112th Congress, 2d Session – – – – – – – – – – – – – House Document 112–132

CENTRAL AND SOUTHERN FLORIDA PROJECT: COMPREHENSIVE EVERGLADES RESTORATION PLAN C–111 SPREADER CANAL WESTERN PROJECT

COMMUNICATION

FROM

THE ASSISTANT SECRETARY OF THE ARMY, CIVIL WORKS, THE DEPARTMENT OF DEFENSE

TRANSMITTING

A REPORT ON THE AUTHORIZATION OF THE C–111 SPREADER CANAL WESTERN PROJECT

VOLUME 3 OF 5

AUGUST 7, 2012.—Referred to the Committee on Transportation and Infrastructure and ordered to be printed

U.S. GOVERNMENT PRINTING OFFICE

77–054 WASHINGTON : 2012

AUTHENTICATED
U.S. GOVERNMENT
INFORMATION
GPO

CENTRAL AND SOUTHERN FLORIDA PROJECT
COMPREHENSIVE EVERGLADES RESTORATION PLAN
C-111 SPREADER CANAL WESTERN PROJECT

FINAL INTEGRATED PROJECT IMPLEMENTATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

Volume 3 Annexes C-F

January 2011

US Army Corps of Engineers®

U.S. ARMY CORPS OF ENGINEERS
JACKSONVILLE DISTRICT

SOUTH FLORIDA WATER MANAGEMENT DISTRICT

This Report Contains [5] Volumes
You Are Here

Volume 1 – Main Report

- Executive Summary
- Section 1 – Introduction
- Section 2 – Existing Conditions/Affected Environment
- Section 3 – Future "Without Project" Condition
- Section 4 – Identification of Problems and Opportunities
- Section 5 – Formulation and Evaluation of Alternatives
- Section 6 – The Recommended Plan
- Section 7 – Environmental Effects
- Section 8 – Plan Implementation
- Section 9 – Coordination, Public Views, and Comments
- Section 10 – Recommendations
- Section 11 – List of Preparers
- Section 12 – Index
- Section 13 – Glossary of Terms
- Section 14 – Acronym List
- Section 15 – References

Volume 2 – Annex A-B

- Annex A – FWCA and Endangered Species Act Compliance
- Annex B – NEPA Information

Volume 3 – Annex C-F

- Annex C – Analyses Required by WRDA 2000 and State Law
- Annex D – Draft Project Operating Manual
- Annex E – Project Monitoring Plan
- Annex F – Reports Provided by RECOVER to Support the PIR

Volume 4 – Appendix A

- Appendix A – Engineering Part I
- Appendix A – Engineering Part II, HTRW Reports

Volume 5 – Appendix B-H

- Appendix B – Cost Estimates
- Appendix C – Environmental Information
- Appendix D – Real Estate
- Appendix E – Agency / Public Coordination
- Appendix F – Plan Formulation and Evaluation
- Appendix G – Economic and Social Considerations
- Appendix H – Recreation Plan

CENTRAL AND SOUTHERN FLORIDA PROJECT
C-111 SPREADER CANAL WESTERN PROJECT

FINAL PROJECT IMPLEMENTATION REPORT
AND
ENVIRONMENTAL IMPACT STATEMENT

US Army Corps of Engineers®

U.S. ARMY CORPS OF ENGINEERS
JACKSONVILLE DISTRICT

SOUTH FLORIDA WATER
MANAGEMENT DISTRICT

January 2011

ANNEX C
ANALYSES REQUIRED BY WRDA 2000 AND STATE LAW

TABLE OF CONTENTS

C.0 ANALYSES REQUIRED BY THE WATER RESOURCES DEVELOPMENT ACT OF 2000 AND STATE LAW C-1
C.1 PART I: ANALYSES REQUIRED BY THE WATER RESOURCES DEVELOPMENT ACT OF 2000 ..... C-1
C.2 LEGAL BASIS - BACKGROUND C-1
C.2.1 WATER RESOURCES DEVELOPMENT ACT (WRDA 2000) C-1
C.2.1.1 Savings Clause Analyses C-2
C.2.1.2 Project-Specific Assurances C-3
C.2.2 Programmatic Regulations (33 CFR PART 385) C-3
C.2.2.1 Pre-CERP Baseline C-3
C.2.2.2 Savings Clause - Flood Protection C-4
C.2.2.3 Savings Clause -Elimination or Transfer of Existing Legal Sources of Water C-4
C.2.2.4 Project Assurances - Identification of Water for the Natural System C-4
C.2.2.5 Project Assurances - Identification of Water for Other Water-Related Needs C-4
C.2.3 Guidance Memoranda C-5
C.3 METHODS C-5
C.3.1 Key project assumptions C-6
C.3.1.1 Information used for all analyses: Pre-CERP Baseline, Existing Conditions Baseline and Initial Operating Regime, Next Added Increment, Next Added Increment Baseline C-7
C.3.2 Savings Clause – Flood Protection and Elimination or Transfer of Existing Legal Sources C-9
C.3.2.1 Analysis for Flood Protection C-10
C.3.2.2 Analysis of Elimination or Transfer of Existing Legal Sources Analysis C-11
C.3.3 Project Assurances - Identifying Water Made Available for the Natural System and for Other Water Related Needs by the Project C-13
C.3.3.1 Volume Probability Curves C-13
C.3.3.2 Analytical Method to Identify Water Made Available for the Natural System C-13
C.3.3.3 Quality, Timing, and Distribution of Water and Water Quality C-16
C.4 RESULTS C-18
C.4.1 Savings Clause - Flood Protection and Elimination or Transfer of Existing Legal Sources C-18
C.4.1.1 C-111 Basin Flood Protection Analysis C-18
C.4.1.2 Elimination or Transfer of Existing Legal Sources C-18
C.4.2 Project Assurances - Identifying Water Made Available by the Project for the Natural System and Other Water Related Needs C-19
C.4.2.1 Identifying Water Made Available by the Project for the Natural System C-19
C.4.2.2 Identifying Water to be Reserved or Allocated for the Natural System C-37
C.4.3 Application of Project Assurances C-39
C.5 LITERATURE CITED C-41
C.6 PART II: ANALYSES REQUIRED BY STATE LAW C-43

LIST OF TABLES

Table C-1 Total Water and Water Diverted by The Project for The Natural System Quantified at S-177 (Cubic Feet/Second) C-38
Table C-2 Total Surface Water and Water Made Available by The Project for The Natural System Quantified at Transects TA-1, TA-2W and TA-2E (Cubic Feet/Second).....C-39

LIST OF FIGURES

Figure C-1 Public Water Suppliers Include Florida Keys Aqueduct Authority, City of Homestead and Florida City C-12
Figure C-2 Location of Transects to Calculate Water Flows to the Natural System C-15
Figure C-3 Location of Transects Applied to Quantify Surface Water Flows for the Natural System....C-16
Figure C-4 Total Flow Available (ECB) at S-177 and Portion not Diverted by S-199 and S-200, C-111 SC Western Project Features That Still Flow Through S-177 (IOR_2DS) in 1978....C-20
Figure C-5 Total Flow Available (ECB) at S-177 and Portion not Diverted by S-199 and S-200, C-111 SC Western Project Features That Still Flow Through S-177 (IOR_2DS) in 1989....C-21
Figure C-6 Total Flow Available (ECB) at S-177 and Portion not Diverted by S-199 and S-200, C-111 SC Western Project Features That Still Flow Through S-177 (IOR_2DS) in 1995....C-22
Figure C-7 Total Flow Available in 2050 (FwoCERP) at S-177 and Portion not Diverted by S-199 and S-200, C-111 SC Western Project Features (FwoCERP_2Ds) in 1978 ....C-23
Figure C-8 Total Flow Available in 2050 (FwoCERP) at S-177 and Portion not Diverted by S-199 and S-200, C-111 SC Western Project Features (FwoCERP_2Ds) in 1989....C-24
Figure C-9 Total Flow Available in 2050 (FwoCERP) at S-177 and Portion not Diverted by S-199 and S-200, C-111 SC Western Project Features (FwoCERP_2Ds) in 1995....C-25
Figure C-10 Total Surface Water Flow for the Initial Operating Regime (IOR_2DS) and Existing Conditions Baseline (ECB) Across Transect TA-1 for 1978 .....C-26
Figure C-11 Total Surface Water Flow for the Initial Operating Regime (IOR_2DS) and Existing Conditions Baseline (ECB) Across Transect TA-1 for 1995 .....C-27
Figure C-12 Total Surface Water Flow for the Initial Operating Regime (IOR_2DS) and Existing Conditions Baseline (ECB) Across Transect TA-2 West for 1978 ....C-28
Figure C-13 Total Surface Water Flow for the Initial Operating Regime (IOR_2DS) and Existing Conditions Baseline (ECB) Across Transect TA-2 West for 1995 ....C-29
Figure C-14 Total Surface Water Flow for the Initial Operating Regime (IOR_2DS) and Existing Conditions Baseline (ECB) Across Transects TA-2 East for 1978..... ....C-30

Figure C-15 C.X Total Surface Water Flow for the Initial Operating Regime (IOR_2DS) and Existing Conditions Baseline (ECB) Water Flow Across Transects TA-2 East for 1995 ..... C-31
Figure C-16 Total Surface Water Flow for Future Without CERP (FwoCERP) and Future without CERP Plus the Project (FwoCERP_2Ds) Across Transect TA-1 for 1978 ..... C-32
Figure C-17 Total Surface Water Flow for Future Without CERP (FwoCERP) and Future without CERP Plus the Project (FwoCERP_2Ds) Across Transect TA-1 for 1995 ..... C-33
Figure C-18 Total Surface Water Flow for Future Without CERP (FwoCERP) and Future without CERP Plus the Project (FwoCERP_2Ds) Across Transect TA-2 West for 1978 ..... C-34
Figure C-19 Total Surface Water Flow for Future Without CERP (FwoCERP) and Future without CERP Plus the Project (FwoCERP_2Ds) Across Transect TA-2 West for 1995 ..... C-35
Figure C-20 Total Surface Water Flow for Future Without CERP (FwoCERP) and Future without CERP Plus the Project (FwoCERP_2Ds) Across Transect TA-2 West for 1978 ..... C-36
Figure C-21 Total Surface Water Flow for Future Without CERP (FwoCERP) and Future without CERP Plus the Project (FwoCERP_2Ds) Across Transects TA-2 East for 1995 ..... C-37

C.0 ANALYSES REQUIRED BY THE WATER RESOURCES DEVELOPMENT ACT OF 2000 AND STATE LAW

C.1 PART I: ANALYSES REQUIRED BY THE WATER RESOURCES DEVELOPMENT ACT OF 2000

This document explains the legal basis and requirements of WRDA 2000 savings clause and project-specific assurances (Section C.1), methods used to analyze WRDA 2000 requirements for the C-111 SC Western project (Section C.2), and results of the analyses (Section C.3).

C.2 LEGAL BASIS - BACKGROUND

Federal law and regulation implementing the Comprehensive Everglades Restoration Plan (CERP) require Project Implementation Reports (PIRs) to address certain assurances as part of the project recommendation for approval and implementation. This section addresses provisions of Section 601(h) of the Water Resources Development Act of 2000 (WRDA 2000) and the Programmatic Regulations for the CERP (33 CFR Part 385) for Savings Clause requirements and Project-Specific Assurances.

The following sections describe the specific requirements from WRDA 2000 and the CERP Programmatic Regulations and present the methods and results of the analyses necessary to meet those requirements.

C.2.1 WATER RESOURCES DEVELOPMENT ACT (WRDA 2000)

Congress enacted the Water Resources Development Act of 2000, Title VI, Section 601, Comprehensive Everglades Restoration Plan (WRDA 2000) which approved the CERP "as a framework for modifications and operational changes to the Central and Southern Florida (C&SF) Project that are needed to restore, preserve, and protect the South Florida ecosystem while providing for other water-related needs of the region, including water supply and flood protection." Section 601(h) of WRDA 2000, entitled "Assurance of Project Benefits" establishes project-specific assurances to be addressed as part of CERP implementation.

Section 601 (h) (1) of WRDA 2000 provides:

> *IN GENERAL - The overarching objective of the Plan is the restoration, preservation, and protection of the South Florida Ecosystem while providing for other water-related needs of the region, including water supply and flood protection. The Plan shall be implemented to ensure the protection of water quality in, the reduction of the loss of fresh water from, the improvement of the environment of the South Florida Ecosystem and to*

achieve and maintain the benefits to the natural system and human environment described in the Plan, and required pursuant to this section, for as long as the project is authorized.

In this document, sections ***C.1.1.1*** and ***C.1.1.2*** discuss the savings clause and project assurances required by WRDA 2000 to be addressed in each PIR. ***SECTION C.1.2*** lists the savings clause and project assurances provisions of the CERP programmatic regulations, which provide supplemental information for implementing the WRDA 2000. ***SECTION C.1.3*** discusses the role of the Draft Guidance Memoranda in the analyses.

C.2.1.1 Savings Clause Analyses

The Savings Clause analysis was required by the WRDA 2000 as a means to protect users of legal sources of water supply and flood protection that were in place at the time of enactment. Briefly, Section 601(h)(5) of WRDA 2000, entitled "Savings Clause", requires an analysis of each project's effects on legal sources of water supply that were in existence on the date of enactment of WRDA 2000 (*i.e.*, December 2000), and effects on levels of service for flood protection in existence on the date of enactment of WRDA 2000. Section 601(h) (5) of WRDA 2000 states:

(A) NO ELIMINATION OR TRANSFER. – Until a new source of water supply of comparable quantity and quality as that available on the date of enactment of this Act is available to replace the water to be lost as a result of implementation of the Plan, the Secretary and the non-Federal sponsor shall not eliminate or transfer existing legal sources of water, including those for –

(i) an agricultural or urban water supply;
(ii) allocation or entitlement to the Seminole Indian Tribe of Florida under section 7 of the Seminole Indian Land Claims Settlement Act of 1987 (25 U.S.C. 1772e);
(iii) the Miccosukee Tribe of Indians of Florida;
(iv) water supply for Everglades National Park; or
(v) water supply for fish and wildlife.

(B) MAINTENANCE OF FLOOD PROTECTION. – Implementation of the Plan shall not reduce levels of service for flood protection that are –

(i) in existence on the date of enactment of this Act; and
(ii) in accordance with applicable law.

(C) NO EFFECT ON TRIBAL COMPACT. – Nothing in this section amends, alters, prevents, or otherwise abrogates rights of the Seminole Indian Tribe of Florida under the compact among the Seminole Tribe of Florida, the State, and the South Florida Water Management District,

defining the scope and use of water rights of the Seminole Tribe of Florida, as codified in section 7 of the Seminole Indian Land Claims Act of 1987 (25 U.S.C. 1772e).

C.2.1.2 Project-Specific Assurances

Subsection 601(h)(4) of WRDA 2000, entitled "Project-Specific Assurances", contains the following requirements for project implementation reports:

(A) PROJECT IMPLEMENTATION REPORTS. –

(i) IN GENERAL. – The Secretary (of the Army) and the non-Federal sponsor shall develop project implementation reports in accordance with Section 10.3.1 of the Plan.

(ii) COORDINATION. – In developing a project implementation report, the Secretary and the non-Federal sponsor shall coordinate with appropriate Federal, State, tribal, and local governments.

(iii) REQUIREMENTS. – A project implementation report shall –

(I) be consistent with the Plan and the programmatic regulations promulgated under paragraph (3);

(II) describe how each of the requirements stated in paragraph (3)(B)[sic] is satisfied;

(III) comply with the National Environmental Policy Act of 1969 (42 U.S.C. 4321 et seq.);

(IV) identify the appropriate quantity, timing, and distribution of water dedicated and managed for the natural system;

(V) identify the amount of water to be reserved or allocated for the natural system necessary to implement under State law, subclauses (IV) and (VI);

(VI) comply with applicable water quality standards and applicable water quality permitting requirements under subsection (b)(2)(A)(ii);

(VII) be based on the best available science; and

(VIII) include an analysis concerning the cost-effectiveness and engineering feasibility of the project.

C.2.2 Programmatic Regulations (33 CFR PART 385)

The following summary of requirements of the Programmatic Regulations provides supplemental information for implementing the Savings Clause and Project Specific Assurances of WRDA 2000.

C.2.2.1 Pre-CERP Baseline

Section 385.35(a) of the Programmatic Regulations requires the development of a pre-CERP baseline to aid the U.S. Army Corps of Engineers and the South Florida Water Management District (SFWMD) when implementing the Savings Clause to determine if existing legal sources of water will be eliminated or

transferred and to demonstrate that the levels of service of flood protection in existence on the date of enactment of WRDA 2000 and in accordance with applicable law will not be reduced by implementation of a project.

The final draft Pre-CERP Baseline document was issued by the U.S. Army Corps of Engineers and the SFWMD in April 2005. In accordance with the programmatic regulations, the final draft Pre-CERP Baseline document will be submitted to the Secretary of the Army for approval and concurrence by the Secretary of the Interior and the Governor.

C.2.2.2 Savings Clause - Flood Protection

Section 385.37 of the Programmatic Regulations requires that PIRs include an analysis of the project's impacts on levels of service for flood protection that existed on the date of enactment of WRDA 2000, December 2000, and in accordance with applicable law. These conditions will be included in the Pre-CERP Baseline (see section C.1.2.1).

C.2.2.3 Savings Clause -Elimination or Transfer of Existing Legal Sources of Water

Section 385.36 of the Programmatic Regulations requires that project implementation reports determine if existing legal sources of water are to be eliminated or transferred as a result of project implementation. If a project is expected to result in an elimination or transfer of an existing legal source of water, the PIR shall include an implementation plan that ensures a new source of water of comparable quantity and quality is available to replace the source that is being transferred or eliminated.

C.2.2.4 Project Assurances - Identification of Water for the Natural System

Section 385.35(b) of the Programmatic Regulations requires that each project implementation report identify the quantity, timing, and distribution of water to be dedicated and managed for the natural system necessary to meet the restoration goals of CERP. This evaluation considers the availability of the Pre-CERP Baseline water and previously reserved water, and whether improvements in water quality are necessary. The existing conditions for this project do not include any previously reserved water within the project area.

C.2.2.5 Project Assurances - Identification of Water for Other Water-Related Needs

Section 385.35(b) of the Programmatic Regulations also requires that procedures be developed for identifying water generated by CERP for use in the human environment and that the quantity, timing, and distribution of water for other water-related needs be identified in project implementation reports.

C.2.3 Guidance Memoranda

The Programmatic Regulations require the development of six guidance memoranda jointly by the USACE and SFWMD. Draft Guidance Memoranda dated July 2007 (http://www.evergladesplan.org/pm/program_docs/cerp-guidance-memo.aspx) provided additional information necessary to complete the analyses initially described in WRDA 2000. Because the guidance memoranda are still in draft form, the Programmatic Regulations allow for PIRs completed prior to their approval to use any method that is deemed appropriate and consistent with applicable law, policy and regulations.

Section C.2.2 of this report contains a description of the assumptions, concepts and methodologies based on the procedures and guidance described in draft Programmatic Regulations Guidance Memorandum 3 (GM 3), "Savings Clause Requirements" at the time this PIR was being developed for identifying project effects on:

1. Existing legal sources of water as of the date of enactment of WRDA 2000 on the user categories listed in Section 601(h)(5)(A) of WRDA 2000.
2. Levels of service for flood protection as required by WRDA 2000, and in accordance with applicable law.

Section C.2.3 of this report contains a description of the assumptions, concepts and methodologies for identifying water made available by the project for the natural system and for other water related needs of the region. The methodologies are based on the procedures and guidance described in draft Programmatic Regulations Guidance Memorandum 4 (GM 4), "Identifying Water Made Available for the Natural System and for Other Water Related Needs", available at the time this PIR was being developed.

Section C.3 of this report summarizes the results of these analyses, including identifying the amount of water made available by the project for the natural system to be reserved or allocated by the State of Florida and the amount of water made available for other water-related needs.

C.3 METHODS

The primary goal of the C-111 SC Western project is to improve of water flows to Florida Bay via Taylor Slough, as well as restore the Southern Glades and Model Land. The C-111 SC Western project objectives are as follows:

- Restore the quantity, timing, and distribution of water delivered to Florida Bay via Taylor Slough to levels nearest as possible to the pre-drainage model runs;

- Improve hydroperiods and hydropatterns in the Southern Glades and Model Lands. The hydroperiods will be improved to optimal levels to support historical vegetation patterns nearest as possible to the pre-drainage model runs; Hydropatterns will be restored to historical sloughs and associated tributaries.
- Return coastal zone salinities in western Florida Bay to levels as close as possible to pre-drainage scenario model runs by restoring upstream water levels in eastern Everglades National Park.

C.3.1 Key Project Assumptions

The process of identifying water is integral to the specific assurances of section 601 of WRDA 2000, and ultimately to ensuring that the overarching objectives of the Comprehensive Everglades Restoration Plan, namely restoration, preservation, and protection of the south Florida ecosystem while providing for other water-related needs of the region, including flood protection and water supply. It is assumed that both the project objectives and WRDA 2000 requirements are compatible, and that the final design of the project will achieve its objectives.

Project Extent and Assumptions. These analyses and results apply only to the Recommended Plan for the recommended project, including the features associated with Alternative 2D Short and its effects described in ***Section 5***, which includes benefits to the natural system. The recommended plan intends to primarily improve the quantity, timing, and distribution of water delivered to Florida Bay via Taylor Slough. It is anticipated that these improvements can be realized through the establishment of a hydraulic ridge between Taylor Slough and the C-111 Canal, to reduce seepage losses from Taylor Slough and its headwaters. The hydraulic ridge will be established by: (1) combining operational changes within the lower C-111 Canal (south of S-177), and (2) the diversion of water that is currently being discharged through S-177, S-18C and S-197 to the existing Aerojet Canal and an above ground detention area to be constructed on Frog Pond lands owned by SFWMD. Marsh stage triggers in Taylor Slough and the adjacent basin will be used to manage pumping rates and to increase the net water distributed west of the existing C-111 Canal system.

The recommended plan also includes the installation of additional intermediate water control structures on the lower C-111 Canal to increase the effective water control elevation of the lower C-111 Canal. These changes will facilitate reducing the seepage losses from Taylor Slough and increase the net water distributed west of the existing C-111 Canal system.

The plan also intends to improve wetland hydroperiods for Southern Glades and Model Land tracts. This will largely be accomplished by proposed modifications

to current operations at structure S-20, installation of an earthen plug in the L-31E Canal near S-20A and installation of earthen plugs in the C-110 Canal.

Absence of Regional or System-wide Effects. Because the C-111 SC Western project is located at or near the coastline, does not alter regional operations and only affects water deliveries to the southernmost canals in the Central and Southern Project or coastal structures, it is assumed to produce no system-wide effects. Therefore, only project-level effects were evaluated for elimination or transfer of existing legal sources, effects on level of service for flood protection, and identification of water made available.

Basins to be Evaluated. Draft Guidance Memorandum 4 (GM #4) requires the identification of the inflow basins that will be affected by a project. Drainage basins located in southern Miami-Dade County that will be affected by the project include ENP and the C-111 Basin including the Model Lands and Southern Glades.

Key Components of water budget. Water flows across key transects, which are located in the Southern Glades and Model Lands, are utilized to quantify water flows to the natural system. This includes surface water or overland flows as well as groundwater flows in the Biscayne aquifer. Although groundwater stages may increase as a result of the project due to the interconnectivity of the surface and groundwater, groundwater flows remain relatively unaffected. Therefore, groundwater will not be quantified for project assurances. However, at times when there is seemingly no water being delivered from S-176, because the structure is closed, there may be some small amount of water that could be pumped by either S-200 or S-199 that is not capture in the S-177 flows. These flows can be quantified at transects located further downstream used to quantify surface water flowing towards Florida Bay.

C.3.1.1 Information used for all analyses: Pre-CERP Baseline, Existing Conditions Baseline and Initial Operating Regime, Next Added Increment, Next Added Increment Baseline

Savings clause and project assurances analyses require consideration of five different sets of assumptions at three different points in time. The three different points in time include 1) the date of enactment of WRDA 2000, 2) the existing conditions at the time of adoption of the C-111 SC Western Project Recommended Plan, and 3) the 2050 future conditions as described below:

- PCB- The Pre-CERP Baseline represents the conditions existing on the date of enactment of WRDA 2000, December 2000;
- ECB- The Existing Conditions Baseline represents conditions in 2007;

- IOR – The Initial Operating Regime represents the same conditions as the ECB plus the recommended project and consumptive uses for each year simulated. The model runs are labeled IOR_2DS;
- NAI Baseline - This condition represents the 2050 conditions with no CERP projects included;
- NAI – This condition represents the 2050 conditions with the recommended project in place.

Draft Guidance Memoranda Nos. 3 and 4 indicate that analyses of the above conditions should be based on hydrological simulations using something like the South Florida Water Management Model (SFWMM). In this case the Regional Simulation Model (RSM) is the preferred regional hydrologic model, which was developed by the SFWMD principally for application in south Florida. The RSM is developed on a sound conceptual and mathematical framework that allows it to be applied generically to a wide range of hydrologic situations. The RSM simulates the coupled movement and distribution of groundwater and surface water throughout the model domain using a Hydrologic Simulation Engine to simulate the natural hydrology and a Management Simulation Engine to provide a wide range of operational capability. Since the RSM model simulates the whole south Florida area, it is not detailed enough to be utilized to analyze the specific condition of the FPDA, however, RSM results were used to calibrate hydrologic/hydraulic model inputs when applicable.

The PDT had initial sought to use the WASH-123D model and conduct multi-year simulations. Instead MODBRANCH was selected to conduct single-year simulations (i.e., three individual single-year simulations representative of "wet," "average," and "dry" conditions) of water management infrastructure in the study area. Because of differences in the simulation periods of record, model simulation capabilities, and model configurations, the PDT adapted its suite of performance measures to fit the framework of the newly-selected model. This included adapting the application of the Draft Guidance Memoranda as well.

MODBRANCH is a hybrid code that couples MODFLOW, a three-dimensional groundwater flow model with Branch, a one-dimensional canal routing model. The model code was originally developed by the United States Geological Survey (USGS). E. D. Swain and E. J. Wexler of the USGS coupled the models. More information on the creation of MODBRANCH may be found in "A Coupled Surface-Water and Ground-Water Flow Model for Simulation of Stream-Aquifer Interaction," (Swain and Wexler, USGS Open File Report 92-138). The U.S. Army Corps of Engineers further modified the model to more accurately represent the characteristics of the South Florida area.

The CERP Programmatic Regulations require evaluation of the Recommended Plan as the next added increment (NAI). The NAI is defined in the CERP Programmatic Regulations as "the next project to be added to a system of projects that includes only those projects that have been approved according to general provision of law or specific authorization of Congress and likely to be implemented by the time the project being evaluated is completed." The NAI analysis evaluates the effects, or outputs, of the Recommended Plan as the next project to be added to the group of already approved CERP projects. Analysis of the NAI illustrates the amount of benefits the selected alternative plan contributes without regard to future CERP projects. It also helps to ascertain whether sufficient benefits would accrue to the selected alternative plan to justify the cost if no additional CERP projects (other than those already existing or authorized) were implemented.

In the case of this analysis, no other CERP projects affecting the C-111 SC Western project area were assumed to exist for the purposes of the NAI analysis. In comparing SFWMM model flows at S-177 (critical structure used to determine flows to the spreader canal) for the future without CERP to the Future with all of CERP constructed, the flows are similar. This means that whether or not CERP boundary conditions (system evaluation) or future without CERP boundary conditions are used, similar results should be obtained in the overall evaluation and comparison of alternatives. Thus all plan comparison and evaluation were completed in a NAI method. Therefore there are no NAI specific analyses. Consistent with the plan formulation approach, this project assurances analysis relies upon Future without CERP scenarios to analyze the water made available with and without the C-111 SC Western project in place. The model simulations are called:

- Future without CERP - This condition represents the 2050 conditions with no CERP projects included;
- Future without CERP plus the Project – This condition represents the 2050 conditions with only the Recommended project in place.

C.3.2 Savings Clause – Flood Protection and Elimination or Transfer of Existing Legal Sources

The purpose of the Savings Clause is to protect existing legal sources of water from elimination or transfer and levels of service for flood protection existing as of December 2000. The expected performance refers to the performance of the system in place when modeled against the period of record. It does not refer to specific design flood targets such as the 10-year flood. The analysis for assessing the impacts to the level of service for flood protection was based on model output from the MODBRANCH model. The PDT determined that modeling the full period of record was impractical and that modeling a subset of the full period of record was an adequate substitute. For the C-111 Spreader Canal project a dry

year, an average year, and a wet year were simulated with the MODBRANCH model. The dry year simulated was 1989, the average year simulated was 1978, and the wet year simulated was 1995.

C.3.2.1 **Analysis for Flood Protection**

The takings analysis in Appendix D compared modeling data from the conditions in existence in December 2000 (Pre-CERP Baseline) to Alternative 2DS. This is consistent with the Savings Clause methods described in Guidance Memorandum #3. The comparison accounted for both groundwater and surface water impacts to different land classes due to C-111 SC Western project implementation. The takings analysis determined the lands impacted based on the following criteria:

Criteria 1: Non-Agricultural Lands (40days + 30 percent).

> Alternative Annual Hydroperiod (at surface) is greater than 40 days longer than the Base run and this value is greater than 30 percent longer than the Base for any of the three years (Average year, Dry year, Wet year).

Criteria 2: Agricultural Lands for Dry Season (Any increase of Hydroperiod at -0.5 ft).

> Alternative Dry Season Hydroperiod (at -0.5 ft) is greater than 5 days longer than the Base Dry Season Hydroperiod (at -0.5ft) for any of the three years (Average year, Dry year, Wet year).

Criteria 3: Agricultural Lands for Wet Season (30 days + 20 percent).

> Alternative Wet Season Hydroperiod (at -0.5 ft) is greater than 30 days longer than the Base wet season Hydroperiod (at -0.5 ft) AND this value is greater than 20 percent longer than the Base for any of the three years (Average year, Dry year, Wet year).

GIS data provided showed the percentage of each individual parcel impacted and a separate data sheet for the agricultural lands, which showed the hydroperiod differences in the dry season and wet season between alternative 2DS and the Pre-CERP Baseline for each of the years analyzed. The takings analysis was conducted for the agricultural lands to determine what were significant and adverse conditions warranting acquisition of a real estate interest. Any increase in any dry season (November through April) of over 5 days was considered as requiring acquisition of a real estate interest (Criteria 2 above). For the wet seasons, the increase had to meet not only Criteria 3 above, but it had to increase the entire hydroperiod to greater than 80 days. Once all this data was

analyzed each parcel or percentage of the parcel was reviewed to determine if only a portion (and what portion) or all of the parcel would have to be acquired.

C.3.2.2 Analysis of Elimination or Transfer of Existing Legal Sources Analysis

Existing legal sources in the project area include water for three public utility wellfields, private wells, industrial facilities and agricultural irrigation wells within the drainage basins. The three public water suppliers include Florida Keys Aqueduct Authority, City of Homestead and Florida City (See ***FIGURE C-1***). Industrial uses include two quarries and the City of Homestead's power plant. Agricultural uses include approximately 20 permittees, including both food production and landscape nurseries.

All project features such as pumps that divert water are located downstream of these sources. Operation of the project features are designed to restore the quantity, timing and distribution of water delivered to Florida Bay via Taylor Slough by increasing existing water levels and overall flows. Project features divert a portion of the water that would normally be discharged to tide through the seawater control structures before reaching Florida Bay. Therefore, no elimination or transfer of water from existing legal sources such as public utility wellfields, private wells industrial facilities or agricultural irrigation wells will occur.

Water that flows into Florida Bay through the canals may also be considered an existing legal source that maintains fish and wildlife. While project features are designed to intercept some of this water, it will be used to restore water flow through Taylor Slough before reaching Florida Bay, but not transfer it for another use. Therefore, no elimination or transfer of water from Florida Bay will occur.

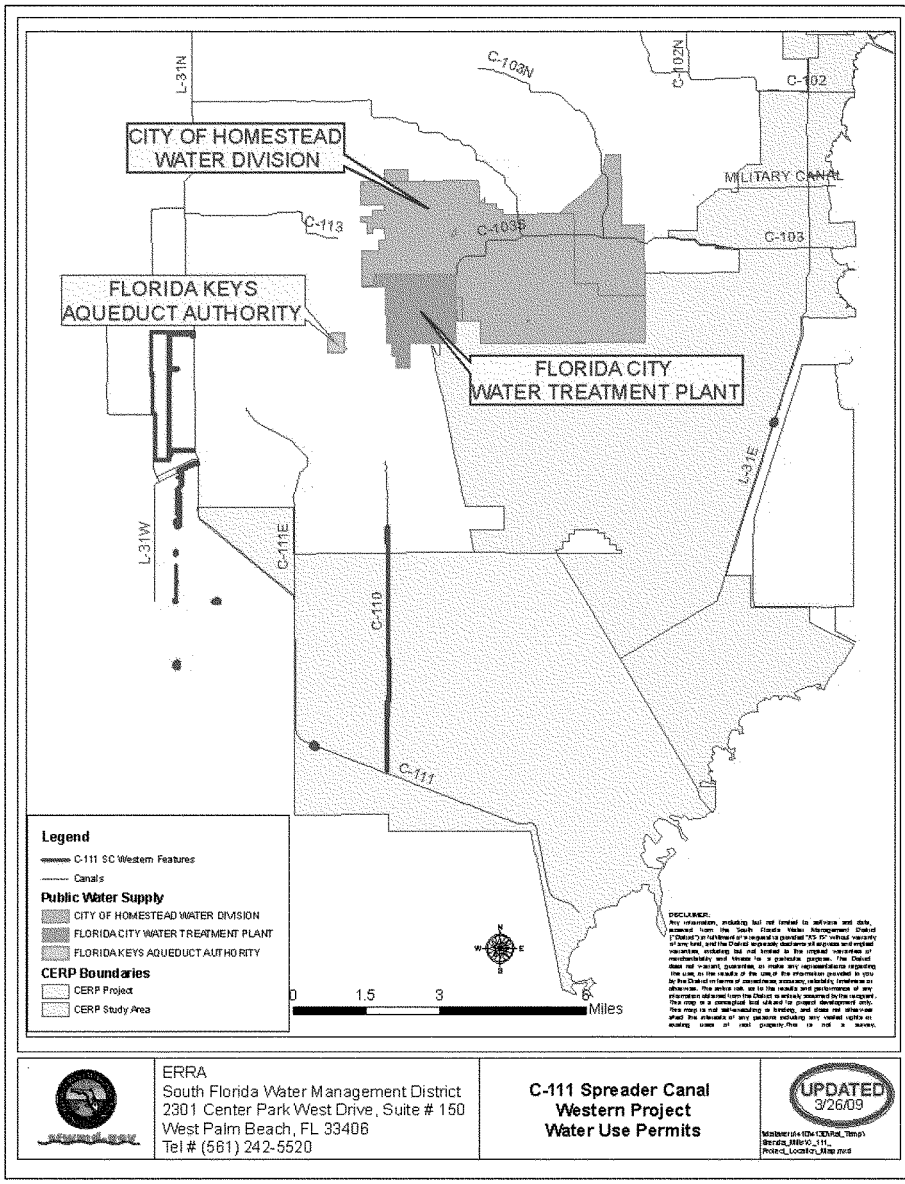


FIGURE C-1: PUBLIC WATER SUPPLIERS INCLUDE FLORIDA KEYS AQUEDUCT AUTHORITY, CITY OF HOMESTEAD AND FLORIDA CITY

C.3.3 Project Assurances - Identifying Water Made Available for the Natural System and for Other Water Related Needs by the Project

Identification of water for the natural system is based on the concept that a quantity of water is needed to achieve the benefits of the project, and the overarching objective of restoration, preservation and protection of the South Florida Ecosystem. The water made available for the natural system is the water used for the protection of fish and wildlife within natural systems, including water that contributes to meeting hydrologic, water quality, and ecologic targets for restoration of natural systems.

The C-111 SC Western project study area is situated at the southern extent of the CERP study area. As such, the potential functions provided by the C-111 SC Western project are largely limited to managing seepage from natural areas to drained areas, and detaining/distributing volumes of water made available by upstream water management infrastructure to features of the Project. The targeted quantity redistributed to Florida Bay via Taylor Slough was estimated based on the volume available to be diverted to Taylor Slough at the S-177 and the overland flows across the Southern Glades and Model Lands.

C.3.3.1 Volume Probability Curves

For purposes of identifying the volume of water made available by the project, volume probability curves were produced depicting the range of daily quantities (mean daily flow) of water delivered to the natural system. As discussed above, three years were simulated by the MODBRANCH model, 1978, 1989, and 1995, which represent the "average", "dry" and "wet" conditions, respectively for South Miami-Dade County. Probability curves indicate the probability (percentage of time equaled or exceeded, on the x-axis) that a certain quantity of water is available as a function of simulated structure flows or calculated at transect in the model domain. Once sorted, the values are ranked from highest to lowest.

C.3.3.2 Analytical Method to Identify Water Made Available for the Natural System

The basic approach used to identify water made available to the natural system was to calculate the quantity of water available to be pumped or diverted into Frog Pond Detention Area or the Aerojet Canal via S-199 and S-200 on a daily basis. Each component of the project relies on pumps to divert water out of the primary drainage system of canals, including the C-111 Canal at S-177 and is intended to allow for improved management of water in the natural areas via reducing the drainage effects of local canals on adjacent wetlands (i.e., Taylor Slough) project features. In addition to the referenced pre-drainage condition, a future without-project condition (set in the year 2050, in the absence of all other CERP features) was used as a baseline against which the ecological performance of each alternative would be compared. Because initial regional hydrologic

simulations indicated that the C-111 SC study area would likely receive similar deliveries of water from the regional system with or without the remaining CERP projects, the project sponsors and the PDT elected to evaluate each alternative with respect to the future without-project condition as referenced above.

Structure flows were quantified at S-177 for the three years simulated and represent the total volume of water available to be redistributed by the project features; specifically S-199 and S-200 pump stations. Since the S-177 is an existing spillway which can pass up to 1400 cfs, its flows in the Existing Condition Baseline (ECB) and Initial Operating Regime (IOR) can be compared to determine how much is being diverted towards Taylor Slough with and without the project in place. This volume of water diverted is also captured in the volume probability curves for S-200, a 225 cfs pump station, which routes water to the Frog Pond Detention Area and S-199, a 225 cfs pump station which discharges to the Aerojet Canal. Only the S-177 flows will be quantified to display the volume of water made available to the natural system from these features.

For each year simulated, a graphic will display two volume probability curves. One curve indicates the total quantity discharged from S-177 in the existing condition (ECB), which represents the total water available to the natural system. The second curve, IOR_2DS, quantifies the water that still reaches S-177 after some portion is diverted to the Frog Pond Detention Area or the Aerojet Canal. In addition, the 10th, 50th and 90th percentile is identified for the ECB, which represents the total water available and the difference between the ECB and IOR_2DS, which represents the total water made available by the project for the natural system are displayed in a table.

Surface water flows across key transects located in the Southern Glades and Model Land were also utilized to quantify the increased flows resulting from the proposed S-198 structure and changed operations at S-20 and S-20A to the natural system, See ***FIGURE C-2***. Multiple transects were applied to assess the environmental effects using the model simulations, namely TA-1, TA-2, TA-3, TA-4, and TA-5 during plan evaluation, See ***APPENDIX C***. Although surface water stages and duration (hydroperiods) may be affected by the Recommended Plan and are described in ***SECTION 5***, there is not a corresponding change in overland flows significant enough to quantify. This is true for the eastern-most transects TA-3, TA-4, and TA-5, which will not be applied to quantify water. Only a subset of these transects were applied to quantify the volume of water made available. In addition, although groundwater stages may increase as a result of the project, groundwater flows do not change significantly and will not be quantified for project assurances.

Of the remaining key transects, TA-2 was divided into a west and east transect to easily capture the changes to flows towards Florida Bay via Taylor Slough. The new transects, TA-2w(est) and TA-2e(ast) when combined with TA-1 quantify the water made available for the natural system by these features (see ***FIGURE C-3***). To capture increases in water made available for the natural system, the flows across the transects in the Existing Baseline Condition, ECB, are compared to with the project in place, IOR_2DS, which represents the total water available. The difference between these conditions for each year simulated represent the surface water made available for the natural system by these features. In addition, the 10th, 50th and 90th percentile identified for the IOR_2DS, which represents the total water available and the difference between the IOR_2DS and ECB, which represents the total water made available by the project for the natural system are displayed in a table.

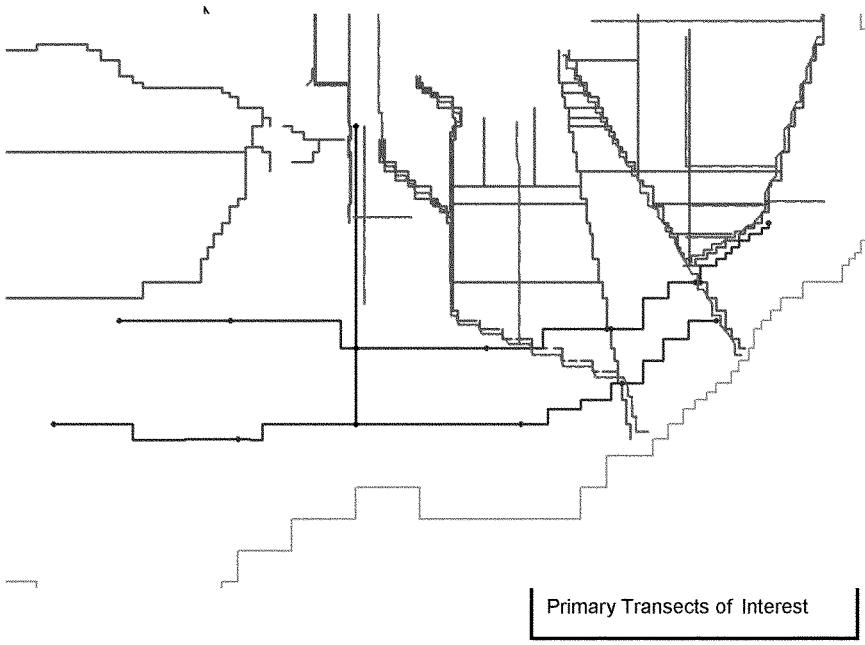


FIGURE C-2: LOCATION OF TRANSECTS TO CALCULATE WATER FLOWS TO THE NATURAL SYSTEM

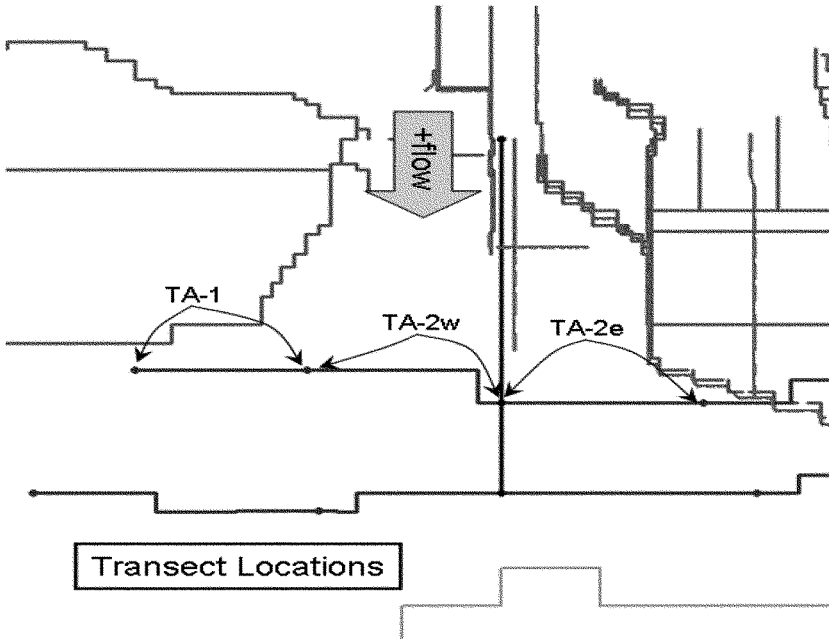


FIGURE C-3: LOCATION OF TRANSECTS APPLIED TO QUANTIFY SURFACE WATER FLOWS FOR THE NATURAL SYSTEM

C.3.3.2.1 Identifying Water Made Available for Other Water Related Needs

No analysis of water made available for other water related needs was calculated since the recommended project does provide water for other water related needs. This is consistent with the project objectives.

C.3.3.3 Quality, Timing, and Distribution of Water and Water Quality

Viewed from a programmatic perspective, identification of water for the natural system associated with the CERP involves an analysis of four different aspects of ecological responses to hydrologic changes: 1) responses to the change in the quantity of water received by the natural system; 2) responses to the timing of those deliveries; 3) responses to the distribution of water delivered to the natural system; and, 4) responses to the quality of the water received by the natural system. n a project specific sense, however, the relative importance of each of these aspects (quantity, timing, distribution, and quality) will vary from project to project depending upon the specific objectives established for the project.

For example, some CERP projects may focus formulation efforts on simply changing the timing (seasonality) or distribution (inflow and outflow points, internal movement) of water delivered to the natural system. Other projects may focus primarily on increasing or decreasing the amount of water delivered to the natural system, while still other projects may focus on improving the quality of the water delivered to the natural system to maintain desirable ecological community structure. All of these aspects (depending upon their applicability to specific projects) are addressed during plan formulation through performance measures and evaluation criteria used to evaluate alternative plans.

To identify the quantity, timing, and distribution of water for the natural system, a probabilistic approach was selected utilizing volume probability curves to depict the distribution of volumes of water that provide natural system benefits as a result of project features through the range of climatic conditions. These volumes of water may include water that is available to meet natural system needs without project features, and the water made available from project features to meet natural system needs.

According to CERP Guidance Memorandum 23.01 "Water Quality Considerations for the Project Implementation Report Phase", water quality is also to be taken into account during plan formulation and evaluation as a project constraint (i.e. projects cannot cause or contribute to violations of water quality standards). Projects such as the C-111 SC Western project should also include features to reduce nutrients and suspended solids through passive means. Accordingly, the project was formulated to improve water quality by diverting canal discharges into wetlands.

When the project is operated, water that normally discharges into the C-111 Canal (via S-177) will be routed into the Frog Pond Detention Area and Aerojet Canal to reduce seepage from ENP. When conditions allow, relatively continuous pumping will be used to maintain the required hydraulic ridge. The potentially continuous pumping is required because when pumping ceases the hydraulic ridge quickly dissipates allowing the diverted water to return to the C-111 Canal.

While a reduction in seepage from ENP would otherwise be expected to have a deleterious effect on water quality within the Lower C-111 Canal, the net effect of the incidental water quality treatment provided within the Frog Pond Detention Area and Aerojet Canal features and by water flowing through ½ mile of limestone aquifer prior to returning to the canal, is anticipated to exceed any reduction in water quality achieved by a reduction in dilution by ENP seepage water. Although it may limit use of the project, adaptive management will be

employed, particularly in the early wet season, if in-situ monitoring indicates otherwise.

C.4 RESULTS

C.4.1 Savings Clause - Flood Protection and Elimination or Transfer of Existing Legal Sources

C.4.1.1 C-111 Basin Flood Protection Analysis

One way to address significant and adverse effects on the level of service of flood protection due to CERP Implementation is to consider acquisition of affected property. The Real Estate Takings Analysis in Appendix D accounted for changes in hydrology that were significant enough to require land acquisition. The Real Estate Takings Analysis identified that total impacted lands were approximately 11,565 acres for Alternative 2D Short, of which approximately 776 acres were in private ownership. SFWMD has agreed to acquire in fee privately owned lands which are determined to have been, impacted by operation of the project.

The planning level modeling, which was completed for purposes of cost estimating, indicated that approximately 11,565 acres could be impacted by the operation of the project. SFWMD owns fee to approximately 9,688 acres which can be provided in fee. Miami-Dade County owns approximately 131 acres in fee which can be provided by perpetual flowage/conservation easements. The State of Florida owns approximately 15 acres which can be provided by easements for the life of the project in accordance with State statutes and the Florida Administrative Code. Florida Power and Light Company own approximately 955 acres which can be provided by perpetual flowage/conservation easements. The modeling predicted that an additional 776 acres, which are owned by private parties, could be impacted by the operation of the project. SFWMD has agreed to acquire in fee privately owned lands which are jointly determined to have been impacted by operation of the project. The project and lands that may be impacted are shown on ***FIGURE D-3*** in ***APPENDIX D***.

C.4.1.2 Elimination or Transfer of Existing Legal Sources

The project results in no elimination or transfer of water from existing legal sources because canal flows and levels upstream of the project, which are the southernmost canals and control structures in the C&SF Project, will not be affected by project. Therefore, no elimination or transfer of water from existing legal sources such as public utility wellfields, private wells or agricultural irrigation wells will occur.

Water that flows into Florida Bay through the canals may also be considered an existing legal source that maintains fish and wildlife. While project features are designed to intercept some of this water, it will be used to restore water flow through Taylor Slough before reaching Florida Bay, but not transfer it for another use. Therefore, no elimination or transfer of water from Florida Bay will occur.

C.4.2 Project Assurances - Identifying Water Made Available by the Project for the Natural System and Other Water Related Needs

Volume probability curves quantify the water made available by the project for the natural system at two locations. First, the project will divert water to the S-199 and S-200 pump stations that currently discharges through S-177 to maintain a hydrologic head between Taylor Slough and the C-111 Canal. Second, surface water levels in Southern Glades and Model Lands increase by installing and operating a new plug on the C-111 Canal and operating the S-20 and S-20A structures differently.

The recommended project does not provide water for other water related needs; therefore, there was no quantification.

C.4.2.1 Identifying Water Made Available by the Project for the Natural System

Water is diverted to the Aerojet Canal by the S-199 and Frog Pond Detention Area by S-200 pump stations that currently discharges through S-177 to maintain a hydrologic head between Taylor Slough and the C-111 Canal. The quantity of water diverted to these project features on a daily basis is calculated for the three years simulated. In general, ***FIGURE C-4***, ***FIGURE C-5***, and ***FIGURE C-6*** provide an estimate of the quantity of water the project is expected to be diverted to improve the quantity, timing and distribution of water to Florida Bay via Taylor Slough.

For each year simulated, 1978, 1989, and 1995, two volume probability curves describe flows through S-177. One curve indicates the total quantity discharged from S-177 in the existing condition (ECB), which represents the total water available to the natural system. The second curve, IOR_2DS, quantifies the water that still reaches S-177 after some portion is diverted to the Frog Pond Detention Area or the Aerojet Canal. The same set of graphics is shown for the simulated flows in 2050, the future without CERP (FwoCERP) compared to the future without CERP plus the Recommended Project (FwoCERP_2Ds) see ***FIGURE C-7, FIGURE C-8***, and ***FIGURE C-9***.

In 1978, the average year, almost all of the water available is diverted towards either the Frog Pond Detention Area or the Aerojet Canal. Water is available to be diverted to Taylor Slough 10% of the time. In 1989, the dry year water is

available for diversion at times when there is seemingly no water being delivered from S-176, because the structure is closed. These flows can be quantified in the transects used to quantify surface water further downstream. In 1995, the wet year, water is available for diversion by the project features 30% of the time (ECB) and is actually diverted up 10% of the time (IOR_2DS minus ECB).

