be incorporated into more detailed planning design in the future. Cost estimates for mid-term measures will be provided in the 2010 Lake Okeechobee Protection Plan update submitted to the Florida Legislature.

1.8 Preferred Technical Plan Refinements and Revisions

The preferred Plan provides a framework and road map for progressive water quality and quantity improvements to benefit the lake and downstream estuaries.

Throughout implementation, it is fully expected that hydrologic and water quality conditions in the watershed will continue to change as land uses in the watershed are modified, and as restoration projects become operational. Performance will be periodically assessed and revisions made as necessary. In addition, the legislation requires annual reports and plan updates every three years.

1.9 For more details…

The preferred Lake Okeechobee Watershed Construction Project Phase II Technical Plan is designed to reduce phosphorus loadings to the lake and to identify additional storage capacity within the watershed. It builds on and consolidates numerous restoration actions into a more cohesive and comprehensive approach. An electronic copy of the Preferred Plan may be downloaded from the following website: https://my.sfwmd.gov/northerneverglades

Preferred Lake Okeechobee Watershed Construction Project Phase II Technical Plan
Overview of LOCAL FEATURES

Project Type	Project Name	Project Description
Source Control Programs	SFWMD's Environmental Resource Permit Program (ERP)	Existing regulatory program which ensures that alterations in stormwater runoff do not degrade surface water quality, flood protection or the function of existing wetland systems. SFWMD has initiated rule development for an ERP basin rule for the Lake Okeechobee, St. Lucie and Caloosahatchee Watersheds that will be based on a performance standard of post-development discharge volumes not exceeding pre-development discharge volumes. The intent of this rule is to ensure that new development is not increasing the volume of stormwater discharging downstream.
	SFWMD's Works of the District Regulatory Phosphorus Source Control Program	Existing regulatory program which governs Best Management Practice (BMP) implementation on agricultural and non-agricultural lands through issuance of permits. SFWMD is updating the rule criteria to be compatible with current initiatives and amendments to the statute. Proposed updates to the rule could include amendments such as expansion of program to entire Lake Okeechobee watershed, establish load-based performance measures for the combined BMP source control programs implemented in the watershed and timeline for BMP implementation; and establish a monitoring network necessary to ensure compliance.
	FDACS Agricultural BMP Programs	On-going program under which FDACS and Natural Resources Conservation Service (NRCS) cooperate with local landowners to develop farm-specific conservation plans for cow/calf, citrus, row crop and other agricultural operations.
	Supplementary Non-Agricultural BMP Programs	On-going programs under which FDEP regulates measures implemented to control phosphorus loads from non-agricultural sources. Includes implementation of site-specific BMPs, master planning for stormwater and wastewater, implementing stormwater retrofits, designing larger urban stormwater projects and public education. FDEP is also expected to propose a Unified Statewide Stormwater Rule (January 2009) to increase the level of treatment required for nutrients in stormwater from new development. FDACS recently adopted the Urban Turf Fertilizer Rule to limit phosphorus and nitrogen content in fertilizers used for urban turf and lawns.
		(Overview of LOCAL FEATURES continues on next page)

Project Type	Project Name	Project Description
Land Management Programs	Comprehensive Planning/Land Development Regulations	On-going Florida Department of Community Affairs program under which local government comprehensive plans are reviewed for consistency with the State's growth management policies.
	Farm and Ranchland Protection Program Partnership	On-going, voluntary NRCS program under which matching funds are provided to State, Tribal or local governments and non-governmental organizations to purchase conservation easements. Such easements typically remain agricultural and provide water quality and storage benefits.
	Florida Ranchlands Environmental Services Project	Recently launched pilot program under development. If successful, local landowners can sell environmental services related to water retention, phosphorus load reduction and wetland habitat expansion to state agencies and other willing buyers.
Alternative Water Storage Facilities	--	Stormwater runoff is held on-site on designated private and state lands thereby reducing flow and discharge of nutrients to the regional drainage systems. These facilities generally require minimal engineering, construction, and operation and maintenance and can be sited on either privately-owned agricultural lands in cooperation with the landowners or on public and tribal lands.
Local Initiatives	Taylor Creek Canals Sediment Removal	Removal of sediment and vegetation from canals and tributaries that drain to Taylor Creek from the Treasure Island and Taylor Creek Isles residential areas.
	Okeechobee City Sediment Trap Installation	Installation of two sediment traps within the city of Okeechobee for the removal of phosphorus-laden particulates that might otherwise enter Lake Okeechobee.
	Nubbin Slough East Flow Diversion	Diverting Nubbin Slough flows to restore the east main tributary of the slough.

Preferred Lake Okeechobee Watershed Construction Project Phase II Technical Plan
Overview of REGIONAL FEATURES

Project Type	Project Name	Project Description
Surface Storage Facilities	Storage Reservoirs	A reservoir that is operated with changing water level for the purpose of storing and releasing water.
Underground Storage Facilities	Aquifer Storage and Recovery	The injection of fresh water into a confined saline aquifer during times when supply exceeds demands (wet season), and recovering it via the same well during times when there is a supply deficit (dry season).
Underground Surface Disposal	Deep Injection Well	The practice of water and wastewater disposal into the deep Floridan Aquifer "Boulder Zone" through use of a high capacity well.
Nutrient Load Reduction Facilities	Stormwater Treatment Areas	Large, constructed wetlands designed to remove pollutants, particularly nutrients, from stormwater runoff using natural processes.
Reservoir-Assisted Stormwater Treatment Areas (RASTAs)	Reservoir-Assisted Stormwater Treatment Areas (RASTAs)	Feature comprised of a reservoir and a stormwater treatment area. The reservoir functions to store and release water directly to the STA in order to optimize STA performance.

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SECTION 2

INTRODUCTION

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TABLE OF CONTENTS

List of Figures

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2.0 INTRODUCTION

This document describes the Phase II Technical Plan (P2TP) for the Lake Okeechobee Watershed (LOW) Construction Project. The P2TP, also known as the Northern Everglades Technical Plan (NETP) has been developed in response to the recent state legislation, which authorized the Northern Everglades and Estuaries Protection Program (NEEPP) [Section 373.4595, Florida Statutes (F.S.)]. The primary intent of the new legislation is:

"*to protect and restore surface water resources and achieve and maintain compliance with water quality standards in the Lake Okeechobee Watershed, the Caloosahatchee River Watershed, and the St. Lucie River Watershed, and downstream receiving water through the phased comprehensive, and innovative protection program which includes long-term solutions based upon the total maximum daily loads.*"

Accordingly, in addition to the LOWCP P2TP, the NEEPP legislation also requires development of watershed protection plans for the Caloosahatchee and the St. Lucie Estuary Watersheds. The estuary watershed plans are to be completed by January 2009. The NEEPP jurisdiction thus covers the Lake Okeechobee Watershed (LOW), the watersheds of the St. Lucie and the Caloosahatchee estuaries, Lake Okeechobee and designated areas south of Lake Okeechobee (**Figure 2-1**).

The new legislation requires the South Florida Water Management District (SFWMD or the District) in collaboration with the Coordinating Agencies, to develop and submit such a plan to the Florida Legislature for ratification by February 1, 2008. The Coordinating Agencies include the District, Florida Department of Environmental Protection (FDEP), and the Florida Department of Agriculture and Consumer Services (FDACS).

The LOWCP P2TP recommendations included in this document are based on best available information to date. All recommendations are subject to modification as additional data and understanding of the dynamics of the watershed and lake are developed, thus allowing maximum flexibility to implement additional phosphorus reduction measures through the Process Development and Engineering (PD&E) component of this plan to achieve the Lake Okeechobee Total Maximum Daily Load (TMDL) and related restoration goals. Implementation of these projects is subject to availability of real estate, formation of local and state partnerships, and the potential for meeting multiple State and District water management, water quality, and water supply objectives.

Philosophies and programs described in this plan reflect collective efforts of an interagency team, representing federal, state, regional, and local public and private stakeholders. Recommendations, performance goals and effectiveness estimates included in this plan are based on current data, best available information to date, and best professional judgment. Program performance and effectiveness may vary from originally established goals and estimates.

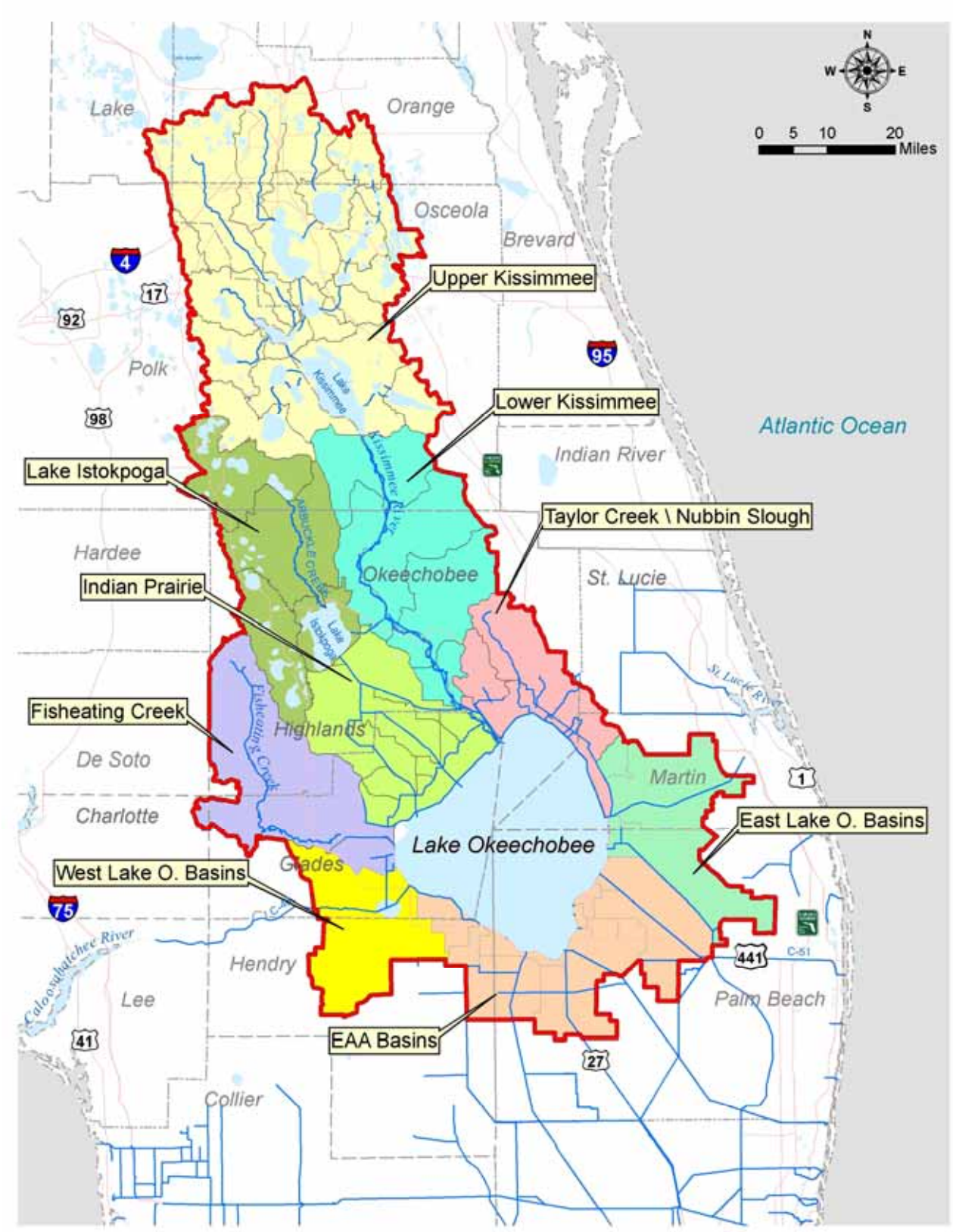

Figure 2-1. Phase II Technical Plan Boundary and Sub-Watersheds.

2.1 Background

Lake Okeechobee is the "liquid heart" of South Florida's interconnected aquatic ecosystem and holds the distinction of being the largest freshwater body in the southeastern United States. The 730 square-mile (mi^2) lake provides a number of values and benefits to the state's population, economy and environment, including environmental, public and agricultural water supply; flood protection; a sport and commercial fishery; navigation/recreation; and natural habitat for a variety of endangered and threatened animal and plant species.

Today, the lake's ecological health is adversely affected by three major influences: (1) excessive nutrient loading; (2) extreme high and low water levels in the lake; and (3) the proliferation of exotic species.

In addition to direct rainfall, the massive lake receives tributary inflows from a number of sources. The Lake Okeechobee watershed encompasses a drainage area of over 3.5 million acres (5,500 mi^2), spanning 10 Florida counties, and is dominated by agricultural land uses that account for just over 50 percent of the total area. Based on hydrologic and geographic boundaries, the watershed includes nine sub-watersheds.

Over the last century, a number of factors have led to adverse changes in the hydrology and water quality of Lake Okeechobee – as well as to the Caloosahatchee and St. Lucie rivers and estuaries. These include changes in land use within the upstream Kissimmee River basin; the construction of the regional water management network for flood control (the Central and Southern Florida public works project built by the U. S. Army Corps of Engineers); loss of available surface water storage; and the subsequent flow of nutrient-enriched local runoff into the water bodies.

The impacts have been significant. Channelization of the Kissimmee River removed regional storage upstream of Lake Okeechobee while making way for growth. As nutrient-enriched runoff from agricultural and urban activities within the watershed flowed into the lake, its water quality suffered. In recognition of increasing phosphorus impacts in the lake, in 2001 the State established a stringent restoration target known as a Total Maximum Daily Load (TMDL) for Lake Okeechobee. The TMDL, which goes into effect in 2015, establishes the maximum amount of phosphorus that Lake Okeechobee can assimilate without causing exceedences of water quality standards. The amount of phosphorus entering the lake has significantly exceeded the TMDL over the past three decades.

In addition, construction of the Herbert Hoover Dike greatly reduced the extent of the lake's natural littoral or shoreline marsh areas, reducing overall lake surface area by a third and, thereby, significantly reducing the lake's available and historical storage capacity. Construction of the protective levee system along with drainage and development efforts to the south, reduced the natural expanse of the Florida Everglades' wetland area by 50 percent, constraining flow south from Lake Okeechobee.

Because the volume of water coming from the upstream basin has remained relatively constant (approximately 3.5 million acre-feet per year (ac-ft/yr), on average, equivalent to about 7.5 feet (ft) over the lake surface area), lake inflows have often exceeded its limited present-day storage

capacity. With discharge capacity to the southern part of the Everglades ecosystem reduced because of constructed changes to the natural system, along with legal and environmental operating constraints, the need to discharge water from the lake to the east (via the St. Lucie River and Estuary) and west (via the Caloosahatchee River and Estuary) has increased. These coastal discharges of excess lake water – driven by the need to maintain safe lake levels in accordance with federal regulations and the U.S. Army Corps of Engineers' operating schedule for Lake Okeechobee – can cause detrimental ecological fluctuations for the delicate estuarine environments in the St. Lucie and Caloosahatchee Estuaries.

2.2 Legislation and Mandated Plans

The legislative mandate for the NEEPP program (Section 373.4595, F.S) brings several on-going ecosystem restoration programs in the Lake Okeechobee and St. Lucie and Caloosahatchee Watersheds under one umbrella (**Figure 2-2**). It provides a platform for ensuring that future restoration and protection efforts in the northern region of the greater Everglades ecosystem are coordinated and build upon success of past and current initiatives.

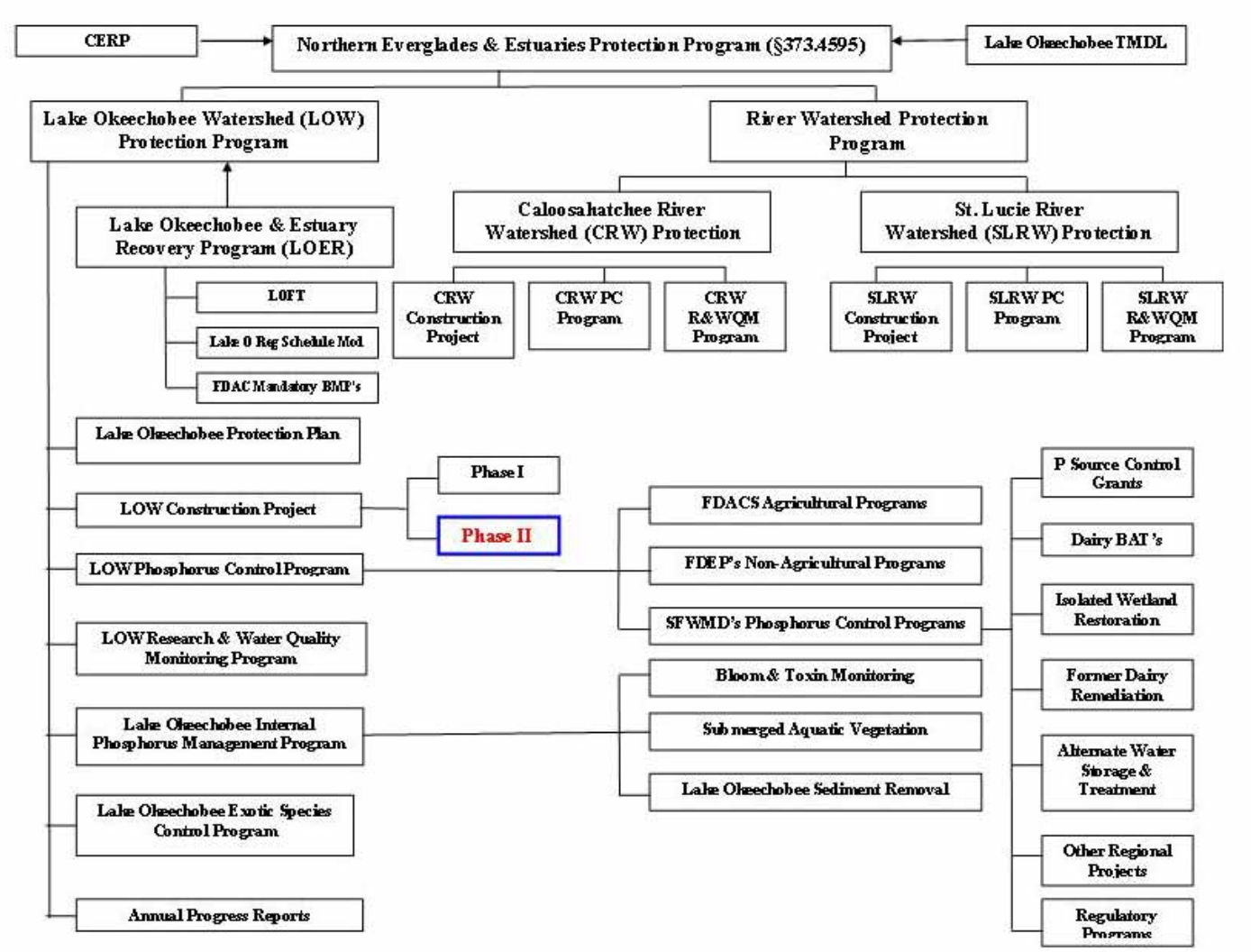

Figure 2-2. NEEPP Legislative Mandates.

Goals and objectives of the NEEPP are supported by several other complementary watershed-scale initiatives that are either currently being implemented or planned for future implementation in the LOW. These initiatives are briefly described below:

2.2.1 Lake Okeechobee and Estuary Recovery Program

The Lake Okeechobee Estuary and Recovery (LOER) program was announced by Governor Jeb Bush in October 2005 to help restore the ecological health of Lake Okeechobee and the St. Lucie and Caloosahatchee estuaries. The program consists of a combination of capital projects and numerous interagency initiatives designed to provide measurable and meaningful improvements to water quality and quantity in Lake Okeechobee and the Caloosahatchee and St. Lucie estuaries. Key state agencies charged with carrying out the plan include SFWMD, FDEP, FDACS, and Florida Department of Community Affairs (FDCA).

The LOER program includes the following major components:

- Lake Okeechobee Fast-Track (LOFT) Projects
- Lake Okeechobee Operating Schedule Revisions
- Revised Environmental Resource Permitting Criteria
- Alternative Water Storage and Disposal Options
- Lake Okeechobee Tributary Total Maximum Daily Loads (TMDLs)
- Mandatory Fertilizer Best Management Practices (BMPs)

Implementation of LOER program components has already been initiated. Information on progress made on individual LOER components is presented in *Section 3.0*. The LOER study area and its goals and objectives significantly overlap with the NEEPP; therefore, the two programs are expected to complement and support each other.

2.2.2 Comprehensive Everglades Restoration Plan

The Comprehensive Everglades Restoration Plan (CERP) provides a framework and guide to restore, protect, and preserve the water resources of central and southern Florida, including the Everglades. The CERP area covers 16 counties over an 18,000-square-mile (mi^2) area and focuses on the update of the Central and Southern Florida (C&SF) Project. The plan was approved by Congress in the Water Resources Development Act (WRDA) of 2000. It includes more than 60 elements, will take more than 30 years to construct, and, in 1999 dollars, was estimated to cost $7.8 billion.

The goal of the CERP is to capture fresh water that now flows unused to the Atlantic Ocean and the Gulf of Mexico and redirect it to areas that need it most. The majority of the water will be devoted to environmental restoration projects that protect the remaining Everglades and other natural areas by providing appropriate water quality and flows. After the natural areas are provided with water, the remaining water will benefit South Florida cities and farmers by enhancing water supplies. CERP is currently being implemented as a joint effort between the federal government and the State of Florida. However, Federal funding issues have delayed the

original estimated 30-year effort. The increased land values will cause the CERP projects to exceed the original 1999 price tag of $7.8 billion.

The CERP study area includes all of the LOW. The goals and objectives of the CERP and the NEEPP significantly overlap; therefore, the two programs complement and support each other. Within the LOW, the CERP recommends implementation of the Lake Okeechobee Watershed (LOW) Project and construction of numerous Aquifer Storage and Recovery (ASR) wells.

In addition, CERP recommendations include implementation of several projects in watersheds adjacent to the LOW such as the C-43 Reservoir, C-44 Reservoir/Stormwater Treatment Area (STA), Everglades Agricultural Area (EAA) Reservoir Projects, and ASR projects. Additional information on the current status of individual CERP components that complement the NEEPP is presented in *Section 3.0*.

2.2.3 Lake Okeechobee Total Maximum Daily Load

A Total Maximum Daily Load (TMDL) [Section 62-304.700(1), Florida Administrative Code (F.A.C.)] for total phosphorus (TP) for Lake Okeechobee was adopted by the FDEP in 2001. This TMDL is based on a five-year rolling average of 140 metric tons per year (mt/yr) which includes atmospheric deposition of 35 mt/yr. The TMDL is allocated to the sum of all non-point sources and includes all direct inflows into Lake Okeechobee.

In addition to the phosphorus TMDL for Lake Okeechobee itself, nutrient TMDLs are also being developed for the northeastern tributaries to the lake. These tributaries include waterbodies in the Kissimmee River Basin and the Fisheating Creek Basin. TMDLs for the Kissimmee River Basin were fast-tracked from an original deadline date of 2010 / 2011 to the end of 2007.

2.2.4 FDEP's Basin Management Action Plans

FDEP's Basin Management Action Plans (BMAPs) are the implementation arm of the TMDL program. BMAPs include detailed pollutant source identification, pollutant load allocations, and specific projects that will be implemented by local stakeholders, Water Management Districts and others. Project timeframes, costs, and environmental benefits are identified where possible.

The BMAP process includes the following key elements:

- Focuses exclusively on water quality restoration
- Requires data collection and source evaluation at a greater level of detail than the TMDL
- Considers all sources (point, non-point, agricultural, stormwater, wastewater, etc.)
- Relies heavily on local stakeholder involvement
- Links to National Pollutant Discharge Elimination System (NPDES) permits, but also contains non-permit obligations that are enforceable through the BMAP itself
- Integrates the concept of adaptive management in addressing unknowns about a water body
- Adopted by the FDEP secretary

The BMAP process is defined in Section 403.067, F.S. This statute provides specific information on the required elements that shall be included in a BMAP but allows for significant flexibility in how those elements are considered. The statute also allows TMDLs to be implemented through other mechanisms that provide sufficient assurances regarding project implementation and success. In the Lake Okeechobee, Caloosahatchee, and St. Lucie Watersheds, the primary BMAP issue will be nutrient load reduction. Salinity issues will not be directly addressed as part of the BMAP process. The Protection Plan will provide the basis for BMAPs developed by the Department.

2.3 Purpose and Scope

The purpose of the P2TP is to provide an overall strategy for improving quality, quantity, timing and distribution of water in the northern Everglades ecosystem and achieve the total phosphorus TMDL for Lake Okeechobee. The plan is intended to achieve the following objectives:

- Meet Lake Okeechobee Watershed Total Maximum Daily Loads
- Manage Lake Okeechobee levels within an ecologically desirable range
- Manage flows to meet desirable salinity ranges for the St. Lucie and Caloosahatchee Estuaries through the delivery of appropriate freshwater releases from the lake made possible by additional water storage north of the lake
- Identify opportunities for alternative water management facilities and practices in the watershed to meet specified goals

2.4 Study Area

The P2TP study area covers the entire LOW as shown in **Figure 2-1**. Counties that fall within this area include portions of Polk, Orange, Osceola, Okeechobee, Highlands, St. Lucie, Glades, Martin, Charlotte, Lee, Hendry, and Palm Beach.

2.4.1 Lake Okeechobee

Lake Okeechobee is a large, shallow eutrophic lake located in south central Florida. It is a central component to the Southern and Central Florida Flood Control project that extends from the headwaters of the Kissimmee River to Florida Bay.

The lake is the largest body of freshwater in the southeastern United States. It has a surface area in excess of 427,500 acres [1,730 square kilometers (km^2)], and it is extremely shallow with a mean depth of 8.9 f) [2.77 meters (m)] and maximal depth of 18 ft (5.5 m) (James et al., 1995). The lake is encircled by an earthen embankment, the Herbert Hoover Dike (HHD), which is approximately 140 miles (mi) long with crest elevations ranging from 32 to 46 ft (9.7 to 14 m) National Geodetic Vertical Datum (NGVD, formerly mean sea level).

The lake provides a number of benefits to society and nature including water supply for agriculture, urban areas, and the environment; flood protection; a multimillion-dollar sport and commercial fishery; and habitat for wading birds, migratory waterfowl, and the federally endangered Everglades snail kite. These benefits have been threatened in recent decades by

excessive phosphorus loading, harmful high and low water levels, and rapid expansion of exotic plants.

2.4.2 Lake Okeechobee Watershed

The Lake Okeechobee Watershed (LOW), as defined hydrologically, consists of the entire area that contributes surface water flow and phosphorus load to Lake Okeechobee. This includes lands that drain by gravity to the lake, as well as areas that are drained by pumps into the lake. The LOW encompasses a drainage area of over 3.5 million acres [5,500 square miles (mi^2) or 14,000 km^2] and is dominated by agricultural land uses that account for almost 52 percent of the total area (1.8 million acres).

The single largest agricultural land use is improved pasture, which is 20 percent of the total area (SFWMD, 2007). Natural areas are the second most predominant land use type in the watershed accounting for 38 percent of the total area (1.3 million acres). Urban areas account for 8 percent of the total area (approximately 262,000 acres) the majority of which lies within the Upper Kissimmee and Lake Istokpoga sub-watersheds. The SFWMD uses Florida Land Use, Cover and Forms Classification System (FLUCCS) to define land use types. This system defines improved pasture and wetlands as follows:

Improved pasture – land has been cleared, tilled, reseeded with specific grass types and periodically improved with brush control and fertilizer application

Wetlands – areas where the water table is at, near or above the land surface for a significant portion of most years. Extensive parts of some river floodplains qualify as Wetlands. These do not include agriculture land where seasonal wetness or short-term flooding may provide an important component of the total annual soil moisture necessary for crop production. But, uncultivated wetlands yielding products such as wood or which are grassed by livestock are retained in the Wetlands category.

Uncultivated wetlands in improved pastures are therefore counted as wetlands and they were grouped as natural areas. This distinction is important when assigning P coefficients (loading rates) since uncultivated wetlands in improved pastures do have a low P loading rate. The P loading rates are 0.72 and 0.2 lb/ac for improved pasture and natural area respectively.

The watershed consists of four distinct tributary systems: the Kissimmee River Valley, Lake Istokpoga-Indian Prairie/Harney Pond, Fisheating Creek, and Taylor Creek/Nubbin Slough. With the exception of Fisheating Creek, all major inflows to Lake Okeechobee are controlled by gravity-fed or pump-driven water control structures.

The four major tributary systems of the LOW are generally bounded by the drainage divides of the major water bodies and are further divisible into the following smaller sub-watersheds based on hydrology and geography:

- Upper Kissimmee
- Lower Kissimmee

- Lake Istokpoga
- Indian Prairie
- Fisheating Creek
- Taylor Creek/Nubbin Slough
- Eastern Lake Okeechobee (C-44/L-8 Basin)
- Western Lake Okeechobee (C-43 Basin)
- Southern Lake Okeechobee, which is a portion of the EAA, including Chapter 298 Districts

Upper Kissimmee, Lower Kissimmee, Taylor Creek/Nubbin Slough, Lake Istokpoga, Indian Prairie, and Fisheating Creek sub-watersheds primarily drain into the lake by gravity. The S-133 basin and other urban areas can also pump into the lake from the north when the lake stage is high. The East and West Lake Okeechobee sub-watersheds also contribute flow by gravity but only when Lake Okeechobee water levels are below 14.5 ft (4.4 m) NGVD and 11.5 ft (3.5m) NGVD, respectively. When lake stages are high making gravity flows impossible, urban areas north of the lake are drained via pumps.

In addition, the South Lake Okeechobee sub-watershed, which includes a portion of the EAA, contributes flow through backpumping. Each sub-watershed is further divisible into basins and sub-basins based on hydrologic and/or geographic divides.

2.4.2.1 Lake Okeechobee Upstream Sub-watersheds

Upper and Lower Kissimmee Sub-watersheds – These two sub-watersheds comprise the Kissimmee River Basin (KRB) which includes most of the areas that drain into Lake Okeechobee from the north and northwest through the Kissimmee River (C-38). The Upper Kissimmee (UK) sub-watershed covers approximately 1,633 mi^2 and includes Lake Kissimmee and the Chain of Lakes area in Orange and Osceola counties. The 758 mi^2 Lower Kissimmee (LK) sub-watershed includes the tributary watersheds of the Kissimmee River that lie between the Lake Kissimmee outlet and the Kissimmee River inlet to Lake Okeechobee. The Kissimmee River Basin contributes the largest surface inflow to Lake Okeechobee. Based on a 1990 to 2005 period of record the Kissimmee River accounted for approximately 53 percent of the total inflow to Lake Okeechobee (SFWMD, 2007).

One of the most conspicuous changes in the LOW over the past 50 years has been the channelization of the Kissimmee River. Historically, the river meandered for approximately 102 miles (165 km), within a 1 mi (1.5 km) to 2 mi (3 km) wide flood plain, before emptying into Lake Okeechobee (Koebel, 1995). River channelization took place between 1962 and 1971, largely for flood control purposes, transforming the river into a 56 mi (90 km) long, 30 ft (10 m) deep, and 300 ft (100 m) wide canal, and resulting in the loss of 30,000 acres (12,000 hectares (ha)) to 35,0000 acres (14,000 ha) of wetland habitat (Koebel, 1995).

The Kissimmee River Restoration Project (KRRP) and the Kissimmee River Headwaters Revitalization Project (KRHRP) are large-scale restoration projects that are currently being implemented in this sub-watershed to reestablish the river-floodplain system's ecological integrity by reconstructing the river's physical form and reestablishing pre-channelization hydrologic characteristics (stage and discharge). When completed, the project will have restored

over 40 $mi^2$of river/floodplain ecosystem including 43 miles of meandering river channel and 27,000 acres of wetlands.

The S-65 series of sub-basins (S-65A, S-65BC, S-65D, and S-65E) are located along the length of the C-38 Canal and form four pools. Structure S-65B was removed as a part of the first phase of Kissimmee River Restoration Project and reduced the number of pools from five to four. The final phase of the restoration project (scheduled to be completed in 2012), will include removal of S-65C to form Pool S-65BCD.

Water levels in each of the pools are regulated according to interim-regulation schedules. Monitoring station S-65 is located at the outlet from Lake Kissimmee to the Kissimmee River. Monitoring stations are located at each of the S-65 structures (at the downstream boundary of each sub-basin). The S-65 Structures are gated spillways and locks that provide flood protection within their respective sub-basins and upstream basins. Each structure is sized to provide a minimum of 3,000 cubic feet per second (cfs) flow-through capacity for flood control in the Upper Kissimmee River Basin, irrespective of local runoff conditions.

Taylor Creek/Nubbin Slough (TCNS) Sub-watershed – Taylor Creek (104 mi^2 watershed) and Nubbin Slough (84 mi^2) basins are interconnected and drain into Lake Okeechobee from the north and northeast. The Nubbin Slough basin includes three tributaries: Lettuce Creek, Henry Creek, and Mosquito Creek, which, along with Nubbin Slough, are intercepted by canals (L-63, L-64, and C-59) and enter Lake Okeechobee through flow control structure S-191. The un-monitored boat locks at S-193 are used for gravity flows into and out of the lake. The lower reaches of Taylor Creek, downstream of S-192, flow into the lake through structure S-193. Additional flow into the lake is provided by pump station structure S-133 which is primarily operated for flood protection.

Lake Istokpoga Sub-watershed – The 392,147 acres (613 mi^2) Lake Istokpoga sub-watershed is located generally to the west and north (upstream) of Lake Istokpoga and is largely characterized by natural lands. It is the source of all inflows to Lake Istokpoga. The primary outlet from Lake Istokpoga is through the S-68 structure, which releases water through a series of canals southeastward to both Lake Okeechobee and the Kissimmee River.

Indian Prairie Sub-watershed – This 398,078 acres (622 mi^2) sub-watershed drains the area between Lake Istokpoga and Lake Okeechobee. It includes C-41, C-40, S-84, L-49, L-59, and S-131 sub-basins.

Fisheating Creek Sub-watershed – The Fisheating Creek sub-watershed drains into Lake Okeechobee from the west side and is the only sub-watershed with an uncontrolled "natural" discharge. It covers approximately 440 mi^2 and originates in western Highlands County and flows south through Cypress Swamp and into Glades County with an average gradient of 0.5 foot per mile. From central Glades County, water leaves the creek channel and flows east through Cowbone Marsh into Lake Okeechobee. Levees have been constructed roughly parallel to the creek near its outlet to the lake.

2.4.2.2 Lake Okeechobee Downstream Sub-watersheds

As shown in **Figure 2-1**, the northern portion of the EAA is included in the LOW because this area can potentially contribute flows to the lake through backpumping. A recently issued Lake Okeechobee Operating Permit (LOOP) allows the District to backpump waters into the lake at S-2 and S-3 for flood control purposes. Runoff from the EAA produced by normal rainfall is discharged into the water conservation areas (WCAs). In addition, the S-4 structure also discharges to Lake Okeechobee because no alternative discharge is available.

2.4.3 Lake Okeechobee Water Control Structures

A wide variety of structures, such as gates, spillways, culverts, and pumps, control the inflows and outflows from Lake Okeechobee. FDEP has issued a 5-year permit to the SFWMD that governs operation and maintenance of 35 different water control structures in the LOW. This permit has the following key features:

- It requires structures to be operated consistent with the federal Lake Okeechobee Regulation Schedule, and the state Lake Okeechobee Protection Plan (LOPP).
- It allows the transfer of water into Lake Okeechobee from the Everglades Agriculture Area (EAA) for flood control through backpumping at the S-2, S-3, and S-4 structures and requires the District to coordinate and report backpumping activities to the State.
- It establishes four regions within the LOW and identifies stringent targets for total phosphorus (TP) loading from each of the four regions. These targets are intended to ensure that the Lake Okeechobee total phosphorus TMDL is met by 2015.
- It includes a comprehensive plan for monitoring water quality.
- It authorizes the installation and operation of temporary forward pumps needed to convey water south of the lake for water supply when lake water levels are low and for lake restoration under certain conditions.
- It requires regional annual evaluations.

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SECTION 3

PLANNING PROCESS

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TABLE OF CONTENTS

List of Tables

List of Figures

3.0 PLANNING PROCESS

A comprehensive and systematic planning process was used to develop the Phase II Technical Plan (P2TP) for the Lake Okeechobee Watershed (LOW) Construction Project. The planning was conducted by a Coordinating Agency Planning Team (CAPT), which included staff from the SFWMD, FDEP, and FDACS. Significant steps in this process included the following:

1. **Characterization of existing conditions** – Existing conditions in the LOW study area were characterized by reviewing available data on previous studies, ongoing projects, and planned initiatives in the LOW. Current and future planned projects that would either contribute to the achievement of P2TP objectives or could be directly integrated into the plan were also identified during this review.

2. **Identification of problems and opportunities** – Water resources projects are generally planned and implemented to solve problems, to meet challenges, and to seize opportunities. In the context of planning, a problem can be thought of as an undesirable condition, while an opportunity offers a chance for progress or improvement. Identification of problems and opportunities gives focus to the planning effort and aids in the development of planning objectives. For the P2TP planning process, problems and opportunities were identified through an interagency brainstorming process and a review of historical documents.

3. **Determination of planning objectives** – Planning objectives are statements of what a plan is attempting to achieve. The objectives communicate to others the intended purpose of the planning process. The P2TP planning objectives were developed from the problem and opportunity statement. Planning objectives were intended to solve the identified problems and take advantage of recognized opportunities.

4. **Identification of planning constraints** – Constraints are restrictions that both define and limit the extent of the planning process and in some sense support and inform it. For the P2TP planning process, the constraints were identified through a CAPT brainstorming process concurrent with the identification of problems and opportunities.

5. **Selection of performance measures** – Performance measures, also known as evaluation criteria, are benchmarks used to guide formulation of alternative plans and evaluate plan performance. For the P2TP planning process, a series of hydrologic performance measures were identified consistent with previous planning processes.

6. **Identification of management measures** – Management measures (MM) are the building blocks of alternative plans. A comprehensive list of MMs was prepared and evaluated through the collective input of the Lake Okeechobee Interagency Team. Using predetermined criteria, the MMs were screened to eliminate features or activities that did not contribute to meeting the planning goals and objectives.

7. **Formulation of alternatives** – A set of four alternative plans were formulated by combining individual MMs.

8. **Evaluation of alternatives** – Performance of each individual alternative plan was determined using agreed upon methodologies and modeling applications. Performance measures were then used to compare the performance of individual plans.

9. **P2TP Selection** – The Plan that best met the legislative goals was selected as the P2TP.

10. **P2TP Processing** – Planning-level budget estimates, implementation schedule, and an adaptive management plan were developed for the P2TP. Funding needs and opportunities were identified. A process development and engineering (PD&E) component was added to identify and implement additional phosphorus reduction measures necessary to achieve the Lake Okeechobee Total phosphorus (TP) TMDL.

Routine, periodic Northern Everglades Interagency Meetings were held to engage CAPT, stakeholders, and the public throughout the planning process. Through these meetings, public input was sought and incorporated into the decision-making process as appropriate.

3.1 Previous Studies and Ongoing projects

There are numerous ongoing or planned projects in the Lake Okeechobee watershed that are aimed at improving water quality and enhancing water supplies for agriculture, industry, and the environment. Some of the major projects, which complement and support the LOWCP P2TP goals and objectives, are described in the following sections.

3.1.1 Lake Okeechobee Protection Plan

The original Lake Okeechobee Protection Plan (LOPP) was delivered to the legislature in 2004 and an update was submitted in February 2007. Because Lake Okeechobee receives excessive phosphorus load from agricultural and urban activities that dominate land use in the LOW, the LOPP contains an integrated management strategy that is based on implementation of phosphorus source-control programs. These control programs include Best Management Practices (BMPs) at parcel level, sub-basin and regional phosphorus control and flow-attenuation projects, and in-lake remediation activities. The LOPP also contains elements of exotic species control and research and monitoring.

During the past 3 years, the cooperating agencies have collectively implemented a large number of total phosphorus (TP) load reduction projects in the LOW. These include TP source-control grants for agricultural landowners, Dairy Best Available Technology (BAT) pilot projects, soil amendments projects, isolated wetland restoration projects, remediation of former dairies, and regional public/private partnerships. A comprehensive Lake Okeechobee monitoring program has also been initiated that regularly monitors water quality and ecological indicators in the lake. The District also conducts project and sub-basin water quality monitoring in the watershed. Research and model applications have been instituted which continue to provide predictive understanding necessary to evaluate the effectiveness of water management alternatives.

3.1.2 Lake Okeechobee Watershed Construction Project, Phase I

LOWCP Phase I was intended to bring immediate TP load reduction to the lake. The project features are designed to improve hydrology and water quality of Lake Okeechobee and downstream receiving waters, consistent with recommendations included in the South Florida Ecosystem Working Group's Lake Okeechobee Action Plan. The LOWCP Phase I included projects identified as the Lake Okeechobee Water Retention Phosphorus Removal Critical Project that was authorized in the Water Resources Development Act of 1996.

These include two isolated wetlands-restoration projects and the construction of two stormwater treatment area facilities in the priority basins. Construction of a 190-acre stormwater treatment area (STA) at the Grassy Island Ranch site (Taylor Creek STA) and a 790-acre STA at the New Palm Dairy location (Nubbin Slough STA) has been completed and start-up operations will soon be initiated. The Dynamic Model for Stormwater Treatment Areas (DMSTA) project TP load reductions of approximately 2.08 and 6.5 mt/yr from the Taylor Creek and Nubbin Slough STAs, respectively.

3.1.3 Lake Okeechobee Watershed Phosphorus Control Program

Phosphorus source control is integral to the success of any water resource protection or restoration program. Source controls in LOW began with the enactment of the Surface Water Improvement Management Act in 1987, which became the Lake Okeechobee Protection Act (LOPA) in 2000. The LOPA preceded the 2007 Northern Everglades and Estuaries Protection Program (NEEPP). The original Act authorized the creation of the Lake Okeechobee Works of the District Program which became effective in 1989. Two other initiatives were instituted during this period to address phosphorus source control from dairies, namely the Florida Department of Environmental Protection's (FDEP) Dairy Rule and the Dairy Buyout Program.

Source control programs have evolved and expanded through cooperative efforts by the South Florida Water Management District (SFWMD), the Florida Department of Environmental Protection (FDEP), and the Florida Department of Agriculture and Consumer Services (FDACS). The 2007 NEEPP further refines the responsibilities of the coordinating agencies to achieve the objectives of the LOPP on an expedited basis, including:

- Develop an interagency agreement that assures the development of BMPs that complement existing regulatory programs and specifies how the BMPs are implemented and verified;
- Address measures to be taken when water quality problems are detected despite BMP implementation;
- Develop a BMP re-evaluation process; and
- Develop programs to provide technical and financial assistance for BMP implementation subject to availability of funds.

The various SFWMD, FDACS, and FDEP programs that are planned or in place are described in the following sections.

3.1.3.1 SFWMD Phosphorus Control Programs

Lake Okeechobee Works of the District Phosphorus Source Control Program – The Lake Okeechobee Works of the District (WOD) program, developed under Chapter 40E-61, F.A.C. in 1989, was the original vehicle for implementing TP load reduction BMPs in the LOW. It was adopted as a result of the Lake Okeechobee Surface Water Improvement and Management plan. The rule was expected to limit the amount of TP that can be discharged from lands within a defined boundary by issuing permits that approved a phosphorus source control plan. The rule criteria are based on the initiatives in place at the time the rule was adopted. It is necessary to update the 1989 program criteria to be consistent with current objectives.

The current objective is to establish criteria to ensure that discharges to Lake Okeechobee Works of the District allow the District to meet the legislative policies established in Chapter 373, F.S. The District is updating the rule criteria to be compatible with current initiatives and amendments to the statute. Proposed updates the rule could include the following amendments:

- Implement a phosphorus source control program utilizing best management practices (BMPs) for all lands within the Lake Okeechobee watershed (LOW);
- Provide an option for agricultural land uses of greater than 100 acres to participate in the FDACS BMP rule under Chapter 5M-3, F.A.C., to meet the intent of the District's WOD rule;
- Define the monitoring network necessary to monitor compliance with the established performance measures, to identify priority areas of water quality concern and BMP optimization, and to provide data to evaluate and enhance performance of downstream treatment facilities;
- Establish a timeline for implementation of all BMP source control programs within the watershed by 2010;
- Establish load-based performance measures for the combined BMP source control programs implemented in the watershed;
- Establish a plan for optimizing the BMP program should the expected water quality criteria not be met;
- Ensure that the rule is consistent with data presented in LOPP; and
- Include incentives for permittees to participate in TP reduction demonstration projects that will provide valuable data for expanding, accelerating, and optimizing the implemented BMPs to meet water quality objectives and for further refinement of the LOW BMP Program as necessary.

SFWMD and FDEP Environmental Resource Permit Program – The existing Environmental Resource Permit (ERP) program began in the mid 1990s. It covers the entire State and regulates activities involving the alteration of surface water flows. These activities include alterations in uplands that alter stormwater runoff, as well as, dredging and filling in wetlands and other surface waters. The purpose of the program is to ensure that alterations do not degrade water quality, compromise flood protection, or adversely affect the function of wetland systems.

FDEP and the District initiated rule development in May and June 2007 respectively of a Unified Statewide Stormwater Rule. Currently, regulatory requirements governing stormwater treatment

are technology-based, and rely primarily upon BMP design criteria that are presumed to achieve a specified level of stormwater treatment. Under the proposed Unified Statewide Stormwater (USS) Rule, FDEP and Florida water management districts are working on criteria that will be based on a performance standard of post-development nutrient loads (total phosphorus and total nitrogen) not exceeding pre-development nutrient loads. The pre-development condition is an existing site with natural vegetation, not necessarily existing conditions. Methods for estimating treatment efficiency in typical water management BMPs and in low impact design type water management BMPs will be included in the rule. The proposed rule will also address retrofit projects, redevelopment and compensating treatment. The intended effect of the rule is to increase the level of treatment required for nutrient loads in stormwater from new development to that of natural conditions, thereby reducing the discharge of nutrients to the lowest reasonable level for new development. The target date for rule adoption is May 2009.

In addition, the District is in the process of developing an ERP basin rule that will require applicants to provide reasonable assurances that they will appropriately improve the hydrology within the Lake Okeechobee, Caloosahatchee River and St. Lucie River watersheds in accordance with Chapter 373.4595, F.S. The basin rule will be supplemental to existing criteria. Average annual discharge volumes and specific storm event discharge volumes will be addressed. Methods for estimating storage capacities in typical water management BMPs and in low impact design type water management BMPs will be included in the rule.

Watershed Phosphorus Control Projects – The SFWMD, in coordination with the FDACS and the FDEP, has developed and implemented more than 30 TP reduction projects. These projects have been implemented under programs such as the Phosphorus Source Control Grants, Isolated Wetland Restoration, Dairy Best Available Technologies, Public/Private Partnerships, Former Dairy Remediation, and Alternate Water Storage and Treatment. All of these projects have some level of performance monitoring to facilitate their evaluation and potential future use of these types of technologies.

3.1.3.2 FDACS Agricultural Programs

The Lake Okeechobee Protection Act (LOPA) (Section 373.4595, F.S.) was amended in 2000 to specifically charge the Florida Department of Agriculture and Consumer Services (FDACS) with developing and implementing an agricultural Best Management Practice (BMP) Program to complement the existing regulatory programs described under *Section 3.1.3.1* in reducing the movement of phosphorus from agricultural lands into Lake Okeechobee and its tributaries. BMPs refers to a practice or combination of practices determined by the coordinating agencies, based on research, field-testing, and expert review, to be the most effective and practicable on-location means, including economics and technical considerations for improving water quality in agricultural and urban discharges. BMPs must be implemented consistent with Section 604.000 (F.S.).

Pursuant to the LOPA, the FDACS adopted a BMP program (Rule 5M-3) that encourages agricultural producers on farms greater than 100 acres in the watershed to implement a conservation, nutrient management, or alternative plan consistent with specified NRCS requirements. These plans are farm-specific assessments that identify existing environmental resource challenges and appropriate BMPs to address those challenges.

Other crop-specific FDACS BMP Programs that do not require the development of conservation plans are also implemented in the LOW. These include Ridge Citrus, Gulf Citrus, Indian River Citrus, Container Nurseries, and Vegetables and Agronomic Crop BMP Programs.

3.1.3.3 Supplemental Non-Agricultural Programs

To complement the SFWMD phosphorus source control program discussed under *Section 3.1.3.1*, the 2000 amendments to the LOPA charged FDEP, in consultation with the SFWMD, with the development of BMPs for non-agricultural land uses to achieve the TMDL. A phased approach has been used to reduce phosphorus loads to Lake Okeechobee from non-agricultural areas in the Lake Okeechobee watershed. The largest contributors of TP load from non-agricultural areas to Lake Okeechobee are existing residential developments without stormwater treatment (yard fertilization, pet wastes, septic tanks, etc.), golf courses, and failing wastewater systems (Septic tanks and package plants). Efforts since the inception of LOPA (Section 373.4595, Florida Statutes) include implementation of BMPs, development of master plans for stormwater and wastewater, implementation of stormwater retrofits, the designing of larger urban stormwater projects, and public education.

There is continued focus on reducing the impacts of non-point source pollution from urban lands through public education programs and nonstructural BMPs. Nonstructural BMPs primarily target homeowners and businesses and rely on behavioral changes rather than the construction of treatment tools or facilities. Addressing pollutant loads from older, existing developments that do not have stormwater treatment continues, with the completion of stormwater master plans for the City of Okeechobee in Okeechobee County and the City of Moore Haven in Glades County.

The SFWMD's Okeechobee Service Center is working cooperatively with Okeechobee County to expand the master plans and begin implementing projects. Stormwater master plans are also being developed for other urban areas within the Lake Okeechobee watershed. Because a majority of the urban areas were developed prior to the adoption of state stormwater regulations, the existing infrastructure is typically inadequate to properly deal with stormwater. Stormwater retrofits, such as detention/retention facilities and swales, are needed to improve the water quality of urban stormwater runoff.

3.1.4 LOW Research and Water Quality Monitoring Program

As required by LOPA, the SFWMD, in cooperation with the FDEP and FDACS, has implemented a comprehensive research and water quality monitoring program for the lake and watershed. Monitoring data collected under this program are used by the coordinating agencies to identify areas of water quality concerns and to optimize water quality improvement programs.

Ongoing monitoring programs include the Lake Okeechobee Watershed Assessment (LOWA) micro-basin monitoring and the SFWMD's ambient water quality monitoring program. In addition, water quality monitoring is conducted by the USGS in the LOW as part of the CERP-recommended Lake Okeechobee Watershed Project.

3.1.5 Lake Okeechobee Internal Phosphorus Management Program

Water quality problems in Lake Okeechobee are a function of both external TP load associated with runoff from the watershed and internal TP loads from lake bed sediments. The objective of the in-lake phosphorus management program is to develop and implement projects that will alleviate loading of phosphorus from the lake bed. In 2007, drought conditions caused low water levels in Lake Okeechobee exposing thousands of acres of phosphorus laden muck sediments. The SFWMD took the opportunity to scrape approximately 2,000 acres of lake bed.

3.1.5.1 Algal Bloom and Toxin Monitoring

Excessive nutrient load has resulted in a major change in the phytoplankton community in Lake Okeechobee. SFWMD's Lake Okeechobee Division currently monitors biomass, taxonomic composition, and toxin production of bloom-forming blue-green algae in Lake Okeechobee on a monthly basis at ten shoreline stations where blooms have historically occurred. Data from this monitoring provide insight into factors controlling the occurrence of algal blooms and toxins in the lake ecosystem.

3.1.5.2 Submerged Aquatic Vegetation Monitoring

A submerged aquatic vegetation (SAV) monitoring program was initiated by the District in 1999. This program documents the abundance and distribution of SAV in the lake through monthly and annual surveys. The entire lake SAV community is mapped annually with an intensive program that includes over 600 sites around the shoreline. Sampling is generally conducted in August at the height of SAV growth. Using these SAV maps, the District determines the total number of acres of each dominant plant species (eelgrass, peppergrass, *Hydrilla*, and *Chara*), and how this acreage changes from year-to-year with variations in lake stage and other conditions.

In addition, monthly surveys are conducted at stations located along 17 fixed transects encompassing the lake's south and west shoreline, covering a region where SAV beds have historically occurred. The sampling includes measurements of plant biomass, water chemistry, clarity of the water, and underwater light penetration.

Historical SAV biomass and distribution data exists from a study conducted in the late 1980s and early 1990s (Zimba et al., 1995). The Zimba et al. historical SAV data are compared to current SAV monitoring program data to identify adverse impacts to SAV beds.

3.1.5.3 Lake Okeechobee Sediment Dredging

Detailed design for the Eagle Bay Island Habitat Enhancement Dredging Project was initiated in Spring 2007. Plans will be developed to remove mud sediments from the lake bed to restore habitat to 2.5 mi^2 area east of Eagle Bay Island. In addition to providing local habitat benefits, the project will evaluate technologies for effective removal of mud sediments, disposal of removed sediments, and sediment stabilization of the area for use in other potential dredging projects within the lake.

3.1.6 Lake Okeechobee Exotic Species Control Program

The objective of this program is to identify exotic species that threaten native flora and fauna within the LOW and to develop and implement measures to protect native species. A LOPA Exotic Species Plan was completed in June 2002 and is currently being implemented in the lake and the watershed.

In 2005, approximately 5,000 acres (2,023 ha) of torpedo grass and 3,000 acres (1,214 ha) of cattail were treated in the Moore Haven and Indian Prairie regions of the marsh. To date, approximately 25,000 acres (10,117 ha) of torpedo grass and 7,400 acres (2,995 ha) of cattail have been treated in the LOW.

In addition, the U.S. Army Corps of Engineers (USACE), with support from the SFWMD, utilizes a combination of biological, mechanical, and chemical measures to control water hyacinth, water lettuce, Hydrilla, alligator weed, and tussocks in Lake Okeechobee.

3.1.7 Kissimmee River Watershed Programs

Several major ecosystem-restoration initiatives are currently ongoing in the Kissimmee River watershed and, by virtue of their location, will be directly integrated into the NEEPP program. Five of the more significant programs include the Kissimmee River Restoration Project with the Kissimmee River Headwaters Revitalization Project, the Kissimmee River Restoration Evaluation Program, the Kissimmee Chain of Lakes Long-Term Management Plan, the Kissimmee Basin Study Modeling and Operations Study, and the Upper Kissimmee River Basin Water Supply Plan.

3.1.7.1 Kissimmee River Restoration Project

The Kissimmee River Restoration Project (KRRP) and the Kissimmee River Headwaters Revitalization Project (KRHRP) were authorized by Congress in 1992 under the Water Resources Development Act (WRDA). Together, these large-scale restoration projects are intended to achieve the following:

- Reestablish the river-floodplain system's ecological integrity by reconstructing the river's physical form and reestablishing pre-channelization hydrologic characteristics (stage and discharge),
- Modify the water storage and regulation schedule to approximate historical flow characteristics of the Kissimmee river system, and
- Increase the quantity and quality of shoreline habitat in Kissimmee, Hatchineha, Tiger, and Cypress Lakes for the benefit of fish and wildlife.

When completed, the project will have restored over 40 mi^2 of river/floodplain ecosystem including 43 miles of meandering river channel and 27,000 acres of wetlands. The project is joint effort between the District and the US Army Corps of Engineers (USACE). In 2006, the Florida Forever Program funded land acquisitions of more than 33,000 acres, the last of the 102,061 acres needed to achieve the river's restoration.

The first of four major phases of canal backfilling were completed in early 2001. It resulted in 15 continuous miles of reconnected river channel and reclaiming almost 6,000 acres of floodplain habitat. The second phase of construction (2006-2007) backfilled 1.9 miles of C-38 canal, removed three weirs, and excavated some portions of river channel. The next major phase of the project is scheduled for October 2009 – April 2011. It will involve backfilling 8.5 miles of canal removing one water control structure, and extend the length of reconnected river channel by approximately 20 miles. All restoration-related construction is projected to be completed by 2012 and evaluation of restoration success will continue through at least 2017.

As the restoration effort proceeds, some positive ecosystem changes have already been observed. Sandbars and sandy bottom have started appearing in the river bed and in formerly isolated sections of the river, oxbows are flowing again. These are positive signs of hydrologic improvement. Emergent and shoreline vegetation have reappeared and are thriving. Water quality has improved and waterfowl are returning. The project is re-establishing the physical form of the river with its historical water levels and flows, while ensuring existing flood protection is maintained.

Other improvements include increased dissolved oxygen (DO) levels, reductions in accumulated sediments, and increased populations of bass and sunfishes in river channels, as well as increased use of the river and floodplain by various bird species. Since the completion of Phase I construction in 2001, wading bird densities have exceeded the projected restoration expectation in this area.

3.1.7.1.1 Kissimmee River Headwaters Revitalization Project

The primary purpose of the Kissimmee River Headwaters Revitalization Project is to provide water storage and regulation schedule modifications needed to approximate the historical flow characteristics of the Kissimmee River system. A secondary objective is to increase quantity and quality of littoral-zone habitat for the benefit of fish and wildlife.

The strategy for accomplishing these objectives involves increasing water-storage capacity of Kissimmee, Hatchineha, Tiger, and Cypress Lakes by approximately 100,000 ac-ft. The canal and structure conveyance capacities will also be increased to accommodate increased storage volumes. The project is scheduled for completion in 2012.

The number of acres expected to be reflooded under the Headwaters Project is 23,236. In addition to the existing 16,000 acres of littoral wetlands occurring under the current regulation schedule with a high pool stage of 52.5 ft, an additional 7,236 acres is expected when the high pool stage is increased to 54 ft under the Headwaters Regulation Schedule.

