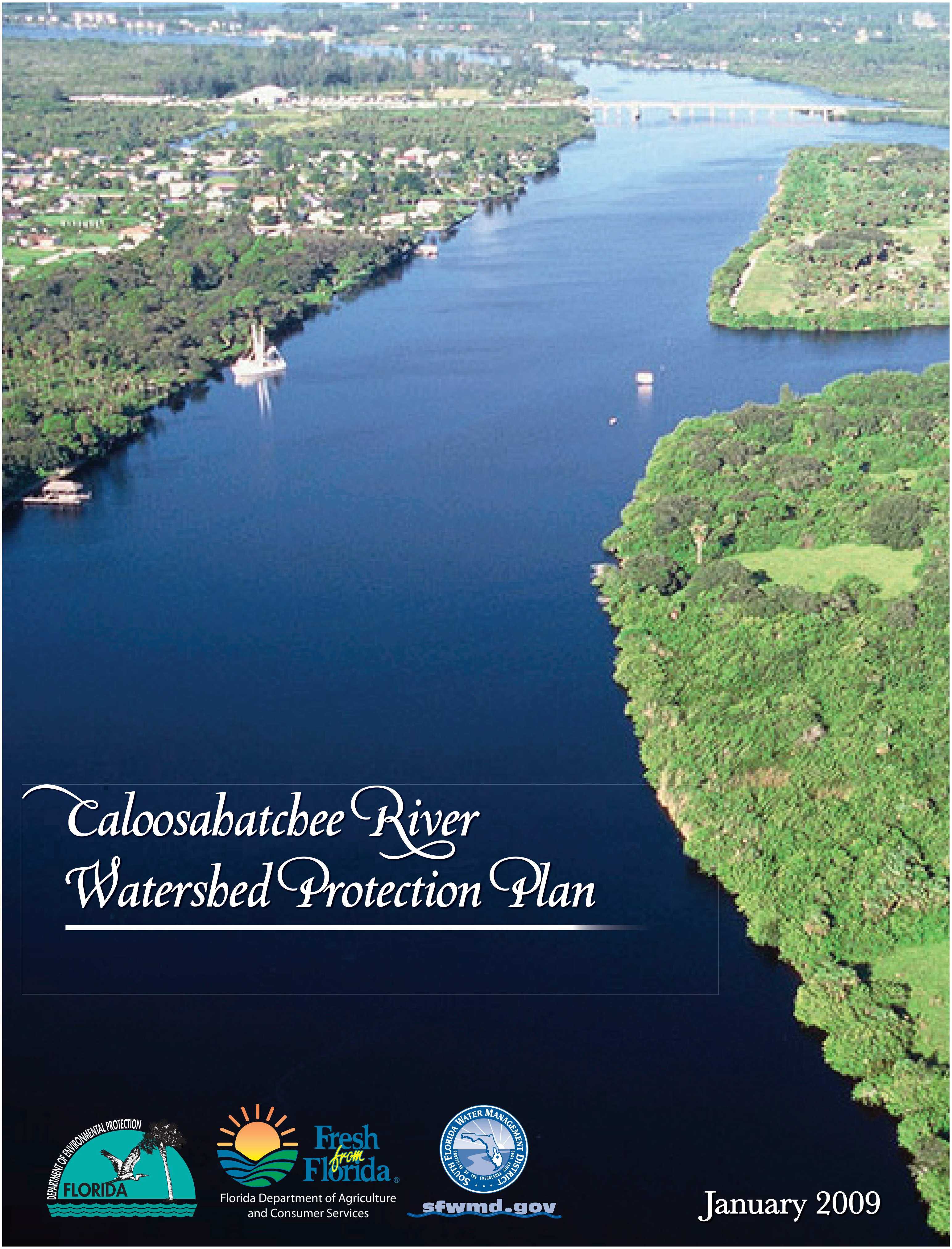

Caloosahatchee River Watershed Protection Plan

DEPARTMENT OF ENVIRONMENTAL PROTECTION
FLORIDA

Fresh from Florida
Florida Department of Agriculture and Consumer Services

SOUTH FLORIDA WATER MANAGEMENT DISTRICT
sfwmd.gov

January 2009

Caloosahatchee River Watershed Protection Plan

January 2009

Prepared by:

South Florida Water Management District

Florida Department of Environmental Protection

Florida Department of Agriculture and Consumer Services

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Lee County
Hendry County
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PURRE Water Coalition
Southwest Florida Watershed Council

EXECUTIVE SUMMARY

The Caloosahatchee River Watershed Protection Plan (preferred Plan) was developed by the South Florida Water Management District (SFWMD) in cooperation with the Florida Department of Environmental Protection (FDEP), the Florida Department of Agriculture and Consumer Services (FDACS), Lee County, and other affected counties and municipalities – along with a diversity of other stakeholder and public input.

Similar to the Lake Okeechobee Watershed Construction Project Phase II Technical Plan, a comprehensive and systematic, multi-agency process was implemented to develop the Caloosahatchee River Watershed Protection Plan. One of the first steps in this plan development process was to inventory existing and planned restoration programs and projects (e.g., Comprehensive Everglades Restoration Plan) and determine the cumulative benefit provided by those initiatives. The cumulative benefit was then compared to the identified objectives of the watershed protection plan to determine if gaps still existed and whether additional projects or programs would be necessary. Key identified objectives include:

- Reducing nutrient loads to meet any adopted Total Maximum Daily Loads (TMDLs). *It should be noted that TMDLs for nutrients are currently under development by FDEP; hence, an interim goal to "maximize reductions in nutrient loads to the estuary" was used for plan development.*
- Reducing the frequency and duration of undesirable salinity ranges in the estuary while meeting other water related needs such as water supply and flood protection.

A set of four alternatives was developed and reviewed. Alternatives were evaluated for nitrogen load removal, phosphorus load removal and water quantity performance. The alternatives were formulated with input from an interagency working team. The resulting Caloosahatchee River Watershed Protection Plan combines the Watershed Construction Project, Watershed Pollutant Control Program and Watershed Research and Water Quality Monitoring Program into a comprehensive approach that best meets the legislative goals.

The preferred Plan identifies the best combination of watershed storage and water quality projects needed to help improve the quality, timing and distribution of water in the natural ecosystem. More specifically, the preferred Plan includes the Caloosahatchee River (C-43) West Basin Storage Reservoir, best management practices (BMPs) and regulatory programs, regional water quality projects with an emphasis on nitrogen reduction, additional storage in the freshwater basins and local water quality/quantity projects.

Working in concert with the expected results from implementing the Lake Okeechobee Watershed Construction Project, Phase II Technical Plan, the Caloosahatchee River Watershed Protection Plan includes:

- Implementation of best management practices on more than 430,000 acres of agricultural lands and 145,000 acres of urban lands;
- Completion of proposed regulatory rule revisions;

- Construction of approximately 36,000 acres of reservoirs and 15,000 acres of Stormwater Treatment Areas (STAs) and Water Quality Treatment Areas;
- Potential reduction of total phosphorus loads to the Caloosahatchee Estuary by 166 metric tons per year (39 percent) and total nitrogen loads by 1,840 metric tons per year (38 percent);
- Restoration of more than 2,000 acres of wetlands within the Caloosahatchee River Watershed; and
- Provision of approximately 400,000 acre-feet of water storage within the Caloosahatchee River Watershed (in addition to the 900,000 acre-feet of identified storage needs in the Lake Okeechobee Watershed).

The preferred Plan also includes recommendations to expand existing estuarine and watershed monitoring programs and to initiate five applied research projects to track progress towards achieving the plan's objectives. Total phosphorus and total nitrogen load reduction performance will be revisited once the TMDLs are formally adopted by FDEP, which will provide specific loading rates, compliance locations, and compliance methodology.

As required by the legislation, the preferred Plan avoids impacts to other water-related needs of the region and actually improves water supply by reducing the frequency of unmet irrigation demands and the frequency and volume of Lake Okeechobee Service Area cutbacks.

The Caloosahatchee River Watershed Protection Plan meets the intent of the legislative directive by providing significant nutrient load reductions and decreases in damaging local discharges to the estuary; building upon existing and planned programs and projects; minimizing real estate acquisition requirements by promoting the involvement of private landowners as partners and emphasizing the use of publicly-owned lands; and accentuating both cost-effective local features and select regional projects.

Implementation will be based on a phased-approach. Phase I includes projects initiated or constructed between 2009 and 2012, followed by Phase II projects initiated between 2013 and 2018. The Long-Term Implementation Phase will include projects initiated beyond 2018.

The preferred Plan includes many existing projects and programs and assumes these efforts will continue; therefore, a variety of federal, state, and local funding sources will be used. Cost estimates, potential funding sources, and cost assumptions are provided below for each preferred Plan component included in Phase I *(with the exception of urban BMPs where the costs reflect full implementation with no phasing. Schedules for urban BMP implementation will be addressed in the Basin Management Action Plan development process)*. Costs for each progressive phase of implementation will be developed as more detailed project designs and information from various projects and studies are available.

Phase I implementation cost estimates:

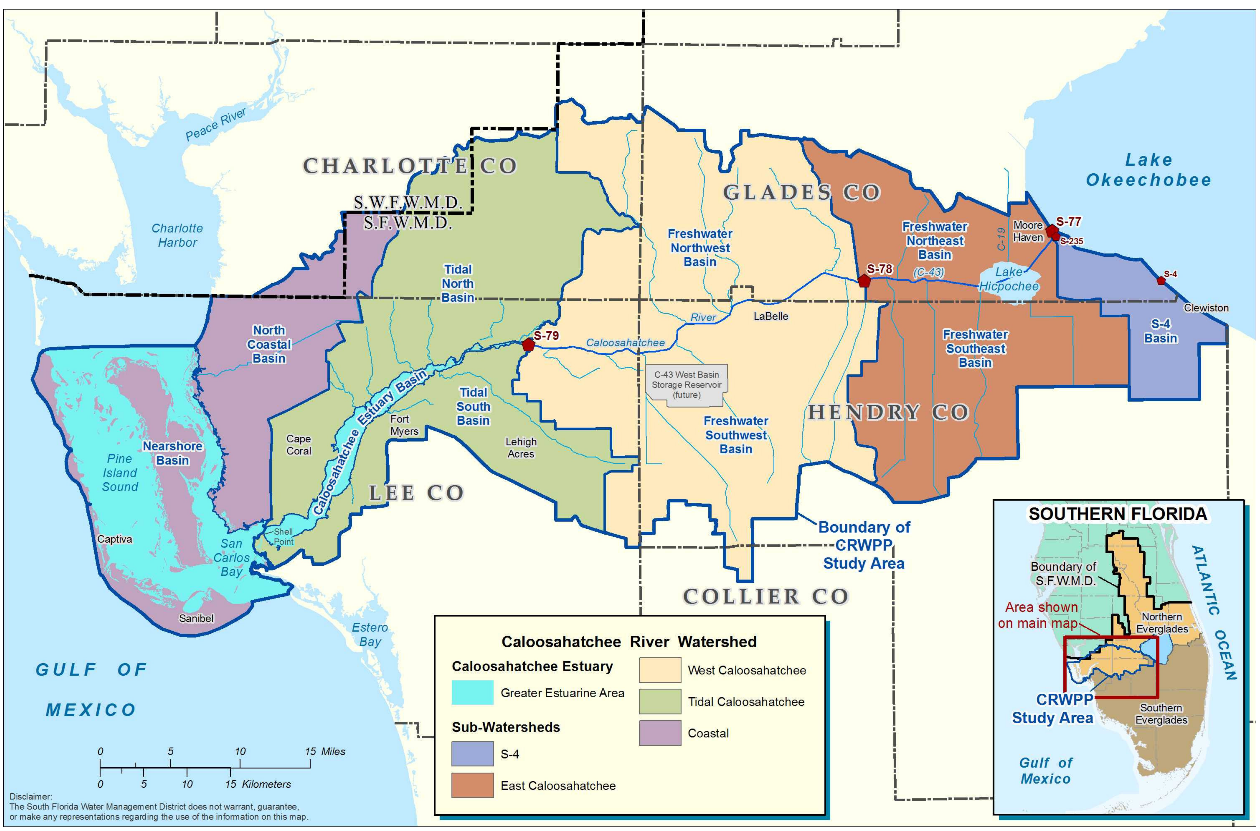
- <u>Watershed Pollutant Control Program</u>
  -- *Agricultural BMPs*: $3.3-$4.0 million from state, SFWMD and/or local funds
  -- *Urban BMPs*: $663-$809 million from state and local funds *(total – no phasing)*

- <u>Watershed Construction Project</u>
  -- *Regional Projects:*
  CERP - $524-$781 million; 50:50 cost-share state and federal funds
  Non-CERP - $117-175 million from state, SFWMD, and/or local funds
  -- *Local Projects:* $15 million from state funds

- <u>Watershed Research and Water Quality Monitoring Program</u>
  -- $5.2 million in state and local funds

The Caloosahatchee River Watershed Protection Plan is based on the best available information to date – incorporating agricultural and urban best management practices to reduce pollutants at the source and "green technologies" to help remove excess nutrients and improve water quality. As additional data and understanding of the dynamics of the watershed are developed and analyzed, plan features may be modified. Plan revisions will be included in the three-year plan updates, as required by the legislation. This approach allows for maximum flexibility for implementing proposed and additional management measures to achieve any adopted nutrient TMDLs, desirable salinity ranges, flow regimes and related restoration goals for the Caloosahatchee River and Estuary.

Caloosahatchee River Watershed Protection Plan Boundary and Sub-Watersheds



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LIST OF ABBREVIATIONS

ac	acre
ac-ft	acre-feet
AFSIRS	Agricultural Field Scale Irrigation Requirement Simulation
ASR	aquifer storage and recovery
BMAP	Basin Management Action Plan
BMP	best management practice
BOD	biological oxygen demand
BOD_5	5-day biochemical oxygen demand
CBASE	Current Base
CERP	Comprehensive Everglades Restoration Plan
CESWQ	Caloosahatchee Estuary Water Quality Monitoring
cfs	cubic feet per second
CH3D	Curvilinear Hydrodynamics 3-Dimensional
CIP	Capital Improvement Plan
CWA	Clean Water Act
DO	dissolved oxygen
DON	dissolved organic nitrogen
DTKN	dissolved total Kjeldahl nitrogen
ECAL	East Caloosahatchee
ECWCD	East County Water Control District
EFDC	Environmental Fluid Dynamics Code
EIS	Environmental Impact Statement
ERC	Environmental Regulation Commission
ERP	Environmental Resource Permit
ET	evapotranspiration
F.A.C.	Florida Administrative Code
FDACS	Florida Department of Agriculture and Consumer Services
FDEP	Florida Department of Environmental Protection
FDER	Florida Department of Environmental Regulation
FDOH	Florida Department of Health
FDOT	Florida Department of Transportation
FLUCCS	Florida Land Use, Covers, and Forms System
F.S.	Florida Statutes
ft	feet
FWRA	Florida Watershed Restoration Act
ha	hectares
HIS	Habitat Suitability Index
HSPF	Hydrological Simulation Program—Fortran
IRL-S PIR	Indian River Lagoon-South Final Integrated Project Implementation Report and Environmental Statement
km	kilometer
km^2	square kilometer
LDR	Land Development Regulations
lb/yr	pounds per year

lb/ac/yr	pounds per acre per year
LCH	Lower Charlotte Harbor
LOER	Lake Okeechobee and Estuary Recovery
LOFT	Lake Okeechobee Fast Track
LOPA	Lake Okeechobee Protection Act
LORSS	Lake Okeechobee Regulation Schedule Study
LOSA	Lake Okeechobee Service Area
LOP2TP	Lake Okeechobee Watershed Construction Project, Phase II Technical Plan
LOWQM	Lake Okeechobee Water Quality Model
LOWSM	Lake Okeechobee Water Shortage Management
m	meter
m^2	square meter
MGD	million gallons per day
mg/L	milligrams per liter
mi	mile
mi^2	square mile
MS4	Municipal Separate Storm Sewer Systems
mt	metric ton
mt/yr	metric tons per year
N	nitrogen
NEEPP	Northern Everglades and Estuaries Protection Program
NERSM	Northern Everglades Regional Simulation Model
NGVD	National Geodetic Vertical Datum
NPDES	National Pollutant Discharge Elimination System
NSM	Natural Systems Model
USNRCS	U. S. Natural Resources Conservation Service
O&M	operation and maintenance
OPTI	Reservoir Optimization Model
P	phosphorus
PD&E	Process Development and Engineering
PIR	Project Implementation Report
ppb	parts per billion
ppm	parts per million
ppt	parts per thousand
RECOVER	Restoration Coordination and Verification
RSM	Regional Simulation Model
RWCA	recyclable water containment areas
RWPPB	River Watershed Protection Plan Base
RWQMP	Research and Water Quality Monitoring Program
SAV	Submerged Aquatic Vegetation
SFER	South Florida Environmental Report
SFWMD	South Florida Water Management District
SFWMM	South Florida Water Management Model
SLRWPP	St. Lucie River Watershed Protection Plan
STA	stormwater treatment area
STORET	Storage and Retrieval (5.3)

SWET	Soil and Water Engineering Technology, Inc.
SWFFS	Southwest Florida Feasibility Study
SWFRPC	Southwest Florida Regional Planning Council
SWIM	Surface Water Improvement and Management Plan
TFI	Target Flow Index
TKN	total Kjeldahl nitrogen
TMDL	Total Maximum Daily Load
TN	total nitrogen
TOC	total organic carbon
TP	total phosphorus
TSS	total suspended solids
UF/IFAS	University of Florida Institute of Food and Agriculture Sciences
µg/L	micrograms per liter
US	United States
USACE	U.S. Army Corps of Engineers
USDOI	U.S. Department of Interior
USDA	U.S. Department of Agriculture
USDA/NRCS	U.S. Department of Agriculture/Natural Resource Conservation Service
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VEC	Valued Ecosystem Component
WaSh	Watershed Hydrology and Water Quality Model
WASP	Water Quality Analysis Simulation Program
WBID	waterbody identification
WCA	Water Conservation Area
WCAL	West Caloosahatchee
WMM	Watershed Management Model
WRAC	Water Resources Advisory Committee
WRDA	Water Resources Development Act
WRF	Water Reclamation Facility
WSE	Water Supply and Environment
yr	year

CHAPTER 1

WATERSHED HISTORY AND PREFERRED PLAN HIGHLIGHTS

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1.0 WATERSHED HISTORY AND PREFERRED PLAN HIGHLIGHTS

1.1 Watershed History and Restoration Efforts

Like most populated areas in the state, natural habitats, drainage patterns, and land uses within the Caloosahatchee River Watershed have been significantly altered over time. Loss of natural habitat from riverfront and coastal development, increased urban development and stormwater runoff, construction of drainage canals, and agricultural activities have affected the quality, quantity, timing, and distribution of flows to the estuary. Wet season flows have increased due to increased and more rapid runoff from land clearing and impervious areas, and dry season flows have decreased due to the lack of (natural) storage and increased water supply demand for agricultural and urban development. Loss of storage within the watershed has resulted from the watershed being drained to accommodate grazing, citrus farms and other agricultural and urban development.

The Northern Everglades and Estuaries Protection Program (NEEPP) was developed in response to legislative findings that the Lake Okeechobee, Caloosahatchee River, and St. Lucie River watersheds are critical water resources that have been, and continue to be, adversely affected from changes to hydrology and water quality.

1.1.1 A Brief History

Prior to the development of a canal system in the late 1800s, the Caloosahatchee River was a sinuous river originating in the natural marshlands west of Lake Okeechobee. In 1881, a canal (C-43) was dredged to connect the Caloosahatchee River to Lake Okeechobee. After the initial dredging, three lock-and-dam structures were added to control flow and stage height in the lake and canal. S-77 at Moore Haven on Lake Okeechobee and S-78 at Ortona were completed in the 1930s; S-79 (W.P. Franklin Lock and Dam) at Olga was completed in 1966. S-79 was constructed to assure a freshwater supply for Lee County and to prevent saltwater intrusion.

Construction of the massive control structures combined with the dredging that widened and deepened the river transformed the shallow and crooked Caloosahatchee River into a regulated waterway, part of the Intracoastal and Okeechobee Waterway system under federal jurisdiction. The river is no longer free-flowing and is operated as two “pools” maintained at different elevations between the major water control structures. These actions provided a navigable connection between the west coast of Florida and Lake Okeechobee, and also made the Caloosahatchee Estuary one of the major outlets for water draining from the vast Upper Kissimmee and Lake Okeechobee Basins.

These changes opened the area to agricultural and urban development, increasing the demand for dry land, better flood protection and consistent water supply. A limited network of local canals now provides flood control and water supply conveyance to accommodate citrus groves, sugar cane, cattle grazing, and rural/urban areas. Residents and businesses continue to rely on the river as a primary source for irrigation, drainage and potable water.

The Caloosahatchee Estuary, west of S-79, has also been significantly altered. Early descriptions of the estuary characterize it as barely navigable, with extensive shoals and oyster bars restricting accessibility. In the 1960s, a navigation channel was dredged and a causeway built across the mouth of San Carlos Bay. Historic oyster bars upstream of Shell Point were mined for use in the construction of roads.

1.1.2 Regional System Modifications – Lake Okeechobee Constraints

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

While making way for growth, channelization of the Kissimmee River removed regional storage upstream of Lake Okeechobee. As nutrient-enriched runoff from agricultural and urban activities within the watershed flowed into the lake, its water quality suffered. Earlier, completion of the Herbert Hoover Dike in 1937 greatly reduced the extent of the lake's natural littoral or shoreline marsh areas, reducing overall lake surface area by a third and, thereby, significantly reducing the lake's available and historical storage capacity. Construction of the protective levee system, along with drainage and development efforts to the south, reduced the natural expanse of the Florida Everglades' wetland area by 50 percent, constraining flow south from Lake Okeechobee.

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

1.1.3 Ecological Consequences

While the physical changes within the 1,687 square mile Caloosahatchee River Watershed created tremendous opportunities for population and economic growth, they also resulted in major changes in the hydrology of the area. Adverse ecological impacts in the estuary have occurred as a result of hydrological changes in the timing, distribution, quality, and volume of freshwater released into the estuary from the watershed and Lake Okeechobee.

Currently, two key conditions are negatively impacting the waterway's overall health. First is the delivery of freshwater to the estuary. The Caloosahatchee Estuary often receives excessive freshwater discharges from its local watersheds, especially during the wet season. This situation is sometimes exacerbated by regulatory discharges from Lake Okeechobee. Conversely, there are often periods during the dry season when flows from the Caloosahatchee River to the estuary stop completely. During drought periods when irrigation demands are high, little or no water is released to the river. Due to the deprivation of freshwater, estuarine salinity levels rise, which impacts seagrasses and oysters.

The combination of an excess of freshwater during the wet season and a lack of discharge during the dry season lead to exaggerated seasonal and short-term fluctuations in salinity throughout the entire estuary. The fluctuations in salinity in any one region of the estuary can exceed the physiological tolerance limits of the organisms that normally live there, causing stress and/or mortality.

A second problem is excessive nutrient loading, which has resulted in eutrophication – typically indicated by blooms of algae, low dissolved oxygen (DO) and periodic fish kills. Excess nutrient loading has been a concern since at least the 1980s, when the state determined that the Caloosahatchee Estuary had reached its nutrient loading limits. More recently, blue-green algae blooms, red tides, and massive accumulation of drift algae have indicated that nutrient loads to the Caloosahatchee Estuary are too high.

Land use changes and drainage practices within the watershed have contributed to elevated nutrient concentrations in the Caloosahatchee River Watershed. Nearly 35 percent of the drainage area is characterized as natural lands (e.g., upland forests, wetlands, barren and open lands). Key developed land uses include improved pasture, citrus, sugarcane, and other agricultural operations; urban areas; and open water. Today, nutrient-ladened surface water runoff from subdivisions, farms, and cities, along with underground septic tanks and discharges from sewage treatment plants, carry high amounts of nitrogen (N) and phosphorus (P) into the river and estuary.

The result of nutrient loading combined with too much or too little freshwater flowing to the Caloosahatchee River is a degraded estuarine ecological community. Documented signs include declines in the abundance and diversity of marine and estuarine species, degradation of water quality, increased phytoplankton and benthic algae, and a reduction in submerged habitat such as oyster and seagrass beds. A lack of suitable habitat causes stress for seagrass and oysters (two primary indicators of healthy estuarine communities in south Florida), as well as threatened and endangered species such as manatees and wood storks. Urbanization and shoreline development have also resulted in an extensive loss of mangrove habitat along the estuary. Mangrove destruction results in a chain of reactions that affect estuarine and offshore productivity.

1.1.4 Economic and Social Value

Despite a variety of human-induced impacts on the natural system, the Caloosahatchee River and Estuary continues to be an important environmental and economic resource for both the state and local communities. The Caloosahatchee Estuary is considered part of the larger Charlotte Harbor National Estuary. A 1998 report estimated that tourism expenditures for the Charlotte Harbor area were more than $1.2 billion in 1996.

Restoration of a healthy, productive aquatic ecosystem is essential not only to maintaining the ecological integrity of a number of publicly owned and managed areas (e.g., Matlacha Pass

Aquatic Preserve, Pine Island Sound Aquatic Preserve, Charlotte Harbor National Estuary, and the Caloosahatchee, Matlacha Pass, Pine Island, and Ding Darling National Wildlife Refuges – along with numerous other federal, state, and local parks and recreation areas), but also to the associated economic benefits and overall quality of life in the watershed.

1.1.5 Preferred Plan Builds Upon Ongoing Efforts

Numerous ongoing or already planned projects in the Caloosahatchee River Watershed are aimed at improving water quality, quantity, timing and distribution. A key benefit of the NEEPP is capturing all restoration-type projects under one umbrella. Major efforts which complement and support the preferred Plan goals and objectives include:

Comprehensive Everglades Restoration Plan (CERP) – Recognizing that construction of the federally-built water management system resulted in unintended consequences on the natural system, Congress authorized the Restudy of the Central and South Florida Project (Restudy) in the early 1990s to assess the measures necessary to restore the south Florida ecosystem. Upon completion of the Restudy, the CERP was proposed in 1999 and approved as the framework for Everglades restoration in the Water Resources Development Act of 2000. The joint state-federal partnership of CERP aims to restore, protect, and preserve the water resources of central and southern Florida, including the Everglades.

To date, the state has invested more than $1.5 billion to acquire 58 percent of the land needed to implement the state-federal CERP initiative.

The CERP projects that have the greatest benefit for the Caloosahatchee Estuary are the Caloosahatchee River (C-43) West Basin Storage Reservoir Project, the Southwest Florida Feasibility Study, the Lake Okeechobee Watershed Project, and Aquifer Storage and Recovery (ASR) Projects.

- Caloosahatchee River (C-43) West Basin Storage Reservoir Project – Currently, the South Florida regional system stores water in Lake Okeechobee. Based on a variety of complex flood control and ecologic factors, excess water is sometimes discharged from the lake via the C-43 canal. The resulting surges of freshwater down the river reduce estuarine salinity levels. Alternately, during drought periods when irrigation demands are high, little or no water is released to the river, allowing estuarine salinity levels to rise. This project will help ensure a more natural, consistent flow of freshwater to the estuary. Excess basin stormwater runoff, along with regulatory releases from Lake Okeechobee, will be captured and stored in a reservoir (170,000 acre-feet capacity) and released slowly, as needed, to restore and maintain the estuary. All needed land has been acquired; pre-construction test cells have been completed and monitored; and project design is complete.

- Southwest Florida Feasibility Study – The study is a comprehensive review of the water issues that face southwest Florida, and is not limited to those related to the regional flood control project. The goal of the feasibility study is to develop a water resources plan for the entire southwest Florida area and provide for ecosystem and marine/estuary restoration and protection, water quality, flood protection, water supply, and other water-related purposes.

- Lake Okeechobee Watershed Project – This project includes six structural components and a modification to the existing Lake Istokpoga Regulation Schedule. The construction components include the Taylor Creek/Nubbin Slough Reservoir and Stormwater Treatment Area (STA), Kissimmee Reservoir, Istokpoga Reservoir, Istokpoga STA and Paradise Run Wetland Restoration. This project will improve quality and quantity of discharges into Lake Okeechobee, which will also benefit the downstream Caloosahatchee River Watershed.

- Aquifer Storage and Recovery – ASR involves the concept of storing partially treated surface water underground, by pumping the water through wells that are used for both recharge (injection) and recover. ASR technology has been demonstrated to be feasible, but has not been tested on the scale that is required for CERP. A pilot project was initiated in the Caloosahatchee River Basin in 2003, just west of LaBelle. The results of the exploratory well indicated that while high capacity ASR technology would not be feasible at that location, other sites within the watershed may be evaluated for a potential pilot project.

C-43 Water Quality Treatment and Testing Facility – One of the first projects identified under NEEPP, this is a joint, 1,350-acre project with Lee County. The purpose of this project is to design and build a testing facility that will study N removal methods and to provide results which can be used to improve the methods of water quality treatment in the Caloosahatchee Basin. The land has been acquired and design is under way.

Lake Okeechobee Protection Act – In 2000, the Florida legislature passed the Lake Okeechobee Protection Act establishing a phased, watershed-based protection program to restore the lake and its tributaries. As required by the Lake Okeechobee Protection Act, SOUTH Florida Water Management District (SFWMD), Florida Department of Agriculture and Consumer Services (FDACS), and Florida Department of Environmental Protection (FDEP) developed the Lake Okeechobee Watershed Protection Plan, detailing a suite of activities for reducing pollutant loads, particularly P, in the watershed.

Since the implementation of the Lake Okeechobee Watershed Protection Plan, the coordinating agencies have reached some notable milestones:

- Adopting a Lake Okeechobee TMDL for P of 140 metric tons to achieve an in-lake target P concentration of 40 parts per billion;
- Constructing the Taylor Creek and Nubbin Slough Stormwater Treatment Areas in partnership with the federal government;
- Completing conservation and nutrient management plans for 278,000 acres of agricultural land in the watershed;
- Investing $7.5 million in individual projects to reduce P from dairy farms, restore isolated wetlands, treat urban stormwater and enhance water storage and habitat on ranchlands;

- Implementing a comprehensive research and water quality monitoring program for the lake and watershed;
- Treating more than 32,000 acres of exotic and invasive vegetation since 2000.

Lake Okeechobee and Estuary Recovery (LOER) – To help further accelerate progress, the $200 million LOER plan was launched in 2005 – a combination of capital projects and numerous interagency initiatives to increase water storage, expand and construct treatment marshes and expedite environmental management initiatives. In addition to expediting construction of a series of Lake Okeechobee Fast-Track projects, other components of the LOER plan included alternative water storage, revisions to permit criteria, changes in fertilizer practices, revisions to the Lake Okeechobee regulation schedule and continued implementation of the Lake Okeechobee Protection Plan components.

Lake Okeechobee Regulation Schedule – A study was initiated in late 2005 by the USACE to develop a new water regulation schedule allowing operational changes within the existing infrastructure to address ecological and Herbert Hoover Dike safety issues. Based solely on current water storage capacity in the system, the operational changes will allow for quicker response and operational flexibility to fluctuating lake conditions and tributary inflows. It also allows for the capability to initiate releases to the Caloosahatchee and St. Lucie River estuaries and the Water Conservation Areas to the south, at lower levels than under the previous schedule. The low-volume releases should add flows to the Caloosahatchee Estuary, helping maintain appropriate salinity ranges. A follow-up study will take into account construction of early CERP projects, including projects expedited by the SFWMD, along with dike rehabilitation efforts, which will provide many additional options for water storage and management.

Regulatory and Source Control Programs/Planning – Examples of existing and proposed source control programs include widespread development and implementation of agricultural Best Management Practices (BMPs), restrictions on the application of wastewater residuals, implementation of the Florida Yards and Neighborhoods Program (minimizes the use of pesticides, fertilizers, and irrigation water) and Florida's consolidated stormwater management programs. As part of the preferred Plan, some regulatory rules will be revised/expanded to ensure compatibility with current initiatives.

For example, the existing Lake Okeechobee Watershed Regulatory Nutrient Source Control Program was adopted in 1989 to specifically address P. The Northern Everglades and Estuary Protection legislation expanded the program boundary to the Caloosahatchee River and St. Lucie River watersheds and added N to the focus of nutrient source controls. Rule development to extend the program to the Caloosahatchee Basin is expected to begin in 2009.

Stormwater Master Programs/Charlotte County – Charlotte County received a federal National Pollution Discharge Elimination System (NPDES) Phase II municipal permit in 2003. The permit allows the creation of a county-wide Stormwater Management Plan with a five-year implementation schedule. Every five years, the county must renew the permit and prove that the plan is being implemented. An annual reporting program provides proof of their continuing effort to protect water quality and meet federal standards.

Stormwater Master Programs/Lee County – Lee County received an NPDES municipal permit in 2004 containing 14 required program elements. A number of the elements identified controls for specific pollutants such as pesticides, herbicides, fertilizers, sanitary seepage, and construction site runoff. Other elements addressed public education, system operation and maintenance, and inspection program implementation. An annual reporting program provides proof of their continuing effort to protect water quality and meet federal standards.

Southwest Florida Regional Planning Council – A Lower West Coast Watersheds Subcommittee was formed in 2006 to address the condition of the Caloosahatchee River and Estuary. Through the work of this Subcommittee, four resolutions have been passed that should positively impact water quality in the watershed. The resolutions address fertilizer, wastewater, wastewater package plants, and onsite wastewater systems planning, treatment, and management.

Research and Monitoring – Research and monitoring in the Caloosahatchee River Watershed have been on-going for a number of years. In the late 1970s, the SFWMD began obtaining biological and physical information to determine the effects of low salinity on fishes and benthic organisms. The SFWMD initiated a continuous, long-term salinity monitoring program in the Caloosahatchee River in 1992.

Significant data gaps and uncertainties in the understanding of the estuarine system and its watershed still exist. An important component of the Caloosahatchee River Watershed Protection Plan (CRWPP) is the continuation of research and monitoring to reduce uncertainty and to close information gaps, and to support improvements to the estuary through the adaptive management process. This will ultimately lead to robust, scientifically-based solutions and more accurately predict the response of the estuarine systems to changes in water quality and quantity.

1.2 Preferred Plan Highlights

The steadfast commitment and support of all levels of government working together with environmental groups and local communities has been instrumental in sustaining support for the long-term restoration of the Caloosahatchee River Watershed. That continued support is just as vital for future efforts. A concerted effort was made during the CRWPP planning process to involve all appropriate and relevant agencies, as well as the public and stakeholders. A multi-disciplinary, multi-agency working team met periodically to collaborate, discuss and develop the technical components of the plan. Those meetings were open to the public, along with numerous other venues for public input.

The draft CRWPP was released for public comment on October 1, 2008, with an open public comment period through October 31, 2008. Input received during this process was considered during the finalization of the preferred Plan and formal responses for each comment are provided in the full plan document.

1.2.1 Plan Components

1.2.1.1 Watershed Construction Project

Identifies water quality and storage projects (known as management measures) to improve hydrology, water quality, and aquatic habitats within the watershed. Various management measures, submitted by working team members, were used to formulate alternatives, which were then evaluated for water storage benefits and nutrient loading reductions.

Water quantity was evaluated by a water budget analysis using the Northern Everglades Regional Simulation Model, based upon a simulation period of 1970-2005. The water storage capacity of each management measure was estimated based upon the best available information. Water quality was evaluated using a spreadsheet model based on water quality data from 1995-2005. P and N reductions for each management measure were estimated and were utilized in the spreadsheet to calculate remaining loads to the Caloosahatchee Estuary upon implementation of the alternatives.

Four alternatives were formulated and evaluated by the working team:

Alternative 1 – Current, ongoing and planned projects
Alternative 2 – Maximize water storage capacity
Alternative 3 – Maximize P and N nutrient load reductions
Alternative 4 – Optimize both water storage capacity and P and N nutrient load reductions

Based on the results of the water quantity and quality analysis, Alternative 4 was identified as the plan that best met the legislative goals. The key findings include:

Water Quantity/Storage – The total storage identified in the preferred Plan is approximately 400,000 acre-feet. The Caloosahatchee River (C-43) West Basin Storage Reservoir accounts for nearly half of that amount, with the remainder to be made up through additional storage in freshwater basins (215,000 acre-ft). The preferred Plan watershed storage is in addition to the approximately 900,000 acre-feet of storage identified in the Lake Okeechobee Watershed Construction Project, Phase II Technical Plan (LOP2TP) to better manage lake levels and to help reduce the need for releases to the estuaries.

An objective of the CRWPP is to reduce the frequency and duration of harmful freshwater releases into the Caloosahatchee Estuary. Based on computer modeling, the preferred Plan:

- Reduces the occurrences of undesirable flows between 2,800 and 4,500 cubic feet per second (cfs) by more than 50 percent over current conditions;
- Reduces the occurrences of undesirable flows greater than 4,500 cfs by 60 percent over current conditions;
- Significantly reduces occurrences of flows less than 450 cfs, resulting in a 98 percent improvement over current conditions;
- Results in an 84 percent improvement over current conditions towards achieving ideal flow distribution.

Overall, the preferred Plan reduces the percentage of months with detrimental high or low flows to 11 percent. Under current conditions, the Caloosahatchee Estuary experiences detrimental flow events 62 percent of the time.

Water Quality – The current load from the Caloosahatchee River Watershed to the Caloosahatchee Estuary is 2,900 metric tons per year (mt/yr) of total nitrogen (TN) and 326 mt/yr of total phosphorus (TP). The preferred Plan achieves a total load reduction of 38 percent for TN and 39 percent for TP. These results reflect the cumulative benefits provided by implementation of the LOP2TP and the CRWPP.

During the plan development process, analyses were conducted to estimate nutrient load reductions by sub-watershed. “Hot spots” contributing high nutrient loads were identified within the watershed and management measures were developed to address these areas. The major focus of management measures implemented for nutrient reductions in the Caloosahatchee River Watershed is N treatment, especially in the West Caloosahatchee Sub-watershed – a major contributor of high N levels.

1.2.1.2 Watershed Pollutant Control Program

The Caloosahatchee River Watershed Pollutant Control Program is designed to be a multi-faceted approach to preventing or reducing pollution at its source through the implementation of existing state regulations and BMPs, along with the development and implementation of improved BMPs focusing on P and N. Key agency responsibilities and programs include:

- FDACS develops, adopts, and implements agricultural BMPs to reduce water quality impacts from agricultural discharges and enhance water conservation. The statewide Urban Turf Fertilizer Rule, adopted in August 2007, limits the P and N content in fertilizers for urban turf and lawns, reducing the amount of P and N reaching Florida’s water resources. The proposed Animal Manure Application Rule, initiated in February 2008, addresses the land application of animal wastes in the Caloosahatchee River Watershed, including minimum application setbacks from wetlands and all surface waters.

- FDEP oversees initiatives to improve existing stormwater and wastewater infrastructure; implement pollutant reduction plans for municipal stormwater management systems; promote improved stormwater treatment through land development regulations; enhance existing regulations for the management of domestic wastewater residuals within the watershed; and administer the NPDES permit program.

- SFWMD regulatory programs include the Environmental Resource Permit (ERP) program and the proposed Caloosahatchee River Watershed Regulatory Nutrient Source Control Program. In March 2008, the District initiated rule development for an ERP basin rule with specific supplemental criteria designed to result in no increase in total runoff volume from new development that discharges ultimately to Lake Okeechobee and/or the Caloosahatchee or St. Lucie Estuaries. Adopted in 1989, the 40E-61 program requires source control measures for P. As a result of the NEEPP legislation, the program will be expanded to include the Caloosahatchee River Watershed and to include N source control.

1.2.1.3 Watershed Research and Water Quality Monitoring Program

The objective of the Research and Water Quality Monitoring Program is to increase the ability to identify robust, scientifically based solutions to the water quality and water quantity issues in the Caloosahatchee River and Estuary and allow for more accurate predictions for responding to ecological changes. It builds upon existing monitoring, research, and modeling efforts and makes recommended modifications to better achieve and assess the goals and targets of the CRWPP.

Monitoring - Existing monitoring in the Caloosahatchee River Watershed includes water quality and flow monitoring. Monitoring efforts are also being undertaken within the Caloosahatchee Estuary including salinity and aquatic habitat monitoring (e.g., oysters and seagrasses).

The preferred Plan recommends that the existing flow, salinity, water quality, and aquatic habitat monitoring programs continue, along with several water quality and flow optimization enhancements, including: 1) East of S-79 – An additional eight long-term sites along the reach of the Caloosahatchee River to provide improved spatial coverage and four new short-term sites in canal tributaries flowing into the Caloosahatchee River to help determine if loads calculated from reach samples accurately reflect the sum of tributary loads; 2) West of S-79 – To address important sampling gaps, reinstate four historic water quality sites, and to eliminate redundancies, remove six sites from the network; and 3) Additional water quality parameter measurements (five-day biochemical oxygen demand and dissolved total Kjeldahl nitrogen) are also recommended at both freshwater and estuarine monitoring sites.

Research – Research projects are intended to reduce or eliminate key uncertainties related to TMDLs and flow and salinity envelopes, and optimize operational protocols. The preferred Plan recommends five applied research projects:

Estuarine Nutrient Budget - This project will construct nutrient budgets of N and P for the Caloosahatchee Estuary and increase the capability to predict the effects of various management measures.

Dissolved Oxygen Dynamics - This project will identify the factors causing DO impairment in the Caloosahatchee Estuary. Understanding DO dynamics will also help to identify impacts from pollutant loads to estuarine ecosystems.

Low Salinity Zone - This project examines the effects of freshwater discharges on the production of fish larvae in the estuary and utilization of the low salinity zones as a nursery area.

Light Attenuation in San Carlos Bay - This study will examine how relative contributions to total light attenuation of chlorophyll-a, colored dissolved organic matter, and turbidity vary with season and freshwater inflow in San Carlos Bay.

Modeling – An integrated modeling framework is proposed to meet water management objectives for coastal ecosystems protection and restoration.

1.2.2 Phased Implementation

The preferred Plan will be implemented in multiple phases. Phase I includes projects that are currently initiated, or that will be initiated or completed by 2012. Phase II includes projects that will be initiated between 2013 and 2018. The Long Term Implementation Phase includes projects that will be initiated beyond 2018.

Table 1-1. Phase I (2009-2012) Projects and Implementation Status

		Initiated	**Completed**
Construction Project	Powell Creek Algal Turf Scrubber		✓
	Alternative Water Storage Facilities- Barron Water Control District		✓
	Caloosahatchee Area Lakes Restoration (Lake Hicpochee)	✓	
	C-43 Water Quality Treatment Demonstration Project (BOMA)	✓	
	Spanish Creek/Four Corners Environmental Restoration Phase I	✓	
	C-43 West Reservoir	✓	
	Local Stormwater Projects (e.g., treatment wetlands, conveyance and structural improvements, and stormwater recovery projects)	✓	✓
	Florida Ranchlands and Environmental Services Projects	✓	
	Farm and Ranchland Partnership	✓	
Pollutant Control Program	Agricultural and Urban BMPs	✓	
	Proposed Revisions to Regulatory Programs (40E-61 Source Control Regulatory Program, ERP Basin Rule, Statewide Stormwater Rule)		✓
	Comprehensive Planning and Growth Management	✓	
Research and Water Quality Monitoring	Monitoring, Research, and Modeling	✓	✓

1.2.3 Preliminary Cost Estimates

The preferred Plan captures a wide array of restoration projects and programs, utilizing a variety of implementation and funding strategies to move projects forward. Many are already included in other planning or restoration efforts.

The coordinating agencies will seek to maximize opportunities for federal and local government cost-sharing programs and opportunities for partnerships with the private sector and local government. In addition, to provide a source of state funding for the continued restoration of the South Florida ecosystem, the 2007 Florida legislature expanded the use of the Save Our Everglades Trust Fund to include Northern Everglades restoration and extended the State of Florida's commitment to Everglades restoration through the year 2020.

Costs estimates, potential funding sources, and cost assumptions are provided below for each Plan component included in Phase I (with the exception of the urban BMP costs where the costs reflect full implementation with no phasing). Costs for each progressive phase of implementation will be developed as more detailed project designs and information from various projects and studies become available.

Phase I implementation cost estimates:

- **Watershed Construction Project**
  <u>Regional Projects</u>
  CERP: For CERP projects included in Phase I, capital costs are estimated to be $524-$781 million. State CERP costs are eligible for a 50 percent cost-share with the federal government and may also include a local cost share.

  Non-CERP: For non-CERP projects (e.g., C-43 Water Quality Treatment and Testing Facility), capital costs are estimated to be $117-$175 million from state, SFWMD and/or local funds.

  <u>Local Projects</u>
  $15 million from state funds. <u>Note</u>: Based on $5 million per year from 2010 to 2012 and does not reflect matching funds from SFWMD or local sources.

- **Watershed Pollutant Control Program**
  Agricultural BMPs: $3.3-$4.0 million from state, SFWMD and/or local funds. <u>Note</u>: Assumes that 100 percent of owner-implemented and 35 percent of cost-share agricultural BMPs within the watershed can be implemented during Phase I, the state contributes 50% for capital costs, and that remaining costs are paid by landowners and federal grants.

  Urban BMPs (total – no phasing): $663-$809 million of total capital costs paid from state and local funds. <u>Note</u>: Reflects total capital costs for full implementation of urban BMPs with no phasing and no cost share assumptions. Additional details regarding funding scenarios and schedules for urban BMP implementation will be established during the

Basin Management Action Plan development process and will be incorporated into future protection plan updates.

- **Watershed Research and Water Quality Monitoring Program**
  $5.2 million in state and local funds. Note: This estimate includes costs for research and additional monitoring. Ongoing monitoring costs are not included, as those programs are already in existence and funded through other mechanisms.

1.2.4 Plan Refinements and Revisions

The preferred Plan provides a framework and road map for progressive water quality and water quantity improvements to benefit the watershed and estuary. Throughout implementation, it is fully expected that hydrologic and water quality conditions in the watershed will continue to change as land uses in the watershed are modified, and as restoration projects become operational. Performance will be periodically assessed and revisions made as necessary. In addition, the legislation requires annual reports and protection plan updates every three years.

CHAPTER 2

INTRODUCTION

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2.0 INTRODUCTION

The Caloosahatchee River Watershed Protection Plan (CRWPP) has been developed in response to recent state legislation, which authorized the Northern Everglades and Estuaries Protection Program (NEEPP), Section 373.4595, Florida Statutes (F.S.). Passed by the Florida Legislature and signed into law by Governor Charlie Crist in 2007, the landmark Northern Everglades and Estuaries Protection Program promotes a comprehensive, interconnected watershed approach to protecting Lake Okeechobee, and the Caloosahatchee and St. Lucie Rivers and Estuaries. The primary goal is to restore and protect surface water resources by addressing not only the water quality but also the quantity, timing, and distribution of water to the natural system.

The legislation requires development of watershed protection plans for the Caloosahatchee and St. Lucie by January 1, 2009. The coordinating agencies, which include the South Florida Water Management District (SFWMD), Florida Department of Environmental Protection (FDEP), and the Florida Department of Agriculture and Consumer Services (FDACS), developed the CRWPP and St. Lucie River Watershed Protection Plan (SLRWPP), in cooperation with Martin, St. Lucie, and Lee counties and affected municipalities, throughout late 2007 and 2008.

The three main components of the plans are: (1) a Watershed Construction Project, which identifies water quality and storage projects to improve hydrology, water quality, and aquatic habitats within the watershed; (2) a Watershed Pollutant Control Program that is a multi-faceted approach to reducing pollutant loads by improving the management of pollutant sources within the watershed; and (3) a Watershed Research and Water Quality Monitoring Program to monitor progress of the programs and the health of the estuaries. The Construction Project is provided in Chapter 6 of this document, the Caloosahatchee River Watershed Pollutant Control Program is included as Chapter 7 of this document, and the Caloosahatchee River Watershed Research and Water Quality Monitoring Program (CRWQMP) is attached as **Appendix E** and summarized in Chapter 8 of this document. A summary of all three components, which collectively represent the Preferred Plan of the CRWPP, is found in Chapter 9.

IMPORTANT NOTE: While acknowledging the impacts of freshwater releases from Lake Okeechobee on the downstream environment, it is important to note that the intent of the protection plan is to identify strategies for addressing and better understanding local watershed influences and inflows on the health of the river and estuary. A separate document, the Lake Okeechobee Watershed Construction Project, Phase II Technical Plan (LOP2TP), focuses on projects and initiatives designed to reduce total phosphorus (TP) loadings to the Lake and to provide additional storage capacity north of the Lake in order to better manage lake levels and help reduce the need for releases to the estuaries. That plan, also a requirement of the Northern Everglades and Estuaries Protection Program, was submitted to the Florida Legislature on February 1, 2008.

2.1 Northern Everglades and Estuaries Protection Program

The Northern Everglades and Estuaries Protection Program recognizes the importance and connectivity of the entire Everglades ecosystem. Implementation of this program will include improving the quality, quantity, timing, and distribution of water to the natural system.

The legislative mandate for the NEEPP (Section 373.4595, F.S.) establishes three watershed protection programs: (1) the Lake Okeechobee Watershed Protection Program; (2) the Caloosahatchee River Watershed Protection Program; and (3) the St. Lucie River Watershed Protection Program (**Figure 2-1**). Under each of these watershed protection programs, a specific watershed protection plan is required. Details of these plans are discussed in the following subsections.

2.1.1 Lake Okeechobee Watershed Protection Program

In 2000, the legislature passed the Lake Okeechobee Protection Act LOPA, Section 373.4595, F.S. (2000), which established a restoration and protection program for the Lake. The intent of the original legislation was to achieve and maintain compliance with state water quality standards in Lake Okeechobee and its tributary waters. This was to be done through a watershed-based, phased, comprehensive and innovative protection program designed to reduce P loads and implement long-term solutions, based upon the Lake's TMDL for P. The Lake Okeechobee Watershed Protection Program includes two phases: Phase I was developed under the original LOPA and Phase II was developed under the NEEPP.

2.1.1.1 Lake Okeechobee Watershed Protection Plan Phase I

Phase I was intended to bring some immediate total phosphorus (TP) load reduction to Lake Okeechobee. The project features are designed to improve hydrology and water quality of Lake Okeechobee and downstream receiving waters, consistent with recommendations included in the South Florida Ecosystem Working Group's Lake Okeechobee Action Plan. Section 528(b)(3) of the Water Resources Development Act (WRDA) of 1996 authorized the identification of critical restoration projects for the South Florida ecosystem. Phase I included a critical restoration project, which was identified as the Lake Okeechobee Water Retention Phosphorus Removal Critical Project. Phase I was delivered to the legislature in 2004 and an update was submitted in February 2007.

2.1.1.2 Lake Okeechobee Watershed Construction Project, Phase II Technical Plan

Phase II identifies construction projects, along with on-site measures, needed to achieve water quality targets for Lake Okeechobee. These efforts, such as agricultural and urban best management practices (BMPs), are to prevent or reduce pollution at its source. In addition, Phase II includes projects for increasing water storage north of Lake Okeechobee to achieve healthier lake levels and reduce harmful discharges to the Caloosahatchee and St. Lucie River estuaries. Phase II was submitted to the legislature in February 2008.

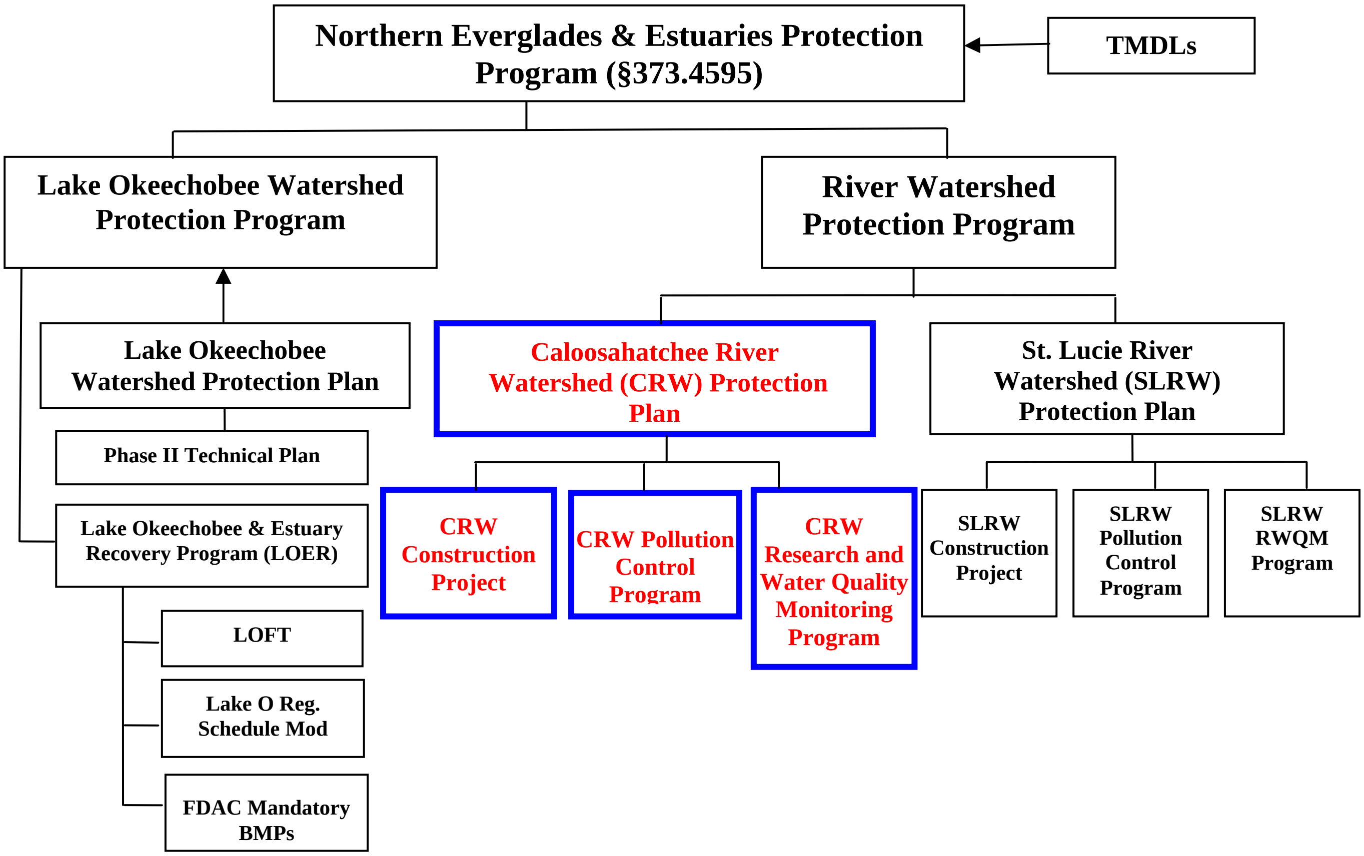

Figure 2-1. Northern Everglades and Estuaries Protection Program Legislative Mandates

2.1.2 Caloosahatchee River Watershed Protection Plan

The CRWPP is required by the NEEPP. This document will be updated every three years. As such, the recommendations included in this plan are based on best available information to date and are subject to modification as additional data and understanding of the dynamics of the watershed and Lake Okeechobee are developed. This will allow maximum flexibility to embrace new technologies, processes and procedures.

This CRWPP identifies the geographic extent of the watershed and is being coordinated, as needed, with the Lake Okeechobee Watershed Protection Plan and SLRWPP. It provides an implementation schedule for pollutant load reductions consistent with any adopted nutrient TMDLs. However, the TMDL for the Caloosahatchee River and Estuary is still under development by FDEP. In order to move forward with the plan, alternatives were formulated to "maximize" reduction of TP and total nitrogen (TN), based on provisional nutrient concentration reduction goals for the system. The CWRPP includes three main components: (1) a Construction Project, (2) a Pollutant Control Program, and (3) a Research and Water Quality Monitoring Program.

2.1.2.1 Construction Project

The purpose of the CRWPP Construction Project is to (1) identify potential water quality and quantity projects within the Caloosahatchee River Watershed, (2) formulate alternatives based on the projects identified, and (3) identify a preferred alternative that results in the most benefit to the Caloosahatchee Estuary. The CRWPP also identifies available funding sources to implement the projects. To ensure timely implementation, the coordinating agencies will coordinate design, scheduling, and sequencing of project facilities with Lee County, Hendry County, Glades County, Charlotte County, and other interested stakeholders and affected local governments. The Construction Project is discussed in more detail in Chapter 6 of this document.

2.1.2.2 Pollutant Control Program

The Caloosahatchee River Watershed Pollutant Control Program is designed to be a multi-faceted approach to reducing pollutant loads by improving the management of pollutant sources within the Caloosahatchee River Watershed. Such improvements will be made through (1) the implementation of regulations; (2) the development and implementation of BMPs; (3) the improvement and restoration of hydrologic function of natural and managed systems; and (4) the utilization of alternative technologies for pollutant reduction, such as cost-effective biologically based, hybrid wetland/chemical and other innovative nutrient control technologies. The coordinating agencies will facilitate the utilization of federal programs that offer opportunities for water quality treatment, including preservation, restoration, or creation of wetlands on agricultural lands. The Pollutant Control Program is discussed in more detail in Chapter 7 of this document.

2.1.2.3 Research and Water Quality Monitoring Program

The Research and Water Quality Monitoring Program (RWQMP) will build upon SFWMD's existing research program and is intended to carry out, comply with, or assess the plans, programs, and other responsibilities created by this program. The program will also conduct an assessment of existing monitoring programs for hydrology, water quality, and aquatic habitat, as well as evaluations of their ability to meet program goals and the identification of potential improvements. The RWQMP is discussed in more detail in Chapter 8 of this document.

2.1.3 St. Lucie River Watershed Protection Plan

The SLRWPP is being developed concurrently with the CRWPP, and will also be submitted to the Florida Legislature no later than January 1, 2009. The SLRWPP comprises the same three components as the CRWPP: (1) a Construction Project, (2) a Pollutant Control Program, and (3) a Research and Water Quality Monitoring Program.

2.2 Purpose and Scope

The purpose of the CRWPP is to provide an overall strategy for improving quality, quantity, timing, and distribution of water in the Caloosahatchee Estuary and to re-establish salinity regimes suitable for the maintenance of a healthy, naturally diverse, and well-balanced estuarine ecosystem. The CRWPP is intended to achieve the following four objectives:

- Minimize the frequency and duration of harmful excess freshwater discharges from the Caloosahatchee River Watershed;
- Maintain minimum flows to the Caloosahatchee Estuary to prevent undesirable high salinity conditions;
- Maximize nitrogen (N) and P load reductions to meet TMDLs as they are established for the Caloosahatchee Estuary; and
- Establish a Research and Water Quality Monitoring Program sufficient to implement the program and projects.

2.3 Background

The Caloosahatchee Estuary is located in Lee County and encompasses approximately 140 square miles (mi^2) of estuarine habitat on Florida's southwest coast in the vicinity of Fort Myers. The estuary consists of the tidal portion of the Caloosahatchee River, which extends from the W.P. Franklin Lock and Dam (Structure S-79) downstream to its mouth at Shell Point, and its associated coastal waters, which include Matlacha Pass, San Carlos Bay, and Pine Island Sound. The estuary is connected to Lake Okeechobee by the Caloosahatchee River (C-43), a man-made connection to the Lake originally created in the late 19th century. The Caloosahatchee River now serves as the western reach of the cross-state Okeechobee Waterway that connects Lake Okeechobee to the Gulf of Mexico at Fort Myers on the west coast.

2.3.1 Historical Conditions

Historical drainage patterns within the Caloosahatchee River Watershed have been highly altered since pre-drainage times. **Figure 2-2** shows the extent of altered flows and wetland loss in the Everglades system, including the Caloosahatchee River Watershed. Continued population growth increased the demands for more land, better flood protection, and consistent water supply. Flood control measures were taken to protect residents by constructing the Herbert Hoover Dike around Lake Okeechobee, and included ditching and draining to create residential land, cities, and agricultural fields.

Prior to the development of a canal system in the late 1800s, the Caloosahatchee was a sinuous river originating in the marshlands of Lake Flirt, west of Lake Okeechobee. Two small lakes, Lettuce and Bonnet, stood between the headwaters of the river and Lake Okeechobee, and were only connected by marshy grassland. In 1881, a canal (C-43) was dredged to connect the Caloosahatchee River to Lake Okeechobee. Dredging opened the area for agriculture, navigation, and development. At the same time, these activities had environmental consequences including lowering Lake Okeechobee's water table and the loss of 76 river bends and 8.2 miles of river length (Kimes & Crocker, 1998).

After the initial dredging, three lock-and-dam structures were added to control flow and stage height in the lake and canal. S-77 at Moore Haven on Lake Okeechobee and S-78 at Ortona were completed in the 1930s; while the last, S-79 at Olga (W.P. Franklin Lock and Dam), was completed in 1966. S-79 was constructed to assure a freshwater supply for Lee County and to prevent saltwater intrusion. The last major improvements, from the massive control structures to the dredging that widened and deepened the river, finished the 80-year process of transforming the shallow and crooked Caloosahatchee River into a regulated navigational waterway, part of the Intracoastal and Okeechobee Waterway system under federal jurisdiction (Kimes & Crocker, 1998).