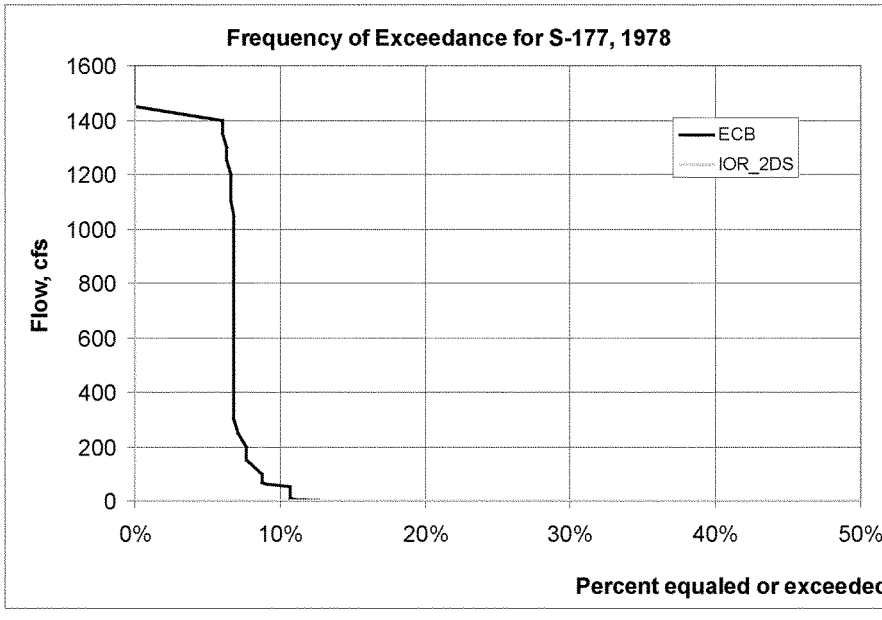


FIGURE C-4: TOTAL FLOW AVAILABLE (ECB) AT S-177 AND PORTION NOT DIVERTED BY S-199 AND S-200, C-111 SC WESTERN PROJECT FEATURES THAT STILL FLOW THROUGH S-177 (IOR_2DS) IN 1978

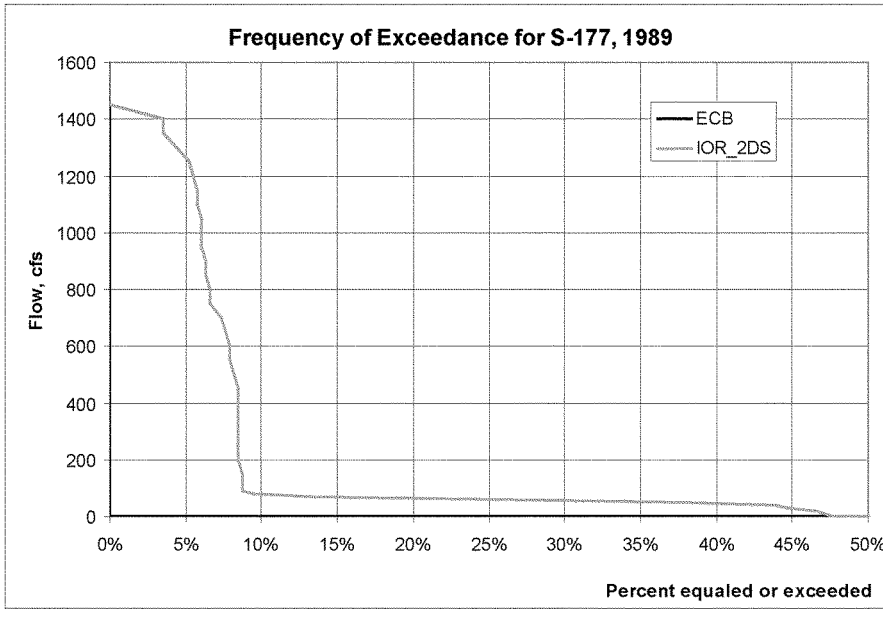


FIGURE C-5: TOTAL FLOW AVAILABLE (ECB) AT S-177 AND PORTION NOT DIVERTED BY S-199 AND S-200, C-111 SC WESTERN PROJECT FEATURES THAT STILL FLOW THROUGH S-177 (IOR_2DS) IN 1989

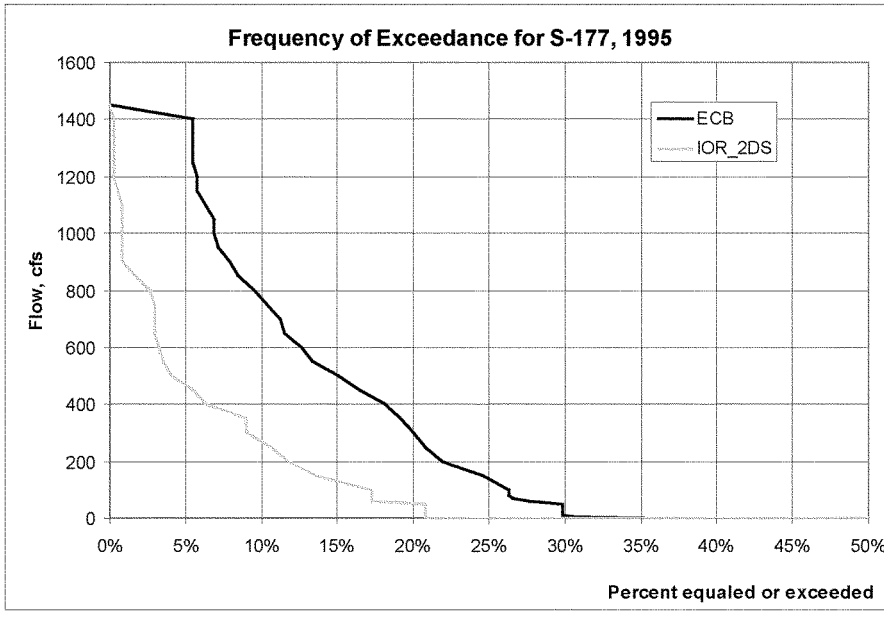


FIGURE C-6: TOTAL FLOW AVAILABLE (ECB) AT S-177 AND PORTION NOT DIVERTED BY S-199 AND S-200, C-111 SC WESTERN PROJECT FEATURES THAT STILL FLOW THROUGH S-177 (IOR_2DS) IN 1995

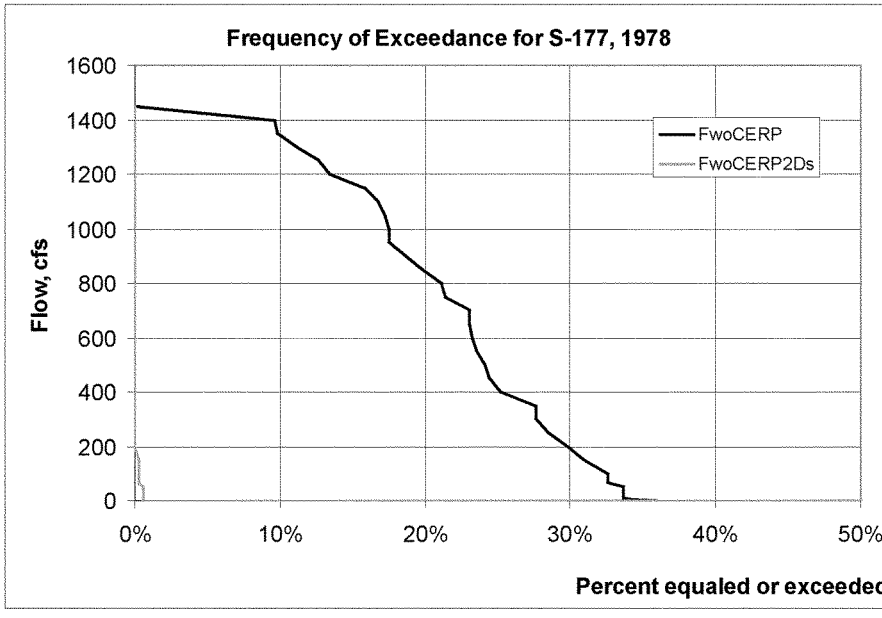


FIGURE C-7: TOTAL FLOW AVAILABLE IN 2050 (FWOCERP) AT S-177 AND PORTION NOT DIVERTED BY S-199 AND S-200, C-111 SC WESTERN PROJECT FEATURES (FWOCERP_2DS) IN 1978

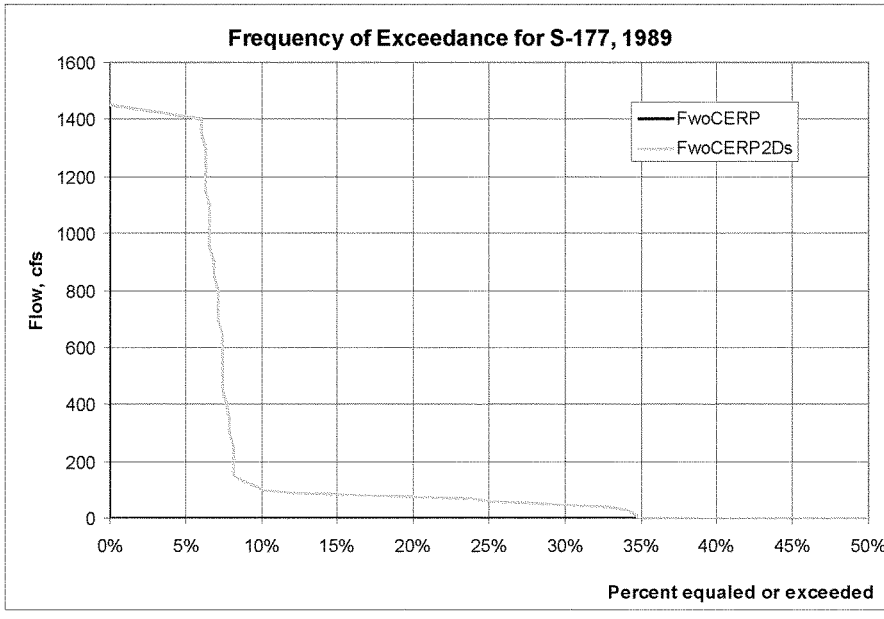


FIGURE C-8: TOTAL FLOW AVAILABLE IN 2050 (FWOCERP) AT S-177 AND PORTION NOT DIVERTED BY S-199 AND S-200, C-111 SC WESTERN PROJECT FEATURES (FWOCERP_2DS) IN 1989

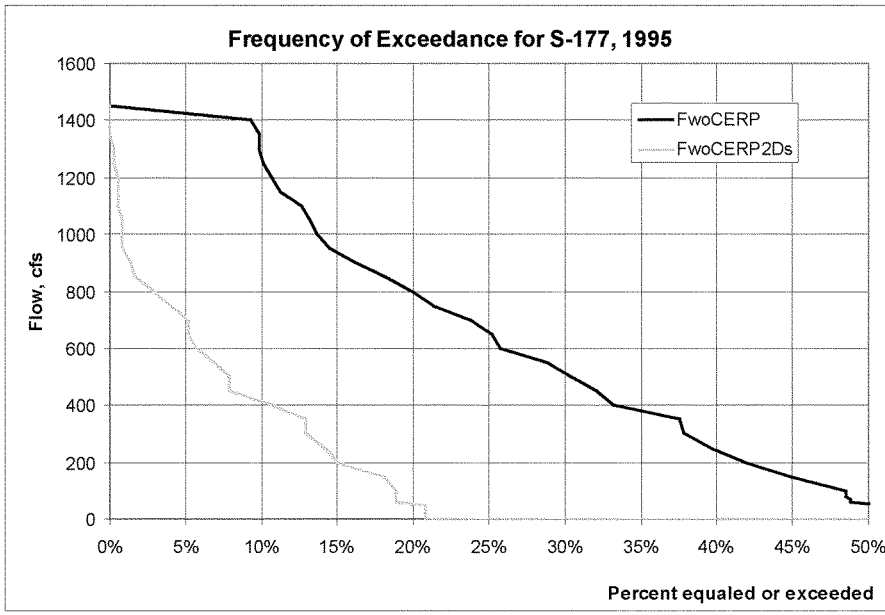


FIGURE C-9: TOTAL FLOW AVAILABLE IN 2050 (FWOCERP) AT S-177 AND PORTION NOT DIVERTED BY S-199 AND S-200, C-111 SC WESTERN PROJECT FEATURES (FWOCERP_2DS) IN 1995

Surface water flows across key transects, which are located in the Southern Glades and Model Lands, are utilized to quantify flows to the natural system. The key transects include TA-1, TA-2 West and TA-2 East as shown in ***FIGURE C-10*** through ***FIGURE C-15*** below. Model simulations are available for all three years simulated, 1978, 1989, and 1995; however, not all simulations are shown. In 1989, which is the year selected to represent dry conditions, no water flows overland to be quantified. In addition, although groundwater stages may increase as a result of the project, groundwater flows in the Biscayne aquifer do not change and will not be quantified for project assurances.

To capture increases in water made available for the natural system, the flows across the transects in the Existing Baseline Condition, ECB, are compared to with the project in place, IOR_2DS, which represents the total water available. The difference between these conditions for each year simulated represent the water made available for the natural system by these features. The Natural System Model, NSM, describes the natural system restoration target and typically is used to determine when too much water is reaching the natural system. However, ***APPENDIX C; ENVIRONMENTAL INFORMATION*** did

not describe anticipate harm occurring. Therefore, water flowing towards Florida Bay in the IOR_2Ds simulation will be considered necessary for the natural system. In addition, the 10th, 50th and 90th percentile identified for the IOR_2DS, which represents the total water available and the difference between the IOR_2DS and ECB, which represents the total water made available by the project for the natural system are displayed in a table. The same set of graphics is shown for the simulated flows in 2050, the future without CERP (FwoCERP) compared to the future without CERP plus the Recommended Project (FwoCERP_2Ds) in ***FIGURE C-16*** through ***FIGURE C-21***. Graphics depicting simulated surface water flows in 1989, the year representing dry conditions, are not included since no surface flows are calculated at the selected transects.

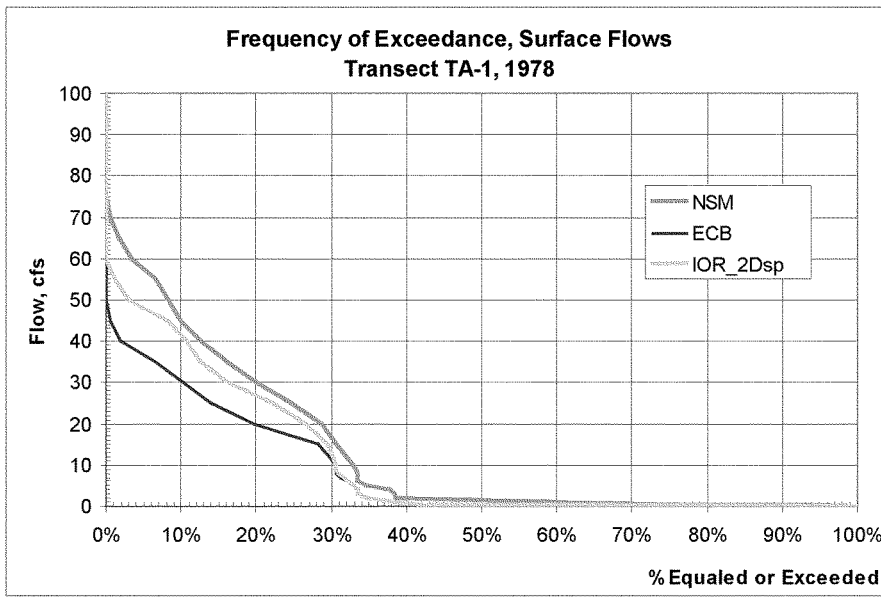


FIGURE C-10: TOTAL SURFACE WATER FLOW FOR THE INITIAL OPERATING REGIME (IOR_2DS) AND EXISTING CONDITIONS BASELINE (ECB) ACROSS TRANSECT TA-1 FOR 1978

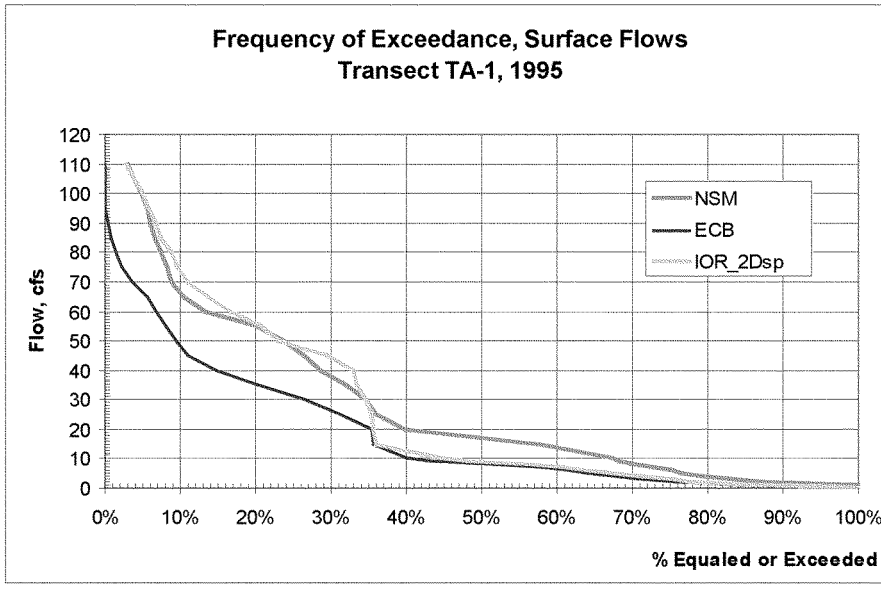


FIGURE C-11: TOTAL SURFACE WATER FLOW FOR THE INITIAL OPERATING REGIME (IOR_2DS) AND EXISTING CONDITIONS BASELINE (ECB) ACROSS TRANSECT TA-1 FOR 1995

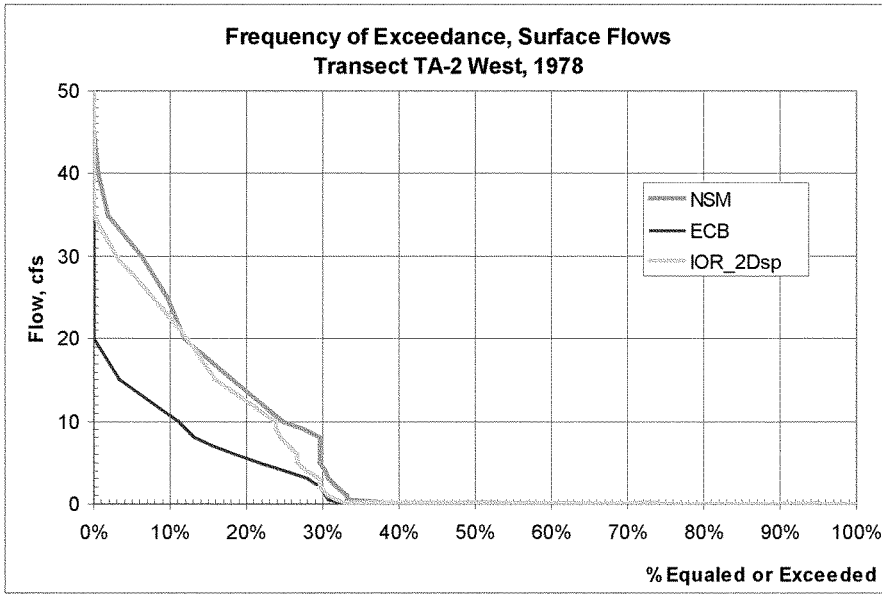


FIGURE C-12: TOTAL SURFACE WATER FLOW FOR THE INITIAL OPERATING REGIME (IOR_2DS) AND EXISTING CONDITIONS BASELINE (ECB) ACROSS TRANSECT TA-2 WEST FOR 1978

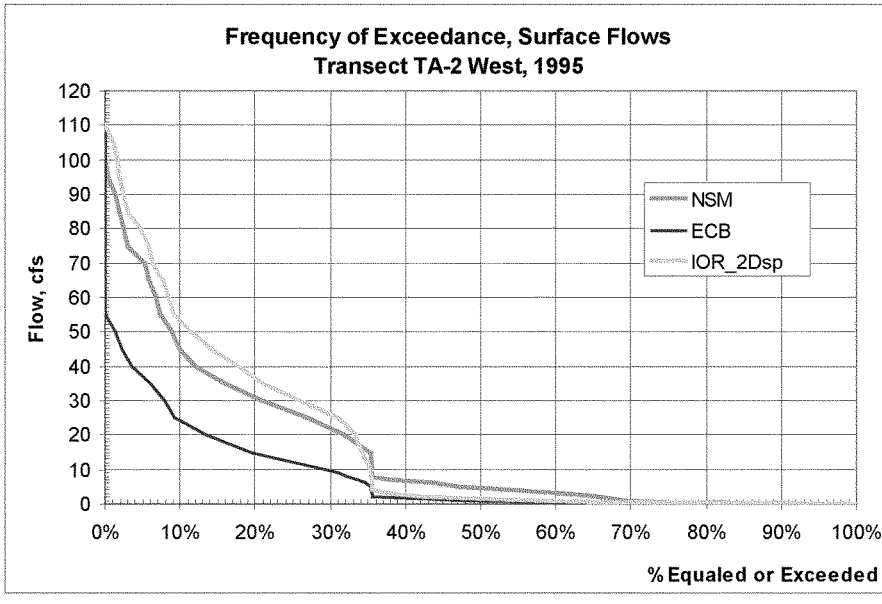


FIGURE C-13: TOTAL SURFACE WATER FLOW FOR THE INITIAL OPERATING REGIME (IOR_2DS) AND EXISTING CONDITIONS BASELINE (ECB) ACROSS TRANSECT TA-2 WEST FOR 1995

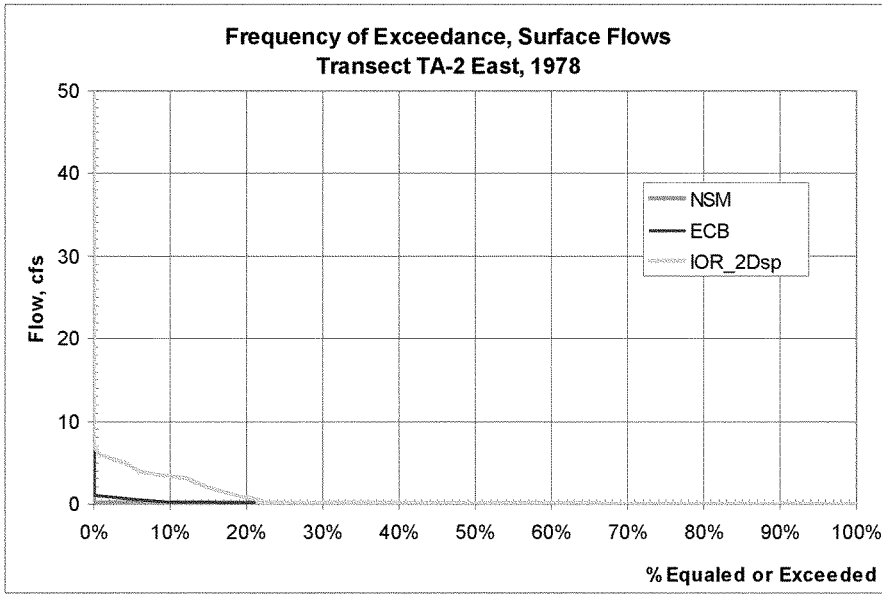


FIGURE C-14: TOTAL SURFACE WATER FLOW FOR THE INITIAL OPERATING REGIME (IOR_2DS) AND EXISTING CONDITIONS BASELINE (ECB) ACROSS TRANSECTS TA-2 EAST FOR 1978

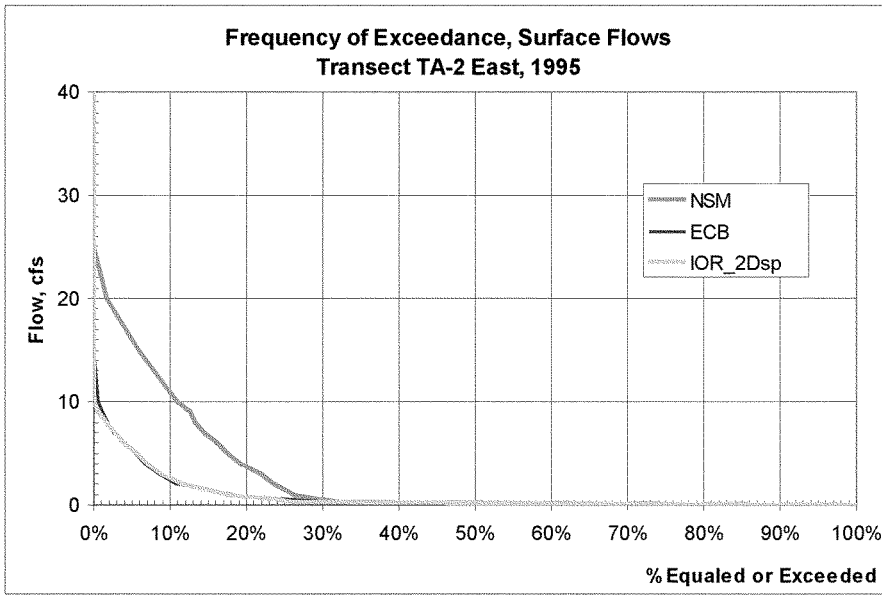


FIGURE C-15: C.X TOTAL SURFACE WATER FLOW FOR THE INITIAL OPERATING REGIME (IOR_2DS) AND EXISTING CONDITIONS BASELINE (ECB) WATER FLOW ACROSS TRANSECTS TA-2 EAST FOR 1995

For 1978, the average year, surface water flows across TA-1 increase with the recommended project in place. For the IOR_2DS there are surface water flows up to 30% of the time and increase up to 60 cfs in the IOR_2DS compared to 50 cfs for ECB. In 1995, the simulated surface water flows across TA-1 increase with the recommended project, IOR_2DS, with flows occurring up to approximately 85% of the time.

Surface water flows across TA-2 West increase in the 1978 and 1995 model simulations with the project in place, IOR_2DS, compared to the ECB, with flows occurring approximately 30% and 40% of the time.

Surface water flows across TA-2 East increase in the 1978 and 1995 model simulations with the project in place, IOR_2DS compared to the ECB, however, the increases are minimal. Surface water flows occur approximately 20% of the time.

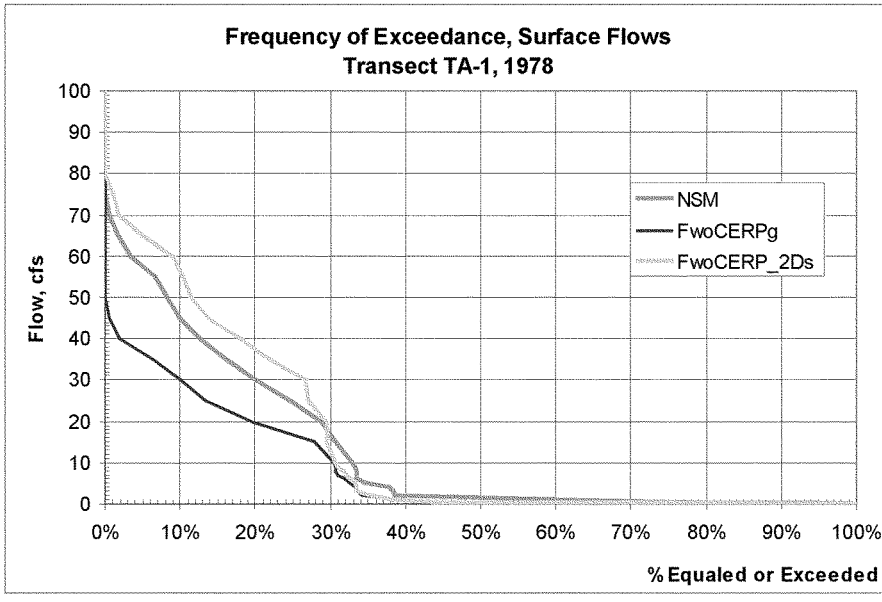


FIGURE C-16: TOTAL SURFACE WATER FLOW FOR FUTURE WITHOUT CERP (FWOCERP) AND FUTURE WITHOUT CERP PLUS THE PROJECT (FWOCERP_2DS) ACROSS TRANSECT TA-1 FOR 1978

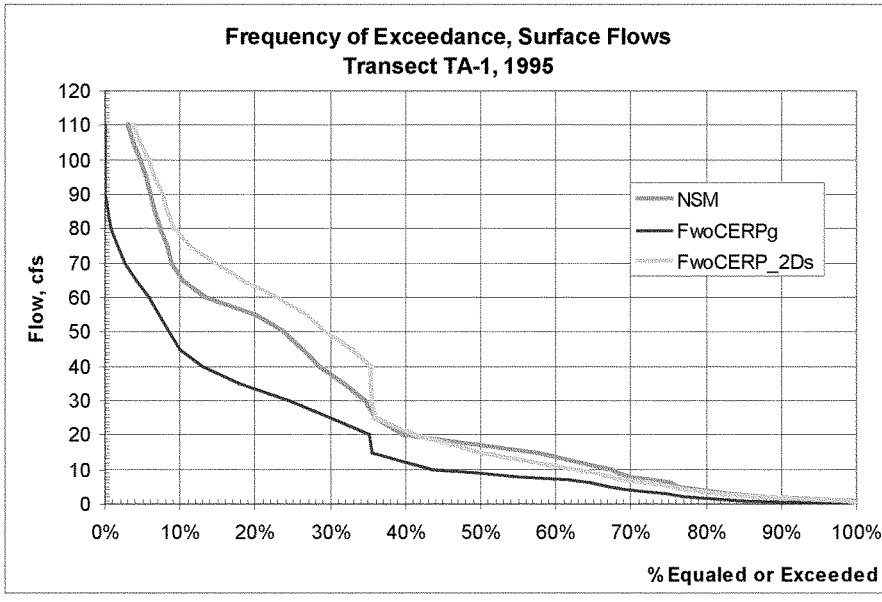


FIGURE C-17: TOTAL SURFACE WATER FLOW FOR FUTURE WITHOUT CERP (FWOCERP) AND FUTURE WITHOUT CERP PLUS THE PROJECT (FWOCERP_2DS) ACROSS TRANSECT TA-1 FOR 1995

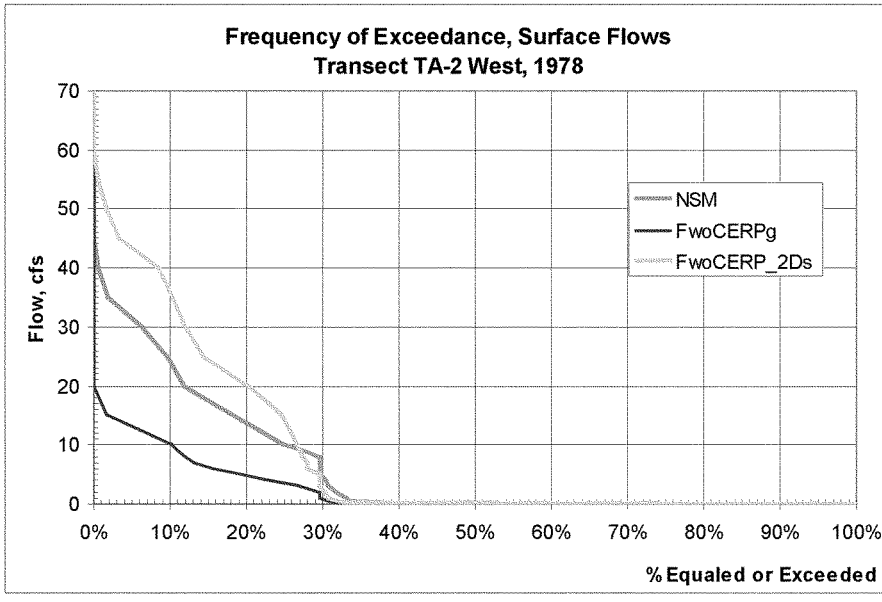


FIGURE C-18: TOTAL SURFACE WATER FLOW FOR FUTURE WITHOUT CERP (FWOCERP) AND FUTURE WITHOUT CERP PLUS THE PROJECT (FWOCERP_2DS) ACROSS TRANSECT TA-2 WEST FOR 1978

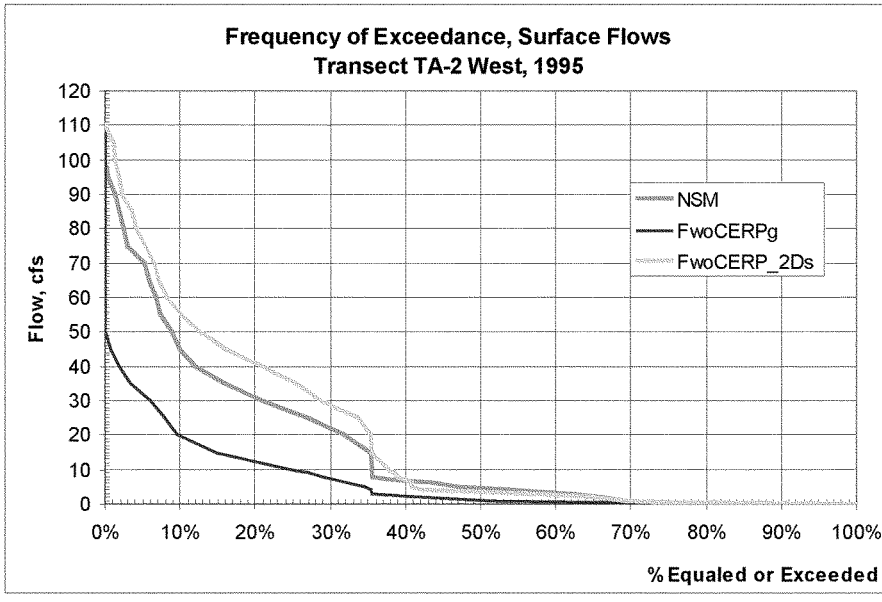


FIGURE C-19: TOTAL SURFACE WATER FLOW FOR FUTURE WITHOUT CERP (FWOCERP) AND FUTURE WITHOUT CERP PLUS THE PROJECT (FWOCERP_2DS) ACROSS TRANSECT TA-2 WEST FOR 1995

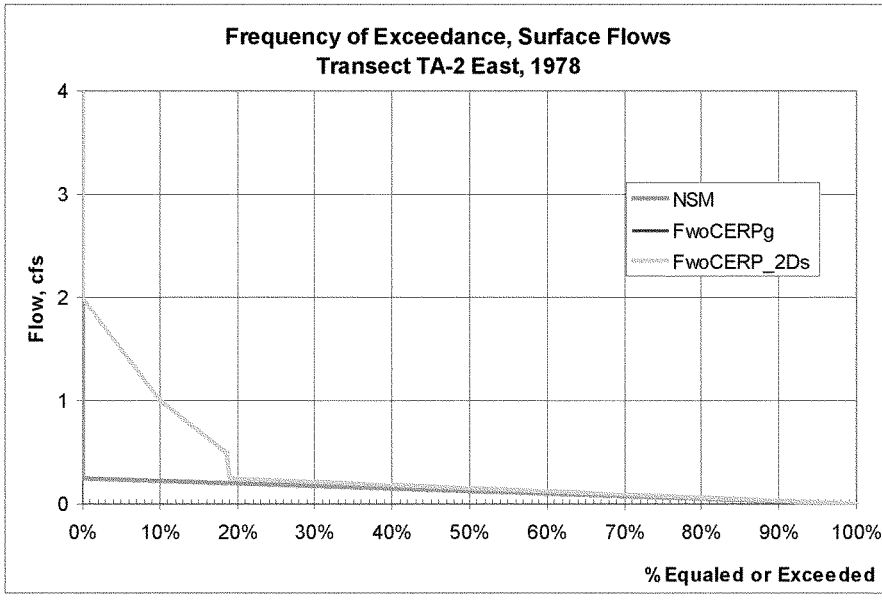


FIGURE C-20: TOTAL SURFACE WATER FLOW FOR FUTURE WITHOUT CERP (FWOCERP) AND FUTURE WITHOUT CERP PLUS THE PROJECT (FWOCERP_2DS) ACROSS TRANSECT TA-2 WEST FOR 1978

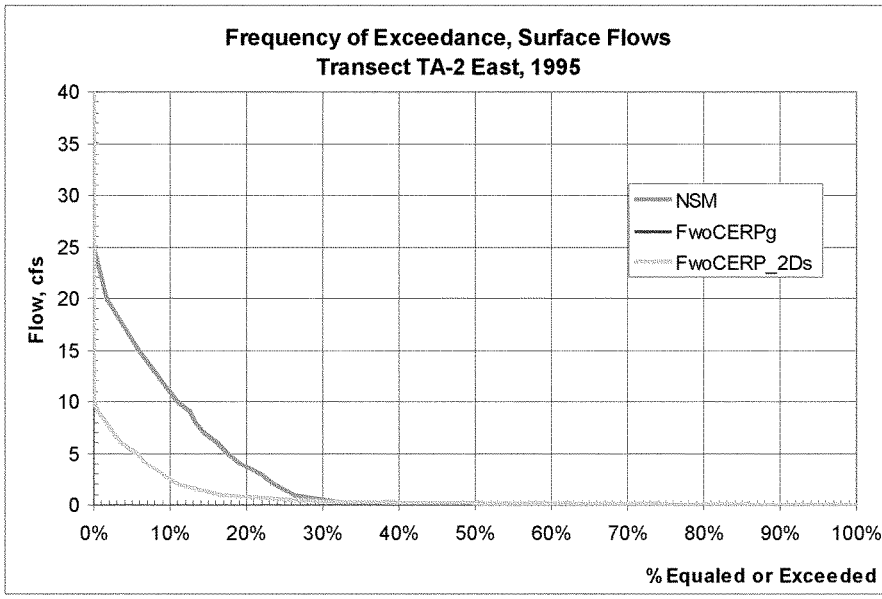


FIGURE C-21: TOTAL SURFACE WATER FLOW FOR FUTURE WITHOUT CERP (FWOCERP) AND FUTURE WITHOUT CERP PLUS THE PROJECT (FWOCERP_2DS) ACROSS TRANSECTS TA-2 EAST FOR 1995

C.4.2.2 Identifying Water to be Reserved or Allocated for the Natural System

The 10th, 50th and 90th percentile identified for the ECB, which represents the total water available for the natural system, the IOR_2DS, which represents the water directed towards C-111 Canal, and the difference between the ECB and IOR_2DS, which represents the total water made available by the project for the natural system are displayed in ***TABLE C-1***. The total water available to be diverted by the C-111 SC Western project ranges from about 775 cfs to 0 cfs. The portion diverted to either the Frog Pond Detention Area or the Aerojet Canal (ECB minus IOR_2DS) is the surface water made available by the C-111 SC Western project and ranges from 504 cfs (10th percentile) to 0 cfs (50th percentile). Water is not available at the median (50% percentile) or higher (90th percentile) or for the representative dry year, 1989.

TABLE C-1: TOTAL WATER AND WATER DIVERTED BY THE PROJECT FOR THE NATURAL SYSTEM QUANTIFIED AT S-177 (CUBIC FEET/SECOND)

Percentile:	10th	50th	90th
1978 Total Water (ECB)	54	0	0
1978 Water Directed towards C-111 Canal (IOR_2DS)	0	0	0
1978 Total Water Made Available by Project, (ECB minus IOR_2DS)	54	0	0
1995 Total Water (ECB)	775	0	0
1995 Water Directed towards C-111 Canal (IOR_2DS)	271	0	0
1995 Total Water Made Available by Project (ECB minus IOR_2DS)	504	0	0

To capture increases in water made available for the natural system, three transects located in South Miami-Dade, quantify surface flows in the Existing Baseline Condition, ECB. These flows are compared to the Initial Operating Regime with the project in place, IOR_2DS, which represents the total water available. The difference between these conditions for each year simulated represent the water made available for the natural system by the Recommended Project. The 10th, 50th and 90th percentile identified for the IOR_2DS, which represents the total water available, the ECB, the existing water, and the difference between the IOR_2DS and ECB, which represents the total water made available by the project for the natural system are displayed in ***TABLE C-2***. The surface water made available by the C-111 SC Western project ranges from 25.6 cfs (10th percentile) to 0 cfs (90th percentile).

TABLE C-2: TOTAL SURFACE WATER AND WATER MADE AVAILABLE BY THE PROJECT FOR THE NATURAL SYSTEM QUANTIFIED AT TRANSECTS TA-1, TA-2W AND TA-2E (CUBIC FEET/SECOND).

Percentile:	**10th**			**50th**			**90th**		
	TA-1	TA-2w	TA-2e	TA-1	TA-2w	TA-2e	TA-1	TA-2w	TA-2e
1978 Total Water (IOR_2DS)	41.4	22.5	3.4	0.4	0.2	0.2	0.1	0	0
1978 Existing Water (ECB)	30.2	10.8	0.3	0.4	0.2	0.1	0.1	0	0
1978 Total Water Made Available by Project (IOR_2DS minus ECB)	11.2	11.7	3.1	0	0	0.1	0	0	0
1995 Total Water (IOR_2DS)	73.5	53.4	2.6	8.8	1.6	0.2	0.8	0.1	0
1995 Existing Water (ECB)	47.9	24.2	2.3	8.1	1	0.2	0.5	0.1	0
1995 Total Water Made Available by Project (IOR_2DS minus ECB)	25.6	29.2	0.3	0.7	0.6	0	0.3	0	0

The State will use its water reservation or allocation authority to protect the water made available by the project for the natural system as required by section 601 of WRDA 2000. The State has elected to protect the existing water in the natural system that the Project Implementation Report identifies as necessary to achieve the benefits of the project, using water reservation or allocation authority under Florida law. To this end, the South Florida Water Management District will protect the existing water and water made available by the project for the natural system as indicated in ***TABLE C-1*** and ***TABLE C-2***.

C.4.3 Application of Project Assurances

The overarching objective of the Comprehensive Everglades Restoration Plan ("Plan") is the restoration, preservation, and protection of the South Florida ecosystem while providing for other water-related needs of the region, including water supply and flood protection. The Federal Government and the State of Florida are committed to the protection of the appropriate quantity, quality, timing, and distribution of water to achieve and maintain the benefits to the natural system described in the Plan. As envisioned in WRDA 2000 and the Programmatic Regulations, each PIR will identify this appropriate quantity, quality, timing, and distribution of water for the natural system.

The following language sets forth these commitments:

"The overarching objective of the Plan is the restoration, preservation, and protection of the South Florida ecosystem while providing for other water-related needs of the region, including water supply and flood protection. The Federal Government and the non-Federal sponsor are committed to the protection of the appropriate quantity, quality, timing, and distribution of water to ensure the restoration, preservation, and protection of the natural system as defined in WRDA 2000, for so long as the project remains authorized. This quantity, quality, timing, and distribution of water shall meet applicable water quality standards and be consistent with the natural system restoration goals and purposes of CERP, as the Plan is defined in the programmatic regulations. The non-Federal sponsor will protect the water for the natural system by taking the following actions to achieve the overarching natural system objectives of the Plan:

1. Ensure, through appropriate and legally enforceable means under Federal law, that the quantity, quality, timing, and distribution of existing water that the Federal Government and the non-Federal sponsor have determined in this Project Implementation Report is available to the natural system, will be available at the time the Project Cooperation Agreement for the project is executed and will remain available for so long as the Project remains authorized.

2a. Prior to the execution of the Project Cooperation Agreement, reserve or allocate for the natural system the necessary amount of water that will be made available by the project that the Federal Government and the non-Federal sponsor have determined in this Project Implementation Report.

2b. After the Project Cooperation Agreement is signed and the project becomes operational, make such revisions under Florida law to this reservation or allocation of water that the Federal Government and the non-Federal sponsor determines, as a result of changed circumstances or new information, is beneficial for the natural system.

3. For so long as the Project remains authorized, notify and consult with the Secretary of the Army should any revision in the reservation of water or other legally enforceable means of protecting water be proposed by the non-Federal sponsor, so that the Federal Government can assure itself that the changed reservation or legally enforceable means of protecting

water conform with the non-Federal sponsor's commitments under paragraphs 1 and 2. Any change to a reservation or allocation of water made available by the project shall require an amendment to the Project Cooperation Agreement.

C.5 LITERATURE CITED

Evans, R., 2007. Calibration and verification of the MODBRANCH (MB_2006) numerical model of South Florida. U.S. Army Corps of Engineers, SAD, Jacksonville District.

Froelich, D. C., 1989, HW031.D – *Finite Element Surface-Water Modeling System: Two-Dimensional Flow in a Horizontal Plane—Users Manual (FESWMS),* Federal Highway Administration Report FHWA-RD-88-177, p. 285.

U.S. Army Corps of Engineers (USACE). 2005. *Hydrologic Engineering Center River Analysis System* (HECRAS), Version 3.1.3, 2005.

C.6 PART II: ANALYSES REQUIRED BY STATE LAW

COMPREHENSIVE EVERGLADES RESTORATION PLAN

C-111 SPREADER CANAL WESTERN PROJECT

FINAL

STATE COMPLIANCE REPORT

June 30, 2009

Table of Contents

1.0 Introduction
2.0 Comprehensive Needs Analysis and Evaluation

- 2.1 Water Supply
- 2.2 Water Quality
- 2.3 Flood Protection
- 2.4 Threatened and Endangered Species
- 2.5 Other Natural System and Habitat Need

3.0 Determination of Project Component Feasibility

- 3.1 Standard Engineering Practices and Technologies & Summary of Project Features
- 3.2 Efficiency and Cost Effectiveness
- 3.3 Project Components Consistency with Restudy Purposes
- 3.4 Project Components Consistency with Implementation of CERP
- 3.5 Project Components Consistency with Operation of other CERP Components

4.0 Determination of Project Consistency with Applicable Laws and Regs

- 4.1 Pre-application Conferences
- 4.2 State Agency Information
- 4.3 Federal Agency Information

5.0 Reasonable Assurances

- 5.1 Water Supply Assurances & Project Effects on Existing Legal Users
- 5.2 Flood Protection Assurance
- 5.3 Adaptive Management to Meet the Needs of the Restored Natural Environment

6.0 Coordination with Existing Utilities and Public Infrastructure

- 6.1 Summary of Utilities within the Project Area & Coordination with Utilities and Public Infrastructure

7.0 Increased Water Supply Available from Project

8.0 GLOSSARY OF ACRONYMS

9.0 REFERENCES

1.0 Introduction

This section will cover the background, purpose, and contextual setting of the project within the Comprehensive Everglades Restoration Plan (CERP). It includes a brief explanation of why the C-111 Spreader Canal (C-111 SC) project is being proposed.

Comprehensive Everglades Restoration Plan - Background Information
The CERP (Plan) provides a framework for restoration of the diverse and significant habitats of the south Florida ecosystem, including the Everglades, which encompasses 18,000 square miles from Orlando to the Florida Reef Tract. Everglades National Park (ENP) (the largest national park east of the Mississippi River, comprising a significant portion of the greater Everglades Ecosystem) is a World Heritage Site, an International Biosphere Preserve and a Wetland of International Importance. The Everglades and the south Florida ecosystem are affected by many factors such as competing demands for recreation, development, and natural and commercial resources and include 68 federally listed threatened and endangered plants and animals.

First authorized by Congress in 1948, construction undertaken as a result of the Central and Southern Florida (C&SF) project expanded the existing network of canals, levees, water storage areas and water control structures in south Florida. Project objectives included flood control, regional water supply, prevention of saltwater intrusion, preservation of fish and wildlife, recreation and navigation. While fulfilling these objectives, the project has had unintended adverse effects on the natural environment that constitutes the Everglades and south Florida ecosystem by disrupting the pre-existing hydrologic regime. As a result, in 1996, the U.S. Army Corps of Engineers (USACE) in conjunction with the South Florida Water Management District (SFWMD) was directed to develop a comprehensive plan to restore, preserve and protect the south Florida ecosystem while providing for other water-related needs of the region such as water quality and flood protection. The resulting plan was submitted to Congress on July 1, 1999 and consists of proposed structural and operational modifications to the C&SF project.

The recommended plan, identified as the CERP, was approved to provide a framework for the restoration of the natural system under Section 601 of the Water Resources Development Act of 2000 (WRDA 2000). The plan consists of 68 different components that work together, to restore, preserve and protect the south Florida ecosystem while providing for other water related needs of the region. The CERP components will be implemented over an approximate 40-year period. Together, these components will benefit the ecological function of more than 2.4 million acres of the south Florida ecosystem by improving and/or restoring the proper quantity, quality, timing and distribution of water in the natural system while also addressing other concerns such as urban and agricultural water supply and maintaining existing levels of flood protection.

One of the 68 components was the C-111 SC project (identified in CERP as the C-111 N Spreader Canal, component WW) located in the Lower East Coast region of Florida. The following map shows the general C-111 SC project area in relation to the rest of south Florida.

Project Area

The C-111 Canal is the southernmost canal of the C&SF Flood Control project and is located in southern Miami-Dade County. The canal serves a basin of approximately 100 square-miles and functions primarily to provide flood protection and drainage for the agricultural areas to the west and south of the city of Homestead, Florida. Southwest of Homestead and Florida City and just south of the agriculturally developed area, the C-111 Canal is joined by the C-111E and courses south to southeast through extensive marl wetland prairie and coastal mangrove marsh before it ends in Manatee Bay. The C-111 Canal and S-18C (located just south of the confluence of C-111E and C-111) were completed in 1966 and the S-197 culverts/earthen plug were completed in 1970. The S-197 structure provides a gravity outlet for stormwater runoff during flood conditions and acts as a barrier to prevent saltwater intrusion into the freshwater wetlands of the Southern Glades Wildlife and Environmental Area (SGWEA), which is located to the north of the ENP's eastern panhandle. The C-111 Canal is also the final segment of the South Dade Conveyance System (SDCS). The canal provides a means to deliver water to ENP's Taylor Slough and the eastern panhandle.

Part of the C-111 SC project area falls within the South Dade Wetlands, which include the Model Land and the Southern Glades. The Southern Glades region is bounded by ENP to the south and west, U.S. Highway 1 to the east, and the Model Lands to the north except for the far western edge, west of C-111E, that extends further north to the boundary of the Frog Pond.

Purpose and Scope

In 1999, the USACE completed the C&SF Project Comprehensive Review Study (Restudy). The purpose of the Restudy was to re-examine the C&SF project to "determine the feasibility of structural or operational modifications to the project essential to the restoration of the Everglades and the south Florida ecosystem, while providing for other water related needs such as urban and agricultural water supply and flood protection in those areas served by the project (WRDA 1996)." The intent of the study was to evaluate conditions within the south Florida ecosystem and make recommendations to modify the C&SF project in order to restore important functions and values of the Everglades and south Florida ecosystem and to plan for the water resources needs of the people of south Florida for the next 50 years. The selected plan (Alternative D13-R) was published in the "Final Integrated Feasibility Report and Programmatic Environmental Impact Statement (PEIS) for the C&SF Project", dated April 1999. The selected plan was approved under the WRDA 2000 as the CERP.

The C-111 SC project was initially, conditionally authorized under the WRDA 2000 as one of the initial set of CERP projects that would serve to "jump-start" restoration in the natural system. The primary restoration purpose for the C-111 SC project identified in the Restudy was:

> "...to improve deliveries and enhance the connectivity and sheetflow in the Model Lands and Southern Glades areas, reduce wet season flows in C-111, and decrease potential flood risk in the lower south Miami-Dade County area."

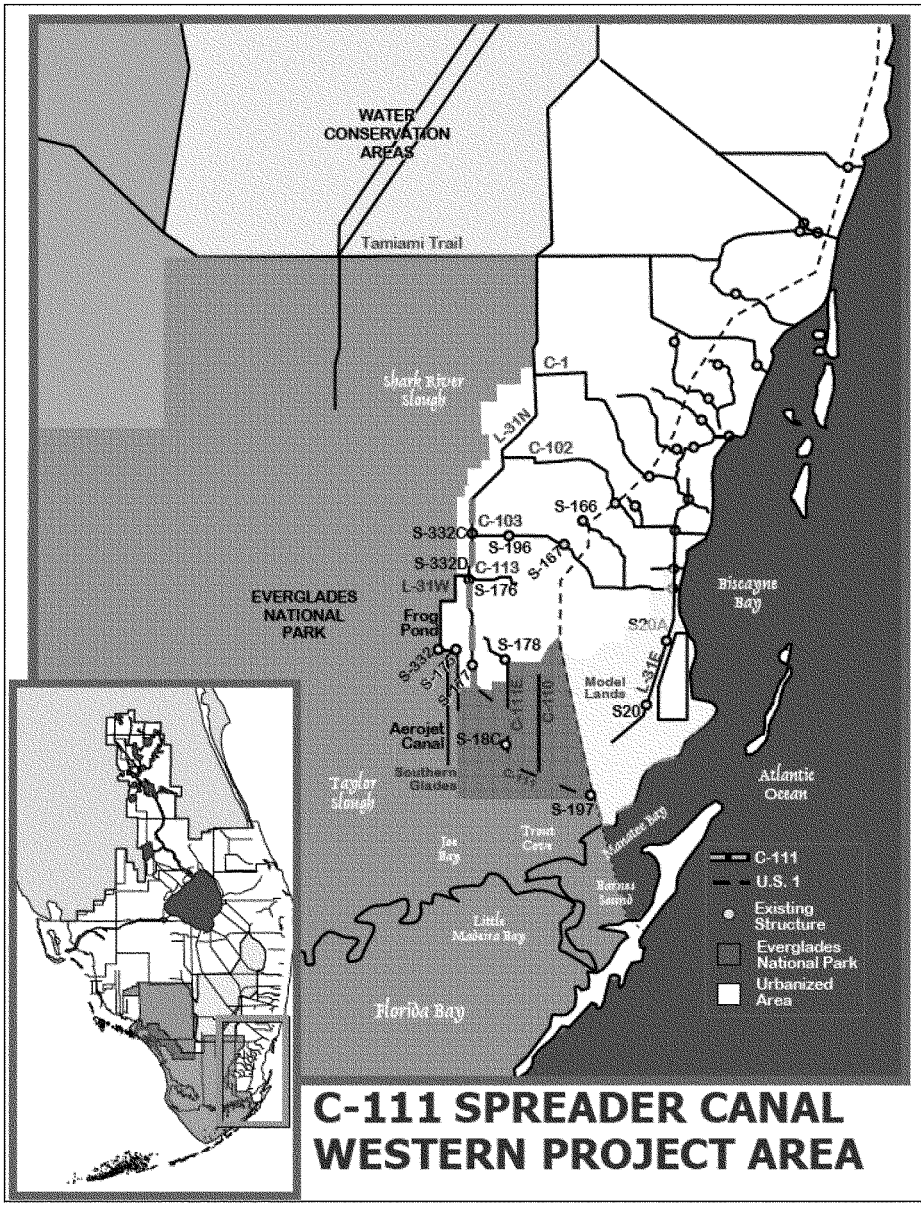


FIGURE 1: PROJECT AREA

2.0 Comprehensive Needs Analysis and Evaluation

Section 373.1501(5)(a), F.S. requires the SFWMD to "Analyze and evaluate all needs to be met in a comprehensive manner and consider all applicable water resource issues, including water supply, water quality, flood protection, threatened and endangered species, and other natural system and habitat needs".

The following sections describe the procedures and methodologies used in assessing these water resources issues along with a description of how these issues have been met or resolved for each project component. For detailed descriptions of these analyses, the reader should refer to the C-111 Spreader Canal Western Project, Final Integrated Project Implementation Report and Environmental Impact Statement.

2.1 Water Supply

The C&SF project and urban development disrupted the natural pattern , resulting in flow and stage patterns shown in **Figure 2** below. The C-111 Basin presents deeper water elevations than the pre-drainage conditions and different flow distribution, particularly in the Taylor Slough and 8.5 SMA.

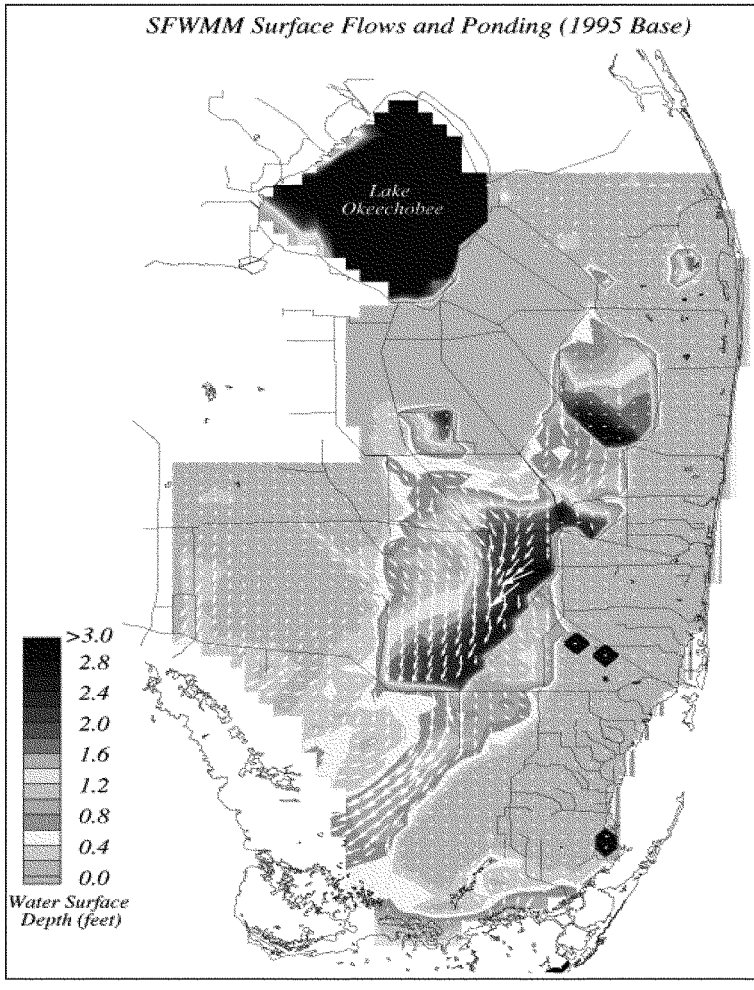


FIGURE 2: SOUTH FLORIDA WATER MANAGEMENT MODEL SURFACE FLOWS AND PONDING (1995 BASE)

In order to restore the original conditions on the C-111 area, the flow patterns and distribution in ridges and sloughs would have to be restored. The ENP-SDCS was authorized for the purpose of improving the supply and distribution of water supplies to ENP and for expanding agricultural and urban needs. Before supplemental water is introduced into the system, canal stages are permitted to recede approximately 1.5 feet below the design optimums.

Optimum and design water levels in the project canals are established on the basis of desirable water control conditions in each area, i.e., optimum groundwater levels, intake and/or discharge structure elevations and removal rates for flood control. Along the east coast salinity control is included as a requirement of canal-level design criteria.

The Biscayne Aquifer underlies approximately 3,000 square miles of Dade, Broward, and southern Palm Beach counties. It is a surficial, highly permeable, wedge-shaped aquifer that ranges from about 100-400 feet in depth along the coast and thins to a few feet thick near its western boundary thirty-five to forty miles inland. This aquifer provides water for municipal and industrial (M&I) water supply and agricultural irrigation along the southeast coast. Seepage and water supply releases from the WCAs recharge the surficial aquifers and prevent saltwater intrusion along the coast. The C&SF system is designed so that, except at coastal salinity structures, canal stages in general may be permitted to recede approximately 1.5 feet below the optimum levels before supplemental water must be introduced into the ENP-SDCS.

The purpose of S-18C is to maintain desirable water levels in the upstream reach of C-111 Canal, pass flood flows up to forty percent of the standard project flood without exceeding design stages upstream, and act as a control point for water deliveries to the eastern panhandle of the ENP. The minimum monthly water releases for the ENP is shown on **Table 1** below.

TABLE 1: MINIMUM MONTLY DELIVERY SCHEDULE AT EASTERN PANHANDLE (AS DELIVERED AT S-18C)

Month	Acre-Feet	Month	Acre-Feet
January	1,540	July	510
February	630	August	860
March	290	September	2,690
April	110	October	4,630
May	110	November	4,060
June	340	December	2,230

The purpose of S-197 is to maintain sufficient water control stages in the upstream section of C-111 Canal to prevent saltwater intrusion. Originally constructed as an earthen plug which would be excavated before or after major storm events, three gated culverts were subsequently added in order to avoid the over drainage, and damaging freshwater releases, associated with excavating the canal plug. Following a particularly damaging discharge in

1988, the SFWMD installed ten additional culverts at S-197 adjacent to the three original culverts. The added operational flexibility provided by the thirteen gated culverts has significantly lowered the volume of unnecessary discharges before, during, and after major storm events.

Additional reductions in the frequency, degree, and duration of S-197 openings have also been realized by removal of the spoil mounds adjacent to the lower C-111 Canal. Currently, water which discharges from S-18C, is allowed to flow over the scraped down canal banks into ENP's panhandle, and towards Florida Bay.

Even further reductions in the frequency, degree, and duration of S-197 openings have been realized as a result of SFWMD's construction of a new gated culvert structure, G-211, in the L-31N Borrow Canal immediately south of its intersection with C-1. As a result, during the experimental program, there has been a reduction in the need for S-331 discharges. With G-211 in place, S-331 has been used to pump water levels in the canal immediately adjacent to the 8.5 SMA in order to drain groundwater from the area.

This project does make water available for the natural system and is quantified in the Final Project Implementation Report and Environmental Impact Statement, Annex C (dated June 2009). The State of Florida will use its water reservation or allocation authority to protect the water made available by the project for the natural system, as required by Section 373.470, F.S. The State has elected to protect the existing water in the natural system that the Project Implementation Report identifies as necessary to achieve the benefits of the project, using water reservation or allocation authority under Florida law. To this end, the South Florida Water Management District will protect the existing water and water made available by the project for the natural system.