3.1.7.2 Kissimmee River Restoration Evaluation Program

The Kissimmee River Restoration Evaluation Program is designed to collect, manage, evaluate and disseminate information related to activities, observations, and measurements associated with restoration of the Kissimmee River and its floodplain ecosystem. This program tracks initial and long-term responses to restoration efforts by evaluating indicators representing physical, chemical, biological, and functional components of the system.

3.1.7.3 Kissimmee Chain of Lakes Long-Term Management Plan

The Kissimmee Chain of Lakes Long-Term Management Plan was initiated by the District in 2003 to improve the health and sustainability of the Kissimmee Chain of Lakes by developing a long-term management plan for 19 regulated lakes in the upper basin. The plan balances improving the health of the lakes with impacts between upstream and downstream ecosystems. The plan is intended to complement existing local, regional, and state government and watershed projects such as the Kissimmee Basin Water Supply Plan, Kissimmee River Basin TMDLs, Lake Okeechobee TMDLs, the LOPP, and SFWMD land-management activities.

This plan is currently under development and scheduled for public release in March 2008. The plan will address the following five goals:

- **Hydrologic Management** – Manage water levels in the Kissimmee Chain of Lakes for flood protection, aquatic habitat enhancement, recreational use (navigation), water supply, aquatic weed control, and protection of downstream water resources.

- **Habitat Preservation and Enhancement** – Manage the Kissimmee Chain of Lakes and adjacent state lands to preserve and enhance habitat, maintain or restore fish and wildlife resources, maintain healthy sport fish populations, and protect threatened and endangered wildlife species.

- **Aquatic Plant Management** – Control aquatic plants in the Kissimmee Chain of Lakes to maintain navigation, reduce risk of damage to in-lake structures, and improve aquatic habitat and ecological integrity.

- **Water quality improvement** – Achieve state water quality standards.

- **Recreation and Public Use** – Manage public lakes and state lands for multiple recreational purposes and maintain healthy fish and wildlife communities.

A draft of the plan is scheduled for public release in April 2008.

3.1.7.4 The Kissimmee Basin Modeling and Operations Study

The Kissimmee Basin Modeling and Operation Study is currently being implemented by the SFWMD and includes both the Upper and Lower Kissimmee River Basins. It will evaluate alternative operations for the 13 structures controlling flow through the Kissimmee Chain of Lakes and the Kissimmee River. Operations must be balanced to meet objectives for flood control, water supply, aquatic plant management, and natural resources of the Kissimmee River, Chain of Lakes, and Lake Okeechobee. Operating criteria will be developed to effectively meet these various objectives with complete reliance on the existing water management infrastructure and land interests of the State of Florida and the SFWMD. The study has no water quality component and is independent of but closely related to the Kissimmee Chain of Lakes Long-Term Management Plan.

Phase I was completed in June 2005. Phase II, initiated in July 2005, includes development of evaluation performance measures, modeling tools, and an alternative plan formulation process. The study is scheduled for completion in September 2008.

3.1.7.5 Upper Kissimmee River Basin Water Supply Plan

The District has concluded, through detailed water supply planning and individual permit actions, that traditional groundwater sources in central Florida are inadequate to meet projected water demands over the next 20 years. If traditional groundwater sources continue to be developed to meet growing public water supply demands in the area, water resources will be harmed. The SFWMD, along with the St. Johns River Water Management District (SJRWMD) and the Southwest Florida Water Management District (SWFWMD), has concluded that sustainable quantities of groundwater in central Florida are insufficient to meet future demands beyond 2013.

Alternative water supply projects need to be developed in addition to continued aggressive conservation and use of reclaimed water. Surface water from the Kissimmee River and Kissimmee Chain of Lakes will need to be used as alternative water supply. A rulemaking effort is underway to codify this understanding. A Kissimmee River and Chain of Lakes Feasibility Study has recently been initiated to evaluate the amount of water that might be withdrawn from the system and where such a water plant might be located. In any case, it is expected that a storage reservoir or ASR well will be necessary to make the project feasible.

3.1.8 Lake Okeechobee and Estuary Recovery Program

The LOFT component of LOER originally consisted of five projects, which included Taylor Creek Reservoir, Lakeside Ranch STA, rerouting of S-133 Basin flows to S-135 Basin, rerouting of S-154 Basin flows to S135 Basin, and Nubbin Slough STA expansion. Three of the five components (Nubbin Slough STA expansion and S-133 and S-154 Basin flow re-routing projects), were determined not to be cost-effective and were therefore dropped (Draft SFER, 2008). Two new projects were recently added to this program, namely the Lemkin Creek Urban Stormwater Facility and the Brady Ranch STA.

A Basis of Design Report (BODR) was recently completed for the Lakeside Ranch STA. This 2,400 acre STA is located in the S-135 basin and is projected to reduce TP load by approximately 8 mt/yr. Construction is expected to start by 2010 and to be completed by 2011.

Also, a BODR for a 2,000 acre reservoir to be located at Grassy Island Ranch site (Taylor Creek Reservoir) in the S-191 basin was recently completed. This 15-ft deep reservoir will provide annual storage capacity of approximately 24,000 ac-ft and reduce TP loads by 2 mt/yr. This feature is currently being evaluated as part of the Phase II Technical Plan (P2TP) and a construction schedule will be identified under the P2TP implementation.

3.1.9 Comprehensive Everglades Restoration Plan

The CERP has recommended the implementation of the LOW Project and construction of several ASR wells within the LOW. In addition, CERP recommendations include

implementation of several projects in watersheds adjacent to the LOW such as the C-43 Reservoir, C-44 Reservoir/STA, EAA Reservoir Projects, and ASR projects.

The objective of the LOW Project is to provide better management of lake water levels, improve lake water quality, provide appropriate releases to the estuaries, restore isolated wetlands in the watershed, and resolve water volume and quality problems in Lake Istokpoga. Through a comprehensive planning process, a tentatively selected plan has recently been identified. The proposed plan for the LOW Project will collectively provide approximately 286,000 ac-ft of storage, reduce TP loads by 74 mt/yr, and restore 3,700 acres of wetlands at an estimated cost of approximately $1.5 billion.

3.1.9.1 Lake Okeechobee Watershed Project

The LOW Project selected plan includes six structural components and a modification to the existing Lake Istokpoga Regulation Schedule. The components are as follows:

- **Taylor Creek/Nubbin Slough Reservoir** – This 1,984-acre storage facility is located in the S-191 sub-basin and will provide a maximum capacity of 32,000 ac-ft at an average depth of 18 ft. It will receive inflows from and discharge back to Taylor Creek. This reservoir feature will remove approximately 3–5 mt/yr of TP by sediment settling. The location and configuration of this feature matches with that of the Taylor Creek Reservoir being considered under the LOFT program.

- **Taylor Creek/Nubbin Slough STA** – This 3,975-acre treatment facility is located in the S-135 sub-basin and will treat flows from S-133, S-191, and S-135 sub-basins. This STA is expected to reduce TP loads by 19 mt/yr. The location of this facility overlaps with that of the Lakeside Ranch STA being considered under LOFT.

- **Kissimmee Reservoir** – This storage facility consists of a 10,281-acre above ground reservoir with a maximum storage capacity of 161,263 ac-ft at 16-ft average depth. The feature is located in the C-41A sub-basin. It will receive flow from and discharge back to the C-38 canal (Kissimmee River). A secondary discharge structure will also allow for releases to the C-41A canal.

- **Istokpoga Reservoir** – This 5,416-acre storage facility will be located in the C-40A and C-41A sub-basins and will provide a maximum storage capacity of 79,560 ac-ft at an average depth of 16 ft. It will receive inflow from and discharge back to the C-41A canal.

- **Istokpoga STA** – This 8,044-acre treatment facility will be located in the L-49 sub-basin. It will receive flow from the C-41 canal and discharge treated water to Lake Okeechobee. It is expected to reduce TP loads by approximately 29.1 mt/yr.

- **Paradise Run Wetland Restoration** – This 3,730-acre wetland restoration site is located at the ecologically significant confluence (under pre-development conditions) of Paradise Run, oxbows of the Kissimmee River and Lake Okeechobee. Under restored conditions it would

have a rain-driven hydrology unless future efforts could link the site to the surface flows from the C-38 or C-41A canals.

- **Lake Istokpoga Regulation Schedule** – The recommended revised Lake Istokpoga Regulation Schedule is based on an El Niño operating strategy. This operating strategy consists of a combined assessment of existing hydrologic conditions and long-term climatic forecasts at the beginning of each dry season to determine whether normal, wet, or dry year recession rule curves should be used.

3.1.9.2 C-44 Reservoir and STA Project

The objectives of the C-44 Reservoir and STA Project are to capture, store, and treat flood runoff from the C-44 basin prior to discharge to the St. Lucie Estuary. Implementation of this project is expected to reduce damaging freshwater discharges, decrease nutrient load, and maintain desirable salinity regimes that are expected to collectively occur as a result of NEEPP and CERP implementation. The project includes construction of a 3,400-acre reservoir and a 6,300-acre STA in Martin County, to be located directly north of the C-44 canal.

3.1.9.3 C-43 Reservoir Project

The C-43 Reservoir Project is intended to capture and store flood runoff from the C-43 basin prior to discharge to the Caloosahatchee Estuary. Implementation of this project is expected to reduce damaging freshwater discharges, decrease nutrient loads, and maintain desirable estuarine salinity regimes that are expected to collectively occur as a result of NEEPP and CERP implementation. The major benefit of the proposed reservoir is expected to be on the low flow side as it is expected to provide supplemental flows to meet the minimum flow (450 cfs) requirements of the estuary. This project includes a 10,000-acre reservoir that will provide approximately 170,000 ac-ft of storage capacity.

3.1.9.4 Everglades Agricultural Area Storage Phase I Reservoir Project

The Everglades Agricultural Area (EAA) Storage Reservoir Project will capture local runoff from the EAA and also store flood discharges from Lake Okeechobee. This project is expected to improve Lake Okeechobee water management, regulate water discharges to the Everglades, and improve the timing of inflows to the Everglades Construction Project (ECP) STAs. Phase I of this project includes a 31,000-acre, two-celled reservoir with a total storage capacity of 360,000 ac-ft. A revised draft project implementation report (PIR) is scheduled for completion in early 2008.

3.1.9.5 Aquifer Storage and Recovery

The CERP includes a large number of ASR wells to store excess water during wet periods for later recovery when water supply is needed. Several ASR wells are planned for the LOW and adjacent watersheds. A series of ASR pilot tests and follow-up studies are currently underway to develop a strategy for the number of ASR wells and their locations.

3.1.10 Other Relevant Projects

3.1.10.1 Herbert Hoover Dike Rehabilitation Project

The primary purpose of the Herbert Hoover Dike (HHD) Rehabilitation Project (WRDA 2000 and 2007) is to rehabilitate the HHD to continue to function as authorized by Congress for the containment of water levels within Lake Okeechobee to provide flood protection, water supply and navigation. During 2007, the U.S. Army Corps of Engineers (Corps) has been very active developing a modified design for Reach 1.

3.1.10.2 Minimum Flows and Levels

Florida law requires the water management districts to establish minimum flows and levels (MFL) criteria for surface waters and aquifers within their jurisdiction [Section 373.042(1), Florida Statutes (F.S.)]. Minimum flow is defined as the "...limit at which further withdrawals would be significantly harmful to the water resources or ecology of the area" [Section 373.042(1), F.S.]. MFL criteria provide technical criteria for protection of major water bodies from significant harm due to reduction in water levels or flows.

As of 2006, the SFWMD had established MFL criteria for 12 water bodies within its jurisdiction including Lake Okeechobee, four areas of the Everglades, and the northern portion of the Biscayne aquifer, lower west coast deeper aquifers, Caloosahatchee River and Estuary, St. Lucie River and Estuary, the northwest fork of the Loxahatchee River, Lake Istokpoga, and Florida Bay.

3.1.10.3 Estuary TMDL and BMAPs

Caloosahatchee Estuary – TMDLs for the Caloosahatchee Estuary, downstream of Franklin Lock are in the process of being researched. Draft TMDLs are expected to be proposed by the fall of 2008, with a deadline for December 31, 2008. These TMDLs will address elevated nutrients in the lower Caloosahatchee River. Once TMDLs have been established, nutrient load allocations within the Caloosahatchee watershed will be established through the Basin Management Action Plan (BMAP) process.

St. Lucie Estuary – TMDLs for the lower, middle, and upper estuary, North Fork, South Fork, Bessey Creek, C-23, C-24, C-25, and C-44 canals are being developed. These TMDLs are expected to be proposed by FDEP in late 2007/early 2008. These TMDLs address elevated nutrients in the St. Lucie watershed. For planning purposes, allocations within St. Lucie Estuary TMDLs will be calculated with and without the influence of Lake Okeechobee discharge.

TMDLs and BMAPs for both estuaries will be incorporated into the Caloosahatchee and St. Lucie River Watershed Protection Plans.

3.2 Problems and Opportunities

Many of the defining characteristics of the pre-drainage Everglades ecosystem, including spatial extent, habitat heterogeneity, and dynamic storage, as a whole, and the LOW in particular, have

either been lost or substantially altered as a result of land use and water management practices during the past 100 years. Because the LOWCP P2TP focuses on the entire watershed, it has a unique opportunity to target site-specific issues and problems, while at the same time evaluating additional opportunities for improving regional water quality and ecological conditions beyond those identified in regional efforts such as the CERP.

Lake Okeechobee's environmental resources are impaired by nutrient enrichment, altered hydroperiod, and expansion of exotic species. The 2007 Draft South Florida Environmental Report (SFWMD, 2007) listed the following major issues as being most critical for restoration of the entire Lake Okeechobee ecosystem:

- External TP loads to the lake must be substantially reduced.
- Internal (in-lake) TP loads from lake sediments must also be reduced, if feasible, otherwise, responses to external TP load reduction initiatives will be considerably delayed.
- Internal TP loads within some tributaries may also need to be reduced in some basins in order to achieve NEEPP objectives.
- Extremely high and low water levels in the lake must be dramatically reduced in their frequency and duration.
- Rapid expansion of exotic plants in the lake littoral zone must be stopped.

The major sources of inflows that cause extremely high and low lake levels and key sources of high nutrient loads to Lake Okeechobee occur in its watershed. This is where these problems need to be addressed.

3.2.1 Lake Okeechobee Water Quality

The FDEP has included Lake Okeechobee in its list of impaired water bodies as required by Section 303(d) of the Clean Water Act. High TP concentrations are the predominant reason for impairment, and TP is currently the sole pollutant considered for TMDL analysis. The FDEP has established an in-lake TP concentration of 40 micrograms per liter (μg/L) or parts per billion (ppb) as a goal for meeting the lake's designated use as a Class I Waters of the State (FDEP 2001).

3.2.1.1 Lake Okeechobee Eutrophication

The rate of eutrophication in Lake Okeechobee has increased from 1973 to the present. Symptoms of this eutrophication include the following:

- Increased algal bloom frequency since mid-1980s. An algal bloom is defined as chlorophyll a concentrations greater than 40 ppb (Carrick et al., 1994; Havens et al., 1995b; Maceina, 1993),
- Increased dominance of blue-green algae following a shift in the total nitrogen:total phosphorus ratio (Smith et al., 1995),
- Increased lake water concentration of total phosphorus,
- Increased average chlorophyll *a* concentrations (Havens et al. 1995a).

The key nutrient contributing to eutrophication of Lake Okeechobee is phosphorus (Federico et al., 1981). Increases in total phosphorus concentrations, coupled with decreases in nitrogen loads from reduced backpumping from the EAA, have shifted the total nitrogen:total phosphorus ratio from greater than 25:1 in the 1970s to around 15:1 in the 1990s. This shift has created conditions more favorable for the proliferation of nitrogen-fixing blue-green algae, which are responsible for the algal blooms (Smith et al. 1995).

Additional information on Lake Okeechobee eutrophication can be found in the South Florida Environmental Report (SFWMD, 2008).

3.2.1.2 Lake Okeechobee Sediment

The TP concentration in Lake Okeechobee sediments has also been increasing. Prior to the 1950s, the lake bottom was comprised primarily of sand with low phosphorus concentrations (Harvey and Havens, 1999). According to Engstrom and Benzonik (1993), phosphorus accumulation rates increased between the 1950s and 1980s. This TP accumulation has resulted in the development of phosphorus-laden mud sediments. The top 10 cm of the lake sediment layer is estimated to contain approximately 30,000 mt of phosphorus that has accumulated over the last 75 years. High TP loads to the lake saturate the mud sediments, which then decrease the lake's capacity to assimilate additional phosphorus (James et al., 1995).

3.2.1.3 Phosphorus Loading to Lake Okeechobee

In 2001, the FDEP established a total maximum daily load (TMDL) for phosphorus loads to Lake Okeechobee as 140 mt/yr. Attainment of the TP TMDL is based on 5-year rolling average that uses monthly TP loads calculated from measured flows and phosphorus concentrations. The 140 mt/yr TMDL includes 35 mt/yr of TP estimated for atmospheric deposition.

Annual phosphorus load to Lake Okeechobee is a function of the TP concentrations of runoff and the volume of inflows. The TP concentration of runoff from the watershed is impacted by land use, management practices, and legacy phosphorus in the soils. The dominant factor influencing TP load to the lake is the volume of inflow. Variations in annual rainfall cause dramatic variations in annual TP load and make it difficult to assess the impacts of changes in land use, management practices, and/or other phosphorus reduction measures.

Figure 3-1 shows annual TP load and total annual surface water inflows to Lake Okeechobee for the period from the 1970s through 2006 (Zhang et al., 2007). This figure illustrates the close correlation between surface water inflows to Lake Okeechobee and TP load. A notable exception occurred in 2005 when TP load was lower relative to 2004, but surface water inflows were higher. One possible explanation for this are hurricanes in 2004 flushed the most mobile phosphorus from the watershed.

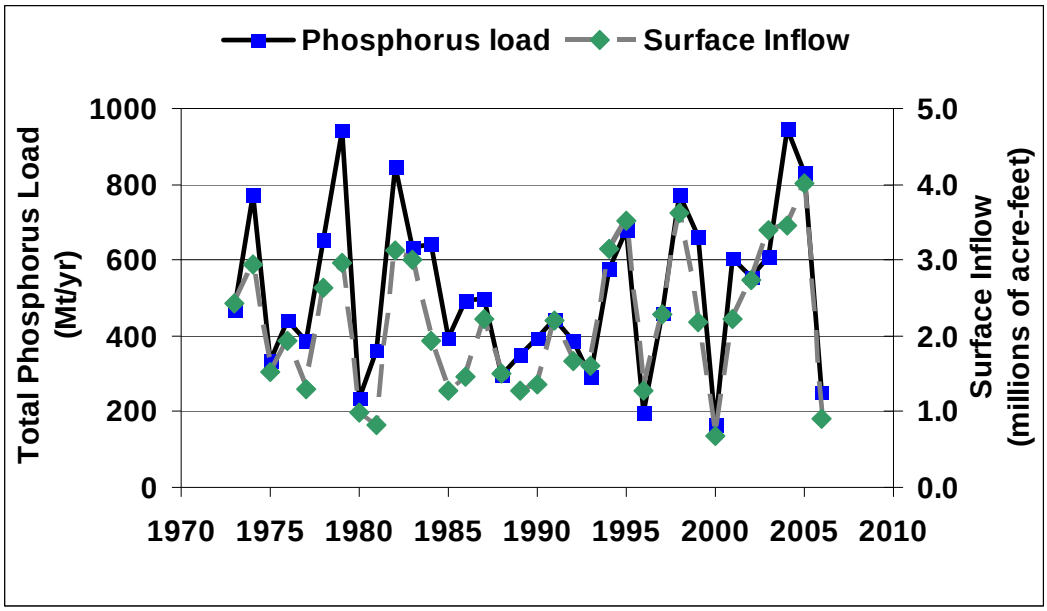

Figure 3-1. Annual total phosphorus (TP) loads and annual surface water inflows to Lake Okeechobee from the 1970's to 2006.

Table 3-1 shows annual phosphorus loads to Lake Okeechobee during the period from 1991 through 2005 (Zhang et al., 2007). During the 10-year period from 1991 through 2000, the average TP load was 468 mt/yr. The average TP load for the period from 2001 through 2005 was 709 mt/yr. The annual load in 2005 was 822 metric tons. These values include 35 mt/yr of atmospheric deposition.

Table 3-1. Historical total phosphorus (TP) load to Lake Okeechobee.

Year	Measured Load [a] (mt/yr)	Long-term 5-year moving average [b] (mt/yr)
1991	445	415
1992	388	393
1993	296	375
1994	580	421
1995	683	478
1996	200	430
1997	470	446
1998	780	543
1999	670	561
2000	169	458
2001	609	540
2002	561	558
2003	614	525
2004	938	578
2005	822	709

[a] Measured load and long term moving average includes atmospheric deposition of 35 mt/yr.
[b] The 5-year moving average is a better indicator of the annual P loading to the lake since it accounts for yearly variations in flows and loads.

3.2.1.4 In-Lake Total Phosphorus Concentrations

Average TP concentrations in lake water have increased from approximately 40 ppb in the 1970s to over 200 ppb in the last two years (**Figure 3-2)** (Zhang et al., 2007).

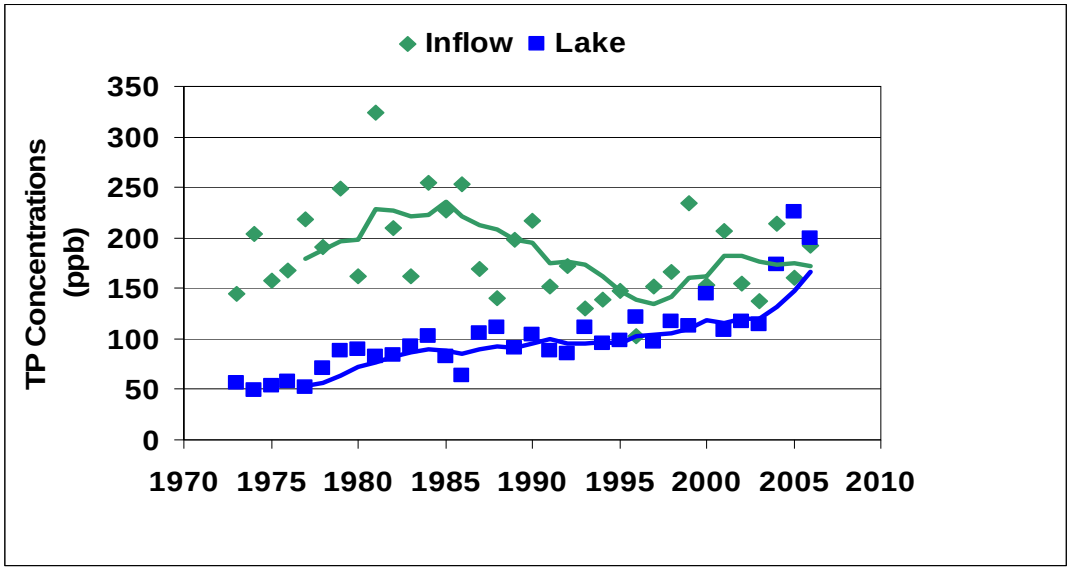

Figure 3-2. In-lake and surface water inflow total phosphorus (TP) concentrations for Lake Okeechobee.

The highest in-lake phosphorus concentration occurred early in 2005 due to the effects of Hurricanes Frances and Jeanne. In-lake phosphorus concentrations increased significantly following these hurricanes as a result of winds that caused suspension of Lake Okeechobee sediments. In-lake phosphorus concentrations remained high following the hurricanes – even higher than inflow concentrations. 2005 and 2006 are the only times when in-lake phosphorus concentrations were greater than inflow concentrations.

3.2.2 Lake Okeechobee Water Levels

In 1978, construction of S-308 (Port Mayaca Lock and Spillway) was completed. This allowed the implementation of an operating strategy that raised the regulation schedule to a seasonal fluctuation between 15.5 and 17.5 ft National Geodetic Vertical Datum (NGVD). After implementing the higher regulation schedule, high water levels, above 17.0 ft NGVD, occurred more frequently and for longer durations. At the same time, during periods of below normal rainfall, extreme low water levels, below 10.0 ft NGVD, occurred more frequently. A wide body of published research, summarized in Havens (2002), documents the ecologic benefits of seasonally variable water levels within the range of 12.5 ft NGVD, in June or July, and 15.5 ft NGVD, in November through January. Such seasonally variable water level fluctuations in Lake Okeechobee benefit native plant and animal communities.

In 2000, the Water Supply and Environment (WSE) Regulation Schedule was implemented. This schedule provides a complex decision matrix based on lake stages in relation to a set of seasonally varying rule curves, tributary storage, and long-term climatic forecasts.

Implementation of this operating strategy provided significant improvements in water management capabilities, particularly reducing extreme high lake stages. However, WSE has been less successful at reducing the occurrence of low lake stages.

Figure 3-3 shows the percent of time water levels in Lake Okeechobee rose above 17 ft NGVD during three periods: 1932 to 1977, 1978 to 1999, and 2000 to 2006. From 1932 to 1977, the lake operating schedule was based on water levels between 13.5 and 15.5 ft NGVD. Between 1978 and 1999, lake operations were based on a 15.5 to 17.5 ft NGVD regulation schedule. Since 2000, the lake has been operated in accordance with the WSE Regulation Schedule. Pre-1978 water levels in Lake Okeechobee were within desirable ranges, between 12.5 and 15.5 ft NGVD, more than 80 percent of the time. Since 1978, lake stages have been within the desirable range only 45 to 50 percent of the time.

3.2.2.1 Extreme High Lake Okeechobee Water Levels

Extreme high stages, above 17 ft NGVD, allow wind-driven waves to directly impact the littoral emergent plant communities and nearshore submerged plant communities, causing physical uprooting of plants. In addition, high stages permit suspended solids from the mid-lake region, where unconsolidated sediments are thickest, to be transported to the shoreline regions, reducing water clarity and light penetration. This reduces the depth at which SAV growth can occur (James and Havens, 2005). High stage conditions also allow deposition of unconsolidated mud in nearshore regions, which can cover the natural sand and peat sediment, reducing their suitability to sustain healthy and balanced vegetative communities.

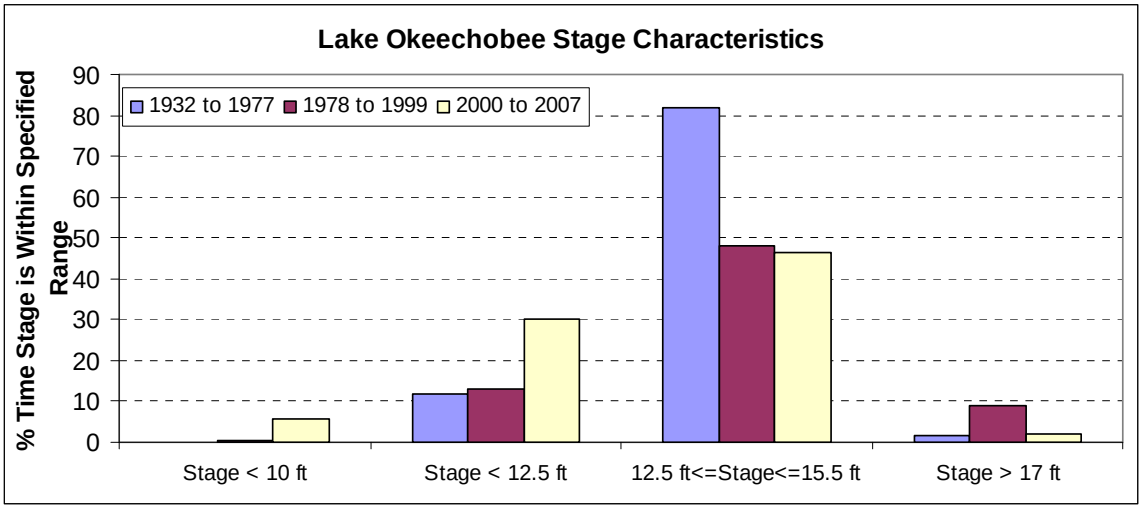

Figure 3-3. Lake Okeechobee stage characteristics
(POR: 1932 – 1977 (13.5 to 15.5 ft, NGVD regulation schedule; 1978 – 1999 (15.5 to 17.5 ft, NGVD regulation schedule); and 2000 – 2007 (WSE Regulation Schedule))

At extreme high stages, nutrient-rich water from the mid-lake region is transported to the littoral zone where it causes changes in periphyton biomass and taxonomic structure, as well as induces shifts in plant dominance, including expansion of cattail. Overall, high lake stages result in extirpation or reduced growth of submerged plants, adverse impacts to germination of

submerged plants, reductions in fish spawning and fish reproductive success, and undesirable shifts among species that comprise the macroinvertebrate community.

3.2.2.2 Extreme Low Lake Okeechobee Water Levels

Extreme low stages, below 10 ft NGVD, can result in desiccation of the entire littoral zone, the shoreline fringing bulrush zone, and nearly all of the lake area that would otherwise support submerged plants. Thus, the in-lake habitat for reptiles, amphibians, wading birds, apple snails, and fish that depend on these aquatic plant-dominated regions for successful foraging and recruitment is severely compromised. Extreme low stages also encourage invasive exotic plants such as torpedo grass and melaleuca to establish in areas of the littoral zone where they did not formerly occur, displacing native vegetation. Recovery from prolonged low stage events is slow, requiring many years of appropriate stage regime, as documented for submerged plants (Havens et al., 2004) and for sport fish such as largemouth bass (Havens et al., 2005).

The incidence of extreme low Lake Okeechobee water levels has been increasing recently (**Figure 3-3).** The 2000 to 2007 period includes data through June of 2007. This data reflects two of the worst droughts on record, which occurred in 2002 and 2007. Both droughts established new record low water levels in Lake Okeechobee. While water supply demands, drainage, and management practices have contributed to these low water levels, climatic conditions have had the most significant impacts.

Recent restoration work conducted on the southern islands re-established hydrologic connections between Torry and Kraemer Islands and the lake proper. This will help to preserve the peat soils in all but the most extreme events. In addition, the U.S. Fish and Wildlife Service South Florida Multi-Species Recovery Plan (1999) recommendations were to remove the remnant agricultural berms on the islands to preserve the gourd habitat through re-establishment of the hydrologic connection between the island and the lake. Recent reports from the field also indicate that the Okeechobee gourd is thriving under the current drought.

3.2.3 Lake Okeechobee Discharges to Caloosahatchee and St. Lucie Estuaries

Based on the Lake Okeechobee WSE Regulation Schedule, regulatory (flood control) discharges are made via the Caloosahatchee River (C-43) and the St. Lucie Canal (C-44) when lake stages are high. Regulatory discharges are also made via the four EAA canals although the capacity of each of these canals is relatively small. Both the Caloosahatchee River and the St. Lucie Canal have primary capacity for local inflows and are only utilized for Lake Okeechobee discharges when secondary capacity is available.

3.2.3.1 Lake Okeechobee Discharges to the Caloosahatchee Estuary

The Caloosahatchee River is the major source of freshwater for the Caloosahatchee Estuary (CE) and southern Charlotte Harbor aquatic environment. Prior to 1880, the river did not connect with Lake Okeechobee and its upstream limit was at Lake Hicpochee. Today, the Moore Haven Lock and Dam (S-77) discharges water from Lake Okeechobee into the Caloosahatchee River. The river bisects the Caloosahatchee watershed and now functions as a primary canal (C-43) that conveys both runoff from the watershed and regulatory releases from Lake Okeechobee.

The canal has undergone a number of alterations to facilitate this increased freshwater discharge and flood protection. These alterations include channel enlargement; bank stabilization; the development of an intricate network of canals within the watershed; and the addition of three lock and dams. The final downstream structure, Franklin Lock and Dam (S-79), demarcates the beginning of the estuary, and acts as a barrier to salinity and tidal action, which historically extended upstream to near the LaBelle area.

Alterations to the Caloosahatchee River and Lake Okeechobee operations have resulted in drastic changes in freshwater inflow to the downstream Caloosahatchee Estuary ecosystem. The large fluctuations in salinity and water quality have adversely impacted estuarine biota (Chamberlain and Doering, 1998a; Sklar and Browder, 1998).

S-79 discharges flows from both Lake Okeechobee and the local Caloosahatchee River drainage area. As a result, the discharge exceedance information depicted in **Figure 3-4** reflects the combined impacts of Lake Okeechobee operations and local inflows on the estuary. Since 2000, discharges in the desirable range (between 450 and 2800 cfs) have occurred more frequently. This may be due to implementation of the MFL criteria for the Caloosahatchee River and Estuary in 2002. However, extreme high flows (greater than 4500 cfs) have continued to occur.

3.2.3.2 Lake Okeechobee Discharges to the St. Lucie Estuary

The St. Lucie Canal (C-44) is a man-made canal constructed by the Everglades Drainage District in the 1920s. The canal was subsequently enlarged and incorporated into the Central and Southern Florida Project (C&SF Project). The Port Mayaca Lock and Dam (S-308) discharges water from Lake Okeechobee into the St. Lucie Canal and the St. Lucie Lock and Dam (S-80) discharges water from the St. Lucie Canal into the St. Lucie River and Estuary.

In addition to the St. Lucie Canal, several other canals have been constructed that discharge local runoff to the estuary.
As a result, the area draining local runoff to the estuary has increased to almost 775 square miles in addition to Lake Okeechobee. Freshwater flow into the estuary tends to be excessive in the wet season and occasionally insufficient in the dry season.

Figure 3-5 depicts the flows to the St. Lucie Estuary at S-80. These flows represent the combined flows from Lake Okeechobee and local inflows from the St. Lucie Canal drainage area. Structure S-308, which was constructed in 1978, discharges from Lake Okeechobee to the St. Lucie Canal and reflects only Lake Okeechobee operations. Moreover, S-80 is only one of several inflows to the St. Lucie Estuary. To evaluate a longer period of record and the impacts from Lake Okeechobee, flow exceedance relationships at S-80 were compiled (**Figure 3-5**). Since 2000, flows have been maintained above 350 cfs for a greater percentage of time. Additionally, flows have been maintained within a desirable range between 350 and 2,000 cfs for a greater percentage of the time. The incidence of extremely high flows (greater than 2000 cfs) has also increased since 2000.

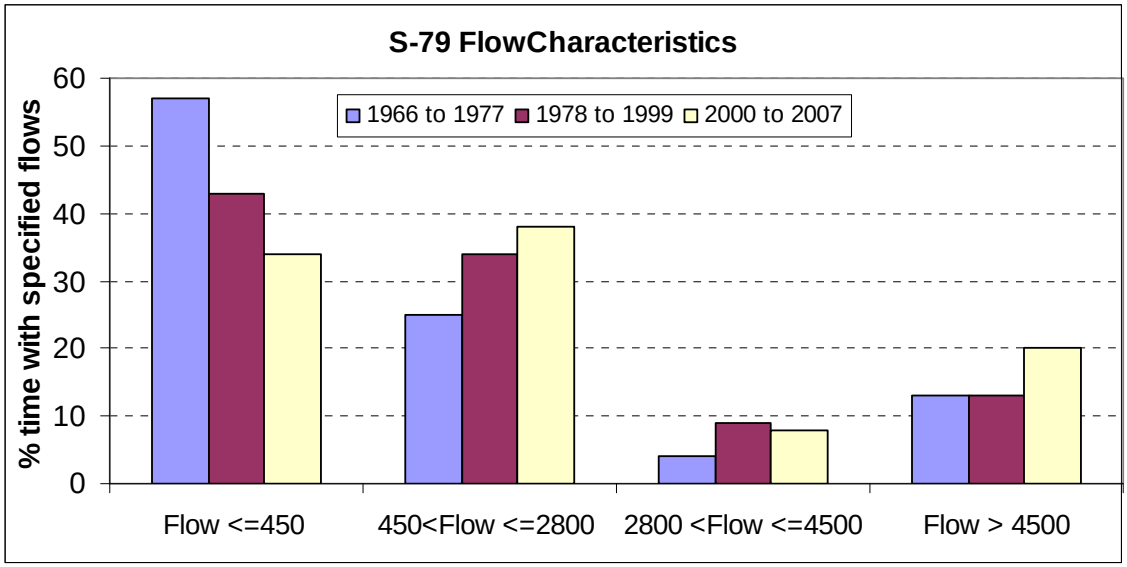

Figure 3-4. S-79 flow characteristics.
(POR: 1966 to 1977; 1978 to 1999; and 2000 to 2007)

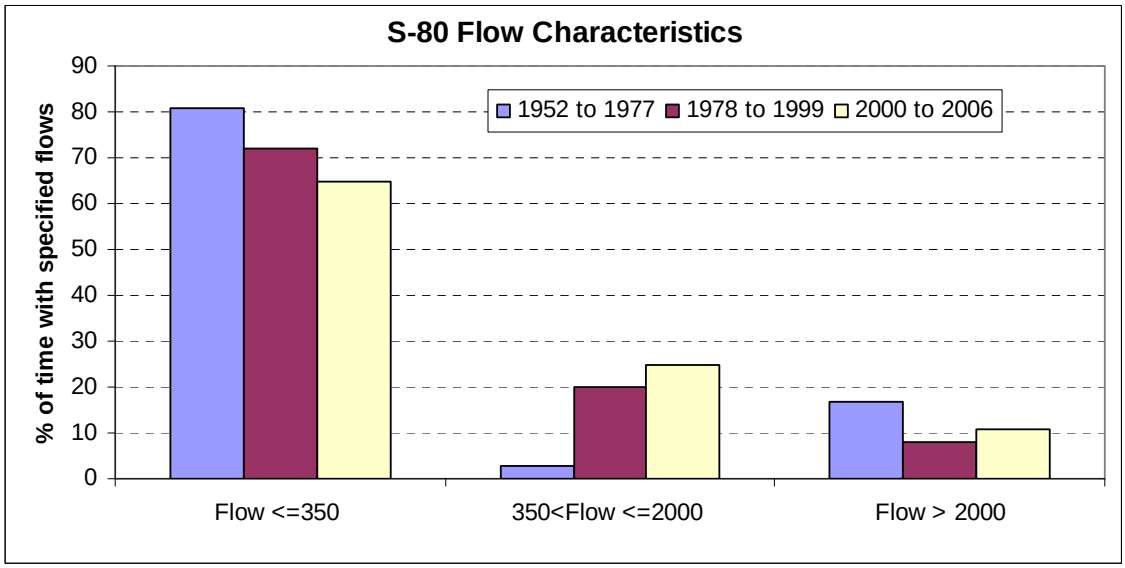

Figure 3-5. S-80 flow characteristics.
(POR: 1952 to 1977; 1978 to 1999; and 2000 to 2007)

3.2.4 Lake Okeechobee Service Area Water Supply

Lake Okeechobee is the primary source of supplemental irrigation for four major adjacent agricultural areas: North Shore, Caloosahatchee, St. Lucie and EAA (**Figure 3-6**). Collectively, these basins are referred to as the Lake Okeechobee Service Area (LOSA). During the dry season when precipitation is low, local sources of irrigation become scarce and the need for supplemental irrigation becomes necessary. Because, presently, there is no substantial off-site water storage, Lake Okeechobee is the only source of supplemental irrigation for these basins.

Average annual supplemental irrigation requirement from Lake Okeechobee amounts to about half a million ac-ft (SFWMD, 2000a).

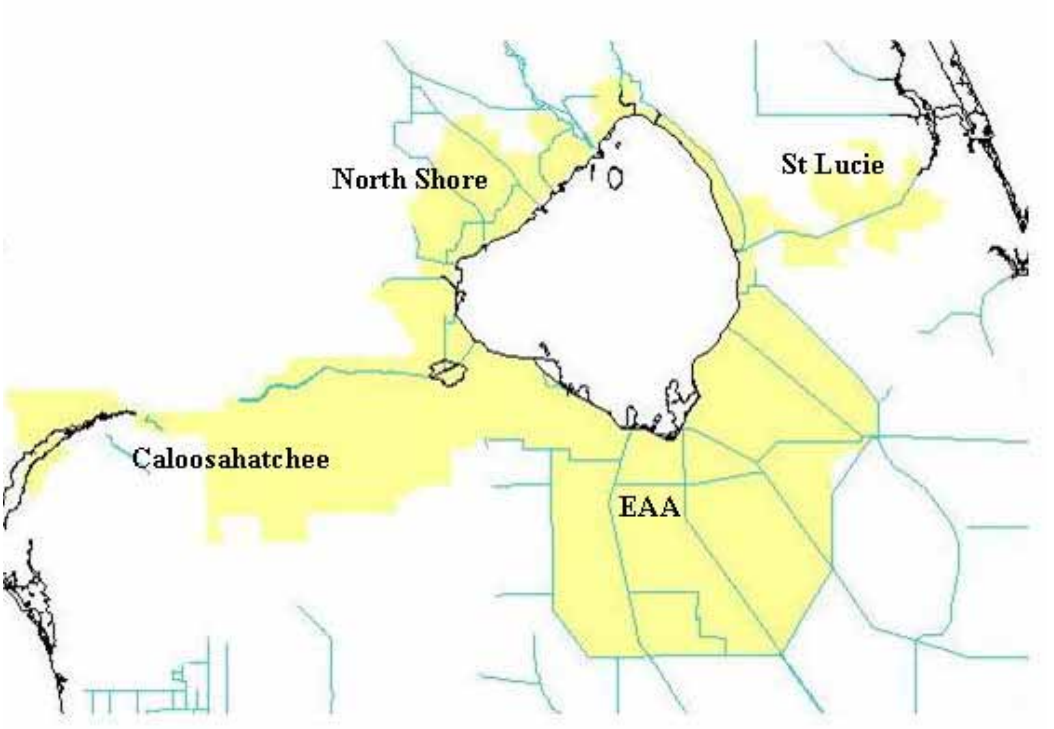

Figure 3-6. Lake Okeechobee service area.

Pursuant to the Water Rights Compact (Public Law No. 100-228, 101 Statute 1556, and Chapter 87-292, Laws of Florida, and codified in Section 285.165, F.S.) and implementing agreements, the Seminole Tribe of Florida has entitlement rights to surface water for its reservations. The Brighton Seminole Reservation northwest of the lake and the Big Cypress Seminole Reservation southwest of the EAA must be considered in addressing Lake Okeechobee water shortage management plan. Cutbacks associated with the water shortage plan and water shortage management may apply to the tribe's water rights in accordance with the Water Rights Compact and the controlling agreements. Water supply shortages are relatively frequent for the Brighton Seminole Reservation and adjoining portions of the C-40 and C-41 basins.

Lake Okeechobee is also a water supply source for the following purposes:

- Supplemental water supply for the City of West Palm Beach
- Protection of the performance of Everglades Construction Project STAs during dry periods
- Providing minimum flows to Caloosahatchee Estuary and portions of St. Lucie Estuary.
- Providing environmental water supply for the Everglades

3.2.5 Lake Stage Management

In addition to Lake Okeechobee, there are many natural lakes in the study area that provide important habitat for fish and wildlife. Many of these lakes, including Lake Istokpoga, Lake Kissimmee, and other lakes in the Upper Kissimmee Basin, are now managed as components of the C&SF Project water management system. As components of this system, the operations that control water levels and discharges from the lakes are greatly influenced by the need to maintain flood protection and/or to provide water supply.

In many cases, the operational practices required to provide these flood control and water supply benefits result in water level fluctuations and discharges from the lakes that are not conducive to maintaining healthy habitats within the lakes. Invasion of exotic species, accumulation of muck in the littoral zone, changes in vegetative communities, and the loss of SAV are examples of problems these lakes have experienced as a result of operational practices. In many cases, extensive modeling and operational investigations have been undertaken to identify operational modifications that would meet the C&SF Project goals and, at the same time, provide healthy ecologic conditions within the lakes. Even though significant improvements have been achieved through operational modifications, problems in many lakes still exist.

3.3 Planning Objectives

The problems and opportunities described above directly lead to the following project objectives:

3.3.1 Lake Okeechobee Water Quality

- Meet the Lake Okeechobee phosphorus TMDL.

3.3.2 Lake Okeechobee Water Levels and Discharges

- Manage Lake levels to improve the ecological health of the Lake.
- Provide management measures to manage Lake levels within the ecologically desirable stage envelope and to manage Lake Okeechobee releases to achieve salinity envelope targets for the St. Lucie and the Caloosahatchee Estuaries.

3.3.3 Water Supply

- Identify opportunities for alternative water supply sources in the watershed.
- Maintain water supply capability for the Lake Okeechobee Service Area (LOSA).

These planning objectives provide the basis for development of evaluation criteria, formulation and screening of alternative plans, evaluation of alternative plans, and selection of the recommended plan.

3.4 Planning Constraints

3.4.1 Kissimmee River Restoration

Kissimmee River Restoration depends on meeting the following five key hydrologic criteria:

- Continuous flow with duration and variability comparable to pre-channelization periods
- Average flow velocities that range between 0.8 and 1.8 ft per second (fps), when flows are within bank
- A stage discharge relationship that results in overbank flows when flows are greater than 1,400 cfs.
- Stage recession rate(s) on the floodplain that are less than 1 foot per month
- Floodplain inundation durations comparable to historic hydrographs

Of these five hydrologic criteria, floodplain recession requirements are the most sensitive to available volumes of water in the Kissimmee Chain of Lakes. The volume required is dependent on the magnitude of the flood event. Enough water needs to be available in Zone B of the Kissimmee Chain of Lakes regulation schedules to sustain a 1 foot per month floodplain recession rate. Methodologies for evaluating impacts on floodplain recession rates are being developed in the Kissimmee Basin Modeling and Operations Study. Recommendations of this study must be consistent with achieving the goals of the Kissimmee River Restoration Project.

3.4.2 Water Supply and Flood Control

The NEEPP legislation requires that water related needs of the region including water supply and flood protection will continue to be met.

3.4.3 Herbert Hoover Dike

The Herbert Hoover Dike is made of natural materials such as gravel, rock, limestone, sand, and shell. During extreme high water conditions, excessive seepage occurs through these natural materials. A recent study reported that it is likely that a failure mode involving piping from seepage has initiated at certain locations. The rate at which piping is occurring is dependent on lake level. It is clear that the seepage volume and distress indicators in certain reaches of the structure at reservoir levels above about Elevation 17 ft are cause for concern to the degree that failure is considered very likely when operating at or above these levels for any significant time. The higher the lake level, the shorter the time required for failure to occur (USACE, 2007). P2TP recommendations should not increase the risk of failure of the Herbert Hoover Dike.

3.4.4 Minimum Flows and Levels

MFL criteria prevent harmful withdrawals from water sources that would be significantly harmful to the water resources or ecology of the area (SFWMD, 2007). MFL criteria have been established for four water bodies within, or adjacent to, the P2TP study area, including: Lake Istokpoga, Lake Okeechobee, and the St. Lucie and Caloosahatchee estuaries. P2TP recommendations cannot reduce the ability to meet the MFL criteria for these water bodies.

3.4.4.1 Lake Istokpoga Minimum Flows and Levels

Lake Istokpoga MFL criteria are intended to address low water levels occurring from regional drought conditions and/or from withdrawals of water from the lake or adjacent aquifers. A MFL violation occurs within Lake Istokpoga when surface water levels fall below 36.5 ft NGVD for 20 or more weeks within one calendar year, more often than once every four years (SFWMD, 2005).

3.4.4.2 Lake Okeechobee Minimum Flows and Levels

Minimum water level criteria for Lake Okeechobee consist of two components: operational criteria and water supply planning criteria. Operational criteria are used to identify when the MFL has been exceeded on a day-to-day basis. Water supply planning criteria provides water managers with information as to how often, and for what duration, the minimum level may be exceeded based on the expected frequency of natural drought events. These criteria are as follows (SFWMD, 2000c):

- **Operational MFL Criteria** - During most years, water levels in Lake Okeechobee should not fall below 11 ft NGVD. However, to make water deliveries from the lake to the Lower East Coast Planning Area, the water level may occasionally fall below 11 ft NGVD from April 15 to July 15, as long as it does not drop below the top of Supply-Side Management Zone C.

- **Water Supply Planning Criteria** - Water level should not fall below 11 ft NGVD for more than 80-days duration, more often than once every six years, on average.

3.4.4.3 St. Lucie River and Estuary Minimum Flows and Levels

Mean monthly flows to the St. Lucie Estuary of more than 28 cfs from St. Lucie River's North Fork represent the amount of water necessary to maintain sufficient salinities in the estuary needed to protect oligohaline organisms. If flows fall below this minimum for two consecutive months, the minimum flow criteria will be exceeded and harm occurs to estuarine resources. If harm, as defined above, occurs during two consecutive years, significant harm and a violation of MFL criteria occurs (SFWMD, 2002a).

3.4.4.4 Caloosahatchee River and Estuary MFL

The MFL rule for the Caloosahatchee Estuary states that a discharge of 300 cfs at S-79 is necessary to maintain a salinity of 10 ppt at the Ft. Myers Yacht Basin. The Caloosahatchee MFL rule includes two salinity criteria. An incident occurs if the 30-day moving average salinity at Fort Myers exceeds 10 ppt and if a single daily average salinity exceeds 20 ppt (SFWMD, 2002b).

3.4.5 Water Quality Standards

Recommendations contained in the P2TP must be permittable with respect to protecting and maintaining all applicable water quality standards.

3.4.6 Everglades Restoration Flows

The future base of this plan includes Everglades rainfall deliveries within the constraints of the system with Acceler8 projects and a version of the Modified Water Deliveries to Everglades National Park (ENP). However, full Everglades restoration flows are not included. It is the intent of this planning process not to preclude additional deliveries to the Water Conservation Areas (WCA) and ENP as these needs are better defined. Future updates of the plan will incorporate more full scale deliveries as better information becomes available.

3.5 Performance Measures

Performance measures (PMs) provide a means to evaluate how well alternatives achieve the project goals. Water resources problems for the study area are described in *Section 3.2* of this document. Identification of the water resources problems led to establishment of the project objectives which are described in *Section 3.3*. The performance measures were developed based on these problems and objectives.
Table 3-2 describes the relationships between the problems, objectives, and performance measures for this project. All of the performance measures for this project were developed by the Restoration Coordination and Verification (RECOVER) program for the CERP or have been successfully applied in other projects. Fact sheets that provide a description of what is being measured, a rationale for why this measure is important, a target, and an evaluation methodology for each individual performance measure are presented in **Appendix A**.

Table 3-2. Summary of Lake Okeechobee Watershed Construction Project (LOWCP) Phase II (P2TP) problems, objectives, and performance measures.

Problems		Objectives	Performance Measures
Lake Okeechobee	Excessive phosphorus loads to Lake Okeechobee	Meet the Lake Okeechobee phosphorus TMDL	Total Surface Phosphorus Loading to Lake Okeechobee
	Undesirable high and low levels in Lake Okeechobee	Manage Lake Okeechobee within ecologically desirable ranges	Lake Okeechobee Extreme High Lake Stage (> 17 ft NGVD)
			Lake Okeechobee Extreme Low Lake State (< 10 ft, NGVD)
			Lake Okeechobee Stage Envelope – Score Below Envelope (see fact sheet for this PM in Appendix A for description of the stage envelope)
			Lake Okeechobee Stage Envelope – Score Above Envelope
			Number of Times Proposed Minimum Water Level & Duration – Criteria Exceeded
Estuaries	Excess regulatory discharges to St. Lucie Estuary	Manage flows to meet desirable salinity ranges for St. Lucie Estuary	Number of Times St Lucie High Discharge Criteria Exceeded – Mean Monthly Flows between 2,000 and 3,000 cfs
			Number of Times St Lucie High Discharge Criteria Exceeded – Mean Monthly Flows > 3,000 cfs

Problems		Objectives	Performance Measures
			Number of Times Salinity Envelope Criteria NOT Met for St Lucie Estuary – Average Monthly Flow < 350 cfs and 14 day moving average flow > 2,000 cfs for 14 days[1]
	Excess regulatory discharges to Caloosahatchee Estuary Undesirable low flows to the Caloosahatchee Estuary	Manage flows to meet desirable salinity ranges for Caloosahatchee Estuary	Number of Times Salinity Envelope Criteria NOT Met for the Caloosahatchee Estuary – Mean Monthly Flows < 450 cfs and Mean Monthly Flows > 2,800 cfs
			Number of Times Caloosahatchee Estuary High Discharge Criteria Exceeded – Mean Monthly Flows between 2,800 and 4,500 cfs
			Number of Times Caloosahatchee Estuary High Discharge Criteria Exceeded – Mean Monthly Flows > 4,500 cfs
Water Supply	LOSA and EAA water supply shortages	Avoid increasing the frequency, duration, or severity of EAA and LOSA water supply demands not met	Water Year LOSA Demand Cutback Volumes for 7 Years with Largest Cutbacks
			Mean Annual EAA/LOSA Supplemental Irrigation Demands Not Met

[1]The efficacy of the 350 cfs performance measure for the St. Lucie Estuary is currently being evaluated. This PM will be further evaluated during the River Watershed Protection Plan Process.

SECTION 4

INTERAGENCY COORDINATION AND PUBLIC INVOLVEMENT

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TABLE OF CONTENTS

List of Tables

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4.0 INTERAGENCY COORDINATION & PUBLIC INVOLVEMENT

A concerted effort was made during the P2TP planning process to involve all appropriate and relevant agencies and keep the public and stakeholders informed about the project. A public outreach initiative (POI) was developed and implemented throughout the planning process. Specific objectives of this initiative included the following:

- Develop and implement an approach that would reach all stakeholders, including minority and low-income populations within the P2TP study area
- Integrate the public outreach efforts with all other aspects of the planning process
- Take advantage of other on-going public efforts being conducted by the District and collaborating agencies as part of other Lake Okeechobee restoration programs
- Use public outreach tools and materials developed for use by various other agencies and programs for education and distribution

The P2TP POI focused on the four following activities:

- Interagency Coordination
- Public Involvement and Stakeholder Notification
- Outreach to Minority and Socially and Economically Disadvantaged Communities
- Internal Management and Communication

4.1 Interagency Coordination

The legislation authorizing the Northern Everglades and Estuaries Protection Program required the South Florida Water Management District to work in collaboration with coordinating agencies such as the Florida Department of Environmental Protection (FDEP) and the Florida Department of Consumer Affairs (FDACS) to develop the Phase II Technical Plan.

Input from other agencies was solicited through informal interaction and during stakeholder and interagency meetings that were periodically held under initiatives such as:

- The Water Resources Advisory Commission (WRAC)
- The WRAC Lake Okeechobee Committee
- The Northern Everglades Interagency Team

Table 4-1 identifies the key interagency meetings at which input on Phase II planning was actively sought.

Table 4-1. Summary of P2TP interagency coordination.