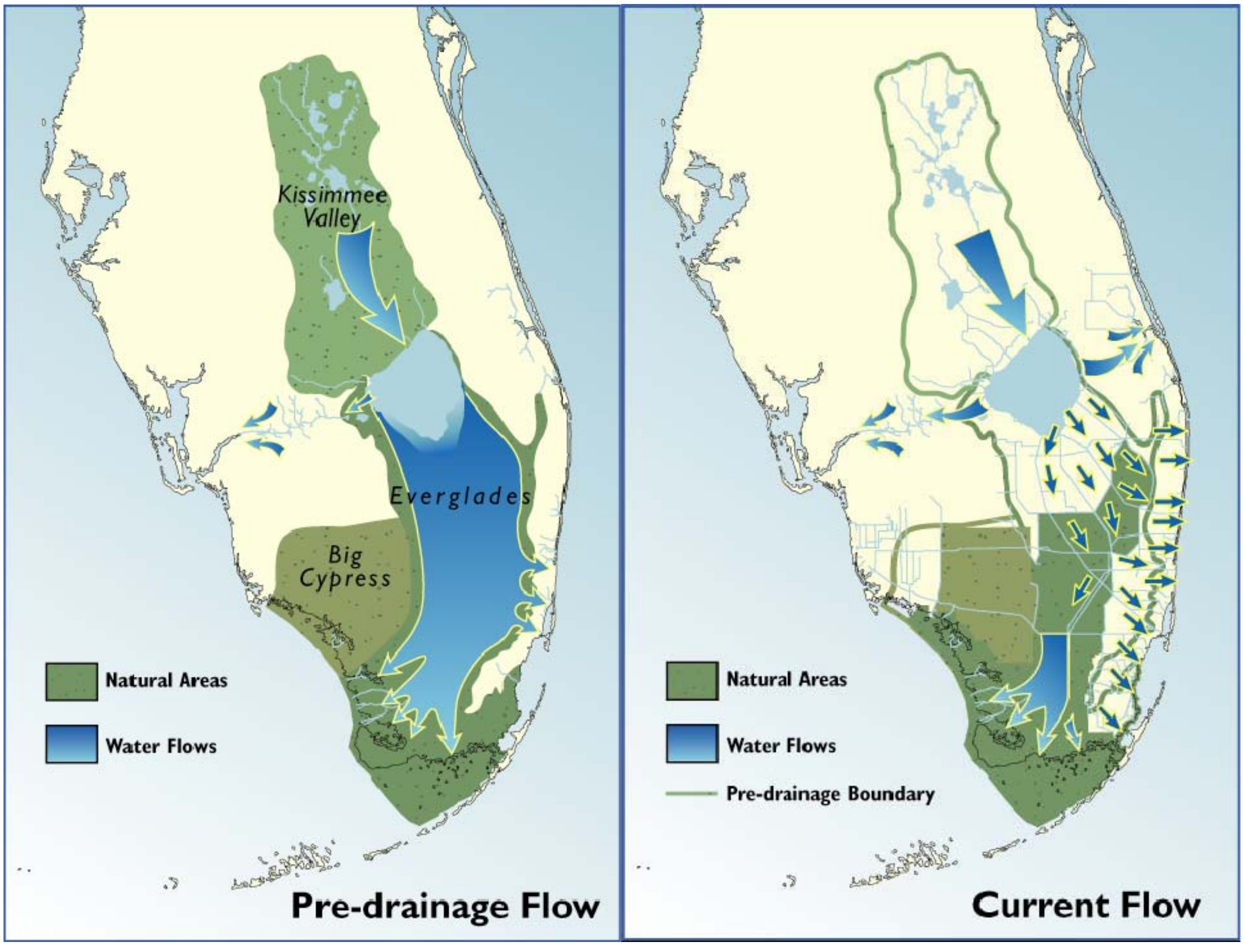

Figure 2-2. Historical vs. Current Everglades Flows

The Caloosahatchee Estuary west of S-79 has also been significantly altered (Chamberlain & Doering, 1998a). Early descriptions of the estuary characterize it as only navigable in a small craft for a few miles before the channel would disappear into marshland. Additionally, extensive shoals and oyster bars restricted accessibility to the estuary. However, once the navigational significance of the waterway was recognized, work began to open it to larger vessels. In the 1960s, a navigation channel had been dredged and a causeway built across the mouth of San Carlos Bay. Historic oyster bars upstream of Shell Point were mined and removed for use in the construction of roads, which include seven automobile bridges and one railroad bridge. All of these projects have resulted in major changes in the hydrology of the Caloosahatchee River Watershed. Adverse ecological impacts in the estuary have occurred as a result of hydrological changes in the timing, distribution, quality, and volume of freshwater released into the estuary from the watershed and Lake Okeechobee. Despite these impacts, the Caloosahatchee Estuary continues to be an important environmental and economic resource.

2.3.2 Current Conditions

The Caloosahatchee River is at the head of a vast estuarine and marine ecosystem that includes aquatic preserves (Matlacha Pass Aquatic Preserve, Pine Island Sound Aquatic Preserve, Charlotte Harbor National Estuary, and the Caloosahatchee, Matlacha Pass, Pine Island, and Ding Darling National Wildlife Refuges), along with numerous other federal, state, and local parks and recreation areas. Restoration of a healthy, productive aquatic ecosystem in the Caloosahatchee River is essential to maintaining the ecological integrity of these publicly owned and managed areas, as well as the associated economic activity in the watershed.

Currently, the watershed is facing a number of conditions that are having a negative impact on its health. First, the delivery of freshwater to the estuary has been altered and is more variable with higher wet season discharges and lower dry season discharges. There is not enough storage capacity in the regional water management system to minimize or prevent the possible harmful effects of periodic high volume discharges of freshwater from the local watershed and Lake Okeechobee to the Caloosahatchee River. Conversely, during dry periods, there is sometimes not enough freshwater available in the regional system to maintain desirable salinity levels in the estuary.

A second problem is excessive nutrient loading, which has resulted in eutrophication. The Florida Department of Environmental Regulation, now FDEP, conducted a waste load allocation study in 1981 and concluded that the estuary had already reached its nutrient loading limits (DeGrove, 1981). Following the study, target concentrations were established for chlorophyll-*a*, TN, and TP.

The combined result of nutrient loading and too much or too little freshwater flowing to the Caloosahatchee River is a degraded estuarine ecological community. This degradation can be characterized by declines in the abundance and diversity of marine and estuarine species, poor water quality, increased phytoplankton and benthic algae, and reductions in submerged habitat. A lack of suitable habitat causes stress for seagrass and oysters (two primary indicators of healthy estuarine communities in south Florida) and other higher trophic-level species, including threatened and endangered species (e.g., manatees, wood storks) (USACE & SFWMD, 2007).

2.3.3 Economic and Social Value

Despite a variety of human-induced impacts on the natural system, the Caloosahatchee River and Estuary continues to be an important environmental and economic resource for both the state and local communities. The Caloosahatchee Estuary is considered part of the larger Charlotte Harbor National Estuary. A 1998 report estimated that tourism expenditures for the Charlotte Harbor area were more than $1.2 billion in 1996.

Restoration of a healthy, productive aquatic ecosystem is essential not only to maintaining the ecological integrity of a number of publicly owned and managed areas (e.g., Matlacha Pass Aquatic Preserve, Pine Island Sound Aquatic Preserve, Charlotte Harbor National Estuary, and the Caloosahatchee, Matlacha Pass, Pine Island, and Ding Darling National Wildlife Refuges – along with numerous other federal, state, and local parks and recreation areas), but also to the associated economic benefits and overall quality of life in the watershed.

2.4 Study Area

The study area encompasses the Caloosahatchee Estuary and its watershed, which are shown on **Figure 2-3**. The following subsections provide basic physical characteristics of the estuary and watershed as it exists today.

Land-use types are one of the physical characteristics of the study area discussed. SFWMD uses the Florida Land Use, Cover and Forms Classification System (FLUCCS) to define land-use types. In the following discussions, the designation "natural areas" includes upland forests, wetlands, barren lands, and open lands. In addition, the designation "urban areas" includes land-use descriptions for the following categories: low, medium, and high density residential; commercial and services; industrial; extractive; institutional; and recreational.

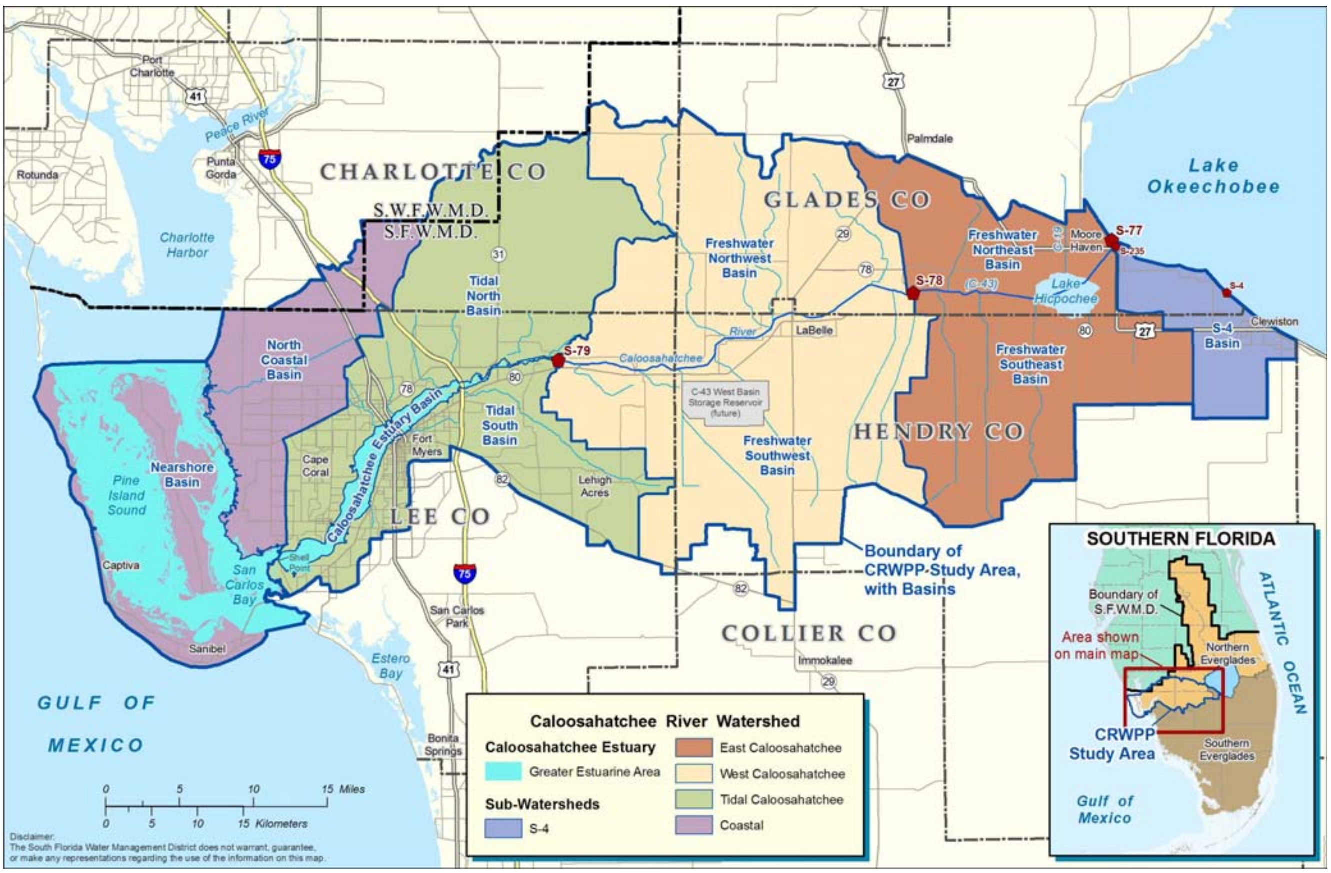

Figure 2-3. Caloosahatchee River Watershed and Sub-watershed Boundary Map

2.4.1 Caloosahatchee Estuary

The Caloosahatchee Estuary is located in Lee County, southwest Florida, and consists of two distinct estuarine areas. It includes the tidal portion of the Caloosahatchee River, which extends about 41 kilometers (km) from the W. P. Franklin Lock and Dam (S-79) downstream to Shell Point, where the river empties into San Carlos Bay. The estuary also includes the Matlacha Pass, San Carlos Bay, and Pine Island Sound areas, which lie near the mouth of the Caloosahatchee River and are directly affected by its flows. The estuary is connected to Lake Okeechobee by the

Caloosahatchee River (C-43 Canal), a man-made connection to the Lake originally created in the early 20th century.

Loss of natural habitat from riverfront and coastal development, increased urban development, construction of drainage canals, and agricultural activities have affected the timing, quantity, quality, and distribution of runoff to the estuary. Wet season flows have risen, due to land clearing and impervious areas increasing runoff, and dry season flows have decreased, due to increased water supply demand for agricultural and urban development. The resulting biological impacts include habitat loss and degradation, decreased biodiversity, and increased prevalence of marine resource diseases.

2.4.2 Caloosahatchee River Watershed

The Caloosahatchee River Watershed consists of the Caloosahatchee Estuary and all lands that drain directly or indirectly into the waters of the estuary. These lands include the drainage area of the Caloosahatchee River, the mainland area that drains into Matlacha Pass, and the nearshore islands in the vicinity of the estuary. The watershed includes portions of Lee, Hendry, Charlotte, and Glades counties, and a small portion of north-central Collier County. It encompasses a drainage area of over 1,079,796 acres [1,687 mi^2 or 4,370 square kilometers (km^2)]. A map of land-use types for the Caloosahatchee River Watershed, based on the FLUCCS, is shown in **Figure 2-4.** The single largest land use is natural areas, which encompass 34.0 percent (366,765 acres) of the total watershed. Improved pastures are second, accounting for 10.8 percent of the watershed (117,152 acres), and citrus farms are third, accounting for 9 percent (96,684 acres). Urban areas are typical of the southwestern reaches of the watershed, as well as areas along the Caloosahatchee River, and account for 13.5 percent of the total area (145,280 acres).

The watershed contains sub-watersheds that may consist of one or more smaller units, referred to as basins. The sub-watersheds include the S-4, East Caloosahatchee, West Caloosahatchee, Tidal Caloosahatchee, and Coastal sub-watersheds.

2.4.3 S-4 Sub-watershed

The S-4 Sub-watershed includes only the S-4 Basin and has a total drainage area of approximately 42,504 acres (66.4 mi^2). The sub-watershed is located in northeastern Hendry County and southeastern Glades County. The predominant land use is sugar cane (32,932 acres), followed by urban areas (4,362 acres) and natural areas (2,431 acres).

Approximately 15 miles of the north boundary of the S-4 Basin run adjacent to Lake Okeechobee. The major drainage canals in the basin include the L-D1 Perimeter Canal, the C-20 and C-21 canals, and the Clewiston (Industrial) Canal. There are four main structures that regulate flows within the S-4 Basin: the S-4 pump station (located at the northern end of the C-20 Canal) that controls flow from the basin into Lake Okeechobee; the S-310 navigational lock structure (located between Lake Okeechobee and the Clewiston Canal); S-169 (a series of three gated culverts connecting the Clewiston Canal and C-21); and S-235 (a pair of gated culverts connecting the L-D1 and C-43 canals). The gates for the S-235 culverts are normally left open, allowing water to flow to the Caloosahatchee River during normal conditions. The gates are closed when the stage in Lake Okeechobee falls below 13.0 feet or during hurricane alerts. The main functions of the canals and structures in the S-4 Basin are removing excess water from the basin and supplying water to the basin when needed. The CRWPP addresses only the Caloosahatchee River Basin inflow from the S-4 Basin. The LOP2TP looked at flows from the S-4 Basin into Lake Okeechobee.

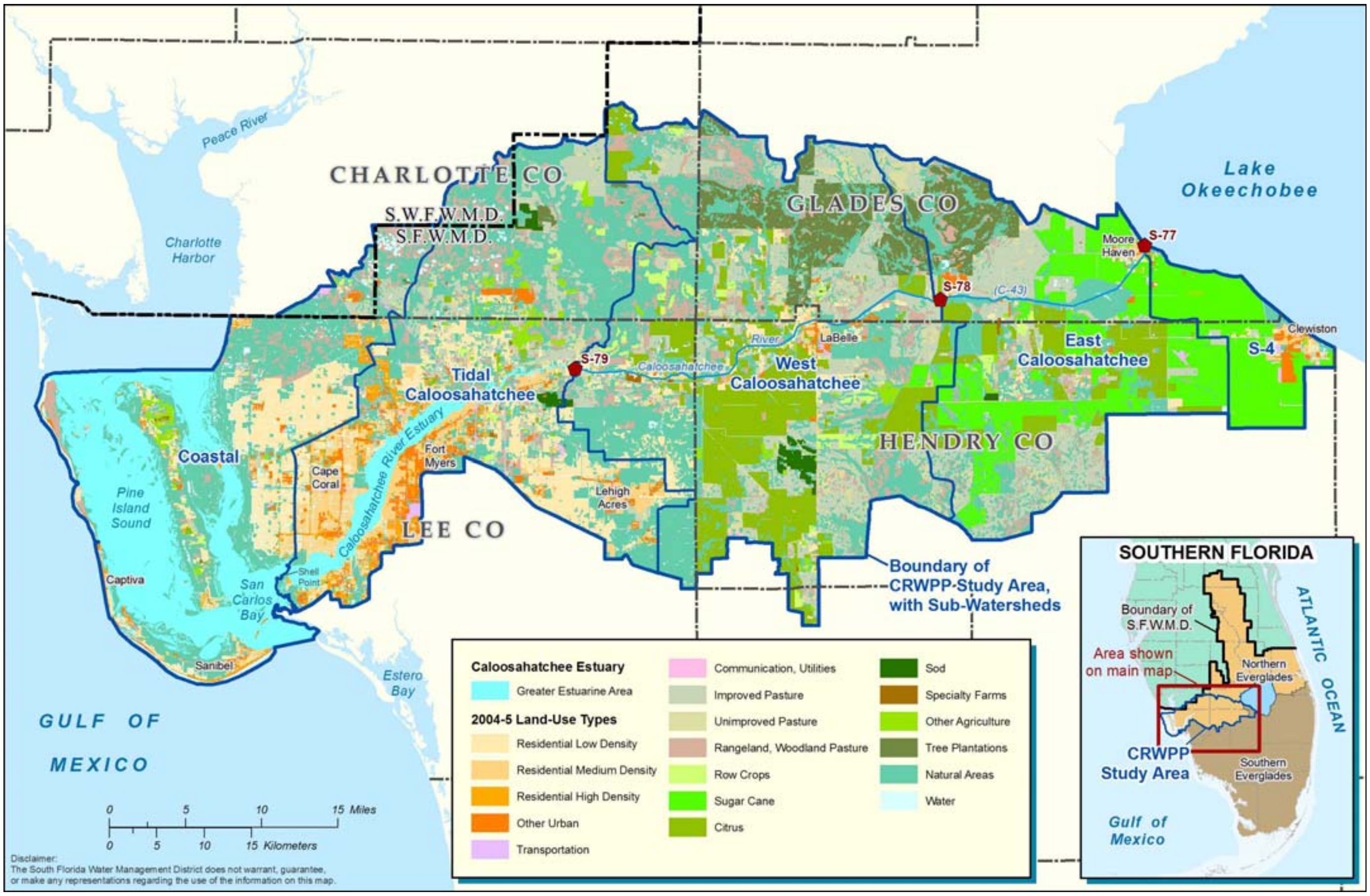

Figure 2-4. Caloosahatchee River Watershed Land Use Map

2.4.4 East Caloosahatchee Sub-watershed

The East Caloosahatchee Sub-watershed consists of the Freshwater Northeast and Freshwater Southeast basins and is located in southern Glades County and northern Hendry County. It has a total drainage area of approximately 198,299 acres (309.8 mi^2). Land-use types in this sub-watershed are mostly characterized by natural areas (55,390 acres), sugar cane (52,751 acres), and improved pastures (36,795 acres).

2.4.4.1 Freshwater Northeast and Southeast Basins

The Freshwater Northeast and Freshwater Southeast basins have drainage areas of approximately 63,724 acres (99.6 mi^2) and 134,575 acres (210.3 mi^2), respectively. The primary conveyance that serves these basins is the C-43 Canal (Caloosahatchee River), which separates the two basins. Two control structures are located in these basins: the S-77 gated spillway (also known as the Moore Haven Lock and Dam) and the S-78 gated spillway (also known as the Ortona

Lock and Dam). The C-43 Canal is intersected by Lake Hicpochee about five miles west of S-77. The C-43 Canal is also an integral part of the Okeechobee Waterway Navigational Project and, along with the St. Lucie Canal, provides a primary outlet from Lake Okeechobee for flood control. Water surface elevations in these basins are regulated by the S-78 gated spillway, and regulatory releases from Lake Okeechobee are made by way of the S-77 gated spillway. The C-19 Canal provides conveyance for agricultural lands to the C-43 Canal and is located in the Freshwater Northeast Basin. Water flows north to south in the C-19 Canal before it discharges into Lake Hicpochee before entering the C-43 Canal. The operational goals of this system are to remove excess waters from the basins and supply surface water to the basins when needed.

2.4.5 West Caloosahatchee Sub-watershed

The West Caloosahatchee Sub-watershed consists of the Freshwater Northwest and Freshwater Southwest basins. A majority of the sub-watershed is located in southern Glades and northern Hendry counties, with smaller portions in eastern Charlotte County, northeastern Lee County, and north-central Collier County. It has a total drainage area of 349,734 acres (546.5 mi^2). Land-use types in this sub-watershed are primarily natural areas (142,980 acres), citrus (69,008 acres), and improved pastures (55,555 acres).

2.4.5.1 Freshwater Northwest and Southwest Basins

The Freshwater Northwest and Freshwater Southeast basins have drainage areas of approximately 162,141 acres (253.3 mi^2) and 187,593 acres (293.1 mi^2), respectively. The primary conveyance that serves these basins is the C-43 Canal, which separates the two basins. Two control structures are located in these basins: the S-78 gated spillway and the S-79 gated spillway (also known as the W.P. Franklin Lock and Dam). The S-78 aids in control of water levels on adjacent lands upstream. The S-79 is the most downstream structure and marks the beginning of the Caloosahatchee Estuary. The S-79 helps maintain specific water levels upstream, regulates freshwater discharges into the estuary, and serves as an impediment to saltwater intrusion upstream of the lock.

2.4.6 Tidal Caloosahatchee Sub-watershed

The Tidal Caloosahatchee Sub-watershed is located in northern Lee County and southwestern Charlotte County and includes the Tidal North, Tidal South, and Caloosahatchee Estuary basins. Numerous tidal creeks drain into the Caloosahatchee Estuary Basin between S-79 and Shell Point. Five domestic wastewater treatment facilities are permitted to discharge treated wastewater to the estuary. Several of these plants, however, currently discharge significantly less than their permitted amounts due to reuse programs (most notably Cape Coral, and to a lesser extent, Fiesta Village and Waterway Estates). The total drainage area of this sub-watershed is approximately 262,023 acres (409.4 mi^2). Major land uses include natural areas (97,453 acres), urban areas (79,124 acres), and improved pastures (21,392 acres).

2.4.6.1 Tidal North and South Basins

The Tidal North Basin alone has a drainage area of approximately 163,505 acres (255.5 mi^2) and the Tidal South Basin has a drainage area of approximately 82,234 acres (128.5 mi^2). The tidal reach of the Caloosahatchee River separates the two basins and is the primary conveyance that serves the basins. The only control structure located in the basins is the S-79 gated spillway, which acts to regulate freshwater discharges to the estuary and serves as an impediment to saltwater intrusion upstream of the spillway.

2.4.6.2 Caloosahatchee Estuary Basin

The Caloosahatchee Estuary Basin consists of the tidal portion of the Caloosahatchee River, which extends from S-79 downstream to the river's mouth at Shell Point. This basin, combined with the tidal waters of the Coastal Sub-watershed, comprises the larger area referred to as the Caloosahatchee Estuary. The Caloosahatchee Estuary Basin has an area of 16,285 acres (25.4 mi^2), and is almost entirely open water. Some small land areas are included within the boundary of this basin due to mapping irregularities. The basin is about 41 km long, and below the I-75 bridge the waterway widens to a maximum extent of about 2.5 km.

2.4.7 Coastal Sub-watershed

The Coastal Sub-watershed consists of the North Coastal and Nearshore basins. The Caloosahatchee River discharges into the sub-watershed at Shell Point. The tidal waters of this sub-watershed comprise a large proportion of the area of the Caloosahatchee Estuary. The sub-watershed has an area of 227,236 acres (355.1 mi^2). The predominant land-use type is open water (101,055 acres), followed by natural areas (68,512 acres), and urban areas (28,279 acres).

2.4.7.1 North Coastal Basin

The North Coastal Basin has a drainage area of approximately 89,583 acres (140 mi^2). The majority of the basin is in western Lee County, with a small portion in southern Charlotte County. The northern part of the basin is drained by Gator Slough, and under normal conditions the entire basin discharges directly into Matlacha Pass and San Carlos Bay.

2.4.7.2 Nearshore Basin

The Nearshore Basin has a total drainage area of approximately 137,653 acres (215.1 mi^2). The basin is located in Lee County and is entirely composed of islands and open tidal waters. The barrier islands of Sanibel, Captiva, North Captiva, and Cayo Costa face the Gulf of Mexico to the west. Pine Island separates Pine Island Sound from Matlacha Pass. For this study, the northern boundary between the Nearshore Basin and Charlotte Harbor was arbitrarily defined as Boca Grande Pass.

CHAPTER 3

PLANNING PROCESS

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3.0 PLANNING PROCESS

A comprehensive and systematic planning process was used to develop the Caloosahatchee River Watershed Protection Plan (CRWPP). The planning was conducted by the coordinating agencies, which included staff from the South Florida Water Management District (SFWMD), Florida Department of Environmental Protection (FDEP), Florida Department of Agriculture and Consumer Services (FDACS), Lee County, and affected municipalities. Planning was performed in consultation with the CRWPP Working Team, which included cooperating agencies (Lee County and affected municipalities), stakeholders, and the interested public. Significant steps in this process included the following:

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

2. **Identification of problems –** Water resource construction projects are generally planned and implemented to solve problems, to meet challenges, and to seize opportunities. In the context of planning, a problem can be thought of as an undesirable condition. Identification of problems gives focus to the planning effort and aids in the development of planning objectives. For the CRWPP planning process, water resource problems were identified through an interagency brainstorming process and a review of historical documents.

3. **Determination of planning objectives –** Planning objectives are statements of what a plan is attempting to achieve. The objectives communicate to others the intended purpose of the plan. The CRWPP planning objectives were developed from the problems and opportunities identified in the working team meetings. Plans are intended to focus on the identified problems and take advantage of recognized opportunities.

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

5. **Selection of performance measures –** Performance measures and indicators are benchmarks used to guide formulation of alternative plans and evaluate plan performance. For the CRWPP planning process, performance measures and/or indicators for water quality and quantity were identified and consistent with previous and current planning processes.

6. **Identification of management measures –** A management measure is a current or future feature, activity, or technology that can be implemented at a specific site within the study area to address one or more planning objectives. Management measures are the building blocks of alternative plans. A comprehensive list of management measures was prepared and evaluated through the collective input of the Caloosahatchee River Working Team (see

Chapter 4.0 for a description of the working team). Using predetermined criteria, the management measures were screened to eliminate features or activities that did not contribute to meeting the planning goals and objectives.

7. **Formulation of alternatives –** A set of four alternative plans was formulated by combining individual management measures.

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

9. **CRWPP Selection -** The plan that best met the legislative goals was selected as the CRWPP.

10. **CRWPP Processing –** Planning-level budget estimates, an implementation schedule, and an adaptive management plan were developed for the CRWPP. Funding needs and opportunities were identified.

Routine, periodic Northern Everglades interagency meetings and working team meetings were held to engage the cooperating agencies, stakeholders and the public throughout the planning process. Through these meetings, public input was sought and incorporated into the decision-making process, as appropriate.

3.1 Ongoing Restoration Efforts and Other Relevant Projects

Numerous ongoing or planned projects in the Caloosahatchee River Watershed are aimed at improving water quality, quantity, timing and distribution, which will complement and support the CRWPP goals and objectives. A key benefit of the Northern Everglades and Estuaries Protection Program (NEEPP) legislation is capturing all restoration-type projects under one umbrella plan. Some of the major projects, which complement and support the CRWPP goals and objectives, are described in the following sections.

3.1.1 Federal and State Partnership Efforts

Several completed or planned federal and state projects contribute to the goals and objectives of the CRWPP. The effects of these projects will be seen on a regional scale. Projects in this section include the Comprehensive Everglades Restoration Plan (CERP) – Caloosahatchee River (C-43) West Basin Storage Reservoir Project Implementation Report (PIR), Southwest Florida Feasibility Study, and the Lake Okeechobee Watershed Project.

3.1.1.1 Comprehensive Everglades Restoration Plan

Recognizing that construction of the federally-built water management system resulted in unintended consequences on the natural system, Congress authorized the Restudy of the Central and South Florida Project in the early 1990s to assess the measures necessary to restore the south Florida ecosystem. Upon completion of the Restudy of the Central and South Florida Project, CERP was proposed in 1999 and approved as the framework for Everglades restoration in the

Water Resources Development Act of 2000. The joint state-federal partnership of CERP provides a framework and guide to restore, protect, and preserve the water resources of central and southern Florida, including the Everglades. The major components of CERP are surface water storage reservoirs, water preservation areas, and management of Lake Okeechobee as an ecological resource. Other major components include improved water deliveries into the estuaries, underground water storage, treatment wetlands, improved water deliveries to the Everglades, removal of barriers to sheet flow, storage of water in existing quarries, reuse of wastewater, pilot projects, improved water conservation, and additional feasibility studies. The CERP projects that have the greatest impact on the Caloosahatchee Estuary are the Caloosahatchee River (C-43) West Basin Storage Reservoir Project, the Lake Okeechobee Watershed Project, Southwest Florida Feasibility Study, and the Aquifer Storage and Recovery (ASR) projects. These projects are summarized in the following subsections.

3.1.1.1.1 Caloosahatchee River (C-43) West Basin Storage Reservoir Project

The purpose of the Caloosahatchee River (C-43) West Basin Storage Reservoir project is to improve the timing and quantity of freshwater flows to the Caloosahatchee Estuary. Currently, the South Florida flood control system stores water in Lake Okeechobee. Excess water is discharged when the lake rises to a level that threatens flooding in the Everglades Agricultural Area, the health of the lake, or the integrity of the Herbert Hoover Dike. The resulting unnatural surges of freshwater down the river reduce estuarine salinity levels.

Alternately, during drought periods when irrigation demands are high, little or no water is released to the river. Deprived of freshwater, estuarine salinity levels rise, which impacts seagrasses and oysters, species that indicate the overall health of the estuary.

The Caloosahatchee River (C-43) West Basin Storage Reservoir will be used to ensure a more natural, consistent flow of freshwater to the estuary. Excess basin stormwater runoff, along with regulatory releases from Lake Okeechobee, will be captured and stored in a reservoir and released slowly, as needed, to restore and maintain the estuary. This project may also provide recreation and water supply benefits.

The Tentatively Selected Plan as identified in the Caloosahatchee River (C-43) West Basin Storage Reservoir PIR provides approximately 170,000 acre-feet of aboveground storage volume in a two-cell reservoir, with normal full pool depths varying from 15 feet at the southeast corner to 25 feet at the northwest corner. The plan encompasses approximately 10,500 acres, acquired by the Department of the Interior with federal Everglades restoration funds and by the State of Florida. Major features of the Tentatively Selected Plan include external and internal embankments, perimeter canals, two pump stations, internal controls, and outflow water control structures.

Potential benefits from project implementation appear to be far-reaching. Based on a salinity model, the area within the Caloosahatchee estuarine system that is beneficially affected conservatively encompasses approximately 71,000 acres in the Caloosahatchee River, San Carlos Bay, and a portion of Pine Island Sound. The total area benefited by project implementation will likely be much larger, including portions of Matlacha Pass, Pine Island Sound, Estero Bay, and the Gulf of Mexico.

In addition, the Tentatively Selected Plan provides deepwater habitat within the impoundment cells, including refugia (created by embankment excavation) for fish and other aquatic animals during extremely dry periods. The perimeter canal may also include littoral areas which may be utilized as forage and nursery habitat by wading birds. The configuration and extent of these areas will be determined during detailed design work.

Finally, reservoir operations will improve water quality in the Caloosahatchee Estuary, since some of the nutrient-laden runoff and lake water will be stored in the reservoir, allowing for the settling of nutrients and other pollutants within the reservoir cells prior to delivery to the estuary. Removals of nutrients by mechanical and biological processes within the reservoir were estimated to be 7.3 metric tons per year (mt/yr) for total nitrogen (TN) (Knight, 2008).

3.1.1.1.2 Lake Okeechobee Watershed Project

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

- **Taylor Creek/Nubbin Slough Reservoir –** This 1,984-acre storage facility is located in the S-191 Sub-basin and will provide a maximum capacity of 32,000 acre-feet at an average depth of 18 feet. It will receive inflows from and discharge back to Taylor Creek. This reservoir feature will remove approximately three-to-five mt/yr of total phosphorus (TP) by sediment settling. The location and configuration of this feature matches with that of the Taylor Creek Reservoir being considered under the Lake Okeechobee Fast-Track (LOFT) program.

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

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

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

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

- **Paradise Run Wetland Restoration –** This 3,730-acre wetland restoration site is located at the ecologically significant confluence (under pre-development conditions) of Paradise Run, oxbows of the Kissimmee River and Lake Okeechobee. Under restored conditions it would have a rain-driven hydrology, unless future efforts could link the site to the surface flows from the C-38 or C-41A canals.

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

3.1.1.1.3 Southwest Florida Feasibility Study

The Southwest Florida Feasibility Study (SWFFS) covers approximately 4,300 square miles of Florida's southern peninsula. The study area encompasses all of Lee County, most of Collier and Hendry counties, and portions of Charlotte, Glades, and Monroe counties. In the SWFFS study area, the Caloosahatchee River serves as the western outlet for discharges of stormwater and flood releases from Lake Okeechobee to the Gulf of Mexico and is a major source of surface water supply for the basin. The SWFFS will provide a comprehensive review of the water issues that face southwest Florida, and is not limited to those related to the Central and Southern Florida Project. The study will develop and address alternatives that protect and restore early wet-season and overland sheet flow conditions that provide for restoration of amphibian, reptile, macro-invertebrate, and forage fish populations. The SWFFS will consider the impacts of freshwater pulsing and/or depletion of freshwater flows to estuaries, improvement of shellfish and fisheries habitat, and protection and restoration of shoreline wetlands that are unique to southwest Florida, such as mangroves. Wide-ranging federal- and state-listed threatened and endangered species, such as the Florida panther, wood stork, and Florida black bear, as well as migratory birds and endemic species, will be prioritized in the study's alternative development and analysis. The study will look at the protection and/or restoration of existing natural resources through land acquisition and conservation easement. The study will plan for proper infrastructure before, or as development occurs, not after. The SWFFS will develop a water resources plan for the entire southwest Florida area and provide for ecosystem and marine/estuary restoration and protection, environmental quality, flood protection, water supply and other water-related purposes.

3.1.1.1.4 Aquifer Storage and Recovery

Aquifer Storage and Recovery (ASR) involves the concept of storing partially treated surface water in the subsurface, by pumping the water through wells that are used for both recharge (injection) and recover. During storage, the water would remain in the Floridan aquifer. Within the Caloosahatchee River Basin, it is anticipated to help minimize high-volume water releases to the estuary. During dry periods, water recovered from ASR wells would be utilized to maintain surface water levels within the River and associated canals and to maintain a minimum flow of freshwater to the estuary. ASR technology has been demonstrated to be feasible, but has not been tested on the scale that is required for CERP. The ASR pilot projects will provide the platforms for the ASR Regional Study to address the uncertainties identified by the National Academy of Sciences.

Pilot projects were authorized for several components of the CERP that were to be implemented on a very large scale. The components of the CERP had sufficient detail for plan selection, but did not have sufficient detail for traditional U.S. Army Corps of Engineers feasibility studies.

The pilot projects will provide further information regarding the hydrogeological and geotechnical characteristics of the upper Floridan Aquifer System within the region and the ability of the upper Floridan Aquifer System to maintain injected water for future recovery. ASR pilot projects have been initiated at various locations around Lake Okeechobee, the Hillsboro Canal (in southern Palm Beach County), and within the Caloosahatchee River Basin. The pilot projects also will evaluate the available technology and contribute information necessary for additional plan formulation and development by the ASR Regional Study team. A comprehensive Technical Data Report of the ASR technologies and cycle testing responses will be prepared. From the information collected at the sites, the ASR Regional Study Team may determine the optimal number of wells, where to site these wells, and any specific treatment requirements to operate the ASR systems.

A pilot project was initiated in the Caloosahatchee River Basin in 2003, at the location of Berry Groves, just west of LaBelle. The results of the exploratory well indicated that high capacity ASR technology would not be feasible at that location. Presently, the Caloosahatchee River ASR pilot project is on “hold,” until an alternative site is selected for future exploratory work.

3.1.1.2 Lake Okeechobee Regulation Schedule and Herbert Hoover Dike

A regulation schedule is a federally authorized tool used by water managers to manage the water levels in a lake or reservoir. Water in Lake Okeechobee previously was managed in accordance with the Water Supply/Environmental (WSE) Regulation Schedule that was approved in 2000. On April 28, 2008, the USACE approved the new 2008 Lake Okeechobee Regulation Schedule. Therefore, all surface water releases from Lake Okeechobee to the estuaries after this date are in accordance with the new schedule.

Water management decisions regarding Lake Okeechobee are highly dependent upon the Herbert Hoover Dike. The Herbert Hoover Dike is an earthen levee that was constructed around the southern portion of Lake Okeechobee for flood control purposes approximately 70 years ago. For decades, the dike has served this purpose; however, it is in need of rehabilitation. Until the rehabilitation is complete, the USACE’s goal is to manage Lake Okeechobee water levels at a safe range for the dike, between 12.5 and 15.5 feet throughout the year (USACE, 2008b).

The previous WSE schedule was developed to improve performance of Lake Okeechobee's littoral zone habitat and water supply without impacting the other lake management objectives. The WSE schedule for maintaining water levels within the lake has proven ineffective in meeting these goals. During extreme wet weather events in the 2004 and 2005 hurricane seasons, Lake Okeechobee rose to 17 and 18 feet National Geodetic Vertical Datum (NGVD) (USACE, 2008b; USACE, 2008c). These high levels are not considered within the safe range for the Herbert

Hoover Dike, as determined by the USACE. Furthermore, implementing the WSE has resulted in ecological impacts to Lake Okeechobee from fluctuating water levels and to the Caloosahatchee River and St. Lucie River estuaries from excessive freshwater releases (USACE, 2007).

The Lake Okeechobee Regulation Schedule Study (LORSS) was initiated in late 2005 to develop a new water regulation schedule allowing operational changes within the existing infrastructure to address these issues. Based solely on current water storage capacity in the system, the operational changes will allow for quicker response and operational flexibility to fluctuating lake conditions and tributary inflows. An additional feature of the new schedule is that it allows for the capability to initiate releases to the Caloosahatchee River and St. Lucie River estuaries and the Water Conservation Areas (WCAs) to the south, at lower levels than under the current schedule. The low-volume releases should add flows to the Caloosahatchee Estuary, but not in excessive quantities, helping maintain appropriate salinity ranges (USACE, 2008b).

Upon fully implementing the Lake Okeechobee Regulation Schedule (USACE, 2008a), water managers began conducting another regulation schedule study (System Operating Manual Study). This study will take into account construction of early CERP projects, including projects expedited by SFWMD, which will provide many additional options for water storage and management. Water managers will also take into account an adjusted lake level afforded by the Herbert Hoover Dike Rehabilitation Project in future revisions to the regulation schedule.

3.1.2 State and Local Efforts

There are several state and local government rules, plans and programs in place that contribute to the goals and objectives of the CRWPP. In addition to the Lake Okeechobee Watershed Construction Project, Phase II Technical Plan (LOP2TP) and the St. Lucie River Watershed Protection Plan (SLRWPP), these water quality initiatives include source control programs, stormwater management programs, and local government water quality resolutions.

3.1.2.1 Lake Okeechobee Watershed Construction Project, Phase II Technical Plan

The LOP2TP was developed in response to NEEPP. The purpose of the LOP2TP is to provide an overall strategy for improving quality, quantity, timing, and distribution of water in the Northern Everglades ecosystem and achieve the TP Total Maximum Daily Load (TMDL) for Lake Okeechobee. The plan is intended to achieve the following objectives:

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

Many of the projects identified in the LOP2TP are also included as management measures in this CRWPP.

3.1.2.2 St. Lucie River Watershed Protection Plan

The SLRWPP also was developed in response to NEEPP. As with this CRWPP, the SLRWPP addresses undesirable water flows and nutrient loading to the St. Lucie River and has the same three main components: (1) a Construction Project, (2) a Pollutant Control Program, and (3) a Research and Water Quality Monitoring Program.

3.1.2.3 "River of Grass" Land Acquisition

The "River of Grass" Land Acquisition is a proposed real estate transaction of historic proportions between SFWMD and United States (US) Sugar Corporation which could bring over 180,000 acres of agricultural lands into public ownership to help revive, restore, and preserve America's Everglades. The proposed acquisition of US Sugar Corporation lands when finalized will provide the unprecedented opportunity to store and treat water on a scale never before envisioned for the benefit of the Everglades ecosystem. The acquisition will build upon and enhance CERP and the State's Northern Everglades Program. If the acquisition is successful, initial conceptual planning will be a SFWMD/State led public effort utilizing the Water Resources Advisory Committee. The potential use of lands acquired within the Caloosahatchee River Watershed will be included in this planning process.

3.1.2.4 Regulatory and Source Control Programs

Pollutant source control is integral to the success of any water resource protection or restoration program. There are several existing source control programs in the watershed that are evolving and expanding through cooperative and complementary efforts by FDEP, FDACS, and SFWMD.

An overview of each of the existing nutrient source control programs in the Caloosahatchee River Watershed is provided below. Details of the comprehensive CRWPP Pollutant Control Program, including improvements to existing programs, are described in Chapter 7 of this document.

3.1.2.4.1 Environmental Resource Permit Program

The existing Environmental Resource Permit (ERP) program is a statewide permitting program that began in the mid-1990s and is implemented by both FDEP and the water management districts. The ERP program regulates activities in, on or over wetlands or other surface waters and the management and storage of all surface waters. This includes activities in uplands that alter stormwater runoff as well as dredging and filling in wetlands and other surface waters. Generally, the program's purpose is to ensure that activities do not degrade water quality, compromise flood protection, or adversely affect the function of wetland systems. The program applies to new activities only, or to modifications of existing activities, and requires an applicant to provide reasonable assurances that an activity will not cause adverse impacts to existing surface water storage and conveyance capabilities, and will not adversely affect the quality of receiving waters such that any applicable water quality standards will be violated. Therefore, the applicant must address the long-term water quality impacts of a proposed activity and must prevent any discharge or release of pollutants from the system that will cause water quality standards to be violated. Rule revisions to the ERP Program are being proposed to improve regulatory criteria as described in Chapter 7 of this document.

3.1.2.4.2 Proposed Caloosahatchee River Watershed Regulatory Nutrient Source Control Program

The existing SFWMD Chapter 40E-61, Florida Administrative Code (F.A.C.), Regulatory Nutrient Source Control Program was adopted in 1989 (as a result of the Lake Okeechobee Surface Water Improvement and Management Plan), to provide a regulatory source control program specifically for phosphorus (P). The NEEPP legislation expanded the program boundary to the Caloosahatchee River Watershed as well as St. Lucie River Watershed and included N, in addition to P, as the focus of nutrient source controls. The program applies to new and existing agricultural and non-agricultural activities, with the goal of reducing nutrients in offsite discharges.

SFWMD is proposing amendments to Chapter 40E-61, F.A.C., to be compatible with NEEPP. To ensure consistency with the CRWPP, rule development is expected to begin in early 2009. Additional details on this program and its expansion can be found in Chapter 7 of this document.

3.1.2.4.3 Agricultural Best Management Practices

The Florida Watershed Restoration Act, Section 403.067, F.S. (1999), authorized FDACS to develop, adopt by administrative rule, and implement agricultural Best Management Practices (BMPs) statewide. In the ensuing years, FDACS has developed and adopted comprehensive BMP manuals for citrus, vegetables, and agronomic crops, containerized nurseries, and sod production. BMP manuals for sod, beef cattle production and the equine industry are scheduled to be adopted by administrative rule by early 2009.

Agricultural landowners participating in FDACS BMP programs must implement nutrient management plans and maintain records verifying nutrient management plan implementation. In addition, typical BMPs include irrigation management (which includes an evaluation of the irrigation system efficiency), surface water management (installation of modern water control structures), and comprehensive ditch maintenance programs. As of the approval date of the CRWPP, agricultural acreage within Glades, Hendry, and Charlotte counties enrolled in FDACS BMP Program totaled 242,000 acres.

Critical components in the success of the agricultural BMP program are the collection and analysis of data to determine whether BMPs are working as anticipated. The interagency team is committed to continue funding on-farm BMP demonstration projects at representative sites that will provide both BMP effectiveness data. In cooperation with the University of Florida Institute of Food and Agriculture Sciences (UF/IFAS), FDACS is conducting BMP demonstration and evaluation projects at representative sites for all agricultural land uses in the watershed as funding becomes available.

3.1.2.4.4 Urban Best Management Practices

There is a continued focus in the Caloosahatchee River Watershed on reducing the impacts of non-point source pollution from urban land use through rules, public education programs, and other non-structural BMPs. Urban BMPs are practices determined by the coordinating agencies to be the most effective and practicable on-location means, including economic and technological considerations, for improving water quality in urban discharges. Examples of urban BMPs implemented in the Caloosahatchee River Watershed include the Florida Yards and Neighborhoods Program, comprehensive planning initiatives, and the Urban Turf Fertilizer Rule, which are discussed in more detail below.

The Florida Yards and Neighborhoods Program is an excellent example of a nonstructural urban BMP program. By educating citizens and builders about proper landscape design (e.g., "right plant-right place" practices), this program is helping minimize the use of pesticides, fertilizers and irrigation water. FDEP has an ongoing monitoring program to determine the effectiveness of this program in reducing nutrient loads.

Comprehensive planning initiatives involve cities, counties, and other entities in the Caloosahatchee River Watershed that are responsible for comprehensive planning and land development approvals. FDEP works with those entities to review current comprehensive plans and associated land development regulations to ensure that they promote low impact design and proper stormwater treatment. The objective is to implement low impact design measures basin-wide to achieve additional nutrient reductions and water storage.

In August 2007, FDACS adopted a statewide Urban Turf Fertilizer Rule. The rule limits the P and N content in fertilizers for urban turf and lawns, thereby significantly reducing the amount of P and N applied in urban areas and limiting the amount of those compounds reaching Florida's water resources. It requires that all fertilizer products labeled for use on urban turf, sports turf and lawns be limited to the amount of P and N needed to support healthy turf maintenance. FDACS expects a 20 to 25 percent reduction in N and a 15 percent reduction in P in every bag of fertilizer sold to the public. The rule was developed by FDACS with input from UF/IFAS, FDEP, the state's five water management districts, the League of Cities, the Association of Counties, fertilizer manufacturers, and concerned citizens. It enhances efforts currently underway to address excess nutrients in the Northern and Southern Everglades. As a component of the Lake Okeechobee and Estuary Recovery (LOER) Plan, the new rule is an essential component to improve water quality through nutrient source control.

3.1.2.5 C-43 Water Quality Treatment and Testing Facility

The C-43 Water Quality Treatment and Testing Facility is a joint project with Lee County and SFWMD and will develop, design, and build a testing facility that will study nitrogen removal methods. The results of the studies and system performance will be used to improve the methods of water quality treatment in the Caloosahatchee Basin. The facility will be located along the Caloosahatchee River in Glades County very near the Ortona Lock and Dam. It is a 1,350 acre project located on a 1,800 acre site. A portion of the site has been set aside for recreational purposes and use by Glades County.

3.1.2.6 Lower Charlotte Harbor Surface Water Improvement and Management Plan

The Lower Charlotte Harbor (LCH) is listed as a Tier 1 Priority Water Body. The designation came from the SFWMD Governing Board decision in 2003 to amend and combine the then listed Tier 2 Caloosahatchee River and Estero Bay, and the Tier 3 Pine Island Sound, Matlacha, and Ding Darling into the LCH. In preparation for development of the LCH Surface Water Improvement and Management (SWIM) plan, a LCH SWIM Reconnaissance Report was authorized in 2004. Upon completion of the Reconnaissance Report the LCH SWIM Plan was developed and approved in February of 2008. The LCH SWIM Plan's basic strategy consists of restoring, protecting, and managing the surface water resources of the LCH Watershed through the use of a prioritized, objective, applied, sustainable, ecosystem, or watershed approach with periodic public review and input.

The Plan is organized around a system of goals, initiatives, strategies, and action steps. In this system, the goals are broad-based and identify objectives of SFWMD. Initiatives are general categories that have been used to divide the plan into distinct subject areas developed by SFWMD staff. Strategies are more detailed descriptions of the underlying work proposed to achieve results. The strategies identify the approaches and methods that will be used to implement the initiatives. Action steps represent specific activities under each strategy suggested to reach project delivery. Each action step has an associated estimate of the funding requirements and schedule for completion. These action steps, as well as the strategies and initiatives referenced above are not mutually exclusive, and may be undertaken concurrently or sequentially. There are six primary initiatives to address within the watershed, which are: Water Quality; Stormwater Quantity; Watershed Master Planning and Implementation; Habitat Assessment, Protection, and Restoration; Outreach; and Funding.

3.1.2.7 Lee County/City of Sanibel

As a source control measure, Lee County and the City of Sanibel have adopted unique fertilizer ordinances. These ordinances limit the amount of P and N that can be applied to landscapes by landscape professionals as well as property owners. All landscape professionals must also attend and pass a landscape BMP course and be certified by the county. Additionally, Lee County and the City of Sanibel have established outreach programs and Lee County has set aside dedicated funding for staff positions to administer their program.

Lee County has budgeted for pollutant source control through its Capital Improvement Plan (CIP). Over $200 million in projects for water quality improvements are either under way or are planed through the CIP process.

3.1.2.8 Southwest Florida Regional Planning Council

The Southwest Florida Regional Planning Council (SWFRPC) formed the Lower West Coast Watersheds Subcommittee in 2006 to address the deteriorating condition of the Caloosahatchee River and Estuary. The Subcommittee's purpose would be to review existing plans to a five-year horizon, identify gaps preventing an effective basin water quality initiative, make recommendations for improvement, and propose a successor coordination tool/entity to implement the emerging recommendations of the SWFFS and the TMDL plan. Through the work of this subcommittee, five resolutions have been passed by the SWFRPC that should have a positive impact on water quality in the watershed. The resolutions address fertilizer, wastewater, wastewater package plants, onsite wastewater systems planning, treatment, and management, and general stormwater management. The resolutions are described in the following subsections.

3.1.2.8.1 Fertilizer Resolution (SWFRPC Resolution #2007-01)

The Fertilizer Resolution provides specific recommendations and guidelines for the consideration of local governments within Southwest Florida as they regulate the use of fertilizers containing N and/or P. This resolution covers the governance of all segments of the community that may be involved in fertilizer application, such as the general public, commercial, institutional, and retail sectors. A broad range of recommendations, such as public education, licensing programs, impervious surfaces, buffer zones, and application specifics, were included to cover the diverse community that may apply fertilizers and may impact water quality in the Caloosahatchee River Basin.

3.1.2.8.2 Wastewater Resolution (SWFRPC Resolution #2007-02)

The Wastewater Resolution gives Southwest Florida local government's specific guidance for the regulation and control of treated wastewater discharges containing N and/or P. This resolution covers multiple types of wastewater treatment scenarios such as reuse applications, processing and disposal of solids/sludge, and the discharge of treated effluent to open waters or ground water aquifers. All of the recommendations support improving and maintaining water and habitat quality through the reduction of nutrients within the treated wastewater stream and/or reduction of the wastewater stream itself into water bodies and adjacent areas affected by groundwater transport.

3.1.2.8.3 Wastewater Package Plant Resolution (SWFRPC Resolution #2007-05)

The Wastewater Package Plant Resolution supports the reduction and elimination of surface water discharges from small wastewater treatment facilities. It provides specific recommendations and guidelines to be considered by local government jurisdictions in Southwest Florida for the regulation and control of treated wastewater discharges containing N and/or P.

3.1.2.8.4 Managed Care Model Guidance for Onsite Wastewater Systems Planning, Treatment and Management Resolution (SWFRPC Resolution #2008-02)

This resolution provides specific recommendations and guidelines for the regulation, management, and control of onsite sewage treatment and disposal systems. These recommendations include regular maintenance and inspection of existing onsite wastewater systems, adopting inspection standards, and requiring training for system inspectors, in addition to other efforts. Through these recommendations, the negative environmental effects of onsite sewage treatment and disposal systems will be minimized for Southwest Florida lakes, canals, estuaries, interior wetlands, rivers, and near shore waters of the Gulf of Mexico. This resolution also will contribute to the regulation of nutrients and the prevention of pathogen contamination entering the water bodies in this region, which will be a crucial step toward improving and maintaining water and habitat quality.

3.1.2.8.5 Stormwater Resolution (SWFRPC Resolution #2007-11)

The purpose of this Resolution is to provide specific recommendations and guidelines to be considered by local government jurisdictions in Southwest Florida for the regulation, control, use, and treatment of stormwater containing N and/or P. This will assist with the protection of Southwest Florida's lakes, rivers and streams, and groundwater. Additionally, this will assist with the proper selection, operation and management of existing stormwater systems to prevent the further degradation of groundwater, lakes, rivers and streams.

3.1.3 Stormwater Management Programs

The Federal Clean Water Act was amended in 1987 to require the U.S. Environmental Protection Agency (USEPA) to regulate storm water discharges through National Pollutant Discharge Elimination System (NPDES) permit program. This program controls water pollution by regulating point sources, such as pipes or man-made ditches, which discharge pollutants into waters of the United States. Industrial, municipal, and other facilities that are connected to a municipal system must obtain permits if their discharges go directly to surface waters. The Stormwater Management Program is a fundamental element of the NPDES program and contains action items that must be implemented by the permit holder. Lee County and Charlotte County are stormwater NPDES permittees and have Stormwater Management Programs that are described in the following section.

3.1.3.1 Charlotte County Stormwater Management Program

On June 2003, Charlotte County submitted an application to obtain a NPDES Phase II municipal permit, which was granted in July 2003. The permit allows the creation of a county-wide Stormwater Management Plan with a five-year implementation schedule. Every five years, the county has to renew the permit and prove that the plan is being implemented. Annual reports will illustrate Charlotte County's continuing efforts to meet federal standards (CCPU, 2008).

3.1.3.2 Lee County Stormwater Management Program

In April 2003, Lee County submitted an application to obtain a NPDES municipal permit, which was granted in March 2004. The Stormwater Management Program for the community contained 14 required program elements. A number of the elements identified controls for specific pollutants such as pesticides, herbicides, fertilizers, sanitary seepage, and construction site runoff. Other elements addressed public education, system operation and maintenance, and inspection program implementation. An annual reporting program provides proof of their continuing effort to protect water quality and meet federal standards. The county is required to show progress on Stormwater Management Program elements as part of the permit renewal process (USEPA, 2003).

3.2 Problems

The quality and quantity of water entering the Caloosahatchee Estuary directly affects the health of the system. Evaluating water quality and quantity can determine long term trends and the state of this estuary. Historical drainage patterns within the Caloosahatchee River Watershed have been highly altered since pre-drainage times. Loss of natural habitat from riverfront and coastal development, increased urban development, construction of drainage canals, and agricultural activities have affected the timing, quantity, quality, and distribution of runoff to the estuary. Wet season flows have intensified, due to increased runoff resulting from land clearing and impervious areas; dry season flows have decreased, due to increased water supply demand for agricultural and urban development. Loss of storage within the watershed has resulted from the watershed being drained to accommodate grazing, citrus farms and other crop farms.

The general problems associated with water entering the Caloosahatchee Estuary include:

- Excess discharges from Lake Okeechobee and watershed runoff occurring mainly during the wet season;
- Insufficient flows to the Caloosahatchee Estuary during the dry season; and
- Excess nutrient loads to the Caloosahatchee River and Estuary.

The following subsections focus on the ecological problems in the Caloosahatchee Estuary, identify the possible causes of the problems, and describe opportunities to improve conditions in the estuary.

3.2.1 Ecological Problems in the Caloosahatchee Estuary

The major ecological problems in the Caloosahatchee Estuary stem from altered hydrology and excess nutrient loading. The combination of an excess of freshwater during the wet season and a lack of discharge during the dry season lead to exaggerated seasonal and short term fluctuations in salinity throughout the entire estuary. The fluctuations in salinity in any one region of the estuary can exceed the physiological tolerance limits of the organisms that normally live there, causing stress and/or mortality (Chamberlain and Doering, 1998 a, b).

Excess nutrient loading has been a concern since at least the 1980s, when the Florida Department of Environmental Regulation (FDER) determined that the Caloosahatchee Estuary had reached its nutrient loading limits. A series of algal blooms and massive accumulations of drift algae that have occurred since 2000 is another indication of coastal eutrophication (Lapointe & Bedford, 2006).

This section focuses on submerged aquatic vegetation (SAV), oysters, and algal blooms. Seagrass and oysters are Valued Ecosystem Components (VECs). VECs sustain an important ecological resource and/or water resource function by providing food, living space, refuge and foraging sites for other desirable species in the estuary. The salinity tolerances and other environmental requirements of SAV and oysters have been used to identify preferred ranges of freshwater inflows. Algal blooms are an indicator of eutrophication.

3.2.1.1 Submerged Aquatic Vegetation

Beds of SAV are important to the ecology of shallow estuarine and marine environments. These beds provide habitat for many benthic and pelagic organisms, function as nurseries for juveniles and other early life stages, stabilize sediments, improve water quality, and can form the basis of a detrital food web (Fonseca & Fisher, 1986; Carter, 1988; Killgore, 1989). Because of their importance, estuarine restoration initiatives often focus on SAV (Batiuk 1992). SAV are commonly monitored to gauge the health of estuarine systems (Tomasko, 1996) and their environmental requirements can form the basis for water quality goals (Dennison, 1993; Stevenson, 1993).

Tape grass (*Vallisneria americana)* is the dominant submerged aquatic vegetation in the upper Caloosahatchee Estuary and occurs in well-defined beds in shallow water (Doering et al., 2001, 2002). *Vallisneria americana* is an important habitat for a variety of freshwater and estuarine invertebrate and vertebrate species, including some commercially and recreationally important fishes (Bortone & Turpin, 1999). Additionally, it can serve as a food source for the Florida manatee (*Trichechus manatus*). Shoal grass (*Halodule wrightii),* turtle grass *(Thalassia testudinum),* and manatee grass *(Syringodium filiforme)* are the most common higher salinity grasses in the Caloosahatchee Estuary. *Argopectin species,* the bay scallop, prefers shoal and turtle grass beds.

All species of SAV have a preferred and tolerable salinity range. The SAV management measures include creation and restoration of wetlands, and incorporation of growth management techniques and initiatives that integrate environmental objectives into urban growth planning. SAV respond unfavorably when salinity alterations fall outside of these ranges. Degraded water quality and physical alterations, such as construction of the Sanibel Causeway and the dredging of the Intracoastal Waterway, have also shown negative impacts to the seagrasses. The result has been a regional decrease of seagrass coverage (Chamberlain & Doering, 1998a). This decline negatively impacts the fish and invertebrate communities. Loss of seagrass also causes destabilization of sediments and a shift in primary productivity from benthic macrophytes to phytoplankton, both of which provide negative biofeedback to further affect seagrass beds (SFWMD, 2006). Further information can be found in the Research and Water Quality Monitoring Program in **Appendix E**.

3.2.1.2 Oysters

The American Oyster (*Crassostrea virginica*), also known as the Eastern or Virginia Oyster, is a natural component of southern estuaries and has been documented to be abundant in these systems. In the Caloosahatchee Estuary, oysters have been identified as a VEC. They filter particles from the water column, provide habitat and play an important role in the food chain. Oysters require firm and stable substrate for attachment; water flows adequate to provide food supplies of plankton and algae; oxygen concentrations greater than three parts per million (ppm); and salinity ranges between 10 to 30 parts per thousand (ppt), with 14 to 28 ppt as optimal conditions. They can tolerate high salinity (40 ppt), but are especially vulnerable to low salinity (~3-5 ppt) for very brief periods (Gunter & Geyer, 1955; Volety, 2003). Oysters are also very susceptible to parasitic diseases, which are more prevalent during periods of high salinity (greater than 25 ppt) and high temperatures.

Recent estimates (2003 to 2004) for the Caloosahatchee River suggest approximately 18.4 acres of oyster reefs. The Caloosahatchee River and Estuary (including San Carlos Bay that forms the estuary portion of the Caloosahatchee River) has an accommodation space of 62,644,983 square meters (m^2) (6264 hectares (ha) or 15,479.36 acres) with oyster reefs comprising 74,336 m^2 (7.43 ha or 18.37 acres). This area translates to 0.12 percent coverage of total surface area available in the estuarine portion (Volety, 2003; RECOVER 2007). Consequently, restoration efforts are expected to improve the recruitment and survivorship of the Eastern Oyster by restoring oyster beds in suitable habitat and maintaining habitat function of oyster beds for fish, crabs, and birds.

3.2.1.3 Algal Blooms

Periodic blooms of algae have been reported within the marine and freshwater portions of the Caloosahatchee Estuary. In many instances, these algal blooms are merely an aesthetic and odiferous nuisance. However, when bloom occurrences cause the annual average chlorophyll-*a* concentration within the water to exceed 11 micrograms per liter (μg/L), then FDEP Impaired Water Rule is violated (Rule 62-303.353, F.A.C.). These blooms can cause depressed dissolved oxygen (DO) below the state criteria, depending on the concentration of the bloom, spatial extent, and duration (Doering, et al. 2006).

In addition to the impact of a bloom on general water quality, certain algal species produce toxins that kill fish, invertebrates, birds and mammals. One such species is *Karenia brevis*, which can produce blooms that are toxic to the marine environment and are referred to as "red tides." Florida red tide blooms typically begin offshore in the Gulf of Mexico and move slowly with the prevailing ocean currents toward southwest Florida. As the bloom progresses, the density of red tide organisms increases to several million cells in each liter of sea water, and the affected area expands to many square miles. Other algal species, such as the freshwater cyanobacteria microcystis species, can enter the estuary during freshwater inflow and cause harmful blooms, depending on environmental conditions such as temperature, season, and nutrient availability.