2.2 Water Quality

The discharge of phosphorus laden runoff into the Everglades Protection Area has resulted in undesirable changes to the oligotrophic ecology of this area. Nutrient and pesticide loading are of concern in the Lower C-111 Basin due to the proximity of intensive agricultural operations in the basin. In the early 1990s, the federal government sued the State of Florida to compel the state to enforce its water quality criteria and protect the Everglades system from excessive phosphorus discharges. The 1991 Settlement Agreement ended this lawsuit and resulted in a Consent Agreement whereby the State was responsible for monitoring phosphorus discharges into the Everglades and working to resolve violations.

Nutrients and Dissolved Oxygen

Since 1992, the SFWMD has published the quarterly "Settlement Agreement Reports" that summarize compliance with phosphorus standards set for LNWR, Shark River Slough, and Taylor Slough. The C-111 Basin is covered in this agreement by the Taylor Slough compliance standards. In the original Consent Degree, the Taylor Slough long-term phosphorus limit was set to 11 parts per billion (ppb) as measured by the flow-weighted concentrations at the S-332, S-175, and S-18C structures. Subsequent changes to structure operations and the construction of new structures has required that the compliance

measurement locations be changed to the S-332D, S-174, and S-18C structures. Over the 16 years (1991-2007) of compliance monitoring and reporting, the Consent Decree standard of 11 ppb has been violated in only one year (1994). More recently, the annual flow-weighted average total phosphorus concentration for the Taylor Slough compliance locations has been below 8 ppb since 2001 and is trending towards 5 ppb which is very close to the natural background concentration. Though the Consent Decree standards are routinely met at the compliance locations, the C-111E Basin presents an area that has elevated phosphorus concentrations. Measurements at S-178, on the C-111E Canal present the highest total phosphorus (TP) concentrations (24 ppb) of any structure in the C-111 Basin.

Analysis of 1990-2000 SFWMD data collected at S-197 showed a relatively low mean concentration of ammonia (0.06 milligrams per liter [mg/L]) and nitrate nitrogen (0.04 mg/L). The 1990-2000 data collected at S-177 showed a mean concentration of ammonia and nitrate nitrogen of 0.13 and 0.09 mg/L, respectively. Dissolved oxygen (DO) mean concentration of 5.8 was well above the state standard for DO of 5.0 mg/L, albeit seven percent of the reported values were below 2 mg/L. The low DO concentrations (less than 2 mg/L) all occurred during the warmer months (June thru October); such low oxygen concentrations values could potentially result in fish kills in C-111 Canal or in Manatee Bay.

The proposed project will merely take water which would otherwise be discharged via S-177 and impound it in the Frog Pond Detention Area, and/or the Aerojet Road Canal Feature. Because the reach of C-111 upstream of S-177 will "see" virtually no change in its water budget, stage, etc. there should be virtually no change in the DO or nutrient concentrations within that reach of the canal. Reaches downstream of S-177 will likely see some very minor improvements as the water budget would tend to be composed more of marsh water (as opposed to S-177 discharged water). Water quality within the two features should be slightly better than that of the C-111 by virtue of traveling through some vegetated lands within the features themselves.

Pesticides

The SFWMD began monitoring pesticides in surface water and sediment in south Florida canals in the mid 1980s. Concentrations of endosulfan sulfate were consistently found by the SFWMD in sediment samples at S-178 while the alpha and beta isomers were occasionally found. Additionally, all three residues were found in sediment samples from structure S-177.

The U.S. Environmental Protection Agency (EPA) monitored contaminants in surface water, sediment, and biota during 1995 in lower C-111 Canal and creeks of northeast Florida Bay. Endosulfan residues were detected in sediments in the C-111 Canal, and Shell and Trout Creeks. Organochlorine contaminants occurred at low concentrations in sediments of canals and creeks. PCBs and PAHs were also at low concentrations but higher in the C-111 Canal than in the creeks.

National Oceanic and Atmospheric Administration (NOAA) conducted a contaminant study of C-111 Canal and Florida Bay from 1993 to 1997. It identified the presence of endosulfan (total), atrazine, chlorpyrifos, and chlorothalonil in surface waters of canals adjacent to agricultural areas that drain into the C-111 Canal and in northeast Florida Bay. Endosulfan

concentrations detected at S-178 exceeded the FDEP and the EPA water quality criterion 40 percent of the time. Florida Bay waters occasionally exceeded EPA marine water quality criteria while freshwater from canal sites had detectable residues exceeding the freshwater criterion. Overall, ten percent of the samples obtained from the canal sites exceeded the endosulfan freshwater criterion.

The effects of pesticide mixtures on biota is not included in state water quality criteria, which are based on the results of single-species, single-chemical toxicity tests conducted in the laboratory. Therefore, the analyses of individual pesticides may underestimate potential adverse effects of pesticides on the biota.

As a result of the proposed project, for similar reasons cited above, the reach of C-111 upstream of S-177 should experience virtually no change in pesticide concentrations. Similarly, reaches downstream of S-177 may see some very minor improvements as the water budget would tend to be composed more of marsh water (versus S-177 discharged water). Water quality within the two features will be dependent on the success of the soil scraping to remove any latent pesticides and on their individual leach abilities.

Mercury

Health advisories have been issued due to elevated mercury levels in freshwater and estuarine fish for many Florida waterbodies, including freshwater wetlands of ENP and Florida Bay. Mercury methylation is of primary concern since this is the process that transforms less toxic inorganic mercury (Hg) to the highly toxic and bioaccumulative methylmercury (MeHg). Sources of mercury to the biota of the Everglades and Florida Bay may include atmospheric deposition, runoff containing mercury, and internal mercury cycling between the sediments, the water column, and various organisms in the food chain.

As part of the District pre acquisition assessment and interim land management Best Management Plan, the District conducted site visits and soil and ground water assessments. During the 2006 Phase II ESA, soil samples were collected from over 1,300 acres within the Frog Pond, and an additional 350 acres in 2009. The soil sampling meets the established protocols in both the US Fish and Wildlife Service (Service), the District assessment guidelines, and the CERP Guidance Memoranda (CGM) #42, Toxic Substances Screening Process - Mercury and Pesticides. No elevated mercury levels were detected above the Sediment Quality Assessment Guidelines Threshold Effects Level of 0.18 mg/kg. Low levels of historic agrochemicals (4,4-DDE, 4,4-DDT, and chlordane) were detected in several 50-acre grids that pose a potential risk to the Service's trustee species. However these impacts are located outside the detention area footprint. Post construction monitoring described in CGM #42 appears to be geared towards identifying the fate of Mercury as a result of treatment trains such as STAs and reservoirs (bodies of water collected for storage and future use). While the C-111 Spreader Canal Western Features Project does include an above ground impoundment designed to infiltrate surface water into groundwater (for purposes of reducing seepage from Everglades National Park), it does not contain STAs or traditional reservoirs, and involves no surface water discharge. Because of this, and because elevated mercury levels were not detected above the Sediment Quality Assessment Guidelines

Threshold Effects Level (0.18 mg/kg), the USACE believes that additional assurances regarding Mercury (or pesticides) are not necessary at this time.

Salinity
The C-111 Basin drains into eastern Florida Bay via Taylor Slough and overland flows from the lower C-111 Canal. Florida Bay currently experiences salinity imbalances that might be caused, in part, by changes in the historic timing and quantity of freshwater deliveries from the C-111 Basin. The SFWMD is currently performing monitoring of salinity levels in Florida Bay.

To provide protection during large storm events, floodwater may be discharged from the lower C-111 Canal through S-197 into the Manatee Bay/Barnes Sound area of southern Biscayne Bay. Freshwater flood control discharges through the S-197 structure may, depending on the duration and total volume of the discharges, cause negative local impacts due to rapid changes in salinity in Manatee Bay/Barnes Sound.

Summary of Phase I and Phase II Environmental Site Assessments (ESA)

The narratives that follow are intended to summarize the ESAs conducted at the Frog Pond property and other C-111 Spreader Canal Project components.

Frog Pond Property

2006 Limited Phase II ESA
In 2006, URS conducted a Limited Phase II ESA which included an extensive soil quality evaluation of the 1,380 acres of agricultural area. Prior to implementing soil sampling, a sampling plan was discussed with the Service. In accordance with the Service's sampling protocol for historically cultivated areas, the former agricultural areas were divided into 29, 50-acre grids. One composite soil sample was collected from each of the 29 grids and composite samples were collected from the equipment staging and mixing areas.

In light of the future intended use of the subject property and the conversion of soils at the site to sediments post-inundation, soil and sediment sample results were evaluated. The evaluation was based on the Sediment Quality Assessment Guidelines (SQAGs) using the values established in the *Consensus-Based Sediment Quality Guidelines for Freshwater*, published by McDonald Environmental Service Ltd. in 2003, as adopted by the Florida Department of Environmental Protection (FDEP). Two SQAGs are applicable. The SQAG-TEC represents a Threshold Effects Concentration below which adverse effects to benthic macro invertebrates (at the bottom of the food chain) are not expected. The SQAG-PEC represents a Probable Effects Concentration above which adverse effects to benthos are considered likely.

Concentrations of copper, above the Service's interim value of 85 mg/kg were exceeded in composite soil samples collected in 24 grids. Concentrations of 4, 4-DDE exceeded the SQAG PEC of 31 ug/kg in composite soil samples collected from two grids. The SQAG TEC was exceeded in composite soil samples collected from four grids. Concentrations of

zinc exceeded the SQAG TEC of 120 mg/kg in composite soil samples collected in 17 grids. In addition, other contaminates such as Barium, Cadmium, Chromium, Lead, total Chlordane, 4, 4-DDT, and 4, 4-DDD were detected at low concentrations within the cultivated areas and or the staging/mixing areas.

2006 Screening Level Ecological Risk Assessment
In an effort to evaluate the potential risk posed by the residual concentration of agrochemicals, a Screening Level Ecological Risk Assessment (SLERA) was completed. The purpose of the SLERA was to elevate the potential risk that residual contaminates would pose to the Service's trustee species. The results of the SLERA indicated that copper poses a potential risk to the snail kite. The SLERA also indicated that for the Service Trustee species, 4, 4-DDE, poses a potential risk to the osprey and zinc poses a potential risk to the snail kite.

2006 Limited Phase II ESA Conclusions / Recommendations
The result of the Phase II ESA soil sampling indicated that concentrations of contaminants were present in the cultivated areas and the staging/mixing areas that pose an unacceptable ecological risk if the property was flooded or inundated. The results of the sampling within the cultivated areas document unacceptable concentration of copper in over 1,200 acres, of zinc in over 850 acres, and 4, 4-DDE in over 100 acres. The zinc and 4-4 DDE are co-located with the copper impacted soils. The assessment also identified impacted soils in the staging/mixing areas. Additional soil assessment is necessary in this area to evaluate the extent of the impacted soil.

Based on the potential risk posed by the impacted soils, a potential cost effective option would be to scrape the impacted soils and relocate the soil to an area that would not be inundated or flooded; therefore URS recommended a Pilot Study to the effectiveness of scraping. On May, 1, 2007, the Service concurred with URS' Pilot Study recommendation.

2007 Pilot Study and Ecological Risk Assessment
Based on the conclusions and recommendations of URS' Phase II ESA, WRS Infrastructure and Environmental (WRS) and URS conducted a Pilot Study in a 5 acre area immediately west of the previously sampled 1,380 acre footprint. Prior to conducting the Pilot Study, URS collected discrete soil samples in a new 50 acre grid identified as Grid 30 to confirm the presences of the previously detected contaminates immediately east of the area. The results confirmed the presences of copper and zinc; however no DDT analytes were detected above applicable standards. Following receipt of the results, WRS scraped the soils within a 5 acre area which exhibited the highest concentrations of copper to the top of the limestone and relocated the soil to a potential berm location.

Following the soil scraping and relocating activities within the 5 acre Pilot Study area, discrete soil samples were collected from the residual soils remaining on top of the limestone bedrock and in the solution cavities/depressions within the limestone bedrock. Based on the Pilot Study, WRS and Newfield's conducted laboratory simulations which involved the leaching of pesticides and metals into the sediment and surface water, and toxicity and bioassay tests, and vertical and spatial evaluation of copper impacts were conducted by URS

within the Pilot Test Area. Using the laboratory simulations, bioassay and toxicity test results as well as the vertical and spatial soil data, an Ecological Risk Assessment (ERA) was formulated for the 1,380 acres at the Frog Pond. This document was submitted by Newfield's to the Service and the FDEP on January 29, 2009.

The ERA indicated that soil scraping would effectively reduce the mass and concentration of copper in the agricultural soils, and would be adequate to effectively reduce risk to the Everglades snail kite, benthic macro invertebrates and other aquatic-feeding birds that may inhabit any habitat created by the construction of a water detention area at the site. On May 27, 2009, the Service commented on the ERA and concurred with soil scraping provided post-scraping confirmation sampling and evaluation would be conducted. The Service recommended that the soils pass leachability testing criteria if they were to be used in the construction of the beams.

2009 Additional Soil Investigations

In an effort to evaluate the site conditions, additional soil Investigations were completed in 350 acres located immediately west of the previously evaluated 1,380 acres. Within the cultivated area seven, 50 acre grids were sampled. A total of seven composite soil samples were collected throughout the proposed detention area footprint. Since most of the area was cultivated prior to 1970, the composite soil samples were analyzed for organochlorine pesticides, organophosphorous pesticides including triazine herbicides, chlorinated herbicides, paraquat, and the eight RCRA Metals: arsenic, barium, cadmium, chromium, lead, mercury, silver, and selenium. The samples were also analyzed for copper, zinc, and for total organic carbon (TOC).

Concentrations of copper, above the Service's interim value of 85 mg/kg were exceeded in composite soil samples collected in four grids. The SQAG TEC of 32 mg/kg was exceeded in the remaining three grids. Concentrations of zinc exceeded the SQAG TEC of 120 mg/kg in two grids. Concentrations of chromium exceeded the SQAG TEC of 43 mg/kg in four grids. Barium exceeded the SQAG TEC in one grid. Arsenic exceeded the SQAG TEC in one grid and the Residential SCTL in all seven grids. In addition, other contaminates such as Barium, Cadmium, Lead, and Endosulfan were detected at low concentrations below applicable guidelines.

Updated Ecological Risk Assessment

The additional soil data collected from the 350 acres were evaluated to update the ERA. The ERA concluded that the data collected from the additional grids were similar to the ERA results of the surrounding 1,380 acres as well as the residual soils after scraping in the Pilot Study area. That is, no unacceptable risk was observed for the Everglades snail kite or other Service Trustee species if soil scraping is conducted.

Based on the additional grid samples, the ERA also concluded that soil scraping may not be necessary to meet risk management goals within Grids 31, 32, and 33 since copper concentrations do not exceed the snail kite benchmark of 85 mg/kg. However, scraping is recommended for the remaining areas within the water detention area footprint.

2009 Additional Soil Investigations Recommendations and Conclusions
Based on the results of the 2006 Phase II ESA, Pilot Study, and 2009 Additional Soil Investigations, URS recommended scraping the impacted soils from within the water detention area footprint. The ERA indicated that select grids within the water detention area footprint may not require scraping, specifically Grids 31, 32, and 33. URS is currently working with WRS compass to determine that if the soils within these grids are left in place, they will not affect the operation of the water detention area. In the event that the soils can remain in place, the Service must provide concurrence on leaving the soils within the water detention area footprint.

The maximum area to be scraped is approximately 620 acres which includes Grids 30 through 36 and portions of Grids 3, 8, 9, 14, 15, 20, 21, 26, 27, 28, and 29. The estimated amount of soils that will be excavated, based on a 6-inch thickness of soils throughout the Frog Pond is 500,150 cubic yards. URS recommended that the excavated soil be used for the construction of the water detention area berms. A second option is to relocate the soils outside the footprint of the project area.

URS is currently formulating a Soil Management Plan, which details the soil scraping, relocation, and confirmation sampling. Due to concentrations of arsenic and copper which were detected in the soil above the SCTLs, the excavated soils will need to be managed and relocated to an area which will limit exposure to the general public. URS is working with WRS Compass, who is designing the water detention area, and the District on the placement of the excavated soils within the berms or in an area of the Frog Pond in such a manner that will limit exposure pathways.

C-111 Spreader Canal Components

2009 Phase I and Limited Phase II Assessment
In light of the future intended use of the subject property and the conversion of soils at the site to sediments post-inundation, soil and sediment sample results were evaluated. The evaluation was based on the Sediment Quality Assessment Guidelines (SQAGs) using the values established in the *Consensus-Based Sediment Quality Guidelines for Freshwater*, published by McDonald Environmental Service Ltd. in 2003 as adopted by the Florida Department of Environmental Protection (FDEP). Two SQAGs are applicable. The SQAG-TEC represents a Threshold Effects Concentration below which adverse effects to benthic macro invertebrates (at the bottom of the food chain) are not expected. The SQAG-PEC represents a Probable Effects Concentration above which adverse effects to benthos are considered likely.

The Phase I ESA conducted on the Study Area identified five potential environmental concerns. Two environmental concerns were identified in the Aerojet Canal area, three in the C-110 Canal area, and one previous environmental concern was identified in the L-31 East Canal area.

Aerojet Canal Area
The Aerojet Canal was identified immediately west of the former Aerojet facility and identified as a potential environmental concern due to surface water runoff and the potential of contaminates to accumulate in the canal sediments. Based on the results of the Phase I ESA, three sediment samples were collected from the Aerojet Canal and analyzed for the Priority Pollutant Full Scan parameters. The results were below applicable SCTLs or below laboratory detection limits (BDL) with the exception of arsenic that were above the Residential SCTL. No further sediment evaluations were warranted in this area.

Also within this area, 100 acres that were formerly and currently utilized for agricultural purposes and is proposed as part of an unlined Aerojet Canal Extension which will deliver water from the C-111 to the Aerojet Canal was identified as a potential environmental concern. Currently, URS is evaluating the 100 acres of former agricultural land. Preliminary results of the additional sampling indicate elevated concentrations of copper above the Service's screening value of 85 milligrams per kilogram (mg/kg). The remaining parameters analyzed are below applicable SQAGs, SCTLs or are below laboratory detection limits.

Excluding the pending soil sample results, no additional potential environmental concerns were identified within or adjacent to this area and is therefore suitable for the District's intended use.

C-110 Canal Area
In 2006, extensive soil quality evaluations were conducted in 4,186-acres of former agricultural area which was the initial proposed area of the C-111 Spreader Canal project. The soil investigations included analyzing areas of historical agriculture use for agrochemicals typically used in farming operations. An additional soil evaluation was conducted in 2007 in the former cultivated areas. Elevated detection limits for selenium above the Service's screening value of 2 mg/kg were identified in the former cultivated areas.

On August 31, 2007, the Service commented on the Limited Phase I/II report of the C-111 Spreader Canal and the Additional Soil Sampling. The Service concurred with URS' evaluations and recommendations for no further actions in the former cultivated areas; however several comments were directed to the selenium detection limits in samples collected in the area which were elevated above SQAGs. Therefore, an additional six, 50-acre grids need to be sampled east and west of the C-110 Canal to document the absence of elevated selenium concentrations in the soils.

Additionally, five areas of potential environmental concern were identified at the Everglades Youth Development Center. These five areas included an above-ground storage tank used to store diesel fuel for a diesel generator, a maintenance shop, small arms shooting range, and a wastewater treatment plant. Also many of the structures at the Everglades Youth Development Center were constructed in the late 1950s, therefore a limited pre-demolition asbestos survey of the buildings was conducted.

In the event the District acquires the Everglades Youth Development Center, additional follow up investigations and corrective actions will be required and the results submitted to the FDEP for review.

Proposed C-110 Canal Plugs
Stockpiled soil material in the northern-most proposed C-110 Canal plug locations were identified as a potential environmental concern. The C-110 Canal was excavated after farming operations had ceased in the 1960s in a former agricultural area and the excavated soils stockpiled on the west bank of the C-110 Canal. To address the potential environmental concern, two composite soil samples were collected from the stockpiled material at two plug locations within the identified former agricultural area. The soil sample analytical results were below applicable SQAGs, SCTLs or below laboratory detection limits with exception of arsenic. Arsenic was detected above the Residential SCTL but below recreational and/or passive use criteria. The stockpiled soil is acceptable for use as a plug and does not pose an unacceptable ecological risk.

Former Cultivated Areas
An additional potential environmental concern was identified north of the C-110 Canal based on the locations of the District's proposed plug locations. Historical aerial photographs in this area indicate approximately 600 acres was used for agricultural activities. When the canal is plugged the approximately 600 acres north of the canal may potentially be inundated or partially flooded throughout portions of the year.

To address the potential environmental concern, URS subdivided approximately 600-acres of land into 12, 50-acres grids per the Service's protocol and collected one composite soil sample from each 50-acre grid. The samples were analyzed for organochlorine pesticides and metal addendums, 8 RCRA metals, copper, and zinc, historically used in farming operations. Currently, URS is evaluating the 600 acres. Preliminary results of the additional sampling indicate low concentrations organochlorine pesticides and metals below applicable SQAGs, SCTLs or below laboratory detection limits.

Excluding the pending soil sample results, no additional potential environmental concerns were identified within or adjacent to this area and is therefore suitable for the District's intended use.

2.3 Flood Protection

The purposes of the canal system in South Dade County are to remove 40-percent standard project flood runoff from the effective drainage area; to reduce depth and duration of larger floods; provide water control to prevent over drainage in the area; prevent saltwater intrusion; and provide facilities to convey water to ENP when runoff is available.

The current operation of the SDCS was developed to meet legal requirements of the ESA in regard to the effects of water management operations on the endangered CSSS while balancing the other federally mandated purposes of flood control and water supply. IOP was developed to address these needs within the existing limitations of the current water management system while the necessary structural modifications associated with the C-111 and MWD projects are underway.

The project anticipates raising water levels in the Frog Pond and Aerojet areas to establish a hydrologic barrier to prevent seepage from the west, thus keeping water in Taylor Slough for

restoration purposes. Present farming activities in the Frog Pond will cease in June 2009 due to expiration of property leases from the SFWMD. Lands identified through modeling output potentially affected by increased water levels have been acquired. Monitoring of water levels will continue during the operation of the project to ensure no adverse impacts to private lands.

It is important to note that the Project Operating Manual, included in the final PIR/EIS, contains numerous safeguards including weekly operations meetings, preservation of pre-storm drawdowns, and the ability to immediately lower water control elevations in response to real time data.

2.4 Threatened and Endangered Species

The region supports a variety of wetland dependent wildlife, including several state- and federally-listed endangered and threatened wildlife species. A reduction of the wetland function and value of coastal and inland habitats within and adjacent to the C-111 Spreader Canal project study area associated with the spread of development and land conversion, is likely to result in an overall loss of fish and wildlife resources within the project area in the future. Disruption of the natural hydrology has resulted in aquatic vegetation community changes and a resultant disruption of aquatic productivity and function that has had repercussions throughout the food chain including wading birds, raptors, larger predatory fishes, reptiles (crocodiles and alligators), and mammals. These effects would likely continue given demands associated with environmental changes for the next 40 years.

Productivity of native fish species, many are important as prey species for wading birds, have been and will continue to be depressed due to water management practices and other factors previously discussed. Introduction and spread of a wide range of exotic fish species has increasingly been problematic in the project study area. The causative factors for this exotic fish problem include illegal introductions, unnatural habitat due to construction of canals and impoundments, and the establishment of vectors for travel and refugia (linear canals and deeper water) unlike the natural Everglades environment. Evaluation of the effects on occurrence and productivity of native fish species is controversial at best, but some studies report that the effect is negative and will be exacerbated in the next 40 years. Maintenance of the popular sport fishery for non-native species such as the butterfly peacock (*Cichla ocellaris*) and native largemouth bass (*Micropterus salmoides*) should remain largely unaffected in the future without the C-111 SC project.

TABLE - 2: FEDERALLY AND STATE-LISTED SPECIES

Common Name	Scientific Name	Listing Status	Principle Listing Agency
Birds			
Arctic peregrine falcon	*Falco peregrinus tundrius*	Endangered	Florida
Black skimmer	*Rynchops niger*	Special Concern	Florida
Brown pelican	*Pelecanus occidentalis*	Special Concern	Florida
Cape Sable seaside sparrow*	*Amodramus maritimus mirabilis*	Endangered	Federal
Everglades snail kite	*Rostrhamus sociabilis plumbeus*	Endangered	Federal
Least tern	*Sterna antillarum*	Threatened	Florida
Limpkin	*Aramus guarauna*	Special Concern	Florida
Little blue heron	*Egretta caerulea*	Special Concern	Florida
Piping plover	*Charadrius melodus*	Threatened	Florida
Reddish egret	*Egretta rufescens*	Special Concern	Florida
Roseate spoonbill	*Ajaja ajaja*	Special Concern	Florida
Roseate tern	*Sterna dougallii dougallii*	Threatened	Federal
Snowy egret	*Egretta thula*	Special Concern	Florida
Tricolored heron	*Egretta tricolor*	Special Concern	Florida
White-crowned pigeon	*Columba leucocephalus*	Threatened	Florida
White ibis	*Eudocimus albus*	Special Concern	Florida
Wood stork	*Mycteria americana*	Endangered	Federal
Reptiles			
American alligator	*Alligator mississippiensis*	Threatened/SA	Federal
American crocodile	*Crocodylus acutus*	Endangered	Federal
Eastern indigo snake	*Drymarchon corais couperi*	Threatened	Federal
Gopher tortoise	*Gopherus polyphemus*	Special Concern	Florida
Miami black-headed snake	*Tantilla oolitica*	Threatened	Florida
Green sea turtle	*Chelonia mydas*	Endangered	Federal
Leatherback sea turtle	*Dermochelys coriacea*	Endangered	Federal
Hawksbill sea turtle	*Eretmochelys imbricata*	Endangered	Federal
Loggerhead sea turtle	*Caretta caretta*	Threatened	Federal
Kemp's Ridley sea turtle	*Lepidochelys kempii*	Endangered	Federal
Mammals			
Everglades mink	*Mustela vison evergladensis*	Threatened	Florida
Florida mastiff bat	*Eumops glaucinus floridanus*	Endangered	Florida
Florida panther	*Puma concolor coryi*	Endangered	Federal
West Indian manatee	*Trichechus manatus*	Endangered	Federal
Fish			
Smalltooth sawfish	*Pristia pectinata*	Endangered	Federal
Mangrove rivulus	*Rivulus marmoratus*	Special Concern	Florida
Invertebrates			
Elkhorn coral	*Acropora palmata*	Endangered	Federal
Staghorn coral	*Acropora cervicornis*	Endangered	Federal
Florida tree snail	*Liguus fasciatus*	Special Concern	Florida
Schaus swallowtail butterfly	*Heraclides aristodemus ponceanus*	Endangered	Federal

*Critical habitat designated for this species
SA: Similarity of Appearance species

Urbanization, water demands, direct loss of habitat, and other demands for land, as well as degradation of existing habitat function, will likely result in a continued decline in populations of threatened, endangered, and state listed species during the next 50 years. A discussion of species of particular concern follows.

American Crocodile

Habitat loss due to development required to support a rapidly growing human population along coastal areas has been and continues to be the primary factor endangering the American crocodile (*Crocodylus acutus*) in Florida. Field and laboratory data suggest that low nest success combined with high hatchling mortality were the primary factors affecting survival. Florida and Biscayne bays are undergoing a number of changes affecting the present and future health of these ecosystems. Crocodile survival is linked to regional hydrological conditions, particularly rainfall, water levels, and salinity. Alternatives for improving water delivery into south Florida estuaries may change salinities, water levels, and availability of nesting habitat in the receiving bodies of water. The rate of mortality of hatchling crocodiles is correlated with the distance that hatchlings have to disperse to find nursery habitat. Nursery habitat is characterized by areas that are protected from wind and wave action, have a salinity range from 0 to 20 parts per thousand (ppt), abundant food, and shelter from predators. Crocodile growth rates are associated with the timing and intensity of salinity levels. American crocodiles thrive in healthy estuarine environments, and are particularly dependent on natural freshwater deliveries. Crocodiles would benefit from restoration of freshwater flow into their estuarine habitat, and harmed by diversion or restriction of flow. Quantity, timing, and distribution of flow are important. Freshwater flows would continue to be diverted to the ocean through canals which would not be beneficial to crocodiles. The American crocodile population in south Florida has increased substantially over the last 25 years and is estimated at around 500 to 1,000 individuals including hatchlings. Habitat protection has accounted for much of this increase but would be unlikely to produce a much greater population increase given potential future human encroachment, development, and land use changes.

American Alligator

The American alligator (*Alligator mississippiensis*) is a keystone species of the south Florida ecosystem. The American alligator's role as a top predator and its effect on the structuring of plant communities and associated aquatic animals (Mazzotti and Brandt, 1994) make it an ideal indicator of ecosystem health. Population growth and survival depends directly on the hydrologic functioning of south Florida watersheds. Each of these watersheds has experienced, and continues to experience, substantial degradation. Current water management practices have and will continue to result in a high and unpredictable rate of nest flooding. Historically, maximum summer water levels were positively correlated with water levels during alligator nest construction. This natural predictability has been lost. Historically, alligators were abundant in prairie habitats of the eastern floodplain, and along the edge habitats of deeper sloughs. Pre-drainage occupancy of the deep water, central sloughs was relatively low. Given the shortened hydroperiod and lowered water tables in the Everglades caused by drainage (Fennema et al., 1994; Van Lent et al., 1993; VanZee, 1999), the alligator has mostly abandoned the southern marl prairies, and today and for the foreseeable future with out project scenario, the distribution of the alligator in the southern

Everglades is shifted to sloughs, canals, and some deeper areas (Craighead, 1968; Mazzotti and Brandt, 1994).

Eastern Indigo Snake

In south Florida, the eastern indigo snake (*Drymarchon corais couperi*) is widely distributed but is not commonly found in great numbers in the wetland complexes of the Everglades. They can however be found in pine rocklands, tropical hardwood hammocks, tree islands, coastal prairies, mangroves, freshwater marshes, abandoned agricultural land and human altered habitat such as levee banks. Because of its relatively large home range, the eastern indigo snake is especially vulnerable to habitat loss, degradation, and fragmentation caused by residential and commercial construction and agriculture, and (Lawler, 1977; Moler, 1985). Habitat destruction and alteration for the present and foreseeable future will be most substantial along the coasts, in the Florida Keys, and along the high ridges of south-central Florida, where human population growth will continue to accelerate. Agricultural interests continue to destroy large expanses of suitable habitat throughout the project area. Even with continued habitat destruction and alterations, this species will probably persist in most areas if large, unfragmented pieces of suitable habitat persist. However, continued habitat fragmentation will result in isolated small groups of eastern indigo snakes that cannot ensure the continuation of viable populations.

Florida Panther

Florida panther (*Puma concolor coryi*) habitat in the C-111 SC project study area includes habitat designated as primary/dispersal zone in the Landscape Conservation Strategy for the Florida Panther in South Florida. This habitat (primary/dispersal zone) is considered to be the most important area needed to support a self-sustaining panther population. Population viability analysis projections indicate that under existing demographic and genetic conditions the panther could be extinct in 24 to 63 years (Seal et al., 1992). Environmental factors affecting the panther include: habitat loss and fragmentation, contaminants, prey availability, human-related disturbance and mortality, disease, and genetic erosion (Dunbar, 1993). Present and probable future population growth and agricultural expansion in south Florida are compromising the ability of natural habitats to support a self-sustaining panther population. The C-111 SC project study area has not been documented in recent years to be heavily used by Florida panthers compared to the current core panther population in Everglades National Park (ENP) and big Cypress National Preserve. A future without project scenario for the Florida panther for the next 50 years however would not contribute to Florida panther recovery and the Landscape Conservation Strategy for the Florida panther in South Florida.

West Indian Manatee

The major threats faced by the West Indian manatee (*Trichechus manatus*) today and continuing into the future are many fold. Collisions with watercraft in recent years account for an average of 25 percent of known manatee deaths in Florida annually. Deaths attributed to water control structures and navigational locks represent four percent of known manatee deaths. The future of the current system of warm-water refuges for manatees is uncertain as deregulation of the power industry in Florida occurs, and if minimum flows and levels are not established and maintained for the natural springs. There are also threats to habitats

caused by coastal development throughout much of the West Indian manatee's Florida range. Florida's human population is growing significantly in conjunction with intensive coastal development with the greater part occurring in the 35 coastal counties. Natural wintering sites in south Florida have been and continue to be altered by activities such as rip-rapping and bulk-heading shorelines, diverting or capping sources of warmer water, and elimination of foraging and resting areas. Demands for water for residential, industrial, and agricultural purposes from the aquifer have and will continue to diminish spring flows as will paving and water diversion projects in spring recharge areas. Nutrient loading from residential and agricultural sources is promoting the growth of algae and clouded water columns, reducing available forage in seagrass beds and refuges. There are threats from natural events such as red tide and cold events. Survival of the West Indian manatees will depend ultimately on maintaining the integrity of ecosystems and habitat sufficient to support a viable manatee population. The majority of West Indian manatee observations in the C-111 SC project study area have been in the C-111 Canal below S-197, the Card Sound Road borrow canal south of the L-31E confluence, the Turkey Point Power Plant outfall canals south of the cooling pond, and along various keys in Florida Bay and the sounds. A future without project scenario for this project will do little to change the accelerating threats faced by the West Indian manatee.

Wood Stork

The prognosis of the United States (U.S.) wood stork (*Mycteria americana*) population over the next 50 years is partially dependent on the success of the overall Comprehensive Everglades Restoration Plan (CERP). It is believed that by restoring the quantity, quality, timing, and distribution of flows in the remaining Everglades wetlands that the prey base so critical to wood storks during the breeding season would be recovered in both the estuarine and freshwater systems. No critical habitat or documented nesting colonies exists in the C-111 SC project study area. The C-111 SC project area is suitable foraging habitat for wood storks and within the maximum 18.6-mile core foraging area of documented nesting colonies outside the project area. Almost all of the freshwater marsh and estuarine areas in the project study area can be considered suitable wood stork foraging habitat. Although approximately 35 percent of the original foraging grounds were lost, the quality of much of the remaining wetlands has become and will continue to be degraded as foraging habitats, if efforts to restore the south Florida ecosystem are successful, a system with heterogeneity and inherent variability would be recreated, which should provide the prey base necessary to restore the wood stork in south Florida.

Cape Sable Seaside Sparrow

The Cape Sable Seaside Sparrow (CSSS) (*Amodramus maritimus mirabilis*) occupies short-hydroperiod mixed-marl prairies characterized by muhlenbergia grass with relatively short hydroperiods. The CSSS avoids sawgrass dominated areas with longer hydroperiods as these areas do not usually allow a suitable dry period for nesting. Conversely, the CSSS avoids areas where woody vegetation has encroached due to overdrainage. In the Taylor Slough area increased water levels due to pumping have precipitated vegetation community dominance shifts to the detriment of CSSS breeding habitat. CSSS have a high level of site fidelity, meaning that they will occupy former optimal habitat areas long after conditions become unacceptable for reproduction. If current water management that results in higher unnatural water levels continues, the CSSS faces an unnaturally high risk of extinction. The

role that fire plays in CSSS ecology is not well understood. While fire is a natural part of the everglades ecology, and can serve to reduce the density of sawgrass and woody vegetation, it can prevent vegetation from becoming too thick to allow CSSS nesting and preclude the sparrows from effectively foraging for food, as well as provide adequate cover from predators. The CSSS populations in the western portion of the C-111 SC project study area (specifically subpopulations C and D) have already declined to near record lows and will continue to decline unless the hydrologic regimes are changed to reduce the frequency of fire in subpopulation C and reduce the frequency of flooding in subpopulation D.

Everglades Snail Kite

No designated critical habitat for the Everglades snail kite (*Rostrhamus sociabilis plumbeus*) is found within the C-111 SC project study area. Wetlands in the Everglades region supporting the Everglades snail kite include Taylor Slough and the C-111 basin west of US Highway 1. The project is expected in general depending on the alternative selected and final water management regime, to have an overall benefit to Everglades snail kites by providing improved seasonal foraging habitat and recovery of native marsh vegetation and prey species. Recent population data collected appears to indicate that the Everglades snail kite population in Florida is declining. The reasons for the decline are unclear but anthropogenic activities; hydrologic management, aquatic weed control, natural climatic fluctuations, and possibly West Nile virus all could conceivably have had an effect. The principal threat to the Everglades snail kite in south Florida is the loss or degradation of wetlands for agricultural and urban development. Degradation of water quality, particularly runoff of phosphorus from agricultural and urban sources is another threat to the Everglades snail kite. The Everglades was historically an oligotrophic system, but major portions have become eutrophic. Nutrient enrichment leads to growth of dense stands of herbaceous emergent vegetation, floating vegetation (primarily water hyacinth and water lettuce) and woody vegetation, which inhibits the ability of Everglades snail kites to find food. Urbanization, water demands, direct loss of habitat, and other demands for land, as well as degradation of existing habitat function will likely result in a continued decline of the Everglades snail kites during the next 40 years.

Bald Eagle

No recent bald eagle (*Haliaeetus leucocephalus*) nesting activity has been recorded in the C-111 SC project study area. Suitable foraging habitat for bald eagles does exist throughout the project area. Preferred habitat for bald eagles consists of large, open-water bodies for foraging and suitable perch and nesting sites nearby. Creation of storage reservoirs, storm water treatment areas (STAs), and large canals could provide this open water habitat. New electrical lines associated with urbanization and any pumps installed with water control structures could present an electrocution hazard for bald eagles. In Florida overall, bald eagle nesting has increased substantially since the early 1970s; however, in the ENP, nesting has remained relatively constant during the same period. A future without project scenario in the C-111 SC project study area would offer no habitat enhancements to expand bald eagle populations in the project area and could increase electrical line hazard due to increased urbanization and associated infrastructure.

Wading Birds
Although there are fluctuations in nesting success for wading birds that are driven by climatic as well as water control related issues, in general, nest numbers and success of wading birds have decreased dramatically across south Florida over the past 100 years. These results are especially evident in data collected for wood storks and white ibis (*Eudocimus albus*). Although data is less complete and suggests regional and short-time period increases for species such as the great egret (*Casmerodius albus*), great blue heron (*Ardea herodias*), cattle egret (*Bubulcus ibis*) and little blue heron (*Egretta caerulea*). Evidence suggests that the degree to which these species populations have increased system-wide and over the longer periods of time is less convincing. A long-term scenario that does not include habitat restoration components of CERP currently being evaluated would undoubtedly result in a continued overall decline in wading bird species due to continued encroachment into habitat and anthropogenic influences on water supply.

Historically the area northeast of Florida Bay in the southwest portion of the C-111 SC project area was the most productive sub-region of the bay for roseate spoonbill (*Ajaja ajaja*) (Lorenz et al., 2002). This area has more recently been heavily impacted by water control structures and management measures that supply water to these foraging grounds (Lorenz, 2000). Nesting effort success in other active sub-regions compared to the northeastern sub-region gives increased credibility to the conclusion that the observed decline is anthropogenic in nature. Other sub-regions in roseate spoonbill nesting habitat are buffered by distance from water management practices. Unless major changes are implemented to water management practices that affect roseate spoonbill habitat and Florida Bay in general, theses areas will continue to decline in ecologic health with resultant further detrimental effects on roseate spoonbill.

CONSERVATION MEASURES
The USACE acknowledges the potential usage and occurrence of the previously discussed threatened and endangered species and/or critical habitat within the C-111 SC Western project boundaries. In recognition of this, disturbance to listed species will be minimized or avoided by limiting construction and other disturbances during critical times. In addition, pumping in the Frog Pond Infiltration Basin and/or the Aerojet Road Canal will cease if ponding at a representative site within CSSS subpopulations C or D reaches a depth of ten centimeters. This project will follow the Sea Turtle and Smalltooth Sawfish Construction Conditions dated March 23, 2006. The USACE also proposes to implement habitat management guidelines for the wood stork, construction protection measures for the American crocodile, and the standard manatee, indigo snake, and shorebird protection measures established by the State of Florida FWC, the Audubon Society, and the FWS.

CONSULTATION
The USACE has consulted with the FWS by letters dated 12 February 2004 and 17 June 2008, on federally listed threatened and endangered species that may be present in the project study area. In a letter dated 14 July 2008, the FWS agreed with the USACE's finding of listed species that may be encountered or adjacent to the project area include the American crocodile (*Crocodylus acutus*), West Indian manatee (*Trichechus manatus*), wood stork (*Mycteria americana*), Eastern indigo snake (*Drymarchon corais couperi*), the Schaus

swallowtail butterfly (*Heraclides areistodemus ponceanus*), the Florida panther (*Puma concolor coryi*), Everglade snail kite (*Rostrhamus sociablis plumbeus*), Cape Sable seaside sparrow (*Ammodramus maritimus*), roseate tern (*Sterna dougallii dougalii*), the crenulated lead-plant (*Amorpha herbacea var. crenulata*), Garber's spurge (*Chamaesyce garberii*), and tiny polygala (*Polygala smallii*). The bald eagle (*Haliaeetus leucocephalus*) has been delisted under the Endangered Species Act but continues to be protected under the Bald and Golden Eagle Protection Act and Migratory Bird Treaty Act. On 5 June 2008, project team members of the USACE met with FWS to discuss potential adverse effects to the Cape Sable seaside sparrow and determine a course of action for proper evaluation. Federally listed species under the purview of the National Marine Fisheries Service include the green sea turtle (*Chelonia mydas*), hawksbill sea turtle (*Eretmochelys imbricata*), leatherback sea turtle (*Dermochelys coriacea*), Kemp's ridley sea turtle (*Lepidochelys kempii*), and the loggerhead sea turtle (*Caretta caretta*). In addition, the project study area contains designated critical habitat for the American crocodile, Everglade snail kite, West Indian manatee, Cape Sable seaside sparrow, elkhorn coral, and staghorn coral. The project area also provides habitat for several state listed species.

State listed endangered species include the arctic peregrine falcon (*Falco peregrinus tundrius*), the Florida mastiff bat (*Eumops glaucinus floridanus*), the bracted colic root (*Aletris bracteata*), Eaton's spikemoss (*Selaginella eatonii*), Wright's flowering fern (*Anemia wrightii*), the Mexican vanilla plant (*Vanilla Mexicana*), and the Schizaea tropical fern (*Schizaea pennula*). Threatened species include the white-crowned pigeon (*Columba leucocephalus*), least tern (*Sterna antillarum*), piping plover (*Charadrius melodus*), Miami black-headed snake (*Tantilla olitica*), the Everglades mink (*Mustela vison evergladensis*), and the pine-pink orchid (*Bletia purpurea*). State-listed species of special concern include the roseate spoonbill (*Ajaia ajaia*), limpkin (*Aramus guarauna*), little blue heron (*Egretta caerulea*), reddish egret (*E. rufescens*), snowy egret (*E. thula*), tricolored heron (*E. tricolor*), white ibis (*Eudocimus albus*), brown pelican (*Pelecanus occidentalis*), black skimmer (*Rynchops niger*), mangrove rivulus (*Rivulus marmoratus*), gopher tortoise (*Gopherus polyphemus*), American alligator (*Alligator mississippiensis*), and the Florida tree snail (*Liguus fasciatus*).

PROJECT BENEFITS

The presence of a system of coastal wetlands integrated by the inflow of freshwater and to varying degrees by tidal exchange is essential to the restoration of a fully functional Florida Bay ecosystem. The proposed project components would improve freshwater delivery to coastal wetlands and adjacent estuaries. Construction of the project would redistribute flow to the salt water wetlands and nearshore bay areas which are expected to result in desirable changes to salinity. Changes in salinity may affect water quality, seagrasses, and/or marine flora and fauna in the nearshore areas, although the impacts to the aquatic resources are anticipated to be beneficial. Phase 1 of the C-111 SC project would be required to meet state water standards. Project construction activities should have limited impacts to existing vegetative communities in the project area and no effect on the nearshore communities downstream of the project area.

PROJECT BENEFITS PER FEATURE

Within the Frog Pond Detention Area, the habitat types to be affected include sawgrass dominated freshwater wetlands. Most of this area, however, consists of agricultural fields located west of the C-111 Canal, east of Levee 31 and north of Southwest 392nd Street (County Road 9336). The majority of the 5,216-acres have been used for cultivation at this site. Current and historical crops cultivated in the area include tomatoes, beans, bananas, corn, onions, cabbage, squash, and okra. Currently, approximately 1,600 acres of the 5,216 acres is being leased out to vegetable farmers. The project benefits include water quality and the restoration of historical overland flows of freshwater through the operation of a hydraulic barrier to prevent canal seepage to the east. Restoration of overland freshwater flows will occur in Taylor Slough and will enhance existing, wetland habitat for native resources including federal and/or state listed plant and animal species. The restored hydrology will also reduce hyper saline conditions in the coastal wetlands and establish appropriate estuarine conditions which will enhance the habitat value of that system for natural resources. This project is expected to have a beneficial effect on the threatened and endangered species utilizing the affected project area.

Within the the Aerojet Road Canal, the habitat types to be affected by the operation of a pump station and bermed canal include sawgrass dominated freshwater wetlands. The project benefits include the rehydration of freshwater wetlands and the restoration of historic overland flows of water through coastal wetlands. The restoration of historic, overland water flows will be accomplished by maintaining a hydrologic barrier to prevent water seepage from Taylor Slough. The restoration of historic drainage and inundation periods is expected to enhance wetland habitat for native species including federal and/or state listed plant and animal species.

Within the lower C-111 Canal, the habitat types to be affected include sawgrass with swamp forest, graminoides with mangroves and fringe mangroves. The project benefits include the restoration of historic overland water flows and rehydration of coastal wetlands by the operation of a structure designed to reduce current levels of seepage from the lower C-111 Canal, while preserving existing levels of flood damage reduction. The rehydration and restoration of coastal wetlands will occur along the south side of the lower C-111 Canal and will enhance the wildlife habitat of adjacent coastal wetlands for native species including federal and/or state listed plant and animal species.

Within the L-31E Canal, the habitat types to be affected include graminoides with mangroves, the hypersaline ecotone, and fringe mangroves. The project benefits include the restoration of coastal wetlands by the construction of a permanent plug at S-20A, and operational changes at S-20. The proposed plug near S-20A, and proposed operational changes at S-20, specifically raising the open and close triggers 0.5 feet, are intended to more closely mimic pre-drainage hydroperiods within the Model Lands. The rehydration and restoration of coastal wetlands will occur along the southeast side of the lower L-31E Canal and will enhance the wildlife habitat of adjacent coastal wetlands for native species including federal and/or state listed plant and animal species.

The project also includes backfilling and/or construction of nine earthen plugs at key locations along the C-110 Canal. The vegetation in this area consists of a mixture of sawgrass and tree islands. The project benefits of this component include the promotion of connectivity of freshwater sheet flow to mimic historic hydrological conditions within the Southern Glades. Restoration of freshwater and coastal wetlands in this area will enhance the habitat for wildlife and native plant species.

Species and critical habitat identified during informal consultation as potentially affected by the proposed project include twenty-two federally listed threatened or endangered species; along with designated critical habitat for the American crocodile, Everglade snail kite, West Indian manatee, elkhorn coral, staghorn coral, and the Cape Sable seaside sparrow.

More information on this section can be found in the Biological Assessment (BA) prepared for this project. The BA is contained in Annex A of the C-111 Spreader Canal Western Project PIR/EIS.

Based on the information contained in the Biological Assessment, the USACE/Jacksonville District has determined that implementation of the proposed project could establish hydrological changes that would alter some of the physical and biological features within designated critical habitat subpopulations C and D (Units 2 and 3) of the Cape Sable seaside sparrow, resulting in a potential adverse modification to portions of critical habitat within those areas. The overall hydrological modifications also "may affect, and is likely to adversely affect" the sub-species.

Additionally, by including the project commitments and conservation measures described in the Biological Assessment, the USACE has determined the project "may affect, but is not likely to adversely affect" the American crocodile, American alligator, West Indian manatee, Florida panther, smalltooth sawfish, wood stork, eastern indigo snake, the Schaus swallowtail butterfly, the green sea turtle, hawksbill sea turtle, leatherback sea turtle, Kemp's ridley sea turtle, the loggerhead sea turtle, the crenulated lead plant, Garber's spurge, and tiny polygala.

Other federally threatened or endangered species that are known to exist or potentially exist within close proximity of the project area, but which will not likely be of concern in this study due to the lack of suitable habitat include, Everglade snail kite, roseate tern, elkhorn coral, and staghorn coral. Potential impacts from project activities to state-listed endangered, threatened, or species of special concern will be minimal and temporary, and not likely to adversely affect any state-protected species.

Recognizing the possibility of re-initiating consultation, the USACE will continue discussions with the U.S. Fish and Wildlife Service (FWS), the National Marine Fisheries Service (NMFS), and the Florida Fish and Wildlife Conservation Commission (FWC) in the event of project design or operational modifications.

2.5 Other Natural System and Habitat Needs

The C-111 SC project study area is situated at the southern extent of the CERP study area. As such, the potential functions provided by the C-111 SC project are largely limited to managing seepage from natural areas to drained areas, and detaining/distributing volumes of water made available by upstream water management infrastructure to features of the Project. The C-111 SC project is intended result in the following:

1. Improvements in flow patterns, hydroperiods and ecological connectivity of the Southern Glades, Model Lands and adjacent natural areas.
2. Improvements in habitat, functional quality of existing natural areas and increase spatial extent where practicable.
3. Improvements in native plant and animal species abundance and diversity.
4. Sufficient water for the restoration of the natural system.
5. Elimination of ecologically damaging flows through C-111 to Barnes Sound and Florida Bay.
6. Ecologically compatible water quality consistent with restoration goals and Federal and state requirements applicable to the Southern Glades, Model Lands and Everglades National Park.
7. Recreational opportunities where available and consistent with environmental restoration goals.

Early in the process, the PDT's original formulation and evaluation strategy encountered setbacks when development of the hydrologic model (i.e., WASH-123D) anticipated to be used for multi-year simulations of each alternative was found to be notably behind schedule. At that point, a decision was made by the Project's sponsoring agencies and the PDT to use an existing model with fewer simulation capabilities (MODBRANCH) that had already been developed to conduct single-year simulations (i.e, three individual single-year simulations representative of "wet," "average," and "dry" conditions) of water management infrastructure in the study area. Because of differences in the simulation periods of record, model simulation capabilities, and model configurations, the PDT adapted its suite of performance measures to fit the framework of the newly-selected model. When the migration from WASH-123D to MODBRANCH occurred, it was recognized by the PDT that long period of record time series would not be available (from MODBRANCH) to allow for computation of event return frequencies or other indicators that rely on multi-year time-series and as such, the PDT would be required to consider the simulations in the context of other CERP-related tools (e.g., of 36-year period of simulation results of compatible South Florida Water Management Model simulations) and exercise some degree of professional judgment when evaluating long-term implications and potential return frequencies of the simulated conditions.

While the formulation process proceeded, continued refinement of the CERP and its individual project elements have yielded simulation results (as recent as November 2007) suggesting that the volumes of water ultimately to be delivered to the project study area could be different from those assumed at the outset and throughout the planning effort. Prior simulations of future-without and future-with CERP conditions exhibited no noteworthy

changes in deliveries to the study area, indicating that with or without CERP's other features, deliveries to the study area would be similar. However, recent simulations associated with the planning of the Everglades Agricultural Area A-1 reservoir and other projects indicate an increased likelihood that the volumes of water potentially delivered to/through the study area could be different (potentially larger) than formerly expected. While the significance of the C-111 SC project has repeatedly been reaffirmed by several prior and ongoing studies (e.g., C-111 South Miami-Dade Project, RECOVER's ongoing CERP refinement efforts), the volumes of water potentially available to C-111 SC management measures remain a source of uncertainty and the subject of ongoing investigations and regional planning efforts. In addition to the uncertainties associated with the timing and volumes of water to potentially be made available by upstream projects, questions remain concerning the potential effects of how increased water levels in an area of very low topographic relief might affect the stormwater routing functions of drainage canals located among upstream agricultural and developed areas.

The project's sponsoring agencies and those represented by the PDT have a strong desire to pursue restoration opportunities at the earliest possible opportunity. Therefore, the Project's sponsoring agencies decided that it would be beneficial to implement the project in two phases. The first phase consists of features that are reasonably certain to allow for improved management of water in the natural areas via reducing the drainage effects of local canals on adjacent wetlands (i.e., western management measures), and several pilot studies that are intended to address critical uncertainties that potentially affect the location, design, and operation of the spreader canal (eastern management measures) that is intended to rehydrate overdrained wetlands of the Southern Glades and Model Lands. Both phases are aligned to independently contribute to a common goal of restoring more natural hydropatterns throughout the study area to provide for more natural timing and distribution of freshwater inputs to Florida Bay.

The first phase of the C-111 SC project consists of largely of management measures in the western portion of the project study area formulated to achieve the following objectives:

Specific Project Objectives Associated with Western Management Measures

i. Improvements in flow patterns, hydroperiods and ecological connectivity of the Southern Glades, Model Lands and adjacent natural areas as quantified via:
   a. Restoration of more natural distribution and timing of freshwater inputs to Florida Bay
   b. Reductions in the influence of the C-111 canal on hydropatterns of Taylor Slough and adjacent natural areas
ii. Improvements in habitat, functional quality of existing natural areas and increase spatial extent where practicable via:
   a. Reductions in the influence of the C-111 canal on hydropatterns of Taylor Slough and adjacent natural areas
   b. Restoration of more natural salinity regime at/near Barnes Sound and Florida Bay
iii. Elimination of ecologically damaging flows through C-111 to Barnes Sound and Florida Bay via:

a. Restoration of more natural distribution and timing of freshwater inputs to Florida Bay
b. Restoration of more natural salinity regime at/near Barnes Sound and Florida Bay

Due to the refined scope of this initial phase, a sub-set of the PDT's performance measures was selected for the evaluation process. The selected performance measures intended to allow for evaluation of each alternative with respect to the objectives expressed above consist of the following:

- Flow timing and distribution
- Hydroperiods
- Stage-inferred salinities in coastal zones

Evaluation of each alternative (including the "future-without project" condition) with respect to the measures referenced above was conducted using a rainfall-driven "pre-drainage" simulation of the study area as a target condition. The pre-drainage simulation was synthesized via removing all man-made structures form the model domain to provide the PDT with a singular, physically-integrated target that illustrated how the natural landscape would have responded to rainfall during the years of simulation. The pre-drainage simulation also guaranteed that derived hydrologic surrogates for targeted ecological conditions would be compatible with and supportive of one another. For these and other reasons, the PDT elected to use a representative pre-drainage simulation to indicate where and when targeted ecological conditions would occur in a natural landscape in lieu of presupposing the nature and distribution of specified hydrologic conditions in a manner that could have resulted in a set of physically-disjointed and potentially antagonistic set of independent target conditions.

Simulated Conditions
In addition to the referenced pre-drainage condition, a future without-project condition (set in the year 2050, in the absence of all other CERP features) was synthesized to be used as a baseline against which the ecological performance of each alternative would be compared. Because initial regional hydrologic simulations indicated that the C-111 SC study area would likely receive similar deliveries of water from the regional system with or without the remaining CERP projects, the project sponsors and the PDT elected to evaluate each alternative with respect to the future without-project condition as referenced above.

For each of the performance measures, a baseline deviation from the target condition was calculated for wet, average, and dry year scenarios using the pre-drainage condition simulation results as targets, and future without-project condition simulation results as what are estimated to exist in the absence future CERP projects (inclusive of the C-111 SC project).

For every formulated project alternative, wet, average, and dry year scenarios were simulated. For each of the performance measures, a deviation from the target condition was calculated for wet, average, and dry year scenarios using the pre-drainage condition

simulation results as targets, and the project alternative results as what are estimated to exist in the future if the alternative is constructed.

Flow Timing and Distribution
The flow timing and distribution performance measure was used as a surrogate for ecological/landscape processes that are affected by water movement (e.g., nutrient redistribution, transport of suspended solids, availability of freshwater, etc.). Because the C-111 SC Western project is intended to allow for improved management of water in the natural areas via reducing the drainage effects of local canals on adjacent wetlands (i.e., Taylor Slough), the PDT was directed to focus on restoring more natural deliveries of water to central Florida Bay via Taylor Slough. In addition to central Florida Bay, Little Madeira Bay and Joe Bay, located at the mouth of Taylor Slough and adjacent to central Florida Bay, are anticipated to benefit from this first-phase objective. The impacts associated with restoring more natural flows to central Florida Bay via Taylor Slough anticipated to directly affect 98,500 acres.

