June 2007

Revised Draft Supplemental Environmental Impact Statement

Including Appendices A through G

Lake Okeechobee Regulation Schedule

U.S. Army Corps of Engineers
Jacksonville District

REVISED DRAFT SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT

Lake Okeechobee Regulation Schedule Study
Lake Okeechobee, Florida

Proposed Action: To implement an interim regulation schedule for Lake Okeechobee

Type of Statement: Revised Draft Supplemental Environmental Impact Statement

Lead Agency: Jacksonville District, U.S. Army Corps of Engineers

Abstract: This Revised Draft Supplemental Environmental Impact Statement supports the proposed operational changes to the Lake Okeechobee Regulation Schedule. Over the past few years, due to heavy rainfall and numerous hurricanes, the lake stage has reached, and sometimes remained at higher than normal levels. Higher than desirable lake levels frequently result in high volume regulatory releases to the Caloosahatchee and St. Lucie Estuaries. These high lake stages and high volume releases to the estuaries contribute to disrupted productivity in the ecological communities of Lake Okeechobee and its estuaries. All alternatives evaluated were based on criteria for managing Lake Okeechobee at a lower level than the current water regulation schedule. The issue of public health and safety based on the integrity issue of the Herbert Hoover Dike (HHD) is also a key factor in the decision making process to select a preferred alternative regulation schedule. The preferred alternative regulation schedule attempts to balance competing objectives including flood control, water supply, navigation and enhancement of fish and wildlife resources. However, with a multi-purpose lake, managing for better performance of one objective often lessens performance in satisfying competing objectives. The alternative regulation schedule recommended represents the best operational compromise at this time to improve the environmental health of certain major ecosystems, while providing for public health and safety as it pertains to the Lake Okeechobee Regulation Schedule and the HHD. Implementation of the Preferred Alternative regulation schedule would be an interim schedule until a new schedule to accommodate the Comprehensive Everglades Restoration Plan (CERP) Band 1 and the fast track (Acceler8) projects is complete, or the HHD seepage berm construction, or equivalent dike repairs, for Reaches 1, 2 and 3 are completed. Following rehabilitation of the HHD in Reaches 1, 2 and 3, sufficient to allow additional storage, the Corps would plan to operate under the new CERP Band 1 schedule (System Wide Schedule) or in the alternative would plan to operate under a new schedule providing storage equivalent to the existing Water Supply and Environment (WSE) schedule.

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The official closing date for the receipt of comments is 45 days from the date on which the notice of availability of this Revised Draft SEIS appears in the Federal Register. The expected Federal Register date is July 6, 2007.

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EXECUTIVE SUMMARY

REVISED DRAFT SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT ON LAKE OKEECHOBEE REGULATION SCHEDULE LAKE OKEECHOBEE, FLORIDA

The U.S. Army Corps of Engineers (Corps) is proposing to implement an interim regulation schedule for Lake Okeechobee and the Everglades Agricultural Area. The regulation schedule will become part of the Water Control Plan for Lake Okeechobee, which is a feature of the Central and Southern Florida (C&SF) Project. This Supplemental Environmental Impact Statement (SEIS) supports the proposed operational changes to the current Water Control Plan. The SEIS explains the recommended Water Control Plan changes, and provides technical information explaining the basis for the recommendation. The SEIS includes a description of the alternative plans considered, an evaluation of the alternative plans, and a description of environmental effects and the projected impacts of the recommended Water Control Plan on the various purposes of Lake Okeechobee and the C&SF Project. The Water Control Plan will be finalized after the public involvement process associated with its development or change is complete.

Background

Lake Okeechobee, a large, natural, freshwater lake, is considered the heart of the water resources system in south Florida. The Herbert Hoover Dike (HHD) and several water control structures allow management of the lake to meet different objectives, including flood control, water supply, and environmental enhancement. Lake Okeechobee benefits south Florida by storing water during wet periods for subsequent environmental, urban and agricultural needs during dry periods.

Over the past few years, Lake Okeechobee has experienced above average lake levels. These extended periods of high water levels within Lake Okeechobee have been identified as causing stress to the structural integrity of the HHD that surrounds the lake, as well as the lake's natural habitat. Additionally, high water levels in the lake have led to high volume freshwater releases to the coastal estuaries, causing stress to marine habitats. To lessen some of the impacts to the environment from high volume releases, and accommodate for HHD structural limitations, a lower lake regulation schedule is necessary.

The current Lake Okeechobee Regulation Schedule (LORS), referred to as Water Supply and Environment (WSE) was supported in a 1999 Environmental Impact Statement (EIS), with a Record of Decision (ROD) signed on July 7, 2000. Since implementation of the WSE schedule, it has been determined that improvements to

performance of the regulation schedule could be achieved. In 2003-2005, Lake Okeechobee experienced consecutive very wet summers. During this time, water managers were faced with regulation schedule constraints under the current water control plan that provided them minimal operating flexibility to adapt to real time effects. In order to improve lake operations under the unusually-wet conditions, a series of operational deviations were approved and implemented between 2003 and 2006. Even under the operational deviations, Lake Okeechobee still experienced continued high water levels that posed structural integrity and public safety issues with the HHD, caused adverse effects to the lake's ecosystem, and contributed to harmful freshwater releases to the Caloosahatchee and St. Lucie estuaries. Environmentalists and scientists within the surrounding communities strongly advocated lowering the lake levels and reducing the large freshwater releases to the estuaries.

To address environmental concerns and HHD integrity issues, in 2005, the Lake Okeechobee Regulation Schedule Study (LORSS) was initiated which focused on alternative schedules designed to lower the normal operating limits of Lake Okeechobee. The study developed several alternatives, which resulted in the selection of Alternative 1bS2-m as the Preferred Alternative. Alternative 1bS2-m was supported in a draft SEIS. Notice of Availability of the draft SEIS appeared in the Federal Register on August 18, 2006. During the draft SEIS public review period, numerous public comments were received. The majority of the public comments centered on the need for improving Alternative 1bS2-m as it related to the Caloosahatchee Estuary performance. While the Preferred Alternative, 1bS2-m, did well in lowering lake operating limits, the public was concerned that the schedule did not adequately reduce the high freshwater releases to the Caloosahatchee Estuary on Florida's west coast.

Based on consideration of public comments received, the Corps made a decision to complete additional alternative plan formulation and subsequent hydrologic simulation modeling in an attempt to improve the Caloosahatchee Estuary performance, while achieving other study objectives. Since additional formulation and modeling was done, which resulted in three new alternatives, it was necessary to revise the August 2006 draft SEIS, instead of finalizing the document. As such, this revised draft SEIS evaluates the new array of alternatives, and incorporates the responses to the many comments received on the August 2006 draft SEIS.

Need or Opportunity

There is a need to manage Lake Okeechobee at a lower operation schedule. Evidence of this has been clearly established for ecological reasons, such as continued deterioration of Lake Okeechobee's littoral zone and both the Caloosahatchee and St. Lucie estuaries. The need to manage Lake Okeechobee at lower levels also stems from structural integrity issues with the HHD levee system that protects the surrounding communities from flood damage.

Major Findings and Conclusions

For a multiple purpose lake, such as Lake Okeechobee, a regulation schedule attempts to balance competing objectives including flood control, water supply, navigation and

preservation of fish and wildlife resources. Thus, managing for better performance of one objective often lessens performance in satisfying competing objectives. An objective of the study is to minimize high lake stage events. The alternatives performed well in meeting this objective. However, there is a trade-off when decreasing the high lake stage events, which is increasing the frequency of low stage events. When water levels reach extreme low stages, there is always the potential for navigation, water supply, and fish and wildlife resource impacts throughout the study area. Lowering lake stages can also create adverse conditions in the Caloosahatchee and St. Lucie Estuaries.

Alternatives

Two alternatives from the August 2006 draft SEIS (the Preferred Alternative 1bS2-m, and Alternative 1bS2-A) were carried forward for further modeling and refinements to better meet the objectives of the LORSS. From these two alternatives, three additional alternatives (referred to in this EIS as Alternatives C, D, and E) were developed. All of the alternatives were modeled and evaluated, and then compared to the No Action Alternative. The alternatives were evaluated using a set of performance measures and evaluation criteria that were previously developed for other studies in the study area and specifically for this study.

It should be recognized that prior to the alternative formulation and evaluation process for the revised draft SEIS and prior to the start of additional modeling, the Corps conducted a detailed review of the assumptions and data sets included in the original modeling for the 2006 draft SEIS. As with most studies, the modeling data sets and assumptions used for the LORSS evolved during the duration of the study. The additional modeling performed for the revised draft SEIS presented an opportunity to update modeling data and assumptions to ensure that the most current data sets and assumptions were considered in the evaluations of the Preferred Alternative refinements resulting from the additional plan formulation.

Preferred Alternative

The Preferred Alternative (Alternative E) recommended in this report represents the best operational compromise at this time to improve and maintain the environmental health of certain major C&SF ecosystems, while providing for public health and safety as it pertains to the LORS and the impact it has on the safe operation of the HHD.

Areas of Controversy

There will always be a level of controversy involved in the operation of a large, complex, multi-purpose project, such as Lake Okeechobee. As authorized, the project has many project purposes, including flood control, water supply for agriculture, municipalities, and Everglades National Park (ENP), preservation of fish and wildlife, recreation, navigation and prevention of salt water intrusion. More often than not, trade-offs will exist in order to meet project purposes. Much controversy centered on the previous Preferred Alternative, IbS2-m, and its potential adverse effects on the Caloosahatchee Estuary. Additionally, there was concern with the high lake constraint set at 17.25 ft. NGVD in the initial modeling. Many of the comments received on the 2006 draft SEIS

requested that the Corps relax the 17.25 ft. constraint for further alternative formulation and evaluation. The Corps recognized the importance of improving the estuary performance as it related to reducing undesirable high volume flows, and relaxed the 17.25 ft. constraint by instead treating it as a performance measure.

Unresolved Issues

The Corps and the United States Fish and Wildlife Service (USFWS) are engaged in formal consultation under the Endangered Species Act (ESA) to identify and evaluate the effects to the endangered Everglade snail kite, wood stork and Okeechobee gourd. An initial determination of "may affect" was made for these species, and issuance of a Biological Opinion by the USFWS is expected prior to finalizing this EIS.

Selected Plan Implementation

Implementation of the Preferred Alternative regulation schedule would be an interim schedule until a new schedule to accommodate the Comprehensive Everglades Restoration Plan (CERP) Band 1 and the fast track (Acceler8) projects is complete, or the HHD seepage berm construction, or equivalent dike repairs, for Reaches 1, 2 and 3 are completed. Following rehabilitation of the HHD in Reaches 1, 2 and 3, sufficient to allow additional storage, the Corps would plan to operate under the new CERP Band 1 regulation schedule (System Wide Schedule) or in the alternative would plan to operate under a new schedule providing storage equivalent to the existing WSE regulation schedule.

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LIST OF ACRONYMS

>	Greater than
<	Less than
ASR	Aquifer Storage and Recovery
BA	Biological Assessment
BO	Biological Opinion
C&SF	Central and Southern Florida
CAA	Clean Air Act
CAR	Coordination Act Report
CERP	Comprehensive Everglades Restoration Plan
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
cfs	cubic feet per second
CLA	Classification Limit Adjustment
cm	centimeter
Corps	U.S. Army Corps of Engineers
CR	County Road
CSSS	Cape Sable Seaside Sparrow
CWA	Clean Water Act
CZM	Coastal Zone Management
CZMA	Coastal Zone Management Act
Decomp	Decompartmentalization
EA	Environmental Assessment
EAA	Everglades Agricultural Area
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
ENP	Everglades National Park
E.O.	Executive Order
EPA	Environmental Protection Agency
ESA	Endangered Species Act
FDEP	Florida Department of Environmental Protection
FFWCC	Florida Fish and Wildlife Conservation Commission
FMP	Fishery Management Plan
FONSI	Finding of No Significant Impact
ft	foot/feet
GMFMC	Gulf of Mexico Fishery Management
HAB	Harmful Algal Blooms

HHD	Herbert Hoover Dike
HTRW	Hazardous, Toxic and Radioactive Waste
IRL	Indian River Lagoon
km	kilometer
LEC	Lower East Coast
LECSA	Lower East Coast Service Area
LOPA	Lake Okeechobee Protection Act
LONIN	Lake Okeechobee Net Inflow
LONINO	Lake Okeechobee Net Inflow Outlook
LOOPS	Lake Okeechobee Operations Screening Model
LORS	Lake Okeechobee Regulation Schedule
LORSS	Lake Okeechobee Regulation Schedule Study
LOSA	Lake Okeechobee Service Area
LOWSM	Lake Okeechobee Water Shortage Management
LWL	Lake Worth Lagoon
MISP	Master Implementation Sequencing Plan
mph	miles per hour
MRR	Major Rehabilitation Evaluation Report
MSCO	Multi-season Climate Outlook
MSFCMA	Magnuson-Stevens Fishery Conservation and Management Act
mt/yr	metric tons per year
NEPA	National Environmental Policy Act
*NGVD	National Geodetic Vertical Datum
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NOA	Notice of Availability
NOI	Notice of Intent
NTO	Non-typical Temporary Operation
PM	Performance Measure
PDSI	Palmer Drought Severity Index
PDT	Project Delivery Team
POR	Period of Record
ppb	parts per billion
ppt	parts per thousand
RECOVER	Restoration, Coordination and Restoration
ROD	Record of Decision
SAFMC	South Atlantic Fishery Management Council

SAV	Submerged Aquatic Vegetation
SCO	Seasonal Climate Outlook
SEIS	Supplemental Environmental Impact Statement
SFWMD	South Florida Water Management District
SFWMM	South Florida Water Management Model
SHPO	State Historic Preservation Officer
SSM	Supply Side Management
STA	Stormwater Treatment Area
THC	Tributary Hydrologic Condition
TMDL	Total Maximum Daily Loads
U.S.	United States
USACE	U.S. Army Corps of Engineers
USFWS	United States Fish and Wildlife Service
WCA	Water Conservation Area
WMA	Wildlife Management Area
WRAC	Water Resources Advisory Commission
WRDA	Water Resources Development Act
WSE	Water Supply and Environment
WST	Water Shortage Trigger

*The elevations described in this document refer to feet above mean sea level, using the standard National Geodetic Vertical Datum Plane of 1929.

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SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT FOR THE LAKE OKEECHOBEE REGULATION SCHEDULE

1. PROJECT PURPOSE AND NEED

1.1. PROJECT AUTHORITY

Authority to complete this study was granted under Section 310 of the 1990 Water Resources Development Act (WRDA) which reads in part: "...(1) CENTRAL AND SOUTHERN FLORIDA-The Chief of Engineers shall review the report of the Chief of Engineers on central and southern Florida, published as house Document 643, 80th Congress, 2nd Session, and other pertinent reports, with a view to determining whether modifications to the existing project are advisable at the present time due to significantly changed physical, biological, demographic, or economic conditions, with particular reference to modifying the project or its operations for improving the quality of the environment, improving protection of the aquifer, and improving the integrity, capability, and conservation of urban water supplies affected by the project or its operations."

1.2. PROJECT LOCATION

Lake Okeechobee is located in south central Florida, and occupies portions of, Glades, Hendry, Martin, Okeechobee, and Palm Beach counties (Figure 1-1). Lake Okeechobee has an area of approximately 730 square miles with its approximate center near 26° 56′ 55″ north latitude and 80° 56′ 34″ west longitude. The area that may be affected by the proposed alternative lake regulation schedules includes much of south Florida beyond the bounds of Lake Okeechobee proper. For the purposes of this study, it has been determined that substantive effects may be regional in nature and importance, but perhaps due to the restricted operational changes being proposed, are not limitless in scope and effect. Hydrologic modeling, using the South Florida Water Management Model (SFWMM), indicate that the southern Water Conservation Areas (WCAs), including WCA 3A below I-75 (Alligator Alley), WCA 2B, 3B, and the Everglades National Park (ENP) are not significantly affected by the operational changes being proposed to the Lake Okeechobee Regulation Schedule (LORS). The areas considered to be most affected and which shall receive the greatest scrutiny in terms of impact assessment are Lake Okeechobee, particularly within the littoral and marsh areas of the lake, and major downstream estuaries including the St. Lucie and Caloosahatchee estuaries. To a lesser degree, other areas considered to be affected are within the Everglades Agricultural Area (EAA), and in the northern WCAs, including WCA 3A north of I-75, WCA 2A, and the Arthur R. Marshall Loxahatchee National Wildlife Refuge (WCA 1), and the Lake Worth Lagoon. Figure 1-2 provides an overall image of the study area including its proximity within the central and south Florida ecosystem.

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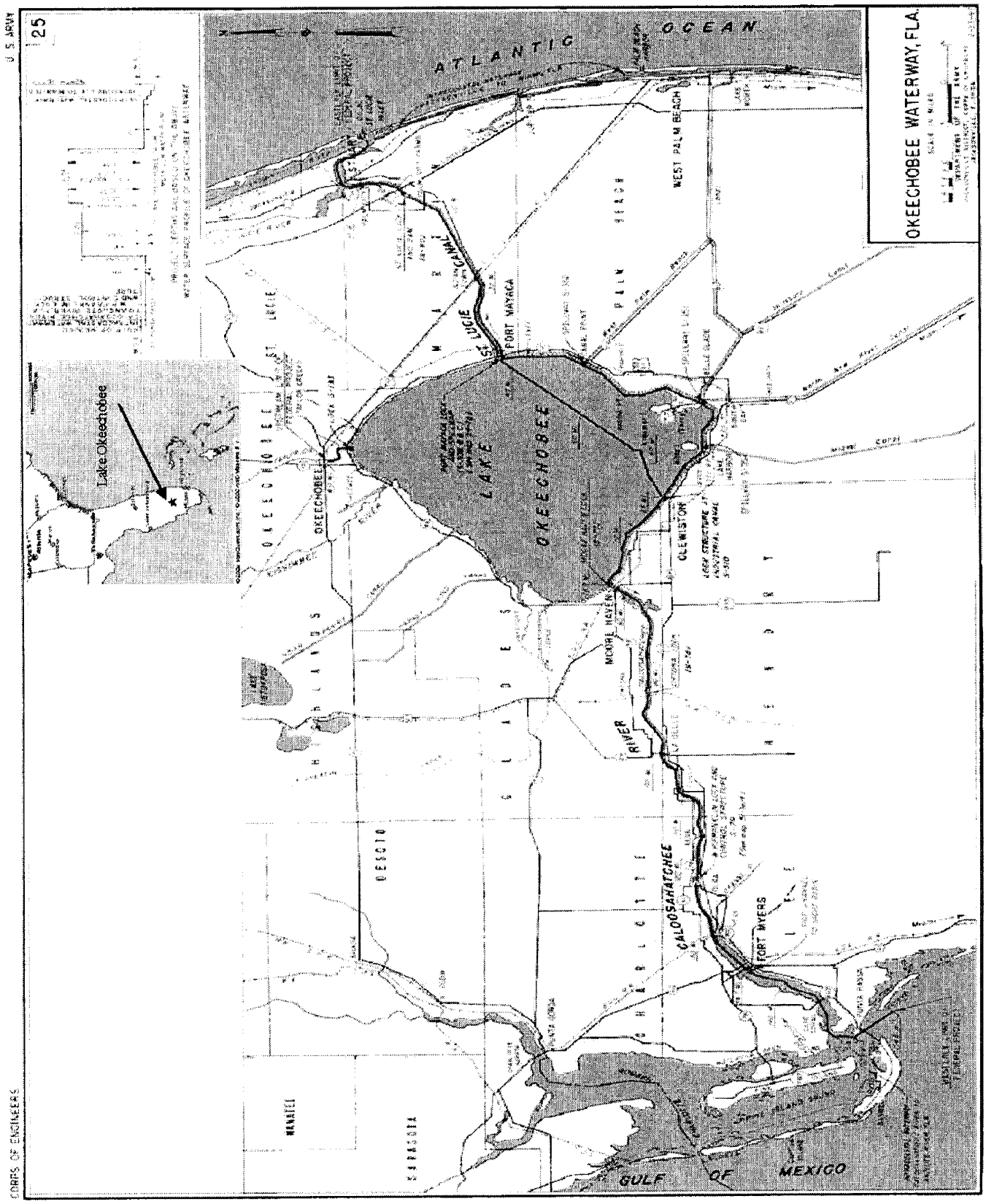

FIGURE 1-1: LOCATION MAP

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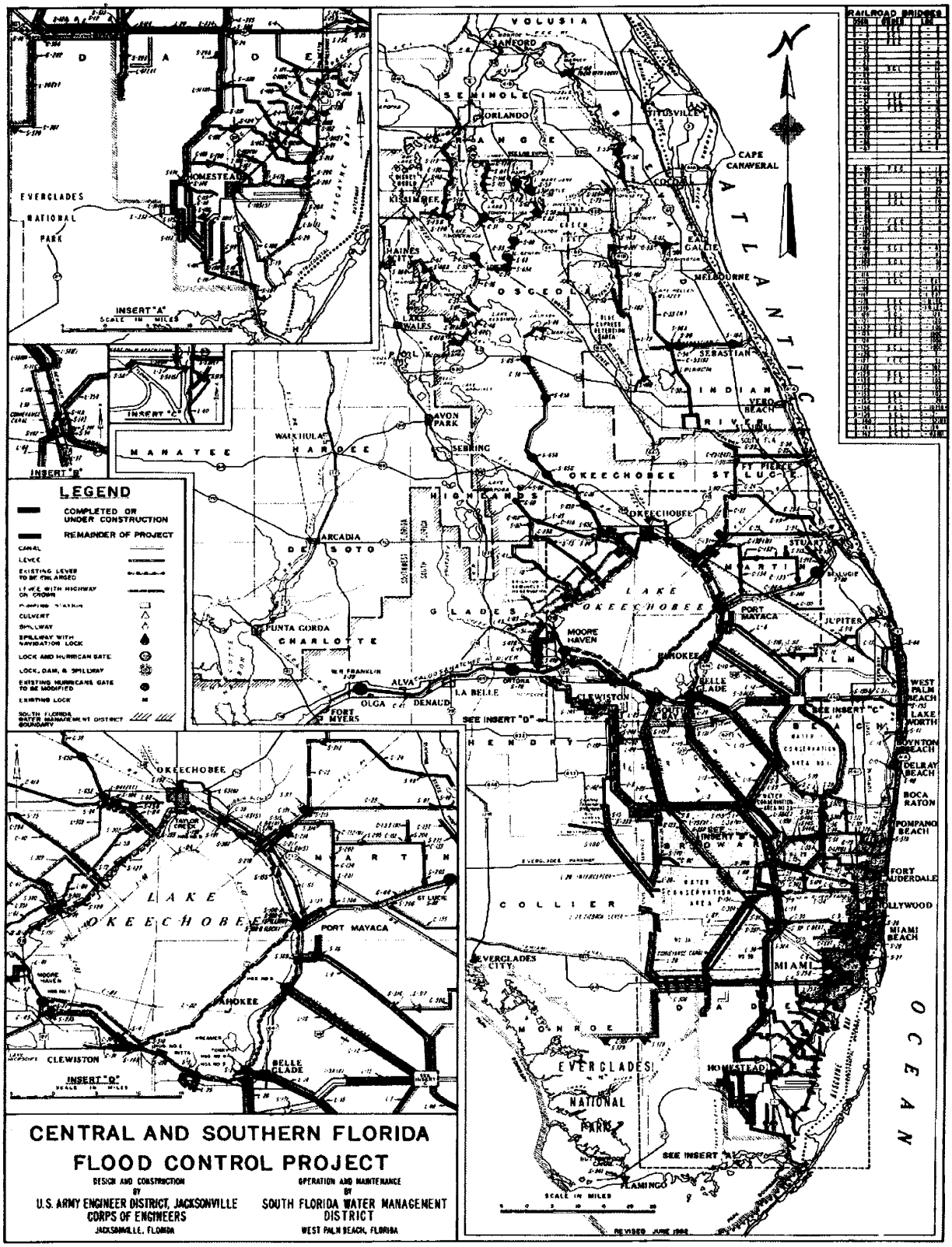

FIGURE 1-2: C&SF PROJECT MAP

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Part of the Okeechobee Waterway, the St. Lucie Canal is the main eastern flood control outlet for Lake Okeechobee. The St. Lucie Estuary is located within portions of both Martin and St. Lucie counties on the southeast coast of Florida. The two forks of the St. Lucie Estuary, the North Fork and South Fork, flow together near the Roosevelt Bridge at the City of Stuart, and then flow eastward approximately six miles to the Indian River Lagoon and Atlantic Ocean at the St. Lucie Inlet.

The Caloosahatchee River is the only flood-control outlet leading west from Lake Okeechobee, part of the Okeechobee Waterway, and combined with the St. Lucie Canal, the only navigable passage between the Gulf of Mexico and the Atlantic Ocean. The river extends approximately 70 miles from Lake Okeechobee, through the Caloosahatchee Estuary, to the lower Charlotte Harbor Basin at San Carlos Bay. The Caloosahatchee River passes through parts of Glades, Hendry, and Lee counties.

The EAA, located south of Lake Okeechobee within eastern Hendry and western Palm Beach counties, encompasses an area totaling approximately 718,400 acres (1,122 square miles) of highly productive agricultural land comprised of rich organic peat or muck soils. A small portion of EAA mucklands is found in western Martin County. The EAA is considered one of Florida's most important agricultural regions. The EAA extends south from Lake Okeechobee to the northern levee of WCA 3A. Its eastern boundary extends to the L-8 Canal. The L-1, L2 and L-3 levees represent the EAA's westernmost limits.

The WCAs cover 1,372 square miles and are located south of Lake Okeechobee and the EAA. WCA 1, also known as the Arthur R. Marshall Loxahatchee National Wildlife Refuge, includes 227 square miles of Everglades wetland habitat. WCA 2, the smallest of the three WCAs, encompasses approximately 210 square miles. The area is divided into two cells by a levee constructed in 1961. The north cell, WCA 2A, covers 173 square miles, and the south cell, WCA 2B, covers 37 square miles. WCA 3, the largest of the WCAs covers an area of 915 square miles.

The Lake Worth Lagoon, located in Palm Beach County, is another estuary of importance within the study area. The Lake Worth Lagoon, centrally located in the county is approximately 20 miles in length, and averages approximately 0.4 miles in width, and six to ten feet in depth (Palm Beach County Department of Environmental Resources Management [PBDERM], 1998). The Lake Worth Lagoon is separated from the Atlantic Ocean by a barrier island. Major freshwater drainage into the estuary occurs from many canal systems. The C-51 canal is the largest inflow of fresh water discharging into the lagoon (PBCDERM, 1998). The C-51 basin includes the West Palm Beach Canal which extends from Lake Okeechobee south and east to the coastline where it empties into Lake Worth Lagoon.

1.3. PROJECT NEED OR OPPORTUNITY

There is a need to manage Lake Okeechobee at a lower lake schedule. Evidence of this need has been clearly established for ecological reasons, such as the continued deterioration of Lake Okeechobee's littoral zone and both the Caloosahatchee and St. Lucie estuaries. The need to manage the lake lower also stems from integrity issues with the Herbert Hoover Dike (HHD) levee system that protects the surrounding communities from flood damage.

1.4. AGENCY GOAL OR OBJECTIVE

The agency goal is to implement a new regulation schedule that would improve the health of Lake Okeechobee and the St. Lucie and Caloosahatchee estuaries, while continuing to ensure public health and safety, and with minimal or no impact to the competing project (lake) purposes. Study objectives consistent with this goal have been determined as follows:

a. Ensure public health and safety
b. Manage Lake Okeechobee at optimal lake levels to allow recovery of the lake's environment and natural resources
c. Reduce high regulatory releases to the estuaries
d. Continue to meet Congressionally authorized project purposes including, flood control, water supply, navigation, fish and wildlife enhancement, and recreation

1.5. BACKGROUND AND RELATED ENVIRONMENTAL DOCUMENTS

The regulation of Lake Okeechobee water levels is performed by the U.S. Army Corps of Engineers (Corps), in consultation with the South Florida Water Management District (SFWMD). Lake Okeechobee is managed as part of the Central and Southern Florida (C&SF) Project for water supply and flood protection needs of the rapidly growing population of south Florida. The main inflows to Lake Okeechobee are the Kissimmee River, Taylor Creek-Nubbin Slough, Indian Prairie Canal, Harney Pond Canal, and Fisheating Creek. The main outflows east and west are the St. Lucie Canal, and the Caloosahatchee River, which comprise the largest outflow capacity. The main outflows south are through the Miami Canal, North New River Canal, Hillsborough Canal, and the West Palm Beach Canal. Inflows to Lake Okeechobee frequently exceed total outflow capacity. The HHD and several water control structures allow management of Lake Okeechobee to meet project purposes which includes flood control, water supply, navigation, recreation and environmental enhancement.

The tool used to perform Lake Okeechobee operations is referred to as a regulation schedule. A regulation schedule is a guideline for water managers to use in regulating the inflow and outflow of water through the various water control structures, i.e. pumps, spillways and locks. Regulation schedules for Federal water resources projects are included in water control manuals prepared in accordance with engineering regulations, and are accompanied by the appropriate environmental documentation required under the National Environmental Policy Act (NEPA). Since construction of the C&SF Project, there have been several authorized Lake Okeechobee regulation schedules to

accommodate structure capabilities, such as HHD (levee) height, and to attempt to address the water supply needs of the growing population of south Florida. During the early 1970s, levee improvements were made so that Lake Okeechobee could safely handle the 15.5 to 17.5 foot authorized regulation schedule. In 1978, consultation regarding the new schedule was conducted with the United States Fish and Wildlife Service (USFWS). This consultation resulted in issuance of a Fish and Wildlife Coordination Act Report (CAR), and a Biological Opinion.

In 1991, the SFWMD requested that the Corps implement an interim 15.65 to 16.75 ft. National Geodetic Vertical Datum (NGVD) schedule. In 1994, an Environmental Assessment (EA) resulting in a Finding of No Significant Impact (FONSI) was prepared for the schedule referred to as Run 25. Lake Okeechobee was operated under the Run 25 schedule until the current schedule, Water Supply and Environment (WSE) was approved in 2000. A Final Environmental Impact Statement (EIS) supporting the WSE schedule was completed in 1999, with a Record of Decision (ROD) signed in July 2000.

When the WSE schedule was approved in 2000, south Florida was in the beginning of a severe drought that lasted through much of 2001. Lake Okeechobee experienced a record low water level of 8.97 ft. NGVD on May 24, 2001. Then to the other extreme, Lake Okeechobee experienced consecutive very wet summers in 2003-2005, with the water level reaching a high of 18.02 ft. NGVD on October 13, 2004. Much of the wet weather pattern was a result of the historically significant hurricane seasons in 2004 and 2005. Years 2004 and 2005 are ranked eighth and ninth for Lake Okeechobee's highest net inflow during the wet season (June-October) since 1914.

In the relatively short period of time since the WSE schedule was approved, some weaknesses in the schedule became evident. High lake levels were a result of the wetter than normal conditions during this time period. WSE contributed to the problem because of schedule regulations that did not allow for releases to be made under the hydrological conditions that existed at that time. Due to the continuing problems with high water elevations under the WSE schedule, in 2003, the Corps officially deviated from the WSE schedule in an attempt to lower Lake Okeechobee. As the recent past has shown, the WSE regulation schedule limits releases from Lake Okeechobee during certain hydrological conditions when water levels are high and during some periods when the lake's littoral zone and estuaries would have benefited from such releases. Not only is this a concern for lake and estuary ecology, but also for integrity issues with the HHD. The deviation was made in an attempt to lower Lake Okeechobee by making relatively small (Level 1) pulses to the estuaries. It was at this time that public concern for the surrounding levee system, the health of Lake Okeechobee and the downstream estuaries led to commitments by executive management of the Corps to re-examine the WSE regulation schedule.

The Corps initiated a multi-phase effort to improve the LORS. The first phase, which began in 2004, implemented a modification to the schedule to increase the flexibility and opportunities to make releases when the lake stage is between the "no regulatory discharge" and "discharge maximum practicable" release zones. The Corps made the

schedule modification as a temporary planned deviation referred to as the Classification Limit Adjustment (CLA), which was implemented to adjust classifications of the hydrologic indicators and forecasts included in the regulation schedule. An EA was prepared in December 2004 (incorporated by reference), with a FONSI signed on January 25, 2005, for the action. The intent of the CLA was to help lower above-average lake levels and to improve ecological conditions within Lake Okeechobee's littoral zone. However, the CLA has not affected the regulation schedule because the appropriate trigger conditions necessary to implement the deviation seldom occur.

Phase 2 of the multi-phase effort to modify the regulation schedule began in July 2005, and is the current Lake Okeechobee Regulation Schedule Study (LORSS) that led to a draft Supplemental Environmental Impact Statement (SEIS) dated August 2006 (incorporated by reference). The Preferred Alternative identified in the August 2006 draft SEIS prompted numerous comments during the public review period. The majority of the public comments centered on the need to improve the performance of the identified Preferred Alternative, referred to as 1bS2-m. In particular, the concerns were that the Preferred Alternative did not adequately address the high volume freshwater releases to the Caloosahatchee Estuary. Based on consideration of the public comments, additional alternative plans were formulated and additional modeling was performed in an attempt to achieve better alternative performance in the model simulations. This revised draft SEIS evaluates the environmental effects of the new alternatives.

Phase 3 efforts, expected to begin in late 2007, will examine a new water regulation schedule based on the effects of the Comprehensive Everglades Restoration Plan (CERP) Band 1 projects and the Fast Track (Acceler8) projects. Band 1 is the group of priority CERP projects expected to be constructed around the 2010 timeframe, and includes a number of the major storage reservoirs in the CERP. A list of the Band 1 projects and Acceler8 projects can be found at http://www.evergladesplan.org under Master Implementation Sequencing Plan (MISP).

The recommendation to adopt a new regulation schedule for Lake Okeechobee as a result of this study should be viewed as one step in the longer process of developing a LORS that will take into account the CERP Band 1 projects. Adjusting the lake's regulation schedule now will change the way the regional system is operated, but the larger problems now existing in the system can only be solved by adding water storage features on a regional scale which is being addressed by the CERP.

1.6. DECISIONS TO BE MADE

A major concern with the present regulation schedule, WSE, is the structural stability of the HHD during high water stages. As such, a decision was made to only evaluate alternative plans that triggered maximum regulatory releases one-foot lower than the WSE regulation schedule requirement. The heightened concern with HHD was emphasized after several hurricanes passed through south Florida during 2004 and 2005, as well as the levee damage around New Orleans caused by Hurricane Katrina in 2005. Prior to these devastating hurricanes, the Corps conducted a lengthy study of

the HHD condition which resulted in a 1999 report titled "Major Rehabilitation Evaluation Report" (MRR). This report documents the condition of the dike, and identifies needed repairs. A table within the MRR identifies the combined probability of levee breach at different lake elevations. Under WSE (elevation 18.53 ft.), there is a 55% probability of levee breach. In response to the findings in the MRR, a Major Rehabilitation Project was approved, and HHD rehabilitation is currently underway. HHD rehabilitation construction, as well as the State's independent report of the technical inspection of the HHD released in 2006, prompted much attention during the LORSS. The State's independent report essentially validated the Corps previous findings from the MRR that the HHD is in need of rehabilitation. After the State's independent report was publicly released, the Corps received a letter of concern from the Governor of Florida (Pertinent Correspondence, Appendix H). The Governor's concern was the potential failure of the dike and the effects a failure could have on the communities around Lake Okeechobee.

While the Corps considers public health and safety as its highest priority, the recent attention given to the HHD stability issue underscores the importance of the implementation of the rehabilitation plan, as well as the plan to develop a new regulation schedule. HHD integrity problems such as seepage, piping, and boils are exacerbated when the lake elevation approaches 18.5 ft., NGVD (USACE, 2005). As a result, the LORSS only considered alternatives that would allow Lake Okeechobee to be managed at a lower average level year-round compared to the WSE regulation schedule. Other important considerations for this study were the environmental needs of Lake Okeechobee, the Caloosahatchee and St. Lucie estuaries, and the greater Everglades (including the WCAs). The work being performed for this study consists of identifying the effects (both beneficial and adverse) associated with the alternatives developed for the LORSS. Broadly, the effort involved:

a. Identifying all environmental, fish and wildlife, cultural and recreational resources in the study area;
b. Assessing the effects of the alternative regulation schedules on these resources;
c. Quantifying impacts to the competing lake management objectives such as flood protection, water supply, recreation and navigation;
d. Evaluating the socio-economic impacts associated with the alternative regulation schedules; and
e. Preparing the required documentation including graphics to present the study's findings and recommendations.

1.7. PUBLIC CONCERNS

Through numerous public meetings and coordination opportunities, agencies, local officials, residents, and environmental groups have expressed their concern over the ecological health of Lake Okeechobee and the coastal estuaries, and are looking to the Corps to resolve the problem. Environmentalists and scientists within the environmental community are strongly advocating for lowering the lake levels and reducing the high volume releases to the estuaries. Agricultural and municipal water supply interests are equally concerned with the potential consequences of managing the lake at lower levels. With these concerns in mind, this study was implemented as

an intermediate step to attempt to resolve these issues solely through the current Federal Authority of making operational modifications. As such, the new alternative regulation schedule can only achieve minor improvement in the timing of water releases and cannot result in significant improvement until more storage is available within the system. In the future, as discussed previously, Phase 3 of the LORSS effort will examine a new regulation schedule based on additional storage available through the CERP Band 1 Projects.

1.8. SCOPING AND ISSUES

1.8.1. ISSUES EVALUATED IN DETAIL

The following issues were identified during scoping and by the preparers of this SEIS to be relevant to the proposed action and appropriate for detailed evaluation:

- Public health and safety
- Flood control
- Water supply
- Impacts to Lake Okeechobee, Everglades and estuarine biota
- Endangered and threatened species
- Water quality
- Navigation

1.8.2. ISSUES SCREENED FROM DETAILED ANALYSIS

The following issues were not considered as important to the proposed action based on scoping and the professional judgment of the preparers of this SEIS:

- Historic properties
- Air quality
- Noise pollution
- Hazardous, toxic and radioactive waste (HTRW)

1.9. PERMITS, LICENSES, AND ENTITLEMENTS

Clean Water Act of 1972
As the proposed action is strictly of an operational nature, and does not involve any new discharge or construction activity, water quality certification from the State of Florida is not required. Furthermore, as there are no structural components contained in the proposed action and no dredge and fill operations being considered, a Section 404 (b) Evaluation is not necessary.

Coastal Zone Management Act
This action will be reviewed for consistency with the State's Coastal Zone Management (CZM) Program, pursuant to the Coastal Zone Management Act (CZMA), 16 U.S.C., 1451-1464, as amended.

2. FORMULATION OF ALTERNATIVES

This section describes in detail the No Action Alternative, the proposed action, and other reasonable alternatives that were studied in detail. Section 5, Affected Environment, presents the beneficial and adverse environmental effects of all alternatives in comparison form, providing a clear basis for the decision maker and the public to choose among the options.

2.1. WHAT IS A REGULATION SCHEDULE?

As part of the operation of the C&SF Project, the Corps establishes a water regulation schedule for Lake Okeechobee. A regulation schedule is a guideline for water managers to use in regulating the inflow and outflow of water through the various water control structures, i.e. pumps, spillways and locks.

The term "regulation schedule" refers to a compilation of operating criteria, guidelines, rule curves and specifications that govern storage and release functions of a reservoir. A regulation schedule is a tool used by water managers to manage the water levels. Typically, a regulation schedule has water level thresholds which vary with the time of year and trigger discharges. The threshold lines of regulation schedules define the release zones and are traditionally displayed graphically. Additionally, a corresponding table is typically used to identify the structure discharge rules for release zones. Regulation schedules for Corps water resources projects are included in water control manuals prepared in accordance with engineering regulations, and are accompanied by the appropriate NEPA-required documentation. The authority for approving water control manuals rests with the appropriate U.S. Army Corps of Engineers Division Commander. For this study, the proposed modification to the LORS will be submitted for review and approval to the commander of the Corps of Engineers South Atlantic Division after conclusion of the public and agency review process.

The LORS has been, and will continue to be, designed to balance multiple, and often competing, project purposes and objectives. Thus, managing for better performance of one objective often lessens performance in satisfying competing objectives. For example, higher regulation schedules tend to benefit water supply, but may increase the risk to public health and safety, and can harm the ecology of the lake. Lower lake schedules may produce lake levels more desirable for lake ecology and improved flood protection, but reduce water supply potential. Lowering lake water levels also has the potential to adversely affect estuarine systems receiving lake discharges. Therefore, the LORS is not developed to optimize performance of any single project purpose, but rather attempts to balance the performance of the multiple project purposes.

Water levels in Lake Okeechobee are driven largely by climatic conditions. The difficulty with Lake Okeechobee is inflows to the lake frequently exceed total outflow capacity, which sometimes causes the lake to rise very quickly. These sudden rises in water level may trigger discharges through the major outlets in an effort to control excessive buildup of water in Lake Okeechobee. The timing and magnitude of these

releases is not only important for preserving flood protection of the region, but also for protecting the natural habitats of the downstream estuaries.

While providing for Federal project purposes, the LORS also provides for the rights of water allocation that rest with the State of Florida. In the case of the C&SF project, the state agency responsible for allocating water is the SFWMD. The SFWMD is responsible for water supply allocation from Lake Okeechobee when lake elevations meet a certain level as determined by the schedule. Releases may be municipal and agricultural water supply, aquifer protection, to maintain appropriate salinity envelope in the estuaries, environmental releases south to the Everglades, or any other beneficial uses the SFWMD deems appropriate. The State's decision regarding appropriating water releases is not determined by the Corps, unless the release would interfere with Federal project purposes.

2.2. DEVELOPMENT OF ALTERNATIVE PLANS

While the issues that surround the implementation of a regulation schedule for Lake Okeechobee are very complex, as are the various scientific and engineering models used, the planning process is relatively straightforward. Various lake regulation schedule alternatives were developed and proposed to replace the existing schedule, WSE. At the beginning of the LORSS, three conceptual alternatives and the No Action Alternative were formulated and evaluated by the LORSS Project Delivery Team (PDT). Alternatives 1 and 2 were conceptual alternatives that were developed by the SFWMD and the Corps respectively, and were used as starting points in the alternative formulation development process. In addition to Alternatives 1 and 2, an alternative from the 1999 LORSS (referred to as Run 22AZE in the 1999 study) was pulled forward into the new LORSS as Alternative 3. This alternative was pulled forward into the current LORSS at the request of resource management agencies on the PDT. Alternatives 1, 2 and 3 were then modeled, and evaluated against performance measures (PM) established at the beginning of the study. PMs were developed for Lake Okeechobee, Caloosahatchee Estuary, St. Lucie Estuary, Lake Worth Lagoon, water supply, public safety, navigation, and the greater Everglades.

Initial Alternative Evaluation Results

The PDT conducted an evaluation of the three alternatives compared to the No Action Alternative. Recommendations and feedback from the LORSS PDT were considered. Since none of the initial three alternatives did well in meeting the planning objectives, the LORSS PDT re-evaluated the initial alternatives in an effort to develop additional alternatives that would better address planning objectives. From this effort evolved eleven alternatives, all of which were variations of Alternatives 1, 2 or 3. For further information on the development and refinement of the alternatives, refer to Appendix E. Using the PM results generated by the SFWMM, the PDT was able to screen the number of alternatives from eleven to five. The subsequent array of alternative plans resulting from the initial screening of the eleven alternatives is as follows:

1. Alternative 1aS2
2. Alternative 1bS2
3. Alternative 2A
4. Alternative 3
5. Alternative 4

During the initial alternative plan formulation effort, much attention was also centering on the ongoing rehabilitation efforts of the HHD. Additionally, the State's independent technical report on HHD was released early in 2006, which reiterated concerns with the structural stability of the HHD. Based on this information, and coupled with a 28 April 2006 letter from the Governor of Florida requesting that the Corps adopt a new regulation schedule to keep Lake Okeechobee at lower levels to protect the surrounding communities, a decision was made to include a maximum lake water level constraint measure for this study. A maximum lake water elevation of 17.25 ft. NGVD was incorporated into the study, and alternatives were formulated to prevent lake elevations exceeding 17.25 ft. NGVD, by maximizing releases from Lake Okeechobee to the estuaries above this stage level. The reason for selecting elevation 17.25 feet as the constraint elevation was to address the numerous factors that generate uncertainty in the rate of rise on the lake primarily during the rainy season. This elevation would be used as a protective buffer against Lake Okeechobee rising to an unacceptable high elevation which may compromise the integrity of the HHD. As a result of this constraint, along with a concurrent decision to include a base flow release zone in all alternatives, the PDT either modified the alternatives listed above, or eliminated them from further study because they were not able to meet the 17.25 feet maximum constraint. Two of the modified alternatives (Alternative 1bS2-A and Alternative 2A-B) were further modified to require zero days with Lake Okeechobee stages above 17.25 feet, resulting in the development of Alternative 1bS2-m and Alternative 2a-m. Through numerous modifications and adjustments of the alternatives to meet the constraint, and in consideration of other project objectives, the following final array of alternatives were carried forward for further analysis by the PDT:

1. Alternative 1bS2-A
2. Alternative 1bS2-m
3. Alternative 2A-B
4. Alternative 2A-m
5. Alternative 3-B
6. Alternative 4-A

It should be noted that Alternative 1aS2 was subsequently eliminated from further consideration during this time, since the modeled alternative could not provide maximum releases until reaching an elevation of 18.50 feet during a significant portion of the year. However, the concept and basic framework of Alternative 1aS2 was built into Alternative1bS2, which was retained for further evaluation by the PDT. Alternative 1bS2 was similar to Alternative 1aS2, but performed much better at meeting the objective of achieving lower lake elevations.

The results of the alternative modeling were shared with the LORSS PDT and posted on the Corps' website (http://hpm.sfrestore.org/loweb/sfwmm/) for public viewing. The LORSS PDT evaluated the above alternatives using the PM results generated by the SFWMM including the new constraint of achieving zero or close-to-zero days above lake elevation 17.25 feet. Alternative 3-B was eliminated from further analysis, because it did not meet the objectives of the study. This was due to constraints in the current LORSS that did not exist back in 1999 when this alternative was developed. In particular, the Storm-water Treatment Area (STA) 3/4 treatment capacity restriction for releases from Lake Okeechobee in the current LORSS created much higher lake elevations than previously modeled in 1999. The high lake elevations did not meet the objective of the study for achieving lower lake elevations. Upon completion of the PM evaluation against the No Action Alternative, the Corps solicited input from the PDT members, and selected Alternative 1bS2-m as the Preferred Alternative.

Selection of Preferred Alternative (1bS2-m)

Based on the evaluation of PMs and other evaluation criteria, Alternative 1bS2-m was identified as the "Preferred Alternative" as presented in the August 2006 draft SEIS. Of all the alternatives, Alternative 1bS2-m was considered the best operational compromise for a new LORS because the alternative:

- produced the best balance of all objectives
- allowed for quicker response to lake inflows
- reduced the frequency of high lake stages
- improved optimum flow releases to the estuaries, including the addition of baseflow releases
- limited impacts to water supply, including greater Everglades

Results of August 2006 Draft SEIS

Following release of the August 2006 draft SEIS for public and agency review and comment, the Corps held a series of public meetings to allow the public opportunities to express their views on the Preferred Alternative, 1bS2-m. Recommendations, feedback and comments from the public review process were considerable, with the majority of the comments focusing on performance of the Preferred Alternative with respect to reducing high volume flows to the Caloosahatchee Estuary. Comment letters received on the August 2006 draft SEIS can be found in Appendix H. Additionally, Appendix H includes a matrix that pulls out substantive comments from the letters, and the Corps response to those comments. Substantive comments on the Preferred Alternative addressed the following topics:

- What was the reason behind the 17.25 ft. high lake constraint
- Release more water south
- Increase STA and storage reservoirs
- Use available SFWMD lands for emergency lake water storage
- Water supply concerns
- Plan is acceptable at managing lake lower
- More equitable discharges to estuaries and WCA

- Concerns due to extreme high release from lake to the Caloosahatchee Estuary
- Release more low flows to reduce high flows
- Economic costs of high releases
- Account for wet weather cycle
- Limited discussion and coordination on endangered and/or threatened species such as manatee and sawfish

Based on consideration of public and agency comments, the Corps initiated further plan formulation and modeling in an attempt to address public comments, and improve the performance of the Preferred Alternative. It should be noted that many of the performance limitations of Alternative 1bS2-m observed in the modeling results revolved around the incorporation of the 17.25 feet high lake constraint. As modeled, Alternative 1bS2-m Lake Okeechobee water levels did not exceed 17.25 feet at any time during the period of record (POR) model simulation. During the development of additional alternatives, this 17.25 feet constraint was removed and treated as a PM, meaning that it would be acceptable for the Preferred Alternative to have some occurrences above the 17.25 feet. elevation in the model simulation. The constraint was removed to allow the storage of additional water within Lake Okeechobee while simultaneously recognizing the need to provide for public health and safety under high lake level events. Consequently, the starting point for the formulation and evaluation of the new set of alternatives was not Alternative 1bS2-m, but the original alternative plan from which 1bS2-m was derived, referred to as Alternative 1bS2-A in the August 2006 draft SEIS. Alternative 1bS2-A allowed Lake Okeechobee to exceed 17.25 feet for 12 days during the POR as modeled.

Through a series of modifications to improve alternative performance (in particular to meet the objective of reducing high volume flows to the Caloosahatchee Estuary), three new alternatives were developed. All alternatives were then compared to the No Action Alternative based on evaluation of the PMs. This resulted in a new Preferred Alternative regulation schedule (Alternative E), which is presented in this revised draft SEIS.

Modeling Updates and Need for Revised Draft SEIS

It is important to note that the updated modeling for the revised draft SEIS included the most current data sets and updated assumptions, as summarized in Appendix E. The updated modeling incorporated the new water shortage rules (termed LOWSM-Lake Okeechobee Water Shortage Management Plan). Earlier alternative simulations in the August 2006 draft SEIS assumed a one-foot lowering of the current Water Shortage Trigger line (also referred to as the "existing SSM" line in the 2007 draft SEIS appendices) as a surrogate for the new Lake Okeechobee Water Shortage Management (LOWSM) plan that was under development by the SFWMD. The SFWMD subsequently provided more detail on LOWSM.

Another important modeling change affects releases to the Lake Worth Lagoon. In the modeling efforts for the August 2006 draft SEIS, L-8 releases from Lake Okeechobee were routed through STA-1E, but STA-1E is not designed to treat L-8 local basin runoff

or Lake Okeechobee discharges (associated with higher nutrient loads). The August 2006 draft SEIS No Action Alternative, i.e., base condition, and alternative modeling assumed treatment of L-8 local basin runoff and Lake Okeechobee discharges by STA-1E, resulting in additional volumes of water being passed through STA-1E, WCA-1, WCA-2 and into WCA-3A. Updated modeling for this SEIS assumes L-8 releases will be routed to tide (through S-155A) as they currently are and will not be routed through STA-1E.

Due to the updated modeling information and improvements to the 2006 Preferred Alternative that led to the formulation of new alternatives, it was necessary to disclose the environmental effects of these new alternatives and to describe alternative plan benefits and impacts in a revised draft SEIS, instead of finalizing the August 2006 draft SEIS. Most importantly, this revised draft SEIS incorporates the public comments and concerns of the August 2006 document.

2.3. UNCERTAINTY OF SFWMD WATER SHORTAGE CUTBACK RULES

Concurrent with the Corps developing a revised LORS, the SFWMD is in the process of reviewing its current water shortage rules in Chapters 40E-21 and 40-E22. The SFWMD water shortage rules provide the framework of when and to what extent low lake levels will trigger water shortage cutbacks. Based on guidance from the SFWMD, the review of the existing water shortage rules is anticipated to be completed in advance of any new regulation schedule resultant from LORSS.