Accumulations of drift algae (seaweed) constitute another problem. The seaweed can smother seagrass beds and render beaches unusable for recreational purposes. While some recent studies have been conducted (LaPointe & Bedford, 2006), the causes of these massive accumulations are not yet fully understood and further investigations, funded by the City of Sanibel and Lee County, are underway.

Marine algal toxins, such as brevetoxin, bioaccumulate and are magnified in the food chain, while anatoxins from freshwater cyanobacteria affect the nervous system. There have been several documented cases in the field where blooms of *Karenia brevis*, a brevetoxin that produces neurotoxins, have killed both vertebrate and invertebrate species. At least 17 invertebrate species normally present in Tampa Bay, Florida have been recorded as absent immediately after red tide incidents. Various species of bivalve shellfish, especially oysters, clams, and coquinas can accumulate so much toxin that they become toxic to both marine animals and humans (SFWMD, 2006).

3.2.2 Potential Causes

Beginning in the1890s, ecological degradation began in the Caloosahatchee River Watershed due to channelization, connection to Lake Okeechobee, and construction of an extensive canal network. The potential causes of the ecological problems in the Caloosahatchee Estuary discussed above include excess water discharges from Lake Okeechobee regulatory releases and the Caloosahatchee River Watershed, insufficient discharges from the Caloosahatchee Watershed, loss of shoreline habitat and function, and nutrient loading (USFWS, 1984). These potential causes and their relationship to the ecological problems are discussed in the following section.

3.2.2.1 Discharges from Lake Okeechobee Regulatory Releases and the Caloosahatchee River Watershed

Construction of drainage systems in the Caloosahatchee River Watershed to accommodate agriculture and urban development has resulted in a loss of storage. During the rainy season, runoff occurs with a shorter duration at higher volumes and peak discharges. These high discharges can be exacerbated by regulatory discharges from Lake Okeechobee sent to the Caloosahatchee Estuary through the C-43 Canal. These discharges have led to extreme and sudden low salinity conditions within the Caloosahatchee Estuary. For example, discharges to the Caloosahatchee Estuary exceeding 2,800 cubic feet per second (cfs) at the S-79 Franklin Lock and Dam have been determined to cause stress to the estuary. Discharges greater than 4,500 cfs have been determined to be severely damaging. Although this CRWPP accounts for Lake Okeechobee regulatory releases, they are addressed in the LOP2TP. This plan focuses on discharges from the Caloosahatchee River Watershed.

The current proposed frequency distribution of mean monthly inflows to the Caloosahatchee Estuary, from S-79 (estuary demand time series EST05), was chosen from several CERP model run options. This distribution best achieves the range of flows from S-79 that are needed for meeting ecological and salinity targets. **Table 3-1** (SFWMD, 2003b; Chamberlain, 2005) identifies the current recommended frequency distribution of average monthly freshwater inflow from S-79 associated with EST05, without contributions from tidal basins downstream of S-79.

Table 3-1. Current Recommended Frequency Distribution (EST05) of Inflow from S-79 (without contributions from tidal basins downstream of S-79)

Discharge Range (cfs) from S-79	Percent Distribution of Flows from S-79
0 to 450	0%
450 to 500	42.8%
500 to 800	31.7%
800 to1500	19.2%
1500 to 2800	5.6%
2800 to 4500	0.7%
>4500	0%

Analysis of modeled flow data from S-79 entering the Caloosahatchee Estuary during the 1970-2005 period of record (432 months) has resulted in a useful snapshot of historic conditions. For example, the modeled mean monthly flows of existing conditions exceeded 2,800 cfs for 117 months (27 percent of the total months), and 37 of those 117 months exceeded 4,500 cfs. Even with implementation of all LOP2TP projects, it is projected that the mean monthly flows exceeding 2,800 cfs for this period of record would have occurred in 76 months, and of those, 21 months would have been above 4,500 cfs. The resulting extreme low salinity conditions stress oyster and seagrass communities and can ultimately lead to reduced populations and coverage.

3.2.2.2 Insufficient Flows from the Caloosahatchee River Watershed

Drainage, loss of storage in the watershed, and urban and agricultural demands for water have decreased dry season flows to the Caloosahatchee Estuary. At times, discharge from the Caloosahatchee River to the downstream estuary ceases entirely and salt water intrudes upstream, with salinities at S-79 often exceeding 10 ppt. These high salinities cause the mortality of brackish water organisms that ordinarily live in this region of the estuary. During such dry periods, a flow of 450 cfs at S-79 is required to maintain salinity less than 10 ppt in the estuary upstream of Fort Myers (SFWMD, 2003a and b; Chamberlain & Doering, 2004; Chamberlain, 2005), which protects SAV and other organisms from salinity-induced stress and mortality. Based on the modeled mean monthly flows of existing conditions at S-79 during the 1970 to 2005 period of record (432 months), average flows of less than 450 cfs occurred in 189 months (44 percent).

3.2.2.3 Loss of Shoreline Habitat and Function

Mangrove habitat is the predominant contributor to the ecological functionality of shoreline habitat in the Caloosahatchee Estuary. Urbanization and shoreline development have resulted in the extensive loss of mangrove habitat along the estuary. Among the ecological functions carried out by mangroves are land formation (Davis, 1940), sediment stabilization, and primary productivity, filtration of land runoff, absorption, and recharge floodwaters. The mangroves also serve as habitats and nurseries, providing food and cover for a multitude of native fish and wildlife (MacNae, 1968; Odum, 1982; Harris, 1983; Dawes, 1998). These functions help to maintain water quality, recycle nutrients, and control erosion (Harris, 1983). In south Florida, mangroves have been destroyed by dredge-fill operations used to create real estate and by port and industrial facilities. Mangrove destruction results in a chain of reactions that affect estuarine and offshore production. In the Tampa Bay estuarine system, which is similar in structure and function to the Caloosahatchee Estuary, 44 percent of the mangrove and salt marsh land has been lost due to construction and resultant turbidity from runoff and pollution (Lewis & Estevez, 1988). This loss in the Tampa Bay Estuary has been linked to declines in fin fish and commercial shrimping in the region (Dawes, 1998; SFWMD, 2006).

3.2.2.4 Increased Nutrients and Contaminants

The amount of nutrients entering the Caloosahatchee River has important effects on the water quality of the system. Organisms use these nutrients, but excessive amounts may have negative impacts. Algal blooms and epiphyte growth may cause decreased water clarity and block sunlight for aquatic plants (Day, 1989). As algae die, organic decomposition depletes the oxygen in the water (LaRose & McPherson, 1983; Drew & Schomer, 1984; Day, 1989). Low levels of DO can have negative effects on fish and other aquatic organisms (Heyl, 1998). Eutrophication may also result in an increase in red tide blooms.

Over-fertilization of estuaries with nutrients from urban and agricultural sources is both a local problem for the Caloosahatchee Estuary and a problem for most estuaries worldwide. In the 1980s, the FDER determined that the Caloosahatchee Estuary had reached its nutrient loading limits based on high chlorophyll-*a* (phytoplankton biomass) and low DO concentrations (DeGrove, 1981). More recently, blue-green algae blooms, red tides, and massive accumulation of drift algae (Lapointe & Bedford, 2006) have been taken as an indication that nutrient loads to the Caloosahatchee Estuary are too high and that the system suffers from eutrophication.

3.3 Planning Objectives

The problems described in Section 3.2 directly lead to the objectives discussed in sections below. Measures to reduce discharges and nutrient loading from Lake Okeechobee through the Caloosahatchee River are addressed in the LOP2TP. Performance measures used to evaluate the performance of the alternative plans are described in Section 3.5.

3.3.1 Caloosahatchee Estuary Salinity Envelope Objective

The objectives of the Salinity Envelope are to:

- Manage Lake Okeechobee and watershed discharges within the proposed flow range (450 to 2,800 cfs, as outlined in Section 3.2.2.1) to maintain salinity ranges for the estuary.

3.3.2 Caloosahatchee River Watershed Water Quality Objectives

The water quality objectives of the Caloosahatchee River Watershed are to:

- Meet TMDLs; and
- Reduce pollutant loads by improving management of pollutant sources throughout the watershed.

3.3.3 Caloosahatchee River Watershed Water Quantity Objective

The water quantity objectives of the Caloosahatchee River Watershed are to:

- Manage the frequency and duration of excess freshwater discharges to the Caloosahatchee Estuary.

3.4 Planning Constraints

3.4.1 Water Supply and Flood Protection

The NEEPP legislation requires that water-related needs of the region, including water supply and flood protection, will continue to be met. Recommendations contained in the CRWPP must continue to meet water supply and flood protection needs for the watershed.

3.4.2 Minimum Flows and Levels

Minimum flows and levels are established to identify where further withdrawals would cause significant harm to the water resources, or to the ecology of the area. The Minimum Flows and Levels Rule for the Caloosahatchee River at S-79, set in Rule 40E-8.221 F.A.C., was established in 2001, based on scientific and peer reviewed technical documentation (SFWMD, 2000). The rule states that:

- A minimum mean monthly flow of 300 cfs is necessary to maintain sufficient salinities at S-79 in order to prevent a minimum flows and levels exceedance. A minimum flows and levels exceedance occurs during a 365-day period, when (a) a 30-day average salinity concentration exceeds 10 ppt at the Fort Myers salinity station (measured at 20 percent of the total river depth from the water surface at a location of latitude 263907.260, longitude 815209.296), or (b) there is a single average salinity exceedance concentration of 20 ppt at the Fort Myers salinity station. Exceedance of either subsection (a) or subsection (b), for two consecutive years is a violation of the Minimum Flows and Levels Rule.

- The minimum flow criteria for the Caloosahatchee River in Rule 40E-8.221, F.A.C., shall be reviewed within one year of the effective date of the rule and amended, as necessary, based on the best available information.

As per the review requirement above, the rule was reviewed and a technical update document (SFWMD, 2003a) was produced. The document reported that 300 cfs at S-79 was insufficient to achieve the 10 ppt minimum flows and levels salinity criteria (a and b above) during periods of below average rainfall, when tributaries downstream of S-79 were contributing below average inflow. Subsequent analysis and documentation (including SFWMD, 2003b; Chamberlain & Doering, 2004) estimated that about 450 cfs is required from S-79 to ensure the minimum flows and levels salinity criteria is achieved under most downstream tidal flow conditions.

CRWPP recommendations cannot reduce the ability to meet the minimum flows and levels salinity criteria.

3.4.3 Lake Okeechobee Proposed Target Minimum Water Level Condition

The proposed target minimum water level condition for Lake Okeechobee allows for only one occurrence over a six-year period when water levels drop below 11 feet NGVD for more than 80 days. CRWPP recommendations should not reduce the ability to meet this proposed minimum water level condition.

3.4.4 Lake Okeechobee Service Area Irrigation Demand

Another CRWPP planning constraint is to ensure that the plan does not adversely affect the Lake Okeechobee Service Area (LOSA) water supply demands.

3.4.5 State Water Quality Standards

Recommendations contained in the CRWPP must protect, maintain or, as necessary, improve water quality within the watershed to be consistent with applicable water quality standards.

3.5 Performance Measures and Indicators

Alternatives were specifically formulated to meet the performance measure targets to the greatest extent possible. The alternative plans were then compared to the performance measure targets to determine their efficiency and effectiveness in achieving CRWPP objectives.

Performance indicators are planning constraints or other parameters of interest that the alternative plans could directly or indirectly affect. Alternative plans were compared to the performance indicators to ensure planning constraints were met and to determine if ancillary impacts on other parameters would occur and, if so, to what extent.

Research results reported by Chamberlain et al. 1995, Doering et al. 1999 and 2001, and Kraemer et al. 1999 were used to determine optimum salinity (envelope) for SAV in the Caloosahatchee Estuary that also protect and promote benthic invertebrates, ichthyoplankton, and zooplankton (Chamberlain & Doering, 1998a; Doering, 2002). A combination of salinity models developed for the estuary, along with watershed modeling efforts, (SFWMD, 2003a) were used to define the optimum distribution of average monthly flows from S-79 (EST05). The defined optimum distribution provides the desirable salinity range in the geographic locations of key estuarine biota and achieves the minimum flows and levels salinity criteria (see Section 3.2.2.1).

Consistent with EST05, a favorable maximum monthly flow of 2,800 cfs at S-79 was identified, below which suitable salinity conditions exist within the estuary for the development of important benthic communities (e.g., oysters and seagrass). Mean monthly flows above 2,800 cfs that approach 4,500 cfs can result in freshwater conditions throughout the estuary, causing severe impacts to estuarine biota, including seagrass upstream and downstream of Shell Point. Oysters also are affected acutely by high flows. Volety et al. (2003) reported salinities of five ppt or lower will result in > 95 percent mortality of juvenile oysters. High juvenile mortality can occur when exposed to this salinity for just a week. Experimental results indicate that adults are able to tolerate salinities as low as five ppt, but cannot tolerate salinities lower than three ppt, which can occur upstream of Shell Point during very high flow events. On the other extreme, average monthly flows below 450 cfs can produce high salinity conditions for tape grass upstream of Fort Myers and increase the probability of Minimum Flows and Levels Rule exceedance and violations. Mean monthly flows that fall well below 450 cfs for consecutive months that extend into late spring and early summer also result in increased oyster mortality.

Table 3-2 describes the relationships between the problems, objectives, performance measures and performance indicators for this project. Water resources problems for the study area are described in Section 3.2 of this document. Identification of the water resources problems led to establishment of the project objectives, which are described in Section 3.3. The performance measures and indicators discussed above were developed based on these problems and objectives.

Table 3-2. Caloosahatchee River Watershed Protection Plan –
Problems, Objectives, Performance Measures and Indicators, and Targets

Problem	Objective	Performance Measure/Indicator	Target
Excess freshwater discharges from Lake Okeechobee regulatory discharge events and local watershed runoff leading to an undesirable low salinity condition	Manage the frequency and duration of excess freshwater discharges to the Caloosahatchee Estuary from the Caloosahatchee River Watershed	The number of times discharge from the Caloosahatchee River Watershed (CRW) exceeds the High Discharge Criteria of: 1. Mean monthly flows from the CRW of greater than 2,800 cfs (14-day moving average) 2. Mean monthly flows from the CRW of greater than 4,500 cfs	1. Limit mean monthly flows greater than 2,800 cfs to 3 months or less over a 432-month period 2. Limit mean monthly flows greater than 4,500 cfs to zero months over a 432-month period
Excess nutrient loads from surface water discharges leading to algae blooms and fish kills	Maximize N and P load reductions to meet anticipated TMDLs	Maximize load reduction and compare against TMDLs as appropriate	Meet TMDLs as established by FDEP
Increases in undesirable high salinity conditions, due to insufficient surface water flows from Caloosahatchee River Watershed, leading to unfavorable conditions for estuarine organisms	Manage watershed discharges to maintain a salinity range conducive to the ecological health of the Caloosahatchee Estuary that includes maintaining salinity < 35 ppt for oysters at Shell Point and upstream and salinity < 10 ppt at Fort Myers location (Minimum Flows and Levels Rule)	Number of months that salinity envelope in the Caloosahatchee Estuary is not met, due to little or no flow from watershed based on the low flow target of 450 cfs Use the Target Flow Index (TFI) based on EST05 flow time series (TFI assesses the level of divergence of each alternative from the desired flow distribution defined by EST05)	Limit average monthly flows of below 450 cfs from October to July TFI value of zero signifies perfect match to EST05. Progressively more negative index values are associated with flow deviations
Lake Okeechobee water levels falling below ecologically desirable levels	Maintain Lake Okeechobee water levels within a desirable range for ecological needs	Number of occurrences that the Lake Okeechobee minimum water level condition was not met during the 432-month Period of Record	Limit to no more than one occurrence every six years when Lake Okeechobee water levels fall below 11 feet NGVD for more than 80 days
Water supply cutbacks that affect the ability to meet existing and future municipal, industrial, and agricultural water supply needs in the region	Ensure plan does not adversely affect the Lake Okeechobee Service Area water supply demands	Evaluate the LOSA demand cutback volumes during seven drought events and annual percentage of water supply demands not met during the period of record	Maintain or reduce the percent of LOSA cutbacks and the annual water supply demands not met

CHAPTER 4

INTERAGENCY COORDINATION AND PUBLIC INVOLVEMENT

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4.0 INTERAGENCY COORDINATION & PUBLIC INVOLVEMENT

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

- Develop and implement an approach that would reach all stakeholders;
- Integrate the public outreach efforts with all other aspects of the planning process; and
- Take advantage of other ongoing public efforts being conducted by the South Florida Water Management District (SFWMD) and collaborating agencies as part of other Caloosahatchee Estuary restoration programs.

The CRWPP public outreach initiative focused on the four following activities:

- Interagency coordination;
- Public involvement and stakeholder notification; and
- Internal management and communication.

4.1 Interagency Coordination

The legislation authorizing the Northern Everglades and Estuaries Protection Program (NEEPP) required SFWMD to work in collaboration with coordinating agencies, such as Florida Department of Environmental Protection (FDEP) and Florida Department of Agriculture and Consumer Services (FDACS), to develop the CRWPP.

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

- The CRWPP Working Team;
- The Water Resources Advisory Commission (WRAC);
- The WRAC Lake Okeechobee Committee;
- Ten County Coalition Meeting; and
- The Northern Everglades Interagency Meetings.

Table 4-1 identifies the key meetings or briefings at which input on CRWPP planning was actively sought.

Table 4-1. Summary of CRWPP Interagency Coordination

Meeting ID	Meeting Date	Meeting Location	Meeting Agenda
Northern Everglades Interagency Meeting	September 5, 2007	Okeechobee, FL	• Northern Everglades Update
WRAC Meeting	September 6, 2007	Naples, FL	• Northern Everglades and Estuaries Protection Program Update
Ten County Coalition Meeting	September 14, 2007	Okeechobee, FL	• Northern Everglades Briefing
Northern Everglades Interagency Meeting	October 17, 2007	Okeechobee, FL	• Northern Everglades Update
CRWPP Working Team Meeting	October 19, 2007	Fort Myers, FL	• Briefing on legislation • Introduced key working team members • Formed the plan schedule • Opened for public comments
Lake Okeechobee WRAC Meeting	October 31, 2007	Okeechobee, FL	• Northern Everglades Update
WRAC Meeting	November 8, 2007	West Palm Beach, FL	• Northern Everglades and Estuaries Protection Program Update
Research and Water Quality Monitoring Program Working Team Meeting	November 9, 2007	Fort Myers, FL	• Briefing on plan status and schedule • Introduced key working team members • Opened for public comments
CRWPP Working Team Meeting	November 20, 2007	Fort Myers, FL	• Briefing on plan status and schedule • Coordinating agencies update • Opened for public comments
Northern Everglades Interagency Meeting	November 27, 2007	Okeechobee, FL	• Northern Everglades Update
Lake Okeechobee WRAC Meeting	November 28, 2007	Clewiston, FL	• Northern Everglades Update
Ten County Coalition Meeting	November 30, 2007	Okeechobee, FL	• Northern Everglades Update
Walt Disney World Environmental Expo Day	December 3, 2007	Orlando, FL	• Northern Everglades display
Joint Meeting of WRAC/South Florida Ecosystem Restoration Task Force	December 5, 2007	Miami, FL	• Northern Everglades Update
Research and Water Quality Monitoring Program Working Team Meeting	December 7, 2008	Fort Myers, FL	• Briefing on plan status and schedule • Opened for public comments
Stetson University	December 8, 2007	Deland, FL	• Northern Everglades Briefing
CRWPP Working Team	December 20, 2007	Fort Myers, FL	• Briefing on plan status

Meeting ID	Meeting Date	Meeting Location	Meeting Agenda
Meeting			and schedule • Coordinating agencies update • Opened for public comments
Combined Lake Okeechobee Committee and WRAC	January 3, 2008	West Palm Beach, FL	• Lake Okeechobee Phase II Technical Plan and River Watershed Protection Plans Briefing
Research and Water Quality Monitoring Program Working Team Meeting	January 23, 2008	Fort Myers, FL	• Briefing on plan status and schedule • Opened for public comments
Northern Everglades Interagency Meeting	January 29, 2008	Okeechobee, FL	• Northern Everglades and Estuaries Protection Program Update
Lake Okeechobee WRAC Meeting	January 30, 2008	Fort Myers, FL	• Northern Everglades: River Watershed Protection Plans Update
Research and Water Quality Monitoring Program Ad-Hoc Group Meeting	February 7, 2008	Conference Call	• Research and Water Quality Monitoring Plan Objectives
Research and Water Quality Monitoring Program Working Team Meeting	February 20, 2008	Fort Myers, FL	• Briefing on plan status and schedule • Opened for public comments
CRWPP Working Team Meeting	February 20, 2008	Fort Myers, FL	• Briefing on plan status and schedule • Coordinating agencies update • Opened for public comments
Lake Okeechobee WRAC Meeting	February 27, 2008	Stuart, FL	• Northern Everglades: River Watershed Protection Plans Update
South Florida Ecosystem Restoration Task Force	February 28, 2008	West Palm Beach, FL	• Northern Everglades and Estuaries Protection Program Update
Ten County Coalition Meeting	February 29, 2008	Okeechobee, FL	• Northern Everglades and Estuaries Protection Program Update
Research and Water Quality Monitoring Program Ad-Hoc Group Meeting	March 4, 2008	Fort Myers, FL	• Evaluation on the existing water quality monitoring efforts.
Environmental Preservation Committee	March 12, 2008	Tallahassee, FL	• Northern Everglades and Estuaries Protection Program Briefing
Research and Water Quality Monitoring Program Working Team Meeting	March 18, 2008	Fort Myers, FL	• Briefing on plan status and schedule • Opened for public comments
Lee County	March 18, 2008	Fort Myers, FL	• Discussion on Regulatory Approaches

Meeting ID	Meeting Date	Meeting Location	Meeting Agenda
			to Management Measures
Lee County Meeting	March 19, 2008	Fort Myers (Conference Call)	• Caloosahatchee River Watershed Protection Plan Discussion
Lake Okeechobee WRAC Meeting	March 26, 2008	Okeechobee, FL	• Lake Okeechobee Phase II Technical Plan and River Watershed Protection Update
Northern Everglades Interagency Meeting	March 27, 2008	Stuart, FL	• Northern Everglades and Estuaries Protection Program Update
City of Sanibel	April 3, 2008	Fort Myers, FL	• Discussion of Management Measures
SFWMD Governing Board Workshop	April 9, 2008	Okeechobee, FL	• Northern Everglades and Estuaries Protection Program Update
Research and Water Quality Monitoring Program Working Team Meeting	April 15, 2008	Fort Myers, FL	• Briefing on plan status and schedule • Opened for public comments
Research and WQ Monitoring Program Ad-Hoc Group Meeting	April 15, 2008	Fort Myers, FL	• Evaluation of existing aquatic habitat monitoring efforts.
CRWPP Working Team Meeting	April 16, 2008	Fort Myers, FL	• Briefing on plan status and schedule and coordinating agencies update • Opened for public comments
Meeting with Florida Department of Community Affairs Secretary Pelham and staff	April 28, 2008	NA (Conference Call)	• Northern Everglades and Estuaries Protection Program Coordination Meeting
Lake Okeechobee WRAC Meeting	April 30, 2008	Clewiston, FL	• Northern Everglades: River Watershed Protection Plans Update
Okeechobee Board of Realtors	May 21, 2008	Okeechobee, FL	• Northern Everglades Update
Research and Water Quality Monitoring Program Working Team Meeting	May 20, 2008	Fort Myers, FL	• Briefing on plan status and schedule • Opened for public comments
CRWPP Working Team Meeting	May 21, 2008	Fort Myers, FL	• Briefing on plan status and schedule and coordinating agencies update • Opened for public comments
Lake Okeechobee WRAC Meeting	May 28, 2008	West Palm Beach, FL	• Northern Everglades: River Watershed Protection Plans Update
Ten County Coalition Meeting	May 30, 2008	Okeechobee, FL	• Northern Everglades and Estuaries Protection

Meeting ID	Meeting Date	Meeting Location	Meeting Agenda
			Program Update
Northern Everglades Interagency Meeting	June 4, 2008	Okeechobee, FL	• Northern Everglades Update
Okeechobee Economic Council Meeting	June 4, 2008	Okeechobee, FL	• Northern Everglades Update
WRAC Meeting	June 5, 2008	Hollywood, FL	• Northern Everglades: River Watershed Protection Plans Update • Analysis of Impacts of Lake Regulation Schedules and its Relation to Northern Everglades
Research and Water Quality Monitoring Program Working Team Meeting	June 17, 2008	Fort Myers, FL	• Briefing on plan status and schedule • Opened for public comments
Lake Okeechobee WRAC Meeting	June 25, 2008	Fort Myers, FL	• Northern Everglades: River Watershed Protection Plans Update
Highlands County Conservation Connection Day	June 25, 2008	Sebring, FL	• Northern Everglades display
CRWPP Working Team Meeting	June 27, 2008	Fort Myers, FL	• Briefing on plan status and schedule and coordinating agencies update • Opened for public comments
WRAC Meeting	July 3, 2008	West Palm Beach, FL	• Northern Everglades: River Watershed Protection Plans Update
Martin County Staff Meeting	July 10, 2008	Stuart, FL	• Northern Everglades Update
Palm Beach Community College	July 11, 2008	Palm Beach Gardens, FL	• Northern Everglades Presentation
Sanibel Mayor Nick Denham	July 21, 2008	Fort Myers, FL	• Northern Everglades Projects
CRWPP Working Team Meeting	July 21, 2008	Fort Myers, FL	• Briefing on plan status and schedule and coordinating agencies update • Opened for public comments
Lake Okeechobee WRAC Meeting	July 24, 2008	Stuart, FL	• Northern Everglades: River Watershed Protection Plans Update
CRWPP Working Team Meeting	August 1, 2008	Fort Myers, FL	• Briefing on plan status and schedule • Coordinating agencies update • Opened for public comments
Rivers Coalition	August 28, 2008	Stuart, FL	• Northern Everglades Presentation

Meeting ID	Meeting Date	Meeting Location	Meeting Agenda
Ten County Coalition Meeting	August 29, 2008	Okeechobee, FL	• Northern Everglades and Estuaries Protection Program Update
SFWMD Governing Board Workshop	September 10, 2008	West Palm Beach, FL	• Northern Everglades: River Watershed Protection Plans Update
Lake Okeechobee WRAC and WRAC Combined Meeting	September 16, 2008	West Palm Beach, FL	• Northern Everglades: River Watershed Protection Plans Update
Northern Everglades Interagency Meeting	October 2, 2008	Okeechobee, FL	• Northern Everglades and Estuaries Protection Plan
Representative Ralph Poppell	October 3, 2008	Titusville, FL	• Northern Everglades Update
Glades County Commission Meeting	October 14, 2008	Moore Haven, FL	• Overview of the draft Caloosahatchee River Watershed Protection Plan
Southwest Florida Watershed Council	October 14, 2008	Fort Myers, FL	• Overview of the draft Caloosahatchee River Watershed Protection Plan
Florida's Heartland Rural Economic Development Initiative Board Meeting	October 20, 2008	Sebring, FL	• Overview of the draft Caloosahatchee River Watershed Protection Plan
Public Workshop for Caloosahatchee River Watershed Protection Plan	October 27, 2008	Fort Myers, FL	• Overview of the draft Caloosahatchee River Watershed Protection Plan
Lee County Commission Meeting	October 28, 2008	Fort Myers, FL	• Overview of the draft Caloosahatchee River Watershed Protection Plan
Hendry County Commission Meeting	October 28, 2008	La Belle, Florida	• Overview of the draft Caloosahatchee River Watershed Protection Plan
Lake Okeechobee WRAC Meeting	October 29, 2008	West Palm Beach, FL	• Northern Everglades: River Watershed Protection Plans Update
Rivers Coalition	November 6, 2008	Stuart, FL	• Northern Everglades and Estuaries Protection Plan Update
Southwest Florida Regional Planning Council Meeting	November 20, 2008	Fort Myers, FL	• Overview of the draft Caloosahatchee River Watershed Protection Plan
SFWMD Governing Board Meeting	December 15, 2008	West Palm Beach, FL	• Northern Everglades River Watershed Protection Plans: Public Comments and Final Plan
Lake Okeechobee WRAC and	December 3, 2008	Key Largo, FL	• Northern Everglades

Meeting ID	Meeting Date	Meeting Location	Meeting Agenda
WRAC Combined Meeting			River Watershed Protection Plans: Public Comments and Final Plan
Ten County Coalition Meeting	December 5, 2008	Okeechobee, FL	• Northern Everglades River Watershed Protection Plans: Public Comments and Final Plan

4.2 Public Involvement and Stakeholder Notification

The public outreach effort for the CRWPP planning process sought to achieve the following goals:

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

4.3 Public Comments

The Draft CRWPP was released for public comment on October 1, 2008, with a public comment period until Oct 31, 2008. The public, stakeholders, and agencies were invited to review and provide comments on the Draft CRWPP. 114 comments were received during the public comment period. The public comments were considered during the finalization of the CRWPP and formal response for each comment was provided in the Final Plan (see **Appendix H**).

CHAPTER 5

TOTAL MAXIMUM DAILY LOADS

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5.0 TOTAL MAXIMUM DAILY LOADS

5.1 Background

The Northern Everglades and Estuaries Protection Program (NEEPP) in Section 373.4595, Florida Statutes (F.S.) requires the Caloosahatchee River Water Protection Plan (CRWPP) to contain an implementation schedule for pollutant load reductions consistent with any adopted Total Maximum Daily Loads (TMDLs) and in compliance with applicable state water quality standards. The Florida Department of Environmental Protection (FDEP) was developing TMDLs for the Caloosahatchee River Watershed during the formulation of the CRWPP. This chapter summarizes the TMDL process and the status of the Caloosahatchee River Watershed TMDL development as of middle to late 2008. Detailed information on TMDLs in the Caloosahatchee River Watershed will be provided in FDEP's *TMDL Report Nutrient and Dissolved Oxygen TMDL for the Caloosahatchee River Basin*.

5.1.1 Clean Water Act and Florida Watershed Restoration Act

A TMDL is the maximum loading of a particular pollutant that can be discharged into a surface water and still meets its designated uses and applicable water quality standards. TMDLs provide important water quality restoration goals that will guide restoration activities.

The TMDL requirements were originally promulgated as a part of the Federal Pollution Control Act of 1972 and were later expanded by the Clean Water Act (CWA) of 1977 and the Water Quality Act of 1987. The law requires states to define state-specific water quality standards for various designated uses and to identify waterbodies for which the ambient water quality has been determined not to meet established standards (Subsection 303(d)). Waterbodies that do not achieve such water quality standards as a result of human-induced conditions are considered impaired. An updated list of impaired waterbodies must be presented by the state to the U.S. Environmental Protection Agency (USEPA) every two years and must designate which of the listed impaired waterbodies will require implementation of the TMDL process.

In Florida, a TMDL study is required when a water segment is determined to be impaired. This process has been defined by the Florida Watershed Restoration Act (FWRA) in Section 403.067, F.S. Regulations have been promulgated under the Impaired Surface Waters Rule Chapter 62-303, Florida Administrative Code (F.A.C.). The rule defines methods to identify water segments requiring a TMDL.

The two-step process for the listing of impaired waters is based on the FWRA. The first step involves developing the initial "planning list" that names potentially impaired waters based on existing impairment-related data. The second step involves developing a focused list of "verified" impaired waters based on additional data. The list of waters for which impairments have been verified using the methodology in the Impaired Waters Rule is referred to as the verified list. This "verified list" is adopted by the FDEP Secretary and constitutes the required 303(d) list. FDEP has developed these lists since 1992, and Florida's 1998 303(d) list included 571 waterbodies located throughout the state.

5.1.2 Total Maximum Daily Load Development Timelines

The schedule for USEPA's TMDL development is done in accordance with a Consent Decree entered in the case styled National Wildlife Federation v. Browner, Case No. 98-356-CIV-Stafford (N.D. Fla.) ("Consent Decree"). The Consent Decree sets forth a timeline for USEPA to adopt TMDLs for those impaired waters listed on Florida 1998 Section 303(d) list. FDEP promulgates TMDLs pursuant to the FWRA in Section 403.067, Florida Statutes. The FWRA stated that all previous Florida 303(d) lists of impairments were for planning purposes only and directed FDEP to develop, and to adopt by rule, a new science-based methodology to identify impaired waters. After a long rulemaking process, the Environmental Regulation Commission adopted the new methodology as Chapter 62-303, F.A.C. (Impaired Waters Rule), in April 2001 and modified it in 2006 and again in 2007.

5.1.3 Total Maximum Daily Load Process

In Florida, the TMDL process is multi-phased and includes the identification, the verification, and the listing of impaired waters, followed by the development and implementation of the TMDL. Below are the phases of Florida’s TMDL process:

1. Preliminary data compilation and assessment
2. Strategic monitoring and assessment to verify water quality parameters
3. Development and adoption of TMDL
4. Development of Basin Management Action Plan (BMAP) and allocations
5. Implementation of BMAP to meet TMDL and monitoring of results

5.1.4 Watershed Approach

In order to address pollutants in the state’s waterbodies, FDEP has adopted a watershed-based management approach, which is implemented using a cyclical management process that rotates through the state’s 52 major hydrologic basins in five groups over a five-year cycle (FDEP Basin 411, 2008). Each of the FDEP Districts is divided into five geographically based groups of watersheds, as broken down in **Table 5-1**. **Figure 5-1** illustrates the basin groups, as well as the rotation schedule for each group.

Table 5-1. Basin Groups and FDEP Districts

FDEP District	Group 1 Basins	Group 2 Basins	Group 3 Basins	Group 4 Basins	Group 5 Basins
Northwest	Ochlockonee-St. Marks	Apalachicola-Chipola	Choctawhatchee-St. Andrews Bay	Pensacola Bay	Perdido Bay
Northeast	Suwannee	Lower St. Johns	-	Nassau-St. Marys	Upper East Coast
Central	Ocklawaha	Middle St. Johns	Upper St. Johns	Kissimmee	Indian River Lagoon
Southwest	Tampa Bay	Tampa Bay Tributaries	Sarasota Bay-Peace-Myakka	Withlacoochee	Springs Coast
South	Everglades West Coast	Charlotte Harbor	Caloosahatchee	Fisheating Creek	Florida Keys
Southeast	Lake Okeechobee	St. Lucie-Loxahatchee	Lake Worth Lagoon-Palm Beach Coast	Southeast Coast-Biscayne Bay	Everglades

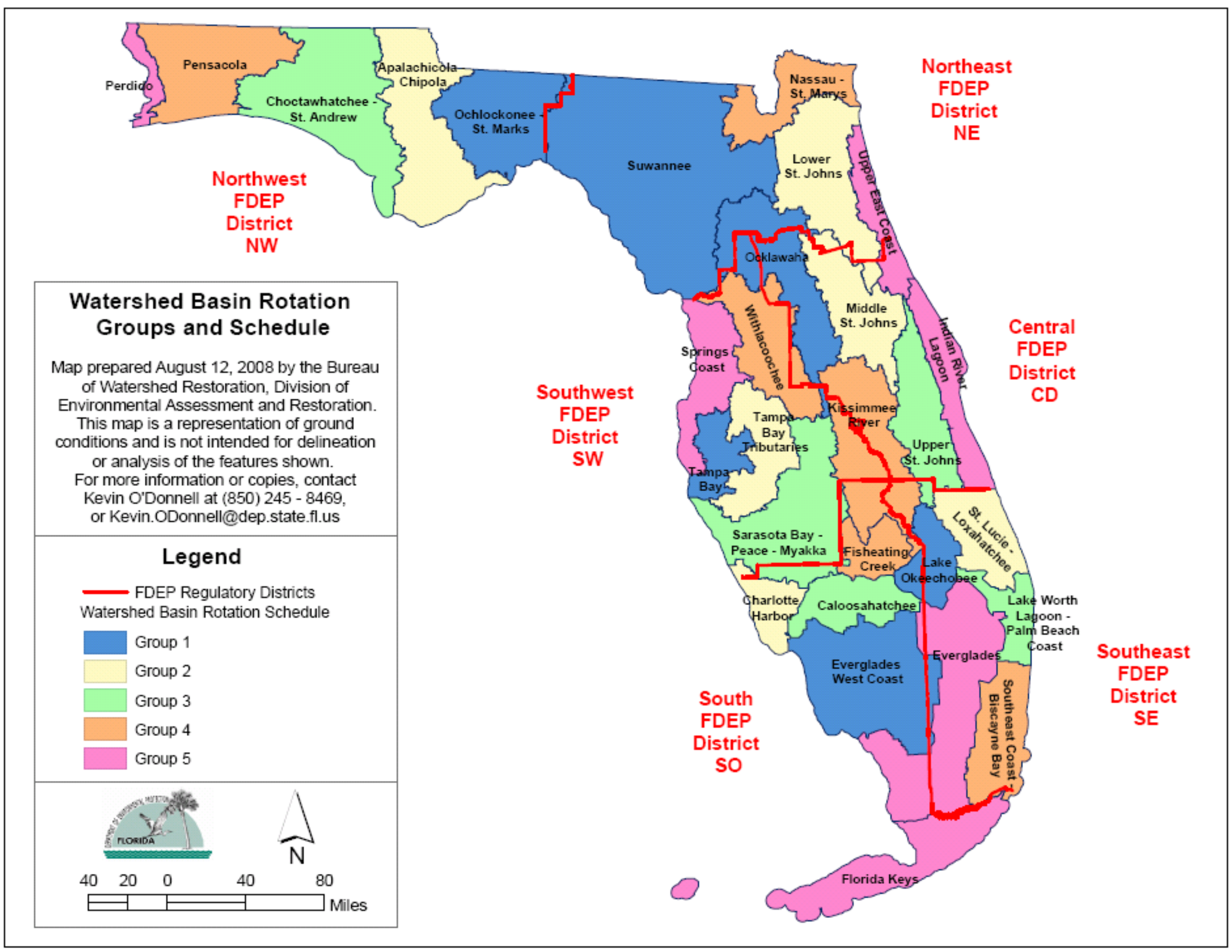

Figure 5-1. Watershed Basin Rotation Groups and Schedule

5.2 Development of Total Maximum Daily Loads for Caloosahatchee River Basin

Florida's impaired waters assessment process divides waters into segments, each of which is assigned a unique waterbody identification (WBID) number. The Caloosahatchee River Basin had eight WBIDs included on Florida's list of impaired waters (1998 303(d)) for various pollutants including fecal coliform bacteria, nutrients (chlorophyll-*a*), and dissolved oxygen (DO). **Figure 5-2** shows the Caloosahatchee River Basin boundary, and **Figure 5-3** depicts the WBIDs within the Caloosahatchee River Basin. Recent information relative to the hydrology within the basin has resulted in proposed changes to some of the WBID boundaries. The map shown in **Figure 5-3** incorporates recent changes to the WBIDs in the Tidal Caloosahatchee area and is consistent with the current WBID version, Run 33, which was completed in July 2008.

In September 2005, FDEP issued a fecal coliform TMDL for Ninemile Canal, WBID 3237D. The TMDL document assessed potential sources of fecal coliform in the watershed, quantified the fecal coliform load allocation appropriate for Ninemile Canal, and outlined the next step in water quality protection after the TMDL had been adopted by rule.

The nutrient (chlorophyll-*a*) and DO TMDL for the Tidal Caloosahatchee River, downstream of the U.S. Army Corps of Engineers (USACE) W.P. Franklin Lock (S-79), is currently being developed by FDEP. Originally, these TMDLs were scheduled to be completed by September 30, 2010. However, the NEEPP fast-tracked these TMDLs (Section 373.4595, F.S.). The legislation states that FDEP "*is directed to expedite the development and adoption of total maximum daily loads for the Caloosahatchee River and estuary… [and to] no later than December 31, 2008, propose for final agency action, total maximum daily loads for nutrients in the tidal portions of the Caloosahatchee River and estuary*."

5.2.1 Impaired Water Body Identification Numbers

Figure 5-3 and **Table 5-2** display the WBIDs in the Tidal Caloosahatchee Basin determined to be impaired for either DO or nutrients (chlorophyll-*a*) based on water quality data from 1996 to 2003 (Cycle 1). As a result of the NEEPP legislation, draft TMDLs for the main stem of the Tidal Caloosahatchee River will be completed by December 31, 2008. The TMDLs for the Tidal Caloosahatchee tributary WBIDs that are currently impaired are due to be completed by 2010.

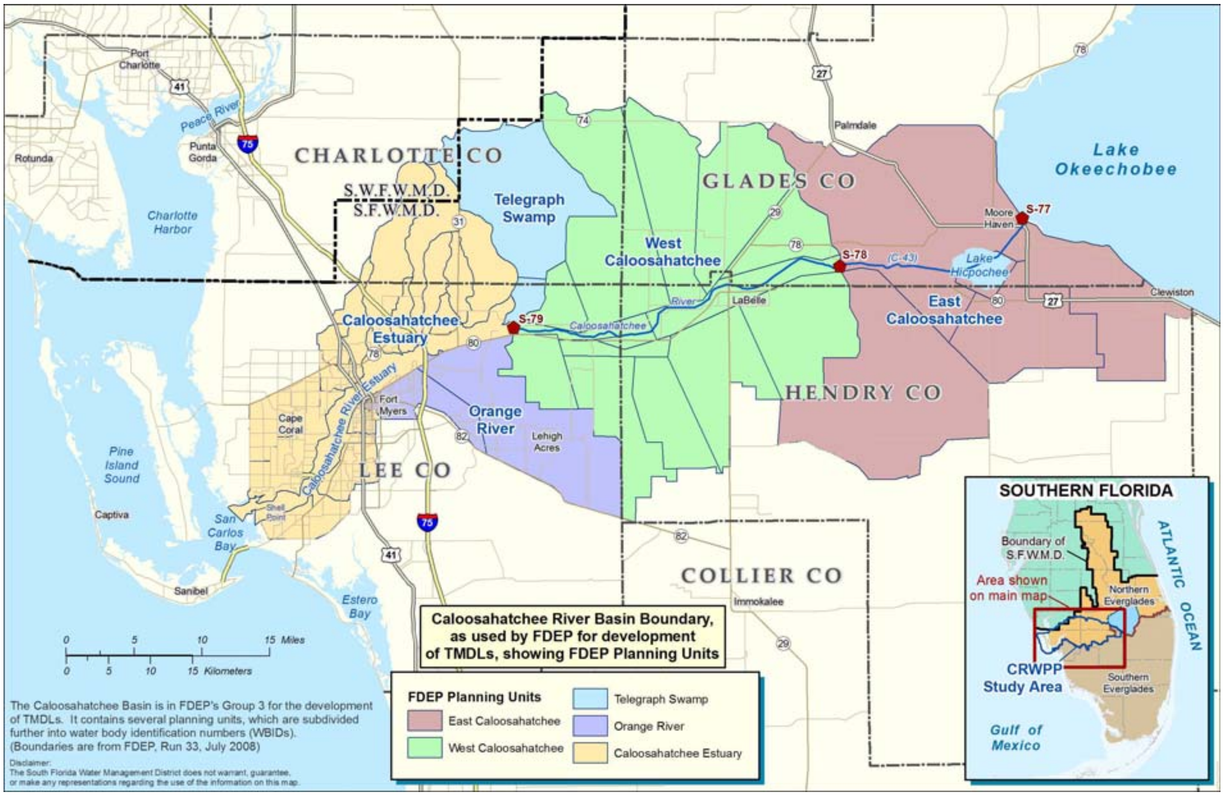

Figure 5-2. Caloosahatchee River Basin Boundary

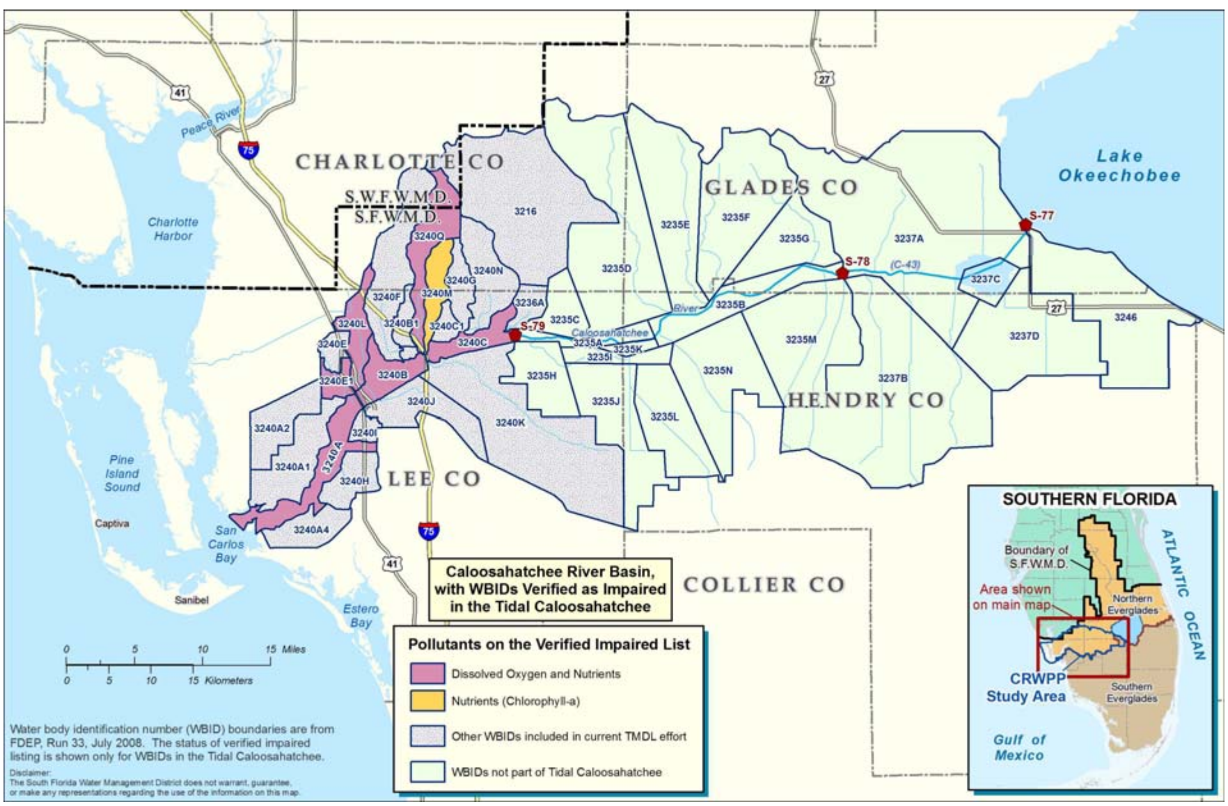

Figure 5-3. Impaired Waterbodies within the Caloosahatchee River Basin

Table 5-2. Nutrient and DO Impaired Waterbodies for Caloosahatchee River Basin

WBID	Waterbody Segment	Waterbody Type	Waterbody Class[1]	Parameters Assessed Using the Impaired Waters Rule[2]
3240A	Tidal Caloosahatchee	Estuary	3M	Dissolved Oxygen
3240A	Tidal Caloosahatchee	Estuary	3M	Nutrients (Chlorophyll-*a*)
3240B	Tidal Caloosahatchee	Estuary	3M	Dissolved Oxygen
3240B	Tidal Caloosahatchee	Estuary	3M	Nutrients (Chlorophyll-*a*)
3240C	Tidal Caloosahatchee	Stream	3F	Dissolved Oxygen
3240C	Tidal Caloosahatchee	Stream	3F	Nutrients (Chlorophyll-*a*)
3240E 1	Hancock Creek	Estuary	3M	Dissolved Oxygen
3240E 1	Hancock Creek	Estuary	3M	Nutrients (Chlorophyll-*a*)
3240L	Gilchrest Drain - Powel	Stream	3F	Dissolved Oxygen
3240L	Gilchrest Drain - Powel	Stream	3F	Nutrients (Chlorophyll-*a*)
3240M	Stroud Creek	Stream	3F	Nutrients (Chlorophyll-*a*)
3240Q	Popash Creek	Stream	3F	Dissolved Oxygen
3240Q	Popash Creek	Stream	3F	Nutrients (Chlorophyll-*a*)

1 The 3 stands for Class III. The designated uses of Class III waters are for recreation, propagation, and maintenance of healthy, well-balanced populations of fish and wildlife. The M stands for marine, and the F stands for freshwater.
2 Based on Cycle 1 Assessment (1996 to 2003 water quality data).
3 Based on Cycle 1 Assessment (January 1, 1997 to June 30, 2004 water quality data).

5.2.2 Modeling Efforts

In order to establish nutrient targets [i.e., TMDLs for total nitrogen (TN) and total phosphorus (TP)] that correspond with other hydrologic and ecological goals (e.g., salinity envelopes), modeling efforts are being undertaken to better understand how the river system interacts with the Gulf of Mexico. Modeling efforts are also intended to determine how the numerous WBIDs are interconnected within a watershed perspective. The modeling effort to support the development of TMDLs for the Tidal Caloosahatchee River involves the development of linked watershed and receiving waterbody numerical models, including the Hydrological Simulation Program—Fortran (HSPF) and the Environmental Fluid Dynamics Code (EFDC). These models are linked together to simulate the hydrologic and water quality functions of the Caloosahatchee River Basin and its receiving waters.

5.2.2.1 Hydrological Simulation Program—FORTRAN

The watershed or hydrologic model of the Caloosahatchee River Basin is being developed using the modeling software called the Hydrological Simulation Program—Fortran (HSPF). The watershed model will be used to simulate rainfall, runoff, evaporation, infiltration, irrigation, stream and channel flow, and related water quality in the tributary sub-basins flowing into the Caloosahatchee River. The model also simulates flow and water quality constituents such as temperature, five-day biochemical oxygen demand (BOD_5), total suspended solids (TSS), TN, TP, corrected chlorophyll-*a*, DO, fecal coliform, and it will provide a pollutant load time-series. All of these parameters are used as input to the Environmental Fluid Dynamics Code (EFDC) hydrodynamic and water quality model.

The hydrologic component of the HSPF model was calibrated using data from 2001 through 2005 and validated using data from 1997 through 1999. The water quality component of the model was calibrated using the ambient water quality data from 2004 through 2005 and validated using data from 2002 through 2003.

5.2.2.2 Environmental Fluid Dynamics Code

The modeling software used to create the receiving waterbody model is the Environmental Fluid Dynamics Code (EFDC). The EFDC water quality model being developed for the TMDL process for the Caloosahatchee Estuary was initially based on the EFDC model of the Caloosahatchee River for the USACE (DSLLC, 2007). The USACE Caloosahatchee Estuary Model was developed to evaluate release scenarios from Lake Okeechobee and as a water management tool.

The EFDC water quality model is a 3-D grid hydrodynamic model that simulates flow, transport, and biogeochemical processes in the tidal Caloosahatchee River Basin. The receiving waterbody model will include a fine-grid hydrodynamic, solids transport, and water quality model. A separate coarse-grid model of the near ocean portion of the Gulf of Mexico extending from Port Charlotte to Naples, Florida was also developed to simulate the effects of meteorological phenomena and tidal interactions between the Caloosahatchee River and its receiving water the Gulf of Mexico, as shown in **Figure 5.4**. The calibration period for the hydrodynamic/salinity component of the EFDC model is from January 1, 2003 to December 31, 2003. The water quality component of the EFDC simulates the biochemical processes involving phytoplankton growth, nutrient cycling, and dissolved oxygen dynamics. The EFDC water quality model used water quality data collected in 2003 for calibration and 2004 for validation.

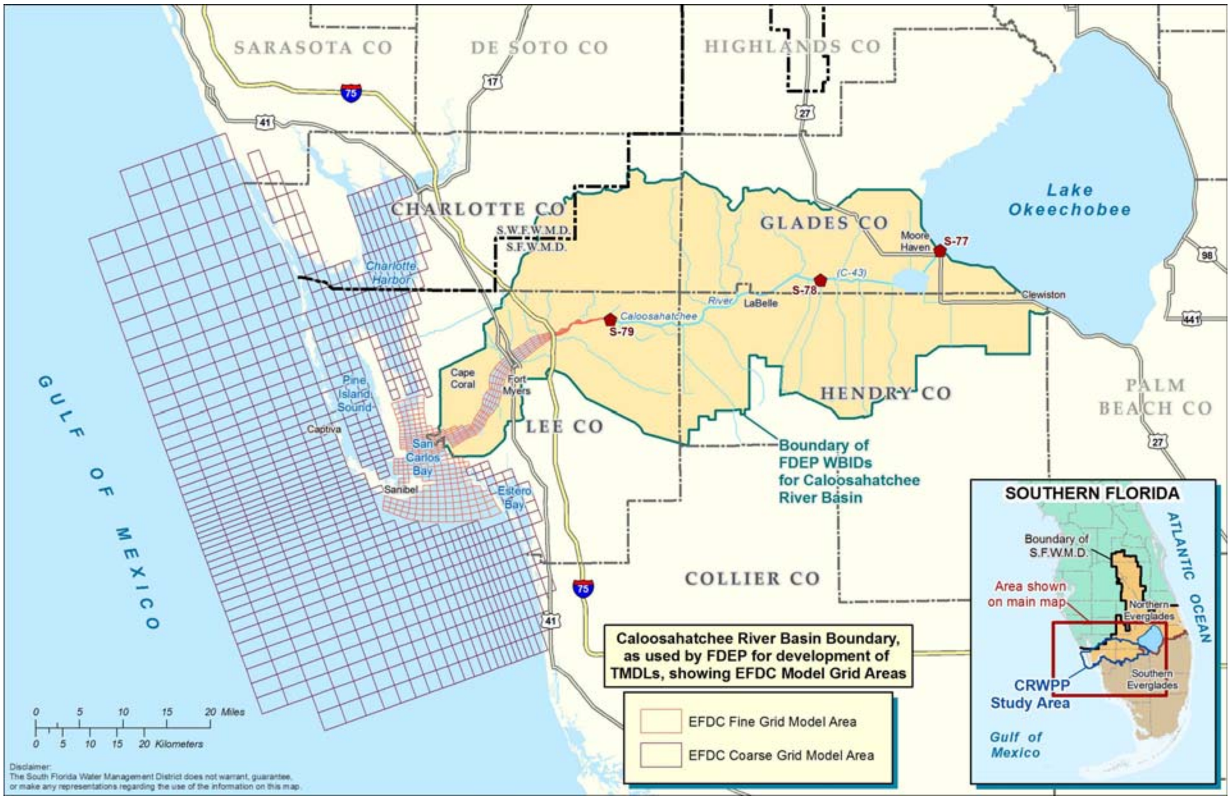

Figure 5-4. EFDC Fine and Coarse-Grain Grid Model Comparison

5.3 Development of Total Maximum Daily Loads for Tidal Caloosahatchee Basin

The major activities that have occurred to date or are currently taking place listed below.

- Camp, Dresser, McKee and Dynamic Solutions, LLC (CDM/DS) was contracted in July 2007 to perform water quality modeling of the Caloosahatchee Estuary.
- Sites for flow monitoring stations on tributaries to the Tidal Caloosahatchee Basin were identified, based on the potential impact to the Caloosahatchee River Basin (size of contributing sub-basin and level of pollutant load).
- The U.S. Geological Survey (USGS) was contracted in August 2007 to install equipment at seven sites to continuously monitor the water level, water velocity, temperature, and salinity, as well as permit computation of discharge within the Caloosahatchee River Basin. These seven sites are located in the Caloosahatchee River near the mouth at Shell Point, Caloosahatchee River at Marker #52 near US-41, Telegraph Creek, Orange River, Hancock Creek, Billy's Creek, and Popash Creek. In the summer and fall of 2007, FDEP calculated flow from five tributaries to the Caloosahatchee River using portable flow meters, specifically at Manuel's Branch, Stroud Creek, Owl Creek, Powell Creek, and Yellow Fever Creek. This work was done prior to the USGS installation of the stationary instrumentation and provided data from smaller tributaries that are no tidally influenced.
- FDEP District personnel began discussions with Johnson Engineering about the firm's sampling program in Telegraph Swamp (where Babcock Ranch property is located) to

determine if and how this data might be uploaded into the Florida Storage and Retrieval (STORET) database. This effort was important because Telegraph Swamp was the single WBID in the Tidal Caloosahatchee Basin for which FDEP had no data for TMDL assessment. These water quality and flow data were subsequently submitted to FDEP.

- In May 2007, monthly Caloosahatchee TMDL Technical Working Group meetings began, and in August 2007 these meetings were supplemented by monthly teleconferences. The goal of these meetings and teleconferences is to facilitate technical discussions between FDEP and local stakeholders to enhance the development of the Tidal Caloosahatchee Basin DO and Nutrient TMDL as well as the subsequent TMDLs in 2010. The topics of discussion include:
  - Optimum locations for USGS flow monitoring instrumentation;
  - Hydrologic computer modeling options;
  - Strategies for developing nutrient target concentrations;
  - Coordination with SFWMD on the Caloosahatchee River Watershed Protection Plan and Research and Water Quality Monitoring Planning;
  - Information gathering for water quality model and TMDL;
  - CDM/DS contract deliverables provided to group for comments, including report with historical data and report with Calibrated/Validated Model;
  - Identification of baseline and management scenarios for model simulations; and
  - Best management practices (BMPs) and other issues relevant to TMDL development.
- In August 2007, a public meeting was conducted in Fort Myers to announce the intent to develop a TMDL for the Tidal Caloosahatchee Basin.
- In May 2008, the FDEP added continuously monitoring YSIs to the USGS flow monitoring sites at Marker #52, Telegraph Creek, and Orange River. The purpose is to supplement the flow data with continuous DO, conductance, and pH data.

5.4 Timetable for Total Maximum Daily Load Completion

An estimate to completion for issuance of the nutrient (TP and TN) and DO TMDL for the Caloosahatchee River Basin is provided in **Table 5-3**. The schedule is based on best available data, but it may be subject to change.

Table 5-3. Caloosahatchee River Basin Total Maximum Daily Load Schedule

Action Item		Projected Dates
1	Writing draft TMDL documents with reviewer inputs	In progress through the middle of November 2008
2	Compile local project details for modeling and TMDL existing and historic conditions chapters	Primarily completed April/2008 for incorporation in model, but information gathering continues throughout project
3	Compile Ag BMP details, with SFWMD assistance, for background information, model setup and scenarios	Through Mid-July 2008

Action Item		Projected Dates
4	Discuss modeled scenario results with Technical Working Group	August through Early November 2008
5	Announce 1st public meeting	Early September 2008
6	1st public meeting: review of TMDL model scenarios	Early October 2008
7	Announce 2nd public meeting	Early October 2008
8	2nd public meeting: review TMDL approach and progress	Early November 2008
9	Review TMDL documents by SFWMD and Working Group	mid October through mid November 2008
10	Internal FDEP administrative review of draft TMDL	Mid-October through November 2008
11	Notice public workshop (Draft TMDL documents required)	Mid-November 2008
12	Post Draft TMDL on FDEP website	Mid-November 2008
13	Comment Period for Draft TMDL	Mid-November 2008 - Late December 2008
14	TMDL public workshop (to present Draft TMDL)	Early December 2008
15	Develop and post Final TMDL documents to website	Early January 2009
16	Administrative steps for adoption	Early January 2009
17	FDEP adoption of TMDLs	Mid-January 2009
18	BMAP kickoff	Late January 2009

5.5 Basin Management Action Plans

This TMDL will be implemented primarily through a BMAP. Section 373.4595 F.S. requires that the BMAP be initiated no later than 90 days after adoption of this TMDL, and that the BMAP be completed as soon as practicable. In the Caloosahatchee River Watershed, the BMAP process will be closely coordinated with the NEEPP Watershed Protection Plan. As discussed in Chapter 1, the CRWPP is being developed primarily by SFWMD, with participation from FDEP, Florida Department of Agriculture and Consumer Services (FDACS), and a variety of interested stakeholders. The CRWPP is due to the Florida Legislature on January 1, 2009.

Section 373.4595, F.S. calls for expeditious implementation of the CRWPP, and states that implementation of the CRWPP and any related BMAPs is a reasonable means of achieving TMDLs and compliance with state water quality standards. SFWMD and FDEP are working closely together to coordinate the NEEPP and BMAP processes, avoid overlap, and ensure that implementation efforts are timely and cost-effective. Prior to initiation of the BMAP, FDEP will closely review the CRWPP and identify components of the CRWPP that are directly applicable to the BMAP. The development of BMAPs and implementation of TMDLs are outlined in Section 403.067(7), F.S. and include the following elements:

- Appropriate load reduction allocations among the affected parties, or to the basin as a whole (403.067(7)(a)2);
- A description of the appropriate management strategies to be undertaken, including regional treatment systems or other public works, where appropriate;

- An implementation schedule;
- A basis for evaluating the Plan's effectiveness;
- Feasible funding strategies;
- Linkages to affected National Pollution Discharge Elimination System (NPDES) permits;
- Mechanisms by which potential future increases in pollutant loading will be addressed;
- A water quality monitoring component sufficient to evaluate progress in pollutant load reductions; and
- An assessment process to occur no less than every five years.

The BMAP will likely include other factors beyond these basic elements. The BMAP development process will occur with the close coordination of local stakeholders and NEEPP coordinating agencies (FDEP, SFWMD and FDACS), many of whom were involved in development of the TMDL.

CHAPTER 6.0

CALOOSAHATCHEE RIVER WATERSHED CONSTRUCTION PROJECT

6.0 CALOOSAHATCHEE RIVER WATERSHED CONSTRUCTION PROJECT

Section 373.4595(4)(b)1., Florida Statutes (F.S.), requires the establishment of a Caloosahatchee River Watershed Construction Project. The purpose of the project is to identify potential water quality and quantity projects within the Caloosahatchee River Watershed and Estuary, formulate alternatives based on the projects identified, and identify a preferred Plan that results in the most benefits to the Caloosahatchee Estuary.