Hydroperiod
The hydroperiod performance measure was used as a surrogate for ecological/landscape processes that are affected by the presence or absence of inundating water levels (e.g., vegetation tolerances to dry or ponded conditions, fire risk potential, etc.). The PDT was directed to focus on restoring more natural deliveries of water to Central Florida Bay via Taylor Slough via reducing the drainage effects of local canals on adjacent wetlands. Due in part to the relatively low degree of topographic relief within the study area, active efforts to reduce the volume of water entering the C-111 canal from adjacent wetlands, and active efforts to modify hydroperiods near Taylor Slough and adjacent natural areas, the hydroperiod performance measure was applied to the entire study area as even slight shifts in water levels can result in noteworthy changes in hydroperiods, associated changes in vegetation communities. The impacts associated with reducing the drainage effects of local canals on Taylor Slough and adjacent natural areas are anticipated to directly affect 129,000 acres.

Near-shore Salinities
The salinity performance measure was used as a surrogate for ecological/landscape processes that are affected by salinity (e.g., osmoregulation). As a result of this first phase's active efforts to decrease the volumes of fresh water drained to tide via the C-111 Canal, and associated efforts to deliver retained water to Central Florida Bay via Taylor Slough, salinities in Little Madeira Bay, Joe Bay, Long Sound, Manatee Bay, and Barnes Sound are anticipated to be affected. As such impacts associated with reducing the drainage effects of local canals on Taylor Slough and adjacent natural areas are anticipated to directly affect 27,500 acres.

Impact and Benefits to Wetlands
The C-111 SC Western project area consists primarily of mixed open land with agriculture, degraded wetlands and fallow fields. The wetlands are of low to moderate quality with limited function and value due to their reduced hydroperiod, infestation by exotic plant species, and location in the landscape (i.e., separation from other habitats and corridors).

Implementation of the C-111 SC Western project would permanently impact approximately 200.73 acres of wetlands and temporarily alter 39.98 acres of wetlands within the project footprint. The impacts to these wetlands will be a result of placement of fill material, excavation, and/or flooding.

The C-111 SC Western project features are designed to enhance or restore wetland habitat functions by distributing freshwater flows through Taylor Slough into freshwater wetlands and downstream estuaries adjoining Florida Bay to provide a more natural and historic overland flow through existing coastal wetlands. Most of the existing wetlands surrounding the project footprint have been impacted by agricultural activities, reduced hydroperiods from ditching, and exotic plant species infestation. Much of these relatively low-functioning wetlands will ultimately be restored through redistribution of freshwater flows thus allowing for an overall higher wetland functional capacity. The project benefits to the natural system, which includes freshwater wetlands; coastal wetlands; the estuarine system-consisting primarily of high value mangrove wetlands, coastal marshes, tidal flats, and the nearshore area, would be significantly greater than the localized functional wetland losses within the project footprint. Additionally, the restoration of historic surface and ground water flows and inundation periods will also enhance the wetland habitat utilized several federal and/or state listed plant and animal species.

3.0 Determination of Project Component Feasibility

Section 373.1501(5)(b), F.S. requires the SFWMD to "Determine with reasonable certainty that all project components are feasible based upon standard engineering practices and technologies and are the most efficient and cost-effective of feasible alternatives or combination of alternatives, consistent with restudy purposes, implementation of project components, and operation of the project." The following sections form the basis for this determination.

3.1 Standard Engineering Practices and Technologies & Summary of Project Features

The design objectives of the C-111 SC Western project include:

- Reduction or elimination of discharges through the S-197 structure during storm events;
- Improved hydration of the wetlands near the C-111 Canal alignment and in the eastern portion of the ENP, including Taylor Slough;
- Increased delivery of fresh water to Florida Bay via Taylor Slough.; and
- Maintenance of the current level of flood control protection provided by the C-111 Canal.

The PDT team decided in March 2008 to divide the Western project components into north and south sections with Ingraham Highway as the division boundary. The main north components include the Frog Pond Detention Area, the Header Distribution Channel, and Pump Station S-200. The main south components include Pump Station S-199, the Aerojet

Canal Extension, the plugs within the Aerojet, C-110, and L-31E Canals, and the water control structure S-198 (See Figure 3).

WRS Infrastructure & Environment, Inc. d/b/a WRScompass was selected by the SFWMD in March 2008 to complete the C-111 SC Western project design. The C-111 SC Western project components will incorporate the design details of the Preliminary Design Report (Brown and Caldwell, October 2007) with modifications. Planned design submittals include the North Intermediate Design Report, the South Preliminary Design Report, and the South Intermediate Design Report. The North and South designs will then be submitted together in the Pre-Final Design Report and Final Design Report.

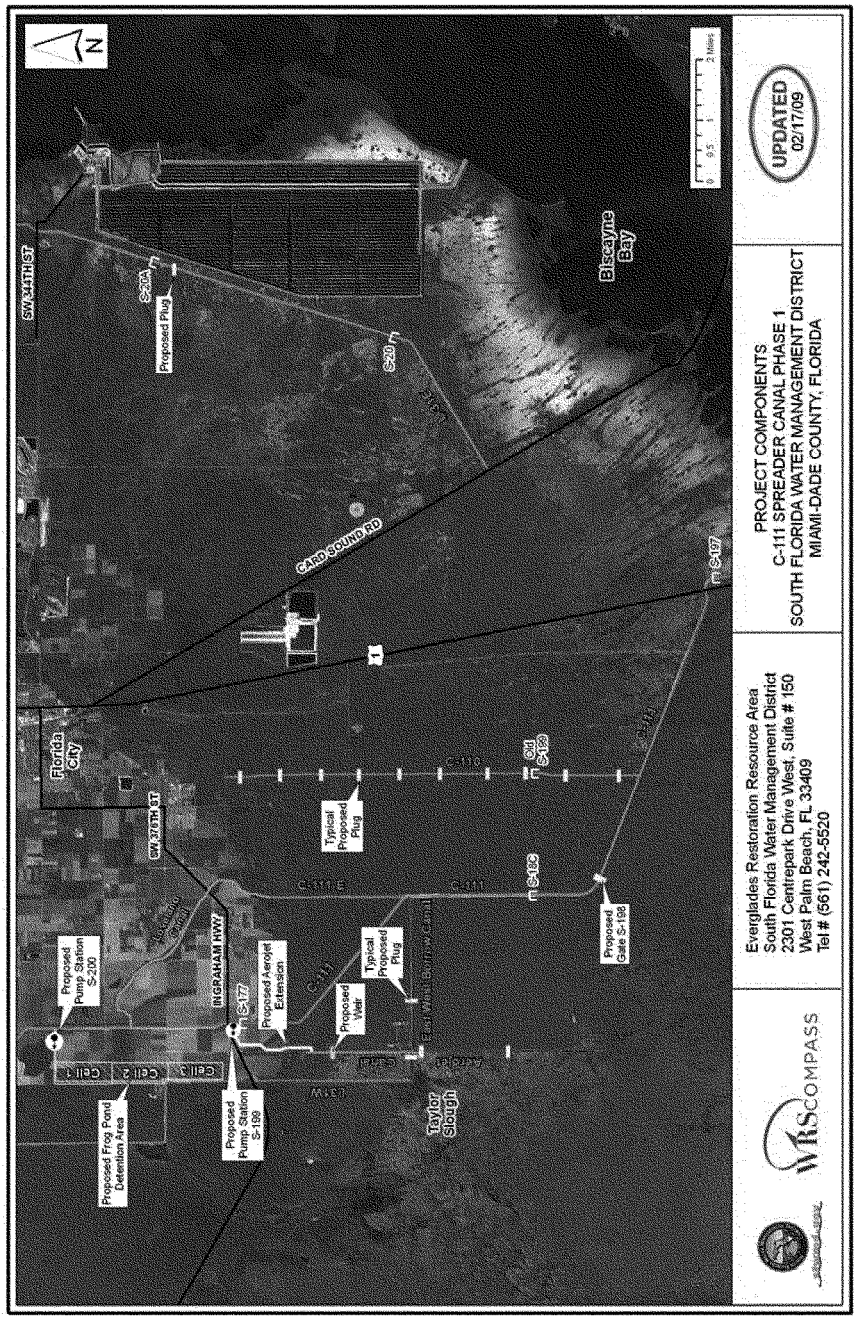


Figure 3: PROJECT COMPONENTS

Summary of Project Features
The SFWMD conducted a series of workshops during the first quarter of 2008 to increase participation from the stakeholders in the development of design refinements to The Recommended Plan. The Recommended Plan will be used to complete the design of the Western phase for this Project.

The Project features north of Ingraham Highway are currently as follows:

- Pump Station S-200 with a total capacity of 225 cfs located on the west side of the C-111 canal at the same latitude as the northern boundary of the Frog Pond Detention Area (FPDA);
- An above grade, concrete-lined, open channel to convey water from the S-200 discharge to the northwest corner of the Frog Pond Detention Area;
- The FPDA, an approximate 600-acre area located along the eastern boundary of the l-31W Canal with a perimeter levee subdivided by internal levees into three detention cells; and
- An above grade, unlined, open channel header distribution channel located along the western boundary of the FPDA with three weirs to allow water into the three cells of the detention area.

The C-111 SC Western project features south of Ingraham Highway are currently as follows:

- Pump Station S-199 with a total capacity of 225 cfs located on the west side of the C-111 Canal just south of Ingraham Highway and north of the existing S-177;
- An above ground, concrete-lined, open channel to convey water from S-199 to the proposed northern extension of Aerojet Canal;
- An above ground, unlined extension of the Aerojet Canal north and east to meet the C-111 Canal between Ingraham Highway and S-177;
- Earthen plugs and weirs in the Aerojet Canal, earthen plugs in the C-110 Canal, one earthen plug in the L-31E Canal; and
- A water control structure S-198 located on the C-111 Canal approximately 1.75 miles southeast of S-18C.

Pump Station S-200
Pump Station S-200 will be located on the west side of the C-111 Canal, north of the Ingraham Highway downstream of S-177. The purpose of this pump station is to convey water from the C-111 Canal to the Frog Pond Detention Area. The pump station will have a total capacity of 225 cfs. For operational flexibility, there will be three, 75 cfs electric motor driven axial flow submersible pumps. A diesel engine powered electric generator will provide the site with standby electricity during power outages. All of the pumps at the pump station will have the capability to be operated remotely or automatically to increase efficiency and reduce operating costs. Operation of the pumping station will be in accordance with the Project Operations Manual (POM). See **Figure 4.Figure for location.**

S-200 Conveyance Channel
The proposed S-200 conveyance channel is designed to convey water from the pump station discharge to the distribution channel within the detention area, a distance of approximately 4,500 feet. The conveyance channel will be concrete-lined and constructed above grade by removing the existing surficial soil material down to the top of limestone and constructing parallel containment levees above the limestone. The bottom and interior side slopes of the channel will be concrete lined. The bed width of the proposed channel is 20 feet with the bed elevation approximating the top of the limestone at about +3.0 feet NAVD88. The conveyance channel levees will have a 14-foot wide crest, per SFWMD design criteria, and a minimum top elevation of +9.0 feet NAVD88 as determined from wind set-up and wave run-up analyses. The levees will be constructed using a well graded mixture of silty sands and gravels excavated from identified borrow sites or other areas as designated by the SFWMD detention area (existing surficial soils). Internal and external channel side slopes will be 4H:1V. The levees will be designed to allow for vehicular traffic and will be connected to roadways around the pump station and levees around the detention area. Velocities in the channel will be maintained below 2.0 feet per second (fps) at the design pumping rate of 225 cfs. See **Figure 4.Figure for location.**

Frog Pond Detention Area (FPDA)
The FPDA is designed to meet the requirements of a Low Hazard Potential Facility. The perimeter containment levee has an elevation of +9.0 feet NAVD88. The average height above existing ground elevation is about 5.5 feet. The preliminary design has accounted for worst case conditions including the avoidance of static water surface overtopping during the 6-hour Probable Maximum Precipitation (PMP) event and during a rainfall equivalent to the 1950 Hurricane Easy event with a Soil Conservation Service (SCS) Type III temporal distribution. The levee design, including 4H:1V side slopes in most cases, provides for a large factor of safety under post-construction, maximum depth, and rapid drawdown conditions. To create three internal cells (Cell S, Cell C and Cell N) within the detention area, two intermediate levees will be constructed within the facility. The two intermediate levees will also have crest widths of 14 feet and crest elevations of +9.0 feet NAVD88, similar to the perimeter levees. Side slopes will be set at 4H:1V on all sides. Because these levees will typically be accessed from the east, turnouts will be constructed at their western terminus to allow operation and maintenance vehicles to turn around rather than having to back out. Like the perimeter levees, it is planned that the internal levees will be constructed of suitable material from on-site borrow sources or others areas as designated by the SFWMD. See **Figure 4.Figure for location.**

Frog Pond Header Distribution Channel
The water distribution channel will be constructed inside the detention area immediately east of the western perimeter levee. As currently proposed, the distribution channel extends from the northern end of Cell N to the southern end of Cell S. The distribution channel has an existing western levee which varies in elevation from approximately 7.0 to 12.0 feet NAVD88 that will be adjusted to a minimum elevation of 9.0 feet NAVD88. The eastern berm is designed with weir sections as necessary to contain design flows and divert them into the detention area cells. The distribution channel bed width has been set at an average width of 180 feet over its entire length and has two weirs adjacent to the intermediate levee

between Cell N and Cell C, and Cell C and Cell S. The crest elevation of these weirs will be 0.5' above adjacent existing ground elevations. As with the inlet channel, the water distribution channel will be constructed above grade by removing the approximate 0.5 foot of surficial soils to the top of limestone. The invert of the channel will follow the top of limestone which increases slightly in elevation from south to north. Flow passes into Cells N, C and S from the water distribution channel through 80 foot long weirs located near the midpoint of each cell berm. The weirs will be constructed with crest elevations 1.2 feet above adjacent ground elevations. The final location of the southern third of the header distribution channel could move approximately 200 ft. east of the location shown in **Figure 4**, and the overall size of the southern cell size reduced to accommodate this change, in order to provide additional buffer to Everglades National Park. See **Figure 4** for location.

Aerojet Canal Modifications

The northern limit of the existing Aerojet Canal presently lies approximately one mile south of Ingraham Highway. Although plugged at various locations, its overall length currently extends a distance of approximatley 4.6 miles. It is proposed to effectively extend the northern limit of the canal to a point approximately 2,300 feet south of State Road (SR) 9336 as an unlined above ground open channel, to construct a concrete-lined above ground channel between the northern canal extension and S-199, construct perimeter grading around all unlined portions of the canal north of the east-west borrow canal, construct a new earthern weir with crest elevation 1.0' below adjacent natural ground, and convert all existing plugs over that same length to similar weirs.

The design concept for the Aerojet Canal is to receive water from the C-111 Canal via the S-199 pump station to create a groundwater mound that will reduce eastward migration of groundwater flow away from Taylor Slough. During the dry season, the Aerojet Canal will receive flows when the C-111 Canal experiences a rise in water level to elevation 3.8 ft NAVD88. Pumping to the Aerojet Canal will be halted if the water rises in the Cape Sable seaside sparrow Subpopulation D habitat to more than 10 centimeters above existing ground elevation at the trigger cell location denoted as 1293. See **Figure 6** for locations of these features.

Pump Station S-199

Pump Station S-199 will be located on the west side of the C-111 Canal, just south of Ingraham Highway and north of the existing S-177. The purpose of this pump station is to convey water from the C-111 Canal to the Aerojet Canal. The pump station will have a total capacity of 225 cfs. For operational flexibility, there will be three 75 cfs electric motor driven pumps. A diesel engine powered electric generator will provide the site with standby electricity during power outages. All of the pumps at the pump station will have the capability to be operated remotely or automatically to increase efficiency and reduce operating costs. See **Figure 5** for location.

S-199 Conveyance Channel

The proposed S-199 conveyance channel is designed to convey water from the pump station discharge to the proposed Aerojet Canal extension, a distance of approximately 4,440 feet. The conveyance channel will be concrete-lined and constructed above grade by removing the

existing surficial soil material down to the top of limestone and constructing parallel containment levees above the limestone. The bottom and interior side slopes of the channel will be concrete lined. The bed width of the proposed channel is 20 feet with the bed elevation approximating the top of the limestone at about +2.0 feet NAVD88. The conveyance channel levees will have a 14-foot wide crest, per SFWMD design criteria, and a minimum top elevation of +8.0 feet NAVD88 as determined from wind set-up and wave run-up analyses. The levees will be constructed using a well graded mixture of silty sands and gravels excavated from identified borrow sites or other areas as designated by the SFWMD detention area (existing surficial soils). Internal and external channel side slopes will be 4H:1V. The levees will be designed to allow for vehicular traffic and will be connected to roadways around the pump station and levees. Velocities in the channel will be maintained below 2.0 feet per second (fps) at the design pumping rate of 225 cfs. See **Figure 5** for location.

Aerojet Canal Extension

The Aerojet Canal extension is designed to meet the requirements of a Low Hazard Potential Facility. The perimeter containment levee has an elevation of +8.0 feet NAVD88. The average height above existing ground elevation is about 5.5 feet. The preliminary design has accounted for worst case conditions including the avoidance of static water surface overtopping during the 6-hour Probable Maximum Precipitation (PMP) event and during a rainfall equivalent to the 1950 Hurricane Easy event with an SCS Type III temporal distribution. The levee design, including 4H:1V side slopes in most cases, provides for a large factor of safety under post-construction, maximum depth, and rapid drawdown conditions. See **Figure 5** for location.

Aerojet Canal Plugs

The weirs to be constructed (and converted from existing earthen plugs) within the Aerojet Canal are designed to attenuate the flows from pump station S-199 and maximize hydraulic heads along the length of the feature. The elevated water level will create a hydraulic ridge that will serve to slow down the flow of surface and groundwater from Taylor Slough into the C-111 Canal. The weir plugs will be 100 feet in length and match the width of the canal at the respective locations. The top elevation of the weir plugs will be set at six (6) inches below average ground elevation in the vicinity of the plug. The upstream and downstream slopes of the plugs will be 4H:1V. See **Figure 6** for location.

C-110 Canal Plugs

The C-110 Canal is located to the east of C-111E Canal and extents southward from S.W. 392nd Street to C-111 Canal, approximately 6.75 miles. The canal will be plugged at about 3,000-ft. intervals. The C-110 Canal plugs are proposed to reduce seepage from the marsh into the adjacent canal. The proposed plugs will be 100 feet in length and will match the width of the canal at the respective locations. The top elevation of the weir plugs will be set to match adjacent natural ground elevations in the vicinity of the plugs. The upstream and downstream slopes of the plugs will be 4H:1V. There are ten plugs proposed for this canal. See **Figure 7** for location.

L-31E Canal Plug
This feature will be installed just south of S-20A on the L-31E Canal. The plug will reduce conveyance and increase water level stages in and around the canal. The proposed plug in the L-31-E Canal is intended to raise the water level in the canal and the adjacent marsh. The plug will be 100 feet in length and match the width of the canal at the proposed location. The top elevation of the plug will be set to match adjacent natural grades. The upstream and downstream slopes of the plug will be 4H:1V. See **Figure 8** for location.

Control Structure S-198
S-198 will be a gated spillway control structure constructed on the C-111 Canal approximately 1.75 miles southeast of S-18C. When closed, it will help reduce seepage from the adjacent marsh. When open, it will pass flood flows with only very minimal head losses. See **Figure 3** or location.

FIGURE 4: S-200 AND FROG POND DETENTION AREA

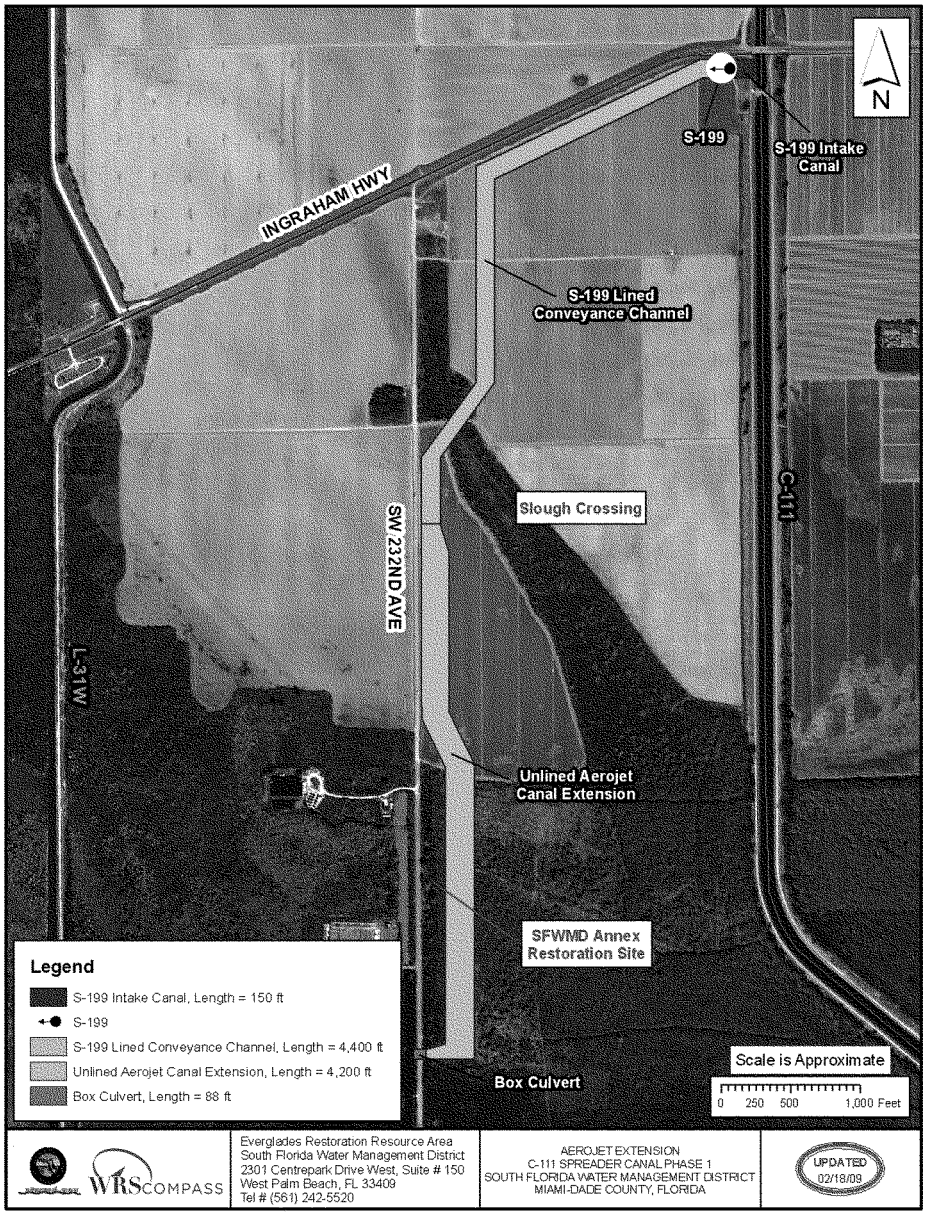
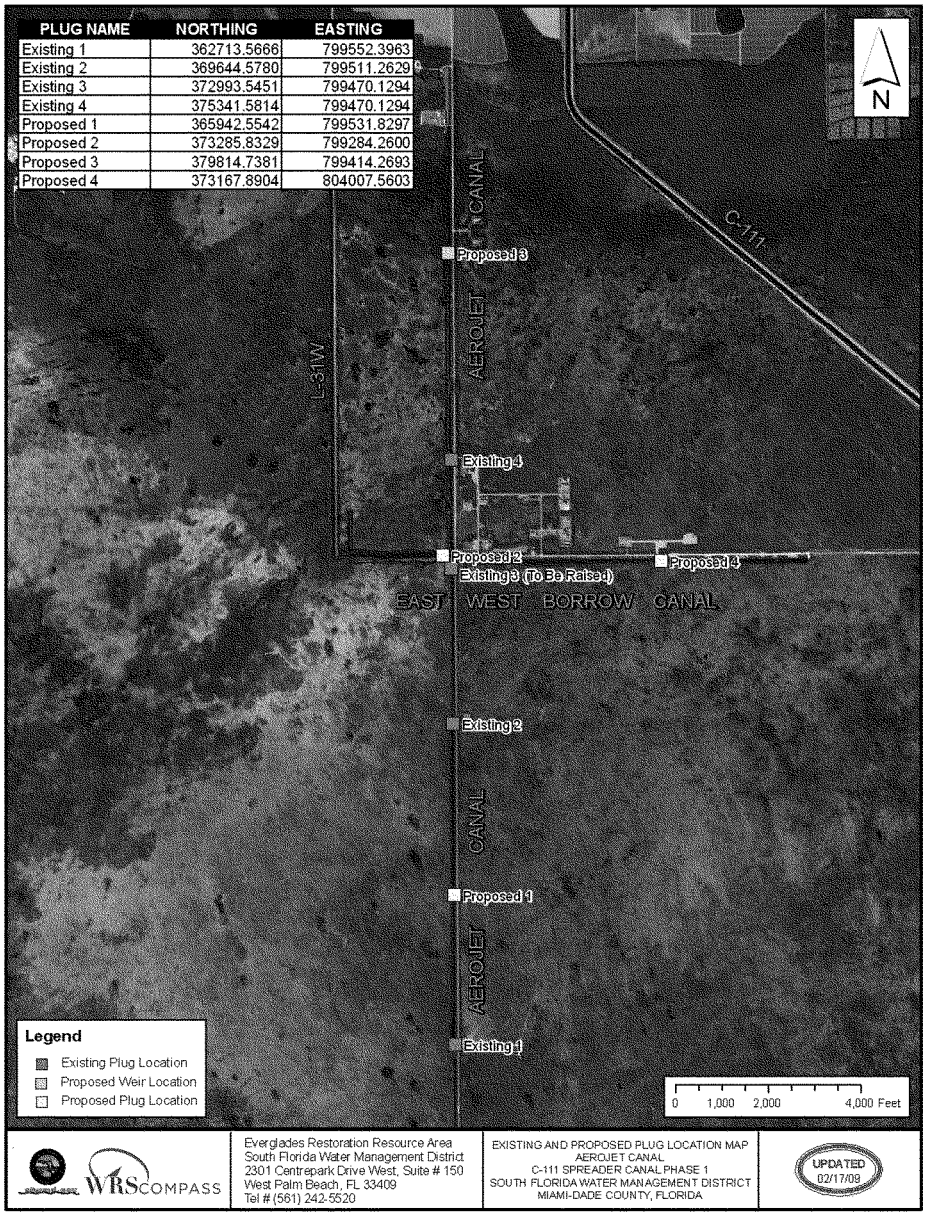
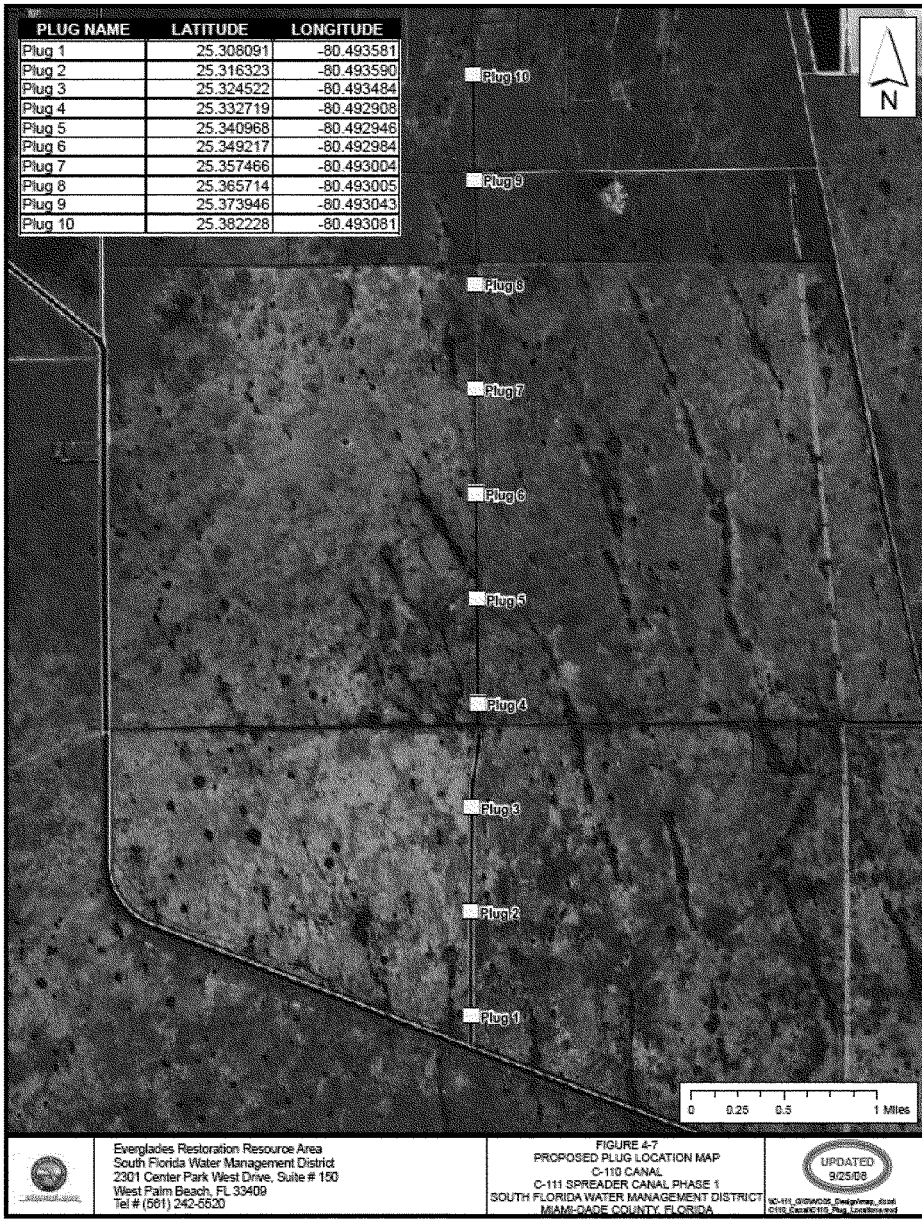


FIGURE 5: S-199 AND AEROJET CANAL EXTENSION



PLUG NAME	NORTHING	EASTING
Existing 1	362713.5666	799552.3963
Existing 2	369644.5780	799511.2629
Existing 3	372993.5451	799470.1294
Existing 4	375341.5814	799470.1294
Proposed 1	365942.5542	799531.8297
Proposed 2	373285.8329	799284.2600
Proposed 3	379814.7381	799414.2693
Proposed 4	373167.8904	804007.5603

FIGURE 6: AEROJET CANAL PLUGS



PLUG NAME	LATITUDE	LONGITUDE
Plug 1	25.308091	-80.493581
Plug 2	25.316323	-80.493590
Plug 3	25.324522	-80.493484
Plug 4	25.332719	-80.492908
Plug 5	25.340968	-80.492946
Plug 6	25.349217	-80.492984
Plug 7	25.357466	-80.493004
Plug 8	25.365714	-80.493005
Plug 9	25.373946	-80.493043
Plug 10	25.382228	-80.493081

FIGURE 7: C-110 CANAL PLUGS

FIGURE 8: L-31E CANAL PLUG

HYDROLOGIC AND HYDRAULIC MODELING FOR ALTERNATIVE ANALYSIS (MODBRANCH)

Overview and Introduction

The MODBRANCH model was used as part of the C-111 Spreader Canal (C-111 SC) Western Project study to estimate the environmental and flooding impacts of various planning conditions and alternatives. Five base conditions were used:

- Drainage (NSMMB),
- Existing Condition Base (ECB),
- Initial Operating Regime (IOR),
- Future without CERP (FwoCERP), and
- Pre-CERP Baseline (PCB1).

In addition to the base conditions, there were many preliminary configurations simulated. Analysis of these preliminary simulations resulted in a selection of six final alternatives. These were designated as Alternatives 1C, 1D, 2D Short, 2D Long, 3D, and 6D.

Model Selection and Utilization

Because of the complex interaction between the Biscayne Aquifer and various drainage canals in the study area, simulations were done using the MODBRANCH model. MODBRANCH is a hybrid code that couples MODFLOW, a three-dimensional groundwater flow model with Branch, a one-dimensional canal routing model. The model code was originally developed by the United States Geological Survey (USGS). E. D. Swain and E. J. Wexler of the USGS coupled the models. More information on the creation of MODBRANCH may be found in "A Coupled Surface-Water and Ground-Water Flow Model for Simulation of Stream-Aquifer Interaction," (Swain and Wexler, USGS Open File Report 92-138). The U.S. Army Corps of Engineers further modified the model to more accurately represent the characteristics of the South Florida area.

Figure 9 shows the model domain (blue line) superimposed on an aerial photograph of the area. Major canals are shown in red. This figure illustrates the complexity of the area. Land elevations vary from the high Atlantic Ridge to the low Everglades. Land use varies from urban to suburban to agricultural to wilderness.

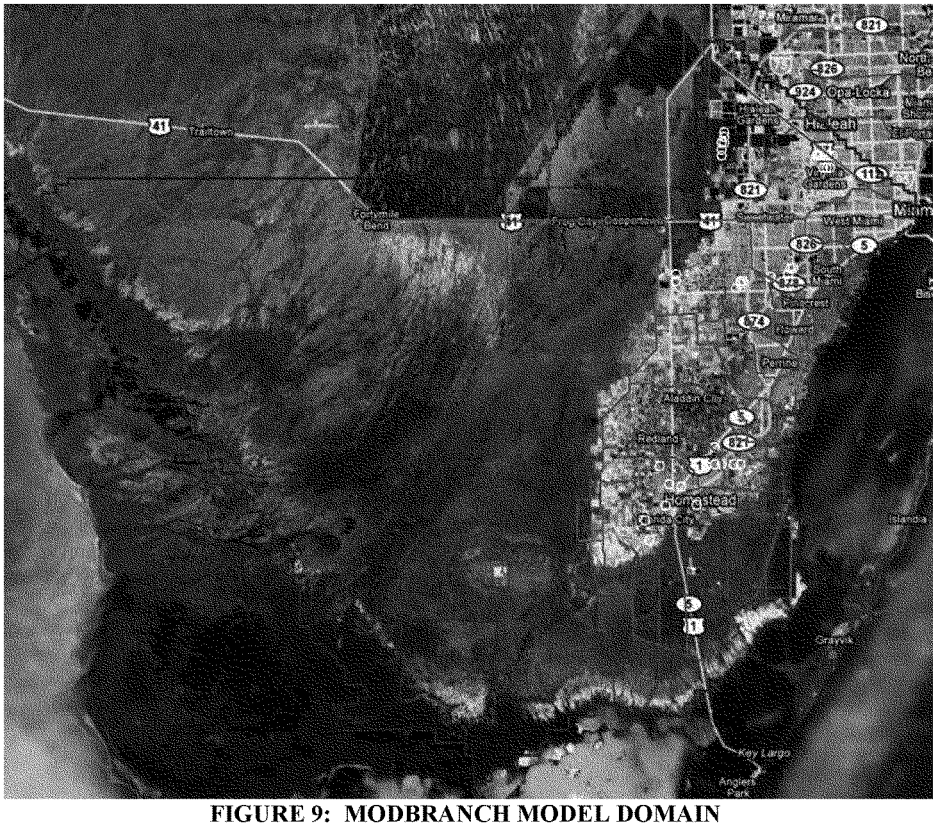


FIGURE 9: MODBRANCH MODEL DOMAIN

Both ground water and overland flow are simulated by the MODFLOW part of MODBRANCH. MODFLOW is a pseudo-three-dimensional, finite difference, ground water model. This model requires defining a model "grid" of specified numbers of rows, columns, and layers. The width of each row or column is determined by required resolution in specific areas.

The model grid is shown in Figure 10 with major canals superimposed. The model is bounded by the Biscayne Bay to the east; Florida Bay to the south; and, the Gulf of Mexico to the west. The northern boundary is roughly 2 miles north and parallel to the following canals: C-6, L-30, L-67C and L-29. The model grid is made up of 239 rows, 259 columns, and 5 layers. The grid resolution varies horizontally from a minimum of 207 feet to a maximum of 5000 feet. Levees are defined by using the horizontal flow barrier package of MODFLOW.

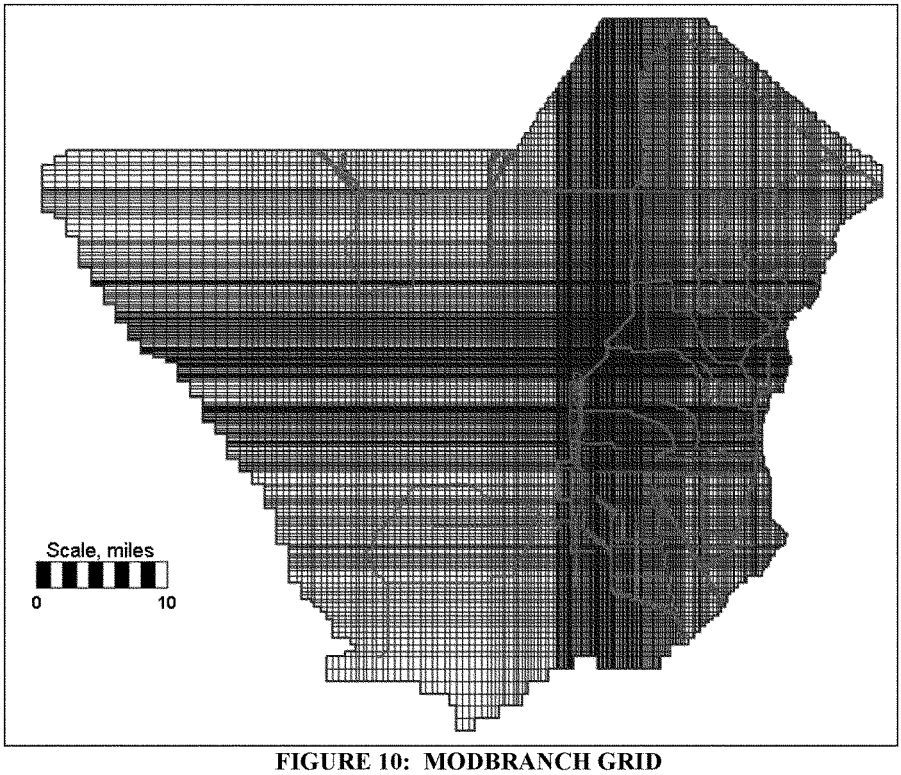


FIGURE 10: MODBRANCH GRID

The primary aquifers in the study area are the Biscayne and the Gray Limestone aquifers. The Biscayne aquifer is the dominant feature in the eastern part of the model while the Gray Limestone aquifer is the dominant feature of the west. Other hydrogeologic layers include the Gray Limestone confining unit and the surficial sediments (peat, muck, caprock, fine sand, marl, and marsh sediments).

3.2 Efficiency and Cost Effectiveness

There were nine initial alternatives that were modeled as well as the Alternative 7R and the Existing Condition Base

Alternative 1C with a spreader canal
Alternative 1D with a spreader canal
Alternative 2C with a spreader canal
Alternative 2D with a spreader canal
Alternative 3C with a spreader canal
Alternative 3D with a spreader canal
Alternative 4C with a spreader canal
Alternative 4D with a spreader canal
Alternative 6C with a spreader canal

After modeling was completed, an analysis was completed to determine the impacted lands for each of the nine initial alternatives. It was determined that a full blown analysis (comparison of existing condition to each of the alternatives – wet year, dry year, average year) would take a considerable effort and a considerable amount of time. The team working with the geographic information system specialists developed that a formula could be applied to each alternative which would show impacted lands. After the modeling data for each alternative along with the modeling data for existing condition was provided to GIS, the data was used to create maps and data information to determine what lands were impacted by each of the alternatives. The comparisons had to account for changes in hydrology that would be significant enough that land acquisition would be required. The formula ultimately used, compared each alternative in a similar fashion and did not compromise the results. The comparison accounted for both groundwater to agricultural lands and surface water impacts to other land classes.

Data was then provided by GIS that showed the percentage of each individual parcel impacted. Once this data was provided, each parcel or percentage of the parcel was reviewed to determine if only a portion (and what portion) or all of the parcel would have to be acquired. This was done for each alternative independently. Once the analysis was complete, the information was used to develop a real estate cost estimate for each of the nine initial alternatives. For SFWMD owned lands, actual acquisition costs were used. There were a few SFWMD parcels that did not have actual acquisition cost provided, but they were reviewed quickly based on information provided by SFWMD to determine the actual acquisition costs.

The amount of SFWMD owned lands in each of the alternatives produced the variance in total estimated real estate costs. If more privately owned lands had to be acquired for the alternative, the cost increased substantially.

After evaluation of these initial nine alternatives, six new alternatives were modeled and the same formula and method of analysis that was to the nine initial alternatives was use to produce the required/impacted acres and the total estimated real estate costs. None of the six

new alternatives contained a spreader canal. The PDT developed a two-phased, two PIR approach that would incorporate some of the principles of the National Academy of Science's (NAS) approach to IAR. Based on this direction a Final Array of Alternatives were developed. **Table 3** provides the acreage impacted and the estimated real estate costs of this Final Array of Alternatives.

TABLE 3: LANDS AND REAL ESTATE COSTS FOR SIX FINAL ALTERNATIVES

ALTERNATIVE	REQUIRED/IMPACTED ACRES	TOTAL ESTIMATED REAL ESTATE COST
1C No SC	864.97	$43,721,100
1D No SC	8,301.69	$53,196,080
2DShort No SC	11,564.65	$47,657,472
2D Long No SC	12,197.88	40,553,136
3D No SC	11,411.22	$44,849,470
6D No SC	5,612.73	$25,299,210

The amount of SFWMD owned lands in each of the alternatives produced the variance in total estimated real estate costs. If more privately owned lands and agricultural land had to be acquired for the alternative, the cost increased substantially.

COST EFFECTIVE/INCREMENTAL COST ANALYSIS

Cost effectiveness and incremental cost analyses (CE/ICA) reveal information about good financial investments given the dollar costs and non-dollar outputs ("benefits") of alternative investment choices for an ecosystem restoration project. This analysis is useful in lending support to identifying the National Ecosystem Restoration (NER) plan. The analyses are conducted in a series of steps that progressively identify alternatives that meet specified criteria and screen-out those that do not.

A cost effectiveness analysis is conducted to ensure that least cost alternatives are identified for various levels of environmental output. Cost effectiveness analysis begins with a comparison of the annual costs and annual outputs of alternatives to identify the least cost plan for every level of output considered. Alternative plans are compared to identify those that would produce greater levels of output at equal or lower costs than other alternatives. Next, through incremental cost analysis (ICA), the cost effective alternative plans are compared to successively identify the alternative plans with the least additional cost per additional output that is, the plans that are the most efficient in production of output. The results of these calculations and comparisons of costs and outputs between alternative plans

provide a basis for addressing the decision question "Is it worth it?" i.e., are the additional outputs worth the costs incurred to achieve them?

CE/ICA analysis compares the alternative plans' average annual costs against the appropriate average annual habitat unit estimates. The average annual outputs are calculated as the difference between with-plan and without-plan conditions over the period of analysis (through year 2050). The following sections present the average annual costs, average annual benefits and the results of cost effectiveness and incremental cost analysis for the alternative plans.

Average Annual Costs

Data for initial construction/implementation, land acquisition, monitoring, and periodically recurring costs for operation, maintenance, repair, replacement, and rehabilitation (O&MRR&R), have been developed through engineering design and cost estimation, and real estate appraisal efforts. Details of that data development are explained and discussed elsewhere in this report. The main issues requiring economic evaluation attention include equivalent time basis calculations, price levels, and timing of project spending.

For purposes of this report and analysis, NED costs, are expressed in October 2008 (FY09) price levels, and are based on costs estimated to be incurred over a 40 year period of analysis. Costs of a plan represent the value of goods and services required to implement and operate and maintain the selected alternative plan.

The following table displays the costs associated with the alternatives. The costs presented in Table 4 are preliminary rough order of magnitude (ROM) estimates and include total initial costs of construction features, real estate, Interest During Construction (IDC), and total average annual costs for each alternative. These costs were used to formulate and evaluate plans to identify the Recommended Plan. The costs for the Recommended Plan were further refined based on additional engineering and environmental evaluations. The O&M cost is an annual estimate for fully implemented components.

Construction and other initial implementation for component costs cannot simply be added to periodically recurring costs for project operation, maintenance, and monitoring. Also, construction costs incurred in a given year of the project can not simply be added to construction costs incurred in other years if meaningful and direct comparisons of the costs of the different components are to be made. A common practice of equating sums of money across time with their equivalent at an earlier single point in time is the process known as discounting. Through this mathematical process, which involves the use of an interest rate or discount rate (4 3/8% at the time of analysis), the cost time stream for the alternative plans were mathematically translated into a equivalent time basis value.

It is recognized that the plan would likely be implemented over a considerable period of time, little by little. For purposes of this evaluation, construction costs are assumed to be incurred on an equal monthly basis during the implementation of the alternative plan as defined.

Interest was computed for construction and PED costs from the middle of the month in which the expenditures were incurred until the first of the month following the estimated construction completion date. Interest during construction was computed for both real estate and construction costs. Interest during construction was computed for the total real estate cost starting from the month prior to construction commencing.

The cost of a project is the investment incurred up to the beginning of the period of analysis. The investment cost at that time is the sum of construction and other initial cost such as real estate and PED cost plus interest during construction. **Table 4** summarizes the total investment cost and total annual equivalent costs of each alternative plan.

TABLE 4: COSTS USED IN COST EFFECTIVENESS FOR PLAN SELECTION

C-111 SC INVESTMENT COST						
	Alt 1C	Alt 1D	Alt 2DS	Alt 2DL	Alt 3D	ALT 6D
Total Construction (Including PED &S/A)	$44,000,000	$47,000,000	$62,000,000	$64,000,000	$72,000,000	$252,000,000
Construction Schedule (Months)	16	16	22	22	24	36
Real Estate	$43,721,000	$53,196,000	$47,657,000	$40,553,000	$44,849,000	$25,299,000
Certification for IDC (Months)	19	19	25	25	27	39
Total First Cost	$87,721,000	$100,196,000	$109,657,000	$104,553,000	$116,849,000	$277,299,000
IDC Construction	$1,350,000	$1,450,000	$2,640,000	$2,730,000	$3,360,000	$64,628,397
IDC Real Estate	$3,240,000	$3,950,000	$4,710,000	$4,005,465	$4,800,000	$4,000,000
TOTAL INVESTMENT	$92,311,000	$105,596,000	$117,007,000	$111,288,465	$125,009,000	$345,927,397
O&M	$706,000	$953,000	$1,201,000	$1,213,000	$1,381,000	$264,000
Period of Analysis	40	40	40	40	40	40
Annualization	$5,106,000	$5,840,000	$6,470,000	$6,160,000	$6,920,000	$19,140,000
Year For First Benefits	2010	2010	2010	2010	2010	2010
Average Annual Cost	$5,812,000	$6,793,000	$7,671,000	$7,373,000	$8,301,000	$19,404,000

Ecological Evaluation

In practice, ecosystem restoration studies typically measure the ecosystem benefits of alternative plans in terms of physical dimensions (number of acres of wetlands, for example), or population counts (number of wading birds, for example), or various habitat-based scores. This study uses habitat units that represent the ecological lift achieved by each alternative. In accordance with policy, the economic analysis of environmental restoration projects does not use monetary benefits when comparing alternative plans. Rather, environmentally quantified benefits are used.

Habitat units are basically the product of acreage and a Habitat Suitability Index (HSI). The HSI is scaled from 0 to 1, with 1 being a pristine acre. The with-project and without-project habitat units are calculated and the difference between the two is known as the habitat unit lift. This habitat unit lift is the primary benefit used by economists in the CE/ICA to determine best buys and cost-effectiveness among possible alternative plans.

Average Annual Benefits

CE/ICA requires a comparison of average annual costs and average annual benefits. The average annual outputs were calculated as the difference between with-plan and without-plan conditions over the period of analysis (through year 2050). The period of analysis for benefit amortization that was utilized is 40 years. The base year, or the first year benefits begin to accrue, is in 2010. The average annual habitat unit lift is calculated as subtracting the future without project habitat units from the future with project habitat units for each year and averaging over the life of the project, which in this case is 40 years. Note that the output values shown reflect the differences between without project and with project on an average annual basis.

The analysis of ecological response times for large, diverse ecosystems is extremely difficult to calculate. For example, when analyzing an estuarine system, certain attributes would have to be examined when predicting the response to changes in salinity. Oysters may provide responses within a year of salinity change towards normal conditions. Seagrasses would normally respond quickly, but these responses are difficult to measure since there would be relocation of certain populations in response to specific currents and salinity concentrations. Small invertebrate and fish species should respond quickly; however, large vertebrate species would take longer to increase as they take longer to mature and reach reproductive ages.

The same difficulty occurs in the examination of freshwater systems. Different attributes, such as sawgrass marshes, periphyton mats, and bayheads respond differently in time to changes in hydroperiods and hydropatterns. Sawgrass marshes are in intense competition with other grasses, sedges and freshwater marsh species. Changes in the content of certain species could occur fairly rapidly in certain areas; however, the competition of populations and/or communities in others areas could take a much greater amount of time for species, populations and communities to become established. As such, the team took a linear approach to predict ecological response time for the three combined Performance Measures for both future without and future with project conditions. The ecological response time was estimated to be 10 years until full impact was realized. The average annual habitat unit lift can be seen in **Table 5** below.

TABLE 5: AVERAGE ANNUAL HABITAT UNIT LIFT FOR SELECTED ALTERNATIVES

(1) Scenario	Habitat Units (HU)	Average Annual HU Lift
Pre-Drainage/Target	**252,400**	**NA**
Future Without (2050)	**159,891**	**NA**
Alt1C	162,292	1,859
Alt1D	175,714	12,649
Alt2D	177,203	13,858
Alt3D	177,417	13,781
Alt6D	181,786	17,619

Cost Effectiveness Analysis

Cost effectiveness (CE) analysis begins with a comparison of the annual costs and annual outputs of alternatives to identify the least cost plan for every level of output considered. Alternative plans are compared to identify those that would produce greater levels of output at equal or lower costs than other alternative plans. The three criteria for cost effectiveness screening are:

1. The same output level could be produced by another plan at less cost;
2. A larger output level could be produced at the same cost; or
3. A larger output level could be produced at less cost.

The CE process involves arraying alternatives by increasing costs with their corresponding output. **Table 6** displays the final array of alternative utilized in the cost effectiveness analysis.

The lowest cost plan with positive output was identified as the first cost effective plan, in this case Alternative 1C. The next plan (Alternative 1D) was then compared against this plan. Since Alternative 1D contains greater output than Alternative 1C, this plan was also identified as cost effective. The next plan (Alternative 2DL) would then be evaluated against this plan and so on. As can be seen from this analysis the first four plans (Alternatives 1C, 1D, 2DL and 2DS) were identified as cost effective plans, but upon examination it was evident that Alternative 3D cost more than Alternative 2DS while providing less output, rendering it non-cost effective. The final plan (Alternative 6D) provides the greatest output at the greatest cost identifying it as the final cost effective plan.

TABLE 6: FINAL ARRAY OF ALTERNATIVE UTILIZED IN THE C-111 SC COST EFFECTIVENESS ANALYSIS

Alternative	Annual Cost	Annual HU Lift	Cost Effective
Alt 1C	$5,812,000	253	Yes
Alt 1D	$6,793,000	881	Yes
Alt 2DL	$7,373,000	3,556	Yes
Alt 2DS	$7,671,000	5,003	Yes
Alt 3D	$8,301,000	2,067	No
Alt 6D	$19,404,000	9,108	Yes

The following graph contains a visual depiction of the cost effectiveness analysis. The graph plots the output of each plan against the cost of each plan. The "cost effectiveness frontier" is indicated by a line passing through all cost effective plans. Any plans above and to the left of plans on the "frontier" line are non-cost effective, Alternative 3D can clearly be seen to lie above the "cost effective frontier" line.

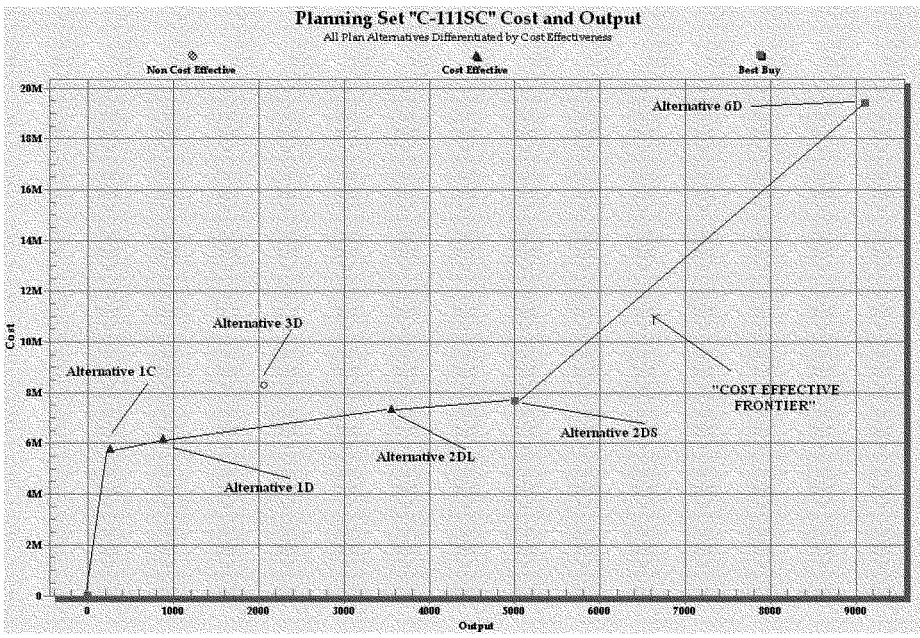


FIGURE 11: C-111 SC ALTERNATIVE PLANS–CE/ICA RUN

Incremental Cost Analysis

This section presents the results of incremental cost analysis for the C-111 SC Western project alternative plans for the optimization of the site. From the remaining cost effective alternatives, the plan with the lowest incremental costs per unit of output of all plans is the first best buy plan (Alternative 2DS). After the first best buy plan is identified, all larger cost effective plans are compared to the first best buy plan in terms of increases in (increments of)

cost and increases in (increments of) output. The alternative plan with the next lowest incremental cost per unit of output (for all cost effective plans larger than the first best buy plan) is the second best buy plan. In this case Alternative 6D is the second and final best buy plan.

TABLE 7: FINAL ARRAY OF ALTERNATIVE UTILIZED IN THE C-111 SC BEST BUY ANALYSIS

Alternative	Annual Cost	Annual HU Lift	AAC/AAHU	Cost Effective
Alt 1C	5812000	253	$22,972	Yes
Alt 1D	6793000	881	$7,711	Yes
Alt 2DL	7373000	3556	$2,073	Yes
Alt 2DS	7671000	5003	$1,533	Best Buy
Alt 6D	19404000	9108	$2,130	Best Buy

Table 8 shows these results of the incremental cost analysis. The first best buy plan, Alternative 2DS, exhibits an incremental cost of $1,533 per habitat unit, delivering a total of 5,003 average annual habitat units. The other best buy plan, Alternative 6D, delivers an additional 4,105 average annual habitat units at an incremental cost of $2,589 per habitat unit.

TABLE 8: RESULTS OF INCREMENTAL COST ANALYSIS: BEST BUY PLANS ARRAYED BY INCREASING OUTPUT BY INCREASING OUTPUT FOR COMBINED HABITAT (ALL PLANS)

Alternative	Average Annual Cost	Output	Average Cost Per Output	Incremental Average Annual Cost	Incremental Output	Incremental Cost Per Output
2DS	**$7,671,000**	**5,003**	**$1,533**	**$7,671,000**	**5,003**	**$1,533**
6D	**$19,404,000**	**9,108**	**$2,130**	**$11,733,000**	**4,105**	**$2,859**

Summary of Cost Effective/Incremental Cost Analysis

As can be seen in the following table, Alternatives 2D and 6D are both cost effective and a best buy. Alternative 1C, 1D and 2DL are cost effective, but not a best buy plan.

TABLE 9: RESULTS OF CE/ICA

Alternative 1C	Alternative 1D	Alternative 2DS	Alternative 2DL	Alternative 3D	Alternative 6D
Cost Effective	**Cost Effective**	**Cost Effective/ Best Buy**	**Cost Effective**		**Cost Effective/ Best Buy**

Alternatives 2DS and 6D are both identified as plans of interest and warrant further analysis. Alternative 2DS is recognized as the plan that is most efficient in the production of habitat units, while Alternative 6D has been identified as the next likely incremental choice.