In recognition of this guidance from SFWMD, modified Water Shortage Trigger (WST) assumptions were included during alternative formulation, modeling, and evaluations for the 2006 draft SEIS and 2007 revised draft SEIS. The No Action Alternative assumes the existing WST line, as set by the SFWMD, to be in place. All alternatives evaluated for the 2006 draft SEIS assumed a 1.0 foot lowering of the existing WST line as a surrogate for the anticipated rule changes by the SFWMD. During the plan formulation period of this revised draft SEIS, the SFWMD provided the Corps with their new proposed water shortage rules as described in the LOWSM Plan (Appendix G). The performance summary of the SFWMD draft LOWSM plan presented in Appendix G is shown compared to the 2006 draft SEIS Preferred Alternative, which represented the best available information for the LORSS during the LOWSM development period. In order to ensure the revised draft SEIS alternatives were evaluated with the best available data for the proposed water shortage rules, the Corps incorporated the SFWMD draft LOWSM plan (Appendix G) into the new round of modeling. Based on guidance from SFWMD, the 2006 draft LOWSM plan was not anticipated to undergo significant change prior to approval by the SFWMD Governing Board later in 2007.

The Corps has recognized that a level of uncertainty exist with the draft LOWSM plan used in evaluating the alternatives. However, alternatives were evaluated using the best available data for water supply planning, as provided by the SFWMD, at the time of alternative modeling and plan formulation. The 2006 draft LOWSM plan lowers the existing WST line by 0.80 feet, which was assumed a more likely scenario than either the current WST line or the 1-foot lowering surrogate previously assumed in the 2006

draft SEIS. If modifications are made to the 2006 draft LOWSM by the SFWMD, the modifications are not anticipated to result in adverse environmental effects, compared to the effects evaluated in this revised draft SEIS and are not expected to effect the comparison of alternatives. SFWMD modifications to the 2006 draft LOWSM may change the anticipated water supply performance, compared to the impacts reported and evaluated for the LORSS alternatives in the 2007 LORSS revised draft SEIS.

The 2006 draft LOWSM plan represents a proposed modification to the existing Water Shortage Rule (also referred to as "existing WST [Water Shortage Trigger]) used by the SFWMD, in place since 2002. The existing Water Shortage Rule is sometimes also referred to as "existing SSM" (Supply-Side Management), but there is a difference between the "SSM" and "WST" terms. The original SSM Plan, which is described in the 1991 SSM "Yellow Book," was implemented during the 1989-1990 drought. Problems during the 2000-2001 drought prompted decision to change the plan, resulting in the existing WST rules. Although technically a misnomer, references within this report and appendices to the "existing SSM" line or rules refer to the existing WST line and rules. All SFWMM simulations completed for the 2007 draft SEIS include either the existing WST operations or the 2006 draft LOWSM plan; the original SSM Plan (1991 Yellow Book) is not the current water shortage plan used by the SFWMD, and the original SSM Plan has not been utilized for the LORS Study.

Table 2-1 provides a summary of Lake Okeechobee Water Shortage Management Plans which have been implemented or proposed by the SFWMD, including key differences in the allocation computation methodology and maximum cutback determination:

ABLE 2-1: SUMMARY COMPARISON OF WATER SUPPLY PERFORMANCE

Plan Name	Trigger Line Extreme Stages[1]	Allocation Computation Methodology[2]	Maximum Cutback Determination [3]	Comments
SSM/Prior 2002	13.5 to 11 ft	As described in "Yellow Book" (A. Hall, 1991). Supply Side Management Method was used to calculate weekly allocation during water shortage for LOSA based on available volume in Lake above "reference elevation" (11.0 ft)	Straight number: Varied on date relative to June 1 and stage of Lake above the reference elevation The maximum cutback would not exceed 67%	Old SSM. Implemented in the 1989-1990 drought. Problems during 2000-2001 drought prompted decision to change plan. Used in several SFWMM simulations prior to the LECRWSP[3] 2000
SSM/2002-present	13 to 10.5 ft (District rule 40E-22.332 F.A.C.)	As described in "Yellow Book" (A. Hall, 1991) with a reference stage of 10.5 ft, but with cutbacks defined by Phase of restrictions per District water shortage rules: Phase I – 15% cutback Phase II – 30% cutback Phase III – 45% cutback Phase IV – 60% cutback	Phased approach (1-4) based on forecast Lake stage on June 1st: 15%, 30% if above or at 10.5 ft; 45%, 60% if below 10.5 ft - Phase I if June 1st Lake stage above 10.5 ft - Phase II if June 1st Lake stage at 10.5 ft - Phase III if June 1st Lake stage below 10.5 ft, District staff will identify a revised reference elevation based on factors in District Rule - Phase IV established by District's Governing Board.	This is based on the Existing Water Shortage Rule (Sometimes called also Existing SSM). This approach has been extensively simulated using SFWMM since 2003. Referred to as the 'existing WST' (Water Supply Trigger) method. This approach was used to evaluate water supply cutbacks for both 'LORS07' and 'TSP3 with existing WST'
LOWSM	12.2 to 9.7 ft	Based on 1 in 10 LOSA demands processed from previous SFWMM simulations	Phased approach (1-4) based on preset set of lines for 15, 30, 45 and 60%. Proposed cutbacks adjusted to keep water supply to LOSA same or better than WSE. Note that SFWMD proposed environmental enhancements in LEC Water Supply plan to address MFL exceedances that were identified to occur with TSP.	District initiated rule development (Feb 2006) to change existing water shortage rule to reflect 1-in-10 LOSA demands and phased-cutback approach. Proposed LOWSM (Sept. 2006) designed to equal or exceed water supply performance as shown in July 2006 version of TSP. Environmental interests object as the proposed LOWSM schedule was not consistent with existing rules for minimum flows and levels for Lake Okeechobee.

[1] Trigger line: Calendar based line advising when the Lake stage is low enough to start considering the imposition of water restrictions.

[2] **Determination of the lake Okeechobee allocation: The initially determined amount of water that will be released from the Lake in order to meet water supply needs in LOSA**

[3] Lower East Coast Regional Water Supply Plan; (May 2000)

2.4. FEATURES OF ALTERNATIVES EVALUATED IN THIS STUDY

Some of the options considered when formulating the alternatives evaluated in this study were:

1) Lower the stage lines defining the operational zones to minimize impact to the HHD;
2) Provide a base flow to one or both of the estuaries to minimize the occurrence of high volume releases to the estuaries;
3) Include a maximum limit of the lake regulatory releases passed through STA-3/4, based on assumed treatment capacity given the current nutrient levels within Lake Okeechobee;
4) Use different types of data to measure tributary hydrologic condition (THC), such as drought indicators and total Lake Okeechobee net inflow (LONIN);
5) Operate within optimal Lake stage envelopes;
6) Provide lake operators with as much flexibility as possible to lower the lake stages when needed to achieve project objectives.

2.5. COMMONALITIES OF ALTERNATIVES

Section 2.6 describes both in text and graphically, the proposed alternative water regulation schedules described as Alternatives A through E. The No Action Alternative, which is the baseline against which all the alternatives were compared is included as well as a description of features common to the alternatives analyzed.

All of the alternatives analyzed in the SEIS included the WSE decision tree framework, and were designed to increase operational flexibility. Considering the potential benefits from recent lake inflow forecasting tools, and the rapid increase in state-of-the-art forecasting technology, it is practical to establish more flexible rules which allow lake managers to utilize supplemental information and apply their best professional judgement in making operational decisions.

All of the alternatives modeled assumed STA-3/4 treatment capacity restriction for releases. STA-3/4 is designed to improve the quality of Lake Okeechobee water, by reducing phosphorus loads, prior to discharging to WCA 2A and 3A. The assumed treatment capacity restriction for STA-3/4 is simulated in the SFWMM by restricting the wet and dry season conveyance capacities for the Miami and North New River canals to pass approximately 58,500 acre-feet, average annual during the dry season and 4,700 acre-feet average annual during the wet season from Lake Okeechobee to the STA-3/4; the average annual treatment capacity constraint is assumed to be approximately 63,200 acre-feet. STA-3/4 is one of six large treatment wetlands managed by the SFWMD as part of the Everglades Construction Project. STA-3/4 was designed to capture stormwater runoff from the basins adjacent to the North New River and Miami canals as well as to capture and treat regulatory releases from Lake Okeechobee. STA-3/4 is located immediately east (and north) of the Holey Land Wildlife Management Area (WMA) north of WCA 3A and west of Highway U.S. 27.

All alternatives modeled and evaluated, with the exception of the No Action Alternative, assume the LOWSM water shortage rules (Appendix G). The No Action Alternative assumes the existing Water Shortage Trigger (WST) line, as set by the SFWMD, to be in place. Another feature of the LOWSM, included in the alternative modeling and evaluation of all alternatives (including the No Action Alternative), is the incorporation of temporary forward pumps. The SFWMD is proposing temporary forward pumps to give water managers the ability to discharge water from Lake Okeechobee during periods of extremely low water levels, when the standard gravity-feed structures would no longer be able to deliver water to users within the EAA and the Lower East Coast. Based on preliminary operational guidance from the SFWMD, the pumps are simulated to trigger on for water supply demands if the lake stage falls below 10.2 feet; while the pumps are assumed turned off when the lake stage recovers to 11.2 feet. Based on guidance from the SFWMD, the water supply temporary forward pump design capacities are assumed as 400 cfs at S-354, 600 cfs at S-351, and 400 cfs at S-352. A Department of Army permit action is underway for installation and operation of the temporary forward pumps.

2.6. DESCRIPTION OF ALTERNATIVES

Each alternative is a variation of operational rules to determine when, where, and how much water will be released from the lake to downstream systems. The best way to display this information is to use charts and decisions trees for each alternative schedule developed. **NOTE: The modeling nomenclature is captured in parenthesis after the alternative name. This should be helpful when referring to the modeling Appendix, E. Additionally, some of the appendices, in particular A, D and E, refer to the Preferred Alternative as the "TSP" (Tentatively Selected Plan). These terms are used interchangeably. References within this report and appendices to the "existing SSM" line or rules refer to the existing Water Shortage Trigger (WST) line and rules, although the terms are not generally used interchangeably in practice.**

2.6.1. NO ACTION ALTERNATIVE

The No Action Alternative is the baseline for the alternative analysis. Under No Action, environmental consequences will still occur because the existing environment is not static. Under No Action, the Corps would continue to manage Lake Okeechobee under the current regulation schedule, WSE, which includes the temporary planned deviation referred to as the CLA approved in 2005. In addition, the No Action Alternative includes operation of the temporary forward pumps, anticipated to be permitted, and installed by the SFWMD, in 2007. The No Action Alternative assumes the existing WST line, as set by the SFWMD, to be in place.

To better understand the No Action Alternative, the current regulation schedule, WSE, must be briefly described. The WSE schedule, approved in July 2000, introduced new elements in the operational decision making process.

One of the elements unique to the WSE schedule is the traditional calendar-based schedule, delineating the different operational zones, as shown in Figure 2-1. Figure

2-1 shows Zones A through E and the table of recommended releases. Zones A through D are regulatory release zones designated for flood control (USACE, 2000). Zone E is referred to as the water supply zone, since regulatory releases cease, and water supply needs are considered. A key feature of the WSE schedule is the lower operational zone labeled Zone D. This zone allows more operational flexibility to deliver water south at lower lake water levels. Zone D also has a key feature for estuary releases. Zone D is divided into three sub-zones, referred to as Level I, II and III. Within these sub-zones, pulse releases of different intensities are made to the Caloosahatchee and St. Lucie estuaries. The higher the level of pulse, the more flows and higher volume of water is delivered to the estuaries.

Another element unique to the WSE schedule is the use of decision trees to guide releases south to the WCAs, and east and west to the estuaries. The decision trees are shown in Figure 2-2 and Figure 2-3. Hydrologic outlooks (forecasts) play an important role in the decision trees. Data are collected weekly to assist managers in navigating the decision trees.

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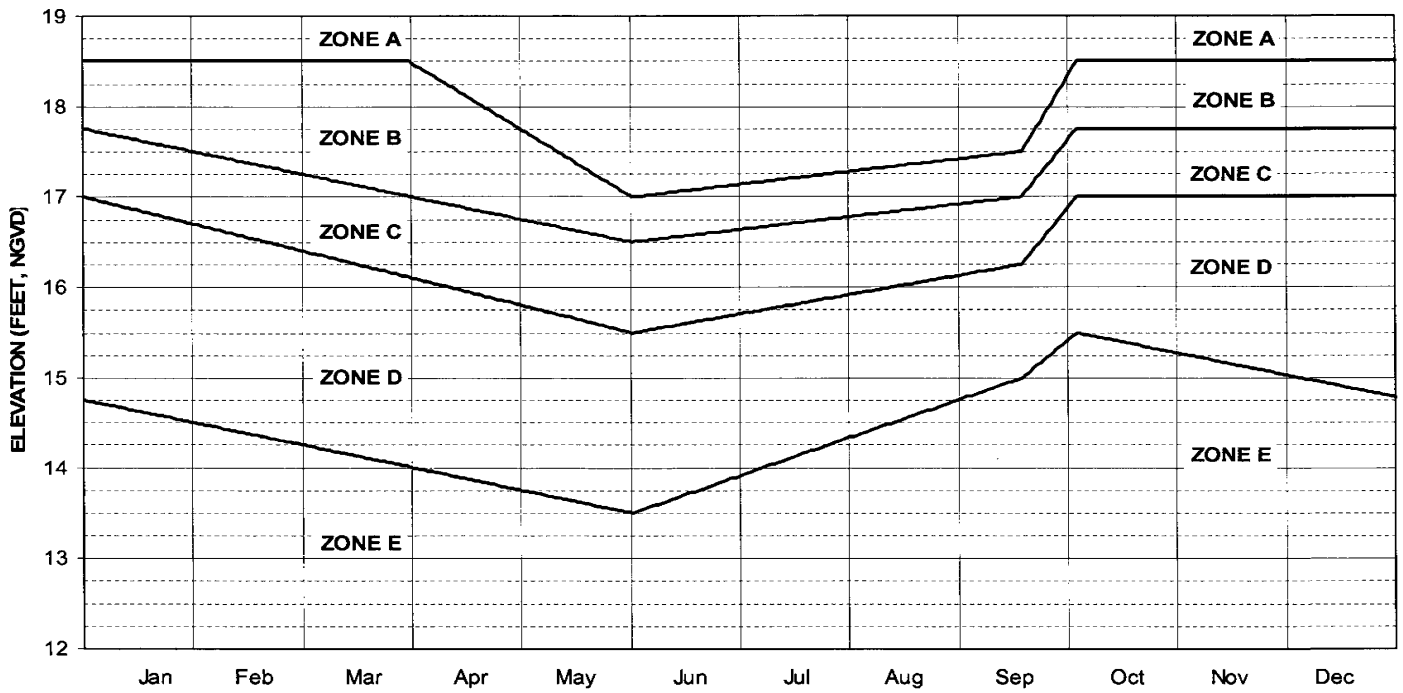

Release though outlets as indicated

Zone	Agricultural canals to WCA's (1,2)	Caloosahatchee River at S-77 (1,2,4)	St. Lucie Canal at S-80 (1,2,4)
A	Pump maximum practicable	Up to maximum capacity	Up to maximum capacity
B (3)	Maximum practicable releases	Normal to wet: Up to 6500 cfs. Dry: Up to maximum pulse release.	Normal to wet: Up to 3500 cfs. Dry: Up to maximum pulse release.
C (3)	Maximum practicable releases	Wet: Up to 4500 cfs. Normal: Up to maximum pluse release. Dry: None.	Wet: Up to 2500 cfs. Normal: Up to maximum pluse release. Dry: None.
D (3.5)	As need to minimize adverse impacts to the littoral zone while not adversely impacting the everglades (see Note 5)	Very wet: Up to maximum pulse release. Otherwise: None	Very wet: Up to maximum pulse release. Otherwise: None
E	No regulatory discharge	No regulatory discharge	No regulatory discharge

Notes

1 Subject to first removal of runoff from downstream basins

2 Guidelines for wet, dry and normal conditions are based on: 1) Selected climatic indices and tropical forecasts and 2) Projected inflow conditions. Releases are subject to the guidelines in the WSE Operation Decision Tree. Parts 1 and 2

3 Releases through various outlets may be modified to minimize damages or obtain additional benefits. Consultation with Everglades and estuarine biologists is encouraged to minimize adverse effects to downstream ecosystems

4 Pulse releases are made to minimize adverse impacts to the estuaries

5 Only when the WCA's are below their respective schedules

CENTRAL AND SOUTHERN FLORIDA

REGULATION SCHEDULE
LAKE OKEECHOBEE

US ARMY ENGINEER DISTRICT
JACKSONVILLE, FLORIDA

05 November 1999

Figure 1

DRAFT

FIGURE 2-1: CURRENT LAKE OKEECHOBEE REGULATION SCHEDULE: WSE

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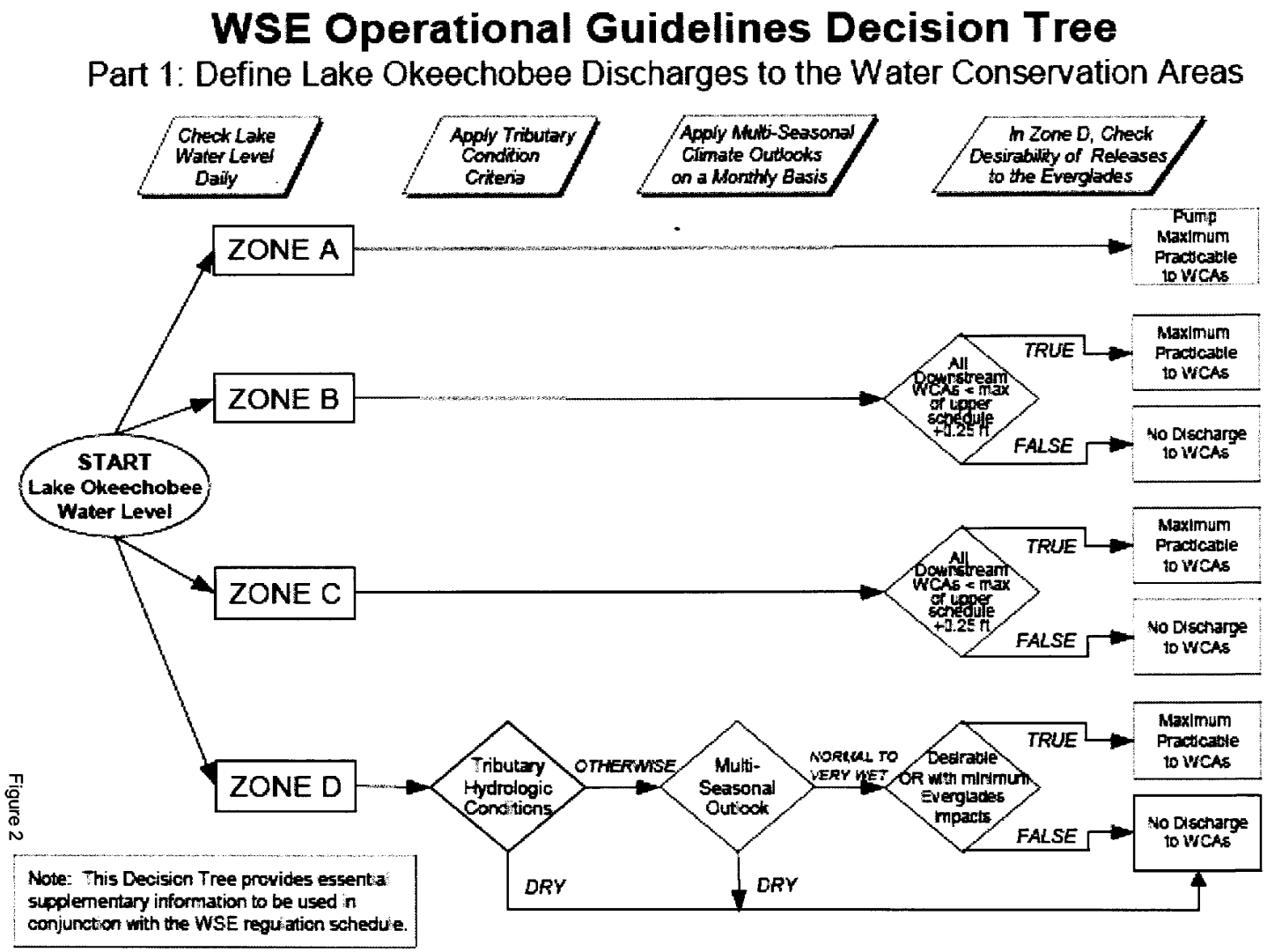

FIGURE 2-2: CURRENT LAKE OKEECHOBEE REGULATION SCHEDULE: WSE

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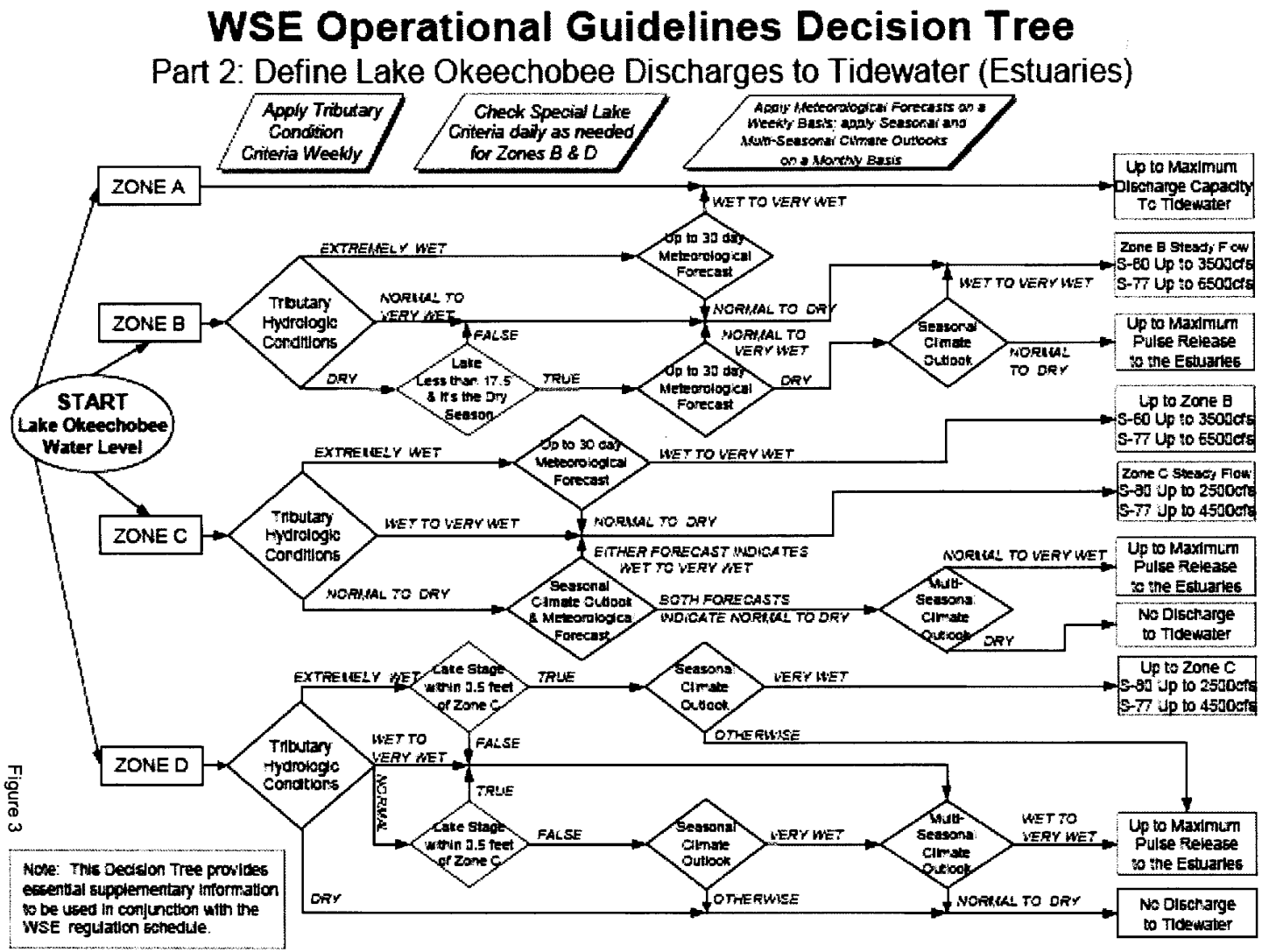

FIGURE 2-3: CURRENT LAKE OKEECHOBEE REGULATION SCHEDULE: WSE

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2.6.2. ALTERNATIVE A (IBS2-A)

Alternative A was developed from the current WSE decision tree, i.e. Operational Guidance, structure. The regulation schedule and Operational Guidance for Lake Okeechobee discharges to the WCAs and discharges to tidewater for Alternative A are shown in Figure 2-4, Figure 2-5, and Figure 2-6, respectively. Operational experience under WSE and the availability of additional climatological data led to the following recommended modifications to WSE for this alternative:

1. Regulation schedule lines for Zone A, Zone B, and Zone C are lowered. If the stage of Lake Okeechobee exceeds 17.25 ft., NGVD, the regulation schedule decision tree specifies maximum practicable releases to the WCAs and tidewater. The lowering of the upper regulatory zones results in a regulation schedule that is more pro-active to limit potential high water conditions within Lake Okeechobee.

2. THC are applied that represent longer-term wet or dry conditions that have persisted in the tributaries. Updated THC indicators enable the proposed regulation schedule to avoid frequent breaks in the regulatory outflows that may occur due to shorter dry periods. The Palmer Drought Index (PDSI) is proposed to replace the 30-day net rainfall, and the 14-day mean LONIN is proposed to replace the 14-day mean S-65E flow. The classification bands for the PDSI and LONIN THC indicators are summarized in Table 2-1.

3. The line representing the divide between Zone D and Zone E is reshaped: the bottom of Zone D is flattened during the periods in which the estuary ecological systems may be more impacted by large freshwater discharges, especially in late winter, early spring, and during the October through November period. The modified regulatory line promotes a quicker response in the autumn and winter months to large inflows that often are generated during the hurricane season.

4. A new base flow zone (Zone D0) is established below the bottom of the re-shaped Zone D. Base flow is allowed when Lake Okeechobee water levels are in Zone D0 or above (Zone C decision tree outcome for dry THC, seasonal, and multi-seasonal forecasts is base flow), but no base flow releases are called for when the stage falls below the bottom of Zone D (Zone D0). During the alternative formulation process, data and recommendations were evaluated and the recommended base flow release was determined to be 450 cubic feet per second (cfs) to the Caloosahatchee Estuary (measured at S-79) and zero base flow to the St. Lucie Estuary. Risks to the water supply performance objective are anticipated to be minimized with the forward pumps assumed in place to allow for water supply at lower Lake water levels. The bottom of the base flow zone ranges from 11.5 ft. NGVD on May 31 to 13.0 ft., NGVD during October and November. For Figure 2-5 (discharges to WCAs), releases to the WCAs when in Zone D0 adhere to the same decision tree as the remainder of Zone D; for

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Figure 2-6 (discharges to tidewater), releases when in Zone D0 will be base flow, and the decision tree of Zone D is not applicable.

THC and seasonal climate forecasts are updated to allow increased operational flexibility in managing lake stages, and specifically to avoid extreme high lake stages. A significant number of decision tree outcomes for THC and seasonal forecast are updated to allow the quicker release of lake water, as compared to WSE (for example, "Extremely wet" THC is changed to "very wet" or "wet to very wet" is changed to "normal to wet"). The additional inclusion of lake stages forecasted to rise into Zones A or B also introduces additional operator flexibility by allowing for utilization of all available hydrologic and meteorological forecasting data. The changes to WSE for Alternative 1bS2 are indicated by the red font in Figure 2-6.

5. Moderate to extreme high discharges to the St. Lucie Estuary are reduced by modifying the maximum discharge rates for Zone B and Zone C from 3500 to 2800 cfs and 2500 to 1800 cfs, respectively.

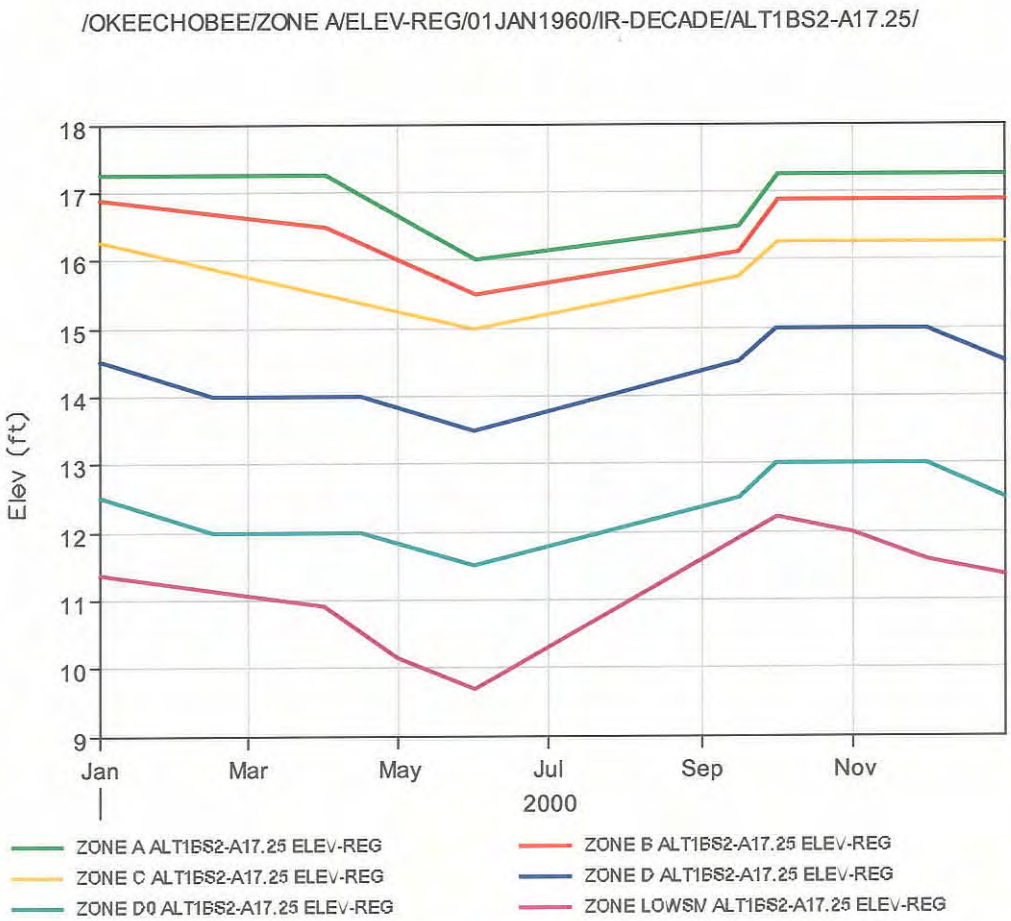

FIGURE 2-4: REGULATION SCHEDULE FOR ALTERNATIVE A

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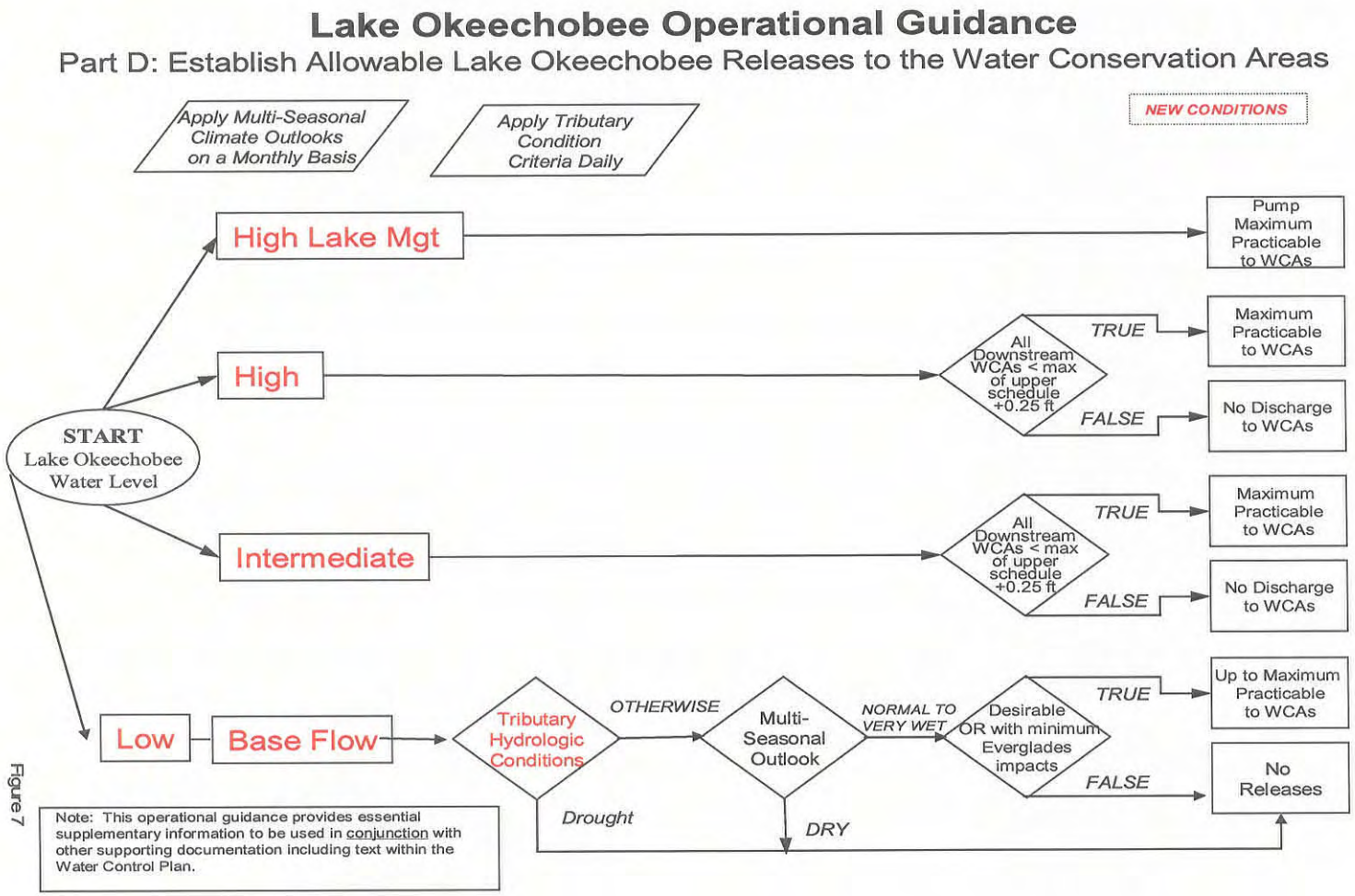

FIGURE 2-5: OPERATIONAL GUIDANCE, PART 1 FOR ALTERNATIVE A, ALTERNATIVE B, ALTERNATIVE C, ALTERNATIVE D, AND ALTERNATIVE E

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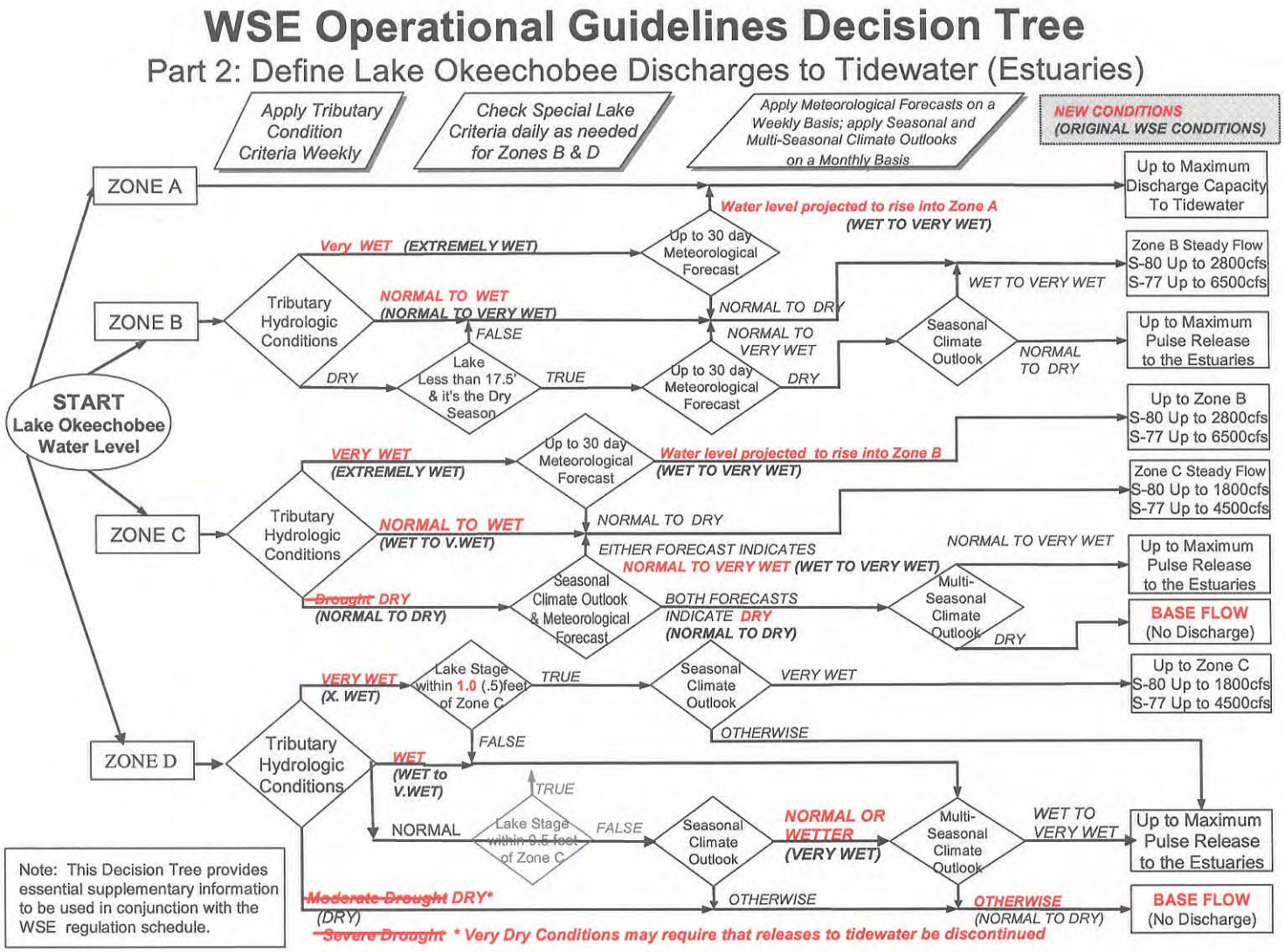

FIGURE 2-6: OPERATIONAL GUIDANCE, PART 2 FOR ALTERNATIVE A AND ALTERNATIVE B

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2.6.3. ALTERNATIVE B (1BS2-M)

Alternative B is the Preferred Alternative (1BS2-m) in the August 2006 draft SEIS. Alternative B is similar to Alternative A, but with lowering of the second and third regulatory release lines and a lowering of the top three regulatory release lines during the late hurricane season from September 15 through November 1. Alternative A simulation output (SFWMM model) showed the 17.25 feet stage criteria for Lake Okeechobee extreme high water to be exceeded for 12 days during the 36-year simulation period-of-record (POR). Alternative A was modified to remove any simulated daily stage in excess of 17.25 feet within Lake Okeechobee for safety issues with the HHD. Modifications to Alternative A to create Alternative B are summarized below:

1. Regulation Zones A, B, and C are lowered during the late hurricane season (September 30 stage breakpoints are changed to November 1)
2. Regulation lines for the bottom of Zones B and C were lowered. Zone B breakpoints were first lowered to be mid-way between the bottom of Zone A and the bottom of Zone C. The bottom of Zone B was then lowered by an additional 0.15 feet and the bottom of Zone C was lowered by 0.10 feet, as required to achieve zero days with lake stage greater than 17.25 feet elevation. The simulated peak stage for Lake Okeechobee is 17.23 feet, during October 1995. The regulation schedule for Alternative B is shown in Figure 2-7; the Operational Guidance remains unchanged from Alternative A (Figure 2-5 and Figure 2-6).

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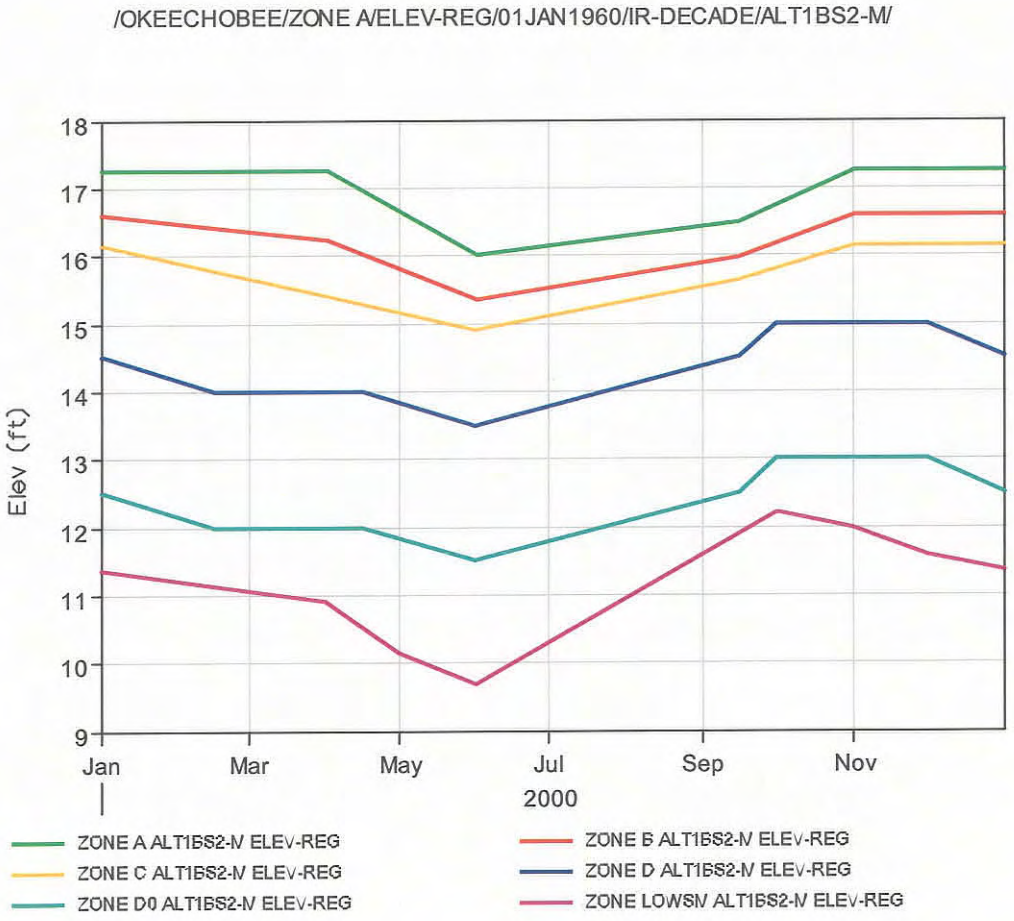

FIGURE 2-7: REGULATION SCHEDULE FOR ALTERNATIVE B

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2.6.4. ALTERNATIVE C (T1)

Alternative C is a modification of Alternative A. The Regulation Schedule for Alternative C is shown in Figure 2-8. The Operational Guidance, Part 1 (releases to WCAs) for Alternative C remains unchanged from Alternative A, and the Operational Guidance with updated terminology is shown in Figure 2-5 The Operational Guidance, Part 2 for and regulation schedule for Alternative C is shown in Figure 2-9. The following changes were made to Alternative C:

1. Lake Okeechobee late season break points are changed from September 30 to November 1 for the top of the High, Intermediate, and Low bands to address the potential of late season hurricanes.
2. Level 3 pulse measured at S-77 is changed from average daily flow of 3000 cfs to 2800 cfs.
3. A base flow of 350 cfs to the St. Lucie Estuary measured at S-80 in low and intermediate bands is included in this alternative.
4. Base flow to the Caloosahatchee Estuary is changed from up to 450 at S-79 to up to 650 cfs measured at S-77 in the low and intermediate bands. It is recognized that discharge at S-79 of up to 800 cfs could be recommended for occasional implementation, but this infrequent recommendation would not be consistent with inclusion for the complete POR modeling; additional flow at S-79 could be delivered by redistribution of the baseflow releases to the St. Lucie Estuary.
5. No changes to base flow of 450 cfs measured at S-79 in the base flow band.
6. The bottom of the base flow band is raised by 0.25 feet.
7. Change the High and Intermediate band flow of up to 2800 cfs measured at S-80 back to WSE level of up to 3500 cfs.

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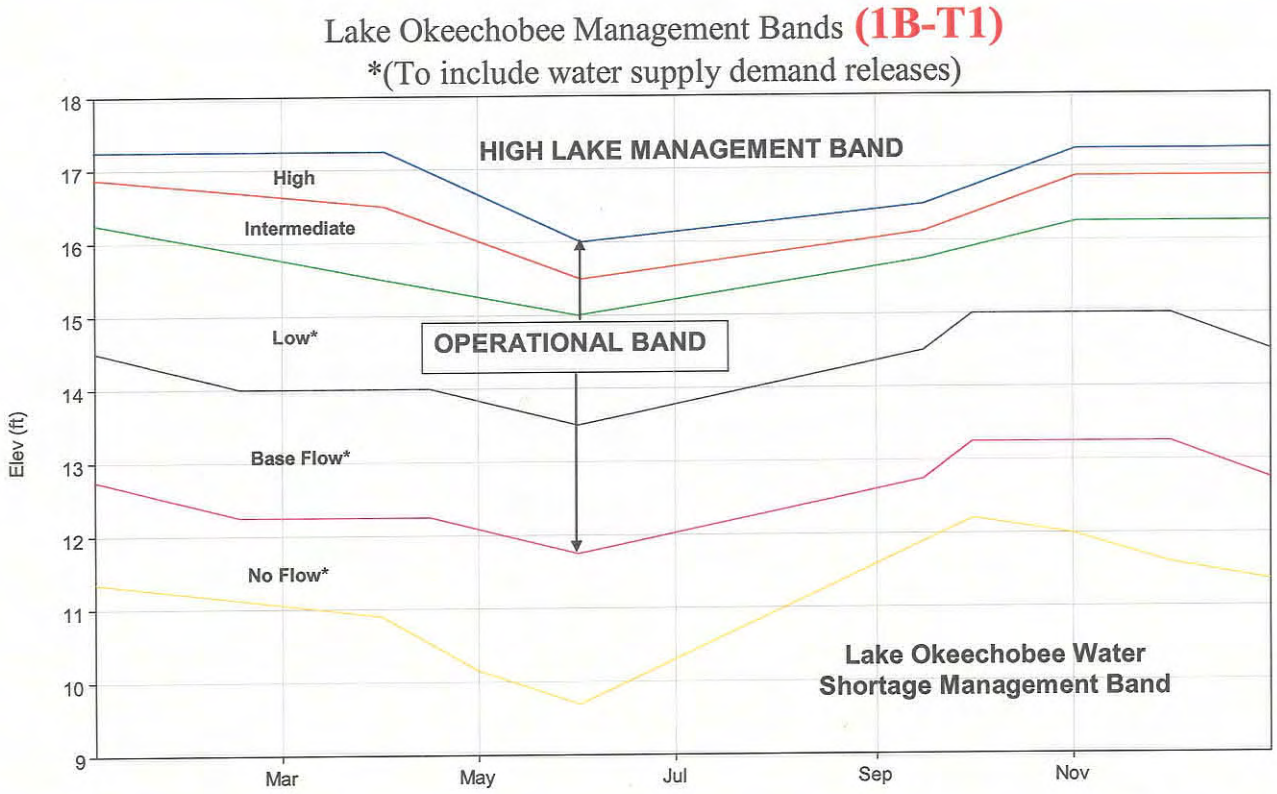

FIGURE 2-8: REGULATION SCHEDULE FOR ALTERNATIVE C

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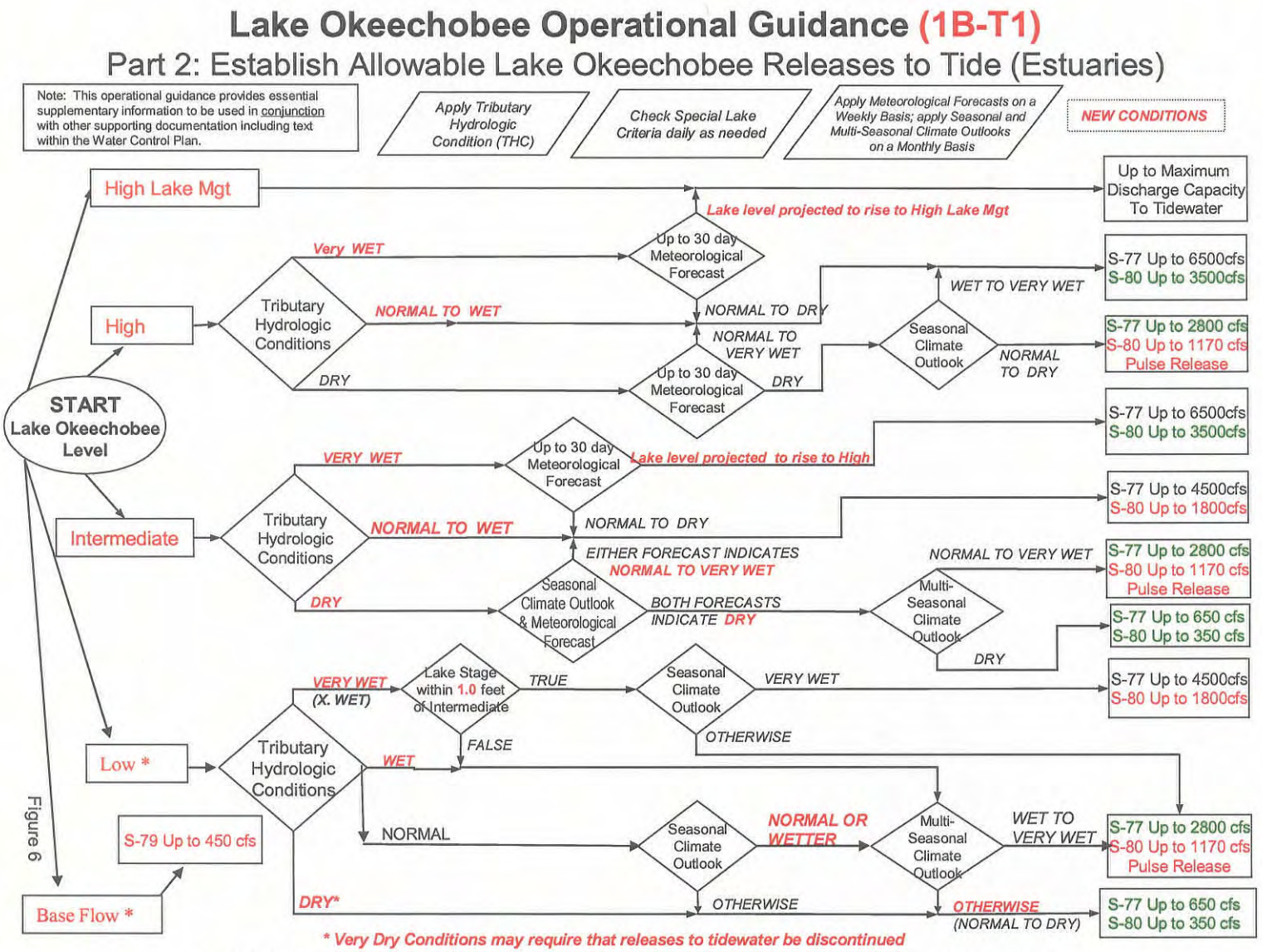

FIGURE 2-9: OPERATIONAL GUIDANCE, PART 2 FOR ALTERNATIVE C

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2.6.5. ALTERNATIVE D (T2)

Alternative D is a modification of Alternative A, and was proposed by the SFWMD based on screening results from the Lake Okeechobee Operations Screening Model (LOOPS). The Operational Guidance, Part 1 (releases to WCAs) for Alternative D remains unchanged from Alternative A, and the Operational Guidance with updated terminology is shown in Figure 2-5. Figure 2-11 shows the Part 2 Operational Guidance. Figure 2-10 shows the regulation schedule for Alternative D. The following changes were made to Alternative A, to develop Alternative D:

1. Zone D0 raised to 12.6 feet to maintain Zone D0 higher than navigation minimum Lake Okeechobee elevation of 12.56 feet.
2. All Caloosahatchee Estuary pulse releases measured at S79 instead of S77, in all lake bands when pulse releases are called for, to reduce high flow exceedences caused by lake release plus local C-43 basin runoff.
3. Bottom of Zone D1 lowered by one half foot, to encourage more pulse releases which help reduce steady higher volume discharges.
4. Add a small baseflow of 200 cfs (low volume discharge) to St. Lucie Estuary (below S-80, to include accounting of C-23 and C-24 basin inflows) whenever base flow releases are called for in decision tree. Additional base flow deliveries at S-79 (450 cfs at S-79 is included, per Alternative A) could be delivered by redistribution of the baseflow releases to the St. Lucie Estuary.