Meeting ID	Meeting Date	Meeting Location	Meeting Agenda
Lee County Commissioner Ray Judah	June 8, 2007	Lower West Coast	Northern Everglades Briefing
Caloosahatchee Partners for Restoration	June 13, 2007	Lower West Coast	Northern Everglades Presentation
Charlotte Harbor National Estuarine Program Executive Director Lisa Beever	June 13, 2007	Lower West Coast	Northern Everglades Briefing
Sierra Club Regional Community Organizer Mari Daltry	June 14, 2007	Lower West Coast	Northern Everglades Briefing
Purre Water Coalition Executive Director Kirk Woodbury	June 21, 2007	Lower West Coast	Northern Everglades Briefing
Audubon of SW Florida President Peter Quasius	June 21, 2007	Lower West Coast	Northern Everglades Briefing
Captiva Sanibel Conservation Natural Resource Policy Director Rae Ann Wessel	June 22, 2007	Lower West Coast	Northern Everglades Briefing
SFWMD GB Member Harkley Thornton, Osceola Commissioner Ken Smith, Osceola Manager, Engineers and Osceola Environmental Lands Conservation Program Coordinator and Osceola Land Conservation Advisory Board	June 26, 2007	Orlando Service Center	Northern Everglades Presentation
City of Sanibel Mayor Mick Denham	June 27, 2007	Lower West Coast	Northern Everglades Briefing
Harbor Branch Field Trip Tour to Lake Okeechobee	June 28, 2007	Okeechobee Service Center	Northern Everglades Briefing
City of Ft. Myers Vice Mayor Larry Kiker	July 2, 2007	Lower West Coast	Northern Everglades Briefing
Florida Gulf Citrus Growers Association Vice President Ron Hamel	July 3, 2007	Lower West Coast	Northern Everglades Briefing
Martin County Commissioner Mike Diterlizzi	July 3, 2007	Martin County	Northern Everglades Briefing
Martin County Commissioner Lee Weberman	July 3, 2007	Martin County	Northern Everglades Briefing
Martin County Commissioner Sara Heard	July 3, 2007	Martin County	Northern Everglades Briefing
Martin County Commissioner Doug Smith	July 3, 2007	Martin County	Northern Everglades Briefing
Northern Everglades Interagency Team Meeting	July 10, 2007	Okeechobee	• Introduce key planning team members to the Interagency group • Present goals and objectives of the Phase II planning process

Meeting ID	Meeting Date	Meeting Location	Meeting Agenda
			• Provide an update on the planning process
PGA National/Devonshire Homeowners Association	July 11, 2007	Palm Beach Gardens	Northern Everglades Presentation
Water Enhancement and Restoration Coalition Director Sharon Arnold	July 12, 2007	Lower West Coast	Northern Everglades Briefing
St. Lucie County Commissioner Charles Grande	July 13, 2007	St. Lucie County	Northern Everglades Briefing
St. Lucie County Commissioner Susan Valerie	July 13, 2007	St. Lucie County	Northern Everglades Briefing
St. Lucie County Commissioner Joe Smith	July 13, 2007	St. Lucie County	Northern Everglades Briefing
City of Cape Coral City Manager Terry Steward	July 17, 2007	Lower West Coast	Northern Everglades Briefing
TMDL Group – monthly meeting with representatives from DEP, Martin County, St. Lucie County, City of Stuart and City of Ft. Pierce	July 17, 2007	Martin County	Northern Everglades Presentation
Okeechobee Mainstreet – various community leaders	July 18, 2007	Okeechobee	Northern Everglades Briefing
Senator Nelson's Regional Director Diana McGee	July 18, 2007	Lower West Coast	Northern Everglades Briefing
St. Lucie County Commissioner Chris Craft	July 18, 2007	St. Lucie County	Northern Everglades Briefing
St. Lucie County Commissioner Doug Coward	July 18, 2007	St. Lucie County	Northern Everglades Briefing
Public Meeting at Martin/St. Lucie Service Center	July 18, 2007	Martin County	Northern Everglades Presentation
La Posada Retirement Community	July 19, 2007	Palm Beach Gardens	Northern Everglades Presentation
City of Sanibel Public Works Director Gates Castle	July 20, 2007	Lower West Coast	Northern Everglades Briefing
Bonita Bay Group Sr. VP of Development Susan Watts	July 23, 2007	Lower West Coast	Northern Everglades Briefing
Battle of Okeechobee with FDEP	July 23, 2007	Okeechobee	Northern Everglades Briefing
Soil & Water Conservation Society Annual Conference	July 24, 2007	Tampa	Northern Everglades Presentation
Captiva Sanibel Conservation Foundation Executive Director Erick Landblat	July 26, 2007	Lower West Coast	Northern Everglades Briefing
Everglades Issues Panel / Pine Jog Fellows/Florida Atlantic University	July 31, 2007	Okeechobee	Northern Everglades Presentation
St. Lucie County Commissioner Paula Lewis	August 3,2007	St. Lucie County	Northern Everglades Briefing
Babcock Ranch Environmental and Planning Steering Committee (Charlotte and Lee counties; state & regional natural resource agencies; and environmental groups	August 8, 2007	Lower West Coast	Northern Everglades Presentation

Meeting ID	Meeting Date	Meeting Location	Meeting Agenda
Northern Everglades Interagency Group	August 15, 2007	Okeechobee	Northern Everglades Presentation
Ft. Myers City Commission Meeting	August 20, 2007	Lower West Coast	Northern Everglades Presentation
Hendry County Administrator Wayne O'Neal	August 20, 2007	Lower West Coast	Northern Everglades Presentation
Florida Citrus Annual Meeting	August 22 & 23	Lower West Coast	Northern Everglades Tabletop Display
Martin County 101 – quarterly class introduces the services of Martin County	August 23, 2007	Martin County	Northern Everglades Tabletop Display & Fact Sheet
Florida Association of Realtors – Land Use Property Rights and Environmental Resources Committee	August 24, 2007	Orlando	Northern Everglades Presentation
Ft. Myers Seniors' Club Meeting	August 26, 2007	Lower West Coast	Northern Everglades Presentation
Cape Coral City Commission Meeting	August 27, 2007	Lower West Coast	Northern Everglades Presentation
Glades County Commissioners Russell Echols and Butch Jones	August 28, 2007	Glades County	Northern Everglades Briefing
Cape Coral Rotary Club	August 29, 2007	Lower West Coast	Northern Everglades Presentation
Lake Okeechobee WRAC	August 29, 2007	Martin/St. Lucie Service Center	Northern Everglades Presentation
East County Water Control District Executive Director David Lindsey	August 30, 2007	Lower West Coast	Northern Everglades Briefing
Okeechobee County Commissioners Ray Domer, Noel Chandler, George Long	August 30, 2007	Okeechobee	Northern Everglades Briefing
Hendry County Engineer Shane Parker	August 31, 2007	Lower West Coast	Northern Everglades Briefing
Highlands County Board of Commissioners	September 4, 2007	Highlands County	Northern Everglades Presentation
Northern Everglades Interagency Group	September 5, 2007	Okeechobee	Northern Everglades Briefing
Lake Okeechobee WRAC	September 5, 2007	Naples	Northern Everglades Briefing
Okeechobee City Commission Meeting	September 5, 2007	Okeechobee	Northern Everglades Presentation
City of La Belle Mayor Paul Puletti	September 5, 2007	Lower West Coast	Northern Everglades Briefing
Horticulture and Natural Resources Committee of the Osceola County Extension Service	September 7, 2007	Orlando	Northern Everglades Briefing
Lee County Commissioner Briefing	September 14, 2007	Lee County	Northern Everglades Briefing
Ten County Coalition Meeting	September 14, 2007	Okeechobee	Northern Everglades Update
Martin County Medical Center Board of Governors	September 17, 2007	Martin County	Northern Everglades Update
Conservancy of SW Florida	September 18, 2007	Lower West Coast	Northern Everglades

Meeting ID	Meeting Date	Meeting Location	Meeting Agenda
			Update
City of Ft Myers Councilman	September 19, 2007	Ft Myers	Northern Everglades Briefing
Southwest Florida Regional Planning Council	September 20, 2007	Lower West Coast	Northern Everglades Presentation
Okeechobee Main Street Meeting	September 24, 2007	Okeechobee	Northern Everglades Briefing
Hendry County Commission Meeting	September 25, 2007	Hendry County	Northern Everglades Presentation
Lee County Commissioner Meeting	September 26, 2007	Lee County	Northern Everglades Briefing
St. Lucie County Conservation Alliance	September 26, 2007	St. Lucie County	Northern Everglades Update
Mitch Hutchcraft	October 1, 2007	Lee County	Northern Everglades Briefing
Lykes Brothers	October 3, 2007	Okeechobee-Brighton Office	Northern Everglades Briefing
Osceola County Commission Meeting	October 8, 2007	Osceola County	Northern Everglades Update
Lee County Commissioner Bob Jones	October 8, 2007	Lee County	Northern Everglades Briefing
YMCA - Newcomers	October 9, 2007	Martin County	Northern Everglades Update
Governing Board Workshop	October 10, 2007	West Palm Beach	Northern Everglades Update
Northern Everglades Interagency Meeting	October 17, 2007	Okeechobee	Northern Everglades Update
Heartland Agricultural Water Resources Forum/ Highland County Citrus Growers Association	October 24, 2007	Sebring	Northern Everglades Briefing
Lee County Commissioner Brian Bigelow	October 25, 2007	Lee County	Northern Everglades Briefing
Great Outdoor Days Event	October 28, 2007	Kissimmee	Northern Everglades Update
Environmental Protection Conference	October 30, 2007	Lee County	Northern Everglades Update
Lake Okeechobee WRAC	October 31, 2007	Okeechobee County	Northern Everglades Update
WRAC	November 8, 2007	West Palm Beach	Northern Everglades Update
Governing Board Workshop	November 14, 2007	Florida Keys	Northern Everglades Update
Northern Everglades Interagency Meeting	November 27, 2007	Okeechobee	Northern Everglades Update
Lake Okeechobee Phase II Technical Plan Public Meeting	November 27, 2007	Okeechobee	Public Workshop on Draft Plan
Lake Okeechobee WRAC	November 28, 2007	Clewiston	Northern Everglades Update
Lake Okeechobee Phase II Technical Plan Public Meeting	November 28, 2007	Clewiston	Public Workshop on Draft Plan
Ten County Coalition	November 30, 2007	Okeechobee	Northern Everglades Update
FlashPoint Television	December 3, 2007	Orlando	Northern Everglades

Meeting ID	Meeting Date	Meeting Location	Meeting Agenda
Interview with Carol Wehle			Briefing
Congressman Connie Mack's DC Scott Henderson and Kara Moore	December 3, 2007	Ft. Myers	Northern Everglades Briefing
Joint Meeting of WRAC/South Florida Ecosystem Restoration Task Force	December 5, 2007	Miami	Northern Everglades Update
Walt Disney World Environmentality Expo Day	December 6, 2007	Orlando	Northern Everglades Display
Lee County Commissioners Ray Judah and Carla Palmer	December 6, 2007	Ft. Myers	Northern Everglades Update
Stetson University	December 8, 2007	Orlando	Northern Everglades Briefing
Gulf Citrus Growers Association E.V.P. Ron Hamel	December 10, 2007	Ft. Myers	Northern Everglades Briefing
Governing Board Workshop	December 12, 2007	West Palm Beach	Northern Everglades Update
Joint Meeting with Palm Beach County Commissioners and SFWMD Governing Board	December 13, 2007	West Palm Beach	Northern Everglades Update
Lee County Commissioner Frank Mann	December 17, 2007	Ft. Myers	Northern Everglades Briefing
Various environmental stakeholders	December 19, 2007	Tallahassee	Northern Everglades Briefing
Bonita Bay Group S.V.P.	December 21, 2007	Ft. Myers	Northern Everglades Briefing
Queens University of London Group	January 1, 2008	Okeechobee	Northern Everglades Presentation
Combined Lake Okeechobee Committee and WRAC	January 3, 2008	West Palm Beach	Northern Everglades Briefing
SFWMD Governing Board	January 8, 2008	Miami	Northern Everglades Briefing and Plan Acceptance

4.2 Public Involvement and Stakeholder Notification

The objectives of the public outreach effort for the Phase II planning process were to achieve the following goals:

- Increase public awareness of the overall goals and objectives of the NEEPP
- Inform the public and receive input regarding the project goals, objectives, progress, issues and findings
- Involve stakeholders, agencies, Tribes and other interested groups and individuals as the plan was developed, to ensure that public values regarding the project were fully considered
- Reduce potential conflict among interested and affected parties by building consensus solutions to emerging issues
- Improve the substantive quality of project-level decisions as a result of public participation
- Increase public trust in the South Florida Water Management District and the other agencies involved in the planning process

4.3 Public Comments

Public, stakeholders, and agencies were invited to review and provide comments on the Draft P2TP. Over 100 comments were received over the four week public comment period (**Appendix E**). These comments were considered during the finalization of the P2TP.

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SECTION 5

WATER QUALITY DATA ANALYSES

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TABLE OF CONTENTS

TABLE OF CONTENTS (CONTINUED)

List of Tables

List of Figures

5.0 WATER QUALITY DATA ANALYSES

5.1 Introduction

Existing water quality in the Lake Okeechobee watershed (LOW) is significantly influenced by the various land use and land management practices within the individual sub-watersheds and drainage basins (Hiscock et al., 2003; Zhang et al.; 2002). The current distribution of land use in the LOW is illustrated in **Figure 5-1**. Phosphorus, in particular, has been identified as a nutrient of major concern in the surface runoff in the LOW (Davis and Marshall; 1975, Fredrico et al., 1981; Joyner, 1972). Average annual flows, phosphorus loads, and concentrations for individual sub-watersheds, based on a 15 year average for the period 1991 to 2005, are shown in **Table 5-1**. These phosphorus loads represent *existing conditions* for LOW water quality.

Numerous regional and site specific phosphorus source control projects are either currently being implemented or are identified for future implementation at various locations in the LOW under the Lake Okeechobee Protection Plan (LOPP) (SFWMD et al., 2007). Cumulatively, these projects are expected to contribute towards reducing total phosphorus (TP) loading to Lake Okeechobee. The predicted phosphorus load reductions under various activities or management measures for each sub-watershed are shown in **Table 5-2**. The goal of the LOPP is to meet a total phosphorus TMDL mandated annual average discharge of 105 metric tons per year (mt/yr) from the watershed. The Lake Istokpoga sub-watershed contributes flow to Lake Istokpoga. Phosphorus load reductions in the Lake Istokpoga sub-watershed are buffered by Lake Istokpoga and are not counted toward the TP load reduction listed in **Table 5-2**.

5.2 Sub-watershed Water Quality Profiles

As previously described in *Section 2.3.2*, the LOW can be broadly divided into nine sub-watersheds based upon hydrologic drainage boundaries (**Figure 2-1**). Water quality conditions within each sub-watershed vary considerably depending upon existing land uses, land management practices, and the magnitude of water quality improvement projects that were either implemented in the recent past or are currently being implemented. Many areas in the LOW are undergoing rapid urbanization. These land use changes, however, are not expected to adversely impact water quantity and quality due to new, more stringent regulatory requirements that are currently under development.

5.2.1 Upper Kissimmee Sub-watershed

The Upper Kissimmee sub-watershed (**Figure 5-1**) is the largest of the nine sub-watersheds, covering just over a million acres or 30 percent of the Lake Okeechobee Watershed. This sub-watershed includes all of the areas drained by tributaries to Lake Kissimmee including Lakes Kissimmee, Marian, Weohyakapka, Tiger, Rosalie, Pierce, Hatchineha, Cypress, Task, Marion, Gentry, Alligator, Conlin, Russel, Tohopekaliga, East Tohopekaliga, Myrtle, Hart, Conway, Butler, Tibet Butler, Sawgrass, Boggy Marsh, Reedy Creek, Shingle Creek, and Boggy Creek. The major canals conveying water within the Upper Kissimmee sub-watershed include C-29A, C-30, C-31, C-32C, C-33, C-34, C-35, and C-37.

Table 5-1. Summary of average annual flows and TP loads to Lake Okeechobee (1991-2005) for each sub-watershed.

Sub-watershed	Area (acres)	Average Annual Discharge) (ac-ft)	Average Annual P Load (mt)	Average Annual P Conc. (ppb)
Upper Kissimmee (S-65)	1,021,674	954,204	91	78
Lower Kissimmee (S-65A,B,C,D,E)	429,283	378,836	77	166
Taylor Creek/Nubbin Slough (S-191,154,133,135)	198,299	187,583	124	537
Lake Istokpoga (S-68)	392,147	299,656	23	63
Indian Prairie Basins (12 basins)	294,147	249,175	89	289
Fisheating Creek & Nicodemus Slough (Culvert 5)	315,007	224,368	55	199
West Lake Okeechobee Basin (S-77)	200,993	5,835	1	139
EAA Basins	361,707	149,488	33	177
East Lake Okeechobee Basins (C-44, L-8)	237,831	109,134	20	151
Total	**3,451,087**	**2,558,279**	**514**	**163**

Table 5-2. Summary of projected Lake Okeechobee TP load reductions associated with LOPP recommended projects and initiatives.

Sub-Watershed	Baseline TP Load (1991- 2005) (mt)	Projected TP Load After All LOPP Recommended Projects are in place (mt)	Projected TP Load Reduction Achieved by LOPP Recommended Projects* (mt)	Projected % TP Load Reduction
Upper Kissimmee	91	78	13	14%
Lower Kissimmee	78	21	57	73%
Taylor Creek/Nubbin Slough	124	42	82	66%
Lake Istokpoga	23	23	0	0%
Indian Prairie Basins	89	51	38	43%
Fisheating Creek	55	39	16	29%
West Lake Okeechobee Basins	1	1	0	0%
EAA	33	12	21	64%
East Lake Okeechobee Basins	20	8	12	60%
Total	**514**	**275**	**239**	**46%**

*Baseline load for LOPP, which used a 10-year period of record (1991-2000) was 433 mt.

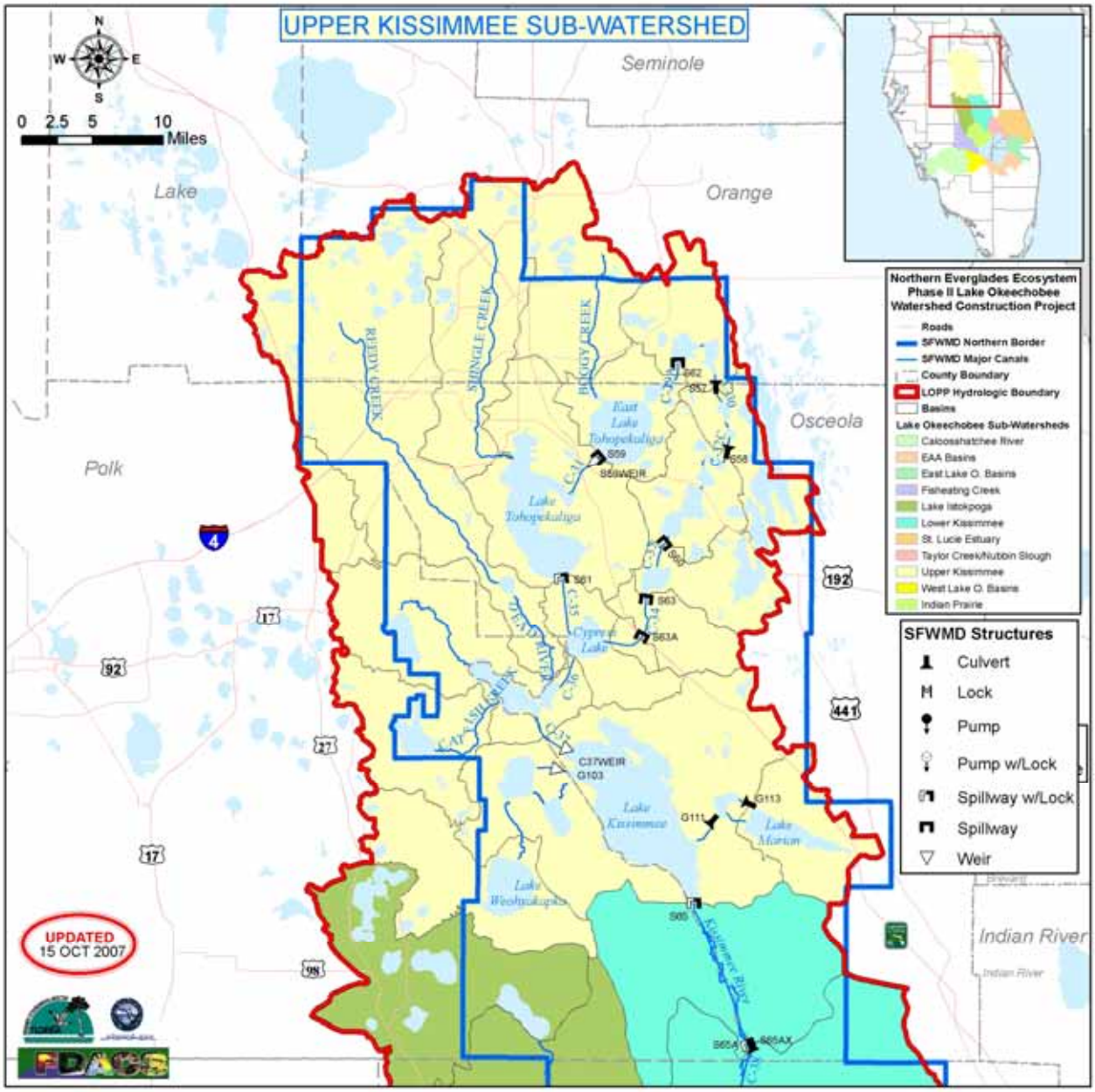

Figure 5-1. Upper Kissimmee River Sub-watershed.

5.2.1.1 Land Uses

More than half (55 percent) of the current land use in this sub-watershed (approximately 570,000 acres) is classified as natural and woodland/rangeland (James and Zhang, 2008) (**Figure 5-2, Table 5-3**). Approximately 207,000 acres (roughly 20 percent) are classified as urban. This is more than half of the total urban development in the entire LOW. This sub-watershed also includes more than 130,000 acres (13 percent) of improved pasture. Only the Lower Kissimmee sub-watershed contains more improved pasture.

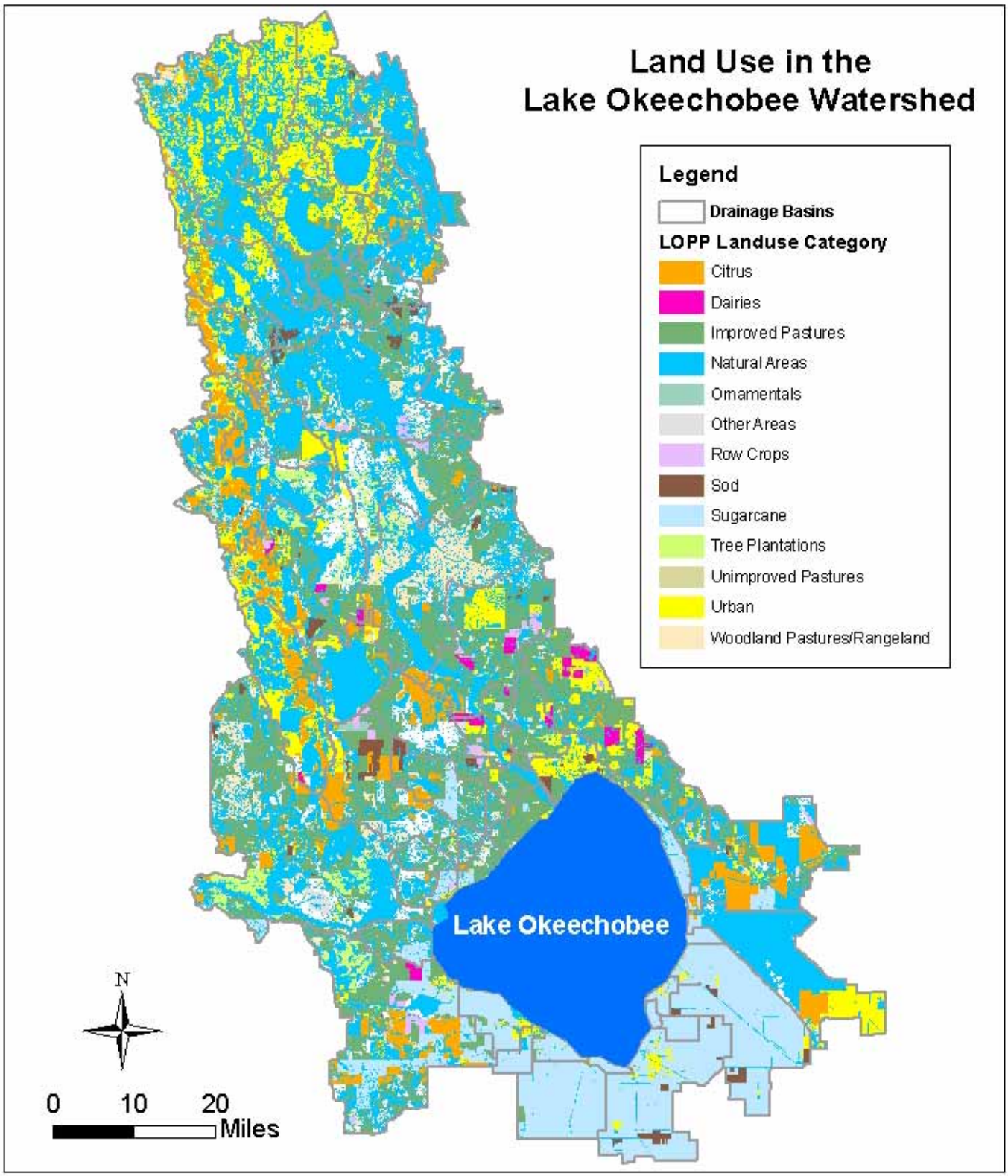

Figure 5-2. 2006 Lake Okeechobee watershed land uses. (Source: James and Zhang, 2008)

Table 5-3. Distribution of land use by sub-watershed in the Lake Okeechobee watershed.

Land Use	Entire Watershed		Upper Kissimmee	Lower Kissimmee (S65A-E)	Taylor Creek/Nubbin Slough (S191, S154, S133, S135)	Lake Istokpoga	Indian Prairie (12 basins)	Fisheating Creek and Nic. Slough	West LO Basins	South LO Basins (10 EAA Basins)	East LO Basins (C-44 and L-8)
	Acres	**%**	**Acres**	**Acres**	**Acres**	**Acres**	**Acres**	**Acres**	**Acres**	**Acres**	**Acres**
Citrus	234,629	7%	57,478	11,666	3,572	55,918	30,331	12,542	23,741	95	39,287
Dairy	22,432	1%	0	5,950	11,085	3,031	177	26	2,164		
Improved Pasture	674,356	20%	133,437	134,894	86,186	48,228	108,424	90,779	48,447	3,819	20,143
Natural Areas	1,282,267	37%	529,079	146,449	38,989	173,433	72,880	122,189	54,847	15,157	129,243
Ornamentals	4,687	0%	187	12	542	348	2,667	541	2	260	126
Other Areas	27,567	1%	8,396	2,358	1,517	3,626	1,707	4,583	1,971	1,105	2,303
Row Crops	23,157	1%	3,391	7,814	817	1,646	3,456	235	4,693		1,104
Sod Farms	39,081	1%	9,505	2,335	2,314	2,933	10,222	2,448	9	9,099	216
Sugarcane	399,711	12%			9,123		12,674	7,220	37,298	320,590	12,806
Tree Plantations	49,687	1%	3,743	8,358		12,710	58	17,919	6,899		
Unimproved Pasture	140,249	4%	27,828	23,468	1,090	24,374	28,845	19,595	8,544		6,505
Woodland/Rangeland	184,381	5%	41,623	64,220	3,620	14,924	15,720	32,720	8,620	65	2,868
Urban	368,884	11%	207,006	21,758	39,444	50,976	6,987	4,209	3,757	11,517	23,230
Total	**3,451,088**	**100%**	**1,021,673**	**429,282**	**198,299**	**392,147**	**294,148**	**315,006**	**200,992**	**361,707**	**237,831**

Source: James and Zhang, 2008

5.2.1.2 Total Phosphorus (TP) Loads and Concentrations

The Upper Kissimmee sub-watershed is the largest contributor of flows to Lake Okeechobee. For the 1991-2005 period of record (POR), this sub-watershed contributed 91 metric tons/year (mt/yr) of total phosphorus at a flow-weighted concentration of 78 ppb (Table 5-1). Overall the Upper Kissimmee sub-watershed contributes approximately 37 percent of the total flow volume and 18 percent of the TP load to Lake Okeechobee. It is recognized that since 2001 TP loads have increased in this sub-watershed.

The Kissimmee River Headwaters Revitalization Project, which is focused on this sub-watershed, is to provide the water storage and regulation schedule modifications needed to approximate the historical flow characteristics of the Kissimmee River system and to increase the quantity and quality of lake littoral zone habitat in Lakes Kissimmee, Hatchineha, Tiger, and Cypress for the benefit of fish and wildlife. Some phosphorus load attenuation will also occur as a result of the restoration of natural flows patterns through headwaters. The exact amount of load reduction achieved by the restoration project has not been determined. Preliminary estimates indicate that between the Upper and Lower Kissimmee sub-watersheds, the TP load reduction could be as much as 20 mt/yr.

However, any reduction in external TP loading to Lakes Kissimmee, Cypress, and Hatchineha is not likely to result in immediate improvements in water quality as these lake sediments are a source of dissolved phosphorus (White et al., 2003). It may take many years for this phosphorus source to be depleted once TP loads to these lakes have been reduced (Mock*Roos, 2003)

Portions of the Upper Kissimmee sub-watershed are projected to experience a significant increase in urbanization over the foreseeable future. By 2060 urban acreage in Central Florida is forecasted to increase by as much as 27 percent. However, these land use changes are not expected to adversely impact water quantity and quality due to new more stringent regulatory requirements.

Many different types of owner-implemented BMPs, typical cost-share BMPs, additional BMPs, and regional public works projects are planned for implementation in this sub-watershed under the LOPP. BMP implementation in this basin is necessary for the long-term protection of Lakes Kissimmee, Cypress, and Hatchineha, as well as downstream areas and Lake Okeechobee. These source control efforts are currently underway but have not been fully implemented. Therefore current water quality data does not reflect improvements that are anticipated with full BMP implementation.

5.2.1.3 Other Contaminants of Concern

FDEP and EPA maintain a list of impaired water bodies in accordance with Section 303(d) of the Clean Water Act. According to Section 303(d) and Section 403.067, F.S., impaired waters are defined as, “those not meeting applicable water quality standards, a broad term that includes designated uses, water quality criteria, the Florida anti-degradation policy, and moderating provisions.”

In the Upper Kissimmee Sub-watershed, 17 water bodies were identified as impaired due to excessive nutrients in the FDEP's February 2006 Verified Impaired Waters List. Mercury and low dissolved oxygen levels were each found to cause impairment to 11 and 5 water bodies, respectively. Other contaminants that caused impairment were copper, lead, and fecal coliforms.

Pursuant to the Governor's 2005 Lake Okeechobee & Estuary Recovery (LOER) Plan, nutrient related TMDLs in the Kissimmee Basin that were originally scheduled to be completed in 2010 / 2011, have been accelerated for completion by December 31, 2007. The pollutant reductions necessary to restore water quality will be implemented as quickly as possible with local stakeholders through the implementation of Basin Management Action Plans (BMAPs). Lower priority, non-nutrient related TMDLs will be developed by 2010/2011.

Waterbodies in the Kissimmee Chain of Lakes (KCOL) under nutrient TMDL development include lakes: Marion, Davenport, Underhill, Holden, Pineloch, Copeland, Olive, Clear, Lorna Doone, Mann, Cane, Catherine, Rock, Butler, Cypress, and Kissimmee (Per. Comm. Pat Fricano, FDEP).

5.2.2 Lower Kissimmee Sub-watershed

The 429,283 acre Lower Kissimmee Sub-watershed lies between the outlet of Lake Kissimmee (S-65) and the C-38 inflow structure to Lake Okeechobee (S-65E) (**Figure 5-3)**. Two of the four "priority" basins, namely S-65D and S-65E identified in the original Lake Okeechobee Surface Water Improvement (SWIM) Plan (SFWMD 1989), are located in this sub-watershed. The primary water management features are C-38 (Kissimmee River) and S-65A, S-65C, S-65D, and S-65E.

When completed, the federally authorized Kissimmee River Restoration Project will restore over 40 square miles of river/floodplain ecosystem, including 43 miles of meandering river channel and 27,000 acres of wetlands in this sub-watershed.

5.2.2.1 Land Uses

The primary land uses in this sub-watershed are natural areas (146,000 acres), improved pasture (135,000 acres), and woodland/rangeland (64,000 acres) which account for 34, 31, and 15 percent, respectively of the total acreage in this sub-watershed (**Figure 5-2, Table 5-3**).

5.2.2.2 TP Loads and Concentrations

The average TP loading (1991-2005) is approximately 77 mt/yr with an average annual TP concentration of 166 ppb (**Table 5-1**). Implementation of LOPP-mandated BMPs, watershed phosphorus-source control projects, regional public works, and the Kissimmee River Restoration Project are estimated to cumulatively reduce TP loads to Lake Okeechobee by 57 mt/yr.

5.2.2.3 Other Contaminants of Concern

In the Lower Kissimmee sub-watershed, two water bodies were identified as impaired due to excessive nutrients in the FDEP's February 2006 Verified Impaired Waters List. Low dissolved oxygen levels caused of impairments to three water bodies.

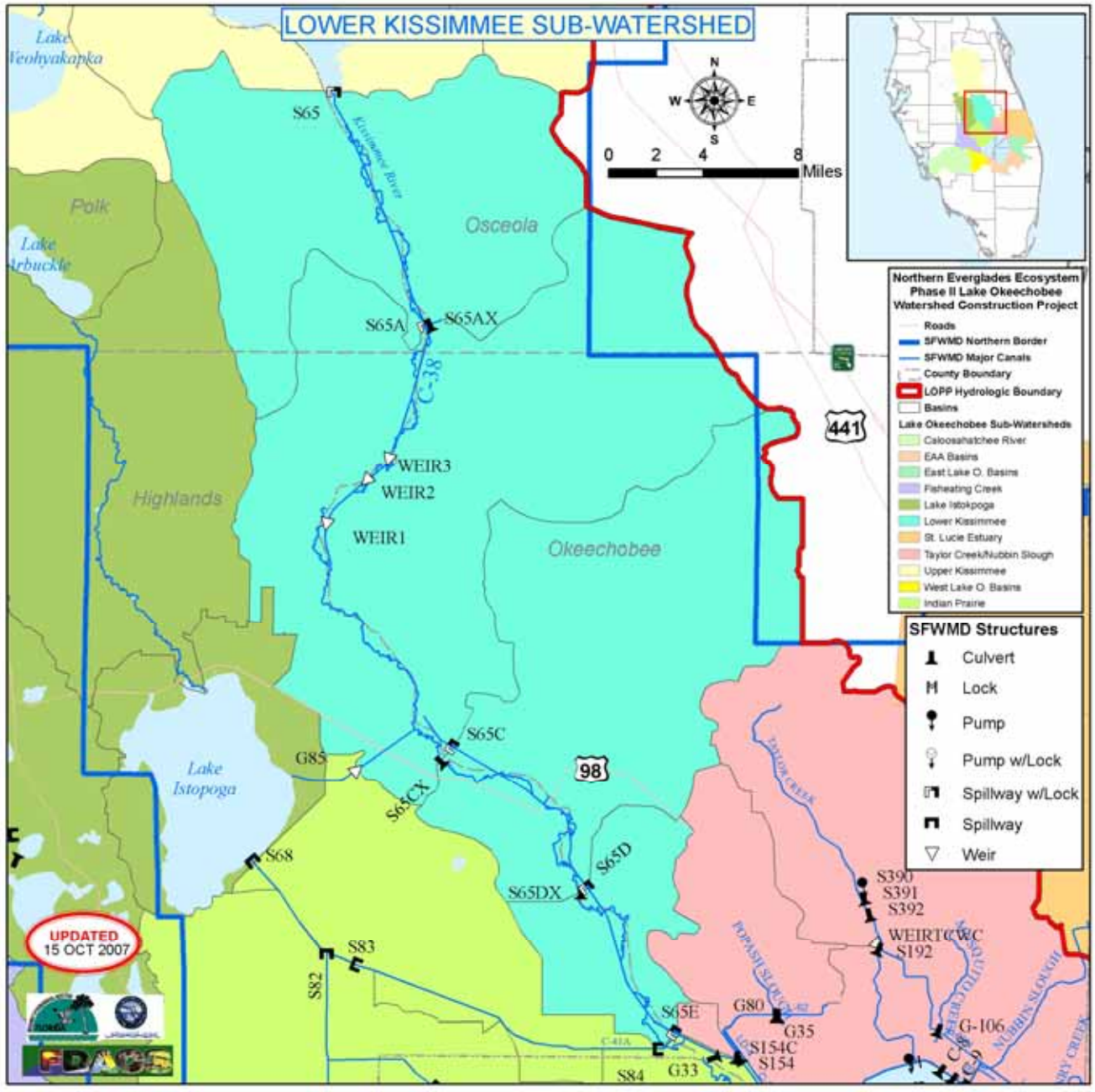

Figure 5-3. Lower Kissimmee Sub-watershed

5.2.3 Taylor Creek/Nubbin Slough Sub-watershed

The Taylor Creek/Nubbin Slough (TCNS) sub-watershed (**Figure 5-4**) is located directly northeast of Lake Okeechobee and is bounded by the Kissimmee River to the west. The primary water management features in this 198,299 acre sub-watershed are S-191, S-135, S-154, C-59, L-63N, L-63S, L-64, L-65, and L-47. Two of the four priority basins, S-191 and S-154, are located in this sub-watershed.

5.2.3.1 Land Uses

Almost half (86,186 acres) of the acreage is improved pasture (**Figure 5-2, Table 5-3**). Natural areas and urban land each constitute about 20 percent of the sub-watershed's acreage. This sub-watershed contains almost half (11,085 acres) of the dairy land in the entire Lake Okeechobee watershed. Dairy farms are contributors to phosphorus runoff in this sub-watershed (Bottcher, 2006).

5.2.3.2 TP Loads and Concentrations

The TCNS sub-watershed contributes 7 percent of the total average annual flow volume to Lake Okeechobee, but it accounts for almost 24 percent of the TP load. The average TP loading for the 1991-2005 POR was approximately 124 mt/yr with an average annual TP concentration of 537 ppb.

The priority basins, S-191 and S-154, have extensive TP reduction projects and BMPs have been constructed and are being planned. A total of 74,874 acres in the sub-watershed have been designated for BMP implementation, 41,188 of which have been currently funded. Ongoing and planned LOPP-mandated BMPs, watershed phosphorus-source control projects, and regional projects are estimated to reduce TP loads to Lake Okeechobee by 66 percent (82 mt/yr).

5.2.3.3 Other Contaminants of Concern

Eight water bodies were identified as impaired due to excessive nutrients in the FDEP's March 2003 Amended Verified Impaired Waters List. Low dissolved oxygen levels caused impairment to three water bodies.

5.2.4 Lake Istokpoga Sub-watershed

The 392,147 acre Lake Istokpoga sub-watershed (**Figure 5-5)** is located generally to the west and north (upstream) of Lake Istokpoga and is largely characterized by natural lands and other low intensity land uses. It is the source of inflows to Lake Istokpoga and includes (from south to north): Lake Istokpoga, Lake Placid, Lake June in Winter, Lake Josephine, Lake Jackson, Lake Arbuckle, and Arbuckle Creek, Lake Livingston, Reedy Lake, and Crooked Lake.

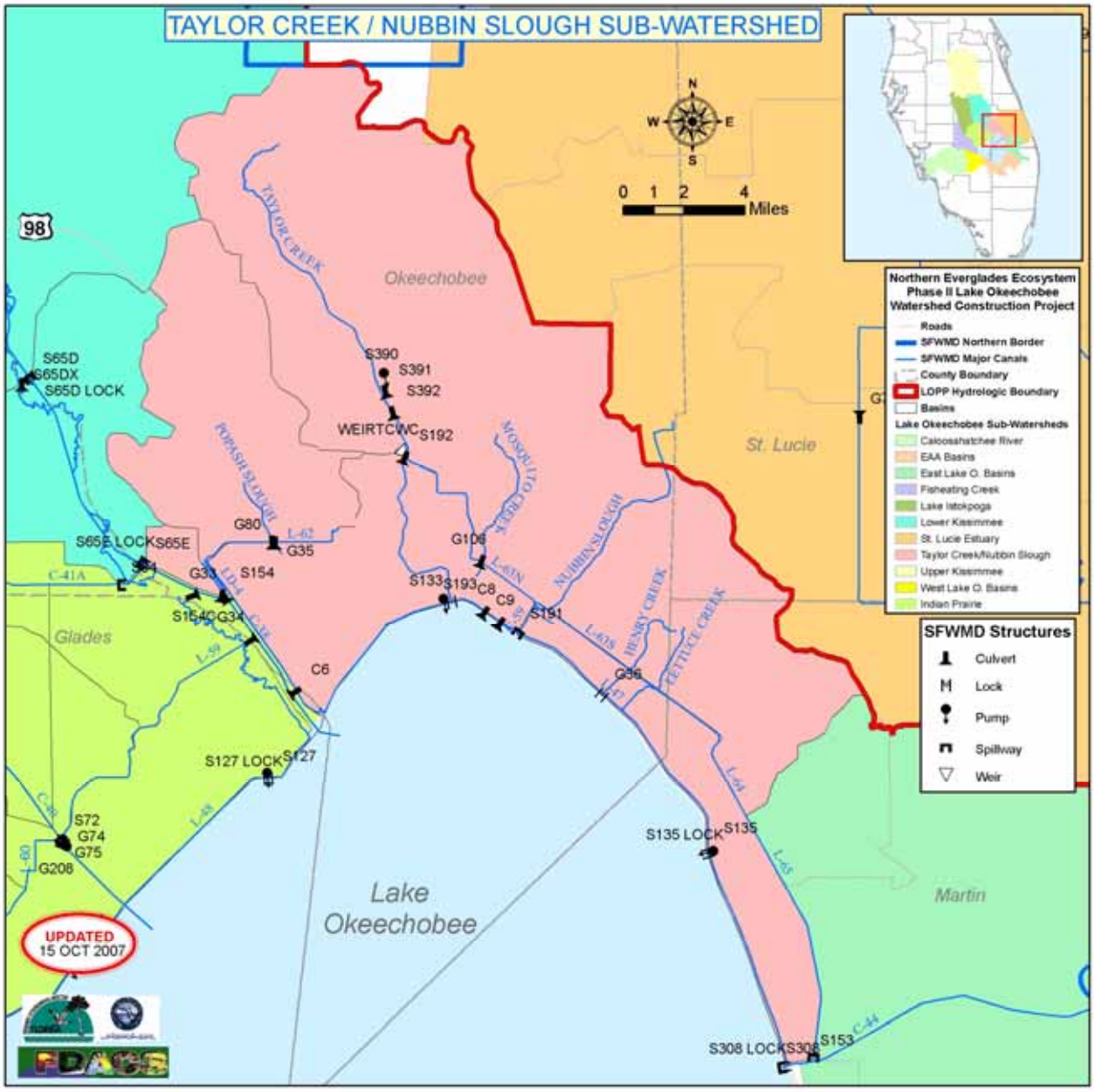

Figure 5-4. Taylor Creek/Nubbin Slough Sub-watershed

The primary outlet of water from Lake Istokpoga is through the S-68 structure, which releases water through a series of canals southeastward to both Lake Okeechobee and the Kissimmee River. Structure G-85, located on the Istokpoga Canal, is an antiquated structure constructed by private interests and later adopted by the District. Although this structure could discharge from Lake Istokpoga to the Kissimmee River, it typically remains closed. G-85 is scheduled for replacement as part of the Kissimmee River Restoration Project.

5.2.4.1 Land Uses

Almost half of the acreage (173,433 acres) is classified as natural area (**Figure 5-2, Table 5-3**). An additional 39,000 acres are classified as woodland/rangeland or unimproved pasture. As a result, more than half of the acreage in this sub-watershed is dominated by low intensity land uses. A reduction of high lake levels has provided the catalyst for development around the lakeshore, including agriculture (citrus and caladium farms), pasture land, and residential and commercial establishments.

Many lakeside areas that once flooded seasonally or infrequently are now drained (MFLs for Lake Istokpoga, 11/7/2005). As a result, the sub-watershed also includes more than 50,000 acres of urban development, the majority of which are concentrated adjacent to its numerous lakes. Citrus land constitutes more than 14 percent of the sub-watershed area with a total of 55,918 acres.

5.2.4.2 TP Loads and Concentrations

Under existing conditions (1991-2005), the average TP load from Lake Istokpoga to Lake Okeechobee (as measured at S-68) is 23 mt/yr with an average annual TP concentration of 63 ppb. The planned implementation of LOPP-mandated owner-implemented, typical cost-share, and additional BMPs will result in a total TP load reduction to Lake Istokpoga of more than 8 mt/yr.

However, the projected TP load reduction is not likely to carry forward to Lake Okeechobee as the Lake Istokpoga sediments are expected to buffer any reductions. Nevertheless, BMP implementation in this sub-watershed is necessary for the long-term protection of Lake Istokpoga, as well as Lake Okeechobee.

5.2.4.3 Other Contaminants of Concern

Four water bodies were identified as impaired due to excessive nutrients in the FDEP's March 2003 Amended Verified Impaired Waters List. Fecal coliform caused impairment in one water body. Dissolved oxygen levels and mercury in fish tissue caused impairments to two and five water bodies, respectively.

5.2.5 Indian Prairie Basins Sub-watershed

The Indian Prairie Basins sub-watershed is located between Lake Istokpoga, the Kissimmee River to the east, and northwest of Lake Okeechobee (**Figure 5-6)**. The primary water management features are the Indian Prairie Canal (C-40), Harney Pond Canal (C-41), and C-41A which convey water to Lake Okeechobee. Total land area in this sub-watershed is estimated at 294,147 acres.

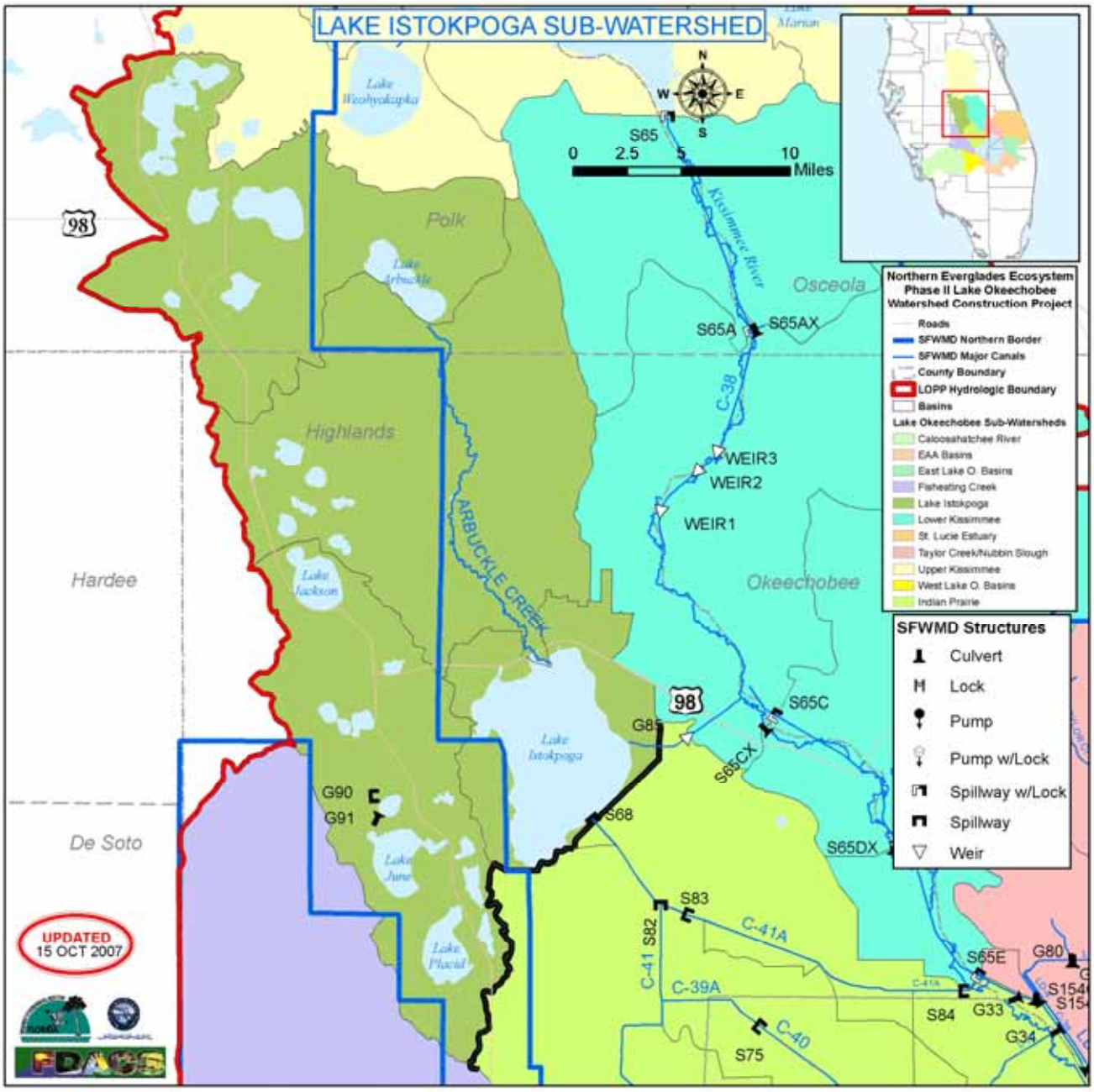

Figure 5-5. Lake Istokpoga Sub-watershed

5.2.5.1 Land Uses

Land use is dominated by improved pasture area (108,424 acres) which accounts for 37 percent of the basin's total acreage (**Figure 5-2, Table 5-3**). The basin also includes significant agricultural acreages for citrus (30,000 acres), row crops (3,400 acres), sod farms (10,000 acres), caladium (2,700 acres), and sugarcane (almost 13,000 acres). Lake Placid, which lies in this sub-watershed, calls itself the "Caladium Capital of the World."

5.2.5.2 TP Loads and Concentrations

For the 1991- 2005 POR, average TP loading was estimated at 89 mt/yr with average annual TP concentrations of 289 ppb. This sub-watershed contributes about 10 percent of the total average annual flow volume and 17 percent of the average annual TP loading to Lake Okeechobee.

Implementation of planned and ongoing BMPs, watershed phosphorus-control projects, and regional public works under LOPP are projected to reduce TP loading by 37 mt/yr.

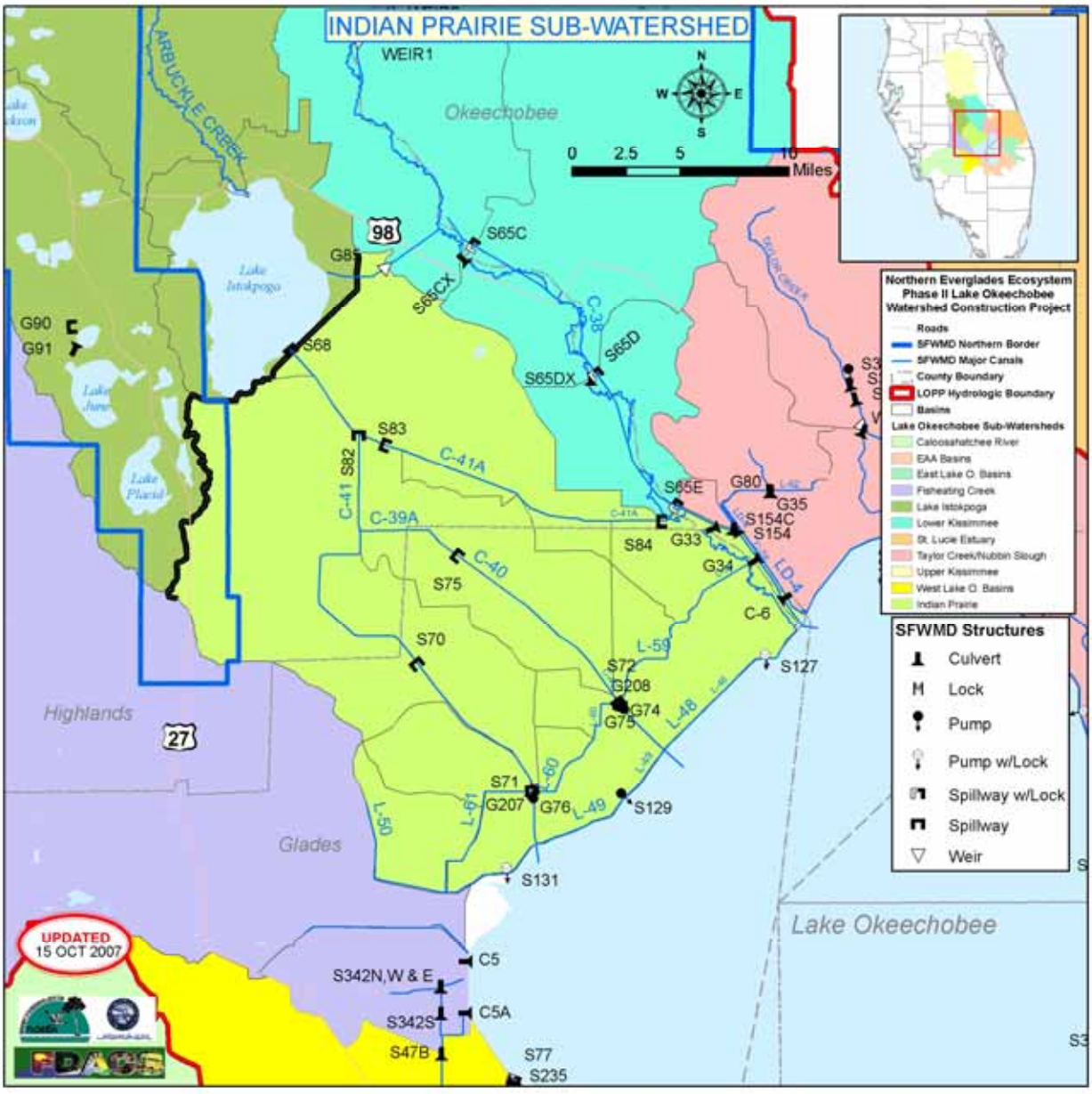

Figure 5-6. Indian Prairie Basins Sub-Watershed

5.2.5.3 Other Contaminants of Concern

Two water bodies were identified as impaired due to excessive nutrients and low dissolved oxygen levels in FDEP's March 2003 Amended Verified Impaired Waters List.

5.2.6 Fisheating Creek Sub-watershed

The Fisheating Creek Sub-watershed includes the entire drainage areas of Fisheating Creek and Nicodemus Slough (**Figure 5-7)**. It is located to the west and northwest of Lake Okeechobee and covers approximately 315,007 acres. Fisheating Creek is the only remaining naturally flowing tributary to Lake Okeechobee. Nicodemus Slough flows are discharged to Lake Okeechobee via Culvert 5A.

5.2.6.1 Land Uses

The lower portion of Fisheating Creek is predominantly natural and is characterized by wetlands and forested areas (**Figure 5-2, Table 5-3**). Much of the land (about 60,000 acres) adjacent to the lower reaches of the creek is covered under a State controlled conservation easement that conserves and protects natural communities along the shores of Fisheating Creek. The State plans to acquire additional lands for conservation in this area. In the upper reaches of Fisheating Creek, major land uses include citrus, improved pasture, and tree plantations.

5.2.6.2 TP Loads and Concentrations

For the 1991-2005 POR, average annual TP loading is approximately 55 mt/yr with an average annual TP concentration of 199 ppb. Planned and ongoing implementation of various types of BMPs under LOPP should reduce TP loading to about 39 mt/yr, a 29 percent reduction.

5.2.6.3 Other Contaminants of Concern

Only one water body was identified as impaired due to excessive nutrients, low dissolved oxygen, and high iron levels in the FDEP's March 2003 Amended Verified Impaired Waters List. The iron impairment was thought to be a naturally occurring condition from ground water seepage into the creek (Kissimmee River/Fisheating Creek Assessment Report, FDEP 2006).

5.2.7 West Lake Okeechobee Sub-Watershed

The West Lake Okeechobee sub-watershed has a total acreage of 200,993 acres and is located directly southwest of Lake Okeechobee (**Figure 5-8)**. This sub-watershed includes Lake Hicpochee, the Caloosahatchee River (C-43), C-19, L-306, L-42, and L-2W.

5.2.7.1 Land Uses

Only 31 percent of the sub-watershed is natural area or forest land. Dominant land uses are citrus (24,000 acres), improved pasture (48,000 acres), and sugarcane (37,000 acres) (**Figure 5-2, Table 5-3**).

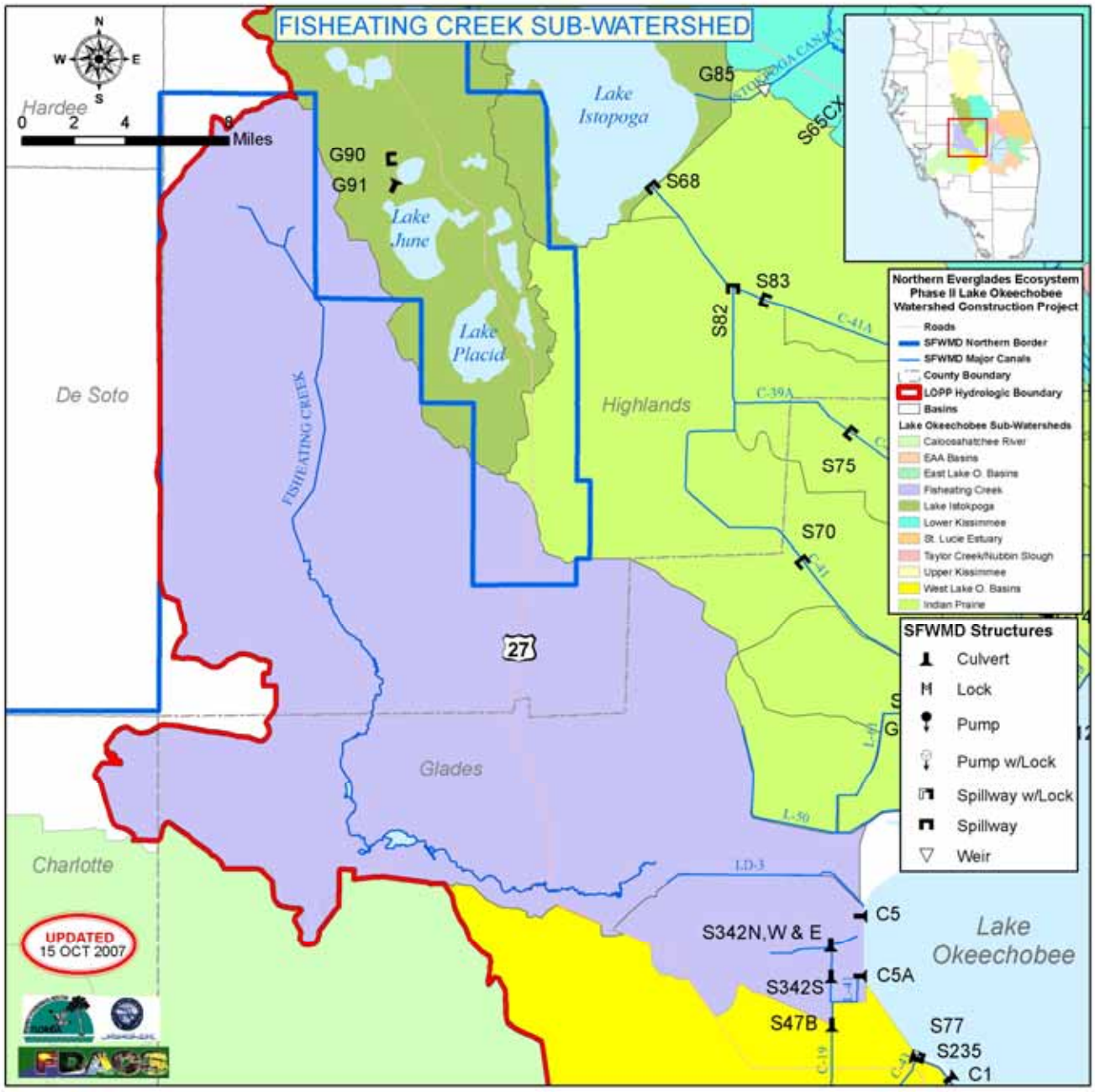

Figure 5-7. Fisheating Creek sub-watershed

5.2.7.2 TP Loads and Concentrations

The average annual flows and loads into Lake Okeechobee from the East Caloosahatchee River are very small. Flows only occur when extreme low Lake Okeechobee stages are below the normal operating level of C-43. As a result, average TP load to Lake Okeechobee from this sub-watershed is approximately 1 mt/yr with an average annual TP concentration of 139 ppb. Implementation of LOPP-mandated BMPs in this sub-watershed will primarily improve water

quality discharged to C-43 and the Caloosahatchee Estuary; it is expected to have minimal impacts, if any, on Lake Okeechobee inflows.