This chapter includes the following five sections which describe the tools and processes used to formulate and evaluate alternatives to meet overall project objectives for water quality and quantity. As a result, a preferred Plan is identified that provides the best overall strategy for improving the hydrology, water quality, and aquatic habitats within the Caloosahatchee River Watershed Protection Plan (CRWPP) study area. The basis for the identification of the preferred Plan is discussed in Section 6.5. A detailed description of the preferred Plan is included in Chapter 9.

Section 6.1 - Management Measures – This section discusses the different management measures identified within the Caloosahatchee River Watershed that can address one or more of the planning objectives. Management measures discussed include water quantity/storage projects, watershed water quality projects, and land management and restoration projects.

Section 6.2 - Water Quantity Analysis Method – This section provides an overview of the analysis method used to evaluate project alternatives in terms of water quantity performance measures and performance indicators.

Section 6.3 - Water Quality Analysis Method and Base Condition Characterization – This section provides an overview of the method used to evaluate project alternatives in terms of water quality performance measures. Section 6.3 also characterizes the current water quality conditions of the Caloosahatchee River Watershed and provides a discussion of the water quality benefits of the base projects included in the River Watershed Protection Plan Base Condition.

Section 6.4 - Formulation of Alternative Plans – This section describes the CRWPP formulation process including the goals, challenges, and development of alternatives. The alternative plans were formulated and evaluated by the coordinating agencies in consultation with the CRWPP Working Team. The water quantity and quality benefits of each alternative are summarized.

Section 6.5 - Alternative Plan Evaluation and Comparison – This section evaluates and compares the water storage and quality results of the four alternatives to the water quantity and water quality targets. This section also identifies the Caloosahatchee River Watershed Construction Project preferred Plan.

SECTION 6.1

MANAGEMENT MEASURES

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6.1 MANAGEMENT MEASURES

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

6.1.1 Management Measures Toolbox

The coordinating agencies developed the management measures toolbox by seeking input from the Caloosahatchee River Watershed Protection Plan (CRWPP) Working Team, a group of federal, state, and local agencies and interested stakeholders. The management measures toolbox is a compilation of various management measures that, if implemented in the Caloosahatchee River Watershed, could achieve the stated project objectives. Management measures include both projects specific to the Caloosahatchee River Watershed and Estuary and management measures from the Lake Okeechobee Watershed Construction Project, Phase II Technical Plan (LOP2TP) that were relevant to the Caloosahatchee River Watershed. The management measures toolbox is provided in **Appendix B**.

The management measure sheets provide the general description/background of the management measure and its purpose, the sub-watershed in which it is located, the size and capacity of the feature, and the status of the initiative as provided by the working team. Each management measure sheet also includes the summary of final water quality and water quantity benefits as determined by the working team. Each management measure was designated with an individual identification code. Management measures included in the LOP2TP begin with the letters CRE-LO. Management measures specific to the Caloosahatchee River Watershed and not included in the LOP2TP begin with the letters CRE. The initial CRE management measures were then assigned numbers in an east to west order. Later management measures were assigned numbers chronologically.

Each management measure was also assigned a level of certainty using the following scale:

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

- Level 5 – Implementation certainty unknown, conceptual idea with limited information.

For management measures, a range (minimum, most likely, and maximum) for nutrient reduction and/or storage benefits was also established. The management measures were then screened for inclusion into the alternatives formulation by determining if the management measure would at a minimum support the objectives of the CRWPP.

6.1.2 Risk and Uncertainties Analysis

With any large water resources planning effort, there are numerous sources of uncertainty that can potentially impact project outcome. Since each management measure carries a level of risk, the risks were also carried over to the alternatives subjecting them to some level of uncertainty. Sources of uncertainty may include:

- Scale of the project;
- Complexity and diversity of the problems and potential solutions;
- Relationships between the impacted physical processes;
- Conceptual nature of some of the plan components based on assigned level; and
- Uncertainty related to the performance of management measures.

6.1.3 Estimating Uncertainties Associated with Management Measure Levels

The potential risks associated with the management measures' assigned level was evaluated so that appropriate risk management approaches could be considered. Since management measures risks fall between Level 1 (substantially defined) to Level 5 (conceptual), all management measures were evaluated allowing for the following criteria.

Level 1 management measures include the following characteristics:

- Substantial data supports the technologies effectiveness in similar conditions and scale;
- Planning, design/engineering and permitting has been completed and shows that, compared to other management measures, this measure is the most appropriate for the site-specific situation;
- Private land owners, stakeholders, interest groups, the general public, and other agencies have been involved in development of the plan;
- Cost estimates have been prepared;
- Site selection has occurred and/or required real estate interests have been obtained;
- Funding has been budgeted and encumbered; and
- Construction may have begun or even completed.

Level 5 management measures may contain the following characteristics:

- The proposed technology may be untested for the use and scale being considered;
- Only conceptual descriptions of the approach have been developed;
- Limited or no coordination has occurred between stakeholders;
- Design work has not been initiated;
- Site selection has not occurred except on a regional basis;
- Funding has not been established; and
- Permitting has not been initiated due to lack of information.

6.1.4 Estimating Uncertainties Associated with Management Measure Performance

A very conservative approach was taken when quantifying water quantity and water quality benefits anticipated from individual management measures. When management measures were evaluated for water quantity or water quality benefits, values were estimated as minimum, most likely, and maximum. The most likely performance value was then assigned to the management measure. If a management measure was submitted with a benefit enumerated, that number was verified and accepted. Many water quality management measures did not have performance values assigned due to insufficient or preliminary information, therefore additional water quality benefits may be provided that are not included in the estimates for the four alternatives.

Despite this conservative approach, uncertainties associated with the performance of management measures remain. Uncertainties in potential water quantity were related to the following factors:

- Availability of adequate land;
- Cost of available land;
- Existence of geotechnical conditions conducive to construction of surface storage reservoirs;
- Availability of land in locations most suitable for capturing and storing flows,
- Interactions among various storage facilities; and
- Specific operational criteria for storage features.

Uncertainties in potential total phosphorus (TP) and total nitrogen (TN) load reduction performance of management measures are related to the following factors:

- Extent of nutrient control with different technologies;
- Most appropriate technology for nitrogen control and how to optimize treatment for nitrogen reduction;
- The availability of lands;
- Accuracy of projected flow volumes and nutrient concentrations;
- Inflow water chemistry; and
- Synergy and interactions between treatment facilities and storage facilities.

6.1.5 Types of Management Measures

The management measures in the toolbox could be applied either at the local (parcel) or regional level (sub-watershed) scale. Local features typically have minimal requirements for engineering, construction, and operations. These local features also have relatively smaller real estate requirements and promote landowner involvement. In contrast, regional features require significant amounts of real estate acquisition, engineering, construction, and operations. Another scale designation is source control which includes projects that contain pollutants on site, many of which were included in the report entitled *Nutrient Loading Rates, Reduction Factors and Implementation Costs Associated with BMPs and Technologies* (Soil and Water Engineering Technology, Inc. 2008) (**Appendix D**).

Management measures can also be broadly grouped into three general categories. These categories include water quantity/storage projects, water quality projects, and land management and restoration projects. **Table 6.1-1** (at the end of this section) shows the scale, general category, and sub-watershed for each management measure in the toolbox.

6.1.5.1 Water Quantity/Storage

Management measures considered for capturing and storing stormwater runoff in the watershed include aboveground reservoirs, alternative water storage/disposal projects, and aquifer storage and recovery (ASR) wells.

6.1.5.1.1 Reservoirs

Aboveground reservoirs are the most common types of surface water storage features that comprise large areas of land surrounded by levees that are used to store water. They also provide ancillary water quality benefits because nutrients and contaminants tend to settle out within the reservoir. Reservoir storage sites are planned at various sites throughout the watershed, including the C-43 Distributed Reservoirs Project and the C-43 West Basin Storage Reservoir.

6.1.5.1.2 Aquifer Storage and Recovery

ASR involves injecting water in to an aquifer through wells and then pumping it out from the same aquifer when needed. The aquifer essentially functions as a water bank. Deposits are made in times of surplus, typically during the rainy season, and withdrawals occur when available water is needed, typically during a dry period. Storage zone monitoring wells are also put in place and equipped with water-level recorders to track the water levels within the storage zone. Monitoring wells can also be used to test water quality parameters such as chloride, alkalinity, bicarbonate, pH, sulfate, sodium, potassium, magnesium, total dissolved solids, specific conductance, salinity, temperature, and turbidity. **Figure 6.1-1** displays a typical ASR well system.

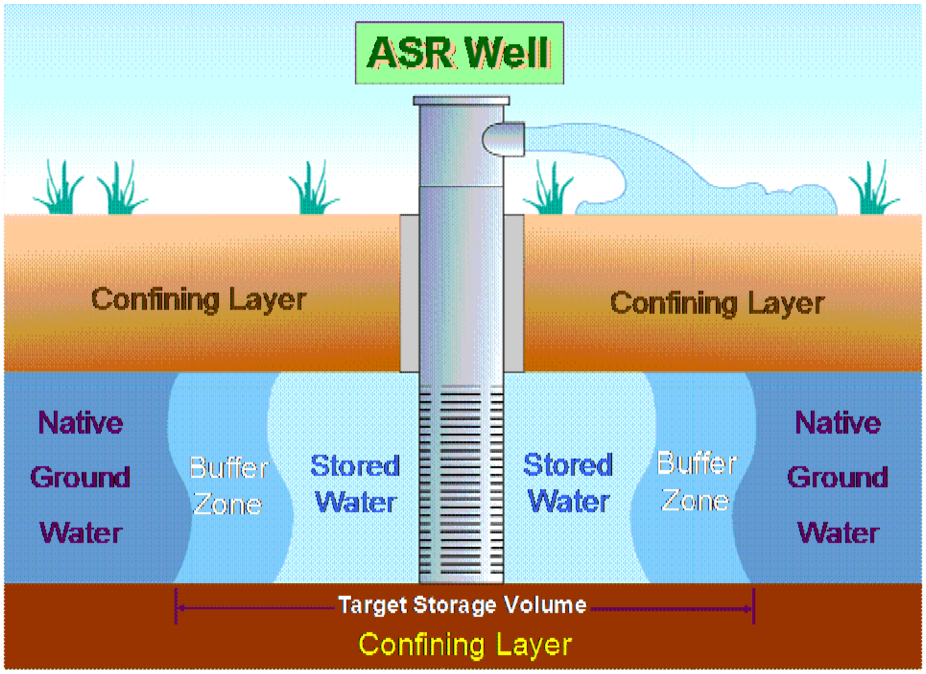

Figure 6.1-1. Typical Aquifer Storage and Recovery Well System

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

A series of CERP pilot projects and a regional ASR study are currently underway and are being evaluated to help determine the magnitude of ASRs needed to assist with managing Lake Okeechobee water levels at more ecologically desirable ranges and to reduce undesirable discharges to the Caloosahatchee and St. Lucie estuaries. The CERP ASR Program initially included three ASR pilot projects: Lake Okeechobee, Hillsboro Canal, and the Caloosahatchee River. However, because of the extensive scope of ASR envisioned for Lake Okeechobee, the Lake Okeechobee ASR Pilot Project was later split into three distinct project locations: Kissimmee River, Port Mayakka, and Moore Haven, bringing the total pilot project sites to five.

6.1.5.1.3 Alternative Water Storage/Disposal

Alternative water storage/disposal projects prevent runoff from reaching the regional drainage system, improve the timing of its delivery, and can be developed on available private, public, and tribal lands. They are used to store and/or dispose of excess water by capturing it prior to runoff or pumping it from areas or canals with excess water, and holding it in the facility. In most cases, alternative water storage/disposal projects involve simple technology approaches such as the use of pumps to move water to the desired area and the construction of weirs, berms, and small impoundments to detain the water in the facility. Alternative water storage/disposal projects typically require minimal design, engineering, and construction effort. If they are established on existing wetlands, they are designed and operated to improve the existing wetland functions.

Several alternative water storage/disposal projects are currently in operation in the Lake Okeechobee Watershed and are planned for both private and public lands located within the Caloosahatchee River Watershed, such as the Recyclable Water Containment Areas.

6.1.5.2 Watershed Water Quality Projects

Watershed water quality projects focus on reducing TP and TN loading within the watershed before nutrients reach the Caloosahatchee Estuary. Management measures under this general category include source control/BMPs, STAs and water quality treatment areas, managed aquatic plant systems, stormwater management system, chemical treatment, Hybrid Wetland Treatment Technology, and waste management.

6.1.5.2.1 Source Control

Source control projects include activities and measures that focus on capturing nutrients at the source and prevent nutrients from leaving the site and entering other surface waters. The main purposes of source control projects are to:

- Minimize the use of nutrients on site;
- Ensure the nutrients are applied in an effective manner; and
- Prevent nutrient laden waters from leaving the site.

Agricultural and urban BMPs are examples of efficient and effective source control measures. The Northern Everglades and Estuaries Protection Program (NEEPP) legislation defines a BMP as "*a practice or combination of practices determined by the coordinating agencies, based on research, field-testing, and expert review, to be the most effective and practicable on-location means including economic and technological considerations for improving water quality in agricultural and urban discharges. Best management practices for agricultural discharges shall reflect a balance between water quality improvements and agricultural productivity*," Section 373.4595(2)(a), Florida Statutes (F.S.)(2007). BMPs include structural measures such as creating physical changes in the landscape to reroute local discharges and erecting fences and barriers; and include non-structural measures such as education, operational changes, fertilizer application techniques, and establishing regulations.

Regardless of how it is achieved, source control is integral to the success of any water resource protection or restoration program. BMPs or other treatments are often utilized in a series to improve water quality by controlling the introduction (source) of nutrients into the local runoff and the movement of off-site nutrients (loss) into the drainage system. This combination of treatment technologies is known as a treatment train, because BMPs and other treatment are implemented in a series, like cars on a train. Without BMPs as the first stage technology utilized within water quality treatment trains, treatment and cost effectiveness of large, regional, capital projects such as reservoirs and

STAs will be limited. Moreover, the total costs associated with pollutant removal can be substantially reduced if the pollutant is not initially allowed to enter the drainage system.

6.1.5.2.2 Stormwater Treatment Areas/Water Quality Treatment Areas

Water quality treatment areas are constructed wetlands designed for optimal nutrient removal. When water flows through flooded wetland cells, plants and algae remove nutrients from the water. Constructed wetlands have been shown to be very efficient in reducing nutrient loads and concentrations.

Like water quality treatment areas, STAs are constructed wetlands that have been used very successfully in South Florida to treat nutrient-rich stormwater runoff. Typically, STAs comprise flooded cells with emergent or submerged vegetation (**Figure 6.1-2**). When water flows through these cells, wetland plants and algae absorb nutrients from the water. Constructed wetlands have been shown to be very efficient in reducing nutrient loads and concentrations. Even after plants in an STA die, leaf decomposition helps sequester sediments on the wetland bottom. Cattail roots readily absorb TP from these sediments (Newman et al., 1998). Over the past decade, more than 40,000 acres of STAs have been constructed in south Florida to facilitate restoration of the Everglades. The STAs are maintained and operated by South Florida Water Management District (SFWMD).

The primary advantage of STAs, particularly as they relate to TP removal, is that they are relatively easy to design, construct, and operate. They do not use any chemicals to precipitate nutrients and are environmentally friendly. However, they require large tracts of land and have relatively high evapotranspiration rates. Increasing the depth of the STAs and using a compartmentalizing design can minimize these disadvantages. STAs also require adaptive management and maintenance in order to maintain their required performance level. As more information of the lifecycle performance of these facilities is obtained, it will be used to validate the efficiencies of STAs. Understanding the removal efficiencies over time will help to identify the performance levels, maintenance, and adaptive management needs. Factors to be considered in the adaptive management process include the size of the watershed, treatment area, inflow/outflow, and nutrient rates. As the Caloosahatchee Estuary is considered to be TN limited, the STA technology may be modified to more specifically target TN removal in addition to TP removal.

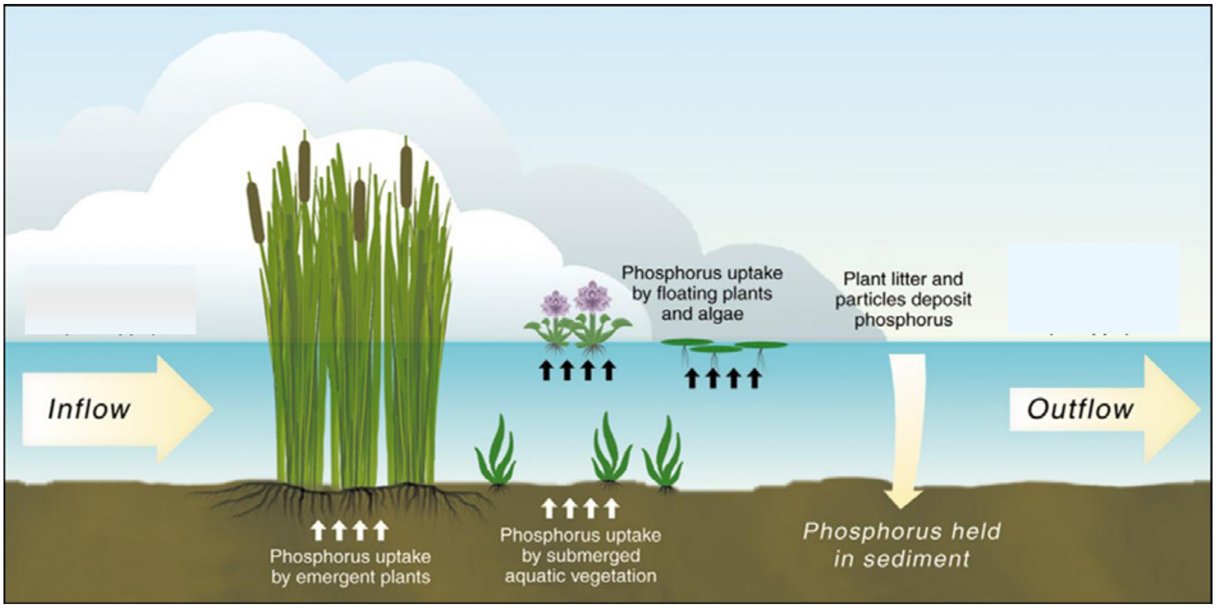

Figure 6.1-2. Typical STA with Emergent and Submerged Vegetation

There are both regional-scale and local-scale water quality treatment areas included in the management measures. The regional-scale water quality treatment areas within the Caloosahatchee Watershed include the Clewiston STA and C-43 Water Quality Treatment and Demonstration Project (BOMA Property). Many of the local-scale water quality treatment areas are smaller wet detention projects associated with older residential developments that lack storm water treatment systems. Collectively, these local-scale water quality treatment areas have the potential to make a significant difference in water quality within the Caloosahatchee Estuary.

6.1.5.2.3 Managed Aquatic Plant Systems

Managed aquatic plant systems are aquatic plant-based water treatment units. The technology involves routing nutrient-loaded stormwater into ponds that are vegetated with plants that have enhanced ability to absorb and assimilate nutrients. A variant of managed aquatic plant systems, which is currently proposed as a management measure to be included in the CRWPP, is known as the Algal Turf Scrubber™ (ATS). This technology developed by HydroMentia, Inc., involves the cultivation of a mixed community of periphytic algae that are cultured on an engineered geomembrane. The geomembrane sits on a grid across which nutrient-rich waters are discharged. Algae that then grow on the geomembrane are periodically scraped and collected with an automatic rake at a harvesting station. The harvested biomass is then conveyed to a bunker for storage and further processing.

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

6.1.5.2.4 Stormwater Management

The installation or upgrade of an urban stormwater management system can improve surface water quality in the watershed. A variety of structures (e.g. wet detention ponds, vegetated swales, diversion weirs, etc.) within the system can attenuate surface water flow to increase percolation for groundwater storage, facilitate settling, and promote nutrient uptake prior to receiving water discharge. Local scale STAs, such as smaller wet detention projects associated with older residential developments that lack stormwater treatment systems, have the potential to make a big difference in water quality within the Caloosahatchee Estuary.

System retrofit projects and local government Stormwater Master Plan implementation projects are management measures that will improve the conveyance of stormwater during storm events and reduce pollutant loadings from urban runoff.

6.1.5.2.5 Chemical Treatment

Chemical treatment involves application of chemicals into stormwater runoff to aid in reduction of contaminant loads and concentrations, and of turbidity (suspended solids) in the water. It has also been successfully used to reduce turbidity and nutrient concentrations in drinking water and wastewater. Application of chemicals to stormwater to reduce nutrient loads is relatively new and has been tested in some locations such as Lake Apopka and the Everglades with varying levels of success (SFWMD et al., 2007). Chemical treatment can be used in combination with wet detention of stormwater, treatment of runoff prior to storage, or with supplemental treatment associated with reservoirs or STAs. The specific technology that will work best at any given location will primarily depend upon inflow water quality and the quantity of water to be treated. Management measures that include chemical treatment may be included in future plan updates.

Review of available literature indicates that calcium, iron, and aluminum salts are effective at reducing TP loads in stormwater runoff (SFWMD et al., 2007). These technologies can be applied both in-stream and in off-line treatment systems. Aluminum sulfate (alum) treatment has been used as a stormwater retrofit option for the past 20 years. This technology is a viable retrofit option for urban areas. Alum treatment of stormwater consistently provides removal efficiencies of 85 to 95 percent for total TP, greater than 95 percent for total suspended solids (TSS), 35 to 70 percent for total TN, 60 to 90 percent for metals, and 90 to greater than 99 percent for total and fecal coliform bacteria (Harper 2007).

6.1.5.2.6 Hybrid Wetland Treatment Technology

Hybrid Wetland Treatment Technology combines the strengths of the two top-ranked nutrient removal technologies, namely treatment wetlands and chemical injection system. This synergy results in nutrient removal efficiencies beyond those attainable by either separate technology with lower capital and operating costs. Optimization of system performance is achieved by adjusting hydraulic retention time (area of facility) and/or chemical dosing rates. Hybrid Wetland Treatment Technology has been previously demonstrated to reduce P concentrations from over 1,000 parts per billion (ppb) to less than 100 ppb (Watershed Technologies, Inc. 2007). Preliminary data from the existing full-scale Hybrid Wetland Treatment Technology facilities in Lake Okeechobee and St. Lucie watersheds show P concentration reductions in the range of 84 to 94 percent. A typical schematic of the treatment system is shown in **Figure 6.1-3**.

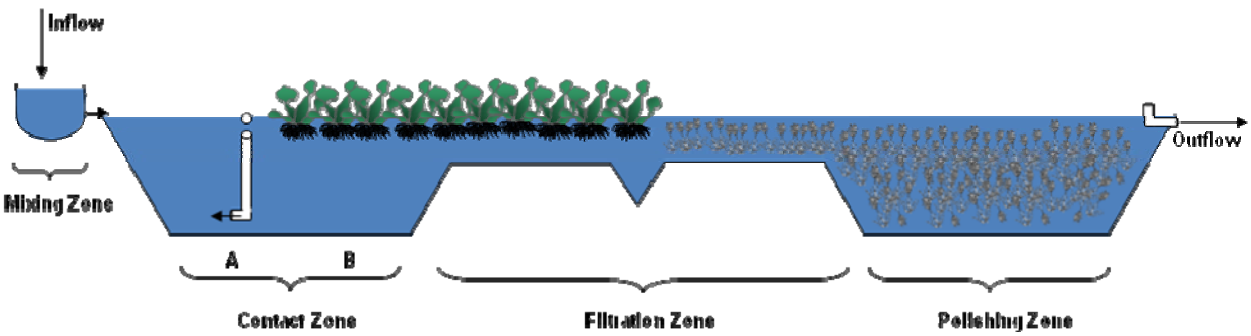

Figure 6.1-3. Typical Hybrid Wetland Treatment Technology

Four pilot Hybrid Wetland Treatment Technology systems are currently being field-tested. Three systems are located in the Lake Okeechobee Watershed and one system is located in the St. Lucie River Watershed. If successful, other locations will be evaluated for application of this technology. Depending on the success of the pilot projects, additional Hybrid Wetland Treatment Technology management measures may be included in future plan updates.

6.1.5.2.7 Waste Management

Effluent discharges from existing domestic wastewater treatment facilities are required to meet minimum secondary treatment standards in accordance with Rule 62-600.420(1), F.A.C. New facility permits and modification/renewal permits are frequently requiring alternative effluent discharge methods, such as reuse and ground water injection, which reduce the P and N load entering the estuary through direct discharge. In addition, other management measures will result in the diversion of wastewater effluent discharges from treatment plants where there is insufficient demand for reclaimed water to facilities that have reclaimed water storage and distribution infrastructure in place, such as the Wastewater Treatment Plant Upgrade and Reclaimed Water Project (CRE 129).

6.1.5.3 Land Management and Restoration

Land management, conservation, and restoration of natural areas within the Caloosahatchee River Watershed are also incorporated into the CRWPP. Many land management and restoration management measures may effectively provide water quantity and/or quality benefits to the surrounding watershed and downstream waterbodies. Management measures include creation and restoration of wetlands and incorporation of growth management techniques and initiatives that integrate environmental objectives into urban growth planning.

6.1.5.3.1 Wetland Restoration

Natural wetlands sequester surface water flows and provide water quality treatment through assimilation and sedimentation. Wetland restoration includes enhancing degraded wetlands or restoring areas that were historically wetlands. Wetland restoration may be stand-alone projects, or they may be integral components of other management measures, such as Florida Ranchlands Environmental Services Project (CRE-LO 87c).

6.1.5.3.2 Land Conservation

Conservation of natural areas in urban settings provides both natural and social benefits. One example is the Coastal and Estuarine Land Conservation Program (CRE-LO 09), which was established in 2002 to protect coastal and estuarine lands considered important for their ecological, conservation, recreational, historical or aesthetic values. The program provides state and local governments with matching funds to purchase significant coastal and estuarine lands, or conservation easements on such lands, from willing sellers. Lands or conservation easements acquired with Coastal and Estuarine Land Conservation Program funds are protected in perpetuity so that they may be enjoyed by future generations.

Another example is the Farm and Ranchland Partnerships (CRE-LO 91), which seeks to acquire easements on private lands to remain in agriculture and to provide water quality and storage benefits in support of the Northern Everglades initiative.

6.1.5.3.3 Integrated Growth Management and Restoration

This category includes programs and projects that integrate environmental restoration objectives with urban growth initiatives. Planning and economic incentives are typically provided to encourage the use of innovative and flexible planning and development strategies creating land use planning techniques that minimize the footprint of developments while conserving natural lands and open spaces. Comprehensive Planning-Land Development Regulations (CRE-LO 68) is an initiative to work with those entities (e.g. cities and counties) in the Caloosahatchee River Watershed responsible for comprehensive planning and land development proposals. The initiative involves reviewing current comprehensive plans and associated land development regulations to assure that they promote low-impact design and proper stormwater treatment.

In 2001, the Florida Legislature established Section 163.3177(11)(d), Florida Statutes, the Rural Land Stewardship Area Program. This program allows counties to designate Rural Land Stewardship Areas, to include all or portions of lands classified in the future land use element as predominantly agricultural, rural, open, open-rural, or a substantively equivalent land use.

Table 6.1-1. Management Measure Summary Table

Management Measure #	Project Feature/Activity	Category	Sub-watershed/ Basin[1]	Project Scale
CRE-LO 01,02,49	Agricultural BMPs- Owner Implemented, Funded Cost Share, and Cost Share Future Funding	Water Quality	All	Source Control
CRE-LO 03	Urban Turf Fertilizer Rule [Lake Okeechobee Estuary and Recovery (LOER)]	Water Quality	All	Source Control
CRE-LO 04	Land Applications of Residuals	Water Quality	All	Source Control
CRE-LO 05	Florida Yards and Neighborhoods	Water Quality	All	Source Control
CRE-LO 07	Environmental Resource Permit (ERP) Regulatory Program	Water Quality	All	Source Control
CRE-LO 08	National Pollutant Discharge Elimination System (NPDES) Stormwater Program	Water Quality	All	Source Control
CRE-LO 09	Coastal & Estuarine Land Conservation Program	Land Management and Restoration	TN, TS, EST, NC, NS	Regional
CRE-LO 12g	Alternative Water Storage (LOER) - Barron Water Control District (BWCD)	Water Quantity/Storage	FSW	Local
CRE-LO 15	Proposed Caloosahatchee River Watershed Regulatory Nutrient Source Control Program	Water Quality	All	Source Control
CRE-LO 21	Lake Okeechobee and Estuary Watershed Basin Rule (LOER)	Water Quality	All	Source Control
CRE-LO 40	West Lake Hicpochee Project	Water Quantity/Storage	FNE	Regional
CRE-LO 41	C-43 Distributed Reservoirs	Water Quantity/Storage	FSE,FNE	Regional
CRE-LO 63	Wastewater & Stormwater Master Plans	Water Quantity/Storage and Water Quality	All	Source Control
CRE-LO 64	Proposed Unified Statewide Stormwater Rule	Water Quality	All	Source Control
CRE-LO 68	Comprehensive Planning - Land Development Regulations (LDR)	Land Management and Restoration	All	Source Control
CRE-LO 87c	Florida Ranchlands Environmental Services Project	Land Management and Restoration	All	Local
CRE-LO 91	Farm and Ranchland Partnerships	Land Management and Restoration	All	Source Control

Management Measure #	Project Feature/Activity	Category	Sub-watershed/ Basin[1]	Project Scale
CRE-LO 92	Clewiston STA	Water Quality	S-4	Local
CRE 01	Recyclable Water Containment Areas (RWCA)	Water Quantity/Storage	All	Local
CRE 02	Recycled Water Containment Area in the S-4 Basin	Water Quantity/Storage	S-4	Local
CRE 04	Caloosahatchee Area Lakes Restoration (Lake Hicpochee)	Water Quality and Water Quantity/Storage	FNE, FSE	Regional
CRE 05	East Caloosahatchee Water Quality Treatment Area	Water Quality	FNE	Regional
CRE 10	C-43 Water Quality Treatment and Demonstration Project (BOMA Property)	Water Quality	FSE	Regional
CRE 11	Caloosahatchee Ecoscape Water Quality Treatment Area	Water Quality and Water Quantity/Storage	FSE	Regional
CRE 13	West Caloosahatchee Water Quality Treatment Area	Water Quality	FSE	Regional
CRE 18	Harns Marsh Improvements, Phase I & II	Water Quantity/Storage	TS	Regional
CRE 19	Harns Marsh Improvements, Phase II Final Design - ECWCD	Water Quantity/Storage	TS	Regional
CRE 20	Yellowtail Structure Construction - ECWCD	Water Quantity/Storage	TS	Local
CRE 21	Hendry County Storage	Water Quantity/Storage	FSW	Regional
CRE 22	Hendry Extension Canal Widening (Construction) - ECWCD	Water Quantity/Storage	FSW	Local
CRE 29	Lehigh Acres Wastewater Treatment & Stormwater Retrofit	Water Quality	FSW	Regional
CRE 30	Aquifer Benefit and Storage for Orange River Basin (ABSORB) - ECWCD	Water Quality and Water Quantity/Storage	TS	Regional
CRE 44	Spanish Creek / Four Corners Environmental Restoration	Water Quality and Water Quantity/Storage	FNW	Regional
CRE 45	Billy Creek Filter Marsh, Phase I & II	Water Quality	TS	Local
CRE 48	Manuel's Branch Silt Reduction Structure	Water Quality	TS	Local
CRE 49	Manuel's Branch East & West Weirs	Water Quality	TS	Local

Management Measure #	Project Feature/Activity	Category	Sub-watershed/ Basin[1]	Project Scale
CRE 53	Caloosahatchee Creeks Preserve Hydrological Restoration	Water Quality and Water Quantity/Storage	TN	Local
CRE 57	Powell Creek Algal Turf Scrubber	Water Quality	TN	Local
CRE 59	North Fort Myers Surface Water Restoration	Water Quality	TN	Local
CRE 64	Yellow Fever Creek/Gator Slough Transfer Facility	Water Quality	TN	Local
CRE 69	Cape Coral Wastewater Treatment & Stormwater Retrofit	Water Quality	TN	Regional
CRE 77	Cape Coral - Canal Stormwater Recovery by ASR	Water Quantity/Storage	TN, NC	Regional
CRE 121	City of LaBelle Stormwater Master Plan Implementation	Water Quality	FSW	Local
CRE 122	Rehydrate Lee County Well Fields (south of Hwy 82)	Water Quantity/Storage	FSW	Regional
CRE 123	North Ten Mile Canal Stormwater Treatment System	Water Quality	TS	Local
CRE 124	Carrell Canal (FMCC) Water Quality Improvements	Water Quality	TS	Local
CRE 125	Shoemaker-Zapato Canal Stormwater Treatment	Water Quality	TS	Local
CRE 126	Fort Myers-Cape Coral Reclaimed Water Interconnect	Water Quality	TN, TS	Regional
CRE 128	East Caloosahatchee Storage	Water Quantity/Storage	FNE, FSE	Regional
CRE 128a	Caloosahatchee Storage - Additional	Water Quantity/Storage	FNE, FSE	Regional
CRE 129	Wastewater Treatment Plant Upgrade and Reclaimed Water	Water Quality and Water Quantity/Storage	All	Regional
CRE 130	Animal Manure Application Rule	Water Quality	All	Source Control
CRE 131	Application of Septage Rule	Water Quality	All	Source Control

[1] Descriptions of the following basins can be found in Chapter 2:

FNE = Freshwater Northeast Basin
FSE = Freshwater Southeast Basin
FNW = Freshwater Northwest Basin
FSW = Freshwater Southwest Basin
TN = Tidal North Basin
TS = Tidal South Basin
NC = North Coastal Basin
NS = South Coastal Basin
EST = Caloosahatchee Estuary

SECTION 6.2

WATER QUANTITY ANALYSIS METHOD

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6.2 WATER QUANTITY ANALYSIS METHOD

This section describes the method used to analyze water quantity for the Caloosahatchee River Watershed, while water quantity results are presented in Section 6.5. To establish a baseline condition to which all alternatives will be compared, the River Watershed Protection Plan Base (RWPPB) Condition is characterized and described. Finally, water quantity performance measures and targets used to evaluate how well each alternative achieves the project goals are described.

The Caloosahatchee River Watershed Protection Plan (CRWPP) builds upon the Northern Everglades Lake Okeechobee Watershed Construction Project, Phase II Technical Plan (LOP2TP). Thus, the analysis method, modeling tools, and overall evaluation methodologies employed in the current planning efforts are similar to the previous plan. These same methods and tools are utilized for the St. Lucie River Watershed Protection Plan (SLRWPP), as well. This approach ensures consistency in water quantity analysis conducted for three Northern Everglades watersheds.

6.2.1 Modeling Tools

The water quantity analysis method used in the CRWPP involves the generation of water budgets for each alternative plan. The water budget information provided by the model feeds into a set of performance measures which, in turn, are used to differentiate and compare alternative plans.

A water budget reflects the relationship among all the components of hydrologic input and output for a given area. Water generally enters a system through precipitation, as well as surface and groundwater flows. Water generally exits the system through human consumption (domestic, municipal, industrial, and agricultural), surface and groundwater flows, evaporation from water surfaces, and transpiration from vegetation. The RWPPB Condition is a scenario that reflects conditions with the LOP2TP in place. Alternatives were developed from a series of management measures that are intended to improve water quantity and quality, consistent with the planning objectives. Each alternative plan represents a unique combination of management measures simulated in the Northern Everglades Regional Simulation Model (NERSM), and whose relative effectiveness is evaluated through a standard set of hydrologic performance measures.

The CRWPP water quantity analysis was performed at each increment of alternative plan development. Lessons learned from the existing alternatives were used to formulate the next alternative. The NERSM was selected as the modeling tool to carry out the water quantity analysis.

6.2.1.1 Northern Everglades Regional Simulation Model (NERSM)

The NERSM is a link-node based model designed to simulate the water budget of a regional scale drainage basin. The model assumes that water in each waterbody is distributed in level pools. Therefore, local-scale features within a watershed, e.g. stages at specific gauging stations and flows across specific transects, are not simulated. The model domain covers Lake Okeechobee and four major watersheds: Kissimmee, Lake Okeechobee, St. Lucie River, and

Caloosahatchee River. The watersheds are further divided into sub-watersheds, as described below. Several management measures were combined to produce a number of alternatives whose individual impacts on pre-established performance measures have been evaluated. The model is an effective tool in comparing the relative performance of the proposed alternatives for the CRWPP.

The computational engine for the NERSM was constructed using an object-oriented approach, which allows new objects to be added without the need to significantly alter the previously coded modules and objects in the computer program. For example, adding the operation of a new reservoir would be simulated as adding a discrete "object" that is automatically assigned with the features and functions commonly defined for a reservoir in the water management system. Input data for the model includes daily records of hydrologic and meteorological data (rainfall and potential evapotranspiration), as well as discharges at the boundaries for the period between 1970 and 2005. Other model input data includes the physical description of management features (e.g., reservoir stage-storage relationship and structure capacities) and corresponding operating rules (e.g., maximum operating levels and reservoir outflow priorities).

6.2.1.1.1 Model Setup

The NERSM boundary includes the Lake Okeechobee, St. Lucie, and Caloosahatchee River watersheds (**Figure 6.2-1**). In the LOP2TP, the East Okeechobee (St. Lucie River), West Okeechobee (Caloosahatchee River), and the Everglades Agricultural Area (EAA) watersheds were not explicitly modeled in the NERSM. However, in the planning efforts of the River Watershed Protection Plans, the NERSM domain was expanded to include direct simulations of the St. Lucie and Caloosahatchee River watersheds. Since the EAA is not explicitly modeled, impacts of the EAA reservoir on the other portions of the study area were considered as boundary conditions. This section focuses on the model set-up common to both the LOP2TP and the RWPPB Condition. The succeeding section will provide additional details on how the two river watersheds were incorporated into the model.

Lakes in the Upper Kissimmee Watershed and pools in the Lower Kissimmee Watershed are simulated as level pools. Watershed inflows, such as local runoff, are treated as boundary conditions and were generated from other hydrologic models or from historical data. A flow pass-through approach is used for the other watersheds where historical runoff into Lake Okeechobee is modified, based on proposed management measures specific to these watersheds.

Lake Okeechobee was also simulated using a lumped hydrologic approach. Certain inflows and outflows from Lake Okeechobee are not simulated, and are incorporated into a modified delta storage term or imposed as boundary conditions. The South Florida Water Management Model (SFWMM) is the main source of boundary conditions for the NERSM. Boundary conditions include water supply deliveries to the Lower East Coast urban areas and environmental releases to the Everglades. Regulatory releases from Lake Okeechobee to the Caloosahatchee and St. Lucie estuaries and to the Water Conservation Areas (WCAs) are simulated based on the Water Supply/Environmental (WSE) Regulation Schedule. The Hybrid Lake Okeechobee Water Shortage Management (LOWSM) water supply management scheme is simulated in conjunction with fixed demand boundary conditions to approximate the water supply drought management cutbacks for Lake Okeechobee Service Area (LOSA) basins. Lake Okeechobee is a primary or secondary source of water supply to the LOSA basins.

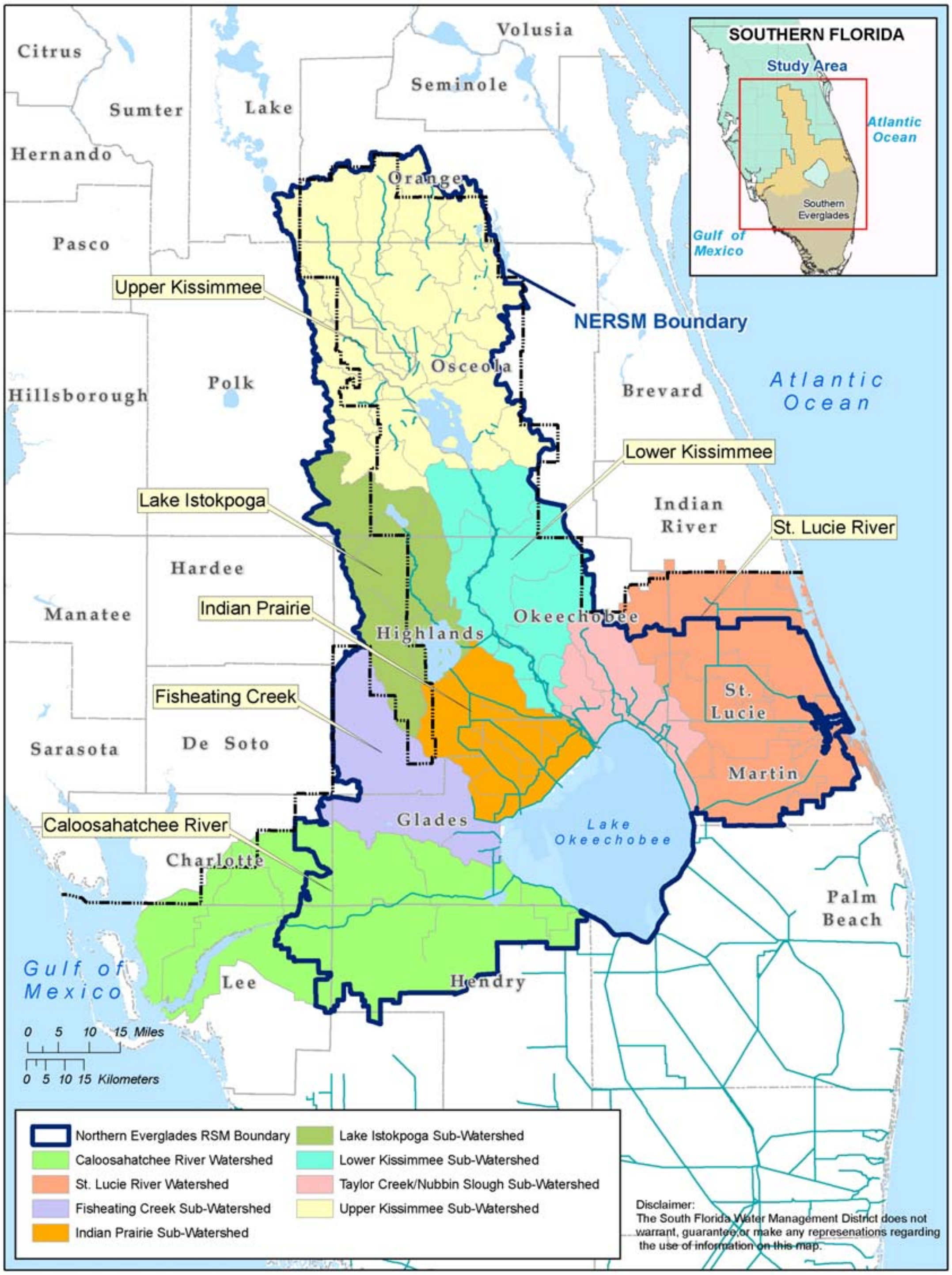

Figure 6.2-1. Watersheds Simulated in the Northern Everglades Regional Simulation Model

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

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

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

6.2.1.1.2 Conceptualization in River Watershed Protection Plans

As mentioned in the previous section, additional conceptualization beyond what was done in the LOP2TP was necessary for the two river watersheds in order to simulate specific management measures outside the original NERSM domain. For a more detailed description of the model setup and conceptualization for Caloosahatchee River and St. Lucie River watersheds, see **Appendix C**.

Caloosahatchee River Watershed

The Caloosahatchee River Watershed is conceptualized as a series of interconnected nodes (e.g., single or multiple basins/storage) and links (e.g., single-purpose or multi-purpose structure). A simple example of the node-link diagrams used for the model is shown in **Figure 6.2-2**. Demand and runoff in the East Caloosahatchee Basin (ECAL) and West Caloosahatchee Basin (WCAL) are very different in magnitude. Therefore, in order to better account for available water for capture by individual water management measures proposed in the CRWPP, the two basins were modeled as two separate nodes. The Caloosahatchee Estuary and the S-4 Basin were also simulated as individual nodes. Specific management measures, such as reservoirs and water quality treatment features proposed in the CRWPP, were modeled as storage nodes. The link node diagrams for all the model runs are included in **Appendix C**.

Storage nodes are linked by single-purpose or multi-purpose water control structures. Inflow into the ECAL includes the S-77 structure, which is used for water supply, environmental, and regulatory purposes; and the S-235 structure, which discharges excess runoff from the S-4 basin. S-77 will also allow natural backflow into Lake Okeechobee when the lake stage is less than 11.5 feet (ft) National Geodetic Vertical Datum (NGVD). This backflow component was identified as a separate outflow time series from ECAL (S-77BK). The ECAL and WCAL basins are connected through the S-78 structure, which controls discharge for water supply, environmental and flood control purposes. The WCAL discharges into the Caloosahatchee Estuary through S-79, which handles both deliveries to meet estuary needs and upstream excess.

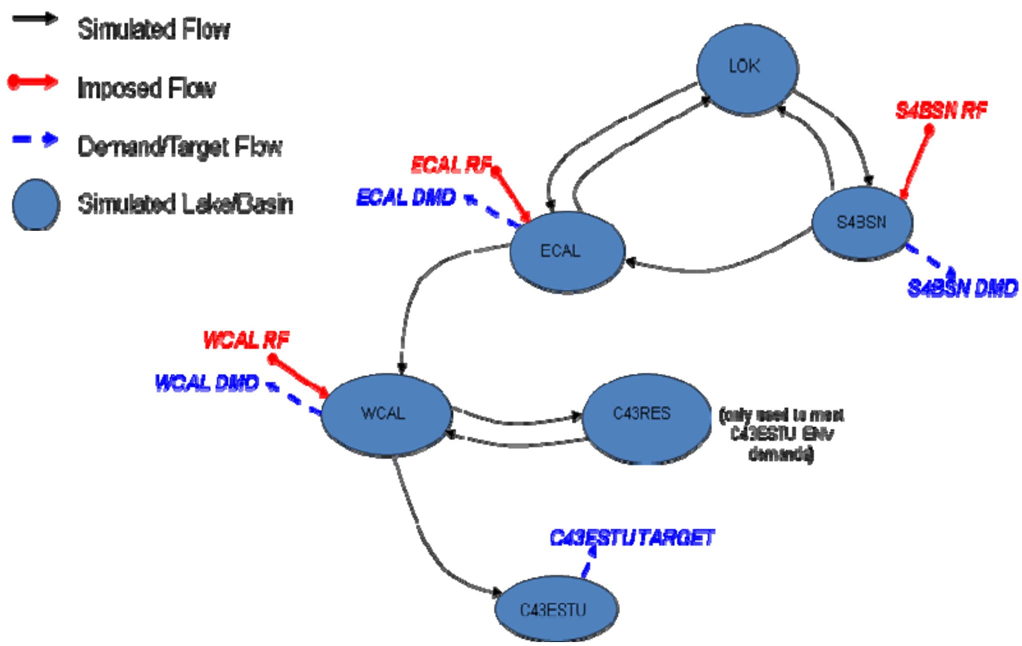

Figure 6.2-2. Sample Node-Link Representation for CRWPP Model

Runoff generated from the ECAL and WCAL basins was applied directly to each corresponding model node as a boundary condition. These runoff time series were adjusted (reduced) for each alternative, in order to account for the footprint of proposed management measures (reservoirs and stormwater treatment areas) to be simulated within the alternative. Agricultural and public water supply demands in ECAL and WCAL basins and environmental needs in the estuary drive water supply and environmental deliveries in the model. Surface water demand from the Olga public water supply plant in Lee County was accounted for in the WCAL demand time series. Excesses in upstream nodes were first used to meet water supply and environmental demands in downstream nodes. The remaining water supply need was met from Lake Okeechobee, subject to the Hybrid LOWSM cutback scheme.

In the RWPPB and alternative scenario simulations, the proposed Comprehensive Everglades Restoration Plan (CERP) Caloosahatchee River (C-43) West Basin Storage Reservoir was included. The purpose of this reservoir is to store basin excess and Lake Okeechobee regulatory releases that exceed estuary demands. During times of low upstream excess and absence of lake regulatory releases, the reservoir is used to meet estuary demands before any additional water is brought in from Lake Okeechobee for environmental purposes. The remaining environmental need may be met from Lake Okeechobee, as long as the lake stage is greater than 11.5 ft NGVD.

St. Lucie River Watershed

The St. Lucie River Watershed is conceptualized using the same node-link approach as Caloosahatchee River Watershed. The St. Lucie River Watershed was subdivided into four non-tidal nodes (C-44, C-23, C-24, and Ten Mile Creek), and one tidal node (comprised of Basins 4,5, and 6, and South Fork, plus the tidal portion of North Fork that is outside the Ten Mile Creek Basin). The non-tidal nodes are linked to the St. Lucie Estuary via structures, S-80, S-48, and S-49, respectively. The tidal node discharges freely into the estuary without an intervening control structure.

NERSM, as used in the LOP2TP, conceptualized the St. Lucie River Watershed as two nodes: C-44 and non-C-44. The model showed that more detail was needed in the non-C-44 model node, in order to simulate the proposed storage facilities in the different sub-basins that comprise this node. Therefore, a total of five basins were simulated in the RWPP model runs, including C-44, C-23, C-24, Ten Mile Creek, and one tidal basin [comprised of the North Fork (excluding Ten Mile Creek), South Fork and Basins 4, 5, and 6].

Three important time series drive this model: basin irrigation demands, basin runoff, and the St. Lucie Estuary target flows. Pre-processed supplemental irrigation demands and basin runoff were associated with each basin represented in the model. Except for the C-44 basin, all runoff and demand time series were obtained from Watershed Hydrology and Water Quality Model (WaSh) modeling (Wan and Roaza, 2003). The runoff and demand time series for C-44 Basin (a part of LOSA), were derived from the Agricultural Field Scale Irrigation Requirements Simulation Water Budget (AFSIRS/WATBAL) model, instead of the WaSh modeling, to be consistent with the rest of LOSA. Non-C-44 basins in the St. Lucie River Watershed are not connected directly to Lake Okeechobee and, thus, do not receive lake supplemental irrigation deliveries from it. Backflow from the C-44 basin into Lake Okeechobee is initiated when the simulated stages at Lake Okeechobee drop to less than 14.5 ft NGVD.

For the RWPPB, the C-44 and Ten Mile Creek reservoirs and stormwater treatment areas (STAs) were added as additional nodes that represent storage facilities expected to be in place by 2015. Both the reservoir and STA facilities in each of these basins were simulated as a combined unit, such that only two additional model nodes are used.

A third important time series that drives the St. Lucie River Watershed simulation is the St. Lucie Estuary target time series. This time series represents the anticipated discharges into the St. Lucie River after features of the Indian River Lagoon-South preferred alternative are put in place. Output from the Reservoir Optimization Model (OPTI-5 that was subsequently upgraded to OPTI-6) used in Indian River Lagoon-South Final Integrated Project Implementation Report and Environmental Statement (IRL-S PIR) was the source for the St. Lucie Estuary target time series and is referred to as NERSM operational targets for the estuary. In order to take advantage of the increased resolution in modeling the area, the time series was parsed into each individual contributing (non-tidal) basin. To be consistent with the objectives of the SLRWPP, no Lake Okeechobee releases were made in the model to meet the low-flow operational targets for the estuary.

For SLRWPP alternative formulation, a combined C-23/C-24 Reservoir and C-23/C-24 STA model nodes were created with associated operating rules. These features are consistent with the IRL-S PIR Recommended Plan. The multiple model node representation of non-C-44 basins facilitates various scenarios for water transfer to occur between C-23 and C-44 Reservoir/STA, C-23/C-24 STA and Ten Mile Creek Basin, C-23 Basin and C-23/C-24 Reservoir, C-24 Basin and C-23/C-24 Reservoir, and C-23/C-24 Reservoir and C-23/C-24 STA, as specified in the IRL-S PIR Recommended Plan (see Appendix C Section 2.2.6.1 for more details).

6.2.1.1.3 Boundary Conditions

Caloosahatchee River Watershed

The NERSM runoff/demand time series for ECAL, WCAL, and S-4 basins were obtained from the AFSIRS/WATBAL model, as used in the SFWMM modeling in support of the Caloosahatchee River (C-43) West Basin Storage Reservoir Project. The AFSIRS/WATBAL hydrologic model is a simplified basin-scale water budget model and is based on the Agricultural Field Scale Irrigation Requirements Simulation (AFSIRS) model (Smajstrla, 1990). The AFSIRS/WATBAL model calculates the supplemental (beyond local net rainfall and storage) demands for irrigated and non-irrigated lands and provides basin scale estimates of runoff. Output from AFSIRS/WATBAL model was used as input to SFWMM and, more recently, to the NERSM.

A 36-year (1970 to 2005) period of record was used for this project. Even though the ECAL and WCAL were represented in the AFSIRS/WATBAL model, the calibration was performed for the entire Caloosahatchee River basin as a whole (Wilcox and Konyha, 2003).

As a part of data pre-processing, an adjustment was done to both the ECAL and WCAL demand/runoff time series, using an assumed seepage value of 40 cubic feet per second (cfs)/day from east to west across S-78 structure. Another adjustment was made to ensure that runoff and demand did not occur on the same day, which is a requirement in the NERSM. The model did not allow for WCAL runoff to meet ECAL demands (unlike AFSIRS/WATBAL), which is better representation of reality compared to a single Caloosahatchee River basin representation.

The Caloosahatchee River (C-43) West Basin Storage Reservoir specifications were taken from the Caloosahatchee River (C-43) West Basin Storage Reservoir Project Implementation Report. Due to the reservoir footprint, the runoff time series was adjusted internally in the NERSM by applying a factor that is defined as the ratio of the remaining contributing watershed area (total watershed area less the C-43 West Basin Storage Reservoir footprint) to the total watershed area.

S-4 Basin runoff/demands were aggregated based on estimates for Disston Water Control District and non-Disston Water Control District portions of S-4 Basin. Other input parameters, like rainfall and potential evapotranspiration for ECAL, WCAL and S-4 Basin, were the same as used in the AFSIRS/WATBAL modeling for Acceler8.

St. Lucie River Watershed

Except for the C-44 Basin, all runoff and demand time series were obtained from WaSh modeling. Because the C-44 Basin is a part of LOSA, the runoff and demand input time series were derived from the AFSIRS/WATBAL model instead of the WaSh modeling. WaSh is a time-dependent, coupled hydrologic and hydraulic simulation model. It includes many features specifically required to simulate conditions in the St. Lucie River Watershed basins, such as irrigation demand and supply, high water table conditions, fully coupled groundwater and surface interactions, reservoirs and STAs, and flow structures.

Operational flow targets in the NERSM were assigned downstream of each contributing basin (represented as model nodes) and were established using OPTI-6. The optimization model

OPTI-6 determines the optimal sizing and operating rules for reservoirs in the watershed, such that the long term natural flow distribution of stormwater discharges to the estuary is matched. It also minimizes the required capacities of the detention reservoirs, while providing reliable supplemental irrigation at the required pumping levels (Wan et al., 2006).

The St. Lucie River Watershed basins demand/runoff flow time series, as produced by WaSh, was used as an input to OPTI-6. The purpose of this effort was to create operational flow targets for all basins, so that the NERSM could know whether to hold or release the water to the estuary. By meeting these operational flow targets, the NERSM can essentially mimic OPTI-6 performance in terms of meeting its ecological/environmental goals.

6.2.1.2 Model Scenarios

Modeling tools were used to evaluate project alternatives by comparing the modeling results to the performance measure targets. Base conditions were established to provide a starting point by which relative comparisons will be made between the project alternatives. The following is a summary of the various scenarios that were modeled to determine system-wide impacts likely to be associated with implementation of each alternative:

- **Current Base** (CBASE) **–** This scenario includes the following assumptions:
  - The conditions are represented as they existed in the Northern Everglades Watershed in 2005;
  - There are no CERP projects or LOP2TP projects in place; and
  - Lake Okeechobee releases to the estuary and WCAs are based on the existing WSE regulation schedule.

- **River Watershed Protection Plan Base** (RWPPB) **–** This scenario assumes the base condition of 2015, with the following projects in place:
  - LOP2TP Recommended Projects: Combined Reservoir storage, STA storage and aquifer storage and recovery (ASR) capacity equal to 914,000 acre-feet, 54,000 acre-feet and 66 million gallons per day, respectively. Additional details can be found in the LOP2TP;
  - Acceler8 Projects: C-43 (Caloosahatchee River) Reservoir, C-44 (St. Lucie Canal) Reservoir and STA, and A-1 (Everglades Agricultural Area Reservoir A-1);
  - Kissimmee Projects: Kissimmee River Restoration Project and the Kissimmee River Headwaters Revitalization;
  - Ten Mile Creek Reservoir in St. Lucie River Watershed; and
  - Authorized MODWATERs and C-111 projects.

- **Alternative Plans –** Management measures were combined to develop alternative plans to meet the performance measure targets (water quantity and quality goals).

6.2.2 Water Quantity Performance Measures and Targets

Performance measures and performance indicators provide a means to evaluate how well each alternative achieves the project goals. Alternative plans are specifically formulated to achieve the targets set for each of the performance measures (e.g., flow ranges, limits, and distribution), as described in Section 6.4. Each alternative is then evaluated on how efficiently and effectively it meets such performance measure targets, as discussed in Section 6.5. The performance measures and indicators utilized in the comparison include the high discharge criteria, the salinity envelope criteria, the proposed Lake Okeechobee minimum water level criteria, and the supplemental irrigation requirements.

6.2.2.1 High Discharge Criteria

As discussed in Section 3.5, favorable maximum monthly flow (from surface water sources) for the Caloosahatchee Estuary (2,800 cfs) will provide suitable salinity conditions to promote the development of identified valued ecosystem components (e.g., oysters and seagrass). Mean monthly flows greater than 4,500 cfs result in freshwater conditions throughout the estuary, causing severe impacts to estuarine biota [Restoration Coordination and Verification (RECOVER), 2007].

The restoration target for the high discharge criteria in the Caloosahatchee Estuary are as follows:

- Limit mean monthly flows greater than 2,800 cfs to three months or less over a 432-month period; and
- Eliminate mean monthly flows greater than 4,500 cfs over a 432-month period.

6.2.2.2 Salinity Envelope

Discharges from the watershed should be managed to maintain a salinity range conducive to the ecological health of the Caloosahatchee Estuary. The relationship between high flows and low salinity conditions are briefly described in Section 6.2.2.1. As discussed in Section 3.5, average monthly flows less than 450 cfs from October to July will produce high salinity conditions that are unfavorable to estuarine biota. The restoration target for the salinity envelope performance indicator in the Caloosahatchee Estuary is as follows:

- Eliminate mean monthly flows less than 450 cfs from October to July; and
- Limit the number of times monthly flows exceed 2,800 cfs for three occurrences.

6.2.2.3 Target Flow Index

The Target Flow Index (TFI) reflects the ideal flow distribution to the estuary, which would result in a healthy and productive estuary. The TFI compares the modeled flow distributions against a target or desired flow distribution at S-79. The green line depicted in **Figure 6.2-3** represents the desired flow distribution at S-79 that was derived from the EST05 time series of flows. The TFI evaluation method calculates a composite score for a given alternative scenario by adding up weighted deviations from a desired flow distribution – more specifically, a set of flow categories that characterizes EST05 (Chamberlain, 2008). Deviation from the desired flow distribution will result in a negative TFI. The TFI progressively becomes negative as the flow deviates from the target. A value of zero signifies a perfect match to EST05.

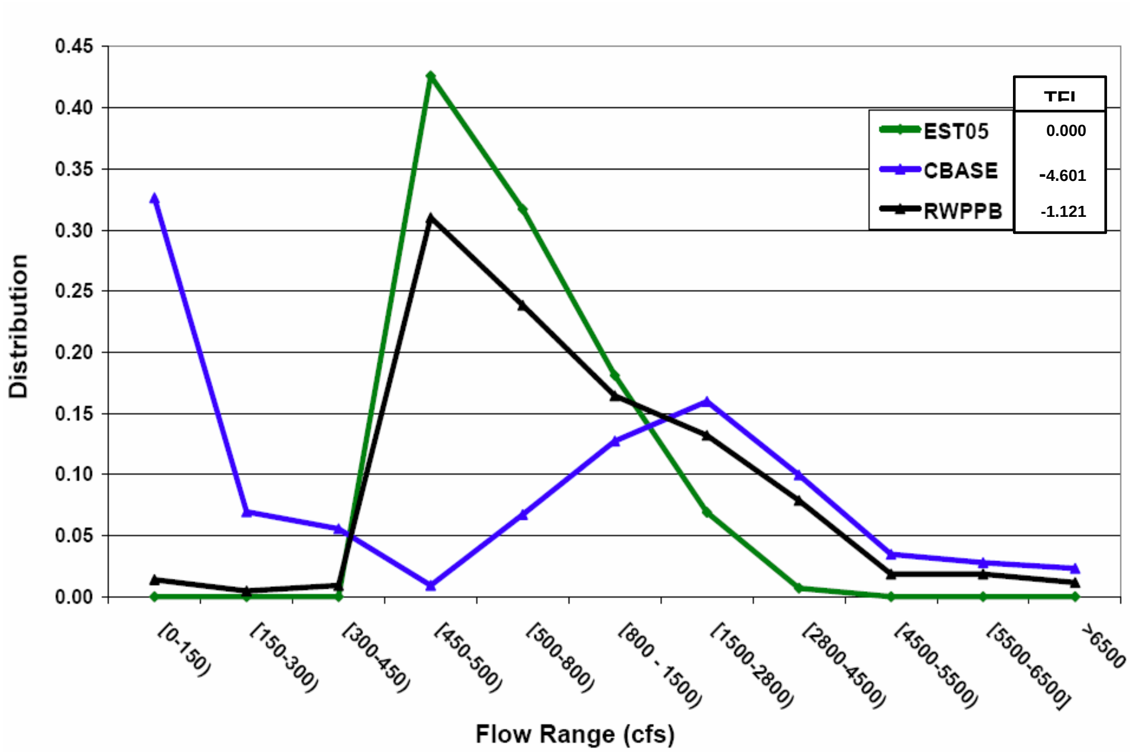

Figure 6.2-3. Target Flow Index Criteria Graph

6.2.2.4 Lake Okeechobee Proposed Minimum Water Level Criterion

This criterion is being used as a performance indicator to ensure that alternatives do not cause any adverse impacts on Lake Okeechobee minimum water levels. The target of the Lake Okeechobee proposed minimum water level performance indicator allows for only one occurrence over a six-year period, when water levels drop below 11 ft NGVD for more than 80 days.