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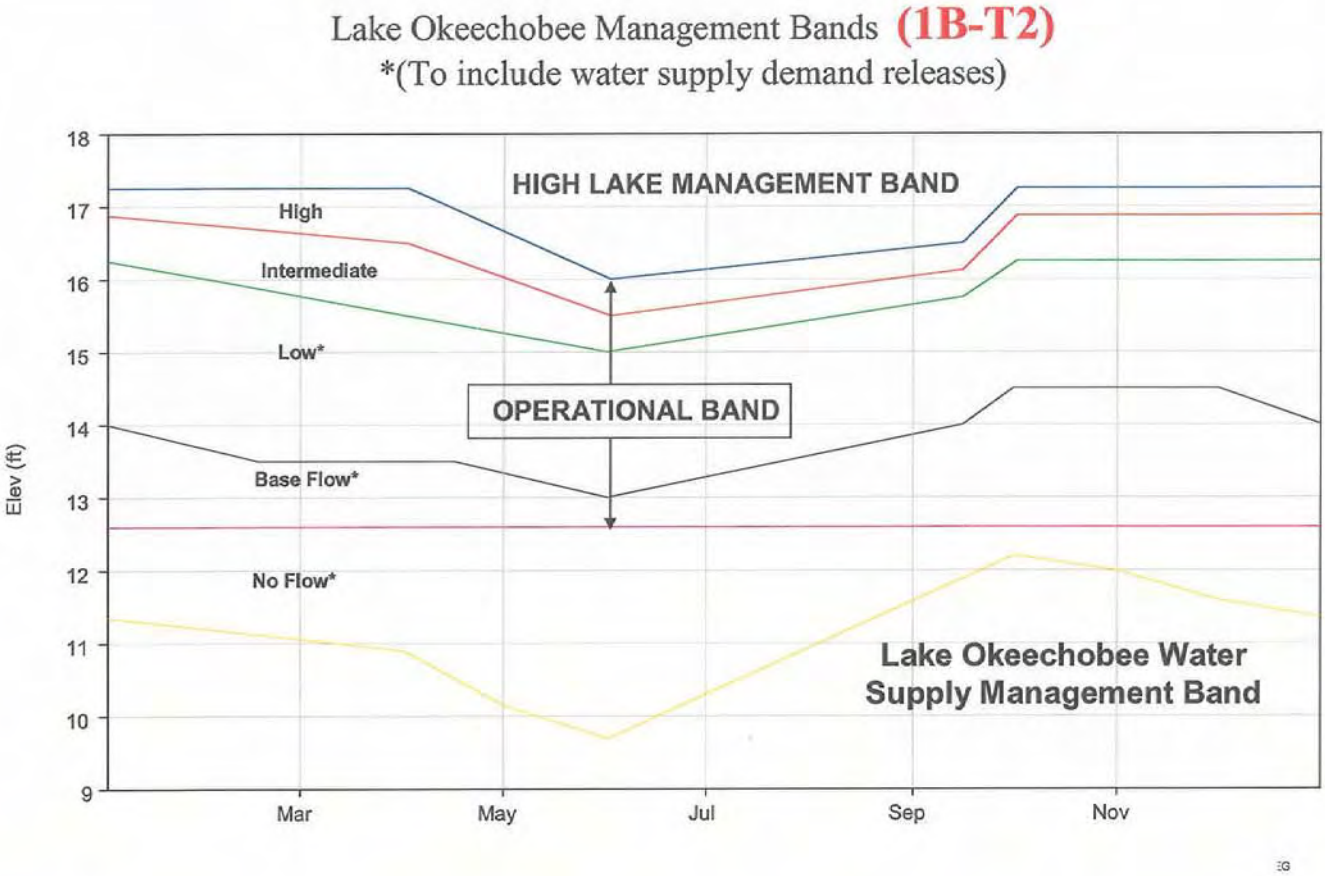

FIGURE 2-10: REGULATION SCHEDULE FOR ALTERNATIVE D

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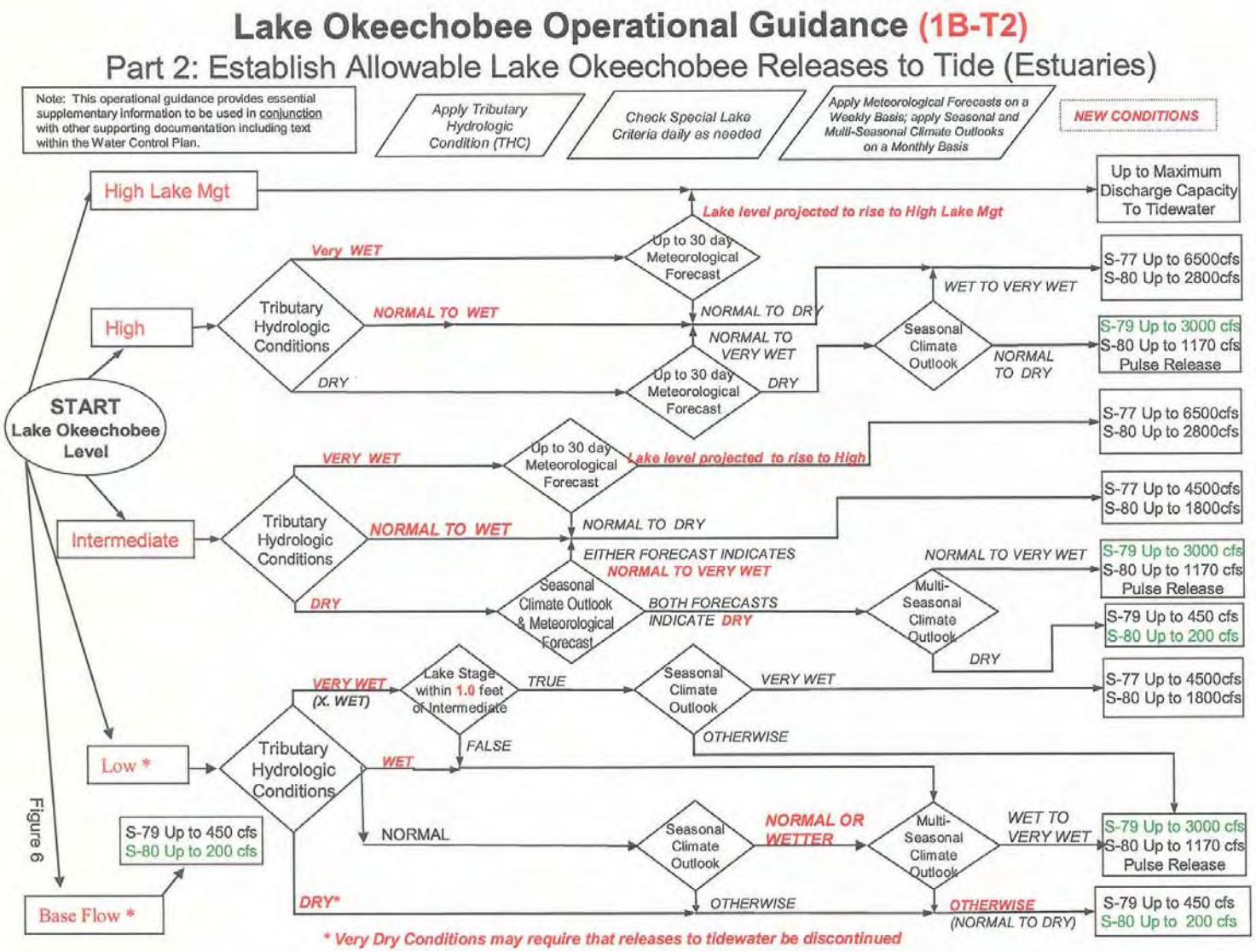

FIGURE 2-11: OPERATIONAL GUIDANCE, PART 2 FOR ALTERNATIVE D

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2.6.6. ALTERNATIVE E (T3)

Alternative E was developed through the collaborative efforts of the Corps and SFWMD, following LORSS PDT review of the updated 2006 SEIS alternatives (Alternatives A and B) and the new C and D alternatives. The Operational Guidance, Part 1 (releases to WCAs) for Alternative E remains unchanged from Alternative A, and the Operational Guidance with updated terminology is shown inFigure 2-5. The regulation schedule, and the Operational Guidance, Part 2, for Alternative E are shown in Figure 2-12 and Figure 2-13. Alternative E was developed from Alternative D, with the following changes:

1. Lake Okeechobee late season break points are changed from September 30 to November 1 for the top of the High, Intermediate, and Low sub-bands of the Operational Band to address the potential of late season hurricanes (consistent with Alternative C).
2. Inclusion of an October 1 breakpoint at 13.0 feet for the bottom of the baseflow Zone D0 (consistent with original 2006 SEIS Alternatives 2a and 4), to provide some protection to low lake levels at the end of the wet season.
3. Caloosahatchee Estuary Level 1 pulse level increased from average daily rate of 1600 cfs to 2000 cfs, to allow for increased releases below 2800 cfs to reduce higher lake levels and the associated higher volume releases.
4. Caloosahatchee Estuary Level 2 pulse level increased from average daily rate of 2300 cfs to 2500 cfs, to allow for increased releases below 2800 cfs to reduce higher lake levels and the associated higher volume releases.
5. Caloosahatchee Estuary Level 3 pulse level unchanged, at average daily rate of 3000 cfs.
6. Maximum Caloosahatchee Estuary discharges reduced from 4500 cfs to 4000 cfs when the Lake Okeechobee stage is within the Intermediate (THC: normal to wet) or Low (THC: very wet) sub-bands of the Operational Band.

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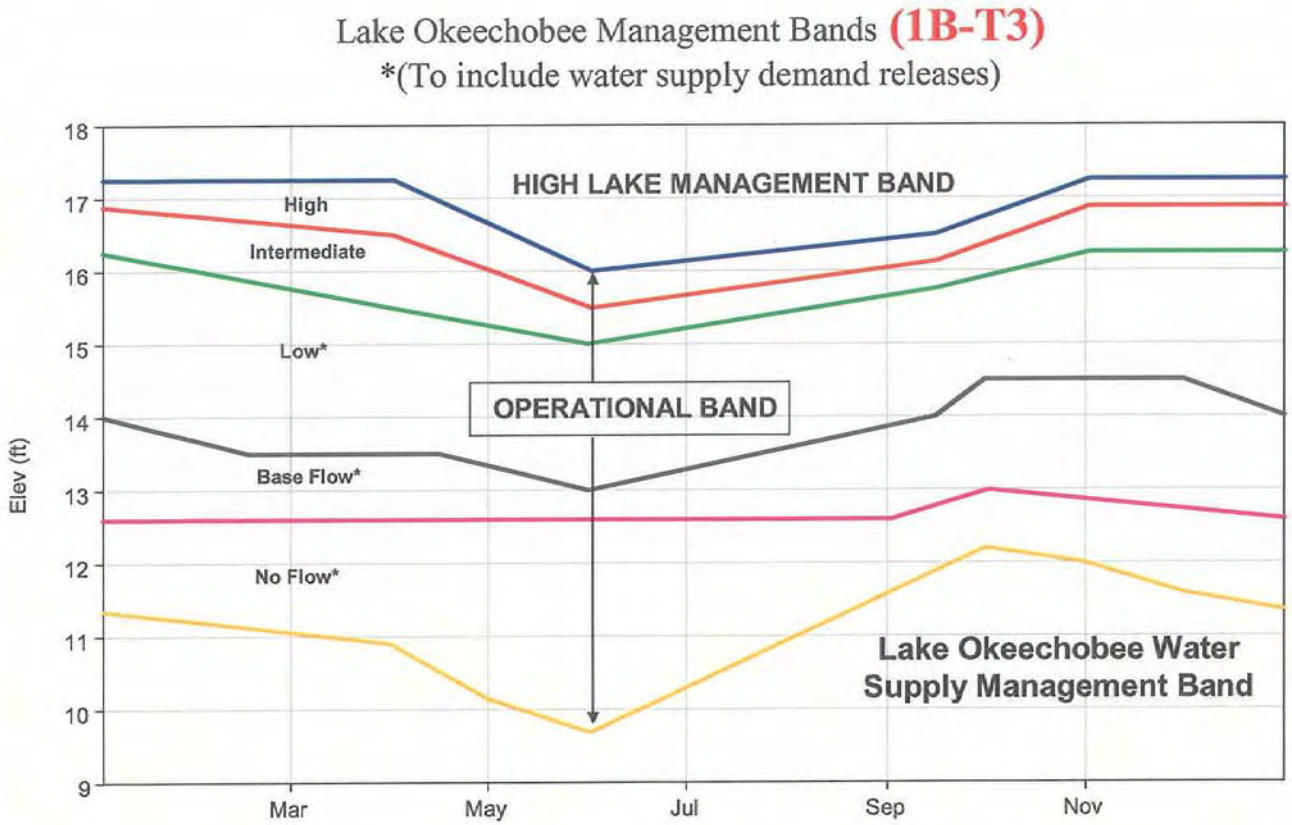

FIGURE 2-12: REGULATION SCHEDULE FOR ALTERNATIVE E

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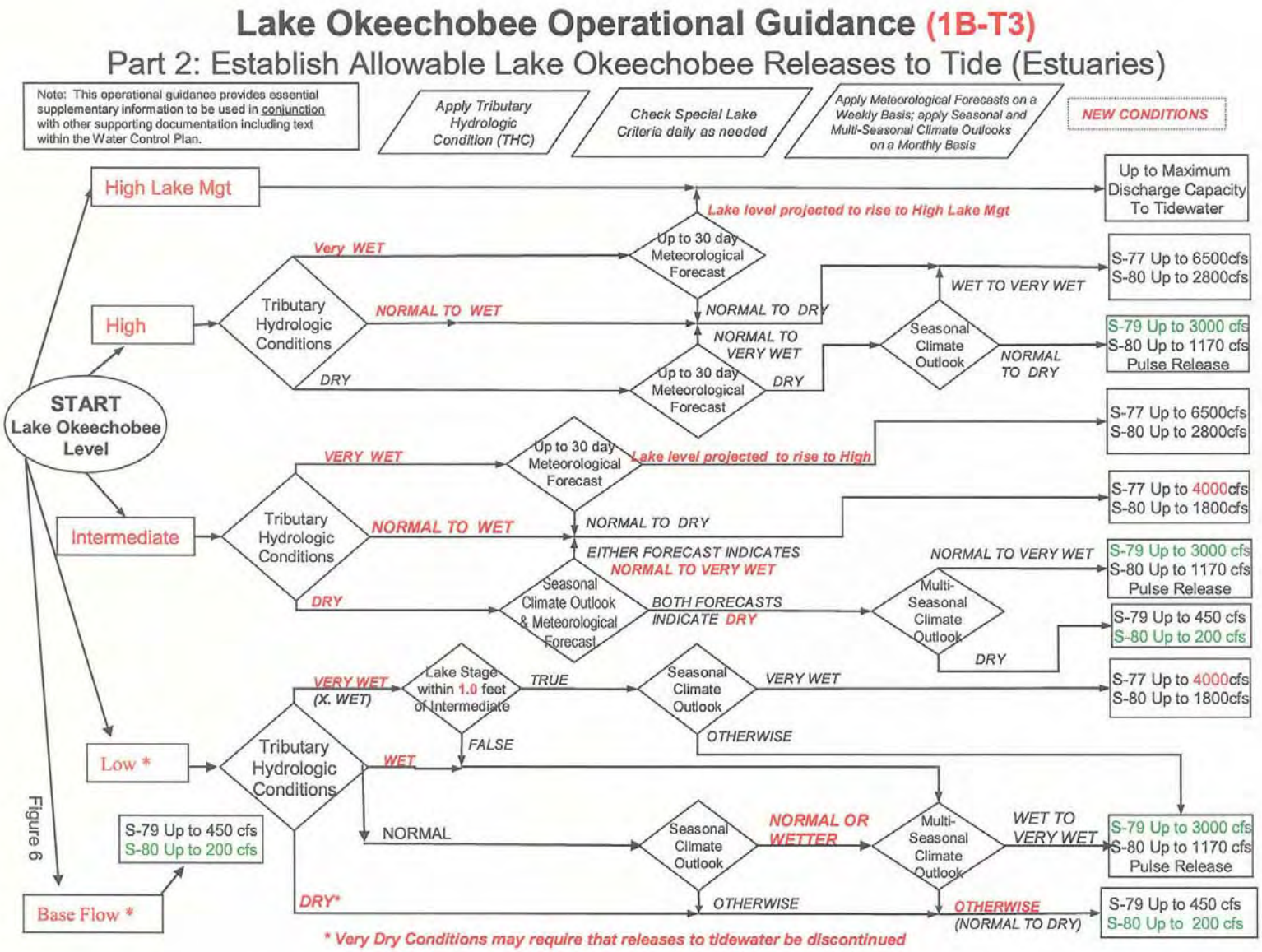

FIGURE 2-13: OPERATIONAL GUIDANCE, PART 2 FOR ALTERNATIVE E

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2.7. ISSUES AND BASIS FOR CHOICE

As listed in Section 1.8, many issues were identified and taken into account during the identification of the Preferred Alternative. Recommendations and feedback from the LORSS PDT, stakeholders and the general public were considered. Meeting the LORSS objectives was an important factor in choosing the Preferred Alternative.

2.8. IDENTIFICATION AND SUMMARY OF THE PREFERRED ALTERNATIVE

The Preferred Alternative is Alternative E (modeling name, T3).

2.9. ALTERNATIVES ELIMINATED FROM DETAILED EVALUATION

As previously discussed, only two alternatives from the 2006 draft SEIS were pulled forward into the evaluation in this revised draft SEIS. Conclusions from the evaluation of the 2006 draft SEIS, indicated that Alternatives 2a, 2a-m, and 4 did not perform adequately in meeting the goals and objectives of the LORSS. Therefore, these alternatives were eliminated from further detailed evaluation.

2.10. SUMMARY COMPARISON OF ALTERNATIVES

Table 2-2 lists alternatives that were considered and summarizes the major features and consequences of the proposed action and alternatives. Environmental effects of the alternatives are described in Section 4.

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TABLE 2-2: SUMMARY OF DIRECT AND INDIRECT IMPACTS

ALTERNATIVE ENVIRONMENTAL FACTOR	Alternative No Action	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E Preferred Alternative
PROTECTED SPECIES	Potential adverse impacts to some species (snail kite, wood stork, Okeechobee gourd) due to extreme high lake occurrences	Beneficial due to better high lake stage performance; Potential for adverse effects due to more low lake occurrences.	Beneficial due to better high lake stage performance; Potential for adverse effects due to more low lake occurrences.	Beneficial due to better high lake stage performance; Potential for adverse effects due to more low lake occurrences.	Beneficial due to better high lake stage performance; Potential for adverse effects due to more low lake occurrences.	Beneficial due to better high lake stage performance; Potential for adverse effects due to more low lake occurrences.
FISH AND WILDLIFE RESOURCES	High lake stage causes adverse effects to lake F&W habitat; Potential for adverse effects to estuaries.	Benefit to lake resources due to lower lake schedule; Potential benefit to CE due to increase in preferred flow range; however increase in high flow events may be negative. Potential improvement to SLE due to decrease in high flow events and increase in preferred flow range. Potential negative effect for CE due to high flows of longer duration.	Benefit to lake resources due to lower lake schedule. Potential benefit to CE due to increase in preferred flow range; however increase in high flow events may be negative. Potential improvement to SLE due to decrease in high flow events and increase in preferred flow range. Potential negative effect for CE due to high flows of longer duration.	Benefit to lake resources due to lower lake schedule; Potential benefit to CE due to increase in preferred flow range; however increase in high flow events may be negative. Potential improvement to SLE due to decrease in high flow events and increase in preferred flow range. Potential negative effect for CE due to high flows of longer duration.	Benefit to lake resources due to lower lake schedule; Potential benefit to estuaries due to increase in preferred flow range. Additionally, reduced high flows to CE would be beneficial. Potential negative effect for CE due to high flows of longer duration.	Benefit to lake resources due to lower lake schedule; Potential benefit to estuaries due to some reduction in high volume flows. CE and SLE would benefit preferred flow events, and base flow releases. Potential negative effect for CE due to high flows of longer duration.

ALTERNATIVE ENVIRONMENTAL FACTOR	Alternative No Action	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E Preferred Alternative
VEGETATION	Adverse effects to lake SAV and emergent vegetation due to high water events; May encourage spread of cattail to interior of western marsh zone of lake.	Lake vegetation would benefit due to reduced high lake occurrences; Increased low lake occurrences benefit plant seed bank germination. See EFH section below for estuary effects.	Lake vegetation would benefit due to reduced high lake occurrences; Increased low lake occurrences benefit plant seed bank germination. See EFH section below for estuary effects	Lake vegetation would benefit due to reduced high lake occurrences; Increased low lake occurrences benefit plant seed bank germination. See EFH section below for estuary effects	Lake vegetation would benefit due to reduced high lake occurrences; Increased low lake occurrences benefit plant seed bank germination. See EFH section below for estuary effects	Lake vegetation would benefit due to reduced high lake occurrences; Increased low lake occurrences benefit plant seed bank germination. Prolonged low lake stages may negatively affect lake vegetation. See EFH section below for estuary effects
FLOOD CONTROL	Greater potential for adverse effects due to higher top zone regulation schedule.	Reduces high lake stage, improving flood control.	Reduces high lake stage, improving flood control.	Reduces high lake stage, improving flood control.	Reduces high lake stage, improving flood control.	Reduces high lake stage, improving flood control.
WATER QUALITY	No improvement expected due to high lake elevation.	Potential for indirect benefits due to reduction >15 ft lake stage; Minimal change, if any, to estuary WQ.	Potential for indirect benefits due to reduction >15 ft lake stage; Minimal change, if any, to estuary WQ.	Potential for indirect benefits due to reduction >15 ft lake stage; Minimal change, if any, to estuary WQ.	Potential for indirect benefits due to reduction >15 ft lake stage; Minimal change, if any, to estuary WQ.	Potential for indirect benefits due to reduction >15 ft lake stage; Minimal change, if any, to estuary WQ.
HISTORIC PROPERTIES	No effect.	No effect.	No effect.	No effect.	No effect.	No effect.

ALTERNATIVE ENVIRONMENTAL FACTOR	Alternative No Action	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E Preferred Alternative
RECREATION	May negatively affect sport fishery due to loss of SAV and emergent vegetation.	Potential improvement to lake sport fishery due to reduced high lake stage events.	Potential improvement to lake sport fishery due to reduced high lake stage events.	Potential improvement to lake sport fishery due to reduced high lake stage events.	Potential improvement to lake sport fishery due to reduced high lake stage events.	Potential improvement to lake sport fishery due to reduced high lake stage events.
AESTHETICS	Potential for adverse effects due to high water levels impacting vegetation and wildlife.	May improve lake aesthetics due to improved lake schedule.	May improve lake aesthetics due to improved lake schedule.	May improve lake aesthetics due to improved lake schedule.	May improve lake aesthetics due to improved lake schedule.	May improve lake aesthetics due to improved lake schedule.
NAVIGATION	No significant adverse effects expected. Days below 12.56 ft NGVD are 2,876	Adverse effects expected due to increased days below 12.56 ft. Total days below are 4,839.	Adverse effects expected due to increased days below 12.56 ft. Total days below are 4,922.	Adverse effects expected due to increased days below 12.56 ft. Total days below are 4,909.	Adverse effects expected due to increased days below 12.56 ft. Total days below are 5,156.	Adverse effects expected due to increased days below 12.56 ft. Total days below are 5,128.
ECONOMICS	Minimal effects expected.	Minimal effects expected.	Minimal effects expected.	Minimal effects expected.	Minimal effects expected.	Minimal effects expected.
WATER SUPPLY	No effect.	Minimal effect compared to the No Action.	Minimal effect compared to the No Action.	Minimal effect compared to the No Action.	Minimal effect compared to the No Action.	Minimal effect compared to the No Action.
ESSENTIAL FISH HABITAT (EFH)	High volume releases may negatively affect EFH in estuaries.	Increase in preferred flows may benefit CE and SLE. No reduction in mean monthly high flows to CE. Reduction in high flows to SLE may benefit EFH.	Increase in preferred flows may benefit CE and SLE. No reduction in mean monthly high flows to CE. Reduction in high flows to SLE may benefit EFH.	Increase in preferred flow range may benefit CE and SLE. Reduction in mean monthly high flows may also benefit EFH in estuaries.	Minimizing flows >2800 cfs to CE, and the increase in preferred flow range to SLE and CE may benefit EFH.	Minimizing flows >2800 cfs to CE and >2000 to SLE is beneficial. An increase in preferred flow range to SLE and CE may benefit EFH. Base flow may benefit EFH.

3. PREFERRED ALTERNATIVE

3.1. SUMMARY OF OPERATIONAL FEATURES

The Preferred Alternative resulted in proposed water management operational guidance to be used on a daily basis in the management of Lake Okeechobee. The proposed operational guidance includes: 2007 Lake Okeechobee Interim Regulation Schedule Part A through D (Figure 3-1 through Figure 3-4 respectively), THCs, weather forecasts, climate-based hydrologic outlooks, and historical as well as projected lake level information.

Through the Preferred Alternative, management of Lake Okeechobee water levels and determination of Lake Okeechobee releases to the WCAs and to tide (estuaries) is based on seasonally varying lake elevations divided into three bands as shown on the proposed 2007 Lake Okeechobee Interim Regulation Schedule Part A (Figure 3-1). These bands include "High Lake Management" (top band on Figure 3-1), "Operational" (middle band on Figure 3-1), and "Water Shortage Management" (bottom band on Figure 3-1 The High Lake Management Band is meant to address public health and safety, especially related to the structural integrity of HHD by providing the ability to make releases up to the maximum capacity that lake outlets will allow. The Operational Band is meant to facilitate authorized project purposes by providing the ability to make releases of various volumes, including no release; Lake Okeechobee outlet canals should be maintained within their optimum water management elevations. The Water Shortage Management Band pertains to low lake levels which necessitate rationing water supplies; Lake Okeechobee outlet canals may be maintained below their optimum water management elevations. The water supply releases made within this band are made according to the SFWMD's draft LOWSM Plan.

The 2007 Lake Okeechobee Interim Regulation Schedule Part B (Figure 3-1) further defines the bands of the regulation schedule. In Part B, the Operational Band is subdivided into additional bands and sub-bands that are directly related to defining allowable Lake Okeechobee releases to the WCAs and to tide (estuaries). In general as lake levels rise through the higher sub-bands, the allowable release rates increase.

Evaluation of the LORSS Preferred Alternative over the POR (1965 to 2000) shows that the proposed regulation schedule releases to the WCAs and to the estuaries will reduce the likelihood of lake levels that both increase the probability of a breach of the HHD and also contribute to poor ecological conditions within Lake Okeechobee. For Lake Okeechobee, a high lake level can lead to the decline of emergent and submerged vegetation which is essential habitat for the lake's fish and wildlife populations.

The LORSS Preferred Alternative provides the ability to make long-term, low-volume releases to the Caloosahatchee Estuary, St. Lucie Estuary, and WCAs. These releases include low-volume pulse releases and base flow releases to the Caloosahatchee

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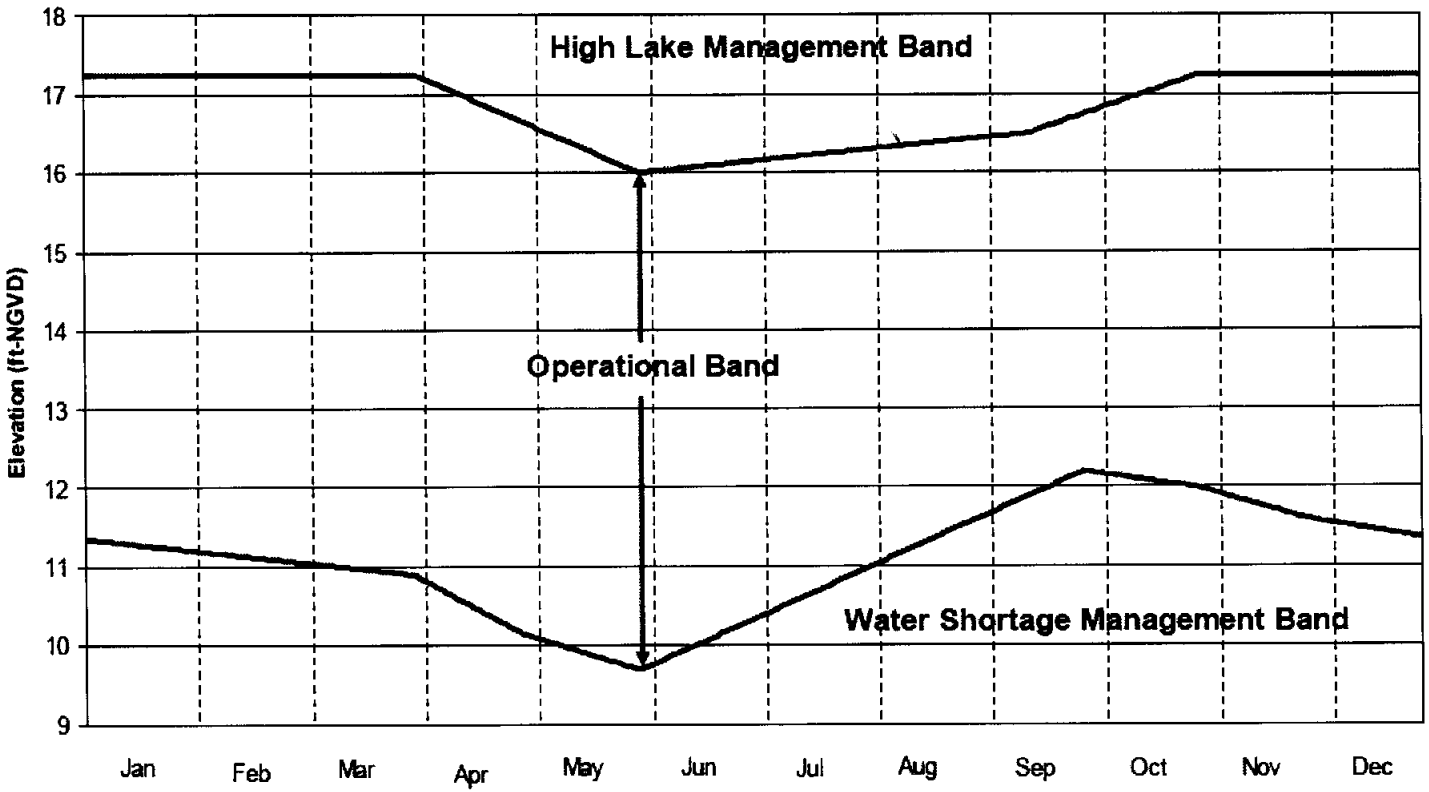

High Lake Management Band: Outlet Canals may be maintained above their optimum water management elevations.
Operational Band: Outlet Canals should be maintained within their optimum water management elevations.
Water Shortage Management Band: Outlet Canals may be maintained below optimum water management elevations. The band elevations may change upon completion of South Florida Water Management District's rule making process.

CENTRAL AND SOUTHERN FLORIDA PROJECT
INTERIM
LAKE OKEECHOBEE AND EVERGLADES AGRICULTURAL AREA
Draft
2007 LAKE OKEECHOBEE REGULATION SCHEDULE PART A
DATED: 07MAR2007
DEPARTMENT OF THE ARMY, JACKSONVILLE DISTRICT

FIGURE 3-1: 2007 LAKE OKEECHOBEE INTERIM REGULATION SCHEDULE PART A

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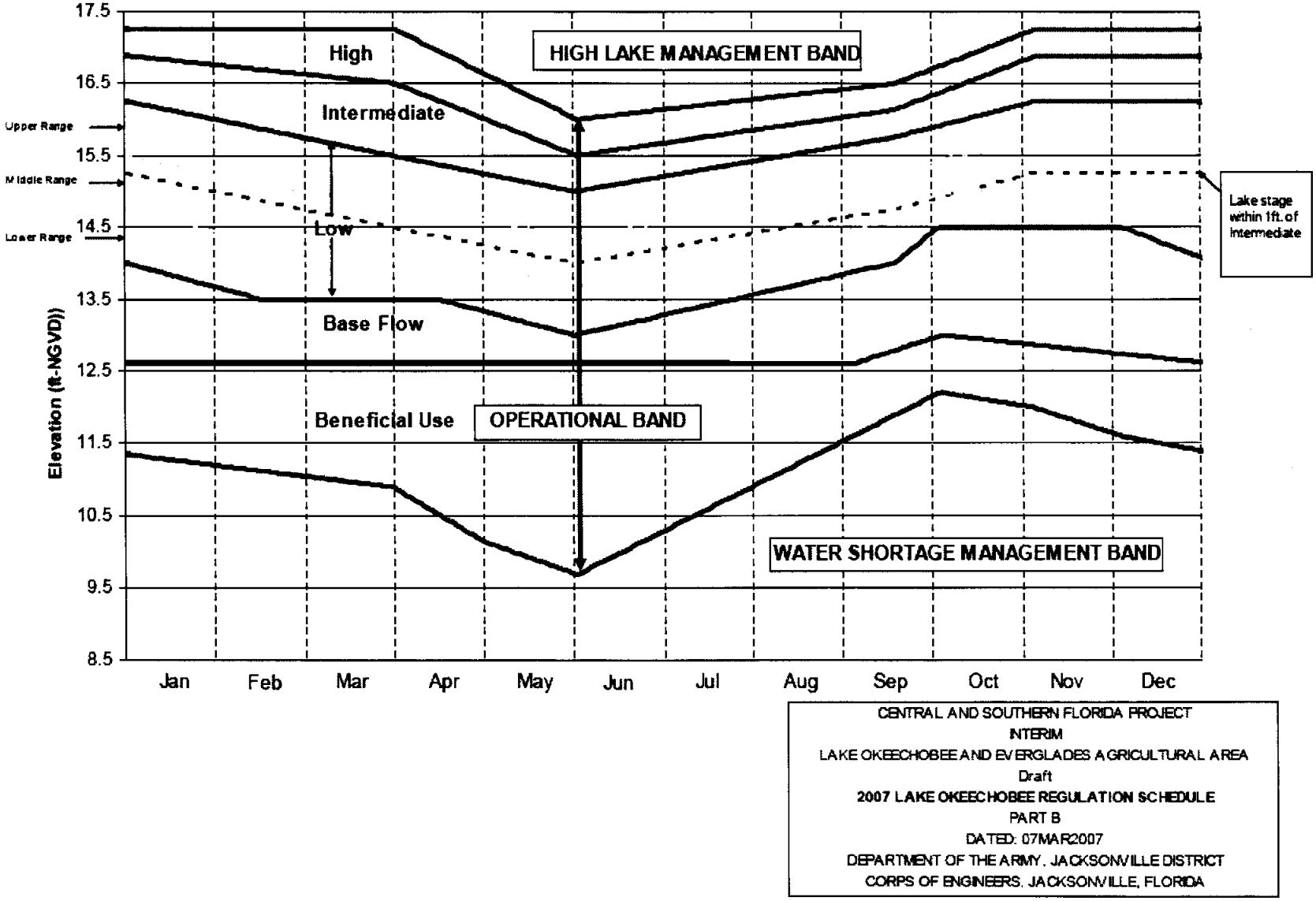

FIGURE 3-2: 2007 LAKE OKEECHOBEE INTERIM REGULATION SCHEDULE PART B

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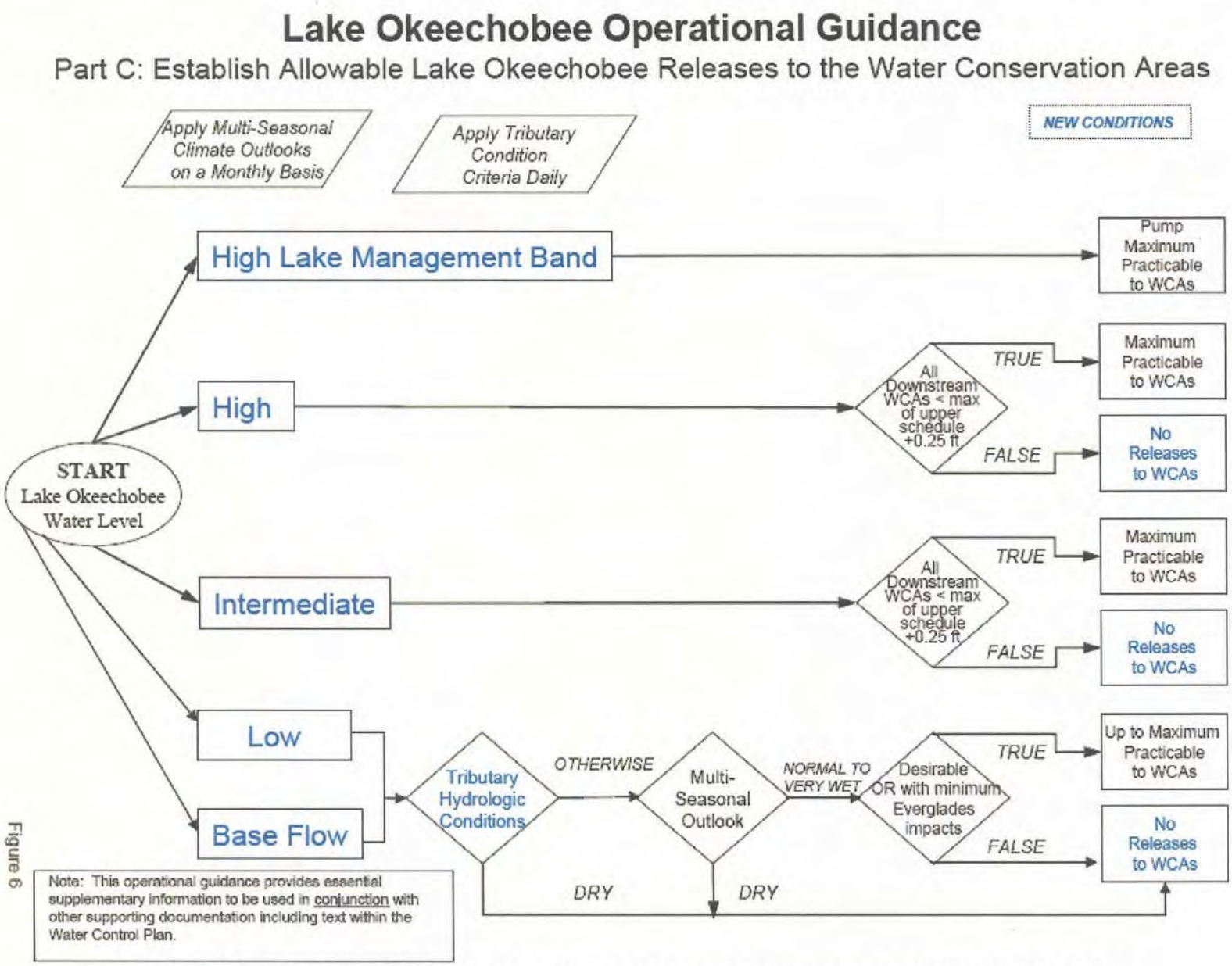

FIGURE 3-3: 2007 LAKE OKEECHOBEE INTERIM REGULATION SCHEDULE PART C

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Lake Okeechobee Operational Guidance

Part D: Establish Allowable Lake Okeechobee Releases to Tide (Estuaries)

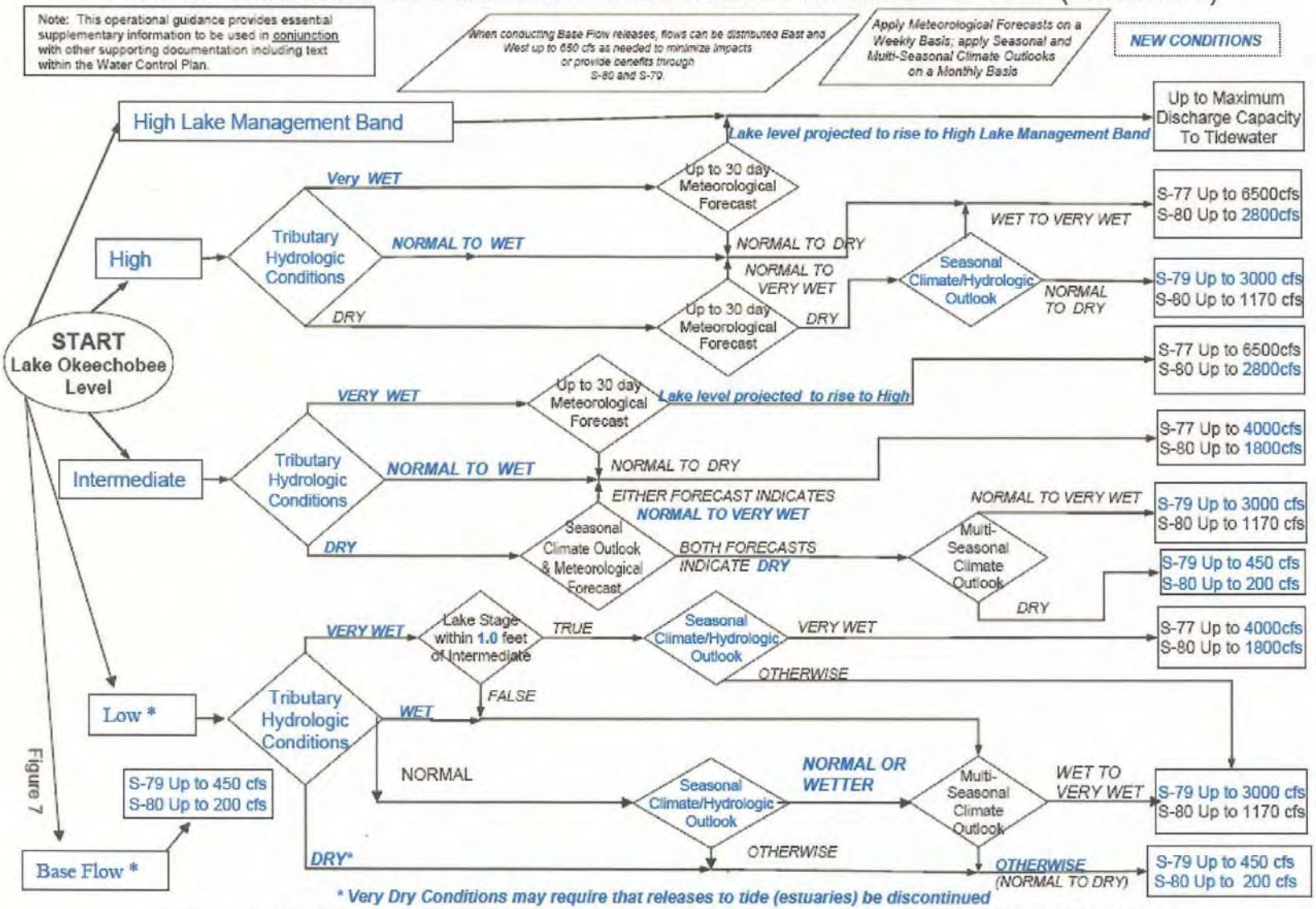

FIGURE 3-4: 2007 LAKE OKEECHOBEE INTERIM REGULATION SCHEDULE PART D

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and St. Lucie estuaries that allow Lake Okeechobee to be maintained at more desirable levels throughout the year. A pulse release attempts to simulate a natural rainstorm event within the basins. The receiving body would respond to the pulse release in a similar fashion as if a rainstorm had occurred in the upstream watershed. Although an average flow rate is targeted for the duration of the pulse release, daily releases vary. The pulse releases and base flow releases are intended to regulate lake levels and reduce the potential for future prolonged high-volume releases to the estuaries. The base flow releases also provide a benefit of maintaining desirable salinity levels in the estuaries. By regulating lake levels, these low-volume releases improve public health and safety performance by reducing risk to the HHD and provide improved benefits for the health of Lake Okeechobee and the estuaries.

3.2. PROPOSED OPERATIONAL GUIDANCE

The Operational Guidance, contained in Appendix A, establishes the allowable quantity, timing, and duration of releases from Lake Okeechobee to the WCAs and to tide (estuaries). Water management decisions will utilize the 2007 Lake Okeechobee Interim Regulation Schedule Parts A through D (Figure 3-1 through Figure 3-4) to provide guidance on releases from Lake Okeechobee. Information shown on Part C and Part D (Figure 3-1 and Figure 3-4) is utilized to establish the allowable releases to the WCAs and the allowable releases to tide (estuaries), respectively.

When the Operational Guidance and/or basin conditions between Lake Okeechobee and the estuaries result in flows deemed undesirable by SFWMD to the estuaries, the SFWMD may seek to store Lake Okeechobee water on available SFWMD designated lands. As CERP reservoirs designed to receive Lake Okeechobee releases become available, they will be operated according to the operations established for those projects. These efforts are intended to reduce undesirable lake releases to the estuaries by first making lake releases to alternative storage areas to minimize flows that are above the estuary's biologically-derived maximum flow criteria.

The "Lake level projected to rise to" phrase in the Lake Okeechobee Operational Guidance to Tide (Figure 3-4) can be determined on a daily basis. Information to be considered includes, but is not necessarily limited to, the following variables: climate forecasts, release constraints due to downstream conditions, actual lake level rate of rise, historical lake levels, and the state of the C&SF Project (including the availability of new facilities proposed by the CERP).

3.3. LAKE OKEECHOBEE MANAGEMENT BANDS

The proposed operational guidance for management of the Lake Okeechobee water levels and outlet canals has three distinct bands defined by seasonal fluctuations of the lake level (Figure 3-1). Each management band is designed to achieve specific objectives consistent with Congressionally-authorized purposes for Lake Okeechobee. The bottom band, at the lower lake levels, is the Water Shortage Management Band. In this band, water in Lake Okeechobee will be managed in accordance with the Water Shortage Plan established by SFWMD. Outlet canals may be maintained below their optimum water management elevations in this band. The top band, at the higher lake

levels, is the High Lake Management Band. The goal for lake management within this band is to quickly lower high lake levels. This will make lake storage available for use during the next rainfall event, to reduce impacts on Lake Okeechobee's submerged aquatic vegetation (SAV) and to reduce the risk to public health and safety, including but not limited to HHD integrity issues; outlet canals may be maintained above their optimum water management elevations in this band. The middle and largest band is the Operational Band, which includes several sub-bands (High, Intermediate, Low, Base Flow, and Beneficial Use Sub-Bands). It is anticipated that the majority of time, lake levels will be within the Operational Band, and Lake Okeechobee would be managed according to the operational criteria established for the sub-bands of the Operational Band, including provisions to meet water supply demands for ENP, salinity control, regional groundwater control, agricultural irrigation, municipalities, and industry. Outlet canals should be maintained within their optimum water management elevations in this band.

Within the High, Intermediate, Low, and Base Flow Sub-Bands, the allowable release from Lake Okeechobee to the WCAs is defined by lake level, hydrologic conditions, effect of desired release on the Everglades, treatment capacity of Storm Water Treatment Areas (STAs), and downstream WCA level(s), as well as long-term climate-based hydrologic outlooks (Figure 3-3). Also within the Operational Band and its sub-bands, the allowable release from Lake Okeechobee to the estuaries is defined by lake level, the trend of the lake level, hydrologic conditions, short-term weather forecasts, and long-term climate-based hydrologic outlooks (Figure 3-4). A detailed description of the management bands follows.

Water Shortage Management Band–varies seasonally between 9.7 to 12.2 ft., NGVD and below. Operations in this band are governed by the SFWMD's LOWSM (**NOTE: draft Water Shortage Management Band elevations may change upon completion of SFWMD's rule making process in 2007.).** The goal of this band is to manage existing water supply contained within Lake Okeechobee in accordance with SFWMD rules and guidance.

High Lake Management Band–varies seasonally between elevations 16.0 and 17.25 ft., NGVD and above. The goal of this band is to reduce the risk to public health and safety and to make releases to lower the lake below the High Lake Management Band as soon as possible. In this High Lake Management Band, it is of the utmost importance that the lake level be reduced as rapidly as possible to make storage available for the next possible rainfall event, to relieve stress on the HHD, and to reduce impacts on Lake Okeechobee's littoral zone. Releases up to the maximum discharge capacity will be made to tide and up to maximum practicable discharges will be pumped to the WCAs and made available to CERP impoundments (as they become available). In an effort to reduce undesirable lake releases to the estuaries, Lake Okeechobee water will also be made available to the SFWMD for their use to store on lands designated by SFWMD (as they become available). Within the High Lake Management Band, the allowable release from Lake Okeechobee to the WCAs and to the estuaries is defined by the lake level as shown on the 2007 Lake Okeechobee Interim Regulation

Schedule Part C and Part D (Figure 3-3 and Figure 3-4), respectively. Actual rates of release from Lake Okeechobee will vary depending on but not limited to downstream channel conditions, estuary conditions, conditions in the WCAs, and conditions in the STAs. Although unlikely to be required due to wet conditions that are likely to exist when lake levels are within this band, Lake Okeechobee releases to meet water supply demands (for ENP, salinity control, regional groundwater control, agricultural irrigation, municipalities, industry, and the environment) may be made at any time within the High Lake Management Band.

Operational Band-the largest management band varies seasonally between 9.7 ft. at its lowest point and 17.25 ft., NGVD at its highest point. The goal of the Operational Band is to manage the lake stage to balance all authorized project purposes. This involves use of flood control releases, environmental releases, base flow releases, and water supply releases. In an effort to reduce undesirable lake releases to the estuaries, Lake Okeechobee water may be stored in CERP reservoirs (as they become available) or SFWMD may seek to store Lake Okeechobee water on available SFWMD designated lands. The USACE will coordinate operations with the SFWMD as necessary. For Lake Okeechobee, an environmental release can be considered as a release from Lake Okeechobee to benefit the lake ecosystem, downstream ecosystems, and/or upstream ecosystems. For Lake Okeechobee, a base flow release to the Caloosahatchee Estuary is a release from Lake Okeechobee at S-77 to achieve a 450 cfs flow at S-79. A base flow release to the St. Lucie Estuary is a release at S-308 to achieve a 200 cfs flow at S-80. When conducting base flow releases, flows up to 650 cfs can be distributed East and West as needed to minimize impacts or provide additional benefits. Very dry THCs may require that releases to tide (estuaries) be discontinued. For Lake Okeechobee, a water supply release can be considered a release from Lake Okeechobee to meet water supply demands (for ENP, salinity control, regional groundwater control, agricultural irrigation, municipalities, industry and the environment). Lake Okeechobee releases to meet water supply demands may be made at any time within the Operational Band. Within the Operational Band, several sub-bands have been established to further define lake releases. As described below, these bands include the Beneficial Use Sub-Band, Base Flow Sub-Band, Low Sub-Band, Intermediate Sub-Band, and High Sub-Band.

Beneficial Use Sub-Band: This sub-band varies seasonally between elevation 9.7 ft. and 13.0 ft., NGVD at its highest point. Except for navigation, SFWMD allocates water to various users in this sub-band. Navigation can typically be supported by releases from Lake Okeechobee that are conducted for other authorized project purposes. Fish and wildlife enhancement and/or water supply deliveries for environmental needs may involve conducting an environmental release from Lake Okeechobee through the SFWMD's "Adaptive Protocols" or other SFWMD authorities.