5.2.7.3 Other Contaminants of Concern

One water body was identified as impaired due to excessive nutrients in FDEP's June 2005 Verified Impaired List. Two water bodies were impaired due to high lead and iron levels. Low dissolved oxygen levels and fecal coliforms caused one water body to be impaired.

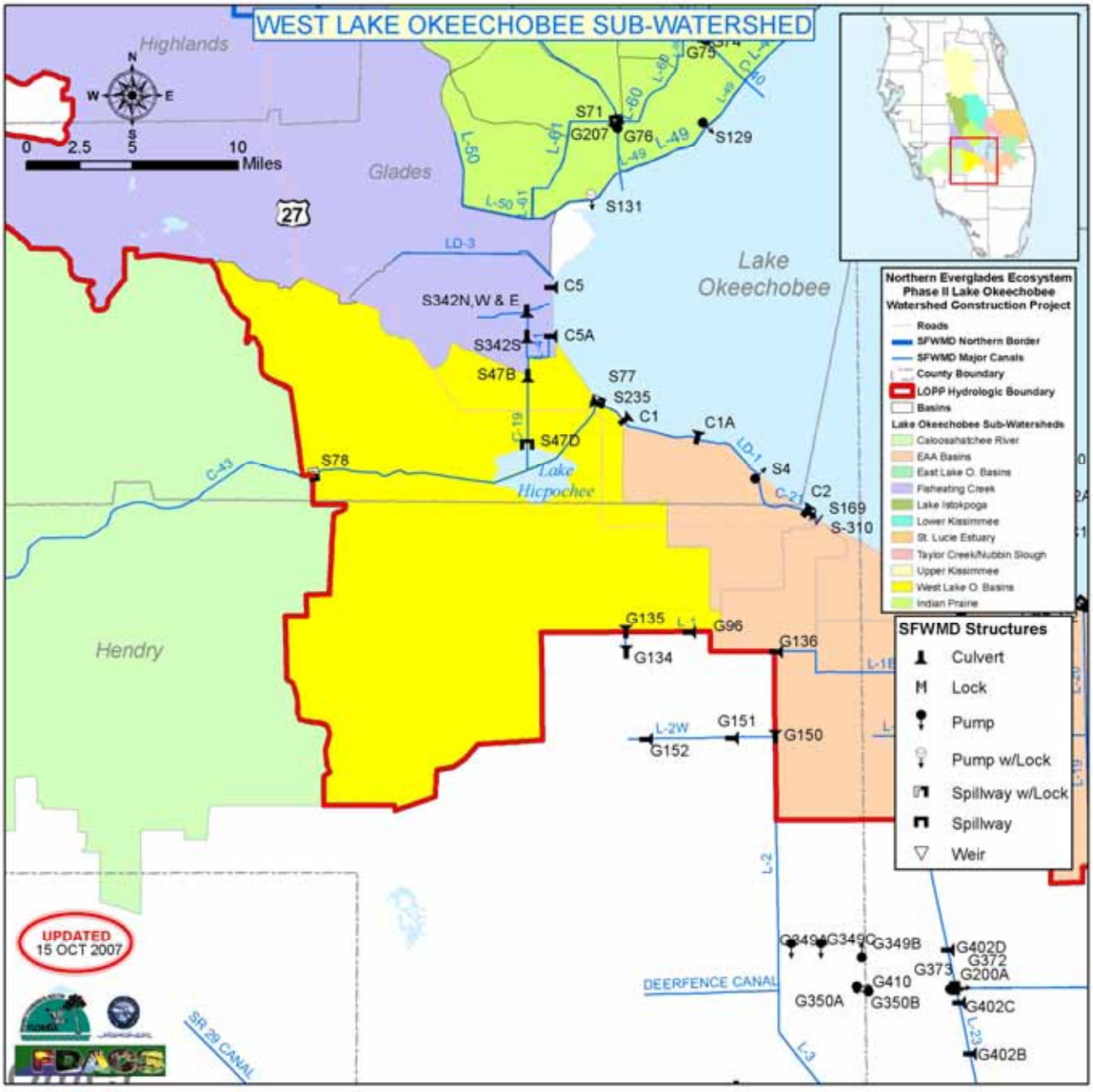

Figure 5-8. West Lake Okeechobee Sub-watershed

5.2.8 EAA Sub-watershed

The Everglades Agricultural Area (EAA) consists of several basins that are located directly southeast of Lake Okeechobee (**Figure 5-9)** and occupies 361,707 acres. Major hydrologic features in this sub-watershed include C-21, L-1, L-1E, L-26, L-25, L-21, L-19, L-20, L-14, L-10, L-12, and L-13.

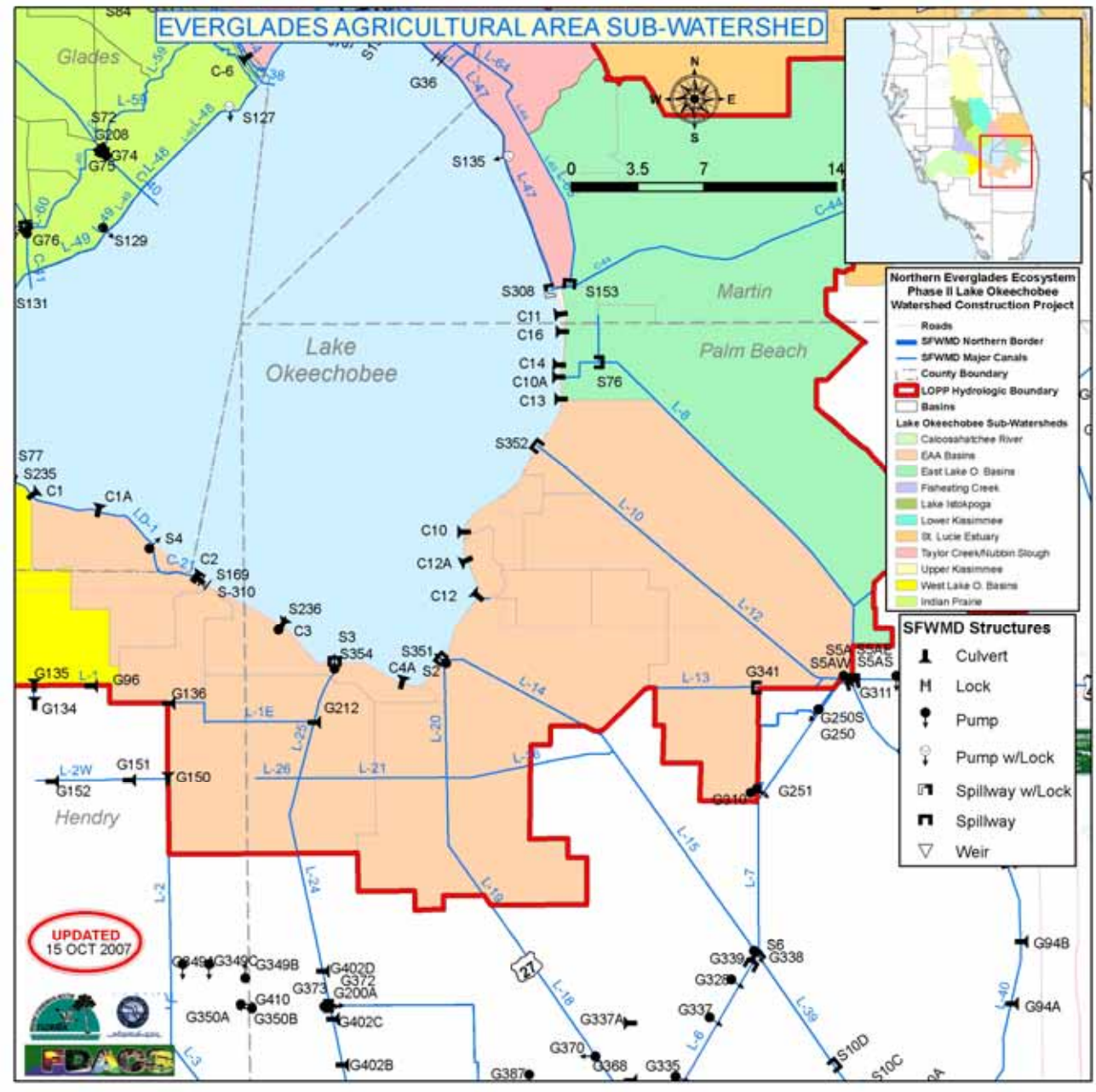

Figure 5-9. EAA Sub-watershed.

5.2.8.1 Land Uses

The primary land use in the EAA is sugarcane (320,590 acres), which accounts for almost 90 percent of the total acreage (**Figure 5-2, Table 5-3**). The other land uses (natural areas, urban centers, and sod farms) each account for 5 percent of the total basin area.

5.2.8.2 TP Loads and Concentrations

For the 1991-2005 POR, average TP loading is 33 mt/yr with an average annual TP concentration of 177 ppb. The 1994 Everglades Forever Act requires EAA landowners to reduce the total phosphorus in their runoff by 25 percent. In the past years, landowners have generally surpassed this goal.

Several non-LOPP projects are slated for implementation in this sub-watershed such as the EAA storage reservoir (CERP); diversion of 298 District flows (Everglades Construction Project) and BMPs under Chapter 40E-61, F.A.C. and Chapter 40E-63, F.A.C. These regional public works projects along with LOPP-mandated BMPs are expected to reduce TP-loads from this sub-watershed by over 60 percent (approximately 21 mt/yr).

5.2.8.3 Other Contaminants of Concern

A total of 14 water bodies were identified as impaired due to excessive nutrients in FDEP's October 2005 303(d) list. Low dissolved oxygen caused impairment in ten water bodies. High chlorophyll-a, turbidity, and mercury were also signs of impairment.

5.2.9 East Lake Okeechobee Sub-watershed

The 237,831 acre East Lake Okeechobee Sub-watershed is located directly east of Lake Okeechobee and includes the St. Lucie Canal (C-44) and L-8 Basin (**Figure 5-10**). The L-8 canal conveys excess storm water from Lake Okeechobee and agricultural areas.

5.2.9.1 Land Uses

About 56 percent of the acreage in this sub-watershed is classified as natural areas or forested (**Figure 5-2**). This sub-watershed also contains the largest acreage of citrus (39,000 acres) in the Lake Okeechobee watershed area. Approximately 13,000 acres are under sugarcane cultivation.

5.2.9.2 TP Loads and Concentrations

For the 1991-2005 POR, average TP loading to Lake Okeechobee is approximately 20 mt/yr with an average annual TP concentration of 151 ppb. The Lake Okeechobee and Estuary Recovery (LOER) Program requires the implementation of mandatory fertilizer BMPs, Environmental Resource Permitting revisions, and storage/disposal plans for excess surface water in an effort to protect the St. Lucie Estuary. These measures along with LOPP-mandated BMPs, regional public works, and other regional projects are expected to reduce the total TP load to Lake Okeechobee by 12 mt/yr.

5.2.9.3 Other Contaminants of Concern

One water body was identified as being impaired due to excessive nutrients in FEDP's October 2005 303(d) list. Low dissolved oxygen and high chlorophyll-a, and copper were identified as other contaminants of concern.

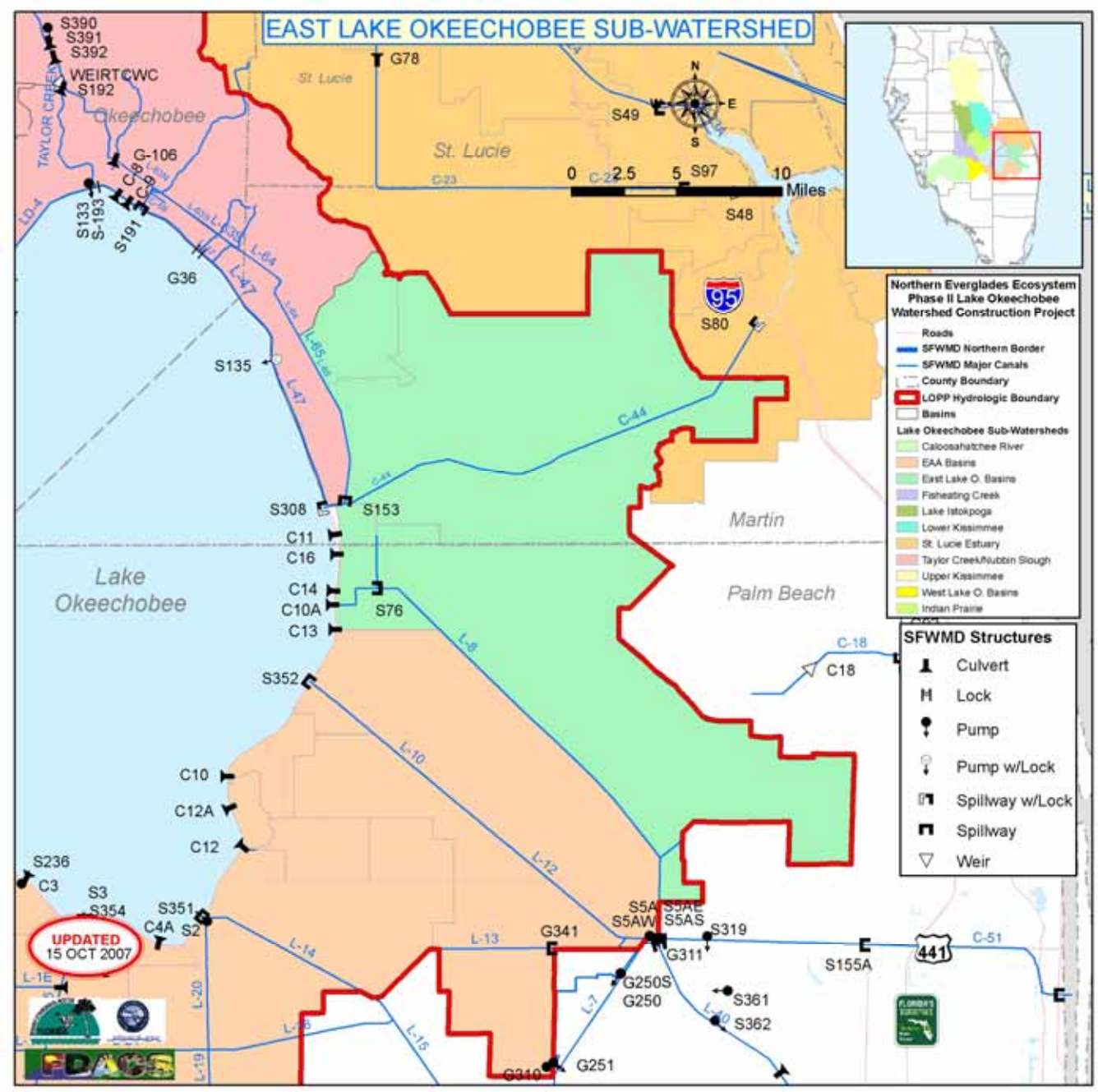

Figure 5-10. East Lake Okeechobee Sub-watershed.

5.3 Relationship Between Sub-watershed Flows and TP Loads

Flows and accompanying total phosphorus (TP) loads from each sub-watershed were analyzed for the 1991 to 2005 POR and for the future after all LOPP recommended projects were implemented to identify those sub-watersheds with disproportionately large TP loads. These sub-watersheds would be targeted by the P2TP for application of water quality improvement measures.

Figure 5-11 shows the percent of the total inflow vs. the percent of the TP loading contributed to Lake Okeechobee from each of the sub-watersheds for the 1991-2005 POR. Sub-watersheds that contribute greater TP loads relative to flows lie above the diagonal line. Conversely, sub-watersheds that discharge greater flows relative to TP loads lie below the diagonal line. The figure shows that TCNS and the Indian Prairie Basins sub-watersheds discharge disproportionately high TP loads under existing conditions. The Upper Kissimmee and Lake Istokpoga sub-watersheds discharge relatively low TP loads to Lake Okeechobee.

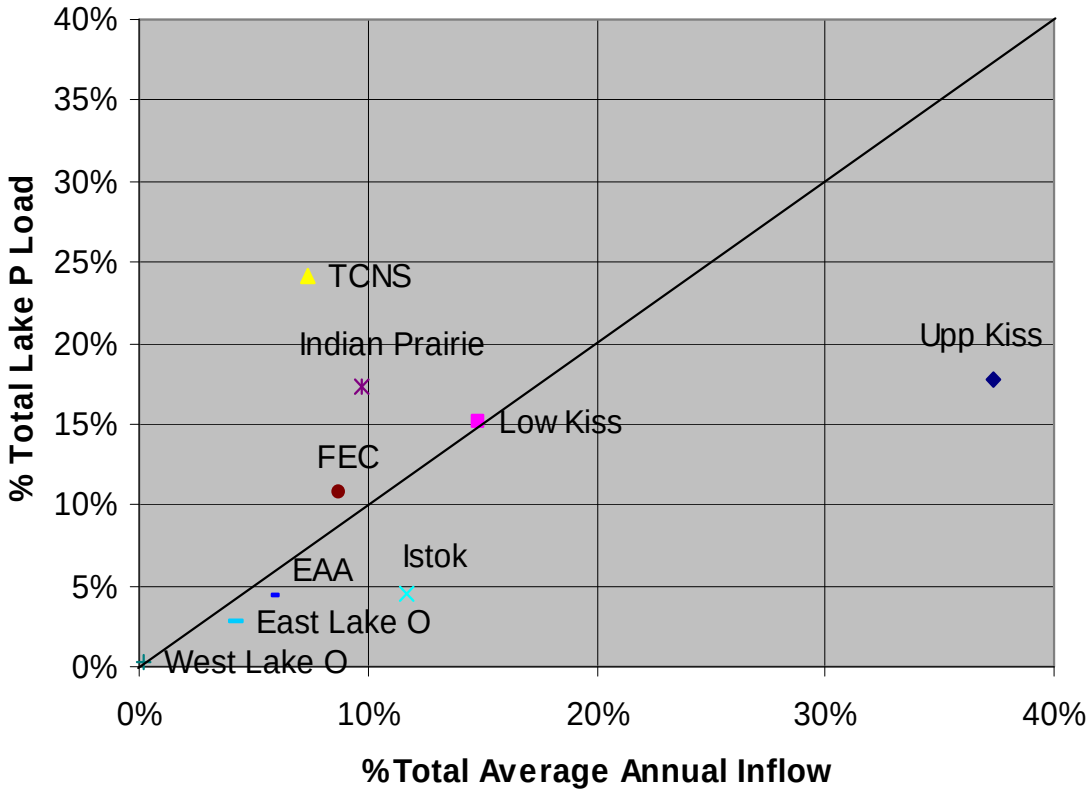

Figure 5-11. Comparison of total Lake Okeechobee inflows to TP loads (1991-2005).

When all LOPP recommended strategies are implemented and become fully operational, the TP loads to Lake Okeechobee are projected to decline dramatically. The sub-watersheds that contribute disproportionately high percentages of the remaining TP loads, however, remain the same (**Figure 5-12**). Indian Prairie, TCNS, and Fisheating Creek sub-watersheds will contribute

significantly greater TP loads relative to their total Lake Okeechobee inflows. The large reductions in TP loads from the TCNS sub-watershed expected to be accomplished under LOPP will bring this sub-watershed closer to a condition where TP loading is proportional to its flow contribution.

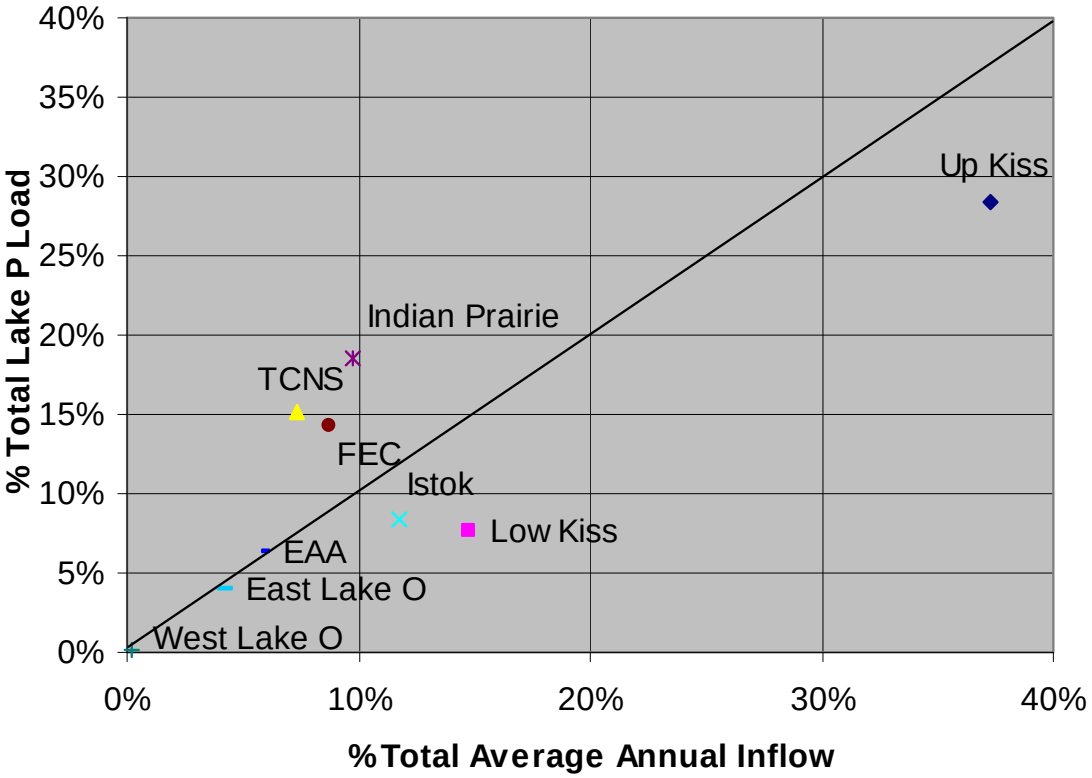

Figure 5-12. Total Lake Okeechobee inflows vs. total phosphorus (TP) loads after LOPP recommended projects are in place.

5.4 Assessment of Water Quality Improvement Needs - LOPP vs. P2TP

5.4.1 LOPP Assessed Water Quality Needs

Based on 1991 to 2000 POR, the 2007 LOPP Update (SFWMD, 2007) reported an annual average Lake Okeechobee TP loading of 433 mt/yr. Allowing for the 105 mt/yr that can be discharged under the TMDL this meant that LOPP had to reduce TP loading by 328 mt/yr (433 mt – 105 mt) (**Table 5-4)**. Note that the TMDL is based on a five-year rolling average and the load reduction required to achieve it will vary as the five-year rolling average is updated.

Table 5-5 summarizes the TP load reduction associated with different initiatives that are recommended for implementation in the LOW by the 2007 LOPP Update. The LOPP recommended initiatives and strategies are projected to cumulatively remove 370 mt/yr, which surpasses the TP load reduction needed to achieve the TMDL.

Table 5-4. TP load reduction required to meet FDEP's total phosphorus (TP) TMDL for Lake Okeechobee (1991-2000).

FDEP's Total Phosphorus TMDL for Lake Okeechobee (calculated as a five-year rolling average)	140 mt/yr
Atmospheric deposition	35 mt/yr
Permitted watershed loading	105 mt/yr
Measured watershed loading (1991-2000) (Baseline)	433 mt/yr
Load reduction needed to achieve TMDL	328 mt/yr

These projected LOPP TP load reductions are based on the assumption that BMPs, watershed phosphorus-source control projects, regional projects and strategies will be appropriately funded in a timely manner, implemented where recommended, and will perform as intended. The difference between the total TP load reduction needed to meet the TMDL (328 mt/yr) and the projected LOPP load reduction (370 mt/yr) is expected to provide a contingency in case some of the recommended projects are not implemented or do not perform at the levels intended. The contingency also recognizes the high loads that the Lake has experienced over the last five years.

5.4.2 P2TP Water Quality Assessment Needs

Although the LOPP used the 10-year POR (1991–2000), the P2TP is based upon a 15-year POR (1991–2005). Measured watershed loading for this 15-year POR was estimated at 514 mt/yr, which is 81 mt/yr greater than the baseline TP load for the LOPP 1991–2000 POR (**Table 5-2**). The additional five-year period (2001 – 2005) includes years dominated by above average annual inflow volumes. Since annual inflow volumes are closely correlated to TP loading, the addition of the five-year period of record resulted in a significant increase in the average annual TP loads (81 mt/yr) addressed in the P2TP. The P2TP will identify strategies to remove this additional 81 mt/yr of TP in order to meet the total phosphorus TMDL for Lake Okeechobee.

5.5 Water Quality Analysis Conclusions

- Existing water quality in the Lake Okeechobee watershed is significantly influenced by the various land use and land management practices within the individual sub-watersheds and drainage basins.

- In the future, implementation of Lake Okeechobee Protection Plan recommended best management practices (BMPs) and other total phosphorus reduction measures are expected to significantly reduce phosphorus loading. However, measured phosphorus reductions in the lake waters are likely to be substantially delayed because of the residual phosphorus in soils within the watershed (legacy phosphorus) and lake sediments.

- Implementation of BMPs in areas that contribute flows to Lake Istokpoga and Lakes Kissimmee, Cypress, and Hatchineha are expected to reduce phosphorus loading to these lakes. While the load reductions to these upstream lakes are not expected to provide an immediate benefit to Lake Okeechobee, implementation of BMPs in these sub-watersheds is necessary to protect water quality in the lakes themselves and to ensure the long-term ability to assimilate phosphorus and protect Lake Okeechobee

Table 5-5. LOPP TP load reduction estimates.

	Estimated TP Load Reduction (mt/yr)	Subtotal (mt/yr)
Current Activities	146	146
LOPP Reduction Tools		88
Typical Cost-Share BMPs that require future funding	31	
Additional agricultural BMPs	30	
Regional Projects (LOFT, Lemkin Creek, Brighton Reservoir, etc.)	27	
CERP		54
LOW Project	54	
LOPP Strategies		82
Total TP Load Reduction Projected by LOPP		**370**

- The Indian Prairie, Taylor Creek/Nubbin Slough, and Fisheating Creek sub-watersheds contribute disproportionately high phosphorus loads to Lake Okeechobee relative to their flow contributions. Therefore, these sub-watersheds were targeted for additional water quality measures

- For the 1991-2000 POR, average TP loading from the watershed to Lake Okeechobee was 433 mt/yr. This does not include atmospheric deposition and exceeds the TMDL mandated watershed TP loading limit of 105 mt/yr by 328 mt.

- The 2007 LOPP update identified numerous projects and strategies which would cumulatively reduce the TP loading from the watershed by 370 mt/yr.

- Projected LOPP TP load reductions are based on the assumption that recommended projects and strategies are appropriately funded in a timely manner, implemented where recommended, and will perform as intended. The difference between the total TP load reduction needed to meet the TMDL (328 mt/yr) and the projected LOPP TP load reduction (370 mt/yr) is expected to provide the contingency in case some of the recommended projects are not implemented or do not perform at the levels intended. The contingency was also recognizes the high loads that the Lake has experienced over the last five years.

- For the 15-year POR adopted by the P2TP, baseline TP loading from the watershed to Lake Okeechobee is 514 mt/yr. This does not include atmospheric deposition and exceeds the TP load reduction required to achieve the TMDL by 409 mt/yr (514-105). This TP reduction is 81 mt/yr greater than the TP load reduction projected by LOPP.

- The P2TP planning process will focus upon reducing this additional TP load of 81 mt/yr.

SECTION 6

WATER QUANTITY DATA ANALYSES

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TABLE OF CONTENTS

List of Tables

List of Figures

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6.0 WATER QUANTITY DATA ANALYSES

This section describes the customized modeling tool (the Northern Everglades Regional Simulation Model, NERSM), which was used to generate and analyze the water budget in the Lake Okeechobee Watershed (LOW) and simulate hydrologic conditions in the LOW under varying scenarios such as current base, future base, and alternative plans.

A water budget reflects the relationship between water input and output through a given area. Water generally enters a system through precipitation and surface and groundwater flows. The water generally leaves the system through human consumption (domestic, municipal, industrial and agricultural), surface and groundwater flows, evaporation, and transpiration from plants.

6.1 Northern Everglades Regional Simulation Model

The Northern Everglades Regional Simulation Model (NERSM) is a basin budget/link-node implementation of the Regional Simulation Model (RSM). It covers the northern extent of the SFWMD boundary down to Lake Okeechobee. The model uses an object-oriented approach, which allows new objects to be added without the need to edit the previous code or functionality of existing modules. For example, the addition and operation of a new reservoir would be simulated as a discrete "object" – there would be no need to modify the coding for other elements of the water management system. Inflows to the model were input as a daily time series (1970–2005) and planning alternatives were simulated by making corresponding changes to the model domain – e.g. the addition of a reservoir or STA in a given sub-watershed.

6.1.1 Model Set-up

Lake Okeechobee and its tributary sub-watersheds to the north, east and west namely Fisheating Creek, Lake Istokpoga/Indian Prairie, Taylor Creek/Nubbin Slough, Lower Kissimmee and Upper Kissimmee, were simulated in the model (**Figure 6-1**).

Note that the East Okeechobee (St Lucie), West Okeechobee (Caloosahatchee), and the EAA Sub-watersheds were not explicitly modeled in NERSM. In this document, these basins are referred to collectively as the Lake Okeechobee Sub-watershed. Storage alternatives specific to these areas are considered in the Acceler8 projects and their impacts to the other portions of the study area were generally taken as boundary conditions.

The NERSM uses a lumped hydrologic approach to model water levels. It assumes that water in each water body is distributed in level pools. Therefore, local-scale features within a sub-watershed, e.g. stages at specific gauging stations and flows across specific transects are not simulated.

Lakes in the Upper Kissimmee Sub-watershed, and pools in the Lower Kissimmee Sub-watershed are simulated as level pools with watershed inflows (local runoff) as boundary conditions obtained from other models or from historical data. A flow pass-through approach is used for the other sub-watersheds where historical runoff into Lake Okeechobee is modified based on proposed management measures specific to these sub-watersheds.

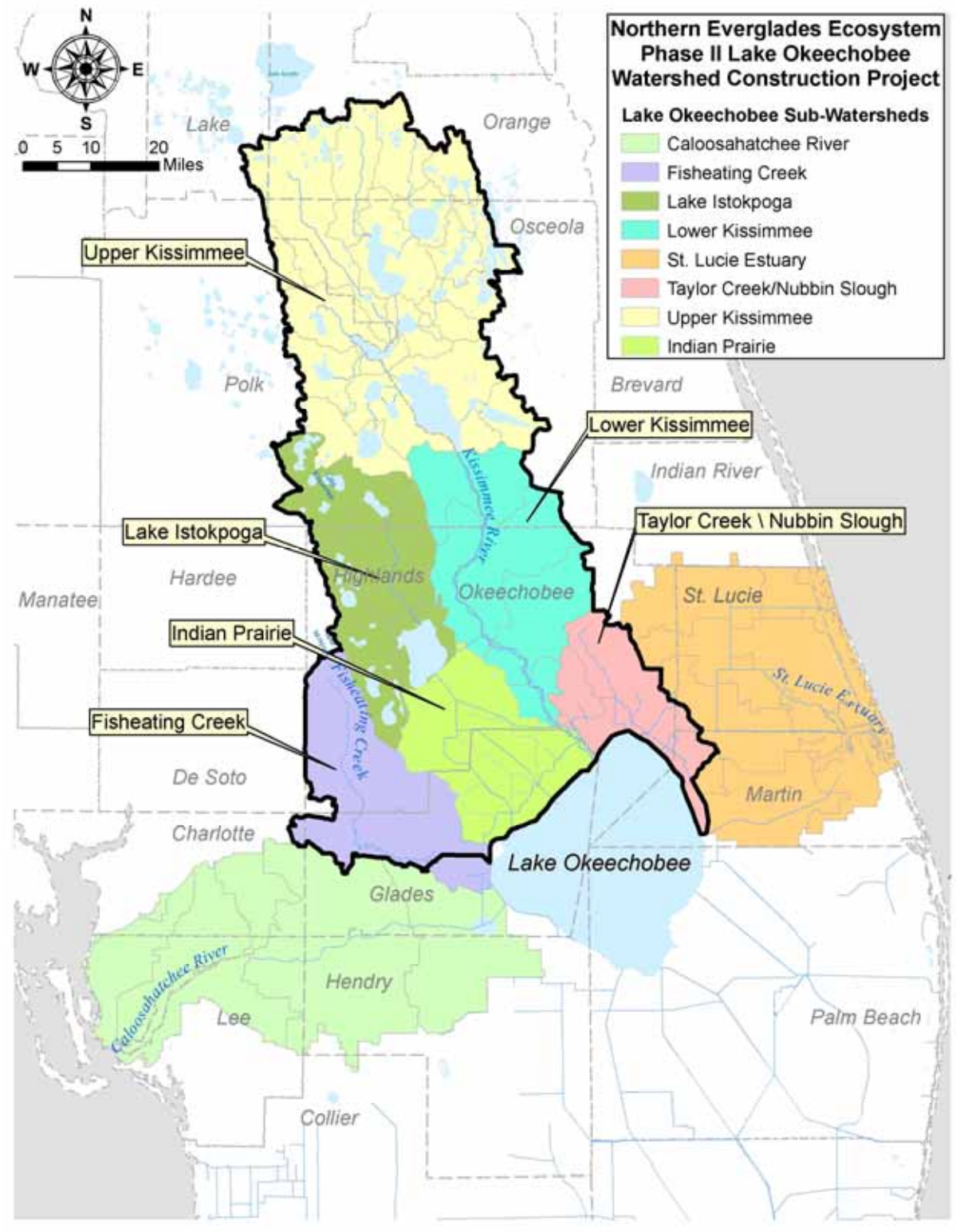

Figure 6-1. Sub-watersheds simulated in the Northern Everglades Regional Simulation Model (NERSM).

Lake Okeechobee is also simulated using a lumped hydrologic approach. Certain inflows and outflows from Lake Okeechobee are not simulated and are incorporated into a modified delta storage (MDS) term or imposed as boundary conditions. The South Florida Water Management Model (SFWMM or 2x2) is the main source of boundary conditions for NERSM. Boundary conditions include water supply demands and environmental releases to the Everglades and to the Lower East Coast urban areas. Regulatory releases from Lake Okeechobee to the C-43 and C-44 Estuaries and to the Water Conservation Areas are simulated based on the WSE schedule. The Hybrid LOWSM water supply management scheme is simulated in conjunction with fixed demand boundary conditions to introduce water supply cutbacks for Lake Okeechobee Service Area (LOSA) basins. Lake Okeechobee is a primary or secondary source of water supply to the LOSA basins.

Both St. Lucie and the Caloosahatchee basin demand/runoff time series are obtained from the SFWMM. C-44 reservoir inflows/outflows are also obtained from the SFWMM and used as boundary condition flows for the future base and alternative scenarios. Due to the strong interaction between Lake Okeechobee and the C-43 reservoir, simulation of this reservoir is included in the future base and alternative scenarios. Furthermore, the procedure for meeting St. Lucie and Caloosahatchee estuary demands are also simulated. For more detailed description of the model setup for Lake Okeechobee and estuaries see **Appendix B**.

A 36-year (1970-2005) period of record (POR) was used for all NERSM simulations. This POR is slightly different from the typical 36-year POR typically used by the SFWMM, namely 1965 to 2000. The inclusion of the five years (2001-2005) in the NERSM POR was driven by the desire to use the most current climatic information available, which includes extreme events such as Hurricanes Charlie, Frances, and Jeanne in 2004, and Hurricane Wilma in 2005.

No history-matching was done during initial model set-up; however, NERSM was validated by making comparative runs with established models currently in use within the model domain: the UKISS for the Upper Kissimmee Sub-watershed (Fan, 1986) and the SFWMM for Lake Okeechobee and areas further south.

A series of assumptions were developed to facilitate model set-up; these are documented in **Appendix B**. Additional information on how each individual sub-watershed was modeled is also included in this appendix.

6.1.1.1 Boundary Conditions

Table 6-1 identifies the source of sub-watershed inflow data for each individual sub-watershed. Predicting changes to these boundary conditions due to future land use and demand changes is outside the scope of this modeling effort; therefore, the same sub-watershed inflow data was used for all model simulations including current base, future base, and alternative simulations. Although the NERSM input data for sub-watershed inflows do not change from one simulation to the next, RSM actually adjusts the values on a daily basis because the size of the drainage basin contributing to runoff into the pool or lake is inversely proportional to the simulated stage in the pool or lake. This allowed a comparison of the performance of the system for different physical configurations of hydrologic components using the same stresses.

Table 6-1. NERSM Sub-watershed inflow data.

Sub-watershed	Source of Inflow Data	Description of Inflow Data
Upper Kissimmee (KUB)	Output of UKISSWIN Model	Flows developed for calibration of UKISSWIN model.
Lower Kissimmee (LKB)	Historical Flows	Consistent with the SFWMM current base simulation, runoff for sub-watershed estimated from historical flow data at LKB boundary structures (S-65E – S-65). Runoff attributed to each basin within LKB based on area. Time series was imposed as boundary condition for each level-pool.
Taylor Creek/Nubbin Slough (TCNS)	Historical Flows	Runoff for sub-watershed assumed to be equal to the historical outflows. Sum of TCNSQ, S-154 and S-135 from DBHYDRO.
Lake Istokpoga	Historical Flows	Runoff for sub-watershed lumped into a single quantity. Sum of historical flows through S-71, S-72, S-84, S-127, S-129 and S-131.
Fisheating Creek (FEC)	Historical Flows	Runoff for sub-watershed estimated from historical flows at Palmdale station – several miles upstream of discharge of Fisheating Creek to LOK. Runoff downstream of Palmdale is included in Modified Delta Storage (MDS) term.
Lake Okeechobee (LOK)	Output from SFWMM	Backflows – flows into LOK – coming from east (St Lucie), west (Caloosahatchee), and south (EAA) taken from SFWMM.

To account for the decreased runoff volumes caused by the added footprints of proposed management measures, these flow time series are corrected internally in RSM by applying a factor which is defined as the ratio of the remaining contributing sub-watershed area (excluding the combined footprint of all management measures in the sub-watershed) to the total contributing sub-watershed basin area.

6.1.2 Model Application and Modeling Scenarios

The following scenarios were modeled using the NERSM:

- **Current Base** – This scenario represented hydrologic conditions as they existed in the LOW in 2005. This condition assumed that no CERP projects had been implemented. Measured data for the 36-year POR (1970-2005) was used for this simulation. Regulatory (flood control) releases from Lake Okeechobee to the estuaries and to the WCAs are simulated based on the WSE Regulation Schedule.

- **Future Base** – This scenario was intended to represent conditions likely to exist in the LOW after the implementation of all Acceler8 (A8) and Lower and Upper Kissimmee Sub-watershed water resources projects, including :

- **A8 projects**: C-43 Reservoir, C-44 Reservoir and STA, Broward Water Preserve Areas, Site 1 Reservoir, Modified Water Deliveries to Everglades National Park, limited version of Everglades rainfall deliveries, and EAA Phase A-1 Reservoir

- **Kissimmee Projects**: Kissimmee River Restoration Project and the Kissimmee River Headwaters Revitalization Project including the headwaters revitalization stage regulation schedule.

CERP Lake Okeechobee ASR was not included in the future base, however, it is anticipated that ASR will play an important role in meeting the storage goal identified in this plan. The results from Lake Okeechobee ASR pilots and the ASR Regional Study will be used to help determine the mix of surface and sub-surface storage needed to better manage Lake Okeechobee water levels.

Also, a number of Lake Okeechobee Protection Plan features have been completed or are currently under development. These projects were not included in the future base because of the need to clearly document all of the activities and projects that are currently underway as well as those to be implemented in the future make up of the overall Plan.

For the future base simulation no land use changes were assumed in the LOW. Therefore, the same sub-watershed inflow time series data used in the current base simulation were applied. External boundary conditions on Lake Okeechobee including environmental flows to the south and water supply demand time series were updated based on output from the South Florida Water Management Model A8 run, which includes those features described in **Appendix B**.

- **P2TP Alternative Plans** – The P2TP planning process formulated and evaluated four separate alternative plans for achieving project goals and objectives. For modeling purposes, known configuration of Level 1, 2, and 3 management measures (MM) were used; whereas for Level 4 and 5 MMs only conceptual configurations were utilized. Each alternative plan was simulated by the NERSM and the output was used to determine system-wide impacts likely to be associated with implementation of that alternative.

  Preliminary operating rules were incorporated into the modeling of alternative plans, as appropriate. For example, excess volume of water within Lake Okeechobee is diverted to offline storage (reservoirs) when needed, such as when the lake stage is above the stage envelope. Similarly, volume of water in offline storage (reservoirs) is returned to Lake Okeechobee when needed, such as when the lake stage is below the stage envelope. Additional information in modeling of individual alternatives is also included in **Appendix B**.

Model simulation output from current and future base simulations were used to prepare and analyze the water budget for the LOW. Additional information on the water budget analyses is presented in **Appendix B**; key observations from this analysis are discussed below in *Section 6.2*. Model output from simulations of the alternative plans were compared and evaluated in terms of performance measures. This information is presented in *Section 8*.

6.2 Water Quantity Data Analyses Observations

Key observations from an analysis of the LOW water budget data are presented below:

- Average annual rainfall in the Lake Okeechobee Watershed is less than the potential ET in the vast majority of the study area with the possible exception of the Upper Kissimmee Sub-watershed. Therefore, ET should be an important consideration in the evaluation of the performance of alternative plans, particularly for reservoirs or STAs that might hold water for extended periods.

- The Upper and Lower Kissimmee and Istokpoga Sub-watersheds contribute close to three-quarters of the total average annual inflow to Lake Okeechobee. The Lower Kissimmee sub-watersheds were targeted for maximizing storage options. Although there is large volume of flow to Lake Okeechobee from the Upper Kissimmee Sub-watershed, further evaluation is needed to determine the storage potential in light of the timing and flow rates required for the Kissimmee River Restoration Project and to maintain the ecologic integrity of the Upper Chain of Lakes.

- **Table 6-2** summarizes important flow characteristics within key sub-watersheds. This information is important for sizing inflow pumps and discharge structures and will also guide development of operational plans for individual storage features.

- Results also indicate that it will be necessary to capture a substantial portion of the peak flows in the watershed in order to store a large percentage of the total flow volume. This is particularly true in the Fisheating Creek Sub-watershed where 60 percent of the total flow volume occurs when discharges are greater than 758 cfs (the 10 percent exceedance level). In other words, 60 percent of the total flow volume resulted from the highest 10 percent of the daily flows.

Table 6-2. Flow characteristics for key Lake Okeechobee sub-watersheds.

Sub-watershed	10% Exceedance Flow Rate	% Total Flow Volume when Flow> 10% Exceedance Flow Rate	5% Exceedance Flow Rate	% Total Flow Volume when Flow> 5% Exceedance Flow Rate
Kissimmee (combined)	3,208 cfs	37%	5,086 cfs	21%
Taylor Creek/Nubbin Slough	776 cfs	44%	1,185 cfs	27%
Lake Istokpoga	1,360 cfs	48%	1,904 cfs	28%
Fisheating Creek	758 cfs	60%	1,260 cfs	39%

6.3 Water Quantity Data Analyses Conclusions

Major conclusions from the water quantity data analysis are as follows:

- ET is an important consideration in the identification and evaluation of potential surface water storage (or treatment) options.

- The Upper Kissimmee, Lower Kissimmee, and Lake Istokpoga Sub-watersheds generate the largest volume of flows to Lake Okeechobee. As a result, these sub-watersheds offer significant potential for water storage.

- Water storage measures must be capable of capturing and storing large volumes of water during peak discharge periods – particularly in the Fisheating Creek Sub-watershed.

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SECTION 7

FORMULATION OF ALTERNATIVE PLANS

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TABLE OF CONTENTS

List of Tables

List of Figures

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7.0 FORMULATION OF ALTERNATIVE PLANS

This section describes the four alternative plans formulated and evaluated by the planning team. Water quality and storage planning targets are identified, which is followed by a description of the management measures (MMs) that were used as building blocks of alternative plans. Information on key components and projected performance of individual alternative plans is also presented.

7.1 Planning Goals

7.1.1 Water Quality Goal

The Northern Everglades and Estuaries Protection Program (NEEPP) legislation established meeting the Lake Okeechobee total phosphorus (TP) Total Maximum Daily Load (TMDL) as the water quality target for the planning process. In 2001, the Florida Department of Environmental Protection (FDEP) established a TMDL of 140 metric tons per year (mt/yr) of TP for Lake Okeechobee in an effort to improve the health of the lake. The TMDL includes 35 mt/yr of estimated atmospheric deposition; therefore, only 105 mt/yr of TP loading is permitted from the watershed. The Lake Okeechobee TMDL is based on the TP reduction needed to restore the natural resources in the lake to those that existed prior to any significant anthropogenic alterations.

As discussed in Section 5, the initial TP loading from the watershed of 514 mt/yr is based on a 15-year period of record (1991- 2005). To meet the TMDL of 105 mt/yr, the TP loading in the LOW must be reduced by 409 mt/yr.

7.1.2 Water Quantity Storage Goal

The NEEPP legislation also recognized that it was important to manage the quantity, timing and distribution of water in the Northern Everglades ecosystem to achieve integrated and comprehensive environmental restoration of Lake Okeechobee and the two estuaries. An analysis was performed to determine the amount of water needed to be stored in the watershed to improve lake stage management and reduce the frequency of damaging freshwater releases to the estuaries.

The South Florida Water Management Model (SFWMM) output for the CERP 2050B (future without project conditions) simulation was used for this analysis. This simulation represents future condition without the CERP projects projected to exist in the Lake Okeechobee Watershed (LOW) in 2050. The total volume of discharge from Lake Okeechobee in excess of the damaging level for each estuary was calculated for each discharge event. A discharge event was defined as a period of continuous damaging discharges from the Lake to the estuaries greater than 30 days in duration, with no interruptions. Some damaging discharge events lasted for relatively short periods (few weeks) while others lasted for many months. The events were sorted by volume and a discharge volume exceedance curve was developed (**Figure 7-1**).

Based on the discharge volume exceedance curve, approximately 90 percent of the damaging freshwater release events from Lake Okeechobee to the estuaries could be avoided by providing

approximately 1.1 million ac-ft of stormwater runoff storage in the watershed. The curve also suggests that there is a breakpoint between 900,000 and 1.3 million ac-ft above which very large incremental increases in storage capacity would produce relatively small improvements in damaging releases to the estuaries.

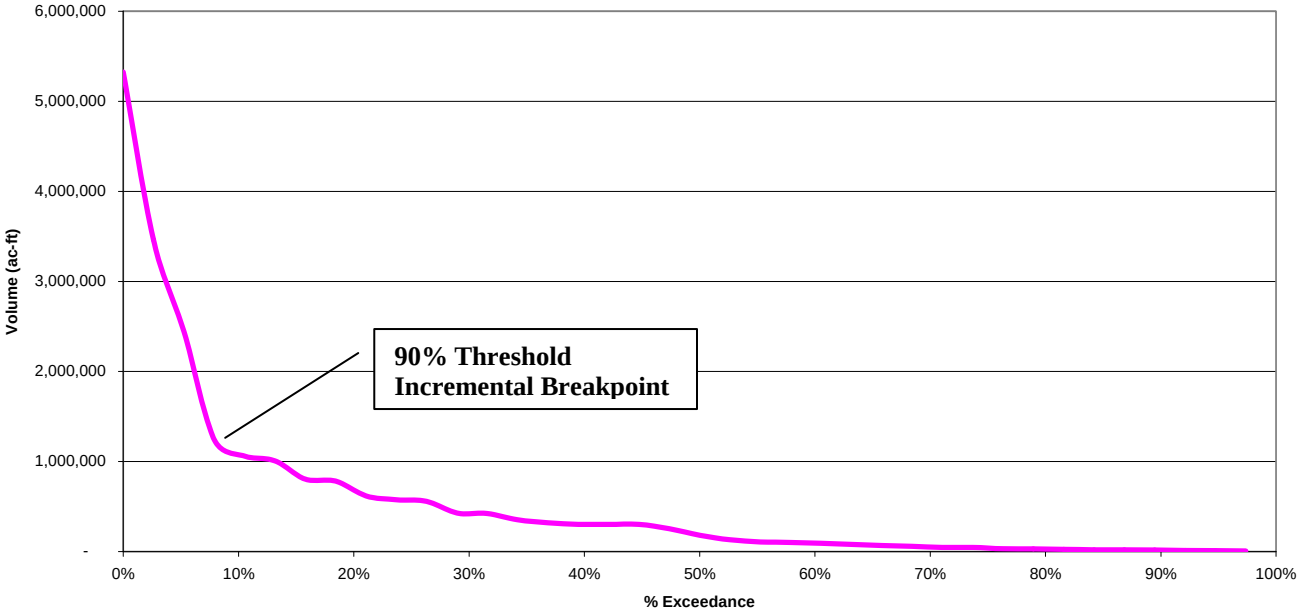

Figure 7-1. Lake Okeechobee regulatory releases (1965-2000).

This analysis only addressed harmful discharges to the estuaries – it did not address ecologically harmful high Lake Okeechobee water levels. Also, this evaluation only considered discharges from Lake Okeechobee. Local runoff from the Caloosahatchee and St. Lucie Estuary watersheds also contributes damaging freshwater discharges to the estuaries – therefore local storage for both the river watersheds would still be required. These additional storage requirements will be addressed in the Caloosahatchee and St. Lucie River Watershed Protection Plans.

A separate analysis using data from the NERSM future base scenario was used to develop a screening level spreadsheet application that allowed for simulation of offline storage for Lake Okeechobee and its sub-watersheds. The application was utilized to determine the divertible volume associated with the objectives of both Lake Okeechobee and the estuaries.

For this analysis, the RECOVER performance measures for Lake Okeechobee stage envelope and extreme events were utilized. For the Caloosahatchee and St. Lucie estuaries, defined target time-series of flows at discharge points into the estuaries (S-79 and S-80) were used. When conditions in the Lake and estuaries would result in less than ideal performance, flow was diverted to offline storage until such time as it was desirable to release back to the Lake.

In order to determine the magnitude of divertible volume (made up of volume both within Lake Okeechobee during high stage events and as Lake discharges to the estuaries) on an event by event basis, the spreadsheet application was run utilizing a 100% efficiency offline storage system with an unlimited inflow/outflow capacity. A divertible event was defined as a period of

continuous release from the Lake to the simulated storage without an interruption of greater than 30 consecutive days.

Results of this analyses indicated that the sorted progression of divertible volume events is not linear, but rather tend toward exponential in nature with the most extreme divertible volume events displaying significantly higher volumes. Peak events tend to be greater than four times the magnitude of median events and one half to two thirds larger than the 10 percent exceedance events (**Table 7-1**).

Table 7-1. Divertable Volume Events for the period 1970-2005.

Scenario	Peak Event (ac-ft)	10% Exceedance Event (ac-ft)	Median Event (ac-ft)
Lake high stages only	1,610,000	990,000	360,000
Lake high stages + estuary targets	2,480,000	1,540,000	550,000

Based on these water quantity analyses, the planning team adopted a water quantity goal of maximizing storage in the LOW with an upper ceiling of approximately 1.3 million ac-ft. This water quantity goal was corroborated through an additional set of sensitivity analyses which evaluated a range of storage values from 900,000 to 4 million ac-ft of storage. Additional information on this sensitivity analyses is contained in **Appendix B**.

7.2 Plan Formulation Challenges

During the plan formulation process, numerous challenges needed to be resolved, including:

1. Alternative plans were developed that concurrently addressed two discrete and sometimes competing project objectives, namely TP load reduction and water storage.
2. Multiple MMs were considered for each project objective.
3. Interdependencies and potential conflicts (resource, real estate, and cost limitations) between storage and P-load reduction MMs had to be considered and evaluated.
4. A very large study area (approximately 3.5 M acres) was available for locating solutions.
5. The process had to allow for equitable consideration of all reasonable alternatives; no feasible alternative could be arbitrarily eliminated without being evaluated.
6. Finally, while cumulative water management and phosphorus loading problems in Lake Okeechobee are the result of combined inputs from all nine sub-watersheds previously identified, solutions had to be identified for individual sub-watersheds. This is because solutions identified for one sub-watershed would not necessarily address issues that exist in another non-contiguous sub-watershed. For example, phosphorus load reduction and water storage in the Taylor Creek/Nubbin Slough sub-watershed is not likely to have much impact on phosphorus load reduction and storage in the Fisheating Creek sub-watershed.
7. Numerous constraints as previously described in *Section 3.4.*

To address these challenges, a structured, systematic, and reproducible process was identified and adopted for formulation of alternative plans. Major steps in this process included the following:

1. Identification of management measures (MMs)
2. Determination of relatively constraint-free acreages within each sub-watershed
3. Combining of MMs to form alternative plans

Additional information on each of these steps is presented in the subsections below.

7.3 Management Measures

A management measure (MM) is a feature or activity that can be implemented at a specific site within the study area to address one or more planning objectives. A feature is a structural element that requires construction or on-site assembly. Storage reservoirs, stormwater treatment areas (STAs), and structural best management practices (BMPs) are examples of features. An activity is a non-structural action or practice that achieves one or more goals. Operational changes, regulatory programs, and modified land management practices are examples of activities. MMs are building blocks that can be combined to form viable alternative plans.

7.3.1 Management Measures Toolbox

The Coordinating Agency Planning Team (CAPT) developed the MM toolbox by seeking input from the multiple agency staff. This toolbox identified various features, activities, technologies, and current and future planned projects that, if implemented in the LOW, could achieve the stated project objectives. Individual fact sheets, which described the salient facts and storage and water quality benefits associated with each MM were prepared (**Appendix C**).

The MMs in the toolbox could be applied either at the parcel scale (local features) or at a sub-watershed scale (regional features). Local features typically have minimal requirements for engineering, construction, and operations. These local features also have relatively less real estate requirements and promote landowner involvement. In contrast, regional features require significant amounts of real estate acquisition, engineering, construction, and operations.

Each MM was assigned a feasibility level using the following scale:

- Level 1 – Already constructed/ implemented or construction/implementation is imminent
- Level 2 – Construction/implementation likely; detailed design/activity development on-going; siting location well defined
- Level 3 – Implementation certainty unknown; conceptual level of design/activity development complete; siting location may be defined
- Level 4 – Implementation certainty unknown; conceptual idea with rough order of magnitude costs and siting location
- Level 5 – Implementation certainty unknown; conceptual idea with limited information.

For each MM, a range (minimum, most likely, and maximum) for phosphorus reduction and/or storage benefits was established. To ensure that only viable MMs were included in the formulation of alternatives, two criteria, proof of concept and other unintended impacts, were used to screen the MM list.

7.3.1.1 Proof of Concept

The proof of concept criterion is a subjective measure of how reliably the MM technology would function under similar conditions and at the same scale that exists in the P2TP. A score of +1, 0, or -1 was assigned to each MM based on the following guidelines:

- Score = +1 if the MM technology has been applied under the same physical conditions that exist in the Northern Everglades and at the same spatial scale that exists in the P2TP.
- Score = 0 if the MM technology has been successfully shown to function based on laboratory analyses and/or pilot test projects, but has not been implemented on the same spatial scale that exists in the P2TP.
- Score = -1 if there is only theoretical evidence to suggest that the MM technology would function under P2TP conditions.

7.3.1.2 Other Unintended Impacts

This criterion provides a measure of the potential for unintended consequences that could result from implementation of an MM. Such unintended impacts could be positive or negative. For example, an MM identified to improve lake stage management might also enhance flood protection. Conversely, an MM intended to improve water quality might have an adverse impact on flood control. A subjective score of +1, 0, or -1 was assigned to each MM based on the following guidelines:

- Score = +1 if there are positive unintended consequences of the MM.
- Score = 0 if there are no positive or negative unintended consequences of the MM.
- Score = -1 if there are negative unintended consequences of the MM.

7.3.2 Types of Management Measures

A wide variety of structural and non-structural management measures were identified for consideration during the planning process. The MMs in the toolbox can be broadly grouped into the general categories described below.

7.3.2.1 Integrated Growth Management and Restoration

This category includes programs and projects that integrate environmental restoration objectives with urban growth initiatives. For example, under the Rural Land Stewardship Areas Program, counties can designate rural lands and natural areas for integrated growth management. Planning and economic incentives are provided for theses areas to encourage use of innovative and flexible planning and development strategies and creative land use planning techniques. The program encourages minimizing development footprint and maintaining a high ratio of

conservation and agricultural lands to development lands thereby maximizing the opportunity for water quality treatment and on-site water storage.

7.3.2.1.1 Wetland Restoration

Natural wetlands inherently sequester surface water flows and provide water quality treatment through assimilation and sedimentation. Restoring degraded wetlands or planting new wetlands in areas that were historically covered with wetlands maybe an integral component of other MMs such as Alternative Water Storage (AWS) and programs such as the Florida Rangelands Environmental Services Project (FRESP).

7.3.2.2 Water Quality

Management measures for achieving water quality improvements were identified for both reducing phosphorus loads from the inflows to the lake and for removing in-lake phosphorus loads. Inflow phosphorus removal applications included treating surface water runoff within canals and tributaries in the watershed using either offline or inline systems. Improving quality of water in Lake Okeechobee could be accomplished by removing the sediments that sequester the nutrients or circulating lake water through STAs located adjacent to the lake.

7.3.2.2.1 Sub-watershed Water Quality

7.3.2.2.1.1 Source Control

Source control refers to all activities and measures that can be undertaken on agricultural and urban lands to ensure the following:

- Amount of nutrients used onsite are minimized to the greatest possible extent,
- The nutrients that are actually used are applied in an effective manner which limits their entry into the local runoff, and
- Nutrients that do find their way into the local runoff and, where possible, excess flows are retained onsite to prevent their entry into the regional drainage system.