6.2.2.5 Supplemental Irrigation Requirements

Supplemental irrigation requirements are being evaluated to ensure that the plan does not adversely affect LOSA water supply demands. This was done utilizing two water supply performance indicators. The first indicator evaluates water supply cutback volumes during the seven worst drought years. The second indicator evaluates demands not met based on the entire period of record. The goal of both indicators is to ensure that “LOSA demands not met” and “cutback volumes” are equal to or better than existing conditions**.**

SECTION 6.3

WATER QUALITY ANALYSIS METHOD AND BASE CONDITION CHARACTERIZATION

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6.3 Water Quality Analysis Method and Base Condition Characterization

This section provides an overview of the water quality analysis method and, based on the results of the analysis, a description of the water quality conditions and conclusions for the Caloosahatchee River Watershed and each individual sub-watershed.

6.3.1 Water Quality Spreadsheet

Water quality modeling was accomplished using algorithms in a Microsoft Excel® spreadsheet to estimate nutrient loads and the load reductions that would result from the implementation of various management alternatives. This simplified approach was selected because of time constraints and, more importantly, limitations in the data needed to populate a more complex, process-based model.

Watershed loading simulations were based on land-use specific total nitrogen (TN) and total phosphorus (TP) loading rates that were compiled from various sources by Soil and Water Engineering Technology, Inc. (SWET, 2008) (**Appendix D**). As described below, calibration of the model was done using flow and nutrient concentrations measured at various structures in the river. The water quality spreadsheet is categorized by sub-watershed and the three basic water quality conditions: the Current Base (CBASE) Condition, the River Watershed Protection Plan Base (RWPPB) Condition, and the Alternative Conditions. **Table 6.3-1** shows an example of the water quality spreadsheet for TN, using Alternative 1 as a representative Alternative Condition. Similar calculations were made for TP, although for simplicity, these results are not shown in the table. The following sections describe the components of the water quality spreadsheet and define the columns, the origin of the data, and how the values were calculated.

6.3.1.1 Current Base Condition

The CBASE Condition section of the water quality spreadsheet (**Table 6.3-1**) is the first building block of the spreadsheet and represents the 2005 condition of the Caloosahatchee River Watershed. It summarizes the average annual discharge (column 3a), the average annual TP or TN load (column 3b), and the resulting average annual TP or TN concentration (column 3c), based on the 1995 to 2005 period of record.

In determining average annual discharge and average annual TP or TN loads, measured data for the Caloosahatchee River (C-43 Canal) at structures S-77, S-78, and S-79 on the C-43 Canal were used. Daily values were available for discharge. Monthly loads were estimated by combining data from monthly water quality samples with the discharge record (i.e., daily flows were summed for the month and multiplied by the grab sample concentration).

There are insufficient data available downstream from S-79 for direct estimation of discharge or loads. Accordingly, simulations for the Tidal Caloosahatchee Sub-watershed and the North Coastal Basin were calibrated to flows and loads estimated in 2008 by the Florida Department of Environmental Protection (FDEP) as part of the Total Maximum Daily Load (TMDL) development process, using the Watershed Management Model (WMM). Sub-basins, land uses, and loading factors in the WMM were identical to those used in the spreadsheet loading model.

Table 6.3-1. Water Quality Spreadsheet Example

1 - Sub-watershed	2 - Area (acres)	3 - Current Base (CBASE) Condition			4 - River Watershed Protection Plan Base (RWPPB) Condition				
		3a - Annual Discharge[1] (ac-ft/yr)	3b - Annual Total Nitrogen Load[1] (mt/yr)	3c - Total Nitrogen Conc.[1] (ppm)	4a - Load Reduction (mt/yr)	4b - Remaining Discharge (ac-ft/yr)	4c - Remaining Conc.[2] (ppm)	4d - Adjusted Remaining Load[2] (mt/yr)	4e - Load Reduction from CBASE (percent)
S-4[5]	42,504	45,698	93.0	1.65	0.0	45,698	1.65	93.0	0.0%
East Caloosahatchee	198,299	232,874	460.4	1.60	0.0	232,874	1.60	460.4	0.0%
West Caloosahatchee	349,734	646,089	1,121.9	1.41	93.2	646,089	1.29	1,028.7	8.3%
Tidal Caloosahatchee	262,023	456,580	863.6	1.53	0.0	456,580	1.53	863.6	0.0%
Coastal	227,236	224,952	360.8	1.30	0.0	224,952	1.30	360.8	0.0%
Lake Okeechobee input[6]	n.a.	975,042	1,950.9	1.62	735.9	674,700	1.46	1,215.0	37.7%
Total for CRWPP	1,079,796	1,606,192	2,899.7	1.46	93.2	1,606,192	1.42	2,806.5	3.2%
Total for CRWPP, with Lake Okee.	n.a.	2,581,234	4,850.6	1.52	829.2	2,280,892	1.43	4,021.4	17.1%

5 - Alternative 1 (Common Elements)											
5a - Owner-Implemented BMPs[3]		5b - Cost-Share BMPs[4]		5c - Local Projects		5d - Regional Projects		5e - Summary of Alternative 1			
Load Reduction (mt/yr)	Remaining Load (mt/yr)	Load Reduction (mt/yr)	Remaining Load (mt/yr)	Load Reduction (mt/yr)	Remaining Load (mt/yr)	Load Reduction (mt/yr)	Remaining Load (mt/yr)	Load Reduction (mt/yr)	Remaining Concen-tration[2] (ppm)	Adjusted Remaining Load[2] (mt/yr)	Load Reduction from RWPPB (percent)
6.9	86.1	13.0	73.1	0.0	73.1	0.0	73.1	19.9	1.30	73.1	21.4%
41.2	419.3	41.8	377.5	0.0	377.5	87.2	290.2	170.2	1.01	290.2	37.0%
96.7	932.0	76.0	856.0	37.5	818.5	42.9	775.6	253.1	0.97	775.6	24.6%
89.4	774.2	79.9	694.2	30.0	664.2	0.0	664.2	199.3	1.18	664.2	23.1%
26.0	334.8	14.7	320.0	1.3	318.8	0.0	318.8	42.0	1.15	318.8	11.6%
n.a.	735.9	n.a.	735.9	0.0	735.9	0.0	735.9	0.0	1.46	1,215.0	0.0%
260.1	2,546.3	225.5	2,320.8	68.8	2,252.0	130.1	2,121.9	684.5	1.07	2,121.9	24.4%
260.1	3,761.3	225.5	3,535.8	68.8	3,467.0	130.1	3,336.9	684.5	1.19	3,336.9	17.0%

Notes for Table 6.3-1:
(1) CBASE conditions are average annual values and are based on measured data for the period 1995 to 2005. Units for all columns: Flow = acre-feet per year (ac-ft/yr); Load = metric tons per year (mt/yr); Concentration = parts per million (ppm).
(2) Where load reductions were projected to result in concentrations less than 0.80 ppm, the remaining load was estimated by multiplying the basin flow by 0.80 ppm.
(3) Owner-implemented best management practices (BMPs) are adjusted for urban pervious areas and the percentages of the BMPs that already have been implemented (30 percent for row crops, 50 percent for ornamentals/nurseries, and percent that became citrus after 1988).
(4) Cost-share BMPs are adjusted for the percentages of the BMPs that already have been implemented (percent that became urban after 1988, 30 percent for row crops, 50 percent for ornamentals/nurseries, and percent that became citrus after 1988).
(5) Approximately 50 percent of the flow from S-4 basin discharges directly into Lake Okeechobee. Flows and loads shown here represent the estimated inputs to the Caloosahatchee Watershed at S-235.
(6) Lake Okeechobee discharges into the Caloosahatchee Watershed at S-77; thus the full reach of the Caloosahatchee River and Estuary are affected by inputs from Lake Okeechobee.

For the Nearshore Basin, neither sampled nor modeled data were available for estimation of source loads or discharge. For that area, the estimates of discharge and load were based solely on land use acreages, as described below.

Approximately half of the flow from the S-4 Sub-watershed discharges directly into Lake Okeechobee and half discharges to the Caloosahatchee Watershed. Flows and loads used in this report represent the estimated inputs from the S-4 Sub-watershed to the C-43 Canal at structure S-235. They were estimated from a water-balance analysis for flow and TP for the S-4 area for the period 1993 to 2004 (Burns & McDonnell, 2008). For this report, the flow and TP discharged to the Caloosahatchee River Watershed were estimated as 48 percent of the totals given in the Interim Draft Report on the S-4 Basin Feasibility Study. That study did not collect TN data; so for this report, the TN load from the S-4 Sub-watershed was estimated as having an average concentration of 1.65 milligrams per liter (mg/L).

The water quality analysis method simulates the sources of flow and loads for the geographic areas of the basins and sub-watersheds that were described in Section 2.4. It also tracks the sources of TP and TN loads for different land-use types and estimates some of the source-load reductions on the basis of land-use types. Because the available data does not contain the necessary level of detail, a procedure was developed to estimate flows and loads for the basins and land-use types. These estimated flows and loads were then adjusted proportionally to fit the available data. This procedure is described in the following paragraphs. Though computed for each basin in the Caloosahatchee River Watershed Protection Plan (CRWPP) study area, most of the tabular data has been compiled by sub-watershed for ease of presentation in this report.

The Florida Land Use, Covers, and Forms System (FLUCCS) land-use categories, described in Section 2.4, were grouped into twenty land-use types for further analysis, and acreages were summed for each basin. **Table 6.3-2** shows the acreages for the land-use types for each sub-watershed.

Runoff coefficients and loading-rate coefficients for TP and TN were developed for the different land-use types in the CRWPP by SWET. The SWET Report can be found in **Appendix D**. The loading-rate coefficients for TP and TN are shown in **Table 6.3-3**. When the coefficients are multiplied by the acreages for each land-use type within each basin, source discharge and loadings were estimated. These coefficients were calibrated for the reach between structure S-78 and S-79, which includes the East Caloosahatchee and West Caloosahatchee sub-watersheds.

Table 6.3-2. Distribution of Land-Use Types by Sub-watershed

Land-Use Type	S-4		East Caloosahatchee		West Caloosahatchee		Tidal Caloosahatchee		Coastal	
	Area (acres)	Percent of Total Area	Area (acres)	Percent of Total Area	Area (acres)	Percent of Total Area	Area (acres)	Percent of Total Area	Area (acres)	Percent of Total Area
Residential Low Density	548	1.3%	3,015	1.5%	14,869	4.3%	30,111	11.5%	28,321	12.5%
Residential Medium Density	1,506	3.5%	383	0.2%	1,758	0.5%	26,183	10.0%	3,567	1.6%
Residential High Density	77	0.2%	59	0.0%	398	0.1%	8,501	3.2%	2,418	1.1%
Other Urban	2,231	5.2%	1,162	0.6%	1,873	0.5%	14,329	5.5%	3,974	1.7%
Improved Pasture	797	1.9%	36,795	18.6%	55,555	15.9%	21,392	8.2%	2,613	1.1%
Unimproved Pasture	0	0.0%	5,752	2.9%	12,736	3.6%	4,873	1.9%	466	0.2%
Rangeland, Woodland Pasture	278	0.7%	10,890	5.5%	31,543	9.0%	23,255	8.9%	12,165	5.4%
Row Crops	0	0.0%	1,080	0.5%	6,354	1.8%	1,632	0.6%	591	0.3%
Sugar Cane	32,932	77.5%	52,751	26.6%	2,058	0.6%	0	0.0%	0	0.0%
Citrus	66	0.2%	26,593	13.4%	69,008	19.7%	824	0.3%	193	0.1%
Sod	0	0.0%	289	0.1%	2,947	0.8%	1,833	0.7%	0	0.0%
Ornamentals	0	0.0%	16	0.0%	369	0.1%	300	0.1%	175	0.1%
Horse Farms	0	0.0%	140	0.1%	38	0.0%	24	0.0%	0	0.0%
Dairies	0	0.0%	18	0.0%	0	0.0%	38	0.0%	0	0.0%
Other Agriculture	325	0.8%	755	0.4%	2,746	0.8%	4,886	1.9%	2,197	1.0%
Tree Plantations	0	0.0%	12,923	6.5%	28,403	8.1%	1,103	0.4%	69	0.0%
Water	717	1.7%	2,061	1.0%	3,639	1.0%	22,896	8.7%	101,055	44.5%
Natural Areas	2,431	5.7%	42,467	21.4%	114,598	32.8%	96,350	36.8%	68,443	30.1%
Transportation	330	0.8%	741	0.4%	645	0.2%	2,674	1.0%	524	0.2%
Communication, Utilities	268	0.6%	408	0.2%	195	0.1%	820	0.3%	467	0.2%
Total	42,504	100.0%	198,299	100.0%	349,734	100.0%	262,023	100.0%	227,236	100.0%

Table 6.3-3. Summary of Land-Use Loading Rates and Acreages

Land-Use Type	Loading Rate		Area in Watershed	
	Total Phosphorus (lb/ac/yr)	Total Nitrogen (lb/ac/yr)	Area (acres)	Percent of Total Area
Residential Low Density	0.68	7.26	76,863	7.1%
Residential Medium Density	1.93	10.56	33,396	3.1%
Residential High Density	4.14	15.84	11,453	1.1%
Other Urban	2.05	11.68	23,568	2.2%
Improved Pasture	1.93	14.65	117,152	10.8%
Unimproved Pasture	0.99	7.26	23,827	2.2%
Rangeland, Woodland Pasture	0.40	5.41	78,130	7.2%
Row Crops	3.45	19.80	9,656	0.9%
Sugar Cane	0.55	10.56	87,741	8.1%
Citrus	0.90	11.22	96,684	9.0%
Sod	2.79	11.88	5,070	0.5%
Ornamentals	4.00	15.84	861	0.1%
Horse Farms	2.51	21.12	202	0.0%
Dairies	12.94	26.40	56	0.0%
Other Agriculture	3.20	10.18	10,909	1.0%
Tree Plantations	0.21	4.09	42,498	3.9%
Water	0.07	1.19	130,368	12.1%
Natural Areas	0.11	2.96	324,289	30.0%
Transportation	2.28	12.14	4,915	0.5%
Communication, Utilities	0.66	7.92	2,159	0.2%
Total			1,079,796	100.0%

For East Caloosahatchee Sub-watershed, the values were adjusted to match the difference in flow and load between structures S-77 and S-78. For the S-4 Sub-watershed, flows and loads were adjusted to match the values derived from the Draft S-4 Feasibility Study. For the West Caloosahatchee Sub-watershed, the values were adjusted to match the difference in flow and load between structures S-78 and S-79. For the Tidal Caloosahatchee Sub-watershed and the North Coast Basin, the values were adjusted to match the values derived from FDEP's WMM model. For the Nearshore Basin, which consists of tidal water bodies and several offshore islands, in-basin assimilation was assumed to reduce the source flows and loads by 10 percent in lieu of more site-specific data.

Input flows and loads to the Caloosahatchee River Watershed from Lake Okeechobee at structure S-77 contribute to the total flow and loads within the Caloosahatchee River and to the flows and loads that discharge from the Caloosahatchee River into the Caloosahatchee Estuary at structure S-79. The measured data for net inflow at S-77 for the 1995-2005 period of record were used to represent the CBASE Condition input from Lake Okeechobee.

The values in columns 3a, 3b, and 3c of **Table 6.3-1** contain the adjusted values for annual flow, load, and concentration that are contributed from each sub-watershed to the riverine and estuarine systems. They represent the best-available estimates of flows and loads from the sub-watersheds, and generally the annual averages for the years 1995 to 2005 are used to define the CBASE. Concentration is a flow-weighted average and is computed by dividing total load by total flow. TP concentration is reported as parts per billion (ppb) or micrograms per liter (µg/L), and TN as parts per million (ppm) or milligrams per liter (mg/L).

6.3.1.2 River Watershed Protection Plan Base (RWPPB) Condition

The water quality RWPPB Condition is the second building block of the water quality spreadsheet, and represents the anticipated loading to the estuarine system after the implementation of several base projects. These base projects are presumed to be in place in the near future and include full restoration of the Kissimmee River, including the Kissimmee River Headwaters Revitalization project, the Northern Everglades Lake Okeechobee Watershed Construction Project, Phase 2 Technical Plan (LOP2TP), the Caloosahatchee River (C-43) West Basin Storage Reservoir Project, and other Acceler8 projects.

The base projects include the LOP2TP projects which will affect the inflow from Lake Okeechobee to the Caloosahatchee River Watershed at S-77. More specifically, implementation of the projects in the LOP2TP is expected to reduce the amount of water that discharges from the Lake to the estuary and it is also expected to affect the quality of the water that is discharged from the Lake. In regards to discharge volumes, the post-project average annual inflow was estimated at 675,000 acre-ft (ac-ft), as compared to 975,000 ac-ft in the pre-project condition. These estimates reflect the post-project flows at S-77 based on Northern Everglades Regional Simulation Model output. In regards to water quality, it was assumed that discharges into Lake Okeechobee were consistent with the Lake Okeechobee phosphorus (P) TMDL of 105 metric tons (mt) (from surface inflows).

To compare discharge loads to the Caloosahatchee River, with and without water quality enhancements in place, two model scenarios were developed: 1) the base scenario, without features that improve water quality; and 2) the LOP2TP scenario, which includes the features that improve water quality and meets the Lake Okeechobee P TMDL of 105 mt. The Lake Okeechobee Water Quality Model (LOWQM) was used to simulate these two scenarios. The model estimated an average lake-wide TP concentration of 80 ppb for the LOP2TP scenario and 88 ppb for the base scenario. Total nitrogen concentrations were estimated at 1.46 ppm for the LOP2TP scenario, and 1.62 ppm for the base scenario (James et al., 2005). Because this model simulates the lake as one completely mixed compartment, specific estimates of nutrient concentrations at the S-77 discharge point were not available, instead discharge loads at S-77 were calculated with the LOWQM estimated TP and TN multiplied by the discharge flow. The combination of reduced volume and reduced concentration resulted in an estimated 36 percent reduction of TP load and an estimated 38 percent reduction of TN load for discharges from Lake Okeechobee.

The only base project within the Caloosahatchee River Watershed is the Caloosahatchee River (C-43) West Basin Storage Reservoir, which is an Acceler8 project to build a 10,000 acre reservoir in the West Caloosahatchee Sub-watershed on the old Berry Groves site west of LaBelle. In written communication from Knight in 2008, removal of nutrients by mechanical and biological processes within the reservoir was estimated to be 7.3 metric tons per year (mt/yr) for TP and 93 mt/yr for TN. The effects of evaporation on outflow volume and concentration were not considered.

In **Table 6.3-1**, column 4a represents the sum of the load reductions from the base projects. Column 4b represents the remaining discharge after implementation of the base projects, and column 4c represents the resulting concentrations, calculated by dividing total load by total flow.

The resulting concentration was then checked against the minimum value that would be expected for a freshwater riverine system under natural conditions for southern Florida. To be conservative, where simulated load reductions resulted in a concentration less than the natural condition, the “natural-condition” concentration value was used to calculate the remaining load (column 4d). For this study, the “natural-condition” concentration for TP was estimated as 80 ppb (0.080 mg/L) and TN as 0.80 ppm (0.80 mg/L). Decisions regarding the concentrations were established in writing between Robert Chamberlin and the South Florida Water Management District (SFWMD) in April 2008. This adjustment of concentration and load for the “natural-condition” concentration is repeated in the water quality spreadsheet for all of the alternative conditions.

The adjusted remaining load (Column 4d) shows the estimated loads from the sub-watersheds under the RWPPB Condition. Column 4e shows the percent reduction in loads that result from the base projects, as compared to the CBASE Condition.

6.3.1.3 Alternative Condition

The Alternative Condition is the third building block of the water quality spreadsheet and represents the anticipated TP and TN load reductions upon implementation of the alternatives. For the purposes of this discussion, Alternative 1 was used as the example for the water quality spreadsheet. Management measures that contribute to load reductions for Alternative 1 include BMPs, as well as local and regional management measures.

As described more fully in Section 6.4, Alternative 1 consists of all the ongoing or imminent projects in these watersheds (aka “common elements”). These projects will be included in all subsequent alternatives. Alternative 2 contains management measures that are optimized for water quantity requirements, in addition to the Alternative 1 projects. Alternative 3 is independent from Alternative 2 and contains management measures that are optimized for improvement of water quality, in addition to the Alternative 1 projects. Alternative 4 represents the alternative that optimizes both quality and quantity. It contains the Alternative 1, 2, and 3 projects, plus a few additional management measures.

The Alternative Condition columns in the water quality spreadsheet are identical for each of the alternatives, except that the BMPs (columns 5a and 5b) are only included in Alternative 1. The BMPs are tabulated for Alternative 1 and thus are implicitly included as “common elements” in all of the subsequent alternatives. Columns 5c, 5d, and 5e are included for all of the alternatives.

BMPs are described more fully in Chapter 7. Owner-implemented BMPs generally include practices that can be implemented by individual landowners without the need for explicit funding by the state. Cost-share BMPs generally consist of programs that require additional funding.

Estimates of removal efficiencies for various BMPs are presented in **Appendix D** (SWET, 2008). These estimates represent the best available information based on available literature and expert opinion. For each land-use type, a percentage of load reduction was estimated for owner-implemented BMPs and cost-share BMPs. Estimates were developed for TP and TN. For certain land-use types, it was presumed that some level of BMP implementation was already in place, and the load reduction was adjusted accordingly. For example, cost-share BMPs for row crops were estimated to reduce TN load by 30 percent for the estimated 70 percent of the row-crop lands that do not yet have cost-share BMPs in place. Load reductions, in mt/yr, thus were calculated as the product of existing load, percent reduction, and percent of area available for reduction. The calculations were made for each land-use type and for the acreages in each basin, and the load reductions were totaled by sub-watershed. Column 5a in the water quality spreadsheet shows the load reduction and remaining load for the application of owner-implemented BMPs, and column 5b shows the load reduction and remaining load for the subsequent application of cost-share BMPs.

The values in columns 5c and 5d contain the load reductions and remaining loads for the local project management measures and the regional project management measures, respectively. In the water quality spreadsheet, the potential load reductions for the individual local and regional management measures were totaled for each sub-watershed. Local and regional management measures are described in Section 6.1, and a complete list of management measures is given in **Table 6.1-1**. The values used for removal efficiency and percent participation, which varied by management measure, are provided in the water quality and water quantity summary at the bottom of each management measure sheet (**Appendix B**). Load reductions for some management measures, such as the Urban Turf Fertilizer Rule, were presumed to be accounted for in the calculations for BMP removals. Some management measures were developed primarily for water quantity benefits and are expected to have little or no direct effect on water quality.

The values in the remaining load columns (under 5e) were calculated by combining the potential load reductions from columns 5a, 5b, and 5c and subtracting them from the remaining load in the RWPPB Condition (column 4d). The resulting concentration was calculated from total load and discharge, as described previously, and compared to the “natural-condition” concentration. The final column under 5e shows the percent reduction in loads that result from the alternative condition. For each alternative in the water quality spreadsheet, the percentage represents the cumulative reduction in load as compared to the RWPPB Condition.

6.3.2 Watershed Water Quality Characterization

The data and results contained in the water quality spreadsheet allow for the evaluation of the relative contribution of TP and TN loadings by sub-watershed, their magnitudes, and the potential for the combinations of management measures to reduce the nutrient loadings contributed from the watershed to the estuarine system.

The CBASE Condition is intended to represent the water quality conditions in the CRWPP study area, as they existed in 2005. Specifically, the CBASE Condition is based on the 1995-2005 monitoring records, supplemented by estimations of runoff and source loadings that are based on the 2004 to 2005 land-use types for the basins and sub-watersheds in the study area. The

RWPPB Condition represents the anticipated flows and loadings after implementation of the base projects. For the CRWPP study area, the RWPPB Condition presumes that the LOP2TP and the Caloosahatchee River (C-43) West Basin Storage Reservoir will be in place.

6.3.2.1 Caloosahatchee River Watershed Water Quality Profile

The Caloosahatchee River Watershed has a total drainage area of approximately 1,080,000 acres. Large volumes of inflow from Lake Okeechobee to the watershed, by way of structure S-77 into the C-43 Canal, have a significant impact on the concentrations and loads of TP and TN downstream and in the estuarine system. The watershed has been described more fully in Section 2.4 and the land-use types have been summarized in **Tables 6.3-2** and **6.3-3**.

Estimated annual flows of 1,606,000 acre-feet and loads of 2,900 mt of TN, and 326 mt of TP are contributed by the CRWPP study area for the CBASE Condition (**Table 6.3-4**). In comparison, annual inflows from Lake Okeechobee have averaged 975,000 acre-feet and annual loads of 1,951 mt of TN, and 104 mt of TP. In terms of relative contribution, as indicated by concentration, the runoff from the CRWPP study area has a higher concentration of TP than the inflow from Lake Okeechobee (165 ppb versus 87 ppb) and a lower concentration of TN (1.46 ppm versus 1.62 ppm).

At the S-79 structure, where the freshwater discharges into the Caloosahatchee Estuary, the average proportions contributed from Lake Okeechobee inflows are 51 percent of the flow volume, 38 percent of the TP load, and 54 percent of the TN load.

If measured at Shell Point, which is at the downstream mouth of the Tidal Caloosahatchee, the average proportions contributed from Lake Okeechobee inflows would be 41 percent of the flow volume, 26 percent of the TP load, and 43 percent of the TN load.

6.3.2.2 Sub-watershed Water Quality Profiles

The sub-watersheds in the CRWPP study area have been described more fully in Section 2.4 and the land-use types have been summarized in **Table 6.3-2**. **Table 6.3-4** summarizes the flows, loads, and concentrations contributed by the various sub-watersheds.

S-4 Sub-watershed - The S-4 Sub-watershed has a total drainage area of 42,500 acres, but it is estimated that only about 22,100 acres contribute discharge to the Caloosahatchee River Watershed. The S-4 Sub-watershed is the farthest upstream of all the sub-watersheds and contributes the least discharge and loads. Average annual discharge to the C-43 Canal is 45,700 acre-feet, with 14 mt of TP annual load and 93 mt of TN. The average concentrations from the S-4 Sub-watershed, however, are the highest of all the sub-watersheds, at 241 ppb for TP and 1.65 ppm for TN.

East Caloosahatchee Sub-watershed - The East Caloosahatchee Sub-watershed lies between structures S-77 and S-78 and has a drainage area of 198,000 acres, or 19 percent of the CRWPP study area. Annually, it contributes about 233,000 acre-feet of discharge, 41 mt of TP, and 460 mt of TN. The average concentration is 144 ppb for TP and 1.60 ppm for TN. The average TP concentration is relatively low and the TN concentration is relatively high, compared to the overall average for the CRWPP study area.

West Caloosahatchee Sub-watershed - The West Caloosahatchee Sub-watershed lies between structures S-78 and S-79 and has a drainage area of 350,000 acres, or 33 percent of the CRWPP study area. Annually, it contributes about 646,000 acre-feet of discharge, 118 mt of TP, and 1,122 mt of TN. The average concentration is 148 ppb for TP and 1.41 ppm for TN. The average TP and TN concentrations are both relatively low, compared to the overall averages for the CRWPP study area.

Tidal Caloosahatchee Sub-watershed - The Tidal Caloosahatchee Sub-watershed lies between structure S-79 and the mouth of the Caloosahatchee River at Shell Point. It has a drainage area of 262,000 acres, or 25 percent of the CRWPP study area. Annually, it contributes about 456,000 acre-feet of discharge, 118 mt of TP, and 864 mt of TN. The average concentration is 210 ppb for TP and 1.53 ppm for TN. The average TP and TN concentrations are both relatively high, compared to the overall averages for the CRWPP study area.

Coastal Sub-watershed - The Coastal Sub-watershed consists of the tidal and offshore areas that do not contribute to the discharge at Shell Point. It has a drainage area of 227,000 acres, or 21 percent of the CRWPP study area. Estimates suggest that the sub-watershed annually contributes about 225,000 acre-feet of discharge, 35 mt of TP, and 361 mt of TN. The average concentration is estimated at 125 ppb for TP and 1.30 ppm for TN. The average TP and TN concentrations are both relatively low, compared to the overall averages for the CRWPP study area.

Table 6.3-4. Summary of Average Annual Flows, TP and TN Loads and Concentrations for Current Base

Sub-watershed					**Total Phosphorus**			**Total Nitrogen**		
	Contributing Area (acres)	Percent of Area for CRWPP	Annual Discharge (ac-ft/yr)	Percent of Total Discharge for CRWPP	Annual Total Load (mt/yr)	Percent of Total Load for CRWPP	Conc. (ppb)	Annual Total Load (mt/yr)	Percent of Total Load for CRWPP	Conc. (ppm)
S-4	22,102	2.1%	45,698	2.8%	13.58	4.2%	241	93.0	3.2%	1.65
East Caloosahatchee	198,299	18.7%	232,874	14.5%	41.26	12.7%	144	460.4	15.9%	1.60
West Caloosahatchee	349,734	33.0%	646,089	40.2%	118.29	36.3%	148	1,121.9	38.7%	1.41
Tidal Caloosahatchee	262,023	24.7%	456,580	28.4%	118.22	36.3%	210	863.6	29.8%	1.53
Coastal	227,236	21.4%	224,952	14.0%	34.77	10.7%	125	360.8	12.4%	1.30
Lake Okeechobee Inflow	n.a.	n.a.	975,042	n.a	104.46	n.a	87	1,950.9	n.a	1.62
Total for CRWPP	1,059,394	100.0%	1,606,192	100.0%	326.12	100.0%	165	2,899.7	100.0%	1.46
Total for CRWPP above S-79	570,135	53.8%	924,660	57.6%	173.13	53.1%	152	1,675.4	57.8%	1.47
Total above S-79, with Lake Okeechobee	n.a.	n.a.	1,899,702	n.a.	277.59	n.a.	118	3,626.3	n.a.	1.55
Total for CRWPP, above Shell Point	832,158	78.6%	1,381,240	86.0%	291.35	89.3%	171	2,538.9	87.6%	1.49
Total above Shell Point, with Lake Okeechobee	n.a.	n.a.	2,356,282	n.a.	395.81	n.a.	136	4,489.9	n.a.	1.54
Total for CRWPP, with Lake Okeechobee	n.a.	n.a.	2,581,234	n.a.	430.58	n.a.	135	4,850.6	n.a.	1.52

6.3.2.3 Benefits from Base Projects in the RWPPB Condition

As mentioned above and in Section 6.3.1.2, the RWPPB Condition presumes that the LOP2TP and the Caloosahatchee River (C-43) West Basin Storage Reservoir are in place.

With implementation of the LOP2TP, the annual inflows from Lake Okeechobee are expected to decrease from 975,000 to 675,000 acre-feet, annual loads of TP are expected to decrease from 104.5 to 66.6 mt, and annual loads of TN are expected to decrease from 1,951 to 1,215 mt. This represents a net decrease of 31 percent in flow, 36 percent in TP, and 38 percent in TN loads.

The Caloosahatchee River (C-43) West Basin Storage Reservoir is estimated to reduce the annual load of TP by 7.3 mt and TN by 93 mt. The reservoir will be constructed for purposes of storing water during periods of excess stream flow and releasing water throughout the dry season to provide adequate inflow to the estuary at S-79. Water quality benefits from the reservoir are expected to be minor, representing a reduction of only 2.2 percent of the TP load and 3.2 percent of the TN load from the study area.

The estimated flows and loads for the RWPPB Condition, for the watershed and by sub-watersheds, are shown in **Table 6.3-5**. For the CRWPP study area, the annual averages are estimated to be 1,600,000 acre-feet of flow, 319 mt of TP, and 2,806 mt of TN, corresponding to flow-weighted concentrations of 161 ppb and 1.42 ppm, respectively.

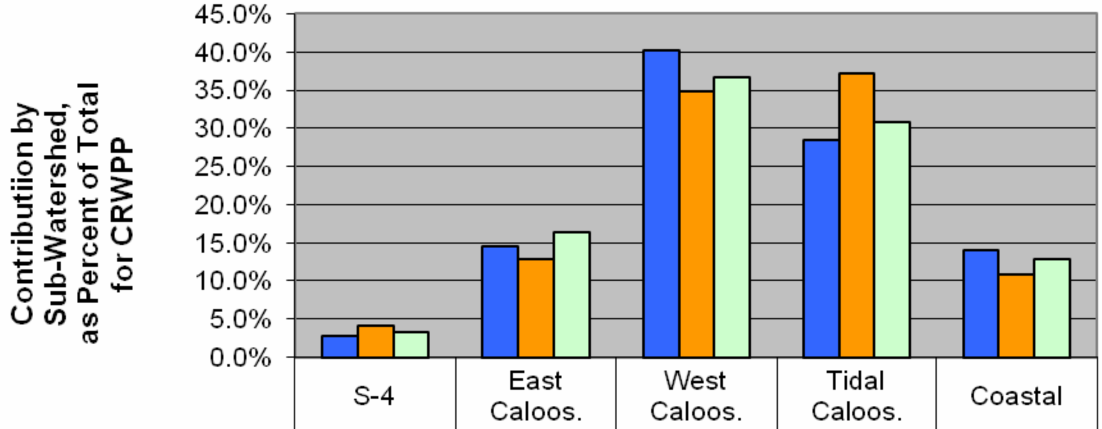
The RWPPB Condition loads are used as the basis for computing the relative load reductions among the various alternative conditions, and are discussed further in Section 6.5.

6.3.2.4 Comparison of Flows and Loads from Sub-watersheds

The estimated flows and loads, by sub-watershed, for the CBASE and RWPPB Conditions are shown in **Table 6.3-4** and **6.3-5**. The relative contributions from each sub-watershed are shown in **Figure 6.3-1**. In the figure, the bars for S-4 are higher for TP and TN than for discharge, indicating that the concentrations in S-4 are higher than the average for the other sub-watersheds. Compared to other sub-watersheds, however, the magnitude of loads from S-4 is small. Similarly, the contributions from the East Caloosahatchee and Coastal sub-watersheds are relatively modest. The greatest discharge is contributed by the West Caloosahatchee Sub-watershed, along with the greatest nitrogen load, but the largest P load is contributed by the Tidal Caloosahatchee Sub-watershed, which has more urbanized areas.

Table 6.3-5. Summary of Average Annual Flows, TP and TN Loads and Concentrations for RWPPB

Sub-watershed					**Total Phosphorus**			**Total Nitrogen**		
	Contributing Area (acres)	Percent of Area for CRWPP	Annual Discharge (ac-ft/yr)	Percent of Total Discharge for CRWPP	Annual Total Load (mt/yr)	Percent of Total Load for CRWPP	Conc. (ppb)	Annual Total Load (mt/yr)	Percent of Total Load for CRWPP	Conc. (ppm)
S-4	22,102	2.1%	45,698	2.8%	13.58	4.3%	241	93.0	3.3%	1.65
East Caloosahatchee	198,299	18.7%	232,874	14.5%	41.26	12.9%	144	460.4	16.4%	1.60
West Caloosahatchee	349,734	33.0%	646,089	40.2%	111.03	34.8%	139	1,028.7	36.7%	1.29
Tidal Caloosahatchee	262,023	24.7%	456,580	28.4%	118.22	37.1%	210	863.6	30.8%	1.53
Coastal	227,236	21.4%	224,952	14.0%	34.77	10.9%	125	360.8	12.9%	1.30
Lake Okeechobee inflow	n.a.	n.a.	674,700	n.a.	66.58	n.a.	80	1,215.0	n.a.	1.46
Total for CRWPP	1,059,394	100.0%	1,606,192	100.0%	318.86	100.0%	161	2,806.5	100.0%	1.42
Total for CRWPP above S-79	570,135	53.8%	924,660	57.6%	165.87	52.0%	145	1,582.1	56.4%	1.39
Total above S-79, with Lake Okeechobee	n.a.	n.a.	1,599,360	n.a.	232.45	n.a.	118	2,797.1	n.a.	1.42
Total for CRWPP, above Shell Point	832,158	78.6%	1,381,240	86.0%	284.09	89.1%	167	2,445.7	87.1%	1.44
Total above Shell Point, with Lake Okeechobee	n.a.	n.a.	2,055,940	n.a.	350.67	n.a.	138	3,660.7	n.a.	1.44
Total for CRWPP, with Lake Okeechobee	n.a.	n.a.	2,280,892	n.a.	385.44	n.a.	137	4,021.4	n.a.	1.43



	S-4	East Caloos.	West Caloos.	Tidal Caloos.	Coastal
Discharge	2.8%	14.5%	40.2%	28.4%	14.0%
Total Phosphorus Load	4.3%	12.9%	34.8%	37.1%	10.9%
Total Nitrogen Load	3.3%	16.4%	36.7%	30.8%	12.9%

Figure 6.3-1. Comparison of Percent Average Annual Discharge and Average Annual TP and TN Loads from each Sub-watershed for RWPPB Condition

6.3.3 Water Quality Conclusions

The water quality Microsoft Excel® spreadsheet was used to demonstrate and compare load reductions of TP and TN with two base conditions and the alternative conditions. The CBASE Condition represents the 2005 flows and loads for the watershed and its sub-watershed components. The RWPPB Condition represents the anticipated loading after several projects are implemented (see Section 6.3.1.2) and is expected to reduce the input of loads from Lake Okeechobee by 36 percent for TP and 38 percent for TN, largely due to the reduced flow volumes into the C-43 Canal. Base projects within the CRWPP study area are not designed for water quality improvements, and are expected to reduce loads to the estuary only by two percent for TP and three percent for TN. The average annual loads contributed within the CRWPP study area under the RWPPB Condition are expected to be 319 mt for TN and 2,806 mt for TP.

The highest concentration of nutrients is estimated to derive from the S-4 Sub-watershed, but because the discharge volume is small, the overall impact of S-4 is relatively small. The West and Tidal Caloosahatchee sub-watersheds contribute most of the flow and loads within the study area. The West Caloosahatchee Sub-watershed contributes the largest flow volume and the largest load of TN. The Tidal Caloosahatchee Sub-watershed contributes the largest load of TP.

For the RWPPB Condition, the overall concentration of TP for the CRWPP study area is 161 ppb, which is twice the expected “natural-condition” concentration value of 80 ppb. The concentration of TN is estimated to be 1.42 ppm, compared to the “natural-condition” concentration value of 0.80 ppm, which likewise leaves plenty of opportunity for the management measures to play an important role in restoring a healthy watershed and estuary.

SECTION 6.4

FORMULATION OF ALTERNATIVE PLANS

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6.4 FORMULATION OF ALTERNATIVE PLANS

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

6.4.1 Planning Goals

The sections below reiterate the water quantity and water quality goals of the Caloosahatchee River Water Protection Plan (CRWPP). The alternative plans were formulated to achieve these goals.

6.4.1.1 Water Quantity Storage Goal

The legislative intent of Northern Everglades and Estuaries Protection Program (NEEPP) finds that the expeditious implementation of the Lake Okeechobee Protection Plan and the River Watershed Protection Plans is needed to improve the quality, quantity, timing and distribution of water in the northern Everglades ecosystem, Section 373.4595(1)(h), F.S. (2007). The water quantity storage goal for the Caloosahatchee River Watershed is to manage flows to meet the high discharge criteria, salinity envelope, and Target Flow Index (TFI) in the Caloosahatchee Estuary, as detailed below.

- The restoration target high discharge criteria for the Caloosahatchee Estuary are as follows:
  - Limit mean monthly flows greater than 2,800 cubic feet per second (cfs) to three months or less over a 432-month period, and
  - Eliminate mean monthly flows greater than 4,500 cfs over a 432-month period.
- The restoration salinity envelope target for the Caloosahatchee Estuary is as follows:
  - Eliminate mean monthly flows below 450 cfs from October to July, and
  - Limit the number of times flows exceed 2,800 cfs for 14 days or more to three, based on a 14-day moving average.
- The target for the TFI is to achieve a flow distribution at S-79 identical to the EST05. EST05 represents the preferred flow distribution at S-79. A flow distribution identical to EST05 is given a TFI score of zero. Improving scores are represented by values approaching zero.

The basis for these goals is discussed in detail in Sections 3.5 and 6.2. This section identifies the storage gained with each alternative in acre-feet, while Section 6.5 discusses the modeling results as they specifically relate to the water quantity storage goals.

6.4.1.2 Water Quality Goal

The NEEPP legislation requires pollutant load reductions consistent with any adopted nutrient Total Maximum Daily Loads (TMDLs) for the Caloosahatchee River Watershed as the water quality objective for the CRWPP planning process. However, during the formulation of the

CRWPP, the TMDLs were under development and had not yet been established for any impaired waterbody segments in the Caloosahatchee River Watershed. TMDLs for nutrients and dissolved oxygen (DO) were originally scheduled for development by September 2010. However; NEEPP directed the Florida Department of Environmental Protection (FDEP) to expedite development of TMDLs for the Caloosahatchee River and Estuary. Specifically, NEEPP directed FDEP to propose TMDLs for nutrients in the tidal portions of the Caloosahatchee River and Estuary by December 31, 2008. TMDLs for the riverine portion of the watershed will be established subsequent to the estuarine TMDLs.

Since nutrient TMDLs did not exist during this planning process, a water quality goal of maximizing nutrient load reductions was utilized. Progress in meeting the total phosphorus (TP) and total nitrogen (TN) water quality goals is measured in the planning process via the water quality spreadsheet, which is discussed in detail in Section 6.3.1. This tool compiles the benefits of the various management measures and performance measures for the existing conditions, the River Watershed Protection Plan Base Condition, and four alternatives. Once TMDLs are established for the watershed, they will be used in future plan updates to assess water quality performance of the plan. Specifically, the TMDLs will be used to determine whether sufficient pollutant load reductions have been implemented in the watershed to achieve the waterbody's designated use and whether any plan refinements are necessary.

6.4.2 Formulation Challenges

During the plan formulation process, numerous challenges needed to be resolved, including the challenges listed below.

- Alternative plans were developed that concurrently addressed two discrete and sometimes competing project objectives, namely TP and TN load reductions and water storage.
- Multiple management measures were considered for each project objective.
- TMDLs have not yet been established in the Caloosahatchee River Watershed, so an interim goal of maximizing load reductions was used for this planning process. Once TMDLs are established in the Caloosahatchee River Watershed they will be applied in future CRWPP updates to assess water quality performance of the plan.
- Water quantity or water quality benefits for some management measures could not be quantified due to the nature or development stage of the projects, although water quantity or water quality benefits are anticipated. These projects were included in the alternatives, but did not contribute to the overall TP and TN load reductions or the water storage capacity for the alternatives.
- The numerous challenges previously discussed in Section 3.4.

To address these challenges, a structured, systematic, and reproducible process was identified and adopted for formulation of alternative plans.

6.4.3 Formulation of Alternatives

The alternatives were formulated by combining management measures from the management measures toolbox, previously discussed in Section 6.1.1, to meet pre-established planning objectives. Both the CRWPP and the St. Lucie River Watershed Protection Plan (SLRWPP) have four alternatives, with the main objectives as listed below:

Alternative 1: Common elements for incorporation into all subsequent alternatives
Alternative 2: Maximize water storage
Alternative 3: Maximize nutrient load reductions
Alternative 4: A combination of management measures from Alternatives 1-3 intended to maximize both water storage and nutrient load reductions

Table 6.4-6 at the end of this section identifies the quantified water quality and storage benefits associated with each management measure. The management measure sheets in **Appendix B** provide the methods used for determining the water quality and storage benefits associated with each management measure, as determined by the working team. The following sections provide details of the four alternatives discussed above and the associated anticipated water quantity and water quality benefits.

6.4.3.1 Alternative 1 – Common Elements

Alternative 1 is defined as the "common elements" and is included in all subsequent alternatives. It includes management measures either already constructed/implemented or with construction/implementation imminent, or management measures for which construction/implementation was imminent pending resolution of certain issues. The management measures in Alternative 1 range from Level 1 to Level 5 (Refer to Section 6.1.1 for a description of the management measure levels).

The key management measures of Alternative 1 are listed below and categorized by the scale of the project: local, regional, and source control. Regional projects are designed to reduce nutrient loads from regional scale sources. Local projects are designed to reduce nutrient loads from local sources. Source control projects are activities and measures that focus on capturing pollutants at the source, preventing the pollutants from leaving the site and entering other surface waters. The water storage capacity and TP and TN reductions for Alternative 1 management measures are also provided and summarized in **Table 6.4-1**.

- **Regional Projects -** Alternative 1 regional projects provide annual average TP and TN reductions of approximately 18.7 and 130.1 metric tons per year (mt/yr), respectively. Alternative 1 regional projects include:
  - Coastal & Estuarine Land Conservation Program
  - Harns Marsh Improvements – Phase I & II (East County Water Control District (ECWCD))
  - Harns Marsh Improvements – Phase II Final Design (ECWCD)
  - Aquifer Benefit and Storage for Orange River Basin (ABSORB) – ECWCD
  - Spanish Creek/ Four Corners Environmental Restoration
  - West Lake Hicpochee Project
  - C-43 Distributed Reservoirs
  - C-43 Water Quality Treatment and Demonstration Project (BOMA property)
  - Hendry County Storage

- **Local Projects -** Alternative 1 local projects provide annual average TP and TN reductions of approximately 13.5 and 68.8 mt/yr, respectively. Alternative 1 local projects include:
  - Billy Creek Filter Marsh Phase I &II
  - North Fort Myers Surface Water Restoration Project
  - Yellow Fever Creek/ Gator Slough Transfer Facility (#208509)
  - Yellowtail Structure Construction (ECWCD)
  - Hendry Extension Canal Widening – Construction (ECWCD)
  - Manuel's Branch Silt Reduction Structure
  - Manuel's Branch East and West Weirs
  - Caloosahatchee Creeks Preserve Hydrological Restoration
  - Powell Creek Algal Turf Scrubber
  - City of LaBelle Stormwater Master Plan Implementation
  - Clewiston STA
  - Alternative Water Storage (LOER) – Barron Water Control District
  - Florida Ranchlands Environmental Services Project

- **Source Control Projects -** Alternative 1 source control projects are anticipated to provide annual average TP and TN reductions of approximately 54.9 and 485.2 mt/yr, respectively. Alternative 1 source control projects include:
  - Agricultural Best Management Practices (BMPs) – Owner Implemented, Funded Cost Share, and Cost Share Future Funding
  - Urban Turf Fertilizer Rule [Lake Okeechobee Estuary and Recovery (LOER)]
  - Land Application of Residuals
  - Florida Yards and Neighbors
  - Environmental Resource Permit (ERP) Regulatory Program
  - National Pollutant Discharge Elimination System (NPDES) Stormwater Program
  - Proposed Caloosahatchee River Watershed Regulatory Nutrient Source Control Program
  - Proposed Unified Statewide Stormwater Rule
  - Animal Manure Application Rule
  - Application of Septage Rule
  - Lake Okeechobee and Estuary Watershed Basin Rule (LOER)
  - Wastewater & Stormwater Master Plans
  - Farm & Ranchland Partnerships
  - Comprehensive Planning – Land Development Regulations (LDR)

The water quality and storage benefits previously described are summarized by project scale in **Table 6.4-1**.

Table 6.4-1. Alternative 1 Benefits by Project Scale

Project Scale	TP Load Reduction[1]	TN Load Reduction[1]	Storage[2]
Regional Projects	18.7 mt/yr	130.1 mt/yr	46,900 ac-ft
Local Projects	13.5 mt/yr	68.8 mt/yr	1,013 ac-ft
Source Control Projects	54.9 mt/yr	485.2 mt/yr	NA

[1] Values are from the water quality spreadsheet described in Section 6.3.1
[2] Values are a sum of the storage for each management measure provided in the management measure summary sheets as calculated by the coordinating agencies.

6.4.3.1.1 Alternative 1 Water Storage Benefits

Increased storage from Alternative 1 is a sum of the storage benefits from Alternative 1 management measures (CRE10: C-43 Water Quality Treatment and Demonstration Project, BOMA property) and Alternative 1 management measures adopted from the Lake Okeechobee Watershed Construction Project, Phase II Technical Plan (LOP2TP) (CRE-LO41: C-43 Distributed Reservoirs and CRE-LO92: Clewiston STA). Alternative 1 includes storage features that would provide an annual average surface storage capacity of approximately 47,900 acre-feet. Of the Alternative 1 storage components, the C-43 Distributed Reservoir, a reservoir/ hydraulic restoration management measure, provided the majority of the surface water storage.

6.4.3.1.2 Alternative 1 Nutrient Load Reductions

Table 6.4-2 below summarizes the water quality benefits from Alternative 1, as captured in the water quality spreadsheet. Alternative 1 would provide a total TP load reduction of 84.8 mt/yr and a total TN load reduction of 684.0 mt/yr. This would leave a Caloosahatchee River Watershed loading of 234.1 mt/yr and a concentration of 118 parts per billion (ppb) for TP and 2,122 mt/yr and a concentration of 1.07 parts per million (ppm) for TN.

Table 6.4-2. Alternative 1 TP and TN Summary

	TP[1]	TN[1]
Current Load from Watershed (Current Base)	326.1 mt/yr	2,900 mt/yr
Remaining Load from Watershed (River Watershed Base Condition)	318.9 mt/yr	2,806 mt/yr
Total Load Reduction for Alternative 1[2]	84.8 mt/yr	684 mt/yr
Remaining Load from Watershed	**234.1 mt/yr**	**2,122 mt/yr**
Remaining Concentration	**118 ppb**	**1.07 ppm**

[1] Values are from the water quality spreadsheet described in Section 6.3.1.
[2] Total reduction may be less than the sum by project scale in Table 6.4-1 due to the load reduction adjustment.

6.4.3.2 Alternative 2 – Maximizing Water Storage

This alternative is intended to maximize storage capacity in the Caloosahatchee River Watershed. Using Alternative 1 as a base, new management measures were added that would provide increased storage capacity. Accordingly, Alternative 2 consisted of all management measures that were included in Alternative 1, plus the following six new features:

- **Cape Coral Canal Stormwater Recovery by ASR (Level 1) –** This feature overcomes water shortfalls during the dry season and provides flood attenuation during the wet season through the use of aquifer storage and recovery (ASR) wells in the Cape Coral Canal System. The project is designed for six wells, one million gallons per day (MGD) each, to be constructed from 2007–2009. Water quality benefits from the well construction are estimated at a net reduction of 4.13 mt/yr for TN and 14.3 mt/yr for TP.

- **Rehydrate Lee County Well Fields (south of Hwy 82) (Level 3)** – This facility would redirect water from Lehigh Acres to rehydrate Lee County well fields to the south of SR 82. A total of approximately 4,000 acre-feet of storage capacity will be provided through this project. In addition, it would provide an estimated annual average reduction of 1.27 mt/yr for TN and an assumed 0.23 mt/yr for TP as reasonable in comparison to TN.

- **West Lake Hicpochee Project (Level 4)** – This project comprises a reservoir and stormwater treatment area along the C-19 and C-43 canals, degradation of berms, exotic plant removal and control. This facility could potentially provide 43,010 acre-feet of aboveground storage capacity. It consists of two cells totaling 5,700 acres that would primarily receive flows from Fisheating Creek (via C-19). Because of its proximity to Lake Okeechobee, it could also be used to store lake waters, if necessary. In addition, this project is estimated to provide an annual average TN load reduction of approximately 27.6 mt/yr and a load reduction of 1.95 mt/yr for TP.

- **Recyclable Water Containment Areas (RWCAs) (Level 4)** – RWCAs act as a distributed reservoir within the agricultural lands. This project utilizes agricultural areas for temporary water storage and water quality benefits. A total of approximately 5,000 acres of storage area would be distributed equally among five sub-regions, with 4-foot berms able to hold water up to a 2-foot depth. Water quality benefits from the project are estimated at a net reduction of 67.5 mt/yr for TN and 14.3 mt/yr for TP.

- **East Caloosahatchee Storage (Level 4)** – This project comprises a series of distributed reservoirs located in the East Caloosahatchee Basin, which could potentially create 100,000 acre-feet of aboveground storage. The current configuration is one large reservoir with an effective area of 8,000 acres and a capacity of 70,000 acre-feet. The total water quality benefit from this project is estimated to reduce TN loading by 69.1 mt/yr and TP loading by 5.16 mt/yr.

- **Recycled Water Containment Area in the S-4 Basin (Level 5)** – This project would use agricultural or other lands on a rotating basis through the S-4 Basin as temporary water storage for water quality and storage benefits. Benefits from this concept include recycling nutrients, water storage, aquifer recharge and decreasing excessive flows to the estuaries. Estimated water quality benefits from this project are a total load reduction of 11.8 mt/yr for TN and 2.41 mt/yr for TP.

6.4.3.2.1 Alternative 2 Water Storage Benefits

Increased storage from Alternative 2 is a sum of the storage benefits from the Alternative 2 management measure, CRE128: East Caloosahatchee Storage, and the Alternative 2 management measure adopted from LOP2TP, CRE-LO40: West Lake Hicpochee Project. Alternative 2 includes storage features that would provide an annual average surface storage capacity of approximately 143,000 acre-feet. The additional projects in Alternative 2 are reservoir/hydrologic restoration features. Of the Alternative 2 storage components, the East Caloosahatchee Storage project provided the majority of the surface water storage.

6.4.3.2.2 Alternative 2 Nutrient Load Reductions

Table 6.4-3 below summarizes the water quality benefits from Alternative 2, as captured in the water quality spreadsheet. The additional six new project features would collectively reduce TP loading by 12.1 mt/yr and TN loading by 118 mt/yr. Thus, Alternative 2 would provide a total TP load reduction of 96.9 mt/yr and a total TN load reduction of 802 mt/yr. This would leave a Caloosahatchee River Watershed loading of 222.0 mt/yr TP and 2,004 mt/yr TN, and concentration of 113 ppb and 1.02 ppm, for TP and TN respectively.

Table 6.4-3. Alternative 2 TP and TN Summary

	TP[1]	**TN[1]**
Current Load from Watershed (Current Base)	326.1 mt/yr	2,900 mt/yr
Remaining Load from Watershed (River Watershed Base Condition)	318.9 mt/yr	2,806 mt/yr
Load Reduction for Alternative 1 Common Elements	84.8 mt/yr	684 mt/yr
Load Reduction for Additional Alternative 2 Projects	12.1 mt/yr	118 mt/yr
Total Load Reduction for Alternative 2	96.9 mt/yr	802 mt/yr
Remaining Load from Watershed	**222.0 mt/yr**	**2,004 mt/yr**
Remaining Concentration	**113 ppb**	**1.02 ppm**

[1] Values are from the water quality spreadsheet described in Section 6.3.1

6.4.3.3 Alternative 3 – Maximizing Water Quality Improvements

This alternative plan is intended to maximize nutrient load reductions in the Caloosahatchee River Watershed. Using Alternative 1 as the basis, new management measures are added for further nutrient load reduction. This plan consists of all features from Alternative 1, plus the following eight new management measures ranging from Levels 2 through 5:

- **Cape Coral Wastewater Treatment and Stormwater Retrofit (Level 2) –** This project is comprised of the implementation of the City of Cape Coral's utility expansion program to changeover from septic systems to gravity sewers for wastewater treatment. In addition, the project contains funding to replace older stormwater inlets with newer inlets designed to assist with stormwater management. Estimated water quality benefits are a total load reduction of 27.0 mt/yr for TN and 5.40 mt/yr for TP.

- **North Ten Mile Canal Stormwater Treatment System (Level 2)** – This project proposes to create a large-scale detention storage/treatment area in the City of Fort Myers for the Fowler commercial corridor and easterly industrial areas. Upon construction, the stormwater runoff can better mimic a pre-developed hydrologic response condition. The projected water quality load reductions from project implementation would be 0.82 mt/yr for TN and 0.33 mt/yr for TP for a three-year event.

- **Carrell Canal (FMCC) Water Quality Improvements (Level 2)** – This project proposes to create a stormwater treatment area (STA) via diversion structures, quiescent settling ponds, and constructed marshes within the "non-play" areas of the existing golf course facility. It will work in conjunction with other stormwater treatment projects in the watershed to improve the overall water quality of Carrell Canal and stormwater discharges to the Caloosahatchee River. Annual estimated water quality load reductions are 0.42 mt/yr for TN and 0.13 mt/yr for TP.

- **Shoemaker-Zapato Canal Stormwater Treatment (Level 2)** – This project proposes to install weir/control structures for peak flow attenuation through increased channel storage and the "balancing" of outfalling stormwater volumes between the Shoemaker and Zapato canal systems. The project should improve water quality and reduce erosion and siltation into Billy Creek and improve stormwater discharges to the Caloosahatchee River. Annual water quality load reductions from the project are estimated at 0.54 mt/yr for TN and 0.14 mt/yr for TP.

- **West Caloosahatchee Water Quality Treatment Area (Level 3)** – This project consists of a constructed wetland designed to treat water from the reservoir to reduce nutrient concentrations from the Caloosahatchee River and nutrient loading to the downstream estuary. Total load reduction is estimated to be 58.5 /yr for TN and 13.9 mt/yr for TP.

- **Lehigh Acres Wastewater Treatment and Stormwater Retrofit (Level 3)** – The purpose of this project is to install structural components to slow and hold stormwater on the land, in order to facilitate settling and nutrient uptake prior to discharge into canals and ditches that discharge to the Caloosahatchee River. In addition, it should eliminate high-density septic systems, as well as the use of private wells for irrigation, which will significantly reduce potential pollutant loading. Annual estimated water quality load reductions are estimated at 68.5 mt/yr for TN and 13.7 mt/yr for TP.

- **Caloosahatchee Ecoscape Water Quality Treatment Area (Level 4)** – This project consists of a constructed wetland designed for optimal removal of nitrogen (N) from the Caloosahatchee River. The purpose of the project is to reduce nutrient concentrations within the Caloosahatchee River and nutrient pollutant loading to the downstream estuary. Total load reduction is estimated as 50.0 mt/yr for TN and 12.0 mt/yr for TP.

- **Caloosahatchee Area Lakes Restoration (Lake Hicpochee) (Level 3)** – The proposed project comprises restoring the historic lake bed of Lake Hicpochee. The restored areas would treat runoff from agricultural canals that currently flow into Lake Hicpochee and the Caloosahatchee River. Annual water quality load reductions from the project are estimated as 100 mt/yr for TN and 24.7 mt/yr for TP.

6.4.3.3.1 Alternative 3 Water Storage Benefits

Increased storage from Alternative 3 is a sum of the storage benefits from the following Alternative 3 management measures – CRE04: Caloosahatchee Area Lakes Restoration (Lake Hicpochee), CRE11: Caloosahatchee Ecoscape Water Quality Treatment Area, and CRE13: West Caloosahatchee Water Quality Treatment Area. Alternative 3 includes additional water quality treatment facilities that would provide an annual average surface storage capacity of approximately 19,000 acre-feet. Of the Alternative 3 storage components, the Caloosahatchee Area Lakes Restoration (Lake Hicpochee) provided the majority of the surface water storage.

6.4.3.3.2 Alternative 3 Nutrient Load Reductions

Table 6.4-4 below summarizes the water quality benefits from Alternative 3, as captured in the water quality spreadsheet. The additional eight new project features would collectively reduce TP loading by 29.8 mt/yr and TN loading by 266 mt/yr. Thus, Alternative 3 would provide a total TP load reduction of 114.6 mt/yr and a total TN load reduction of 950 mt/yr. This would leave a Caloosahatchee River Watershed loading of 204.2 mt/yr TP and 1,856 mt/yr TN, and concentration of 103 ppb and 0.94 ppm, for TP and TN respectively.

Table 6.4-4. Alternative 3 TP and TN Summary

	TP[1]	**TN**[1]
Current Load from Watershed (Current Base)	326.1 mt/yr	2,900 mt/yr
Remaining Load from Watershed (River Watershed Base Condition)	318.9 mt/yr	2,806 mt/yr
Load Reduction for Alternative 1 Common Elements	84.8 mt/yr	684 mt/yr
Load Reduction for Additional Alternative 3 Projects	29.8 mt/yr	266 mt/yr
Total Load Reduction for Alternative 3	114.6 mt/yr	950 mt/yr
Remaining Load from Watershed	**204.2 mt/yr**	**1,856 mt/yr**
Remaining Concentration	**103 ppb**	**0.94 ppm**

[1] Values are from the water quality spreadsheet described in Section 6.3.1

6.4.3.4 Alternative 4 – Optimize Water Storage and Water Quality Improvements

This alternative plan was intended to optimize storage capacity and reduce nutrient loads in the study area. It was conceived as a hybrid between Alternative 2 and 3 and essentially increases storage capacity, as well as furthers nutrient load reduction. Accordingly, it consists of all previous components from Alternatives 1 through 3, while adding the following four new management measures:

- **East Caloosahatchee Water Quality Treatment Area (Level 3)** – This project consists of a constructed wetland designed for optimal N removal from water that currently flows into Lake Hicpochee. Upon construction, the water will be diverted to the wetland treatment facility and then back to the Caloosahatchee River, bypassing Lake Hicpochee. The total estimated water quality benefit from the proposed project would be 80.1 mt/yr load reduction for TN and 19.2 mt/yr load reduction for TP.

- **Caloosahatchee Storage – Additional (Level 4)** - The proposed project is located in the Freshwater Basins of the Caloosahatchee River and could potentially create 50,000 acre-feet of aboveground storage to meet additional demands. Estimated water quality benefits calculated for the project are a reduction of 58.0 mt/yr TN and 4.30 mt/yr TP.