Base Flow Sub-Band: This sub-band varies seasonally between elevation 12.6 ft. and 14.5 ft., NGVD. In this band, the allowable release from Lake Okeechobee to the WCAs is defined by lake level, hydrologic conditions, effect of desired release on the Everglades, treatment capacity of STAs, downstream WCA level(s), THCs, and climate-

based hydrologic outlooks as shown on the 2007 Lake Okeechobee Interim Regulation Schedule Part D (Figure 3-4). Also in this sub-band, continuous, low-volume releases can be made to the Caloosahatchee Estuary and the St. Lucie Estuary. Base flow limits are defined as up to 450 cfs measured at S-79, and up to 200 cfs measured at S-80. If the basin runoff between Lake Okeechobee and the estuary is less than this "base flow", then Lake Okeechobee releases are made to supplement the difference. These base flow releases of excess lake water may have environmental benefits to the estuaries and help to reduce the chances of subsequent high volume discharges. In addition, the SFWMD may allocate water to the environment through its "Adaptive Protocols" or other SFWMD authorities.

Low Sub-Band: This sub-band varies seasonally between elevation 13.0 ft. and 16.25 ft., NGVD. In this sub-band, operations for releases to the WCAs and base flow to the estuaries will be conducted consistent with the Base Flow Sub-Band. Lake Okeechobee releases to the estuaries that are greater than base flow are allowed within this sub-band and are defined by lake level, hydrologic conditions, lake level's distance from the Intermediate Sub-Band, THCs, and climate-based hydrologic outlooks as shown on the 2007 Lake Okeechobee Interim Regulation Schedule Part D (Figure 3-4). As shown on Part B, this sub-band was divided into thirds (Upper Range, Middle Range, Lower Range). Within the Upper Range, the pulse release to the Caloosahatchee Estuary is up to 3000 cfs while to the St. Lucie Estuary it is up to 1170 cfs (3000/1170). The pulse release in the Middle Range and the Lower Range is 2500/950 and 2000/730, respectively. Within the Low Sub-Band, the release from Lake Okeechobee to the WCAs is defined by lake level, THCs, effect of desired release on the Everglades, downstream WCA level(s), and the multi-seasonal climate-based hydrologic outlook as shown on the 2007 Lake Okeechobee Interim Regulation Schedule Part C (Figure 3-3). The maximum allowable lake releases to the WCAs and estuaries is provided as follows:

(1) To WCAs-When THCs and the multi-seasonal climate/hydrologic outlook are not in their dry classifications, then up to maximum practicable release to the WCAs are allowable if the release is beneficial to, or will result in minimum Everglades impacts. Both the quantity and quality of Lake Okeechobee water will be considered.

(2) To Estuaries-When tributary conditions are very wet, the lake level is within 1.0 foot of the Intermediate Sub-Band, and the seasonal climate forecast is very wet, then lake releases up to 4000 cfs at S-77 and up to 1800 cfs at S-80 (4000/1800) are allowable.

(3) To Estuaries–When the lake level is not within one foot of the Intermediate Sub-Band, or tributary conditions are not very wet, and the multi-seasonal climate/hydrologic outlook is wet, then lake releases up to 3000 cfs at S-79 and up to 1170 cfs at S-80 (3000/1170) are allowable. These releases are intended to be made in a pulse release that is sensitive to the estuary environment.

Intermediate Sub-Band: This sub-band varies seasonally between elevation 15.0 ft. to elevation 16.88 ft., NGVD. In this sub-band, operations for base flow to the estuaries will be conducted consistent with the Base Flow Sub-Band. Lake Okeechobee releases to the estuaries that are greater than base flow are allowed within this sub-band and are defined by lake level, THCs, the projected rise of Lake Okeechobee, short term meteorological forecasts, seasonal hydrologic outlooks, and climate-based hydrologic outlooks as shown on the 2007 Lake Okeechobee Interim Regulation Schedule Part D (Figure 3-4). The allowable release from Lake Okeechobee to the WCAs is defined by lake level and downstream WCA level(s), as shown on the 2007 Lake Okeechobee Interim Regulation Schedule Part C (Figure 3-3). The maximum allowable lake releases to the WCAs and estuaries is provided as follows:

(1) To WCAs-When all downstream WCAs are less than a quarter of a foot above the maximum elevation of their regulation schedules, then up to maximum practicable release to the WCAs are allowable. Downstream WCAs refer to the WCAs downstream of the WCA receiving Lake Okeechobee discharges. For example, if it is desired to make a release to WCA-3A (via STA-3/4), then WCA-1 and WCA-2A water levels do not constrain the release to WCA-3A since they are upstream of WCA-3A. However, if it is desired to make a release to WCA-2A (via STA-3/4), and if the WCA-3A water level was higher than a quarter of a foot above the maximum of its regulation schedule, then no release to WCA-2A would be made.

(2) To Estuaries-When tributary conditions are very wet and the lake level is projected to rise into the High Sub-Band, lake releases up to 6500 cfs at S-77 and up to 2800 cfs at S-80 (6500/2800) are allowable.

High Sub-Band: This sub-band varies seasonally between elevation 15.5 ft. at its lowest point and elevation 17.25 ft., NGVD. In this sub-band, releases to the Caloosahatchee Estuary of up to 3000 cfs measured at S-79, and up to 1170 cfs to the St. Lucie Estuary measured at S-80, can always be made for management of the lake level. The allowable lake releases to the estuaries are defined by lake level, THCs, the projected rise of the lake, short term weather forecasts, and the seasonal climate/hydrologic outlook as shown on the 2007 Lake Okeechobee Interim Regulation Schedule Part D (Figure 3-4). The allowable release from Lake Okeechobee to the WCAs is defined by lake level and downstream WCA level(s), as shown on the 2007 Lake Okeechobee Interim Regulation Schedule Part C Figure 3-3). The maximum allowable lake releases to the WCAs and estuaries is provided as follows:

(1) To WCAs-When all downstream WCAs are less than a quarter of a foot above the maximum elevation of their regulation schedules, then up to maximum practicable release to the WCAs are allowable.

(2) To Estuaries-When THCs are very wet and the lake level is projected to rise into the High Lake Management Band, then lake releases up to maximum discharge capacity are allowable.

3.4. MAKE-UP RELEASE DESCRIPTION

Historically, the planned Lake Okeechobee releases to tide (estuaries) have been subject to reduction or prevention by downstream conditions such as downstream local basin runoff, the tidal cycle, and tidal storm surge. Similarly, planned Lake Okeechobee releases to the WCAs have also been limited by high water levels in the WCAs, STA treatment capacity limits, and limited or no conveyance capacity in the primary canals within the EAA. When these conditions have occurred in the past, the releases have been delayed or discontinued. To address this issue, proposed operational guidance includes conducting releases from Lake Okeechobee to tide and/or to the WCAs (via STAs) to make up releases that were previously reduced or prevented. These make-up releases from Lake Okeechobee to tide (estuaries) and WCAs will occur as soon as possible and may occur when Parts C and D (Figure 3-3 and Figure 3-4) do not allow releases or prescribe a lower volume release. The lake make-up releases to tide (estuaries) would be limited to a pulse release from Lake Okeechobee not to exceed 2800 cfs measured at S-79, and 2000 cfs at the St. Lucie Estuary when the lake level is below the Intermediate Sub-Band. This includes releases from all C&SF Project structures that discharge into the St Lucie Estuary. The environmental effects of this action are similar to those modeled, and would be no greater than those effects already discussed in Section 6 of this SEIS.

3.5. DECISION-MAKING PROCESS

The decision-making process for Lake Okeechobee water management operations considers all Congressionally-authorized project purposes. The decision-making process to determine quantity, timing, and duration of the potential release from Lake Okeechobee includes consideration of various information related to water management. This information includes but is not necessarily limited to: C&SF Project conditions, historical lake levels, estuary conditions/needs, lake ecology conditions/needs, WCA water levels, STA available capacity, current climate conditions, climate forecasts, hydrologic outlooks, projected lake level rise/recession, and water supply conditions/needs.

Part A of the 2007 Lake Okeechobee Interim Regulation Schedule (Figure 3-1) can be considered a starting point in the decision-making process for Lake Okeechobee water management operations. Part A allows a quick visual determination of which of the general management bands applies to the current lake stage.

Use of the 2007 Lake Okeechobee Interim Regulation Schedule Parts B through D (Figure 3-2 through Figure 3-4) will result in the determination of releases from Lake Okeechobee. The elevation guidelines include appropriate variations by season to conform to competing project purposes. As with WSE, recreation and navigation is provided for when water is available and/or through releases conducted for other project purposes.

The release to be implemented will be limited to the allowable release determined from Part C and Part D (Figure 3-3 and Figure 3-4), except as noted in the Make-up Release Description. Releases can vary up to the allowable release based on consideration of

current and anticipated conditions/needs stated in the first paragraph of this section. This process allows for the quantity, timing, and duration of the releases to be performed to address the competing needs associated with water resources and the Congressionally-authorized project purposes.

When operating near band and sub-band limits, up to 30-day forecasts will be made and releases will be scheduled to lower or maintain Lake Okeechobee at the desired level during the 30-day period. Scheduling of releases may include the adjustment of band/sub-band limits when determining the release to implement. Factors considered in adjusting the band/sub-band limits would include but not be limited to: availability of STA treatment capacity, SFWMD designated lands, CERP reservoirs, and the condition of tributary basins. The band/sub-band adjustment is meant to transition into and out of sub-bands by allowing flows to gradually increase or decrease between sub-bands. An example of this adjustment would be: a condition above is occurring, lake level is 0.2 feet below the Intermediate Sub-Band and projected to rise into the Intermediate Sub-Band, then the allowable Lake Okeechobee release would be determined by following Part D with the lake level considered to be in the Intermediate Sub-Band (not 0.2 ft. below the Intermediate Sub-Band). The environmental effects of utilizing forecasts to gradually increase or decrease Lake Okeechobee releases are similar to those effects discussed in Section 6, which are based on modeling simulations.

3.6. ADDITIONAL OPERATIONAL FLEXIBILITY

It is anticipated that future events similar to those experienced over the POR (1965-2000) will be effectively managed by the Preferred Alternative. The Preferred Alternative was also simulated for the 2001 through 2005 period, and deemed effective for managing high lake elevations under this set of conditions. Occasionally, additional operational flexibility will be used to address circumstances (i.e., hydrologic conditions, lake levels, spawning in the estuaries, downstream runoff, etc.) that were not evaluated in the Preferred Alternative for the POR. Additional operational flexibility provides water managers the ability to consider releases from Lake Okeechobee to the WCAs and to tide (estuaries) to minimize damages or to meet project purposes when the 2007 Lake Okeechobee Interim Regulation Schedule Parts A through D (Figure 3-1 through Figure 3-4) are not effective at managing lake levels consistent with the intent of the Preferred Alternative.

Release decisions will take into account the estuarys' biologically-derived maximum flow, future water supply demands, C&SF Project system-wide conditions, and lake ecological conditions, as appropriate. Consideration of the concern for public health and safety is the USACE's highest priority. When conditions exist for such releases, experts on estuarine, lake, and wetland ecology would provide scientific input with regard to the effects these release would have on the environment. The environmental effects would be evaluated on the basis of existing conditions in the ecosystems, as quantified by the PMs described in Section 4 of this SEIS. Additionally, these operations would have environmental effects similar to the effects discussed in Section 6, which are based on modeling simulations. The additional operational flexibility will be considered to obtain additional benefits, and to provide the opportunity to minimize

impacts in the longer term. For instance, past experience shows that low volume releases carried out in a pro-active manner can reduce the later need for more potentially damaging high volume releases to the estuaries, and also reduce littoral zone impacts due to rapidly rising stages. The additional operational flexibility is expected to provide benefits to a variety of fish, wildlife, and aquatic plants, both in the lake and in downstream ecosystems.

Once implemented, releases will be discontinued when the conditions that prompted them have ceased or the desired outcome is achieved. Based upon the evaluation of historical conditions and the expected performance of the Preferred Alternative, it is anticipated that use of additional operational flexibility will be infrequent.

Each event to be addressed by additional operational flexibility is unique and releases to be implemented will be defined by a desired outcome or time-period. The public will be notified of the planned releases, desired outcome, and implementation time period by the USACE's normal water management notification process (press release, internet webpage). The following sections identify the scenarios that would trigger the use of additional operational flexibility and provide details on releases to be considered under each scenario. Additionally, the environmental effects for each situation have been considered. The Additional operational flexibility will be used to address circumstances which were not evaluated in the Preferred Alternative POR, such as the following:

a. Undesirable/Prolonged High Lake Levels

Releases may be considered to prevent anticipated high lake levels or to lower high lake levels, in order to reduce risk to the HHD and to prevent additional adverse environmental impacts to Lake Okeechobee. In 2003, continuous high lake levels (above 15 ft., NGVD in excess of 13 months) resulted in a Temporary Deviation. The purpose of this Temporary Deviation was to minimize the risk of high lake levels, to lower Lake Okeechobee for prevention of additional adverse impacts in the lake and to reduce the potential of high-volume continuous releases to the estuaries. These intended purposes were accomplished while balancing other management objectives of water supply and flood control.

In the event that there are ongoing or planned activities at C&SF Project features (including CERP Projects) upstream or downstream of Lake Okeechobee, and high lake levels are projected to occur or anticipated to occur as a result of these activities and based on any combination of planned water management operations, climate forecasts, and historical information/data, then additional releases to the WCAs and to tide (estuaries) could be considered. All project purposes will be considered. When possible, the lake releases to tide (estuaries) would be limited to a pulse release from Lake Okeechobee not to exceed 2800 cfs measured at S-79 and 2000 cfs measured at the St. Lucie Estuary. This includes releases from all C&SF Project structures that discharge into the St Lucie Estuary. Releases to the WCAs would depend on available treatment capacity in the STAs.

Additional releases might be implemented to lower Lake Okeechobee's level in advance of planned activities and/or to prevent high lake levels. An example is a planned muck removal operation involving a lake drawdown in the Kissimmee River Basin that could result in the need to create storage in Lake Okeechobee prior to the planned Kissimmee River Basin drawdown.

b. Climate Conditions

In the event that climate conditions including but not limited to, El Nino, La Nina, and/or active hurricane season forecasts are projected to create or continue high lake levels, additional operational flexibility would allow releases to WCAs and to tide (estuaries) to be implemented. The lake releases to tide (estuaries) should be limited to a pulse release from Lake Okeechobee not to exceed 2800 cfs measured at S-79 and 2000 cfs measured at the St. Lucie Estuary. This includes releases from all C&SF Project structures that discharge into the St Lucie Estuary. The wet spring of 2004 (normally the dry season) and an overly active hurricane season are examples of conditions that could be addressed with additional operational flexibility.

c. Low Volume Releases

In the event that the lake level is above the Water Shortage Management Band and conditions exist that would require low-volume releases, additional operational flexibility would allow low-volume releases to be implemented. The low-volume releases would be implemented to address conditions including, but not limited to the following: to prevent and/or to lower high lake levels, to address algal blooms, to disperse saltwater in the river and/or estuary, or improve other conditions related to the Congressionally-authorized project purposes. The proposed low-volume releases would be limited to a pulse release from Lake Okeechobee of up to 2000 cfs measured at S-79 and up to 730 cfs measured at S-80.

As an example, a Low Volume Release operation occurred in 2004. Operations were conducted that included a pulse release that averaged up to 1600 cfs to the Caloosahatchee Estuary and up to 730 cfs measured at S-80. The purpose of these operations was to minimize the risk of high lake levels, to lower Lake Okeechobee for prevention of additional adverse impacts in the lake and to reduce the potential of high constant releases to the estuaries. These intended purposes were accomplished while balancing other management objectives of water supply and flood control. The effects of such releases are displayed in Table 3-1.

TABLE 3-1: EFFECTS OF RELEASES ON LAKE OKEECHOBEE WATER LEVEL

Effects of Beneficial Use Sub-band Releases on Lake Okeechobee Water Level

Lake Okeechobee Release (average daily cfs)	Lake Okeechobee Release		Lake Okeechobee Release	
	Duration (days)	Effect on Lake Okeechobee (feet)[1]	Duration (days)	Effect on Lake Okeechobee (feet)[1]
200	1	0.001	20	0.023
300	1	0.002	20	0.035
400	1	0.002	20	0.046
500	1	0.003	20	0.058
600	1	0.003	20	0.070
700	1	0.004	20	0.081
800	1	0.005	20	0.093
900	1	0.005	20	0.104
1000	1	0.006	20	0.116
1100	1	0.006	20	0.128
1200	1	0.007	20	0.139
1300	1	0.008	20	0.151
1400	1	0.008	20	0.162
1500	1	0.009	20	0.174
1600	1	0.009	20	0.186
1700	1	0.010	20	0.197
1800	1	0.010	20	0.209
1900	1	0.011	20	0.220
2000	1	0.012	20	0.232
2100	1	0.012	20	0.244
2200	1	0.013	20	0.255
2300	1	0.013	20	0.267
2400	1	0.014	20	0.278
2500	1	0.014	20	0.290
2600	1	0.015	20	0.301
2700	1	0.016	20	0.313
2800	1	0.016	20	0.325

1 Effect on Lake Okeechobee based on lake storage change from elevation 10.5 ft.to 11.5 ft. (341,500 acre-feet)

Effects of evapotranspiration on Lake Okeechobee Water Level

Month	Evapotranspiration		Evapotranspiration	
	Duration (days)	Effect on Lake Okeechobee (feet)[2]	Duration (days)	Effect on Lake Okeechobee (feet)
January	1	0.006	20	0.120
February	1	0.008	20	0.160
March	1	0.011	20	0.220
April	1	0.012	20	0.240
May	1	0.013	20	0.260
June	1	0.012	20	0.240
July	1	0.011	20	0.220
August	1	0.01	20	0.200
September	1	0.009	20	0.180
October	1	0.009	20	0.180
November	1	0.007	20	0.140
December	1	0.006	20	0.120

2 From the Drought Contingency Plan contained in Lake Okeechobee EAA Water Control Manual

4. EVALUATION TOOLS

4.1. MODELING

What is the South Florida Water Management Model?

The SFWMM was the tool used to evaluate all LORSS alternatives. The SFWMM is a regional-scale computer model that simulates the hydrology and the management of the water resources system from Lake Okeechobee to Florida Bay. It covers an area of 7600 square miles using a mesh of two mile by two (2x2) mile cells. In addition, the model includes inflows from Kissimmee River, and runoff and demands in the Caloosahatchee River and St. Lucie canal basins. The model simulates the major components of the hydrologic cycle in south Florida including rainfall, evapotranspiration, infiltration, overland and groundwater flow, canal flow, canal-groundwater seepage, levee seepage and groundwater pumping. It incorporates current or proposed water management control structures and current or proposed operational rules. The ability to simulate water shortage policies affecting urban, agricultural, and environmental water uses in South Florida is a major strength of this model. The SFWMM simulates hydrology on a daily basis using climatic data for the 1965-1995 period which includes many droughts and wet periods. For the current LORSS, the SFWMM v5.5 was used, which added an additional five years of climatic data from 1996-2000. The model was calibrated and verified using water level and discharge measurements at hundreds of locations distributed throughout the region within the model boundaries. Technical staffs of many federal/state/local agencies and public/private interest groups have accepted the SFWMM as the best available tool for analyzing regional-scale structural and/or operational changes to the complex water management system in south Florida.

Why is the SFWMM needed?

The hydrology of south Florida is unique due to the flat topography, high water table, sandy soils, and high conductivity of the aquifer system. With the rapid population growth in south Florida, the water control system has been expanded and its operation has become increasingly complex, making the southern Florida water management system one of the most complex in the world. Currently, federal/state/local agencies are involved in numerous environmental restoration and water resources development projects that are necessary to sustain the quality of life in this rapidly growing region. These projects can potentially cost billions of dollars and accurate determination of their benefits and costs is extremely important. Simulation models have become the only feasible means of assessing system-wide impacts of the various proposed modifications to the water resources system in south Florida. The SFWMM, developed specifically for the south Florida system, is currently the best available tool that can simulate the complexities of the water control system and operational rules of proposed regional-scale water management alternatives and provide adequate information for making water management decisions.

4.2. PERIOD OF SIMULATION

The SFWMM produces daily output for a 36-year period of record (POR), 1965-2000. Efforts are ongoing by the SFWMD to compile the climatological data needed to extend the SFWMM POR through 2005. The additional information, though desirable, was not available for the current LORSS. However, the Preferred Alternative was simulated for the 2001 through 2005 period using the Lake Okeechobee Operations Screening Model (LOOPS), and the preferred alternative was deemed effective for managing high lake elevations under this set of conditions. For informational purposes, a summary of the LOOPS hydrologic output is provided in Appendix E.

4.3. PERFORMANCE MEASURES

All alternatives were evaluated against a set of PMs. CERP based PMs were used for Lake Okeechobee ecology, the estuaries and greater Everglades while public safety, navigation and water supply were developed with input from the LORSS PDT.

4.3.1. LAKE OKEECHOBEE ECOLOGY

The PMs for Lake Okeechobee: extreme low lake stage, Lake Okeechobee extreme high lake stage, and Lake Okeechobee stage envelope, were utilized to evaluate the alternatives of the LORSS effort. In-depth documentation and rationale for these PMs is available through the Restoration Coordination and Verification (RECOVER) PM documentation in the draft RECOVER CERP System-wide PMs report (RECOVER, 2006), at the following web address:
www.evergladesplan.org/pm/recover/eval_team_perf_measures.cfm.

Extreme low and extreme high lake stage are evaluated with response curves. For extreme low lake stage, zero weeks below ten feet, elevation NGVD responds to a score of 100, and 540 weeks or greater with stages below ten feet responds to a worst case situation (15 weeks per year over 36 year simulation period), with scores linearly varied between the two extremes. For extreme high lake stage, zero weeks above 17 feet elevation NGVD responds to a score of 100 and 396 weeks or greater with stages above 17 weeks responds to the assumed worst case situation (11 weeks per year), with scores linearly varied between the two extremes.

The stage envelope PMs similarly documents the benefits of seasonally-variable water levels within the range of 12.5 feet (June-July low) and 15.5 feet (November-January high) on the plant and animal communities of Lake Okeechobee. The conceptualization of the optimal stage envelope seasonal variation is shown in Figure C-11 of Appendix E (the comparison actually utilizes smoothed boundaries for the upper and lower envelope); in simplified terms, penalty points are assigned to each alternative based on deviations outside of the envelope, with increased penalty points with increased distance away from the optimal envelope. The worst case scenario for variability above the stage envelope is assumed to be one where the lake stage hydrograph is always in the poor zone (1.0 foot outside of the stage envelope), which equates to a total score of 1872 foot-weeks; the response curve is a line between 0 (target, score of 100) and 1872 foot-weeks (score of 0). For deviation of lake stage

below the envelope, the target is 192 weeks. This is the score that would be obtained if all years had hydrographs within the optimal zone, except for once per decade the stage falling to just below 11 feet elevation for an average of three months. The response curve is a line between 192 (192 foot-weeks or less receives a score of 100) and 1872 foot-weeks (worst case scenario receives a score of zero).

4.3.2. NORTHERN ESTUARIES

High volume releases to the estuaries generally occur during the wet season. During the dry season (mid-November to mid-May), high volume releases are usually infrequent.

To evaluate the various alternatives, three PMs were examined for the Caloosahatchee and St. Lucie estuaries: the number of mean monthly flows in various flow ranges over the 36 year POR (POR equates to 432 months), a duration measure based on the weekly moving average discharge at S-79 for the Caloosahatchee; the two-week moving average total discharge to the St. Lucie; and finally the number of mean monthly flows in various flow ranges during the critical spring spawning period.

The PM used for the Lake Worth Lagoon was based on the RECOVER hydrologic PMs for the Central Zone of the Lake Worth Lagoon, which is based on the salinity tolerances of oysters (*Crassostrea virginica*).

It is important to note that the hydrologic model output assumes maximum practicable releases from Lake Okeechobee within each decision tree band, with consideration of downstream operational constraints. This provides a very useful means for comparing the effects of all alternatives. However, the decision making process to determine quantity, timing, and duration of the potential release considers estuary conditions/needs, potential impacts from lake releases, local runoff, and dry weather conditions. Although modeled and represented in the modeling output, maximum releases are not always necessary or recommended.

<u>CALOOSAHATCHEE ESTUARY</u>

For the LORSS, estuarine scientists provided input to gauge estuary performance. Estuary PMs were quantified in terms of occurrences and duration of critical inflows from the W.P. Franklin Lock and Dam structure (S-79), which demarcates the beginning of the estuary, and acts as a barrier to salinity and tidal action. Too much salt in the upper estuary may adversely impact the brackish water organisms that normally inhabit this region. Since maintaining an optimal salinity regime in the estuary is an important factor, the PMs used were based on freshwater discharges from the Caloosahatchee River (C-43 canal) at the S-79 structure.

During the driest times, a mean monthly flow of 450 cfs at S-79 is required to maintain viable salinity conditions in the upper estuary. To assist the estuary in receiving this low volume release, all of the alternatives, except the No Action Alternative, would provide environmental base flow releases to the Caloosahatchee Estuary. This feature was included to address the dry season inflows that may be too low to maintain a viable

salinity gradient in the estuary. This is critical for the estuary because during times of extended low inflow conditions, when salinity is too high in the upper estuary, tape grass (*Vallisneria americana*), which is a salt tolerant, fresh water species, becomes very sparse and can disappear completely (Doering et al., 2002).

For the Caloosahatchee Estuary, flows between 450 cfs and 2800 cfs sustain an ecologically appropriate range of salinity conditions in the estuary. These flow targets include Lake Okeechobee releases combined with basin runoff. Flows greater than 2800 cfs are considered by estuarine scientists as being high for the Caloosahatchee Estuary. High flows in this range can cause salinity to fall below the tolerance range of many organisms living in the more marine lower estuary. Prolonged flows of 4500 cfs are considered more undesirable as salinity is depressed in San Carlos Bay which may cause adverse effects to seagrasses and other organisms in this region. High flows greater than (>)2800 cfs in the Caloosahatchee Estuary may prevent the early life stages of fish, shellfish and other commercially and recreationally important species from utilizing estuarine habitat. Alternatives with the fewest number of mean monthly flows exceeding 2800 cfs are preferred.

ST. LUCIE ESTUARY

The natural shoreline and inter-tidal areas of the estuary were once populated by mangroves, SAV, and oyster beds but now due to shoreline alternations and salinity alterations supports very little vegetation. Most SAV coverage in the St. Lucie is now found only near the Indian River Lagoon, or St. Lucie Inlet. However, the American Oyster (*Crassostrea virginica*) does still inhabit the estuary. Maintaining the correct salinity in the estuary allows oyster bars to persist and flourish.

A preferred flow envelope (350 cfs -2000 cfs) has been established for the St. Lucie estuary. These guidelines defined 350 cfs mean monthly total flow from the watershed as the minimum flow target that created the highest salinity gradient and a 2000 cfs maximum inflow target that created the lowest preferred salinity gradient (a salinity of about eight parts per thousand [ppt] at the Roosevelt Bridge). The lowest preferred salinity was based primarily on the lower salinity physiological tolerances of the American oyster, which historically flourished in the mid estuary before major drainage infrastructure was constructed in the watershed. Accordingly, if inflows from groundwater and surface water runoff to the inner estuary exceeded about 2000 cfs, salinity in the mid estuary will cause significant stress and a high probability of oyster mortality.

The low flow target for the St. Lucie Estuary was originally based on groundwater and not on high salinity tolerances of the American oyster, since they can spawn and grow rapidly in seawater. The minimum total flow target for the inner estuary was based on the amount of groundwater it receives with present watershed hydrology (Haunert and Konyha 2004). While the low target is not directly based on oyster salinity tolerance, salinities associated with these flows (25 ppt at the Roosevelt Bridge) would expose oysters to a greater risk of mortality from predators and parasites.

Hydrologic PMs used for the St. Lucie were: 1) distribution of mean monthly flows for the entire POR; 2) mean monthly flows during the critical period (March–June) when many estuarine dependent species reproduce; 3) duration of high flows. Mean monthly total inflows to the St. Lucie Estuary were divided into flow classes based on the RECOVER PMs.

Mean monthly total inflows in the 2000–3000 cfs range result in low salinities throughout the estuary. Flows greater than 3000 cfs may begin to impact more marine water in the Indian River Lagoon. The longer durations of high-flow releases (consecutive two-week periods with a 14-day average flow >3000) are of concern for protecting aquatic resources, including oysters and SAV. Minimizing flows >2000 cfs would provide a salinity range more favorable to oysters and downstream SAV.

LAKE WORTH LAGOON

The RECOVER hydrologic PMs for the Central Zone of the Lake Worth Lagoon are based on the salinity tolerances of oysters (*Crassostrea virginica*). A minimum salinity target of 15 ppt was chosen because this is a mid-range salinity that meets the requirements of all life stages. Discharges into the Central Zone of 500 cfs or less will maintain salinity at or above the 15 ppt minimum. A seven-day moving average is used to quantify flow. To reflect deleterious effects of very high discharges (>1000 cfs) a two-day moving average is employed to calculate target inflows.

4.3.3. WATER CONSERVATION AREAS (GREATER EVERGLADES)

Indicator Regions (Figure 4-1) representing a variety of habitat types in the Everglades were used to evaluate the alternatives. A subset of the total number of Indicator Regions was selected to represent the range of hydrologic conditions in the WCAs, northern dry areas, southern wet areas, and several middle regions. The Indicator Regions used for the WCAs were 100, 102, 110, 113, 115, 121, 124, 125, and 128, and for northern Shark River Slough 129. The Indicator Regions used for snail kites were 101, 112, 115, 117, 118, and 119.

A subset of Hydrologic PMs was used in these analyses to evaluate impacts of the alternatives on the Everglades. Only hydrologic conditions, not water quality, were evaluated. These hydrologic PMs were peat dry-out, tree island inundation, wading bird breeding season water recession rates and reversals, and snail kite breeding and apple snail reproduction.

Peat dry-out, total weeks: Evaluation is based upon the number of weeks that water depths fell below one foot or lower below the surface. Peat dry-out increases the frequency and severity of peat fires, which can severely damage wetland ecosystems. The target is to reduce the weeks of very low water tables. Lower numbers are preferred.

Wading Bird Nesting Success: Wading birds nest from January through May in the Everglades. The two PMs that target wading birds are recession rates and reversals.

Recessions and Reversals: Recession rates describe the declines in water depths, and reversals are defined as rapid increases in water depths.

Recessions: As water depths decline in the dry season, wading bird food species are concentrated in the shallower water, increasing the wading birds' feeding efficiency. Optimal water depths for wading birds vary with the species, and move across the landscape as water depths decrease. The concentrated prey allows the parent birds to feed their hatchlings and to successfully fledge the year's young. The months that are important for this PM are January through May each year.

Target recession rates are -0.1 foot per week. This measure reports the number of weeks that recession rates fall into the "good" category (declining water depths between 0.16 and 0.05 feet per week). The goal is to increase the percent of weekly recession rates falling into the "good" category during the wading bird breeding season. Higher numbers are better.

Reversals: When water depths increase during the breeding bird season (January through May), food prey concentrated in shallower pools disperse, reducing feeding efficiencies of the parent birds. Reduction in feeding reduces nesting success of wading birds, so reversals should be avoided during this period of the year. This PM summarizes the percent of weeks of reversals (when recession rates are above the desired recession rates and increasing). Lower numbers are better.

Tree island inundation: Tree species on tree islands are adapted to a period of inundation. However, excessive periods of long-term inundation can reduce the survival of tree species when one year, or a succession of years, exceed the tree species tolerances. Tree Island Inundation PM records the duration, in weeks, of water depths above two and a half feet. The preferred number of weeks should not exceed 17 per year.

Greater Everglades Snail Kite: Like the wading birds, snail kites also reproduce during the early part of the year and feed upon apple snails. Rapid water depth reversals are harmful to apple snail reproduction, and loss of a year's cohort of apple snail eggs impacts snail populations for two to three years. Lack of prey inhibits snail kite reproduction and survival and therefore conditions that decrease apple snail populations negatively impact snail kites.

The PM for the snail kites indicates "Optimal" (O) conditions, "Marginal" (M) conditions, and "Unsustainable" (U) conditions for snail kites. For the select Indicator Regions, ratings of "Unsustainable" were valued at 0, "Marginal" at 5, and "Optimal" at 10. These values are summed over the selected Indicator Regions.

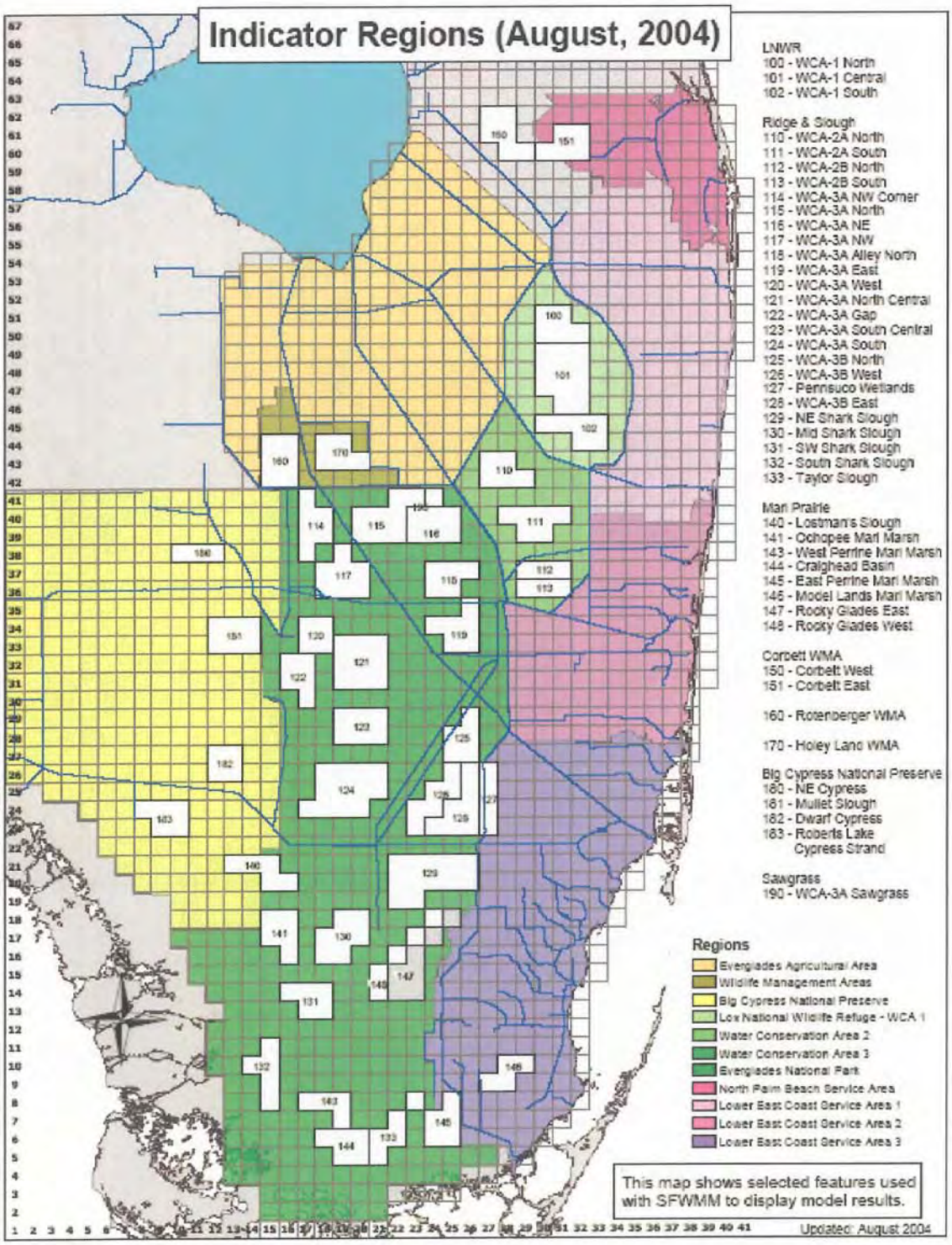

FIGURE 4-1: GREATER EVERGLADES INDICATOR REGION

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4.3.4. WATER SUPPLY

Several PMs were used to compare the potential water supply impacts of the alternatives. The water supply PMs are rooted in and include the Lake Okeechobee Service Area (LOSA) water supply PMs promulgated and used by Recover for CERP system wide evaluations. These PMs reflect the CERP water supply goals which are to:

- Provide at least a 1-in-10 level of service as indicated by simulations using the South Florida Water Management Model (SFWMM) in which three or less water years in the 36-year simulation period have water shortages in which significant SSM cutbacks are necessary.

- Additionally, the performance targets are to minimize the severity and duration of any water restrictions over and above those that might be expected when drought levels exceed a 1-in-10 severity.

The frequency, duration and severity measures used match the Recover measures for LOSA. In addition a measure has been included which is based on the frequency of water shortages in LEC Coastal Basins but focuses only on the impact of Lake Okeechobee conditions on the frequency of these shortages (assuming there are no locally triggered coastal basin shortages).

Other measures have been included which present percent of demands not met, total demands not met during a simulation and number of times demands not met in a water year exceeded 100,000 and 200,000 acre-feet. These measures help to round out and present a clearer and more robust picture of the effects of the shortages. Ranking of alternatives are generally not changed by considering these measures in addition to those from Recover.

The following PMs were evaluated in this revised draft SEIS:

- Additional Supply Side Management Cutbacks (acre-feet)
- Frequency of Water Shortages (years)
- Duration of Water Shortages (months)
- Severity of water shortages score
- Water years with SSM cutbacks >100,000 acre-feet
- Water years with SSM cutbacks >200,000 acre-feet
- EAA percent of Demands not met
- Other LOSA percent of Demands not met
- Coastal Basin Supply Side Management water shortages

4.3.5. HERBERT HOOVER DIKE

One of the goals of the LORSS is to reduce the frequency of high lake stages that may be stressful to the HHD levee system surrounding Lake Okeechobee, which provides flood protection for the surrounding area. Lake Okeechobee water levels are managed

to minimize risks for each hurricane season. Issues such as seepage, piping, and boils are exacerbated when the lake elevation approaches 18.5 ft., NGVD (USACE, 2005), which is the maximum release elevation of the current schedule, WSE. For the current LORSS, a main objective was to look at ways to develop an alternative schedule that lowers the maximum release trigger for flood protection purposes. As such, a PM for flood protection was developed. The PM was selected to formulate releases that minimized lake elevation >17.25 ft. NGVD. Operationally, this means that at elevation 17.25 ft. NGVD, maximum lake releases would be made east, west and south, in an attempt to lower the high lake levels. The reason for selecting elevation 17.25 ft. NGVD as the PM elevation was to address the numerous factors that generate uncertainty in the rate of rise on the lake primarily during the rainy season. This elevation would be used as a predictive buffer against Lake Okeechobee rising to an unacceptable high elevation that could compromise the integrity of the HHD and could result in a breach of the levee.

4.3.6. NAVIGATION

The hydrologic PM used for navigation was based on the 1965-2000 simulation POR. The performance of each alternative was measured by the number of times in the POR that lake stage is below 12.56 feet.

4.4. EVALUATION OF WATER SHORTAGE CUTBACK ASSUMPTIONS

Concurrent with the 2007 LORSS draft SEIS, the SFWMD is in the process of examining its current water shortage rules in Chapter s 40E-21 and 40-E22. The SFWMD water shortage rules provide the framework of when and to what extent low lake levels will trigger water shortage cutbacks. Modification of the water shortage rules is important as the Preferred Alternative model run projects lower lake levels more often than the existing WSE schedule.

During the plan formulation period of this revised draft SEIS, the SFWMD provided the Corps with their new proposed water shortage rules as described in the LOWSM Plan (Appendix G). The 2006 draft LOWSM plan is included in the modeling assumptions and evaluations provided in Appendix E. Based on guidance from SFWMD, the 2006 draft LOWSM plan was not anticipated to undergo significant change prior to approval by the SFWMD Governing Board later in 2007. As a result, the LOWSM was used as a basis for incorporating water shortage assumptions in the Alternatives model runs.

Since the evaluation of the alternative model runs, the SFWMD rule development process has produced a significant amount of public and stakeholder input on the newly proposed lake management methodologies. This input includes significant concerns of low lake levels, including increases in the potential for Lake Okeechobee minimum flow and level (MFL) exceedances, which occur under the proposed LORS changes. In particular there was concern that Phase I and II cutbacks under the LOWSM proposal would not be triggered until the lake levels fell below 11 feet NGVD. In recognition that the existing lake MFL is based on the amount of time the lake remains below 11 feet

NGVD, requests were made to implement the phased cutbacks prior to reaching that level. Rules pertaining to the MFL's are found in the Florida Administrative Code, Chapter 40E-8.221(1). MFL information can also be accessed at **www.sfwmd.gov**.

The SFWMD is continuing to review potential modifications to the 2006 draft LOWSM plan based on the requests received. In order to document the potential range of effects associated with SFWMD modifications to the 2006 draft LOWSM plan (assumed in place for Alternative A through E presented and evaluated in this report), a comparison of the simulated water supply performance for the No Action Alternative, the Preferred Alternative with LOWSM and the Preferred Alternative with Existing Water Shortage Triggers (WST) is provided in Section 6.12.1. The Preferred Alternative with existing WST simulation provides information on the implications if the SFWMD implements water shortage restrictions under its current rules (assumes no changes to the current SFWMD Water Shortage Plan in response to the LORSS proposed modifications to the Lake Okeechobee Regulation Schedule).

4.5. ANALYSIS COMPLETED FOR INFORMATIONAL PURPOSES ONLY: NOT A FEDERAL ACTION

Section 4.5.1 and 4.5.2 are provided for informational purposes, and are not Federal actions. As such, these actions have not been considered in the alternative analysis and effects evaluation as required by the NEPA.

4.5.1. STORAGE OF LAKE WATER ON PUBLIC/PRIVATE LANDS

In January 2007, the SFWMD Governing Board passed a resolution requesting the Corps to take into consideration increased storage capacity on public and private lands in the Okeechobee Watershed to receive Lake Okeechobee water releases. A copy of the resolution letter is provided in Appendix H. The SFWMD lands for water storage would be utilized to achieve a more refined balance between the competing needs of Lake Okeechobee and estuarine ecosystems, flood control, and water supply. The Corps is strongly supportive of this initiative and continues to work with SFWMD on ways to proceed with the action. The analysis described in this section demonstrates potential benefits that could be realized from utilization of the SFWMD lands for water storage to receive Lake Okeechobee water releases.

The SFWMD proposal to allow water storage on SFWMD public and private lands has the potential to reduce the frequency of high volume flow releases to the Caloosahatchee and St. Lucie estuaries from the conditions presented and evaluated for the 2007 LORSS SEIS preferred alternative (Alternative E). The SFWMM simulation of the 2007 LORSS SEIS preferred alternative does not assume availability of the proposed SFWMD lands for water storage. To provide a quantification of the potential estuarine benefits that could be realized from utilization of the SFWMD lands

for water storage, an analysis was completed using the mean monthly flows from the SFWMM simulation of the 2007 LORSS Preferred Alternative. The assumptions and results from this analysis are documented in the remainder of this section.
The SFWMD has stated that 450,000 acre-feet of storage will be available for water storage to attenuate and reduce anticipated high flows to the Caloosahatchee and St. Lucie estuaries. Approximately one-third of this proposed storage volume (150,000 acre-feet) would be available through lands that have currently been identified by the SFWMD, including the Holeyland and Rotenberger WMAs located south of Lake Okeechobee. The locations for the total 450,000 acre-feet storage volume have not been identified by the SFWMD. Conveyance improvements, new water control structures, and impoundment design specifications required for operational utilization of the storage features have not been sufficiently identified for their inclusion in local or regional hydrologic models. Based on the inability to complete a modeling analysis similar to the SFWMM analysis used to evaluate the suite of alternatives identified in this report, an alternate analysis tool was required to provide a quantification of potential estuarine benefits of the SFWMD storage initiative. A spreadsheet tool was used to analyze the time series for Lake Okeechobee discharges to the Caloosahatchee and St. Lucie estuaries from the SFWMM simulation of the 2007 LORSS Preferred Alternative to provide a general quantification of the potential estuarine benefits from utilization of the SFWMD lands for water storage. The time series data used for this analysis is available on the Corps LORSS modeling web page with the SFWMM standard model output for Alternative E (Alternative T3 is the original simulation name for Alternative E, as referenced during the LORSS modeling and within Appendix E), at the following address: **http://hpm.sfrestore.org/loweb/sfwmm/**.

Several key assumptions were utilized for this analysis, and these assumptions should be fully considered for interpretation of the results. In addition to the documented assumptions intrinsic to the SFWMM modeling tool (presented in Appendix E), the following assumptions are noted for this analysis:

- 2007 LORSS SEIS preferred alternative simulation (Alternative E) mean monthly flows from the SFWMM are used for the analysis;
- SFWMD public lands will be available for water storage, including all necessary conveyance and control infrastructure;
- Storage will be utilized to capture Lake Okeechobee releases when undesirable "high" flows are experienced at the St. Lucie below S-80 and Caloosahatchee at S-79 estuaries. SFWMM mean monthly flows for the 2007 LORSS SEIS preferred alternative will be used to identify months with undesirable high flows to the estuaries (1965-2000 POR). Separate evaluations were conducted assuming capture of Lake Okeechobee releases by SFWMD storage lands when estuaries were simulated to receive extreme high flows (Caloosahatchee River Estuary greater than 4500 cfs, St. Lucie Estuary greater than 3000 cfs) and intermediate high flows (Caloosahatchee River Estuary greater than 2800 cfs, St. Lucie Estuary greater than 2000 cfs);
- Storage lands may be utilized north of Lake Okeechobee, south of Lake Okeechobee, or within the C-43 or C-44 basins, prior to release from Lake

Okeechobee to the estuaries. The analysis assumes the water stored does not enter Lake Okeechobee later and is not used for irrigation or any other purpose that would affect the lake stage and trigger additional releases;

- Storage will not be utilized to capture local runoff in the C-43 and C-44 basins, which also contribute to the undesirable "high" flows;
- Storage volumes are available at the start of each water year (October 1 through September 30). If all available storage volume is entirely used during a given water year, the remaining Lake Okeechobee releases will be sent to the estuaries based on the LORSS TSP simulation output (monthly flows are reduced for partial capture of a given monthly flow volume). Water years are adjusted when consecutive "high" flow months extend across two water years, to ensure storage is not unrealistically assumed to be available due to the transition to the next water year (ending water year is extended; starting water year is shortened);
- Two potential available storage scenarios are evaluated: 150,000 acre-feet (lands currently identified by SFWMD) and 450,000 acre-feet (stated target of SFWMD);
- Equal halves of the total available storage volume is assumed available to the Caloosahatchee River Estuary and St. Lucie Estuary for each water year. If all Lake Okeechobee releases during St. Lucie Estuary high flow months are captured during a given water year, the "excess" storage volume is available to reduce Caloosahatchee River Estuary high flow months.

The SFWMM simulation of the 2007 LORSS SEIS Preferred Alternative (Alternative E) does not assume availability of the proposed SFWMD lands for water storage. The proposed storage features and conveyance and control structures that would be required to utilize the storage are not included in the current version of the SFWMM. The SFWMM simulation PMs for Alternative E show the following frequency of high flow months to the Caloosahatchee Estuary (at S-79): 29 months with mean monthly flows greater than 4500 cfs and 64 months with mean monthly flows greater than 2800 cfs. The simulation PMs for Alternative E show the following frequency of high flow months to the St. Lucie Estuary (includes releases from S-80 plus C-23 and C-24 basins): 31 months with mean monthly flows greater than 3000 cfs and 73 months with mean monthly flows greater than 2000 cfs. Local basin runoff from the C-43 basin (between Lake Okeechobee and S-79), C-44 basin (between Lake Okeechobee and S-80), and the C-23 and C-24 basins (inflows to St. Lucie Estuary east of S-80) contribute to the high flows experienced at the Caloosahatchee and St. Lucie estuaries, and these local basin contributions are included in the PMs totals. Local basin runoff volumes are included in the SFWMM simulations. Local basin runoff alone (without any additional contributions from Lake Okeechobee releases) is noted to exceed Caloosahatchee Estuary high flow thresholds with the following frequency: six months with mean monthly flows greater than 4500 cfs and 37 months with mean monthly flows greater than 2800 cfs. Local basin runoff alone is noted to exceed St. Lucie Estuary high flow thresholds with the following frequency: 11 months with mean monthly flows greater than 3000 cfs and 54 months with mean monthly flows greater than 2000 cfs. For months during which estuary high flow thresholds are exceeded by the local runoff

volumes, the capture of Lake Okeechobee releases by assumed available SFWMD storage will not be able to eliminate the high flow event simulated to occur at the estuary. The purpose of this analysis is to determine the number of high flow months able to be eliminated by utilization the proposed SFWMD lands to capture (store) releases from Lake Okeechobee, and the inability to completely eliminate all high flow months (due to the local runoff contributions) is recognized with this documentation. Reduction in the number of high flow months would represent an environmental benefit to the estuaries, as documented throughout this revised draft SEIS.

In the previous discussion of analysis assumptions, it was noted that separate evaluations were conducted assuming capture of Lake Okeechobee releases when estuaries were simulated to receive extreme high flows (Caloosahatchee River Estuary greater than 4500 cfs, St. Lucie Estuary greater than 3000 cfs) and when estuaries were simulated to receive intermediate high flows (Caloosahatchee River Estuary greater than 2800 cfs, St. Lucie Estuary greater than 2000 cfs). The two evaluations are presented separately in the following paragraphs.

The first evaluation assumes capture of Lake Okeechobee releases by SFWMD storage lands when estuaries were simulated to receive extreme high flows: Caloosahatchee River Estuary greater than 4500 cfs and St. Lucie Estuary greater than 3000 cfs. For the scenario with 150,000 acre-feet of available storage, the Caloosahatchee River Estuary number of months greater than 4500 cfs are shown to reduced by four months (25 months total) and the St. Lucie Estuary number of months greater than 3000 cfs are shown to be reduced by seven months (24 total months). For the scenario with 450,000 acre-feet of available storage, the Caloosahatchee River Estuary number of months greater than 4500 cfs are shown to be reduced by eight months (21 months total) and the St. Lucie Estuary number of months greater than 3000 cfs are shown to be reduced by 13 months (18 total months).

The second evaluation assumes capture of Lake Okeechobee releases by SFWMD storage lands when estuaries were simulated to receive intermediate high flows: Caloosahatchee River Estuary greater than 2800 cfs and St. Lucie Estuary greater than 2000 cfs. For the scenario with 150,000 acre-feet of available storage, the Caloosahatchee River Estuary number of months greater than 2800 cfs are shown to reduced by six months (58 months total) and the St. Lucie Estuary number of months greater than 2000 cfs are shown to be reduced by seven months (66 total months). For the scenario with 450,000 acre-feet of available storage, the Caloosahatchee River Estuary number of months greater than 2800 cfs are shown to reduced by seven months (57 months total) and the St. Lucie Estuary number of months greater than 2000 cfs are shown to be reduced by 11 months (62 total months).

Utilization of storage during intermediate high flow events experienced by the estuaries is expected to reduce or eliminate storage availability to capture extreme high flow events that may follow. The scenario with 150,000 acre-feet of available storage used to capture intermediate high flows results in three additional months of flows greater than 4500 cfs (extreme high flow criteria) to the Caloosahatchee River Estuary and one

additional month of flows greater than 3000 cfs (extreme high flow criteria) to the St. Lucie Estuary, when compared to the utilization of 150,000 acre-feet of available storage to capture only the extreme high flows. The scenario with 450,000 acre-feet of available storage used to capture intermediate high flows results in two additional months of flows greater than 4500 cfs to the Caloosahatchee River Estuary and one additional month of flows greater than 3000 cfs to the St. Lucie Estuary, when compared to the utilization of 450,000 acre-feet of available storage to capture only the extreme high flows.