3.3 Project Components Consistency with Restudy Purposes

In 1999, the USACE completed the C&SF Project Comprehensive Review Study (Restudy). The purpose of the Restudy was to re-examine the C&SF project to "determine the feasibility of structural or operational modifications to the project essential to the restoration of the Everglades and the south Florida ecosystem, while providing for other water related needs such as urban and agricultural water supply and flood protection in those areas served by the project." The intent of the study was to evaluate conditions within the south Florida ecosystem and make recommendations to modify the C&SF project in order to restore important functions and values of the Everglades and south Florida ecosystem and to plan for the water resources needs of the people of south Florida for the next 50 years. The selected plan (Alternative D13-R) was published in the "Final Integrated Feasibility Report and Programmatic Environmental Impact Statement (PEIS) for the C&SF Project", dated April 1999. This Study is also referred to as the "Yellow Book". The selected plan was approved under the WRDA 2000 as the CERP.

The C-111 SC project was initially, conditionally authorized under the WRDA 2000 as one of the initial set of CERP projects that would serve to "jump-start" restoration in the natural system. The primary restoration purpose for the C-111 SC project identified in the Restudy was:

> "...to improve deliveries and enhance the connectivity and sheetflow in the Model Lands and Southern Glades areas, reduce wet season flows in C-111, and decrease potential flood risk in the lower south Miami-Dade County area."

Changes Since The Restudy

Shortly after the approval of the CERP, a Project Delivery Team (PDT) was formed and began to evaluate and further formulate the plan for the C-111 SC project. As formulation proceeded, deficiencies in the potential for restoration of the project study area were identified. Specifically, the project goals and objectives that were identified in the Restudy did not completely address the entire needs of the ecosystem.

Another issue with the Yellow Book proposal was the uncertainty associated with the construction of water quality features and the spreader canal. Although preliminary modeling analyses were utilized to predict the effects of these two features, the team believed that actual operation of these features on a limited scale would be necessary to accurately predict effects. The team felt that the formulation and implementation of these features would best be developed through Incremental Adaptive Restoration (IAR). Through the use of IAR, these two project features could be optimized to produce maximum benefits while keeping project costs to a minimum by avoiding relocation or elimination of initial project features.

As envisioned within the Yellow Book, the central feature of the C-111 SC Project was to be construction of a six-mile (+/-) long spreader canal and elimination of the lower C-111 Canal. The C-111 SC's Project Delivery Team (PDT) recognized that key hydrologic and hydraulic decision critical uncertainties existed with respect to construction of the C-111 SC

Project as envisioned in the Yellow Book. As a result of these decision critical uncertainties, stakeholder concern that the yet to be completed C-111 South Dade Federal Project would not be sufficient to restore flows to Eastern Florida Bay via Taylor Slough, and recognition that the C-111 SC Project was intended to be an enhancement of the C-111 South Dade Federal Project, federal and local sponsor leadership directed the PDT to develop a two-phased, two PIR approach, based in part on the principles of the National Academy of Sciences' approach to Incremental Adaptive Restoration (IAR). Incremental Adaptive Restoration involves making investments in restoration that are significant enough to secure environmental benefits while also resolving important scientific uncertainties

Recognized as the highest priority of the two phases, the first phase of the restoration, the C-111 SC Western Project PIR features, were intended primarily to generate early benefits to Eastern Florida Bay by reducing seepage from Taylor Slough to the extent that this can be realized within the current overall Central & South Florida (C&SF) System operations.

Although the features recommended within the C-111 SC Western Project PIR are intended to increase flows to Eastern Florida Bay via Taylor Slough, the project will need to be adaptively managed in order to avoid violating constraints such as impacting the Cape Sable seaside sparrow (CSSS), reducing existing levels of flood protection, and/or causing other unacceptable impacts.

3.4 Project Components Consistency with Implementation of CERP

Although there are several environmental restoration efforts in the vicinity of the proposed C-111 SC Western project, the efforts are not expected to have any effects on the planning and design of the proposed project. The proposed project is situated at the "end" of the Everglades, where the wetland system ceases overland flow and empties into Florida Bay and its associated estuarine environments. The C-111 SC project would only receive water from other CERP projects. The proposed project would not send water to any other systems nor would any other projects rely on it for operations.

Listed within this section are brief descriptions of other key CERP projects related to the C-111 SC Western project. Also included are short statements regarding any possible effects related to the C-111 SC Western project and if available the timing for implementation of these related projects.

Modified Water Deliveries (MWD) to Everglades National Park Project

The authorized improvements for the MWD project are structural modifications and additions to the existing C&SF project required to enable water deliveries for the restoration of more natural hydrologic conditions in ENP. Together, these improvements would enable the re-establishment of the historic Shark River Slough flow-way from Water Conservation Area (WCA) 3A through WCA 3B to ENP.

Construction of new spillway structures S-355A and B and the raising of the Tigertail Indian Camp have been completed. Land acquisition is near completion for the 1992 flood mitigation levee/canal right-of-way around the 8.5 Square Mile Area (8.5 SMA).

Although the MWD project will influence the C-111 SC project, the only direct effects that will occur are possible increases in the amount of water available to the proposed C-111 SC Western project area. Additionally, water available to the C-111 SC project may be improved in quality. All features of the proposed C-111 SC project would be constructed regardless of the MWD project implementation schedule.

Biscayne Bay Coastal Wetlands (BBCW) Project in the CERP
The purpose of the BBCW project is to rehydrate wetlands and reduce point source discharge, improve water quality and provide more natural timing and quantity of water to Biscayne Bay. The proposed project would replace lost overland flow and partially compensate for the reduction in groundwater seepage by redistributing available surface water entering the area from regional canals.

The BBCW project would not affect any of the project area that is proposed for both C-111 SC project. Additionally, it has been determined that the BBCW project and C-111 SC project will not compete for water to accomplish restoration purposes. The water that will be utilized for restoration in the BBCW project is completely derived from a different drainage basin than the water that will be utilized for the C-111 SC Western project.

3.5 PROJECT COMPONENTS CONSISTENCY WITH THE OPERATION OF OTHER CERP COMPONENTS

The main purpose of the Draft Project Operating Manual (DPOM) is for day-to-day use in water management for essentially all foreseeable conditions affecting the C-111 Spreader Canal Western project. The C-111 SC Western project is part of the original C-111 SC Project. This DPOM has been designed to assist operators in maximizing flows to Central Florida Bay via Taylor Slough, and improving hydroperiods within the Model Lands, while maintaining or improving the existing Central and Southern Florida (C&SF) Project purposes (e.g. flood damage reduction). The project will be operated in accordance with the DPOM to achieve the goals, purposes, and benefits outlined in the Project Implementation Report (PIR), including the quantity, quality, timing, and distribution of water for the natural system, and other water-related needs.

As envisioned within the Yellow Book, the central feature of the C-111 SC Project was to be construction of a six-mile (approx) long spreader canal and elimination of the lower C-111 Canal. The C-111 SC Project Delivery Team (PDT) recognized that key hydrologic and hydraulic decision critical uncertainties existed with respect to construction of the C-111 SC Project as envisioned in the Yellow Book. As a result of these decision critical uncertainties, stakeholder concern that the yet to be completed C-111 South Dade Federal Project would not be sufficient to restore flows to Eastern Florida Bay via Taylor Slough, and recognition that the C-111 SC Project was intended to be an enhancement of the C-111 South Dade Federal Project, federal and local sponsor leadership directed the PDT to develop a two-phased, two PIR approach, based in part on the principles of the National Academy of Sciences' approach to Incremental Adaptive Restoration (IAR). Incremental Adaptive Restoration involves making investments in restoration that are significant enough to secure environmental benefits while also resolving important scientific uncertainties

Recognized as the highest priority of the two phases, the first phase of the restoration, the C-111 SC Western Project PIR features, were intended primarily to generate early benefits to Eastern Florida Bay by reducing seepage from Taylor Slough to the extent that this can be realized within the current overall Central & South Florida (C&SF) System operations.

Although the features recommended within the C-111 SC Western Project PIR are intended to increase flows to Eastern Florida Bay via Taylor Slough, the project will need to be adaptively managed in order to avoid violating constraints such as impacting the Cape Sable Seaside Sparrow (CSSS), reducing existing levels of flood protection, and/or causing other unacceptable impacts.

Other Project Operational Relationships

There are several projects that may affect the C-111 SC Project. This plan has been developed based on the operations of existing related projects, and/or related planned projects with approved operating plans, including both CERP and non-CERP activities. A summary of each related project and its relationship to the C-111 SC Project is provided below.

C-111 SC Eastern Project Phase

The overall C-111 SC Project will be authorized via two separate, yet related, phases. The C-111 SC Western Project is the focus of this report. The subsequent Eastern Project Phase, which will make recommendations regarding construction of a full scale spreader canal to replace the existing lower C-111 Canal, will be described in a separate future report. Although the C-111 SC Eastern project will chronologically follow the C-111 SC Western project, it is important to note that the planned operations for the C-111 SC Eastern project could precipitate changes to the C-111 SC Western project operations, or wholly supersede it.

C-111 South Dade Project

The C-111 General Reevaluation Report (GRR) recommended project modifications designed to maintain existing flood damage reduction and other C&SF Project purposes in developed areas east of the C-111 Canal while restoring more natural hydrologic conditions in the Taylor Slough, Florida Bay, and the eastern panhandle area of ENP. Structural components include the degradation of the lower four miles of the L-67 extension canal, raising of the western levee of the S-332B detention area to reduce the frequency of surface water flows from the detention cell into ENP, construction of the temporary S-332C Pump Station, construction of four new reservoirs within the C-111 Project area (S-332B north detention area, S-332C detention area, connector detention area between S-332B and S-332C detention areas, and the S-332D detention area), and construction of a temporary S-356 Pump Station to discharge from L-31N Canal into the L-29 Canal. The C-111 GRR, approved in July 1994, recommends the development of an operational plan for Shark River Slough and Taylor Slough as part of the Experimental Program. The 1994 GRR approved nine plugs in the C-110 Canal (a feature which was subsequently passed to the C-111 SC Project team) and backfill for L-31W from S-176 west all the way around to S-332. The Project Operation Manual (POM) for the C-111 South Dade Federal Project will be reviewed

and revised, as needed, to incorporate any operational changes recommended within the C-111 SC Western Project.

Modified Water Deliveries to Everglades National Park Project
When implemented, the Modified Water Deliveries (MWD) to the ENP will authorize structural improvements and additions to the existing C&SF Project which will support more natural hydrologic conditions in ENP. These improvements include the construction of several structures, modifications to existing S-334, and raising Highway US 41 (Tamiami Trail) where it crosses L-31N. While the proposed construction and modifications may impact the quantity and timing of water received in the C-111 Basin, because the C-111 SC Western Features "takes what is given", it is not anticipated that the POM for the C-111 Federal Project will need to be revised to include changes recommended within MWD.

Combined Operational Plan for the Modified Water Deliveries to the Everglades National Park and C-111
The Combined Operational Plan for the MWD ENP and C-111 Canal will establish a long-term operations plan for the C-111 Canal and MWD. The combined operational plan will specify the operations for the C-111 Canal and MWD Project components including conveyance between Water Conservation Area (WCA)-3A and 3B, seepage control on the east side of ENP, and elevated portions of Tamiami Trail between WCA-3B and ENP to restore more natural flows into ENP. Implementation of the combined operational plan could precipitate changes to the operations. However, the scope of those changes, if any, is impossible to determine at this time.

Biscayne Bay Feasibility Study
The purpose of the reconnaissance phase of the Biscayne Bay Feasibility Study is to determine if there is a need for additional water in Biscayne Bay (over and above the amount anticipated from CERP), define the federal interest in providing additional water to those areas, and identify a non-federal interest to participate in a cost-shared feasibility study to determine the adverse and beneficial environmental, social, and economic impacts of providing additional water to Biscayne Bay. The study area provides a boundary to the C-111 SC Basin.

Biscayne Bay Coastal Wetlands Project
The Biscayne Bay Coastal Wetlands (BBCW) CERP Project is intended to rehydrate wetlands and reduce point source discharge, improve water quality and provide more natural timing and quantity of water to Biscayne Bay. The proposed project will replace lost overland flow and partially compensate for reduction in groundwater seepage by redistributing, through a spreader system, available surface water entering the area from regional canals. The project includes pump stations, spreader swales, STAs, flow ways, levees, culverts, and backfilling canals. The southern limit of the BBCW Project conceptual footprint reaches very close to the eastern limit of the C-111 SC Project. The project should compliment the C-111 SC Project by adding water to the wetlands in the northern area of the Model Land, however, it is premature to determine if the BBCW CERP Project would precipitate changes to the operations proposed for the C-111 SC Western Project.

Florida Bay and Florida Keys Feasibility Study
The Florida Bay and Florida Keys (FB&FK) Feasibility Study was intended to take a comprehensive look at the FB&FK marine environments, and the actions and land uses upstream, to determine the modifications that are needed to successfully restore water quality and ecological conditions of Biscayne Bay. The reconnaissance phase of this project was followed by the Biscayne Bay Feasibility Study, Phase 1, for which Miami-Dade County was the local sponsor. Biscayne Bay Feasibility Study, Phase 1 provided only for the development of a hydrodynamic tool that could address the questions raised in the Reconnaissance Study. Phase 2, a concept to couple a water quality modeling tool to the existing hydrodynamic model, has been placed on indefinite hold because the technology is not yet available to provide effective coupling between the Phase 1 model and available water quality modeling tools. It is pre-mature to determine if the FB&FK Feasibility Study would precipitate changes to the operations proposed for the C-111 SC Western project.

West Dade Wastewater Reuse Technology Feasibility Study
Miami-Dade County Water and Sewer Department (MDWSD) is sponsoring the study of constructing a new 100–150 million gallons per day (MGD) regional wastewater facility in western Dade County that can treat and reuse reclaimed water from municipal sources. While most changes should be complementary, any unanticipated adverse impacts could precipitate changes to the operations proposed for the C-111 SC Western project.

4.0 Determination of Project Consistency with Applicable Laws and Regulations

Section 373.1501(5) (c), F.S. requires the SFWMD to "determine with reasonable certainty that all project components are consistent with applicable laws and regulations, and can be permitted and operated. For purposes of such determination:

1. The District shall convene a pre-application conference with all state and federal agencies with applicable regulatory jurisdiction;
2. State agencies with applicable regulatory jurisdiction shall participate in the pre-application conference and provide information necessary for the District's determination; and
3. The District shall request that federal agencies with applicable regulatory jurisdiction participate in the pre-application conference and provide information necessary for the District's determination."

The following subsections form the basis for this determination. The reader is directed to Annex B (NEPA Information) of the C-111 Spreader Canal Western Project Final Integrated PIR/EIS, to view a complete listing of all of the local, state and federal comments and concerns with their responses. These are captured in the "Comment Response Matrix" within the Annex B.

Based upon these interagency discussions at the federal, state, and local levels, the SFWMD has determined with reasonable certainty that this project is consistent with applicable laws and regulations and can be permitted and operated as proposed.

4.1 Pre-application Conference

A pre-application conference was held on November 14, 2008, at the SFWMD Miami-Dade Regional Service Center, in Miami, Florida. Federal, state, and local regulatory agencies representatives attended. The following agencies were present:

- U. S. Army Corps of Engineers
- Florida Department of Environmental Protection
- Florida Fish and Wildlife Conservation Commission
- Miami-Dade County, Department of Environmental Resource Management
- South Florida Water Management District

SFWMD staff presented an overview of the C-111 Spreader Canal Western project. Questions were raised and answered during this portion of the conference. At the end of the conference, there was a general indication that there was reasonable certainty that the project could be permitted. The District stated that continued coordination during the detailed designs would be requested. The official summary of the 1501 Pre-application is included and follows this portion of the report.

C-111 Spreader Canal Project Phase 1
1501 Pre-Application Meeting

Meeting Summary/Minutes
SFWMD Miami-Dade Regional Service Center
Friday, November 14, 2008

Time: 10:00 to 12:00 pm

Attendees:

SFWMD	Jorge Jaramillo, Nirmala Jeyakumar, John Shaffer, Nester Yglesias, Raymond Sciortino
USACE	Kimberly Taplin, Alisa Zarbo
FDEP	Tracy Robb, Erin Steurer, Annet Forkink, Inger Hansen, Kathleen Greenwood
Miami-Dade DERM	Matt Davis
FWC	Dan Castillo

A pre-application meeting was held for the C-111 Spreader Canal Project-Phase 1, in accordance with Florida Statutes 373.1501 (5)(c)(a), on November 14, 2008, at the SFWMD Miami-Dade Regional Service Center, in Miami, Florida.

I. Introductions
Mr. Jaramillo, Project Manager welcomed the attendees to the pre-application meeting. The attendees introduced themselves and the agencies they represented.

II. Overview

A. Chapter 373.1501 Florida Statute Requirements
Ms. Jeyakumar gave a brief description of the Chapter 373.1501 Florida Statute Requirements.

B. Project Components and Feasibility
Mr. Jaramillo presented the project features, feasibility and schedule using a Powerpoint presentation. The project objectives, schedule and components were discussed in detail with interaction from various agency staff during the meeting.

C-111 Spreader Canal Phase 1 – Project Description:

The project objectives, described in the meeting, include:

8. Improve the quantity, timing, and distribution of water delivered to Florida Bay via Taylor Slough
9. Improve hydroperiods and hydropatterns in the Southern Glades and Model Lands
10. Reduce ecologically damaging flows to Florida Bay and other receiving waters

These objectives will be accomplished by implementing the following project features:

1.0 Frog Pond Detention Area and Pump Station No.1
A 200 CFS (or 225 CFS) pump station, designated Pump Station No.1, will route excess water from C-111, which would otherwise be discharged down the lower C-111 via S-177, to a 516 acre above ground impoundment, designated the Frog Pond Detention Area (FPDA), located within the southern portion of the SFWMD owned Frog Pond Lands. This impoundment will create a hydraulic seepage barrier between Taylor Slough and C-111 which will reduce the amount of groundwater that Taylor Slough currently loses to C-111 due

to seepage. The impoundment will have an above ground cascading header channel which will stage up approximately 2' above existing ground before "feeding" the three cells which will make up the detention area. Weirs will be constructed between the header channel and receiving cell to ensure that the header stage meaningfully rises prior to discharging to the detention area cells. A series of cascading weirs will also be constructed within the header channel to ensure that potentiometric heads are maximized along the length of the channel. The header channel will be fed by a lined conveyance channel located along the northern limits of the detention area. The pump station will consist of four 50 CFS pumps (alternatively three 75 CFS pumps) to allow stepped operations. In order to prevent overflowing, pumping will be discontinued if the elevation of the header channel exceeds a pre-determined stage above the existing ground. Pumping will also cease if ponding within Cape Sable Seaside Sparrow (CSSS) Sub-population C reaches a depth of 10 cm, as measured at a pre-determined representative location.

2.0 Aerojet Canal Impoundment and Pump Station No. 2
A second 200 CFS (or 225 CFS) pump station, designated Pump Station No.2, will mirror the operations of Pump Station No.1 and route excess water from C-111 to the Aerojet Canal via a northerly extension of the Aerojet Canal. Similar to the FPDA header channel, a series of cascading weirs will be constructed in the Aerojet Canal to ensure that potentiometric heads are maximized along the length of the canal. Similar to Pump Station No.1, Pump Station No.2 pumping will be discontinued if the elevation of the canal exceeds a pre-determined stage above existing ground. Pumping will also cease if ponding within Cape Sable Seaside Sparrow (CSSS) Sub-population D reaches a depth of 10 cm, as measured at a pre-determined representative location.

3.0 C-111 Water Control Structure (S-197B)
An operable "S-197 like" structure will be constructed within the lower C-111, at a location between S-18C and the theoretical confluence of C-111 and C-110. The proposed structure is intended to reduce current levels of seepage into the lower C-111, while preserving existing levels of flood damage reduction.

4.0 L-31E Canal Changes
This feature includes an earthen plug constructed within the L-31E Canal just downstream of S-20A, and operational changes at S-20. The purpose of the plug and operational changes at S-20, specifically raising the open and close triggers 0.5 feet, is to cause hydroperiods within the Model Lands to more closely mimic pre-drainage conditions.

5.0 C-110 Canal Changes
Earthen plugs will be constructed throughout the C-110 Canal in order to maximize water levels in and around the canal.

The current schedule for the project is:

- September 2008 – Completed Preliminary Design
- March 2009 – 1501 Report Finalized for Approval
- May 2009 – Complete Final Design
- Fall 2009 – Initiate Construction
- Summer 2011 – Finish Construction & Begin Operations

Mr. Shaffer stated that a draft project operations manual will be available in March 2009 as part of the Project Implementation Report (PIR) currently being prepared by USACE and SFWMD for phase one of the C-111 Spreader Canal project.

Mr. Shaffer stated that a second PIR will be prepared for phase two of the C-111 Spreader Canal project. The second PIR will include lessons learned from the phase one project.

Mr. Jaramillo stated that Pump Station No.1 and Pump Station No.2, which are located along the west side of C-111 between S-176 and S-177, are not designed to provide flood protection but rather environmental restoration.

Ms. Hansen expressed concern about impacts to high quality native vegetation along the Aerojet Canal by constructing berms along the canal.

Mr. Shaffer explained that the function of the S-197B control structure is two-fold. The first function, typically during the dry season, will be to elevate water levels in the C-111 between S-18C and S-197B by keeping its gates closed. This will reduce the amount of seepage to the canal from nearby wetland areas. The second function, typically during the wet season, will be to lower water levels in the canal between S-18C and S-197B, when necessary for flood protection, by periodically opening its gates.

In addition, S-197B will be designed to have the same outflow capacity as S-197 in order to maintain the current level of flood protection provided by the C-111 drainage system. Mr. Shaffer explained that before deciding to build S-197B, the District plans to incrementally increase the trigger elevations of S-18C by 0.1 feet annually for several years to determine if the same environmental benefits can be achieved while maintaining adequate flood protection without building S-197B.

Ms. Hansen expressed concern about the agricultural community not agreeing with the District's plan to incrementally raise trigger elevations at S-18C. Ms. Hansen requested a copy of this proposed plan. District staff reassured Ms. Hansen that the agricultural community will be kept informed of the details of this plan.

Ms. Hansen stated that the design of S-197B needs to be coordinated with the Fish and Wildlife Service in order to provide safety measures for manatees. District staff agreed to coordinate the design of S-197B with the Fish and Wildlife Service.

III. Project Compliance with State Law

A. Analysis & Evaluation of Water Resource Issues
Mr. Shaffer explained the level of analysis performed for water resource issues related to the project, including water supply, water quality, flood protection and threatened and endangered species.

Mr. Shaffer explained that the draft biological assessment has been written, and that particular attention was given to the Cape Sable Seaside Sparrow by defining safe seasonal water levels for their habitat.

B. Reasonable Assurances
Mr. Shaffer explained how the project will satisfy the reasonable assurances criteria, including no impacts to existing legal users, no impacts to existing level of service for flood protection and meeting adaptation needs of the restored natural environment. Mr. Shaffer stated that the savings clause document is still in the early stages of development.

IV. Coordination with Existing Utilities and Public Infrastructure
Mr. Jaramillo mentioned that coordination with existing utilities, such as Florida Power and Light Company, will be performed by the District through Susan Coughanour.

V. Agency Discussion
Ms. Jeyakumar stated that wetland impacts will be quantified in both the 404 and1502 permit applications. Mr. Davis from Miami-Dade DERM requested that the District use a Class IV permit application for the project. This permit application would also need to include the delineation of wetland areas within the project footprint when submitted.

Mr. Castillo asked what the impact of the Aerojet Canal extension would be on the use of the adjacent agricultural lands currently leased for dove hunting. Mr. Jaramillo responded by saying that the SFWMD Land Management Department will coordinate this issue with FWC.

Ms. Zarbo stated the need to do a site visit to look at the existing vegetation and delineate the locations of wetlands within the project area. Ms. Zarbo requested that the 404 permit application be submitted to her as soon as possible in order to approve the permit by June 2009. The District staff agreed to do so.

Attendees discussed how the design plans were still in development and that they would be submitted with the 1502 permit application even though the final location of some of the project features, especially in the vicinity of the Aerojet Canal, had not been finalized.

ACTION ITEMS

- Preparation of meeting minutes to be distributed to all the agencies who attended and give them the opportunity to review and make comments with regards to the accuracy of the minutes.

- Agencies to provide feedback if in agreement to the meeting minutes and/or provide additional comments via email to Alex Perez.

Adjourn
The meeting ended at approximately 12:00 pm and was followed by a site visit to look at the project features.

Site Visit to Aerojet Canal and Frog Pond Area:
After the pre-application meeting the attendees visited the Aerojet Canal and Frog Pond Area project sites together.

FDEP representatives suggested exploring the possibility of constructing the Aerojet project feature in phases starting from the north and continuing south.

FDEP representatives suggested exploring the possibility of relocating berms required along the eastern canal bank to the edge of Aerojet Road, and minimizing berm construction impacts west of the canal in order to preserve relatively high quality wetland vegetation adjacent to portions of the Aerojet Canal.

The agency staff had a good discussion during the site visit it was decided to hold a separate meeting in the near future to delineate wetlands and look at project impacts.

4.2 State Agency Information

The **Florida Department of Environmental Protection (FDEP)** has participated actively in the planning and evaluation process directed by the SFWMD and USACE, leading to the development of the project. FDEP will also continue to assign agency staff to work with the SFWMD and the interagency teams working on ongoing and future detailed planning efforts. Furthermore, to effectively fulfill their responsibilities under the approval process created in Section 373.026(8) F.S., and the criteria for approval listed in Section 373.1501(5) F.S., FDEP is continuing to participate with the SFWMD staff in the coordination and the preparation of information to be submitted to FDEP for review and approval. FDEP has committed to working with the SFWMD and USACE to issue permits in a timely manner.

Achieving water quality standards will be an underlying consideration of the FDEP during the permitting of these project components. FDEP has and will continue to work with the SFWMD and USACE to ensure that surface water discharges and ground water recharge from these components will meet water quality standards and water quality objectives. This position is consistent with both the intent and language of the CERP and the Comprehensive Restoration Plan Regulation Act (CERPRA) permitting legislation (Section 373.1502, F.S.)

The **Florida Fish and Wildlife Conservation Commission (FWCC)** have two areas of regulatory function in the permitting process. The first is when construction activities trigger regulations that the FWCC has developed and enforced under Chapter 39 of the Florida Administrative Code (FAC). These regulations protect species that the FWCC has designated as endangered, threatened, or of special concern. These rules protect individuals of listed species, their active nests, their eggs, and their young. The rules would only impact the project efforts if the construction or operation activities directly killed or harmed a listed animal or fish, or if the species were disturbed from their nests such that juveniles were killed.

The second area of permit involvement is an indirect role of commenting when solicited via rules of other agencies that are issuing permits or approvals for projects that have the potential to affect fish and wildlife habitat. SFWMD staff will continue to coordinate with the FWCC to develop satisfactory wildlife-survey methodologies to identify the extent to which listed species may be affected by the individual projects, and if necessary, propose actions to avoid "taking" an individual of a state listed species.

Multiple meetings have been held with the **Florida Dept of Transportation (FDOT).** The majority of these meetings were related to coordinating the US Hwy 1 widening. FDOT's principal concern was the protection of the roadway sub-grade from increased water table elevations. This concern was largely alleviated by FDOT and SFWMD entering into a Joint Participation Agreement (JPA) to install asphaltic base in the sub-grade which will support the higher anticipated water table elevations.

The **Florida Dept of Agriculture and Consumer Services (FDACS)** have also actively participated throughout the planning process. Their main concerns have largely been associated with the potential of flooding, specifically, that a rise in groundwater elevations could result in root zone flooding that will be detrimental to crops.

These concerns will be addressed by stage override triggers that will be established immediately downstream of S-177 and/or in the adjacent farm fields to establish a "backstop" at which S-18C triggers will return to their highest "successful" increment. More detailed explanation of this can be found in the C-111 Spreader Canal Western Project PIR/EIS, Annex E (Project Monitoring Plan), Hydrometeorological Monitoring. This monitoring plan (cost estimated at $ 1.5 Million dollars) will be utilized to monitor project effects, and provide the feedback needed to avoid the negative consequences which would accompany adverse increases in groundwater elevations.

Also discussed in the Project Monitoring Plan, the plan includes provisions for pre-storm drawdown of the C-111 Canal system which is an essential part of flood damage reduction, and this plan makes no attempt to change those operations. The addition of the 450 cfs of (total) installed capacity at S-200 and S-199 may be utilized as needed to assist in pre-storm drawdown. The pre-storm operations for new structure S-198 will match those of S-197.

In anticipation of heavy rainfall based on National Weather Service Advisories and SFWMD forecasts, the L-31W, C-111 and C-111E canals will be drawn down as much as is currently practiced in order to allow for the maximum amount of canal and groundwater storage. Operations during hurricanes or tropical storms will continue to follow the SFWMD's *Emergency Preparedness Manual – Suggested Hurricane Operating Procedures.*

Two new well sites are proposed for installation within the agricultural area between the S-177 and S-178 structures to specifically monitor ground water changes in relation to adaptive water management practices at S-18C. This farming area is unique in its geographic location at the foot of the coastal bench and is considerably lower in land elevation than surrounding farm areas just to the north. Changes in the water table can impact local root crops causing reductions in crop yields or complete loss of crops. Real time monitoring sensors will be installed to measure these changes in ground water levels and uplink the data into the SFWMD telemetry system or provide direct communications through a cellular link. This will provide operations staff in West Palm Beach the ability to directly evaluate ground water changes in response to local rain events and current water management operations.

Ground water level measurements for new agricultural sites will be outfitted with pressure transducers and data loggers to record changes in water level fluctuation at roughly 30 minute intervals. Approximately 8 inch diameter wells will be installed at least 8.0 feet below the existing ground surface and screened at 24 inch intervals to measures the full range of anticipated ground water fluctuations within the agricultural fields.

There is concern on how the planned rise in water elevation in the local canals (due to change in operation of S-18C) will influence the usability of adjacent land for agricultural purposes. Currently, agriculture located in the adjacent land is primarily composed of vegetable and ornamental nursery crops. Vegetables are predominantly grown during the dry season while

ornamental nursery crops are produced year round. Nursery crops may be containerized or may be planted in the field. Additional testing of the soil properties will be conducted within the agricultural lands above to monitor flooding risk and develop criteria relating operations to soil conditions that may provide an early signal to modify operations and lower the impacts of higher ground water stages.

Soil water retention curves for each of three local soil types will be determined to increase understanding their soil water holding capacity and drainage characteristics. The soil water retention curve provides a relationship between the soil suction or tension and the soil water volumetric content. The soil water retention curve is developed in the laboratory. This relationship is used to understand soil water dynamics in the field, where real-time soil moisture data at specific sites is collected using soil moisture sensors. A series of 6 soil moisture sensors (2 in each of the three representative soil types) will be installed and monitored by the University of Florida Institute of Food and Agricultural Sciences (IFAS) within the local agricultural fields at predetermined sites (sites will be determined based on distribution of the target soils obtained during field recon).

The soil moisture data collected will be correlated with measured groundwater level using hydrostatic assumptions and groundwater level data. The development of these hydrologic relationships depends on the collection and evaluation of quality, geo-referenced soil moisture, groundwater level, and canal stage data. All wells will be installed with continuous data loggers and data downloaded on a routine basis by the IFAS staff.

After the initial first year of field monitoring, the IFAS staff will provide an assessment relating the soil characteristics correlated to water management operations and recommend criteria for operational adjustments to protect crops from high ground water stages. Monitoring will continue into the first year of increased stage control at S-18C to evaluate, verify, and revise the protection criteria, if needed.

Borehole groundwater flowmeters will also be installed at two locations near the Aerojet Canal to record ground water flow velocities and directions induced by the project operations. These wells will provide direct physical evidence of the change in ground water flow direction and velocity induced as a result of pumping into the Aerojet Canal. It is expected that groundwater seepage from Taylor Slough will be reduced by the counterbalance of a higher groundwater head on the Aerojet Canal, resulting in a net increase in water flow down Taylor Slough compared to the existing conditions.

Flowmeter wells will be screened at approximately 24 inch intervals and installed to a depth of roughly 25 feet to monitor the near surface ground water flow. To aid in the interpretation of the data derived from these borehole flowmeters, a physical video log will be recorded for each of the installed wells and a flow velocity measured for each strata/zone identified in the well . This will identify any preferential flow spaces within the shallow geology of the well that would influence ground water flow velocities. Monitoring sensors for continuous measurement of ground water flow will be positioned in the well to represent the dominant geological characteristics influencing flow.

4.3 Federal Agency Information

The following federal agencies are members of the project development team (PDT):

- U.S. Fish and Wildlife Service
- National Marine Fisheries Service
- U.S. Environmental Protection Agency
- Department of Interior/National Park Service

These agencies are considered to be partners in Comprehensive Everglades Restoration Plan (CERP) projects. The following will summarize the main concerns from federal agencies and how those concerns are being addressed.

U. S. Environmental Protection Agency (EPA)

The EPA requested further discussion in the Final PIR/EIS pertaining to water quality benefits provided directly by the project or indirectly (e.g. District land acquisition removal from farming and potential development).

The change in land use will result in improved water quality conditions. Since the project is not targeting water quality improvement, these benefits are not included in the overall benefit assessment.

The EPA requested further discussion if the project will attempt to control invasive species on the 776 acres of private lands that are purchased, since these will become available for opportunistic invasive species.

At this time, there are no plans for invasive species control on lands that are required for project purposes.

The EPA suggested cumulative impacts should include positive impact of other CERP projects (i.e. C-111 SC Eastern Project, Modified Water Delivery, etc).

This C-111 SC Western project anticipates more water from other CERP projects and this analysis is included in the system-wide formulation contained in Section 5 of the main body of the Final PIR/EIS. Direct effects from other projects are not anticipated; only indirect effects.

Department of Interior/National Park Service (NPS)

NPS states that monitoring and adaptive management plans should include; 1) Surface water and groundwater monitoring that addresses potential contaminants of concern such as nutrients, pesticides, and metals within Taylor Slough and the Southern Glades wetlands. 2) Nutrient enrichment bioassessment monitoring at the Frog Pond Detention area and transects that extend into the Taylor Slough marsh. 3) Fish bioaccumulation monitoring for pesticides and metals for native fish at the existing Taylor Slough monitoring stations.

The following is the response to this concern, by number as it appears.

1) The project features are designed so that there will be no surface water discharges to Everglades National Park. The existing surface water monitoring in the source canals demonstrates compliance with state standards. The Corps and its local sponsor believe that the existing monitoring of nutrients collected by Everglades National Park staff as required by the Settlement Agreement and the TP Rule is sufficient to understanding nutrient loading in Taylor Slough. The project co-sponsor, the SFWMD, currently samples stations upstream of the proposed Detention Areas and associated groundwater wells for pesticides, the results of which have with few exceptions met standards. Similar sampling for trace metals, have shown so few excursions from the standards in the past that the SFWMD has systematically removed trace metals from its monitoring requirements. The exception to this has been mercury which is primarily derived from atmospheric deposition as opposed to surface water runoff. Site specific monitoring associated with potential residual trace metal and pesticide contamination in the FPDA has been incorporated into the monitoring plan.

2) The planned FPDA is not designed to function as a wetland, but rather as an infiltration basin. Monitoring of nutrient enrichment in the FPDA would be compromised by routine maintenance activities such as vegetation management. As stated above, the FPDA is not designed to have a surface water discharge so the Corps and its sponsor do not consider it a significant source of nutrient loads in Taylor Slough. For this reason, vegetation transect monitoring into Taylor Slough is not planned as part of this project. However, the Corps recognizes the value of this type of monitoring and encourages the Park and others to continue to conduct such studies in the Taylor Slough basin.

3) The SFWMD conducts monitoring of surface waters for pesticides and mercury at stations upstream of the inflows to these detention areas. The Corps and the SFWMD believe this monitoring to be sufficiently protective.

Another concern from the NPS is that consideration should be given to extending the Frog Pond detention feature northward to connect fully with the existing C-111 detention area complex, so that better control of seepage from Taylor Slough can be accomplished. Any gaps in the seepage control system may compromise the benefits expected from a more natural hydroperiod in Taylor Slough.

The extension of the FPDA northward was included in the FPDA sizing analysis that has been added to the PIR/EIS. The northern position of the FPDA was sited to avoid higher quality wetlands that exist to the north of the proposed feature. Two ongoing efforts outside the C111SC Western project are directed at reducing seepage out of this area. Contract number 9 of the C-111 South Dade project contains features that would be implemented in this area in order to reduce seepage levels out of ENP. Additionally, ongoing operational evaluations for the C&SF project should also serve to reduce seepage out of ENP, specifically operations related to S-332D. In the spirit of Incremental Adaptive Restoration, these efforts will be followed until the initiation of the Eastern PIR. If seepage in this area becomes a concern, it will likely be addressed in the Eastern PIR.

The NPS recommends that the plugging of the C-111 SC western Phase 1 project be fully integrated, in design and scheduled implementation, with the plugging in the C-111 South Dade project. To better complete the objectives of the project, NPS recommends plugs at several additional sites 1) The L-31 W must be backfilled and/or adequately plugged to ensure the C-111 SC detention areas function properly. For the Aerojet feature to be fully functional, the drainage imposed by the L-31W must be stopped. 2) The Aerojet Canal system currently has an east-west feeder canal that will compromise the effectiveness of the recommended project plan. NPS recommends that this canal be plugged in coordination with the South Dade and C-111 SC projects to prevent groundwater losses eastward from the Aerojet feature 3) NPS recommends that the additional plug be installed in the L31E, as it will provide additional benefit with low cost. 4) Within the project, overdrainage of the Model Lands by the Card Sound Road canal could also be reduced at relatively low cost. NPS recommends that plugs be installed in this canal, one north and one south of its junction with L31E, as part of the recommended project.

The majority of the L-31W Canal will backfilled under Contract Number 9 of the C-111 South Dade project. The remainder of the Canal will be plugged under the same Contract. Both of these features will serve to prevent drainage by the Canal. The east-west feeder canal is actually a borrow canal that will be plugged as part of the Recommended Plan of the C-111SC Western project. The plugs should serve to prevent seepage losses from the Aerojet Canal. The features that have been proposed for the L-31E Canal are intended to provide learning opportunities for the future Eastern project while at the same time providing a "jump-start" for restoration in this area of project. The limited features that are proposed will guide further restoration features such as the possible construction of additional plugs for the future-proposed Eastern project. The C-111SC Western project focused mainly on the restoration of Taylor Slough and its downstream areas; however, some limited restoration features were proposed in the Model Lands area. The features in the Model Lands area were mainly focused on elements that would provide a learning opportunity for future restoration efforts. It is likely that additional features such as the elimination of the drainage effects of any canals in the Model Lands will be addressed under the future-proposed C-111 SC Eastern project.

Another concern is the effect of seepage losses from Everglades National Park is felt most strongly during the dry season, when marshes dry out early in the season. Additionally, seasonal lowering of the water table affects Biscayne National Park resources. Reducing wet season canal seepage from the Everglades National Park, the Southern Glades and Model Lands, and operating the system to extend marsh hydroperiods in the entire project area into the dry season, should provide project benefits to both Parks.

The Draft Project Operating Manual has been crafted in the spirit of adaptive management that will allow project operations to be optimized through the construction, testing, and implementation of the proposed project. All efforts will be made to maximize restoration efforts and mimic the natural, historical function of the ecosystem in the area, including extending marsh hydroperiods in certain areas while reducing seepage out of ENP to the fullest extent possible without harming other resources.

U.S. Fish & Wildlife Service (FWS)

This federal agency is somewhat unique (from other federal agencies) in that they provided non-binding recommendations, which the sponsors will consider for inclusion, as appropriate, and that they also provided Conservation Measures, which the sponsors have committed to incorporate in order to minimize impacts to the threatened & endangered species.

These recommendations and conservation measures can be found in the C-111 SC Western Project, Final PIR/EIS, Annex A (FWCA and Endangered Species Act Compliance).

5.0 Reasonable Assurances

Florida Statute Section 373.1501(5)(d) states that the SFWMD shall "Consistent with this Chapter, the purpose for the restudy in the Water Resources Development Act of 1996, and other applicable federal law, provide reasonable assurances that the quantity of water available to existing legal users shall not be diminished by implementation of project so as to adversely impact existing legal users, that existing levels of service for flood protection will not be diminished outside the geographic area of the project, and that water management practices will continue to adapt to meet the needs of the restored natural environment."

The overarching objective of the Comprehensive Everglades Restoration Plan is the restoration, preservation, and protection of the South Florida ecosystem while providing for other water-related needs of the region, including water supply and flood protection. The Federal Government and the State of Florida are committed to the protection of the appropriate quantity, quality, timing, and distribution of water to achieve and maintain the benefits to the natural system described in the Plan. As envisioned in WRDA 2000 and the Programmatic Regulations, each project will identify this appropriate quantity, quality, timing, and distribution of water for the natural system.

The hydrologic modeling, analytical procedures, and calculations performed for these evaluations were based on the information contained and the procedures developed for the draft programmatic Guidance Memorandum 3 ("Savings Clause Requirements"). Because the Guidance Memorandum 3 has not been finalized, all of the data and information contained in this report is considered to be preliminary and is subject to change as a result of further evaluations that may be performed to maintain consistency with the approved final programmatic guidance memoranda.

Analyses performed to make these determinations include both groundwater and surface water hydrologic modeling. Analyses associated with State Assurances occur at both the system-wide and project levels to confirm there will be no unexpected impacts to existing legal users of water or significant adverse effects on the level of service for flood protection as a result of the project.

5.1 Water Supply Assurances & Project Effects on Existing Legal Users

The primary goal of the C-111 SC Western project is to improve of water flows to Florida Bay via Taylor Slough, as well as restore the Southern Glades and Model Land.

The process of identifying water is integral to the specific assurances and ultimately to ensuring that the overarching objectives of the Comprehensive Everglades Restoration Plan, namely restoration, preservation, and protection of the south Florida ecosystem while providing for other water-related needs of the region, including flood protection and water supply. It is assumed that the final design of the project will achieve its objectives.

Project Extent and Assumptions
These analyses and results apply only to the recommended plan, including the features associated with Alternative 2D Short which includes benefits to the natural system. The recommended plan intends to primarily improve the quantity, timing, and distribution of water delivered to Florida Bay via Taylor Slough. It is anticipated that these improvements can be realized through the establishment of a hydraulic ridge between Taylor Slough and the C-111 Canal, to reduce seepage losses from Taylor Slough and its headwaters. The hydraulic ridge will be established by: (1) combining operational changes within the lower C-111 Canal (south of S-177), and (2) the diversion of water that is currently being discharged through S-177, S-18C and S-197 to the existing Aerojet Canal and an above ground detention area to be constructed on Frog Pond lands owned by SFWMD. Marsh stage triggers in Taylor Slough and the adjacent basin will be used to manage pumping rates and to increase the net water distributed west of the existing C-111 Canal system.

The recommended plan also includes the installation of additional intermediate water control structures on the lower C-111 Canal to increase the effective water control elevation of the lower C-111 Canal. These changes will facilitate reducing the seepage losses from Taylor Slough and increase the net water distributed west of the existing C-111 Canal system.

The plan also intends to improve wetland hydroperiods for Southern Glades and Model Land tracts. This will largely be accomplished by proposed modifications to current operations at structure S-20, installation of an earthen plug in the L-31E Canal near S-20A and installation of earthen plugs in the C-110 Canal.

Absence of Regional or System-wide Effects
Because the C-111 SC Western project is located at or near the coastline, does not alter regional operations and only affects water deliveries to the southernmost canals in the Central and Southern Project or coastal structures, it is assumed to produce no system-wide effects. Therefore, only project-level effects were evaluated for elimination or transfer of existing legal sources, effects on level of service for flood protection, and identification of water made available.

Existing Legal Users

Existing legal users in the project area include water for three public utility wellfields, private wells, industrial facilities and agricultural irrigation wells within the drainage basins. The three public water suppliers include Florida Keys Aqueduct Authority, City of Homestead and Florida City (See **Figure 12**). Industrial users include two quarries and the City of Homestead's power plant. Agricultural uses include approximately 20 permittees, including both food production and landscape nurseries.

All project features such as pumps that divert water are located downstream of these users. Operation of the project features are designed to restore the quantity, timing and distribution of water delivered to Florida Bay via Taylor Slough by increasing existing water levels and overall flows. Project features divert a portion of the water that would normally be discharged to tide through the seawater control structures before reaching Florida Bay. Therefore, no dimishment of water available to existing legal users such as public utility wellfields, private wells industrial facilities or agricultural irrigation wells will occur.

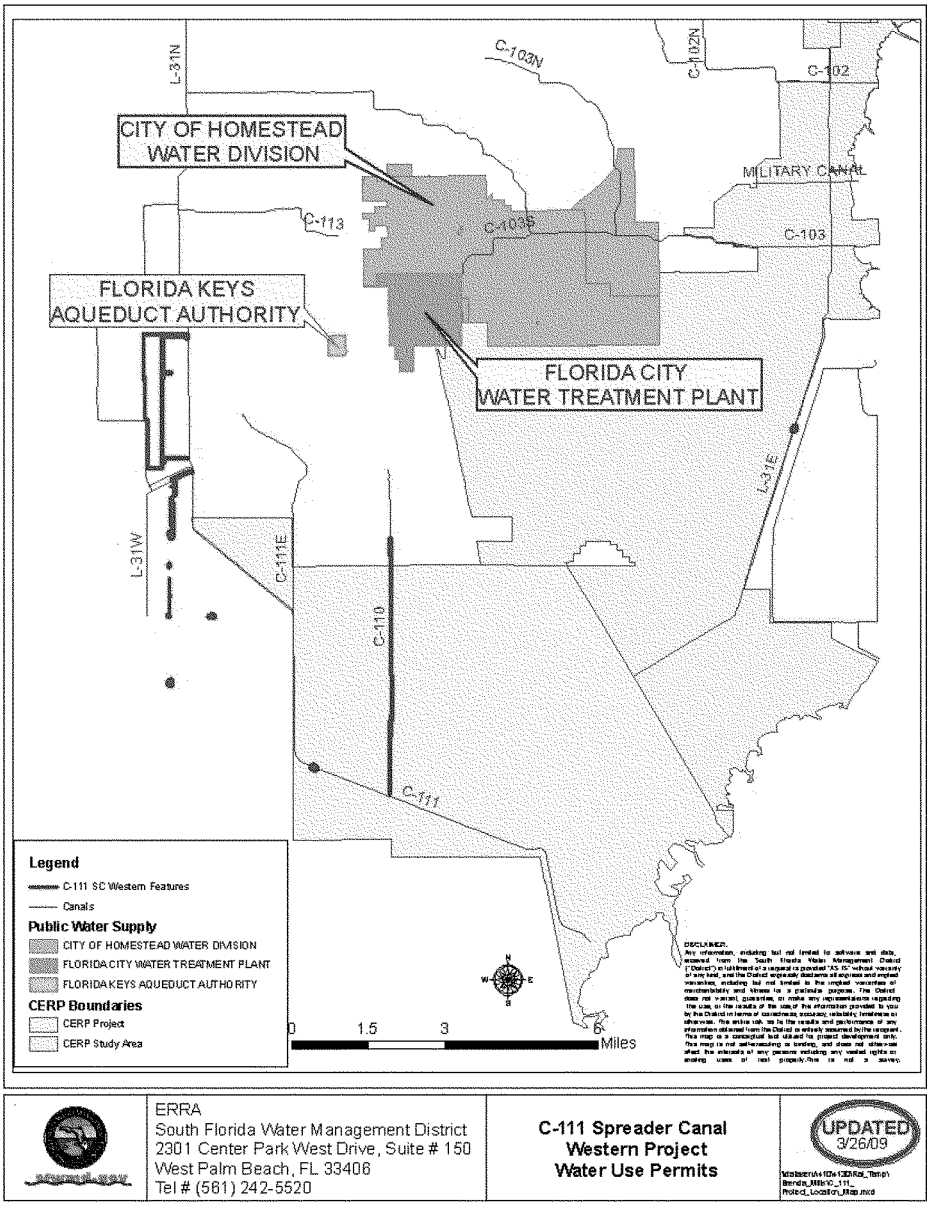


FIGURE 12: PUBLIC WATER SUPPLIERS INCLUDE FLORIDA KEYS AQUEDUCT AUTHORITY, CITY OF HOMESTEAD AND FLORIDA CITY

5.2 Flood Protection Assurances

The purpose of the flood protection assurances is to protect existing legal sources of water from elimination or transfer and levels of service for flood protection existing as of December 2000. The expected performance refers to the performance of the system in place when modeled against the period of record. It does not refer to specific design flood targets such as the 10-year flood. The analysis for assessing the impacts to the level of service for flood protection was based on model output from the MODBRANCH model. The PDT determined that modeling the full period of record was impractical and that modeling a subset of the full period of record was an adequate substitute. For the C-111 Spreader Canal project a dry year, an average year, and a wet year were simulated with the MODBRANCH model. The dry year simulated was 1989, the average year simulated was 1978, and the wet year simulated was 1995.

Analysis for Flood Protection

The analysis compared modeling data from the conditions in existence in December 2000 (Pre-CERP Baseline) to Alternative 2DS. This is consistent with the methods described in CERP Guidance Memorandum #3. The comparison accounted for both groundwater and surface water impacts to different land classes due to C-111 SC Western project implementation. The takings analysis determined the lands impacted based on the following criteria:

Criteria 1: Non-Agricultural Lands (40days + 30 percent).
Alternative Annual Hydroperiod (at surface) is greater than 40 days longer than the Base run and this value is greater than 30 percent longer than the Base for any of the three years (Average year, Dry year, Wet year).

Criteria 2: Agricultural Lands for Dry Season (Any increase of Hydroperiod at -0.5 ft).
Alternative Dry Season Hydroperiod (at -0.5 ft) is greater than 5 days longer than the Base Dry Season Hydroperiod (at -0.5ft) for any of the three years (Average year, Dry year, Wet year).

Criteria 3: Agricultural Lands for Wet Season (30 days + 20 percent).
Alternative Wet Season Hydroperiod (at -0.5 ft) is greater than 30 days longer than the Base wet season Hydroperiod (at -0.5 ft) AND this value is greater than 20 percent longer than the Base for any of the three years (Average year, Dry year, Wet year).

GIS data provided showed the percentage of each individual parcel impacted and a separate data sheet for the agricultural lands, which showed the hydroperiod differences in the dry season and wet season between alternative 2DS and the Pre-CERP Baseline for each of the years analyzed. The takings analysis was conducted for the agricultural lands to determine what were significant and adverse conditions warranting acquisition of a real estate interest. Any increase in any dry season (November through April) of over 5 days was considered as requiring acquisition of a real estate interest (Criteria 2 above). For the wet seasons, the increase had to meet not only Criteria 3 above, but it had to increase the entire hydroperiod to greater than 80 days. Once all this data was analyzed each parcel or percentage of the parcel was reviewed to determine if only a portion (and what portion) or all of the parcel would have to be acquired.

C-111 Basin Flood Protection Analysis
To ensure that existing levels of service for flood protection will not be diminished due to CERP Implementation is to consider acquisition of affected property. The Real Estate Takings Analysis accounted for changes in hydrology that were significant enough to require land acquisition. The Real Estate Takings Analysis identified that total lands that could be impacted were approximately 11,655 acres for Alternative 2D Short, of which approximately 776 acres were in private ownership.

The planning level modeling, which was completed for purposes of cost estimating, indicated that approximately 11,565 acres could be impacted by the operation of the project. SFWMD owns fee to approximately 9,688 acres which can be provided in fee. Miami-Dade County owns approximately 131 acres in fee which can be provided by perpetual flowage/conservation easements. The State of Florida owns approximately 15 acres which can be provided by easements for the life of the project in accordance with State statutes and the Florida Administrative Code. Florida Power and Light Company owns approximately 955 acres which can be provided by perpetual flowage/conservation easements. The modeling predicted that an additional 776 acres, which are owned by private parties, could be impacted by the operation of the project. SFWMD has agreed to acquire in fee privately owned lands which are determined to have been impacted by the operation of the project.

5.3 Adaptive Management to Meet the Needs of the Restored Natural Environment

Based upon the procedures outlined for the planning process, adaptive water management practices were utilized during the modeling runs and the development of the recommended plan. Along with standard engineering practices and procedures for the detailed design and the establishment of the Restoration Coordination and Verification (RECOVER) process, adaptive water management practices will continue throughout plan implementation.

These practices and procedures will ensure that the project will contain the most efficient and cost effective components to meet the needs of the restored natural environment and human environment. The project which is the subject of this report has been a part of past procedures and will be a part of future procedures to maintain this assurance.

Adaptive management (AM) consists of an active strategy for dealing with the considerable uncertainties that characterize management of large natural ecosystems, which are complex and difficult to predict. The overall purpose of AM is to maximize the chance of success and includes methods, such as proactive approaches to dealing with uncertainties, the use of modern ecosystem science and scientific practices, active collaboration, and the use of open, inclusive, and integrative processes.

Five key principles help implement this approach to adaptive management:

1. Anticipate future uncertainties and contingencies
2. Employ science-based approaches to build knowledge
3. Design robust projects that can be adapted to changing conditions
4. Build a shared understanding through collaboration and conflict resolution
5. Reconcile competing objectives to benefit both nature and society

The C-111 Spreader Canal project is a component of the CERP, which consists of sixty-eight (68) major components. The uncertainty associated with a program of this magnitude was recognized during the Restudy, which led Congress to address the necessity of AM in the Water Resources Development Act of 2000.

As such, a fundamental implementation principle for CERP is to utilize adaptive assessment and management in order to continually refine and improve the performance of CERP projects so that planned benefits are attained. Incremental revisions of optimal project designs and project operations throughout the planning and implementation process will lead to improved performances. The use of the adaptive assessment policy minimizes the effects of uncertainty with respect to the effects of CERP projects on the natural system and other water-related needs of the region related to the design and implementation of the CERP.

The measurement of benefits attributable to CERP projects must consider individual outputs as well as system-wide interdependencies among projects. This evaluation methodology applies to hydrological linked projects that operate optimally in a synergistic fashion. Therefore, until other CERP projects are implemented, some benefits may not be realized. Moreover, interim and long-term impacts will be largely determined by implementation of CERP components and operational strategies. Regional evaluations will be used to improve information necessary to predict and assess shortfalls attributable to sequencing issues versus shortfalls in performance.

The project team considered the uncertainty in the estimation of habitat unit values for the various alternatives and how would ecological outputs respond over time, and how do continued high runoff volumes affect outputs over time. Consideration of "if" and "when" other CERP components were constructed were also considered in the estimate of ecological outputs, demonstrating the sensitivity of Lower East Coast outputs to the construction of other CERP components.

6.0 Coordination with Existing Utilities and Public Infrastructure

Section 373.1501(5)(e), F.S., requires the SFWMD to "Ensure that implementation of project components is coordinated with existing utilities and public infrastructure and that impacts to and relocation of existing utility and public infrastructure are minimized."

6.1 Summary of Utilities & Coordination with Utilities and Public Infrastructure

Major utilities and public infrastructure owners within the study area have been actively involved throughout the planning phase of the C-111 Spreader Canal Western Features Project. Although some utilities and infrastructure owners have opted simply to monitor the plans progression, all major utilities and public infrastructure have had an opportunity to actively participate, either as members of the Project Delivery Team (PDT), as commenting agencies, or both. Coordination with utility and public infrastructure owners officially began at the NEPA scoping meeting, and has continued through notification of availability of the Project Implementation Report / Environmental Impact Statement (PIR/EIS).

The list of Major utilities and public infrastructure owners within the study area which have been involved, to varying degrees, throughout the planning phase of the project include:

- Florida Power & Light (FPL)
- Florida Keys Aqueduct Authority (FKAA)
- Miami-Dade County Water & Sewer Dept (MDC WASD)
- Florida Department of Transportation (FDOT)
- Florida City
- City of Homestead

There are a number of existing FPL distribution and transmission power lines and easements that transverse the eastern and western portions of the C-111 SC Project area. FPL also owns and operates the Everglades Mitigation Bank (FPL EMB) in the eastern portion of the C-111 SC Project Area between US 1 and L-31E, and the FPL Turkey Point Power Plant adjacent to Biscayne Bay.

Recent meetings with FPL have focused on integrating existing distribution line facilities in the Frog Pond and Aerojet areas that are part of the western components of the C-111 SC Phase I Project and making arrangements to meet the electrical power needs of the proposed pump stations and other facilities. There are existing distribution power lines north and south of Inghram Highway that serve existing SFWMD facilities and pump stations, some of which will need to remain, some of which may need to be relocated, and some of which can be removed because they are no longer needed. Those FPL facilities authorized by SFWMD ROW permit that need to be removed or relocated will be done at FPL expense. Those FPL facilities authorized by easement on lands acquired by the District for the project that need to be removed or relocated will be done at SFWMD expense. FPL and the District will execute a Power Distribution Contract that will include the provision of power to new facilities as well as the relocation or removal of any existing facilities.