Collectively, source control practices are also referred to as Best Management Practices (BMPs). As defined in the NEEPP legislation, "*a BMP means a practice or combination of practices determined by the coordinating agencies, based on research, field-testing, and expert review, to be the most effective and practicable on-location means including economic and technological considerations for improving water quality in agricultural and urban discharges*." The legislation also specifies that BMPs for agricultural practices shall reflect a balance between water quality improvements and agricultural productivity. BMPs include structural measures such as creating physical changes in the landscape to reroute local discharges, erecting fences and barriers, etc. and non-structural measures such as education, changing attitudes and behaviors, and establishing regulations.

Regardless of how it is achieved, source control is integral to the success of any water resource protection or restoration program. Without BMPs as the first stage technology utilized within water quality treatment train to control introduction (source) of nutrients into the local runoff and

movement off site (loss) into the drainage system, treatment and cost effectiveness of large, regional, capital projects such as reservoirs and STAs will be limited.

Numerous source and loss control programs currently are in operation within the LOW. Several are the direct result of the LOPA which preceded the NEEPP. These control programs have been developed and implemented cooperatively by the District, FDEP and FDACS. Estimates of load reduction associated with these programs were developed by an expert consultation group based on various land use types (Bottcher, 2006). The consultation group consisted of SFWMD, FDACS, and FDEP staff and researchers from UF/IFAS.

The LOW Works of the District Regulatory Phosphorus Source Control Program under Chapter 40E-61, FAC, will use these load reduction estimates to establish performance measures for the combined source control programs implemented in the watershed by the coordinating agencies. The performance measures will establish a reasonable range that can be consistently anticipated from source control programs so that downstream treatment facilities may be effectively planned and designed as necessary. Strategic monitoring locations will be utilized to measure performance and to enhance and optimize the source control programs.

Examples include widespread development and implementation of agricultural BMPs and restrictions on the application of wastewater residuals. Other currently implemented source and loss control programs predate the LOPA. These include continued implementation of the Florida Yards and Neighborhoods Program and Florida's consolidated stormwater management programs.

7.3.2.2.1.2 Stormwater Treatment Areas

Stormwater Treatment Areas (STAs) are constructed wetlands that have been used very successfully in South Florida to treat nutrient-rich stormwater runoff. When water flows through these wetlands, plants (including tiny algae) absorb nutrients from the water, using them in life processes or storing them in their tissues. Constructed wetlands planted with certain types of vegetation in a certain sequence have been shown to be very efficient in reducing nutrient loads and concentrations. Even after plants in an STA die, they are still at work. Leaf decomposition helps form sediments in the wetland bottom. Cattail roots readily absorb phosphorus from these sediments, producing yet more leaves. Over the past decade, over 40,000 acres of STAs have been constructed and are being operated in South Florida by the District to facilitate restoration of the Everglades.

The primary advantage of STAs is that they are relatively easy to design, construct, and operate and since they do not use any chemicals to precipitate nutrients, they are very environmentally friendly (green technology). However, similar to reservoirs, they require large tracts of land for construction and will have relatively high evapotranspiration (ET) rates.

7.3.2.2.1.3 Managed Aquatic Plant Systems

Managed Aquatic Plant System (MAPS) are aquatic plant-based water treatment units. The technology involves routing nutrient loaded stormwater into ponds that are vegetated with plants that have enhanced ability to absorb and assimilate nutrients. A variant of a MAPS, that is

currently being tested in the LOW, is known as the Algal Turf Scrubber™, (ATS). This technology developed by HydroMentia, Inc., involves the cultivation of a mixed community of periphytic algae that are cultured on an engineered geomembrane. The membrane sits on a grid upon which nutrient-rich waters are discharged. Algae that grow on the geomembrane are periodically scrapped and collected with an automatic rake at a harvesting station. The harvested biomass is then conveyed to a bunker for storage and further processing.

The two primary advantages of MAPS are that the plant biomass is routinely harvested and potentially recycled into marketable products and they require relatively little land, making them a cost-effective option for locations that are land limited either due to land availability or cost. The effectiveness of the MAPS in treating nutrient rich stormwater on a large scale has not yet been demonstrated.

7.3.2.2.1.4 Chemical Treatment

Chemical treatment involves application of chemicals into contaminated stormwater runoff to aid reduction of contaminant loads and concentrations. Chemical treatment is generally used to lower turbidity of local discharges. It has also been successfully used to reduce turbidity and nutrient concentrations in drinking water and wastewater. Application of chemicals to stormwater to reduce nutrient loads is relatively new. It has been tested with varying levels of success in some locations such as Lake Apopka and the Everglades.

Review of available literature indicates that calcium, iron, and aluminum salts are effective at reducing total phosphorus loads in stormwater runoff. These technologies can be applied both in-stream and in off-line treatment systems. They can be used for pre-treating stormwater runoff prior to storage and additional treatment in a reservoir or a STA; they can also be used as post-treatment units to polish effluent from reservoirs and STAs. The specific technology that will work best at any given location will primarily depend upon influent water quality and the quantity of water that has to be treated.

7.3.2.2.2 In-lake Water Quality

Water quality problems in Lake Okeechobee are a function of both external loading associated with runoff from the watershed and internal loadings from the sediments on the lake bed. These sediments are estimated to cover more than 197,000 acres of the lake bed with an approximate volume of 262 million cubic yards (EA, 2002).

The upper 4 to 12 inches of the sediment bed is composed largely of particles with relatively low specific gravity and because this layer tends to disperse very easily in the water column, it is often described as the fluid mud layer. Particles of the fluid mud layer are known to be associated with large quantities of bound phosphorus. Most of these fluid mud sediments are confined to the deeper pelagic regions of the lake and their negative impacts are primarily related to periodic resuspension of phosphorus into the water column.

Several alternative options have been proposed for dealing with Lake Okeechobee's sediment-bound nutrient loads.

7.3.2.2.2.1 Muck Sediment Removal

Due to current drought in South Florida, Lake Okeechobee stages fell to below 9 ft which completely exposing large tracts of near shore areas that normally remain fully submerged. Taking advantage of this situation, the District initiated an emergency program under which approximately 2,000 acres of the exposed areas were scraped and the nutrient-rich mucks were removed for off-site disposal. This scraping is expected to expose the natural bottom which should promote the re-growth of native vegetation once the lake levels return to normal. For obvious reasons, this approach has very limited applicability outside of a drought situation.

7.3.2.2.2.2 Dredging

Due to their fluid nature, the Lake Okeechobee mud sediments from the deeper areas beyond the littoral shelf cannot be easily removed by using conventional dredging technologies without severely compromising ambient water quality. A pilot dredging project was conducted in 2001 to demonstrate use of innovative dredging technologies and processes under conditions similar to Lake Okeechobee. The study showed that the fluid muds could be removed using a modified hydraulic dredge that essentially worked like a vacuum to gently suck up the muds while minimizing resuspension. Commercial application of the technology used by the pilot dredging project however has not been demonstrated.

More recently, the District has initiated a near-shore dredging project in the lake. The objective of this demonstration project is to remove sediments from a 2.5 square mile area adjacent to the Eagle Bay Island using a technique that minimizes adverse environmental impacts and can be scaled up for use in other parts of the lake. The demonstration area has a layer of mud sediments that prevents the growth of native aquatic vegetation; therefore, the area has limited habitat value.

Removal of the mud sediments is expected to expose the natural sand bottom and seed source and therefore promote the resurgence of native emergent and submergent plant communities. Return of the native vegetation is expected to initiate overall ecosystem restoration, improving conditions to foster a healthy and diverse macro invertebrate community and foraging habitat for fish and wading birds.

It should be noted that compared to other lake restoration projects (Cooke et al. 1993), removal of mud sediments from Lake Okeechobee will require an order of magnitude of greater effort. Dredging methodologies examined for this effort are largely vacuum or pump based and are not expected to result in substantial turbidity problems.

7.3.2.2.2.3 Disking/Plowing

There are two distinct types of soil tilling, both of which may be useful in dealing with lake sediments. They are disking and plowing. Disking involves mixing the organic sediments with the underlying layer of mineral soils, usually sands. Mixing the two soils together is expected to reduce the turbidity production and phosphorus flux into the water column. Mixing of the soils is expected to significantly reduce the amount of the organic sediments that are exposed to the water column. Plowing is a similar action, but is accomplished with a farm implement that is

designed, not to mix the soil layers, but to invert the two layers. If the organic layer is about one foot or less in thickness, it should be possible to plow the soil and leave about one foot or so of mineral soil over the organic soils. Some mixing will occur, but it should be much less than with the disking approach. Plowing should result in a more nearly complete sequestration from the water column of the organic sediments below a layer of mineral soils.

7.3.2.2.2.4 Recirculating STAs

Another option of dealing with the high phosphorus concentrations in lake waters which, at least in part, originate from the sediments is to treat lake waters using STAs located adjacent to the lake to treat lake water and recirculate the treated water back to the lake. Such systems are intended to treat nutrient–rich flows from the watershed. However, during periods when there is little or no flow from the watershed and lake levels are relatively high, lake waters could be diverted to these systems for treatment. Given the large volumes of lake water that have to be treated and the very high phosphorus loads in the sediments, the use of recirculating STAs is expected to provide a relatively small contribution to the overall load reduction that is required to achieve restoration of Lake Okeechobee. Note that at this time, TP load reduction from in-lake waters does not count toward the TMDL.

7.3.2.3 Water Storage

MMs considered for capturing and storing stormwater runoff in the watershed included aboveground reservoirs, Alternative Water Storage Facilities, (AWSFs), and Aquifer Storage and Recovery (ASR) wells. Each type of feature has its own advantages and disadvantages.

A very large amount of water storage capacity is required in the LOW to significantly manage lake stages in Lake Okeechobee and reduce damaging freshwater releases to the Caloosahatchee and St. Lucie estuaries. A combination of different types of storage options were considered because a single type of water storage can not practically provide the required storage capacity.

Alternative formulation for water storage features for this plan focused on the four southern sub-watersheds; Lower Kissimmee, Fisheating Creek, Lake Istokpoga, and Taylor Creek/Nubbins Slough which also includes run-off from the Upper Kissimmee sub-watershed. A separate analysis evaluating the potential for storage of excess surface water from the Upper Kissimmee sub-watershed is ongoing independent of this planning process through the Upper Kissimmee Basin Regional Water Supply Feasibility Study. Initial indications are that there may be some volume of excess surface water in this sub-watershed.

7.3.2.3.1 Reservoirs

Above ground reservoirs are one of the most common types of surface water storage features. They are relatively easy to design, construct, and operate and several large reservoirs are currently being designed and constructed in the greater Everglades ecosystem. Storing water in reservoirs also has water quality benefits; nutrients and other contaminants tend to settle out within the reservoir.

One of the major drawbacks of reservoirs is that they are very land intensive. In order to reduce the acreage needed to site a reservoir, its footprint can be reduced by increasing the depth up to a certain point. For the P2TP planning process, the reservoirs considered are 16-ft deep consistent with other reservoirs such as C-43 and C-44. Actual reservoir depth will be determined through advanced planning and engineering analyses.

Another major disadvantage of reservoirs is that they are typically subject to very high evapotranspiration (ET) rates due to the large exposed surface area. Reservoir ET rates can be reduced significantly by compartmentalizing the feature and increasing depth. High ET rates may be beneficial in situations where there is a large amount of excess water in the system.

7.3.2.3.2 Alternative Water Storage Facilities

In compliance with 373.4595(3)(b)2.g. the Lake Okeechobee Estuary and Recovery (LOER) action plan recommended evaluating options for storage and/or disposal of excess surface water runoff by capturing and holding it onsite on available private, public, and tribal lands. In most cases low technology approaches such as the use of weirs, berms, and small impoundments are used to detain water on-site. These alternative water storage facilities (AWSFs) essentially prevent the runoff from reaching the regional drainage system or improve the timing of its delivery. AWSFs typically require minimal design, engineering, and construction effort. Several AWSFs are currently in operation in the LOW on both private and public lands. Numerous additional sites are currently being evaluated for siting new AWSFs. Note that storage in AWSFs is intended to be compatible with improving wetland functions

7.3.2.3.3 Aquifer Storage and Recovery

Aquifer Storage and Recovery (ASR) involves injecting water into an aquifer through wells and then pumping it out when needed. The aquifer essentially functions as a water bank. Deposits are made in times of surplus, typically during the rainy season, and withdrawals occur when available water is needed, typically during a dry period.

Interest and activity in aquifer storage and recovery (ASR) in southern Florida has greatly increased over the past 10 to 15 years. In South Florida, ASR wells have typically been used to store excess freshwater during the wet season and subsequently recover it during the dry season for use as an alternative drinking-water supply source. Water is injected down an ASR well, stored in an aquifer, and withdrawn using the same well. Many utility-operated ASR facilities now have wells completed in deep confined aquifers for this purpose. Large scale application of the ASR technology is under evaluation as a storage option in the Comprehensive Everglades Restoration Plan.

A series of CERP pilot projects and a regional ASR study are currently being evaluated to help determine the magnitude of the application of ASR to help meet the storage necessary to improve Lake Okeechobee's operating levels to more ecologically desirable ranges as well as reduce undesirable discharges to the St. Lucie and Caloosahatchee estuaries and to address potential problems that have been identified that could limit application of this storage option.

7.3.2.4 Water Disposal

7.3.2.4.1 Deep Well Injection

Deep injection wells have been extensively used across the US to dispose of a variety of fluid materials for many years. Depending upon the nature of material discharged and the depth at which the fluid is discharged, deep wells are classified by EPA as belonging to one of five classes, namely, I, II, III, IV, and V. The requirements for siting, permitting, and monitoring and the costs for construction and operation vary significantly by well class.

Deep injection wells were considered by the P2TP planning team to dispose of excess stormwater run-off at selected locations in the watershed. A typical deep injection well is 24 inches in diameter and discharges 2,000 to 3,000 ft below the surface into the boulder zone. They are conceptually installed in clusters of four arranged in a linear array and can dispose up to 17 million gallons of stormwater runoff per day per well.

Permitting requirements for deep injection wells are generally easier to meet than those for ASR wells (because ASR wells typically inject into drinking-water aquifers, whereas injection wells typically inject into aquifers containing salt water). Deep injection wells also have the added advantage of permanently disposing of the nutrient- and pollutant-contaminated stormwater. Additionally, injection wells can typically be operated at higher pumping rates than ASR wells, because they inject water into a high capacity aquifer called the boulder zone. The primary disadvantage of using existing deep injection wells is that once the water is injected it cannot be easily recovered without major retrofitting. New wells can be designed with recovery options.

7.4 Determination of Relatively Constraint-Free Acreages (CFA)

To identify land areas within the P2TP project study area with the fewest MM siting constraints, a customized, GIS-based spatial data tool, the Land Suitability Model (LSM), was created. The LSM incorporates multiple land characteristics as discrete data layers and allows the quick visual identification of those land areas with the fewest siting constraints. Data inputs for the LSM included most recent land use/land cover information and pre-determined siting constraints.

For the lower half of the P2TP study area, which coincided with the CERP's LOW Project study area, 2004 updated land use/land cover information was used. For the upper half of the P2TP study area, 1999 land use/land cover information was updated using Florida Land Use, Covers, and Forms System (FLUCCS) Level 1 codes (FDOT, 1999). This update identified agricultural/rural areas that have become urbanized since 1999.

7.4.1 MM Constraints

The LSM incorporated the following siting constraint criteria (**Table 7-2**):

- **Real estate** – Because relatively large parcels of land would be needed to site the P2TP management measures and most of the land will have to be acquired from current land owners, a desirable feature was ability to identify acreages that would require relatively

fewer real estate transactions. By using this feature, fewer individuals and businesses would be impacted and administrative costs would be significantly reduced.

Therefore, areas with a parcel density of six or fewer parcels per section (large-sized parcels with few owners) were considered highly suitable. In contrast, areas with parcel density of 26 or more parcels per section (many small-sized parcels with many different owners) were considered to have low suitability. Areas with a parcel density from 7 to 25 parcels per section were considered moderately suitable. Note that while relatively fewer number of owners was considered a desirable attribute, it is recognized that real estate transactions will have to be conducted with these land owners.

- **Existing wetlands** – Another siting objective was to avoid or minimize adverse impacts to existing wetlands. Therefore locating an MM feature outside existing wetlands was considered a positive attribute. If features had to be located in existing wetlands then mitigation would be required. Accordingly, areas outside the boundaries of existing wetlands were designated as highly suitable and areas within the boundaries of existing wetlands were designated as moderately suitable. This constraint was included in the LSM to meet the intent of the legislation which requires that potential impacts to wetlands be identified to the maximum extent practicable.

- **Ecologic value** – The goal was to avoid locating project features in areas with high ecological value and preferentially site MMs on lands with relatively low ecological values. An ecologic value score (EVS) ranging from 0 to 10 was assigned to each major land use/land cover type in the study area based on best professional judgment. The EVS reflected habitat type and project suitability and included consideration of critical habitats, threatened & endangered species distribution, and biodiversity issues.

  A low EVS (0 to 2) represents land areas with low ecologic value and high suitability for locating project features. In contrast, a high EVS (>4) represents parcels with high ecologic value and low suitability for locating project features. Areas with an EVS between 2 and 4 were characterized as having moderate suitability. This constraint was included in the LSM to meet the intent of the legislation which requires that potential impacts to threatened and endangered species be identified to the maximum extent practicable.

- **Land use economic values** – This goal intends to minimize impacts to the regional economy. High intensity land uses that require more intensive labor and/or economic resources were considered to be poor sites for locating project features. Using best professional judgment, a low, moderate, or high economic values was assigned to each major land use/land cover type in the study area. Parcels that had low economic values, based on existing land use, were considered highly suitable for locating project features. This relatively simple approach to estimating land use economic values was considered adequate for preliminary planning. During the advanced planning phase, detailed analyses of real estate costs and economic impacts associated with varying land uses will be conducted.

- **Cultural resources** – Land areas that contain culturally important resources were to be avoided during the locating process to prevent adverse impacts. A 300 ft buffer zone was

considered adequate to lessen the impacts and, accordingly, areas outside a 300 ft buffer zone of known culturally important resources were considered highly suitable for locating project features, whereas areas inside the 300 ft buffer zone were considered moderately suitable.

- **Infrastructure** – Proposed project features cannot be sited on lands occupied by infrastructure such as large drainage canals, roads, highways, utility corridors, airports, etc. For linear infrastructure features, a 100 ft protection corridor on either side was considered to provide adequate protection. Therefore, areas within the 200 ft buffer were assigned low suitability and locations outside the 200 ft buffer were considered highly suitable for locating project features. For airports, the Federal Aviation Authority (FAA) requires a 10,000 ft buffer zone, accordingly all locations within 10,000 ft of a major airport were assigned a low suitability and areas outside the 10,000 ft buffer were considered highly suitable.

Table 7-2. Land Suitability Model (LSM) attributes.

Constraint Layer	Criteria	Suitability Attributes			Data Source
		Category 1 High Suitability	Category 2 Moderate Suitability	Category 3 Low Suitability	
Real Estate	Minimize number of impacted parcels	0 to 6 parcels/ section	7 to 25 parcels/ section	26 or more parcels/ section	FDR, 2003
Existing Wetlands	Avoid existing wetlands	Outside the boundary of existing wetlands	Within the boundary of existing wetlands	--	SFWMD, 1999
Ecologic Value	Avoid areas with high ecologic values	Areas with ecologic values between 0 and 2	Areas with ecologic values between 3 and 4	Areas with ecologic values greater than 4	USFWS, 2007
Land Use Economic Values	Minimize regional economic impacts and real estate costs	Land use types with low economic impact/ value	Land use types with moderate economic impact/ value	Land use types with high economic impact/ value	SFWMD, 2003a
Cultural Resources	Avoid areas of culturally significant resources	Areas outside a 300 ft buffer zone	Areas inside a 300-ft buffer zone	--	FDHR, 2002
Infrastructure	Avoid overlap with major infrastructure features	Areas outside the 100 ft buffer zone	--	Areas inside the buffer zone	FGDL, 2007 SFWMD, 1997

7.4.2 LSM Scoring Approach

Using the values in **Table 7-2**, each land area was assigned a level of suitability value for each constraint layer. The suitability attribute values ranged from high suitability (Category 1), to moderate suitability (Category 2), to low suitability (Category 3).

Each land area was then evaluated for overall suitability using the scoring strategy presented in **Table 7-3**. For example, a land area which received Category 1 suitability values for all constraint layers other than Cultural Resources, would receive a LSM score of 2. Each suitability attribute level indicates the extent to which a given area could be considered relatively suitable for siting a project feature.

Table 7-3. Land Suitability Model (LSM) scoring strategy.

LSM Score	Scoring Strategy	Suitability Attribute
1	No Category 2 or 3	Very Good
2	One Category 2	Good
3	Two Category l 2	Moderate
4	Three or more Category 2	Marginal
5	One Category 3	Poor

7.4.3 Secondary Screening Criteria

Soil type was used as a secondary screening criterion. After the LSM identified areas with the fewest constraints and the lowest LSM scores, the soil type layer was superimposed on the LSM model output. The soil types for the suitable sites were evaluated to identify areas more suitable for locating water storage features such as reservoirs versus those areas that are more suitable for locating stormwater treatment areas (STAs). To reduce loss of water through infiltration, water storage features would be preferentially located in areas with non-porous soils types. Locations with hydric soils were considered best suited for locating STAs.

7.4.4 LSM Output

Those areas with the fewest constraints are shown in the LSM output **(Figure 7-2)**. Darker areas received a high LSM score and are considered to have poor suitability for locating project features. Lighter areas received a low LSM score and are considered to have high suitability. For example, areas that received a LSM score of 5 (poor suitability) are shown in the darkest shade of brown; areas that are received a LSM score of 1 (very good suitability) are shown in white.

Note that the LSM model output is only intended to provide general guidance on constraint-free acreages within the study area. Detailed analyses of locations for siting specific project features will be performed during feasibility studies. Also, output from planning tools such as the LSM is typically used to guide siting of large, regional facilities such as reservoirs and STAs; it is not intended to be used for locating smaller, local projects such as wetland rehydration.

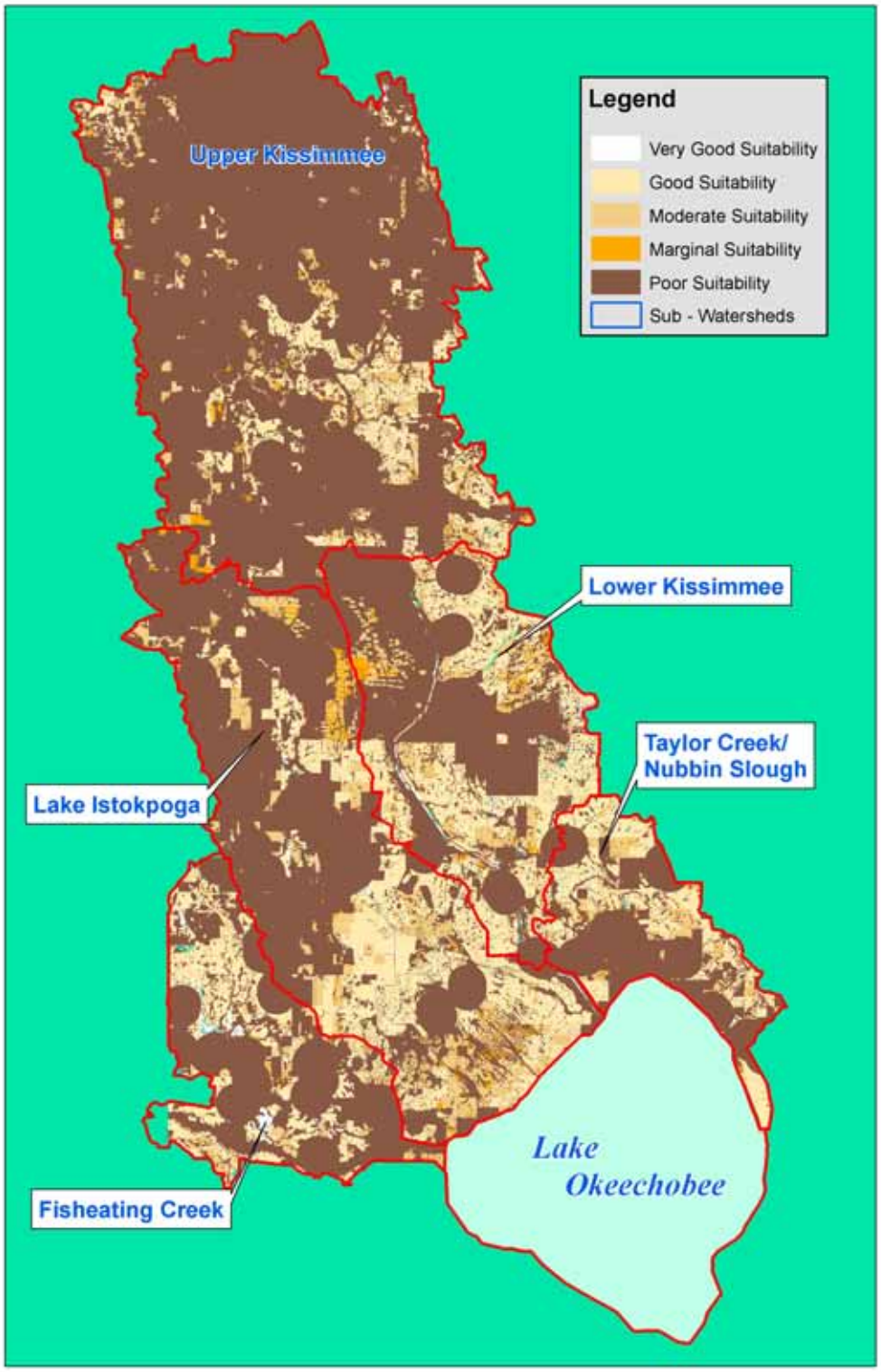

Figure 7-2. Land Suitability Model output.

7.5 Plan Formulation

Alternative plans were formulated by the CAPT by considering all five levels of MMs. Because Level 1 and Level 2 MMs were either already constructed/ implemented or their construction/ implementation was imminent these MMs would be included in all alternative plans. This suite of Level 1 and Level 2 MMs is referred to as *common elements*.

By combining viable MMs, four alternative plans were identified that met pre-established planning objectives:

7.5.1 Alternative 1 – Common Elements

This alternative characterizes the TP load reduction and storage that would be provided by the Level 1 and Level 2 MMs. It also includes certain Level 3 and Level 4 MMs for which, in the planning team's opinion, construction/implementation was imminent pending resolution of certain issues. Key features of Alternative 1 included the following:

- **Level 1 local features** – Owner-implemented Agricultural BMPs, Funded Cost-shared BMPs, Cost-shared Future Funding Agricultural BMPs, Additional Agricultural BMPs, ECP diversions, Urban Turf Fertilizer Rule, Land Application of Residuals, Florida Yards and Neighborhoods, ERP Regulatory Program, NPDES Stormwater Program, Coastal and Estuarine Land Conservation Program, Watershed Phosphorus Source Control Projects, Alternative Water Storage Facilities (5 sites), Florida Ranchlands Environmental Services Project (4 existing projects), and Local Initiatives (3 projects)

- **Level 1 regional features** – Taylor Creek Critical Project STA, Nubbin Slough Critical Project STA, Taylor Creek Algal Turf Scrubber Nutrient Recovery Facility, and Kissimmee River ASR Pilot Project

- **Level 2 local features** –Works of District Regulatory Phosphorus Source Control Program, Alternative Water Storage Facilities (3 sites), and Florida Ranchlands Environmental Services Project (4 new pilot projects)

- **Level 2 regional features** –Lakeside Ranch STA, Lemkin Creek Urban Stormwater Facility, Seminole Brighton ASR Pilot, and Taylor Creek ASR Reactivation

- **Level 3 local features** –FP&L Martin Cooling Pond, Comprehensive Planning – Land Development Regulations, and Lake Okeechobee and Estuary Watershed Basin Rule

- **Level 3 regional features** –Taylor Creek Reservoir, Brady Ranch STA, Paradise Run 10-well ASR system, Paradise Run Wetland Restoration Project, and Rolling Meadows Catfish Wetland Restoration

- **Level 4 regional features** –Kissimmee Reservoir, Istokpoga Reservoir, and Istokpoga STA

The project goal is to reduce TP loading from the watershed by 409 mt/yr and achieve the Lake Okeechobee TP TMDL. Level 1 and 2 MMs of Alternative 1 are projected to cumulatively reduce TP loads by 239 mt/yr; the Level 3 and 4 MMs are projected to reduce TP loads by another 62 mt/yr. Overall, Alternative 1 would provide reduced TP loading by 301 mt/yr, which would fall short of meeting the TMDL by 108 mt/yr (**Table 7-4**).

Table 7-4. Summary of total phosphorus (TP) load reduction associated with Alternative 1.

Initial TP load (1991-2005)		514 mt/yr
TMDL		105 mt/yr
Load reduction required to meet TMDL		409 mt/yr
Load reduction provided by Level 1 and Level 2 Project features of Alternative 1	239 mt/yr	
Load reduction provided by Level 3 and Level 4 Project features of Alternative 1	62 mt/yr	
Total load reduction provided by Alternative 1		301 mt/yr
TMDL shortfall		108 mt/yr

Alternative 1 also includes several storage features that would provide annual average surface storage capacity of approximately 265,000 ac-ft.

7.5.2 Alternative 2 – Maximizing Storage

This alternative plan was intended to maximize storage capacity in the LOW. Using Alternative 1 as a base, new MMs were added that would provide increased storage capacity. Accordingly, it consisted of all MMs that were included in Alternative 1 plus the following three, new, Level 4 structural features[1]:

- **Kissimmee Reservoir East –** This feature would provide up to 200,000 ac-ft of storage capacity and reduce TP loads by approximately 6.5 mt/yr. It would be located to the east of Kissimmee River in the Lower Kissimmee Sub-watershed. It consists of a 16-ft deep, 14,000-acre reservoir that would primarily receive flows from and discharge back to the Kissimmee River. Water stored in this reservoir can potentially also be diverted to the Taylor Creek/Nubbin Slough Sub-watershed for additional treatment.

- **Istokpoga/Kissimmee Reservoir** – This facility would provide a total of 600,000 ac-ft of storage capacity with flows coming from the Istokpoga Basin and the Kissimmee River. The configuration for this proposed reservoir was developed by modifying a feature evaluated by the CERP LOW Project during early planning stages. The reservoir would occupy 42,000 acres in the southern reaches of the Lake Istokpoga and Indian Prairie Sub-watersheds. Because of its proximity to Lake Okeechobee and its large size, this feature could also be used to store lake waters, if needed. It would also provide annual average TP load reduction

[1]Note that configuration of Level 4 MMs (size, depth, and location) presented is based on conceptual planning only, additional feasibility studies will have to be conducted to finalize the configuration of these features.

of approximately 6.2 mt/yr from watershed flows and 22.7 mt/yr of load reduction for in-lake waters.

- **Fisheating Creek Reservoir** – This facility would provide 250,000 ac-ft of storage capacity in the Fisheating Creek Sub-watershed. It consists of a 17,500 acre, 16-ft deep reservoir that would primarily receive flows from Fisheating Creek. Because of its proximity to Lake Okeechobee, it could also be used to store lake waters, if necessary. This reservoir would also provide annual average TP load reduction of approximately 2.6 mt/yr from watershed flows and 12.9 mt/yr of load reduction for in-lake waters.

Besides providing significant additional storage capacity, the three proposed reservoirs would also collectively provide TP load reduction of 15 mt/yr. Thus Alternative 2 would reduce TP loads by 316 mt/yr. This would leave a TP TMDL shortfall of 93 mt/yr (**Table 7-5**).

Table 7-5. Summary of total phosphorus (TP) load reduction associated with Alternative 2.

Initial TP load (1991-2005)		514 mt/yr
TMDL		105 mt/yr
Load reduction required to meet TMDL		409 mt/yr
Load reduction provided by Alternative 1	301 mt/yr	
Load reduction provided by the three new project features in Alternative 2	15 mt/yr	
Total load reduction provided by Alternative 2		316 mt/yr
TMDL shortfall		93 mt/yr
Additional in-lake TP load reduction		36 mt/yr

The Istokpoga/Kissimmee and the Fisheating Creek reservoirs could also be used to store Lake Okeechobee water. Therefore, the Northern Everglades Regional Simulation Model (NERSM) simulation for Alternative 2 also included an operating rule that dictated when lake water would be pumped into and out of the proposed reservoirs. Storing lake waters in the proposed features is expected to reduce Lake Okeechobee TP loads by 36 mt/yr. At this time, this load reduction does not count towards the TMDL.

Alternative 2 focused on maximizing storage and provided approximately 1.3 million ac-ft of surface storage.

7.5.3 Alternative 3 – Maximizing Water Quality Improvements

This alternative plan was intended to maximize TP load reduction in the LOW. Using Alternative 1 as the basis, new MMs were added to increase TP load reduction. This plan consisted of all features from Alternative 1 plus the following seven, new Level 4 MMs:

- **S-154 Basin Deep Injection Well –** This feature would be located in the S-154 drainage basin of the Lower Kissimmee Sub-watershed which is characterized by relatively high TP loading. Approximately 16,500 ac-ft of water would be disposed of annually into the boulder zone using a cluster of deep injection wells. Disposal of this water would provide an average TP load reduction of 9 mt/yr.

- **Istokpoga Canal RASTA** – This feature would provide 28,000 ac-ft of storage capacity. It consists of a 2,000 acre, 16-ft deep reservoir coupled with a 5,000 acre STA. This feature would target runoff from the Lower Kissimmee, the Lake Istokpoga, and the Indian Prairie Sub-watersheds. Collectively, this RASTA would reduce TP loads by approximately 10 to 18 mt/yr.

- **Fisheating Creek RASTAs** – Even after all LOPP-mandated BMPs and watershed phosphorus source control projects are implemented in the Fisheating Creek Sub-watershed, it is projected that 39 mt/yr of TP would continue to be discharged to Lake Okeechobee from this drainage basin. To markedly reduce TP loading from this sub-watershed, two separate, strategically located RASTAs were conceptualized.

  - **Fisheating Creek RASTA I** would provide 39,000 ac-ft of storage capacity in the upper reaches of the Fisheating Creek Sub-watershed. It consists of a 9,000 acre STA and a 3,000 acre, 10-ft deep reservoir. This RASTA would reduce TP loads by approximately 28-29 mt/yr.

  - **Fisheating Creek RASTA II** would provide 15,000 ac-ft of storage capacity in the lower reaches of the Fisheating Creek Sub-watershed. It consists of a 1,350 acre, 12-ft deep reservoir and a 450 acre STA. This RASTA would reduce TP loads by approximately 2-3 mt/yr.

- **Clewiston STA** – This 700 acre STA would be located south of Lake Okeechobee and would reduce TP loads approximately 2.5 mt/yr.

- **S-133 Water Quality Treatment Facility** – It was important to locate a water quality improvement feature in the S-133 sub-basin of the Lower Kissimmee Sub-watershed because the original plan of treating flows from this sub-basin using one of the LOFT STAs has recently been shown to be impracticable. This feature would reduce TP loads by 2-3 mt/yr. The exact nature of this feature (STA, deep well, expansion of the existing Lemkin Creek Urban Stormwater Treatment Area, or a combination of these) would be determined through a feasibility study.

- **S-68 STA** – One of the major sources of TP loading in the Istokpoga/Indian Prairie Sub-watershed is flows from the intense agricultural operations located to the south of Lake Istokpoga. A 5,000 acre STA was conceptualized to capture these flows. This STA would be located in the Lake Istokpoga and Indian Prairie Sub-watersheds and reduce TP loads by 8 mt/yr.

These seven new project features would collectively reduce TP loading by 63 mt/yr. Thus, Alternative 3 would provide a total TP load reduction of 364 mt/yr. This would leave a TP TMDL shortfall of 45 mt/yr (**Table 7-6**). Annual average surface storage capacity associated with Alternative 3 was estimated at 330,000 ac-ft.

Table 7-6. Summary of total phosphorus (TP) load reduction associated with Alternative 3.

Initial TP load (1991-2005)		514 mt/yr
TMDL		105 mt/yr
Load reduction required to meet TMDL		409 mt/yr
Load reduction provided by Alternative 1	301 mt/yr	
Load reduction provided by the seven new project features in Alternative 3	63 mt/yr	
Total Load reduction provided by Alternative 3		364 mt/yr
TMDL shortfall		45 mt/yr

7.5.4 Alternative 4 – Optimize Storage and Water Quality Improvements

This alternative plan was intended to optimize storage capacity and reduce TP loads in the study area. It was conceived as a hybrid between Alternative Plans 2 and 3 and would essentially reduce some storage capacity to increase TP load reduction. Accordingly, it consisted of all constituents of Alternative 1 plus the following nine, new MMs:

- **Nicodemus Slough RASTA** – This proposed feature would provide approximately 168,000 ac-ft of storage capacity and reduce TP loads up to 33 mt/yr in the lower reaches of the Fisheating Creek Sub-watershed. The RASTA complex consists of a 6,500 acre STA coupled with an 11,000 acre, 16-ft deep reservoir. Because of its proximity to Lake Okeechobee, it could also be used to store and treat lake waters, if necessary.

- **Fisheating Creek RASTA I –** same configuration as previously described in Alternative 3

- **Fisheating Creek RASTA II –** same configuration as previously described in Alternative 3

- **Taylor Creek STA** – This proposed 2,000 acre STA would replace the LOFT 2,000 acre reservoir at the same location that was originally proposed for Alternative 1. This feature would reduce TP loads by 6 mt/yr. Since flows in Taylor Creek, which would be the primary source of water for this STA, are transient, this STA could also treat water from the East Kissimmee Reservoir.

- **Istokpoga/Kissimmee RASTA** – This proposed feature would provide a total annual average storage capacity of 273,600 ac-ft and collect runoff from the Lake Istokpoga and Indian Prairie Basin Sub-watersheds and the Kissimmee River Sub-watershed. It includes an 8,000 acre STA coupled with a 19,000 acre reservoir and it would be located in the Indian Prairie Basin Sub-watershed. The RASTA complex would reduce TP loads by 37 mt/yr. Because of its proximity to Lake Okeechobee and its large size, this feature could also be used to store and treat Lake Okeechobee waters, as appropriate.

- **Kissimmee Reservoir East –** same configuration as previously described in Alternative 2

- **S-154 Basin Deep Injection Well –** same configuration as previously described in Alternative 3

- **Clewiston STA –** same configuration as previously described in Alternative 3

- **S-133 Water Quality Treatment Facility** – same configuration as previously described in Alternative 3

- **S-68 STA –** same configuration as previously described in Alternative 3

These nine new project features would collectively reduce TP loads in watershed flows by approximately 59 mt/yr and in-lake loading by approximately 74 mt/yr. Thus, Alternative 4 would provide a total TP load reduction of 360 mt/yr. This would leave a TMDL shortfall of 49 mt/yr (**Table 7-7**).

Table 7-7. Summary of total phosphorus (TP) load reduction associated with Alternative 4.

Initial TP load (1991-2005)		514 mt/yr
TMDL		105 mt/yr
Load reduction required to meet TMDL		409 mt/yr
Load reduction provided by Alternative 1	301 mt/yr	
Load reduction provided by the nine new project features in Alternative 4	59 mt/yr	
Total Load reduction provided by Alternative 4		360 mt/yr
TMDL shortfall		49 mt/yr
Additional in-lake TP load reduction		74 mt/yr

The Nicodemus Slough and the Istokpoga/Kissimmee RASTAs could also be used to store and treat Lake Okeechobee water. The NERSM simulation for Alternative 4 included an operating rule that dictated when lake water would be pumped into and out of the proposed reservoirs and STAs. Storing and treating lake water in the two RASTAs is expected to reduce Lake Okeechobee TP loads by approximately 74 mt/yr. At this time, this TP load reduction does not count toward the TMDL.

Annual average surface storage capacity associated with Alternative 4 was estimated at 900,000 ac-ft. **Table 7-8** compares the projected performance of the four alternative plans; individual management measure components of each of the four alternative plans are shown in **Table 7-9**.

Table 7-8. P2TP comparison of alternative plan performance.

Alternative No.	Alternative Characterization	Projected Average TP Load Reduction* (mt/yr)	Estimated TMDL Shortfall (mt/yr)	Projected Surface Storage Capacity (ac-ft)
1	Current, on-going, and planned projects	301	108	265,000
2	Maximizes storage capacity	316	93	1,300,000
3	Maximizes phosphorus load reduction	364	45	330,000
4	Integrates the most efficient and effective combination of storage capacity and phosphorus load reduction	360	49	900,000

*target reduction is 409 mt/yr.

Table 7-9. Management measures associated with P2TP Alternative Plans.

MM ID	Management Measure	MM Description	MM Level	Alternative Plans			
				Alt 1	Alt 2	Alt 3	Alt 4
1	Agricultural BMPs - Owner Implemented	Conservation plans, including Agricultural Nutrient Management Plans, have enrolled over 527,370 acres in the LOW to reduce TP load to lake. Costs incurred by owner.	1	√	√	√	√
2	Agricultural BMPs - Funded Cost Share	Conservation plans, including Agricultural Nutrient Management Plans, have enrolled over 527,370 acres in the LOW to reduce TP load to lake. Costs to be shared between land owner and the State.	1	√	√	√	√
3	Urban Turf Fertilizer Rule (LOER)	FDACS prepared statewide draft rule to regulate N and P in urban turf fertilizers.	1	√	√	√	√
4	Land Application of Residuals	LOPA requirement that domestic wastewater residuals will not add to TP loadings in Lake Okeechobee.	1	√	√	√	√
5	Florida Yards and Neighborhoods	Educate citizens and builders about proper landscape design to minimize nutrient loading to lake by reducing use of pesticides, fertilizers, and irrigation water.	1	√	√	√	√
7	ERP Regulatory Program	Permit regulating activities involving alteration of surface water flows.	1	√	√	√	√
8	NPDES Stormwater Program	Rules implemented by EPA to reduce stormwater pollutant loads discharged to surface waters.	1	√	√	√	√
99	Taylor Creek Critical Project	142 acre STA located at the Grassy Island Ranch Site on District owned lands. Receives flow from and discharges to Taylor Creek. Provides annual average load reduction of 0.3 mt.	1	√	√	√	√
100	Nubbin Slough Critical Project	809 acre STA located at the New Palm Dairy Site on District owned lands. Receives flow from and discharges to Nubbin Slough. Provides average TP load reduction of 0.9 mt/yr.	1	√	√	√	√
13	Taylor Creek Algal Turf Scrubber Nutrient Recovery Facility	A 15 MGD facility on a District owned property at the Grassy Island Site in S-191 basin. Consists of an engineered system in which attached algae are cultured and biomass is routinely harvested to facilitate recovery of pollutants from impaired waters. Projected average TP-load reduction is approximately1.82 mt/yr.	1	√	√	√	√
53	Watershed Phosphorus Source Control Projects	About 30 ongoing projects in the four priority basins to treat water and reduce TP loads at source.	1	√	√	√	√
49	Agricultural BMPs - Cost Share Future Funding	Conservation plans, including Agricultural Nutrient Management Plans, have enrolled over 527,370 acres in the LOW to reduce TP load to lake. Costs to be shared between land owner and the State.	1	√	√	√	√
50	Agricultural BMPs - Additional	Advanced level BMPs including chemical treatment and	1	√	√	√	√

MM ID	Management Measure	MM Description	MM Level	Alternative Plans			
				Alt 1	Alt 2	Alt 3	Alt 4
	Agricultural BMPs	retention/detention ponds to treat water and reduce TP load at source in all basins north of Lake Okeechobee.					
93	Kissimmee River ASR Project	Facility is located along the Kissimmee River, 2 miles north of Lake Okeechobee. It is intended to test the feasibility of using ASR technology as part of CERP.	1	√	√	√	√
12a	LOER AWS - Brighton Reservoir	500-acre stormwater storage and treatment area located in the L-61 East Basin.	1	√	√	√	√
12b	LOER AWS - Clewiston Site	728 acres of primarily State and some privately owned land bordering Lake Okeechobee just outside of Clewiston. Temporary 50 cfs pump would deliver C-21 regional water into the site for storage	1	√	√	√	√
12e	LOER AWS - Avon Park Air Force Range	On-site retention on 3,600 acres providing approximately 10,000 acre-feet of storage capacity. Includes restoration of existing levee and water control structures. Will reduce flows and nutrient loading to Arbuckle Marsh.	1	√	√	√	√
12f	LOER AWS - Indiantown Citrus Growers Association	3,550 acre-feet of water storage on 1,775 acres. Includes rehabilitation and relocation of pump stations and widening ditches to reduce surface water volume discharged to St. Lucie Estuary	1	√	√	√	√
12g	LOER AWS - Barron Water Control District	5,000 acre-feet of water storage on 6,129 acres. Includes weir construction and ditch retention to enable water quality improvements and reuse by growers	1	√	√	√	√
12h	LOER AWS - Raulerson and Sons, Inc.	300 acre-feet of water storage on 670 acres. Will reduce flows and nutrient loading to Fish Slough	1	√	√	√	√
12i	LOER AWS - Kissimmee Prairie Preserve State Park	3,800 acre-feet of water storage on 1,920 acres. Will enhance quality of water entering Kissimmee River via Duck Slough, Lake Okeechobee, and the Everglades	1	√	√	√	√
87a_1	FRESP - Alderman-Deloney Ranch (C-25 basin)	43 ac-ft of on-site storage and TP-load reduction of 0.078 mton/yr Located in C-25 basin.	1	√	√	√	√
87a_2	FRESP - Williamson Cattle Company (S-191)	150 ac-ft of on-site storage and TP-load reduction of 0.24 mton/yr. Located in S-191 basin.	1	√	√	√	√
87a_3	FRESP - Buck Island Ranch (C-41)	967 ac-ft of on-site storage and TP-load reduction of 1.5 mton/yr Located in C-41 basin.	1	√	√	√	√
87a_4	FRESP - Lykes Bros (C-40)	5,000 ac-ft of regional water storage and TP-load reduction of 0.2 mt/yr. Located in C-40 basin.	1	√	√	√	√
70a	Local Initiatives - Taylor Creek Sediment Removal (S-133)	Removal of sediment and vegetation from canals tributary to Taylor Creek in the Treasure Island and Taylor Creek Isles residential areas.	1	√	√	√	√
70b	Local Initiatives - Okeechobee City Sediment Trap (S-133)	Two sediment traps installed within the city of Okeechobee to remove P-laden particles that would enter Lake Okeechobee.	1	√	√	√	√

MM ID	Management Measure	MM Description	MM Level	Alternative Plans			
				Alt 1	Alt 2	Alt 3	Alt 4
70c	Local Initiatives - Nubbin Slough East Diversions (S-133)	Restoration of the east main tributary flow conveyance to Nubbin Slough to reduce flooding.	1	√	√	√	√
116	In-lake Features – Muck Sediment Removal	Involves removal of muck sediments from shore line areas that are completely exposed due to extremely low lake stages. This scraping exposes the natural bottom which in turn promotes re-growth of native vegetation once the lake levels return to normal.	1	√	√	√	√
15	LO WoD Rule Regulatory P Source Control Program	Amend Lake Okeechobee Works of the District rule to meet current needs including: P source control program, BMP optimization, and monitoring network to measure effectiveness of all BMP Programs within the watershed.	2	√	√	√	√
16	Lakeside Ranch STA (LOFT)	2,400 acre STA in western Martin County between Beeline Highway and Lake Okeechobee. Will provide annual average TP-load reduction of 8 mt.	2	√	√	√	√
17	Lemkin Creek Urban Stormwater Facility (LOFT)	150 acre stormwater treatment facility located on District owned lands in Okeechobee County southwest of the City of Okeechobee. Will provide annual average TP-load reduction of 1 mt	2	√	√	√	√
18	Seminole Brighton Reservation ASR Pilot	One 5 MGD ASR well system located along the C-41 Canal on the western edge of the Reservation in Glades County.	2	√	√	√	√
19	Taylor Creek ASR Reactivation	One 6 MGD well system located adjacent to the L-63N Canal in Okeechobee, Florida.	2	√	√	√	√
87b_1	FRESP - C.M. Payne and Son, Inc (Fisheating Creek)	932 ac-ft of on-site storage in Fisheating Creek Sub-watershed	2	√	√	√	√
87b_2	FRESP - Lightsey Cattle Company (Fisheating Creek)	135 ac-ft of on-site water storage in Fisheating Creek Sub-watershed	2	√	√	√	√
87b_3	FRESP - Syfrett Ranch West (C-41A)	140 ac-ft of regional water storage in C-41A basin	2	√	√	√	√
87b_4	FRESP - Rafter T Ranch (Arbuckle Creek)	1,145 ac-ft of on-site storage along Arbuckle Creek	2	√	√	√	√
12c	LOER AWS - Rolling Meadows	Stormwater storage on 400 acres of District-owned land. Will reduce runoff and nutrient loading to Lake Kissimmee.	3	√	√	√	√
12d	LOER AWS - Sumica	1,920 acres of over drained property which has been over drained by adjacent DOT box culverts. Project proposes to install a rip rap weir upstream of the box culverts to maintain stormwater for hydrologic restoration on-site before eventually reaching Lake Kissimmee.	3	√	√	√	√
12k	LOER AWS - Lykes Nicodemus Slough	Design, engineer, and implement a water storage area on 15,129 acres of which a flowage easement exists on the southern most 2,000 acres in an area surrounding Nicodemus Slough near Fisheating Creek. The project will have the potential to store 13,000 to 26,000 acre feet of water from Lake Okeechobee.	3	√	√	√	√

MM ID	Management Measure	MM Description	MM Level	Alternative Plans			
				Alt 1	Alt 2	Alt 3	Alt 4
12n	LOER AWS - Fisheating Creek Marsh Watershed Project	Evaluate, engineer, and rehabilitate PL 566 water control structures in the Fisheating Creek Marsh Watershed project area to more effectively store and manage water and reduce phosphorus runoff from more than 50,000 acres in the headwaters of Fisheating Creek.	3	√	√	√	√
120	Central County Water Control District Reservoir	Construct and operate the CCWCD reservoir under a cooperative agreement between the South Florida Water Management District and CCWCD to provide both flood protection and excess water storage in the Caloosahatchee Basin.	3	√	√	√	√
21	LO and Estuary Watershed Basin Rule (LOER)	Develop specific supplemental permit criteria designed to reduce TP loads and total runoff volume from new developments that discharge to Lake Okeechobee, St. Lucie, or Caloosahatchee Estuary.	3	√	√	√	√
23	Taylor Creek Reservoir (LOFT)	Will provide approximately 24,000 ac-ft of storage. 1,600 acre, 16-ft deep reservoir located on District owned lands in at the Grassy Island Ranch Site.	3	√	√	√	--
24	Brady Ranch STA (LOFT)	1,800 acre STA proposed to be located in Western Martin County between the Beeline Highway and Lake Okeechobee immediately east of Lakeside Ranch.	3	√	√	√	√
26	10 Well ASR System (Paradise Run)	50 MGD ASR system along Lake Okeechobee in the area of Paradise Run in Highlands County, south of the S-65E structure.	3	√	√	√	√
28	Paradise Run Wetland Restoration (LOW Project)	3,730 acre wetland restoration site located at the confluence of Paradise Run, oxbows of the Kissimmee River, and Lake Okeechobee.	3	√	√	√	√
62	Florida Power and Light Martin Cooling Pond	95,000 ac-ft cooling pond located north of the C-44 Canal, east of the L-65 Canal, and west of Indiantown in Martin County.	3	√	√	√	√
68	Comprehensive Planning-Land Development Regulations	Basin-wide work with cities and counties to review current plans and ensure promotion of low impact design for stormwater treatment.	3	√	√	√	√
56	Rolling Meadows/Catfish Creek Restoration	Hydrologic restoration of Catfish Creek and the creation of an impoundment to restore littoral wetlands.	3	√	√	√	√
116	Lake Bed Disking/Plowing	Disking involves mixing the organic sediments on the lake bed with the underlying layer of mineral soils, usually sands. Mixing the two soils together is expected to reduce the turbidity production and phosphorus flux into the water column. Mixing of the soils is expected to significantly reduce the amount of the organic sediments that are exposed to the water column. Plowing is a similar action, but is accomplished with a farm implement that is designed, not to mix the soil layers, but to invert the two layers.	3	√	√	√	√
12j	LOER-AWS - Dupuis	Design, engineer, and implement additional 1 to 2 feet of storage in	4	√	√	√	√

MM ID	Management Measure	MM Description	MM Level	Alternative Plans			
				Alt 1	Alt 2	Alt 3	Alt 4
		the Dupuis marsh before on-site stormwater enters the L-8 Canal.					
12l	LOER-AWS - Stokes	Design, engineer and implement an on-site stormwater storage project on a 490 acre site in the Fisheating Creek Basin. The project will have the potential to store approximately 510 ac-ft of water.	4	√	√	√	√
12m	LOER-AWS - Waste Management St. Lucie Site	Enter into a partnership arrangement to modify borrow areas into minor above ground impoundment(s). Preliminary hydrologic investigation is in process.	4	√	√	√	√
12p	LOER-AWS - Istokpoga Marsh Improvement District	Design and construct an agricultural water treatment facility within the Istokpoga Marsh Improvement District to reduce phosphorus runoff and provide additional storm water storage for the 19,209 acre area.	4	√	√	√	√
12q	LOER-AWS - Caulkins	Rehabilitation and relocation of internal pump stations. During regulatory releases to the St. Lucie Estuary irrigation facilities will be utilized to draw excess stormwater into the 3,400 acre project site. The detention of stormwater within the existing ditch system will result in water quality improvements thereby promoting water conservation and reducing the volume of surface water discharge from the site.	4	√	√	√	√
12r	LOER – AWS Lake Wales Ridge State Forest Lake Kissimmee Site	Internal ditch plugs and modified control structures on 800 ac-ft of additional storage.	4	√	√	√	√
29	Kissimmee Reservoir	Will provide approximately 161,263 ac-ft of storage to be provided by 10,281 acre, 16-ft deep reservoir located in Istokpoga/Indian Prairie Sub-watershed and will capture flows from the Lower Kissimmee Sub-watershed.	4	√	√	√	√
30	Istokpoga Reservoir	Will provide storage capacity of 79,560 ac-ft; 5,416 acre, 16-ft deep reservoir located in and will capture flows from the Istokpoga/Indian Prairie Sub-watershed.	4	√	√	√	√
31	Istokpoga STA	Will provide approximately 29 mt/yr of TP-load reduction; 8,044 acre treatment facility; Will target flows from the Istokpoga Sub-watershed.	4	√	√	√	√
107	Kissimmee Reservoir East	Will capture flows from the Kissimmee River and store approximately 200,000 ac-ft of water. 12,500, 16-ft deep reservoir located to the east of the Kissimmee River in the Lower Kissimmee Sub-watershed.	4	--	√	--	√
108	Istokpoga/Kissimmee Reservoir	It would provide a total of 600,000 ac-ft of storage capacity with half the flows coming from the Istokpoga Basin and the other half coming from the Kissimmee River. 42,000 acre reservoir located in the	4	--	√	--	--

MM ID	Management Measure	MM Description	MM Level	Alternative Plans			
				Alt 1	Alt 2	Alt 3	Alt 4
		southern reaches of the Lake Istokpoga/Indian Prairie Sub-watershed. Because of its proximity to Lake Okeechobee and its large size, this feature could also be used to store lake waters, if needed.					
114	Istokpoga/Kissimmee RASTA	Would provide total annual average storage capacity of 273,600 ac-ft and target flows from both, the Istokpoga/Indian Prairie Basin and the Kissimmee River. 8,000 acre STA coupled with a 19,000 acre reservoir. Projected annual average load reduction of 37 mt. Because of it's proximity to Lake Okeechobee and its large size, this feature could also be used to store and treat Lake Okeechobee waters, as appropriate.	4	--	--	--	√
61	FEC RASTA I	Will provide annual average P-load reduction of approximately 28 to 29 mt/yr. 9,000 acre STA coupled with a 3,000 acre, 10-ft deep reservoir.	4	--	--	√	√
77	FEC RASTA II	Will provide annual average P-load reduction of approximately 2-3 mt/yr. 1,350 acres, 12-ft deep reservoir coupled with a 450 acre STA.	4	--	--	√	√
109	FEC Reservoir	Will provide approximately 250,000 ac-ft of storage capacity and its primary source of water would be Fisheating Creek. 17,500 acre, 16-ft deep reservoir located in the Nicodemus Slough region of the Fisheating Creek Sub-watershed. Given it's proximity to Lake Okeechobee it could also be used to store lake waters, if necessary.	4	--	√	--	--
115	Nicodemus Slough RASTA	Will provide approximately 168,000 ac-ft of storage capacity and an annual average P-load reduction of up to 33 mt/yr. 6,500 acre STA coupled with an 11,000 acre, 16-ft deep reservoir. Given it's proximity to Lake Okeechobee it could also be used to store and treat lake waters, if necessary.	4	--	--	--	√
112	Istokpoga Canal RASTA	Located along the boundary of the Lower Kissimmee and the Lake Istokpoga/Indian Prairie Sub-watersheds thereby allowing flows from both sub-watersheds to be captured and treated. Collectively, this RASTA would provide an annual average P-load reduction of approximately 10 to 18 mt/yr. 2,000 acre, 16-ft deep reservoir coupled with a 5,000 acre STA.	4	--	--	√	--
32	(LO) In-Lake Dredging	Involves removal of phosphorus-contaminated mud sediments from the deeper areas of the lake beyond the littoral shelf using innovative technologies. Exemplified by the recently initiated demonstration dredging and habitat restoration project being implemented near Eagle Bay. The area selected for the demonstration project is currently covered with mud sediments which prevent the growth of	4	√	√	√	√