The analysis described in this section demonstrates the potential for estuarine benefits, in the form of reduced frequency of high volume flow events, from the utilization of proposed SFWMD lands for water storage. Additional details regarding the quantity and location of available storage, conveyance and control structures, and operational protocols (including restrictions) are expected to be defined in the future, at which time additional modeling analysis could be completed. The analysis has also demonstrated the need to consider trade-offs associated with timing of storage utilization when developing guidelines for the utilization of SFWMD public lands storage to capture Lake Okeechobee regulatory releases. The analysis has shown potential trade-offs associated with the capture criteria used for Lake Okeechobee releases by presenting separate evaluations for the capture of extreme high flows and intermediate high flows. Similarly, utilization of storage to capture local basin runoff may reduce or eliminate storage availability to capture Lake Okeechobee releases that may follow.

The quantified potential estuarine benefits presented for this analysis are unique to this analysis. Alternate analysis approaches, modified analysis assumptions, or new local or regional modeling efforts may provide additional information to assist in the quantification of the potential benefits from utilization of the proposed SFWMD lands for water storage.

4.5.2. LAKE OKEECHOBEE PERIODIC MANAGED RECESSION

Since Lake Okeechobee has experienced prolonged high water levels with subsequent undesirable effects to the lake's ecosystem, there was discussion during the LORSS to incorporate a managed recession into the Preferred Alternative regulation schedule. While the Corps agrees that a periodic managed recession may be a necessary management action in the future, the likelihood of implementing this action under the new regulation schedule would be minimal. Due to the fact that the new implemented schedule would be in place for three-years, and 2006-2007 proved to be a natural recession event for Lake Okeechobee, a full National Environmental Policy Act (NEPA) analysis for a managed recession was not conducted for this phase of the LORSS. If the need for a managed recession occurs under the new schedule, an analysis similar to the one in Appendix F would be completed. Appendix F also includes a summary completed by the SFWMD which outlines the high probability of a natural recession occurring under the Preferred Alternative schedule.

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5. AFFECTED ENVIRONMENT

The Affected Environment section succinctly describes the existing environmental resources of the areas that would be affected if any of the alternatives were implemented. This section describes only those environmental resources that are relevant to the decision to be made. It does not describe the entire existing environment, but only those environmental resources that would affect or that would be affected by the alternatives if they were implemented. This section, in conjunction with the description of the No Action Alternative forms the base line conditions for determining the environmental effects of the proposed action and reasonable alternatives.

5.1. GENERAL ENVIRONMENTAL SETTING

Lake Okeechobee is a subtropical lake in south central Florida with a surface area of 730 square miles and an average depth of nine feet. Lake Okeechobee is a major feature of the Kissimmee-Okeechobee-Everglades system, which is a continuous hydrologic system extending from central Florida south to Florida Bay. Lake Okeechobee provides a number of values to society and nature including water supply for agriculture, urban areas and the environment, flood protection, a multi-million dollar sport fishery, and habitat for many birds and animals, including endangered and threatened species. These values of Lake Okeechobee have been threatened in recent decades by excessive phosphorus loading transported by sediment, harmful high water levels, and rapid expansion of exotic plants (USEPA, 2006).

As a result of the lake's shallow depth, wind is a major influence on Lake Okeechobee. Prior to construction of a perimeter dike system, Lake Okeechobee was much larger than it is now, with an extensive wetland littoral zone along the shoreline. Today, Lake Okeechobee is constrained within the HHD, and the littoral zone is much smaller. As a result, when water levels are above 17 ft., NGVD, the entire littoral zone is flooded; leaving minimal habitat for wildlife that requires exposed ground. When water levels are below 11 ft., NGVD, the entire marsh is dry, and not available as habitat for fish or other aquatic life. Lake Okeechobee's littoral zone is characterized by emergent and submerged vegetation covering an area of approximately 150 square miles (25 percent of Lake Okeechobee's surface area), and is primarily located along the western shore of Lake Okeechobee (Havens et al., 1996) (Figure 5-1). The littoral zone is sensitive to nutrient loading and light availability (Havens, et al., 1999). The vegetation and cover types within the Lake Okeechobee region have been greatly altered during the last century. At present, the littoral zone vegetation consists of many native plant species but also consists of many less desirable and invasive and/or exotic species. The invasion of exotic vegetation has impacted the health and productivity of the littoral zone plant community. Anthropogenic disturbances such as altered hydrology and pollution, along with nutrients, can directly and indirectly affect the health of Lake Okeechobee.

The Caloosahatchee River is the major source of freshwater for the Caloosahatchee Estuary. Alterations to the Caloosahatchee River and watershed over the past century have resulted in a major change in freshwater inflow to the estuary. The Caloosahatchee River was originally a shallow, meandering river with headwaters in the proximity of Lake Hicpochee, near Lake Okeechobee. In the early 1900s, a man-made canal was constructed connecting Lake Okeechobee to the Caloosahatchee River. Today, the river extends from Lake Okeechobee to San Carlos Bay. The river now functions as a primary canal (C-43) that conveys both runoff from the Caloosahatchee watershed and releases from Lake Okeechobee. The canal has undergone numerous alterations including channel enlargement, bank stabilization, and a series of three lock and dam structures. The final downstream structure, W.P. Franklin Lock and Dam (S-79), demarcates the beginning of the estuary (Figure 5-2), and acts as a barrier to salinity and tidal action, which historically extended east near the LaBelle area. As a result of hydrological changes to this ecosystem, the timing, distribution, quality, and volume of freshwater entering the estuary from the watershed and Lake Okeechobee has resulted in negative ecological impacts. Despite these impacts, the Caloosahatchee Estuary continues to be an important environmental and economic resource.

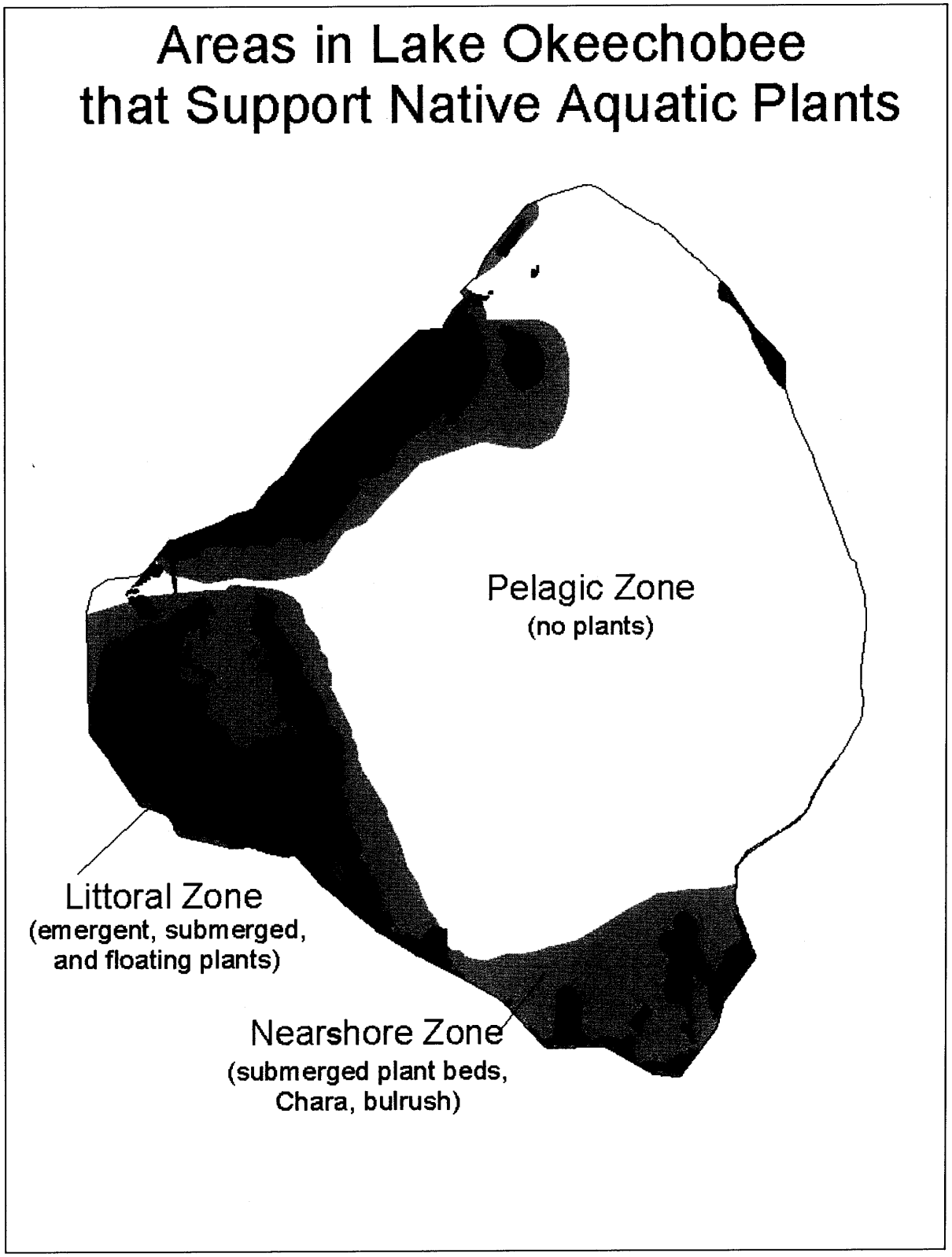

FIGURE 5-1: LAKE OKEECHOBEE ZONES

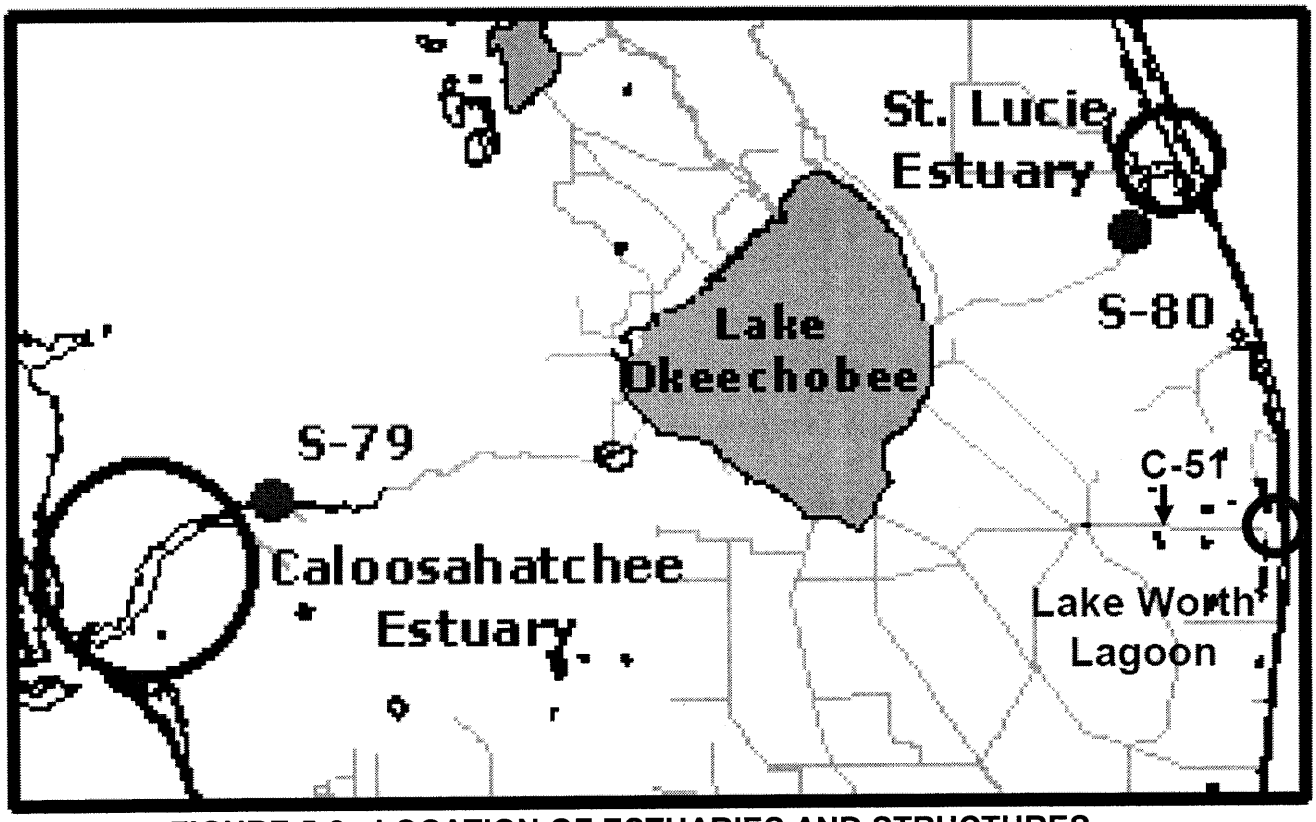

FIGURE 5-2: LOCATION OF ESTUARIES AND STRUCTURES

The St. Lucie Estuary, which is part of the Indian River Lagoon ecosystem, is located on the east coast of Florida (Figure 5-2). The St. Lucie River is approximately 35 miles long and has two major forks, the North and the South, that flow together and then eastward to the Indian River Lagoon and Atlantic Ocean at the St. Lucie Inlet. Historically, the St. Lucie River system was a freshwater stream flowing into the Indian River Lagoon. An inlet (today referred to as the St. Lucie Inlet) was dug in the late 1800s by local residents to provide direct access to the Atlantic Ocean, thus changing the St. Lucie from a river to an estuary. Then in the early 1900s, the St. Lucie Canal (C-44) was constructed providing an outlet from Lake Okeechobee to the St. Lucie River. The C-44 Canal is used for navigation and releases from Lake Okeechobee. As a result, freshwater flow from C-44 into the estuary tends to be excessive at times, in particular during the wet season, leaving the estuary with too much freshwater. Other major canals constructed in the watershed contributing to fresh water inflow into the estuary include C-23 and C-24 canals. A combination of excessive freshwater inflows, runoff, nutrient loading, and shoreline alterations all contribute to the declining ecological health of the St. Lucie Estuary.

The Lake Worth Lagoon, located in Palm Beach County, is another estuary of importance and evaluated in the LORSS. In size, the Lake Worth Lagoon is the major estuarine water body in Palm Beach County (PBCDERM, 1998). The Lake Worth Lagoon, centrally located in the county is approximately 20 miles in length, and

averages approximately 0.4 miles in width, and six to ten feet in depth (PBDERM, 1998). The Lake Worth Lagoon is separated from the Atlantic Ocean by a barrier island. Historically, Lake Worth Lagoon has been one of the most abused and least protected coastal water bodies in Florida, subjected to much environmental degradation (PBCDERM, 1998). Major freshwater drainage into the estuary occurs from many canal systems. The C-51 canal (Figure 5-2) is the largest inflow of fresh water discharging into the Lake Worth Lagoon (PBCDERM, 1998). The C-51 basin includes the West Palm Beach Canal which extends from Lake Okeechobee south and east to the coastline where it empties into Lake Worth Lagoon. Like most coastal areas in Florida, due to population increase, much of the Lake Worth Lagoon shoreline has been altered. As 65% of the shoreline is currently bulkheaded with only 19% in its original condition, fish and wildlife needs conflict with development and loss of habitat (PBCDERM, 1998).

All of the northern estuary systems are host to plant and animal communities such as seagrass beds, macroalgae, mangroves, oyster bars, birds, fishes, corals, sponges and endangered and threatened species. Additionally, the estuaries attract a variety of commercial, recreational and educational activities such as fishing, boating, ecotourism, and sightseeing.

5.2. VEGETATION

The discussion of vegetation occurring within the study area is organized by physiographic area, beginning with Lake Okeechobee, the estuaries, EAA and concluding with the WCAs. An increased topic of concern is harmful algal blooms (HAB) that occur in the estuaries and Lake Okeechobee. As such, a discussion on algal blooms is presented in this section.

Harmful Algal Blooms

Generally, the proliferation of algae provides the energy source to fuel food webs, so most algae are not harmful even when they form "blooms" that are sometimes seen in coastal, estuarine, and inland waters. However, a small percentage of algae produce toxins, and are termed HAB. HAB occur when algae, simple plants that live in water, produce toxic or harmful effects on people, fish, shellfish, marine mammals and birds. HAB also include blooms of non-toxic species that have harmful effects on marine ecosystems. For example, when masses of algae die and decompose, oxygen can be depleted in the water, causing the water to become low in oxygen. Low oxygen can have adverse effects on marine organisms by forcing them to leave the area, or causing mortality. Two algal groups have traditionally received the dubious distinction of constituting nuisance bloom populations or HAB. They include the prokaryotic cyanobacteria (*Cyanophyceae*, or blue-green algae) and dinoflagellates (*Dinophyceae*).

Perhaps one of the best known HAB is "red tide." Red tides are HABs that occur when microscopic algae in seawater proliferate to higher-than-normal concentrations. The dinoflagellate, *Karenia brevis*, is the most common red tide organism that is responsible for the red tide outbreaks along the southwest coast of Florida. The Florida red tides occur in the Gulf of Mexico almost every year, generally in the late summer or early fall.

Not a new phenomenon, red tide has been documented along Florida's gulf coast since the early 1800s, with anecdotal reports of the effects dating back to the 1500s (FMRI, 2006). Accounts of G. *breve* blooms were linked with noxious "gases" and massive fish kills along the west coast of Florida as early as 1844 (Tester and Steidinger, 1997). Red tides can adversely affect fish, birds, and marine mammals; cause health problems for humans; and adversely affect local economies (FWRI, 2006). Red tide occurrences are most common off the central and southwestern coast of Florida between Clearwater and Sanibel Island, but may occur anywhere in the Gulf (FWRI, 2006). Red tides may also occur, but are less common, along the southeastern Atlantic coast as far north as North Carolina (FWRI, 2006).

A substantial amount of information has been accumulated through the years as a result of red tide research. The factors that lead to the initiation of a red tide bloom are not well understood; scientists have been monitoring and studying the phenomenon for a number of years. The role that nutrients play in red tide, or any HAB is in question. Research does support red tide bloom outbreaks first appearing offshore (Dragovich and Kelly, 1966; Steidinger 1975; Steidinger and Haddad, 1981 as documented by Tester and Steidinger, 1997) and are associated with the fronts caused by the onshore-offshore meanders of the Loop Current water along the outer southwest Florida shelf (Tester and Steidinger, 1997). As for nutrients, and the role human activities play in red tide, this is a big question facing researchers today. What is known, and published scientific data indicate, is that significant nutrient enrichment has occurred in Florida's coastal waters over the past several decades. This would be expected as there is an increase in coastal populations and development which leads to disturbance of wetland systems that filter nutrients, and leads to more surface runoff. There has also been a large increase in agriculture, fertilizer use, and mining of phosphate deposits that contribute to an increase in nutrient loading into our coastal waters. There is much controversy with Lake Okeechobee freshwater releases and the linkage of those releases with HAB. This would be expected since the Lake Okeechobee watershed contributes high nutrient loading into Lake Okeechobee. As a result, Lake Okeechobee water has a higher than average concentration of nutrients (phosphorus and nitrogen). However, there are a number of combinations of multiple factors, physical, chemical and biotic, that generally lead to the development and persistence of HAB (Paerl, 1988). Through years of research it has become apparent that no individual factor, such as excessive nutrient loading, dominates HAB formation. The Caloosahatchee Estuary also showed blue green algal bloom activity during the summer of 2006 when there was virtually no flow from Lake Okeechobee to the Caloosahatchee River.

5.2.1. LAKE OKEECHOBEE BASIN

The vegetation and cover types within the Lake Okeechobee region have been greatly altered during the last century. Historically, the natural vegetation was a mix of freshwater marshes, hardwood swamps, cypress swamps, pond apple forests, and pine flatwoods. The freshwater marshes were the predominant cover type throughout, especially along the southern portion of Lake Okeechobee where it flowed into the Everglades. These marshes were vegetated primarily with sawgrass (*Cladium jamaicense*) and scattered clumps of carolina willow (*Salix caroliniana*), sweetbay

(*Magnolia virginiana*), and cypress (*Taxodium* sp.). Hardwood swamps dominated by red maple (*Acer rubrum*), sweetbay, and sweet gum (*Liquidambar styraciflua*) occurred in riverine areas feeding Lake Okeechobee, while cypress swamps were found in depressional areas throughout the region. Pine flatwoods composed of slash pine (*Pinus elliottii*), cabbage palm (*Sabal palmetto*), and saw palmetto (*Serenoa repens*) were prevalent in upland areas especially to the north.

Lake Okeechobee has an extensive littoral zone that occupies approximately 150 square miles (about 25 percent) of the lake's surface (Milleson, 1987). Littoral vegetation occurs along much of Lake Okeechobee's perimeter, but is most extensive along the southern and western borders (Milleson 1987). The littoral zone plant community is composed of a mosaic of emergent, submergent and natant plant species. Richardson and Harris (1995) refer to a total of 30 distinguishable vegetative community types in their digital cover map study. Emergent vegetation within the littoral zone is dominated by herbaceous species such as cattail (*Typha* spp.), spike rush (*Eleocharis cellulosa*), and torpedo grass (*Panicum repens*) which is an invasive exotic species. Other emergent vegetation observed includes bulrush (*Scirpus californicus*), sawgrass, pickerelweed (*Pontederia cordata*), duck potato (*Sagittaria* spp.), beakrush (*Rhynchospora tracyi*), wild rice (*Zizania aquatica*), arrowhead (*Sagittaria latifolia*), button bush (*Cephalanthus occidentalis*), sand cordgrass (*Spartina bakeri*), fuirena (*Fuirena scirpoidea*), rush (*Scirpus cubensis),* southern cutgrass (*Leersia hexandra*), maidencane (*Panicum hemitomon*) white-vine (*Sarcostemma clausum*), dogfennel (*Eupatorium capillifolium*), mikania (*Mikania scandens*). Woody vegetation consist of primrose willow (*Ludwigia peruviana*), Carolina willow, and melaleuca (*Melaleuca quiquenervia*) an invasive exotic species. Over the years, there has been an on-going multi-agency effort to eradicate melaleuca. The eradication effort of melaleuca has been extremely effective.

The submerged vegetation is composed almost entirely of hydrilla (*Hydrilla verticillata*) which is an invasive exotic species, pondweed (*Potamogeton illinoensis*), bladderwort (*Utricularia* spp.), Chara (*Chara spp.*) and vallisneria, also known as wildcelery, eel grass, or tape grass (*Vallisneria americana*).

The natant, or floating, component of the littoral zone consists of lotus lily (*Nelumbo lutea*), fragrant water lily (*Nymphaea odorata* and *N. mexicana*), water hyacinth (*Eichhornia crassipes*) which is an invasive exotic species, water lettuce (*Pistia stratiotes*), duckweed (*Lemna* sp.), coinwort (H*ydrocotyle umbellata*), and ludwigia (*Ludwigia leptocarpa*).

Hydrilla is one of several problem species which occur on Lake Okeechobee. Although it provides good fish habitat, its prolific growth, as evidenced in Fisheating Bay in the mid 1990s, causes navigation and water quality problems. A significant expansion of cattail in the littoral zone has also been observed.

Melaleuca, a resilient species found in a variety of habitats, is one of the principal species of concern on Lake Okeechobee. Melaleuca is capable of displacing native

vegetation, including sawgrass marsh (Laroche and Ferriter, 1992), and has been observed to displace native species in other marsh types, cypress-hardwood forests, and pine savanna (Schmitz and Hofstetter, 1994). Ewel (1990) described melaleuca sites in south Florida as having hydroperiods of six to nine months. Shomer and Drew (1982) noted that melaleuca colonization rates appeared to be inversely proportional to the length of the hydroperiod. Over the past decade, there has been much progress in removing melaleuca along western shore of Lake Okeechobee. Melaleuca control has been focused on areas adjacent to the rim canal, on spoil islands peripheral to the HHD, in wetland pockets behind the dike, and in the western littoral zone. Through the aggressive eradication programs carried out, melaleuca is at manageable levels at this time in Lake Okeechobee.

Brazilian pepper (*Schinus terebinthifolius*), an invasive exotic species, is frequently associated with ditch banks (Barber 1994) and is commonly found along canal banks within Lake Okeechobee. Very little is known about its hydroperiod requirements, but Duever et al. (1986) found that it thrives in areas with three to four month hydroperiods, while Doren and Jones (1994) stated that it rarely grows on sites flooded longer than three to six months, and is absent from deeper wetland communities. As with melaleuca, Brazilian pepper removal efforts are continuous around Lake Okeechobee.

Australian pine (*Casurina* spp.), an invasive exotic species, is a major invader of short hydroperiod areas where it can be found in dense stands, which preclude establishment of native species. One of the species (*C. quinquenervia*) is intolerant of extended inundation, but another (*C. glauca*) invades sawgrass marsh and burned hardwood hammocks in the Everglades (Doren and Jones 1994). Until recently, Australian pine was commonly found along the rim canal and in monotypic stands on the berm of the HHD and in areas behind the dike. Over the past decade, eradication and removal efforts have been successful in removing this tree on the berm of HHD.

Another exotic that continues to plague resource managers throughout Lake Okeechobee is torpedograss, which is spreading rapidly into areas of spike rush, where it forms dense rooted mats and appears to be tolerant of a wide variety of hydroperiods. Other species include water hyacinth (native to South America) and water lettuce, which clog waterways and are found primarily in canals and backwater areas as well as in Lake Okeechobee, and both may root in wet soil. These latter two species, along with hydrilla, pose navigation problems for boaters and fisherman, flood control and water supply challenges for water managers, and are among the principal species targeted by aquatic plant control efforts by the Corps.

5.2.2. ST. LUCIE ESTUARY

Seagrasses were once common in the St. Lucie Estuary, but virtually disappeared over the years, except for areas around the St. Lucie inlet near Indian River Lagoon. Seagrass meadows improve water quality by removing nutrients, dissipating the effects of waves and currents, and by stabilizing bottom habitats, thereby reducing suspended solids. Seagrass beds support some of the most abundant fish populations in the Indian River Lagoon, with large species diversity. Seagrass and macroalgae

(collectively referred to as SAV) are highly productive areas and are perhaps the most important habitat of the Indian River Lagoon (IRL CCMP, 1996). Pinfish (*Lagodon rhomboides*) and several species of mojarra (Gerreidae) are very abundant in the seagrass habitat. These species are known to feed on seagrasses and on the epiphytes and epifauna of the seagrasses, providing a critical link in the food chain between the primary producers and the higher level consumers such as the common snook (*Centropomus undecimalis*) and spotted seatrout (*Cynoscion nebulosus*).

The natural shoreline and inter-tidal areas of the St. Lucie Estuary were once populated by mangroves and other detritus producing vegetation, but now due to shoreline alterations supports very little vegetation. In many areas, seawalls and docks have replaced mangroves and seagrasses. Freshwater from the St. Lucie River basin and Lake Okeechobee releases influence estuarine water quality and composition, contributing to adverse effects to seagrasses in this system. Most SAV coverage in the St. Lucie Estuary is only found near the Indian River Lagoon. Those species known to occur near the Indian River Lagoon are shoal grass (*Halodule wrightii*), wigeongrass (*Ruppia maritima*), and Johnson's seagrass (*Halophila johnsonii*), star grass (*Halophila engelmanii*) and paddle grass (*Halophila decipiens*).

5.2.3. CALOOSAHATCHEE ESTUARY

Seagrasses are undoubtedly among the most important vegetation of the Caloosahatchee Estuary. In the Caloosahatchee River the primary species of importance is Vallisneria (*Vallisneria americana*), also known as tape grass and commonly found in still and fast flowing waters. In the Caloosahatchee River, Vallisneria is used extensively as an indicator species as it has proven to be an excellent ecological representative for a wide variety of other biota for this area. Although Vallisneria is salt tolerant, it is a freshwater plant species. During times of extended low inflow conditions, when salinity is too high in the upper estuary, this grass becomes very sparse and can disappear completely (Doering et al., 2002). When growing conditions are favorable, the most extensive beds are found in the 640 acre area between Beautiful Island and the Ft. Myers Bridge which constitutes about 60 percent of the reported areal coverage of the species in the Caloosahatchee (SFWMD, 2002). Vallisneria is a valuable waterfowl food and is considered an excellent plant for fish spawning areas along the river margin.

Shoal grass (*Halodule wrightii*), turtle grass (*Thalassia testudinum*), and manatee grass (*Syringodium filiforme*) are the most common higher salinity grasses in the Caloosahatchee Estuary.

Approximately 2,995 acres of mangroves are found in the Lower Caloosahatchee River Subbasin (Post, Buckley, Schuh, and Jernigan, 1999). In the Caloosahatchee Estuary, mangroves support fish and macro-invertebrate communities by providing protected nursery areas for fishes, crustaceans, and shellfish, and food for a multitude of commercial and recreational marine species. Urbanization and shoreline development has resulted in an extensive loss of mangrove habitat along the Caloosahatchee Estuary.

5.2.4. LAKE WORTH LAGOON

Seagrasses cover approximately 35 percent of the total submerged area of Lake Worth Lagoon (PBCDERM, 1998). Three species of seagrass found within the lagoon are Johnson's seagrass (*Halophila johnsonii*), shoal grass (*Halodule wrightii*) and paddle grass (*Halophila decipiens*). As an estuary, Lake Worth Lagoon has developed to serve as spawning, nursery, and feeding grounds for many fish and invertebrate species. Some mangrove communities still exist along the shoreline of the lagoon.

5.2.5. EVERGLADES AGRICULTURAL AREA

The EAA is located on the southern tip of Lake Okeechobee and is one of the most productive agriculture regions in the State. Over 505,000 acres of the EAA are under production with sugar cane that accounts for over 80 percent of total crop coverage (USEPA, 2006). Lake Okeechobee provides water south to the EAA (Figure 5-3) through three structures, S-351, S-354, and S-352. The EAA, covering 1,122 square miles south of Lake Okeechobee is the largest contiguous area of historic Everglades cover that has been converted by land use practices. The EAA historically consisted of several different plant communities. A dense swamp of pond apple, willow and elderberry formed broad bands along the southern rim of Lake Okeechobee. The remainder of what is now the EAA was dominated by sawgrass marshes. The present EAA contains primarily agricultural cropland.

Several large tracts of land at the south end of the EAA were never directly converted to agricultural lands, although seasonal water patterns have been greatly altered by water management practices. These areas are known as the Holey Land and Rotenberger WMAs, and the former Brown's Farm WMA (now converted to STA 2). These three areas comprise approximately 18 percent of the EAA and retain much of their historic sawgrass marsh and associated plant communities, although the plant cover has been altered by hydroperiod changes, fires, soil subsidence and invasion of exotic plant species and cattail. It is not expected that these areas will experience any modification to their existing in-flows under the LORS alternatives and are thus not further discussed.

5.2.6. WATER CONSERVATION AREAS (GREATER EVERGLADES)

The WCAs comprise about one-third of the original Everglades. The area is currently divided into five shallow water impoundments surrounded by levees and canals. These impounded marshes are managed to provide flood protection to the cities and farms to the east and to provide water for agricultural and municipal use during the dry season.

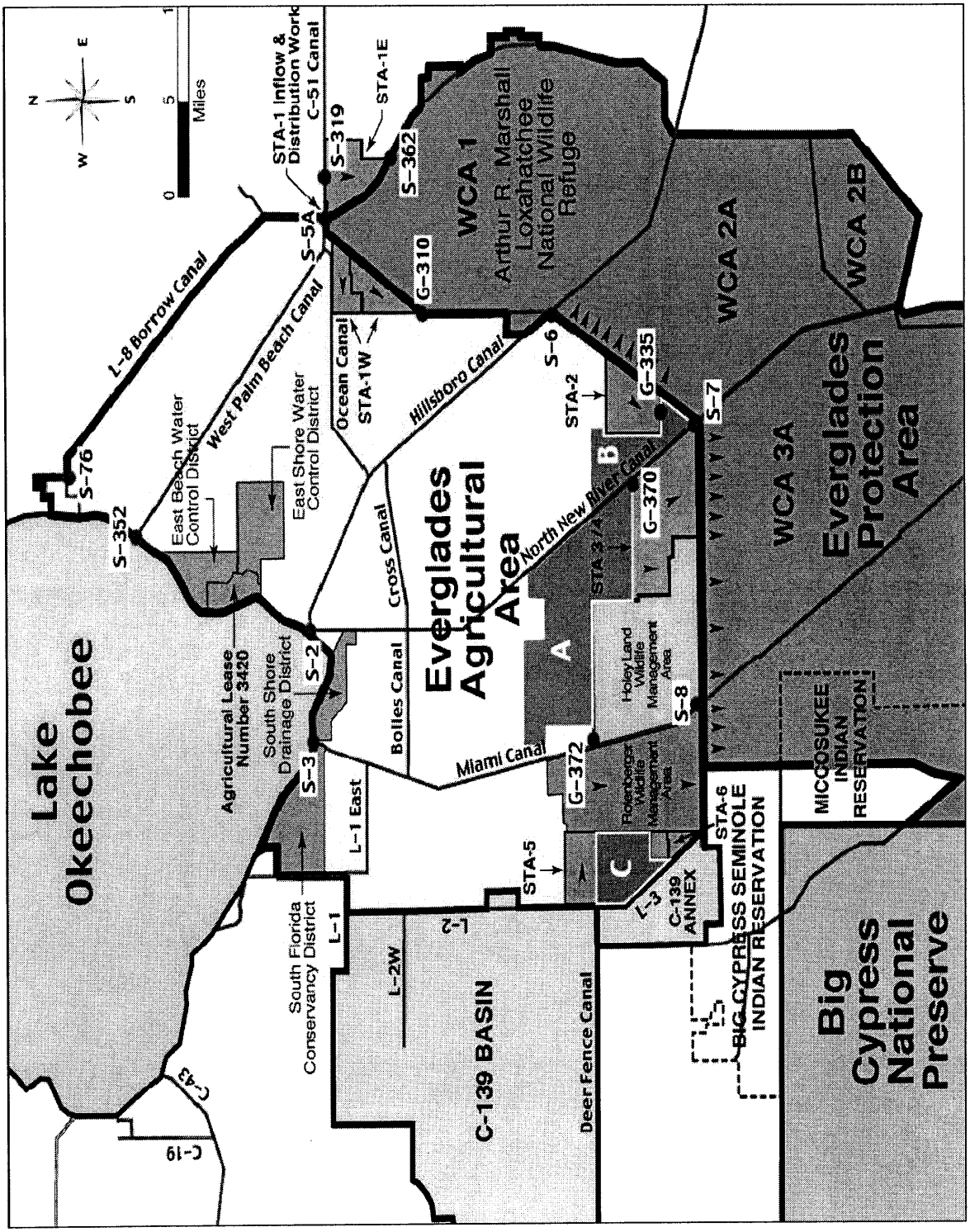

FIGURE 5-3: LOCATION OF EAA AND WCAS

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The WCAs are vegetated with a mosaic of habitat types dominated by sawgrass. Nearly all of the WCAs (Figure 5-3) are a patterned peatland, consisting of long, linear sawgrass ridges interspersed with teardrop-shaped tree islands (hammocks) and willow strands. Tree islands are a unique feature of the Everglades ecosystem. Tropical hardwoods are found on some of the relatively unaltered tree islands in the southern portion of the area. The landscape pattern of ridge and slough has been altered significantly but appears largely intact in portions of the WCAs and into ENP (Science Coordinating Team 2003).

The ridge and slough patterns were developed in broad, shallow to intermediate depth basins with peat substrate in response to the original hydrologic flow regimes of the Everglades. The dominant plant cover is sawgrass and/or buttonbush and/or mixed emergents. In general, there are now three recognizable types of basin wetland communities present:

1. Sawgrass ridges now interspersed, composed of sawgrass, with cattail, maidencane, arrowhead, pickerelweed, willow, button bush, wax myrtle (*Myrica cerifera*), and saltbush (*Baccharis glomeruliflora*).
2. Wet prairie, composed of beak rush, spike rush, maidencane, string lily (*Crinum americanum*), and white water lily.
3. Aquatic slough, composed of white water lily, floating heart (*Nymphoides aquatica*), spatterdock (*Nuphar luteum*), bacopa (*Bacopa caroliniana*), and bladderwort.

The following species are associated with some portions of this community: pond cypress (*Taxodium ascendens*), bald cypress (*Taxodium distichum*), willow, buttonbush, wax myrtle, sawgrass, and royal fern (*Osmunda regalis*).

A hydric hammock is a wetland forest community that occurs in lowlands over sandy, clay organic soil, often over limestone. Its water regime is mesic to hydric; climate is subtropical or temperate; and fire is rare or not a major factor. The following species are associated with this community: sweet bay (*Magnolia virginiana*), red bay (*Persea borbonia*), cocoplum (*Chrysobalanus icaco*), strangler fig (*Ficus aurea*), wax myrtle, willow, elderberry (*Sambucus simpsonii*), hackberry, cabbage palm (*Sabal palmetto*), red maple (*Acer rubrum*), false nettle (*Boehmeria cylindrica*), water oak (*Quercus nigra*), hornbeam, and needle palm (*Rhapidophyllum hystrix*).

Vegetation within the WCA 1 consists of a matrix of wet prairies, sawgrass prairies, and aquatic slough communities with some ridge and slough patterning. Tree islands are interspersed throughout the area. Plant community cover within WCA 1 has shifted as a result of impoundment of the marsh by perimeter levees and alteration of hydroperiods by the C&SF Project operation. The southern, lower elevation areas of WCA 1 have been flooded for long periods of time, while the northern portions of the area have experienced more frequent drying. Areas which have experienced shortened hydroperiods have experienced shifts to woody vegetation (wax myrtle and willow), while lower elevations have experienced shifts to more aquatic flora. In addition,

WCA 1 currently includes approximately 6,000 acres (four percent total cover) of cattail marsh that was not present prior to the early 1960s. A number of factors influence establishment of cattails in the Everglades. These include physical disturbance of underlying soil profile by canal construction activities, proximity to seed sources, fire, hydrologic changes and the availability of nutrients. Exotic vegetation that was uncommon prior to 1965 is a growing problem. Melaleuca and Brazilian pepper are both rapidly spreading along the perimeter and into the interior marsh. Old World climbing fern (*Lygodium microphyllum*) is also a major invasive exotic species in WCA 1.

Major plant communities in WCA 2A now consist of remnant drowned tree islands, open water sloughs and large expanses of sawgrass, and sawgrass intermixed with dense cattail (*T. domingensis*) stands. Some remnant ridge and slough patterning remains. Remaining tree islands are found primarily at higher ground level elevations, located in the northwest corner of WCA 2A. Remnant (drowned) tree islands, dominated primarily by willow, are found scattered throughout the central and southern sections of WCA 2A.

Several studies conducted within WCA 2A show that cattails out-compete sawgrass in their ability to absorb nutrients. There is increased cattail production during years of high nutrient inflows (Toth, 1988; Davis, 1991). Cattails are considered a high nutrient status species that is opportunistic and highly competitive, relative to sawgrass, in nutrient-enriched situations (Toth, 1988; Davis, 1991). Davis (1991) concluded that both sawgrass and cattail increased annual production in response to elevated nutrient concentrations, but that cattail differed in its ability to increase plant production during years of high nutrient supply.

The community structure and species diversity of Everglades vegetation located north of I-75 (WCA 3A North) is very different from the wetland plant communities found south of I-75 (WCA 3A South). Improvements made to the Miami Canal and impoundment of WCA 3A by levees during the early to mid-1900s have over-drained the north end of WCA 3A and shortened its natural hydroperiod. These hydrological changes have increased the frequency of severe peat fires that have resulted in loss of tree islands, sawgrass ridges, aquatic slough, and wet prairie habitat that were once characteristic of the area. Today, northern WCA 3A is largely dominated by sawgrass and lacks the natural structural diversity of plant communities seen in southern WCA 3A. Most of the ridge and slough patterning is severely degraded.

Over drainage of the northwestern portion of WCA 3A has allowed the invasion of a number of terrestrial species such as salt bush (*B. halmifolia*), dog fennel, and broom sedge (*Andropogon* spp.). Melaleuca has become well established in the southeastern corner of WCA 3A North, and is spreading to the north and west.

Everglades vegetation located in the central and southern portion of WCA 3A probably represents some of the best examples of original, undisturbed Everglades habitat left in south Florida. This region of the Everglades appears to have changed little since the

1940s, and contains a mosaic of tree islands, wet prairies, sawgrass stands, and aquatic sloughs similar to those reported by Loveless (1959). The existing ridge and slough patterning is largely intact spatially, although the vertical difference between ridge tops and slough bottoms has lessened.

The majority of vegetation within WCA 3A south can be described as typical Everglades habitat with some exceptions due largely to the canalization and construction of levees which compartmentalize the WCAs. Water depths in southern WCA 3A are deeper than they would be without levees and Tamiami Trail.

5.3. THREATENED AND ENDANGERED SPECIES

Federally endangered and threatened species known to occur within the project area include:

COMMON NAME	SCIENTIFIC NAME	STATUS
Everglade snail kite	*Rostrhamus sociabilis plumbeus*	E(CH)
Wood stork	*Mycteria americana*	E
West Indian manatee	*Trichechus manatus*	E(CH)
Bald eagle	*Haliaeetus leucocephalus*	T
Eastern indigo snake	*Drymarchon corais couperi*	T
Cape sable seaside sparrow	*Ammodramus maritimus mirabilis*	E
Okeechobee gourd	*Cucurbita okeechobeensis*	E
Small-toothed sawfish	*Pristis pectinata*	E
Johnson's seagrass	*Halophila johnsonii*	T

E=Endangered; T=Threatened; CH=Critical Habitat has been designated

5.3.1. EVERGLADE SNAIL KITE

The snail kite occupies the watersheds of the Everglades, Kissimmee River, Caloosahatchee River, the upper St. Johns River, and Lake Okeechobee. "Each of these watersheds has experienced, and continues to experience, pervasive degradation due to urban development and agricultural activities" (USFWS, 1999). Snail kite habitat consists of freshwater marshes and the shallow vegetated edges of lakes where the apple snail (*Pomacea paludosa*), the kite's main food source, can be found. Snail kite populations in Florida are highly nomadic and mobile; tracking favorable hydrologic conditions and food supplies, and thus avoiding local droughts. Snail kites move widely throughout the primary wetlands of the central and southern portions of the State of Florida. Lake Okeechobee and surrounding wetlands are major nesting and foraging habitat, particularly the large marsh in the southwestern portion of Lake Okeechobee and the area southwest of the inflow of the Kissimmee River (USFWS, 1999). Critical habitat was designated for the snail kite in 1977. Critical habitat includes the entire littoral zone and western shore of Lake Okeechobee.

The snail kite has a highly specialized diet typically composed of Florida apple snails, which are found in palustrine, emergent, long-hydroperiod wetlands. As a result, the snail kite's survival is directly dependent on the hydrology and water quality of its habitat

(USFWS, 1999). Snail kites require foraging areas that are relatively clear and open in order to visually search for apple snails. Suitable foraging habitat for the snail kite is typically a combination of low profile marsh and a mix of shallow open water. Shallow wetlands with emergent vegetation such as spike rush, bulrush, and other native emergent wetland plant species provide good snail kite foraging habitat as long as the vegetation is not too dense to locate apple snails. Dense growth of plants reduces the ability of the snail kite to locate apple snails. The degradation of water quality in Lake Okeechobee, due in part to runoff of phosphorus from agriculture lands, promotes dense growth of both native and exotic vegetation, in particular cattail, water lettuce (*Pistia stratiotes*) and water hyacinth (*Eichhornia crassipes*), which inhibits the ability of snail kites to find food. Bennetts and Kitchens (1997) noted that quality of habitat for kites is adversely influenced by changes in water quality and expansion of non-native plants. Lake Okeechobee has experienced high rates of phosphorus loading in recent decades due to altered land use in the watershed. At present, phosphorus loading is in excess of 500 metric tons per year (Havens & Gawlick, 2005), compared to the Florida Department of Environmental Protection's (FDEP) recommended annual load of 140 metric tons (FDEP, 2001).

Snail kite nesting primarily occurs from December to July (peak in March-June), but can occur year-round. Nesting usually occurs over water, which deters predation. Nesting substrates include small trees such as willow and pond apple, and in herbaceous vegetation such as sawgrass, cattail, bulrush and reed. Kites appear to prefer woody vegetation when water levels are adequate to inundate the site (Rodgers, 1996). Nests are more frequently placed in herbaceous vegetation around Lake Okeechobee during periods of low water when dry conditions beneath willow stands (which tend to grow to the landward side of cattails, bulrushes and reeds) prevent snail kites from nesting in woody vegetation (USFWS, 1999). Nest collapse is rare in woody vegetation but common in non-woody vegetation, especially on lake margins (Rodgers, 1996).

Historically, Lake Okeechobee's littoral zone has provided one of South Florida's largest habitats for the snail kite (Bennetts and Kitchens, 1997). However, species experts have reported a decline in the overall Florida population estimate for the snail kite in recent years, as well as a lack of substantial numbers of snail kite nests in Lake Okeechobee. Observations since 1992 suggest a general degradation of nesting habitat in the littoral zone of Lake Okeechobee from the loss of willows in nesting areas (USFWS, 1999).

The south/central Florida region, including Lake Okeechobee, has experienced extreme weather events over the past few years. For instance, a regional drought occurred in 2000-2001, and above average rainfall in 2004 and 2005. Above average rainfall coupled with very active hurricane seasons in 2004 and 2005, has allowed less favorable conditions in the littoral zone of Lake Okeechobee. The major hurricanes of 2004 (Frances and Jeanne) caused significant ecological damage inside Lake Okeechobee, uprooting much of the lake's submerged vegetation and causing suspension and transport of soft mud sediments from the center of the lake to the shallow shoreline areas (Havens, 2005b). As a result, Lake Okeechobee remained

highly turbid for months after the hurricanes. The combination of high turbidity and deep water blocked light penetration to the lake bottom in shoreline areas (Havens, 2005). Lack of suitable light penetration can adversely impact SAV in Lake Okeechobee.

During years 2000-2001, snail kite survival dropped substantially in response to the regional drought (Kitchens et al., 2006). Lake Okeechobee had a record low stage of 9.2 ft., NGVD, at which time much of the shoal area became dry (Havens, et. al., 2005). Droughts, such as the one that occurred in 2000-2001, can severely impact the snail kite's forage and nesting habitats. In particular, snail availability to kites is greatly reduced during droughts (Beissinger, 1995). When droughts lead to a drying out (dry-down) of a breeding site during breeding season, droughts have a negative effect on survival and reproduction of snail kites (Bennets and Kitchens, 2000). To date, the assumption has been that during a drought, snail kites move from areas most affected by drought toward areas least affected by drought (Martin, et al., 2006). In extreme droughts, Lake Okeechobee is sometimes the only major wetland habitat with adequate water levels which are suitable for foraging and nesting (Havens & Gawlick, 2005). Havens and Gawlick (2005) report that the prolonged period of extreme low stage in 2000-2001 appeared to have nearly eliminated the apple snail population from Lake Okeechobee's littoral zone. However, it is also important to note that dry-downs are not necessarily harmful to apple snail populations, as long as they do not coincide with the peak period of egg-production or last for many months (Havens & Gawlick, 2005).

Even though drought conditions have negative effects, it is also recognized that occasional droughts are necessary to maintain native emergent vegetation such as spike rush, which is favorable to snail kite foraging.

Regulation of water stages in Lake Okeechobee is particularly important to maintain the balance of vegetative communities required for snail kites and the apple snail. Fluctuation and timing of lake stages affect the distribution of vegetative communities, and overall habitat quality (nesting sites, foraging habitat) for the snail kite. According to the USFWS (1999), a water stage of 14.5-15.0 ft. NGVD on Lake Okeechobee is recommended near the beginning of the snail kite nesting season during most years, with a gradual recession in late winter to late spring. This water stage coincides with several ecological studies on the littoral system of Lake Okeechobee. These studies have shown that a spring recession of lake levels from near 15 ft. to 12 ft. NGVD (January through May) favors nesting birds and other wildlife in the littoral marsh and allows for re-invigoration of willow stands (Smith et al., 1995). It is the extreme prolonged high and low lake levels which are undesirable for the Lake Okeechobee ecosystem. Factors contributing to habitat loss in Lake Okeechobee include prolonged periods of deep water and expansion of exotic vegetation (during low lake levels) such as torpedograss (Havens and Gawlick, 2005).

5.3.2. BALD EAGLE

The bald eagle is currently listed as threatened by the USFWS and the Florida Fish and Wildlife Conservation Commission (FFWCC). The bald eagle occurs in various habitats

near lakes, large rivers and coastlines. Most breeding eagles construct nests within several hundred yards of open water (USFWS, 1999). Shorelines, such as the shorelines around Lake Okeechobee, the Okeechobee Waterway, and estuaries provide fishing and loafing perches, nest trees, and open flight paths for the bald eagle (USFWS, 1999). The bald eagle primarily feeds on fish, but is known to occasionally prey on small mammals and will feed on carrion. Bald eagles are known to nest around the study area. Nesting season occurs from October through May. The bald eagle mates for life and uses the same nesting site year after year, if the territory is available. According to the FFWCC database, for the period of 2000-2004, two nests were reported in close proximity to Lake Okeechobee. One nest, located in Palm Beach County near Lake Harbor, was last listed as active in 2003. The second nest, located in Glades County northeast of Lake Port, was active in 2004.

5.3.3. WOOD STORK

The wood stork is listed as endangered by the USFWS and the FFWCC. Wood storks forage in freshwater marshes, seasonally flooded roadside or agriculture ditches, narrow tidal creeks, shallow tidal pools, managed impoundments, and depressions in cypress heads and swamp sloughs. Wood storks typically feed on fish between two and 25 centimeters (cm) in length. Wood storks have nested in small numbers around Lake Okeechobee, and are regularly seen foraging in the area (Smith, et al., 1995). Data gathered by Smith, et al., (1995) indicate that wood storks are attracted to Lake Okeechobee in large numbers only when the stage drops below 15 ft., NGVD. A lake stage above 15 ft., NGVD eliminates most of the foraging habitat available to wading birds on Lake Okeechobee (Aumen and Gray, 1995), whereas a lake stage below 11.8 ft., NGVD reduces the diversity of available foraging habitats and the number of acceptable nesting colony sites (Smith et al., 1995). As Aumen and Gray (1995) discuss, a regulation schedule for Lake Okeechobee benefiting wading birds should include a moderately paced draw down in water level to below 15 ft., NGVD coincident with the dry season and the usual wading bird nesting season (January–June).

5.3.4. CAPE SABLE SEASIDE SPARROW

Cape Sable Seaside Sparrow (CSSS) are medium-sized sparrows restricted to the Florida peninsula. They are non-migratory residents of freshwater to brackish marshes (USFWS, 1999). CSSS have a very restricted range and occur only in the Everglades region of Miami-Dade and Monroe counties of south Florida (USFWS, 1999). Critical habitat for the sparrow was designated on August 11, 1977 under Title 50 of the Code of Federal Regulations Part 17.95 (50 CFR 17.95). A key constituent element for the CSSS should be a hydroperiod pattern that maintains the preferred vegetative communities for successful breeding. During the breeding season, surface water levels should be at or below the surface within the short-hydroperiod prairies, and should be achieved through adherence to a rainfall-driven operational schedule within its habitat (USFWS, 1999).

5.3.5. WEST INDIAN MANATEE

The West Indian manatee has been classified as an endangered species since 1967. The manatee lives in freshwater, brackish, and marine habitats and prefers water

depths of at least three to seven feet. Water temperature colder than 77 degrees Fahrenheit increases the manatee's susceptibility to cold stress and cold induced mortality. Primary threats to manatees today are attributed to collisions with watercraft, degradation of habitat, and accidents occurring at water control structures. Manatees feed on a variety of submerged, emergent and floating vegetations and usually forage in shallow grass beds adjacent to deeper channels. During the summer months, manatees range throughout water bodies of south Florida. In the winter months, manatees tend to congregate in warm water areas such as springs and power plant facilities e.g., the Florida Power and Light power plant at Ft. Myers, adjacent to the Caloosahatchee National Wildlife Refuge. A park has been established in this vicinity for manatee viewing. The utilization of Lake Okeechobee and the tributaries and canal systems in south Florida by the manatee is not uncommon. Manatees are often seen in the Caloosahatchee River, St. Lucie Canal and Lake Okeechobee. The Caloosahatchee River Estuary also serves as critical habitat for the manatee. The Caloosahatchee National Wildlife Refuge located adjacent to I-75 on the Caloosahatchee River serves as a refuge for the manatee. The manatee is known to move through the Okeechobee Waterway lock structures when traveling to and from the coast.