Early coordination with the Florida Department of Transportation (FDOT) has resulted in FDOT agreeing to substitute asphaltic limestone base (for traditional limestone) into the sub-grade of the phased US Hwy 1 widening. Inclusion of the asphaltic base will allow water tables to increase by up to 1 foot in areas adjacent to the highway.

Coordination with the Florida Keys Aqueduct Authority (FKAA) and other water suppliers have generally been focused on well field protection considerations. Well field protection has been treated as a constraint since project inception, and has had an important role in alternative formulation, alternative comparison, and even plan recommendation. .

7.0 Increased Water Supply Available from Project

State Requirements

Florida Statute Section 373.470(3)(c) states that "Prior to executing a project cooperation agreement with the Corps for the construction of a project component, the District, in cooperation with the Corps shall complete a project implementation report to address the project component's economic and environmental benefits, engineering feasibility, and other

factors provided in Section 373.1501 sufficient to allow the District to obtain approval under Section 373.026. Each project implementation report shall also identify the increase in water supplies resulting from the project component. The additional water supply shall be allocated or reserved by the District under Chapter 373."

Part II of Chapter 373, F.S. contains the laws of the State of Florida governing permitting of consumptive uses of water in Florida. Section 373.223(4), F.S., provides that:

> *"The Governing Board or the department, by regulation, may reserve from use by permit applicants, water in such locations and quantities, and for such seasons of the year, as in its judgment may be required for the protection of fish and wildlife or the public health and safety. Such reservations shall be subject to periodic review and revision in the light of changed conditions. However, all presently existing legal uses of water shall be protected so long as such use is not contrary to the public interest."*

This statute provides the legal framework for water that may be reserved from use for the protection of fish and wildlife or for the protection of public health and safety. When water is reserved under this statute, it is not available to be allocated for use under a consumptive use permit and is protected for the natural system. The statute also requires existing legal uses of water be protected so long as such existing use is not contrary to the public interest. Additionally, the statute directs that reservations shall be reviewed periodically to assess changed conditions and revised as necessary. Reservation of water is by administrative rule. The SFWMD anticipates that both CERP and non-CERP related reservation rules will be adopted for protection of water made available for the natural system or the SFWMD will use its allocation authority, which also derives from Section 373.223(4), F.S to protect water for the natural system.

Identifying Water for the Natural System

Identification of water for the natural system is based on the concept that a quantity of water is needed to achieve the benefits of the project, and the overarching objective of restoration, preservation and protection of the South Florida Ecosystem. The water made available for the natural system is the water used for the protection of fish and wildlife within natural systems, including water that contributes to meeting hydrologic, water quality, and ecologic targets for restoration of natural systems.

Water flows across key transects, which are located in the Southern Glades and Model Lands, are utilized to quantify water flows to the natural system (see **Figure 13**). This includes surface water or overland flows as well as groundwater flows in the Biscayne aquifer. Although groundwater stages may increase as a result of the project due to the interconnectivity of the surface and groundwater, groundwater flows remain relatively unaffected. Therefore, groundwater will not be quantified. However, at times when there is seemingly no water being delivered from S-176, because the structure is closed, there may be some small amount of water that could be pumped by either S-200 or S-199 that is not capture in the S-177 flows. These flows can be quantified at transects located further downstream used to quantify surface water flowing towards Florida Bay (TA-1 and TA-2W). For each year simulated, a graphic will display two volume probability curves. One curve indicates the total quantity discharged from S-177 in the existing condition (ECB), which

represents the total water available to the natural system. The second curve, IOR_2DS, quantifies the water that still reaches S-177 after some portion is diverted to the Frog Pond Detention Area or the Aerojet Canal. In addition, the 10th, 50th and 90th percentile is identified for the ECB, which represents the total water available and the difference between the ECB and IOR_2DS, which represents the total water made available by the project for the natural system are displayed in a table.

Surface water flows across these key transects were also utilized to quantify the increased flows resulting from the proposed S-198 structure and changed operations at S-20 and S-20A to the natural system. Multiple transects were applied to assess the environmental effects using the model simulations, namely TA-1, TA-2, TA-3, TA-4, and TA-5 during plan evaluation. Although surface water stages and duration (hydroperiods) may be affected by the recommended project, there is not a corresponding change in overland flows significant enough to quantify. This is true for the eastern-most transects TA-3, TA-4, and TA-5, which will not be applied to quantify water. Only a subset of these transects were applied to quantify the volume of water made available. In addition, although groundwater stages may increase as a result of the project, groundwater flows do not change significantly and will not be quantified.

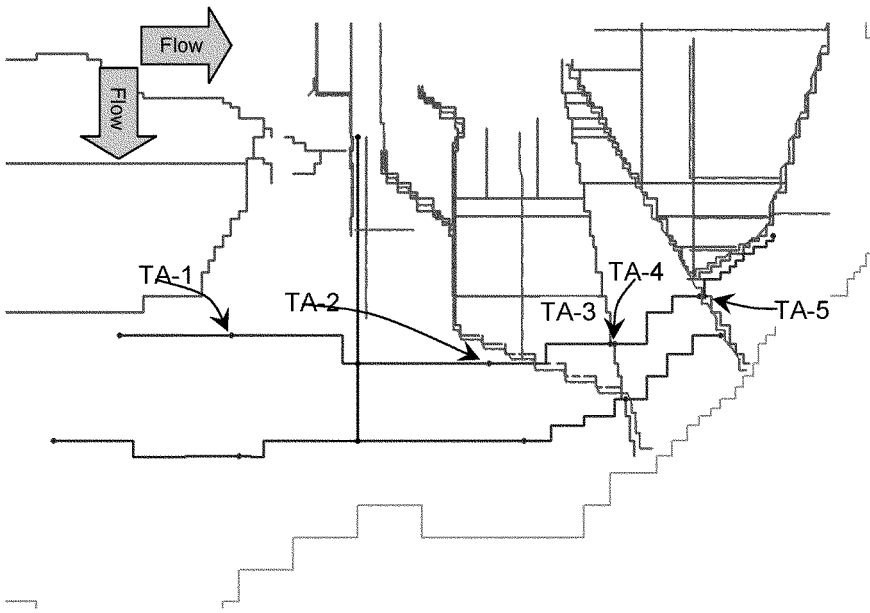


Figure 13: Location of Transects to Quantify Surface Water Flows for the Natural System

Of the remaining key transects, TA-2 was divided into a west and east transect to easily capture the changes to flows towards Florida Bay via Taylor Slough. The new transects, TA-2w(est) and TA-2e(ast) when combined with TA-1 quantify the water made available for the natural system by these features (see **Figure 14**). To capture increases in water made available for the natural system, the flows across the transects in the Existing Baseline Condition, ECB, are compared to with the project in place, IOR_2DS, which represents the total water available. The difference between these conditions for each year simulated represent the surface water made available for the natural system by these features. In addition, the 10th, 50th and 90th percentile identified for the IOR_2DS, which represents the total water available and the difference between the IOR_2DS and ECB, which represents the total water made available by the project for the natural system are displayed in a table.

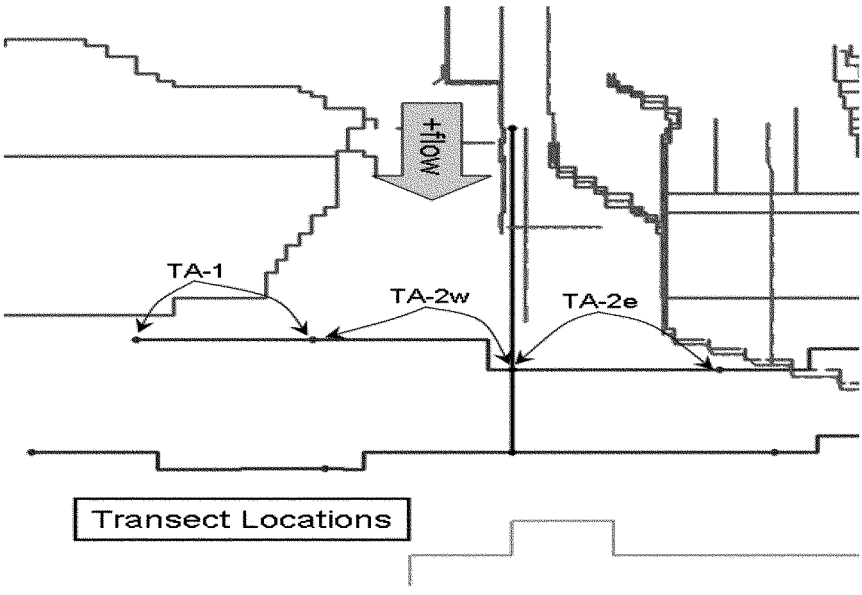


Figure 14: Location of Transects to Quantify Surface Water Flows for the Natural System

Water Restoration Targets

The C-111 SC Western project study area is situated at the southern extent of the CERP study area. As such, the potential functions provided by the C-111 SC Western project are largely limited to managing seepage from natural areas to drained areas, and detaining/distributing volumes of water made available by upstream water management infrastructure to features of the project. The targeted quantity redistributed to Florida Bay

via Taylor Slough was estimated based on the volume available to be diverted to Taylor Slough at the S-177 and the overland flows across the Southern Glades and Model Lands.

Volume Probability Curves

Beneficial water created by the project was determined by comparing volume probability curves for the with-project condition for a given time window (i.e., a specific month, year, or period) against volume probability curves for a target (ecologically beneficial) for the same condition. The volume probability curves depicting the incremental additional beneficial water for the natural system made available by the project under the full range of hydrologic conditions comprise the quantity, timing, and distribution of water identified to be reserved or allocated for the natural system.

For purposes of identifying the volume of water made available by the project, volume probability curves were produced depicting the range of daily quantities (mean daily flow) of water delivered to the natural system. As discussed previously, three years were simulated by the MODBRANCH model, 1978, 1989, and 1995, which represent the "average", "dry" and "wet" conditions, respectively for South Miami-Dade County. Probability curves indicate the probability (percentage of time equaled or exceeded, on the x-axis) that a certain quantity of water is available as a function of simulated structure flows or calculated at transect in the model domain. Once sorted, the values are ranked from highest to lowest.

Identifying Water Made Available by the Project for the Natural System

Volume probability curves quantify the water made available by the project for the natural system at two locations. First, the project will divert water to the S-199 and S-200 pump stations that currently discharges through S-177 to maintain a hydrologic head between Taylor Slough and the C-111 Canal. Second, surface water levels in Southern Glades and Model Lands increase by installing and operating a new plug on the C-111 canal and operating the S-20 and S-20A structures differently.

Water is diverted to the Aerojet Canal by the S-199 and Frog Pond Detention Area by S-200 pump stations that currently discharges through S-177 to maintain a hydrologic head between Taylor Slough and the C-111 Canal. The quantity of water diverted to these project features on a daily basis is calculated for the three years simulated. In general, **Figure 15**, **Figure 16**, and **Figure 17** provide an estimate of the quantity of water the project is expected to be diverted to improve the quantity, timing and distribution of water to Florida Bay via Taylor Slough.

For each year simulated, 1978, 1989, and 1995, two volume probability curves describe flows through S-177. One curve indicates the total quantity discharged from S-177 in the existing base condition (ECB), which represents the total water available to the natural system. The second curve, IOR_2DS, quantifies the water that still reaches S-177 after some portion is diverted to the Frog Pond Detention Area or the Aerojet Canal. The same set of graphics is shown for the simulated flows in 2050, the future without CERP (FwoCERP) compared to the future without CERP plus the Recommended Project (FwoCERP_2Ds) see **Figure 18**, and **Figure 19**, and **Figure 20**.

In 1978, the average year, almost all of the water available is diverted towards either the Frog Pond Detention Area or the Aerojet Canal. Water is available to be diverted to Taylor Slough 10% of the time. In 1989, the dry year water is available for diversion at times when there is seemingly no water being delivered from S-176, because the structure is closed. These flows can be quantified in the transects used to quantify surface water further downstream. In 1995, the wet year, water is available for diversion by the project features 30% of the time (ECB) and is actually diverted up 10% of the time (IOR_2DS minus ECB).

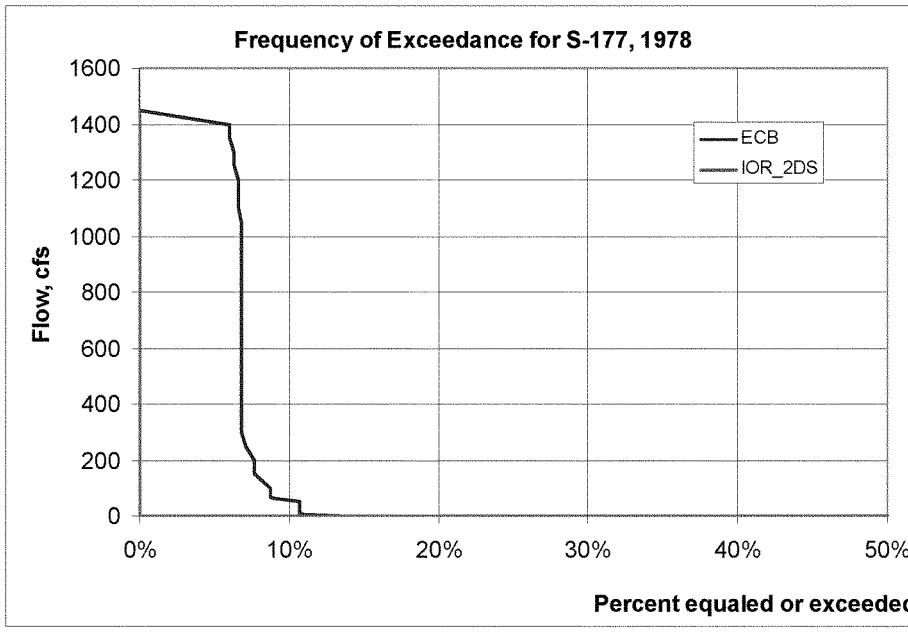


FIGURE 15: TOTAL FLOW AVAILABLE (ECB) AT S-177 AND PORTION NOT DIVERTED BY S-199 AND S-200, C-111 SC WESTERN PROJECT FEATURES THAT STILL FLOW THROUGH S-177 (IOR_2DS) IN 1978

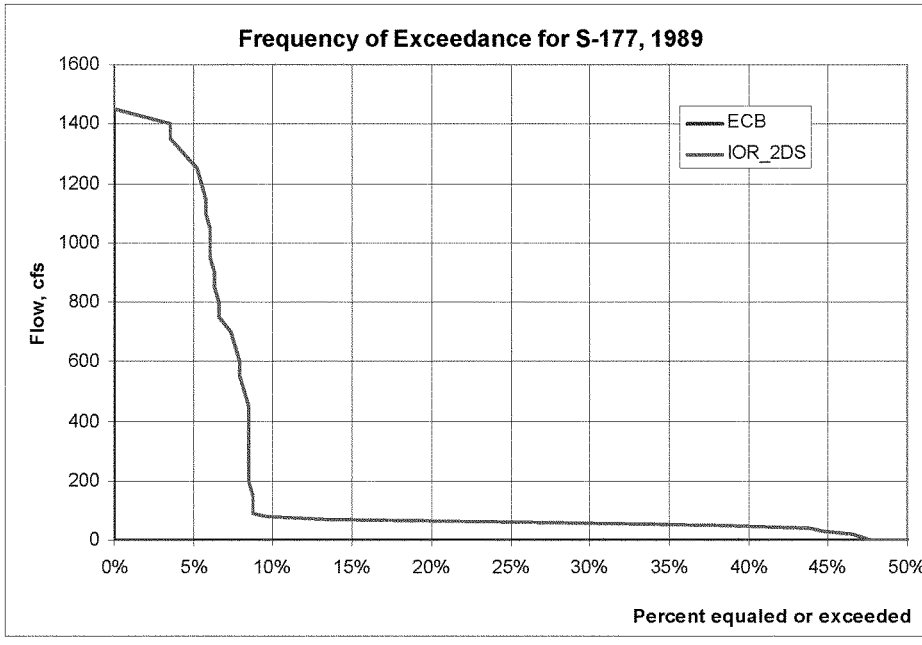


FIGURE 16: TOTAL FLOW AVAILABLE (ECB) AT S-177 AND PORTION NOT DIVERTED BY S-199 AND S-200, C-111 SC WESTERN PROJECT FEATURES THAT STILL FLOW THROUGH S-177 (IOR_2DS) IN 1989

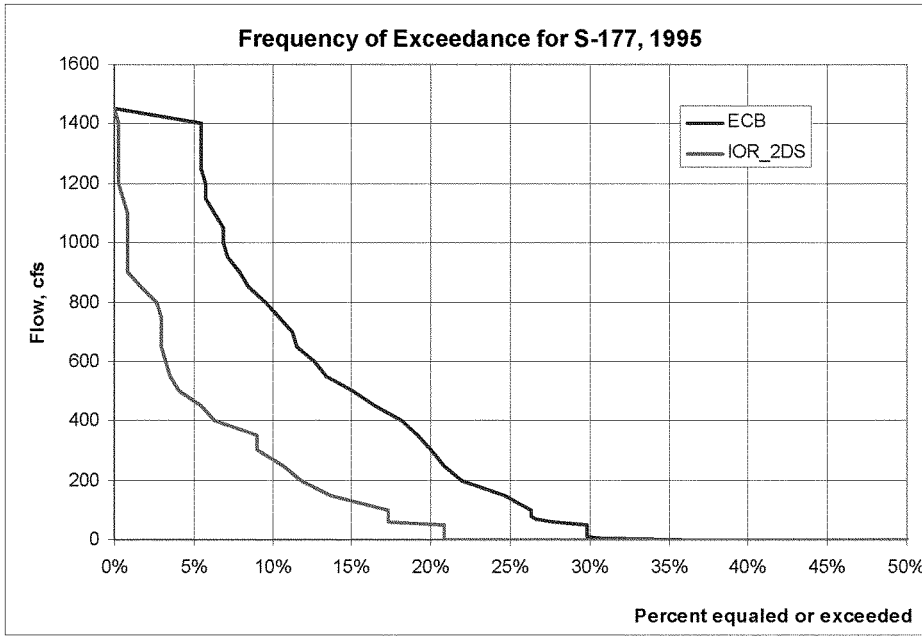


FIGURE 17: TOTAL FLOW AVAILABLE (ECB) AT S-177 AND PORTION NOT DIVERTED BY S-199 AND S-200, C-111 SC WESTERN PROJECT FEATURES THAT STILL FLOW THROUGH S-177 (IOR_2DS) IN 1995

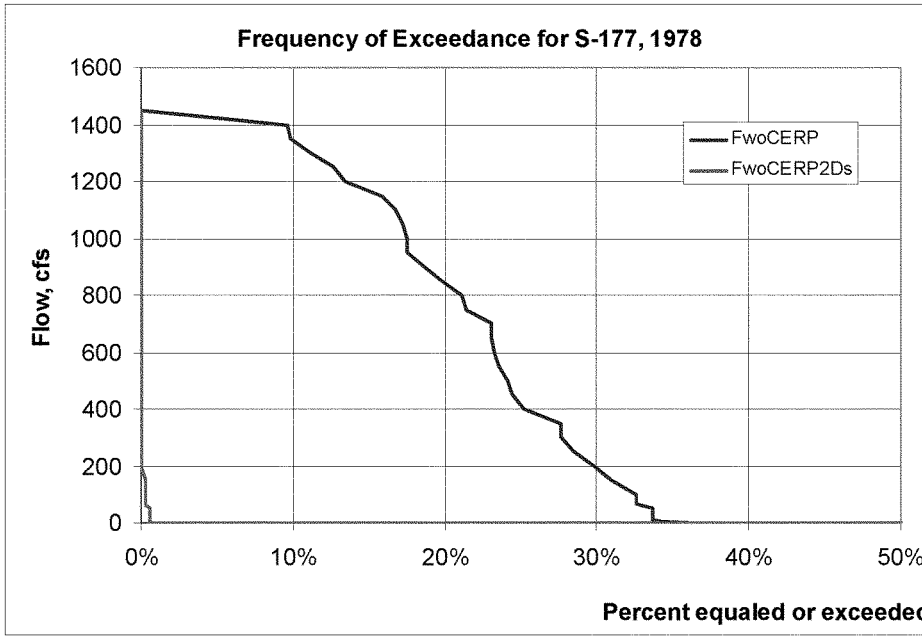


FIGURE 18: TOTAL FLOW AVAILABLE IN 2050 (FWOCERP) AT S-177 AND PORTION NOT DIVERTED BY S-199 AND S-200, C-111 SC WESTERN PROJECT FEATURES (FWOCERP_2DS) IN 1978

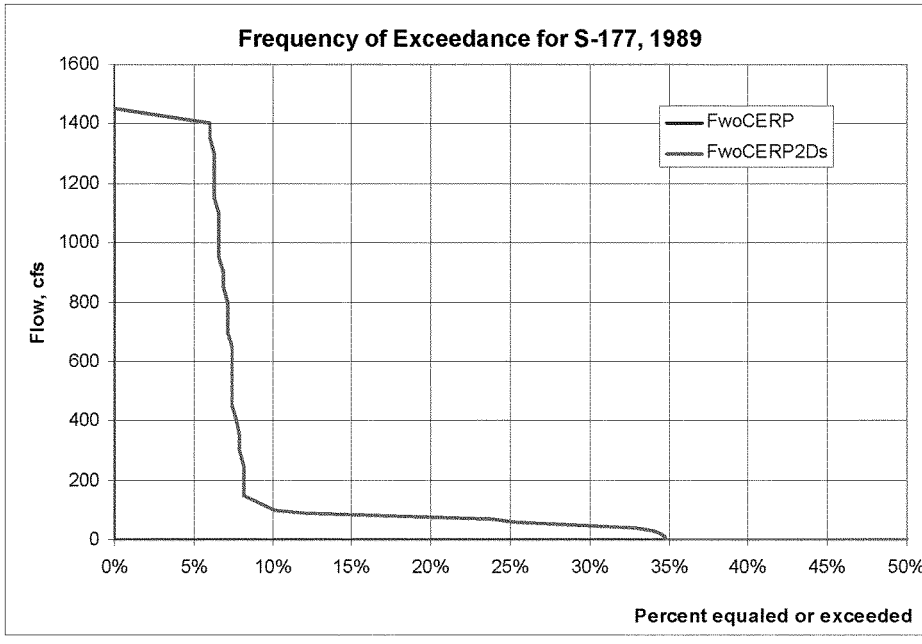


FIGURE 19: TOTAL FLOW AVAILABLE IN 2050 (FWOCERP) AT S-177 AND PORTION NOT DIVERTED BY S-199 AND S-200, C-111 SC WESTERN PROJECT FEATURES (FWOCERP_2DS) IN 1989

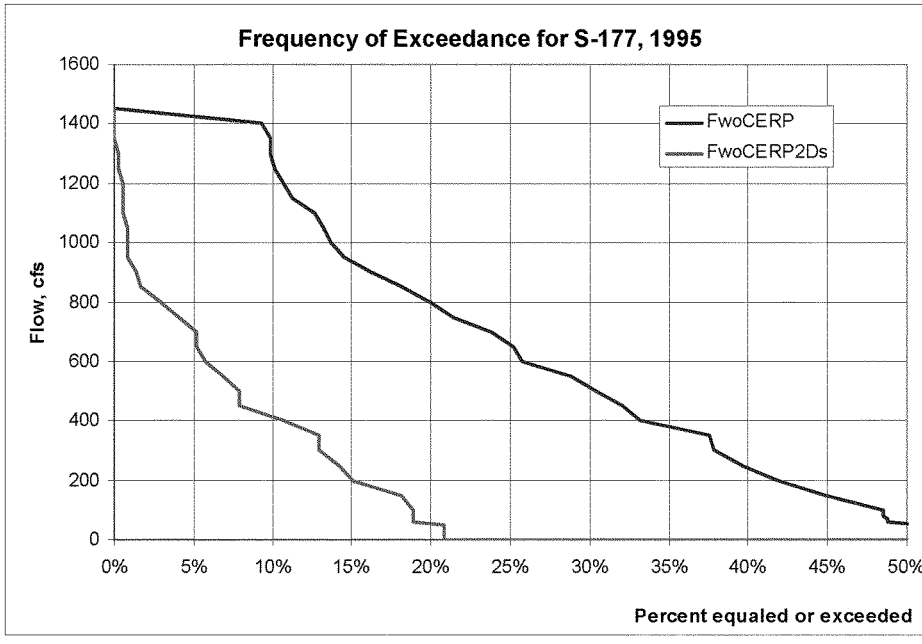


FIGURE 20: TOTAL FLOW AVAILABLE IN 2050 (FWOCERP) AT S-177 AND PORTION NOT DIVERTED BY S-199 AND S-200, C-111 SC WESTERN PROJECT FEATURES (FWOCERP_2DS) IN 1995

Identifying Water to be Reserved or Allocated for the Natural System

The 10th, 50th and 90th percentile identified for the ECB, which represents the total water available for the natural system, the IOR_2DS, which represents the water directed towards C-111 Canal, and the difference between the ECB and IOR_2DS, which represents the total water made available by the project for the natural system are displayed in **Table 10**. The total water available to be diverted by the C-111 SC Western project ranges from about 775 cfs to 0 cfs. The portion diverted to either the Frog Pond Detention Area or the Aerojet Canal (ECB minus IOR_2DS) is the surface water made available by the C-111 SC Western project and ranges from 504 cfs (10th percentile) to 0 cfs (50th percentile). Water is not available at the median (50% percentile) or higher (90th percentile) or for the representative dry year, 1989.

Table 10: Total Water and Water Diverted by the Project for the Natural System quantified at S-177 (cubic feet/second)

Percentile:	10th	50th	90th
1978 Total Water (ECB)	54	0	0
1978 Water Directed towards C-111 Canal (IOR_2DS)	0	0	0
1978 Total Water Made Available by Project, (ECB minus IOR_2DS)	54	0	0
1995 Total Water (ECB)	775	0	0
1995 Water Directed towards C-111 Canal (IOR_2DS)	271	0	0
1995 Total Water Made Available by Project (ECB minus IOR_2DS)	504	0	0

To capture increases in water made available for the natural system, three transects located in South Miami-Dade, quantify surface flows in the Existing Baseline Condition (ECB). These flows are compared to the Initial Operating Regime with the project in place, IOR_2DS, which represents the total water available. The difference between these conditions for each year simulated represent the water made available for the natural system by the recommended Project. The 10th, 50th and 90th percentile identified for the IOR_2DS, which represents the total water available, the ECB, the existing water, and the difference between the IOR_2DS and ECB, which represents the total water made available by the project for the natural system are displayed in **Table 11**. The surface water made available by the C-111 SC Western project ranges from 25.6 cfs (10th percentile) to 0 cfs (90th percentile).

Table 11: Total Surface Water and Water Made Available by the Project for the Natural System quantified at Transects TA-1, TA-2w and TA-2e (cubic feet/second)

Percentile:	10th			50th			90th		
	TA-1	TA-2w	TA-2e	TA-1	TA-2w	TA-2e	TA-1	TA-2w	TA-2e
1978 Total Water (IOR_2DS)	41.4	22.5	3.4	0.4	0.2	0.2	0.1	0	0
1978 Existing Water (ECB)	30.2	10.8	0.3	0.4	0.2	0.1	0.1	0	0
1978 Total Water Made Available by Project (IOR_2DS minus ECB)	11.2	11.7	3.1	0	0	0.1	0	0	0
1995 Total Water (IOR_2DS)	73.5	53.4	2.6	8.8	1.6	0.2	0.8	0.1	0
1995 Existing Water (ECB)	47.9	24.2	2.3	8.1	1	0.2	0.5	0.1	0
1995 Total Water Made Available by Project (IOR_2DS minus ECB)	25.6	29.2	0.3	0.7	0.6	0	0.3	0	0

The State of Florida will use its water reservation or allocation authority to protect the water made available by the project for the natural system, as required by Section 373.470, F.S.. The State has elected to protect the existing water in the natural system that the Project Implementation Report identifies as necessary to achieve the benefits of the project, using water reservation or allocation authority under Florida law. To this end, the South Florida Water Management District will protect the existing water and water made available by the project for the natural system as indicated in **Table 10** and **Table 11**.

8. GLOSSARY OF ACRONYMS

AFB	Alternative Formulation Briefing
AIWW	Atlantic Intracoastal Waterway
ASA(CW)	Assistant Secretary of the Army for Civil Works
ASR	Aquifer Storage and Recovery
AST	Aboveground Storage Tanks
AQI	Air Quality Index
BMP	Best Management Practice
BOD	Biochemical Oxygen Demand
BY	Budget Year
C	Canal
C&SF	Central and Southern Florida
CAR	Coordination Act Report
CE/ICA	Cost Effectiveness/Incremental Coat Analysis
CEM	Conceptual Ecological Models
CERCLA	Comprehensive Environmental Response, Compensation & Liability Act
CERP	Comprehensive Everglades Restoration Plan
CERPRA	Comprehensive Everglades Restoration Plan Regulatory Act
CESAJ	U.S. Army Corps of Engineers, Jacksonville District
CFR	Code of Federal Regulations
cfs	Cubic Feet per Second
cm	centimeter
COD	Chemical Oxygen Demand
Corps	U.S. Army Corps of Engineers
CPI	Cost Performance Index
CWA	Clean Water Act (of 1977)
CWCCIS	Civil Works Construction Cost Index System
CZMA	Coastal Zone Management Act
DCT	Design Coordination Team
DEP	Department of Environmental Protection [Florida – FDEP]
DMSTA	Dynamic Model for Stormwater Treatment Areas
DO	Dissolved Oxygen
DOD	Dissolved Oxygen Demand
DOI	Department of the Interior
DOT	Department of Transportation
E&D	Engineering and Design
EA	Environmental Assessment
EAA	Everglades Agricultural Area
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
ELVM	Everglades Landscape Vegetation Model

EO	Executive Order
EPA	Environmental Protection Agency
ER	Engineering Regulation
ESA	Endangered Species Act
ET	Evapotranspiration
FAC	Florida Administrative Code
FDEP	Florida Department of Environmental Protection
FC	Flood Control
FCSA	Feasibility Cost Sharing Agreement
FDEP	Florida Department of Environmental Protection
FDOT	Florida Department of Transportation
FEIS	Final Environmental Impact Statement
FEMA	Federal Emergency Management Agency
FFWCC	Florida Fish and Wildlife Conservation Commission
FIFRA	Federal Insecticide, Fungicide and Rodenticide ACT
FLUCCS	Florida Land Use / Land Cover Classification System
FNAI	Florida Natural Areas Inventory
FONSI	Finding of No Significant Impact
FPL	Florida Power & Light
fps	Feet per second
F.S.	Florida Statutes
FS	Feasibility Study
FWC	Florida Fish and Wildlife Conservation Commission (same as FFWCC)
FWCA	Fish and Wildlife Coordination Act
FWO	Future Without Condition
FY	Fiscal Year
GIS	Geographical Information Systems
GM	Guidance Memorandum
GMS	Groundwater Modeling System
H&H	Hydraulics and Hydrology
Hg	Mercury
HTRW	Hazardous, Toxic, Radioactive Wastes
HQ	Headquarters
HU	Habitat Unit
ICA	Incremental Cost Analysis
ICU	Initial CERP Update
ICW	Atlantic Intracoastal Waterway
IG	Interim Goals
IT	Interim Targets
ITR	Independent Technical Review
IWR	Institute for Water Resources

kac-ft/yr	Kilo acre-feet/year
L	Levee
LEC	Lower East Coast of Florida
LEC Plan	Lower East Coast Plan
LECSA	Lower East Coast Service Area
LERRDS	Lands, Easements, Right-of-Ways, Relocation, and Disposal
LI	Large Impoundment
LOS	Level of Service
m	meter
M&I	Municipal and Industrial
MAP	Monitoring and Assessment Plan
MCACES	Microcomputer Aided Cost Engineering System
MCL	maximum containment levels
MFL	Minimum Flow and Levels
mgd	Million gallons per day
mg/l	Milligrams per liter
MISP	Master Implementation Sequencing Plan
MLW	Mean Low Water
MOA	Memorandum of Agreement
MOU	Memorandum of Understanding
MPMP	Master Program Management Plan
MSRP	Multi-Species Recovery Plan
MSSW	Management and Storage of Surface Water
MTBE	Methyl Tertiary Butyl Ether
N	Nitrogen
NAI	Next Added Increment
NED	National Economic Development
NEPA	National Environmental Policy Act
NER	National Ecosystem Restoration
NGVD	National Geodetic Vertical Datum
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPL	National Pollutant List
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
NSM	Natural System Model
O&M	Operations and Maintenance
OASA (CW)	Office of the Assistant Secretary of the Army for Civil Works
OMMR&R	Operation, Maintenance, Repair, Replacement, and Rehabilitation
OFW	Outstanding Florida Water
OMB	Office of Management and Budget

OPE	Other Program Element
OSE	Other Social Effects
OSHA	Occupational Safety and Health Administration
P	Phosphorus
P&G	Principles and Guidelines
PCA	Project Cooperation Agreement
PCB	Polychlorinated Biphenyls
Pb	Lead
PCA	Project Cooperation Agreement
PDT	Project Delivery Team
PE	Professional Engineer
PED	Planning, Engineering and Design
PEIS	Programmatic Environmental Impact Statement
PIR	Project Implementation Report
P.L.	Public Law
PM	Performance Measures
PM	Project Manager
PMP	Project Management Plan
POC	Parameters of Concern
POC	Pollutants of Concern
POR	Period of Record
ppb	Parts per billion
ppm	Parts per million
ppt	Parts per thousand
QA	Quality Assurance
QAQC	Quality Assurance and Quality Control
QC	Quality Control
QM	Quality Management
RCRA	Resource Conservation Recovery Act
RCP	Reinforced Concrete Pipe
RED	Regional Economic Development
RECOVER	Restoration Coordination and Verification
RED	Regional Economic Development Effects
Restudy	C&SF Project Comprehensive Review Study
RET	Regional Evaluation Team [sub-team of RECOVER]
RIMS	Regional Input-Output Modeling System
ROD	Record of Decision
ROW	Right of Way
RPDT	Regional Project Delivery Team
SAV	Submerged Aquatic Vegetation
SAS	Surficial Aquifer System

SCORP	Florida State Comprehensive Outdoor Recreation Plan
SF	System Formulation
SFERTF	South Florida Ecosystem Restoration Task Force
SFWMD	South Florida Water Management District
SFWMM	South Florida Water Management Model
SHPO	State Historic Preservation Officer
SOP	Standard Operating Procedure
SPF	Standard Flood Project
SR	State Road or State Route
STA	Stormwater Treatment Area
TCM	Travel cost method
TMDL	Total Maximum Daily Load
TN	Total Nitrogen
TP	Total Phosphorus
UDV	Unit day value
US	United States
USACE	United States Army Corps of Engineers (also known as the Corps)
USDW	Underground Source of Drinking Water
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	United States Geological Survey
UST	Underground Storage Tank
VE	Value Engineering
WCA	Water Conservation Area
WPA	Water Preserve Areas
WPAFS	Water Preserve Areas Feasibility Study
WQ	Water Quality
WRAC	Water Resources Advisory Commission
WRAP	Wetland Rapid Assessment Procedure
WRDA	Water Resources Development Act
WS	Water Supply

9.0 REFERENCES

USACE 1999. Central and Southern Florida Project, Comprehensive Review Study, Final Integrated Feasibility Report and Programmatic Environmental Impact Statement.

SFWMD 2006. 2005-2006 Lower East Coast Water Supply Plan Update.

USACE 2009. C-111 Spreader Canal Western Project, Draft Integrated Project Implementation Report and Environmental Assessment.

USACE 2009. C-111 Spreader Canal Western Project, Final Integrated Project Implementation Report and Environmental Assessment.

ANNEX D
DRAFT PROJECT OPERATING MANUAL

TABLE OF CONTENTS

D.0 DRAFT PROJECT OPERATING MANUAL D-1
D.1 INTRODUCTION D-1
D.2 GENERAL PROJECT PURPOSES, GOALS, OBJECTIVES AND BENEFITS D-1
D.3 PROJECT FEATURES D-3
D.3.1 Existing Features D-3
D.3.1.1 Structure 175 ..... D-5
D.3.1.2 Structure 176 ..... D-5
D.3.1.3 Structure 177 ..... D-5
D.3.1.4 Structure 178 ..... D-5
D.3.1.5 Structure 18C D-6
D.3.1.6 Structure 197 ..... D-6
D.3.1.7 Structure 332 ..... D-6
D.3.1.8 Structure 332I D-7
D.3.1.9 Structure 322B D-7
D.3.1.10 Structure 332C D-7
D.3.1.11 Structure 332D D-7
D.3.1.12 Structure 20 ..... D-8
D.3.1.13 Structure 20A D-8
D.3.1.14 L-31N Levee and Canal D-8
D.3.1.15 Levee 31 West and Canal D-8
D.3.1.16 Levee 31 East and Canal D-9
D.3.1.17 Canal 111 ..... D-9
D.3.1.18 Canal 111 East D-9
D.3.1.19 Canal 110 ..... D-9
D.3.1.20 Aerojet Canal D-10
D.3.1.21 C-111 South Detention Area formerly S-332 B West and S-332C D-11
D.3.1.22 S-332 D Detention Area D-11
D.3.2 Proposed Features D-14
D.3.2.1 S-200 Pump Station D-14
D.3.2.2 Frog Pond Detention Area D-16
D.3.2.3 S-199 Pump Station D-16
D.3.2.4 Aerojet Canal D-16
D.3.2.5 S-198 Structure D-17
D.3.2.6 S-18C Operations D-17
D.3.2.7 S-20 Triggers D-17
D.3.2.8 L-31E Near S-20A Plug D-17
D.3.3 Removed Features D-18
D.3.3.1 C-110 Canal Plugging or Backfill D-18
D.4 PROJECT RELATIONSHIPS D-18
D.4.1 C-111 SC Eastern Project PIR D-18
D.4.2 C-111 South Dade Project D-18
D.4.3 Modified Water Deliveries to Everglades National Park Project D-19
D.4.4 Interim Operational Plan for Protection of the Cape Sable Seaside Sparrow D-19

D.4.5 Combined Operational Plan for the Modified Water Deliveries to the Everglades National Park and C-111 ..... D-20
D.4.6 Biscayne Bay Feasibility Study D-20
D.4.7 Biscayne Bay Coastal Wetlands Project D-20
D.4.8 Florida Bay and Florida Keys Feasibility Study D-21
D.4.9 Florida Power and Light's South Dade Mitigation Bank D-21
D.4.10 RMC South Florida, Inc. Mitigation Area D-21
D.4.11 West Dade Wastewater Reuse Technology Feasibility Study D-21
D.5 MAJOR CONSTRAINTS D-22
D.5.1 Existing Legal Users, Levels of Flood Damage Reduction, and Water Quality D-22
D.5.2 Structural Stability D-23
D.5.3 Minimum water supply to ENP D-23
D.5.4 Saltwater Intrusion D-23
D.6 STANDING INSTRUCTIONS TO PROJECT OPERATORS D-24
D.7 OPERATIONAL STRATEGY TO MEET PROJECT OBJECTIVES D-27
D.7.1 Achieving Natural System Goals, Objectives, and Benefits D-27
D.7.2 Flood Damage Reduction D-28
D.7.2.1 Normal and Emergency Operations D-28
D.7.2.2 Hurricane or Tropical Storm Operations D-28
D.7.2.3 Storage Weir Discharge D-29
D.7.2.4 Uncontrolled Discharge D-29
D.7.3 Water Quality D-29
D.7.4 Water Supply Operations D-30
D.7.5 Recreation D-31
D.7.6 Fish and Wildlife D-32
D.7.7 Navigation D-32
D.7.8 Panhandle Wetland and Salt Water Intrusion Protection Measures D-32
D.8 PRE-STORM/STORM OPERATIONS D-35
D.9 CONSISTENCY WITH THE IDENTIFICTION OF WATER AND RESERVATIONS OR ALLOCATIONS OF WATER FOR THE NATURAL SYSTEM D-36
D.10 CONSISTENCY WITH SAVINGS CLAUSE AND STATE ASSURANCES PROVISIONS D-36
D.11 DROUGHT CONTINGENCY PLAN D-36
D.12 FLOOD EMERGENCY ACTION PLAN D-37
D.13 DEVIATION FROM NORMAL OPERATING CRITERIA D-38
D.13.1 Emergencies D-38
D.13.2 Unplanned Minor Deviations D-38
D.13.3 Planned Deviations D-39
D.14 RATE OF RELEASE CHANGE D-39
D.15 SEEPAGE CONTROL D-39
D.16 INITIAL RESERVOIR/STORAGE/TREATMENT AREA FILLING PLAN D-39
D.17 NON-TYPICAL OPERATIONS FOR RESERVOIR/STORAGE/ TREATMENT AREA PERFORMANCE D-40
D.18 AQUIFER STORAGE AND RECOVERY SYSTEM PLAN D-40

D.19 WATER CONTROL DATA ACQUISITION SYSTEM PLAN D-40
D.20 CONSISTENCY WITH THE ADAPTIVE MANAGEMENT PROGRAM AND PERIODIC CERP UPDATES D-41
D.21 INTERIM OPERATIONS DURING CONSTRUCTION D-41
D.22 PRELIMINARY OPERATIONS DURING OPERATIONAL TESTING AND MONITORING PHASE D-41
D.23 CONCEPTUAL DESCRIPTION OF PROJECT OPERATIONS FOR TRANSITION FROM THE INITIAL OPERATING REGIME TO THE NEXT-ADDED INCREMENT CONDITION D-47

LIST OF TABLES

Table D-1 Pump Station S-200 On/Off Triggers D-24
Table D-2 Pump Station S-199 On/Off Triggers D-25
Table D-3 Revised Operational Criteria for S-20 ..... D-26
Table D-4 Current Minimum Monthly Water Delivery Targets for the S-18C Structure D-34

LIST OF FIGURES

Figure D-1 Project Location D-2
Figure D-2 Existing Features D-4
Figure D-3 C-111 South Detention Area and S-332D Detention Area D-13
Figure D-4 Proposed Features D-15
Figure D-5 Historical Water Level Changes at Marsh Gauge Site EPSW and Dry Season Flow Rates at The S-18C Structure D-33
Figure D-6 Average Recession Rate at NP-EPS (EPSW) Gage D-34
Figure D-7 Named Creeks for Which A Minimum Flow and Level Annual Flow Rate Has Been Established Under Florida Statute D-35
Figure D-8 Potential Benefits and Impacts at S-18C D-43
Figure D-9 Operational Testing and Monitoring of Incremental Increases in Water Control Elevations at S-18C D-44
Figure D-10 Target Implementation Schedule for Testing Incremental Increases in S-18C Control Elevations D-45

D.0 DRAFT PROJECT OPERATING MANUAL

D.1 INTRODUCTION

The main purpose of this Draft Project Operating Manual (DPOM) is for day-to-day use in water management for essentially all foreseeable conditions affecting the C-111 Spreader Canal Western project. The C-111 SC Western project is part of the original C-111 SC Project. This DPOM has been designed to assist operators in maximizing flows to Central Florida Bay via Taylor Slough, and improving hydroperiods within the Model Lands, while maintaining or improving the existing Central and Southern Florida (C&SF) Project purposes (e.g. flood damage reduction). The project will be operated in accordance with the DPOM to achieve the goals, purposes, and benefits outlined in the Project Implementation Report (PIR), including the quantity, quality, timing, and distribution of water for the natural system, and other water-related needs identified in Guidance Memorandum (GM) #4.

It is important to note that the project is currently in the PIR/Environmental Impact Statement (EIS) Phase, and there is a high probability that modifications and/or revisions to the Project Operating Manual (POM) will occur during subsequent project phases. Report preparation is pursuant to Engineering Regulation (ER) 1110-2-240, and is in accordance with guidance contained in Engineering Manual (EM) 1110-2-3600, ER 1110-2-8156, and the Programmatic Regulations GM #5. All elevations referenced in this DPOM are in feet, and reference National Geodetic Vertical Datum (NGVD) 1929, followed by North American Vertical Datum (NAVD) 1988 unless otherwise stated.

D.2 GENERAL PROJECT PURPOSES, GOALS, OBJECTIVES AND BENEFITS

The original C-111 SC Project is a component of the Comprehensive Everglades Restoration Plan (CERP), also known as the Yellow Book. The overall goal of the C-111 SC Project is ecological restoration of the Southern Glades and Model Lands, including downstream estuaries, by improving timing, distribution, quantity and quality of water deliveries.

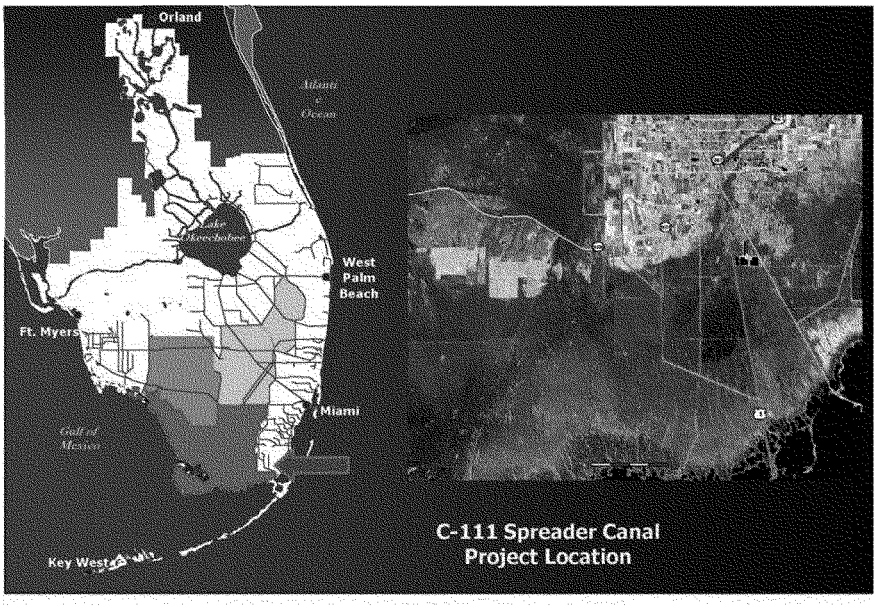


FIGURE D-1: PROJECT LOCATION

As envisioned within the Yellow Book, the central feature of the C-111 SC Project was to be construction of a six-mile (+/-) long spreader canal and elimination of the lower C-111 Canal. The C-111 SC's Project Delivery Team (PDT) recognized that key hydrologic and hydraulic decision critical uncertainties existed with respect to construction of the C-111 SC Project as envisioned in the Yellow Book. As a result of these decision critical uncertainties, stakeholder concern that the yet to be completed C-111 South Dade Federal Project would not be sufficient to restore flows to Eastern Florida Bay via Taylor Slough, and recognition that the C-111 SC Project was intended to be an enhancement of the C-111 South Dade Federal Project, federal and local sponsor leadership directed the PDT to develop a two-phased, two PIR approach, based in part on the principles of the National Academy of Sciences' approach to Incremental Adaptive Restoration (IAR). Incremental Adaptive Restoration involves making investments in restoration that are significant enough to secure environmental benefits while also resolving important scientific uncertainties

Recognized as the highest priority of the two phases, the first phase of the restoration, the C-111 SC Western Project PIR features, which are the subject of this DPOM, were intended primarily to generate early benefits to Eastern Florida Bay by reducing seepage from Taylor Slough to the extent that this can

be realized within the current overall Central & South Florida (C&SF) System operations.

Although the features recommended within the C-111 SC Western Project PIR are intended to increase flows to Eastern Florida Bay via Taylor Slough, the project will need to be adaptively managed in order to avoid violating constraints such as impacting the Cape Sable seaside sparrow (CSSS), reducing existing levels of flood protection, and/or causing other unacceptable impacts.

D.3 PROJECT FEATURES

D.3.1 Existing Features

Structure 174 (S-174) is a gated spillway located on the L-31W Canal, approximately 300 feet west of the L-31 West's junction with C-111. Originally used in conjunction with S-332 pump station and S-175 spill way, this structure delivered water to the L-31W Canal, which could either be delivered to Taylor Slough (via S-332), or shunted down the lower L-31E (via S-175). Before backfilling of the L-31 W Canal (September 2007), this structure could remove excess water from either L-31N or the L-31W or both. Since backfilling of the L-31W Canal, the functions of S-174 have been replaced with the S-332D pump station and a detention area, and S174 operations have been discontinued. No changes to the inactive status of S-174 are being recommended within this plan.

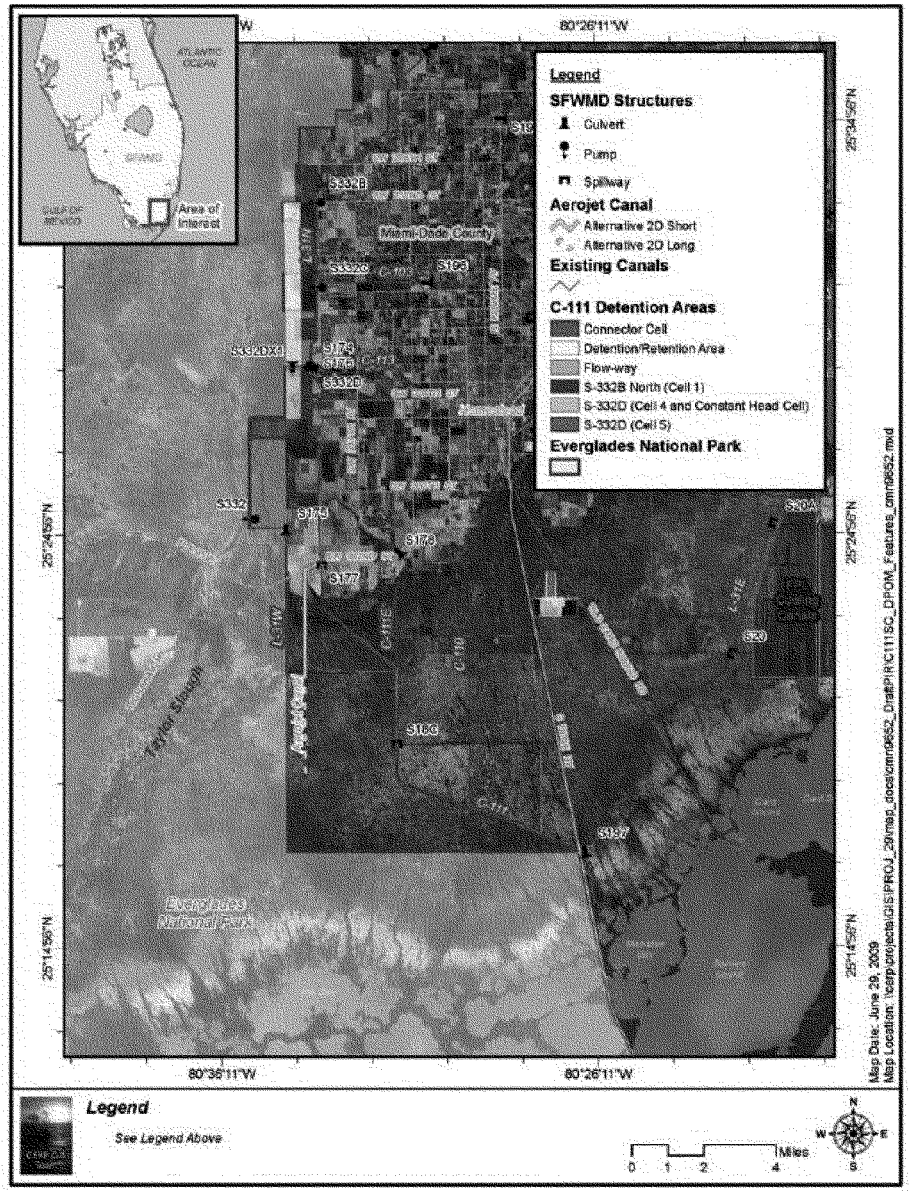


FIGURE D-2: EXISTING FEATURES

D.3.1.1 **Structure 175**

Structure 175 (S-175) is a triple-barreled, reinforced concrete pipe culvert located on L-31W Borrow Canal about 1.5 miles north of Ingraham Highway (State Road [SR] 9336). Originally S-175 was intended to work with the S-174 to maintain upstream water control stages in the L-31W Borrow Canal; however since construction of the S-332D pump station and detention area, releases from S-175 are no longer required for flood protection, and the structure is no longer active. No changes to the inactive status of S-174 are being recommended as part of this plan.

D.3.1.2 **Structure 176**

Structure 176 (S-176) is a reinforced concrete, gated spillway with discharge controlled by a vertical lift gate. S-176 is located on the C-111 Canal approximately five miles west of Homestead, Florida. Originally used in concert with S-174 to maintain a desirable water control stage upstream in the L-31N Borrow Canal, S-176 is now used if S-332D is insufficient, or if S-332D's capacity is limited (e.g. during maintenance). It has the ability to pass the design flood (40 percent of the standard project flood [SPF], 630 cubic feet per second [cfs]) without exceeding upstream flood design stage, and restricts downstream flood stages and discharge velocities to non-damaging levels. During moderately dry conditions, S-176 can pass sufficient flow to maintain stages downstream, within the C-111 Canal, near design levels. As currently envisioned, S-176 operations will not be revised in order to meet project purposes or achieve project benefits.

D.3.1.3 **Structure 177**

Structure 177 (S-177) is a reinforced concrete, gated spillway with discharge controlled by a vertical lift gate. The structure, which is located on the C-111 Canal just downstream from SR 9336 (Ingraham Highway), maintains optimum water levels upstream in C-111 Canal. It passes the design flood (40 percent of the SPF, 1400 cfs) without exceeding upstream flood design stage, and restricts downstream flood stages and discharge velocities to non-damaging levels. During moderately dry conditions, S-177 can pass sufficient flow to maintain stages downstream at levels near the design stages, and helps maintain desirable water control conditions upstream in C-111 Canal. As currently envisioned, changes to S-177 operations will be limited to a conditional 0.1 foot increase in its open criteria. The 0.1 foot increase will be conditioned on the operability of two new electric pump stations to be constructed upstream of S-177 (please see ***SECTION D.3.2***, Proposed Features).

D.3.1.4 **Structure 178**

Structure 178 (S-178) is a single-barreled, reinforced concrete box culvert located at the north end of Canal 111E (C-111E) at Ingraham Highway (SR 9336).

S-178 maintains optimum water control stages upstream in C-111E, passes the design flood (40 percent of the SPF, 510 cfs) without exceeding upstream flood design stages, and restricts downstream flood stages and channel velocities to non-damaging levels. As currently envisioned, S-178 operations will not be revised in order to meet project purposes or achieve project benefits.

D.3.1.5 **Structure 18C**

Structure 18C (S-18C) is a reinforced concrete, gated spillway with discharge controlled by two vertical lift gates. The structure is located on the C-111 Canal approximately six miles downstream of S-177 (six and one half miles upstream from S-197). S-18C maintains a desirable freshwater head against saltwater intrusion upstream and passes flood flows up to 40 percent SPF (2100 cfs) without exceeding design stages upstream, and acts as a control point for water deliveries to the Eastern Panhandle of the Everglades National Park (ENP). As currently envisioned, S-18C's open and/or close triggers may be incrementally increased in order to reduce return seepage to the C-111 Canal, contributing to a net increase in flows to Central Florida Bay via Taylor Slough.

D.3.1.6 **Structure 197**

Structure 197 (S-197) is a thirteen-barreled corrugated metal pipe culvert located near the mouth of the C-111 Canal approximately three miles from the shore of Manatee Bay and 750 feet east of US Highway 1. This structure maintains optimum upstream water control stages in the C-111 Canal, and prevents tidal saltwater from directly entering the C-111 Canal. S-197 is opened infrequently, allowing much of the discharge from S-18C to flow over the lowered banks of the lower C-111 Canal towards the panhandle of ENP. S-197 does however release water during major flood events according to established guidelines. The design discharge rate is 40 percent of the SPF (2400 cfs). As currently envisioned, S-197 operations will not be revised in order to meet project purposes or achieve project benefits.

D.3.1.7 **Structure 332**

Pump Station 332 (S-332) is a six-unit pumping plant located at the head of Taylor Slough on L-31W approximately six miles west of Homestead, Florida. Historically, Pump Station S-332 functioned as a component of the conveyance canal system to ENP and South Dade County. This structure is no longer operated, and the related C-111 South Dade Federal Project has been authorized to decommission and remove the structure. As such, S-332 operations will not be revised in order to meet project purposes or achieve project benefits.