- **Wastewater Treatment Plant Upgrade and Reclaimed Water (Level 4)** – This project will address the treatment of effluent entering the Caloosahatchee Estuary through upgrading existing wastewater treatment plants, constructing future planned plants with higher treatment levels, and beneficially distributing reclaimed water. Water quality benefits are anticipated to occur as a result of this project; however, the magnitude of these benefits is undetermined.

- **Fort Myers-Cape Coral Reclaimed Water Interconnect (Level 5)** – This proposed project would construct a transmission line between the Fort Myers South Wastewater Treatment Plant and the Cape Coral Everest Parkway Water Reclamation Facility. This would remove the City of Fort Myers' wastewater discharge from the Caloosahatchee Estuary, eliminate the need for the city to construct an injection well for reclaimed water disposal, and will provide reclaimed water to the City of Cape Coral, which has the necessary infrastructure for water distribution. Fort Myers would have an estimated 9 MGD reduction in flow.

6.4.3.4.1 Alternative 4 Water Storage Benefits

Increased storage from Alternative 4 is derived from the storage benefit of CRE 128a: Caloosahatchee Storage – Additional. This reservoir/ hydraulic restoration feature would provide an annual average surface storage capacity of approximately 50,000 acre-feet.

6.4.3.4.2 Alternative 4 Nutrient Load Reductions

Table 6.4-5 summarizes the water quality benefits from Alternative 4, as captured in the water quality spreadsheet. The additional four new project features would collectively reduce TP loading by 23.5 mt/yr and TN loading by 138.1 mt/yr. The projects for Alternatives 2 and 3, and the extras for Alternative 4 collectively could reduce TP loading by 36.1 mt/yr for TP and 326.5 mt/yr for TN. Thus, Alternative 4 would provide a total TP load reduction of 120.9 mt/yr and a total TN load reduction of 1,010.5 mt/yr. This would leave a Caloosahatchee River Watershed loading of 197.9 mt/yr TP and 1,760 mt/yr TN, and concentration of 101 ppb and 0.91 ppm, for TP and TN respectively.

Table 6.4-5. Alternative 4 TP and TN Summary

	TP[1]	**TN[1]**
Current Load from Watershed (Current Base)	326.1 mt/yr	2,900 mt/yr
Remaining Load from Watershed (River Watershed Base Condition)	318.9 mt/yr	2,806 mt/yr
Load Reduction for Alternative 1 Common Elements	84.8 mt/yr	684 mt/yr
Load Reduction for Additional Alternative 4 Projects	36.1 mt/yr	326 mt/yr
Total Load Reduction for Alternative 4	120.9 mt/yr	1,010 mt/yr
Remaining Load from Watershed	**197.9 mt/yr**	**1,760 mt/yr**
Remaining Concentration	**101 ppb**	**0.91 ppm**

[1] Values are from the water quality spreadsheet described in Section 6.3.1

Table 6.4-6. Summary of Management Measures Associated with the CRWPP Alternatives

ID	Management Measure	Management Measure Description	Level	Alternative Plans			
				Alt 1	Alt 2	Alt 3	Alt 4
CRE-LO 01,02,49	Agricultural BMPs- Owner Implemented, Funded Cost Share, and Cost Share Future Funding	Implementation of agricultural BMPs and water quality improvement projects to reduce the discharge of nutrients from the watershed.	1	√	√	√	√
CRE-LO 03	Urban Turf Fertilizer Rule [Lake Okeechobee Estuary and Recovery (LOER)]	Florida Department of Agriculture and Consumer Services (FDACS) rule which regulates the content of P and N in urban turf fertilizers to improve water quality.	1	√	√	√	√
CRE-LO 04	Land Application of Residuals	Subsection 373.4595(4)(b)2.of the NEEPP requires that after December 31, 2007, the FDEP may not authorize the disposal of domestic wastewater residuals within the Caloosahatchee River Watershed unless the applicant can affirmatively demonstrate that the nutrients in the residuals will not add to nutrient loadings in the watershed.	1	√	√	√	√
CRE-LO 05	Florida Yards and Neighborhoods	Provides education about the land-use design to the citizens by promoting the Florida Yards & Neighborhood programs to minimize the pesticides, fertilizers and irrigation water.	1	√	√	√	√
CRE-LO 07	Environmental Resource Permit (ERP) Regulatory Program	The ERP program regulates activities in, on, or over wetlands or other surface waters and the management and storage of all surface waters. This includes activities in uplands that alter stormwater runoff as well as dredging and filling in wetlands and other surface waters. Generally, the program's purpose is to ensure that activities do not degrade water quality, compromise flood protection, or adversely affect the function of wetland systems. The program applies to new activities only, or to modifications of existing activities, and requires an applicant to provide reasonable assurances that an activity will not cause adverse impacts to existing surface water storage and conveyance capabilities, and will not adversely affect the quality of receiving waters such that any applicable water quality standards will be violated.	1	√	√	√	√
CRE-LO 08	National Pollutant Discharge Elimination System (NPDES) Stormwater Program	To reduce stormwater pollutant loads discharged to surface waters, especially from existing land uses and drainage systems. This is especially true for the master drainage systems owned and operated by cities, counties, FDOT, and Chapter 298 water control districts. This also can help to reduce stormwater pollutant loads from existing industrial sites and from new construction sites.	1	√	√	√	√
CRE-LO 09	Coastal & Estuarine Land Conservation Program	To protect important coastal and estuarine areas that have significant conservation, recreation, ecological, historical, or aesthetic values, or that are threatened by conversion from their natural or recreational state to other uses (CELCP Final Guidelines, 2003)..	1	√	√	√	√

ID	Management Measure	Management Measure Description	Level	Alternative Plans			
				Alt 1	Alt 2	Alt 3	Alt 4
CRE-LO 12g	Alternative Water Storage (LOER) - Barron Water Control District	This project will provide 5,000 acre-feet of water storage on 6,129 acres. Includes weir construction and ditch retention to enable water quality improvements and reuse by growers. Water quality benefits are anticipated to occur as a result of this project; however, the magnitude of these benefits is undetermined.	1	√	√	√	√
CRE-LO 15	Proposed Caloosahatchee River Watershed Regulatory Nutrient Source Control Program	To implement a nutrient source control program utilizing BMPs for the Caloosahatchee River Watershed. Ongoing activities include revising 40E-61 Rule to reflect the requirements of the Northern Everglades Protection Act and to expand the rule boundary to include the Caloosahatchee River Watershed as defined by the act.	2	√	√	√	√
CRE-LO 21	Lake Okeechobee and Estuary Watershed Basin Rule (LOER)	In February 2008, SFWMD initiated rule development for an ERP basin rule. The intent is to develop specific supplemental permit criteria for new permitted projects to demonstrate that no increase in total runoff volume will occur from new development that ultimately discharges to Lake Okeechobee or the Caloosahatchee or St. Lucie estuaries.	3	√	√	√	√
CRE-LO 40	West Lake Hicpochee Project	Project comprises a reservoir and stormwater treatment area along the C-19 and C-43 canals, degradation of berms and exotic removal and control. This project could potentially create 55,090 acre-feet of above ground storage and will result in 27.6 and 1.95 mt/yr of TN and TP, respectively.	4	--	√	--	√
CRE-LO 41	C-43 Distributed Reservoirs	The project involves storage reservoirs to capture the excess run-off. This project will result in 39.4 and 2.65 mt/yr of TN and TP, respectively.	4	√	√	√	√
CRE-LO 63	Wastewater & Stormwater Master Plans	Implement urban stormwater retrofitting projects or wastewater projects to achieve additional nutrient reductions and water storage basin wide by working with entities responsible for wastewater and stormwater programs in the service area.	4	√	√	√	√
CRE-LO 64	Proposed Unified Statewide Stormwater Rule	Intended to increase the level of nutrient treatment of stormwater from new development and thereby reduce the discharge of nutrients and excess stormwater volume. Treatment rule will be based on a performance standard of post-development nutrient loading that does not exceed pre-development nutrient loading.	4	√	√	√	√
CRE-LO 68	Comprehensive Planning - Land Development Regulations (LDR)	Basin-wide work with state agencies, cities and counties to review current plans and ensure promotion of low impact design through coordinated comprehensive planning and growth management initiatives.	3	√	√	√	√
CRE-LO 87c	Florida Ranchlands Environmental Services Project (FRESP)	The Florida Ranchlands Environmental Services Project will design a program in which ranchers in the Northern Everglades sell environmental services of water retention, nutrient load reduction, and wetland habitat expansion to agencies of the state and other willing buyers. Pilot project program is	1	√	√	√	√

ID	Management Measure	Management Measure Description	Level	Alternative Plans			
				Alt 1	Alt 2	Alt 3	Alt 4
		currently underway.					
CRE-LO 91	Farm and Ranchland Partnerships	There are two USDA Natural Resources Conservation Service (NRCS) programs that help farmers and ranchers keep their land in agriculture, the Farm and Ranchlands Protection Program and the Wetlands Reserve Program. Both programs provide funds to purchase conservation easements.	4	√	√	√	√
CRE-LO 92	Clewiston STA	The State of Florida currently owns 766 acres of land along the southwestern boundary of Lake Okeechobee in Clewiston that can be used as a stormwater treatment area to treat stormwater that is currently discharging to Lake Okeechobee. Water quality benefits are anticipated to occur as a result of this project; however, the magnitude of these benefits is undetermined.	4	√	√	√	√
CRE 01	Recyclable Water Containment Areas (RWCA)	Utilizes the agricultural lands for reduction of nutrient loads into the Caloosahatchee River. This project will result in 67.5 and 14.3 mt/yr of TN and TP, respectively.	4	--	√	--	√
CRE 02	Centralized Recycled Water Containment Area in the S-4 Basin	Utilizes the agricultural or other lands for temporary storage to remove nutrients and treat agricultural stormwater runoff from the S-4 Basin to help reduce nutrient loading to the Caloosahatchee River, aquifer recharge and add a temporary back up water supply for irrigation. This project will result in 11.9 and 2.41 mt/yr of TN and TP, respectively.	5	--	√	--	√
CRE 04	Caloosahatchee Area Lakes Restoration (Lake Hicpochee)	Restore historical lake bed of Lake Hicpochee using 5,300 acres within footprint of state-owned lands, which will treat runoff from agricultural canals that currently flow into Lake Hicpochee and the Caloosahatchee River. Total load reduction is estimated as 100.4 mt/yr for TN and 24.7 mt/yr for TP.	3	--	--	√	√
CRE 05	East Caloosahatchee Water Quality Treatment Area	The project consists of a constructed wetland designed for optimal removal of N within Lake Hicpochee and the Caloosahatchee River, and to reduce the nutrient pollutants loading to the downstream estuary. This project will result in 80.1 and 19.2 mt/yr of TN and TP, respectively.	3	--	--	--	√
CRE 10	C-43 Water Quality Treatment and Demonstration Project (BOMA property)	The project consists of a constructed wetland designed for optimal removal of N from the Caloosahatchee River and to reduce the nutrient pollutants loading to the downstream estuary. Total load reduction is estimated as 47.8 mt/yr for TN and 9.21 mt/yr for TP.	3	√	√	√	√
CRE 11	Caloosahatchee Ecoscape Water Quality Treatment Area	The project consists of a constructed wetland designed for optimal removal of N from the Caloosahatchee River and to reduce the nutrient pollutants loading to the downstream estuary. Total load reduction is estimated as 50.0 mt/yr for TN and 12.0 mt/yr for TP.	4	--	--	√	√

ID	Management Measure	Management Measure Description	Level	Alternative Plans			
				Alt 1	**Alt 2**	**Alt 3**	**Alt 4**
CRE 13	West Caloosahatchee Water Quality Treatment Area	The project consists of a constructed wetland designed to treat water from the reservoir to reduce nutrient concentrations from the Caloosahatchee River and nutrient pollutants loading to the downstream estuary. Total load reduction is estimated as 58.5 mt/yr for TN and 13.9 mt/yr for TP.	3	--	--	√	√
CRE 18	Harns Marsh Improvements, Phase I & II	Construction of a control weir at the outlet of Harns Marsh into the Orange River, which will raise water levels in Harns Marsh and create 1,450 acre-feet of storage capacity in the canal. This project also includes replacement of other outlet structures (S-HM-2) and (S-HM-3); along with the addition of a controllable gate structure next to the existing inlet to the South Marsh structure (S-HM-1). This project will result in 1.52 and 0.24 mt/yr of TN and TP, respectively.	1	√	√	√	√
CRE 19	Harns Marsh Improvements, Phase II Final Design - ECWCD	Repair the Able Canal weirs, replacement of structure (S-OR-1) and (S-OR-1SE), and install pump station to lift water during dry period. This project could help to reduce discharge into the Orange River at least 20 percent for the 25-year design storm. This project will result in 0.61 and 0.09 mt/yr of TN and TP, respectively.	2	√	√	√	√
CRE 20	Yellowtail Structure Construction - ECWCD	The Yellowtail Structure will replace an old, failing broad crest weir with a new sheet pile weir with operable gates that will allow a better control of canal water quantity and quality, and will help on water recharge purposes. This project will result in 0.32 and 0.03 mt/yr of TN and TP, respectively.	2	√	√	√	√
CRE 21	Hendry County Storage	Buy land for additional storm water storage and treatment during the rainy season and to provide base flows for the ECWCD's outfalls along with additional groundwater recharge in the dry season. This project will result in 2.72 and 0.68 mt/yr of TN and TP, respectively.	3	√	√	√	√
CRE 22	Hendry Extension Canal Widening (Construction) - ECWCD	This proposed canal widening project will help to address additional stormwater storage in the 5.5 mile section of Hendry Extension Canal. Water quality benefits are anticipated to occur as a result of this project; however, the magnitude of these benefits is undetermined.	2	√	√	√	√
CRE 29	Lehigh Acres Wastewater Treatment and Stormwater Retrofit	This project consists of the installation of stormwater treatment features in Lehigh Acres and updates the current stormwater management system. This project also consists of the conversion of high-density septic tanks to centralized wastewater treatment including installation of the infrastructure for a treated wastewater reuse system. This project will result in 68.4 and 13.7 mt/yr of TN and TP, respectively.	3	--	--	√	√
CRE 30	Aquifer Benefit and Storage for Orange River Basin (ABSORB) - ECWCD	Project primarily oriented to increase stormwater storage capacity and SW Lehigh Acres groundwater recharge. This project will result in 3.72 and 0.37 mt/yr of TN and TP, respectively.	2	√	√	√	√

ID	Management Measure	Management Measure Description	Level	Alternative Plans			
				Alt 1	Alt 2	Alt 3	Alt 4
CRE 44	Spanish Creek/ Four Corners Environmental Restoration	Restore flow ways, build 400-acre deep reservoir and remove citrus grove. This project will result in 42.8 and 6.79 mt/yr of TN and TP, respectively.	2	√	√	√	√
CRE 45	Billy Creek Filter Marsh Phase I & II	This project includes construction of a filter marsh facility and a water control structure. The water control structure diverts flows into the filter marsh facility, providing additional attenuation of stormwater flows within the channel itself. The filter marsh facility will consists of an 8-acre open water lake, 13-acre wetland marsh and incorporate/restore an existing 12-acre cypress hammock. This project will result in 2.05 and 0.51 mt/yr of TN and TP, respectively.	1	√	√	√	√
CRE 48	Manuel's Branch Silt Reduction Structure	Install a silt reduction structure near the mouth of the creek to reduce the silt associated with the stream bank scour, erosion and degradation. This project will result in 0.14 and 0.11 mt/yr of TN and TP, respectively.	2	√	√	√	√
CRE 49	Manuel's Branch East and West Weirs	The project involves the installation of two weir water control structures within the existing canal. This project will result in 0.42 and 0.16 mt/yr of TN and TP, respectively.	2	√	√	√	√
CRE 53	Caloosahatchee Creeks Preserve Hydrological Restoration	This project will consist of culvert construction and plugging existing ditches to increase the retention time on the Caloosahatchee Creeks Preserve to help in the rehydration of the wetland and in the quality of water that later discharges into the Caloosahatchee River. It is estimated that this will contribute 1,200 acres of storage capacity and will result in 21.8 and 5.44 mt/yr of TN and TP, respectively.	2	√	√	√	√
CRE 57	Powell Creek Algal Turf Scrubber	This project proposes to install a mobile unit of Algal Turf Scrubber system to remove nutrients, based on the results of a pilot project. This project will result in 0.06 and 0.02 mt/yr of TN and TP, respectively.	2	√	√	√	√
CRE 59	North Fort Myers Surface Water Restoration Project	The proposed management measure includes channel improvements, construction of weirs to control runoff form Palermo and to incorporate filter marsh to reduce contaminants. This project will result in 0.68 and 0.06 mt/yr of TN and TP, respectively.	1	√	√	√	√
CRE 64	Yellow Fever Creek/Gator Slough Transfer Facility (#208509)	Construct an interconnection facility between the Gator Slough Canal and Yellow Fever Creek to transfer the surface waters during the high flow periods. This project will result in 1.26 and 0.15 mt/yr of TN and TP, respectively.	1	√	√	√	√
CRE 69	Cape Coral Wastewater Treatment and Stormwater Retrofit	The City of Cape Coral is implementing a program that involves conversion of septic systems to gravity sewers. This project also includes replacement of older stormwater inlets with the newer inlets designed to assist stormwater. This project will result in 27.0 and 5.40 mt/yr of TN and TP, respectively.	2	--	--	√	√
CRE 77	Cape Coral Canal Stormwater Recovery by ASR	Using aquifer storage and recovery wells in Cape Coral to overcome water shortfall during dry season and to provide flood attenuation during wet season. This project will result in 4.13 and 0.82 mt/yr of TN and TP, respectively.	1	--	√	--	√

ID	Management Measure	Management Measure Description	Level	Alternative Plans			
				Alt 1	Alt 2	Alt 3	Alt 4
CRE 121	City of LaBelle Stormwater Master Plan Implementation	This project will include stormwater conveyance and water quality storage improvements within the City of La Belle consisting in approximately 149 acres resulting in 34.8 and 5.80 mt/yr of TN and TP, respectively.	2	√	√	√	√
CRE 122	Rehydrate Lee County Well Fields (south of Hwy 82)	Redirecting water from Lehigh Acres to rehydrate Lee County well fields to the south of SR 82. This project will result in 1.27 and 0.23 mt/yr of TN and TP, respectively.	3	--	√	--	√
CRE 123	North Ten Mile Canal Stormwater Treatment System	Stormwater storage/detention 12 acre-feet area for urban and commercial area. Estimated at 0.82 mt/yr for TN and 0.33 mt/yr for TP for 3-year event.	2	--	--	√	√
CRE 124	Carrell Canal (FMCC) Water Quality Improvements	Stormwater treatment area to contribute with 0.13 mt/yr for TN and 0.14 mt/yr for TP reduction coming to Carrel Canal.	2	--	--	√	√
CRE 125	Shoemaker-Zapato Canal Stormwater Treatment	Installation of weir/control structures to increase channel storage providing peak flow attenuation, reducing erosion and siltation into Billy Creek. This project will result in 0.54 and 0.14 mt/yr of TN and TP, respectively.	2	--	--	√	√
CRE 126	Fort Myers-Cape Coral Reclaimed Water Interconnect	Installation of a 20-inch diameter transmission line from Fort Myers Treatment Plant to Cape Coral Reclamation Treatment Plant. This will help prevent discharging 9 MGD treated water into Caloosahatchee River. Water quality benefits are anticipated to occur as a result of this project; however, the magnitude of these benefits is undetermined.	5	--	--	--	√
CRE 128	East Caloosahatchee Storage	Construction of distributed reservoirs on 7500 acres of private properties. The project could potentially create 100,000 acre-feet of above ground storage and will result in 69.1 and 5.16 mt/yr of TN and TP, respectively.	4	--	√	--	√
CRE 128a	Caloosahatchee Storage - Additional	Creation of 50,000 acre-feet of above ground storage in the Caloosahatchee Watershed. This project will result in 58.0 and 4.30 mt/yr of TN and TP, respectively.	4	--	--	--	√
CRE 129	Wastewater Treatment Plant Upgrade and Reclaimed Water	Upgrade existing wastewater treatment plants to reduce the effluent loadings. Includes the potential for distribution as reclaimed water. Also construct future plants to higher treatment levels. Water quality benefits are anticipated to occur as a result of this project; however, the magnitude of these benefits is undetermined.	5	--	--	--	√
CRE 130	Animal Manure Application Rule	Landowners who apply more than one ton per acre of manure must develop conservation plans, approved by the US Department of Agriculture/National Resource Conservation Service (USDA/NRC), that specifically address the application of animal wastes and include soil testing to demonstrate the need for manure application.	1	√	√	√	√

ID	Management Measure	Management Measure Description	Level	Alternative Plans			
				Alt 1	Alt 2	Alt 3	Alt 4
CRE 131	Application of Septage Rule	FDOH rule which regulates the regarding application of septage in the Caloosahatchee and St. Lucie rivers. Entities disposing of septage within the watersheds must develop and submit to FDOH an agricultural use plan that limits applications, based upon nutrient loading.	1	√	√	√	√

SECTION 6.5

ALTERNATIVE PLAN EVALUATION AND COMPARISON

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6.5 ALTERNATIVE PLAN EVALUATION AND COMPARISON

Section 6.5 evaluates and compares the water quantity and water quality results for Alternatives 1 through 4 of the Caloosahatchee River Watershed Protection Plan (CRWPP). The four alternatives are a combination of various management measures more fully described in Sections 6.1, 6.4, and **Appendix B.**

Alternative 1: Alternative 1 is defined as the "common elements" and is included in all subsequent alternatives. Alternative 1 includes the Level 1 through 4 management measures for which construction or implementation were determined to be imminent by the working team. All source control management measures are included in Alternative 1.

Alternative 2: Alternative 2 maximizes the surface water storage in the freshwater watershed. Six management measures were added to the common elements. Among the management measure included is the East Caloosahatchee Storage Project, potentially creating 100,000 acre-feet of aboveground storage in the watershed.

Alternative 3: Alternative 3 maximizes the total phosphorus (TP) and total nitrogen (TN) load reductions in water from the Caloosahatchee River Watershed, again including the common elements of Alternative 1. Eight water quality management measures were incorporated in Alternative 3, including five regional projects and three additional local projects.

Alternative 4: Alternative 4 is a compilation of Alternative 2 and Alternative 3 with three management measures added to increase storage capacity and improve water quality in the watershed. Alternative 4 is intended to optimize watershed storage and maximize TP and TN load reductions in the watershed. The three additional regional management measures are the Fort Myers-Cape Coral Reclaimed Water Interconnect, the Caloosahatchee Storage - Additional (50,000 acre-feet), and the East Caloosahatchee Water Quality Treatment Area.

In an effort to determine the appropriate level of storage to implement within the watershed, the working team evaluated varying levels of watershed storage beyond what was prescribed in Alternative 2. Based on the insight gained from this effort, the working team determined that the four additional management measures in Alternative 4 provided the most practicable water storage in the watershed needed to minimize damaging flows to the Caloosahatchee Estuary.

6.5.1 Water Quantity

One objective of the CRWPP is to improve water quantity and delivery to the Caloosahatchee Estuary by reducing the frequency and duration of harmful freshwater releases. There are three performance measures for evaluating the plan alternatives with respect to water quantity: the High Discharge Criteria, the Salinity Envelope Criteria and the Target Flow Index (TFI). The criteria are based on maintaining the ecological health of the system and measure total flows to the Caloosahatchee Estuary at the Franklin Lock and Dam structure (S-79). The CRWPP only addresses the watershed contribution to the estuary. Lake Okeechobee discharges were addressed in the Lake Okeechobee Watershed Construction Project, Phase II Technical Plan (LOP2TP).

6.5.1.1 High Discharge Criteria

The target for the ecology-based high discharge criteria is three or fewer occurrences of mean monthly flows greater than 2,800 cubic feet per second (cfs) and no occurrences of mean monthly flows over 4,500 cfs for the model simulated 36-year period of record (1970 to 2005). The basis for the High Discharge Criteria is discussed in detail in Section 6.2. The following sections present the Northern Everglades Regional Simulation Model (NERSM) results for the high discharge criteria and evaluate and compare the performance of the four alternatives relative to the criteria.

6.5.1.1.1 High Discharge Criteria Results

The performance of the base conditions and the four alternatives compared to the high discharge criteria target are provided in **Figure 6.5-1**. The left bars represent a tally of the mean monthly flows greater than 2,800 cfs and the right bars represent a tally of the mean monthly flows greater than 4,500 cfs.

Under the RWPPB condition, discharges exceeding 2,800 cfs decreased by 31 percent and discharges exceeding 4,500 cfs decreased by 43 percent compared to the CBASE Condition. These improvements are from the base projects included in the RWPPB Condition, including the LOP2TP Preferred Alternative and the C-43 Reservoir.

All of the alternatives showed improvement in reducing the number of exceedances compared to the RWPPB Condition. As expected, Alternative 4 showed the greatest improvement for both flow threshold values, reducing the number of watershed discharges greater than 2,800 cfs to 41 and reducing the number of discharges greater than 4,500 cfs to 16.

The implementation of the alternatives reduced the occurrences of total basin and Lake Okeechobee flows greater than 2,800 cfs by 7 percent to 20 percent, from the RWPPB shown in **Figure 6.5-1**. The number of occurrences of total discharges greater than 4,500 cfs also decreased from the RWPPB condition to all four alternatives by about 5 percent to 24 percent.

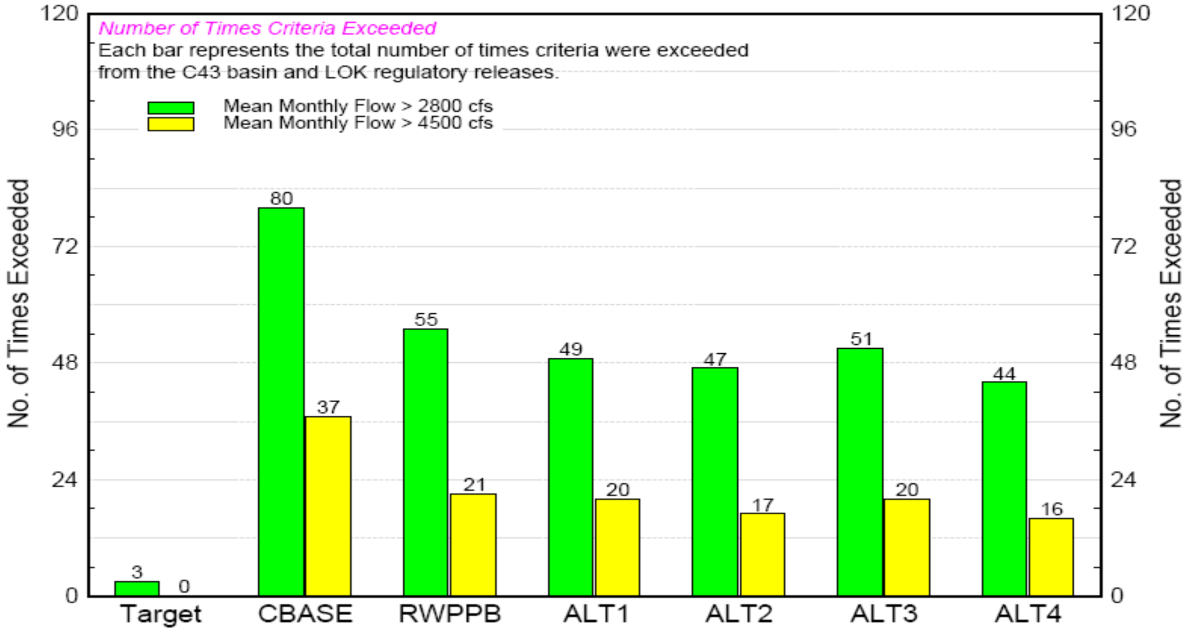


Figure 6.5-1. High Discharge Criteria Performance

Tables 6.5-1a and **6.5-1b** further divide each of the exceedances depicted in **Figure 6.5-1** by its source. This is important, since this plan's objective is to address the watershed contribution to the estuary. Lake Okeechobee discharges were addressed in the LOP2TP. Identifying the source of water that contributes to the exceedances of the High Discharge Criteria helps to focus the management measures on this objective. When considering the Caloosahatchee River Watershed contribution only, the four alternatives reduced the number of discharges greater than 2,800 cfs by 21 percent to 39 percent and the occurrences of discharges greater than 4,500 cfs by 14 percent to 43 percent.

Table 6.5-1a. Breakdown of Flows Greater than 2,800 cfs to Estuary by Source (Number of Months out of 432 Total Months of Simulation (1970-2005 period of record))

Discharges greater than 2,800 cfs	**CBASE**	**RWPPB**	**ALT1**	**ALT2**	**ALT3**	**ALT4**
Caloosahatchee River Watershed	**48**	**33**	**26**	**22**	**26**	**20**
Lake Okeechobee	**21**	**5**	**7**	**7**	**7**	**8**
Caloosahatchee River Watershed and Lake Okeechobee Combined	**11**	**17**	**16**	**18**	**18**	**16**
TOTAL	**80**	**55**	**49**	**47**	**51**	**44**

Table 6.5-1b. Breakdown of Flows Greater than 4,500 cfs to Estuary by Source
(Number of Months out of 432 Total Months of Simulation (1970 to 2005 period of record))

Discharges greater than 4,500 cfs	CBASE	RWPPB	ALT1	ALT2	ALT3	ALT4
Caloosahatchee River Watershed	**10**	**7**	**6**	**5**	**5**	**4**
Lake Okeechobee	**5**	**1**	**2**	**1**	**2**	**1**
Caloosahatchee River Watershed and Lake Okeechobee Combined	**22**	**13**	**12**	**11**	**13**	**11**
TOTAL	**37**	**21**	**20**	**17**	**20**	**16**

6.5.1.2 Salinity Envelope

The salinity envelope target is the second CRWPP water quantity performance measure. The restoration salinity envelope targets for the Caloosahatchee Estuary eliminate the occurrence of mean monthly flows less than 450 cfs from October to July, and limit the number of times monthly flows exceed 2,800 cfs to three occurrences. Meeting the mean monthly flow targets will ensure that the salinity envelope targets are met.

Meeting the salinity envelope target will maintain desirable salinity levels in the Caloosahatchee Estuary conducive to the estuary's ecologic health. Like the High Discharge Criteria, this performance measure considers both the quantity and duration of discharges to the Caloosahatchee Estuary from the Caloosahatchee River Watershed.

6.5.1.2.1 Salinity Envelope Results

Figure 6.5-2 illustrates the number of times the salinity envelope criteria are not met for the Caloosahatchee Estuary based on modeled mean monthly flows for the period of record (top chart), and the number of consecutive months when exceedances occurred (bottom chart). On the top chart, the bars on the left indicate the number of months the average surface water flows were less than 450 cfs, and the bars on the right indicate the number of months the average flow from the Caloosahatchee River Watershed exceeded 2,800 cfs. On the bottom chart, the numbers on the left of each column represent the number of times the salinity envelope low flow criterion was not met for consecutive months, and the numbers on the right of each column represent the same for the salinity envelope high flow criterion.

As can be seen in **Figure 6.5-2,** Alternative 4 resulted in a 98% improvement over current conditions in regards to the salinity envelope low flow criterion, reducing the number of exceedances from 189 to 4. In addition, Alternative 4 resulted in a 66 percent reduction (from 55 to 44) in the number of exceedances of the salinity envelope high flow criterion, whereas Alternative 1 resulted in a reduction of only 33 percent (from 55 to 49).

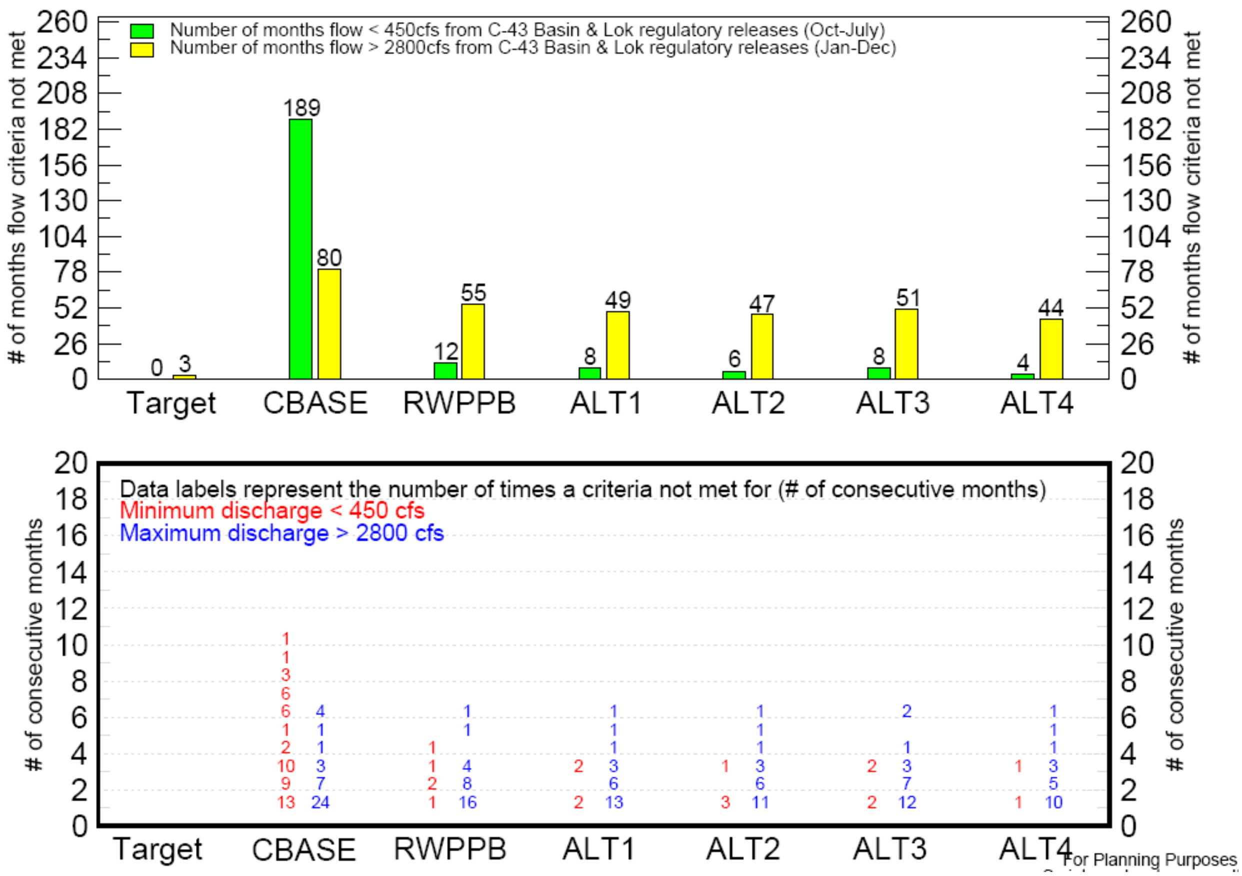


Figure 6.5-2. Salinity Envelope Criteria Performance

6.5.1.3 Target Flow Index

TFI was the third CRWPP water quantity performance measure. TFI compares the modeled flow distributions to a desired flow distribution. Deviation from the desired flow distribution will result in a negative TFI. The TFI becomes progressively negative as the flow distribution deviates further from the targeted distribution. The goal is to have a TFI value of zero, which would indicate a perfect match of the flow distribution corresponding to the ecologically-based target flow time series, EST05.

6.5.1.3.1 Target Flow Index Results

Figure 6.5-3 displays the flow distribution graph of the base conditions and the alternatives, as well as the TFI score for EST05. The EST05, which is depicted by the green line, is the desired condition or target flow distribution and therefore has a TFI of zero.

As expected, the TFI for the RWPPB Condition is closer to the desired value of zero at –0.121, an improvement from the CBASE Condition by 76 percent. All of the alternatives showed improvement in reaching the desired flow distribution when compared to the RWPPB Condition. The flow distribution for the alternatives matched the EST05 flow distribution better than the distribution for the RWPPB Condition. The corresponding TFI scores for the alternatives were closer to the EST05 by 35 percent to 15 percent compared to the RWPPB Condition, with

Alternative 4 being the closest to EST05 with a score of -0.733. Alternative 4 results in an 84 percent improvement over current conditions.

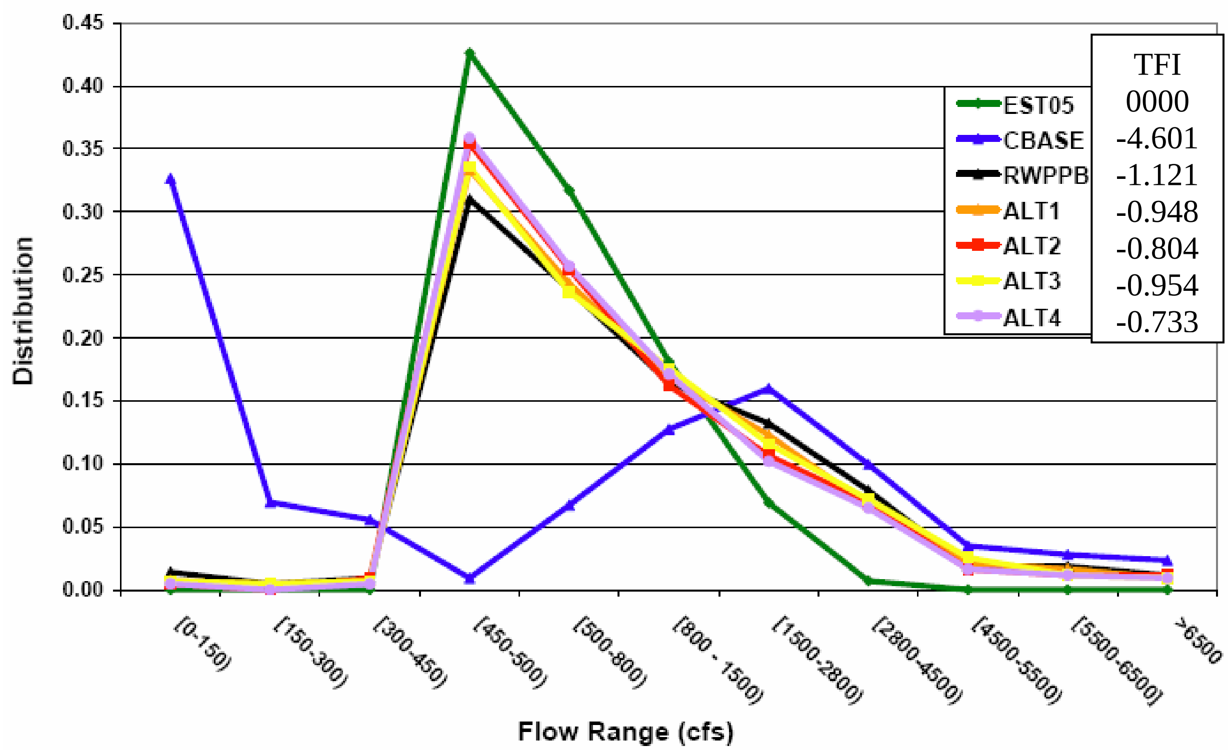


Figure 6.5-3. Target Flow Index Performance

6.5.1.4 Lake Okeechobee Proposed Minimum Water Level Criteria

Performance indicators were used to measure how an alternative may impact, either directly or indirectly, other water related needs of the region. One performance indictor in the Caloosahatchee River Watershed is the Lake Okeechobee minimum water levels. The target minimum water level condition for Lake Okeechobee allows for only one occurrence over a six-year period when water levels drop below 11 feet National Geodetic Vertical Datum (NGVD) for more than 80 days. The model results are provided in **Figure 6.5-4.** The RWPPB and all of the CRWPP alternatives met the Lake Okeechobee minimum water level criteria, with only one occurrence when the lake's water levels were less than 11 feet NGVD for greater than 80 days.

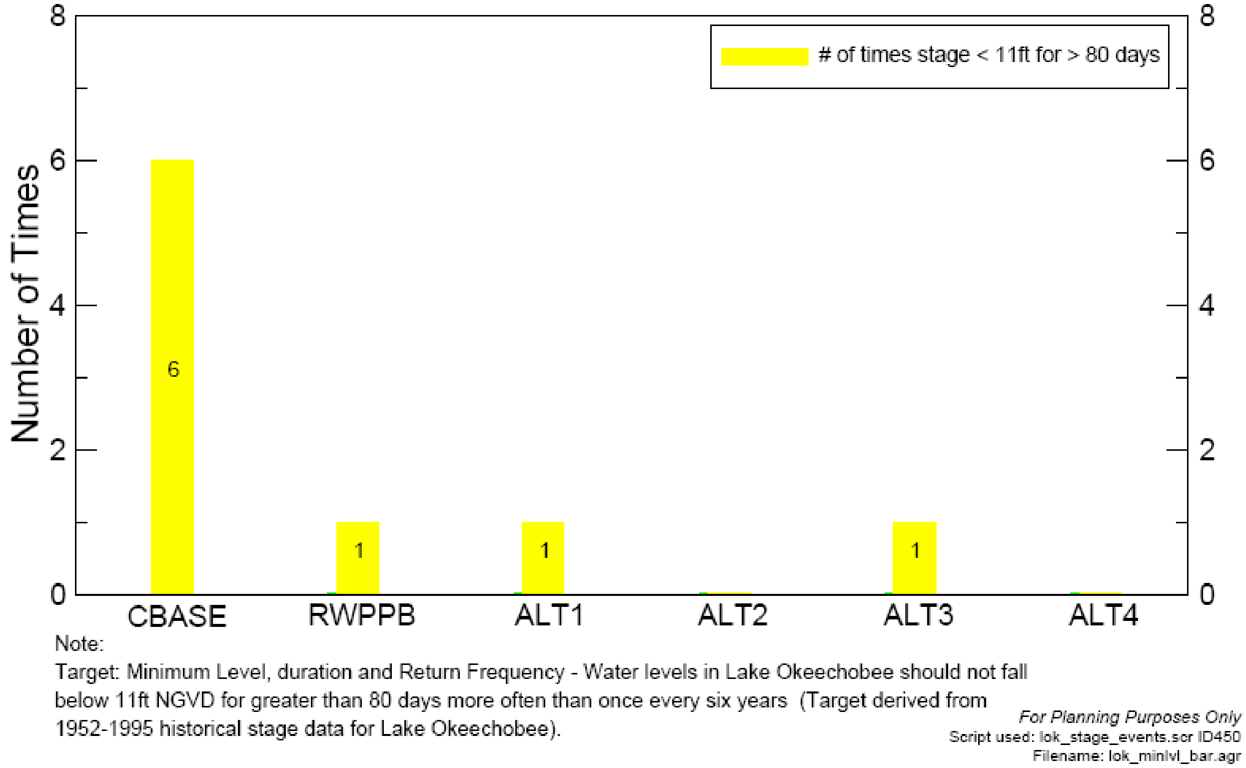


Figure 6.5-4. Lake Okeechobee Minimum Water Level Performance

6.5.1.5 Lake Okeechobee Service Area Irrigation Demand

Another CRWPP performance indicator is to ensure that the plan does not adversely affect the Lake Okeechobee Service Area (LOSA) water supply demands. The water supply impact of the RWPPB and each of the alternatives are shown in **Figure 6.5-5**. All alternatives were evaluated to determine their impact on Lake Okeechobee's capacity to meet Lake Okeechobee Service Area (LOSA) water supply demands by using the most severe seven water years within the period of record. Alternative 4 provided the greatest reduction in demand cutback volumes. The additional reductions in Water Year 2001 cutbacks with Alternative 4 compared to Alternatives 1, 2, and 3 are a likely result of additional storage in the Caloosahatchee River Watershed reducing demands on Lake Okeechobee.

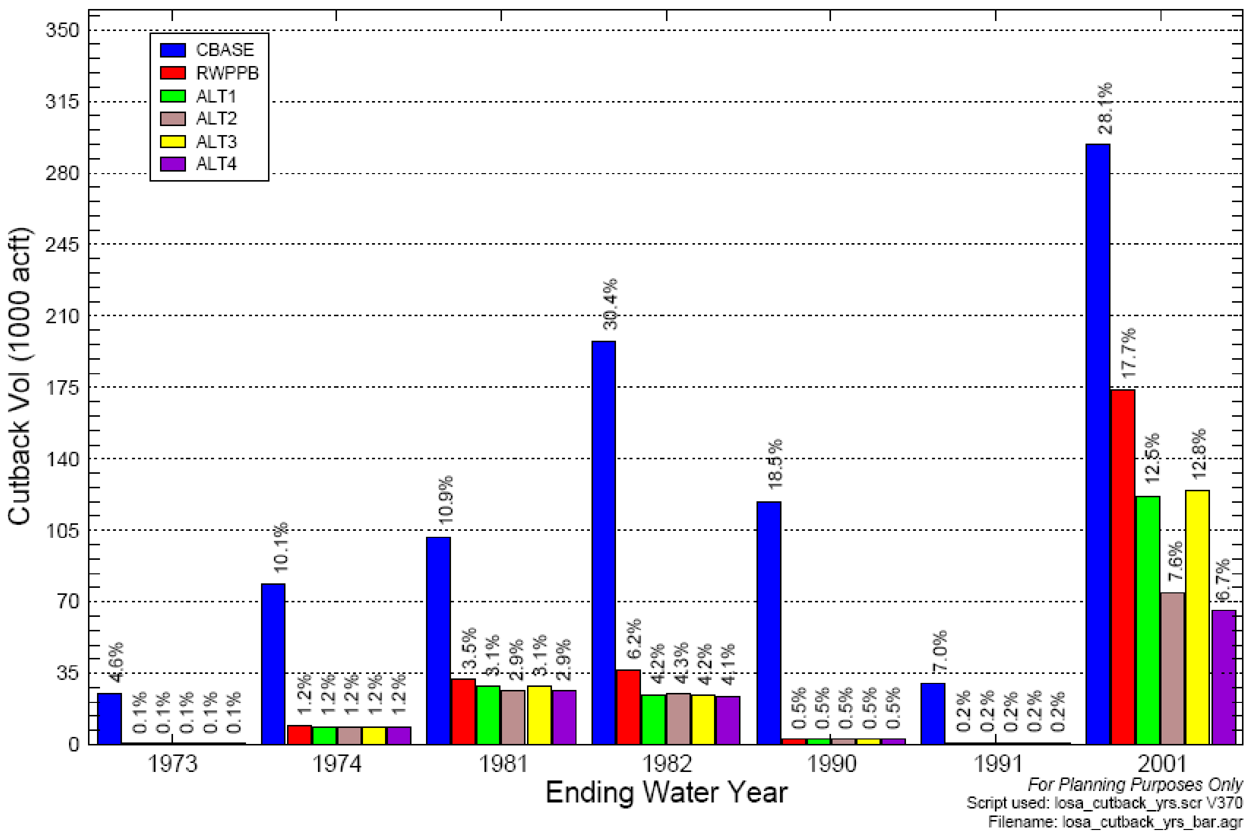


Figure 6.5-5. Lake Okeechobee Service Area Performance

Figure 6.5-6 shows the sources and volumes of water supplies (top two bar charts) and the mean annual percentage of water supply demands not met for the Everglades Agricultural Area and other LOSA area (bottom two bar charts), for the same seven water years with the most severe LOSA water supply cutbacks. All alternatives showed reduction in cutbacks relative to RWPPB, with Alternative 4 providing the lowest cutback volume and/or percentage.

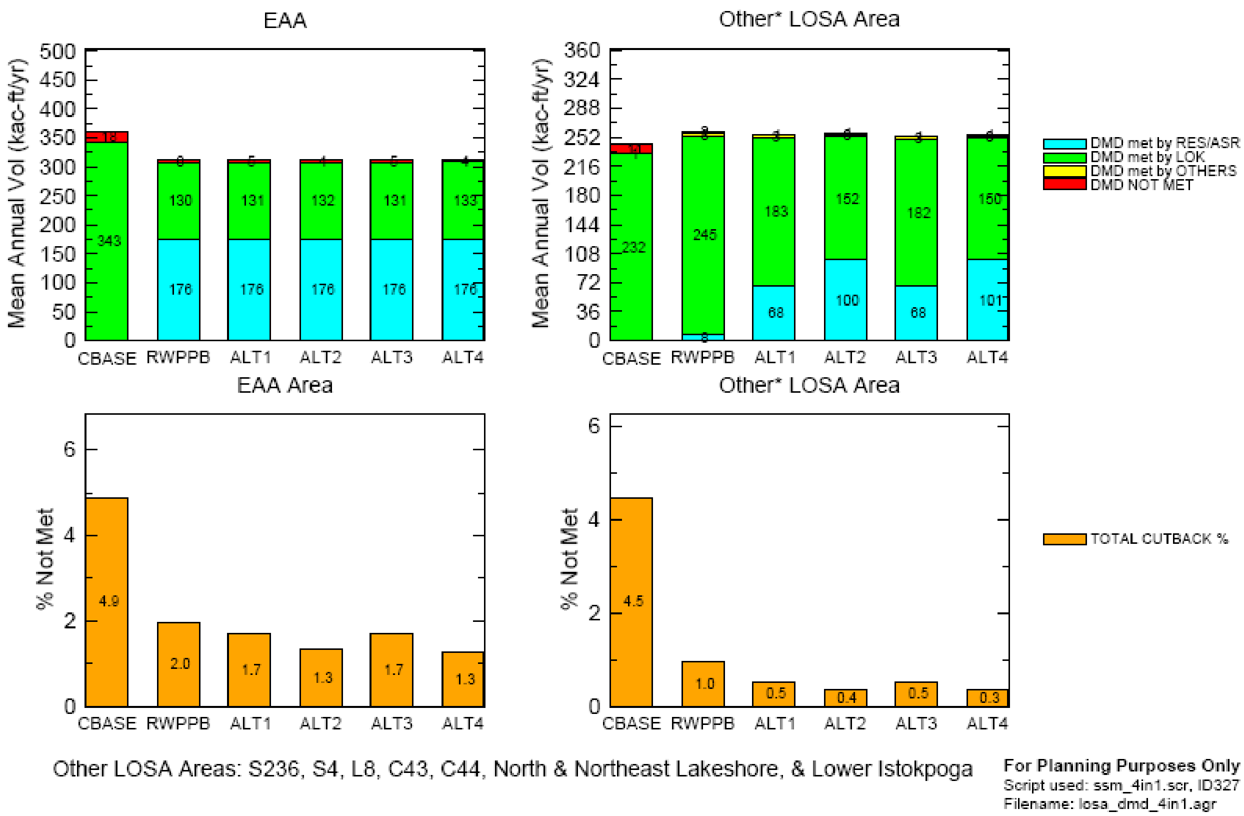


Figure 6.5-6. Lake Okeechobee Supplemental Irrigation Performance

6.5.2 Water Quality

The Northern Everglades and Estuaries Protection Program (NEEPP) in Section 373.4595, Florida Statutes (F.S.) requires the CRWPP to contain an implementation schedule for pollutant load reductions consistent with any adopted nutrient Total Maximum Daily Loads (TMDLs) and in compliance with applicable state water quality standards. The Florida Department of Environmental Protection (FDEP) was developing TMDLs for the Caloosahatchee River Watershed during the formulation of the CRWPP and as a result, an interim water quality goal was used by the coordinating agencies to maximum nutrient load reductions. NEEPP requires the CRWPP to be updated every three years. Therefore, the water quality goals will be updated in the three-year update of the CRWPP to include any established TMDLs in the Caloosahatchee River Watershed.

The working team also considered estimated natural background concentrations of TP and TN against which all alternative condition concentrations were then checked. The "natural condition" was based on the minimum value that would be expected for a freshwater riverine system under "natural conditions" for southern Florida. For this study, the natural background concentration for TP was estimated as 80 parts per billion (ppb) (0.080 mg/L) and TN as 0.80 parts per million (ppm) (0.80 mg/L). Decisions regarding the concentrations were established in writing between Robert Chamberlin and the South Florida Water Management District (SFWMD) in April 2008.

The water quality evaluation method was described in Section 6.3. The base projects that influence anticipated TP and TN loading to the Caloosahatchee Estuary are: the C-43 West Basin Storage Reservoir and implementation of the LOP2TP.

6.5.2.1 Water Quality Results

The summaries of TP and TN load reductions are provided in **Tables 6.5-2** and **6.5-3**, respectively. The range of total average annual load reductions from the alternatives compared to the RWPPB Condition is 27 to 38 percent (84.8 and 121.0 mt/yr) TP and 24 to 36 percent (684 and 1,011 mt/yr) TN.

Each of the four alternatives provides a reduction in annual TP and TN loads compared to the CBASE and RWPPB conditions, with Alternative 4 achieving the maximum load reductions. The load reductions from the Caloosahatchee River Watershed represent water quality benefits from the CRWPP projects only. Alternative 4 resulted in a 39 percent reduction in TP loading and a 38 percent reduction in TN loading from the Caloosahatchee River Watershed. With Alternative 4, the combined average annual TP and TN loading was reduced 39 percent for TP and 38 percent for TN compared to the CBASE Condition, and 31 percent for TP and 25 percent for TN compared to the RWPPB Condition.

For the load contributed from Lake Okeechobee and the Caloosahatchee River Watershed, the total load reduction of 38 percent for TN has resulted in a remaining load and concentration of 3,011 mt and 1.08 ppm, respectively. Similarly, the total load reduction of 39 percent for TP has resulted in a remaining load and concentration of 265 mt and 94 ppb, respectively. Remaining TP and TN concentrations are higher than the natural background concentrations, although to a much lesser extent than under the CBASE and RWPPB conditions. The major focus of management measures implemented for nutrient reductions in the watershed is TN treatment, especially in the West, East, and Tidal Caloosahatchee sub-watersheds. These sub-watersheds are major contributors of high TN levels, as discussed below and also in Section 6.3.2.4.

Table 6.5-2. Total Phosphorus Load Reductions

Total Phosphorus		Annual Load (mt/yr)	Concentration (ppb)	Load Reduction (%)	
				RWPPB Condition[1]	CBASE Condition[2]
RWPPB Condition	Lake Okeechobee	66.6	80	n.a.	36%
	Caloosahatchee River Watershed	318.9	161	n.a.	2%
	Combined	385.4	137	n.a.	10%
Alt 1	Lake Okeechobee	66.6	80	0%	36%
	Caloosahatchee River Watershed	234.1	118	27%	28%
	Combined	300.6	107	22%	30%
Alt 2	Lake Okeechobee	66.6	80	0%	36%
	Caloosahatchee River Watershed	222.0	113	30%	32%
	Combined	288.6	103	25%	33%

Total Phosphorus		Annual Load (mt/yr)	Concentration (ppb)	Load Reduction (%)	
				RWPPB Condition[1]	CBASE Condition[2]
Alt 3	Lake Okeechobee	66.6	80	0%	36%
	Caloosahatchee River Watershed	204.2	103	36%	37%
	Combined	270.8	96	30%	37%
Alt 4-Preferred Plan	Lake Okeechobee	66.6	80	0%	36%
	Caloosahatchee River Watershed	197.9	101	38%	39%
	Combined	264.5	94	31%	39%

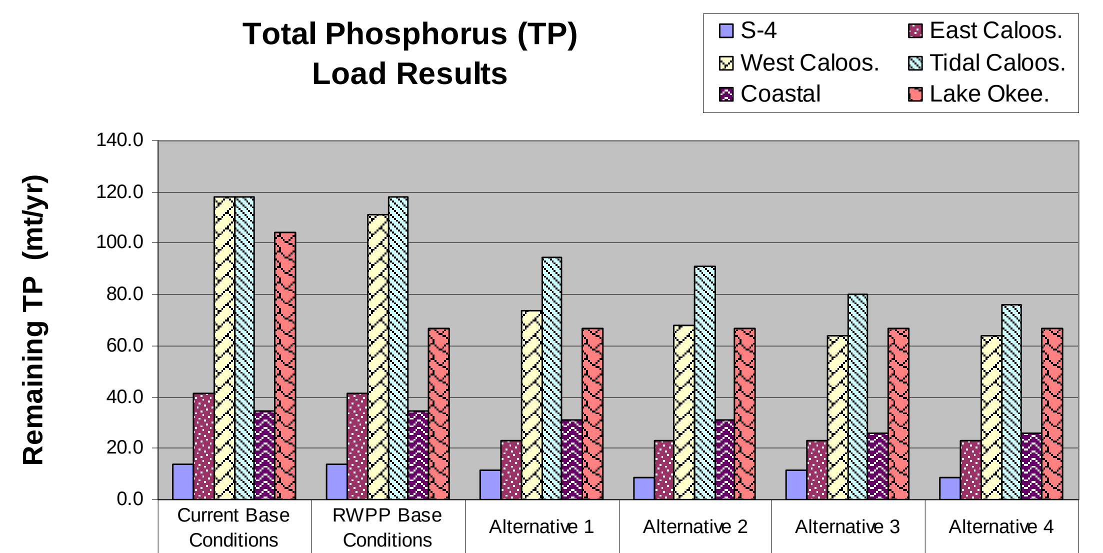
[1] Percent load reduction compared to RWPPB Condition – only applies to Alternatives 1 through 4.
[2] Percent load reduction compared to CBASE Condition – only applies to Alternatives 1 through 4.

Table 6.5-3. TN Load Reductions

Total Nitrogen		Annual Load (mt/yr)	Concentration (ppm)	Load Reduction (%)	
				RWPPB Condition[1]	CBASE Condition[2]
RWPPB Condition	Lake Okeechobee	1,215	1.46	n.a.	38%
	Caloosahatchee River Watershed	2,806	1.42	n.a.	3%
	Combined	4,021	1.43	n.a.	17%
Alt 1	Lake Okeechobee	1,215	1.46	0%	38%
	Caloosahatchee River Watershed	2,122	1.07	24%	27%
	Combined	3,337	1.19	17%	31%
Alt 2	Lake Okeechobee	1,215	1.46	0%	38%
	Caloosahatchee River Watershed	2,004	1.02	29%	31%
	Combined	3,219	1.15	20%	34%
Alt 3	Lake Okeechobee	1,215	1.46	0%	38%
	Caloosahatchee River Watershed	1,856	0.94	34%	36%
	Combined	3,071	1.09	24%	37%
Alt 4 - Preferred Plan	Lake Okeechobee	1,215	1.46	0%	38%
	Caloosahatchee River Watershed	1,796	0.91	36%	38%
	Combined	3,011	1.08	25%	38%

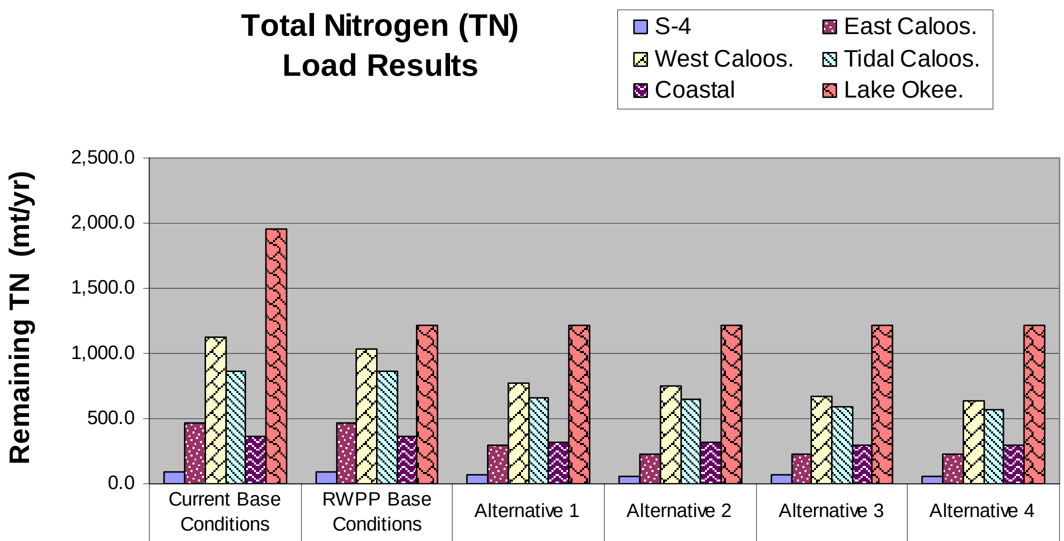
[1] Percent load reduction compared to RWPPB Condition – only applies to Alternatives 1 through 4.
[2] Percent load reduction compared to CBASE Condition – only applies to Alternatives 1 through 4.

As discussed in Section 6.3.2.4, the West and Tidal Caloosahatchee sub-watersheds were identified "hot spots" (sub-watersheds with disproportionately high annual TN loads and concentration); therefore, they were targeted for water quality management measures. The focused water quality efforts applied to these sub-watersheds are highlighted in **Figures 6.5-7 and 6.5-8** (the reduction of height in the bars for West and Tidal Caloosahatchee sub-watersheds). Remaining loads to the estuary from the West Caloosahatchee Sub-watershed were reduced by 38 percent for TN and 43 percent for TP. Similarly, from the Tidal Caloosahatchee Sub-watershed remaining loads were reduced 34 percent for TN and 36 percent for TP. Although not as large in magnitude, loads from the East Caloosahatchee Sub-watershed were significant; water-quality efforts were estimated to reduce the annual loads by 50 percent for TN and 44 percent for TP.