5.3.6. OKEECHOBEE GOURD

The Okeechobee gourd is an annual or perennial, fibrous-rooted, high-climbing vine with tendrils, belonging to the gourd family *Cucurbitaceae* (USFWS, 1999). Today, the Okeechobee gourd has an extremely limited distribution. Lake Okeechobee is one of two areas where the gourd is currently found. There are several localized sites along the southeastern and northeastern shore of Lake Okeechobee, where this vine plant is known to grow. Around Lake Okeechobee, the gourd relies on pond apple trees to support its vines above rising water levels during the wet season. Water management levels in Lake Okeechobee affecting the snail kite and wood stork are also likely to affect the Okeechobee gourd. Fluctuating lake levels are necessary for the continued survival and recovery of the gourd within and around Lake Okeechobee. The endangered Okeechobee gourd flourishes when suitable soils are exposed during low water levels (USFWS, 1999).

5.3.7. EASTERN INDIGO SNAKE

The Eastern indigo snake has been classified as a threatened species by the USFWS and the FFWCC. The Eastern indigo snake is a large, black, non-venomous snake in North America. The Eastern indigo prefers drier habitats, but may be found in a variety of habitats from xeric sand hills, to cabbage palm hammocks, to hydric hardwood hammocks (Schaefer and Junkin, 1990). This species is generally an upland species snake, occupying a wide variety of habitat. The main reason for the snakes decline is habitat loss due to development. Further, as habitats become fragmented by roads, Eastern indigo snakes become increasingly vulnerable to highway mortality as they travel through their large territories (Schaefer and Junkin, 1990). The HHD and other levees within the Lake Okeechobee project area would be the primary area the snake would utilize.

5.3.8. SMALLTOOTH SAWFISH

The endangered smalltooth sawfish (*Pristis pectinata*) is one of two species of sawfish that inhabit United States (U.S.) waters. The U.S. population of smalltooth sawfish experienced severe range reduction and decline over the last century. The biology and ecology of *P. pectinata* is poorly known and the species was thought to be close to extirpation from United States waters before moderate numbers of individuals were recently documented in Florida, particularly south and southwest Florida. The core range of this species is now the area from the mouth of the Caloosahatchee River, south through the Ten Thousand Islands, along the Everglades coast, and into Florida Bay (Simpfendorfer and Wiley, 2005). The smalltooth sawfish was listed as a Federally endangered species in 2003.

Smalltooth sawfish commonly reach five and one half meters. Little is known about the life history of these animals, but they may live up to 25-30 years and mature after about ten years. Like many elasmobranches (e.g. sharks), smalltooth sawfish are ovoviviparous, meaning the mother holds the eggs inside her until the young are ready to be born. Sawfish species inhabit shallow coastal waters of tropical seas and estuaries throughout the world. Sawfish are most often found within a mile of land such as in estuaries, river mouths, bays, or inlets. They occur in a wide range of habitat types including seagrass flats, mud bottoms, oyster bars, sand bottoms, artificial reefs, coral reefs, and mangrove shorelines. It has been reported that the smalltooth sawfish can tolerate a wide range of salinities, including freshwater (Compagno and Cook, 1995 reference by Simpfendorfer and Wiley, 2005). During a recent study, Simpfendorfer and Wiley (2005) reported no encounters of the smalltooth sawfish in areas of permanent freshwater. However, many encounters were reported at the mouths of rivers or other sources of freshwater inflow, suggesting that estuarine areas may be an important factor in their distribution. The smalltooth sawfish has been reported to be found in the Caloosahatchee River, particularly in the lower parts of the river near the mouth (personal correspondence, G. Poulakis, FFWCC). This portion of the river is where the majority of sawfish are caught and tagged by FFWCC for research and monitoring purposes. Additionally, anglers most commonly report seeing and catching the species in the lower parts of the river near the mouth.

Smalltooth sawfish generally eat whatever small schooling fish may be abundant locally, such as mullet. They may also feed on crustaceans and other benthic organisms. The sawfish has been seen as "stirring the mud with its saw" to locate its prey, or attacking schools of small fish by slashing sideways with its saw and eating the wounded fish (NMFS, 2000).

5.3.9. JOHNSON'S SEAGRASS

The threatened Johnson's seagrass (*Halophila johnsonii*) has been found growing only along approximately 200 kilometers (km) (approximately 125 miles) of the coastline in southeastern Florida from Sebastian Inlet, Indian River County to northern Key Biscayne. This narrow range and apparent endemism indicates that Johnson's seagrass has the most limited geographic distribution of any seagrass in the world.

Johnson's seagrass occurs in dynamic and disjunct patches throughout its range. Growth appears to be rapid and leaf pairs have short life spans while horizontally spreading from dense apical meristems (Kenworthy, 1997). Kenworthy suggested that horizontally spreading rapid growth patterns and a high biomass turnover could explain the dynamic patches observed in distribution studies. New information reviewed in Kenworthy (1999, 1997) confirms H. johnsonii's limited geographic distribution in patchy and vertically disjunct areas between Sebastian Inlet and northern Biscayne Bay.

Johnson's seagrass occurs over varied depths, environmental conditions, sand substrates, and water quality. In tidal channels, H. johnsonii is found in coarse sand substrates, although it has been found growing on sandy shoals in soft mud near canals and rivers where salinity may fluctuate widely (Virnstein et al., 1997).

Areas of concern for this species include seagrass beds located in proximity to rivers and canal mouths where low salinity, highly colored water is discharged. Freshwater discharge into areas adjacent to seagrass beds may provoke physiological stress upon the plants by reducing the salinity levels. Additionally, colored waters released into seagrass areas reduce the amount of sunlight available for photosynthesis.

Personal communication with local scientists, seagrass monitoring data from the SFWMD and St. Johns River Water Management District, and a resource inventory by Palm Beach County Department of Environmental Resources Management show *H. johnsonii* is present in Lake Worth Lagoon and near the mouth of the St. Lucie inlet.

5.3.10. STATE LISTED SPECIES

Additional State listed species present within the effected area, and which may be affected by regulation schedule alternatives are presented in Table 5-1.

TABLE 5-1: STATE LISTED SPECIES

Scientific Name	Common Name	USFWS	FFWCC
Trichechus manatus	West Indian manatee	E	E
Rostrhamus sociabilis plumbeus	snail kite	E	E
Mycteria americana	wood stork	E	E
Haliaeetus leucocephalus	bald eagle	T	T
Ammodramus maritimus mirabilis	Cape sable seaside sparrow	E	E
Drymarchon corais couperi	Eastern indigo snake	T	T
Alligator mississippiensis	American alligator		SSC
Ajaja ajaja	roseate spoonbill		SSC
Aramus guarauna	limpkin		SSC
Egretta caerulea	little blue heron		SSC
Egretta rufescens	reddish egret		SSC
Egretta thula	snowy egret		SSC
Egretta tricolor	tri-colored heron		SSC
Eudocimus albus	white ibis		SSC
Grus canadensis pratensis	Florida sandhill crane		T
Pelecanus occidentalis	brown pelican		SSC
Rhynchops niger	black skimmer		SSC
Centropomus undecimalis	common snook		SSC
Cucurbita okeechobeensis	Okeechobee gourd	E	E
Pituophis melanoleucus mugitus	Florida pine snake		SSC

5.4. FISH AND WILDLIFE RESOURCES

As with the above discussion of existing vegetation, the below discussion of fish and wildlife resources inhabiting the study area is organized by physiographic area, beginning with Lake Okeechobee itself, the estuaries, EAA and concluding with the WCAs.

5.4.1. LAKE OKEECHOBEE

The area around Lake Okeechobee includes a wide variety of habitat opportunities for wildlife, including wading and migratory birds, many mammals, amphibians, and reptiles, as well as prey species such as crayfish, prawns, apple snails (Pomacea paludosa), and aquatic insects. The USFWS has designated six wildlife species as threatened or endangered and likely to occur in the vicinity of the Lake Okeechobee study area (Section 5.3). There are also State-listed species present within and around Lake Okeechobee, including several of the wading bird species that are not on the Federal list. The Corps conducted a two year wildlife survey within the western littoral zone of Lake Okeechobee, gathering baseline data for key habitat types for reptiles, amphibians, and migratory and resident birds (USACE, 1999). Much of the information below was gathered from the study.

Lake Okeechobee is home to a large number of fish species, some of which are valued as commercial and sportfish, and others serving as part of the cornerstone of the littoral zone food web. The USACE (1999) found numerous small fish species, including the Cyprinodontids such as the golden topminnow (*Fundulus chrysotus*), the least killifish (*Heterandria formosa*), and the Florida flagfish (*Jordanella floridae*) which are important food resources for wading birds, amphibians, and reptiles. Over a five-year period (1987-1991), mean annual commercial harvest was 2,008 metric tons (Fox, et al., 1992, 1993). Commercially important fish species included white catfish, bluegill, and red-ear sunfish.

Additionally, Furse and Fox (1994) revealed that numerous sportfish occur in the littoral zone. The largemouth bass (*Micropterus salmoides*) is one of the most popular gamefish in the State of Florida, and is a major predator of small fish, amphibians, birds, and reptiles. Additionally, the black crappie (*Pomoxis nigromaculatus*), bluegill (*Lepomis macrochirus*), and redear sunfish (*L. microlophus*) are sportfish found in high numbers in the littoral zone.

Macroinvertebrate diversity in the western littoral zone provides yet another vital component to the food web. Macroinvertebrate species incidentally sampled during field investigations in the western littoral zone included the apple snail, an important food resource of the snail kite (*Rostrhamus sociabilis plumbeus*), crayfish (*Procambarus* spp.), grass shrimp (*Paleomonetus paludosus*), and Dytiscid beetles (Dytiscidae).

Significant changes in recent years have been observed on Lake Okeechobee. Valuable fish habitat including bulrush, spike rush and SAV has been lost and/or replaced by exotic species such as torpedograss and hydrilla. Reports of muddy, turbid water, and drowned vegetation are not uncommon among the public and fisherman. Fishing guides report fish spawning has been poor for the last five years. Others report that shiners (an important bait fish) are becoming increasingly difficult to find and more and more fishermen are forced to the same areas to fish for them.

A major area of concern to the life cycle of fish and wildlife species is the western littoral zone and marsh, thus the description below will focus on this area as a representative of similar littoral resources around Lake Okeechobee.

The western littoral zone provides tremendous foraging and nesting habit for a wide range of avifauna. Previous studies (Smith and Collopy, 1995; David, 1994) have documented birds including the endangered wood stork (*Mycteria americana*), the Federally and State endangered snail kite, great blue heron (*Ardea herodias*), white ibis (*Eudocimus albus*), pied-billed grebe (*Podilymbus podiceps*), great egret (*Casmerodius albus*), snowy egret (*Egretta thula*), little blue heron (*E. caerulea*), tricolored heron (*E. tricolor*), and common moorhen (*Gallinula chloropus*) that have commonly been observed utilizing the study area.

Other birds that may utilize the littoral zone include the threatened bald eagle (*Haliaeetus leucocephalus*), black skimmer (*Rhyncops niger*), brown pelican (*Pelecanus occidentalis*), double-crested cormorant (*Phalacrocorax auritus*), and anhinga (*Anhinga anhinga*).

According to range maps presented in Conant and Collins (1991), reptile and amphibian diversity should be quite high in littoral and marsh areas of Lake Okeechobee. Studied species on Lake Okeechobee include the American alligator (*Alligator mississippiensis*) and the Florida soft-shelled turtle (*Apalone ferox*) (USACE, 1999). Currently, no published inventories are available on the diversity of reptiles and amphibians inhabiting the western littoral zone of Lake Okeechobee.

The Corps found large numbers of the greater siren (*Siren lacertina*) along with the green water snake (*Nerodia floridana*) and the banded water snake (*N. fasciata*). Additional common species sampled included frogs such as the southern leopard frog (*Rana utricularia*), the green tree frog (*Hyla cinerea*), and the squirrel tree frog (*H. squirrela*). The American alligator was the only listed species of reptile recorded by the Corps and there are no listed species of amphibians currently known to utilize the study area.

Of additional interest is the possibility of colonization of exotic amphibians and reptiles within Lake Okeechobee. Several reports from local residents have confirmed sightings of non-native species of lizards, such as the green iguana (*Iguana iguana*), the spiny-tailed iguana (*Ctenosaura pectinata*), and the brown basilisk (*Basiliscus vittatus*). Established populations of such species could be extremely harmful to native reptile and amphibian populations.

Lake Okeechobee also provides major resources for mammals. The Okeechobee Waterway, a designated channel that runs around the perimeter of the lake, as well as across the lake, provides habitat for the endangered West Indian manatee (*Trichechus manatus latirostris*). Additionally, river otters (*Lutra canadensis*), bobcats (*Felis rufus*), and the Florida water rat *(Neofiber alleni*), a species of special concern as listed by the

Florida Committee for Rare and Endangered Plants and Animals, have been observed within the Lake Okeechobee area.

5.4.2. NORTHERN ESTUARIES

The northern estuaries refer to the St. Lucie Estuary on the east coast of Florida (which flows into the Indian River Lagoon), the Caloosahatchee Estuary on the west coast of Florida, and the Lake Worth Lagoon on the east coast in Palm Beach County.

St. Lucie Estuary

The Indian River Lagoon system is a biogeographic transition zone, fed by the St. Lucie Estuary, rich in habitats and species, with the highest species diversity of any estuary in North America (Gilmore, 1977). Species diversity is generally high near inlets and toward the south, and low near cities where nutrient input, freshwater input, sedimentation, and turbidity are high and where large areas of mangroves and seagrasses have been lost. For biological communities and fisheries, seagrass and mangrove habitats are extremely important (Virnstein and Campbell, 1987).

Most of the predominantly freshwater fishes recorded from the IRL system, such as minnows (Cyprinidae), bullhead catfishes (Ictaluridae), and sunfishes (Centrarchidae) are found mainly or exclusively in the tributary streams including the streams feeding the St. Lucie Estuary. Examples of other species in this habitat include all of the ubiquitous forms mentioned above as well as Florida gar; gizzard shad; flagfish; bluefin killifish (*Lucania goodei*); mosquitofish (*Gambusia affinis*); least killifish; sailfin molly (*Poecilia latipinna*); inland silverside (*Menidia beryllina*); gulf pipefish (*Syngnathus scovelli*); leatherjack (*Oligoplites saurus*); gray snapper (*Lutjanus griseus*); Irish pompano (*Diapterus auratus*); silver jenny (*Eucinostomus gula*); fat sleeper (*Dormitator maculatus*); bigmouth sleeper (*Gobiomorus dormitor*); and lined sole (*Achirus lineatus*). Fish species that specialize in creek-mouth habitats include yellowfin menhaden (*Brevoortia smithi*); gafftopsail catfish (*Bagre marinus*); timucu, a needlefish (*Strongylura timucu*); gulf killifish (*Fundulus grandis*); striped killifish (*F. majalis*); mosquitofish; sailfin molly; lined seahorse (*Hippocampus erectus*); chain pipefish (*S. louisianae*); gulf pipefish; tarpon snook (*Centropomus pectinatus*); Atlantic bumper (*Chloroscombrus chrysurus*); gray snapper; Irish pompano; silver jenny; great barracuda (Sphyraena barracuda); gobies, sleepers, puffers, filefish (*Monacanthus* spp.) and many others.

In addition to finfish, the St. Lucie Estuary and Indian River Lagoon support a variety of shellfish. Blue crabs, stone crabs, hard clams and oysters are important estuarine commercial species. The blue crab accounted for approximately 80 percent of shellfish landings in the Indian River Lagoon between 1958 and 1988 (IRL CCMP, 1996).

The American Oyster (*Crassostrea virginica*) is an important indicator organism in the St. Lucie Estuary, because it is known to be sensitive to salinity changes in its environment. Oysters are commonly used as an indicator of spawning season, but many other species of saltwater fish also begin spawning in late winter/early spring.

Without optimum salinity, because of excessive freshwater, other fish species may be affected by fresh water releases.

Caloosahatchee Estuary
The Caloosahatchee Estuary starts at the W.P. Franklin Lock and Dam (S-79) and continues downstream nearly 30 miles to San Carlos Bay. Although various changes have historically occurred in the Caloosahatchee Estuary (channelization, shoreline hardening, point and non-point source pollution impacts), the estuary sustains numerous and diverse fish and wildlife populations. Important resources within the estuarine portions of the Caloosahatchee are SAV (i.e. seagrasses), oyster bars, open bottom community, and mangrove-lined shorelines. These communities provide important habitat supporting many wildlife species.

Tape grass (*Vallisneria Americana*) is dominant SAV in the upper Caloosahatchee Estuary and occurs in well-defined beds in shallow water. Extensive beds of tape grass are known to exist between Beautiful Island and the Route 41 bridges in Ft. Myers, when growing conditions are favorable. Tape grass is an important habitat for a variety of freshwater and estuarine invertebrate and vertebrate species, including some commercially and recreationally important fishes (Bortone and Turpin, 1999; Rozas and Minello, 2006). Additionally, tape grass can serve as a food source for the Florida manatee.

Manatees, waterfowl, and wading birds rely on seagrass communities as foraging areas. SAV are an integral nursery area for commercially and recreationally important fish and shellfish. Seagrass communities provide critical refugia for juvenile fish such as redfish, grouper, snook, and spotted seatrout. In addition, the upper and middle portions of the Caloosahatchee River support a blue crab fishery. Oyster bars and open bottoms of sand, mud, shell, and bedrock provide important habitat and food for other estuarine species. They harbor a rich macro invertebrate community that is utilized by wading birds, as well as shorebirds and fish.

In the Caloosahatchee Estuary, mangroves support fish and macro invertebrate communities by providing a protected nursery area. Important marine and estuarine species that spend part of their life cycle in the mangrove community include snook, snapper, tarpon, jack, sheepshead, red drum, ladyfish, blue crab, and shrimp. Mangrove forests also provide important foraging and nesting habitat for diverse populations of birds.

Lake Worth Lagoon
As an estuary, the Lake Worth Lagoon has developed to serve as spawning, nursery, and feeding grounds for many fish and invertebrate species. Recreational and commercial fish species, invertebrates, birds, endangered and threatened species use the existing natural estuarine communities of the lagoon. Within Lake Worth Lagoon, seagrass communities provide critical refugia for juvenile fish such as red drum, grouper, snook, and spotted seatrout. A total of 261 species of fish have been collected in Lake Worth Lagoon, including fish species found in the vicinity of the inlets

(Crigger, Graves, and Fike, 2005). The manatee uses Lake Worth Lagoon as refuge and a travel corridor. Several bird sanctuaries and rookeries are also located in the Lake Worth Lagoon (Crigger *et al.*, 2005).

5.4.3. EVERGLADES AGRICULTURAL AREA

Wildlife habitat within the EAA is mostly limited to the canal systems. Flooded and cultivated agricultural fields attract feeding birds, especially waders. The Holey Land and Rotenberger WMAs located at the south end of the EAA support populations of wading birds, deer, hogs and waterfowl. Wading birds and some raptors also frequent the flooded fields and canals. Raptors find abundant food sources in small mammals, snakes and other reptiles, which often inhabit sugar cane fields. The extensive canal system supports fish species that normally would not be common inhabitants of the Everglades marshes, but are typically found in lakes. These fish include black crappie, catfish, and shad. Oscars (*Astronotus* spp.), spotted tilapia (*Tilapia mariae*), walking catfish (*Clarias batrachus*), and the black acara (*Cichlasoma bimaculatum*) are examples of exotic fish species that have become established within the region.

5.4.4. WATER CONSERVATION AREAS (GREATER EVERGLADES)

The WCAs as a whole contain a number of important species whose existence, population numbers and sustainability are markedly influenced by water levels. The American alligator, a keystone Everglades species, has rebounded in terms of population numbers since the 1960s when the reptile was placed on the endangered species list by the USFWS. Alligators, it is believed, play an important ecological function by maintaining "gator holes", or depressions, in the muck which are thought to provide refuge for aquatic organisms during times of drought and concentrates food sources for wading birds. High water during periods of nest construction which occurs from June to early July (Woodward et al., 1989) decreases the availability of nesting sites. If conditions become too dry, water levels may fall too low to maintain gator holes, forcing the animal to seek other areas to survive.

Other important reptile species commonly encountered within the study area include a number of species of turtles, lizards, and snakes. Turtle species include the snapping turtle (*Chelydra serpentina*), striped mud turtle (*Kinosternon bauri*), mud turtle (*K. subruburm*), cooter (*Chrysemys floridana*), Florida chicken turtle (*Deirochelys reticularia*), and Florida softshell turtle (*Trionys ferox*). Lizards such as the green anole (*Anolis carolinensis*), are found in the central Everglades, and several species of skinks occur more commonly in terrestrial habitats. Numerous snakes inhabit the wetland and terrestrial environments. Drier habitats support such species as the Florida brown snake (*Storeria dekayi*), southern ringneck snake (*Diadophis punctatus*), southern black racer (*Coluber constrictor*), scarlet snake (*Cemophora coccinea*), and two rattlesnakes (*Sistrurus miliarius* and *Crotalus adamanteus*). The Eastern indigo snake (*Drymarchon corais*), a Federally listed threatened species, and the Florida pine snake (*Pituophis melanoleucus mugitus*), a State species of special concern, may also exist in drier areas of the study area. Wetter habitats support more aquatic species such as the water snake (*Natrix sipedon*), the green water snake, mud snake (*Francia abacura*), eastern garter snake (*Thamnophis sirtalis*), ribbon snake (*T. sauritus*), rat snake

(*Elaphe obsoleta*), and the Florida cottonmouth (*Agkistrodon piscivorus*) (McDiarmid and Pritchard, 1978).

Important amphibians, known to occur in south Florida, include the Everglades bullfrog, or pig frog (*R. grylio*), Florida cricket frog (*Acris gryllus*), green tree frog (*Hyla cinerea),* and southern leopard frog, southern chorus frog *(Pseudacris nigrita*) and various tree frogs are common to tree islands and cypress forests. Salamanders inhabit the densely vegetated, still or slow-moving waters of the sawgrass marshes and wet prairies. They include the greater siren and the Everglades dwarf siren (*Pseudobranchus striatus*). Toads such as the southern toad (*Bufo Terrestris*), the oak toad (*Bufo quercicus*) and the eastern narrow-mouth toad (*Gastrophryne carolinensis*) also occur within the study area.

Colonial wading birds (*Ciconiformes*) are a conspicuous component of the wildlife communities that utilize the WCAs as both feeding and breeding habitat. These include 11 species of herons and egrets, two species of ibis, the wood stork, and the roseate spoonbill (Robertson and Kushlan, 1984). Historically, white ibis has been the most abundant colonial wading bird species within the WCAs. Surveys indicate that the great egret is the second most abundant species (Frederick and Collopy, 1988). The great blue heron, little blue heron, tricolored heron, green backed heron (*Butorides striatus*), snowy egret (*E. thula*), cattle egret (*Bubulcus ibis*), black crowned night heron (*Nycticorax nycticorax*), and yellow crowned night heron (*N. violacea*), are also common wading bird species found throughout the WCAs. The roseate spoonbill (*Ajaia ajaja*), a State listed species of special concern, and the wood stork, a Federally listed endangered species, both occur within the WCAs. The WCAs support additional aquatic avifauna, such as the limpkin (*Aramus guarauna*), two bitterns (*Ixobrycus exilis* and *Botarus lentiginosus*), the anhinga, as well as a number of resident and migratory waterfowl.

The Everglades fish community is composed of a variety of forage fish important in the diet of many wading birds, sport fish, native species and exotics introduced partly through aquacultural practices and the aquarium trade. Forage species include the Florida flagfish, bluefin killifish, least killifish, shiners, mosquito fish, and sailfin molly.

Generally, Everglades sport fish are harvested from the borrow canals that surround the marsh. As water levels in the canal and marsh rise, fish populations disperse into the interior marsh and reproduce with minimum competition and predation. As water levels recede, fish concentrate into the deeper waters of the surrounding canals, where they become available as prey for wildlife and fishermen. In some instances, the canal fishery has experienced major fish kills due to overcrowding and oxygen depletion. The WCAs provide a valuable sport fishery for south Florida. Many of the canals, notably along U.S. Highway 41, I-75, and in the L-35B and L-67A provide valuable recreational fishing for largemouth bass, sunfish, oscar, gar, bowfin (*Amia calva*), catfish and other species.

Besides supporting a valuable recreational fishery for the region, fish communities in the WCAs provide a major food source for Everglades wading birds, alligators, and other carnivorous reptiles and mammals. Fish community structure and abundance is highly dependent on water levels. Consequently, fishing success by humans or wildlife is also dependent on water levels (Dineen, 1974). For a more complete listing of common Everglades fishes refer to Gunderson and Loftus (1993).

Several game and non-game wildlife species occur within the WCA system including: white-tailed deer (*Odocoileus virginianus*), common snipe (*Capella gallinago*), and marsh rabbit (*Sylvilagus palustris*). Blue-winged teal (*Anas discors*), mottled ducks (*A. fulvigula*) and other game waterfowl are found in the sloughs of the northeast corner. Feral hogs (*Sus scrofa*) may also be present in drier areas or on tree islands.

5.5. ESSENTIAL FISH HABITAT

In accordance with the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) of 1976 and the 1996 Sustainable Fisheries Act, an Essential Fish Habitat (EFH) Assessment is necessary for implementation of the Preferred Alternative. An EFH Assessment is a review of the proposed action and its potential impacts to EFH. The rules promulgated by the National Marine Fisheries Service (NMFS) in 1997 and 2002 further clarify EFH by definition as "those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity." *Waters* include aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include areas historically used by fish where appropriate. *Substrate* includes sediment, hardbottom, structures underlying the waters, and any associated biological communities. *Necessary* means the habitat required to support a sustainable fishery and managed species' contribution to a healthy ecosystem. *Spawning, breeding, feeding, or growth to maturity* covers all habitat types used by a species throughout its life cycle.

Only species managed under a federal fishery management plan (FMP) are covered under (50 CFR 600). The act requires federal agencies to consult on activities that may adversely influence EFH designated in the FMPs. The activities may have direct (e.g., physical disruption) or indirect (e.g., loss of prey species) effects on EFH and may be site-specific or habitat-wide. The adverse result(s) must be evaluated individually and cumulatively.

The St. Lucie Estuary and the Southern Indian River Lagoon are within the jurisdiction of the South Atlantic Fishery Management Council (SAFMC) and are located in areas designated as EFH for estuarine waters, mangroves, seagrasses, and live bottom communities. The estuary provides EFH for adult and juvenile red drum (*Sciaenops ocellatus*), shrimp, spiny lobster (*Panulirus argus*), and the snapper-grouper complex. In addition, the nearshore hardbottom habitat outside of the St. Lucie and Ft. Pierce Inlets is designated as EFH Areas of Special Concern for the snapper-grouper complex.

The Caloosahatchee Estuary is within the jurisdiction of the Gulf of Mexico Fishery Management Council (GMFMC). In the estuary, EFH is defined as all estuarine waters

and substrates (mud, sand, shell, rock and associated biological communities), including the sub-tidal vegetation (seagrasses and algae) and the adjacent inter-tidal vegetation (marshes and mangroves). The estuary provides EFH for adult and juvenile brown shrimp (*Penaeus aztecus*), pink shrimp (*Panaeus duorarum*), white shrimp (*Penaeus setiferus*), gray snapper (*Lutjanus griseus*), red drum (*Sciaenops ocellatus*), Spanish mackerel (*Scomberomorus maculates*), spiny lobster (*Panulirus argus*), stone crab (*Menippe mercenaria*), and gulf stone crab (*Menippe adina*).

In conformance with the 1996 amendment to the MSFCMA, the information provided in the SEIS will comprise the required EFH Assessment. The SEIS will be coordinated with the NMFS Habitat Conservation Division which will initiate consultation under the MSFCMA.

5.6. COASTAL BARRIER RESOURCES

There are no coastal barrier resources in the project study area.

5.7. FLOOD PROTECTION

One of the primary functions of the C&SF Project is to provide a highly-efficient flood control system designed to keep urban and agricultural areas dry in the wet season by discharging excess water to tide or into the WCAs and ENP. Flood control works on Lake Okeechobee consist of a system of about 1,000 miles of encircling levees designed to withstand a severe combination of flood stage and hurricane occurrence, plus the regulatory outlets of St. Lucie Canal and the Caloosahatchee River. The design discharge of Moore Haven Spillway is 9,300 cfs and St. Lucie Spillway is about 16,000 cfs (USACE, 1999). Following removal of local runoff from the agricultural areas south of Lake Okeechobee, an additional regulatory capability of several thousand cfs is available through the Miami, North New River, Hillsboro, and West Palm Beach Canals by pumping into the three WCAs. The crest elevation of the levee system surrounding the lake ranges from 32 to 45 ft., NGVD. Possible flooding due to overtopping of levees within the HHD system is limited to short duration events involving wave run-up in addition to hurricane-induced storm surge.

5.8. WATER SUPPLY

As one of its planned purposes, Lake Okeechobee supplies water for agricultural irrigation, municipalities, industry, and ENP, and for regional groundwater control and salinity control.

A primary use of Lake Okeechobee is to provide water supply for adjacent urban and agricultural lands and a backup water supply for lower east and west coast Florida counties. Currently, C-43 provides an important source of potable water for Lee County and the City of Ft. Myers and is also used as a source of water for irrigation by agriculture.

During years of normal rainfall, the regulation schedule allows for an ample supply of water to be stored in Lake Okeechobee during wet periods for use during the dry season.

During dry periods, increased water usage and large dry season water losses due to evapotranspiration require an operational water allocation plan for Lake Okeechobee, especially when regional water supplies become low and may not meet anticipated service area demands. The SFWMD has developed a water supply management plan that requires various actions to be taken according to the severity of the conditions exhibited in the LORS. The basis of this plan is an allocation scheme which parcels out lake water based on estimated water use for the remainder of the dry season. A target water level in Lake Okeechobee is established for the beginning of the wet season (June 1st) and allotments are computed such that lake water levels will not fall below the critical target stage, assuming average climatic conditions. Operational flexibility is built into the plan to make available the special actions that proved successful during the 1981–1982 drought.

Water supply deliveries from Lake Okeechobee for agriculture, human consumption or environmental needs are made mostly under the State's water supply authority. The State may allocate water for municipal and agricultural water supply, to maintain appropriate salinity envelope in the estuaries, or to provide environmental releases south, or any other beneficial uses the State deems appropriate. The State's decision regarding appropriating water releases is not determined by the Corps, unless the release would interfere with Federal project purposes.

SSM (Hall, 1991) provides guidelines for apportioning of Lake Okeechobee's releases among different water users and release points when extreme drought conditions persists and cutbacks are imposed by the State.

5.9. WATER QUALITY

Lake Okeechobee

Waters of Lake Okeechobee have been designated by the State of Florida as Class I Waters, suitable for potable water supplies, and Class III, recreation, propagation and maintenance of a healthy, well-balanced population of fish and wildlife

Water quality data indicate that Lake Okeechobee is currently in a eutrophic condition, primarily due to excessive nutrient loads from the agricultural sources both north and south of the lake. Section 303(d) of the Clean Water Act (CWA) requires states to develop a list of waters not meeting water quality standards or not supplying their designated uses. According to FDEP's 1998 303(d) list, the water quality of Lake Okeechobee is impaired due to phosphorus, dissolved oxygen, iron, un-ionized ammonia, coliforms and chlorides. High phosphorus concentrations resulting from human-induced hydrologic and land use modifications are the predominant reason for impairment (FDEP, 2001). The in-lake total phosphorus concentrations have doubled over the last 50-years as a result of increased inputs from the watershed (FDEP, 2001). From 1995 to 2000, the average concentration of total phosphorus in the pelagic region of Lake Okeechobee was approximately 100 parts per billion (ppb) (FDEP, 2001). In September 2004, hurricanes Frances and Jeanne passed just to the northeast of Lake Okeechobee producing winds in the 70 to 80 miles per hour (mph) range to the lake. Due to Lake Okeechobee's average shallow depth, wind easily affects sediment

suspension. Total phosphorus concentrations climbed to levels as much as four to five times higher than normal as a result of the 2004 hurricanes (SFWMD, 2005). The U.S. Environmental Protection Agency (EPA) and the FDEP have prepared and approved a Total Maximum Daily Load (TMDL) for phosphorus for Lake Okeechobee (FDEP, 2001) which is hereby incorporated by reference. The purpose of this TMDL is to attain acceptable phosphorus loads in the lake.

Caloosahatchee River Basin

The Caloosahatchee River/Estuary system has been altered by agricultural and urban development during the past century, and is challenged by a variety of water quality problems, including altered salinity, elevated nutrients and increased sediment loading (SFWMD, 2005). The channelized section of the river also shows degraded water quality conditions, due to agricultural inputs, as compared to tributaries lying in less developed areas of the basin.

Water quality has been a concern in the Caloosahatchee Estuary since the late 1970s and early 1980s. A waste load allocation study in the Caloosahatchee conducted by the Florida Department of Environmental Regulation concluded that the estuary had reached its nutrient loading limits as indicated by elevated chlorophyll *a* (Chla) and depressed dissolved oxygen concentrations (DeGrove 1981). Target concentrations for chlorophyll *a* (20 ug/l), TN (1.0 mg/l) and TP (0.15 mg/l) were established as upper limits for acceptable water quality in the region of the estuary between Cape Coral and Beautiful Island. Similarly, McPherson and Miller (1990) concluded that additional nitrogen loading would result in increases in phytoplankton and benthic algae.

Doering and Chamberlain (1998) summarized water quality conditions in the Caloosahatchee Estuary, San Carlos Bay and Pine Island Sound. Compared to other Florida estuaries (Friedeman and Hand 1989) median concentrations of Chla and TSS were relatively low while median concentrations of dissolved oxygen, TN and color were relatively high. Turbidity and concentrations of TP were close to the statewide median values for estuaries. Concentrations of TN, TP and Chla that exceeded the upper limits established by DER (DeGrove 1981) occurred mainly in the upper estuary between S-79 and Ft. Myers. Although dissolved oxygen concentration were generally high in the overall system, some values at or below 2 mg/l were observed at the head of the Caloosahatchee Estuary and these occurred in the warmer months between May and October (Doering and Chamberlain 1998). Most studies conducted in the Caloosahatchee find a relatively poorer water quality in the upper estuary that improves as proximity to the ocean increases.

Freshwater discharges from Lake Okeechobee are often viewed as a main contributor of nutrient loading to the Caloosahatchee Estuary. In fact, discharges of Lake Okeechobee are just a piece of the puzzle of water quality issues in the Caloosahatchee River and estuary. While Lake Okeechobee water is extremely high in nutrient concentrations as indicated above in Section 5.9, it is only a fraction of the Total Nitrogen (TN) and Total Phosphorus (TP) loading into the Caloosahatchee Estuary. Table 5-2 is provided to summarize, by percentage, the estimated year 2000

average basin water and nutrient loads for the entire Caloosahatchee River/Estuary basin as presented by SFWMD (2005).

TABLE 5-2: ESTIMATED 2000 EXISTING WATER AND NUTRIENT LOADS WITHIN THE CALOOSAHATCHEE RIVER/ESTUARY WATERSHED BASIN BY PERCENTAGE (source: SFWMD, 2005)

Watershed Source	Annual Flow	TN (MT/yr)	TP (MT/yr)
Lake Okeechobee	31%	28%	11%
Caloosahatchee River freshwater basin	46%	50%	63%
Caloosahatchee River Estuary basin	23%	21%	26%

Water quality in the Caloosahatchee Estuary varies as a function of freshwater discharge at S-79 and source of that discharge (C-43 Basin or Lake Okeechobee). In general, the concentrations of color, and total and dissolved inorganic nitrogen in the estuary increased as discharge at S-79 increased. When the river basin was the major source of discharge, the concentrations of nutrients (excepting ammonia) and color were relatively higher than when the Lake was the major source (Doering and Chamberlain, 1999a).

St. Lucie River Basin

Water quality conditions along the St. Lucie River may be considered less impaired in undeveloped areas of the basin. However, conditions are more degraded in urbanized areas along the extensive network of canals that drain this area. Major water quality issues in the St. Lucie Estuary stem from high variability in salinity, frequent events of low dissolved oxygen, high nutrient concentrations and light limitation of plant growth due to high levels of humic substances and suspended solids brought into the system with the freshwater (Chamberlain and Hayward, 1996).

5.10. HAZARDOUS, TOXIC AND RADIOACTIVE WASTE

A preliminary assessment indicated no evidence of HTRW affecting this action.

5.11. AIR QUALITY

Clean Air Act (CAA) General Conformity Rule. Section 176(c) of the CAA requires that Federal agencies assure that their activities are in conformance with Federally-approved CAA state implementation plans for geographical areas designated as "nonattainment" and "maintenance" areas under the CAA. On 30 November 1993, EPA published its final General Conformity Rule to implement Section 176(c). EPA's final rule addresses how Federal agencies are to demonstrate that activities in which they engage confirm with Federally approved CAA state implementation plans. The EPA rule contains a number of "exempted" or "presumed to conform" activities which include a number of Corps activities. As applicable and required, CAA conformity

determinations will be completed during feasibility studies and included in feasibility reports.

5.12. NOISE

Ambient noise levels are low to moderate in the Lake Okeechobee region. The major noise producing sources are vehicular and boat traffic.

5.13. AESTHETIC RESOURCES

Lake Okeechobee, the Caloosahatchee River Basin and the St. Lucie Estuary have several landscape features that are aesthetically appealing to tourists and local communities.

5.14. RECREATION RESOURCES

Lake Okeechobee and the St. Lucie and Caloosahatchee estuaries are considered popular recreational resources in south Florida. Fishing, recreational boating, sightseeing, wildlife watching, camping and swimming are just a few of the recreational activities in which residents and visitors participate. Lake Okeechobee is host to more than 500 permitted bass fishing tournaments annually and ranks as the top bass fishing lake in the U.S. (Havens, et al., 2004a).

5.15. NAVIGATION

A navigable waterway exists from the Intracoastal Waterway at St. Lucie Inlet on the Atlantic Coast across the State by way of St. Lucie Canal, Lake Okeechobee, and Caloosahatchee River to the Gulf of Mexico. The Caloosahatchee River is the western navigational channel for the Okeechobee Waterway. When the Lake Okeechobee stage is below 12.56 ft., NGVD, the authorized project depth is not maintained. The waterway consists of 154 miles of navigation channel, including Lake Okeechobee. Commercial and recreational navigation via the Okeechobee Waterway takes advantage of this shortcut across the Florida peninsula.

5.16. HISTORIC PROPERTIES

This action was coordinated in accordance with Section 106 of the *National Historic Preservation Act* (NHPA) of 1966, as amended, and 36 CFR, Part 800: *Protection of Historic Properties*. The State Historic Preservation Officer (SHPO) advises and assists the Corps in identifying historic properties (archaeological, architectural, and historical) listed, or eligible for listing, in the *National Register of Historic Places*, assessing the project's effects, and considering alternatives to avoid or minimize effects.

6. ENVIRONMENTAL EFFECTS

This section is the scientific and analytic basis for the comparisons of the alternatives. See Table 2-1 in Section 2.0 Alternatives, for summary of impacts. The following includes anticipated changes to the existing environment including direct, indirect, and cumulative effects.

6.1. GENERAL ENVIRONMENTAL EFFECTS

6.2. VEGETATION

6.2.1. LAKE OKEECHOBEE

Extreme High

At the extreme high stage (>17 feet), it has been documented that wind driven waves can cause large-scale loss of submerged and emergent plants by physical uprooting (Havens et al., 2004c). Reduction in the duration and severity of high water stages is expected to be more favorable for maintenance of more diverse vegetative communities in the littoral zone, which in turn should provide for more favorable habitat conditions for fish and wildlife. The anticipated overall increase in diversity of littoral vegetation is expected to include larger areas vegetated by willow, which has been adversely impacted through the years by prolonged high water elevations. Willow is important nesting substrate for wading birds and the endangered snail kite. Very high water levels are also destructive to apple snail habitat. Emergent vegetation is important for the apple snail, because the snail must breath air. Snails need to climb the plant stems to breath air, and they need the portion of the stems to remain above water level for their eggs to hatch (USFWS, 2007).

More extreme high water stages (>17 feet) would be significantly reduced under the Preferred Alternative, or any of the alternatives, compared to the No Action Alternative, thereby decreasing the likelihood of erosion of bulrush and other emergent vegetation from the deep water edge of the littoral zone. Decreasing high water stages would encourage healthy growth of plants and vegetative recruitment. Lake scientists agree that even prolonged periods of moderately high lake levels are known to impact marsh vegetation. When lake stages exceed 15 feet for long periods, especially when light penetration is inhibited by turbid water, adverse impacts to SAV can occur. Modeling simulations indicate that the No Action Alternative had two events of lake stage >15 feet for 365 days. All other alternatives have zero events. As the past has shown, even moderate high lake levels (>15 feet) of prolonged (>12 months) duration, may cause significant harm to Lake Okeechobee's ecosystem. All of the alternatives did equally well with reducing lake stages >17 feet. The No Action Alternative performed the worst for this PM.

Extreme Low

The extreme low stage, identified at ten feet, is the depth at which substantial adverse effects on Lake Okeechobee may occur. It is at this depth where detailed field observations during the 2000-2001 drought indicated that adverse effects such as rapid spread of terrestrial weedy plants, severe loss of SAV and loss of apple snail population, occurred. Even when the lake stage falls below 11 feet, the entire littoral zone is dry (Havens and Gawlik, 2005).

As would be expected, alternatives that did the best in reducing extreme high lake stage occurrences did worse at reducing extreme low lake stage occurrences. The No Action Alternative has fewer low lake stage events than the other alternatives, as would be expected since it has more high lake stage events. The remainder of the alternatives scored relatively the same for lake stages less than (<) ten feet. All of the alternatives will have more low stage events compared to the No Action Alternative. However, the positive ecological effect of alternatives lowering the lake stage to reduce the high extreme events potentially out weights the possible adverse ecological effects of occasional extreme low water events.

Even though adverse effects occur during low lake stages, there are a number of benefits to the ecosystem that also occur, such as drying and oxidation of accumulated organic detritus in the littoral zone, favorable conditions for marsh fires that burn away cattail and torpedograss thatch, and exposure of moist soil for plant germination (Havens et al., 2004c).

Stage Envelope

Although the stage envelope is optimal for Lake Okeechobee, it is also necessary for the system to occasionally experience the extreme highs, and particularly the extreme lows, which would mimic more natural conditions. In Lake Okeechobee, water level management that mimics natural conditions will have the greatest benefits to plant communities (FFWCC, 2003).

A water management regime similar to the Lake Okeechobee Stage Envelope PM, where water levels are between 12.5 feet (June-July low) and 15.5 feet (November-January high), is the target range for the Preferred Alternative. A wide body of published research documents the benefits of variable water levels within this range (Havens & Gawlick, 2005; FFWCC, 2003; Smith, et al., 1995; Aumen and Gray, 1995). A January to June stage recession would provide benefits for wading birds nesting and foraging, development of good submerged and emergent vegetation habitat for fish and wildlife, and in general, benefits the littoral wetland by providing a range of water depths that subject most of that area to wetting and drying (Havens et al, 2003c). Although these conditions are beneficial, they should not be repeated every year. Lake Okeechobee experts recognize that there should also be years of extreme stage, especially stages below 11 feet that are needed to periodically dry out lower elevation littoral areas so they can benefit from detritus oxidation and fires (Aumen and Gray, 1995; Havens et al., 2004c).

All alternatives performed basically the same for the percentage of time within the stage envelope as indicated in Table 6-1. The differences within the stage envelope were minor with the No Action Alternative falling within the stage envelope 27.52 percent of the time and the Preferred Alternative falling within the envelope 25.26 percent of the time. The remaining alternatives fell somewhere in between these scores

Due to the small differences in the performance of Alternatives A through E, it is unclear whether one alternative is significantly better for lake vegetation or lake ecology in general. The differences are indistinguishable from each other in their potential ecological effect on Lake Okeechobee.

TABLE 6-1: LAKE OKEECHOBEE ECOLOGICAL PERFORMANCE

ALTERNATIVE	Hi Events above 17 ft.	Low Events below 11 ft.	# of times lake stage is >15 ft. for >365 days	Low stage <11 ft for >80 days	% of time w/in Stage Envelope
No Action	11	11	2	5	27.5
Alt A	4	20	0	6	26.6
Alt B	2	21	0	7	27.0
Alt C	2	17	0	8	27.3
Alt D	3	19	0	6	25.4
Alt E (Preferred)	2	23	0	6	25.3

6.2.2. ESTUARINE VEGETATION AND OYSTERS

Lake Okeechobee releases, along with other tributary inflows and stormwater runoff, can have a direct effect on estuarine health due to the relationship of freshwater releases and the salinity in the estuaries. Maintaining the desired salinity within the estuaries is a delicate balance. That balance is often dependent on the volume, duration and timing of lake releases to the estuaries.

Caloosahatchee Estuary

Salinity tolerances of submerged grasses are used as performance indicators to identify minimum and maximum inflows from S-79. Mean monthly flows less than 450 cfs are thought to allow salinity in the upper estuary to exceed the tolerance of tape grass (SFWMD, 2003). Flows greater than 2800 cfs depress salinity in the lower estuary and threaten the marine shoal grass typical of this region (Doering, et al., 2002). Mean monthly flows greater than 4500 cfs depress salinity in San Carlos Bay and threaten turtle grass beds typical of this region (SFWMD, 2003).

Low Flow

Alternatives with the lowest occurrences of mean monthly flows below the low flow limit of <450 cfs are better. As indicated in Table 6-2, Alternatives A through E provide significant relief from low (<450 cfs) mean monthly flows as compared to the No Action Alternative.

TABLE 6-2: CALOOSAHATCHEE MEAN MONTHLY FLOWS				
Alternative		CFS at S-79		
	<450	450-2800	2800-4500	>4500
No Action	198	160	45	29
Alt A	104	260	32	36
Alt B	105	257	35	35
Alt C	116	247	35	34
Alt D	131	238	34	29
Alt E (Preferred)	131	237	35	29

High Flow

High flow is measured by occurrences of mean monthly flows greater than 2800 cfs, as measured at the S79, from Lake Okeechobee regulatory releases in combination with flow from the Caloosahatchee River (C-43) basin. Alternatives with the least occurrences in the high flow range are considered better. Alternatives A through E reduce the months of flows between 2800 – 4500 cfs. Only Alternatives D and E equaled the No Action Alternative in the >4500 cfs flow class. Alternatives A, B and C had a greater number of months in the >4500 cfs flow class compared to the No Action Alternative.

Acceptable Flow

Alternatives A through E had a significantly greater number of months in the acceptable flow range of 450-2800 cfs as indicated in Table 6-2.

Duration of High Flows

All alternatives had high flows (>4500 cfs) of longer duration than the No Action Alternative (Table 6-3). This was reflected in the total number of weeks of high flows greater than five weeks and at times, Alternatives B and C, had very long duration flows in the 13 to 16 week range. The No Action Alternative had the fewest number of weeks of high flow greater than five weeks. Of Alternatives A through E, Alternative E had the fewest number of weeks of high flow greater than five weeks.

TABLE 6-3: CALOOSAHATCHEE ESTUARY: DURATION					
	Weekly Moving Avg >4500 cfs				
	13-16 wk	10-12wk	8-9 wk	6-7 wks	Sum
No Action	0	20	8	0	28
Alt A	0	42	26	20	88
Alt B	13	42	16	12	83
Alt C	13	21	26	6	66
Alt D	0	31	16	32	79
Alt E (preferred)	0	32	8	25	65

St. Lucie Estuary

Like the Caloosahatchee Estuary, similar ecological problems exist in the St. Lucie Estuary. Maintaining a favorable salinity envelope within the estuary will benefit oysters and SAV. Although estimates of oyster salinity tolerance vary in the literature, a range of approximately 8-25 ppt appears tolerable, with a higher minimum (10-12 ppt) required for larval development. Although SAV coverage within the St. Lucie Estuary is limited, SAV that have the greatest potential to flourish in the shallow, inter to outer estuary waters are wild celery (*Vallisneria Americana*), widgeon grass (*Ruppia martina),* and shoal grass (*Halodule wrightii*). The salinity requirements to maintain persistent SAV beds of these species are 0 to 10 ppt, 5 to 15 ppt, and 22 to 38 ppt, respectively (Haunert and Konyha 2004). Mean monthly total inflows in the 2000–3000 cfs ranges result in low, damaging salinities throughout the St. Lucie Estuary adversely impacting oyster beds. Flows greater than 3000 cfs may adversely affect more marine waters in the Indian River Lagoon and the seagrasses residing there.

Low Flow
Alternatives with the lowest occurrences of mean monthly flows below the low flow limit of <350 cfs are better. As indicated in Table 6-4, Alternatives A through E provide significant relief from low (<350 cfs) mean monthly flows as compared to the No Action Alternative.

TABLE 6-4: ST. LUCIE MEAN MONTHLY TOTAL FLOWS				
	CFS			
Alternative	<350	350-2000	2000-3000	>3000
No Action	127	231	43	31
Alt A	129	237	36	30
Alt B	129	238	38	27
Alt C	123	244	37	28
Alt D	103	254	44	31
Alt E (Preferred)	103	256	42	31

High Flow
When examining the distribution of mean monthly flows for the entire POR, only Alternative D did worse (by 1-month) at reducing high flows >2000 cfs, when compared to the No Action Alternative. All other alternatives showed at least minor improvement in reducing flows >2000 cfs (Table 6-4). The preferred alternative only improves high flows >2000 cfs by 1-month. To the extent that the Preferred Alternative is able to reduce high freshwater flows to the estuary and Indian River Lagoon system, it will benefit SAV, including seagrasses which are currently in a declining state from sediment and nutrient deposition from upstream sources. Clearer water and more stable salinity are expected to foster re-colonization of the bottom by benthic plants, especially shoal grass.

Acceptable Flow
All alternatives improve flows in the preferred or tolerable range between 350–2000 cfs, with Alternative E, the Preferred Alternative, performing the best.

Duration of High Flows
All alternatives had high flows of longer duration than the No Action Alternative (Table 6-5). The 14-day moving average total inflow exceeded 3000 cfs for more than ten weeks (five two-week periods) in Alternatives A through E. The No Action Alternative had no such occurrences.

TABLE 6-5: ST. LUCIE ESTUARY: DURATION OF HIGH FLOWS				
	2 week Moving Avg >3000 cfs			
	>5 periods	4-5 periods	2-3 periods	Sum
No Action	0	13	25	38
Alt A	7	12	16	35
Alt B	8	12	14	34
Alt C	7	13	15	35
Alt D	8	12	16	36
Alt E (preferred)	8	12	16	36

Lake Worth Lagoon

Altered estuarine salinity has resulted in declines of SAV in the Lake Worth Lagoon. Maintaining the balance of freshwater discharges into the lagoon similar to those discussed for oysters in Section 6.4.2 would also benefit the potential growth of seagrasses. The differences between the alternatives were so minimal, that it would be difficult to discern any ecological consequences if one alternative was selected over another.

Estuarine Mangroves
As described in Sections 5.4.2, 5.2.3 and 5.2.4, mangroves are found along the shorelines of the northern estuaries. Urbanization/shoreline development has resulted in an extensive loss of these mangrove communities. The salinity balance needed for mangroves varies among species. Each mangrove species has a different level of salt tolerance, which in part determines its location in tidal zones. Mangroves are highly dependent on freshwater runoff to maintain an optimum salinity balance. Changes in freshwater discharges to the estuaries from any of the alternatives would not be substantial enough to cause adverse effects to mangroves in any of the estuaries within the study area. The Preferred Alternative schedule would benefit mangroves as well as SAV because it provides the ability to make long-term, low volume releases to the estuaries, when the estuaries would benefit from such releases. The intent of the releases is to maintain desired salinity in the estuaries, and reduce the potential for future prolonged high-volume releases that may be undesirable for estuary vegetation.