D.3.1.8 **Structure 332I**

Pump Station 332I (S-332I) is co-located with S-332 and consists of three temporary pumps, 100 cfs each. This structure is no longer operated; and the related C-111 South Dade Project has been authorized to decommission and remove the structure. As such, S-332I operations will not be revised in order to meet project purposes or achieve project benefits.

D.3.1.9 **Structure 322B**

Pump Station 332B (S-332B) is located approximately 2.3 miles upstream of S-177 on the L-31N Canal. The primary purpose for the pump station is to pump water from the canal upstream of S-176 into the (currently) 240 acre S-332B North Detention Area, and the (currently) 160 acre S-332B West Detention Area. The pump station contains four diesel driven pumps with 125 cfs capacity each and one electric motor pump with 75 cfs capacity. The pump station is intended to maintain a hydraulic ridge between the southern limits of the 8.5 Square Mile Area (8.5 SMA) stormwater treatment area (STA) to the northern limit of the S-332C detention area. Under current operational guidance (Interim Operating Plan [IOP]), no more than two of the 125 cfs diesel pumps can pump into the S-332B North Detention Area, and no more than two of the 125 cfs diesel pumps (and the single 75 cfs electric pump) can pump into the S-332B West Detention Area. As currently envisioned, S-332B operations will not be revised in order to meet project purposes or achieve project benefits.

D.3.1.10 **Structure 332C**

Pump Station 332C (S-332C) is located approximately 1.2 miles upstream of S-177 on the L-31N Canal. The primary purpose for the pump station is to pump water from the canal upstream of S-176 into the (currently) 300 acre S-332C detention area. The pump station contains four diesel driven pumps with 125 cfs capacity each and one electric motor pump with 75 cfs capacity. The pump station is intended to extend the hydraulic ridge from S-332B West cell to the hydraulic ridge created by the S-332D detention area. Under current operational guidance (IOP), maximum pumping of 500 cfs may occur from July 16 to November 31; 325 cfs from December 1 to January 31; and 165 cfs from February 1 to July 15. As currently envisioned, S-332C operations will not be revised in order to meet project purposes or achieve project benefits.

D.3.1.11 **Structure 332D**

Pump Station 332D (S-332D) is located at the junction of the L-31N and the L-31W Borrow Canal. The primary purpose for the pump station is to pump water from the canal upstream of S-176 into the 2,090 acre S-332D detention area. The pump station contains four diesel driven pumps with 125 cfs capacity each and one electric motor pump with 75 cfs capacity. Under current

operational guidance (IOP), maximum pumping of 500 cfs may occur from July 16 to November 31; 325 cfs from December 1 to January 31; and 165 cfs from February 1 to July 15. As currently envisioned, S-332D operations will not be revised in order to meet project purposes or achieve project benefits.

D.3.1.12 **Structure 20**

Structure 20 (S-20) is a reinforced concrete, gated spillway with discharge controlled by a vertical lift gate. The structure is located on L-31E Canal approximately three miles from the shore of Biscayne Bay. Although the area served by this structure is largely wetlands, some mixed uses continue to be served by this structure. This structure was designed to pass the design flood (40 percent of the SPF, 450 cfs), without exceeding upstream flood design stage, to restrict discharge velocities to non-damaging levels, and to prevent tidal saltwater from directly entering the L-31E Canal. As currently envisioned, S-20's normal open and close trigger will be increased 0.5 foot, to prevent over-drainage of the S-20 Basin, increase hydroperiods within the Model Lands, and reduce overall seepage losses from the west.

D.3.1.13 **Structure 20A**

Structure 20A (S-20A) is a reinforced concrete, gated spillway located on L-31E Canal approximately two miles from the shore of Biscayne Bay. Originally intended to assist S-20 in maintaining optimum water control stages, S-20A is no longer operational, and no changes have been recommended in order to meet project purposes or achieve project benefits.

D.3.1.14 **L-31N Levee and Canal**

Levee 31 North (L-31N) is the flood protection levee which prevents overflow from ENP into the mixed use development to the east. The levee extends from its northern limit, near Tamiami Trail to its southern limit, immediately north of Pump Station S-332D. The L-31N Borrow Canal is a key part of the South Dade Conveyance System (SDCS). As currently envisioned, L-31N Levee and Canal operations will not be revised in order to meet project purposes or achieve project benefits.

D.3.1.15 **Levee 31 West and Canal**

Levee 31 West (L-31W) extends west from its junction with L-31N Levee to the ENP boundary and then follows southward for approximately eight miles. The L-31W Levee Canal collects seepage from the west and runoff from the east. Portions of L-31 W Levee Canal have recently been filled under the C-111 South Dade Federal Project and additional filling will take place under subsequent phases of the C-111 South Dade Federal Project. L-31W Levee Canal operations will not be revised in order to meet project purposes or achieve project benefits.

D.3.1.16 **Levee 31 East and Canal**

Levee 31 East (L-31E) extends from north of the C-1 Canal to Card Sound Road (Old Dixie Highway), and contains S-20, and the inoperable S-20A. The purpose of this levee is to protect lands west of the levee from inundation by tide-associated flooding. As currently envisioned, an earthen plug will be installed within the L-31E Canal, just downstream of the inoperable S-20A structure, to serve as a drainage divide, to increase hydroperiods within the Model Lands, and to reduce overall seepage losses from the west.

D.3.1.17 **Canal 111**

Canal 111 (C-111) begins downstream of S-176 and continues southward approximately 1.1 miles south of S-177 where C-111 turns southeast to the intersection of C-111E, a distance of approximately 2.7 miles. C-111 then continues due south approximately three miles, then southeast for approximately five and a half miles to structure S-197. The C-111 Canal meanders generally southeast for another two and a half miles (+/-) to its point of discharge at Manatee Bay. As described in the description of structure S-18C, and within ***SECTION D.7.1***, Achieving Natural System Goals, Objectives, and Benefits, water levels within the reach of the C-111 Canal between S-177 and S-18C will be incrementally increased in order to reduce return seepage to the C-111 Canal, which will contribute to a net increase in flows to Central Florida Bay via Taylor Slough. Additionally, construction of a new gated spillway (S-198) between S-18C and S-197 will reduce current levels of seepage from the lower C-111 Canal, while preserving existing levels of flood damage reduction.

D.3.1.18 **Canal 111 East**

Canal 111 East (C-111E) originates downstream of structure S-178, which controls water elevations within Loveland Slough area. The C-111E initially runs parallel to, and approximately one mile east of, the C-111 Canal. The C-111E routes S-178 discharges to the C-111 Canal, at its point of confluence with the C-111 Canal, slightly more than three miles south of S-178. C-111E was designed to remove the 40 percent SPF runoff and reduce the depth and duration of floods exceeding design conditions. Stages within the C-111E Canal, which are also dependent on S-18C operations, may be incrementally increased as a result of incremental increase in S-18C open and/or close triggers. These increased stages should further reduce the net volume of water seeping from the west.

D.3.1.19 **Canal 110**

Canal 110 (C-110) is located to the east of C-111E and extends southward from S.W. 392nd Street to the C-111 Canal. The C-110 was originally intended to remove the 40 percent SPF runoff, and to reduce the depth and duration of

floods exceeding design conditions. As currently envisioned, the C-110 Canal will be backfilled in its entirety, or have a series of earthen plugs installed at key locations in order to promote sheet flow within the southern Everglades. Excess spoil not utilized in construction of the plugs may also be placed into the canal to further promote sheetflow and to lessen the effects of any remaining canal segments. The intent of the plugging and/or backfilling is to eliminate year-round, canal-attributable overdrainage of the southern Everglades, and to promote more natural sheetflow within this area.

D.3.1.20 **Aerojet Canal**

The Aerojet Canal begins approximately one mile south of Ingraham Highway (SR 9336) and continues south along Aerojet Road (S.W. 232nd Avenue) for a distance of approximately 4.6 miles. The canal was originally constructed to barge solid rocket boosters from the Aerojet complex, but construction was suspended on the canal before it was connected to the C-111 Canal. Several plugs currently exist along the length of the canal, and the C-111 South Dade Federal Project authorized additional plugs. As currently envisioned, the Aerojet Canal will be converted to a linear hydraulic cutoff feature fed by a 225 CFS pump station (three 75 cfs electric pumps), which will be constructed immediately upstream of S-177 (downstream of Ingraham Highway). The existing earthen plugs will be scraped down approximately one foot, and additional earthen weir/plugs will be constructed to elevations approximately one foot below the existing adjacent marsh grades. These plugs will reduce seepage losses to the south year round, and during pumping events, will result in higher heads in the upper canal reaches and reduce seepage from the headwaters of Taylor Slough. Berms will be constructed at those locations along the canal where sufficient elevations do not exist to contain the flows which will be delivered via the proposed pump station.

The S-332 B West Detention Area was constructed as part of the emergency construction required by the Interim Operation Plan for Protection of the Cape Sable Seaside Sparrow (IOP for Protection of the CSSS). This detention area along with S-332B West and S-332C were intended to create a hydraulic ridge to the extent possible with the limited area available at that time. The S-332B North Detention Area currently covers approximately 240 acres and can receive flow from two of the four 125 cfs diesel pumps located within the temporary S-332B pump station. This Detention Area has been functional since April 30, 2003. Operations are generally limited to one 125 cfs pump due to the depth limit of 2.0 feet (stage of about 8.0 feet NGVD).

The S-332B North detention area will be enlarged and connected to the 8.5 SMA STA. Once enlarged this detention area will be call the C-111 North Detention Area (NDA). The NDA will extend from and include what is now the S-332B North detention area and end at the 8.5 SMA STA. The final detention area will

cover an area of approximately 1,440 acres which is about 1,200 acres more than the 460 acres provided by S-332B North. Although work will continue to expand these Detention Areas, no changes to their operations are recommended as part of this plan.

D.3.1.21 **C-111 South Detention Area formerly S-332 B West and S-332C**

The S-332B West Detention Area covered approximately 160 acres and received flow from two of the four 125 cfs diesel pumps and the 75 cfs electrical pump located within the temporary S-332B pump station. This Detention Area initially became functional on April 17, 2000.

The S-332C Detention Area covered approximately 300 acres and received flow from four 125 cfs diesel pumps and a single 75 cfs electric pump located within the temporary S-332C pump station. This Detention Area was functional since August 2, 2002.

The S-332B West and S-332C detention areas were expanded and connected by construction started in 2008 and completed in May of 2009. This detention area is now called the C-111 South Detention Area (SDA). The SDA receives inflow from both the S-332B (two 125 cfs diesel pumps and one 75 cfs electrical pump) and S-332C pump station. The SDA extends from and include what is now the S-332B West and S-332C detention areas and end at the S-332D system. The SDA is about 300 feet wide and covers an area of approximately 1,300 acres which is about 840 acres more than the 460 acres currently provided by S-332B West and S-332C detention areas.

D.3.1.22 **S-332 D Detention Area**

S-332 D Detention Area routes discharges from the S-332D pump station west to a high head cell, and then through two detention areas (south then west) and finally through a flow way area (south) before discharging into Taylor Slough near S-332. The S-332D pump station originally became operational on August 31, 1999, and began discharging water into the L-31W Borrow Canal. In June 2002, the S-332D Detention (Frog Pond) Area came online. The detention area includes a high head cell, two cascading detention areas, and a flow way. The S-332D Header Cell covers approximately 39 acres, has an average bottom elevation of approximately 5.5 feet NGVD (4.0 feet NAVD) and a 1,820-foot long discharge weir with a crest elevation of 8.2 feet NGVD (6.7 feet NAVD). The weir discharges into the first detention area (Cell 4) which covers approximately 350 acres, has an average bottom elevation of approximately 5.3 feet NGVD (3.8' NAVD), and an earthen berm that acts as a broad crested weir with a top elevation of approximately 6.7 feet NGVD (5.2 feet NAVD). This detention area discharges to a second detention area (Cell 5) which covers approximately 400 acres, has an average bottom elevation of 5.1 feet NGVD (3.6 feet NAVD), and a

weir crest elevation of approximately 6.0 feet NGVD (4.5 feet NGVD). The 1,900-foot long weir is constructed of concrete and discharges into the scraped portion of the flow way which covers an area of approximately 1,300 acres. The flow way discharges through an approximately 2,000 foot-long levee gap located in the southwest corner of the flow way near S-332, which directs flow towards Taylor Slough. Although work will continue around this facility (e.g. L-31 W filling, and connections to S-332 C), no changes to their operations are recommended as part of this plan. The approximate locations of the S-332B, C, and D facilities are shown in ***FIGURE D-3*** below.

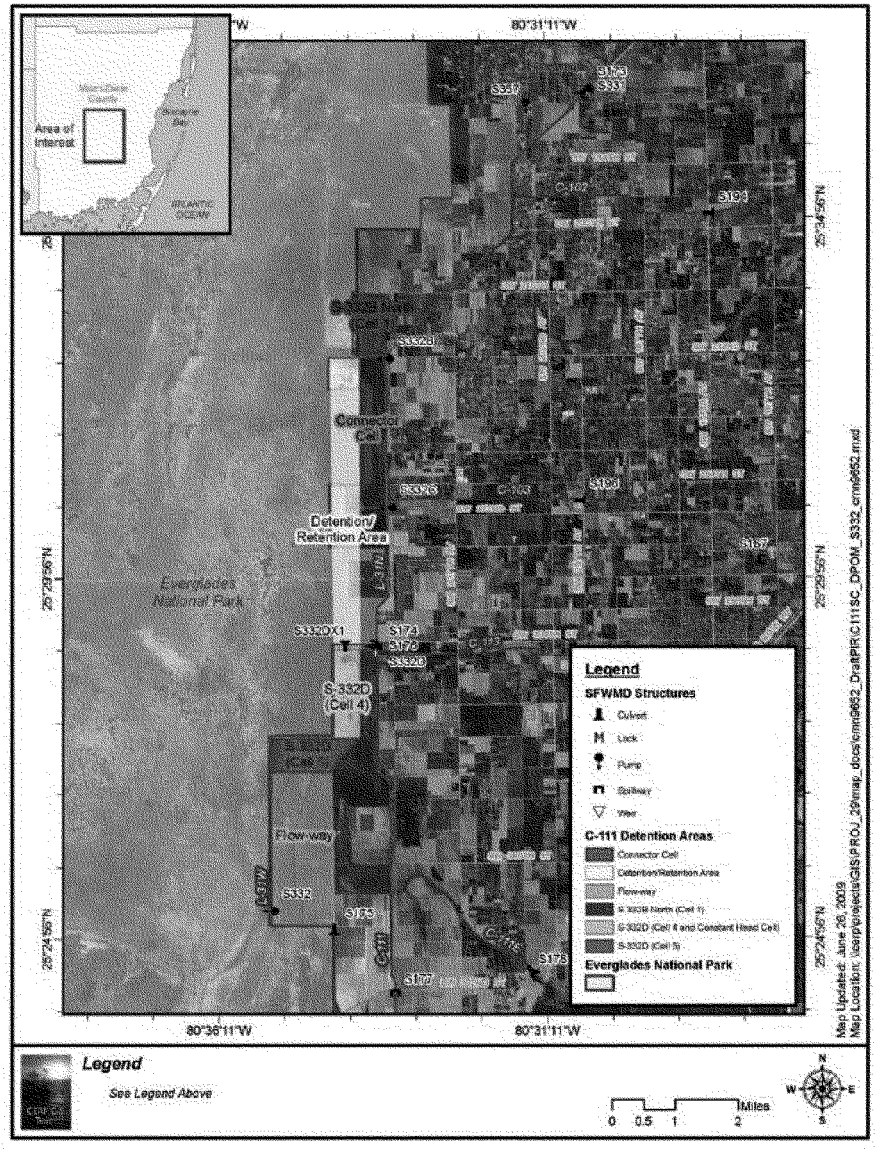


FIGURE D-3: C-111 SOUTH DETENTION AREA AND S-332D DETENTION AREA

D.3.2 Proposed Features

D.3.2.1 **S-200 Pump Station**

The S-200 Pump Station is a new 225 cfs (three electric 75 cfs pumps) pump station to be constructed downstream of S-176. When triggered by increased stages between S-176 and S-177, the pump station will route water to a 510-acre (exterior dimension) above-ground impoundment called the Frog Pond Detention Area (FPDA), which will be constructed within the southern portion of the South Florida Water Management District (SFWMD)-owned Frog Pond Lands (***FIGURE D-4)***.

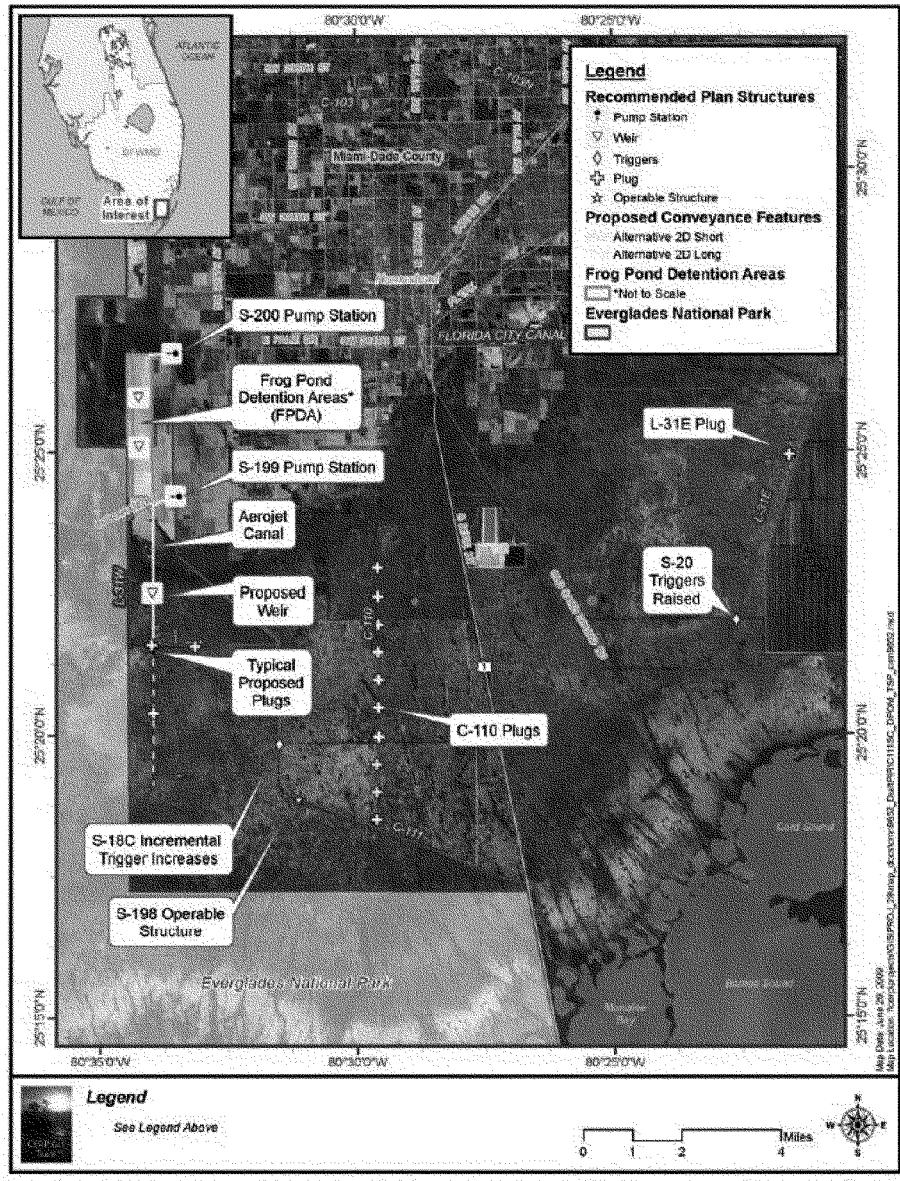


FIGURE D-4: PROPOSED FEATURES

D.3.2.2 **Frog Pond Detention Area**

The FPDA will contain a header canal with cascading water levels maintained by a series of internal weirs at a maximum depth of two and a half feet above ground. When sufficient water is available, the header canal will "feed" a series of three overflow detention cells. Weirs will be constructed between the header canals and receiving overflow cells to ensure that the header canal remains flooded prior to discharging any overflow to the detention cells. The header cell will be fed by a lined conveyance channel located along the northern limits of the detention area. The 225 cfs pump station (S-200) will consist of three 75 cfs pumps to allow stepped operations. In order to prevent overflowing, pumping will be discontinued if the elevation of the header canal exceeds two and a half feet above the existing ground. Pumping at S-200 will cease if ponding at a pre-determined representative site within designated CSSS Critical Habitat Unit 2 (west of the FPDA) exceeds ten centimeters during the critical portion of the nesting season, as identified by U.S. Fish and Wildlife Service (FWS) (February 1st thru July 15th) and the Hydrometeorological Monitoring ***Annex E*** of the PIR.

D.3.2.3 **S-199 Pump Station**

The S-199 Pump Station will be a second 225 cfs pump station (three 75 cfs pumps), constructed immediately upstream of S-177, downstream of Ingraham Highway (SR 9336). This pump station will work in tandem with the FPDA, and will have similar operating criteria. This pump station will discharge water to a proposed aboveground flow way, which will in turn discharge to an aboveground extension of the Aerojet Canal. Similar to the FPDA Pump Station, pumping will be discontinued if the elevation of the canal exceeds two and a half feet above existing ground. Pumping at S-199 will cease if ponding at a pre-determined representative site within designated CSSS Critical Habitat Unit 3 (south of the FPDA and Aerojet Canal) exceeds ten centimeters during the critical portion of the nesting season, as identified by FWS (February 1st thru July 15th) and the Hydrometeorological Monitoring ***Annex E*** of the PIR.

D.3.2.4 **Aerojet Canal**

The Aerojet Canal will be extended north in order to meet the above- ground flow way described above. Although constructed above ground, the bottom of this feature will be scarified, and a weir constructed at its downstream end, to encourage groundwater mounding over its entire length. Within the existing portions of the Aerojet Canal, existing earthen plugs will be scraped down approximately one foot, and additional earthen weir/plugs will be constructed to elevations approximately one foot below the existing adjacent marsh grades. These plugs will reduce seepage losses to the south year round, will assist pumped water to achieve higher heads in the upper canal reaches, and will help

reduce seepage from the headwaters of Taylor Slough. Berms will be constructed at those locations along the canal where sufficient elevations do not exist to contain the flows which will be delivered via the proposed pump station, S-199.

D.3.2.5 **S-198 Structure**

The S-198 Structure will be constructed in the C-111 Canal between S-18C and the C-110 Canal. The operable gated spillway is intended to reduce current levels of seepage from the lower C-111 Canal, while preserving existing levels of flood damage reduction.

D.3.2.6 **S-18C Operations**

Operational Testing and Monitoring of Incremental Changes in S-18C Operations have been included within the plan in order to test whether additional restoration can be realized while maintaining existing levels of flood damage reduction. Open and close triggers will be increased in increments of no more than 0.1 feet at any time and the total increased change in the open trigger criteria shall not exceed 0.4 feet. Stage override triggers will be established immediately downstream of S-177 and/or in the adjacent farm fields to establish a "backstop" at which S-18C triggers will return to their highest "successful" increment (see ***HYDROMETEOROLOGICAL MONITORING, ANNEX E***).

D.3.2.7 **S-20 Triggers**

Increased Open and Close Triggers at S-20 of up to one half foot in the normal open and close triggers have been included within this plan in an attempt to more closely mimic pre-drainage hydroperiods within the Model Lands. The proposed increases in S-20 triggers may need to be done in an incremental manner, somewhat similar to the proposed incremental testing at S-18C, and coordinated with Turkey Point Power Plant cooling canal operations, in order to minimize impacts to Turkey Point and/or other landowners within the basin.

D.3.2.8 **L-31E Near S-20A Plug**

A Permanent Plug in the L-31E Near S-20A has been included within the plan. Similar to the Increased Open and Close Triggers at S-20 described above, this is a further attempt to more closely mimic pre-drainage hydroperiods within the Model Lands. Similar to the increased open and close triggers at S-20, the plug may need to be constructed in an incremental manner, and coordinated with Turkey Point Power Plant cooling canal operations, in order to minimize impacts to Turkey Point and/or other landowners within the basin.

D.3.3 Removed Features

D.3.3.1 **C-110 Canal Plugging or Backfill**

C-110 Canal Plugging or Backfill is proposed as part of this plan. Depending on the local availability of fill material, the plan includes backfilling and/or construction of earthen plugs at key locations within the C-110 Canal in order to promote sheet flow within the Southern Glades. As currently envisioned, at a minimum, nine plugs will be constructed at semi-regular intervals by using the original spoil material which was placed along the excavated canal banks. Excess spoil not used for construction of the plugs may be placed in the canal to fill residual canal segments between plugs and/or shallow the canal depth to further promote sheetflow and to lessen the effects of any remaining canal segments. If suitable material is identified offsite, it may be used to supplement the existing fill, up to the degree necessary to entirely fill the canal.

D.4 **PROJECT RELATIONSHIPS**

There are several projects that may affect the C-111 SC Project. This plan has been developed based on the operations of existing related projects, and/or related planned projects with approved operating plans, including both CERP and non-CERP activities. A summary of each related project and its relationship to the C-111 SC Project is provided below.

D.4.1 C-111 SC Eastern Project PIR

The overall C-111 SC Project will be authorized via two separate, yet related, PIRs. The C-111 SC Western PIR is the focus of this first DPOM. The subsequent Eastern PIR, which will make recommendations regarding construction of a full scale spreader canal to replace the existing lower C-111 Canal, will be described in a separate DPOM. Although the C-111 SC Eastern project will chronologically follow the C-111 SC Western project, it is important to note that the POM for the C-111 SC Eastern project could precipitate changes to the C-111 SC Western project POM, or wholly supersede it.

D.4.2 C-111 South Dade Project

The C-111 General Reevaluation Report (GRR) recommended project modifications designed to maintain existing flood damage reduction and other C&SF Project purposes in developed areas east of the C-111 Canal while restoring more natural hydrologic conditions in the Taylor Slough, Florida Bay, and the eastern panhandle area of ENP. Structural components include the degradation of the lower four miles of the L-67 extension canal, raising of the western levee of the S-332B detention area to reduce the frequency of surface water flows from the detention cell into ENP, construction of the temporary S-332C Pump Station, construction of four new reservoirs within the C-111

Project area (S-332B north detention area, S-332C detention area, connector detention area between S-332B and S-332C detention areas, and the S-332D detention area), and construction of a temporary S-356 Pump Station to discharge from L-31N Canal into the L-29 Canal. The C-111 GRR, approved in July 1994, recommends the development of an operational plan for Shark River Slough and Taylor Slough as part of the Experimental Program. The 1994 GRR approved nine plugs in the C-110 Canal (a feature which was subsequently passed to the C-111 SC Project team) and backfill for L-31W from S-176 west all the way around to S-332. The POM for the C-111 South Dade Federal Project will be reviewed and revised, as needed, to incorporate any operational changes recommended within this POM.

D.4.3 Modified Water Deliveries to Everglades National Park Project

When implemented, the Modified Water Deliveries (MWD) to the ENP will authorize structural improvements and additions to the existing C&SF Project which will support more natural hydrologic conditions in ENP. These improvements include the construction of several structures, modifications to existing S-334, and raising Highway US 41 (Tamiami Trail) where it crosses L-31N. While the proposed construction and modifications may impact the quantity and timing of water received in the C-111 Basin, because the C-111 SCWF "takes what is given", it is not anticipated that the POM for the C-111 Federal Project will need to be revised to include changes recommended within MWD.

D.4.4 Interim Operational Plan for Protection of the Cape Sable Seaside Sparrow

The IOP is a set of alternative water management practices employed to protect the federally listed endangered CSSS. The operational component is a marsh-driven plan for management of the structural components. The net effect of the IOP operations is to lessen the quantity of water near CSSS Sub-population A during the nesting season, and provide more water to the sparrow populations on the east side of ENP by routing water around ENP with usage of new temporary pumps to both maintain flood control levels in the canals, and allow seepage into Taylor Slough through the new detention ponds constructed under the C-111 South Dade Federal Project. In addition, it contains rules to maintain flood protection for areas east of ENP. While IOP certainly affects the quantity and timing of water received in the C-111 Basin, because the C-111 SC Western project "takes what is given", it is not anticipated that the POM for the C-111 South Dade Federal Project will need to be revised to include changes recommended within MWD. The IOP will be reviewed and revised, as needed, to incorporate operational changes recommended within this POM.

D.4.5 Combined Operational Plan for the Modified Water Deliveries to the Everglades National Park and C-111

The Combined Operational Plan for the MWD ENP and C-111 Canal will establish a long-term operations plan for the C-111 Canal and MWD. The combined operational plan will specify the operations for the C-111 Canal and MWD Project components including conveyance between Water Conservation Area (WCA)-3A and 3B, seepage control on the east side of ENP, and elevated portions of Tamiami Trail between WCA-3B and ENP to restore more natural flows into ENP. Implementation of the combined operational plan could precipitate changes to the operations described within this POM. However, the scope of those changes, if any, is impossible to determine at this time.

D.4.6 Biscayne Bay Feasibility Study

The purpose of the reconnaissance phase of the Biscayne Bay Feasibility Study is to determine if there is a need for additional water in Biscayne Bay (over and above the amount anticipated from CERP), define the federal interest in providing additional water to those areas, and identify a non-federal interest to participate in a cost-shared feasibility study to determine the adverse and beneficial environmental, social, and economic impacts of providing additional water to Biscayne Bay. The study area provides a boundary to the C-111 SC Basin. It is premature to determine if the implementation of structural or operational changes recommended within Combined Structural and Operational Plan (CSOP) would precipitate changes to the operations described within this POM.

D.4.7 Biscayne Bay Coastal Wetlands Project

The Biscayne Bay Coastal Wetlands (BBCW) CERP Project is intended to rehydrate wetlands and reduce point source discharge, improve water quality and provide more natural timing and quantity of water to Biscayne Bay. The proposed project will replace lost overland flow and partially compensate for reduction in groundwater seepage by redistributing, through a spreader system, available surface water entering the area from regional canals. The project includes pump stations, spreader swales, STAs, flow ways, levees, culverts, and backfilling canals. The southern limit of the BBCW Project conceptual footprint reaches very close to the eastern limit of the C-111 SC Project. The project should compliment the C-111 SC Project by adding water to the wetlands in the northern area of the Model Land, however, it is premature to determine if the BBCW CERP Project would precipitate changes to the operations described within this DPOM.

D.4.8 Florida Bay and Florida Keys Feasibility Study

The Florida Bay and Florida Keys (FB&FK) Feasibility Study was intended to take a comprehensive look at the FB&FK marine environments, and the actions and land uses upstream, to determine the modifications that are needed to successfully restore water quality and ecological conditions of Biscayne Bay. The reconnaissance phase of this project was followed by the Biscayne Bay Feasibility Study, Phase 1, for which Miami-Dade County was the local sponsor. Biscayne Bay Feasibility Study, Phase 1 provided only for the development of a hydrodynamic tool that could address the questions raised in the Reconnaissance Study. The tool was the TABS-MDS hydrodynamic model that was eventually used in the BBCW CERP Project to support alternative development. Phase 2, a concept to couple a water quality modeling tool to the existing hydrodynamic model, has been placed on indefinite hold because the technology is not yet available to provide effective coupling between the Phase 1 model and available water quality modeling tools. It is pre-mature to determine if the FB&FK Feasibility Study would precipitate changes to the operations described within this DPOM.

D.4.9 Florida Power and Light's South Dade Mitigation Bank

Florida Power and Light's (FP&L's) mitigation bank consists of 13,367 acres of wetland interspersed within the Model Lands project area. In addition to preservation, numerous hydrologic improvements have been, or will soon be, implemented. While most changes anticipated as part of this DPOM should be complementary, any unanticipated adverse impacts could precipitate changes to the operations described within this DPOM.

D.4.10 RMC South Florida, Inc. Mitigation Area

RMC South Florida, Inc. owns and operates rock mines between US Highway 1 and Card Sound Road, south of Florida City. Approximately 1147 acres in the northern part of the Model Lands north of the mining operation are to be restored as mitigation for the rock mines. Similar to FP&L's Mitigation Bank, while most changes should be complementary, any unanticipated adverse impacts could precipitate changes to the operations described within this POM.

D.4.11 West Dade Wastewater Reuse Technology Feasibility Study

Miami-Dade County Water and Sewer Department (MDWSD) is sponsoring the study of constructing a new 100–150 million gallons per day (MGD) regional wastewater facility in western Dade County that can treat and reuse reclaimed water from municipal sources. Similar to FP&L's Mitigation Bank, while most changes should be complementary, any unanticipated adverse impacts could precipitate changes to the operations described within this DPOM.

D.5 MAJOR CONSTRAINTS

Because this project relies heavily on the re-distribution of existing water, without due consideration during preliminary project design, development of this operating plan, and during adaptive management, there would be a risk of violating one or more of the constraints described below.

D.5.1 Existing Legal Users, Levels of Flood Damage Reduction, and Water Quality

Section 601(h)(5)(A) of the Water Resources Development Act (WRDA) requires that "Until a new source of water supply of comparable quantity and quality as that available on the date of enactment of this Act (December 11, 2000) is available to replace the water to be lost as a result of implementation of the Plan, the Secretary and the non-Federal sponsor shall not eliminate or transfer existing legal sources of water, including those for:

- an agricultural or urban water supply;
- allocation or entitlement to the Seminole Indian Tribe or Florida under Section 7 of the Seminole Indian Land Claims Settlement Act of 1987 (25 U.S.C. 1772e);
- the Miccosukee Tribe of Indians of Florida;
- water supply for Everglades National Park; or,
- water supply for fish and wildlife."

Section 601(h)(5)(B) of the WRDA requires that implementation of the Plan shall not reduce levels of service for flood protection that are;

i. in existence on the date of enactment of this Act (December 11, 2000); and
ii. in accordance with applicable law.

Florida Statute 373.1501(5)(d) similarly requires that the quantity of water available to existing legal users shall not be diminished by implementation of project components so as to adversely impact existing legal users, that existing levels of flood protection will not be diminished outside the geographic area of the project component, and that water management practices will continue to adapt to meet the needs of the restored natural environment."

The Endangered Species Act requires that federally listed endangered and/or threatened species and/or their critical habitats are not adversely affected by the proposed project. The Cape Sable seaside sparrow (CSSS) is an endangered species with critical habitat at the headwaters of Taylor Slough and in the area south of Aerojet Canal and west of the C-111 Canal. In order to allow for successful nesting, surface water levels must be limited in these areas.

Florida Statutes also require that all surface water discharges meet State Water Quality Standards. Discharges to the Everglades Protection Area will also have to meet the terms of the Settlement Agreement.

The above constraints have been recognized during preliminary design, and assurances have been incorporated into the development of this operating plan to reduce this risk. It is important that operators remain vigilant to ensure that this risk continues to be considered when applying any necessary adaptive management measures.

D.5.2 Structural Stability

Project operators will need to continue to ensure that safe levels are maintained in all canals in reservoirs from a structural stability perspective. Consideration has been given during preliminary design, and assurances have been incorporated into the development of this operating plan to ensure structural stability during the normal course of operations, and the Final POM will include maximum head differences which can be maintained across all new structures. Existing structures will be operated in accordance with their current operational limits for structural stability.

D.5.3 Minimum water supply to ENP

A minimum water supply to ENP from the C&SF Project was guaranteed in June 1970 by PL 91-282. This law stipulated that an annual minimum of 315,000 acre-feet or 16.5 percent of total project deliveries, whichever is less, would be distributed to ENP on a monthly basis. This included 270,000 acre-feet to Shark River Slough via the S-12 structures; 37,000 acre-feet to Taylor Slough at S-332; and 18,000 acre-feet to the eastern Panhandle at S-18C. Subsequent acts have authorized the USACE to modify the schedule of water deliveries to ENP, including IOP for protection of the CSSS. Under IOP, S332D is operated to meet the Taylor Slough rainfall formula discharge. The minimum water supply needs of ENP have been recognized during preliminary design, and assurances have been incorporated into the development of this operating meet this requirement. It is important that operators remain vigilant to ensure that this risk continues to be considered when applying any necessary adaptive management measures.

D.5.4 Saltwater Intrusion

Portions of aquifer underlying the project area are at increased risk of saltwater intrusion because of their proximity to the coast, low elevation, highly transmissive aquifer characteristics, and/or geographical relation to permitted water users. The potential for salt water intrusion has been recognized during preliminary design, and assurances have been incorporated into the development of this operating plan to reduce this risk. It is important that

operators remain vigilant to ensure that this risk continues to be considered when applying any necessary adaptive management measures.

D.6 STANDING INSTRUCTIONS TO PROJECT OPERATORS

The standing instructions which follow are to be used for the normal day-to-day operations for all proposed and existing structures. Unless otherwise noted, existing structures will continue to be operated under the current IOP for the protection of the CSSS, until such time that these operations are superseded by the Combined Operating Plan for the MWD and South Dade C-111 Projects.

The proposed C-111 SCWF Project will result in two new operable pump stations upstream of S-177 (S-200 and S-199), and a new gated spillway between S-18C and S-197 (S-198). Pump Station S-200, to be constructed downstream of S-176, is intended to initiate pumping prior to reaching the open trigger for flood control operations at S-177 (currently when the headwater stage at S-177 reaches elevation 4.2 feet NGVD). It consists of three individual 75 cfs electric pumps which will trigger according to the schedule depicted in ***TABLE D-1*** below.

TABLE D-1: PUMP STATION S-200 ON/OFF TRIGGERS
(*w/ S-177 Open/Close Shown for Comparison)

Pump	Rating	Pump On Elevation	Pump Off Elevation
S-200A	75 CFS	3.8 ft (NGVD)/2.3 ft (NAVD)	3.6 ft (NGVD)/2.1 ft (NAVD)
S-200B	75 CFS	3.9 ft (NGVD)/2.4 ft (NAVD)	3.6 ft (NGVD)/2.1 ft (NAVD)
S-200C	75 CFS	4.0 ft (NGVD)/2.5 ft (NAVD)	3.6 ft (NGVD)/2.1 ft (NAVD)
*S-177	1400 CFS	Open 4.3 ft (NGVD)/2.8 ft (NAVD)	Close @ 3.6 ft NGVD/2.1 ft (NAVD)

As described in the Existing Features section of this document, open trigger at S-177 will be conditionally increased by 0.1 foot in order to accommodate the addition of three new pump trigger elevations. The 0.1 foot increase will be specifically conditioned on the ability of the two new electric pump stations to be fully operational. If something (e.g. loss of electric power) should render either station temporarily inoperable, S-177's open trigger will revert to its current elevation of 4.2 feet NGVD (2.7 feet NAVD).

During current operations of the S-332D Pump Station, a significant amount of the pumped water returns to the C-111 Canal as seepage from one or more of the

S-332D cells. In order to reduce S-177 openings, the S-200 pumps may also be used on a "one-to-one" basis with the 125 cfs pumps at Pump Station S-332D, at any time that the S-177 headwater is at or above elevation 3.8 feet NGVD (2.3 feet NAVD). For example if two of the 125 cfs diesel pumps are on at S-332D, and S-177's headwater is at least 3.8 feet NGVD (2.3 feet NAVD), then up to two of the S-200 pumps can be turned on independent of the stages in ***TABLE D-1*** and ***TABLE D-2***.

To avoid overtopping, and to ensure the stability of the FPDA, pumping will cease if stages in northernmost detention cell (Cell 1) reach a stage of 7.5 feet NGVD (6.0 feet NAVD). Operations at S-200 will also cease for protection of the CSSS, if ponding at a pre-determined representative site (see Hydrologic Monitoring Annex) within designated CSSS Critical Habitat Unit 2 exceeds ten centimeters during the critical portion of the nesting season, as identified by the FWS (February 1st thru July 15th) and the Hydrologic Monitoring Annex.

Operations at Pump Station S-199, which is to be constructed immediately upstream of S-177 (downstream of Ingraham Highway [SR 9336]) will mirror those at S-200, as depicted in ***TABLE D-2*** below.

TABLE D-2: PUMP STATION S-199 ON/OFF TRIGGERS
(*w/ S-177 Open/Close Shown for Comparison)

Pump	Rating	Pump On Elevation	Pump Off Elevation
S-199A	75 cfs	3.8 ft (NGVD)/2.3 ft (NAVD)	3.6 ft (NGVD)/2.1 ft (NAVD)
S-199B	75 cfs	3.9 ft (NGVD)/2.4 ft (NAVD)	3.6 ft (NGVD)/2.1 ft (NAVD)
S-199C	75 cfs	4.0 ft (NGVD)/2.5 ft (NAVD)	3.6 ft (NGVD)2.1 ft (NAVD)
*S-177	1400 cfs	Open 4.3 ft (NGVD)/2.8 ft (NAVD)	Close @ 3.6 ft (NGVD)/2.1 ft (NAVD)

Similar to the Frog Pond Detention Area, in order to avoid overtopping, and to ensure the stability of, the Aerojet Canal perimeter berms, pumping will cease if stages downstream of S-199 reach a stage of 5.5 feet NGVD (4.0 feet NAVD). Operations at S-200 will also cease for protection of the CSSS, if ponding at a pre-determined representative site (see Hydrologic Monitoring Annex) within designated CSSS Critical Habitat Unit 3 (south of the FPDA and Aerojet Canal) exceeds 0.328 feet (ten centimeters) during the critical portion of the nesting season, as identified by FWS (February 1st thru July 15th) and the Hydrologic Monitoring Annex.

The proposed structure S-198, which is to be constructed between S-18C and the existing S-197, structure is intended to reduce current levels of seepage from the lower C-111 Canal, while preserving existing levels of flood damage reduction. As such, its operations will mimic those of S-197.

As described in ***SECTION D.3***, as part of this project, S-20 open and close trigger stages will be increased one half foot. Under the revised operational criteria, the operational triggers will be as depicted in ***TABLE D-3*** below.

TABLE D-3: REVISED OPERATIONAL CRITERIA FOR S-20

Trigger	Action
Normal Operations	
Headwater Rises to El. 2.9 ft (NGVD)/1.4 ft (NAVD)	Gate Open at 6 inches/minute
Headwater Rises or Falls to El. 2.6 ft (NGVD)/1.1 ft (NAVD)	Gates Become Stationary
Headwater Falls to El. 2.3 ft (NGVD)/0.8 ft (NAVD)	Gate Close at 6 inches/minute
Emergency Flood Fighting Mode	
Headwater Rises to El. 1.4 ft (NGVD)/-0.1 ft (NAVD)	Gate Open at 6 inches/minute
Headwater Rises or Falls to El. 1.2 ft (NGVD)/-0.3 ft (NAVD)	Gates Become Stationary
Headwater Falls to El. 1.0 ft (NGVD)/-0.5 ft (NAVD)	Gate Close at 6 inches/minute

In addition to the changes described above, the project will also experiment with incremental increases in the open and/or close stage triggers at S-18C. Because of the experimental, incremental, and adaptive nature of the changes at S-18C, these changes are not considered part of the standing instructions to project operators, and are discussed in ***SECTION D.7.1***, Achieving Natural System Goals, Objectives, and Benefits.

It is important to note that the spillways in the C-111 Basin are designed to pass 40 percent of the SPF without exceeding damaging levels. The spillway discharge rating curves that are being used must be applicable to the particular flow regime encountered, and spillway gates should be opened and closed gradually to provide an even transition to the new flow regime and to minimize hydraulic effects downstream. The tailwater stage should be allowed to build up before the next gate opening operation takes place. Spillway gate openings should be checked against the Maximum Allowable Gate Opening (MAGO)

Curve to insure that the gate openings do not exceed the allowable gate opening for non-damaging operations. Those MAGO curves are based on retaining the hydraulic jump within the stilling basin and providing safe velocities over the riprap and to insure the safety of the structure. For large floods, the MAGO curves may be exceeded in the "Riprap Control" range, however some damage to the riprap will likely occur. The stilling basin reduces kinetic energy of the flow entering the downstream channel. The stilling basin and downstream riprap are intended to prevent scour downstream of the spillway from undermining or otherwise threatening the integrity of the structure.

D.7 OPERATIONAL STRATEGY TO MEET PROJECT OBJECTIVES

The operational strategies described in this plan are intended to meet the goals, objectives, and benefits in the PIR, and include restoration, preservation, and protection of the south Florida ecosystem, while providing for the other water-related needs of the region, as well as meeting the requirements for protection of health and public safety.

D.7.1 Achieving Natural System Goals, Objectives, and Benefits

The most obvious goal of the C-111 SCWF Project features is to maximize flows to Central Florida Bay via Taylor Slough. This could be achieved by diverting water that would normally be discharged through the S-177 structure and redirecting this water to either the FPDA, and/or to the Aerojet Canal to reduce the groundwater gradient between the lower Taylor Slough and the lower C-111 Canal. The linear staging of water in these features will act as a hydraulic seepage barrier, and will reduce the current amounts of seepage from Taylor Slough, allowing more water to reach Central Florida Bay. The Standing Instructions to Project Operators, which were described in ***SECTION D.6***, are intended to increase flows to Central Florida Bay via Taylor Slough, and were developed by balancing the desire to "harvest" water for seepage protection with the desire to avoid inducing additional seepage into the C-111 Canal.

As described earlier in this document, the plan includes constructing a new operable structure (S-198) between S-18C and S-197 to further reduce the rapid west to east drop in water levels of the lower C-111 Canal, and further reduce seepage losses from Taylor Slough. As described in the Standing Instructions to Project Operators, operation of S-198 in the same fashion as S-197 will ensure that existing levels of flood damage reduction are preserved when open. When closed however, it will encourage higher upstream heads by reducing the C-111 Canal's tendency to drain areas with relatively higher groundwater elevations towards areas with lower groundwater elevations.

The operations described in the Standing Instructions to Project Operators have been developed to provide a net improvement in the environmental benefits to

Taylor Slough by reducing the quantity of water seeping back to the lower C-111 Canal system. Based on the initial operational experience and monitoring of the water levels throughout the basin, minor refinements in the operating regime may be evaluated during the initial testing and monitoring period, in order to identify ways to maximize the potential environmental benefits commensurate with the design of the recommended plan.

In order to quantify the potential benefits and impacts associated with incrementally higher control elevations at S-18C during the initial operational testing and monitoring phase, the project will test incremental increases in water level control elevations at S-18C. The resulting information will be used for future planning guidance and defining operations within the Preliminary and Final POMs.

D.7.2 Flood Damage Reduction

D.7.2.1 **Normal and Emergency Operations**

The C-111 SC Western project features are intended to operate in conjunction with existing C&SF Project features. The existing features are currently operated as outlined in IOP.

D.7.2.2 **Hurricane or Tropical Storm Operations**

The official hurricane season is from June 1 through November 30. However, tropical cyclone activity can occur outside of this timeframe. When there are tropical depressions, tropical storms, and/or hurricanes in the Atlantic/Caribbean Basin or Gulf Coast of Florida, the National Hurricane Center (NHC) issues tropical cyclone public advisories, forecast advisories, forecast discussions, and strike probability forecasts.

The SFWMD Operations Control Division has defined operational procedures to be implemented depending on the timing or amount of advance warning prior to the onset of tropical storm force winds. This information is found in the Emergency Preparedness Manual–Suggested Hurricane Operating Procedures, April 2004. In addition, U.S. Army Corps of Engineers, Jacksonville District (CESAJ) Standing Operating Procedure (SOP) 500-1 1 dated September 9, 2002 should be consulted for emergency preparation and actions.

The SFWMD operational procedures are termed "conditions" and are briefly summarized as follows:

- Condition 4: 72 to 48 hours prior to the impact of tropical storm force winds, or rain forecast to exceed two inches, is the earliest level of preparation when the system is evaluated and initial adjustments are

made to operations depending on the forecast and nature of the storm. Coordinate with the U.S. Army Corps of Engineers (USACE) and local drainage districts.

- Condition 3: 48 to 24 hours prior to the impact of tropical storm force winds, continue pre-storm operations and coordination with the USACE and local drainage districts.
- Condition 2: 24 to 12 hours prior to the impact of tropical storm force winds, bring telemetry-controlled sites to final pre-storm configuration, establish alternate emergency control station if necessary.

The remaining level of preparation is:

- Condition 1: 12 to 0 hours prior to the impact of tropical storm force winds; during the event; and recovery after the event. It is important to note that some storm events do not allow for the full Condition 4 with even 48-hours of advanced warning.

As discussed elsewhere in this plan, IOP includes provisions for pre-storm drawdown of the C-111 Canal system which is an essential part of flood damage reduction, and this plan makes no attempt to change those operations. The addition of the 450 cfs of (total) installed capacity at S-200 and S-199 may be utilized as needed to assist in pre-storm drawdown. The pre-storm operations for new structure S-198 will match those of S-197. For more details on pre-storm operations, please refer to Section 8, Pre-Storm Operations.

D.7.2.3 **Storage Weir Discharge**

This section is not applicable to this project.

D.7.2.4 **Uncontrolled Discharge**

This section is not applicable to this project.

D.7.3 Water Quality

Public Law 92-500 requires that all Federal facilities be managed, operated, and maintained to protect and enhance the quality of water and land resources through conformance with applicable Federal, state, interstate, and local substantive standards. Although this project was not formulated for specific water quality benefits, the Florida Department of Environmental Protection (FDEP) will review the project design and proposed project operations to determine if either would likely cause or contribute to violations of state water quality. Strict adherence to the conditions contained within the resulting State Water Quality certification will ensure compliance under FS 373.1501 and 373.1502 and will ensure that existing water quality is preserved during all phases of the project, including the construction phase.

D.7.4 Water Supply Operations

The C-111 SC Western project is a restoration project, and as a water user is unable to supply additional water to the regional system. As such, the DPOM for the C-111 SC Western project is proposing no change to existing regional water supply operations.

A minimum water supply to ENP from the C&SF Project was guaranteed in June 1970 by PL 91-282. This law stipulated that an annual minimum of 315,000 acre-feet or 16.5 percent of total project deliveries, whichever is less, would be distributed to ENP on a monthly basis. This included 270,000 acre-feet to Shark River Slough via the S-12 structures; 37,000 acre-feet to Taylor Slough at S-332; and 18,000 acre-feet to the eastern Panhandle at S-18C. Subsequent acts have authorized the USACE to modify the schedule of water deliveries to ENP. As part of this authorization, IOP (described in D.4.4) for protection of the CSSS, was implemented. As such, structure S-332D is operated to meet the Taylor Slough rainfall formula discharge while remaining consistent with marsh restoration.

A minimum flow and level (MFL) was adopted for northeast Florida Bay by the state under Ch. 40E-8 Florida Administrative Code (F.A.C.) (April 2007). A MFL is defined by Ch. 373.0421 (1) Florida Statute (F.S.) as "the limit at which further withdrawals would be significantly harmful to the water resources or ecology of the area." In developing minimum flows and levels for water bodies within the jurisdiction of the SFWMD adopted a narrative definition of "significant harm." Significant harm is defined in Ch. 40E-8 F.A.C. as the temporary loss of water resource functions which result from a change in surface or ground water hydrology that takes more than two years to recover. The specific water resource functions addressed by a MFL and the duration of the recovery period associated with significant harm are defined for each priority water body based on the MFL technical support document and summarized in Chapter 40E-8, as follows;

> A minimum flow level necessary to maintain salinity into northeastern Florida Bay of 105,000 acre-feet of water over a 365-day period (a running total measured at West Highway Creek, at 25014'33" north and 80026'50" west; Trout Creek, at 25012'53" north and 80032'01" west; Mud Creek, at 25012'09" north and 80035'01" west; Taylor River, at 25011'27" north and 80038'21" west; and McCormick Creek, at 25010'03" north and 80043'55" west), is estimated to be necessary to maintain salinity as described in paragraph (5)b and (5)c of 40E-8.221 Minimum Flows and Levels: Surface Waters.

In accordance with the MFL legislation, these requirements are expected to be met under normal operating conditions for most years, and a prevention strategy has been established for Florida Bay as a protective measure to prevent harm resulting from insufficient flows. These prevention strategies are described in paragraph (5)b and (9)a-d of 40E-8.421 Prevention and Recovery Strategies, as follows;

(a) Modifications to operations for improved management of freshwater discharges to the headwaters of Taylor Slough and the southeast Everglades should consider the MFL, in coordination with:
   1. The Modified Waters Deliveries to Everglades National Park project and the C-111 Canal project, and any associated operational and construction plans pursuant to these projects;
   2. The C-111 Canal Spreader State Expedited Construction and CERP Projects;
   3. The CERP Florida Bay and Florida Keys Feasibility Study.

(b) The SFWMD, in cooperation with other management agencies, will continue field monitoring and research to assess salinity, water level, and flow conditions and biological resource response in the region specified above.
(c) The update of the Lower East Coast (LEC) Plan (anticipated in 2006) will contain a description of the elements, scheduling, and funding of the research and monitoring program and additional details of the prevention strategy for Florida Bay pursuant to Section 373.0421, F.S.
(d) These MFL criteria will be reviewed and may be revised no later than five years after adoption based on new information from the CERP Florida Bay and Florida Keys Feasibility Study or other scientific data that may become available. After the initial review, the MFL criteria will be reviewed at subsequent five-year intervals in conjunction with updates to the LEC Plan.

An additional protective measure to prevent harm is proposed for northeast Florida Bay as part of the operational testing and monitoring for increases in the water control at S-18C as described in ***SECTION D.7.8***, Panhandle Wetland and Salt Water Intrusion Protection Measures. As other information becomes available through development of operating criteria for the MWD Project or the C-111 South Dade Federal Project, the DPOM for the C-111 SC Western project may be revised.

D.7.5 Recreation

No special operations (e.g. special release fishing tournaments) are part of the DPOM of the C-111 SC Western project. Although passive recreation may result

from operation of the project's above ground impoundment, no specific operations will be made for recreational purposes.

D.7.6 Fish and Wildlife

As a restoration project, the entire plan has been developed with the intent of promoting wetland and water dependent fish, wildlife, and their habitats. With exception of the establishment of nesting season overrides for the CSSS, which have been described in detail in ***SECTION D.6***, no other special operating criteria have been established.

D.7.7 Navigation

There are no authorized navigational projects within the project area. As such, special operations to support navigation have not been included within this plan.

D.7.8 Panhandle Wetland and Salt Water Intrusion Protection Measures

Model simulations show the diversion of water by the S199 and S-200 pump stations reduces the quantity of water released at the S-177 structure and reduces water delivery to the lower S-18C structure which provides water to the C-111 Canal Panhandle Wetlands. Previous monitoring of surface and groundwater water levels in this region indicate this area is prone to salt water intrusion in the dry season and may receive too much water in the wet season. The marsh gauge site EPSW located in the panhandle region of the lower C-111 Canal system provides a historical perspective of the relationship between S-18C flows and local marsh water levels near West Highway Creek. ***FIGURE D-5*** depicts the daily water levels within the marsh plotted with the monitored flow rates at S-18C for each dry season period (beginning January 1 and ending May 31). Marsh water levels generally decline below ground level at this site as rainfall diminishes and the flow at S-18C declines below 100 cfs. Water levels remain below ground until rainfall and flow rates at S-18C increase. This trend is repeated annually in most years. Conversely, marsh water levels during the wet season typically remain above ground.