	Current Base Conditions	RWPP Base Conditions	Alternative 1	Alternative 2	Alternative 3	Alternative 4
S-4	13.6	13.6	11.3	8.9	11.3	8.9
East Caloos.	41.3	41.3	23.0	23.0	23.0	23.0
West Caloos.	118.3	111.0	73.9	68.2	63.8	63.8
Tidal Caloos.	118.2	118.2	94.7	90.8	80.0	76.1
Coastal	34.8	34.8	31.2	31.2	26.2	26.2
Lake Okee.	104.5	66.6	66.6	66.6	66.6	66.6

Figure 6.5-7. Remaining Total Phosphorus Loads by Sub-watershed



	Current Base Conditions	RWPP Base Conditions	Alternative 1	Alternative 2	Alternative 3	Alternative 4
S-4	93.0	93.0	73.1	61.2	73.1	61.2
East Caloos.	460.4	460.4	290.2	229.8	229.8	229.8
West Caloos.	1,121.9	1,028.7	775.6	748.6	667.1	637.6
Tidal Caloos.	863.6	863.6	664.7	645.8	592.5	573.6
Coastal	360.8	360.8	318.8	318.8	293.8	293.8
Lake Okee.	1,950.9	1,215.0	1,215.0	1,215.0	1,215.0	1,215.0

Figure 6.5-8. Remaining Total Nitrogen Loads by Sub-watershed

6.5.3 Identification of the Preferred CRWPP Construction Project

NEEPP requires the CRWPP to contain an implementation schedule for pollutant load reductions consistent with any adopted nutrient TMDLs and applicable state water quality standards, and to consider and balance water supply, flood control, estuarine salinity, aquatic habitat, and water quality considerations when assessing current water management practices within the Caloosahatchee River Watershed. Both TP and TN load reduction from watershed flows to the Caloosahatchee Estuary and additional storage capacity in the Caloosahatchee River Watershed is required to achieve the restoration goals for the Caloosahatchee Estuary.

Each alternative was evaluated for its performance at reducing damaging discharges to the Caloosahatchee Estuary and TP and TN loads while maintaining existing levels of water supply. Alternative 4 was selected as the plan that best met the legislative intent of NEEPP. Alternative 4 is referred to as the preferred CRWPP or the preferred Plan from this point forward.

The preferred Plan achieved a total load reduction of 38 percent for TN and 39 percent for TP, as shown in **Table 6.5-4**. These results reflect the "big picture" benefits provided by implementation of the LOP2TP and the CRWPP. The load reductions to the estuary achieved by each plan are also included in **Table 6.5-4**. It should be noted that the total load reduction of 39 percent for P has resulted in a remaining load and concentration of 265 metric tons (mt) and 94 ppb, respectively. On the other hand, the total load reduction of 38 percent for N has resulted in remaining load and concentration of 3,011 mt and 1.08 ppm, respectively. However, based on the current assessment, it appears that excessively high N levels throughout the watershed pose the greatest water quality challenge. Therefore, the major focus of management measures implemented for nutrient reductions in the watershed is N treatment, especially in the West Caloosahatchee Sub-watershed, which is a major contributor of high N levels. Total phosphorus and total nitrogen load reduction performance will be revisited once the TMDLs are formally adopted by FDEP, which will provide specific loading rates, compliance locations, and compliance methodology.

Table 6.5-4. Load Reductions Achieved by the Preferred Plan for Total Phosphorus and Total Nitrogen

	Total Phosphorus	**Total Nitrogen**
Total Load Reduction[1]	39%	38%
Watershed Load Reduction[2]	38%	36%
Lake Okeechobee Load Reduction[3]	36%	38%
Resulting Load	265 mt	3,011 mt
Resulting Concentration	94 ppb	1.08 ppm

[1] Total load reduction from Lake Okeechobee and Caloosahatchee River Watershed compared to the CBASE Condition
[2] Load reductions only from the Caloosahatchee River Watershed compared to the RWPPB Condition
[3] Load reductions only from the Lake Okeechobee compared to the CBASE condition

In addition to the water quality benefits mentioned above, implementation of the preferred Plan is anticipated to result in the following water quality and water quantity benefits:

Water Quantity

- Construction of approximately 36,000acres of reservoirs and over 15,000 acres of Stormwater Treatment Areas and and Water Quality Treatment Areas;
- Providing approximately 400,000 acre-feet of water storage within the Caloosahatchee River Watershed;
- Over 50 percent reduction of the occurrences of flows between 2,800 and 4,500 cfs from current conditions;
- Over 60 percent reduction in flows greater than 4,500 cfs from current conditions;
- A 98 percent improvement over current conditions for flows less than 450 cfs;
- An 84 percent improvement over current conditions towards the achievement of the Target Flow Index; and
- Reduction in the percentage of months with detrimental high or low flows from 62 percent to 11 percent.

Water Quality

- Implementation of BMPs on more than 430,000 acres of agricultural lands and 145,000 acres of urban lands;
- Completing regulatory rule revisions (ERP and Regulatory Nutrient Source Control Rule revisions);

- Construction of approximately 15,000 acres of Stormwater Treatment Areas and Water Quality Treatment Areas; and
- Restoring more than 2,000 acres of wetlands and natural areas within the Caloosahatchee River Watershed.

CHAPTER 7

CALOOSAHATCHEE RIVER WATERSHED POLLUTANT CONTROL PROGRAM

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7.0 CALOOSAHATCHEE RIVER WATERSHED POLLUTANT CONTROL PROGRAM

Pollutant source control is integral to the success of any water resource protection or restoration program. Source control programs in the Caloosahatchee River Watershed are evolving and expanding through cooperative and complementary efforts by the Florida Department of Environmental Protection (FDEP), the Florida Department of Agriculture and Consumer Services (FDACS), and the South Florida Water Management District (SFWMD). The Caloosahatchee River Watershed Pollutant Control Program is designed to be a multi-faceted approach to reducing pollutant loads. The program includes improving the management of pollutant sources within the watershed through implementation of regulations and best management practices (BMPs) and development and implementation of improved BMPs focusing on nitrogen (N) and phosphorus (P). The Northern Everglades and Estuaries Protection Program (NEEPP) legislation [Section 373.4595, Florida Statutes (F.S.) (2007)] further refines the responsibilities of the coordinating agencies to achieve the objectives of the Caloosahatchee River Watershed Protection Program (CRWPP) on an expedited basis, including:

- Implementation of non-point source BMPs on agricultural and non-agricultural lands to ensure that the amount of nutrients discharged offsite are minimized to the greatest possible extent;
- Coordination with local governments to implement the nonagricultural, nonpoint-source BMPs within their respective geographic boundaries;
- Assessment of current water management practices within the watershed and development of recommendations for structural, nonstructural, and operational improvements that consider and balance water quality and supply, flood control, estuarine salinity, and aquatic habitat considerations;
- Ensuring that domestic wastewater residuals within the Caloosahatchee River Watershed do not contribute to nutrient loadings in the watershed;
- Coordination with the Florida Department of Health (FDOH) to ensure that septage disposal within the watershed is under an approved agricultural use plan, limiting applications based on nutrient loading limits established in the proposed revisions SFWMD’s 40E-61 Regulatory Nutrient Source Control Program;
- Ensuring that entities utilizing land-application of animal manure develop a resource management system level conservation plan;
- Utilization of alternative and innovative nutrient control technologies;
- Utilization of federal programs that offer opportunities for water quality treatment, including preservation, restoration, or creation of wetlands on agricultural land; and
- Implementation of a source control monitoring program to measure the collective performance and progress of the coordinating agencies’ programs, to support adaptive management within the programs, to identify priority areas of water quality concern and BMP optimization, and to provide data to evaluate and enhance performance of downstream treatment facilities.

Source control programs are anticipated to be implemented through a phased approach based on identified priority areas of water quality concern.

7.1 Non-Point Source Best Management Practices

Nutrient source controls refer to activities and measures (many are referred to as BMPs) that can be utilized on agricultural and non-agricultural lands to ensure that the amount of nutrients, specifically P and N, in offsite discharge is minimized, thereby preventing excessive nutrients from entering the waterways. Implementation of BMPs is a relatively cost-effective pollutant reduction and prevention measure. BMPs include structural and non-structural measures. Structural measures include creating physical changes in the landscape to reroute discharges, installing water control structures, and erecting barriers. Non-structural source control measures include education, operational or behavioral changes, and establishing regulations.

The major categories of commonly used BMPs are nutrient management, water management, and erosion control. Nutrient management considers the amount, timing, and placement of nutrients, such as fertilizer. Water management considers the timing, volume, maintenance, and overall efficiency of the stormwater and irrigation systems. Erosion control practices prevent the off-site transport of nutrients in particulate matter and sediment.

One key component of an effective BMP program is education to make participants aware of practices and activities that may contribute to pollutants in discharges. The education component of source control also includes providing the latest technical information, through demonstration and research projects, to continually optimize the effectiveness of BMPs and to introduce alternative nutrient source control technologies. Much of the region-specific BMP research to date has been conducted in partnership with the University of Florida Institute of Food and Agricultural Sciences (UF/IFAS). Another key factor for an effective source control program is the proper implementation of the BMPs. The coordinating agencies are making a complementary effort to verify that participants are trained and implementing BMPs properly.

There are existing and proposed nutrient source control programs within the Caloosahatchee River Watershed. These programs are developed and implemented cooperatively by SFWMD, FDEP, and FDACS, in collaboration with local governments and private landowners. Examples include development and implementation of agricultural and non-agricultural BMPs, development of agricultural use plans that limit nutrient loading, restrictions on the application of domestic wastewater residuals and septage, implementation of the Florida Yards and Neighborhoods Program, and several urban stormwater management programs.

These nutrient source control programs will continue, regardless of the number, size, and configuration of the capital water quality improvement projects described and prioritized elsewhere in this plan. Nutrient source control is a critical component of watershed restoration; it is typically less expensive to prevent pollution than to remediate its impacts. Further, these programs operate under authorities and requirements independent of the NEEPP.

7.1.1 South Florida Water Management District Nutrient Source Control Programs

7.1.1.1 Environmental Resource Permit Program

One of the earlier pollutant source control programs began in the 1980s in Chapters 17 to 25, Florida Administrative Code (F.A.C.) and focused on the regulation of stormwater. Since the

1990s, stormwater quality has been regulated under the Environmental Resource Permit (ERP) program, which is found in Part IV of Chapter 373, F.S. The ERP program regulates activities involving the alteration of surface-water flows, and it includes activities in uplands that alter stormwater runoff, as well as dredging and filling in wetlands and other surface waters. Generally, the program's purpose is to ensure that alterations do not degrade water quality, compromise flood protection, or adversely affect the function of wetland systems.

In May 2007, FDEP initiated the development of the Unified Statewide Stormwater rule. In June 2007, SFWMD also initiated rule development to incorporate the Unified Statewide Stormwater rule. The rule will be based on a performance standard of post-development total nitrogen (TN) and total phosphorus (TP) loading not exceeding pre-development natural conditions. The pre-development natural condition is proposed to be defined as the condition of the site as if it were naturally vegetated, not necessarily the conditions existing at the site today. The intended effect of the rule is to increase the level of treatment required for TN and TP in stormwater from new development, which is anticipated to adequately address the discharge of nutrients in general. Methods for estimating treatment efficiency in typical water management BMPs and in low impact design type water management BMPs are proposed to be included in the rule, as well as retrofit projects, redevelopment and compensating treatment. The rule is also anticipated to have an incidental effect of reducing the volume of stormwater. The proposed date for rule adoption is mid to late 2010.

In March 2008, SFWMD initiated rule development for an ERP Basin Rule with supplemental criteria designed to result in no increase in total runoff volume from new development that ultimately discharges to Lake Okeechobee or the Caloosahatchee or St. Lucie estuaries. This rule will be supplemental to existing criteria and the proposed USS rule. Average annual discharge volumes are proposed to be addressed. Methods for estimating storage capacities in typical water management BMPs and in low-impact design type water management BMPs are also proposed to be included in this rule. The target effective date of the rule is mid to late 2010.

7.1.1.2 Proposed Caloosahatchee River Watershed Regulatory Nutrient Source Control Program

The existing SFWMD 40E-61 Regulatory Nutrient Source Control Program was adopted in 1989 [Chapter 40E-61, Florida Administrative Code (F.A.C.)], as a result of the Lake Okeechobee Surface Water Improvement and Management (SWIM) Plan, to provide a regulatory source control program specifically for P. The NEEPP legislation expanded the program boundary to the Caloosahatchee River Watershed and included N, in addition to P, as the focus of nutrient source controls. The program applies to new and existing activities with the goal of reducing nutrients in offsite discharges.

SFWMD is proposing to modify Chapter 40-61, F.A.C. to be compatible with recent amendments to the NEEPP to include the following:

- Implement a nutrient source control program utilizing BMPs for agricultural and non-agricultural lands within the Northern Everglades, including the Caloosahatchee River Watershed;

- Recognize agricultural lands that are greater than 100 acres and are participating in the FDACS BMP program as meeting the intent of the proposed rule, to prevent duplication of effort;
- Define the monitoring network necessary to gauge the collective effectiveness of the source control programs implemented by the coordinating agencies, to make water quality compliance determinations as necessary, to identify priority areas of water quality concern, and to provide data to evaluate and enhance performance of downstream treatment facilities;
- Establish water quality performance criteria specific to the collective source control programs and develop a plan for optimizing the collective BMP programs, should the expected water quality performance criteria not be met;
- Establish nutrient concentration limits for sites utilized for septage application or disposal;
- Ensure that the rule is consistent with data presented in the CRWPP; and
- Include incentives to participate in nutrient reduction demonstration and research projects that will provide valuable data for expanding, accelerating, and optimizing the implemented BMPs to meet water quality objectives and for further refinement of the programs, as necessary.

To ensure consistency with the CRWPP, rule development is expected to begin in 2009.

7.1.2 Florida Department of Agriculture and Consumer Services Nutrient Source Control Programs

7.1.2.1 Agricultural Best Management Practices Program

The Florida Watershed Restoration Act (Section 403.067, F.S.), enacted in 1999, authorizes FDACS to develop, adopt by administrative rule, and implement agricultural BMPs statewide. Through the Office of Agricultural Water Policy, FDACS develops, adopts and implements agricultural BMPs to reduce water quality impacts from agricultural discharges and enhance water conservation. Where agricultural nonpoint source BMPs or interim measures have been adopted by FDACS, the owner or operator of an agricultural nonpoint source addressed by such rule shall either implement interim measures or BMPs or demonstrate compliance with the SFWMD's 40E-61 Regulatory Nutrient Source Control Program, by conducting monitoring prescribed by FDEP or SFWMD.

The Office of Agricultural Water Policy's role involves assisting agricultural producers in selecting, funding, properly implementing, and maintaining BMPs. The Office of Agricultural Water Policy employs field staff and contracts with service providers to work with producers to identify and to implement BMPs appropriate for their operations. A detailed explanation of adopted agricultural BMPs can be found at www.floridaagwaterpolicy.com. Printed BMP manuals can be obtained in local extension offices at county agricultural centers or by contacting Office of Agricultural Water Policy field staff.

The Office of Agricultural Water Policy has adopted, by rule, BMPs that address the following operations in the Caloosahatchee River Watershed:

- Container Nurseries (Chapter 5M-6, F.A.C.);
- Vegetable and Agronomic Crops (Chapter 5M-8, F.A.C.); and
- Citrus (Chapter 5M-2, F.A.C.).

The Office of Agricultural Water Policy is currently developing and will be adopting BMP manuals of statewide application for cow/calf, equine, container nursery, and sod operations. BMPs for all agricultural land uses in the Caloosahatchee River Watershed are expected to be adopted and available for implementation (enrollment) by early 2009.

When the 2007 Florida legislature enacted the NEEPP legislation, significant portions of agricultural acreage within the Caloosahatchee River Watershed were already implementing (enrolling) water resource protection BMPs previously adopted by FDACS. As of the approval date of the CRWPP, agricultural acreage within Glades, Hendry, and Charlotte counties enrolled in the FDACS BMP Program totaled 242,000 acres. Enrolled acreage is expected to increase dramatically when the beef cattle BMP manual is adopted in early 2009.

To meet the intent of the NEEPP legislation with regard to agriculture in the Caloosahatchee Basin, the Office of Agricultural Water Policy will conduct the following activities during 2008 to 2012, as necessary and feasible:

- Adopt BMP manuals for cow/calf, equine, container nursery, and sod operations;
- Intensify its efforts to sign up cow/calf and equine producers for BMP implementation in the Caloosahatchee Basin;
- Work with FDEP to identify priority cow/calf and equine BMPs and verify their effectiveness;
- Develop a BMP implementation assurance program to follow up with selected cow/calf and equine operations on whether they are implementing BMPs and keeping appropriate records;
- Provide or participate in training and educational opportunities for producers regarding BMP implementation and its importance to water quality;
- Evaluate the need for BMP enrollment and implementation for other commodities in the basin and conduct these on a priority basis; and
- Continue on-farm BMP demonstration projects at representative sites to provide BMP effectiveness data and insight into what new or modified BMPs may be necessary to reach nutrient reduction goals.

7.1.2.2 Animal Manure Application Rule

In February 2008, FDACS initiated rule development to control the land application of animal wastes in the Caloosahatchee River Watershed. The proposed rule includes minimum application setbacks from wetlands and all surface waters. Landowners who apply more than one ton per acre of manure must develop conservation plans, approved by the US Department of Agriculture/National Resource Conservation Service (USDA/NRC), that specifically address the application of animal wastes and include soil testing to demonstrate the need for manure application. All use of animal manure must be recorded and included in the operation's overall nutrient management plan. FDACS expects to complete rule making for this effort by the fall of 2008.

7.1.2.3 Urban Turf Fertilizer Rule

In August 2007, FDACS adopted a statewide Urban Turf Fertilizer Rule 5E-1.003(2) F.A.C. The rule limits the P and N content in fertilizers for urban turf and lawns, thereby reducing the amount of P and N applied in urban areas and limiting the amount of those compounds reaching Florida's water resources. It requires that, by July 1, 2009, all fertilizer products labeled for use on urban turf, sports turf, and lawns be limited to the amount of P and N needed to support healthy turf maintenance. FDACS expects a 20 to 25 percent reduction in N and a 15 percent reduction in P in every bag of fertilizer sold to the public.

The rule was developed by FDACS, with input from UF/IFAS, FDEP, the state's five water management districts, the League of Cities, the Association of Counties, fertilizer manufacturers, and concerned citizens. The rule enhances efforts currently underway to address excess nutrients in the northern and southern Everglades. As a component of the Lake Okeechobee and Estuary Recovery (LOER) Plan established in October 2005, the new rule is an essential component to improve water quality through nutrient source control.

In addition, the Southwest Florida Regional Planning Council (SWFRPC) has approved a resolution (SWFRPC Resolution #07-01) addressing urban fertilizer use that adds additional limitations to urban fertilizer use. Lee County and the City of Sanibel have adopted ordinances (Lee County Ordinance No. 08-08 and City of Sanibel Ordinance No. 07-003), which further limit the use of fertilizers in their urban areas.

7.1.3 Florida Department of Environmental Protection Pollutant Source Control Programs

FDEP is responsible for several existing and planned source control programs primarily targeting urban and non-agricultural issues. Programs include:

- Initiatives to improve existing stormwater and wastewater infrastructure;
- Implementation of pollutant reduction plans for municipal stormwater management systems;
- Land development regulations to promote proper stormwater treatment;
- Enhancement to existing regulations for the management of domestic wastewater residuals within the watershed;
- Coordination with applicable authorities on septage disposal to ensure that nutrient loadings are considered; and
- Administering the National Pollution Discharge Elimination System (NPDES) permit program.

7.1.3.1 Stormwater and Wastewater Infrastructure Updates and Master Planning

Stormwater and wastewater infrastructure updates and master planning are the responsibility of, and implemented by, the local governments. Portions of the Caloosahatchee River Watershed urbanized area were developed prior to the implementation of ERP. In these areas, stormwater retention and treatment levels are often inadequate to protect surface water quality. Local governments in the Caloosahatchee River Watershed have been conducting stormwater management projects for more than ten years, well before the initiation of municipal stormwater permits in the watershed. Additionally, the SWFRPC has approved a Stormwater Resolution (SWRRPC Resolution #2008-11) providing specific recommendations and guidelines to be considered by local government jurisdictions in Southwest Florida for the regulation, control, use, and treatment of stormwater containing N and /or P.

7.1.3.1.1 National Pollution Discharge Elimination System Wastewater Facilities

There are five domestic wastewater treatment facilities that are permitted to discharge treated wastewater to the Caloosahatchee River (**Table 7-1**). All meet Advanced Wastewater Treatment Standards (F.S. 403.086) for N and are more stringent for P. All offer secondary treatment with additional nutrient removal; some have high-level disinfection and/or dechlorination for public access reuse, which is used for urban irrigation.

All capacities listed in this section are in "annual average daily flow," except for Waterway Estates, which uses both annual average and "maximum monthly daily flow."

Fort Myers Central Wastewater Treatment Plant (WWTP) (FL0021261) has a permitted treatment capacity of 11 million gallons per day (MGD). This facility has two disposal methods for the treated effluent:

- An 11 MGD permitted surface water discharge (Caloosahatchee River); and
- A 1.5 MGD public access re-use system that has a planned expansion up to 6 MGD in this permit cycle (by 2011).

Fort Myers South WWTP (FL0021270) has a permitted treatment capacity of 12 MGD. This facility has one disposal method for the treated effluent, a 12 MGD permitted surface water discharge (Caloosahatchee River).

Fiesta Village WWTP (FL0039829) has a permitted treatment capacity of 5 MGD. This facility has two disposal methods for the treated effluent:

- 5 MGD permitted surface water discharge (Caloosahatchee River); and
- 2.01 MGD public access reuse system.

This facility is also permitted for intermittent discharges from reuse storage/stormwater ponds. These indirect discharges occur only during high water events.

Waterway Estates Wastewater Treatment Facility (WWTF) in North Fort Myers (FL0030325) has a permitted treatment capacity of 1.25 MGD. This facility has two disposal methods for the treated effluent:

- 1 MGD surface water discharge (Caloosahatchee River); and
- 0.95 MGD public access re-use system.

It should also be noted that unlike other facilities, this facility has a maximum of 1.5 MGD for both capacity and reuse disposal, if measured by "maximum monthly daily flow" as opposed to "annual average daily flow."

The City of Cape Coral (FL0030007) operates two water reclamation facilities under one collective permit. **Everest Parkway Water Reclamation Facility (WRF)** has a permitted treatment capacity of 8.5 MGD and is currently expanding to a capacity of 13.4 MGD. **Southwest WRF** has a permitted treatment capacity of 6.6 MGD and is currently expanding to 15.0 MGD. The facilities utilize three methods for disposal of treated effluent:

- 15.1 MGD capacity surface water discharge (shared – Caloosahatchee River);
- 29.4 MGD public access reuse system (shared); and
- Independent underground injection wells:
  - **Everest Parkway WRF** uses a 3.35 MGD underground injection well; and
  - **Southwest WRF** uses a 3.75 MGD underground injection well currently under expansion to 9.6 MGD. When Southwest WRF completes the expansion to its injection well, it will disconnect from the river outfall and function under an independent permit.

Table 7-1. Point Sources in Tidal Caloosahatchee River Domestic Wastewater Treatment Facility Effluents

Facility Name	NPDES Permit No.	Permitted Flow (MGD)	Year	Average Daily Flow[1] (MGD)	Surface Water Discharge[2] (MGD)	Reuse Systems Disposal[3] (MGD)
Fort Myers Central	FL0021261	11	2005-2007	6.809	5.899	0.91
Fort Myers South	FL0021270	12	2005-2007	8.866	8.866	0
City of Cape Coral	FL0030007	15.1	2005-2007	9.405 + deep well injection	3.899	5.506
Waterway Estates	FL0030325	1.25	2005-2007	1.07	0.987	0.086
Fiesta Village	FL0039829	5	2005-2007	2.89	1.885	1.005

[1] The Average Daily Flow is the average daily flow, averaged on an annual basis, being treated and discharged from the facility (including all disposal types).
[2] The Surface Water Discharge column describes the average daily flow being discharged to the tidal Caloosahatchee River.
[3] The Reuse Systems Disposal column describes the average daily flow being sent to a reuse system.

7.1.3.1.2 Stormwater Infrastructure and Master Planning

Local governments have constructed and continue to build stormwater retrofits, such as detention/retention facilities and swales, to improve the quality of urban stormwater runoff. Lee, Hendry, and Glades counties do not have stormwater utilities in place, but do have dedicated mechanisms used to fund stormwater improvements through Capitol Improvement Plans.

Charlotte County and the Southwest Florida Water Management District jointly fund the Charlotte County Master Stormwater Management Plan which was completed in 1998. The Master Plan targeted ten major stormwater basins for drainage analysis and planning. The Master Plan identified 40 major water control structures which need to be replaced due to deterioration or to meet current design and Comprehensive Plan Level of Service conveyance standards. The highest priority projects are contained within Charlotte County's adopted, multi-year Capital Improvements Program.

Lee and Hendry counties also have adopted Stormwater Master Plans in order to address flooding and property damage concerns, address water quality issues, and preserve the environment and enhance wildlife habitat. Objectives of the Lee County Plan are to identify existing flowways, streams, and runoff rates for each basin and recommend actions for protection and improvement of each flowway and stream. Hendry County's Surface Water Master Plan includes the development of watershed boundaries, wetland maps, a conveyance element database, and detailed hydrologic-hydraulic studies for the northwest portion of the County.

Local utilities are also aggressively pursuing upgrades to their wastewater management systems to protect water quality. Improvements to lift stations, inspection frequency and replacement of leaking sewer lines, and related activities help limit the introduction of nutrients into surface waters. Additionally, the SWFRPC has approved a Wastewater Resolution (SWFRPC Resolution #2007-02) providing specific recommendations and guidelines to be considered by local government jurisdictions in Southwest Florida for the regulation and control of treated wastewater discharges containing N and/or P. The SWFRPC has also approved a Wastewater Package Plant Resolution (SWFRPC Resolution #2007-05) providing specific recommendations and guidelines to be considered by local government jurisdictions in Southwest Florida for the regulation and control of treated wastewater discharges from small wastewater treatment facilities (Package Plants) containing N and/or P.

7.1.3.2 Municipal Separate Storm Sewer System Permit Program

Local governments (Lee County, Glades County, Hendry County, and Charlotte County) and the Florida Department of Transportation (FDOT) operate permitted Municipal Separate Storm Sewer Systems (MS4s) in the Caloosahatchee River Watershed. An MS4 is a publicly-owned conveyance or system of conveyances designed or used for discharging stormwater, which can include streets, curbs, gutters, ditches and storm drains. These water conveyance systems are permitted through the statewide MS4 permitting program and receive a NPDES permit administered by FDEP (see Chapter 62-624, F.A.C.). The purpose of the MS4 permitting program is to develop, implement, and enforce a stormwater management plan to reduce the discharge of pollutants to the maximum extent practicable, to protect water quality and to comply with the water quality requirements of the Clean Water Act (CWA).

The stormwater collection systems are owned and operated by Lee County and co-permittees, including the City of Cape Coral, City of Fort Myers, Town of Fort Myers Beach, and the City of Sanibel. All are on MS4 Phase I Permit Number FLS000035. As shown in Table 7.2, Charlotte County, which has population areas in northern portions of some Tidal Caloosahatchee waterbody identifications (WBIDs), is covered by a separate MS4 Phase II permit (Permit Number FLR04E043).

Table 7-2. Municipal Separate Storm Sewer System Permittees in the Tidal Caloosahatchee Watershed

County	Name	Permit ID Number	MS4 Type
Lee	Lee County Board of County Commissioners	FLS000035	Phase I
Lee	City of Fort Myers	FLS000035	Phase I
Lee	City of Sanibel	FLS000035	Phase I
Lee	City of Cape Coral	FLS000035	Phase I
Lee	Town of Fort Myers Beach	FLS000035	Phase I
Charlotte	Charlotte County	FLR04E043	Phase II

Permit duration is five years. Most of the MS4 permits in the Caloosahatchee Basin are Phase I permittees, up for renewal in 2008. However, there are a few Phase II permittees. Each phase is summarized in the following subsections.

7.1.3.2.1 Phase 1 Municipal Separate Storm Sewer Systems

Phase 1 MS4s consist of jurisdictions with a population of 100,000 individuals or more that were designated by the U.S. Environmental Protection Agency in 1990. Issuance of Phase I MS4 permits is complete; therefore, any new MS4 facilities will be permitted as a Phase II facility. Phase I MS4s are regulated through an individual NPDES permit that addresses:

- Implementation of stormwater master plan to reduce pollutants to the maximum extent practicable;
- Development of storm sewer system map;
- Implementation of a monitoring plan;
- Calculation of Event Mean Concentrations and Seasonal Pollutant Loadings, at least once per permit term (usually in year three or five years);
- Post-construction runoff control (met through state stormwater permitting requirements [ERP] under Part IV, Chapter 373, F.S., as a qualifying alternative program); and
- Pollution prevention/good housekeeping.

7.1.3.2.2 Phase II Municipal Separate Storm Sewer Systems

Phase II MS4s are regulated under an NPDES generic permit that requires implementation of BMPs to meet the following six minimum control measures:

- Education and outreach (e.g. Florida Yards and Neighborhoods Program);
- Public participation;
- Illicit discharge detection and elimination;
- Construction site runoff control;
- Post-construction runoff control (met through state stormwater permitting requirements [ERP] under Part IV, Chapter 373, F.S., as a qualifying alternative program); and
- Pollution prevention/good housekeeping.

7.1.3.3 Comprehensive Planning – Land Development Regulations

The Office of Intergovernmental Programs coordinates FDEP's involvement in statewide planning efforts conducted under various authorities, including Chapter 187, F.S. (the State Comprehensive Plan), which sets forth goals that articulate Florida's desired future. The State Comprehensive Plan is reviewed annually, and local plans are updated every five-to-seven years through the Evaluation and Appraisal Report process. Throughout this process, FDEP has the formal opportunity to evaluate proposed amendments to the Comprehensive Plan, which are based upon the evaluation and appraisal report, to ensure that they are consistent with FDEP rules and policies.

Local governments in the Caloosahatchee Basin are taking steps to implement low impact design principles to minimize nutrient sources and loss and enhance water storage.

7.1.3.3.1 Domestic Wastewater Residuals – Senate Bill 392/2007 changes to Section 373.4595, Florida Statues

In response to the 2007 residuals-related changes to Section 373.4595, F.S., FDEP's Division of Water Resource Management promulgated a program guidance memo. The memo provides general procedures for FDEP district offices to implement the requirements within the current regulatory framework of Chapter 62-640, F.A.C. This guidance is consistent with the NEEPP legislation stating that "*After December 31, 2007, the Department may not authorize the disposal of domestic wastewater residuals within the Caloosahatchee Watershed unless the applicant can affirmatively demonstrate that the nutrients in the residuals will not add to nutrient loadings in the watershed*." Section 373.4595(4)(a)2.e., F.S. (2007).

Effectively, the provisions will be phased in as wastewater treatment facility permits expire. Permit renewals must include the appropriate nutrient balance demonstration, required by the statute in the site agricultural use plan and submitted with the facility permit renewal application.

Additionally, Chapter 62-640, F.A.C., is undergoing rule making. Under the proposed revisions, the nutrient balance demonstration must be submitted with the Nutrient Management Plan when a land application site is permitted.

7.1.4 Other Pollutant Source Control Programs

7.1.4.1 Application of Septage – Senate Bill 392/2007 changes to Section 373.4593, Florida Statues

Sections 373.4595(4)(a)2.f. and (4)(b)2.f., F.S. (2007), require all entities disposing of septage within the Caloosahatchee and St. Lucie River watersheds to develop and submit to the FDOH, an agricultural use plan that limits applications based upon nutrient loading. In response to these NEEPP requirements, FDOH has notified all county permitting authorities in the watersheds of the requirement that entities disposing of septage within the watersheds develop and submit to FDOH an agricultural use plan that limits applications based upon nutrient loading. At this time, there are no known septage application sites in these watersheds. Once SFWMD or FDEP has promulgated nutrient concentration limits for runoff from sites in these watersheds, through the SFWMD's 40E-61 Regulatory Nutrient Source Program or another validly adopted rule, FDOH will notify all county permitting authorities in the watersheds that nutrient concentrations originating from these application sites may not exceed the established limits.

7.1.4.2 Florida Ranchlands Environmental Services Project

Launched in October 2005, the Florida Ranchlands Environmental Services Project will design a program under which ranchers in the northern Everglades watersheds can sell environmental services of water retention, P load reduction, and wetland habitat expansion to agencies of the state and other willing buyers. To document the level of environmental services provided by ranch water-management projects, the Florida Ranchlands Environmental Services Project will field test different methods of monitoring and modeling of hydrology, water and soil chemistry and vegetation change.

These ranchers will bring such services on line quickly, in comparison to other options, because land purchase is not required. The program will complement public investment in regional water storage and water treatment facilities. The sale of the water retention services will add income for ranchers and will provide an incentive to combat converting land uses for more intensive agriculture and urban development land uses that can increase stormwater flow, pollution, and habitat impacts.

The Florida Ranchlands Environmental Services Project is being implemented through a collaboration of the World Wildlife Fund, eight participating ranchers, the USDA/NRCS, FDACS, SFWMD, and FDEP. Technical support is being provided by scientists from the MacArthur Agro-Ecology Research Center and the University of Florida. Funding from federal, state, and private sources exceeds five million dollars for Phase One, which includes pilot project implementation and program design.

7.1.4.3 Florida Yards and Neighborhoods Program

The Florida Yards and Neighborhoods Program is an excellent example of a nonstructural program. It is a partnership of UF/IFAS, Florida's water management districts, FDEP, the National Estuary Program, the Florida Sea Grant College Program, concerned citizens, members of private industry and numerous other nongovernmental agencies. It is implemented through the counties' UF/IFAS Cooperative Extension Service. The program addresses the serious problems of pollution in stormwater runoff, water shortages and disappearing habitats by enlisting Floridians to preserve and to protect our natural resources. By educating citizens and builders about proper landscape design (e.g., "right plant-right place" practices), this program is helping minimize the use of pesticides, fertilizers, and irrigation water. FDEP has an ongoing monitoring program to determine the effectiveness of this program in reducing nutrient loads. More information on this program, as well as other FDEP BMPs, can be found at www.dep.state.fl.us/water/nonpoint/pubs.htm.

7.2 Summary

Source control is integral to the success of any water resource protection or restoration program; it is typically less expensive to prevent pollution than remediate its impacts. Source control programs in the Caloosahatchee River Watershed are evolving and expanding through cooperative and complementary efforts by FDEP, FDACS, and SFWMD. Activities underway, which will significantly improve the source control program's contribution to the achievement of NEEPP legislation objectives, include:

- Adoption of BMP manuals for cow/calf, equine, container nursery, and sod operations (all agricultural land uses in the Caloosahatchee River Watershed expected to have FDACS-adopted BMP manuals by early 2009);
- Proposed revisions will be implemented to supplement the ERP program, including the proposed statewide stormwater treatment rule that is intended to increase the level of treatment required for nutrients (N and P) in stormwater from new development, and the proposed basin rule for the Lake Okeechobee and estuary watershed basins with specific supplemental criteria designed to result in no increase in total runoff volume from new development;
- Expansion of the SFWMD's 40E-61 Regulatory Nutrient Source Control Program to include the Caloosahatchee River Watershed is planned for both P and N;
- Restrictions to the P and N content in fertilizers for urban turf and lawns; and
- Restrictions on the disposal of domestic wastewater residuals, septage, and animal manure within the watershed are proposed.

Collectively, these source control programs will require all agricultural and non-agricultural land uses to implement and be accountable for BMPs through the FDACS BMP program or the SFWMD's Regulatory Nutrient Source Control Program, or by demonstrating compliance with water quality standards, as applicable.

CHAPTER 8

CALOOSAHATCHEE RIVER WATERSHED RESEARCH AND WATER QUALITY MONITORING PROGRAM SUMMARY

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8.0 CALOOSAHATCHEE RIVER WATERSHED RESEARCH AND WATER QUALITY MONITORING PROGRAM SUMMARY

The Northern Everglades and Estuaries Protection Program (NEEPP) requires the establishment of a Caloosahatchee River Watershed Research and Water Quality Monitoring Program (RWQMP). According to the NEEPP, this program shall build upon the South Florida Water Management District's (SFWMD) existing research program and be sufficient to carry out, comply with, or assess the plans, programs, and other responsibilities created by the Caloosahatchee River Watershed Protection Plan (CRWPP). The RWQMP shall also conduct an assessment of the water volumes and timing from the Lake Okeechobee and Caloosahatchee River Watershed and their relative contributions to the timing and volume of water delivered to the Caloosahatchee Estuary. This section provides the summary of the RWQMP, whereas the full version of the program is included as **Appendix E**.

The objective of the RWQMP is to identify scientifically based solutions to improve the water quality and quantity in the Caloosahatchee River Watershed and to provide more accurate predictions of ecological responses to changes in the Caloosahatchee River Watershed to these solutions. Information generated through the monitoring, modeling and research efforts will help support potential changes in the design and operation of the NEEPP.

8.1 Research and Water Quality Monitoring Program Document Structure

The RWQMP includes five chapters, which are described in the following paragraphs.

Chapter 1 provides an introduction to the RWQMP, a brief summary of the ecological history of the Caloosahatchee River Watershed, and the rationale for the program.

Chapter 2 identifies the specific goals and objectives of the RWQMP based on the legislation. This chapter specifies how research, modeling, and monitoring contribute to the adaptive management of nutrient load reduction goals and the implementation and operation of projects designed to achieve them.

Chapter 3 presents the current state of knowledge regarding hydrology, water quality and aquatic habitat in the Caloosahatchee River Watershed. It also identifies the effects of discharges from Lake Okeechobee on the Caloosahatchee Estuary, along with salinity and freshwater inflow goals. Also included in this chapter is a detailed chemical and physical analysis of the water quality, along with the ecological importance and distribution of submerged aquatic vegetation and oysters.

Chapter 4 is a summary of existing monitoring programs for hydrology, water quality, and aquatic habitat. The programs are evaluated based on their ability to meet program goals and potential improvements are identified. Finally, a recommended monitoring plan is described.

Chapter 5 describes ongoing research and modeling applicable to the RWQMP goals and objectives. Plans for future research and modeling are also described and prioritized. Integration of research, modeling, and monitoring will establish scientifically sound performance measures and support improvements to the Caloosahatchee Estuary through the adaptive management process.

8.2 Goals and Objectives

Research, modeling, and monitoring are essential for the design and operation of programs to restore and protect the Caloosahatchee River Watershed.

The following objectives are keys to the success of the RWQMP:

- Build upon SFWMD's existing monitoring, research, and modeling programs;
- Implement, comply with, or assess the plans, programs, and other responsibilities of NEEPP;
- Assess the water volumes and timing from Lake Okeechobee and the St. Lucie River and Caloosahatchee River watersheds and their relative contributions to the timing and volume of water delivered to each estuary;
- Provide technical information regarding inflow targets and salinity envelopes for the estuaries;
- Provide for the scientific studies that are necessary to support the design and operation of the Caloosahatchee River Watershed Construction Project facilities;
- Facilitate creation of predictive and/or numeric modeling tools for quantitative assessment and prediction of the overall program progress;
- Provide the empirical data and conceptual understanding of the Caloosahatchee River Watershed and Estuary for support and improvement of the predictive models and to identify new water quality management measures;
- Collect data as necessary to quantify load reductions in order to meet any applicable Total Maximum Daily Loads (TMDLs) in the Caloosahatchee River Watershed;
- Implement salinity monitoring sufficient to measure the frequency and duration of undesirable salinities for those biotic resources upon which salinity envelopes are based;
- Monitor oysters and seagrasses to determine if reductions in undesirable salinities and/or nutrient loads have the desired ecological result; and
- Support annual reporting of the conditions of hydrology, water quality, and aquatic habitat required by the NEEPP in Section 373.4595(6), F.S.

8.3 Status, Trends and Targets

Chapter 3 of the RWQMP addresses the status, trends, and targets in hydrology, salinity, and aquatic habitats. The CRWPP will use this information to establish a goal for salinity and freshwater inflow targets for the estuary based upon existing research and documentation.

Trends identified in Chapter 3 of the RWQMP include:

- Change in the delivery of freshwater to the estuary at S-79 has grown more variable with higher wet season discharges and lower dry-season discharges;
- Freshwater inflows are such that in general about half the discharge at S-79 is attributed to runoff from the eastern and western basins and half to Lake Okeechobee;

- Compared to watershed runoff alone, additional flows from Lake Okeechobee effectively increase the frequency and duration of high flows which, damage the marine portion of the estuary, but decrease the frequency and duration of the damaging low flows that impact upstream, low salinity regions;
- At 27 stations, mainly in tidal creeks of the Caloosahatchee Estuary, 74 percent showed slight increases in the concentration of ammonia and 44 percent showed slight increases in TN and dissolved inorganic TP; and
- Comparisons to TN (1.0 milligrams per liter (mg/L)), TP (0.15 mg/L) and chlorophyll-*a* (20 micrograms per liter (µg/L)) standards established for the upper estuary by FDEP Regulation (DeGrove, 1981) revealed:
    - Most exceedances occurred in the estuary upstream of Fort Myers;
    - DO concentrations less than the state standard (4.0 mg/L), or the generally accepted threshold for hypoxia (2.0 mg/L), were relatively rare and confined to the upper reaches of the Caloosahatchee Estuary;
    - Low DO concentrations tended to occur during the warmer months of May through October;
    - In the upper and mid-estuarine regions, chlorophyll-*a* concentrations exceeded the nutrient standard in 40 percent of the samples; and
    - In the lower estuary and San Carlos Bay, the vast majority of measured concentrations were below the standard.

An optimal flow envelope for the estuary (Shell Point to Km 30) would be 600 cfs to 1,000 cfs. Flow less than 1,500 cfs and 3,000 cfs would preserve optimal salinities for San Carlos Bay and Pine Island Sound, respectively. In general, the desired salinity envelope consists of:

- < 10 parts per thousand (ppt) upstream of the Fort Myers Bridges (measured at the Fort Myers Yacht Basin);
- > 15 ppt at the Cape Coral Bridge and ~ 20 ppt in Iona Cove;
- 14 to 28 ppt just upstream of Shell Point; and
- ~ 25 ppt (range 22 ppt to 36 ppt) in San Carlos Bay.

The general monthly average flow range objectives to support the optimal flow envelope are:

- Maintain mean monthly flows greater than 450 cfs, with the majority of flows in the range 450 to 800 cfs, which supports the widest range of species;
- Limit the flows greater than about 2,800 cfs and avoid flows that exceed 4,000 to 4,500 cfs, which harm seagrass beds as far as lower Pine Island Sound; and
- End destructive flows that exceed 6,500 cfs, which destroy marine life far from the estuary mouth and sends poor water quality up Pine Island Sound and into the Gulf of Mexico.

The combination of enhanced drainage in the Caloosahatchee River watershed, flood control releases from Lake Okeechobee, population growth, and urban and agricultural development have created problems for the Caloosahatchee Estuary. Seasonal and short term fluctuations in stormwater runoff drive changes in salinity that are beyond the tolerance limits of most marine and estuarine organisms. The Caloosahatchee Estuary shows typical signs of eutrophication (extreme nutrient levels) including intense algal blooms and periods of hypoxia (low DO levels) and anoxia (absence of DO). Other environmental problems identified include degraded benthic communities, decreases in the extent of seagrasses, and the loss of functioning oyster reefs.

8.4 Monitoring, Research, and Modeling Assessment

Assessments of monitoring, research, and modeling will be used to track progress and to identify if the plan objectives and targets are being met. They will also aid in identifying potential shortfalls or accomplishments. For example, information gained from monitoring, modeling, and research can be used to identify any necessary refinements to flow and salinity envelopes, pollutant load reduction goals, and changes to facility operations and implementation priorities.

Research and monitoring in the Caloosahatchee and St. Lucie River Watersheds have been ongoing for more than 40 years (Phillips, 1960). Continued monitoring with the integration of research and modeling will establish scientifically sound performance measures and support improvements to the Caloosahatchee River Estuary through the adaptive management process.

8.4.1 Monitoring Assessment

The environmental monitoring in the Caloosahatchee River Watershed RWQMP has two major purposes: (1) to quantify long-term change and (2) to support adaptive management. Quantification of long-term change measures progress towards program goals such as meeting any adopted nutrient TMDLs. The monitoring program includes establishing a goal/target, the systematic collection of data, using that data to measures change or progress towards the goal/target, and determining when modifications to the project are required.

The objectives of the RWQMP were already identified in Section 8.2 above. One of the objectives is to build upon existing monitoring programs. A brief summary of the existing programs is provided below and detailed discussion of the programs can be found in Chapter 4 of the RWQMP in **Appendix E**.

8.4.1.1 Existing Watershed Monitoring Programs

Existing watershed monitoring programs include flow monitoring and water quality monitoring:

- **Flow Monitoring Program:** The existing flow monitoring is conducted daily at the major water control structures along the Caloosahatchee River (S-77, S-78, and S-79). Currently, nine hydrologic data flow sites collect data and provide information for calibration of watershed loading models and estuarine hydrodynamic models. Three of those stations are located in the Caloosahatchee Estuary, while the remaining six sites are in tidal tributaries and are maintained by the U.S. Geological Survey (USGS) Department, FDEP, and Lee County.

- **Water Quality Monitoring Programs:** Water quality monitoring efforts are being conducted at freshwater sites in the watersheds that eventually drain into the Caloosahatchee Estuary, including the Caloosahatchee River and its watershed and the

Tidal Basins located to the west of S-79. Watershed monitoring efforts are being carried out by several state and local governmental agencies and a non-profit organization including SFWMD, Lee County, East County Water Control District, City of Cape Coral, City of Fort Myers, and Sanibel Captiva Conservation Foundation (SCCF). Monitoring east of S-79 is currently sparse and is only sufficient for determining long-term trends and characterizing the quality of water entering the Caloosahatchee Estuary at S-79, exiting the East Caloosahatchee Basin at S-78 and exiting Lake Okeechobee at S-77. The frequency of water quality sampling at S-79 and S-78 may not be sufficient for accurate calculation of load, which requires further investigation. Since individual tributaries to the Caloosahatchee River are not routinely sampled, tracking progress towards the TMDL at spatial scales smaller than the East and West Caloosahatchee Basins is not possible.

8.4.1.2 Existing Estuarine Monitoring Programs

Existing estuarine monitoring includes salinity monitoring and water quality monitoring:

- **Salinity Monitoring**: There are currently two salinity monitoring programs in the Caloosahatchee River and Estuary: a SFWMD program and a program recently established by SCCF. The salinity information currently being collected is adequate to determine the frequency and duration of undesirable salinity ranges resulting from Caloosahatchee River discharges at S-79. The FDEP Aquatic Preserves Program has recently established two stations in Matlacha Pass that will further enhance salinity monitoring capability.

- **Water Quality Monitoring**: The existing water quality monitoring effort established for the estuarine portion of the Caloosahatchee River is being carried out by numerous governmental entities. Organizations at state, regional, and local levels, as well as universities and private organizations including SFWMD, Charlotte Harbor National Estuary Program, Lee County, cities of Sanibel and Cape Coral, FDEP, SCCF, Florida Fish and Wildlife Research Institute, and Charlotte Harbor Estuaries Volunteer Water Quality Monitoring Network are involved. Sampling in most of the estuarine portion of the study area is sufficient to assess status and trends in water quality. However, the lower Caloosahatchee Estuary between Marker 66 and Shell Point is not sampled adequately at this time. Sampling at the head of the estuary, just downstream of S-79, also is not covered adequately.

8.4.1.3 Aquatic Habitat (Oyster and Seagrass) Monitoring

Existing aquatic habitat monitoring includes seagrass monitoring and oyster monitoring.

- **Seagrass Monitoring**: There are currently six SAV monitoring efforts in the tidal waters within the CRWPP boundaries, with the sampling conducted by SFWMD’s Restoration Coordination and Verification (RECOVER), FDEP South District, FDEP Charlotte Harbor Aquatic Preserve, and FDEP Estero Bay Aquatic Preserve. Five aerial photography surveys, conducted since 1999, have been used to evaluate incremental and long-term changes throughout the entire region and within major sections of the system.

The existing SAV monitoring programs are sufficient for detecting trends and assessing the status of seagrasses in the CRWPP study area on multiple spatial and temporal scales. The two-to-three year frequency of aerial photography surveys is sufficient to detect long-term large-scale changes, but not frequent enough to account for the impact of extreme drought or storm events.

- **Oyster Monitoring**: RECOVER currently conducts monitoring of oysters in the Caloosahatchee Estuary at six stations. The program measures various aspects of oyster condition, life history, and distribution. Most parameters are measured monthly or seasonally; the regional distribution of oysters will be mapped every five years (RECOVER, 2007). The present oyster monitoring program is sufficient to detect long term change in population size and physiological condition and to support adaptive management. The working team has recommended that measurements (e.g. percent coverage) be standardized when possible.

8.4.2 Research Projects Assessment

Research projects are intended to reduce or eliminate key uncertainties in nutrient load reductions, flow and salinity envelopes, and to optimize the operation protocols. The four research projects in the Caloosahatchee River Watershed RWQMP are summarized below. Chapter 5 of the RWQMP provides a detailed description of these projects, and assesses their adequacy in achieving the CRWPP goals/targets.

- **Estuarine Nutrient Budget**: Over-enrichment with nutrients from urban and agricultural sources is a problem for the Caloosahatchee Estuary. A well-constrained nutrient budget is critical to understanding the origin, magnitude, and management of problematic nutrient loads and guide prioritization for load reductions. The project will construct nutrient budgets for nitrogen (N) and phosphorus (P) for the Caloosahatchee Estuary. Terms in the nutrient budget will be determined by a variety of methods. Some of the terms in the budget can be derived from existing information (i.e. nutrient load at S-79). Others, such as storm water runoff from the Tidal Caloosahatchee Basin, may require a modeling effort. Still others, such as the flux of nutrients out of the bottom sediments, may require direct measurement. Results of this project can be used to support water quality modeling efforts that will reduce the uncertainties related to nutrient TMDLs and increase the capability to predict effects of various management measures, including best management practices.

- **DO Dynamics**: Low oxygen concentrations are often associated with excess nutrient loading and have been a recognized problem in the Caloosahatchee Estuary since the 1980s (DeGrove, 1981). The DO dynamics research project will identify the factors causing the DO impairment in the Caloosahatchee Estuary. Once causes are known, appropriate management solutions can be implemented. The results of this study will provide critical information that will guide the selection of management solutions. This research project supports the CRWPP goal of achieving the TMDL for the Caloosahatchee Estuary and improving DO conditions in the Caloosahatchee Estuary.

- **Low Salinity Zone**: Much of the work that supports estimates of minimum and maximum freshwater inflow requirements to the Caloosahatchee Estuary is based on the salinity tolerances of freshwater and marine organisms that inhabit the system. The low salinity zone research project examines elements of the estuarine food web. The ultimate goal is to understand the role of freshwater discharge and production of fish larvae in the estuary. Results can be applied to establishing water reservations, to refining flow and salinity envelopes, and to providing guidelines for delivery of freshwater to the Caloosahatchee Estuary.

- **Light Attenuation in San Carlos Bay**: A resource-based method (Corbett & Hale, 2006) is being considered to establish nutrient TMDLs in the Caloosahatchee Estuary. Nutrient load reductions would be based on achieving water clarity in San Carlos Bay that allows enough light for seagrasses to grow to a depth of 2.2 meters. Three major water quality constituents have been identified that attenuate light in the Southern Charlotte Harbor: turbidity, colored dissolved organic matter, and chlorophyll-*a* (McPherson & Miller, 1994). This light attenuation research study will determine how relative contributions to total light attenuation of chlorophyll-*a*, colored dissolved organic matter, and turbidity vary with season and freshwater inflow in San Carlos Bay. Information from this study will better define controls on light attenuation in San Carlos Bay and the relationship between the TMDL and its resource goal. Results can be used to determine when, and in what conditions, resource light attenuation goals may be met.

8.4.3 Modeling Assessment

An integrated modeling framework combining the resource-based Valued Ecosystem Component (VEC) approach and linked watershed and estuarine models has been used for years in the Minimum Flows and Levels Program and for CERP-related projects. Integrated or linked models have been used to simulate the effects of changes in population, land use, or management practices in the watershed on estuarine physics, chemistry, and ecology (Wan et. al., 2006). Three existing modeling efforts include the Watershed Hydrology and Water Quality Models, the Estuary Hydrodynamic and Water Quality Models, and the Ecological Response Models.

8.4.3.1 Caloosahatchee River Watershed Hydrology and Water Quality Models

Effective management that aims to protect water quality requires a big picture view of water resources at the watershed-scale. Watershed models provide the necessary links for this purpose, particularly when it comes to understanding how non-point sources of pollution interact with point sources, and how these jointly affect the downstream water quality. The Watershed Hydrology and Water Quality Models include the Agricultural Filed Scale Irrigation Requirements Simulation/Water Balance (AFSIRS/WATBAL), the Northern Everglades Regional Simulation Model (NERSM), MIKESHE and the Hydrologic Simulation Program Fortran (HSPF) Model for the Caloosahatchee River Basins TMDLs. The capability of these models is provided in **Table 8-1**.

Table 8-1. Capabilities of the Watershed Hydrology and Water Quality Models

Hydrologic Models
AFSIRS/WATBAL
1. Determines demands from groundwater and surface waters 2. Determines demands for the major irrigated and non-irrigated land uses 3. Determines runoff from land irrigated with ground water 4. From land irrigated with surface water and non-irrigated lands 5. Four basin model covering lands b/t S-77/S-235 and S-79 influencing regional system
NERSM
1. Basin budget/link node implementation of the Regional Simulation Model Subdivided into East and West Caloosahatchee Basins 2. Simulates 1970-2005 using a 1-day time step
MIKESHE
1. Integrates surface water and groundwater simulating hydrologic processes in the watershed 2. Includes evaporation, runoff, stormwater detention, river hydraulics, stream management, groundwater withdrawals and recharge provides total daily flow from tidal basin watershed.
HSPF Model for Caloosahatchee River Basin TMDLs
1. Simulates flow and water quality in the freshwater and tidal watersheds 2. Simulates flow and water quality constituents such as temperature, BOD5, N, P, Chlorophyll-a and DO 3. Provides pollutant load input to the estuarine hydrodynamic and water quality models

8.4.3.2 Estuary Hydrodynamic and Water Quality Models

For the Caloosahatchee Estuary hydrodynamic and water quality simulation, modeling tools are needed that are capable of: (1) simulating the impacts induced by the watershed loading; (2) assessing estuary hydrodynamics; and (3) assessing estuary water quality processes. The Estuary Hydrodynamic and Water Quality Models include the Curvilinear Hydrodynamic Three Dimensional (CH3D), Hydrodynamic Salinity Model, and the Environmental Fluid Dynamic Code and Water Quality Analysis Simulation Program (EFDC/WASP) Model for Caloosahatchee River Basin TMDLs. The capability and water management practice applications of these models are provided in **Table 8-2**.

Table 8-2. Capability of the Estuarine Hydrodynamic and Water Quality Models

Estuarine Hydrodynamic and Water Quality Model	
CH3D Hydrodynamic Salinity Model	
1. Predicts circulation and distribution of salinity as influenced by tide, wind, and freshwater flows 2. Predicts spatial and temporal distribution of salinity in estuary 3. Provides salinity and velocity outputs for input to ecological and habitat suitability models 4. Solves three dimensional equations of motion with given computational variables	
EFDC/WASP Model for Caloosahatchee River Basin TMDLs	
Hydrodynamic/Salinity Component 1. Simulates 1D, 2D, 3D flow transport, and biogeochemical process in surface water systems 2. HSPF provided flow input to the EFDC model	**Water Quality Component** 1. Simulates eutrophication process involving phytoplankton growth, nutrient cycling and DO dynamics

8.4.3.3 Ecological Response Model

The Estuarine Ecological Response Model was developed based on available literature data to evaluate the influence of watershed hydrology on stream ecosystem health. Currently, it includes the Tape Grass Model and the Habitat Suitability Index (HSI) Models developed for multiple species (three submerged aquatic vegetation species and eastern oyster) in the Caloosahatchee Estuary. The capability and water management practice applications of these models are provided in **Table 8-3**.

Table 8-3. Capability of the Estuarine Ecological Response Models

Estuarine Ecological Response Models
Tape Grass Model
1. Integrates both field and lab data to predict effect of environmental variables 2. Calibrated based on measured data variables
HSI Models
1. Provides output based on salinity, temperature, dept, substrate and high flow frequency for each species 2. Calculates habitat suitability monthly

8.5 Research and Water Quality Monitoring Program Recommendations

The recommended RWQMP has been formulated to fulfill the objectives and reporting requirements of the CRWPP and to support adaptive management. It builds upon the existing monitoring, research, and modeling components discussed above, and makes recommendations/modifications to these efforts to better achieve and assess the objectives/targets of the CRWPP.

8.5.1 Monitoring Needs

The recommended monitoring program has been formulated to fulfill the objectives and reporting requirements of the CRWPP, as well as to support adaptive management.

8.5.1.1 Watershed Quality and Flow Monitoring in the Watershed

The RWQMP recommends that the current long-term flow monitoring and water quality monitoring conducted in the tidal basin west of S-79 by Lee County, USGS, and FDEP should continue as it is now planned. BOD_5 and dissolved TKN (DTKN) should be added to the water quality parameters measured in the monthly grab samples. Measurement of BOD_5 is used to quantify the DO demand in oxidation of organic carbon and provide a measure of labile organic loads to the receiving waters. The most recent water quality modeling effort in the Caloosahatchee Watershed was undertaken by FDEP for TMDL development and includes BOD_5 as one of the water quality constituents. DTKN allows the calculation of dissolved organic nitrogen, which constitutes most of the TN load. The following parameters should be considered for inclusion in the monitoring program at specific locations, based on the potential for possible impairments now or in the future: sediment oxygen demand, fecal coliform, total dissolved solids, total hardness, iron, copper, lead, arsenic, and zinc.

Eight long-term water quality and flow monitoring sites are proposed along the Caloosahatchee River to provide spatial coverage necessary for tracking progress towards the TMDL and for supporting adaptive management and development of a Basin Management Action Plan. Monthly water quality and continuous flow will be measured at each station allowing calculation of loading to each section of the river. Once problem sections of the river are identified, a secondary level of local monitoring will be conducted by SFWMD for a limited time period to ascertain the most appropriate BMPs associated with the water quality concern identified.

Four short-term water quality and flow monitoring sites in canal tributaries flowing into the Caloosahatchee River are also recommended. These stations will help determine if loads calculated from grab samples accurately reflect the sum of tributary loads. A three-year study is contemplated to help identify hot spots and support calibration of watershed models.

8.5.1.2 Water Quality and Salinity Monitoring in the Caloosahatchee Estuary

Salinity monitoring stations maintained by SFWMD and SCCF should be continued. In general, the water quality monitoring conducted by all agencies in estuarine and marine waters of the study area is adequate to meet program goals and should continue. Some redundancies have been identified; the removal of one existing Lee County station and five SFWMD/Florida International University stations is recommended. Because the Caloosahatchee Estuary is currently under-sampled spatially, four historical stations from the Caloosahatchee Estuary Water Quality Program should be re-instated (CES02, CES05, CES07, and CES08). BOD_5 and DTKN should be added to the water quality parameters measured in the monthly grab samples in estuarine and marine waters in order to monitor progress towards meeting any adopted nutrient TMDLs.

8.5.1.3 Aquatic Habitat Monitoring

The present oyster monitoring program, conducted by RECOVER, is sufficient to meet the goals of CRWPP and is recommended to continue, along with mapping of oyster beds at a frequency of at least every five years. The current multi-agency approach to seagrass monitoring in the study area should also continue. SAV aerial photography surveys should continue at the historical sampling frequency of every two-to-three years. It is also recommended that measurements (e.g. percent coverage) be standardized where possible.

8.5.2 Prioritization of Research

Each major project (e.g. Nutrient Budget) can be broken down into several components. Examination of each project shows that several projects may have common components. The commonalities between components of the various projects are summarized in **Table 8-4** of the RWQMP. The source of data for each component is given (existing data, new measurements, model, etc). Components funded in any given year may be prioritized according to the number of projects to which they belong.

Table 8-4. Commonalities between Components of the Various Projects

Research Component	Research Projects				Source
	Nutrient Budget	**DO Dynamics**	**Low Salinity Zone**	**Light Attenuation**	
INPUTS					
Franklin Lock Loads (S-79)	√	√	√	√	Monitoring
Tidal Basin Loads					
Surface Flows	√	√	√	√	Model/Measurements
Groundwater	√	√	√	√	Model/Measurements
Wastewater Treatment Facilities	√	√	√	√	New Measurements
Gulf of Mexico	√				Model for Flow Literature Concentration
Atmospheric Deposition	√				Literature/ Data Analysis
INTERNAL CYCLING					
Primary Productivity/ Water Column Respiration	√	√	√	√	New Measurements
Organic Matter Decomposition (incl DON)	√	√			New Measurements
Benthic Nutrient Flux	√	√			New Measurements
DO Time Series		√	√		New Measurements
INTERNAL CYCLING					
San Carlos Bay Times Series					
Color				√	New Measurements
Turbidity				√	New Measurements
Chlorophyll-*a*				√	New Measurements
TSS				√	New Measurements
PAR (Kd)				√	New Measurements
OUTPUTS					
Export to Gulf	√				Model
Denitrification	√				Benthic Flux Project
BIOMASS					
Larval/ Juvenile Fish				√	New Measurements
Zooplankton				√	
Benthic microalgae				√	
Phytoplankton (species/groups)				√	

8.5.3 Model Refinements

The following refinements to the existing models are included in the recommended RWQMP:

- Further evaluate and refine the watershed hydrology/water quality models with longer period of calibration and validation to better simulate nutrient cycling and DO dynamics in major canals.

- Integrate a user-friendly graphic user interface for management of the geo-spatial data, such as land use change and irrigation demands.
- Refine Caloosahatchee Estuary CH3D model with groundwater seepage data and sediment transport scheme including integration with a water quality component.
- Update estuary water quality models with newly collected data including the benthic fluxes, diurnal DO concentrations, and sediment and turbidity in order to simulate the impact in the estuary from watershed loading for adaptive management. Also, the simulation period also needs to be extended to cover a longer time period.
- Expand the Estuarine Ecological Response Model to include other VECs such as seagrass and fish larvae.
- Incorporate the HSI models into ArcGIS to portray responses spatially and temporally to facilitate policy decisions. The models need to be further validated with comprehensive monitoring data. A comprehensive assessment is also necessary to evaluate the model for both long-term and short-term applications.
- Convert the SAV model to a common platform, such as a FORTRAN program with linkages to spreadsheets or another user-friendly interface, to increase computation efficiency. Also, expand the SAV model for broader applications to include other SAV species, such as *Halodule wrightii* and *Thalassia testudinum*.