6.2.3. EVERGLADES AGRICULTURE AREA

Under any of the alternatives, regulatory discharges from Lake Okeechobee will be confined to existing canal systems and flow through the EAA without impacting existing vegetation. Furthermore, native vegetation, within remnant wetlands and within the Rotenberger and Holey Land WMAs will not be impacted.

6.2.4. WATER CONSERVATION AREAS (GREATER EVERGLADES)

Peat dry-out, total weeks: Evaluation is based upon the number of weeks that water depths fell below one foot or lower below the surface. Peat dry-out increases the frequency and severity of peat fires, which can severely damage wetland ecosystems. The target is to reduce the weeks of very low water tables. Lower numbers are preferred. All of the alternatives increase the number of weeks of peat dry-out relative to the No Action Alternative (Figure 6-1).

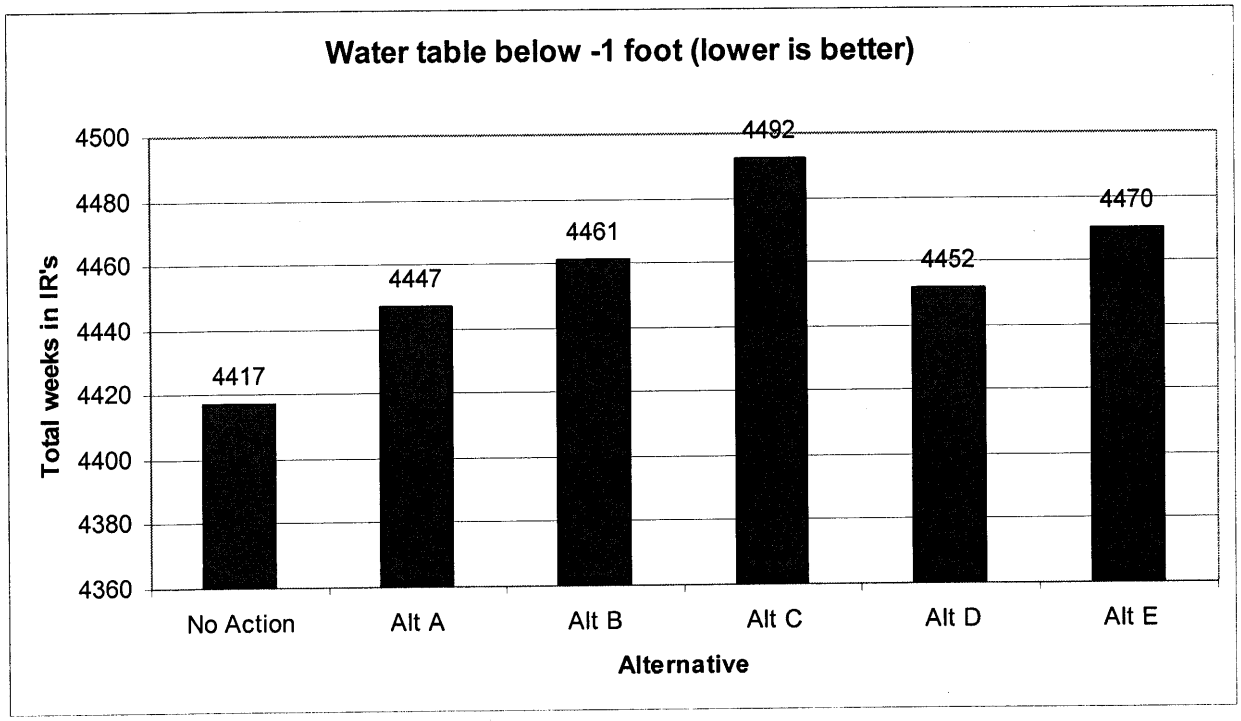

FIGURE 6-1: WEEKS OF PEAT DRY OUT OVER 36-YEAR SIMULATION PERIOD

Tree island inundation: Tree species on tree islands are adapted to a period of inundation. However, excessive periods of long-term inundation can reduce the survival of tree species when one year, or a succession of years, exceed the tree species tolerances. The tree island inundation PM records the duration, in weeks, of water depths above two and a half feet. The preferred number of weeks should not exceed 17 per year. Although the total number of weeks (events * duration) varies, none of these differences is ecologically significant (Figure 6-2) because they do not exceed an overall average of 17 weeks per year.

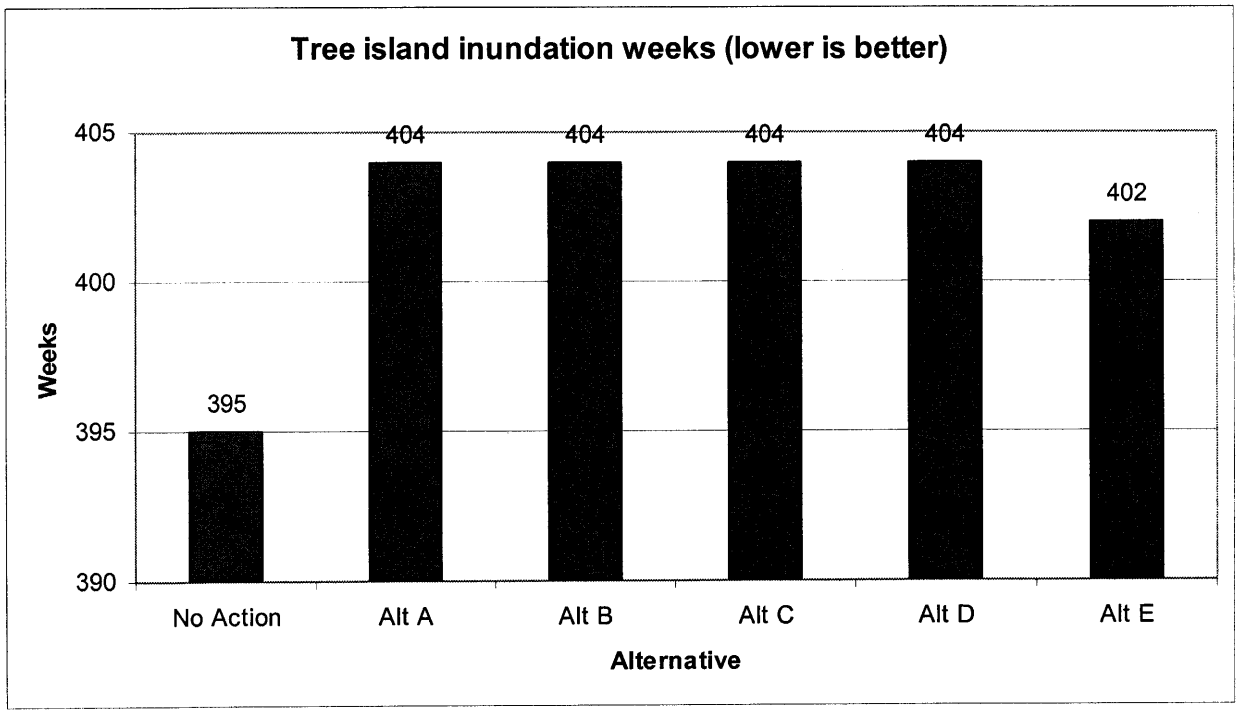

FIGURE 6-2: TOTAL WEEKS OF TREE ISLAND INUNDATION (NONE EXCEED 17 WEEKS PER YEAR AVERAGE)

6.3. THREATENED AND ENDANGERED SPECIES

Formal consultation in accordance with the Endangered Species Act (ESA) included submittal of an initial Biological Assessment (BA) to the USFWS on June 30, 2006. Updated information and a subsequent revised BA was sent to USFWS on December 15, 2006, following selection of a new alternative. The updated information did not change the Corps' original effect determinations. Additional information on ESA consultation is found in Appendix H.

The Corps initiated consultation with NMFS by letter dated August 10, 2006. The draft SEIS constituted as the BA for Johnson's seagrass on the east coast, and smalltooth sawfish on the west coast. The NMFS replied by letter dated September 27, 2006 that additional information was needed for evaluation of the Preferred Alternative. The Corps responded to the NMFS need for additional information by addressing their comments within this EIS, and by separate cover letter.

6.3.1. EVERGLADE SNAIL KITE

No Action Alternative

The issue of high water levels and the detrimental effects on the littoral zone of Lake Okeechobee has been a major concern since the 1990s, and a major focus of the LORSS. The littoral zone of Lake Okeechobee provides one of the largest habitats in south Florida for the snail kite (Bennetts and Kitchens, 1997) and it supports large populations of wading birds (Smith et al., 1995). High water effects result in declines of

submerged plants, as well as loss of bulrush and other emergent vegetation, where apple snails (main food source for the snail kite) lay their eggs.

Under the No Action Alternative, during abnormally wet periods of heavy rainfall and runoff, Lake Okeechobee would continue to experience high stages >16 feet, NGVD, and extreme high lake stages >17 feet, NGVD. During periods of extreme high lake levels (>17 feet), wind and erosion cause emergent and submerged plants to be torn loose from their substrate, resulting in a loss of important fish and wildlife habitat. When compared to the other alternatives, the No Action Alternative ranks the worst for high lake stage events, and is the only alternative with prolonged periods of moderately high lake stages (>15 feet for 365 days). Prolonged inundation of the littoral zone by stages >15 feet under the No Action Alternative reduces diversity of marsh vegetation on which that species depends. This alternative would continue to allow high lake stages which could adversely affect the Everglade snail kite.

As would be expected, since the No Action Alternative performs the worse for high lake stage events, it out performs the other alternatives for frequency of low lake stage events. As described in Section 5.3.1, prolonged extreme low lake events could be adverse for the snail kite's forage and nesting habitats, and may have adverse effects of the apple snail population. The No Action Alternative as modeled has 11 days of low stage events <11 feet.

Alternatives A through E

All of the alternatives performed essentially the same for percent of time within the stage envelope of 12.5 feet (June-July low) and 15.5 feet (November–January high). Habitat for the snail kite is expected to improve with a water management regime that mimics more natural hydrologic variability. Alternative C ranks the best with 27.3 percent of time in the stage envelope, and Alternative E ranks slightly less at 25.3 percent (Table 6-1). A wide body of published research documents the benefits of seasonally variable water levels within this range for the benefit of many plants and animal communities on Lake Okeechobee.

Alternatives A through E were developed to manage Lake Okeechobee at lower elevations, reducing the frequency of high lake stage events. Alternatives A through E reduce the frequency of events >17 ft. According to Bennetts and Kitchens (1997), snail kites nest primarily in willow and other woody vegetation types. One factor contributing to loss of this habitat in Lake Okeechobee includes prolonged periods of deep water. Compared to the No Action Alternative, which has 11 events where the lake stage is above 17 feet, Alternatives A through E reduce these events considerably as indicated in Table 6-1.

Extreme low lake stage is defined by the technical experts to be a depth below ten feet. It is at this level that detailed field observations during the 2000-2001 drought indicated that negative effects (rapid spread of terrestrial weedy plants, loss of nearly all the submerged vegetation habitat and loss of the apple snail population) occurred. These extreme low conditions could impact nesting and foraging habitat for the snail kite.

Macro-invertebrates such as the apple snail are impacted by extreme low water levels due to effects on plant habitat. Because snail kites feed almost exclusively on the apple snail, *Pomacea paludosa*, their survival depends directly on the hydrologic functioning of watersheds (Bennets et al., 1998). Apple snails require water levels above ground surface in order to produce egg clusters, and newly hatched snails are less able to survive dry periods than are adult-sized snails (Darby 2003). Darby (2003) has documented a peak in apple snail egg cluster production in March-April and has suggested that dry-outs below ground level prior to or during this peak can substantially reduce apple snail populations through reduced egg cluster production and reduced hatchling survival. Lake Okeechobee would experience increased number of low lake stage events under alternative A through E, with Alternative E (Preferred Alternative) having slightly more events below 11 feet (Table 5-1). The PM shown in Table 6-1 (<11 feet for >80 days) is useful for comparing the alternatives with regard to apple snail effects. Events below 11 feet are not necessarily negative for the snail kite, unless the duration of this event is prolonged, or occurs during the peak period of apple snail egg production, or during the peak of snail kite nesting. A prolonged period of extreme low stage in 2000-2001 appeared to have nearly eliminated the apple snail population from Lake Okeechobee's littoral zone (Havens and Gawlick, 2005). Additionally, if water recedes too quickly during snail kite nesting season, there is a chance for nest collapse and/or nest predation.

Alternatives A through E may have some negative effects on the snail kite and its critical habitat due to low lake stage occurrences; however, it is expected that the overall effects of implementing any of these alternatives over the No Action Alternative would be beneficial to the species.

For snail kite effects in the greater Everglades, refer to Section 6.4.4.

6.3.2. WOOD STORK

The quality of foraging habitat within Lake Okeechobee is expected to improve as a result of lower lake levels and a more natural hydrologic variability (moderately declining water levels during the wading bird nesting season) achieved by all alternatives compared to the No Action Alternative. Wood storks are also found within other areas of the LORSS region such as greater Everglades and along the Caloosahatchee River and St. Lucie canal.

Alternatives A through E may affect the wood stork, but beneficial effects are expected for this species. The No Action Alternative would continue to allow high lake levels, adversely impacting Lake Okeechobee's littoral zone that the wood stork utilizes.

6.3.3. WEST INDIAN MANATEE

As described above for the snail kite, all alternatives, except the No Action Alternative, would be beneficial for Lake Okeechobee's littoral zone plant and animal communities. All alternatives, except the No Action Alternative, would reduce the frequency of high water levels that have been detrimental over the years to Lake Okeechobee's resources. If littoral zone improvements are achieved, then there is the potential for an

increase in the vegetative community on which the manatee feeds. There would be no significant adverse effect on habitat conditions for the manatee within Lake Okeechobee as a result of any of the alternatives.

The Caloosahatchee River Estuary also serves as critical habitat for the manatee. The Caloosahatchee National Wildlife Refuge located adjacent to I-75 on the Caloosahatchee River and the Ding Darling Wildlife Refuge at Sanibel Island, along with many other coastal areas in the study area, serve as a refuge and provide suitable habitat for the manatee. Based on the evaluation and discussion in Section 6.2, Northern Estuaries, it has been determined that the Preferred Alternative provides significant improvements to the estuaries in the number of months in the acceptable flow range. Similarly, the Preferred Alternative is equal to or better than the No Action Alternative in reducing the number of high flow releases from Lake Okeechobee. As such, there would be no effect on the manatee or its critical habitat from the Preferred Alternative.

6.3.4. BALD EAGLE

The potential improvement to conditions of Lake Okeechobee's littoral zone may result in enhanced productivity of fish in the lake. Additionally, potential improvements to the coastal estuaries may result in enhanced productivity of fish. As such, foraging conditions may be slightly improved for the eagle for all alternatives compared to the base. It is determined that the Preferred Alternative, or any of Alternatives A through E, would have no effect on the bald eagle.

6.3.5. EASTERN INDIGO SNAKE

The Eastern indigo snake occurs primarily on uplands. Implementation of any of the alternatives, including the No Action Alternative, would not affect the Eastern indigo snake.

6.3.6. CAPE SABLE SEASIDE SPARROW

The modeling simulations indicate that the hydrology of the indicator regions of the Everglades corresponding to occupied CSSS habitat is not adversely affected by the No Action Alternative or Alternatives A through E. Therefore, neither the species nor its designated critical habitat would likely be affected by these alternatives.

6.3.7. OKEECHOBEE GOURD

The Okeechobee gourd would benefit from any of the alternatives, except the No Action Alternative, as all of the alternatives lower the high lake stages. By decreasing the high stage events, Alternatives A through E would allow for more low lake stage events. As such, there would be a potential benefit to listed species, such as the Okeechobee gourd, where a lower lake stage is crucial for its survival. Low lake stages allow for suitable habitat areas within the littoral zone that are able to dry out and allow for seed germination. Implementation of the Preferred Alternative or any of the described alternatives may affect the gourd; however, the reduction of extreme high water under these alternatives would be beneficial overall to this species.

6.3.8. SMALLTOOTH SAWFISH

Since the Florida smalltooth sawfish population is currently restricted to waters of southwest Florida, releases from Lake Okeechobee to the St. Lucie Estuary will not affect this species. It would be more common for the smalltooth sawfish to be found along the coastal areas of the Caloosahatchee Estuary, or near the mouth of the Caloosahatchee River. Some research and monitoring in the Charlotte Harbor estuarine system is currently being conducted by the FFWCC. In studies documenting occurrences of sawfish along the southwest coast of Florida, anglers have reported encountering sawfish on a regular basis in the Charlotte Harbor area, and near the mouth of the Caloosahatchee River (Seitz and Poulakis, 2002). As part of the Charlotte Harbor study, the FFWCC is currently conducting monthly random sampling for sawfish in the Caloosahatchee River (FFWCC, 2005).

It has been documented that juvenile sawfish use shallow habitats with a lot of vegetation, such as mangrove forests and SAV, as important nursery areas. Although the studies referenced in this EIS did not document information on salinity, species distribution maps showed no occurrences in areas of permanent freshwater and many occurrences in estuarine areas. Simpfendorfer and Wiley (2005) reported that the smalltooth sawfish is likely to occur in freshwater only in estuarine areas that are receiving high levels of freshwater input and so are temporally fresh. Simpfendorfer and Wiley (2005) concluded that further study will be required to determine the tolerance of the smalltooth sawfish to freshwater and whether long-term exposure to very low salinities or freshwater leads to changes in distribution. Since minimal information is known at this time about the salinity tolerance levels of the smalltooth sawfish and how salinity levels affect this species, the Corps has determined that the proposed alternative regulation schedule would not likely adversely affect the sawfish. A more stable salinity regime under the Preferred Alternative may result in increased SAV coverage, and therefore increase the population of small fish and benthic organisms, which are a food source for the smalltooth sawfish.

6.3.9. JOHNSON'S SEAGRASS

One of the objectives of this study is to reduce high regulatory releases to the St. Lucie Estuary, and thereby improve the salinity regime to the area. As discussed in Section 6.2, the Preferred Alternative has the highest number of months of any alternative in the acceptable flow range of 350 cfs to 2000 cfs. This is a significant improvement with the performance for the St. Lucie Estuary. Mean monthly total inflows in the 2000–3000 cfs range are known to result in low salinities throughout the St. Lucie Estuary, with flows greater than 3,000 cfs potentially causing impact to marine waters in the Indian River Lagoon. The Preferred Alternative improves flows greater than 2,000 cfs by one month over the POR, as compared to the No Action Alternative. This one-month decrease in high flow events is minor; however, when focusing in on the mean monthly flows during March through June (critical spawning time in estuary) the Preferred Alternative out-performed the No Action Alternative by having seven fewer months greater than 2000 cfs.

The decreased freshwater discharges from Lake Okeechobee would cause less stress to seagrasses, including Johnson's seagrass, in the Indian River Lagoon. As such, the Corps has determined that the Preferred Alternative, Alternative E, is not likely to adversely affect Johnson's seagrass, or critical habitat for Johnson's seagrass.

6.3.10. STATE LISTED SPECIES

Of the State listed species not evaluated above, the American alligator, brown pelican, and black skimmer (species of special concern) may slightly benefit from the Preferred Alternative by the improved fish production in Lake Okeechobee, which those species consume. The wading birds, roseate spoonbill, limpkin, little blue heron, reddish egret, snowy egret, tricolored heron, and white ibis, may benefit by the improved spring water recession regime.

6.4. FISH AND WILDLIFE RESOURCES

The effects analysis for fish and wildlife resources overlaps, or compliments, the effects on vegetation in Section 6.2. To avoid duplication of analysis, refer to Section 6.2 for additional information on fish and wildlife resources.

6.4.1. LAKE OKEECHOBEE

Although the pelagic zone of Lake Okeechobee is important in supporting commercial and recreational fisheries, the littoral zone of Lake Okeechobee is highly productive, sustains a greater diversity of fish and wildlife, and is the area most affected by changes to the LORS. Lake Okeechobee's littoral zone provides critical habitat for fish and wildlife, including Federal listed species as described in Section 6.3. A general understanding of how fish and wildlife respond to changes in habitat structure and resource availability leads to a consensus among experts that Lake Okeechobee's fish and wildlife may be harmed by extreme high and low stage events (Havens et al., 2004c; FFWCC, 2003).

The extreme water levels can completely dry out or inundate Lake Okeechobee's entire littoral zone. The current LORSS focused on alternatives that would allow lower occurrences of extreme high water events, since high water levels have been a major concern since the 1990s due to the detrimental effects on the ecology of Lake Okeechobee. Scientists observed a large-scale loss of aquatic vegetation and impacts to fisheries in Lake Okeechobee when high water conditions persisted from 1995 to 1999 (Havens, et al., 2001). Greater water depths have devastated woody plants, and submerged and emergent macrophytes, resulting in habitat destruction and alteration of primary production in the Lake Okeechobee ecosystem (FFWCC, 2003).

Maintaining the heterogeneous native plant communities, which are intrinsic to a healthy lake littoral zone, may also facilitate an improvement in fish stocks and wading birds under conditions brought about by the Preferred Alternative. By improving lake hydroperiods, including a lowering of overall lake stages and reductions in both prolonged high and extreme high lake stages, conditions for wading bird foraging, nesting, spawning and feeding habitat for fish should be improved. When low-to-moderate water levels occur in Lake Okeechobee, resulting in dense plants such as

bulrush and peppergrass, the biomass and taxonomic diversity of macro-invertebrates is maximal (Warren and Vogel, 1991). Many of these animals, including grass shrimp, amphipods, and a variety of larvae are integral to the diets of largemouth bass, black crappie, redear sunfish, and bluegill sunfish (Havens and Gawlick, 2005). Alternatives A through E will reduce the occurrences of high lake levels as indicated in Table 6-1, which will benefit fish and wildlife resources in Lake Okeechobee.

All of the alternatives will have more occurrences of extreme low lake levels compared to the No Action Alternative as indicated in Table 6-1. The duration of these low lake stage events is critical to the degree of effects. Much emphasis is placed on the low lake stage PM because it is extremely useful for evaluating potential effects on the endangered snail kite, in particular effects on its habitat and food source as discussed in Section 6.3.1. During extreme low lake levels, mobile species such as manatees, alligators, turtles and predator fish could seek refuge in Lake Okeechobee's rim canal, or principle navigation canals.

6.4.2. NORTHERN ESTUARIES

A critical reproduction period for many estuarine dependent organisms is during the period of March–June. The volume, duration and timing of freshwater inflow to estuaries is extremely important for the optimal balance of salinity. Oysters are commonly used as an indicator of spawning season, but many other species of saltwater fish begin spawning in late winter/early spring. Without optimum salinity, because of excessive freshwater, other fish species may be affected too by fresh water releases. It is during the springtime that freshwater flows to the estuaries should be monitored closely and possibly reduced, so larvae are retained in the system and not flushed out by excessive freshwater flows. Freshwater releases should be monitored to allow for appropriate salinity conditions for oyster reproduction. Optimal salinity for spawning is 10-30 ppt (Mazzotti, et al. 2003).

Caloosahatchee Estuary

Alternatives A through E out-performed the No Action Alternative, having fewer months with mean monthly inflows greater than 2800 cfs (Table 6-6). The Preferred Alternative had seven fewer months, compared to the No Action Alternative, of flows greater than 2800 cfs.

TABLE 6-6: CALOOSAHATCHEE ESTUARY

Mean Monthly Flows: Mar-Jun			
CFS:	<450	450-2800	>2800
No Action	75	46	23
Alt A	43	84	17
Alt B	44	82	18
Alt C	49	78	17
Alt D	56	73	15
Alt E (preferred)	56	72	16

St. Lucie Estuary

During the critical period (March-June) when many estuarine dependent species reproduce, the alternatives all out-performed the No Action Alternative, having fewer months with mean monthly inflows greater than 2000 cfs. The Preferred Alternative tied Alternative B with six less months of flows greater than 2000 cfs (Table 6-7).

TABLE 6-7: ST. LUCIE ESTUARY			
Mean Monthly Flows: Mar-Jun			
Alternative	<350	350-2000	>2000
No Action	60	61	23
Alt A	61	65	18
Alt B	62	65	17
Alt C	62	61	21
Alt D	58	66	20
Alt E	60	67	17

Lake Worth Lagoon

Alternatives A through E either out performed or equaled the No Action Alternative. Analysis of the seven-day moving average revealed only small differences between the alternatives with times exceeding 500 cfs all falling within five or six days of each other Table 6-8. Analysis of the two-day moving average indicated that the Preferred Alternative equaled the No Action Alternative while all other alternatives had fewer exceedances of the 1000 cfs criterion. Results for the alternatives all fell within three to 11 days of each other. Comparing differences (five to six days, three to 11 days) to the number of days in the POR (>13,000) provides perspective on just how small these differences are. The differences between the alternatives were so minimal, that it would be difficult to discern any ecological consequences if one alternative was selected over another.

TABLE 6-8: LAKE WORTH LAGOON			
Moving Average Flow (S40 + S41 + S155)			
Number of days in 36 year POR			
CFS:	7-day ≤ 500	7-day > 500	2-day >1000
No Action	12,717	432	420
Alt A	12,740	409	412
Alt B	12,742	407	409
Alt C	12,736	413	414
Alt D	12,737	412	412
Alt E (preferred)	12,736	413	420

6.4.3. EVERGLADES AGRICULTURAL AREA

Under any of the alternatives, regulatory discharges from Lake Okeechobee would be confined to existing canal systems and flow through the EAA without impacting

agricultural fields or remnant wetlands where wildlife may occur. Although canal stages may be slightly higher at certain times of the year, this is not expected to be at any level that may affect existing fish and wildlife habitat.

6.4.4. WATER CONSERVATION AREAS (GREATER EVERGLADES)

Wading Bird Nesting Success: Wading birds nest from January through May in the Everglades. The two PMs that target wading birds are recession rates and reversals. Recession rates describe the declines in water depths, and reversals are defined as rapid increases in water depths.

Recessions: As water depths decline in the dry season, wading bird food species are concentrated in the shallower water, increasing the wading birds' feeding efficiency. Optimal water depths for wading birds vary with the species, and move across the landscape as water depths decrease. The concentrated prey allows the parent birds to feed their hatchlings and to successfully fledge the year's young. The months that are important for this PM are January through May each year.

Target recession rates are -0.1 foot per week. This measure reports the number of weeks that recession rates fall into the "good" category (declining water depths between 0.16 and 0.05 feet per week). The goal is to increase the percent of weekly recession rates falling into the "good" category during the wading bird breeding season. Higher numbers are better. The Alternatives are slightly better than the No Action Alternative (Figure 6-3), but the differences are not ecologically significant.

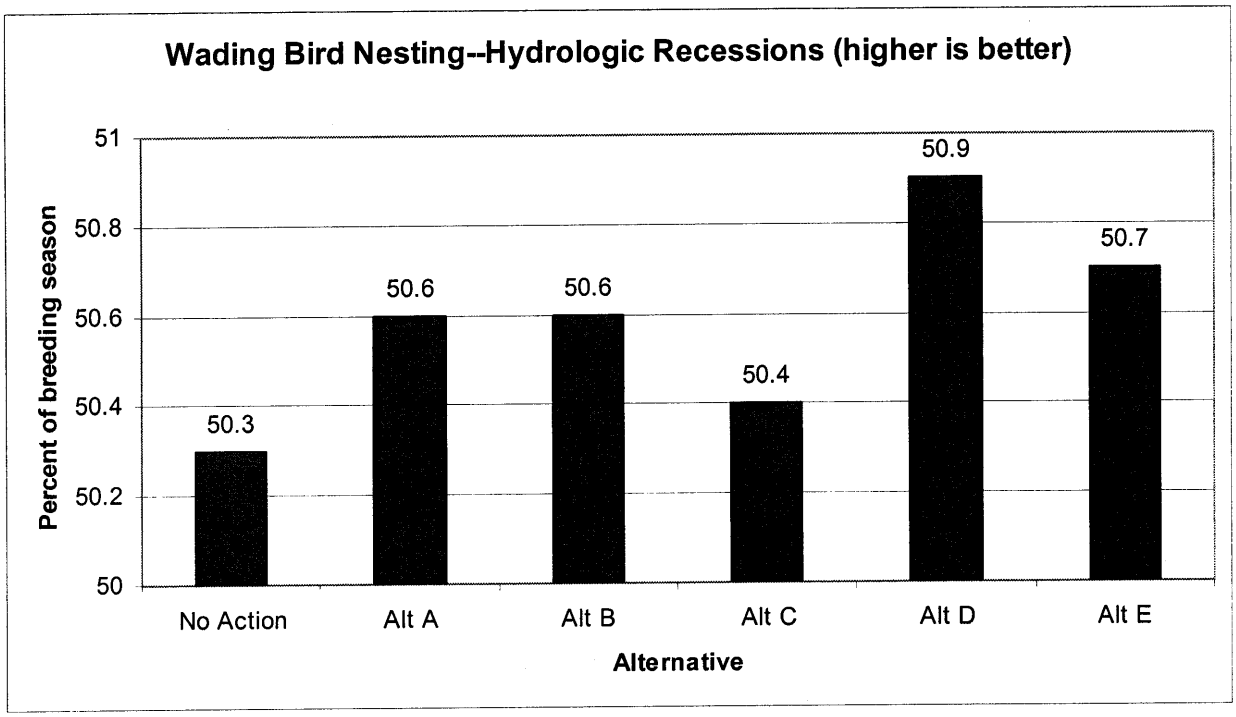

FIGURE 6-3: PERCENT RECESSIONS DURING THE WADING BIRD BREEDING SEASON

Reversals: When water depths increase during the breeding bird season (January through May), food prey concentrated in shallower pools disperse, reducing feeding efficiencies of the parent birds. Reduction in feeding reduces nesting success of wading birds, so reversals should be avoided during this period of the year. This PM summarizes the percent of weeks of reversals (when recession rates are above the desired recession rates and increasing). Lower numbers are better. For this PM, reversals are slightly better for all alternatives (Figure 6-4) relative to the No Action.

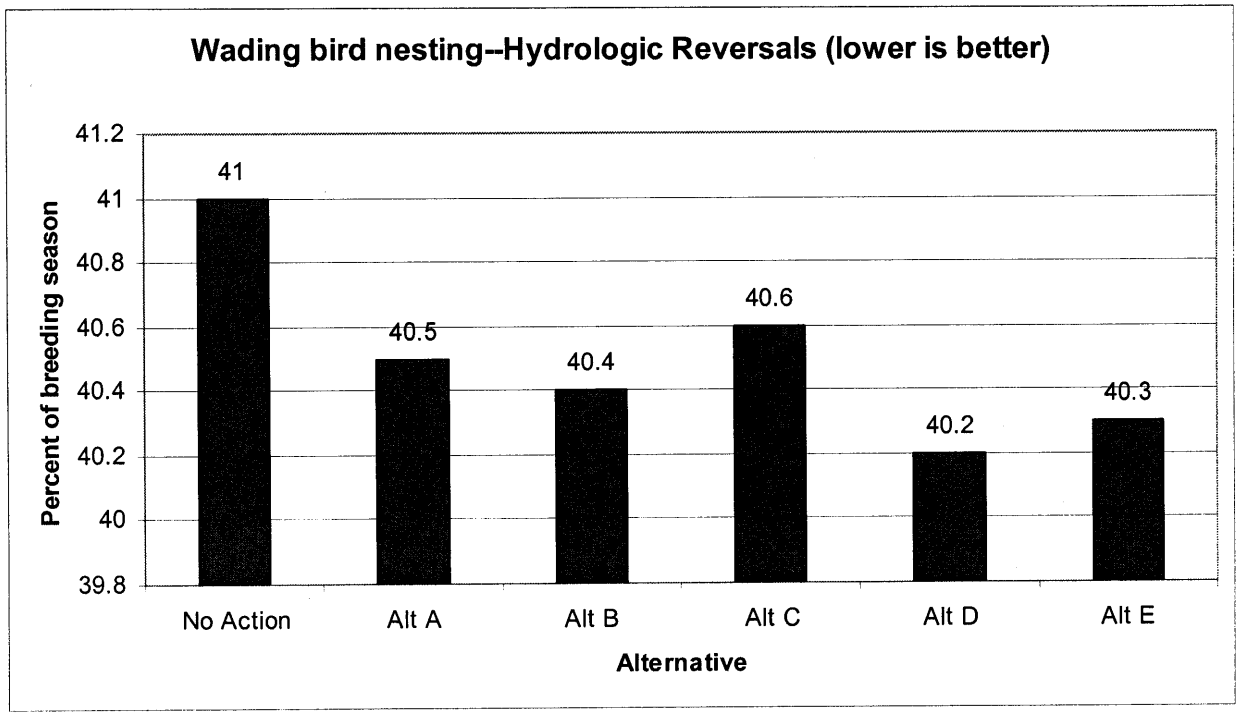

FIGURE 6-4: PERCENT REVERSALS DURING THE WADING BIRD BREEDING SEASON

Greater Everglades Snail Kite: Like the wading birds, snail kites also reproduce during the early part of the year and feed upon apple snails. Rapid water depth reversals are harmful to apple snail reproduction, and loss of a year's cohort of apple snail eggs impacts snail populations for two to three years. Lack of prey inhibits snail kite reproduction and survival and therefore conditions that decrease apple snail populations negatively impact snail kites. Higher is better. Alternatives A and B performed slightly better than the other alternatives for the snail kite (Figure 6-5).

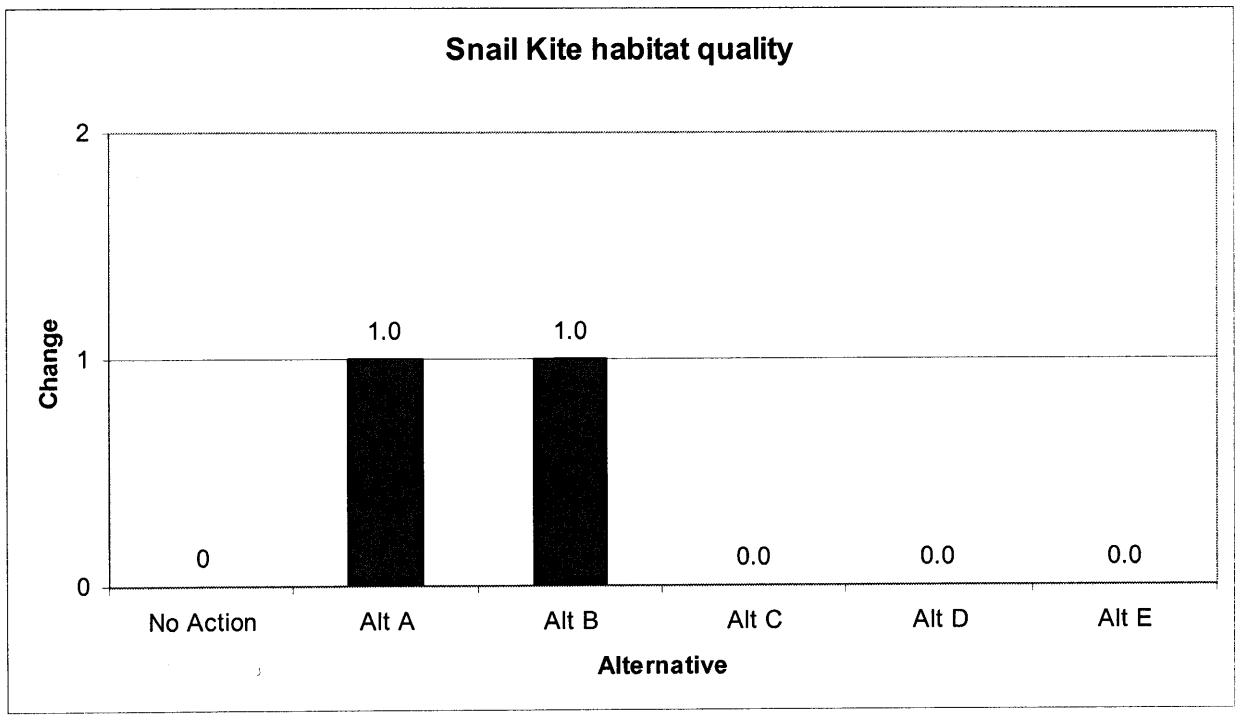

FIGURE 6-5: COMPARISON OF SNAIL KITE HABITAT SUITABILITY

6.5. ESSENTIAL FISH HABITAT ASSESSMENT

6.5.1. PREFERRED ALTERNATIVE

In addition to this section, further evaluation of estuary effects for the Preferred Alternative can be found in Sections 6.2.2 and 6.4.2.

The Preferred Alternative shows improvement to both the Caloosahatchee and St. Lucie estuaries, and the Lake Worth Lagoon. High freshwater flows are equal to or reduced for the Caloosahatchee Estuary and the St. Lucie Estuary, thereby potentially reducing the frequency of algal blooms, turbid water and fish kills. Although improvements are not substantial, improved conditions for sensitive estuarine biota, such as species dependent on this habitat for egg, larval, and juvenile stages, may be seen. The Preferred Alternative will reduce the number of flows >2000 cfs from Lake Okeechobee to the St. Lucie Estuary. This reduction in high regulatory flows may provide improvement for the St. Lucie Estuary. Improved conditions within estuarine communities may result in improvements to SAV, oysters, fish, such as redfish, grouper, snook and spotted seatrout, and other fauna in the estuary.

Springtime is a critical period in estuarine systems because many estuarine dependent organisms reproduce at this time. High flows >2800 cfs in the Caloosahatchee and >2000 cfs in the St. Lucie, may prevent the early life stages of fish, shellfish and other commercially and recreationally important species from utilizing estuarine habitat.

Alternatives with the fewest number of mean monthly flows exceeding these limits are to be preferred.

One important operational change from the No Action to the Preferred Alternative is the built in flexibility of the Preferred Alternative to provide relief to the estuaries. This was accomplished through the ability of the Preferred Alternative schedule to make long-term, low volume releases to the estuaries, when the estuaries would benefit from such release. These releases include low-volume pulse releases and base flow releases. The intent of the releases is to maintain desired salinity in the estuaries, and reduce the potential for future prolonged high-volume releases that may be undesirable to EFH such as SAV.

6.5.2. ALTERNATIVES A THROUGH E

Refer to discussions in Section 6.2.2 and 6.4.2.

6.6. HISTORIC PROPERTIES

Historic properties would not be affected by any of the alternatives.

6.7. SOCIO-ECONOMIC

The following discussion of socio-economic existing conditions focuses on the principal social and economic forces of the Lake Okeechobee region. The forces include: commercial navigation via the Okeechobee Waterway, agriculture in the area immediately surrounding Lake Okeechobee, urban municipalities, recreation and sport and commercial fishing. More detailed information on the socio-economic conditions within the study area are presented in Appendix D.

Commercial Navigation

The Lake Okeechobee Waterway connects Stuart on the Atlantic Ocean with Ft. Meyers on the Gulf of Mexico. It includes 154 miles of navigation channel and five lock and dam structures. The Port Mayaca and Moore Haven locks connect Lake Okeechobee to the St. Lucie Canal and Caloosahatchee River respectively. Commercial navigation on this waterway has been stable over the ten year period from 1988-1998, with sustained year to year variation (USACE 1998). The Lake Okeechobee Waterway was used to transport 430,000 tons of freight in 1995. Petroleum products were the predominant commodities transported (USACE 1998). There are no commercial shipping lines that regularly pass through the waterway, rather traffic consists primarily of special barge traffic which takes advantage of the shortcut across the Florida peninsula, saving about three to five days of travel.

Agriculture

The immediate area surrounding Lake Okeechobee is largely rural, with agriculture being critical to the local and regional economy. There are estimated to be over 700,000 irrigated acres of farm land in the LOSA, which includes the EAA. The EAA alone, accounted for over $750 million in agricultural production, and provided employment for over 20,000 full time workers in 1989 (Snyder and Davidson, 1994). Agricultural production consists predominantly of sugarcane, as well as rice, row crops,

and sod. There is also extensive improved and unimproved pastureland, particularly west and north of Lake Okeechobee. The St. Lucie and Caloosahatchee basins, which also receive irrigation water from Lake Okeechobee, contain an estimated 138,000 and 49,000 acres, respectively of citrus crops, sugarcane, vegetables, sod, and ornamentals (USACE 1998). During prolonged droughts, significant volumes of water are required by the agricultural community in the Lower East Coast. Row crops such as truck vegetables, are the predominant crop type in the Lower East Coast.

Urban

The urban landscape surrounding Lake Okeechobee includes the incorporated municipalities of Belle Glade, Clewiston, Moore Haven, Okeechobee City, Pahokee, and South Bay. These communities range in population from approximately 1,635 (Moore Haven) to 14,906 (Belle Glade). Residential and commercial water users depend on Lake Okeechobee's water supply for well field recharge, drinking water, and industrial processes.

In addition to the area immediately surrounding Lake Okeechobee, the populations of the Caloosahatchee and St. Lucie basins, and of the Lower East Coast, can be affected by Lake Okeechobee operations. The 2000 population of the affected 16 county region was approximately 8.5 million. The combined population of these areas, along with the rural areas adjacent to Lake Okeechobee, accounts for just less than 40 percent of the State's population. The economy of south Florida is based on services, agriculture, and tourism. The Lower East Coast counties' economies are strongly oriented to the services industry, while the counties surrounding Lake Okeechobee are heavily agricultural.

Recreation and Sport Fishing

Lake Okeechobee is the largest recreational resource in the region and provides a wide variety of water based recreation including fishing, boating, picnicking, sightseeing, camping, swimming, hunting, airboating, and hiking. The littoral zone, along Lake Okeechobee's western shore, provides valuable habitat for the lake's popular sport fishery. Lake Okeechobee is recognized as supporting one of the best recreational fisheries in the nation. A variety and abundance of sport fish, including largemouth bass, black crappie, bluegill, and redear sunfish are targeted by sport fishermen from around the country. Consequently, sport fishing is a major activity on Lake Okeechobee. There is also several major sport fishing tournaments held on Lake Okeechobee annually, which bring significant revenues to the marinas, fishing guides, hotels, and support industries along the lake. It should be noted that Lake Okeechobee supports several commercial finfishing endeavors, including fisheries for bullhead catfish, gizzard shad, striped mullet (*Mugilcephcalus*), and gar (*Lepisosteus spp*).

Heavy seasonal waterfowl utilization of Lake Okeechobee attracts tourists and recreational enthusiasts, such as hunters. Common waterfowl species include ring-necked duck (*Aythya collaris*), American wigeon (*Anas americana*), Northern pintail (*Anas acuta*), green-winged teal (*Anas crecca*), blue-winged teal (Anas discors), lesser scaup (*Aythya affinis*), and Florida duck (*Anas fulvigula*).

Lake Okeechobee has been a historic tourist destination for purely aesthetic reasons. Airboat rides are popular tourist activities on Lake Okeechobee. Recreation levels in 1996 at Lake Okeechobee are estimated at over 64,000 visitor-hours, with an annual value of over $78,000,000 (USACE 1998).

Commercial Fishing

The commercial fishing industry in Lake Okeechobee utilizes primarily haul seines to catch bluegill, redear sunfish, and catfish. Catfish are caught by trot lines, and wire traps. Bullhead, shad, gar, mullet, and tilapia are also caught, although since the net ban, mullet are no longer considered a commercial species. There are reports of commercial mullet trapping on Lake Okeechobee, mostly in the canals (FFWCC pexs. corn.). The annual wholesale value of the commercial fishery was estimated in 1998 (USACE) to be approximately $2,326,932, employing about 210 fishermen and landside workers.

There are also commercial fisheries on Lake Okeechobee, which harvest the American alligator and the Florida soft-shell turtle (Diemer and Moler, 1995). Alligators are harvested from the lake population to supplement the stock in alligator tanning operations. Soft-shell turtles are harvested by commercial fishermen, with some individual yields in excess of 13,640 kilograms (30,000 pounds) annually. The majority of the harvest is prepared for shipment to Japan, or sold locally, primarily to the Miccosukee Tribe of Indians of Florida.

Land Use

The following section will address the general land use within the vicinity of Lake Okeechobee. The area is rural in character with most lands dedicated to agriculture. In general, sugar cane is the predominant crop in the south, row crops and sugar cane in the east, and pastureland with dairy production in the north. Urban areas, which are generally few and modest in population, service the agriculture sector, as well as the tourists who come to Lake Okeechobee to fish, hunt, and enjoy other recreational pursuits.

Agriculture

There is an abundance of agricultural lands surrounding Lake Okeechobee and throughout the affected area. The section below discusses the existing agricultural conditions by physiographic region, beginning with the largest area, the EAA, immediately south and east of Lake Okeechobee.

Everglades Agricultural Area

More than 600,000 acres are farmed in Palm Beach County (UFBEBR, 1995), and sugarcane was harvested in about half of that acreage in 1996 (FASS, 1996d). Much of this acreage is likely categorized as unique farmland based upon its location, growing season, and high value crops, including sugarcane and vegetables. Sugarcane receipts accounted for 68 percent of total field crop sales in Florida in 1996 (FASS, 1996c). The EAA is known for its sugarcane production and sugar processing, but Palm Beach County also ranks 15th among Florida counties for acres of citrus (PASS,

1996b). This region is characterized by mid-size farms averaging 690 acres each with high productivity of more than $1300 per acre (UFBEBR, 1995). More than 18,000 people are employed in agricultural production and services representing a payroll of more than $26 million (UFBEBR, 1995). Total market value of agricultural products in Palm Beach County is approximately $900 million, ranking it first among counties in the State of Florida (UFBEBR, 1995) and third among U.S. counties (FDACS, 1994).

The EAA is highly dependent upon the system of canals running through the region to provide necessary drainage of excess water during the wet season as well as supplemental water supplies for irrigation during the dry season. Approximately two thirds of the land farmed in the EAA is irrigated, totaling more than 400,000 acres (UFBEBR, 1995). The EAA has traditionally relied upon Lake Okeechobee for its water supply during drier periods, and looked to the WCAs to the south to receive their excess drainage.

Continued agricultural production in the EAA has become increasingly controversial. Some of the factors that may affect the EAA agriculture include water quality concerns, soil subsidence, and urban encroachment. The water quality concerns, particularly phosphorus loading, are being addressed through best management practices, STAs, and growing use of organic farming practices and rice cultivation in rotation with sugarcane production. Although sugarcane cultivation in the EAA has come under some sharp criticism in recent years, sugarcane is recognized as the most appropriate crop for this region. Sugarcane requires less phosphorus fertilizer than other crops grown in the EAA (Sanchez, 1990), and sugarcane has been found to remove 1.79 times more phosphorus than was applied as fertilizer (Coale et al., 1993). Florida sugarcane only requires small amounts of pesticides due to disease resistant and tolerant cultivars, and uses cultivation instead of herbicides for weed control. Sugarcane also tolerates greater variability in water table levels, allowing for more flexible water management strategies (Glaz, 1995).

Soil subsidence has become a potential threat to long-term crop production in the EAA. The average historic rate of subsidence of one inch per year has slowed to 0.56 inches per year since 1978 (Shih et al., 1997). The lower rate was attributed to several factors including higher water tables and an increased proportion of land planted to sugarcane. Surveys conducted by Shih et al. (1997) found an average of 1.62 feet to 4.36 feet of soil remaining over I1 transects. Prevention of continued soil subsidence will depend on maintaining high ground water levels to prevent further oxidation of the soil profile. This, in turn, will require development of more water-tolerant sugarcane varieties and/or increased rice cultivation. This research is currently underway and showing promising results (Glaz, 1997). A strong agricultural economy in the EAA based on profitable crop production is the best defense against conversion of agricultural land to urban land.

Kissimmee River Basin

Immediately north of Lake Okeechobee, Osceola, Polk, Highlands, and Okeechobee counties surround the Kissimmee River Basin. More than two million acres in these counties are farmed, with more than half of this area devoted to pastureland (UFBEBR,

1995). Much of this acreage is likely categorized as unique farmland based upon its location, growing season, and high value crops, including citrus. Approximately a quarter of a million acres in the Kissimmee River Basin are irrigated (UFBEBR, 19951), requiring a dependable water supply. This region is characterized by large farms with relatively low productivity per acre. These four counties are among the top five counties in Florida for cattle production, both beef and dairy (FASS, 1996a). More than 200,000 acres are used for citrus production. Approximately 11,000 people are employed in agricultural production and services representing a payroll of approximately $21 million. The market value of all agricultural products in this region totals approximately $575 million (UFBEBR, 1995).

Martin and St. Lucie Counties (Upper East Coast)
At present, the dominant land use in the basin is agriculture (covering approximately 45 percent of the basin). Agricultural activities include 228,000 acres of citrus, 211,000 acres in range and citrus, and 9,500 acres of vegetable crops (SCS, 1994). The present urban land use (17 percent of the basin) is concentrated along the coast and the lagoon shorelines. Urban growth is rapidly extending westward, replacing agricultural land. Future land use patterns indicate that this trend will continue as urbanization intensifies along the coast, especially in the southern counties (Swain and Bolohassen, 1987). Present forested uplands and wetlands comprise 11 and 18.8 percent of the basin, respectively.

Caloosahatchee River Basin
Approximately one half million acres are farmed in the Caloosahatchee River Basin, and approximately three-fourths of that area is pastureland. The region is characterized by large farms averaging 1,800 acres, with relatively low productivity per acre (UFBEBR, 1995). Glades County ranks eighth in the State of Florida for cattle production (FASS, 1996a). Citrus production in the Caloosahatchee River Basin covers more than 20,000 acres (FASS, 1996b) and is currently increasing. Much of this acreage is likely categorized as unique farmland based upon its location, growing season, and high value citrus crops. Approximately 5,000 people are employed in agricultural production and services, and the payroll totals approximately $5 million. Agricultural products in this region have a total market value of more than $135 million (UFBEBR, 1995).

More than 77,000 acres of farmland are irrigated in the Caloosahatchee River Basin (UFBEBR, 1995). Reliable water supply is a big concern in this region which has traditionally relied upon water deliveries through the Caloosahatchee River from Lake Okeechobee. Irrigation demands can be expected to increase as additional land is used for citrus production.

Urban Land Use
A significant use of land outside the agricultural context is for urban development. Five incorporated communities are situated around Lake Okeechobee and range in population from approximately 1,600 to 15,000.

TABLE 6-9: 2000 POPULATION ESTIMATES, COMMUNITIES SURROUNDING LAKE OKEECHOBEE (2000 CENSUS)

COMMUNITY	POPOULATION	COUNTY
Belle Glade	14,906	Palm Beach
Clewiston	6,460	Hendry
Moore Haven	1,635	Glades
Okeechobee City	5,784	Okeechobee
Pahokee	5,985	Palm Beach

The Brighton Seminole Indian Reservation occupies a large area of land west of Lake Okeechobee in Glades County. The southern end of this reservation is near the HHD just north of Lakeport. Major transportation corridors around the perimeter of Lake Okeechobee include several highways and railroads. County Road (CR) 78 parallels Lake Okeechobee along its western and northern shores from Moore Haven to Okeechobee.

From Lake Okeechobee, State Highway 98 follows the northern and eastern portion of the lake to Pahokee. CR 715 then follows the HHD from Pahokee to Belle Glade, where State Highway 27 follows the southern lake area back to Moore Haven and CR 78.

The municipalities of Stuart at the mouth of the St. Lucie Estuary, Fort Pierce to the north of Stuart, and Jupiter to the south, are the three principal urban centers nearest the outlet of the C-44 within Martin and St. Lucie Counties.

On the west side of Lake Okeechobee, along the Caloosahatchee River and on Charlotte Harbor, urban areas include the cities of LaBelle, Alva, Olga, Fort Myers, and Cape Coral. Land use adjacent to the Caloosahatchee Estuary is largely residential and urban with the city of Cape Coral on its northern bank and the highly urbanized City of Fort Myers on its south bank. Both of these communities have experienced rapid growth with even more growth anticipated in the near future (SFWMD, 1997).