MM ID	Management Measure	MM Description	MM Level	Alternative Plans			
				Alt 1	Alt 2	Alt 3	Alt 4
		native aquatic vegetation; therefore, the area has limited habitat value					
38	C-44 Littoral	Project includes creation of a littoral zone of native vegetation to "treat" for water entering the C-44 via the S308 can benefit Lake Okeechobee and the St Lucie Estuary	4	--	--	--	--
40	Lake Hicpochee	Project comprises a reservoir and stormwater treatment area along the C-19 and C-43 Canals, degradation of berms, and exotic removal and control. This project could potentially create 55,090 acre feet of above ground storage.	4	--	--	--	--
41	C-43 Distributed Reservoirs	Project objectives are to capture excess run-off within the West Lake Okeechobee Watershed which will then be operated to achieve both environmental flows to the Caloosahatchee Estuary and agricultural demands in the West Lake Okeechobee Watershed	4	--	--	--	--
47	Upper Kissimmee/Chain of Lakes Reservoir	Supplying surface water from the Kissimmee valley lakes and tributaries for water supply is considered the most viable water supply project in the basin and has been identified priority project with the District. A storage reservoir or ASR is expected to be a component of any withdrawal facility to improve reliability. Reductions in p-loads would be incidental to the water diverted for consumption.	4	--	--	--	--
59	Nicodemus Slough STA	Proposed facility would provide significant load reduction in FEC. Since this feature would draw water from close to the mouth of the creek, it would be able to treat loads from the entire drainage basin.	4	--	--	--	--
60	Fisheating Creek Managed Aquatic Plant Systems	Treatment units consisting of managed aquatic plan systems would be considered for siting in this sub-watershed at selected locations. Such units would be used in conjunction with source control practices to treat agricultural runoff with high phosphorus loads.	4	--	--	--	--
65	L-65 Culvert to L-8 Tieback	Install a high volume (1000+/- cfs) inverted culvert under the C-44 Canal from the L-65 Canal to the L-8 Tieback Canal to facilitate the movement of low nutrient water from Stormwater Treatment Areas north of Lake Okeechobee to the L-8 Reservoir.	4	--	--	--	--
71	KRR in Pool E	Complete backfilling of C-38 in Pool D. Pool E could be managed to maximize nutrient removal. STAs would be constructed on the floodplain adjacent to C-38. Some water moving through C-38 would be directed into the STAs but C-38 would remain intact for flood control.	4	--	--	--	--
73	Central Florida Recharge Project	Supplying surface water from the lakes and tributaries for aquifer recharge may offset a portion of the environment impacts projected to occur and that will limit future use of the Floridan aquifer system.	4	--	--	--	--

MM ID	Management Measure	MM Description	MM Level	Alternative Plans			
				Alt 1	Alt 2	Alt 3	Alt 4
		Water delivered to these RIB would move to the Floridan aquifer and a small percentage would be blended with reclaimed water for irrigation. Water would be moved to these RIBs only during high lake levels. Reductions in p-loads would be incidental.					
74	Indian Prairie Basin Regional STA	Located primarily in the Indian Prairie Sub-watershed this feature would consist of a 6,680 acre STA and a 1,531ac wetland Preservation/Enhancement Area.	4	--	--	--	--
75	In-Lake Chemical Treatment	Will involve application of chemical treatment technologies inside Lake Okeechobee to reduce in-lake TP loads.	4	--	--	--	--
78	Taylor Creek Wetland Restoration (Grassy Island)	Project would provide for incidental water storage and also reduce phosphorus from the runoff; would be sited on District owned lands	4	--	--	--	--
79	Nubbin Slough Wetland Restoration (New Palm Dairy)	Project would provide for incidental water storage and also reduce phosphorus from the runoff; would be sited on District owned lands	4	--	--	--	--
80	ASR-TCNS	New ASR facility in the TCNS Sub-watershed	4	--	--	--	--
81	Managed Aquatic Plant Systems in S-133	Proposed MAPS would target flows and load from a specific portion of the drainage basin and provide a certain amount of localized load reduction	4	--	--	--	--
82	Chemical Treatment in Taylor Creek Reservoir	Addition of a chemical treatment unit to the proposed LOW Project Taylor Creek Reservoir in order to enhance TP load reduction	4	--	--	--	--
85	Three Lakes WMA Hydrologic Restoration	Project is intended to reestablish more natural hydrology and partially restore wetlands on the property. This may provide more temporary water storage and potential for phosphorus removal.	4	--	--	--	--
90	Gardner-Cobb Marsh	Project would be sited on District owned lands in the Upper Kissimmee Sub-watershed and reduce the rate of run-off from this region by holding the water higher, as well as, provide incidental nutrient reductions due to plant uptake from overland flows in the marsh	4	--	--	--	--
91	Farm and Ranchland Protection Program Partnership	Voluntary USDA Natural Resources Conservation Service (NRCS) program that helps farmers and ranchers keep their land in agriculture. The program provides matching funds to State, Tribal or local governments and non-governmental organizations to purchase conservation easements.	4	√	√	√	√
94	Deep Well Injection- C-40 below S-72	Deep-injection well	4	--	--	--	--
95	Deep Well Injection- C-43 at Berry Groves Reservoir	Deep-injection well	4	--	--	--	--
96	Deep Well Injection- C-44 St. Lucie Canal	Deep-injection well	4	--	--	--	--
97	Deep Well Injection- C-41 below S-71	Deep-injection well	4	--	--	--	--

MM ID	Management Measure	MM Description	MM Level	Alternative Plans			
				Alt 1	Alt 2	Alt 3	Alt 4
98	Deep Well Injection- Taylor Creek/Nubbin Slough	Deep-injection well	4	--	--	--	--
104	Larson Dairy Lagoon Treatment System (HWTT)	Hybrid Wetland Treatment Technology™ (HWTT) is an innovative approach that combines beneficial attributes of the two top ranked nutrient removal technologies, namely wetland treatment and chemical injection. Exemplified by four pilot HWTT systems that are currently being tested in the LOW.	4	√	√	√	√
105	Upper Nubbin Slough Tributary Treatment System (HWTT)	Hybrid Wetland Treatment Technology™ (HWTT) is an innovative approach that combines beneficial attributes of the two top ranked nutrient removal technologies, namely wetland treatment and chemical injection. Exemplified by four pilot HWTT systems that are currently being tested in the LOW.	4	√	√	√	√
106	Upper Mosquito Creek Watershed Treatment System (HWTT)	Hybrid Wetland Treatment Technology™ (HWTT) is an innovative approach that combines beneficial attributes of the two top ranked nutrient removal technologies, namely wetland treatment and chemical injection. Exemplified by four pilot HWTT systems that are currently being tested in the LOW.	4	√	√	√	√
63	Wastewater/Stormwater Master Plan	Project involves assessing, planning, and updating wastewater/stormwater master plans to address short term and long term quality and quantity issues dealing with urban stormwater runoff. The updated plans will identify specific projects to be implemented to improve urban wastewater/stormwater quality. Exemplified by the on-going wastewater/master plan update projects in City of Okeechobee.	4	√	√	√	√
64	Unified Statewide Stormwater Rule	Intended to increase the level of nutrient treatment of stormwater from new development and thereby reduce the discharge of nutrients and excess stormwater volume.	4	√	√	√	√
54	S-154 Basin Deep Injection Well	Annual average P-load associated with the lost water is estimated to be approximately 9 mt/yr. Located in the S-154 drainage basin this cluster of deep injection wells would be used to irretrievably pump 16,500 ac-ft of runoff into the boulder zone.	4	--	--	√	√
92	Clewiston STA	Will provide annual average P-load reduction of approximately 2.5 mt/yr. 700 acre STA located south of Lake Okeechobee.	4	--	--	√	√
113	Taylor Creek STA	Projected annual average P-load reduction is approximately 4 mt. 2,000 acre STA located on District owned lands at the Grassy Island Ranch Site in S-191 Basin. Would receive flows from and discharge to Taylor Creek. Since flows in Taylor Creek, which would be the	4	--	--	--	√

MM ID	Management Measure	MM Description	MM Level	Alternative Plans			
				Alt 1	Alt 2	Alt 3	Alt 4
		primary source of water for this STA, are transient, this STA could also treat water from the East Kissimmee Reservoir.					
111	S-68 STA	Will provide approximately 8 mt/yr of P-load reduction on an annual average basis. 5,000 acre STA located in the Istokpoga/Indian Prairie Sub-Watershed.	5	--	--	√	√
110	S-133 Water Quality Treatment Facility	A 4-well cluster with a 1,000 ac-ft storage pond to optimize the removal of flow and well operation.	5	--	--	√	√
48	Compartmentalization of Lake	Establishing compartments within the Lake to facilitate lake stage management.	5	--	--	--	--
55	Construction of S-64 Structure on C-37	This project was part of the original design for the C&SF Project. It would allow greater flexibility for lake management in the upper basin. It may be possible to perform draw downs of Lake Toho without also drawing down Lake Kissimmee.	5	--	--	--	--
57	Istokpoga Creek Reservoir	Proposed reservoir would create extra storage during times of excess water. Water could be withdrawn via Istokpoga Canal from either Lake Istokpoga or the Kissimmee River (under periods of high flow). The reservoir would then serve as a source of water to the Kissimmee River, Lake Istokpoga, or downstream water-users during periods of less abundant rainfall.	5	--	--	--	--
58	Alternative Water Storage in Indian Prairie Region	Maximize water storage and meet all water supply needs within the region by limiting discharges to the Lake to when a standard level of flood protection is needed. This system would have the potential to reduce phosphorus loads by nearly 100 percent.	5	--	--	--	--
67	EAA Flow way	Originally suggested in 1993, the concept of the EAA Flow-way is to convert approximately 120,000 acres of primarily agricultural land into a natural wetland flow-way that would allow water to flow south from Lake Okeechobee to Water Conservation Area 3A (WCA 3A).	5	--	--	--	--
69	Lower Kissimmee Reservoir	One or two reservoir(s) would be constructed on either currently unused land owned by the SFWMD or on new lands to be acquired. It would be sized to provide the lesser of either the maximum required volume of storage capacity, or to utilize the entire available area.	5	--	--	--	--
72	Ice Cream Slough	Creation of a wetland impoundment on SFWMD owned land. Restoration of historic floodplain conditions in this area has the potential to retain water in Pool A as well as remove phosphorus from Ice Cream Slough discharge into C-38.	5	--	--	--	--
84	Yates Marsh Hydrologic Restoration	Wetland restoration project to restore hydrology of the marsh.	5	--	--	--	--
86	Upper Chain of Lakes Sediment Removal	Take advantage of low water levels during droughts to remove	5	--	--	--	--

MM ID	Management Measure	MM Description	MM Level	Alternative Plans			
				Alt 1	Alt 2	Alt 3	Alt 4
		phosphorus laden sediments; this would enhance the phosphorus assimilation capacity of sediments in the upper basin lakes.					
87c	Florida Ranchlands Environmental Services Project- full implementation	Implementation of this program beyond the ongoing pilot projects	5	--	--	--	--
88	Chemical Treatment in Istokpoga Reservoir	Addition of a chemical treatment unit to the proposed LOW Project Istokpoga Reservoir in order to enhance TP load reduction	5	--	--	--	--
89	Chemical Treatment in Kissimmee Reservoir	Addition of a chemical treatment unit to the proposed LOW Project Kissimmee Reservoir in order to enhance TP load reduction	5	--	--	--	--

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SECTION 8

ALTERNATIVE PLAN EVALUATION AND COMPARISON

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TABLE OF CONTENTS

List of Tables

List of Figures

TABLE OF CONTENTS (CONTINUED)

List of Figures (continued)

8.0 ALTERNATIVE PLAN EVALUATION AND COMPARISON

This section describes the process by which the four alternative plans were evaluated and compared to each other and to current and future base conditions, as appropriate. It also includes a description of the process by which the P2TP was selected.

8.1 Alternative Plan Evaluation

Performance of each of the four alternative plans was evaluated to determine the extent to which each plan contributed toward achievement of the two major goals, namely

- meeting the Lake Okeechobee Total Phosphorus (TP) TMDL, and
- providing additional storage capacity in the watershed to better manage Lake Okeechobee stages for ecological purposes and reduce magnitude and frequency of harmful freshwater releases to the two estuaries, while meeting water supply needs.

8.1.1 Water Quality Performance Evaluation

Contribution of each alternative plan toward meeting the Lake Okeechobee TP TMDL was determined by using an Excel spreadsheet tool. For each alternative plan, the reductions in TP loading were estimated at the sub-watershed level, in two parts:

- First, TP load reductions associated with LOPP (SFWMD, 2007) recommended BMPs (owner implemented, funded typical cost-share, typical cost-share BMPs requiring future funding, and advanced BMPs); watershed phosphorus source control projects; and other regional projects were identified and analyzed for each sub-watershed (**Table 8-1**). All LOPP recommended projects were considered Level 1 or 2 MMs by the P2TP planning process.

- Then, TP load reductions associated with Level 3, 4, and 5 MMs were estimated using flows, loads, and TP concentrations after the LOPP (SFWMD, 2007) recommended projects were in place (**Table 8-2**).

Total TP load reduction within each sub-watershed is the sum of the TP load reductions from LOPP projects and the Level 3, 4, and 5 MMs. Total TP load reduction provided by an alternative plan was determined as the sum of TP load reductions across the nine sub-watersheds in the study area. TP load reduction associated with each alternative plan was then compared to the TMDL mandated TP load reduction to determine shortfalls, if any.

Table 8-1. TP load reduction estimates for LOPP recommended Level 1 and 2 MMs.

		Sub-Watershed									
		Upper Kissimmee (S-65)**	**Lower Kissimmee (S-65A, B ,C ,D ,E)**	**Taylor Creek/ Nubbin Slough (S-191, 154,133,135)**	**Lake Istokpoga (S-68)****	**Indian Prairie Basins (12 basins)**	**Fisheating Creek & Nicodemus Slough (Culvert 5)**	**West Lake Okeechobee Basin (S-77) *****	**EAA Basins**	**East Lake Okeechobee Basins (C-44, L-8)**	**Total**
Existing Conditions	Average Annual Discharge (Measured) (1991-2005) (ac-ft)	954,204	378,836	187,583	299,656	249,175	224,368	5,835	149,488	109,134	2,558,279
	Annual Average P Conc. (Calculated) (1991-2005) (ppb)	78	166	537	63	289	199	139	177	151	163
	Average Annual P Load (Measured) (1991-2005) (mt)	**91**	**77**	**124**	**23**	**89**	**55**	**1**	**33**	**20**	**514**
Estimated Phosphorus Reduction (mt)	Owner Implemented BMPs [1] (MM 1 from Table 7-9)	7	10	12	2	11	5	0	2	2	41
	Funded Typical Cost-Share BMPs [2] (MM 2)	0	13	17	0	1	0	0	0	0	31
	Watershed P Control Projects [3] (MM 53)	0	11	19	0	2	0	0	0	0	32
	Regional Public Works Projects [4] (MMs 99, 100, EAA Reservoir, C-44 Reservoir, Kissimmee River Restoration, ECP Diversions)	13	7	1	0	0	0	0	21	7	47
	Typical Cost-Share BMPs that Require Future Funding [5] (MM 49 from Table 7-9)	8	8	10	3	12	7	0	0	2	39
	Additional Agricultural BMPs [6] (MM 50 from Table 7-9)	7	8	13	3	9	3	0	0	2	36
	Other Regional Projects [7] (MMs 17, 12a, 18, 19, 93, 16 from Table 7-9)	0	0	10	0	2	0	0	0	0	13
Level 1 and 2 Resulting Conditions	Total Load Reduction to the Lake (mt)	**13**	**57**	**82**	**0**	**37**	**15**	**0**	**23**	**13**	**239**
	Adjusted Remaining Load Above TMDL* (mt)	**78**	**21**	**42**	**23**	**51**	**39**	**1**	**12**	**8**	**275**

Notes:
(1) Reduction resulting from Owner BMPs - applied to all basins except the eight EAA basins.
(2) Reduction resulting from cost-share BMPs implemented with federal and state subsidies.
(3) Reduction due to ongoing watershed projects: PSCGP, Dairy BATs, Isolated Wetlands, etc.
(4) Reduction resulting from implementation of EAA Reservoir (11 mt), C-44 Reservoir (7 mt), LO Critical Projects (1 mt), Kissimmee River Restoration (KRR) (20 mt), and the ECP/Diversions (BMPs for 8 of the 10 EAA basins have been realized in 2005) (9 mt).
(5) Potential future (typical), BMPs implemented by land owners with government cost-share.
(6) Chemical treatment with retention/detention for Citrus, Dairy, Row crop, Ornamentals, and Sod.
(7) Reductions from Lemkin Creek STA (1.1 mt), Brighton Reserve Reservoir and ASR (2.3 mt), Taylor Creek ASR (1.2 mt), Kissimmee ASR (0.1 mt), and the LOER fast-track project - Lakeside ranch STA (8 mt).

* To be conservative, where TP reductions were projected to result in concentrations less than 30 ppb, the remaining load was estimated by multiplying the basin flow by 30 ppb instead of a lower projected concentration.
**TP reductions from implementing BMPs were applied to individual land uses within the Lake Kissimmee basins and Lake Istokpoga basins. While these reductions are important from the overall long-term restoration perspective, they will have little or no short-term improvement on what is leaving the basins due to lakes' internal buffering effects. Therefore, these load reductions were not carried through the remaining spreadsheet calculations.
***The TP loads into Lake Okeechobee from the East Caloosahatchee basin are small due to the manner in which the basin operates. Therefore, reductions associated with BMP projects in the Caloosahatchee will primarily benefit the Caloosahatchee basin itself, this, there are no TP load reductions to the lake.

Table 8-2. P2TP Alternative Plans total phosphorus (TP) load reduction by sub-watershed.

		Sub-Watershed									
		Upper Kissimmee (S-65)**	**Lower Kissimmee (S-65A,B,C,D,E)**	**Taylor Creek/Nubbin Slough (S-191,154,133,135)**	**Lake Istokpoga (S-68)****	**Indian Prairie Basins (12 basins)**	**Fisheating Creek & Nicodemus Slough (Culv 5)**	**West Lake Okeechobee Basin (S-77) *****	**EAA Basins**	**East Lake Okeechobee Basins (C-44, L-8)**	**Total**
Alternative #1 Load Reduction Management Measures (8)	Load reduction from Level 1 and 2 MMs (mt) (From Table 8-1)	13	57	82	0	37	15	0	23	13	239
	Load reduction from remaining Alt 1 MMs (mt) (MMs 23, 24, 26, 28, 29, 30, 31 from Table 7-9)	4	8	15	0	36	0	0	0	0	62
	Total Load Reduction (mt)	17	65	97	0	73	15	0	23	13	301
	Adjusted Remaining Load Above TMDL* (mt)	74	14	26	23	15	39	1	12	8	213
	Remaining Concentration (ppb)	63	29	113	63	50	143	139	66	57	67
Alternative #2 Load Reduction Management Measures (9)	Load reduction from Level 1 and 2MM (mt) (from Table 8-1)	13	57	82	0	37	15	0	23	13	239
	Load reduction from remaining Alt 1MMs (mt) (MMs 23, 24, 26, 28, 29, 30, 31 from Table 7-9)	4	8	15	0	36	0	0	0	0	62
	Load reduction from remaining Alt 2MMs (mt) (MMs 107, 108, 109 from Table 7-9)	10	0	0	3	0	3	0	0	0	15
	Total Load Reduction (mt)	23	57	82	3	37	18	0	23	13	316
	Adjusted Remaining Load Above TMDL* (mt)	65	14	26	20	15	37	1	12	8	198

		Sub-Watershed									
		Upper Kissimmee (S-65)**	**Lower Kissimmee (S-65A,B,C,D,E)**	**Taylor Creek/Nubbin Slough (S-191,154,133,135)**	**Lake Istokpoga (S-68)****	**Indian Prairie Basins (12 basins)**	**Fisheating Creek & Nicodemus Slough (Culv 5)**	**West Lake Okeechobee Basin (S-77) *****	**EAA Basins**	**East Lake Okeechobee Basins (C-44, L-8)**	**Total**
	Remaining Concentration (ppb)	55	30	113	55	50	133	139	66	57	63
Alternative #3 Load Reduction Management Measures (10)	Load reduction from Level 1 and 2MMs (mt) (from Table 8-1)	13	57	82	0	37	15	0	23	13	239
	Load reduction from remaining Alt 1MMs (mt) (MMs 23, 24, 26, 28, 29, 30, 31 from Table 7-9)	4	8	15	0	36	0	0	0	0	62
	Load reduction from remaining Alt 3MMs (mt) (MMs 54, 110, 111, 112, 61, 77, 92 from Table 7-9)	0	0	12	12	6	31	0	3	0	63
	Total Load Reduction (mt)	17	65	109	12	79	46	0	26	13	364
	Adjusted Remaining Load Above TMDL* (mt)	74	14	15	11	9	8	1	10	8	150
	Remaining Concentration (ppb)	63	30	64	30	30	30	139	52	57	48
Alternative #4 Load Reduction Management Measures (11)	Load reduction from Level 1 and 2MMs (mt) (Table 8-1)	13	57	82	0	37	15	0	23	13	239
	Load reduction from remaining Alt 1MMs (mt) (MMs 23, 24, 26, 28, 29, 30, 31 from Table 7-9)	4	8	15	0	36	0	0	0	0	62

		Sub-Watershed									
		Upper Kissimmee (S-65)**	**Lower Kissimmee (S-65A,B,C,D,E)**	**Taylor Creek/Nubbin Slough (S-191,154,133,135)**	**Lake Istokpoga (S-68)****	**Indian Prairie Basins (12 basins)**	**Fisheating Creek & Nicodemus Slough (Culv 5)**	**West Lake Okeechobee Basin (S-77) *****	**EAA Basins**	**East Lake Okeechobee Basins (C-44, L-8)**	**Total**
	Load reduction from remaining Alt 4MMs (mt) (MMs 54, 110, 113, 111, 114, 107, 61, 77, 115, 92 from Table 7-9)	14	0	14	9	1	18	0	3	0	59
	Total Load Reduction (mt)	31	65	111	9	74	33	0	26	13	360
	Adjusted Remaining Load Above TMDL* (mt)	60	14	12	14	14	21	1	10	8	154
	Remaining Concentration (ppb)	51	30	52	38	46	78	139	52	57	49

Notes:

(8) Alternative 1 reductions include Taylor Creek Reservoir (2 mt), Brady Ranch STA (5 mt), Paradise Run ASR (1.4 mt), and LOWP projects (54.3 mt) (5% reduction for Upper Kissimmee, 30% for Lower Kissimmee, 20% for Taylor Creek Nubbin Slough, and 70% for Indian Prairie).

(9) Alternative 2 reductions include Kissimmee reservoir east (6.5 mt), Istokpoga/Kissimmee reservoir (6.2 mt from the watershed and 22.7 mt from in-lake circulation), and Fisheating Creek reservoir (2.6 mt from the watershed and 12.9 mt from in-lake circulation). They are additive to Alternative 1 reductions.

(10) Alternative 3 reductions include S-154 deep injection wells (9 mt), S-133 water quality treatment (2.5 mt), S-68 STA (8 mt), Istokpoga canal RASTA (10 mt), FEC RASTA (31.2 mt), and Clewiston STA (2.5 mt). They are also additive to Alternative 1 reductions, but Alternatives 2 and 3 are independent.

(11) Alternative 4 reductions include S-154 deep injection wells (9 mt), S-133 water quality treatment (2.5 mt), Taylor Creek STA (net benefit of 4 mt including 6 mt from STA minus 2 mt from reservoir already included in Alt. 1), S-68 STA (8 mt), Istokpoga/Kissimmee RASTA (8.9 mt from the watershed and 28 mt from in-lake circulation), Kissimmee reservoir east (6.5 mt), Fisheating Creek RASTAs and Nicodemus Slough RASTA (18 mt from the watershed and 46 mt from in-lake circulation), and Clewiston STA (2.5 mt). They are also additive to Alternative 1 reductions, but Alternatives 2, 3 and 4 are independent.

* To be conservative, where reductions were projected to result in concentrations less than 30 ppb, the remaining load was estimated by multiplying the basin flow by 30 ppb instead of a lower projected concentration.

** Reductions from implementing BMPs were applied to individual land uses within the Lake Kissimmee and Lake Istokpoga basins. However, these reductions will have little or no short-term improvement on what is leaving the basins due to lakes' internal buffering effects. Therefore, these load reductions were not carried through the remaining spreadsheet calculations.

*** The TP loads into Lake Okeechobee from the East Caloosahatchee basin are small due to the manner in which the basin operates. Therefore, reductions associated with BMP projects in the Caloosahatchee will primarily benefit the Caloosahatchee basin itself, thus there are no TP load reductions to the lake.

8.1.2 Water Quantity (Storage) Performance Evaluation

The ability of each alternative plan to provide additional storage capacity in the watershed was determined through NERSM simulations. Each alternative plan was evaluated for its potential impact on Lake Okeechobee and the two estuaries using pre-determined performance measures (See *Section 3* for a description of the PMs). The potential impact of each alternative plan on water supply was also assessed using a pre-determined performance measure.

8.1.2.1 Lake Okeechobee

8.1.2.1.1 Lake Okeechobee Extreme Low Stage

Improved Lake Okeechobee stage management is one of the primary objectives of the P2TP. Stage management includes minimizing the duration of both extreme high (>17 ft NGVD) and low (<10 ft NGVD) lake stages. **Figure 8-1** shows the simulated performance of each of the four alternative plans (NETPA1, NETPA2, NETPA3, and NETPA4) and the future base conditions (NETPFB) with respect to the frequency of undesirable extreme low stage events in Lake Okeechobee.

A score of 100 percent indicates that lake stages never fell below 10 ft NGVD for 15 weeks or more in a year during the 36-year period of record, which is a desirable condition. A score of 0 percent represents the worst score indicating the least desirable outcome (i.e. extreme high or low stages which exceed 15 weeks in duration).

Alternative plan performance with respect to the stage management performance measure (PM) is directly related to the plan's storage capacity – the more storage an alternative plan has, the more water it can make available to the lake during the dry season, thereby preventing lake stages from falling below 10 ft NGVD for prolonged durations. Accordingly, Alternatives 2 and 4 which have total storage capacities in excess of 900,000 ac-ft and produce the best scores. Compared to the future base conditions, all four alternative plans showed improved performance in regard to managing the stage levels in Lake Okeechobee.

8.1.2.1.2 Lake Okeechobee Extreme High Stage

The simulated performance of each of the four alternative plans and the future base conditions (NETPFB) is shown in **Figure 8-2** with respect to the frequency of undesirable extreme high stage events in Lake Okeechobee. A score of 100 percent indicates that lake stages never exceeds 17 ft NGVD for 11 weeks or more during a single year in the period of record, which is a desirable condition. A score of 0 percent represents the worst score indicating the least desirable outcome.

Once again, the performance of an individual alternative plan performance with respect to this PM is also directly related to storage capacity – the more storage an alternative plan has, the more water it can store during wet seasons, thereby preventing lake stages from exceeding 17 ft NGVD for prolonged durations. Accordingly, Alternatives 2 and 4 scored the highest and overall all four plans scored higher than the future base condition.

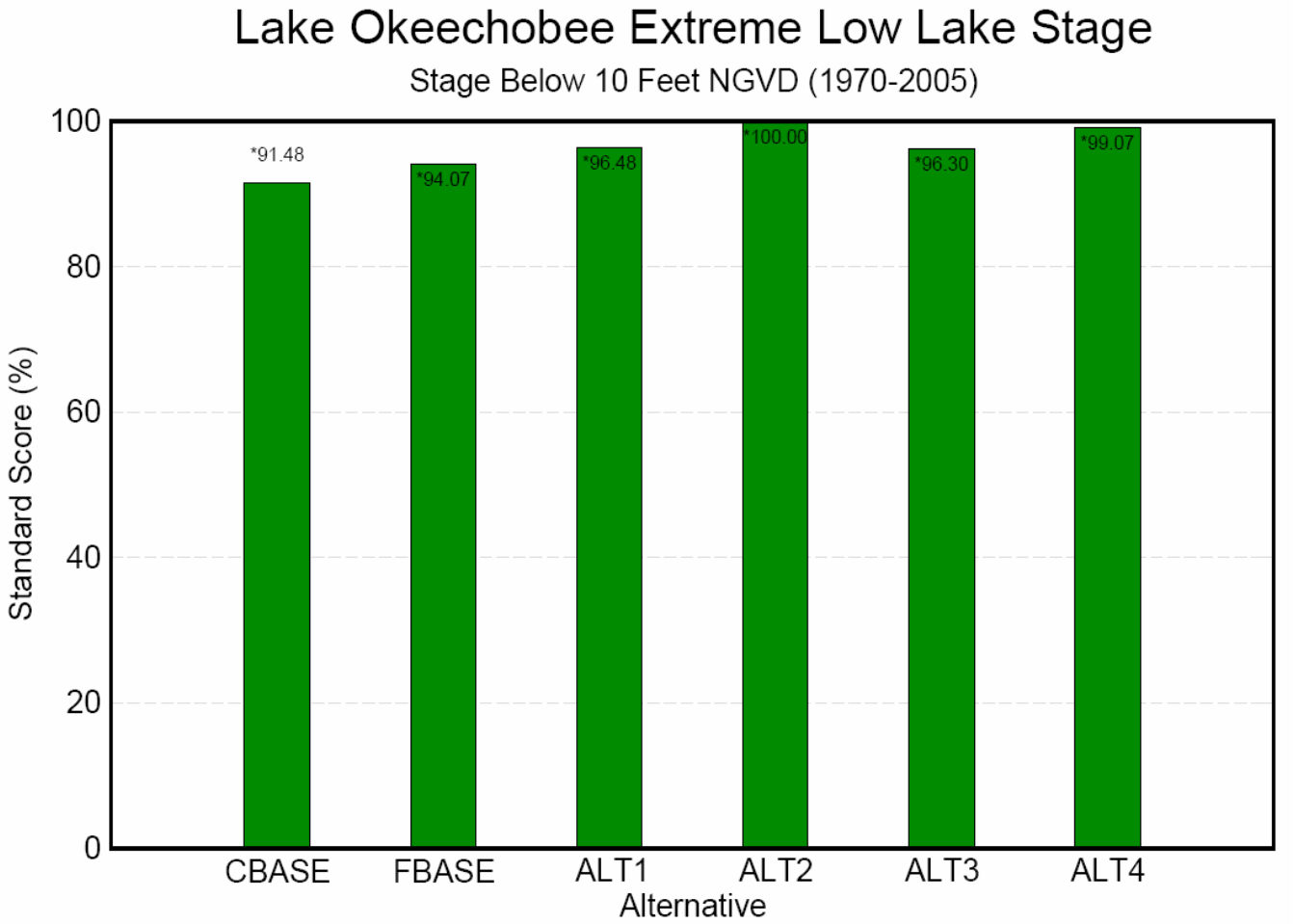

Figure 8-1. Simulated performance of Alternative Plans and Base Scenarios – Lake Okeechobee Extreme Low Lake Stage.

(Score = 0 if Lake Stage falls below 10 ft for an average of 15 weeks per year or more;
Score = 100 if Lake Stage never falls below 10 ft)

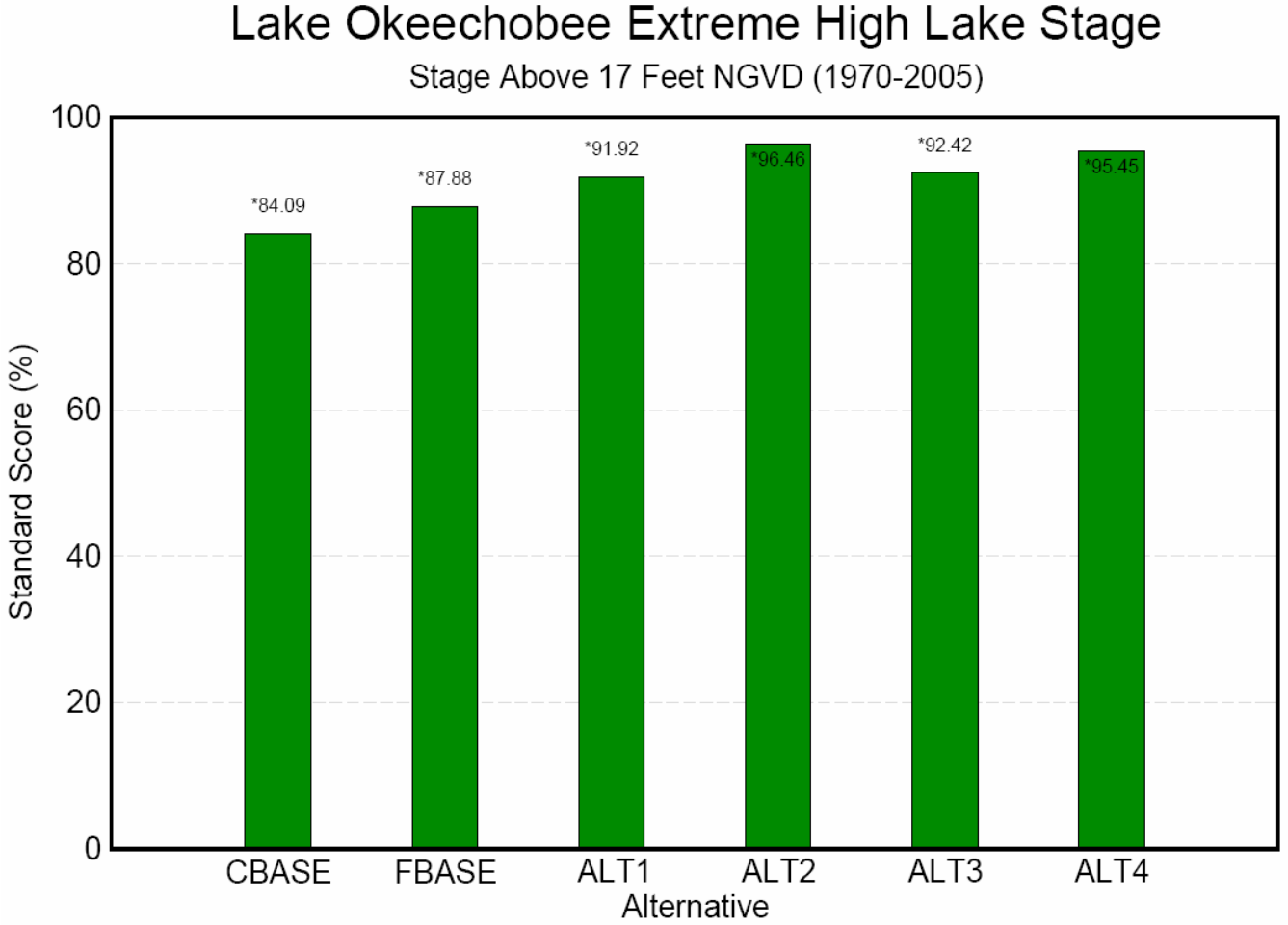

Figure 8-2. Simulated performance of Alternative Plans and Base Scenarios – Lake Okeechobee Extreme High Lake Stage.

(Score = 0 if Lake Stage exceeds 17 ft for an average of 11 weeks per year or more;
Score = 100 if Lake Stage never exceeds 17 ft)

It is also desirable to maintain Lake Okeechobee stages within an ecologically beneficial seasonal stage envelope (**Figure 8-3**). Lake stages fluctuate in response to a combination of seasonal, annual, and inter-annual climatic conditions and operational practices. Research (Havens 2002) has confirmed that lakes stage should ideally vary seasonally between 12.5 ft, NGVD (June-July low) and 15.5 ft, NGVD (November-January high). A healthy variation of lake stages result in annual flooding and drying of the littoral zone, promoting development of diverse plant and animal communities. Decreasing water levels toward the end of winter and spring allow wading birds to easily prey on resources in the littoral zone. However, if the lake stage falls below the envelope too frequently, the littoral zone is threatened.

Stage \ Month	J	F	M	A	M	J	J	A	S	O	N	D	
19	3.5	4	4.5	5	6	6.5	6.5	6	5	4	3.5	3.5	
18.5	3	3.5	4	4.5	5.5	6	6	5.5	4.5	3.5	3	3	
18	2.5	3	3.5	4	5	5.5	5.5	5	4	3	2.5	2.5	
17.5	2	2.5	3	3.5	4.5	5	5	4.5	3.5	2.5	2	2	
17	1.5	2	2.5	3	4	4.5	4.5	4	3	2	1.5	1.5	A
16.5	1	1.5	2	2.5	3.5	4	4	3.5	2.5	1.5	1	1	
16	0.5	1	1.5	2	3	3.5	3.5	3	2	1	0.5	0.5	B
15.5	**0**	0.5	1	1.5	2.5	3	3	2.5	1.5	0.5	**0**	**0**	
15	**0**	**0**	0.5	1	2	2.5	2.5	2	1	**0**	**0**	**0**	
14.5	**0**	**0**	**0**	0.5	1.5	2	2	1.5	0.5	**0**	**0**	**0**	
14	0.5	**0**	**0**	**0**	1	1.5	1.5	1	**0**	**0**	0.5	0.5	
13.5	1	0.5	**0**	**0**	0.5	1	2	0.5	**0**	**0**	1	1	
13	1.5	1	0.5	**0**	**0**	0.5	0.5	**0**	**0**	0.5	1.5	1.5	
12.5	2	1.5	1	0.5	**0**	**0**	**0**	**0**	**0**	1	2	2	
12	2.5	2	1.5	1	**0**	**0**	**0**	**0**	0.5	1.5	2.5	2.5	
11.5	3	2.5	2	1.5	0.5	0.5	0.5	0.5	1	2	3	3	
11	3.5	3	2.5	2	1	1	1	1	1.5	2.5	3.5	3.5	C
10.5	4	3.5	3	2.5	1.5	1.5	1.5	1.5	2	3	4	4	
10	4.5	4	3.5	3	2	2	2	2	2.5	3.5	4.5	4.5	
9.5	5	4.5	4	3.5	2.5	2.5	2.5	2.5	3	4	5	5	
9	5.5	5	4.5	4	3	3	3	3	3.5	4.5	5.5	5.5	
8.5	6	5.5	5	4.5	3.5	3.5	3.5	3.5	4	5	6	6	
8	5.6	6	5.5	5	4	4	4	4	4.5	5.5	5.6	5.6	
7.5	7	6.5	6	5.5	4.5	4.5	4.5	4.5	5	6	7	7	

Figure 8-3. Lake Okeechobee stage envelope.

The Lake Stage Envelope performance measure (PM) assesses the duration and extent of lake stages (average weekly) that are outside the desirable envelope. The simulated performance of the four alternative plans and the future base relative to this PM is shown in Figures **8-4** and **8-5**. A score of 100 percent indicates that lake stages do not fall below or above the ecologically desirable envelope. A score of 0 percent represents a worst score scenario.

Alternative Plans 2 and 4 performed the best for this PM because they have large storage capacities that allow them to store or release water in order to maintain lake stages within the desirable envelope. Alternative 2 performs better than Alternative 4 because it has almost 40 percent greater storage capacity. All four alternatives resulted in a significant improvement in the ability to maintain desirable lake stages compared to the future base condition.

The Lake Okeechobee Minimum Flow and Level (MFL) specifies that water levels should not fall below 11 ft NGVD for greater than 80 days more often than once every six years (or 6 times during the 36-year period of record). The frequency of MFL violations is addressed in the Performance Measure for Number of Times Proposed Minimum Water Level & Duration Criteria Exceeded. **Figure 8-5** compares the performance of the future base condition and the four alternative plans against this PM. The future base condition and all four alternative plans comply with the MFL requirement.

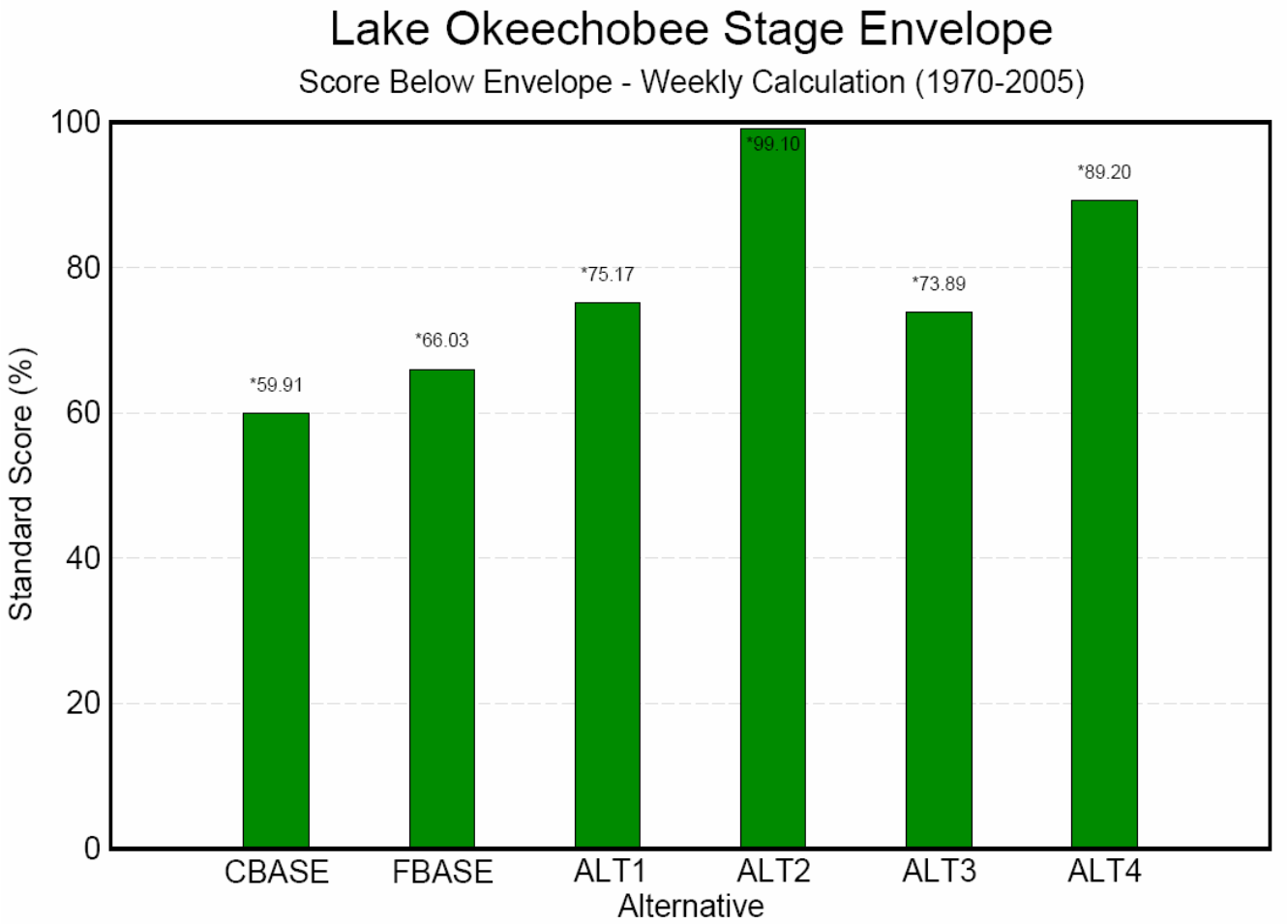

Figure 8-4a. Simulated performance of Alternative Plans and Base Scenarios – Lake Okeechobee Stage Envelope Score below Envelope.

(Score = 0 if Lake Stage falls below the ecologically desirable envelope by 1 ft or more on average;
Score = 100 if Lake Stage never falls below the ecologically desirable envelope)

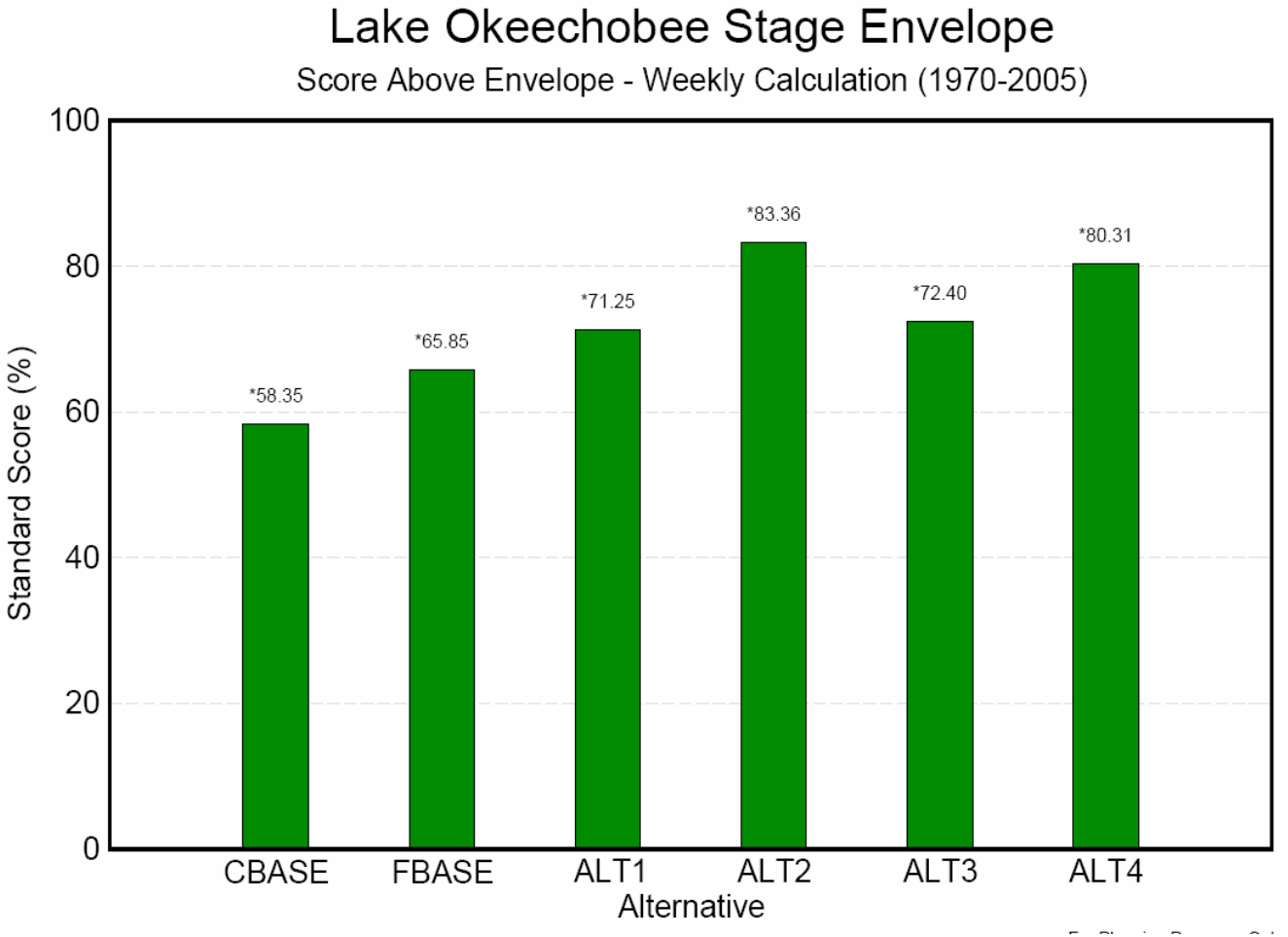

Figure 8-4b. Simulated performance of Alternative Plans and Base Scenarios – Lake Okeechobee Stage Envelope Score above Envelope.

(Score = 0 if Lake Stage exceeds the ecologically desirable envelope by 1 ft or more on average;
Score = 100 if Lake Stage never exceeds the ecologically desirable envelope)

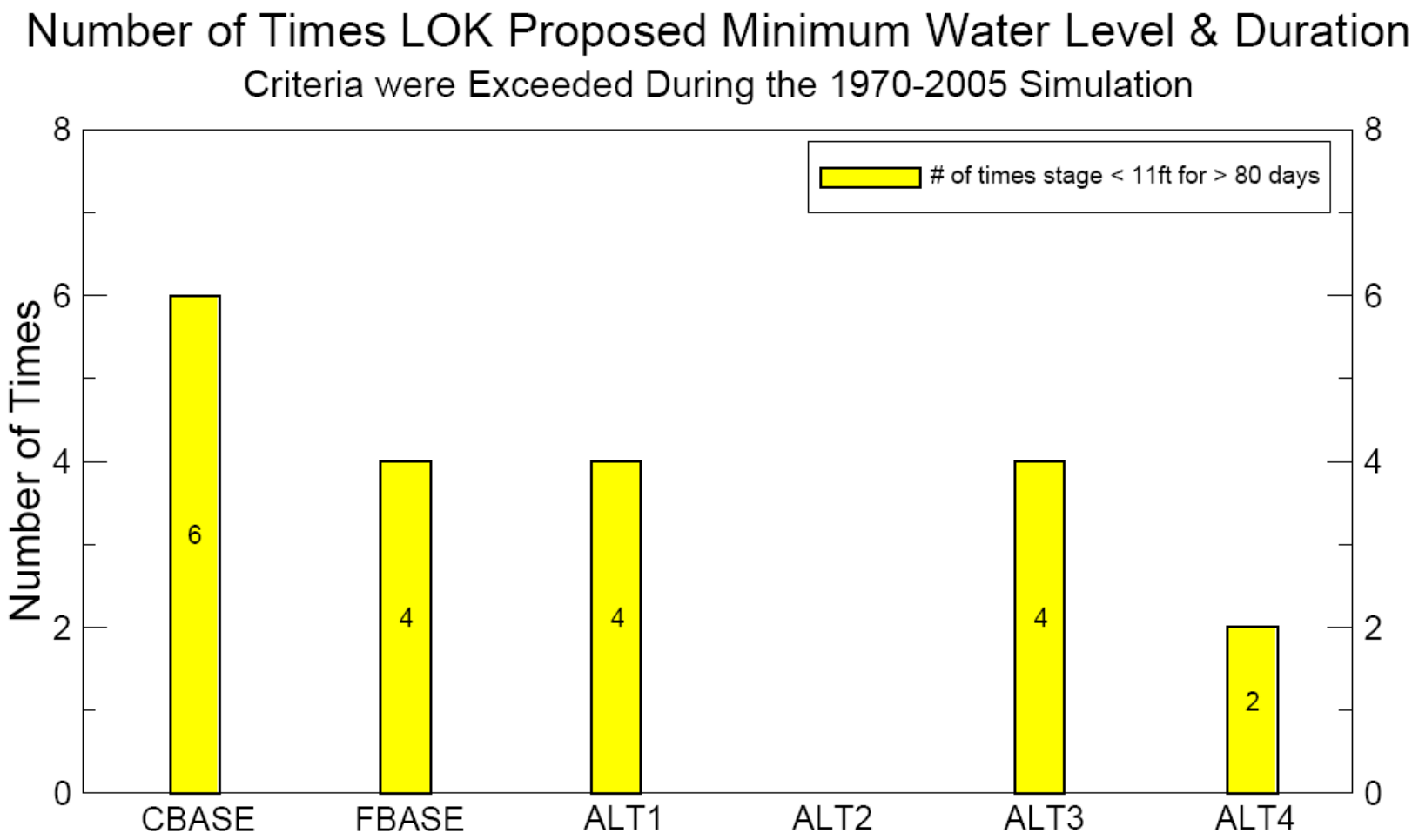

Figure 8-5. Simulated performance of Alternative Plans and Base Scenarios – Number of Times LOK Proposed Minimum Water Level & Duration Criteria Exceeded.

(Target: Minimum Level, duration and Return Frequency – Water levels in Lake Okeechobee should not fall below 11ft NGVD for greater than 80 days more often than once every six years.)

8.1.2.2 Caloosahatchee (C-43) Estuary

Another project objective of the P2TP is to reduce frequency and duration of harmful freshwater releases into the Caloosahatchee Estuary at the S-79 structure. Large volumes of freshwater releases into the estuary lower salinity concentrations and adversely impact abundance and diversity of estuarine flora and fauna. Conversely, long periods of zero or extremely low flows can cause undesirable increases in salinity concentrations.

Mean monthly discharges to the estuary in excess of 2,800 cfs cause stress to the ecosystem while mean monthly discharges greater than 4,500 cfs are known to result in severe damage. The goal is to reduce the occurrence of such discharges to a frequency that approximates natural conditions. **Figure 8-6** shows the number of mean monthly discharge events at S-79 in excess of 2,800 cfs and 4,500 cfs for each of the four alternative plans and the future base condition. Alternatives with greater storage capacity are able to capture and store excess water until conditions allow for non-damaging releases. Therefore, Alternative 2, with the largest storage capacity, produces the most significant reductions in damaging discharges. Discharges to the Caloosahatchee Estuary at S-79 consist of contributions from Lake Okeechobee plus local inflows from the C-43 drainage basin. **Table 8-3** compares the number of high flow events associated with Lake Okeechobee discharges and local inflows at S-79.

Table 8-3. Comparison of Lake Okeechobee and local discharges at S-79.
(Number of months discharge > 2,800 cfs (432 total months of simulation))

	Current Base	Future Base	ALT1	ALT2	ALT3	ALT4
Number of months Lake Okeechobee (LOK) regulatory discharges > 2,800 cfs	21	13	13	9	13	9
Number of months Caloosahatchee (C-43) Basin > 2,800 cfs	48	28	27	26	27	26
Number of months combined (not individually) LOK and C-43 Basin runoff discharges > 2,800 cfs	11	14	15	8	14	16
Total number of months S-79 > 2,800 cfs	80	55	55	43	54	51

Notes:

1. Number of months Lake Okeechobee regulatory discharges>2,800 cfs – This is the number of additional months that Lake Okeechobee discharges only is greater than 2,800 cfs.
2. Number of months Caloosahatchee (C-43) Basin>2,800 cfs – This is the number of months that runoff originating from within Caloosahatchee Basin is greater than 2,800 cfs.
3. Number of months combined (not individually) Lake Okeechobee and C-43 Basin runoff discharges > 2,800 cfs – This is the number of months that a combination of runoff from within the Caloosahatchee Basin and Lake Okeechobee regulatory discharges are greater than 2,800 cfs.
4. Number of months S-79 > 2,800 cfs – Total number of months discharge across S-79 is greater than 2,800 cfs. - These flows that are greater than 2,800 cfs could be caused by runoff from within the Caloosahatchee Basin, Lake Okeechobee regulatory discharges, or a combination of runoff from within the Caloosahatchee Basin and Lake Okeechobee regulatory discharges.

The data in **Table 8-3** indicate that while regulatory releases from Lake Okeechobee do contribute to the problems in the Caloosahatchee Estuary, local discharges from the C-43 basin also play an important role. The Caloosahatchee River Watershed Protection Plan, which will be prepared separately and implemented, will address problems associated with local discharges into the estuary and recommend solutions to address this issue. This highlights the fact that to achieve holistic restoration of the Northern Everglades ecosystem, many different initiatives have to converge and complement each other in space and time.

Maintenance of Caloosahatchee Estuary salinity concentrations at levels that are conducive to its ecologic health requires maintaining flows at S-79 within a desirable salinity envelope. The goal is to avoid mean monthly flows less than 450 cfs (particularly from October through July) and mean monthly flows greater than 2,800 cfs. The capture and storage of excess water during wet conditions helps reduce the need for high discharges at S-79. The storage of excess water can also contribute toward maintaining minimum flows during dry conditions. Consequently, alternatives with large storage capacities (Alternatives 2 and 4) exhibit better performance as shown in **Figure 8-7**.

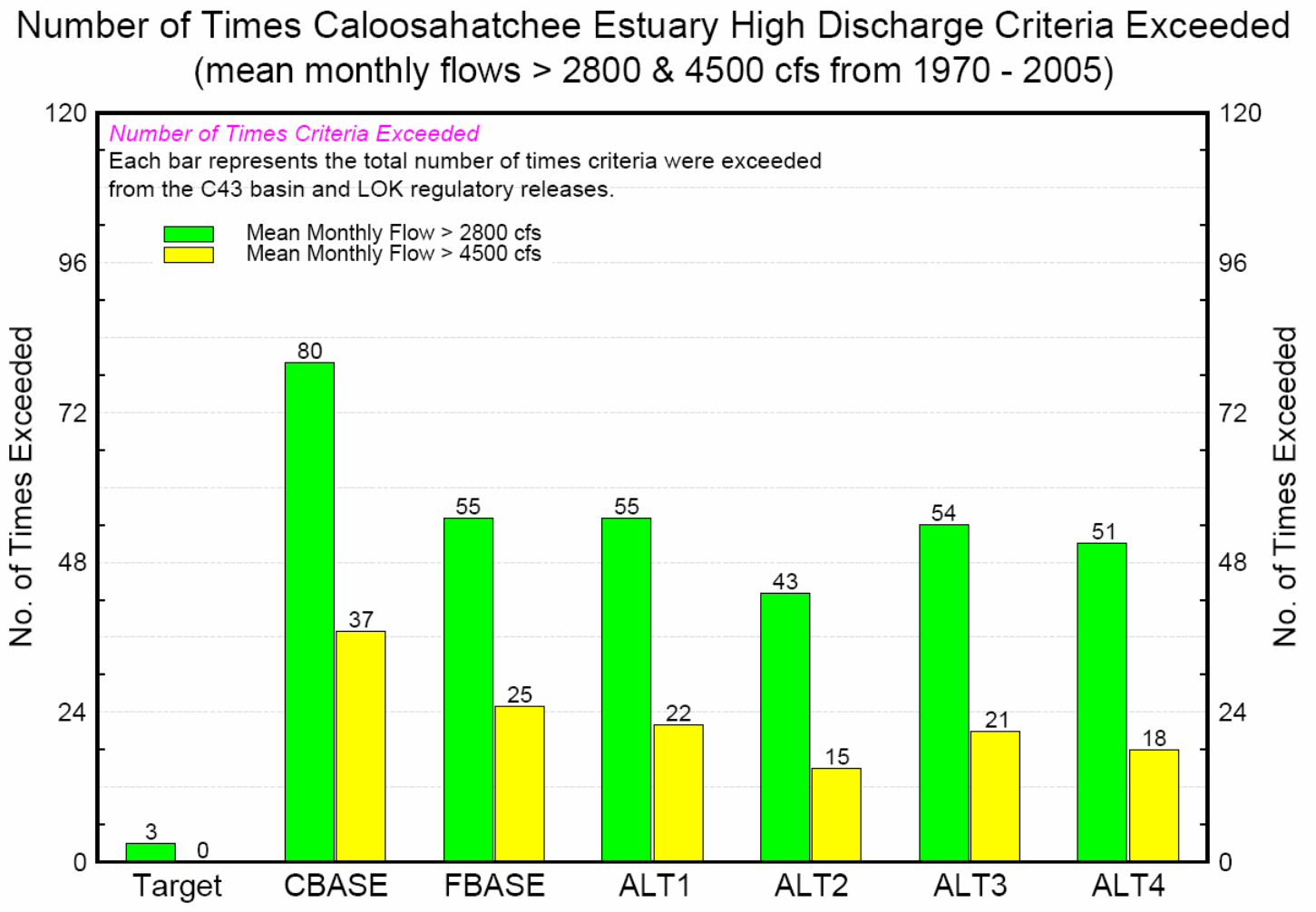

Figure 8-6. Simulated performance of Alternative Plans and Base Scenarios –Number of Times Caloosahatchee Estuary High Discharge Criteria Exceeded.