CHAPTER 9

PREFERRED PLAN PROJECTS AND ACTIONS

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9.0 PREFERRED PLAN PROJECTS AND ACTIONS

The Caloosahatchee River Watershed Protection Plan (CRWPP) was developed in response to the Northern Everglades and Estuaries Protection Plan (NEEPP) legislation, Section 373.4595, Florida Statutes (F.S.) (2007). This legislation requires the CRWPP to include a Construction Project, a Watershed Pollutant Control Program, and a Research and Water Quality Monitoring Program (RWQMP). This chapter provides an overview of all three components, which collectively comprise the preferred Plan and describes the plan implementation strategy, initial costs and funding estimates, cost share opportunities, and the process for plan refinements and revisions.

9.1 Watershed Construction Project

The Caloosahatchee River Watershed Construction Project is detailed in Chapter 6. The following sections highlight the Caloosahatchee River Watershed Construction Project (Construction Project) features. The features are broadly grouped into the following three general categories: (1) Water Quantity/Storage, (2) Water Quality, and (3) Land Management and Restoration. Individual projects are categorized based on their primary objective and discussed in the following sections (See Table 6.4-6).

9.1.1 Water Quantity/Storage

The Construction Project water quantity/storage projects are designed to capture and store stormwater runoff in the Caloosahatchee River Watershed and include aboveground reservoirs, alternative water storage/disposal projects, and aquifer storage and recovery (ASR) wells. These projects include both local and regional projects.

9.1.1.1 Reservoirs

Aboveground reservoirs are the most common type of surface water storage features. Aboveground reservoirs typically comprise large areas of land surrounded by levees that are used to store water. This water is typically withdrawn from the Caloosahatchee River Watershed and stored during the wet season to provide attenuation and reduce the discharge of freshwater in the estuary. In the dry season, this water can then be released to reduce the demand on the Caloosahatchee River for freshwater to be used for irrigation, or may provide flows needed for environmental purposes. These types of reservoirs also provide ancillary quality benefits; nutrients and other contaminants tend to settle out within the reservoir. Several large reservoirs are currently being designed and constructed in the greater Everglades ecosystem.

Reservoir storage sites are planned at various sites throughout the Caloosahatchee River Watershed, including:

- C-43 Distributed Reservoir (CRE-LO 41);
- Harns Marsh Improvements – Phase I & II (CRE 18);
- Harns Marsh Improvements – Phase II Final Design ECWCD (CRE 19);
- Yellowtail Structure Construction – ECWCD (CRE 20);

- Hendry County Storage (CRE 21);
- Hendry Extension Canal Widening (Construction) – ECWCD (CRE 22);
- East Caloosahatchee Storage (CRE 128); and
- Caloosahatchee Storage – Additional (CRE 128a).

9.1.1.2 Aquifer Storage and Recovery

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

Interest and activity in ASR in southern Florida have greatly increased over the past 10 to 15 years. In south Florida, ASR wells have typically been used to store excess freshwater during the wet season and subsequently recover it during the dry season for use as an alternative drinking water supply source. Many utility-operated ASR facilities now have wells completed in deep confined aquifers and available for this purpose. Large-scale application of the ASR technology is under evaluation as a storage option in the Comprehensive Everglades Restoration Plan (CERP). The Construction Project includes the Cape Coral Canal Stormwater Recovery by ASR (CRE 77) and the Rehydrate Lee County Well Fields – south of Hwy 82 (CRE 122) projects.

9.1.1.3 Alternative Water Storage/Disposal

Alternative water storage/disposal projects essentially prevent runoff from reaching the regional drainage system or improve the timing of its delivery, and can be developed on available private, public, and tribal lands. They are used to store and/or dispose of excess water by capturing it prior to runoff or pumping it from areas or canals with excess water, and holding it on-site. Alternative water storage/disposal projects typically require minimal design, engineering, and construction effort, as compared to constructed reservoirs, because of the use of low technology approaches. Approaches include the use of existing infrastructure, such as pumps to move water to the desired area, and weirs, berms, and small impoundments needed to detain the water in the facility. If they are established on existing wetlands, they are designed and operated to improve the existing wetland functions.

The Construction Project includes the following alternate water storage/disposal projects: Alternate Water Storage (LOER) – Barron Water Control District (CRE-LO12g), Recyclable Water Containment Areas (RWCA) (CRE 01), and Recycled Water Containment Area (RWCA) in the S-4 Basin (CRE 02).

9.1.2 Watershed Water Quality Projects

Caloosahatchee River Watershed water quality projects focus on reducing total nitrogen (TN) and total phosphorus (TP) loading within and from the watershed. The projects are a combination of the source control efforts described in Section 9.2 and projects including water quality treatment areas/stormwater treatment areas (STAs), stormwater management, waste/wastewater management, and innovative nutrient control technologies (e.g., managed aquatic plant systems, Hybrid Wetland Treatment Technology).

9.1.2.1 Water Quality Treatment Areas and Stormwater Treatment Areas

Water quality treatment areas are constructed wetlands designed for optimal nutrient removal. When water flows through flooded wetland cells, plants and algae remove nutrients from the water. Constructed wetlands have been shown to be very efficient in reducing nutrient loads and concentrations.

STAs, a type of water quality treatment area, are constructed wetlands that have been used very successfully in South Florida to treat nutrient-rich stormwater runoff. Typically, wetland cells in STAs include emergent vegetation or a combination of emergent and submerged vegetation.

There are both regional scale and local scale water quality treatment areas and STAs included in the Construction Project. The regional scale water quality treatment areas within the Caloosahatchee River Watershed include the C-43 Water Quality Treatment Demonstration Project (BOMA Property) (CRE 10), the Caloosahatchee Ecoscape Water Quality Treatment Area (CRE 11), East Caloosahatchee Water Quality Treatment Area (CRE 05), and the West Caloosahatchee Water Quality Treatment Area (CRE 13). The Construction Project also includes the Clewiston STA (CRE-LO 92), Caloosahatchee Area Lakes Restoration (Lake Hicpochee) (CRE 04), and the West Lake Hicpochee Project (CRE-LO 40).

9.1.2.2 Stormwater Management

The installation or upgrade of an urban stormwater management system can improve surface water quality in the Caloosahatchee River Watershed. A variety of structures (e.g. wet detention ponds, vegetated swales, diversion weirs, baffle boxes, etc.) within a surface water management system can attenuate surface water flow to increase percolation for groundwater storage, facilitate settling, and promote nutrient uptake prior to receiving water discharge. System retrofit projects and local government Stormwater Master Plan implementation projects are management measures that will improve the conveyance of stormwater during storm events and reduce pollutant loadings from urban runoff.

The Construction Project includes a variety of stormwater projects. These projects generally consist of the construction of filter marshes, construction of facilities to transfer water between basins, installation of water control structures, repair or improvement of existing water control structures, and widening of canals to provide additional storage and attenuation. These projects are constructed on both a local and regional scale. The projects consist of the following:

- Lehigh Areas Wastewater Treatment and Stormwater Retrofit (CRE 29);
- Billy Creek Filter Marsh Phase I and II (CRE 45);
- Manuel's Branch Silt Reduction Structure (CRE 48);
- Manuel's Branch East & West Weirs (CRE 49);
- North Fort Myers Surface Water Restoration (CRE 59);
- Yellow Fever Creek/ Gator Slough Transfer Facility (CRE 64);
- Cape Coral Wastewater Treatment and Stormwater Retrofit (CRE69);

- City of LaBelle Stormwater Master Plan Implementation (CRE 121);
- North Ten Mile Canal Stormwater Treatment System (CRE 123);
- Carrell Canal (FMCC) Water Quality Improvements (CRE 124); and
- Shoemaker-Zapato Canal Stormwater Treatment (CRE 125).

9.1.2.3 Waste/Wastewater Management

The Construction Project includes several waste or wastewater management projects. These include projects to eliminate septic systems and install central sewer systems, the interconnection of wastewater facilities to provide an additional source of reclaimed water, and the upgrading of existing wastewater treatment plants. The Construction Project includes the following projects: Leigh Acres Waste Water Treatment & Stormwater Retrofit (CRE 29), Cape Coral Reclaimed Water Interconnect (CRE 126), and Wastewater Treatment Plant Upgrade and Reclaimed Water (CRE 129).

9.1.2.4 Innovative Nutrient Control Technologies

9.1.2.4.1 Managed Aquatic Plant Systems

Managed aquatic plant systems are aquatic plant-based water treatment units. The technology involves routing nutrient loaded stormwater into ponds that are vegetated with plants that have enhanced ability to absorb and assimilate nutrients. A variant of managed aquatic plant systems, which is currently proposed as a management measure to be included in the CRWPP, is known as the Algal Turf Scrubber™. This technology, developed by HydroMentia, Inc., involves the cultivation of a mixed community of periphytic algae that are cultured on an engineered geomembrane. The membrane sits on a grid upon which nutrient-rich waters are discharged. The Construction Project includes the Powell Creek Algal Turf Scrubber (CRE 57). The Powell Creek project will include a pilot project with the potential for a large scale project, depending on the outcome of the pilot project.

9.1.2.4.2 Hybrid Wetland and Chemical Treatment

Hybrid Wetland Treatment Technology combines the strengths of the two top ranked nutrient removal technologies, namely treatment wetlands and chemical injection systems. This technology forms a synergistic relationship that results in nutrient removal efficiencies beyond those attainable by either technology separately, but with lower capital and operating costs. Optimization of system performance is achieved by adjusting hydraulic retention time (area of facility) and/or chemical dosing rates. Hybrid Wetland and Treatment Technology has been previously demonstrated to reduce P concentrations from over 1,000 parts per billion (ppb) to less than 100 ppb (Watershed Technologies, Inc. 2007).

Chemical treatment involves application of chemicals into stormwater runoff to aid in reduction of contaminant loads and concentrations, and of turbidity (suspended solids) in the water by promoting the coagulation and flocculation of suspended solids. Chemical treatment can be used in combination with wet detention of stormwater, treatment of runoff prior to storage, or with supplemental treatment associated with reservoirs or STAs. Currently, there are no chemical treatment or Hybrid Wetland and Treatment Technology management measures in the

Construction Project. However, these technologies will be further evaluated during the plan refinement process and may be incorporated in future plan updates.

9.1.3 Land Management and Restoration Projects

The Construction Project management measures related to land management and restoration include creation and restoration of wetlands, land conservation, and incorporation of growth management techniques and initiatives that integrate environmental objectives into urban growth planning.

9.1.3.1 Wetland Restoration

Natural wetlands sequester surface water flows, recharge the aquifer, and provide water quality treatment through assimilation and sedimentation. Wetland restoration includes enhancing degraded wetlands and restoring areas that were historically wetlands.

The Construction Project includes a variety of wetlands projects, both at the local and regional scale: Spanish Creek/Four Corners Environmental Restoration (CRE 44), Caloosahatchee Creeks Preserve Hydrological Restoration (CRE 53), and Rehydrate Lee County Well Fields – south of Highway 82 (CRE 122).

9.1.3.2 Land Conservation

Conservation of natural areas in urban settings provides both natural and social benefits. The goal of land conservation programs is to protect coastal and estuarine lands considered important for their ecological, conservational, recreational, historical, or aesthetic values. There are programs that provide state and local governments with matching funds to purchase significant coastal and estuarine lands, or conservation easements on such lands, from willing sellers. The Construction Project includes the Coastal and Estuarine Land Conservation Program (CRE-LO 09), Florida Ranchlands Enviromental Services Project (CRE-LO 87c), and the Farm and Ranchland Partnerships (CRE-LO 91).

9.1.3.3 Integrated Growth Management and Restoration

This category includes programs and projects that integrate environmental restoration objectives with urban growth initiatives. Planning and economic incentives are typically provided to encourage the use of innovative and flexible planning, development strategies, and creative land use planning techniques that minimize the footprint of developments while conserving natural lands and open spaces. The Construction Project includes both the Rural Land Stewardship Area Program and the Comprehensive Planning & Growth Management (CRE-LO 68).

9.2 Watershed Pollutant Control Program

Pollutant source control is integral to the success of any water resource protection or restoration program. Nutrient source controls refer to activities and measures, also referred to as Best Management Practices (BMPs), that can be utilized on agricultural and non-agricultural lands to ensure that the amount of phosphorus (P) and nitrogen (N) in off-site discharge is minimized, thereby preventing nutrients from entering the Caloosahatchee River Watershed.

Implementation of source controls is a relatively cost-effective pollutant reduction and prevention measure, as it is typically less expensive to prevent pollution than to remediate its impacts. There are presently several existing and proposed nutrient source control programs within the Caloosahatchee River Watershed. These programs are developed and implemented cooperatively by the South Florida Water Management District (SFWMD), Florida Department of Environmental Protection (FDEP), and Florida Department of Agricultural and Consumer Services (FDACS) in collaboration with local governments and private landowners.

The Caloosahatchee River Watershed Pollutant Control Program is designed to be a multi-faceted approach to reducing pollutant loads. The program includes improving the management of pollutant sources within the Caloosahatchee River Watershed through implementation of regulations and BMPs and development and implementation of improved BMPs focusing on N and P. This section provides an overview of the program. Please refer to Chapter 7 for the complete Caloosahatchee Lucie River Watershed Pollutant Control Program.

9.2.1 SFWMD Nutrient Source Control Programs

The Environmental Resource Permit (ERP) Program regulates activities involving the alteration of surface-water flows, and includes activities in uplands that alter stormwater runoff, as well as dredging and filling in wetlands and other surface waters. Generally, the program's purpose is to ensure that alterations do not degrade water quality, compromise flood protection, or adversely affect the function of wetland systems.

The ERP Program only applies to new or modified development. It operates on the assumption that permit requirements will result in adequate water-storage capacity and no increase in P loading. SFWMD has initiated development of an ERP basin rule with specific supplemental criteria designed to result in no increase in total runoff volume from new development that discharges ultimately to Lake Okeechobee and/or the Caloosahatchee or St. Lucie estuaries. The tentative date for rule adoption is mid to late 2010.

The Regulatory Nutrient Source Control Program, (Chapter 40E-61, F.A.C.), adopted in 1989, was a result of the Lake Okeechobee Surface Water Improvement and Management (SWIM) Plan to provide a regulatory source control program specifically for P. The NEEPP legislation expanded the program boundary to the Caloosahatchee River Watershed and included N, in addition to P, as the focus of nutrient source controls. The program applies to new and existing agricultural and non-agricultural activities with the goal of reducing nutrients in off-site discharges.

SFWMD plans to propose modifications to Chapter 40E-61, F.A.C. for consistency with the goals and objectives of NEEPP. To ensure consistency with the CRWPP, rule development is expected to begin in 2009.

9.2.2 FDACS Nutrient Source Control Programs

FDACS has adopted, by administrative rule, agricultural BMPs addressing containerized nursery, vegetable and agronomic crop and citrus land uses in the Caloosahatchee River Watershed. FDACS is currently developing and will be adopting BMP programs for cow/calf, sod and equine operations. BMPs for all agricultural land uses are expected to be adopted by early 2009.

In February 2008, FDACS initiated rule development to control the land application of animal wastes in the Caloosahatchee River Watershed. The proposed rule includes minimum application setbacks from wetlands and all surface waters. Landowners who apply more than one ton per acre of manure must develop conservation plans approved by the U.S. Department of Agriculture/National Resource Conservation Service (USDA/NRCS). The conservation plan must specifically address the application of animal wastes, and the landowner must conduct soil testing to demonstrate the need for manure application. All use of animal manure must be recorded and included in the operation's overall nutrient management plan. FDACS expects to complete rule making for this effort by the end of 2008.

In August 2007, FDACS adopted a statewide Urban Turf Fertilizer Rule. The rule limits the P and N content in fertilizers being applied to urban turf and lawns, thereby limiting the amount of those compounds reaching Florida's water resources. It requires that, by July 1, 2009, all fertilizer products labeled for use on urban turf, sports turf, and lawns be limited to the amount of P and N needed to support healthy turf maintenance. As a component of the Lake Okeechobee and Estuary Recovery (LOER) Plan established in October 2005, the new rule is an essential component to improve water quality through nutrient source control. See Sections 7.1.2 for a more in-depth description of FDACS nutrient source control programs.

9.2.3 FDEP Pollutant Source Control Programs

FDEP is responsible for several existing and planned source control programs primarily targeting urban and non-agricultural issues. These programs include:

- Initiatives to improve existing stormwater and wastewater infrastructure;
- Implementation of pollutant reduction plans for municipal stormwater management systems;
- Land development regulations to promote proper stormwater treatment;
- Enhancement to existing regulations from the management of domestic wastewater residuals within the Caloosahatchee River Watershed;
- Coordination with applicable authorities on septage disposal to ensure that nutrient loadings are considered; and
- Administering the National Pollution Discharge Elimination System (NPDES) permit program.

As a result of these programs, local governments have constructed numerous stormwater retrofit projects and are continuing to pursue additional projects to improve the quality of water in urban runoff. Local utilities have also aggressively pursued upgrades to wastewater management systems to improve water quality. FDEP also administers the statewide Municipal Separate Storm Sewer Systems (MS4) Program. The MS4 Program requires that a stormwater management plan be developed to reduce the discharge of pollutants to the maximum extent practicable to protect water quality and comply with the water quality requirements of the Clean Water Act (CWA). Please refer to Chapter 7 for a complete description of all FDEP programs.

9.2.4 Other Pollutant Source Control Programs

Launched in October 2005, the Florida Ranchlands Environmental Services Project established a program under which ranchers in the northern Everglades watersheds can sell environmental services of water retention, P load reduction, and wetland habitat expansion to agencies of the state and other willing buyers. To document the level of environmental services provided by ranch water-management projects, the Florida Ranchlands Environmental Services Project will field test different methods of using monitoring and modeling of hydrology, water and soil chemistry, and vegetation change. The Florida Ranchlands Environmental Services Project is being implemented through a collaboration of the World Wildlife Fund, eight participating ranchers, USDA/NRCS, FDACS, SFWMD, and FDEP.

The Florida Yards and Neighborhoods Program is an excellent example of a nonstructural program. It is a partnership of the University of Florida, Institute for Food and Agricultural Sciences (UF/IFAS), Florida's water management districts, FDEP, the National Estuary Program, the Florida Sea Grant College Program, concerned citizens, members of private industry and numerous other nongovernmental agencies. It is implemented through the counties' UF/IFAS Cooperative Extension Service. The program addresses the serious problems of pollution in stormwater runoff, water shortages, and disappearing habitats by enlisting Floridians to preserve and to protect our natural resources.

9.2.5 Local Programs

The Southwest Florida Regional Planning Council approved a Stormwater Resolution (SWFRPC Resolution #2008-11) providing specific recommendations and guidelines to be considered by local government jurisdictions in Southwest Florida for the regulation, control, use, and treatment of stormwater containing N and/or P. Additionally, the Southwest Florida Regional Planning Council has approved a Wastewater Resolution (SWFRPC Resolution # 2007-02) providing specific recommendations and guidelines to be considered by local government jurisdictions in Southwest Florida for the regulation and control of treated wastewater discharges containing N and/or P. The Southwest Florida Regional Planning Council has also approved a Wastewater Package Plant Resolution (SWFRPC Resolution # 2007-05) providing specific recommendations and guidelines to be considered by local government jurisdictions in Southwest Florida for the regulation and control of treated wastewater discharges from small wastewater treatment facilities (Package Plants) containing N and/or P.

Lee County and the City of Sanibel have enacted fertilizer ordinances that provide more restrictive residential and commercial application schedules. Additionally, education, certification, and enforcement capability have been included to assure compliance.

9.3 Watershed Research and Water Quality Monitoring Program

The recommended RWQMP has been formulated to fulfill the goals and reporting requirements of the CRWPP and support adaptive management. It builds upon the existing monitoring, research, and modeling components discussed above, and makes recommendations/modifications to these efforts to better achieve and assess the goals/targets of the CRWPP.

9.3.1 Monitoring Program

The monitoring program consists of a watershed monitoring component and an estuarine monitoring component.

9.3.1.1 Watershed Monitoring – Water Quality

As stated previously under Section 8.4.1, monitoring east of S-79 is currently sparse. The frequency of water quality sampling at S-79 and S-78 may not be sufficient for accurate calculation of load and this issue requires investigation. Identification of problem areas and tracking progress toward the Total Maximum Daily Load (TMDL) at spatial scales smaller than the East and West Caloosahatchee basins are not possible with existing monitoring activities. Recommendations include the addition of eight long-term water quality and flow monitoring sites along the reach of the Caloosahatchee River, east of S-79. These additional sites will provide the spatial coverage necessary for tracking progress towards the TMDL, and will support adaptive management and development of a Basin Management Action Plan. Monthly water quality and continuous flow will be measured at each station, allowing calculation of loading to each reach of the Caloosahatchee River. Four short-term water quality and flow monitoring sites in canal tributaries flowing into the river are also recommended. These stations will help determine if loads calculated from reach samples accurately reflect the sum of tributary loads. Additionally, two new water quality parameters are recommended to be added to the monthly suite of water quality grab sample analytes in order to support progress towards meeting any adopted nutrient TMDLs. These parameters are: dissolved total Kjeldahl nitrogen (DTKN) and 5-day biological oxygen demand (BOD_5). Measurement of BOD_5 will support modeling efforts and provide a measure of the labile organic loads to the receiving waters. DTKN allows the calculation of dissolved organic nitrogen, which often constitutes most of the TN load. The following parameters should be considered for inclusion in the monitoring program, based on the potential for possible impairments now or in the future: sediment oxygen demand, fecal coliform, total dissolved solids, total hardness, iron, copper, lead, arsenic, and zinc. The sampling suite will be re-evaluated at the three-year CRWPP re-evaluation period.

In addition, the RWQMP recognizes that a SFWMD-sponsored source control monitoring program, to measure the success of the collective Source Control Programs (SFWMD, FDEP and FDACS) at the sub-watershed level, is under development and may refine the proposed Caloosahatchee Tributary Monitoring Program. At the sub-watershed level, monitoring activities associated with the program will assess the collective success of pollutant source control BMPs, compliance with pollution reduction targets, and the need for additional BMPs or optimization of existing BMPs. At the local level, this monitoring will identify priority areas of water quality concern and provide data to enhance performance of downstream treatment facilities. This program also will provide data that can be used in adaptive management, as well as modeling and tracking of progress towards achieving TMDLs.

9.3.1.2 Estuary Monitoring – Water Quality, Flow, Salinity, and Aquatic Habitat

Existing estuarine monitoring includes water quality, flow, salinity, submerged aquatic vegetation, and oyster habitats.

Water Quality Monitoring: The existing water quality monitoring effort established for the estuarine portion of the Caloosahatchee River is being carried out by SFWMD, FDEP, Lee

County, City of Cape Coral, City of Sanibel, Charlotte Harbor National Estuary Program, Florida International University (FIU), Sanibel-Captiva Conservation Foundation (SCCF), Florida Fish and Wildlife Research Institute, and the Charlotte Harbor Estuaries Volunteer Water Quality Monitoring Network. In general, the water quality monitoring conducted by all agencies in estuarine and marine waters of the study area are adequate to meet program goals and should continue. Some redundancies have been identified; the removal of one existing Lee County station and five SFWMD/FIU stations are recommended. Because the Caloosahatchee Estuary is currently under-sampled spatially, four historical stations from the Caloosahatchee Estuary Water Quality Monitoring Program should be re-instated (CES02, CES05, CES07 and CES08).

As recommended for watershed monitoring, BOD_5 and DTKN should also be added to the water quality parameters measured in the estuary monthly grab samples. The following parameters should be considered for inclusion in the monitoring program, based on the potential for possible impairments now or in the future: sediment oxygen demand, fecal coliform, total dissolved solids, total hardness, iron, copper, lead, arsenic, and zinc.

Flow Monitoring: Historically, there have been few measurements of freshwater inflows to the Caloosahatchee Estuary from the Tidal Basin west of S-79. To quantify these flows, eight additional flow sites and one cooperative site with Lee County were added by the USGS, in cooperation with Florida Department of Environmental Protection (FDEP). The current long-term flow monitoring conducted in the tidal basin west of S-79 by Lee County, United States Geological Survey and FDEP should continue as it is now planned.

Salinity Monitoring: Salinity monitoring is essential to supporting water quality modeling, refining salinity envelopes, and quantifying the goal of reducing undesirable salinity ranges. Salinity monitoring stations maintained by SFWMD and SCCF are sufficient and should also be continued.

Submerged Aquatic Vegetation (SAV) Monitoring: There are currently six SAV monitoring efforts in the tidal waters within the CRWPP boundaries. There have been five aerial photography surveys conducted since 1999. Aerial survey information has been used by various organizations to evaluate incremental and long-term changes throughout the entire region and within major sections of the system. The existing programs are sufficient for detecting trends and assessing the status of seagrasses in the CRWPP study area on multiple spatial and temporal scales. The current multi-agency approach to seagrass monitoring in the study area should also continue. SAV aerial photography surveys should continue at the historical sampling frequency of every two-to-three years.

Oyster Monitoring: Monitoring of oysters in the Caloosahatchee Estuary is currently conducted by the Restoration Coordination and Verification Program (RECOVER) at six stations. Various aspects of oyster condition, life history and distribution are measured. While most parameters are measured monthly or seasonally, the regional distribution of oysters is mapped every five years (RECOVER, 2007). The current oyster monitoring program conducted by RECOVER should continue, along with mapping of oyster beds, at a planned frequency.

9.3.2 Research Program

Research projects are intended to reduce or eliminate key uncertainties in the proposed TMDL and in flow and salinity envelopes, and to optimize the operation protocols. The four research projects in the RWQMP are summarized below. Chapter 5 of the RWQMP provides a detailed description of these programs, and assesses their adequacy in achieving the CRWPP goals/targets.

- **Estuarine Nutrient Budget**: Over-enrichment with nutrients from urban and agricultural sources is a problem for the Caloosahatchee Estuary. This project will construct nutrient budgets of TN and TP. Results of this project can be used to support water quality modeling efforts that will reduce the uncertainties related to nutrient TMDLs and increase the capability to predict effects of various management measures, including BMPs.

- **Dissolved Oxygen (DO) Dynamics**: This research project will identify the factors causing the DO impairment in the Caloosahatchee Estuary. Understanding of DO dynamics will also help to identify impacts from the pollutant loads to estuarine ecosytems. Once causes are known, appropriate management solutions can be implemented. The results of this study will provide critical information that will guide the selection of these management solutions.

- **Low Salinity Zone**: Much of the work that supports estimates of minimum and maximum freshwater inflow requirements to the Caloosahatchee Estuary is based on the salinity tolerances of freshwater and marine organisms that inhabit the system. The low salinity zone research project examines elements of the estuarine food web. The ultimate goal is to understand the role of freshwater discharge and production of fish larvae in the estuary. Results can be applied to establishing water reservations, to refining flow and salinity envelopes, and to providing guidelines for delivery of freshwater to the Caloosahatchee Estuary.

- **Light Attenuation in San Carlos Bay**: This study will determine how relative contributions to total light attenuation of chlorophyll-*a*, colored dissolved organic matter, and turbidity vary with season and freshwater inflow in San Carlos Bay. Information from this study will better define controls on light attenuation in San Carlos Bay and the relationship between the TMDL and its resource goal. Results can be used to determine when, and under what conditions, resource light attenuation goals may be met.

9.3.2.1 Research Project Priorities

Each major research project (e.g., Nutrient Budget) can be broken down into several components. Examination of the components of each project shows that several projects may have common components. The major research projects and commonalities between components of these projects are summarized in **Table 9-1**. The source of data for each component is given (existing data, new measurements, model etc). Items funded in any given year may be prioritized according to the number of projects to which they belong.

Table 9-1. Components and Commonalities of Major Research Projects in the Caloosahatchee River Watershed and Estuary

Research Component	Research Projects				Source
	Nutrient Budget	**DO Dynamics**	**Low Salinity Zone**	**Light Attenuation**	
INPUTS					
Franklin Lock Loads (S-79)	√	√	√	√	Monitoring
Tidal Basin Loads					
Surface Flows	√	√	√	√	Model/Measurements
Groundwater	√	√	√	√	Model/Measurements
Wastewater Treatment Facilities	√	√	√	√	New Measurements
Gulf of Mexico	√				Model for Flow Literature Concentration
Atmospheric Deposition	√				Literature/ Data Analysis
INTERNAL CYCLING					
Primary Productivity/ Water Column Respiration	√	√	√	√	New Measurements
Organic Matter Decomposition (incl DON)	√	√			New Measurements
Benthic Nutrient Flux	√	√			New Measurements
DO Time Series		√	√		New Measurements
INTERNAL CYCLING					
San Carlos Bay Times Series					
Color				√	New Measurements
Turbidity				√	New Measurements
Chlorophyll-*a*				√	New Measurements
TSS				√	New Measurements
PAR (Kd)				√	New Measurements
OUTPUTS					
Export to Gulf	√				Model
Denitrification	√				Benthic Flux Project
BIOMASS					
Larval/ Juvenile Fish				√	New Measurements
Zooplankton				√	
Benthic microalgae				√	
Phytoplankton (species/groups)				√	

9.3.3 Modeling Needs and Recommendations

Numerous models have been developed or are currently under development for use in the Caloosahatchee River Watershed, as summarized in **Table 9-2**. An assessment of existing models and their ability to meet future modeling needs was conducted and a set of modeling recommendations was developed.

Table 9-2. Existing Caloosahatchee River Watershed Models

Watershed Water Quality and Hydrology	Estuary Water Quality and Hydrology	Estuarine Ecology
ASFIRS/WATBAL Hydrologic Model	CH3D Hydrodynamic Model	Tapegrass Model
Northern Everglades Regional Simulation Model (NERSM)	EFDC/WASP Model	Habitat Suitability Index
MIKESHE Hydrologic Model		
HSPF Model		

An integrated modeling framework, combining the resource-based Valued Ecosystem Component (VEC) approach and linked watershed and estuarine models, is proposed to meet water management objectives for coastal ecosystems protection and restoration (SFWMD, 2008). Specifically, the watershed model estimates the quantity, timing, and quality of freshwater inflow to the estuary. The estuarine hydrodynamic, sediment transport, and water quality models, in turn, simulate the estuarine conditions in terms of salinity, water quality, and sediment transport. Finally, the ecological models simulate the responses of estuarine resources and processes to the estuarine conditions.

9.3.3.1 Watershed Hydrology and Water Quality Modeling

Effective management that aims to protect water quality requires a "big picture" view of water resources at a watershed-scale. Watershed models provide the necessary links for this purpose, particularly when it comes to understanding how non-point sources of pollution interact with point sources, and how these jointly affect the downstream water quality.

Watershed hydrology and water quality simulation modeling tools are needed that are capable of (1) simulating the hydrologic interaction of the Caloosahatchee River Watershed with other components of the Northern Everglades Program (Lake Okeechobee and St Lucie River watersheds); (2) watershed loading simulation; (3) optimizing operations/sizing of features; and (4) a user-friendly graphic user interface. Additionally, watershed models are in need of refinement with longer period of calibration and validation to enhance the simulations of nutrient cycling and DO dynamics. An integration of watershed models with estuarine models is also needed.

9.3.3.2 Estuary Hydrodynamic and Water Quality Modeling

Estuary hydrodynamic and water quality simulation modeling tools are needed that are capable of (1) simulating the impacts induced by the watershed loading, (2) estuary hydrodynamics, and (3) estuary water quality processes. Estuarine models also need refinements in integration with watershed loadings and with longer periods of calibration and validation to enhance the nutrient and DO simulations.

9.3.3.3 Estuarine Ecologic Response Modeling

Future efforts in the estuarine ecologic response modeling should simulate the habitats for seagrass, oyster, and fish larvae to represent the entire spectrum of the valued ecosystems in the estuary. A set of ecological performance measures representing different habitats for fish larvae, oysters, and seagrass will be needed to direct operation for both the dry season and the wet season. Eventually, a community-level ecological response model should be developed to predict the ecosystem change with the anticipated improvement in the habitats. A graphic user interface will also need to be developed to provide explicit linkage between management objectives and predicted improvements with restoration actions.

The Habitat Suitability Index (HSI) models should be incorporated into ArcGIS to portray responses spatially and temporally to facilitate policy decisions. The models need to be further validated with comprehensive monitoring data. A comprehensive assessment is also necessary to evaluate the model for both long-term and short-term applications.

The SAV model should be converted to a common platform, such as a FORTRAN program with linkages to Microsoft Excel® or other userfriendly interface to increase computation efficiency. For broader applications, the SAV model needs to be expanded to include other SAV species, such as *Halodule wrightii* and *Thalassia testudinum*. A numeric ecological model will need to be set up for each species and calibrated with field monitoring data. A broad range of tests will also need to be conducted under different salinity, light and water temperature conditions. Additionally, current water quality linkage applications need to be established.

9.4 Preferred Plan Implementation

The Watershed Construction Project, Watershed Pollutant Control Program, and Watershed Research and Water Quality Monitoring Program collectively comprise the preferred Caloosahatchee River Watershed Protection Plan. The following sections provide information on various aspects of program implementation including real estate requirements, phasing approach, costs, and plan refinements.

9.4.1 Real Estate Requirements

Specific locations for some preferred Plan features have already been determined, while for other project features, locations have been identified only to the sub-watershed level. Land acquisition needs will be developed over time through the Process Development and Engineering (PD&E) process. During PD&E, conceptual planning will be conducted to further evaluate project siting and real estate acquisition requirements. The results of feasibility studies will help define the real estate requirements which will be reflected in future Plan updates.

To the extent possible, opportunities for less than fee acquisition, such as the Wetland Reserve Program, will be evaluated. It is expected that real estate acquisition for individual features will occur over a period of time. State- and SFWMD-owned lands would be preferentially evaluated for siting preferred Plan project features. However, many of the existing state- and SFWMD-owned acreages have already been targeted for specific features.

9.4.2 Operations, Maintenance, Permitting, and Monitoring

The following sections describe the operations, maintenance, permitting, and monitoring needed for the preferred Plan, to the greatest extent possible. This section will be revised in future CRWPP updates, as more information becomes available. **Appendix F** provides greater detail on these items.

9.4.2.1 Operations & Maintenance

With very few exceptions, the majority of project features included in the preferred Plan are likely to require some level of operation and maintenance (O&M). Consideration of O&M needs from the outset of planning is important to insure that the project goals and objectives are achieved in the most efficient, effective, and safe manner. O&M collectively refers to the following five major elements:

- **Operations –** ongoing activities required to operate the management measure to achieve the project objectives, including water control, fuels and materials, monitoring, etc.;
- **Maintenance –** ongoing activities required to maintain system in an operable condition, including machinery maintenance, mowing, inspections, etc.;
- **Repair –** periodic repair of machinery or other structural elements as needed to restore complete operability of the management measure, including machinery repair, filling scour holes, repairing erosion, etc.;
- **Replacement –** periodic replacement of project elements that have reached or exceeded their functional life including pump replacement, stop-log riser replacement, etc.; and
- **Rehabilitation –** major rehabilitation of a project component may be required under the following circumstances:
    - when the component has exceeded its functional life and continued repair and replacement activities are no longer cost effective;
    - when there are substantive changes in conditions at the facility or associated components of the water management system that preclude meeting the project objectives or result in other undesirable impacts; or
    - changes in design or safety standards.

9.4.2.2 Permitting

Construction and implementation of the preferred Plan features will require a variety of permits and regulatory approvals. Types of permits and approvals needed are likely to vary with feature type and location.

Obtaining all required federal and state permits for implementation and operation of a project feature often requires an intensive level of effort. Permitting can result in significant project delays if it is not adequately considered early in project development. However, specific permit requirements and/or issues may not be evident until a substantial level of detail has been developed during planning and design.

The types of permits and level of effort required during the permitting process may vary greatly for similar or identical measures, depending on the physical conditions that exist at the project site and surrounding area. During the PD&E process, continuing consideration will be given to the types of permits required and the potential permitting issues that must be addressed. In this way, the level of effort and time requirements can be factored into the planning and design process to minimize the potential for significant permit-related project delays.

Federal and state permits are likely to be required for the types of project features contained in the preferred Plan, are described in **Appendix F**. Local permit requirements will vary from site to site and will have to be addressed on a site-specific basis.

9.4.2.3 Monitoring

A comprehensive monitoring and information system will be utilized to provide the data necessary to measure the performance and effectiveness of the preferred Plan in satisfying the restoration goals of the CRWPP. The SFWMD will utilize the current monitoring base and monitoring proposed in the Caloosahatchee River Watershed RWQMP to provide any project-specific resources needed to document the effectiveness of nutrient control efforts in meeting Caloosahatchee River Watershed TMDLs, when established, and to assure compliance with all future permit requirements.

Monitoring is generally required to determine if individual project features and the plan, as a whole, are performing as intended. Typically, monitoring requirements for individual projects are established during the permitting and design process. Since the two primary objectives of the CRWPP are storage and water quality improvements, it can be expected that performance of all structural and non-structural project features included in the plan will have to be monitored for flow and P and N load reduction.

Project-level assessments may also be needed that will focus on estimating the performances of both regional projects (i.e. water quality treatment areas, STAs) and local projects (i.e stormwater retrofits) located throughout the Caloosahatchee River Watershed. Results of the project-level assessment will provide important water quality reduction information, including the assessment of the size of the sub-watershed verses the size of the treatment facility and residence time/pollution removal efficiencies. The results also will assist in evaluating specific nutrient reductions from different types of treatment systems. The overall temporal performance (life cycle) of these facilities over time will also be estimated through this effort. This information will ultimately be used in the adaptive management process to improve the overall performance of treatment facilities of various sizes (i.e. regional and local scale). In addition, safety monitoring will be required for features, such as reservoirs and water quality treatment features. BMPs will also need to be inspected periodically to ensure structural efficacy and that expected performance is achieved.

SFWMD has established an Environmental Monitoring Coordination Team to critically review and evaluate all new monitoring requests to ensure permit compliance, scientific validity, and efficiency. Any future monitoring requirements associated with the CRWPP will be subject to review and approval by the Environmental Monitoring Coordination Team. All current and future water quality data collection, analysis, validation, management, and storage will be conducted in accordance with the FDEP Quality Assurance Rule, 62-160, Florida Administrative Code (F.A.C.), the *District Field Sampling Quality Manual* and/or the *CERP Quality Assurance Systems Requirements Manual.*

9.4.3 Phased Implementation

The NEEPP legislation states that the River Watershed Protection Plans shall be achieved through a phased program of implementation. Therefore, implementation of the preferred Plan described in this chapter will occur through an iterative, adaptive, and phased implementation process. The preferred Plan will be implemented in at least the following three phases.

Phase I - Projects that will be initiated or completed between 2009 and 2012 (**Table 9-3**). This phase will primarily focus on continued implementation of ongoing measures and initiatives. Projects were included in Phase I if current project schedules indicate the project will be initiated or completed by 2012. It is recognized that implementation of these projects is contingent upon funding from many different sources and that actual implementation timeframes may vary. Changes in project schedules will be reflected in annual reports and three-year updates, as appropriate (see Section 9.4.6 for more information regarding plan updates). Phase I includes the projects listed below:

- **Regional Projects**:
  - CERP C-43 West Reservoir
  - Caloosahatchee Area Lakes Restoration (Lake Hicpochee) (CRE 04)
  - C-43 Water Quality Treatment Demonstration Project (CRE 10)
  - Spanish Creek/Four Corners Environmental Restoration Phase I (CRE 44)
- **All Source Control Projects** (Note: The Pollutant Control Project features are accounted for in these source control projects.):
  - Agricultural BMPs- Owner Implemented, Funded Cost Share, and Cost Share Future Funding (CRE-LO 1, 2 and 49)
  - Land Application of Residuals (CRE-LO4)
  - Additional Agricultural BMPs (CRE-LO 50)
  - Urban Turf Fertilizer Rule (LOER) (CRE-LO 3)
  - Florida Yards and Neighborhoods (CRE-LO 5)
  - National Pollutant Discharge Elimination Sysetm (NPDES) Stormwater Program (CRE-LO 8)
  - Environmental Resource Permit Program (CRE-LO 7)
  - Proposed Caloosahatchee River Watershed 40E-61 Regulatory Nutrient Source Control Program (CRE-LO 15)
  - Wastewater and Stormwater Master Plans (CRE-LO 63)
  - Proposed Unified Statewide Stormwater Rule (CRE-LO 64)
  - Comprehensive Planning-Land Development (CRE-LO 68)
  - Lake Okeechobee and Estuary Watershed Basin Rule (LOER) (CRE-LO 21)
- **Local Stormwater, Wastewater, and Habitat Restoration Projects**:
  - Alternative Water Storage - Barron Water Control District (CRE-LO 12g)
  - Harns Marsh Improvements, Phase I and II (CRE 18)

- Billy Creek Filter Marsh, Phase I and II (CRE 45)
- Hendry Extension Canal Widening (CRE 22)
- North Fort Myers Surface Water Restoration (CRE 59)
- Yellow Fever Creek/Gator Slough Transfer Facility (CRE 64)
- Cape Coral Canal Stormwater Recovery by ASR (CRE 77)

- **Land Management Projects:**
  - Florida Ranchlands and Environmental Services Program (CRE-LO 87c)
  - Farm and Ranchland Partnerships (CRE-LO 91)
  - Coastal and Estuarine Land Conservation Program (CRE-LO 9)
- **Research & Water Quality Monitoring Plan:** Monitoring, Research, and Modeling

Table 9-3. Phase 1 (2009-2012) Projects and Implementation Status

		Initiated	**Completed**
Construction Project	Powell Creek Algal Turf Scrubber		✓
	Alternative Water Storage - Barron Water Control District		✓
	Caloosahatchee Area Lakes Restoration (Lake Hicpochee)	✓	
	C-43 Water Quality Treatment Demonstration Project (BOMA)	✓	
	Spanish Creek/Four Corners Environmental Restoration Phase I	✓	
	C-43 West Reservoir	✓	
	Local-Stormwater Projects (e.g., treatment wetlands, conveyance and structural improvements, and stormwater recovery projects)	✓	✓
	Florida Ranchlands and Environmental Services Projects	✓	
	Farm and Ranchland Partnerships	✓	
Pollutant Control Program	Agricultural and Urban BMPs	✓	
	Proposed Revisions to Regulatory Programs (40E-61 Regulatory Nutrient Source Control Program, ERP Basin Rule, Statewide Stormwater Rule)	✓	
	Comprehensive Planning and Growth Management	✓	
Research and Water Quality Monitoring	Monitoring, Research, and Modeling	✓	✓

Phase II - Projects that will be initiated or completed between 2013 and 2018. Phase II projects will be identified in the 2012 CRWPP three-year update. The 2012 CRWPP three-year update will also provide a status update on Phase I projects. The 2015 and subsequent CRWPP three-year updates will provide status reports and any proposed refinements and revisions regarding Phase I and Phase II.

Long-Term Implementation Phase - Projects that will be initiated subsequent to 2018. The Long-Term Implementation Phase will be further defined during the 2015 and 2018 CRWPP three-year updates.

9.4.3.1 Phase I Implementation Benefits

The following benefits are anticipated from implementation of the Phase I projects:

- Ongoing implementation of BMPs on more than 430,000 acres of agricultural lands and over 145,000 acres of urban lands;
- Completing regulatory rule revisions (ERP and Regulatory Nutrient Source Control Rule revisions);
- Completing design and initiating construction of approximately 9,380 acres of reservoirs and over 6,700 acres of STAs and water quality treatment areas;
- Restoring 2,000 acres of wetlands within the Caloosahatchee River Watershed; and
- Providing approximately 178,600 acre-feet of water storage within the Caloosahatchee River Watershed.

9.4.4 Cost Estimates and Funding Sources

9.4.4.1 Phase I Implementation Cost Estimate

The preferred Plan captures a wide array of projects and programs; therefore, there will be a variety of implementation and funding strategies utilized to move the preferred Plan projects forward. Many of these projects are already included in other planning or restoration efforts (e.g., CERP). This plan assumes that those projects will continue to be implemented through the existing mechanisms or programs as originally intended.

To provide a source of state funding for the continued restoration of the South Florida ecosystem, the 2007 Florida Legislature expanded the use of the Save Our Everglades Trust Fund to include Northern Everglades restoration and extended the State of Florida's commitment to Everglades restoration through the year 2020. Save Our Everglades Trust Fund appropriations are determined on an annual basis through the state's budget process. Opportunities for cost sharing, partnering, and grant funding will be utilized to optimize use of resources, as required by section 373.4595(4), F.S.

For purposes of this planning effort, costs have been broken into three categories. It is recognized that there may be other alternative funding strategies for these projects in addition to those found below.

- **CERP** - Costs for CERP projects are eligible for a 50 percent cost share with the federal government. The non-federal contribution may be provided by the state, SFWMD, or local sources.
- **Non-CERP** - Costs for non-CERP features will primarily be borne by SFWMD and the state, with potential for local cost sharing.
- **Local** - Costs for local projects will be covered entirely by the local government or may be cost shared by the local government and state or SFWMD sources.

Cost estimates, potential funding sources, and cost assumptions are provided for each Plan component included in Phase I (with the exception of Urban BMPs where the cost reflects full implementation with no phasing). Costs for each progressive phase of implementation will be developed as more detailed project designs and information from various projects and studies become available.

- **Watershed Construction Project**
  <u>Regional Projects</u>
  CERP: For CERP projects included in Phase I, capital costs are estimated to be $524-$781 million. State CERP costs are eligible for a 50 percent cost-share with the federal government and may also include a local cost share.

  Non-CERP: For non-CERP projects (e.g., C-43 Water Quality Treatment and Testing Facility), capital costs are estimated to be $117-$175 million from state, SFWMD and/or local funds.

  <u>Local Projects</u>
  $15 million from state funds. <u>Note</u>: Based on $5 million per year from 2010 to 2012 and does not reflect matching funds from SFWMD or local sources.

- **Pollutant Control Program**
  Agricultural BMPs: $3.3-$4.0 million from state, SFWMD and/or local funds. <u>Note</u>: Assumes that 100% of owner-implemented and 35% of cost-share agricultural BMPs within the watershed can be implemented during Phase I, the state contributes 50% for capital costs, and that remaining costs are paid by landowners and federal grants.

  Urban BMPs: $663-$809 million from state and local funds. <u>Note</u>: Reflects total capital costs for full implementation of urban BMPs with no phasing and no cost share assumptions. Additional details regarding funding scenarios and schedules for urban bmp implementation will be established during the Basin Management Action Plan development process and will be incorporated into future Protection Plan updates.

- **Research and Water Quality Monitoring Program**
  $5.2 million in state and local funds. <u>Note</u>: This estimate includes costs for research and additional monitoring. Ongoing monitoring costs are not included, as those programs are already in existence and funded through other mechanisms.

Cost estimates are based on the following assumptions:

- Costs do not include dollars that have already been expended to date;
- Costs include the full cost to build a project completely, even if construction period goes beyond Phase I;
- High cost estimates are based upon 10 percent annual real estate inflation and nine percent annual construction inflation; and
- Low cost estimates are based upon 6 percent annual real estate inflation and two percent annual construction inflation.

9.4.4.2 Future Implementation Cost Estimate

Costs for each progressive stage of implementation will be developed as more detailed project designs and information from various projects and studies are available. It is anticipated that modifications and refinements in the methods used to reduce TP and TN loading to the Caloosahatchee Estuary will occur in the future, as a result of model and technology refinements described in Section 9.4.6.2 and Section 9.4.6.3, respectively. Factoring this type of information in will provide additional clarity regarding the scope and engineering and design specifics of projects that will be included in subsequent stages and reduce the uncertainty associated with cost estimates. Cost estimates for Phase II will be provided in the 2012 CRWPP three-year update.

9.4.4.3 Funding Sources and Cost-Sharing Opportunities

The majority of funding for the implementation of this preferred Plan will be from state, SFWMD, federal, and local sources. The 2007 NEEPP legislation provides a dedicated state funding source for the Northern Everglades restoration by expanding the use of the Save Our Everglades Trust Fund to include the Lake Okeechobee Watershed Protection Plan, the CRWPP, and the St. Lucie River Watershed Protection Plan. The legislation specifically states *"There is created within the Department of Environmental Protection the Save Our Everglades Trust Fund. Funds in the trust fund shall be expended to implement the comprehensive plan defined in s. 373.470(2)(a), the Lake Okeechobee Watershed Protection Plan defined in s. 373.4595(2), the Caloosahatchee River Watershed Protection Plan defined in s. 373.4595(2), and the St. Lucie River Watershed Protection Plan defined in s. 373.4595(2)…"* (Section 373.472, F.S.)(2007).

The legislation also extends the state's commitment to provide funding for CERP and the Northern Everglades through the year 2020. Section 470(6)(a) F.S (2007) states *"Except for funds appropriated for debt service, the department shall distribute funds in the Save Our Everglades Trust Fund to the district in accordance with a legislative appropriation and s. 373.026(8)(b) and (c). Distribution of funds to the district from the Save Our Everglades Trust Fund shall be equally matched by the cumulative contributions from the district by fiscal year 2019-2020 by providing funding or credits toward project components."* This is intended to be a recurring source of funding from the state, but must be appropriated by the legislature annually. Funding from the state is to be matched by SFWMD. Many of the local features will have cost sharing with landowners and local governments, as well as state and federal grant programs.

The rate of implementation for non-CERP projects will be dependent upon the level of funding from state, SFWMD, local, and select federal sources. The rate of implementation for CERP projects will be dependent upon federal, state, and SFWMD sources.

It is recognized that multiple sources of funding beyond the recurring annual state and SFWMD appropriations will be required to complete the implementation of the preferred Plan (**Appendix G**). These sources may include funding from federal government agencies (United States Army Corps of Engineers, United States Department of the Interior, USDA, etc.) local governments, tribal communities, and private landowners.

9.4.5 Implementation Challenges

An array of public agencies works to protect and manage the Caloosahatchee River Watershed and Estuary. Most of these agencies have multiple roles in the management of water resources. With this overlapping framework for water resource management, both challenges and opportunities are inevitable. For instance, though an agency may play a role in managing the resource, the level of funding dedicated to the different responsibilities may vary significantly and will change as the agencies' priorities change. This plan will be updated regularly in order to account for these types of changes throughout the implementation process. Because water resources do not follow jurisdictional lines and are affected by all levels of government, identifying and pursuing effective management approaches that reach across these jurisdictional lines is critical to the successful implementation of the CRWPP. Linking water resource management and land-use programs, as well as seeking cooperative management and funding opportunities is a necessary part of plan implementation. Continued participation by public and private organizations will assist in maintaining the momentum for protecting and managing the water resources within the Caloosahatchee Watershed.

9.4.6 Plan Refinement and Revisions

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

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

Portions of this CRWPP have already been implemented or are in the process of being implemented. More detailed planning and design of other features will begin in 2009 and continue throughout the CRWPP implementation stages. During implementation, the hydrologic and water quality conditions in the Calooshatachee River Watershed will continue to change as land use changes and individual projects affecting the quality and quantity of water become operational. Therefore, it is important to have a procedure in place to ensure that:

- A process is established to promote more thorough planning from initial design through project implementation;

- Plan performance is adequately and appropriately monitored over time;
- The CRWPP is revised at periodic intervals, as necessary, based on evaluation of monitoring data; and
- Plan progress is reported to the legislature, regulatory agencies, and the public on a regular basis.

Similar to other state initiatives (e.g. Everglades Protection Area Tributary Basins Long-Term Plan for Achieving Water Quality Goals), this procedure is expected to be borne out through PD&E. The recommendations for PD&E are described in this section. A description of the strategy for plan refinement, revision, and reporting is also provided.

9.4.6.1 Process Development and Engineering

The primary objective of the PD&E is to provide a roadmap for further refinement of the design of individual plan components. The PD&E will also identify additional measures that, if implemented, will increase certainty that the overall plan objectives for improving water quality and quantity are met. The PD&E procedure recognizes the following:

- Achieving improvements in the quality, quantity, timing, and distribution of water and achievement of water quality standards will involve an adaptive management approach, whereby the best available information is used to develop and expeditiously implement incremental improvement measures in a cost-effective manner.
- Continued engineering evaluations will be necessary to increase certainty in the overall operation and performance of integrated hydrology and water quality improvement strategies.
- Significant technical and economic benefits can be realized by integrating the preferred Plan water quality and water quantity management measures with CERP projects, even to the extent that existing schedules should be re-evaluated in some basins and synchronized with CERP implementation schedules.
- The Nutrient and DO TMDL for the Tidal Calooshatachee River and tributaries are currently under development and are anticipated to be completed in December 2008. Depending upon of the outcome of the development of the TMDLs, the preferred Plan may need to be modified and/or additional projects may need to be added to the preferred Plan.

Key elements of the PD&E procedure include model refinement, technology refinement, sub-watershed conceptual planning, adaptive management (resulting from research and water quality monitoring), and plan updates and revisions. These elements are further described in the following sections.

9.4.6.1.1 Model Refinements

An integrated modeling approach is recommended to provide the technical support for implementation and adaptive management of the CRWPP. In addition, several modeling needs have been identified to refine or update the existing models. These continuous improvements are further described in the RWQMP (**Appendix E**).

9.4.6.1.2 Technology Refinements

Existing technology refinement efforts will play an important role in optimizing and refining the implementation of many features that make up the preferred Plan. These features currently include BMP research and refinement, STA integration and refinement, and further research on innovative nutrient control techniques, chemical treatment, and hybrid wetland treatment technologies.

BMP Research and Refinement: Several uncertainties exist in estimating BMP performance. Some uncertainties associated with the performance of BMPs include the impacts of different soils and hydrologic conditions, the quantity of water that can be held on a parcel without impacting an agricultural operation, and legacy nutrients currently within the Caloosahatchee River Watershed. The BMP performance estimates utilized in the CRWPP were based on best professional judgment and take into account the uncertainties described above and information available from literature, as well as actual performance data observed within the Caloosahatchee River Watershed to date. These estimates will continue to be refined over time, as ongoing and future research provides additional information through the technology and model refinement efforts.

Water Quality Project Integration and Refinement: The preferred Plan establishes a technical framework through PD&E for the refinement and integration of water quality projects for the purpose of meeting water quality goals for the watershed and estuary. The goal of water quality project refinement and integration is to apply adaptive management analyses that will assist in determining how to optimize nutrient removal in individual projects and how to integrate multiple water quality projects throughout the watershed.

Innovative Nutrient Control Technologies: Evaluation and testing of technologies, such as chemical treatment and hybrid wetland treatment technologies that have the potential to remove nutrients in a cost-effective manner to meet any adopted TMDLs in the St. Lucie River Watershed, will be conducted. The results of these and other testing and evaluations in the future will play a role in refining and optimizing the CRWPP.

Hybrid Wetland Treatment Technology: Hybrid Wetland and Treatment Technology combines the strengths of the two top-ranked nutrient removal technologies, namely treatment wetlands and chemical injection system. This synergy results in nutrient removal efficiencies beyond those attainable by either separate technology, with lower capital and operating costs. Optimization of system performance is achieved by adjusting hydraulic retention time (area of facility) and/or chemical dosing rates. Hybrid Wetland and Treatment Technology has been previously demonstrated to reduce P concentrations from over 1000 ppb to less than 100 ppb. Preliminary data from the existing Hybrid Wetland and Treatment Technology pilot facilities in Lake Okeechobee and St. Lucie River watersheds show P concentration reductions in the range of 84 to 94 percent. Based on the results of the ongoing pilot projects, additional Hybrid Wetland and Treatment Technology projects may be located within the St. Lucie watershed.

Nitrogen Reduction Technology: The treatment efficiency of most of the included water quality features is well documented with regards to TP reductions. Unfortunately, there is not as much existing information regarding how well these facilities address reductions of TN in the South Florida region. Additional investigations to determine the most efficient and effective methods of reducing TN loads and concentrations will be included in future efforts.

9.4.6.1.3 Sub-watershed Conceptual Planning

The preferred Plan has provided a general framework and road map to follow that will result in progressive improvements in nutrient loading to the Caloosahatchee Estuary and additional storage that will reduce undesirable Caloosahatchee River Watershed discharges. However, due to the general nature of many of the projects identified in this planning process, a significant amount of detailed planning, design and engineering will be necessary prior to project implementation.

In addition, the results of other feasibility efforts will be used to help meet the preferred Plan's objectives in as cost-effective a manner as possible. Studies and pilot projects that test and evaluate various water quality treatment technologies will be used to refine and optimize nutrient removal.

Level 4 and 5 features of the preferred Plan are those that have the least detail and have not been sited at this time. Therefore, for these features, the initial stages of more detailed planning and design, prior to more detailed engineering, will be an evaluation of lands that are currently in SFWMD ownership and how best to maximize their utilization for water quality and surface storage and minimize the need for additional lands. This conceptual planning may be performed on a site-specific basis; however, most initial planning will be conducted on a broader sub-watershed scale. In compliance with the NEEPP requirements, the siting analyses will consider potential impacts to wetlands and threatened and endangered species. After siting of features is completed, more detailed design and engineering will follow.

9.4.6.1.4 Adaptive Management

In order to improve environmental conditions in both estuaries, protection plans will call for the construction of facilities designed to help meet any adopted TMDLs and flow/salinity targets by attenuating and storing storm water runoff, and reducing nutrient loads. Operation of these facilities will be vital to their success. Monitoring and short-term studies will be required to adaptively manage these facilities to meet environmental objectives.

Research conducted within the context of an environmental protection program supports and informs adaptive management. Adaptive management is the iterative and deliberative process of applying the principles of scientific investigation to the design and implementation of a program to better understand the ecosystem and predict its response to implementation and to reduce key uncertainties. The basis of adaptive management is the use of feedback loops that iteratively feed new information into the decision-making process for planning, implementation, and assessment of project components. The three-year assessment, specified in the legislation, provides this feedback loop and ensures the incorporation of adaptive management in the River Watershed Protection Plans.

Research for adaptive management uses a combination of models (conceptual to numeric) and observational and experimental studies to reduce uncertainty in the proposed TMDL and salinity/flow targets, improve the operations of water storage and water quality projects and increase predictive capability. The role of modeling is to provide a mechanism for synthesis, hypothesis specification, and preliminary testing, and to enhance predictive capability.

9.4.6.1.5 Plan Updates and Revisions

The coordinating agencies will prepare CRWPP updates and revisions, which may be necessary based on new information from PD&E, updated water quality and hydrologic data, and adaptive management. In addition, other agencies and the public will have the opportunity to provide input to the coordinating agencies in developing proposed changes through numerous public forums. A process for updating and revising the CRWPP throughout the various implementation stages is described below.

9.4.6.1.5.1 Types of Updates and Revisions

Revisions to the preferred Plan will be classified as minor or major, based on the following criteria:

- Magnitude and nature of the proposed revisions (i.e., scope, schedule, budget);
- Potential for the proposed revision to have environmental impacts that are significantly different from those previously considered by the coordinating agencies for the project;
- Potential for the revision to impact the intent and purpose of the preferred Plan; and
- If the revision requires SFWMD Governing Board approval.

The classification of the revision will not necessarily determine the nature of any accompanying permit requirements that may be necessary.

9.4.6.1.5.2 Process for Updates, Revisoins, and Reporting

The following process is proposed for updating the CRWPP and reporting.

- **Monthly/Bi-monthly Coordinating Agency Meetings** – This forum will be used to discuss progress of implementation, review new information and data, present proposals for revisions (minor and major) along with supporting documentation, and to seek review and comments.

- **Semi-annual Coordinating Agency Review** – New information compiled as a result of the Interagency Coordinating Meetings and other agency and public input will be reviewed by SFWMD, FDEP, and FDACS.

- **Annual Report in the South Florida Environmental Report (SFER)** – SFWMD will submit the required annual report in the SFER (a.k.a. Consolidated Water Management District Annual Report) to FDEP, the Governor, the President of the Senate, and the Speaker of the House of Representatives. This annual report will summarize the status of research and monitoring, project implementation, and recommended revisions to the CRWPP. In addition, major updates and revisions to the plan will be identified and described in the annual report. The discussion will include a description of the need for the revision and its impacts on the CRWPP's scope, schedule, budget, and objectives.

Public comments received during the coordination of the proposed plan revision will also be noted in the annual report.

- **Annual Work Plan –** The Annual Work Plan will be submitted for each fiscal year to FDEP, identifying the projects and funding necessary to implement those projects.
- **CRWPP Update –**Every three years SFWMD, in cooperation with the coordinating agencies, will formally update, revise, and submit the CRWPP to the State Legislature.

9.4.6.2 Public Involvement

Public involvement will be sought regarding proposed updates and revisions to the CWRPP through discussion with the groups listed below.

- **Northern Everglades Interagency Coordinating Meetings –** This forum will be used to discuss progress of implementation, review new information and data, present proposals for revisions (minor and major) along with supporting documentation, and to seek review and comments from the coordinating agencies, stakeholders, and the general public.
- **Water Resources Advisory Commission (WRAC) and Lake Okeechobee Committee Meetings –** Regular updates will be provided to WRAC and the Lake Okeechobee Committee, which advises SFWMD Governing Board on a variety of environmental restoration and water resource management issues. WRAC also serves as a forum for improving public participation and decision-making on water resource issues. These meetings will be used to discuss progress of implementation and seek input from stakeholders, as well as the general public.
- **SFWMD Governing Board Meetings –** Updates on progress of implementation and proposals for major revisions will be discussed as appropriate. This forum will provide an opportunity for input from stakeholders, as well as the general public.
- Other public meetings, as necessary.

9.4.7 Force Majeure

Extraordinary events or circumstances beyond the control of the coordinating agencies may prevent or delay implementation of the preferred Plan. Such events may include, but are not limited to, Acts of Nature (including fire, flood, drought, hurricane, or other natural disaster), as well as unavoidable legal barriers or restraints, including litigation of permits for individual CRWPP projects.

CHAPTER 10

LITERATURE CITED

10.0 LITERATURE CITED

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