Recreation Resources

Recreation resources in the Lake Okeechobee region are primarily water based within Lake Okeechobee and include boating, fishing, and nature interpretation. Lake Okeechobee provides approximately 40 miles of navigable waterway for commercial navigation and many more for recreational boating. Twenty-five Corps-built land and water-based recreational facilities are located along Lake Okeechobee. The Florida National Scenic Trail encompasses Lake Okeechobee atop the HHD (approximately 140 miles long). Approximately 94 percent of the recreation lands available to the public in this region are owned by the State or Federal government (SCOW, 1994). Bike riding, hiking, picnicking, camping, and nature interpretation are popular land based recreation activities in the region. Substantially altered water deliveries to this region could result in flooding and have a detrimental affect on many natural and

recreation resources in the area. The ample water based recreation resources in the Lake Okeechobee region receive extensive use and future demand is anticipated to increase. The St. Lucie Canal provides approximately 34 miles of navigable waterway with four Corps/County recreation facilities that include boating, fishing, camping and day use facilities (USACE, 1991). The approximately 44 miles of Intracoastal Waterway, within the Upper East Coast, provides many coastal recreational navigation opportunities.

Public beaches in the Upper East Coast are the most popular forms of recreation in the region. Four State of Florida Aquatic Preserves, and four State Parks and Recreation Areas are within the Upper East Coast. Five artificial coastal reefs provide popular diving and fishing spots. The region also includes high quality recreation opportunities within the Dupuis Reserve State Forest and Wildlife and Environmental Area and the St. Lucie Inlet Preserve. Overall, existing recreation resources in the region receive heavy annual usage that is expected to increase in the future.

Recreation resources in the WCA region are inland water and upland resources that include the Arthur R. Marshall Loxahatchee National Wildlife Refuge, and Rotenberger and Holey Land WMAs (SCOW, 2000). These areas provide high quality boating, fishing, and nature interpretation activities. The Miccosukee State Indian Reservation is within the WCA region boundary. Hunting, boating, and fishing occur within the Everglades WMA, including the Miccosukee State Indian Reservation.

The Caloosahatchee River provides approximately 67 miles of navigable waterway with ten Corps recreation facilities that include boating, fishing, picnicking, and camping. The J.N. "Ding" Darling National Wildlife Refuge, a popular birding area, administers Caloosahatchee, Matlacha Pass, Island Bay National Wilderness area and Pine Island National Wildlife Refuge, all located near the region's western edge. Boca Grande Pass is world renowned for record tarpon, and Sanibel and Captiva Islands are reported among the top shelling destinations in the Western Hemisphere.

Caloosahatchee State Park and Recreation Area is located near Alva on the Caloosahatchee River. Estero River and Hickory Creek State Canoe Trails are within the region and provide excellent recreation resources. Cayo Costa State Park, Sanibel Island State Park, and State Aquatic Preserves are located in the region.

6.8. AESTHETICS

Aesthetics within the study area should not be affected in the short-term. Since there will not be any structural modifications to the existing operations system, no visible impediments to existing landscapes will be present. While plant communities may change over time through varying water management practices, succession, and competition, among other factors, significant (observable) changes to plant communities usually require a few to several years to occur. Over the longer term, improved hydroperiods within Lake Okeechobee and the St. Lucie Estuary are expected to benefit native plant communities which should support enhanced numbers of native fish and wildlife. A reduction in the occurrence of prolonged and extreme high

lake stages within Lake Okeechobee for instance should reduce excessive turbidity, and enhance wading and foraging conditions and nesting success for wading birds, two components of the ecosystem which contribute greatly to the visual aesthetic/appeal. Healthier seagrass beds in the St. Lucie Estuary and Indian River Lagoon will provide better habitat for fish stocks which, although not easily seen by the casual observer, also act as food sources and support bald eagles and other fish eating raptors whose presence may enhance the wilderness aesthetic of the estuary.

There are not expected to be any affects on existing or future aesthetics within the EAA, nor to the Caloosahatchee River. Neither area benefits greatly from the proposed action in terms of improved hydroperiods and flows through these areas will not affect related resources, existing land use or other variables that may enhance or detract from current appearances.

6.9. RECREATION

Improvements to Lake Okeechobee's hydroperiod should reduce the occurrence of prolonged high lake stage events in particular, that have adversely impacted native aquatic and marsh vegetation around the lake over the past several years. The littoral and marsh habitat provides important nesting, breeding and feeding areas for fish and wildlife and the health and sustainability of these vegetation communities is crucial to the recreation resources, particularly fishing, hunting, and wildlife viewing. The Preferred Alternative (1bS2-m), by allowing for lower lake levels, would protect and enhance fish and wildlife habitat within Lake Okeechobee, to a certain degree, by reducing over inundation of emergent and floating vegetation and improving light penetration to SAV, components of which are important habitat throughout the life cycle of fishes, wading birds, raptors, waterfowl, and other animals which make up the food chain. Moreover, lower lake levels may also contribute to a reduction in sediment and nutrient transport into the back water marsh areas and littoral zone and reduce resuspension of nutrients which contribute to algae bloom production. These improvements to hydroperiod, aquatic vegetation, and water quality should translate into better opportunities for fish and wildlife reproduction, foraging and cover, and allow for larger, more sustainable populations for fishing, hunting, and wildlife observation.

The slightly reduced freshwater flows >2000 cfs to the St. Lucie Estuary in particular may improve fish and wildlife habitat and improve conditions for the fishery. Although high regulatory releases would still be necessary on occasion, the reduced volume of lake water sent to the estuary would improve overall salinity regimes, water clarity and color, reduce turbidity and probably reduce the oxygen demand of deposited silts. Any condition that favors growth and expansion of seagrasses and improved water quality, will enhance the fishery and opportunities for commercial and sport fishing. Wildlife viewing may also be enhanced with healthy and sustainable seagrass beds. Habitat for prey species such as invertebrates and forage fishes which are food sources for eagles, wading birds, marine mammals and other watchable species will enhance opportunities to view these animals. Manatees, which feed directly on seagrasses will also benefit through improved conditions for their primary food source

All of the proposed alternatives, including the Preferred Alternative, would have more occurrences of low water stages, and extreme low water stages, than the WSE schedule. Low water events would impact recreational boat users navigating Lake Okeechobee, and accessing the lake from local boat ramps. Some boat ramps and marinas may be inaccessible during low water events below >11 feet.

6.10. NAVIGATION

Boating access to Lake Okeechobee is affected by water levels. At lake stages below 12.56 ft., NGVD, the authorized project depth cannot be maintained. During low lake level, navigational access to much of the fishing area is reduced. The rim canal and boat trails become inaccessible during low water periods. Boat ramp access and marina access is impacted in certain areas around Lake Okeechobee when water levels fall below 12 feet. Table 6-10 below gives lake conditions at a glance for Route 1.

TABLE 6-10: NAVIGATION DEPTHS ON LAKE OKEECHOBEE, ROUTE 1 (SOURCE: WWW.SAJ.USACE.ARMY.MIL)

Lake Level (ft., NGVD)	Available Navigation Depth (ft.)
13.12	7.06
12.62	6.56
12.12	6.06

The hydrologic PM used for navigation was based on the 1965-2000 simulation POR. The performance of each alternative was measured by the number of times in the POR that lake stage is below 12.56 feet (Table 6-11). In summary, all of the alternatives performed worse than the No Action Alternative for days below 12.56 feet. Adverse effects to navigation would occur under any alternative, including the Preferred Alternative.

TABLE 6-11: DAYS BELOW 12.56 FT.

Alternative	Days lake stage below 12.56 ft., NGVD
No Action	2876
A	4839
B	4922
C	4909
D	5156
E (preferred)	5128

6.11. COASTAL BARRIER RESOURCES

There are no coastal barrier resources located in the project area.

6.12. WATER SUPPLY

Several PMs were used to evaluate impacts to water supply as indicated in Table 6-12. In addition to providing the PMs, a weighting scoring system was used to give an overall assessment of water supply performance for each of the runs evaluated. The chief use of the scoring system was to allow an overall ranking of each alternative from a water supply standpoint as part of the process of considering the relative performance of each alternative across goal areas.

The scores were assigned on a scale of +3 to -3 with +3 being much better, +2 being better, +1 being slightly better and 0 being no change. Similarly -1 is slightly worse, -2 is worse and -3 is much worse. All measures were assigned the same weight except that the number of water years with cutbacks greater than 100,000 acre feet was weighted 0.5 while the number greater than 200,000 was weighted as 1.5. All other measures are weighted as 1.

All scores are relative to the No Action condition. For the Recover based measures performance targets have been established and the scoring considered the performance of the No Action Alternative relative to the target in developing the scores. For the other measures the absolute magnitude of the score in the No Action condition and the relative change in the frequency or amount relative to that No Action Alternative was used.

All alternatives evaluated performed better than the No Action Alternative. Alternatives A, B and C performed about equally and were in the better range, while Alternative D performed only slightly better than the No Action.

The performance of the Alternative E (Preferred Alternative) is virtually identical to Alternative D, and slightly better than the No Action Alternative.

12/5/2006

Lake Okeechobee Regulation Schedule Study - Water Supply Evaluation

Weight	Water Supply (data from Woehlcke Analysis 11/21/06)	No Action		Alternative A			Alternative B			Alternative C			Alternative D			Alternative E		
		Data		Data	Dif from Base	Rating	Data	Dif from Base	Rating	Data	Dif from Base	Rating	Data	Dif from Base	Rating	Data	Dif from Base	Rating
1	Additional Supply Side Management (SSM) Cutbacks (acre-fee	0		-385,600		2	-358,020		2	-368,060		2	-274,790		1	-279,650		1
2	Frequency of Water Shortages (years)	7		4	57%	2	4	57%	2	4	57%	2	7	100%	0	7	100%	0
2	Duration of Water Shortages (months)	17		9	53%	2	10	59%	2	10	59%	2	13	76%	1	13	76%	1
2	Severity of Water Shortages Score	11		5	45%	2	5	45%	2	5	45%	2	8	73%	1	8	73%	1
0.5	Water Years with SSM Cutbacks >100,000 acre-feet	4		0	0%	2	1	25%	2	0	0%	2	1	25%	2	1	25%	2
1.5	Water Years with SSM Cutbacks >200,000 acre-feet	1		0		0	0		0	1		0	0		0	0		0
1	EAA Percent of Demands not Met	6		5	83%	1	6	100%	0	5	83%	1	6	100%	0	6	100%	0
1	Other LOSA Percent of Demands not Met	4		3	75%	1	3	75%	1	3	75%	1	3	75%	1	3	75%	1
2	Coastal Basin Supply Side Management Water Shortages	5		4	80%	1	0	0%	1	4	80%	1	5	100%	0	5	100%	0
13	Overall Score ---->		**0.00**			**1.46**			**1.38**			**1.46**			**0.54**			**0.54**

Scale System:
(3) = Much Better
(2) =Better
(1) = Slightly Better
(0) = No Difference
(-1) = Slightly Worse
(-2) = Worse
(-3) = Much Worse

TABLE 6-12: WATER SUPPLY EVALUATION

6.12.1. EVALUATION OF SFWMD WATER SHORTAGE CUTBACK ASSUMPTIONS

This section presents a summary comparison of water supply performance from South Florida Water Management Model simulations of the No Action Alternative, the Preferred Alternative with LOWSM and the Preferred Alternative with Existing Water Shortage Triggers (WST). As discussed in Section 4.4, this comparison is needed because the 2006 draft LOWSM Plan is not consistent with existing SFWMD rules pertaining to Lake Okeechobee MFLs, and additional review is ongoing by the SFWMD. The analysis of the Preferred Alternative with existing WST simulations has been motivated by the lack of compatibility between LOWSM and the Lake Okeechobee MFL Rule. SFWMD conducted several simulations attempting to improve performance of low stages in the lake by modifying some of the elements of LOWSM. These simulations provide enough evidence to demonstrate that irrespective of which Lake Okeechobee Water Shortage management scheme is used, no major improvements in the Lake Okeechobee MFL performance is achieved.

Table 6-13 shows that for the individual measures and for the overall score the Preferred Alternative with LOWSM performs slightly better than the No Action Alternative while the Preferred Alternative with Existing WST performs significantly worse. This is further illustrated by looking more closely at the amounts and percents of demands not met.

TABLE 6-13: SUMMARY COMPARISON OF WATER SUPPLY PERFORMANCE

Weight	Water Supply Performance Measure/Indicator	No Action		Prefered Alt w/LOWSM			Prefered Alt w/ WST		
		Data		Data	Ratio to Base	Rating	Data	Ratio to Base	Rating
1	Additional Supply Side Management (SSM) Cutbacks (acre-feet)	0		-279,650		1	1,299,470		-3
2	Frequency of Water Shortages (years)	7		7	100%	0	14	200%	-3
2	Duration of Water Shortages (months)	17		13	76%	1	37	218%	-3
2	Severity of Water Shortages Score	11		8	73%	1	22	200%	-3
0.5	Water Years with SSM Cutbacks >100,000 acre-feet	4		1	25%	2	7	175%	-2
1.5	Water Years with SSM Cutbacks >200,000 acre-feet	1		0		0	4	400%	-3
1	EAA Percent of Demands not Met	6		6	100%	0	15	250%	-3
1	Other LOSA Percent of Demands not Met	4		3	75%	1	10	250%	-3
2	Coastal Basin Supply Side Management Water Shortages	5		5	100%	0	6	120%	-1
13	Overall Score ----->		**0.00**			**0.54**			**-2.65**
	Scale System:								
	(3) = Much Better								
	(2) =Better								
	(1) = Slightly Better								
	(0) = No Difference								
	(-1) = Slightly Worse								
	(-2) = Worse								
	(-3) = Much Worse								

First, simulated effects are discussed based on the PM for mean annual supplemental irrigation, demands and demands not met. In the EAA the mean annual volume of demands not met during the 1965-2000 POR are 21,000 acre-feet for the No Action Alternative and the same for the Preferred Alternative with LOWSM (6% not met). The model run for the Preferred Alternative with existing WST, demands not met increase to

55,000 acre-feet and the percentage of demands not met is 15%. In the rest of LOSA the demands not met average 9,000 acre feet (4%) for the No Action Alternative and 8,000 acre-feet (3%) for the Preferred Alternative with LOWSM. For the Preferred Alternative with existing WST the mean annual demands not met are 23,000 acre-feet (10%).

Particular emphasis is given to water supply impacts under the most significant drought conditions experienced within the simulation POR, as water supply needs under drought conditions are highly susceptible to the observed lowering of Lake Okeechobee stages under the alternatives. To do this the mean annual demands not met during the drought years 1971, 1975, 1981, 1985 and 1989 are analyzed. In the EAA the mean annual volume of demands not met during the selected drought years are 61,000 acre-feet (13%) for the No Action Alternative and 58,000 acre-feet for the Preferred Alternative with LOWSM (also 13% not met). The model run for the Preferred Alternative with existing WST for these drought years, shows demands not met increase to 167,000 acre-feet and the percentage of demands not met is 33%. In the rest of LOSA the demands not met during the selected drought years average 26,000 acre feet (8%) for the No Action Alternative and 21,000 acre-feet (6%) for the Preferred Alternative with LOWSM. For the Preferred Alternative with existing WST the mean annual demands not met are 58,000 acre-feet (17% not met).

In the Lower East Coast Coastal Basins the No Action Plan and the Preferred Alternative with LOWSM both show five years during which water shortages would be implemented because of low levels in Lake Okeechobee relatively early in the dry season. In the Preferred Alternative with existing WST this increases to six years which is a slight increase. Some of the impacts could be lessened because there may also be locally caused water shortages during those years and the particular months within them when the low levels in Lake Okeechobee indicate that coastal water shortage cutbacks would be implemented.

Water demands not met for the Big Cypress and Brighton Seminole Reservations also increase in the Preferred Alternative with existing WST. These effects are discussed based on mean annual supplemental irrigation demands not met. For the Big Cypress Reservation the mean annual percent of demands not met during the 1965-2000 POR are 4.6% for the No Action Alternative and 7.6% for the Preferred Alternative with LOWSM. The model run for the Preferred Alternative with existing WST shows 9.3% of the demands not being met. For the Brighton Reservation the demands on average 3.5% of demands are not met for the No Action Alternative and 2.4% are not met for the Preferred Alternative with LOWSM. For the Preferred Alternative with existing WST the mean annual percentage of demands not met increases to 9.0%.

Water Supply for the Seminole Tribe of Florida Reservations

Two reservations of the Seminole Tribe of Florida rely on Lake Okeechobee as a supplemental irrigation supply source for their surface water federal entitlement rights, with specific volumes of water identified for this purpose for the Big Cypress Seminole

reservation, and an operational plan addressing drought–water shortage declarations for the Brighton Seminole Indian Reservation in the Indian Prairie Canal basin.

The Seminole Tribe has raised concerns about the reliability of Lake Okeechobee as a source under the pending Lake Okeechobee Regulation schedule change. Securing a dependable source of water for the Tribe's reservation is of particular important considering the Tribe's surface water federal entitlement rights.

For the Brighton Reservation, other options of securing both short and long-term water supply deliveries to agricultural operations in the Southern Indian Prairie Basin are being evaluated extensively. For the Big Cypress Reservation, forward pumps to deliver water from the lake at lower stages to the Miami Canal will be an important consideration (SFWMD 2007).

Refer to Section 6.19 (Native Americans) for LORSS alternative discussion of effects.

Economic Effects with Potential Supply Side Management

The potential effects of the 2007 draft SEIS LORSS Alternatives, including potential changes in supply side management are summarized in Table 6-14 through 6-17. To account for the uncertainty with SFWMD water shortage cutback rules (discussion is provided in section 2.3 and section 4.4), the potential economic effects with the 2007 draft SEIS LORSS preferred alternative (Alternative E in this main report, which is also referred to as Alternative T3 in the SEIS appendices) are summarized for two potential water shortage management scenarios: (1) the Preferred Alternative with 2006 draft LOWSM water shortage trigger assumptions (the LOWSM assumption is included for all other alternatives, except the No Action Alternative), and (2) the Preferred Alternative with the existing WST assumptions.

Table 6-14 compares value of unmet water demand for agriculture. Impacts will occur to sugarcane specifically, and will not impact other crops. Additionally, all impacts occur in the EAA and none in the four service areas. The dollar totals in table 6-14 represent reduction in sugarcane yields as a result of changes in water supply compared to the No Action Alternative (2007LORS). With the potential supply side management, sugarcane yields in the EAA will be negatively impacted by approximately $500,000 annually.

The hydrologic effects of the alternative regulation schedules also have implications for M&I water supply. In the LORSS area, most of the M&I water use is in the three service areas of the LEC. If water demands exceed supplies, shortages may result, and cutbacks may be imposed by the SFWMD. Table 6-15 represents the effects of the alternative schedules, including potential supply side management impacts.

Tables 6-16 and 6-17 examine the potential effects of the alternative regulation schedules on the RED account. The RED account registers indirect and secondary effects to the region that are expected to result from the direct economic effects of the

alternative plans. Direct economic effects represent the impacts of economic stimuli in terms of changes in regional industrial output, earnings, or employment. Indirect economic impacts represent the resultant economic changes in the industries that support and rely upon the industries directly affected by the stimuli. In addition, induced economic impacts are those impacts experienced by all local industries as direct and indirect effects alter household income and ultimately change local household spending patterns. Tables 6-16 and 6-17 display total impacts to the regional economy, a summation of direct, indirect, and induced impacts. A regional input-output model, *IMPLAN*, was used to estimate the RED effects of the LORSS alternatives. This model is defined in Appendix D, section 8-1.

TABLE 6-14: VALUE OF UNMET DEMAND FOR AGRICULTURAL WATER SUPPLY EAA AND LEC WITH POTENTIAL SUPPLY SIDE MANAGEMENT ($2006)*

Scenario	Area	Total 2000	Average Annual 2000
2007LORS	Total	$2,573,060	$71,474
1bs2_a	Total	$3,690,324	$102,509
1bs2_m	Total	$3,815,519	$105,987
T1	Total	$3,714,756	$103,188
T2	Total	$5,323,139	$147,887
T3 (LOWSM)	Total	$5,165,974	$143,499
T3 (WST)	Total	$20,389,626	$566,378

**(totals were generated by the South Florida Water Management Model economic post processor, normalized to 2006 prices, and then given an average annual value between the model analysis period of 36 years)*

TABLE 6-15: VALUE OF UNMET DEMAND FOR M&I WATER SUPPLY (2000) WITH POTENTIAL SUPPLY SIDE MANAGEMENT($2006)*

Scenario	Area	Total M&I 2000	Average Annual M&I 2000
2007LORS	**Total**	$487,630,000	$10,764,528
1bs2_a	**Total**	$(40,894,000)	$(1,135,944)
1bs2_m	**Total**	$(40,894,000)	$(1,135,944)
T1	**Total**	$(40,894,000)	$(1,135,944)
T2	**Total**	$7,997,000	$222,139
T3(LOWSM)	**Total**	$7,997,000	$222,139
T3 (WST)	**Total**	$84,731,000	$2,353,645

**(totals were generated by the South Florida Water Management Model economic post processor, indexed to 2006 prices, and then given an average annual value between the model analysis period of 36 years. Totals in parenthesis denote that demand has been met and exceeded by the expressed total)*

TABLE 6-16: IMPACTS ON EMPLOYEE COMPENSATION AS A RESULT OF ALTERNATIVE MODEL RUNS, INCLUDING POTENTIAL SUPPLY SIDE MANAGEMENT (2003 DOLLARS)

ALTERNATIVE	IMPACT
2007LORS	$-10,708
1BS2_a	$-15,358
1BS2_m	$-15,879
T1	$-15,462
T2	$-22,157
T3 (LOWSM)	$-21,500
T3 (SSM)	$-84,009

TABLE 6-17: IMPACTS ON REGIONAL INDUSTRY OUTPUT AS A RESULT OF ALTERNATIVE MODEL RUNS, INCLUDING POTENTIAL SUPPLY SIDE MANAGEMENT (2003 DOLLARS)

ALTERNATIVE	Total
2007LORS	$-56,309
1BS2_a	$-80,759
1BS2_m	$-83,499
T1	$-81,294
T2	$-116,510
T3 (LOWSM)	$-113,053
T3 (SSM)	$-441,749

6.13. FLOOD PROTECTION

The LORS, along with the levees around the lake, is a method of flood control used as a means to protect life and property adjacent to Lake Okeechobee (USACE, 2000). The top zone of the current regulation schedule describes maximum, safe discharge of floodwater from Lake Okeechobee. It is of the utmost importance that the lake level be reduced as rapidly as possible in this zone to make room for the next possible flood event, to relieve stress and erosion of the levees, and to reduce impact on Lake Okeechobee's littoral zone (USACE, 2000).

A major concern with the present water regulation schedule, and a focus of the LORSS, is regarding the structural stability of the HHD during high water stages. Issues such as seepage, piping, and boils are exacerbated when the lake elevation approaches 18.5 ft., NGVD (USACE, 2005), which is the maximum release elevation of the current schedule. The heightened concern with HHD was emphasized after several hurricanes passed through south Florida during 2004 and 2005, and the significant amount of rainfall that pushed lake elevations to levels that caused HHD issue.

For the current LORSS, a main objective was to look at ways to develop an alternative schedule that lowers the maximum release trigger for flood protection purposes. As such, a PM for flood protection was developed. The PM was selected to formulate releases that minimized lake elevation >17.25 ft. NGVD. Operationally, this means that at elevation 17.25 feet, maximum lake releases would be made east, west and south, in an attempt to lower the high lake levels. The reason for selecting elevation 17.25 feet as the PM elevation was to address the numerous factors that generate uncertainty in the rate of rise on Lake Okeechobee primarily during the rainy season. This elevation would be used as a predictive buffer against Lake Okeechobee rising to an unacceptable high elevation that compromised the integrity of the HHD that could result in a breach of the levee.

The Preferred Alternative, as modeled, significantly reduced lake stages >17.25 ft. The No Action Alternative had 348 days >17.27 ft., whereas the Preferred Alternative had only eight days >17.25 ft. Compared to the No Action Alternative, all alternatives significantly reduced lake high stages >17.25 ft. Alternative A had nine days above, Alternatives B and C had zero days above, and Alternative D had 12 days above.

6.14. WATER QUALITY

Excessive loads of nutrients to the lake, such as phosphorus, originate from agricultural and urban activities that dominate the watershed. Even though water quality is critical to the health of Lake Okeechobee, the estuaries and greater Everglades, a water quality assessment is outside the bounds of the LORSS. The LORS is operational in nature, and minimal improvements to water quality can be achieved by operational changes. Indirect effects to water quality may be gained through a lower schedule as presented in the Preferred Alternative. The lower schedule may be beneficial to plant growth, which would assist in providing water quality improvements. Reducing the frequency of high volume flows to the estuaries may indirectly improve water quality in those estuaries. Additionally, there are very minor adverse effects from any alternative to the receiving marsh areas in the WCAs. This is primarily due to the STAs water quality treatment capacity (currently 64,000 acre-feet annual average), based on a lake water phosphorus level) constraint on regulatory discharges from Lake Okeechobee to the WCAs. As phosphorus levels decline in Lake Okeechobee more water can be treated in these STAs and delivered south to the WCAs.

Numerous projects, initiatives and programs have been instituted with the express purpose of addressing environmental problems associated with water quality in Lake Okeechobee, Caloosahatchee Estuary and St. Lucie Estuary, as well as the

Everglades. A major CERP project that is specifically focusing on nutrient reduction to Lake Okeechobee is the Lake Okeechobee Watershed Project (LOW). As part of the LOW Project, STAs would be constructed to capture nutrients, such as phosphorus, before entering into Lake Okeechobee. Similar projects are being developed along the Caloosahatchee River and St. Lucie Canal. Cumulatively, these actions would assist in improving water quality in Lake Okeechobee and other water bodies within the study area.

TP loading to Lake Okeechobee now averages 714 metric tons per year (mt/yr) averaged over 2002-2006 (SFWMD, 2007). This loading is more than five times higher than the TMDL of 140 mt/yr considered necessary to achieve the target in-lake TP goal of 40 parts per billion (SFWMD, 2007). Due to the operational nature of the Preferred Alternative, it is not anticipated that adverse effects on TMDL goals would occur. On the contrary, if the littoral zone vegetation rebounds from damages experienced from the 2004 and 2005 hurricane seasons, the vegetation may actually assist in the attainment of TMDL goals set by FDEP. No measurable impact to Lake Okeechobee water quality is anticipated from the Preferred Alternative due to the limitations of operational only regulation schedule adjustments.

6.15. HAZARDOUS, TOXIC AND RADIOACTIVE WASTE

A preliminary assessment indicated no evidence of HTRW affecting this action.

6.16. AIR QUALITY

Air quality would not be impacted by any of the alternatives.

6.17. NOISE

With implementation of any of the alternatives, there would be no affect on existing or future noise levels.

6.18. PUBLIC SAFETY

Public health and safety, as it relates to flood protection, was a major factor in the development of alternative regulation schedules. Minimizing the frequency of exceedence of 17.25 feet elevation was used as it offers additional protection for public safety. The detailed evaluation for flood protection is located in Section 6.13.

Not only does public safety relate to flood protection, but it also relates to other objectives of the Lake Okeechobee Water Control Plan such as water supply. The surface and groundwater in the Lake Okeechobee area provide a valuable source of water for public, domestic, industrial and agricultural use for much of southwest Florida. The Preferred Alternative would have minimal impact on current public water supply, as further detailed in Section 6.12.

6.19. NATIVE AMERICANS

The Seminole Tribe has surface water entitlement rights pursuant to the 1987 Water Rights Compact between the Seminole Tribe of Florida, the State of Florida, and the SFWMD, a state and federal law. Additional documents addressing the Water Rights

Compact entitlement provisions have since been executed. These documents include Agreements between the Tribe and SFWMD and a SFWMD Final Order. Of particular interest in this regard is the 1996 Agreement which commits the SFWMD to study and/or mitigate impacts to the Tribe's ability to obtain surface water supplies at both the Brighton and Big Cypress Reservations which may be diminished as a result of various activities, including changes in the Lake Okeechobee Regulation Schedule.

Two reservations of the Seminole Tribe of Florida rely on Lake Okeechobee as a supplemental irrigation supply source for their surface water federal entitlement rights, with specific volumes of water identified for this purpose for the Big Cypress Seminole Reservation and an operational plan addressing drought–water shortage operations for the Brighton Seminole Indian Reservation in the Indian Prairie Basin.

Analysis of the proposed Lake Okeechobee regulation schedule shows it may result in the Lake's levels declining to below 10 ft. NGVD on a more frequent basis. This is a concern for both the Brighton and Big Cypress Reservations since both Reservations rely on the Lake, in part, for water supply, and it is difficult to convey water out of the Lake below this level. The Seminole Tribe has raised concerns about the reliability of Lake Okeechobee as a source under the pending LORS change. Securing a dependable source of water for the Tribe's reservation is of particular importance considering the Tribe's surface water federal entitlement rights. During the LORSS, SFWMD staff met with the Tribe and Corps representatives to discuss proposed short and long-term measures to address the issue at both Reservations and continues to evaluate alternative short-term and long-term means of delivering water at low Lake levels.

For the Brighton Reservation, various options of securing both short and long-term water supply deliveries to agricultural operations in the Southern Indian Prairie Basin are being evaluated extensively and implemented where possible. For example, the SFWMD is currently funding development of an aquifer storage and recovery (ASR) well on the Brighton Reservation as a possible alternative water supply source. Other water source and conveyance options continue to be explored. For the Big Cypress Reservation, forward pumps to deliver water from the Lake at lower stages to the Miami Canal. Also, real-time operational decisions made during a declared drought event are made while fully cognizant of the Tribe's water rights.

Simulated Water Supply Performance for the Seminole Tribe Reservations: Brighton and Big Cypress

Simulated water supply effects on the Brighton and Big Cypress Seminole Tribe Reservations are summarized for the percent of water supply demand not met, based on SFWMM PM graphics shown in Appendix E, Figures C-82 through C-85. Unmet demand for the Brighton Reservation is summarized as follows: 3.5 percent for the No Action Alternative; 2.0 percent for Alternative A; 2.1 percent for Alternative B; 2.1 percent for Alternative C; 2.4 percent for Alternative D; and 2.4 percent for Alternative E. Unmet demand for the Big Cypress Reservation is summarized as follows: 4.6

percent for the No Action Alternative; 7.1 percent for Alternative A; 7.3 percent for Alternative B; 7.1 percent for Alternative C; 7.7 percent for Alternative D; and 7.6 percent for Alternative E.

The SFWMM operations for the water supply delivery to the Seminole Reservations, including assumed structures and operational triggers, were not modified for the LORSS simulations. It is recognized that modifications or improvements to the water supply delivery network may be necessary to continue to provide water supply deliveries per the Water Rights Compact agreement with the State of Florida and SFWMD. Modifications to improve existing canal conveyance, addition of new pump structures, and modified structure operations are not easily accomplished within the SFWMM; therefore, modifications to the existing configuration were not included in the LORSS simulations for the No Action Alternative base condition or other LORSS alternatives.

6.20. DRINKING WATER

Implementation of any of the alternatives would not adversely impact drinking water consumption for the surrounding communities.

6.21. CUMULATIVE EFFECTS

Cumulative impacts are impacts likely to occur due to the Proposed Action or alternatives in combination with other past, present and reasonably foreseeable future actions.

There are many studies/projects identified for the central/southern portion of Florida, which may affect the study area in the future. Many, but not all, of the studies/projects fall under the CERP. Cumulatively, these projects would provide improvements in water deliveries to the coastal estuaries such as the Caloosahatchee and St. Lucie. Some major projects that would directly or indirectly improve the quantity, quality, timing and distribution of water to the Caloosahatchee Estuary are the Southwest Florida Feasibility Study, C-43 Basin Storage Reservoir, and Picayune Strand Hydrologic Restoration. Those directly affecting the St. Lucie Estuary are Indian River Lagoon-South and C-44 Basin Storage Reservoir. Projects directly affecting estuaries and Lake Okeechobee are the Lake Okeechobee Watershed Project and Kissimmee Restoration. The EAA Reservoirs will also benefit the physiographic ecosystems influenced by Lake Okeechobee. These projects and their purposes are summarized below. For details on CERP projects, refer to the CERP website found at: **http://www.evergladesplan.org/**).

The **Southwest Florida Feasibility Study** is in the process of identifying southwest Florida water resources conditions and developing potential solutions to the problems identified. The project area includes the Caloosahatchee and Big Cypress watersheds, and is addressing the health of upland and aquatic ecosystems in this 4,300 square mile area. The major goal is to define the hydrologic linkages among nearly 30 federal, state, or county-managed areas and to coordinate the management and stewardship of these areas. A principal goal for all of southwest Florida's hydrological restoration is the reestablishment of the minimum freshwater flows, and the elimination of freshwater

point-source discharges, needed to restore more natural hydrology, i.e. salinity patterns, in the estuaries.

The **C-43 Basin Storage Reservoir** project purpose is to capture Caloosahatchee River Watershed (C-43 basin) runoff and releases from Lake Okeechobee. The reservoir would be designed, in part, to provide water quality benefits in terms of reduced salinity and nutrients in the Caloosahatchee Estuary.

The **Picayune Strand Hydrologic Restoration project** is located in the Big Cypress watershed of the Everglades region, in an area of approximately 94 square miles in southwestern Collier County. The project purpose is to restore and enhance the fish and wildlife habitat, particularly wetlands, by reducing over-drainage. The project would reestablish more natural overland flows and improve the quality of the coastal estuaries by spreading the freshwater discharges more evenly among bays and moderating the large salinity fluctuations currently caused by point discharges from the Faka Union Canal.

The **C-44 Basin Storage Reservoir** is a 10,000 acre reservoir slated to be built in Martin County. The reservoir will be designed to capture local runoff to meet flow distribution goals to the Indian River Lagoon and the St. Lucie Estuary.

The **Indian River Lagoon South Restoration** Project is designed to reverse the impacts of pollution and unnaturally large freshwater flows to the surrounding water bodies. The project will assist in achieving the balance of fresh and salt water in the Indian River Lagoon and St. Lucie Estuary.

The **Lake Okeechobee Watershed Project** will in part address phosphorus loads to the lake and also provide alternative storage locations (reservoirs) so that water levels in the lake can be regulated for greater environmental benefits while still serving water supply and other water resource functions. The LOWP is intended to reduce the phosphorus load by 53 metric tons per year and store approximately 273,000 acre feet of water (SFWMD, 2007). The load reduction will assist in meeting the TMDL goals for Lake Okeechobee.

The **EAA Reservoirs** are designed to capture, store and redistribute freshwater lost to tide and to regulate the quantity, timing and distribution of water for environmental deliveries. The benefit for Lake Okeechobee would be a reduction in flood control releases to the estuaries, improvements of environmental water deliveries to the WCAs, and to provide an alternate source of water (currently the primary source is Lake Okeechobee) to meet agricultural irrigation demands.

The **Kissimmee River Restoration** project is currently undergoing restoration efforts that will return a significant portion of the Kissimmee River to it historic riverbed and flood plain. These actions will provide a more natural fluctuation of water levels in both the upper and lower basins.

The restoration of hydrology from all CERP related projects, but in particular, projects listed above, will produce extensive cumulative beneficial effects to Lake Okeechobee, St. Lucie and Caloosahatchee estuaries, as well as other physiographic regions within the LORSS. Cumulatively, these projects would reduce undesirable freshwater releases from Lake Okeechobee as well as reducing watershed runoff to the estuaries by redirecting or capturing some of these flows. Through this reduction, it's anticipated that a more natural salinity gradient within the estuaries, as well as reducing the fluctuation of salinity caused by freshwater flows, would occur. Water quality improvement would be expected to occur in Lake Okeechobee, estuaries and greater Everglades, as a result of implementation of the above projects.

In addition to CERP projects, other authorized improvements to the C&SF Project (Modified Water Deliveries [MWD] to ENP and South Dade Canals or C-111) projects are to be completed, which would enable water deliveries for restoration of more natural hydrologic conditions to the Everglades. Together, these projects would enable the re-establishment of the historic Shark River Slough flow-way from WCA-3A through WCA-3B to ENP. Currently, MWD and C-111 are partially completed and are operated in accordance with the Interim Operating Plan (IOP), until the Combined Structural and Operational Plan (CSOP) is implemented. Superseding IOP, was the Interim Structural and Operational Plan (ISOP), which was implemented in 2000. The plans provide the operational protocol to protect the endangered Cape Sable Seaside Sparrow while providing the additional water deliveries to ENP. All of these plans were or are being developed as temporary solutions until the MWD and the C-111 Projects are complete. When complete, the MWD and C-111 projects would allow for more favorable hydroperiods and water levels in WCA 3 A and B, and ENP.

Other Federal, State, and Local Initiatives affecting the LORS

The following summarizes other initiatives that cumulatively would affect the LORSS. Many initiatives are related to water quality improvement and mandated by laws, statutes, agreements and permits, to assist in environmental restoration efforts underway for central and south Florida.

There are many studies and projects that are directly dealing with water quality issues is Lake Okeechobee. Some of the primary sources of water contamination in the Lake Okeechobee system are suspended solids, nutrients, animal wastes and pesticides. When these substances are present in excess, algal blooms, fish kills, sedimentation, health hazards, aesthetic changes and modifications of species diversity may result. A State act passed in 2000, the Lake Okeechobee Protection Act (LOPA), establishes a restoration and protection program for Lake Okeechobee, which focuses on meeting water quality standards. Reducing phosphorus loads to Lake Okeechobee is an important focus of the LOPA. Other State water quality improvement initiatives are being accomplished through best management practices, surface water improvement and management, pollutant load reduction goal, settlement agreement and consent decree, and Lake Okeechobee and Estuary Recovery (LOER). Through the CWA, EPA has proposed TMDL for the Lake Okeechobee tributaries, which establishes the amount of a pollutant that can be assimilated in a water body.

South of Lake Okeechobee is the State's Everglades Construction Project (construction of over 44,000 acres of STAs), which is currently underway, and will assist in restoration of Lake Okeechobee and its estuaries. The STAs will use naturally occurring biological processes to reduce the levels of phosphorus from Lake Okeechobee, Everglades Agriculture Area, etc. that enter the Everglades. Cumulatively, the Everglades Construction Project would improve the volume, timing and distribution of water entering the Everglades, which would assist in reducing the volume of undesirable discharges to Caloosahatchee Estuary, St. Lucie Estuary and Lake Worth.

These numerous interagency initiatives are designed to provide measurable and meaningful improvements to water quality and water quantity in Lake Okeechobee and the St. Lucie and Caloosahatchee Estuaries. Collectively and cumulatively, these water quality improvement efforts would reduce elevated nutrient levels, reduce the levels of resuspended sediments, and may reduce the rapid expansion of exotic and nuisance plant growth in Lake Okeechobee and other system water bodies. Public health and safety as it relates to the HHD and downstream systems will also benefit cumulatively from a lower lake schedule and projects listed above that provide water storage.

Other state initiatives such as storage of lake water on public/private lands (Section 3.4) and implementation of new Water Shortage Trigger rules (2006 draft LOWSM Plan represents one proposal by the SFWMD) would be more immediate benefits to many physiographic regions in the LORSS planning areas. Storage of water, combined with the operational changes of the Preferred Alternative, would benefit the estuaries by reducing high volume freshwater releases, or reduce the duration of those releases. The LOWSM plan would be used to adjust or modify water supply demands during dry periods. The LOWSM plan (including the temporary forward pumps) may reduce the likelihood of adverse effects to water supply, and decrease exceedences/violations of Minimum Flows and Levels (MFL) set for Lake Okeechobee and the estuaries as a result of implementing a lower lake schedule.

6.22. IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

6.22.1. IRREVERSIBLE

An irreversible commitment of resources is one in which the ability to use and/or enjoy the resource is lost forever. One example of an irreversible commitment might be the mining of a mineral resource. As there are no proposed construction activities or alteration of existing features or landscape, there should be no irreversible commitment of resources as a result of this action.

6.22.2. IRRETRIEVABLE

An irretrievable commitment of resources is one in which, due to decisions to manage the resource for another purpose, opportunities to use or enjoy the resource as they presently exist are lost for a period of time. An example of an irretrievable loss might be where a type of vegetation is lost due to road construction. As there are no proposed

construction activities or alteration of existing features or landscape, there should be no irreversible commitment of resources as a result of this action.

6.23. UNAVOIDABLE ADVERSE ENVIRONMENTAL EFFECTS

As the proposed action is completely operational, and does not contain any physical features, construction, or addition or removal of structures, and the action is designed to enhance conditions to the natural environment, there are minimal adverse effects anticipated to the natural and human environment.

6.24. CONFLICTS AND CONTROVERSY

There will always be a level of controversy with any issue related to water management in south Florida, especially as it relates to the LORS. There was much controversy with the Corps' original Preferred Alternative (1bS2-m) in the 2006 draft SEIS. The controversy stemmed largely from the west coast stakeholders and their concern with minimal improvement for the Caloosahatchee Estuary. The Corps took consideration of these concerns in an attempt to improve the 2006 Preferred Alternative schedule. This revised draft SEIS is a result of the Corps efforts to improve performance of the Preferred Alternative.

6.25. ENVIRONMENTAL COMMITMENTS

Once a week (currently Tuesday), a group of water managers, scientists and engineers from the Corps, SFWMD, and other agencies meet via telephone conference to discuss the state of the C&SF system and possible operational scenarios. Reports on the ecological and hydrological status of different physiographic areas, such as estuaries and the Everglades, are presented. Under a new regulation schedule, the Corps would continue consulting with the agencies weekly to determine the status of the individual ecosystems in the study area. Much attention from the group centers on the spring season (March–June), which is critical for all ecosystems in the area. For Lake Okeechobee, allowing spring recessions with limited reversals is critical to plants and animals, including nesting and foraging habitat for the endangered snail kite. Additionally, many estuarine dependent species reproduce in the spring. This is a critical period for maintaining certain flow ranges for proper salinity regimes in the estuaries.

6.26. COMPLIANCE WITH ENVIRONMENTAL REQUIREMENTS

6.26.1. NATIONAL ENVIRONMENTAL POLICY ACT OF 1969

Environmental information on the action has been compiled and presented in this draft SEIS. The project is in compliance with the NEPA.

6.26.2. ENDANGERED SPECIES ACT OF 1973

A species list was requested from NMFS on September 15, 2005. By letter dated August 10, 2006, the Corps initiated consultation with NMFS. The Corps made a "may effect, not likely to adversely affect" determination for the smalltooth sawfish and Johnson's seagrass. The NMFS replied by letter dated September 27, 2006 that

additional information would be needed for their evaluation. This revised draft SEIS will serve as the updated BA for the two species.

A species list was requested from USFWS on August 29, 2005, and received on September 30, 2005. Informal consultation was initiated with USFWS by letter dated March 8, 2006. Formal consultation was initiated with USFWS by letter dated June 30, 2006, which included a BA of effects on endangered and threatened species. Based on new information, an updated BA was submitted to USFWS on December 15, 2006. The updated BA did not change the Corps' determination of effects on endangered and threatened species. A Biological Opinion is expected from the USFWS prior to finalizing the SEIS. This action will be fully coordinated under the ESA and will be in full compliance with the Act.

6.26.3. FISH AND WILDLIFE COORDINATION ACT of 1958

This action has been coordinated with the USFWS. A draft CAR was received from the USFWS on February 6, 2007, and included as Appendix C. A final CAR will be included in the final SEIS. This project is in full compliance with the Act.

6.26.4. NATIONAL HISTORIC PRESERVATION ACT OF 1966 (INTER ALIA)

Coordination with the Florida State Historic Preservation Officer has been initiated. The action is in partial compliance with the Act.

6.26.5. CLEAN WATER ACT OF 1972

The Proposed Action is in compliance with this act. As the Proposed Action is strictly of an operational nature, and does not involve any new discharge or construction activity, water quality certification from the State of Florida is not required. Furthermore, as there are no structural components contained in the Proposed Action and no dredge and fill operations being considered, a Section 404(b) Evaluation is not appropriate.

6.26.6. CLEAN AIR ACT OF 1972

No air quality permits will be required for this action.

6.26.7. COASTAL ZONE MANAGEMENT ACT OF 1972

A Federal consistency determination in accordance with 15 CFR 930 Subpart C is included in this report as *Appendix B*. State consistency review will be performed during the coordination of the revised draft SEIS and the State will determine if the action is consistent with the Florida CZM Program.

6.26.8. FARMLAND PROTECTION POLICY ACT OF 1981

There would be no conversion of prime or unique farmland to other uses. This Act is not applicable.

6.26.9. WILD AND SCENIC RIVER ACT OF 1968

The Northwest Fork of the Loxahatchee River is designated a Wild and Scenic River. This resource is not expected to be adversely impacted by the Proposed Action. The study is in full compliance with this Act.

6.26.10. MARINE MAMMAL PROTECTION ACT OF 1972

The Proposed Action would not adversely impact marine mammals. Therefore, this action is in compliance with the Act.

6.26.11. ESTUARY PROTECTION ACT OF 1968

The Indian River Lagoon and Charlotte Harbor are part of the National Estuary Program established by Section 320 of the CWA. This action would not adversely affect these estuaries. As such, the action is in compliance with this Act.

6.26.12. FEDERAL WATER PROJECT RECREATION ACT

The effects of the Proposed Action on outdoor recreation have been considered. Benefits to fishing, boating and wildlife viewing should be accrued by implementation of the Proposed Action. Therefore, the action is in compliance with this Act.

6.26.13. FISHERY CONSERVATION AND MANAGEMENT ACT OF 1976

This action is being coordinated with the NMFS and will be in compliance with the Act.

6.26.14. SUBMERGED LANDS ACT OF 1953

The action would occur on submerged lands of the State of Florida. The project has been coordinated with the State and is in compliance with the Act.

6.26.15. COASTAL BARRIER RESOURCES ACT AND COASTAL BARRIER IMPROVEMENT ACT OF 1990

There are no designated coastal barrier resources in the project area that would be affected by this action. These Acts are not applicable.

6.26.16. RIVERS AND HARBORS ACT OF 1899

The Proposed Action will not obstruct navigable waters of the United States. The action is in full compliance.

6.26.17. ANADROMOUS FISH CONSERVATION ACT

Anadromous fish species will not be affected. The action has been coordinated with the NMFS and is in compliance with the Act.

6.26.18. MIGRATORY BIRD TREATY ACT AND MIGRATORY BIRD CONSERVATION ACT

No migratory birds will be adversely affected by the action. The action is in compliance with these Acts.

6.26.19. MARINE PROTECTION, RESEARCH AND SANCTUARIES ACT

The term "dumping" as defined in the Act (3[33 U.S.C. 1402](f)) does not apply to the action proposed. Therefore, the Marine Protection, Research and Sanctuaries Act does not apply to this action.

6.26.20. MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT

This act requires the preparation of an EFH Assessment and coordination with the NMFS. The EFH Assessment within the draft SEIS will be coordinated with the NMFS during the normal NEPA coordination process. This action is in compliance with the Act.

6.26.21. EXECUTIVE ORDER (E.O.) 11990, PROTECTION OF WETLANDS

No wetlands will be affected by the action. This action is in compliance with the goals of this E.O.

6.26.22. E.O. 11988, FLOOD PLAIN MANAGEMENT

The project area is in the base flood plain (100-year flood) and has been evaluated in accordance with this E.O. The action is in compliance.

6.26.23. E.O. 12898, ENVIRONMENTAL JUSTICE

The Proposed Action will not result in adverse health or environmental effects. Any impacts of this action will not be disproportionate toward any minority. The activity does not (a) exclude persons from participation in, (b) deny persons the benefits of, or (c) subject persons to discrimination because of their race, color, or national origin. The activity would not impact "subsistence consumption of fish and wildlife."

6.26.24. E.O. 13089, CORAL REEF PROTECTION

The Proposed Action will not result in adverse impacts to coral reef ecosystems. No coral reef habitats exist within or near the project area. This Act is not applicable.

6.26.25. E.O. 13112, INVASIVE SPECIES

This action does not authorize, fund, or carry out action that might spread or introduce invasive species.

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7. LIST OF PREPARERS

7.1. PREPARERS AND REVIEWERS

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8. PUBLIC INVOLVEMENT

8.1. SCOPING AND DRAFT SEIS

A scoping letter, dated July 21, 2005, was sent out by the Corps to agencies and interested parties soliciting views, comments, and information about environmental and cultural resources, study objectives and important issues within the study area. A Notice of Intent (NOI) to prepare a draft SEIS appeared in the Federal Register on August 3, 2005. During the 60-day comment period, many written responses were received that represented several issues. These issues were subsequently compiled and infused into the plan formulation process. A sampling of issues resulting from the scoping process are included in Section 1.8. A copy of the Corps' scoping letter and NOI can be found in Appendix H. It should be noted that the 60-day scoping comment period was extended through November 2005 due to the impact of Hurricane Wilma on the south Florida regional communities.

Four public scoping meetings were conducted at the following locations:

•Clewiston	October 11, 2005
•Ft. Myers	November 14, 2005
•Okeechobee	November 15, 2005
•Stuart	November 17, 2005

In addition to the scoping meetings, public workshops were held during the planning phase of the regulation schedule development. The first workshop was held at the Okeechobee Civic Center in Okeechobee, Florida on February 22, 2006. The purpose of the public workshop was to present the LORS alternatives under consideration. Interested individuals, groups, and agencies were invited to attend and were given an opportunity to comment and ask questions. The workshop was video taped and can be found on the Corps' Jacksonville District webpage at: **www.saj.usace.army.mil**. A second round of workshops was held on the following dates: July 11, 2006 at John Boy Auditorium in Clewiston, Florida; July 12, 2006 at the Lee County Commission Chambers in Fort Myers, Florida; and July 13, 2006 at Indian River Community College in Stuart, Florida. The purpose of the public workshops was to inform the public of the tentative selected plan (or Preferred Alternative regulation schedule). Numerous presentations to the Water Resources Advisory Commission (WRAC)/Lake Okeechobee Committee were conducted throughout the study process.

A Notice of Availability (NOA) of the draft SEIS appeared in the Federal Register on August 18, 2006. Copies of the draft SEIS were mailed to agencies and individuals, and provided to local libraries for viewing. Additionally, the draft SEIS was uploaded to the Corps environmental webpage for public viewing. Separate letters (dated September 8, 2006) were provided to the Miccosukee and Seminole Indian Tribes requesting consultation on the draft SEIS. A series of four public meetings were held in 2006 after release of the draft SEIS. Meetings took place in Stuart on September 12,

Okeechobee on September 13, Ft. Myers on September 14, and Clewiston on September 18.

In response to public input on the Corps' Preferred Alternative presented in the August 2006 draft SEIS, additional plan formulation and modeling took place to improve the performance of the 2006 Preferred Alternative. Due to the updated modeling information and improvements to the 2006 Preferred Alternative that led to three new alternatives, it is necessary to disclose the environmental effects of this effort as it relates to benefits and impacts. It was decided to disclose this information in a revised draft SEIS, instead of finalizing the August 2006 draft SEIS. Most importantly, this revised draft SEIS incorporates the public comments of the August 2006 document. Agency and public comment letters received on the 2006 draft SEIS, and the Corps' responses to those comments, are located in Appendix H.

8.2. AGENCY COORDINATION

Coordination with local, state and federal agencies was achieved by inviting staff of those agencies to participate as team members. Team members were invited to participate in weekly team meetings via teleconference and video conference throughout the planning process of the study. The EPA, USFWS, NMFS, FDEP, FFWCC, SFWMD, Seminole Tribe of Florida, Lake Worth Drainage District, city governments of Lee County, Martin County, City of Sanibel, Broward County, and Miami-Dade County Office of Water Management, all contributed one or more staff as active participants of the study team. The issues and concerns of these agencies and governments were continuously a part of study team activities.

8.3. LIST OF STATEMENT RECIPIENTS (REVISED DRAFT SEIS)

Copies of the revised draft SEIS were sent to local, state, and federal agencies, interested parties and individuals for review and comment in accordance with the Council on Environmental Quality's (CEQ) NEPA regulations and related Corps guidance. A complete mailing list can be found in Appendix H. In addition, the revised draft SEIS can be found at the following Corps website:
http://planning.saj.usace.army.mil/envdocs/envdocsb.htm.

8.4. COMMENTS RECEIVED AND RESPONSE

This revised draft SEIS incorporates the public comments and concerns of the August 2006 draft SEIS. Agency and public comment letters received on the 2006 draft SEIS, and the Corps' responses to those comments, are located in Appendix H.

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