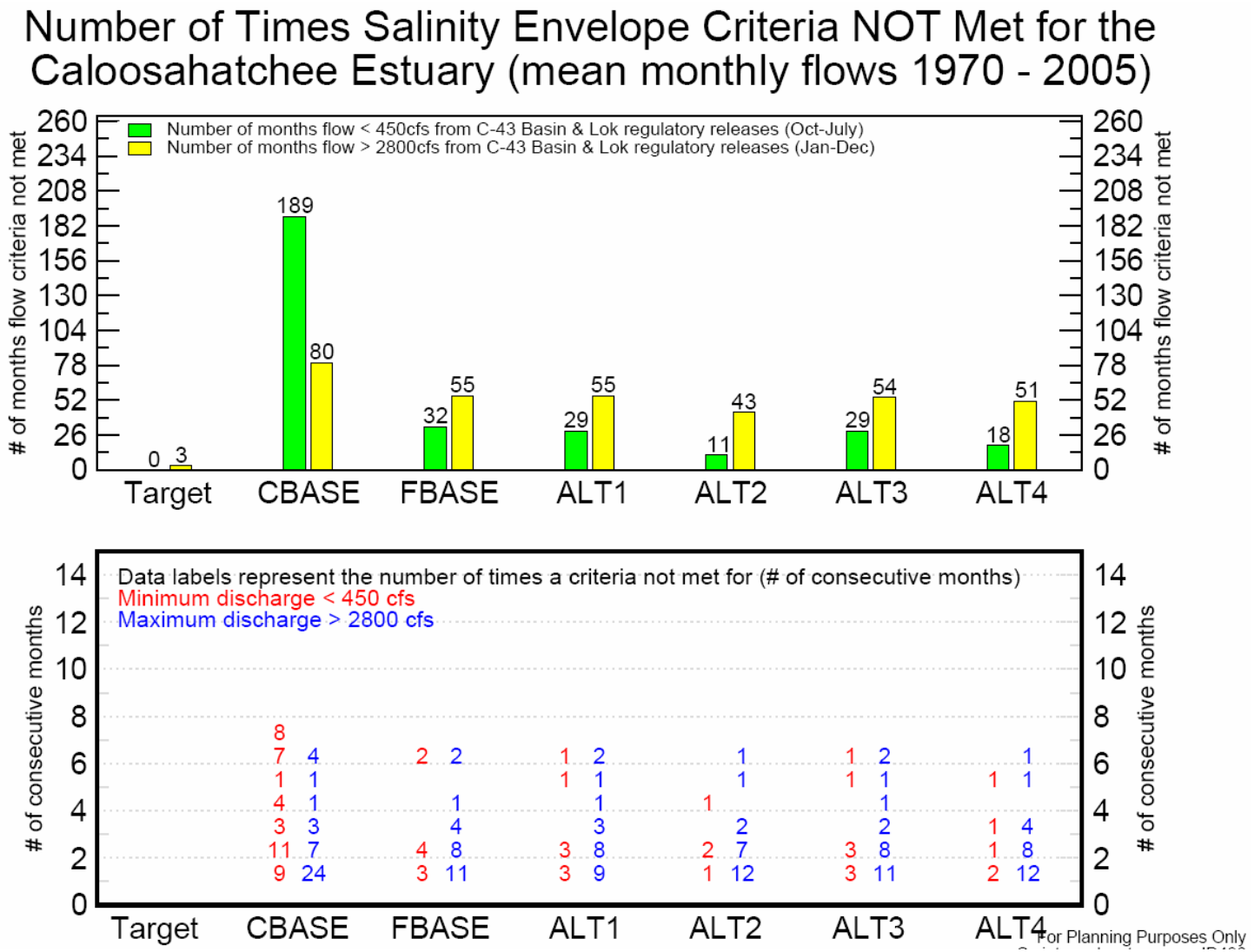

Figure 8-7. Simulated performance of Alternative Plans and Base Scenarios – Number of Times Salinity Envelope Criteria for the Caloosahatchee Estuary NOT Met.

8.1.2.3 St Lucie (C-44) Estuary

Another P2TP project objective is to minimize the frequency and duration of harmful freshwater releases to the St Lucie Estuary. Similar to the situation in Caloosahatchee Estuary, the release of large and untimely volumes of freshwater into the St. Lucie estuary also lowers salinity concentrations and adversely impact the abundance and diversity of estuarine flora and fauna. Maintenance of minimum flows is also required to avoid undesirable increases in estuary salinity concentrations.

In addition to discharges from Lake Okeechobee, the St. Lucie Estuary also receives local stormwater discharges from the C-44, C-23, C-24, and the Tidal Southfork Basins. The P2TP is only addressing discharges from Lake Okeechobee to C-44. The St Lucie River Watershed Protection Plan will be prepared and implemented as a separate document. The plan will address problems associated with local discharges into the estuary and recommend solutions to address this issue. Cumulatively, mean monthly discharges (from local runoff plus Lake Okeechobee discharges) to the estuary in excess of 2,000 cfs cause stress to the ecosystem. Mean monthly discharges greater than 3,000 cfs result in severe damage to the estuary. The overall goal is to reduce the frequency of damaging discharges.

Figure 8-8 compares the simulated performance of the four alternative plans and the future base condition with respect to the number of monthly St. Lucie Estuary mean discharge events in excess of 2,000 cfs and 3,000 cfs. The largest improvements are provided by the alternatives which reduce the number of monthly discharge events to the estuary in excess of a mean of 3,000 cfs. Alternative 2 reduces the number of these events by almost 25 percent relative to the future base condition. However, many of the mean monthly flow events over 3,000 cfs were reduced in severity by the other alternatives which have mean monthly flows between 2,000 cfs and 3,000 cfs. As a result, the alternatives did not produce a significant reduction in the number of mean monthly flow events between 2,000 cfs and 3,000 cfs. Extremely large storage volumes (in excess of 2,000,000 ac-ft) would be required to produce significantly improved performance relative to these high discharge PMs.

Maintenance of salinity concentrations in the St Lucie Estuary at levels that are conducive to its ecologic health requires maintaining inflows within a desirable salinity envelope. The goal is to avoid mean monthly flows less than 350 cfs and 14-day rolling average discharges from exceeding 2,000 cfs.

Figure 8-9 shows the frequency of low flow events (< 350 cfs) and high flow events caused by local inflows and discharges from Lake Okeechobee. The future base condition and all alternative plans perform better than the target of “no more than 31 events in the 36-year period of record with average monthly flows less than 350 cfs.” All alternatives reduce the contribution of Lake Okeechobee discharges to maximum flow exceedances compared to the future base condition. Alternatives 2 and 4 provide the best performance because of their large storage capacities.

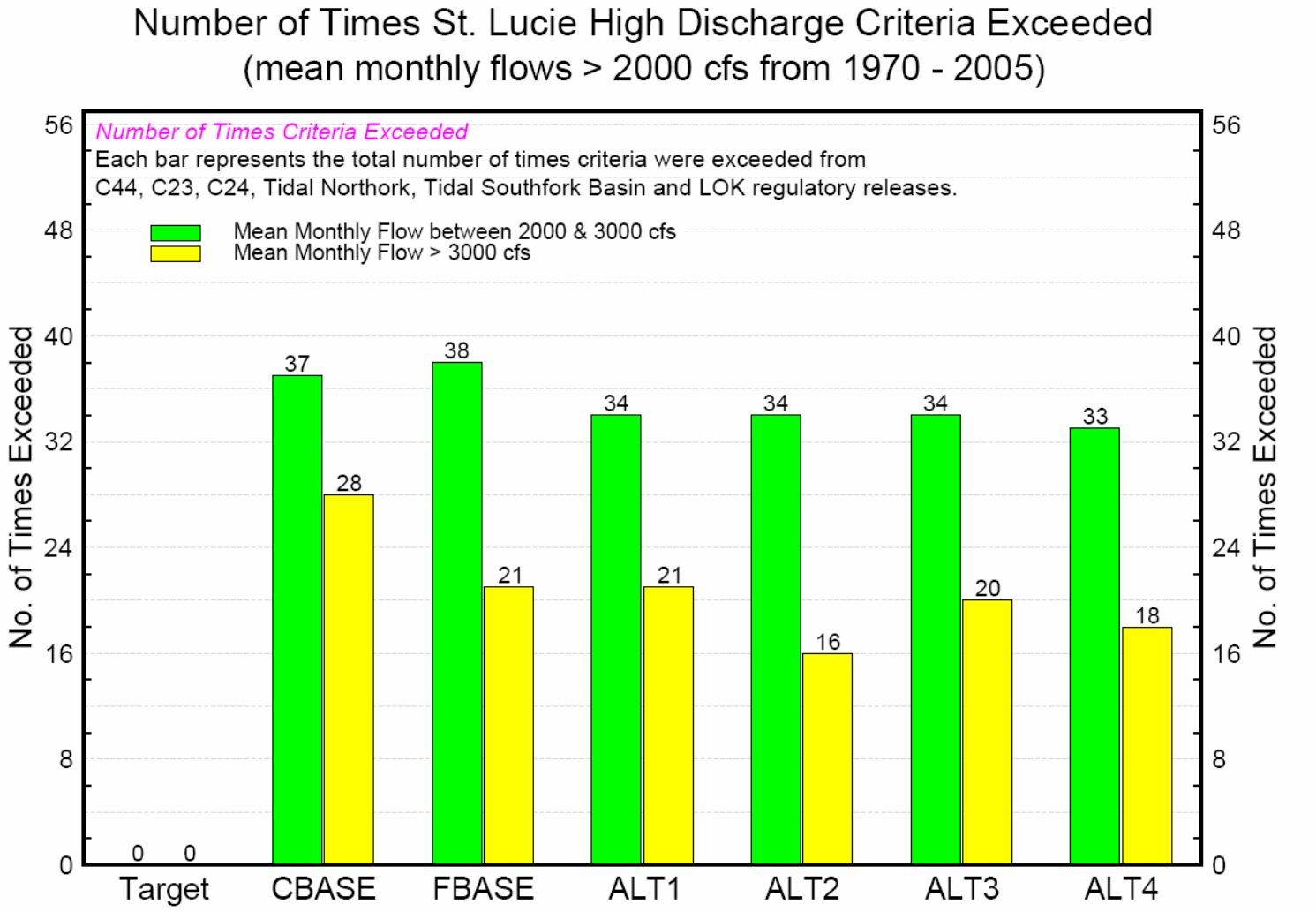

Figure 8-8. Simulated performance of Alternative Plans and Future Base – Number of Times St. Lucie Estuary High Discharge Criteria Exceeded.

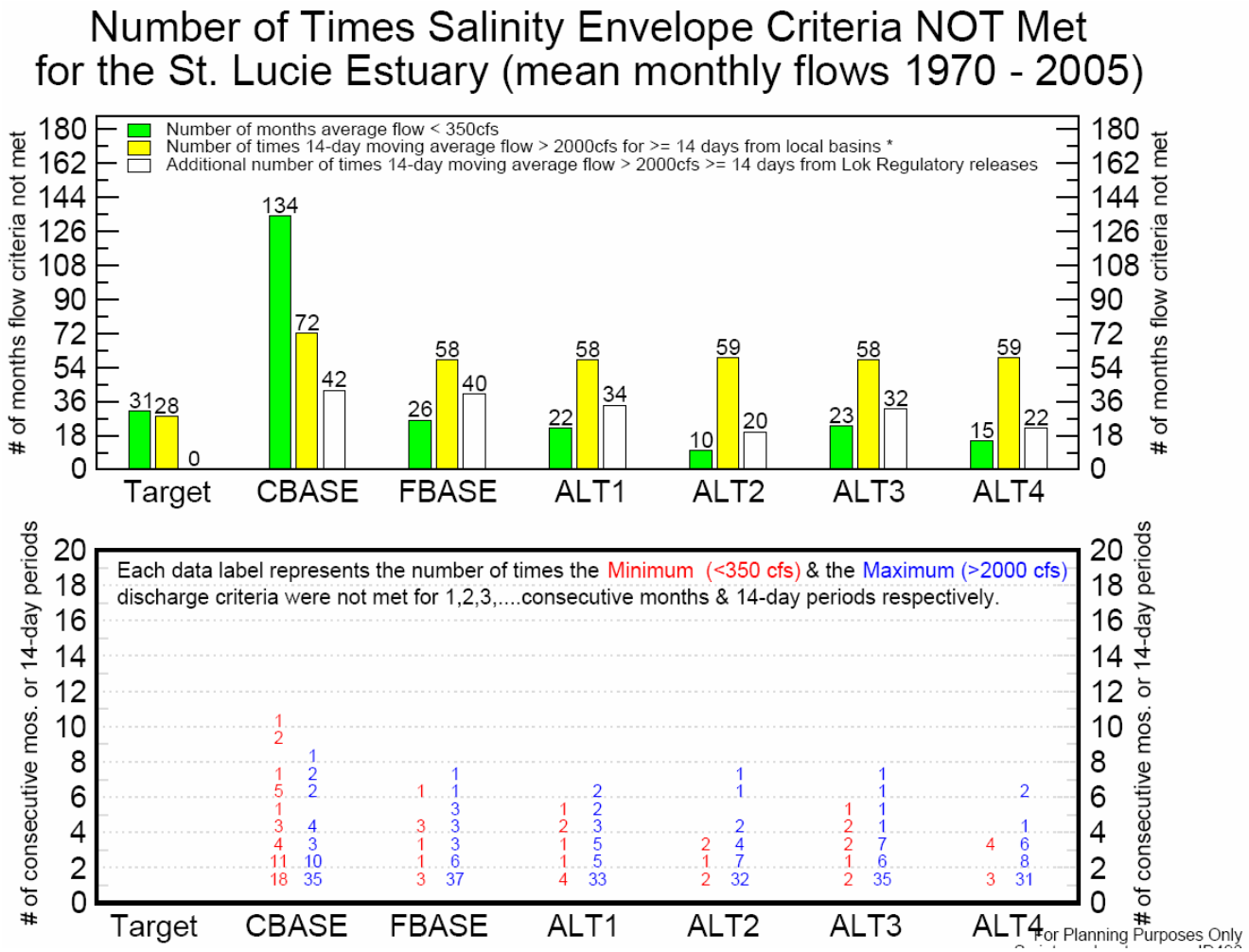

Figure 8-9. Simulated performance of Alternative Plans and Future Base – Number of Times Salinity Envelope Criteria for the St. Lucie Estuary NOT Met.

8.1.2.4 LOSA and EAA Water Supply

A P2TP project constraint is to achieve Lake Okeechobee water quality and water management benefits while meeting the other water related needs of the region including water supply. By using 7 years in the period of record with the most severe Lake Okeechobee Service Area (LOSA) water supply cutbacks, the water supply impact of each alternative plan can be compared. **Figure 8-10** shows the percentages and volumes of water supply cutbacks that would occur for each alternative during the seven most severe water shortage years. In each of the seven years, the water supply cutback volumes were reduced by each of the alternatives relative to the future base condition. The additional storage capacity of Alternative 2 resulted in the greatest reductions in cutbacks. However, in all but two of the seven years, the performance of Alternative 4 was comparable to Alternative 2.

Figure 8-11 shows the sources of water supply and the mean annual percentage of water supply demands not met for the EAA and LOSA. The additional storage capacity provided by Alternative 2 results in the largest increase in demands met in both, the EAA and LOSA. Overall, all four alternative plans appear to reduce demands not met as compared to the future base condition.

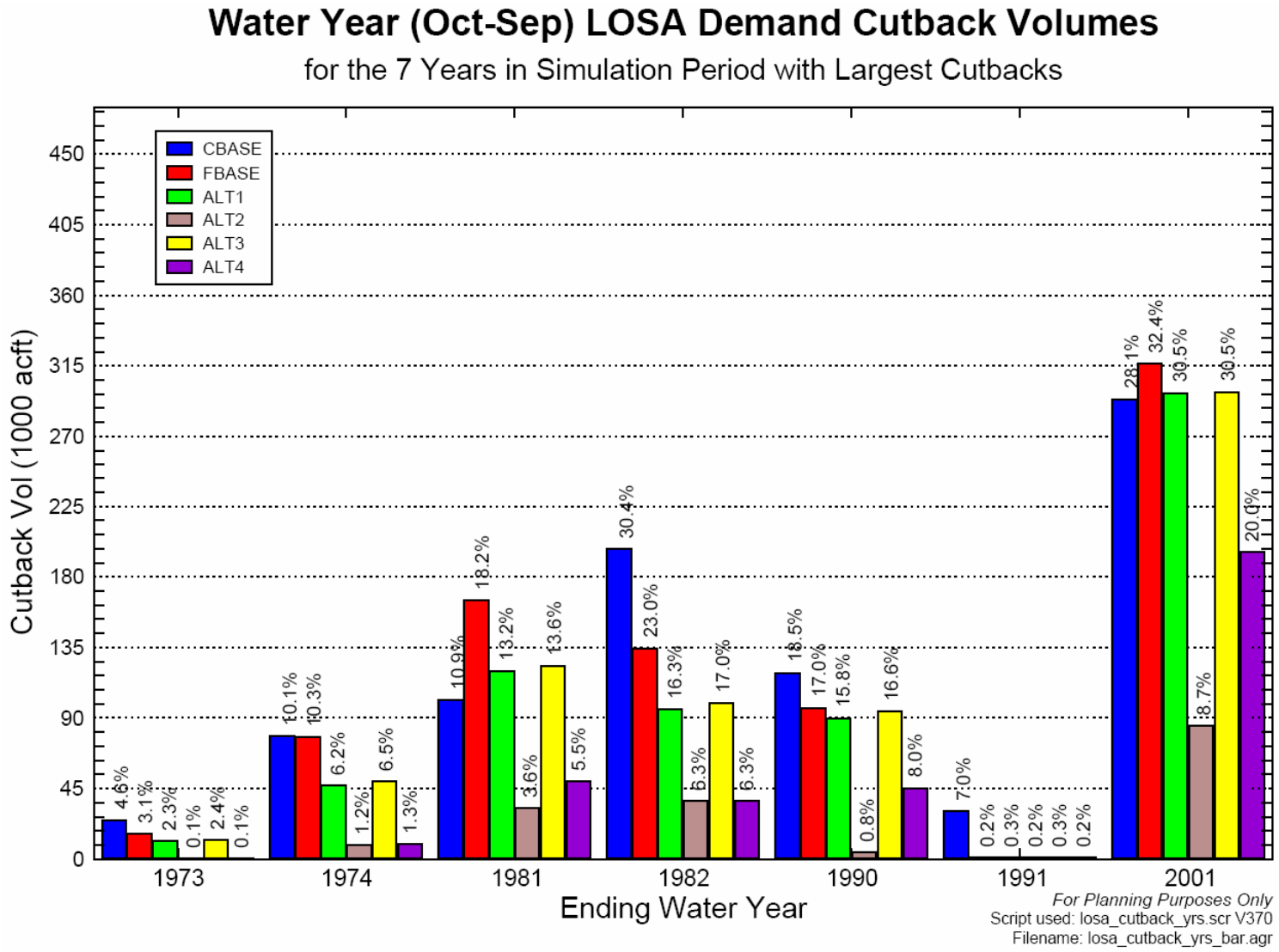

Figure 8-10. Simulated performance of Alternative Plans and Future Base – Water Year LOSA Demand Cutback Volumes.

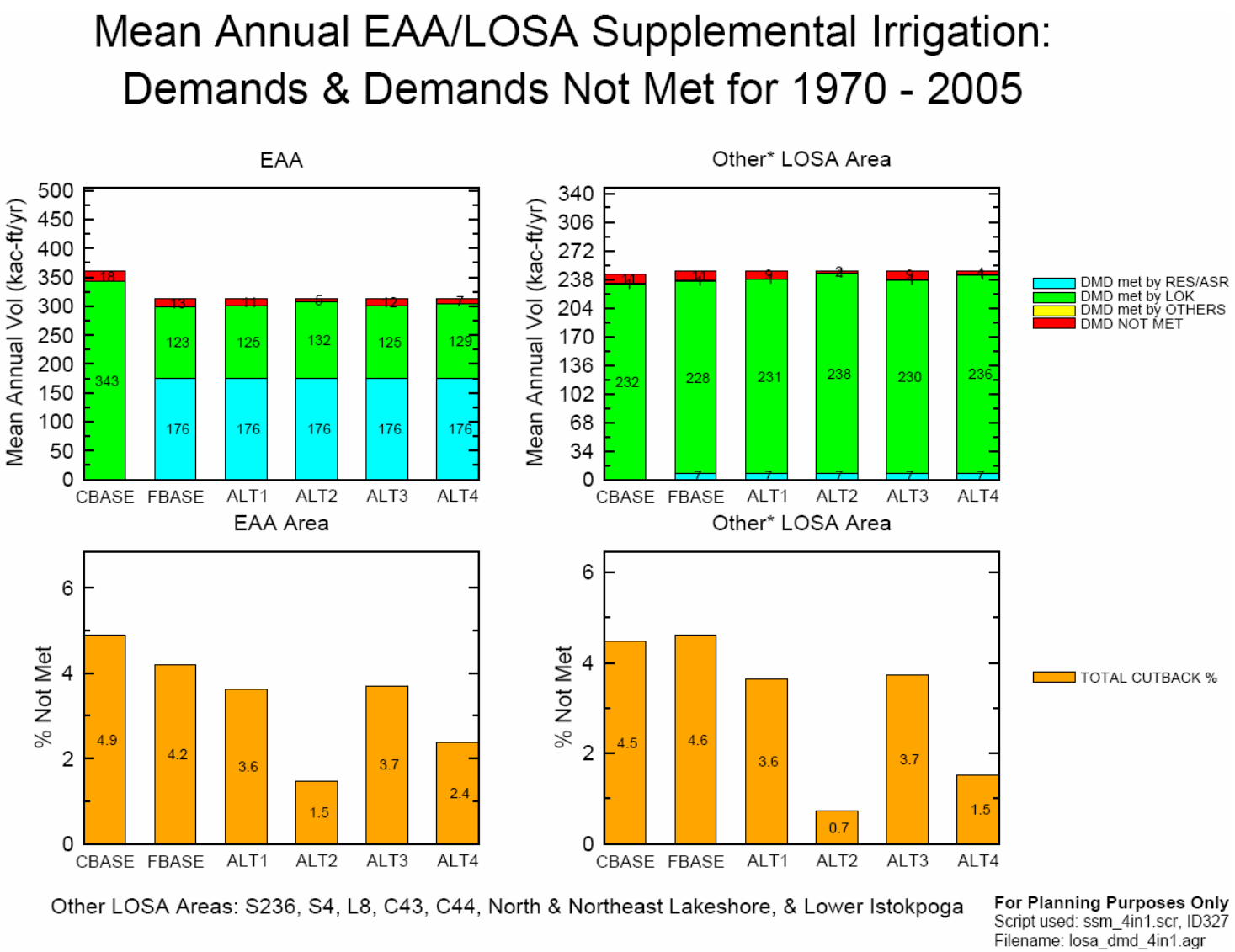

Figure 8-11. Simulated performance of Alternative Plans and Future Base – Mean Annual LOSA/EEA Supplemental Demands & Demands Not Met.

8.2 Alternative Plan Comparison

The simulated performance of each of the four alternative plans was compared with respect to the PMs, the other alternative plans, and to the current and future base conditions (**Table 8-4)**. In this table, the score of the best performing alternative(s) for a given PM is highlighted in bold text and the score of the second best alternative(s) is italicized.

From a water storage perspective, projects that will become operational in the future base condition will substantially improve water management capabilities compared to the current base condition. The future base condition will reduce undesirable high stages, reduce undesirable low stages, and increase frequency of water levels within the desirable seasonal stage envelope in Lake Okeechobee.

Similar improvements are also anticipated from altering water discharges to the St Lucie and Caloosahatchee Estuaries for the future base condition. These enhancements will result from the completion of the planned C-43, C-44, and EAA reservoirs as part of the Acceler8 Program.

A noteworthy benefit of Alternatives 2 and 4 is a reduction in the in-lake phosphorus load. This is accomplished by the withdrawal of Lake Okeechobee water, reducing the phosphorus concentration in an STA or reservoir, and then returning water to the lake with reduced phosphorus concentrations. The net result is a reduction in the total phosphorus load stored in Lake Okeechobee. These benefits are noted in **Table 8-4**.

Table 8-4. Performance Measure evaluation of current and future base conditions and Alternatives 1 through 4[a]

Performance Measure/Indicator	Target	Current Base	Future Base	Alt 1	Alt 2	Alt 3	Alt 4
Water Quality (ability to meet the TMDL)[b]							
Total surface phosphorus load reductions to Lake Okeechobee (metric tons)[c]	409	NA	NA	301	316	**364**	*360*
Total phosphorus load reduction to In-lake Loads (metric tons)[d]	Maximize	NA	NA	0	36	0	**74**
Water Quantity Storage							
Lake Okeechobee							
Extreme Low Lake Stage*	100	91.67	94.07	96.48	**100.00**	96.30	*99.07*
Extreme High Lake Stage*	100	83.59	87.88	91.92	**96.46**	92.42	*95.45*
Below Envelope - Weekly Average*	100	61.03	66.03	75.17	**99.10**	73.69	*89.20*
Above Envelope - Weekly Average*	100	58.00	65.85	71.25	**83.36**	72.40	*80.31*
Minimum Water Level and Duration **	< 6	6	4	4	**0**	4	*2*
Caloosahatchee Estuary							
High Discharge Exceeded							
Mean Monthly Flow > 2,800 cfs**	3	82	55	55	**43**	54	*51*
Mean Monthly Flow > 4,500 cfs**	0	38	25	22	**15**	21	*18*
Number of months Lake Okeechobee regulatory releases >2,800 cfs**	0	21	13	13	**9**	13	9
Salinity Envelope							
Mean Monthly Flow < 450 cfs**	0	190	32	29	**11**	29	*18*
Mean Monthly Flow >2,800 cfs**	3	82	55	55	**43**	54	*51*
St. Lucie Estuary							
High Discharge Exceeded							
2,000 cfs < Mean Monthly Flow < 3,000 cfs**	0	37	38	*34*	*34*	*34*	**33**
Mean Monthly Flow > 3,000 cfs**	0	28	21	21	**16**	20	*18*
Salinity Envelope							
Mean Monthly Flow < 350 cfs**	31	134	26	22	**10**	23	*15*
14-day (MAF) > 2,000 cfs from Lake Okeechobee Regulatory Releases**[e]	0	42	40	34	**20**	32	*22*
Water Supply							
Everglades Agricultural Area Mean Annual Percent Demand not Met (%)	0	4.7	4.2	3.6	**1.5**	3.7	*2.4*
Lake Okeechobee Service Area Mean Annual Percent Demand not Met (%)	0	4.4	4.6	3.6	**0.7**	3.7	*1.5*
Water Year Lake Okeechobee Service Area Demand Cutback Volumes- 7 Worst Years (K ac-ft)	Fig 8-10	Fig 8-10	Fig 8-10	Fig 8-10	**Fig 8-10**	Fig 8-10	*Fig 8-10*

[a] For each evaluation criterion, the alternative that performs the best is **bolded** and the second best performing alternative is *italicized.*

[b] Initial average load is 514 mt/yr (1991-2005); Total Maximum Daily Load (excluding atmospheric deposition) is 105 mt/yr. Load reduction needed to achieve the Total Maximum Daily Load is 514-105 = 409 mt/yr.

[c] This load reduction is counted toward meeting the Total Maximum Daily Load.

[d] At this time, this load reduction, while desirable, does not count toward the Total Maximum Daily Load .

[e] This evaluation criterion assesses whether the Lake Okeechobee Minimum Flows and Levels criteria are met. All alternatives result in less than 1 event per 6 years with stages below 11 ft NGVD for more than 80 days and are in compliance with the Minimum Flows and Level criteria.
*Standard Score
**Frequency

8.3 Risks and Uncertainties Analyses

With any large water resources planning effort, there are numerous sources of uncertainty that can potentially impact project outcome. Each source carries with it a level of risk of an undesirable outcome. For the P2TP projected performance of each of the four alternative plans was subject to some level of uncertainty. Major sources of this uncertainty include:

- large scale of the project,
- complexity and diversity of the problems and potential solutions,
- relationships between the impacted physical processes,
- conceptual nature of some of the plan components (Level 3, 4, and 5 MMs), and
- uncertainty related to the performance of some Level 1 and 2 MMs.

A risk and uncertainty (R&U) analyses was conducted to qualitatively assess the range of uncertainties associated with the projected performance of each of the four alternative plans. The results of the R&U analyses were used to guide the selection of the preferred plan.

8.3.1 R&U Analyses Methodology

8.3.1.1 Estimating Uncertainties Associated with MM Levels

In the P2TP planning process, potential risks of unanticipated outcomes must be considered so that appropriate risk management approaches can be developed and undertaken.

Each of the four P2TP alternative plans is made of up to five different types of MMs (Levels 1 to 5). Level 1 MMs generally have the following characteristics:

- There are substantial data supporting the effectiveness of the technology under similar conditions and scale.
- Planning work has been completed and shows that, compared to other alternatives, this measure is the most appropriate for the site specific situation.
- Private land owners, stakeholders, interest groups, the general public, and other agencies have been involved in development of the plan.
- Design work has progressed or has been completed and cost estimates have been prepared.
- A site has been identified and/or required real estate interests have been obtained.
- Funding has been budgeted.
- Progress has been made in gathering information, preparing/submitting permit applications, and/or processing permits.
- In some cases, construction has been initiated or even completed. In the completed projects, MM benefits are currently being evaluated.

In contrast, Level 5 MMs have the following characteristics:

- The proposed technology may be untested under the conditions and at the scale being considered.
- Only conceptual descriptions of the approach have been developed.
- Limited or no coordination with other interests has been conducted.
- No design work has been initiated.
- A site has not been identified other than on a regional basis.
- No funding has been budgeted.
- There is not enough information to initiate permitting.

The characteristics of Levels 2, 3, and 4 MMs lies between the two extremes (Levels 1 and 5).

Based on the MM characterization, a level of uncertainty was assigned to each MM level type **(Table 8-5)**. The increasing levels of uncertainty from 15 percent to 75 percent reflect the decreasing amount of available supporting information. Note that these estimates of uncertainty were subjective and are intended to support relative assessment of relative uncertainties.

Table 8-5. Uncertainty Associated with management measure (MM) levels.

Management Measure Level	Assigned Uncertainty (%) (plus or minus)
1	15%
2	30%
3	45%
4	60%
5	75%

8.3.1.2 Estimating Uncertainties Associated with MM Performance

Each alternative plan is composed of multiple levels of MMs. An estimate was made of the percent of the total water quality and water quantity benefits contributed by the MMs in each level. Alternatives that derive the majority of their benefits from Level 1 and 2 MMs will have relatively low levels of uncertainty (and risk). Conversely, alternatives that derive the majority of their benefits from Level 4 and 5 MMs are likely to have relatively high levels of uncertainty (and risk). **Table 8-6** shows the percentage of TP load reduction and storage capacity derived from the different MM Levels.

Uncertainties related to the TP load reduction performance for each alternative are relatively similar. This is because Level 1 and 2 MMs provide the majority (> 65 percent) of the projected TP load reduction for all alternatives. However, this analysis does account for the uncertainties related to interactions between the effectiveness of MMs within an alternative plan. If an actual TP load reduction of a MM is less than or greater than what was projected, it could impact inflow phosphorus concentrations and the performance of other MMs in the plan. The net result could be either better or worse overall performance. Uncertainties in potential TP load reduction performance of individual MMs are related to the following factors:

- The proof of concept for the phosphorus reduction technology

- The availability of lands
- Accuracy of projected flow volumes and phosphorus concentrations
- Inflow water chemistry

Table 8-6. Relative contribution of MM levels to total phosphorus (TP) load reduction and storage capacity.

	Alternative 1		Alternative 2		Alternative 3		Alternative 4	
	% Total TP Load	% Total Storage	% Total TP Load	% Total Storage	% Total TP Load	% Total Storage	% Total TP Load	% Total Storage
Level 1	79%	92%	75%	20%	65%	74%	66%	29%
Level 2	4%	--	4%	--	3%	--	3%	--
Level 3	17%	8%	16%	2%	15%	7%	15%	3%
Level 4	--	--	5%	78%	14%	19%	14%	68%
Level 5	--	--	--	--	3%	--	2%	--
Total	100%	100%	100%	100%	100%	100%	100%	100%

Uncertainties related to the storage capacity of each alternative cover a much wider range – from less than 20 percent to more than 50 percent. This is because Alternatives 2 and 4 derive most of their storage capacities from Level 4 MMs. These alternatives also include the largest storage capacities. The relatively small storage capacities of Alternatives 1 and 3 are largely provided by Level 1 MMs.

Uncertainties in potential storage capacities are related to the following factors:

- Availability of adequate land
- Cost of available land
- Existence of geotechnical conditions conducive to construction of surface storage reservoirs
- The location of available land near tributaries with large flows

Based on the Level 1 through 5 uncertainties described in **Table 8-5** and the proportion of benefits derived from each level of MM shown in **Table 8-6**, the overall uncertainties for each alternative were estimated. These uncertainties are useful for comparing the relative risks associated with the four alternatives. **Table 8-7** provides estimates of overall uncertainties of TP-load reduction and storage capacity benefits of Alternatives 1 through 4. A more thorough analysis of risk and uncertainty should be performed using more specific and quantitative information.

The primary sources of uncertainty for phosphorus load reduction effectiveness are largely associated with water quality MMs performance issues. Conversely, the primary sources of uncertainty for water storage are related to the magnitude to which storage MMs are implemented. As a result, the TP load reduction uncertainty of an alternative should not be compared with the uncertainty in storage capacity.

Table 8-7. Uncertainties for total phosphorus (TP)-load reduction and storage capacity for each alternative plan.

Alternative Plan	TP Load Uncertainty	Storage Uncertainty
1	21%	17%
2	23%	51%
3	28%	26%
4	27%	47%

Results from this preliminary R&U analysis were used in qualitative comparisons of the potential risks associated with Alternatives 1 through 4 for TP-load reduction and storage capacity.

8.4 Identification of the Preferred Phase II Technical Plan

A modified version of Alternative 4 was selected as the plan that best met the legislative goals (i.e. Phase II Technical Plan or the Preferred Plan). The two major goals of the NEEPP legislation are to meet the Lake Okeechobee total phosphorus (TP) TMDL and to provide additional storage capacity in the watershed in order to better manage Lake Okeechobee stages and reduce the magnitude and frequency of harmful freshwater releases to the two estuaries while meeting other water related needs. Both TP-load reduction from inflows to the lake and additional storage capacity in the watershed are required to achieve the restoration goals for Lake Okeechobee and the St. Lucie and Caloosahatchee estuaries.

Each alternative was evaluated for its performance at reducing phosphorus, improving Lake Okeechobee water levels, reducing damaging discharges to estuaries, and maintaining water supply. It was clear that Alternative 1 on its own would not meet the water quality and water quantity objectives (**Table 8-4**). Alternative 2 performed best at improving Lake Okeechobee water levels and reducing damaging discharges to the estuaries (**Table 8-4**). Alternative 3 performed best at reducing phosphorus inputs to Lake Okeechobee (**Table 8-4**). Alternative 4 performed the best when balancing the achievement of both water quality and water quantity objectives (**Table 8-4**). It falls short, however, of meeting the TMDL by 49 mt/yr. It also provides slightly lower water quantity benefits for Lake Okeechobee and the estuaries than Alternative 2, which had a larger storage capacity.

Therefore, a modified version of Alternative 4 became the basis for the preferred Plan. Additional features were added to address the phosphorus reduction shortfall and to provide a storage range from 900,000 to 1.3 million ac-ft for optimum water quantity performance.

The Preferred Plan (*modified Alternative 4*) includes additional measures to address the shortfall in phosphorus load reduction necessary to achieve the TMDL. These additional measures include refining, optimizing, and maximizing site-specific source controls as well as integrating and optimizing regional projects that include reservoirs and stormwater treatment areas. In addition, if necessary, expanded application of ASR and deep well technology, and limited application of chemical treatment technologies will be used to further reduce TP loading in order to achieve the TMDL.

A total storage capacity ranging from 900,000 to 1.3 million ac-ft is needed to achieve a more ecologically desirable range of Lake Okeechobee levels and to better manage lake discharges to achieve more desirable salinity ranges for the St. Lucie and Caloosahatchee estuaries. The storage need will be met with a combination of alternative water storage on public and private lands, surface reservoirs and ASR.

The Preferred Plan includes the following features:

- Builds upon the LOPP by fully incorporating all projects included in the 2007 LOPP update.
- Encompasses and builds upon all other on-going and planned efforts in the watershed that are directed toward Lake Okeechobee restoration including CERP and LOER.
- Initially emphasizes lower cost and locally applied source control options by incorporating and prioritizing all on-going and planned BMP and watershed phosphorus-source control programs.
- Promotes involvement of private landowners as partners in the restoration program through project features such as the BMPs, FRESP, and alternative water storage projects.
- Minimizes real estate acquisition requirements by attributing substantial TP-load reduction to source control options and promoting storage and treatment on privately owned lands.
- Includes regional projects that will complement and build upon success of source control options.
- Includes additional water quality projects necessary to meet the Lake Okeechobee TMDL for total phosphorus.
- Identifies the range of storage needed (900,000 – 1.3 million ac-ft) for lake stage and discharge management.

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SECTION 9

PREFERRED PLAN PROJECTS AND ACTIONS

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TABLE OF CONTENTS

TABLE OF CONTENTS

List of Tables

9.0 PREFERRED PLAN PROJECTS AND ACTIONS

An important aspect of the 2007 legislation that sets it apart from previous action is the requirement to identify both the water quality treatment and water quantity storage needed to improve the health of Lake Okeechobee and the St. Lucie and Caloosahatchee estuaries. The Lake Okeechobee Watershed Construction Project Phase II Technical Preferred Plan represents the best blueprint that current technology allows for achieving water quality standards while better managing lake levels. An explanation of how this plan was identified as the best Preferred Plan to meet these objectives can be found in *Section 8.4*. This section describes the suite of Preferred Plan features and provides their projected performance. Operations and maintenance, monitoring and permitting requirements are identified, where appropriate.

9.1 Technical Preferred Plan Summary

The Preferred Plan consists of a suite of local and regional project features and includes both structural and non-structural management measures (MMs) and builds upon ongoing treatment and restoration projects that are in the planning, design, or construction phases. Collectively, all the project features operating together are expected to provide necessary improvements in water quality and quantity. All five levels of MMs are represented in the Preferred Plan. The degree of uncertainty around the projected benefits for each MM level varies from *certain* (for Level 1 MMs) to *uncertain* (for Level 5 MMs) (**Table 9-1**).

Table 9-1. Summary of P2TP benefits and degree of uncertainty for MM level.

MM Level	Configuration Information	Implementation Certainty	Projected Benefits Certainty	Cost Estimate Confidence
1	Well established	Certain	Very High	Very High
2	Known	High	High	High
3	Conceptual	Moderate	Moderate	Moderate
4	Limited	Low	Low	Low
5	Very Limited	Uncertain	Very Low	Very Low

Water Quality Goal

The NEEPP legislation identified the Lake Okeechobee Total Phosphorus (TP) TMDL of 140 mt as the water quality goal. To that end, the Preferred Plan includes a variety of water quality improvement measures including source control (Best Management Practices and changes in regulatory requirements), stormwater treatment areas, deep injection wells, and innovative nutrient control technologies to achieve the TMDL. In addition, implementation of the Preferred Plan provides the capability to reduce in-lake total phosphorus loads by approximately 75 mt/yr and ancillary water quality benefits may result from implementation of storage features. It is recognized that it may be necessary to further optimize and refine the management measures as well as incorporate chemical treatment and expand the use of deep-well injection to meet the TP TMDL.

Water Quantity Storage Goal

The Preferred Plan has identified a water quantity storage goal in the range of 900,000 to 1.3 million ac-ft in order to achieve Lake Okeechobee levels within a more ecological desirable range and to better manage lake discharges to achieve more desirable salinity ranges for the St. Lucie and Caloosahatchee estuaries. It is important to note that the storage goal of 900,000 to 1.3 million ac-ft is not in addition to existing or planned projects. It is an overall goal that can be achieved through various means including low intensity/local measures such as alternative storage and land management activities as well as through more intensive/regional measures such as ASR and large-scale storage reservoirs. The magnitude of this storage need that can be achieved through low intensity/local measures has not yet been quantified. As more detailed information on these features is compiled, it will be possible to quantify the water storage benefit from these features. Regardless, it is recognized that these local features alone will not be able to achieve the water quantity storage goal.

Therefore, regional measures, such as ASR and storage reservoirs, will be required. It is anticipated that a combination of these two approaches will be necessary and that co-location and integration of these two storage methods may provide the best solution. Results of ongoing Lake Okeechobee ASR pilot and regional studies, will allow for a determination of the best combination of these measures to achieve the identified storage goal.

9.2 Preferred Plan Features

9.2.1 Local Project Features

Local project features provide an important foundation for this Preferred Plan to improve water quality and storage. Local project features typically require minimal engineering, construction, and operation efforts, and can be implemented more rapidly. Local project features are generally implemented at the parcel-scale and usually do not require land acquisition. Project features of they type are usually implemented through rules and public education or outreach efforts. Many of these project features are existing on-going programs or processes that will continue to be implemented and optimized as new information becomes available. Local project features offer tremendous opportunities for landowner involvement.

9.2.1.1 Lake Okeechobee Watershed Phosphorus Source Control Programs

Source control refers to all activities and measures that can be used on agricultural and urban lands to ensure that:

- the amount of nutrients used onsite are minimized to the greatest possible extent
- those nutrients that are used are applied in an effective manner which minimizes their entry into the local runoff
- local runoff is retained onsite to prevent nutrients from entering the regional drainage system

Collectively, source control measures (also referred to as Best Management Practices or BMPs) include structural and non-structural measures. Structural measures include creating physical changes in the landscape to reroute local discharges, erecting fences and barriers, and installation

of water control structures. Non-structural source control measures include education, operational changes, and establishing regulations.

Numerous source control programs are currently being implemented in the LOW by the District, FDEP, and FDACS to reduce nutrient loads from both agricultural and urban land use practices. Most of these programs are expected to continue in the future and several of them are slated to be expanded to cover new geographic areas or revised to incorporate more stringent requirements. The LOPA directive is that the LOW source control programs shall be implemented on an expedited basis and that the coordinating agencies shall develop an interagency agreement that assures the development of BMP programs that complement existing regulatory programs (see *Section 9.2.1.1.1*) and specifies how BMPs will be implemented and verified. LOPA also directs that the agreement shall address measures to be taken by the coordinating agencies during any BMP reevaluation performed as a result of water quality problems being detected. All of the coordinating agencies' source control programs have been integrated into the Preferred Plan and are expected to significantly contribute to achieving the Lake Okeechobee TP TMDL. It is expected that the coordinating agencies will execute an Interagency Agreement in 2008 to meet the source control program directives of LOPA.

Based on the 2007 LOPP update, source control BMPs will be implemented in the Lower Kissimmee (five basins), Taylor Creek/Nubbin Slough (4 basins), Indian Prairie (12 basins), Fisheating Creek (2 basins), and East Lake Okeechobee (2 basins) sub-watersheds by 2009. BMP implementation in the Lake Istokpoga (4 basins) and Upper Kissimmee Basins (18 basins) will commence in 2009. BMPs in the Lake Istokpoga sub-watershed will be fully implemented by 2012. BMPs in the Upper Kissimmee sub-watershed will be fully implemented by 2015. The S-4 and Industrial Canal basins located in the Southern sub-watershed implement the BMP program under their existing WOD permit.

The currently implemented agricultural BMPs, in addition to those planned for implementation, are projected to reduce TP loads to Lake Okeechobee by approximately 147 mt/yr (see Table 8-1 for more details on BMP reduction). This projection includes TP reductions associated with the major ongoing LOW source control programs described in the next sections.

9.2.1.1.1 SFWMD Phosphorus Control Programs

9.2.1.1.1.1 Environmental Resource Permit Program

The existing Environmental Resource Permit (ERP) program, which covers the entire SFWMD jurisdiction, regulates activities that alter surface water flows. These include land development projects that influence stormwater runoff in upland areas and dredging and filling activities in wetlands and surface waters. The primary objective of the ERP program, which is implemented by the District and FDEP, is to ensure that alterations in stormwater runoff do not degrade surface water quality, compromise flood protection, or adversely affect the function of wetland systems.

Prior to adoption of the rulemaking activities discussed below and in following sections, it is anticipated that this existing process will be enhanced by utilizing a nutrient analysis to determine if proposed activities will impact downstream water quality. Under the existing WOD

program, where projects are found to have impacts, acceptable mitigation will be required for project approval. This program applies to both agricultural and non-agricultural activities. In addition, the District is in the process of developing an ERP basin rule that will require applicants to provide reasonable assurances that they will appropriately improve the hydrology within the Lake Okeechobee, Caloosahatchee River and St. Lucie River watersheds in accordance with Chapter 373.4595, F.S. The basin rule will be supplemental to existing criteria. Average annual discharge volumes and specific storm event discharge volumes will be addressed. Methods for estimating storage capacities in typical water management BMPs and in low impact design type water management BMPs will be included in the rule.

9.2.1.1.1.2 Works of the District Regulatory Phosphorus Source Control Program

Phosphorus source controls in LOW began with the enactment of the Surface Water Improvement Management Act in 1987 which led to the adoption of the Lake Okeechobee Works of the District (WOD) rule under Chapter 40E-61, FAC. This rule was initially adopted to address the reduction of phosphorus to Lake Okeechobee based on the goals and objectives of the SWIM Plan for the lake. It is the foundation of all subsequent BMP Programs which are directed to complement the existing WOD BMP and the ERP programs. It was recognized at the time that the WOD rule was originally adopted that additions or amendments to the rule may be necessary in the future, consistent with the results of research and evaluation.

The WOD BMP Program is an on-going program of BMPs implemented by issuing permits for agricultural and non-agricultural land uses. It is a comprehensive program of BMP plan approval, verification of implementation through reporting and field visits, and data evaluation to identify optimization efforts. This program is expected to continue under NEEPP to meet current goals and objectives. The District is refining the existing rule criteria to be compatible with current initiatives and amendments to the statute. The initiatives include:

- Implement a phosphorus source control program utilizing best management practices (BMPs) for all lands within the Lake Okeechobee watershed (LOW);
- Provide an option for agricultural land uses of greater than 100 acres to participate in the FDACS BMP rule under Chapter 5M-3, F.A.C., to meet the intent of the District's WOD rule;
- Establish a timeline for implementation of all BMP source control programs within the watershed by 2010
- Establish load-based performance measures for the combined BMP source control programs implemented in the watershed
- Define the monitoring network necessary to monitor compliance with the established performance measures, to identify priority areas of water quality concern and BMP optimization, and to provide data to evaluate and enhance performance of downstream treatment facilities
- Establish a plan for optimizing the combined BMP source control programs should the expected water quality criteria not be met;
- Ensure that the rule is consistent with data presented in LOPP; and
- Include incentives for permittees to participate in TP reduction demonstration projects that will provide valuable data for expanding, accelerating, and optimizing the implemented

BMPs to meet water quality objectives and for further refinement of the LOW BMP Program as necessary.

In order to have BMPs fully implemented in LOW and performance measures in place by 2010, the rule amendments must be adopted in 2008. Once adopted, it is anticipated that there will be a phased approach to implementation based on areas identified as water quality priorities and District resources.

9.2.1.1.2 FDACS Agricultural BMP Programs

Based on directives under the 2000 LOPA, FDACS has been developing and implementing agricultural BMPs to reduce the movement of TP from agricultural lands into Lake Okeechobee. These voluntary agricultural BMP programs are expected to continue under the NEEPP. Rule (Chapter 5M-3, F.A.C.) adopted by FDACS pursuant to LOPP encourages agricultural producers on greater than 100 acres to implement a conservation, nutrient-management, or alternative Plan consistent with specified National Resources Conservation Service (NRCS) requirements. These Plans are farm-specific assessments that identify existing environmental resource challenges and appropriate BMPs to address those challenges.

As a result, FDACS and NRCS have executed an interagency Memorandum of Agreement that commits available federal resources to expedite conservation planning in the LOW. Funding through this agreement has been used to identify, train, and contract with private-sector technical service providers to develop Plans for cow/calf, citrus, row crop, and other agricultural operations. This effort has significantly increased Plan development and implementation, including the engineering and design of planned water control structures.

Completed conservation Plans now cover approximately 527,370 acres (213,423 ha) in the watershed (including approximately 22,000 acres of dairies). These Plans are in various stages of implementation. In addition, conservation Plans are being developed for an additional approximately 600,000 acres (242,811 ha) of agricultural operations.

Other voluntary FDACS BMP programs, which do not require the development of conservation Plans, but do require management plans, include Ridge Citrus, Gulf Citrus, Indian River Citrus, Container Nurseries, and Vegetable and Agronomic Crop BMP programs. FDACS is currently preparing an estimate of the acreage in the LOW with notice of intents (NOI) submitted under these programs. Preliminary estimates indicate that more than half of the agricultural acreage in the LOW is currently under non-regulatory FDACS programs to plan and implement practices to control offsite movement of TP.

At the current rate of participation, all agricultural acreage in the watershed is expected to be covered either by F.A.C. Rule 5M-3 required conservation Plans or other FDACS BMP programs by July 2010 and will have functioning BMPs in place by 2015.

9.2.1.1.3 Supplemental Non-Agricultural BMP Programs

In coordination with the District, under LOPP, FDEP is charged with implementing supplemental phosphorus source control programs complementary to existing regulatory

programs in non-agricultural areas. The largest non-agricultural contributors of TP loads to Lake Okeechobee are residential developments without stormwater treatment (e.g., yard fertilization, pet wastes, septic tanks, etc.), golf courses, and failing wastewater systems (e.g., septic tanks and package plants). Measures implemented to control TP loads from these sources include implementing site-specific BMPs, master planning for stormwater and wastewater, implementing stormwater retrofits, designing larger urban stormwater projects, and public education. All of these efforts will continue under the NEEPP.

Additionally, FDEP and the District initiated rule development in May and June 2007 respectively of a Unified Statewide Stormwater Rule. Currently, regulatory requirements governing stormwater treatment are technology-based, and rely primarily upon BMP design criteria that are presumed to achieve a specified level of stormwater treatment. Under the proposed Unified Statewide Stormwater (USS) Rule, FDEP and Florida water management districts are working on criteria that will be based on a performance standard of post-development nutrient loads (total phosphorus and total nitrogen) not exceeding pre-development nutrient loads.

The pre-development condition is an existing site with natural vegetation, not necessarily existing conditions. Methods for estimating treatment efficiency in typical water management BMPs and in low impact design type water management BMPs will be included in the rule. The proposed rule will also address retrofit projects, redevelopment and compensating treatment. The intended effect of the rule is to increase the level of treatment required for nutrients loads in stormwater from new development to that of natural conditions, thereby reducing the discharge of nutrients to the lowest reasonable level for new development. The target date for rule adoption is May 2009.

Another statewide program targeting phosphorus in urban discharges is the **Urban Turf Fertilizer Rule**. The Urban Turf Fertilizer (UTF) Rule, which was adopted by FDACS in 2007, limits P and nitrogen (N) content in fertilizers that are used for urban turf and lawns. This Rule is intended to reduce nutrient loads from urban fertilizer applications by requiring that all fertilizer products labeled for urban use (turf, sports turf, and lawns) only contain the amount of P and N that is actually needed to support healthy turfs and lawns. The rule requires that applications rates for phosphorus not exceed an application rate of 0.25 pounds (lbs) P_2O_5 per 1000 ft^2 per application and not exceed 0.50 lbs P_2O_5 per 1000 ft^2 per year.

The rule also requires that application rates for nitrogen not exceed 0.7 lbs of readily available nitrogen per 1000 ft^2 per application, with no more than 1 lb total N per 1000 ft^2 per application. Under this rule, FDACS expects a 20-25 percent reduction in N and a 15 percent reduction in P in every bag of fertilizer sold to the public. The UTF Rule will continue to be enforced under the NEEPP. Note that the UTF represents the current state of science and will revised by FDEP research.

9.2.1.2 Land Management Programs

Land management programs are designed to protect sensitive environmental resources from unintended adverse impacts that result from changes in land use or land management practices in the watershed. Several ongoing regulatory programs focus on reducing nutrient loads through

implementation of improved land management practices. Most of these programs are expected to continue under NEEP and some programs will be expanded. All ongoing and future planned land management programs have been incorporated into the Preferred Plan and are expected to significantly contribute to the overall achievement of LOWCP Phase II goals and objectives. In recognition of the importance of natural lands restoration, the South Florida Ecosystem Restoration Task Force (SFERTF) undertook a study to identify and prioritizes natural attributes of lands necessary to achieve natural system restoration goals for the South Florida ecosystem. This study reported that two types of lands are needed to achieve natural system restoration in the South Florida ecosystem:

a. lands needed for construction and operation of project features that will capture, store, and treat water to provide improvements in the quantity, quality, timing and distribution of water necessary to achieve natural system restoration; and

b. "natural lands" on which historical, pre-drainage water flows and levels will be restored, such as lands on which sheet flow will be restored, drained wetlands will be re-hydrated, and/or wetland/upland mosaics will be enhanced and preserved to expand the spatial extent of wetlands and natural areas within the Everglades.

Both types of lands are critical to accomplishing the natural system restoration goals of the Comprehensive Everglades Restoration Plan (CERP) and both are under severe development pressure that is driving up land costs at an exponential rate. The study focused on prioritization of natural lands on which historical flows and levels will be restored. It analyzed 189,471 acres of unacquired natural lands and prioritized 186,087 of those acres based upon their outstanding natural attributes and the key role they could play in ecosystem restoration (SFERTF, 2006).

Major land management programs that are currently being implemented in the LOW include the following:

9.2.1.2.1 Comprehensive Planning/Land Development Regulations

Land use decisions fall under the purview of local government and are governed by local government comprehensive Plans, local ordinances, and regulations. The Florida Department of Community Affairs (FDCA) is the state land Planning agency and is responsible for reviewing local government comprehensive Plans for consistency with the State's growth management policies. The FDCA has established processes to allow for input from state agencies, regional Planning councils, water management districts, and other stakeholders regarding local government comprehensive Plans, Plan amendments, and evaluation and appraisal reports. However, some land use changes important to the P2TP do not require an amendment to a local government comprehensive Plan. As such, it will be important to keep track of relevant zoning changes and special use provisions since they can vary from county to county.

The FDCA provides technical assistance to local governments in the LOW for local government comprehensive Plan amendments, developments agreements, Developments of Regional Impact, Evaluation and Appraisal Reports, and other Planning related efforts. The FDCA works with these entities to ensure that local decisions consider water resource issues in the LOW such as

promoting low impact design, stormwater management, and water quality protection. The FDCA will continue supporting local government Planning efforts under the NEEPP. Another important growth management and planning effort that falls under the authority of the FDCA is the Rural Land Stewardship Areas (RLSA) Program. This program authorizes counties to designate rural land stewardship areas. These lands may include all or portions of lands classified in the future land use element of the local government comprehensive Plan as predominantly agricultural, rural, open, open-rural, or a substantively equivalent land use. The intent of the RLSA Program is to maintain the viability of agriculture, protect rural character, prevent the encroachment of urban sprawl into rural and agricultural areas, and preserve open space for agriculture and protect natural resources.

This planning technique also contemplates a minimal development footprint and a high ratio of conservation/preservation lands to development lands. Within these areas, planning and economic incentives are applied to encourage the implementation of innovative and flexible planning and development strategies and creative land use planning techniques. This and other land use planning techniques, such as clustering development and transferable development rights, are tools that can facilitate the construction of public works projects and the acquisition of lands necessary to protect and restore the watershed and downstream receiving water bodies.

9.2.1.2.2 Farm and Ranchland Protection Program Partnership

The Farm and Ranchland Protection Program (FRPP) is a voluntary USDA Natural Resources Conservation Service (NRCS) program that helps farmers and ranchers keep their land in agriculture. The program provides matching funds to State, Tribal, or local governments and non-governmental organizations to purchase conservation easements. These easements which would remain in agriculture will provide water quality and storage benefits.

9.2.1.2.3 Florida Ranchlands Environmental Services Project (FRESP)

This program, launched in October 2005, is intended to provide a mechanism by which local landowners can sell environmental services related to water retention, TP load reduction, and wetland habitat expansion to state agencies and other willing buyers. This program has been incorporated into the Preferred Plan because it offers several distinct advantages:

- There are no land acquisition costs and it offers a financial incentive to landowners to promote participation.
- Private entities can typically implement projects much quicker and cheaper than government agencies.
- The sale of environmental services will provide additional income for ranchers, who face low profit margins, and will provide an incentive against selling land for more intensive agriculture and urban development—land uses that will further aggravate water flow, pollution, and habitat problems.
- The program complements public investment in regional water storage and water treatment facilities.

FRESP is currently being implemented through a collaboration of the World Wildlife Fund (WWF), eight participating ranchers, NRCS, FDACS, SFWMD, and FDEP. Technical support is being provided by scientists from the MacArthur Agro-Ecology Research Center and the University of Florida. Funding from Federal, state, and private sources exceeds $5 million for Phase 1, which includes pilot project implementation and program design. In addition, the District has provided State Community Budget Issue Request (CBIR) funding for similar additional pilot projects on private lands.

The program is currently field testing different methods of using monitoring and modeling of hydrology, water and soil chemistry, and vegetation change to document the level of environmental services provided by ranch level water-management practices.

To date, the following private landowners have agreed to participate in this program; efforts are on-going to invite other landowners to join the program.

- **Buck Island Ranch** – This ranch, located in the Lake Istokpoga Sub-watershed, will provide approximately 967 ac-ft of on-site water storage and treatment with removal of an estimated 3,341lb of TP per year.

- **Lykes Brothers, Inc.** – This project, located in the Lake Istokpoga Sub-watershed, will provide 5,000 ac-ft of regional water storage. Some water quality improvements are also expected from retaining water on-site; these benefits have not yet been quantified.

- **Williamson Cattle Company** – This project, located in the S-191 sub-basin of the Taylor Creek/Nubbin Slough Sub-watershed, will provide approximately 150 ac-ft of storage and treatment, removing an estimated at 548 pounds of TP removal per year.

- **Alderman Delony Ranch** – The project, located in the East Lake Okeechobee Sub-watershed, will provide approximately 43 ac-ft of storage in the C-25 sub-basin. TP removal is estimated to bet 172 lb /yr.

- **Syfrette Ranch West** – The project, located in the Lake Istokpoga Sub-watershed, will provide approximately 140 ac-ft of water storage capacity. Some water quality benefits are expected from this project; these have not yet been quantified.

- **Rafter T Ranch (Arbuckle Creek)** – The project, located in the Lake Istokpoga Sub-watershed, will store approximately 1,145 ac-ft of water. Some water quality benefits are expected from this project; these have not yet been quantified.

- **Payne and Son** – This site, located in the Fisheating Creek Sub-watershed, will provide approximately 932 ac-ft of storage capacity. Some level of water quality improvement is expected from this project; these benefits have not been quantified.

- **Lightsey Cattle Company** – This site, located in the Fisheating Creek Sub-watershed, will provide approximately 135 ac-ft of storage capacity. Some level of water quality improvement is expected from this project; these benefits have not been quantified.

9.2.1.3 Alternative Water Storage Facilities

These alternative water storage facilities (AWSFs) are primarily intended to retain stormwater runoff on site and thereby reduce flow to the regional drainage systems. Nutrient load associated with the detained volume of water is also prevented from leaving the parcel. AWSFs thus provide both localized water quantity and water quality benefits in the LOW and contribute to overall improvements in Lake Okeechobee water quality and stage management. AWSFs generally require minimal engineering, construction, and operation and maintenance efforts and can be sited either on privately owned agricultural lands in cooperation with the landowners or on public and tribal lands.

Under the LOER initiative, AWSF implementation plans were completed for four locations in the LOW and four other locations were identified for siting such facilities. These eight facilities have been incorporated into the Preferred Plan. Provisions for identification of other locations in the LOW to site such facilities is also included in the Preferred Plan. To date the following locations in the LOW have been identified for siting AWSFs:

- **Brighton Reservoir** – This facility will provide storage capacity of up to 1,300 ac-ft and reduce TP loads by approximately 1.5 mt/yr. It will consist of a 500 acre reservoir to be located on the Brighton Seminole Reservoir in Lower Kissimmee sub-watershed.

- **Avon Park Air Force Range (APAFR)** – Approximately 10,000 ac-ft of stormwater runoff will be retained on a 3,600 acre site at this location. Some water quality improvements are also expected from capturing and holding water on-site; these benefits have not yet been quantified. This project also includes restoration of an existing levee and replacement of selected water control structures in Arbuckle Marsh. Stormwater runoff to Arbuckle Creek and Lake Istokpoga will be reduced by this project.

- **Indiantown Citrus Growers Association (ICGA)** – Approximately 3,550 ac-ft of stormwater will be retained on a 1,775 acre site at this location. Phase 1 of the project will include the rehabilitation and relocation of existing pump stations. The ICGA will use their irrigation pumps at the St. Lucie Canal to draw regulatory regional lake releases into their site for disposal, which will reduce freshwater volumes to the estuary. Phase 2 of the project will include widening ditches in the ICGA ditch system.

- The detention of stormwater within the existing ditch system is expected to result in water quality improvements, promote water conservation, and reduce the volume of surface water discharged to the St. Lucie Canal and Estuary. Expected water quality benefits of the project have not yet been quantified.

- **Barron Water Control District (BWCD)** – 5,000 ac-ft of stormwater runoff will be retained on a 6,129 acre site at this location. Water retention will be accomplished through the construction of two weirs in an existing canal within the BWCD canal system. Some water quality improvements are also expected from this project; these benefits have not yet been quantified.

- **Raulerson and Sons Inc., Ranch** – This site would provide approximately 300 ac-ft of storage on a 670 acre site. On-site stormwater runoff will be captured from the farm and pumped into three stormwater ponds; this AWSF is expected to meet approximately 82 percent of the farm's irrigation demands. Storing water on this site will also reduce runoff to Fish Slough. Some water quality improvements are expected from retaining water on-site; these benefits have not yet been quantified. Implementation funds will be obtained from contributions and grants from the District, Alternative Water Supply Funding, FDACS, local farmers, and USDA EQIP.

- **Kissimmee Prairie Preserve State Park** – This feature would store approximately 3,800 ac-ft of storage on a 1,920 acre parcel. Some water quality improvements are also expected from retaining water on-site; these benefits have not yet been quantified. This project is expected to reduce stormwater runoff and enhance water quality entering Duck Slough. The park is owned by the State of Florida and managed by FDEP's Division of Recreation and Parks.

- **Rolling Meadows** – This site would provide approximately 2,912 ac-ft of storage on 720 acre District owned parcel located in the Upper Kissimmee Sub-watershed. It will detain, store, and provide some natural treatment for runoff that would otherwise flow into Lake Kissimmee. A bermed area already exists that can be incorporated into the design of the proposed project. A new culvert is proposed to restore natural flows and gravity-feed into the bermed area. Small agricultural pumps could be used to fill the detention area with additional agricultural land runoff. Some water quality improvements are expected from retaining water on-site; these benefits have not yet been quantified.

- **Sumica** – This site would provide approximately 281 ac-ft of storage on a portion of 1,920 acres of land in Polk County (Upper Kissimmee sub-watershed) which has been over drained by adjacent DOT box culverts. This project proposes to install a rip rap weir upstream of box culverts to maintain stormwater for hydrologic restoration on-site before eventually reaching Lake Kissimmee. Some water quality improvements are expected from retaining water on-site; these benefits have not yet been quantified.

- **Fisheating Creek Marsh Watershed Project** – This project would provide between 11,000 to 22,000 ac-ft of storage. It will evaluate, engineer, and rehabilitate PL 566 water control structures in the Fisheating Creek Marsh Watershed to more effectively store and manage water and reduce phosphorus runoff from more than 50,000 acres in the headwaters of Fisheating Creek.

- **Lykes Nicodemus Slough** – This project will have the potential to store 13,000 to 26,000 ac-ft of water from Lake Okeechobee. It includes design, engineering, and implementation of a water storage area on 15,129 acres of which a flowage easement exists on the southern most 2,000 acres in an area surrounding Nicodemus Slough near Fisheating Creek.

- **Central County Water Control District (CCWCD) Reservoir** – This project would provide approximately 4,800 acre-ft of additional storage in the LOW. It involves construction and operation of the CCWCD reservoir under a cooperative agreement between

the South Florida Water Management District and CCWCD to provide both flood protection and excess water storage in the Caloosahatchee Basin. Currently there are conveyance facilities in place which hydraulically connect the CCWCD reservoir to the Caloosahatchee River.

- **Dupuis** – This site would store between 1,250 to 4,500 ac-ft of runoff. The project includes design, engineering, and implementation of an additional 1 to 2 feet of storage in the Dupuis marsh before on-site stormwater enters the L-8 Canal.

- **Stokes** – This site would provide approximately 510 ac-ft of water on a 490 acre site in the Fisheating Creek Basin. Estimated TP load reduction projected to range from 0.004 mt/yr to 0.02 mt/y.

- **Istokpoga Marsh Improvement District** – This project is projected to provide up to 1,920 ac-ft of on-site storage. It includes design and construction of an agricultural water treatment facility within the Istokpoga Marsh Improvement District to reduce phosphorus runoff and provide additional storm water storage for the 19,209 acre area. The Istokpoga Marsh Improvement District was created in 1962 and Highlands County is the local sponsoring organization. Estimated TP load reduction is projected to range from 0.09 mt/yr to 0.24 mt/yr.

- **Caulkins** – This project includes rehabilitation and relocation of internal pump stations. During regulatory releases to the St. Lucie Estuary irrigation facilities will be utilized to draw excess stormwater into the 3,400 acre project site. The detention of stormwater within the existing ditch system will result in water quality improvements thereby promoting water conservation and reducing the volume of surface water discharge from the site.

- **Waste Management St. Lucie Site** – This project involves entering into a partnership arrangement to modify borrow areas into minor above ground impoundment(s). Preliminary hydrologic investigation is in process. Details are being developed.

- **Lake Wales Ridge State Forest Lake Kissimmee Site** - Internal ditch plugs and modified control structures on 800 acres of the site are estimated to provide approximately 800 acre-ft of additional storage.

9.2.1.4 Local Initiatives

The Preferred Plan includes all ongoing and future planned local initiatives that will contribute to overall flow attenuation and nutrient load reduction to Lake Okeechobee. Three local projects are ongoing in the TCNS Sub-watershed; opportunities for similar other projects are currently being investigated.

- **Taylor Creek Canals Sediment Removal** – This project includes sediment and vegetation removal from canals and tributaries that drain to Taylor Creek from the Treasure Island and Taylor Creek Isles residential areas. Approximately 1 mt of TP was removed from the system by this project.

- **Okeechobee City Sediment Trap Installation** – This project includes installation of two sediment traps within the city of Okeechobee for the removal of phosphorus-laden particulates that contribute to the load entering Lake Okeechobee. The water quality improvements expected from this project have not yet been quantified.

- **Nubbin Slough East Flow Diversion** – This project includes diverting Nubbin Slough flows to restore the east main tributary of the slough. The diversion is expected to provide flood control and water quality benefits. The water quality improvements expected from this flow diversion project have not yet been quantified.

9.2.2 Regional Features

Although local features are expected to provide substantial TP load reductions and some flow attenuation, they are not large enough in scale to achieve the overall Preferred Plan objectives. Therefore, the Preferred Plan includes several large structural features that will be implemented on a regional basis. Several of these structural features, particularly STAs and storage facilities, are Level 4 or 5 MMs and therefore they are conceptual in nature. For planning process preliminary configuration of such features included general sizing, sources of water, and location at a sub-watershed scale. Specific project locations were not identified.

There are multiple ways to achieve the storage goal identified in the Preferred Plan; these include alternative water storage, reservoirs and ASR. Storage as formulated in this planning process primarily evaluated the use of surface storage reservoirs rather than rely on CERP Lake Okeechobee ASR. The conceptual configuration for these storage features is shown in **Table 9-2**. Ongoing Lake Okeechobee ASR Pilots and the ASR regional study will help determine the application of ASR. The results of these efforts will be incorporated into more detailed planning and design (see Section 10) which will be used to determine the mix of ASR and surface storage.

At the regional level, water quality improvements were primarily achieved through the use of Stormwater Treatment Areas (STAs). Similar to reservoirs, only conceptual configurations were developed for these Level 4 and 5 water quality features (**Table 9-3**).

The regional features will require substantial real estate acquisition, engineering, design, and construction and will be more expensive than local features. However, they are expected to provide the remaining load reduction and storage capacity necessary to achieve the TMDL and improve Lake stage management.

9.2.2.1 Storage

Three stand-alone storage features are included in the Preferred Plan (**Table 9-2**). While these facilities were modeled and evaluated as surface water reservoirs, the storage benefits derived from these types of projects may also be attained through smaller scale storage on private lands, ASR, or surface water reservoirs, or a combination of these. The appropriate mix of storage will become more defined as results from ASR pilots and the ASR Regional Study become available.

In addition, depending upon the outcome of the Upper Kissimmee Regional Water Supply Feasibility Study a portion of the storage capacity currently identified for the Lower Kissimmee Sub-watershed could be located in the Upper Kissimmee Sub-watershed.

Table 9-2. Location and capacity of Preferred Plan storage features.

Storage ID	Sub-watershed	Storage Capacity (ac-ft)	TP load reduction to Lake (mt/yr)	Source Water
Kissimmee East Storage	Lower Kissimmee	200,000	6.5	• Receives flows from and discharge back to the Kissimmee River • Stored water can potentially also be diverted to the TCNS Sub-watershed for additional treatment
Kissimmee Storage	Lower Kissimmee	161,263	12	• Receives flows from and discharges to Kissimmee River • CERP-LOW Project feature
Istokpoga Storage	Istokpoga/Indian Prairie	79,560	7	• Receives flows from Lake Istokpoga/Indian Prairie and discharges to Indian Prairie • CERP-LOW Project feature

9.2.2.2 Stormwater Treatment Areas

The following stand-alone STAs are included in the Preferred Plan (**Table 9-3**). Note that while these facilities were modeled and evaluated as specific facilities during the planning exercise, more detailed planning and design will better define the specific types of facilities that are needed to attain the phosphorus reductions for the specific basin. In addition, the results of the proposed innovative treatment technology projects may influence the type and design of other nutrient treatment facilities.

Table 9-3. Location and TP load reduction of Preferred Plan STAs.

STA ID	Sub-watershed	TP load reduction to Lake (mt/yr)	Source Water
Taylor Creek Critical Project STA	TCNS	0.3	• Receives flows from and discharges to Taylor Creek
Nubbin Slough Critical Project STA	TCNS	0.9	• Receives flows from and discharges to Nubbin Slough
Lakeside Ranch STA	TCNS	8	• Receives flows from L-63 and discharges to Lake Okeechobee
Brady Ranch STA	TCNS	5	• Receives flows from L-63 and discharges to Lake Okeechobee
Istokpoga STA	Istokpoga/Indian Prairie	29	• Receives flow from and

			discharges to C-41 Canal • LOW Project Feature
S-68 STA	Istokpoga/Indian Prairie	8	• Receives flows the area south of S-68
Clewiston STA	EAA	2.5	• Receives flow from C-21
Taylor Creek STA	TCNS	6	• Receives flow from Taylor Creek and Kissimmee Reservoir East
Lemkin Creek Urban Stormwater Facility	Lower Kissimmee	1.1	• Located on District-owned lands in the Lower Kissimmee Sub-watershed

9.2.2.3 Reservoir Assisted Stormwater Treatment Areas

Three, large, reservoir-assisted stormwater treatment areas (RASTAs) are included in the Preferred Plan to maximize TP load reduction and water storage (**Table 9-4**). While these facilities were modeled and evaluated as RASTAs during the planning exercise, benefits from these types of projects may be attained through a combination of surface water reservoirs and ASR as well as other types of nutrient treatment facilities. As noted previously, the results of AST pilots and regional study along with results of the proposed innovative treatment technology projects will help determine the mix of facilities needed to meet the storage and treatment needs for specific basins.

Table 9-4. Location, water storage, and TP load reduction of Preferred Plan RASTAs.

RASTA ID	Sub-watershed	Storage (ac-ft)	TP load reduction to Lake (mt/yr)	TP Load reduction to in-lake loads (mt/yr)	Source Water
Istokpoga/ Kissimmee RASTA	Istokpoga/ Indian Prairie	273,600	8.9	28.1	• Receives flows from Istokpoga/Indian Prairie Basin and Kissimmee River • Will also store and treat Lake Okeechobee Waters
Fisheating Creek RASTA	Fisheating Creek	41,580	9	23	• Receives flows from and discharges back to Fisheating Creek
Nicodemus Slough RASTA	Fisheating Creek	158,400	9	22.6	• Receives flows from Fisheating Creek and discharges to Lake Okeechobee • Will also store and treat Lake Okeechobee waters

9.2.2.4 Aquifer Storage and Recovery

To complement surface storage, the Preferred Plan also includes features for subsurface storage using the Aquifer Storage and Recovery (ASR) technology. Five ASR facilities are currently identified for inclusion in the Preferred Plan (**Table 9-5**). It is anticipated that additional ASR features will be identified in the future to help meet the storage goal of the Preferred Plan. Information from Lake Okeechobee ASR pilots and the ASR Regional Study will help determine

the mix of surface and subsurface storage needed to better manage Lake Okeechobee water levels.

9.2.2.5 Deep Injection Wells

One deep injection well is included in the Preferred Plan; feasibility of additional deep injection well facilities will be evaluated during planning and design.

S-154 Basin Deep Injection Well – This proposed 4-well cluster and a 1,000 ac-ft storage pond is expected provide approximately 19,000 ac-ft of storage TP load reduction of 8.3 to 10.6 mt/yr. The feature will consist of a single deep injection well system located at the intersection of the S-154 connection to the C-38 Canal. The proposed well disposes a relatively small volume of water, approximately 68 million gallons per day (MGD), relative to the overall flow of water entering Lake Okeechobee. It was included in the NERSM modeling.

Table 9-5. Location, water storage, and TP load reduction of Preferred Plan ASR.

ASR ID	Sub-watershed	Storage (ac-ft)	TP load reduction (mt/yr)	Comments
Kissimmee Pilot	Lower Kissimmee	3,780 (5 million gallons per day (MGD))	0.1	• Facility is currently being implemented as a part of CERP. • Cycling testing, pumping into the Upper Floridan aquifer, storing for a period of time, followed by recovery is scheduled for late 2007 depending upon Lake Okeechobee water levels
Paradise Run 10-well System	Lower Kissimmee	22,950 (50 MGD)	1.4	• Maximum pumping capacity of up to 50 MGD
Seminole Brighton Reservoir ASR System		3,780 (5 MGD)	0.8	• One 5 MGD ASR well system to be located along the C-41 Canal on the western edge of the Seminole Brighton Reservation in Glades County • Construction to be completed in late 2009.
Taylor Creek ASR Reactivation	Taylor Creek/Nubbin Slough Sub-watershed	5,400 (6 MGD)	1.2	• Assessment and eventual re-activation of the TCNS ASR system • One 6 MGD well system is proposed adjacent to the L-63N Canal

9.2.3 Other Projects

The Preferred Plan includes several other projects that are intended to contribute to overall achievement of NEEPP goals and objectives.

9.2.3.1 In-Lake Treatment

Three project features are included in the Preferred Plan for reducing in-lake TP loads. For the purpose of this Preferred Plan, in-lake load TP load reductions are not counted towards the TMDL.

Muck Sediment Removal – This is accomplished by scraping the lake bed as it is exposed due to falling water levels, and transporting the muck off-site. The scraping is typically conducted mechanically and is intended to expose the natural bottom, which then promotes re-growth of native vegetation once the lake levels return to normal.

Dredging – Innovative dredging techniques are currently being evaluated for use in Lake Okeechobee. If successful, these techniques will be applied at other locations in the lake.

Recirculating STAs – Two RASTAs (Istokpoga/Kissimmee RASTA and Nicodemus Slough RASTA) have been sited along Lake Okeechobee shoreline. Both systems are intended to treat nutrient–rich flows from the watershed; however, during dry periods when there is little or no flow from the watershed, lake waters could be diverted to these systems for treatment. Treatment of in-lake waters would provide additional beneficial TP load reduction.

9.2.3.2 Innovative Nutrient Control Technologies

The legislation authorizing the P2TP specifically required that innovative nutrient treatment technologies be considered for inclusion in the Preferred Plan. The following innovative nutrient control technologies meet this requirement:

Taylor Creek Algal Turf Scrubber® Nutrient Recovery Facility – This ongoing project is a scaled-up demonstration of HydroMentia's proprietary water treatment technology that uses algae to remove pollutants from water. Algal Turf Scrubbers® (ATS) are engineered systems in which attached algae are cultured and the algal biomass is routinely harvested to facilitate recovery of pollutants from impaired waters. The objectives of the facility are to: (1) reduce TP loads from stormwater runoff associated with the Taylor Creek drainage basin; (2) provide secondary enhancement of water quality associated with the targeted flows from Taylor Creek through increased dissolved oxygen levels; and (3) recover and recycle captured nutrients through the harvesting and composting of harvested algae biomass. The project is located on a District-owned parcel at the Grassy Island Ranch and is designed to treat 15 MGD of water from Taylor Creek and reduce TP loads by 1.8 mt/yr.

Hybrid Wetland Treatment Technology (HWTT) – This innovative approach combines beneficial attributes of the two top ranked nutrient removal technologies, namely wetland treatment and chemical injection. Four pilot HWTT systems will be field tested in the LOW under a FDACS initiative. If successful, other locations will be evaluated for application of this technology.

Chemical Treatment – The Preferred Plan includes selective application of chemical treatment using alum salts to achieve the TP load reduction required to reach the TMDL. If alum is

applied, this chemical treatment will be used in conjunction with reservoirs and STAs to enhance TP load reduction. A feasibility study will be conducted to evaluate locations, dosages, and cost-effectiveness prior to implementation of the chemical treatment technology.

9.2.3.3 Wetland Restoration

Restoring degraded wetlands adds to the ecosystem's natural ability to trap flows and contaminants. Two wetland restoration projects are included in the Preferred Plan.

Paradise Run Wetland Restoration – Approximately 3,730 acres of degraded wetlands will be restored as part of this project at the ecologically significant confluence of Paradise Run, Kissimmee River oxbows, and Lake Okeechobee. This feature is a component of CERP's LOW Project. Under restored conditions the wetland will have a rain-driven hydrology unless efforts to further enhance watershed conditions could link the wetland site to the surface flows from the C-38 (Kissimmee River) or C-41A (Istokpoga) Canals.

Rolling Meadows/Catfish Creek Restoration – Rolling Meadows/Catfish Creek is located at the southern end of Lake Hatchineha on District /FDEP owned lands. The proposed restoration project would include hydrologic restoration of Catfish Creek and the creation of a wetland that can potentially hold up to one foot of water in the Upper Kissimmee Sub-watershed.

9.2.3.4 Miscellaneous Projects

Other miscellaneous projects that are expected to contribute to overall NEEPP goals and objectives include the following:

Florida Power and Light Martin Cooling Pond – This feature will expand currently available storage capacity at an existing 7,000 acre impoundment located at FP&L's Martin County Facility. The impoundment has a current maximum storage capacity of 95,000 ac-ft and provides power Plant cooling water. A recently completed feasibility study evaluated increasing the storage capacity of this pond by upgrading the embankments, seepage management systems, and emergency spillways.

S-133 Water Quality Treatment Facility – It was important to locate a water quality improvement feature in the S-133 sub-basin because the original Preferred Plan of treating flows from this sub-basin using one of the LOFT STAs has recently been shown to be impractical. The proposed feature would reduce TP loads by 1-2 mt/yr. The exact nature of this feature (STA, deep well, expansion of the existing Lemkin Creek Urban Stormwater Treatment Area, or a combination of these) would be determined during the implementation stage through a feasibility study.

9.3 Preferred Plan Real Estate Requirements

Specific locations for some Preferred Plan features have already been determined (Level 1, 2, and 3 MMs); while for other project features (Level 4 and 5 MMs) locations have been identified only to the sub-watershed level. Land acquisition needs will be developed over time through the

process development and engineering process. The results of feasibility efforts will be factored into the more detailed planning to help define the real estate requirements.

Results from studies and pilot projects that test and evaluate various water quality treatment technologies may influence the size and location of water quality treatment feature. Information from Lake Okeechobee ASR pilots and the ASR Regional Study will help determine the mix of above and below surface storage needed to better manage Lake Okeechobee water levels. Utilization of ASR for storage requires significantly less land than surface storage through reservoirs or RASTAs. Subsequent Preferred Plan updates will provide more refined estimates of real estate requirements as research is completed for ASR and other project features.

During Process Development and Engineering stage, conceptual planning will be conducted to further evaluate project siting and real estate acquisition requirements. To the extent possible, opportunities for less than fee acquisition, such as the wetland reserve program will be evaluated. It is expected that real estate acquisition for individual features will occur over a period of time. State and District-owned lands would be preferentially evaluated for siting Preferred Plan project features. However, many of the existing State-and District-owned acreages have already been targeted for specific features.

When it is necessary to acquire private lands and in an effort to compensate eligible counties where lands are acquired for project purposes and subsequently removed from the tax rolls, the Legislature has created a ten year program for payments in lieu of taxes. See Fla. Stat. Section 373.59(10)(b). Payment in lieu of taxes will be paid by the District for private lands acquired in counties eligible for this program

The District recognizes that the legislature has requested a schedule for the acquisition of lands or sufficient interests necessary to achieve the construction schedule. Currently, the development of such a schedule is premature for the reasons discussed above. This schedule will be developed and periodically updated based on information and recommendations from the Process Development and Engineering component of this plan, as contemplated by section 373.4595(3)(b)2, F.S.

9.4 Operations & Maintenance

With very few exceptions, the majority of projects features included in the Preferred Plan are likely to require some level of operation and maintenance (O&M). Consideration of operation and maintenance needs from the outset of Planning is important to insuring that the project goals and objectives are achieved in the most efficient, effective, and safe manner. The term "operations and maintenance" collectively refers to the following five major elements:

- **Operations** – ongoing activities required to operate the management measure to achieve the project objectives – includes water control, fuels and materials, monitoring, etc.

- **Maintenance** – ongoing activities required to maintain system in an operable condition – includes machinery maintenance, mowing, inspections, etc.

- **Repair** – periodic repair of machinery or other structural elements as needed to restore complete operability of the management measure – includes machinery repair, filling scour holes, repairing erosion, etc.

- **Replacement** – periodic replacement of project elements that have reached or exceeded their functional life – includes pump replacement, stop-log riser replacement, etc.

- **Rehabilitation** – major rehabilitation of a project component may be required under the following circumstances:

9.5 Monitoring

A comprehensive monitoring and information system will be utilized to provide the data necessary to measure the performance and effectiveness of the NEEPP (SB 392) in satisfying the restoration goals of the LOPP. It has been determined that the Lake Okeechobee TMDL established in accordance with Section 403.067, Florida Statutes, and future, additional TMDL's set forth for other contributing pollutants to the surface water resources of the Lake Okeechobee watershed, are appropriate foundations for achieving restoration. The District will utilize the current monitoring base and provide any project specific resources needed to document the effectiveness of phosphorus control efforts in meeting Lake Okeechobee watershed TMDL's and to assure compliance with all future permit requirements.

The District maintains and/or provides funding for a well established and comprehensive water quality monitoring network within the boundaries of the geographical area identified in the Preferred Plan. This network consists of over 325 individual locations where water quality information is collected. This network provides water quality data used for the following initiatives:

- LOPA-Watershed (including Lake Istokpoga) and In-Lake Management
- LOPA Lake Okeechobee Operating Permit
- Lake Okeechobee Watershed Assessment (WOD Rule)
- CERP – Critical Project Permit Requirements, Lake Okeechobee Watershed Project Assessment, and the Restoration Coordination and Verification Program (RECOVER)
- Kissimmee River Restoration
- Upper Chain of Lakes Long -Term Management
- Lake Okeechobee Conceptual Ecological Model
- South Florida Environmental Report

Water quality monitoring stations have been integrated with the hydrologic monitoring network and can now identify pollutant loadings at structures discharging into Lake Okeechobee and at major tributary structures throughout the watershed. The District will continue to leverage the existing water quality and hydrologic monitoring networks, wherever possible, to satisfy watershed based and project specific monitoring requirements.

Biological monitoring needs will be integrated with the RECOVER program efforts within the watershed, will continue to support the Lake Okeechobee Conceptual Ecological Model and will

also be determined on a project specific basis when permit requirements for biological monitoring are identified.

All current and future water quality data collection, analysis, validation, management and storage will be conducted in accordance with the FDEP Quality Assurance Rule, 62-160, F.A.C., the *District Field Sampling Quality Manual* (FSQM) and/or the CERP Quality Assurance Systems Requirements (QASR) manual.

The District has established an Environmental Monitoring Coordination Team (EMCT) to critically review and evaluate all new monitoring requests to ensure permit compliance, scientific validity and efficiency. Any future monitoring requirements associated with the Lake Okeechobee Watershed Protection Plan will be subject to review and approval by the EMCT.

9.6 Permitting

Construction and implementation of the Preferred Plan features will require a variety of permits and regulatory approvals. Types of permits and approvals needed are likely to vary with feature type and location.

Obtaining all required federal and state permits for implementation and operation of a project feature often requires an intensive level of effort. Permitting can result in significant project delays if it is not adequately considered early in project development. However, specific permit requirements and/or issues may not be evident until a substantial level of detail has been developed during Planning and design.

The types of permits and level of effort required during the permitting process may vary greatly for similar or identical measures depending on the physical conditions that exist at the project site and surrounding area. During the Project Development & Environmental (PD&E) process, continuing consideration will be given to the types of permits required and the potential permitting issues that must be addressed. In this way the level of effort and time requirements can be factored into the Planning and design process to minimize the potential for significant permit-related project delays.

Federal and state permits, and potential permitting issues, that are likely to be encountered for the types of project features contained in the Preferred Plan are described in **Appendix D**.

9.7 Preferred Plan Implementation

The Preferred Plan calls for an iterative, adaptive and phased implementation process. Therefore, implementation of the Preferred Plan is expected to occur in three stages. The first stage, Initial Implementation Measures, will occur from approximately 2008 to 2010, and will primarily focus on continued implementation of ongoing measures and initiatives. For instance, this stage will include ongoing implementation of the LOPP and LOER water quality measures and LOER alternative water storage facilities (**Table 9-6**).

Table 9-7. Mid-term Implementation Measures (2011 – 2015).

		Water Quality	Water Quantity
Projects	Continued Implementation of Previous Measures	✓	✓
	Implementation of Additional Water Quality Measures as optimized by Technology and Model Refinement Studies	✓	✓
	Initiate Implementation of Appropriate Combination of Storage Methods based upon CERP ASR Feasibility Studies	✓	✓
Technology and Model Refinement	BMP Research and Refinement	✓	✓
	STA Integration and Refinement	✓	✓
	ASR Feasibility- Final Results of ASR Regional Study, Data from LOER ASR and Pilot Projects	✓	✓

✓ = Primary benefit ✓ = Ancillary benefit

Table 9-8. Long-term Implementation Measures (Beyond 2015).

		Water Quality	Water Quantity
Projects	Continued Implementation of Previous Measures	✓	✓
	Continue Implementation of Storage (ASR/Surface Storage)	✓	✓
Technology and Model Refinement	Process Development and Engineering	✓	✓

✓ = Primary benefit ✓ = Ancillary benefit

9.7.1 Initial Implementation Stage Benefits

- Implementing Best Management Practices on 1.3 million acres of agricultural lands;
- Completing Environmental Resource Permit and Works of the District rule revisions;
- Initiating/completing implementation of approximately 100,000 ac-ft of long-term alternative water storage;
- Completing design and initiating construction of more than 2,600 acres of Stormwater Treatment Areas;
- Completing the initial suite of Lake Okeechobee Protection Plan phosphorus source control projects;
- Implementing eight Florida Ranchlands Environmental Services Projects;
- Completing cycle testing of CERP Aquifer Storage and Recovery pilot projects, the interim report, optimization analysis, and Floridan Aquifer groundwater model;
- Completing implementing 65 million gallons per day of Aquifer Storage and Recovery storage;
- Restoring 4,470 acres of wetlands within the Lake Okeechobee watershed; and
- Reducing phosphorus loads to Lake Okeechobee by approximately 150 metric tons.

9.8 Preliminary Cost Estimates

9.8.1 Initial Implementation Stage Cost Estimate

To provide a source of State funding for the continued restoration of the South Florida ecosystem, the 2007 Florida Legislature expanded the use of the Save Our Everglades Trust Fund to include Northern Everglades restoration and extended the State of Florida's commitment to Everglades restoration through the year 2020.

The costs for non-CERP features will be primarily borne by the South Florida Water Management District and the State, while CERP costs are eligible for up to a fifty percent cost share with the federal government. It is anticipated that once the Lake Okeechobee Watershed Project – a component of the CERP state-federal partnership effort – is formally authorized by Congress, the federal government will provide its fifty percent cost sharing commitment on a series of reservoirs and stormwater treatment areas in the Lake Okeechobee watershed. It is important to note that a portion of the estimated CERP cost is for projects that the South Florida Water Management District is expediting ahead of authorization to achieve environmental benefits earlier. Completion of these Lake Okeechobee Fast Track projects, however, is dependent on continued State and SFWMD funding in advance of federal appropriation. Cost estimates for the initial implementation stage were calculated for features for which construction began during the initial implementation stage (**Table 9-9**).

Table 9-9. Cost estimate for the initial implementation stage of the Preferred Plan.

Category of Cost	Cost estimate
Non-CERP	$260-320 Million
CERP	$1-1.4 Billion

Cost estimates presented in **Table 9-9** are based on the following assumptions:

- Costs do not include dollars that have already been expended to date
- CERP ASR costs are not included in the cost estimate
- Costs include the full cost to build a project completely even it construction period goes beyond the initial implementation stage
- LOFT projects included are eligible for federal cost share, however those funds will be needed in advance of the CERP project from State and SFWMD sources
- Not all of the project features within CERP's LOW Project are implemented within the initial implementation stage
- High cost estimate based upon the following:
  - 10% annual-Real Estate inflation

- 9% annual- Construction inflation

- Low cost estimate based upon the following:
  - 6% annual- Real Estate inflation
  - 2% annual- Construction inflation

9.8.2 Future Implementation Stages Cost Estimate

Costs for each progressive stage of implementation will be developed as information from various pilot projects and studies are factored into more detailed planning design in the future. It is anticipated that modifications and refinements in the methods used to reduce phosphorus loading to Lake Okeechobee will occur in the future as the result of Technology and Model Refinement described in *Section 10*.

Results from Lake Okeechobee ASR pilots and the ASR Regional Study will be used to help determine the mix of above and below surface storage needed to better manage Lake Okeechobee water levels. Factoring this type of information will provide clarity of the projects that will be proposed for the future stages and reduce the uncertainty associated with cost estimates. Cost estimates for the Mid-Term Implementation Stage will be provided in the 2010 Preferred Plan update.

9.9 Funding Sources and Cost-Sharing Opportunities

9.9.1 Funding Sources

The majority of funding for the implementation of this Preferred Plan will be from State, SFWMD and Federal sources. The 2007 NEEPP legislation provides a dedicated state funding source for the Northern Everglades restoration by expanding the use of the Save Our Everglades Trust Fund to include the Lake Okeechobee Watershed Protection Plan and the River's Watershed Protection Plans for the Caloosahatchee and St. Lucie.

The Bill also extends the state's commitment to provide funding for CERP and the Northern Everglades through the year 2020. For FY2008 the Florida legislature allocated $100 million from the Everglades Trust Fund (ETF) to the initiate implementation stage of this Preferred Plan. This is intended to be a recurring source of funding from the State, but must be appropriated by the Legislature annually. Funding from the State is to be matched by the SFWMD. Many of the local features will have cost sharing with landowners and local governments, as well as State and Federal grant programs

The rate of implementation for non-CERP projects will be dependent upon the level of funding from State, SFWMD, and select federal sources. The rate of implementation for CERP projects will be dependent upon federal, state, and SFWMD sources.

It is recognized that multiple sources of funding beyond the recurring annual State and SFWMD appropriations will be required to complete the implementation of the Preferred Plan (**Table 9-10**). These sources could include funding from federal government agencies (USACE, DOI, USDA, etc.) local governments, tribal communities, and private landowners. Also, it is

anticipated that once the Comprehensive Everglades Restoration Plan's LOW Project is fully authorized by the Congress, the federal government will honor it previous commitment to provide fifty percent cost sharing on a series of reservoirs and stormwater treatment areas in the Lake Okeechobee Watershed.

Table 9-10. Potential funding sources for implementation of Preferred Plan features.

Program	Purpose
FEDERAL	
U.S. Army Corps of Engineers	
Comprehensive Everglades Restoration Plan	CERP Projects are eligible for 50:50 cost sharing per WRDA, 2000.
Small Navigation Projects	To provide the most practicable and economic means of fulfilling the needs of general navigation, through projects not specifically authorized by Congress.
Department of Interior - Federal land acquisition programs	
Land and Water Conservation Fund – Federal Land Acquisition	Acquisition for various federal agencies (Fish and Wildlife Service, National Park Service, Bureau of Land Management, and Forest Service).
Grant programs strictly for land acquisition by non-Federal entities	
Cooperative Endangered Species Conservation Fund Act Program (Fish and Wildlife Service)	To provide grants to States for Recovery Land Acquisition. (There is additional funding for Habitat Conservation Fund Land Acquisition Grants.)
Grant programs that may be used for land acquisition and other purposes by non-Federal agencies	
Land and Water Conservation Fund State Grant Program (National Park Service)	To provide matching grants to States and local governments for the acquisition and development of public outdoor recreation areas and facilities.
Grant programs that may be used for land acquisition and other purposes by Federal and non-Federal agencies	
North American Wetlands Conservation Act (Fish and Wildlife Service)	May fund the acquisition of habitat for waterfowl and migrating birds in support of the North American Waterfowl Management Plan.
Federal Aid Wetlands Conservation (Fish and Wildlife Service)	May fund the acquisition of habitat for waterfowl and migrating birds in support of the North American Waterfowl Management Plan.
Other partnership programs supporting non-land acquisition conservation activities	
Private Stewardship Grants Program (Fish and Wildlife Service)	To provide grants for on-the-ground conservation projects on private lands benefiting federally listed, threatened, endangered species or other at-risk species.
Partners for Fish and Wildlife Program (Fish and Wildlife Service)	To provide assistance to landowners to voluntarily restore wetlands, streams, grasslands, woodlands, and other important habitat that support fish and wildlife.
Fish and Wildlife Service Challenge Cost Share	Foster innovative and creative cooperative efforts to restore natural resources and establish or expand wildlife habitat, with an emphasis on Federal lands and resources.

STATE	
Florida Forever Program/Board of Trustees (Department of Environmental Protection)	To fund the acquisition and restoration of environmentally sensitive lands, lands to protect water resource development and supply, to increase public access, public lands management and maintenance, and increase protection of land by acquisition of conservation easements. Florida Forever is the umbrella funding source for the state programs listed below.
Florida Forever Program Water Management Districts (Department of Environmental Protection)	To fund the acquisition of lands and capital project expenditures necessary to implement the water management districts' priority lists; $25 million of the annual Florida Forever allocation to the SFWMD is to be used exclusively for the acquisition of land needed to implement CERP.
Florida Communities Trust (Department of Community Affairs)	To fund the state's land acquisition grant program for local governments and non-profits to acquire lands that promote outdoor recreation and natural resource protection needs identified in local government comprehensive plans.
Florida Forever Program In-holdings and Additions Programs (Department of Environmental Protection)	To acquire in-holdings and additions to existing conservation lands.
Florida Greenways and Trails (Department of Environmental Protection)	To fund the statewide initiative to create a system of greenways and trails connecting communities and conservation areas.
Florida Recreation Development Assistance Program (Department of Environmental Protection)	To fund the acquisition or development of land for public outdoor recreation and the acquisition of in-holdings and additions for state parks.
Save Our Everglades Trust Fund (Department of Environmental Protection)	To implement CERP.
Florida's Rural Land Stewardship Program (Department of Community Affairs)	The intent of the program is to direct development of rural lands to preserve agriculture and protect the environment. Local governments designate Stewardship areas within their Comprehensive Plans and credits are allocated to individual parcels based on environmental and other values. The credits are recorded as a covenant or restrictive easement.
COUNTIES	
Orange County Green PLACE	To preserve conservation and water resource lands.
Osceola County S.A.V.E Osceola	To acquire lands to protect open space and water quality, preserve natural areas, protect endangered or threatened animals or Plants and provide passive recreation such as trails.
Polk County Environmental Lands Program	To acquire, preserve, manage and restore endangered and environmentally sensitive lands, water resources and important wildlife habit.
NON GOVERNMENTAL ORGANIZATIONS	
Green Horizon Land Trust, Inc.	To preserve environmentally valuable or sensitive lands and open space areas in and around the Central Florida Ridge for the benefit of the general public, and to educate the public as to the importance of such lands and their preservation.

National Fish and Wildlife Foundation	To award challenge grants that address priority actions promoting fish and wildlife conservation and the habitats on which they depend; work proactively to involve other conservation and community interests; leverage available funding; and evaluate project outcomes.
The Conservation Fund	To forge partnerships to preserve our nation's outdoor heritage, American's legacy of wildlife habitat, working landscapes and community open space.
The Nature Conservancy (TNC)	To preserve Plants, animals and natural communities representing the diversity of life on Earth. TNC works to increase public funding at the local, state and federal level and works with landowners to craft innovative land protection projects.
Trust for Public Lands (TPL)	To help agencies and communities create a vision for conservation, raise funds for conservation and complete conservation real estate transactions. TPL raises public as well as private funds and packages projects to funders and agencies.
Bureau of Land Management Challenge Cost Share	To leverage federal dollars with private and state funding for conservation efforts, benefiting resources on Bureau of Land Management administered public lands. The program solicits partnerships and partnership funding through a variety of resource management programs, including fisheries, wildlife, threatened and endangered species, cultural resources and recreation.

The next stage, Mid-Term Implementation Measures (2011 to 2015), will continue implementation of previous measures and implement additional water quality measures as optimized by Technology and Model Refinement Studies. This stage will initiate implementation of the appropriate combination of storage methods based upon the results of ongoing CERP Lake Okeechobee ASR Pilots and Regional Study (**Table 9-7**).

The final stage, Long-Term Implementation Measures (beyond 2015), will include continued implementation of previous measures and continued implementation of storage through appropriate combination of storage methods (**Table 9-8**). See *Section 7* for additional information on MMs.

Table 9-6. Initial Implementation Measures (2008 – 2010).

		Water Quality	**Water Quantity**
Projects	Agricultural and Urban BMPS and Regulatory Programs	✔	✓
	LOPP Phosphorus Source Control Projects	✔	✓
	Local Government Initiatives	✔	✔
	Florida Ranchlands and Environmental Services Projects	✔	✔
	LOER Alternative Water Storage Projects (Alternative water storage facilities, Paradise Run 10 Well ASR System, Seminole Brighton ASR Pilot, and Taylor Creek ASR Reactivation)	✓	✔
	LOER Stormwater Treatment Areas (Brady Ranch STA and Lemkin Creek Water Quality Treatment Facility)	✔	✓
	CERP ASR Pilots	✓	✔
	CERP Lake Okeechobee Watershed Project (Istokpoga STA, Lakeside Ranch STA, Taylor Creek Reservoir, and Paradise Run Wetland Restoration)	✔	✔
Technology and Model Refinement	BMP Research and Refinement	✔	✓
	Chemical Treatment Feasibility Study	✔	✓
	Water Quality Model Development	✔	✓
	ASR Feasibility- Pilot Cycle Testing, ASR Regional Study, ASR Optimization Analysis	✓	✔
	Hydrologic Model Refinement	✓	✔

✔ = Primary benefit ✓ = Ancillary benefit

SECTION 10

PLAN REFINEMENT AND REVISIONS

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TABLE OF CONTENTS

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10.0 PLAN REFINEMENT AND REVISIONS

The Preferred Plan provides a framework and road map for progressive water quality and quantity improvements to benefit the lake and downstream estuaries.

Throughout implementation, it is fully expected that hydrologic and water quality conditions in the watershed will continue to change as land uses in the watershed are modified, and as restoration projects become operational. Performance will be periodically assessed and revisions made as necessary. In addition, the legislation requires annual reports and protection plan updates every three years.

Portions of this Plan have already been implemented or are in the process of being implemented. More detailed planning and design of other features will begin in 2008 and continue throughout the Plan implementation stages. During implementation, the hydrologic and water quality conditions in the LOW will continue to change as land use changes and individual projects affecting the quality and quantity of water become operational. It is therefore important to have a procedure in place to ensure that:

1. Provide a process to move through more detailed planning and design to project implementation.
2. Plan performance is adequately and appropriately monitored over time,
3. Plan is revised at periodic intervals, as necessary, based on evaluation of monitoring data, and
4. Plan progress is reported to the Legislature, regulatory agencies, and the public on a regular basis.

Similar to other state initiatives (e.g. Everglades Protection Area Tributary Basins Long-Term Plan for Achieving Water Quality Goals), it is anticipated that this procedure will be borne out through Process Development and Engineering. The recommendations for Process Development and Engineering (PD&E) are described in this section. A description of the strategy for plan refinement, revision, and reporting is also provided.

10.1 Process Development and Engineering

The primary objective of the PD&E is to provide a roadmap for further refinement of the design of individual plan components. The PD&E will also identify additional measures that, if implemented, will increase certainty that the overall plan objectives for improving water quality and quantity are met. The PD&E procedure recognizes that:

- Achieving improvements in the quality, quantity, timing, and distribution of water and achievement of water quality standards will involve an adaptive management approach, whereby the best available information is used to develop and expeditiously implement incremental improvement measures in a cost-effective manner;

- Continued engineering evaluations will be necessary to increase certainty in the overall operation and performance of integrated hydrology and water quality improvement strategies; and

- Significant technical and economic benefits can be realized by integrating the Lake Okeechobee Watershed (LOW) Construction Project water quality and water quantity management measures with CERP projects, even to the extent that existing schedules should be re-evaluated in some basins and synchronized with CERP implementation schedules.

- LOW Tributary TMDLs may influence the types of projects that will be needed in the watershed.

Key elements of the PD&E procedure are described below:

10.1.1 Model and Technology Refinement

Model and Technology Refinement efforts likely to be required to support implementation of the Preferred Plan include:

- Identification of new technologies that can be used either to accelerate achievement of plan objectives or increase cost-effectiveness of implementation
- Modification of existing analytical and monitoring tools, and
- Development of new analytical and monitoring tools

10.1.1.1 Lake Okeechobee Watershed Water Quality Model Development

This effort is primarily focused on development of an assessment tool that will evaluate various phosphorus control programs at the watershed level to maximize water quality improvements to meet the lake's TMDL goal of 140 mt/yr. Specifically, the project will update input data sets; add an enhanced sub-model to better represent internal lake processes in the upper chain of lakes; refine and integrate hydrodynamic modeling and water quality tools; and evaluate the effectiveness of the field level BMPs and the basin/regional level phosphorus control projects on phosphorus load reductions to the lake.

10.1.1.2 Northern Everglades Regional Simulation Model Refinement

The migration to a detailed modeling approach is planned for the Northern Everglades. Initially, a basin or "pot" model set-up of the Regional Simulation Model (RSM) was used to evaluate the relative benefits of different sets of management measures. Performance measures at a regional level, e.g., Lake Okeechobee and the Caloosahatchee and St. Lucie estuaries, were formulated, quantified and analyzed. RSM refinement would, then, incorporate updated data sets, more rigorous channel routing and potentially mesh-based representation of the sub-watersheds.

In addition, the spatial extent of model would be expanded to include areas not previously considered such as additional tributary basins influencing the St. Lucie Estuary (e.g. C23/C24, Ten-Mile Creek, South Fork, etc.). The additional model extent and resolution in the hydrology

of the study area will provide more detailed water budgets and better interface to the water quality evaluation component of the project. Sub-regional as well as localized performance measures will also be possible due to this effort. Further refinement to the operational package for Lake Okeechobee may also be required to represent potential changes to the regulation schedule as envisioned by the U.S. Army Corps of Engineers.

10.1.2 Existing Technology Refinement

Existing technology refinement efforts will play an important role in optimizing and refining the implementation of many features that make-up the Preferred Plan and currently include:

- Best Management Practices (BMP) Research and Refinement
- Stormwater Treatment Area Integration and Refinement
- Lake Okeechobee ASR Pilots and Regional Study

10.1.2.1 BMP Research and Refinement

Several uncertainties exist in estimating BMP performance. Some uncertainties associated with the performance of BMPs include the impacts of different soils and hydrologic conditions, the quantity of water that can be held on a parcel without impacting an agricultural operation, and legacy phosphorus currently within the watershed. The BMP performance estimates utilized in this plan were based on best professional judgment and take into account the uncertainties described above, information available from literature, as well as actual performance data observed within the watershed to date. These estimates will continue to be refined over time as ongoing and future research provides additional information through the Technology and Model Refinement efforts.

10.1.2.2 STA Integration and Refinement

The Preferred Plan establishes a technical framework through Process Development and Engineering for the refinement and integration of STAs for the purpose of meeting water quality goals for Lake Okeechobee. The goal of STA refinement and integration is to apply adaptive management analyses that will assist in determining how STAs can effectively treat water over time. Flow, water quality, vegetation, and soil data may all be collected on a routine basis, and used to understand removal performance of the STAs, and the analysis and interpretation of this data is intended to form the basis for potential modifications to the configuration or operation of STAs if it is determined that further water quality improvements within the watershed are needed and can be achieved within the STAs.

10.1.2.3 Lake Okeechobee ASR Pilots and Regional Study

Lake Okeechobee ASR, as applied in CERP, plays an important role attenuating high and low Lake Okeechobee levels by storing water from Lake Okeechobee when lake levels are high and releasing water back to Lake Okeechobee when lake levels are declining. A series of pilot projects are currently underway as well as an ASR Regional Study. The pilot facilities will have a defined cycle testing plan for the first two years of operations. These pilots and the Regional Study will provide information on the magnitude that ASR could be feasibly implemented in the

vicinity of Lake Okeechobee as well as the operational scheme that will provide the optimum benefits. This information will be used in the more detailed planning and design needed to determine the mix of surface storage and ASR that will be constructed to improve the management of Lake Okeechobee levels in the future.

10.1.3 Innovative Nutrient Control Technologies

Evaluation and testing of technologies, such as chemical treatment and hybrid wetland treatment technologies, that have the potential to remove phosphorus in a cost-effective manner to help meet the phosphorus TMDL for Lake Okeechobee will be conducted. The results of these and other testing and evaluation in future will play a role in refining and optimizing the Plan.

10.1.3.1 Chemical Treatment Pilot Study

The chemical treatment pilot study would investigate available information on chemical treatment technologies that have recently been tested for reducing total phosphorus loads in stormwater runoff. Currently there are several different types of technologies that can be applied both in-stream and in off-line treatment systems. As a result treatment costs are likely to vary depending upon influent water quality, volume of water treated and level of treatment desired.

The location of chemical addition (pre treatment vs. polishing) also plays a major part in determining total treatment cost. Selection of potential technologies appropriate for use with the Lake Okeechobee watershed should be based on results of the pilot study which will evaluate the comparative effectiveness of these differing applications.

10.1.3.2 Hybrid Wetland Treatment Technology

The Hybrid Wetland Treatment Technology (HWTT) combines beneficial attributes of the two commonly used nutrient removal systems, namely treatment wetland and chemical injection systems. The technology capitalizes on many of the positive attributes of treatment wetlands (effective N and suspended solids removal), and on the effective P removal capability of chemical additive systems. The use of chemical additives within the HWTT is minimized by a patented approach of recycling the active flocs that are formed following additive application. The additive flocs are retained within the reaction chamber, and can be removed later, if desired.

A proposed HWTT feasibility study will evaluate the technical efficacy and cost-effectiveness of implementing this technology within the LOW. The feasibility study will identify potential sites to test the HWTT on a small, pilot scale and, if successful, on a larger scale.

10.1.4 Sub-Watershed Conceptual Planning

This Preferred Plan has provided a general framework and road map to follow that will result in progressive improvements in phosphorus loading to Lake Okeechobee and additional storage that will improve Lake Okeechobee's operating levels to more ecologically desirable ranges as well as reduce undesirable discharges to the St. Lucie and Caloosahatchee estuaries. However, due to the general nature of many of the projects identified in this planning process a significant

amount of more detailed planning, design and engineering will be necessary prior to project implementation.

In addition, the results of other feasibility efforts will be used to help meet the Preferred Plan's objectives in as cost effective a manner as possible. Studies and pilot projects that test and evaluate various water quality treatment technologies will be used to refine and optimize phosphorus removal. The results from Lake Okeechobee ASR pilots and the ASR Regional Study will be used to help determine the mix of surface and sub-surface storage needed to better manage Lake Okeechobee water levels.

Significant progress has been made on a number of features and the initial focus will be on completing these features such as Lakeside Ranch STA, Lemkin Creek Urban Stormwater Facility, Seminole Brighton Reservation ASR, and Taylor Creek ASR reactivation. More detailed planning, design and engineering will also continue on features such as Brady Ranch STA, Taylor Creek Reservoir/STA and Paradise Run ASR. In addition, engineering and design of a number of Alternative Water Storage features will also continue.

Level 4 and 5 features of the Preferred Plan are those that have the least detail and have not been sited at this time. Therefore, for these features the initial stages of more detailed planning and design prior to more detailed engineering will be an evaluation of lands that are currently in District ownership and how best to maximize their utilization for water quality and surface storage. This conceptual planning may be performed on a site-specific basis; however, most other planning will be conducted on a broader sub-watershed scale. In compliance with the NEEPP legislative requirements, the siting analyses will consider potential impacts to wetlands and threatened and endangered species. After siting of features is completed more detailed design and engineering will follow.

This stage in the PD&E process will also evaluate known issues in the LOW such as those related to siting of project features in the Fisheating Creek Sub-watershed. The CERP LOW Project had identified several issues that will have to be addressed in this sub-watershed, including:

- Potential for navigation impedance in the creek
- Presence of several, large culturally significant resource sites
- Impacts on critical habitats

10.2 Plan Updates and Revisions

Updates and revisions to the Plan resulting from a number of factors including information from Process Development and Engineering, updated water quality and hydrologic data, and adaptive management will be prepared by the Coordinating Agencies. In addition, other agencies and the public will have the opportunity to provide input to the Coordinating Agencies in developing proposed changes through numerous public forums. A process for updating and revising the Plan throughout the various implementation stages is described below.

10.2.1 Types of Updates and Revisions

Revisions to the Plan will be classified as minor or major based on the following criteria:

- Magnitude and nature of the proposed revisions (i.e., scope, schedule, budget);
- Potential for the proposed revision to have environmental impacts that are significantly different from those previously considered by the Coordinating Agencies for the project;
- Potential for the revision to impact the intent and purpose of the Phase II Technical Plan;
- Revision may require SFWMD Governing Board approval.

The classification of the revision will not necessarily determine the nature of any accompanying permit requirements that may be necessary.

10.2.2 Process for Updates, Revisions, and Reporting

The following process is proposed for updating the Plan and reporting:

- Monthly Interagency Coordinating Meetings – this forum is used to discuss progress of implementation, review new information and data, proposals for revisions (minor and major) along with supporting documentation, and to seek review and comments;

- Semiannual Coordinating Agency Review- new information compiled as a result of the Interagency Coordinating Meetings and other agency and public input will be reviewed by the South Florida Water Management District, Department of Environmental Protection and the Department of Agriculture and Consumer Services to determine plan revisions that may be necessary;

- Annual Report in the South Florida Environmental Report (SFER) – the SFWMD will submit the required Annual Report in the South Florida Environmental Report (SFER) (a.k.a. Consolidated Water Management District Annual Report) to the Department of Environmental Protection, the Governor, the President of the Senate, and the Speaker of the House of Representatives. This annual report will summarize the status of research and monitoring, project implementation, and recommended revisions to the protection plan. In addition, major updates and revisions to the plan will be identified and described in the annual report. The discussion will include a description of the need for the revision and its impacts on the plan's scope, schedule, budget, and objectives. Public comments received during the coordination of the proposed plan revision will also be noted in the annual report.

- Annual work plan submitted for each fiscal year to the Department of Environmental Protection identifying the projects and funding necessary to implement those projects

- Every three years the SFWMD in cooperation with the coordinating agencies will formally update, revise and submit the protection plan to the State Legislature.

10.2.3 Public Involvement

Public involvement will be sought regarding proposed updates and revisions to the Protection Plan through discussion with the following groups:

- Monthly Interagency Coordinating Meetings – this forum is used to discuss progress of implementation, review new information and data, proposals for revisions (minor and major) along with supporting documentation, and to seek review and comments from the coordinating agencies, stakeholders, and the general public;

- Water Resources Advisory Commission and Lake Okeechobee Committee meetings – regular updates will be provided to the WRAC and Lake Okeechobee Committee, which advises the SFWMD Governing Board on a variety of environmental restoration and water resource management issues. The WRAC also serves as a forum for improving public participation and decision-making on water resource issues. These meetings will be used to discuss progress of implementation and seek input from stakeholders as well as the general public;

- South Florida Water Management District Governing Board meetings – updates on progress of implementation and proposals for major revisions will be discussed as appropriate. This forum provides an opportunity for input from stakeholders as well as the general public ;

- Other public meetings as necessary.

10.2.4 Force Majeure

Extraordinary events or circumstances beyond the control of the Coordinating Agencies may prevent or delay implementation of Plan projects. Such events may include, but are not limited to, Acts of Nature (including fire, flood, drought, hurricane, or other natural disaster) as well as unavoidable legal barriers or restraints, including litigation of permits for individual Plan projects.

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SECTION 11

REFERENCES

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11.0 REFERENCES

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