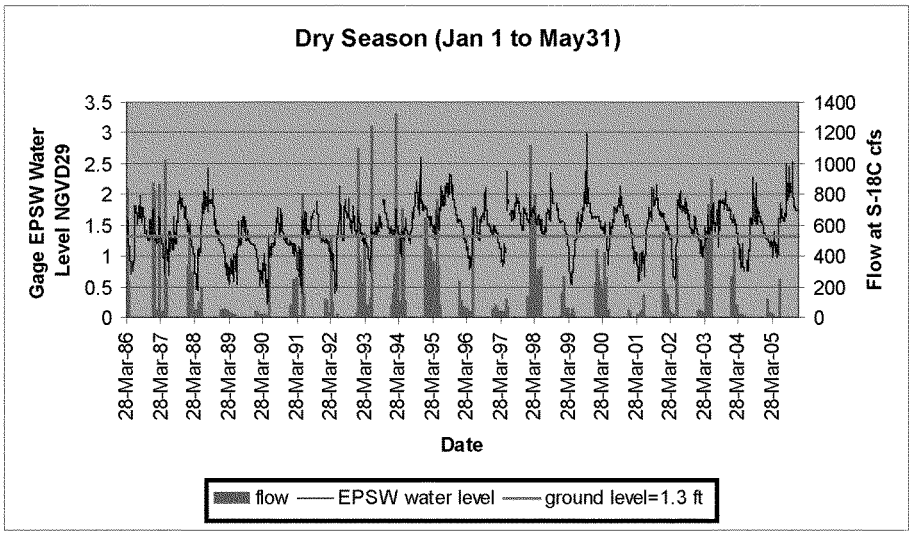


FIGURE D-5: HISTORICAL WATER LEVEL CHANGES AT MARSH GAUGE SITE EPSW AND DRY SEASON FLOW RATES AT THE S-18C STRUCTURE

Under current water management practices, monthly minimum water delivery targets have been established for S-18C (***TABLE D-4***) for environmental purposes and to control salt water intrusion in the lower C-111 Basin. During the wet season, S-18C discharges frequently exceed these minimums. With the decline in seasonal rainfall in the dry season, water is typically imported into the C-111 Basin to maintain minimum canal levels and prevent salt water intrusion. The dry season water deliveries are expected to be partially maintained throughout the incremental testing of higher water level controls at S-18C by groundwater leaking around the structure from the higher upstream water level controls. The average historical recession rate at gauge station EPSW, based on the period of record November 1, 1986 to April 30, 2008 is depicted in ***FIGURE D-6*** below. Daily water level changes are monitored at EPSW. A regression for each year (1986-2007) indicates average monthly decrease of 0.1077 with a 95 percent confidence interval of -0.0175 to 0.2330. Should the marsh water level at the EPSW gauge appear to drop too quickly compared with the 95 percent confidence interval (approximately 0.25 feet per month) during the six months between November to April, and if headwater stages at S-18C allow, the operator shall attempt to recover the slope of the recession curve by opening one of S-18C's two gate structures (each individual gate is 22.8 feet wide) approximately 0.5 foot or 1.0 foot above the -7.0 feet NGVD (-8.5 feet NAVD) submerged sill elevation. The structure shall remain open until the

recession slope is recovered or until upstream conditions at S-18C no longer allow.

TABLE D-4: CURRENT MINIMUM MONTHLY WATER DELIVERY TARGETS FOR THE S-18C STRUCTURE

Month	Acre Ft		Month	Acre Ft
Jan	1,540		July	510
Feb	630		Aug	860
Mar	290		Sep	2,690
Apr	110		Oct	4,630
May	110		Nov	4,060
June	340		Dec	2,230

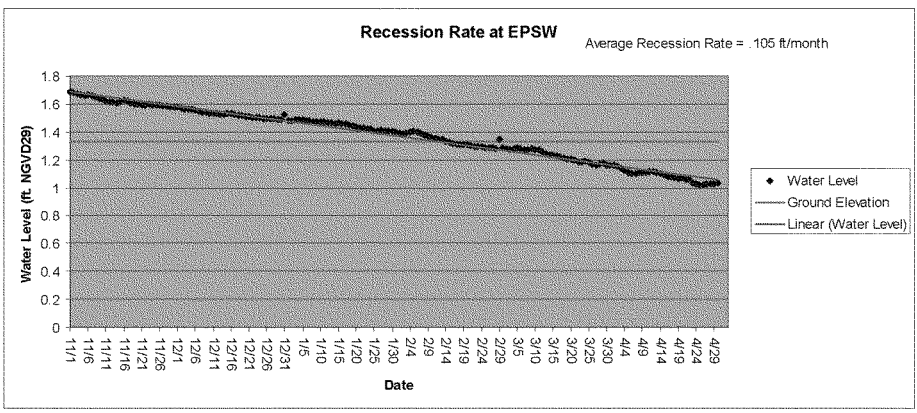


FIGURE D-6: AVERAGE RECESSION RATE AT NP-EPS (EPSW) GAGE

The current MFL criteria (40E-8.221[5]a-c, April 2007) specify a minimum aggregate flow of 105,000 acre feet annually for several named creeks draining the panhandle region; West Highway Creek, Trout Creek, Mud Creek, Taylor River, and McCormick Creek (***FIGURE D-7).*** Model simulations indicate the incremental increase in S-18C water level controls will contribute more flow to Trout Creek, Mud Creek, Taylor River, and McCormick Creek and potentially reduced flow to West Highway Creek which is located to the eastern side of the panhandle basin. This spatial difference in distribution of flow favoring the westerly creeks is attributed to the geographic location of the creek headwaters lying within the topographic gradient of Taylor Slough and proximity of the S-18C Structure. Higher water levels upstream of S-18C will promote a push in groundwater to the west and toward the western creeks. Because West Highway

Creek is down gradient from S-18C, it could receive less water. Independent of whether or not this occurs, the aggregate flow of all named creeks is expected to exceed the 105,000 acre feet per year.

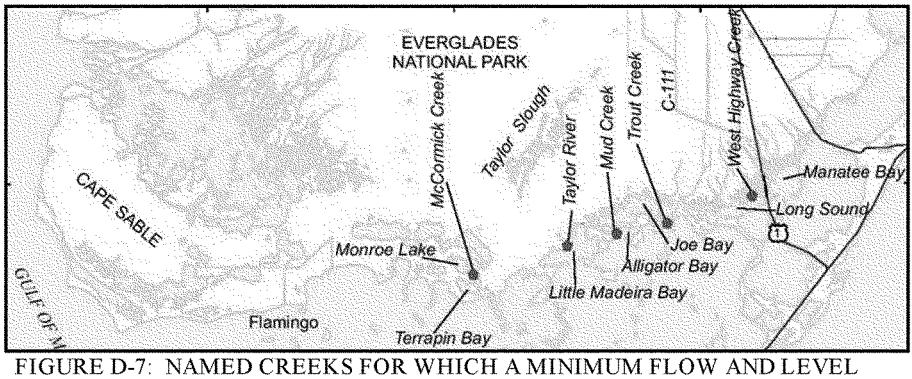


FIGURE D-7: NAMED CREEKS FOR WHICH A MINIMUM FLOW AND LEVEL ANNUAL FLOW RATE HAS BEEN ESTABLISHED UNDER FLORIDA STATUTE

D.8 PRE-STORM/STORM OPERATIONS

As also described in the Hurricane or Tropical Storm Operations Section, currently SFWMD implements canal drawdown operations in the South Dade Conveyance System (SDCS)/Miami Dade County for forecasted storm events based on impending rainfall events. The South Dade Conveyance System is composed of L-31N, L-31W, and the C-111 Canal system and control structures. Refer to ***SECTION D.7.4*** for the operational procedures, conditions, to be implemented prior to the onset of tropical storm force winds. Like most of the C&SF Flood Control Project, the C-111 Basin makes extensive use of pre-storm canal, and groundwater, drawdowns. The intent of these pre-storm operations is primarily to restore groundwater and canal storage, and to get the system prepared to convey runoff which would otherwise exceed the capabilities of the system. Although intended to minimize loss of life and/or property, these pre-storm operations attempt to avoid negative impacts to the natural system, and to minimize negative impacts when they are unavoidable.

As described elsewhere in this document, the addition of the 450 cfs of total installed capacity at S-200 and S-199 may be utilized as needed to assist in pre-storm drawdown. The pre-storm operations for new structure S-198 will match those of S-197.

In anticipation of heavy rainfall based on National Weather Service Advisories and SFWMD forecasts, the L-31W, C-111 and C-111E canals will be drawn down as much as is currently practiced in order to allow for the maximum amount of canal and groundwater storage. Operations during hurricanes or tropical storms will continue to follow the SFWMD's *Emergency Preparedness Manual – Suggested Hurricane Operating Procedures*, April 2004. In addition, CESAJ SOP 500-1 1 dated 9 September 2002 should be consulted for emergency preparation and actions.

D.9 CONSISTENCY WITH THE IDENTIFICTION OF WATER AND RESERVATIONS OR ALLOCATIONS OF WATER FOR THE NATURAL SYSTEM

The operating criteria within this DPOM will be consistent with the operating criteria used to identify the water made available for the natural system during wet, average, and dry periods (see the Project Assurances section of the PIR). Additionally, the operating criteria within this DPOM will be consistent with the water reservations or allocations for the natural system made by the State in accordance with Section 601 of WRDA 2000.

D.10 CONSISTENCY WITH SAVINGS CLAUSE AND STATE ASSURANCES PROVISIONS

The operating criteria within the DPOM will be consistent with those used for evaluating conformance with the Savings Clause during development of the PIR. In addition, the operating criteria within the DPOM will be consistent with those used for evaluating conformance with State assurances provisions during development of the PIR.

D.11 DROUGHT CONTINGENCY PLAN

If the SFWMD determines there is an increased likelihood that there will be an insufficient amount of water to meet the estimated anticipated user demands within a source class or to protect the water resource from serious harm, the following actions may be initiated by the SFWMD and the Jacksonville District Corps of Engineers. The actions include but are not limited to:

1. Initiation of the SFWMD Water Shortage Plan and "General Water Use Restrictions" as established in Chapter 40E-21.271 by the SFWMD.
2. SFWMD's Water Shortage Plan provides specific guidelines for water restrictions which are based on the type of use and severity of the drought. Included within the plan are water use reductions which range from 15% to as much as 60% of estimated need.
3. Enforcement of the water use restrictions by SFWMD.
4. Public press releases shall be made on an "as-need" basis through the Public Affairs Office (PAO) of the Jacksonville District. These statements shall

provide the public with a full explanation of drought operations and expected conditions in an effort to reduce inquiries from recreation sand concerned interests. Similarly, the SFWMD will make press releases notifying the public of water use restrictions.

5. Drought situation reports for the Central and Southern Florida Project and other projects within the Jacksonville District shall be prepared by the Water Management Section of the Jacksonville District. This report shall provide detailed information on current and forecast situations for informational purposes of District and South Atlantic Division (SAD) elements. The report will include general descriptions of the drought and climatic conditions, current Palmer Indices, rainfall summaries, stages and storages for the projects, and current water use restrictions.
6. Temporarily relax State standards for water quality requirements in the lake and the Water Conservation Areas to permit the continued operation of agricultural pumps, and conserve remaining water in storage.
7. Should water quality or all water supply storage become depleted, potential alternatives include, but are not limited to:
8. Emergency reallocation of water from other parts of the Central and Southern Project.

   Declaration by the state of Florida of a water emergency. After a water emergency has been declared, emergency diversions to meet the needs of human consumption, necessary sanitation, and public safety can be made.

Volumes 2 through 7 of the SOM, which will also include specific SFWMD Water Shortage Plan rules.

D.12 FLOOD EMERGENCY ACTION PLAN

The Flood Emergency Action Plan will be completed for the C-111 SC Project prior to construction completion. The Flood Emergency Action Plan to be developed should be consulted for related emergency preparation and action. Local emergency management offices will be provided copies of the Flood Emergency Action Plan as necessary. This plan may be used to supplement Hurricane or Tropical Storm Regulations. As outlined in ER 1130-2-530, the Flood Emergency Action Plan shall include the following:

- A written emergency notification procedure for serious abnormal conditions to provide for safety of individuals in the vicinity of the storage area and also trigger immediate response for remedial assistance to the levee/water control structure.
- A description or list of conditions leading to emergency situations and ways of dealing with them should they occur.
- Storage area de-watering procedures.
- Levee/water control structure failure inundation maps.

- Listing of location, types, and quantity of emergency repair materials and equipment.
- Details outlining responsibilities for inspection and execution of emergency repairs.
- List of contractors available within a reasonable distance of the project area.

D.13 DEVIATION FROM NORMAL OPERATING CRITERIA

Deviations from the normal operating criteria described in this DPOM will generally fall into one of three categories; emergency, unplanned minor deviations, and planned deviations. Prior approval for deviations, other than emergency deviations (which require post-emergency notification) will be obtained from the Jacksonville District, USACE.

D.13.1 Emergencies

Examples of emergencies that may result in a need to deviate from normal operating criteria include: drowning and other accidents; failure of the operation facilities; chemical spills; treatment plant failures; and other temporary pollution problems. Water control actions necessary to abate the problem will be implemented immediately unless such action would create equal or worse conditions. The USACE's South Atlantic Division (SAD) will be informed of the problem and the emergency operating changes as soon as practicable. In addition, the State of Florida (FDEP) and Department of Interior (DOI) will also be informed.

D.13.2 Unplanned Minor Deviations

There are unplanned instances that may create a temporary need for minor deviations from the normal operating criteria, although these deviations are not considered emergencies. Construction accounts for the major portion of these incidents requiring minor deviations. Examples of activities that may require short-term deviations include construction of utility stream/canal crossings and bridge work. Deviations are sometimes necessary to perform maintenance and inspection of facilities. Requests for changes in release rates generally involve time periods ranging from a few hours to a few days. Each request will be analyzed on its own merits. In evaluating the proposed deviation, consideration will be given to upstream watershed conditions, potential flood threat, existing condition of the reservoir/storage area, and alternative measures that can be taken. In the interest of maintaining good public relations, requests for minor deviations are generally granted, providing that these deviations will not have adverse effects on the ability of the project to achieve the authorized purposes. Approval for these minor deviations normally will be obtained from SAD by telephone. Written confirmation explaining the deviation and the cause will be

furnished to the SAD water control manager. As with emergency deviations, the State of Florida (FDEP) and the DOI will also be informed.

D.13.3 Planned Deviations

Each circumstance should be analyzed on its own merits. Sufficient data on flood potential, lake and watershed conditions, possible alternative measures, benefits to be expected, and probable effects on other authorized and useful purposes, together with the USACE district recommendation, will be presented by memorandum, facsimile, or electronic mail to the USACE-SAD for review and approval. In addition, the non-Federal sponsor, the State of Florida (FDEP and SFWMD), and the Department of the Interior should be consulted as part of the process of receiving approval from SAD for the deviation.

D.14 RATE OF RELEASE CHANGE

Section is not applicable to this project.

D.15 SEEPAGE CONTROL

It would not be an overstatement to describe the entire C-111 SC Western project as a seepage control project. Diverting water into the proposed FPDA is intended to assist in preventing seepage from Taylor Slough. Staging water first in the FPDA's header canal, which is located near the western limits of the feature, is intended to minimize return seepage to the C-111 Canal. Overriding the pumps when stages exceed 30 inches above ground elevation will further reduce return seepage, while minimizing migration of the stagnation point (point at which head of ENP marsh waters equals that resulting from FPDA towards ENP).

Further south, but similar to the FPDA, diverting water into the Aerojet Canal will assist in preventing seepage out of ENP, more specifically, Taylor Slough. Similar to the FPDA, overriding the pumps when stages exceed 30 inches above ground elevation will also minimize migration of the stagnation point towards ENP.

Because these features will by definition seep, other than overriding the pumps when stages exceed 30 inches above ground, no special operations to reduce seepage appear necessary.

D.16 INITIAL RESERVOIR/STORAGE/TREATMENT AREA FILLING PLAN

The proposed project does not involve traditional reservoirs (i.e. impoundments intended to hold water for extended periods of time) or water quality treatment areas. Initial filling of the proposed FPDA and Aerojet Canal features will not

differ from "everyday" filling as described in Standing Instructions to Project Operators.

D.17 NON-TYPICAL OPERATIONS FOR RESERVOIR/STORAGE/ TREATMENT AREA PERFORMANCE

The proposed project does not involve traditional reservoirs or water quality treatment areas. There are no procedures or changes in operating criteria to be used for minimizing or avoiding dryout during a drought. During regular maintenance (or other activities which would involve temporarily taking a feature off-line) of any feature that provides flood mitigation for another feature (e.g. S-199 and S-200, which provide mitigation for increased triggers at S-18C), operations of the previously mitigated for feature will necessarily revert to current existing operations. Features which are not mitigated for (e.g. increased stages at S-20) shall not require a reversion to existing operations.

D.18 AQUIFER STORAGE AND RECOVERY SYSTEM PLAN

Aquifer Storage and Recovery (ASR) systems are not a part of this project.

D.19 WATER CONTROL DATA ACQUISITION SYSTEM PLAN

The Water Control Data Acquisition System Plan (WCDASP) for this project has been started during the PIR phase, will probably be completed during the Plans and Specifications Phase, and will be a subset of the Water Control Data System that is specific to CERP. For the C-111 SC Project, pump stations and water control structures will be equipped with remote automation components and will be operated through remote telemetry using the Supervisory Control and Data Acquisition (SCADA) system.

The automation components of all pump stations and structures that will be operated and maintained by the SFWMD will meet SFWMD standards. Equipment used in data acquisition essential to the water control management function will be included in the WCDASP. This includes all hardware and software used for acquisition, transmission, processing, display, and dissemination of hydrologic, meteorological, water quality, and project data for the purpose of supporting the water control mission. The C-111 SC Project includes but is not limited to; uninterruptible power supplies, field data collection platforms, and data communication devices and circuits.

For details regarding new hardware locations please see the hydrometeorological plan, ***ANNEX E, PART I.***

D.20 CONSISTENCY WITH THE ADAPTIVE MANAGEMENT PROGRAM AND PERIODIC CERP UPDATES

After initiation of long-term operations and maintenance of the C-111 SC Project, the POM may be further modified based on operating criteria approved by the USACE and the SFWMD resulting from CERP updates and/or recommendations from the adaptive assessment process as outlined in GM #6.

D.21 INTERIM OPERATIONS DURING CONSTRUCTION

Interim operations utilized during the construction phase will be developed in conjunction with the detailed construction schedule. All interim operations will be conducted to be consistent with the Assurances of Project benefits as set forth in Section 601 of WRDA 2000 and as discussed in the Programmatic Regulations and the GM. For additional details regarding how operations will ensure project benefits, please see Section 7, *Operational Strategy to Meet Project Objectives, Section 4, Project Relationships*, and Section 5, *Major Constraints*.

D.22 PRELIMINARY OPERATIONS DURING OPERATIONAL TESTING AND MONITORING PHASE

Preliminary operations during the Operational Testing and Monitoring Phase shall generally be as described in ***SECTION D.6***, Standing Instructions to Project Operators and in ***SECTION D.7***, Operational Strategy to Meet Project Objectives. As described in ***SECTION D.7***, a cornerstone of this plan, which is critical to maximizing restoration while maintaining or improving existing levels of flood damage reduction, and resolving decision critical uncertainties related to maximizing restoration, is the testing of incremental increases in water level control elevations at S-18C. The process of incrementally changing water level controls will be governed by an iterative cycle of implementing small operational changes in water levels at the structure, monitoring the effects on flood control through a partial or complete rainfall cycle, measuring and quantifying the cumulative benefits and impacts to the environment and agriculture during the testing cycle, validating the prior model simulations of these changes to improve predictive accuracy, simulating the next incremental benefits and impacts of water level changes and then instituting these changes for a prescribed partial or complete rainfall cycle. The steps in this process and iteration cycle are depicted in ***FIGURE D-9***. Open and close triggers will be increased in increments of no more than 0.1 feet at any time and the total increased change in the open trigger criteria shall not exceed 0.4 feet. Stage override triggers will be established immediately downstream of S-177 and/or in the adjacent farm fields to establish a "backstop" at which S-18C triggers will return to their highest "successful" increment (see ***HYDROMETEOROLOGICAL MONITORING PLAN, ANNEX E***).

At the conclusion of this iterative process, the ecological benefits and potential impacts to agriculture will have been quantified and permanent changes in water control management can be recommended for implementation under the Final POM and/or a subsequent PIR.

Sensitivity modeling of the Recommended Plan infrastructure and operations of the lower C-111 Canal system, conducted with SFWMD's Regional System Model (RSM), identified a range of additional benefits that could be achieved by incremental increases in the water level controls at the S-18C structure. Model results showed meaningful increases in Taylor Slough water flow with each 0.1 foot incremental increase in the open criteria at the S-18C structure. With each 0.1 foot increase in S-18C's open criteria however, hydrologic models predicted an increased risk for reducing levels of flood damage reduction. This was particularly evident to the agricultural lands which lie south of Ingraham Highway (SR 9336) between the water control structures S-177 and S-178. ***FIGURE D-8*** depicts the predicted benefits of increased flows to Taylor Slough and the potential number of acres of agricultural lands that could potentially be adversely impacted by higher groundwater stages attributed to higher water level controls at the S-18C water control structure. Although the models employed in making the above predictions are based on the best available science, they have inherent uncertainties, perhaps as high as 0.5 feet, which could have the effect of over or understating predicted benefits and/or the potential impacts to local agriculture.

FIGURE D-8 depicts the potential benefits and impacts by higher water control levels at S-18C.

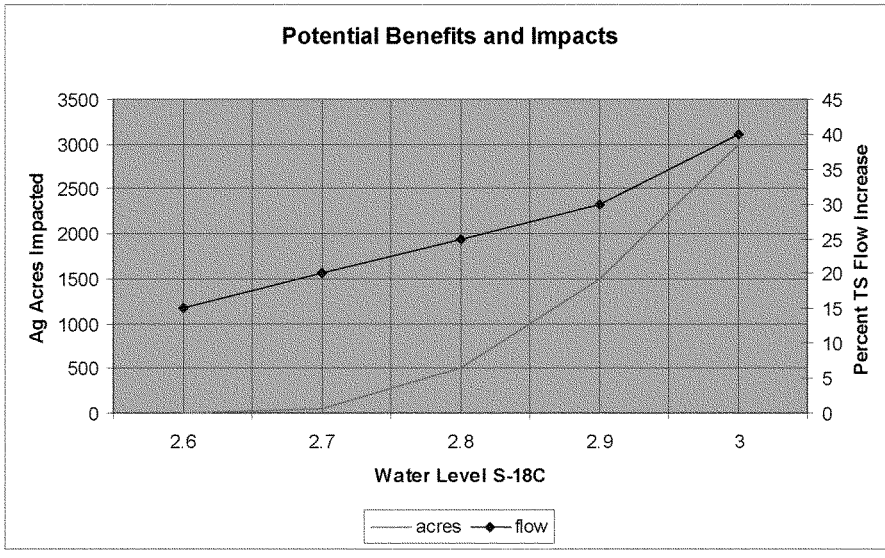


FIGURE D-8: POTENTIAL BENEFITS AND IMPACTS AT S-18C

In order to quantify the potential benefits and impacts associated with incrementally higher control elevations at S-18C during the initial operational testing and monitoring phase, the project will test incremental increases in water level control elevations at S-18C. The resulting information will be used for future planning guidance and defining operations within the Preliminary and Final POMs.

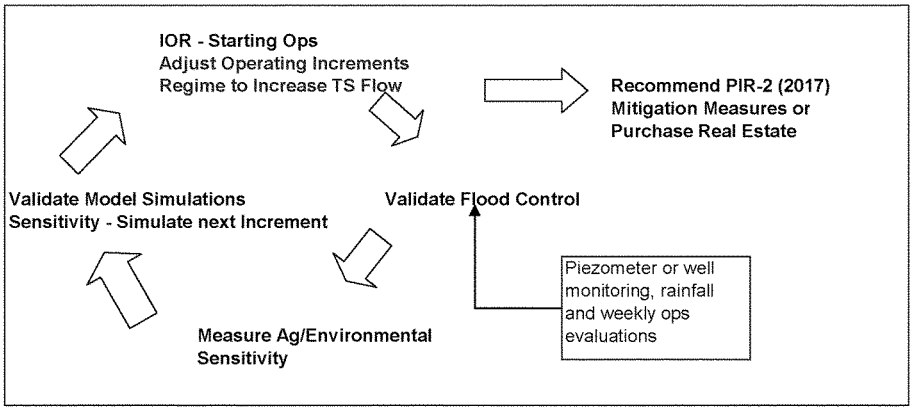


FIGURE D-9: OPERATIONAL TESTING AND MONITORING OF INCREMENTAL INCREASES IN WATER CONTROL ELEVATIONS AT S-18C

An important safeguard to minimize potential economic impacts to privately owned lands is identified in the flood control validation step (***FIGURE D-9***). Real time water levels will be monitored at the privately owned lands which could experience a higher risk of flooding impact with the implementation of operational testing phase. A network of piezometers or wells will be installed to constantly monitor water level changes in response to changes in increased water level controls and local rainfall. This information will be discussed as part of the regular weekly USACE/SFWMD operations meeting, and operational changes will be recommended to respond to specific environmental or flood control concerns. Factors such as antecedent water levels, local storm activity and predicted major storm events would be considered along with the above prescribed monitoring data to identify if the current incremental water level changes would exacerbate flooding. Deviations in operations could be immediately implemented to lower water control levels as recommended by the operating staff and based on real time monitoring data reflecting prescribed conditions when the risk of flooding has increased beyond an acceptable level. Operations at the current incremental increase in control level would then be reinstituted later when conditions appear more favorable.

It is anticipated that as the water level controls incrementally increase above the initial operating criteria, the duration of time these higher levels are maintained could become brief depending on the local rainfall conditions and other flood control factors within the basin. In all cases, a pre-storm drawdown (see ***SECTION D.8***) in preparation of anticipated flood events, as already authorized as part of the C-111 Basin operations approved under the IOP, will

take precedence over testing of incremental water level changes. Immediate deviations in the water control levels to lower operating criteria can be implemented in response to real time monitoring data that indicate flooding risks have increased.

Operation of the constructed plan features and implementation of the incremental increases in water control criteria will require time to observe and measure changes in the water levels throughout the basin under a representative range of wet and dry season conditions. The newly constructed FPDA and Aerojet Canal pump stations will add new capability and flexibility of operations for water management. The basic initial operations, utilizing the new Frog Pond and Aerojet facilities, will be evaluated over a period of at least one year before attempting to make incremental changes in water control levels at S-18C. Following successful completion of this initial phase, the first incremental increase in water level control will be implemented and evaluated over the next two complete hydrologic cycles. As the first major change in the water level control affecting the flood control conditions within the basin, it will be important to fully test and evaluate the range of climatic conditions and water level responses within the basin. Pending the successful outcome of this effort, subsequent incremental increases in water level controls would then be implemented at S-18C over subsequent hydrologic cycles. Although the actual schedule for implementation may vary for several reasons (e.g. atypical rainfall distribution), the anticipated schedule for implementing incremental increases at S-18C triggers is shown in ***FIGURE D-10*** below.

	Year 1	Year 2	Year 3	Year 4	Year 5
Initial Ops (No Increase)					
Increment 1 (0.1' Increase)					
Increment 2 (0.2' Increase)					
Increment 3 (0.3' Increase)					
Increment 4 (0.4' Increase)					

FIGURE D-10: TARGET IMPLEMENTATION SCHEDULE FOR TESTING INCREMENTAL INCREASES IN S-18C CONTROL ELEVATIONS

In addition to the changes in control elevations at S-18C, during the initial operational testing and monitoring period, minor changes in the operational criteria at S-200 and S-199 may also be tested in order to explore how best to deliver excess water via the FPDA and the Aerojet Canal. These operational

changes will primarily seek to balance the distribution of water within the system to better meet environmental demands while maintaining consistency with the defined operating constraints. Any permanent changes in operations at these, or other structures, will be captured in the Final Project Operating Manual.

Extensive monitoring of the basin water level responses will be conducted throughout each phase of the operational testing and monitoring period. This will include documenting the durations and frequencies of time in which water controls were returned to either Initial Operating Regime(IOR) base water level controls or the next lower increment of water level control in which potential risks of flooding impacts to agriculture were deemed minimal. The associated environmental response (e.g. increases in Taylor Slough flows) will be monitored with each incremental increase of water level control during the operational testing and monitoring phase of the project.

Incremental increases in dry season water level controls could be implemented and evaluated using the above scheme to determine if higher water levels could be sustained during the dry season to improve estuarine and Taylor Slough environmental benefits. The risk of flooding during this period is greatly reduced and offers an opportunity to determine if higher incremental stage controls can reduce the decline of water levels in Taylor Slough as canal levels decline in the dry season. The same operational protocols would be followed including the use of pre-storm drawdowns, weekly operational reviews of basin water level conditions and invoking immediate deviations to lower water level controls in the event that an unacceptable flooding risk is determined by real time monitoring data.

Unacceptable risks of flooding will be pre-determined for the specific crop and soil type within the potentially affected agricultural lands and for a range of soil elevations. There are three main concerns to be addressed regarding the change in canal elevation and the potential impacts to agricultural lands, as follows;

- Will the rise in canal water level change soil moisture so that the land is not suitable for current uses, and;
- Will the rise in canal water level prevent adequate flood protection, and;
- How much time should be allowed to lower the water table if a large rainfall event is expected?

The above flooding risks are closely related to the specific properties of the local soils. Soil properties vary within this region with three dominant soil types: Biscayne gravelly marl, Krome very gravelly loam, and Chekika very gravelly loam. Each of these soil types have slightly different soil properties that influence drainage and how their specific capillary action may change with

increases in ground water levels. The capillary properties may contribute to crop damage by maintaining saturated soil conditions near the root zone. Specific monitoring of these soil conditions is proposed in the Hydrometerological Monitoring Plan. Data collected during the initial first year of base operations will be used to develop criteria relating ground water level changes and an early signal that soil conditions have passed a risk threshold where crops could be damaged. Appropriate measures would then be made to lower ground water levels through operational changes.

A minimum separation depth between measured groundwater and the root zone for individual crops will be utilized as a determinant of flooding risk. Increased water levels extending into the root zones for more than 72 hours will not be allowed. The flexibility to operate higher water level controls will depend on how quickly groundwater levels rise into the root zone or allow saturated conditions to develop within the farm fields.

An alternative strategy is to identify farm acres that are more likely to experience higher risks to flooding during higher operational water control levels and negotiate lease arrangements for a specified testing period to reduce cultivated acres. This would reduce the potential constraint on the incremental increases in water level control due to risk of economic impacts.

D.23 CONCEPTUAL DESCRIPTION OF PROJECT OPERATIONS FOR TRANSITION FROM THE INITIAL OPERATING REGIME TO THE NEXT-ADDED INCREMENT CONDITION

With the exception of features which are likely to be recommended within the pending C-111 SCEF PIR, because the project does not make additional water available, and because it is located at the southern end of the C&SF Project system, it is unlikely that additional increments of restoration which follow, including the Next Added Increment, will significantly affect operations of the project features. Modifications to operations during transition to the Next Added Increment Condition will be documented as part of the Next Added Increment Condition, and revisions to the POM made as required.

ANNEX E
PROJECT MONITORING PLAN

PART I HYDROMETEOROLOGICAL MONITORING

PART II REGULATORY PLAN: WATER QUALITY COMPLIANCE

PART III ECOLOGICAL MONITORING

PART IV NUISANCE AND EXOTIC VEGETATION CONTROL PLAN

TABLE OF CONTENTS

E PROJECT MONITORING PLAN E-1
E.1 INTRODUCTION E-1
E.1.1 Coordination with the Monitoring and Assessment Plan and Assessment Process E-3
E.1.2 Structure of the C-111 Spreader Canal Western Monitoring Plan E-4
E.1.3 Project Phasing E-5
E.1.4 Estimated Monitoring and Management Plan Costs E-5
E.1.5 C-111 Spreader Canal Western Project Implementation Report Project Description E-6
E.1.5.1 Frog Pond Detention Area E-6
E.1.5.2 Aerojet Canal E-7
E.1.5.3 Secondary Water Control Features E-8
E.1.5.3.1 One Operable Structure in the Lower C-111 Canal E-8
E.1.5.3.2 Incremental Operational Changes at S-18C E-8
E.1.5.3.3 Plug at S-20A and Operational Changes at S-20 ..... E-8
E.1.5.3.4 C-110 Canal Plugs E-8

LIST OF FIGURES

FIGURE E-1: C-111 SPREADER CANAL RECOMMENDED PLAN E-9

ATTACHED DOCUMENTS:

PART I HYDROMETEOROLOGICAL MONITORING PLAN
PART II REGULATORY PLAN – WATER QUALITY COMPLIANCE
PART III ECOLOGICAL MONITORING PLAN
PART IV NUISANCE AND EXOTIC VEGETATION CONTROL PLAN

E PROJECT MONITORING PLAN

E.1 INTRODUCTION

The South Dade and Everglades National Park (ENP) Wetlands system has been significantly altered by human activities. Historically, Florida Bay and Biscayne Bay, including Barnes Sound and Card Sound, served as outlets for Everglades' runoff, and freshwater flowed overland toward these estuaries through Shark River Slough, Taylor Slough, and broad channels in the coastal ridge known as transverse glades. Freshwater flow patterns and volumes have been altered by regional drainage. This has resulted in the over-drainage of freshwater marshes and an inland migration of saline conditions in both the groundwater and surface waters. This has decreased the quality and spatial extent of freshwater wetland habitats and the landward expansion of saltwater and mangrove wetlands, including low-productivity, sparsely vegetated dwarf mangrove communities typical of the hypersaline "white zone." Concurrently, these changes in the quantity, distribution, and timing of freshwater flow to the coast have degraded estuarine ecosystems, largely via changes in salinity. Increased intensity and frequency of hypersalinity and rapid changes in salinity associated with flood-control water releases have resulted in degradation of habitat quality and the loss of or reduction in populations of important estuarine species that once were abundant in the area, including penaeid shrimp, crocodiles, and finfish, such as red drum and spotted sea trout.

Prior to the hydrologic changes described above, estuarine communities associated with coastal bays and adjacent waters provided important habitat for numerous organisms. Submersed aquatic vegetation (SAV) habitats, together with juvenile fishes and various macroinvertebrates, are indicators of healthy estuarine ecosystems. Similarly, in the upstream wetlands, sloughs, marl marshes and mangrove marshes provided important habitat for aquatic species such as fishes, amphibians, and insect larvae, and are indicators of healthy south Florida coastal wetlands.

The C-111 Spreader Canal (C-111 SC) and other projects within the Comprehensive Everglades Restoration Plan (CERP) focus on re-directing flow from canals toward the coastal wetlands and estuaries to re-establish more natural overland flow regimes that will provide appropriate hydropatterns and salinity regimes to re-establish and sustain key ecosystem characteristics through the southern Everglades and Florida Bay.

As described in the Yellow Book, the central feature of the C-111 SC project was to be construction of a six mile (+/-) long spreader canal and elimination of the lower C-111 Canal. The C-111 SC Project Delivery Team (PDT) recognized that key hydrologic and hydraulic decision critical uncertainties existed with respect to construction of the C-111 SC project as envisioned in the Yellow Book. In

recognition of these uncertainties, federal and local sponsor leadership directed the PDT to develop a phased project, based in part on the National Resource Council's (NRC) principals of Incremental Adaptive Restoration (IAR). The initial phase–Western PIR, which is the subject of this plan, is primarily intended to achieve early restoration benefits by increasing flows to Florida Bay via Taylor Slough. The second phase–Eastern PIR (which may or may not be constructed concurrently with the subject phase), will involve the completion of an in-situ, small scale, spreader canal design-test intended to reduce decision-critical uncertainties related to a full scale C-111 Spreader Canal project, which will be recommended within a second, subsequent, PIR.

C-111 SC Western PIR Monitoring Plan: Monitoring recommended within this plan is required to: 1) document the benefits of the project and the extent to which this initial phase of the project results in hydrological and ecological changes toward long-term CERP restoration goals described by Restoration Coordination and Verification (RECOVER); and 2) demonstrate that the western features do not result in unacceptable unintended consequences. The information learned from this monitoring plan will provide feedback to CERP Managers on whether there are system-wide issues that need to be addressed as part of implementation of future CERP projects and operations to ensure the goals and objectives are achieved for Taylor Slough and Northeast Florida Bay. This monitoring plan will also establish ecological baselines, support development of restoration targets for subsequent PIRs, and may identify additional management options that may be needed to address CERP restoration goals and objectives. Specific information which will likely be gleaned from implementation of this plan should help determine following:

- Whether the Frog Pond and Aerojet Canal operations will improve patterns of freshwater flow, salinity, and water quality through Taylor Slough to the nearshore waters of Florida Bay.
- Whether these hydrological improvements will improve the distribution, community structure and viability of estuarine ecosystems and associated biota.
- Ecosystem responses to changes in water depth and duration, and decreases in salinity magnitude and spatial extent within the southeastern Everglades wetlands.
- Whether improvements in wetland hydropatterns will result in an increase in overall habitat functional quality that will support increased plant and animal species diversity and expanded and intensified wildlife utilization.

The duration of the monitoring parameters presented in this Project Monitoring Plan is designed to not exceed five consecutive years. These monitoring efforts

will be cost shared during the construction phase of the project in accordance with Section 601(b)(2) of WRDA 2000.

E.1.1 Coordination with the Monitoring and Assessment Plan and Assessment Process

The CERP RECOVER organization and the CERP PDTs recognize that the effects from implementing the CERP projects must be monitored at both system-wide and local scales. RECOVER is responsible for the design and implementation of system-wide monitoring, while the individual CERP PDTs are responsible for design and implementation of monitoring to determine local effects and project performance. To implement the system-wide program, RECOVER has developed the CERP Monitoring and Assessment Plan (MAP; RECOVER 2004a) and the associated Quality Assurance Systems Requirements (QASR; RECOVER 2004b), a quality assurance/quality control (QA/QC) document. The MAP and the individual project monitoring plans must be closely coordinated to ensure that measures and targets selected by the project teams are consistent with system-wide measures and that duplication of effort is avoided. The project-level monitoring plan should ensure appropriate temporal and spatial coverage of monitoring parameters, which will likely mean filling gaps in the MAP monitoring effort and adding additional project-level parameters not included in the MAP. RECOVER is also developing a guidance memorandum for standardizing assessment activities. The C-111 SC Western PIR monitoring plan will implement those procedures when finalized.

The C-111 SC Western PIR Ecological and Water Quality Monitoring Plan will utilize the protocols and results of the MAP whenever possible. However, since the MAP is designed to detect system-wide or regional changes, only certain parameters are to be measured, and only across large spatial scales. Ecological and water quality effects of individual project features may not be adequately detected using the MAP parameters and sampling site arrays, which would make evaluation of project success at the local scale challenging. This, in turn, could limit the ability to adaptively manage the project to improve outcomes. Additional parameters and sampling sites have, therefore, been included in this monitoring plan where necessary to detect project-specific changes.

It should be noted that extensive hydrological, water quality, and ecological monitoring is supported by organizations and funds external to CERP and this project. The RECOVER MAP describes the identity of many of these complementary programs and acknowledges the importance of their findings to CERP. This C-111 SC Western Monitoring Plan likewise identifies and acknowledges these programs, with the intent to utilize all relevant available information to a maximum extent in the interest of maximizing understanding and fiscal efficiency. Within this plan, portions of these external programs that are expected to be of particular importance to the C-111 SC Western project have

been identified, with the expectation that critical information will continue to be provided in support of the project and CERP.

Overall assessment of project monitoring plan results will be coordinated by the South Florida Water Management District (SFWMD) and RECOVER to report actual project performance with respect to the parameters identified in this plan. Results will be synthesized and reported to CERP managers and PDT staff on the overall performance of the project, as well as any information obtained which would assist in subsequent PIRs. The C-111 SC Western feature's performance status will be reported as part of the RECOVER System Status Report. Project status workshops may be held for scientists, managers, and stakeholders to communicate the project's performance or any unanticipated ecological changes.

This C-111 SC Western project monitoring plan was developed assuming that major, ongoing monitoring programs that are not funded by the Project would continue to supply data relevant to the Project. Should any of these programs (e.g. coastal water quality and seagrass monitoring) be discontinued or significantly curtailed, then the Federal and local sponsors of the Project may re-evaluate monitoring priorities for proper evaluation of the project.

E.1.2 STRUCTURE OF THE C-111 SPREADER CANAL WESTERN MONITORING PLAN

The C-111 SC Western Monitoring Plan is comprised of three primary sections: (1) the ecological monitoring section, (2) the water quality compliance monitoring section, and (3) the hydro-meteorological section. These sections are provided below as three separate sub-appendices. The ecological section includes sub-sections pertaining to conditions and attributes within the downstream wetlands and estuaries: 1) hydrologic, salinity, and water quality parameters, 2) vegetation, and 3) fauna. Project objectives applicable to each component are identified, and the monitoring parameters that will evaluate the extent to which each objective is achieved are presented. For each monitoring parameter, the following are provided: (1) justification relative to project objectives, (2) description of the project-level monitoring component, (3) MAP monitoring component, (4) comparison of project-level and MAP components, (5) data management and QA/QC, and (6) monitoring cost estimates.

The water quality component associated with inputs from canals and permit compliance is provided as a separate appendix because it adheres to the structure and requirements specified in CERP Guidance Memorandum 40 for CERP water quality monitoring. Note that water quality monitoring within the ecological section is distinct from that in the compliance section in that the latter pertains to inflows from project structures and engineered detention areas, while the former is within the natural wetlands and estuarine regions and pertains to documenting and understanding ecological change (such as how changing

freshwater flow affects nutrient inputs to Florida Bay and any algal blooms within the bay). It is important to note that given the level of uncertainty of how much water will be diverted to what areas, and where that water will enter the bay, the specifics of the monitoring components described below may need to be adjusted over the life of the project.

The hydro-meteorological section is designed to measure surface water levels, ground water levels, and/or flow rates, along with the measurement of weather characteristics (e.g., rainfall). This monitoring is necessary to relate operational changes with local hydrologic conditions within the Frog Pond Detention Area and Aerojet Canal, Agricultural lands between S-177 and S-178 water control structures, Southern Glades wetlands (east and north of the C-111 Canal), Taylor Slough, the ENP Panhandle, and the Model Land wetlands west of US Highway 1. Each of these regions may be influenced by proposed operational changes and adaptive management of the regional water resources proposed in the Draft Project Operating Plan. A monitoring network of surface and ground water levels, structure flow rates, canal stages, rainfall, and weather will be maintained within the basin to measure these water conditions.

E.1.3 Project Phasing

As previously described, the C-111 SC project will be implemented with two PIRs, the C-111 SC Western project is intended primarily to generate early benefits to Eastern Florida Bay by reducing seepage from Taylor Slough.

E.1.4 Estimated Monitoring and Management Plan Costs

The Recommended Plan includes a Project Monitoring Plan to ensure proper operation of the Project, ensure compliance with existing laws and regulations, and evaluate project performance. The monitoring plan includes hydrometeorological monitoring, water quality monitoring, ecological monitoring, and endangered species monitoring. The recommended plan also includes a vegetation management plan to control nuisance and exotic vegetation. The duration of the monitoring and management measures ranges between 5 and 10 years. The monitoring and management efforts will be cost shared during the construction phase of the Project per the term of the Master Agreement. All costs associated with the physical operation of the Project will be funded through O&M. The total estimated cost for monitoring and vegetation management to be funded during construction is $7,639,668. The post construction cost, and annual O&M cost, are $6,583,000 and $256,000, respectively. The following table details the costs.

Monitoring Activity	Cost During Construction	Cost Post-Construction	Post Construction Annual Cost (O&M)
Hydrometeorological	$ 1,483,631	$ 303,034	
Water Quality	105,000	70,000	
Ecological	1,552,000	803,000	
Endangered Species (CSSS)	1,394,837	903,393	
Vegetation Management	3,104,200	4,504,200	
TOTAL	$ 7,639,668	$ 6,583,000	$ 267,376

E.1.5 C-111 Spreader Canal Western Project Implementation Report Project Description

Components of the C-111 SC Western project are discussed below:

E.1.5.1 Frog Pond Detention Area

As currently envisioned, water that otherwise would be discharged via S-177 is routed to the proposed above ground, 590 acre Frog Pond Detention Area (FPDA) via a proposed S-200 pump station (225 cfs) to be constructed downstream of S-176. The FPDA is designed to meet the requirements of a Low Hazard Potential Facility. The perimeter containment levee has an elevation of +9.0 feet NAVD88. The average height above existing ground elevation is about 5.5 feet. The S-200 pump station, which will trigger at stages slightly lower than S-177's current open criteria [Interim Operational Plan (IOP)] will discharge to a concrete-lined, aboveground, conveyance channel, that discharges to an aboveground, cascading header channel located along the western side of the proposed aboveground FPDA.

The cascading header channel will assist in prevention of seepage losses from Taylor Slough and will ensure that available water is staged higher prior to discharge into one of three individual cells within FPDA. Cascading water levels will be maintained by constructing two 80-foot long east-west weirs at 1/3 points along the length of the header canal. The weir crest elevations are set to be 0.5 ft above existing ground elevation.

Just upstream of the two header weirs and just upstream of the southern levee of the southern detention area cell, 80-foot long north-south weirs will be constructed between the header canal and FPDA cells. The weirs crest elevations are set to be 1.2 ft above existing ground elevation.

Pumping will cease if ponding within the Cape Sable seaside sparrow (CSSS) subpopulation C reaches a depth of ten (10) centimeters, as measured at a pre-determined representative location.

Note: Planning level design of the FPDA was established at 530 acres for alternative comparison purposes. The size of the FPDA has increased to 590 acres after preliminary detailed modeling and design.

E.1.5.2 Aerojet Canal

Similar to the FPDA, water that otherwise would be discharged via S-177 is routed to the Aerojet Canal that is proposed to be extended several thousand feet to the north. The northern limit of the existing Aerojet Canal presently lies approximately one mile south of Ingraham Highway. Although plugged at various locations, its overall length currently extends a distance of approximately 4.6 miles. It is proposed to effectively extend the northern limit of the canal to a point approximately 2,300 feet south of State Road (SR) 9336 as an unlined above ground open channel, to construct a concrete-lined above ground channel between the northern canal extension and S-199, construct perimeter grading around all unlined portions of the canal north of the east-west borrow canal, construct a new earthen weir with crest elevation 1.0 foot below adjacent natural ground, and convert all existing plugs over that same length to similar weirs. A second, S-199 pump station (225 cfs), will have the same triggers as S-200 and will be constructed immediately upstream of S-177 (downstream of State Road 9336). S-199 will discharge into a concrete-lined, aboveground channel which will be constructed parallel to (south of) SR 9336. The conveyance channel will, in turn, discharge to an above ground, unlined, northern extension of the Aerojet Canal.

The intent of the Aerojet Canal features is to extend the hydraulic ridge created by the FPDA south of SR 9336, thus reducing Taylor Slough seepage from what is reportedly the leakiest section of the C-111 Canal system. The reduction of seepage losses keeps water within the natural system, increasing project benefits. Similar to the FPDA header canal, cascading water levels will be maintained within the Aerojet Road Canal by converting 3 existing earthen plugs to broad crested weirs and construction of a new broad crested weir. The crest elevations will be 1 foot below adjacent existing grades, and the canal will include sufficient freeboard to prevent levee bank from being overtopped.

Pumping will cease if ponding within CSSS subpopulation D reaches a depth of ten (10) centimeters, as measured at a pre-determined representative location.

E.1.5.3 Secondary Water Control Features

E.1.5.3.1 One Operable Structure in the Lower C-111 Canal

The plan also includes the construction of an operable structure within the lower C-111 Canal. The proposed structure is intended to create groundwater mounding, thereby reducing current levels of seepage from the lower C-111 Canal while preserving existing levels of flood damage reduction.

E.1.5.3.2 Incremental Operational Changes at S-18C

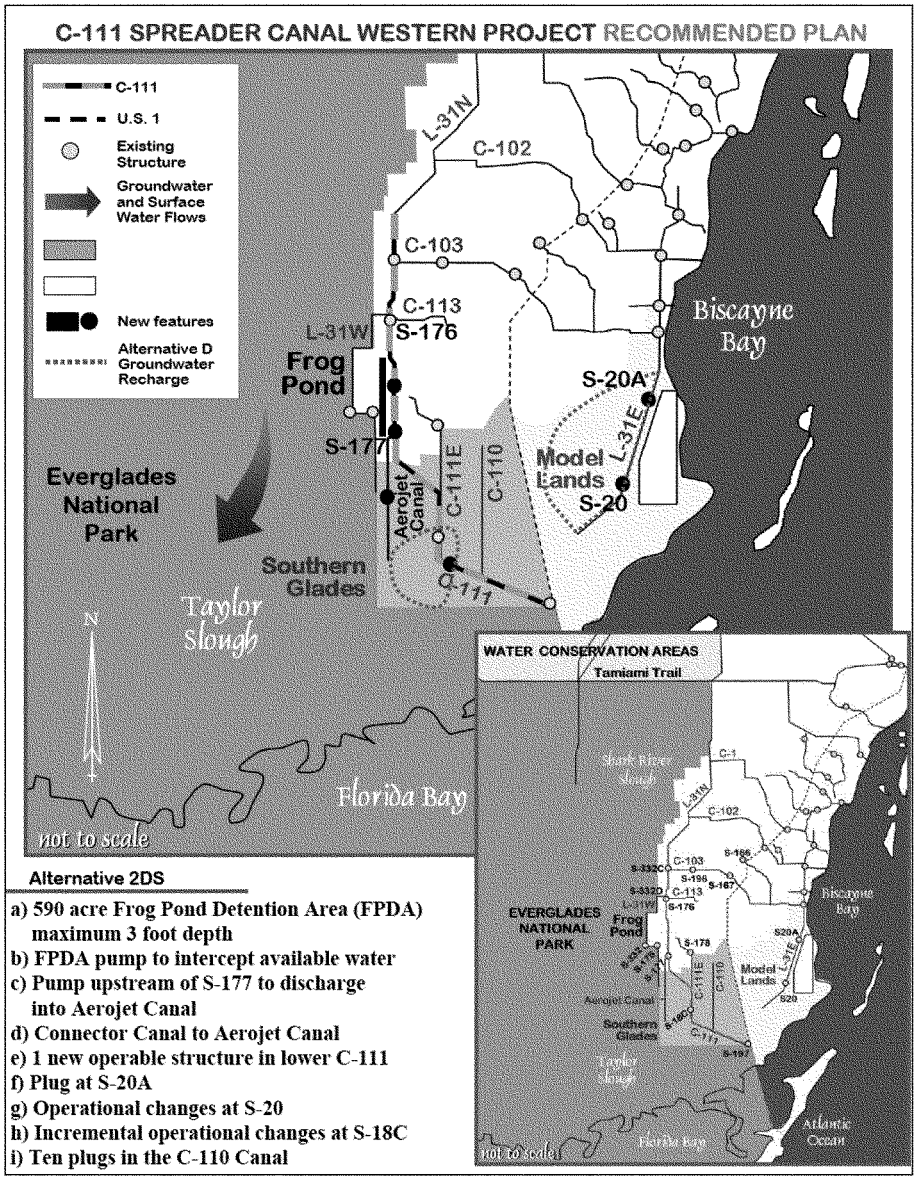
In order to maximize restoration opportunities, the plan includes incremental operational changes in the current "open and close" triggers at existing structure S-18C. The "open and close" triggers will be increased in increments of no more than 0.1-feet per year and the total change in either trigger shall not exceed 0.4-feet. Stage override triggers will be established immediately downstream of S-177 and/or in the adjacent agricultural lands to establish a "backstop" at which S-18C triggers will return to their existing levels. The incremental operational changes at S-18C will serve to supplement groundwater mounding in the lower C-111 area.

E.1.5.3.3 Plug at S-20A and Operational Changes at S-20

The plan includes the construction of a permanent plug at existing structure S-20A in the L-31E Canal, and operational changes at existing structure S-20. The proposed plug near S-20A and proposed operational changes at S-20, specifically raising the "open and close" triggers to 0.5-feet, are intended to restore hydroperiods within the Model Land.

E.1.5.3.4 C-110 Canal Plugs

Finally, the plan includes construction of earthen plugs at key locations within the C-110 Canal in order to promote sheet flow within the Southern Glades. As currently envisioned, ten plugs will be constructed at semi-regular intervals by returning the existing spoil material from the canal banks to the Canal. Any remaining spoil not utilized in construction of the plugs will be placed into the canal to further promote sheetflow and to lessen the effects of the of any remaining canal segments.



Alternative 2DS

a) 590 acre Frog Pond Detention Area (FPDA) maximum 3 foot depth
b) FPDA pump to intercept available water
c) Pump upstream of S-177 to discharge into Aerojet Canal
d) Connector Canal to Aerojet Canal
e) 1 new operable structure in lower C-111
f) Plug at S-20A
g) Operational changes at S-20
h) Incremental operational changes at S-18C
i) Ten plugs in the C-110 Canal

FIGURE E-1: C-111 SPREADER CANAL RECOMMENDED PLAN

ANNEX E
PROJECT MONITORING PLAN

PART I: HYDROMETEOROLOGICAL MONITORING PLAN

Hydrometeorological Monitoring Plan

For

C-111 Spreader Canal Western Features CERP Project
February 10, 2009

Authoring Organization's Representative (Monitoring Plan Coordinator) **Date**

Lead CERP Project Manager **Date**

Representative, Local Sponsor (Monitoring Organization) **Date**

Representative, Federal Sponsor (Monitoring Organization) **Date**

Project Quality Assurance Officer **Date**

TABLE OF CONTENTS

E PART I: HYDROMETEOROLICAL MONITORING PLAN ..... Annex E Part I--E-1
E.1 PROJECT DESCRIPTION ..... Annex E Part I--E-1
E.1.1 Introduction and Background ..... Annex E Part I--E-1
E.1.2 Purpose and Scope ..... Annex E Part I--E-3
E.1.3 Active Mandates and/or Permits ..... Annex E Part I--E-4
E.2 DATA COLLECTION ..... Annex E Part I--E-4
E.2.1 Monitoring Data Elements ..... Annex E Part I--E-5
E.2.2 Monitoring Locations ..... Annex E Part I--E-5
E.2.3 Data Collection Frequency and Parameter Lists ..... Annex E Part I--E-5
E.2.3.1 Surface Water Level Monitoring ..... Annex E Part I--E-8
E-2.3.2 Groundwater Level and Flow Monitoring ..... Annex E Part I--E-14
E-2.3.3 Surface Flow Monitoring ..... Annex E Part I--E-22
E-2.3.4 Meteorological Monitoring ..... Annex E Part I--E-24
E.2.4 Instrumentation/Programming ..... Annex E Part I--E-27
E.2.5 Elevation Survey of Monitoring Site Installations ..... Annex E Part I--E-27
E.3 DATA VALIDATION, DATA STORAGE AND ARCHIVAL ..... Annex E Part I--E-27
E.3.1 Raw Data ..... Annex E Part I--E-28
E.3.2 Validated Data ..... Annex E Part I--E-28
E.3.3 Data Storage and Archival – DBHYDRO Database ..... Annex E Part I--E-29
E.4 QUALITY ASSURANCE AND QUALITY CONTROL ..... Annex E Part I--E-29
E.5 COST ESTIMATES ..... Annex E Part I--E-30
E.6 FUTURE REVISION NOTES AND MODIFICATIONS ..... Annex E Part I--E-35

LIST OF TABLES

Table E-1: Surface Water Data Reporting Frequency By Site ..... Annex E Part I--E-10
Table E-2: Ground Water Level and Flow Monitoring Sites Reporting Frequency of Data Collection ..... Annex E Part I--E-16
Table E-3: Well Construction Details for Groundwater Monitoring Wells Installed Adjacent to the Proposed Frog Pond Detention Area ..... Annex E Part I--E-21
Table E-4: Surface Flow Monitoring Sites ..... Annex E Part I--E-24
Table E-5: Meteorological Monitoring Sites Within The Project Area... Annex E Part I--E-26

LIST OF FIGURES

Figure E-1: Project Location ..... Annex E Part I--E-2
Figure E-2: Project Features and Related Areas Of Interest ..... Annex E Part I--E-7
Figure E-3: Surface Water Level (Stage) Monitoring Sites ..... Annex E Part I--E-9
Figure E-4: Additional Surface Water Monitoring Sites Within Cape Sable Seaside Sparrow Designated Critical Habitat Units 2 and 3 ..... Annex E Part I--E-13
Figure E-5: Ground Water Level (Stage) and Flow Monitoring Sites..... Annex E Part I--E-15
Figure E-6: Groundwater Stage Monitoring Wells Near The Frog Pond Detention Area. ..... Annex E Part I--E-20
Figure E-7: Surface Flow Monitoring Sites ..... Annex E Part I--E-23
Figure E-8: Meteorological Monitoring Sites Within The Project Area . Annex E Part I--E-25

GLOSSARY

ADaPT – Automated Data Processing Tool software.

ADR – Automated Data Review software

Assessment – to interpret responses in natural and/or human systems based on data acquired though monitoring activities.

Constraint – a condition that is to be minimized or avoided in the plan formulation and selection process to ensure that the project component does not result in undesirable changes in the project area or downstream waters. Example: The component shall not cause or contribute to a violation of state water quality standards.

Data Quality Objectives (DQO) – is a process that identifies the intended use of the data including the types of decisions that will be made based on the results. The analytes of interest, corresponding action levels, sampling design and quality control measures are also identified as well as data repositories into which the data will be entered, the mechanisms used to ensure that the data are accurately entered into a database and to verify that the data in the database are correct, and the level of data quality acceptable for this project.

EDMS – Environmental Data Management System

EM – Engineering Manual: USACE documents that provide guidance on various aspects of project design and implementation.

EMCT – Environmental Monitoring Coordination Team, a group of senior-level managers that participate in planning and reviewing project-level monitoring activities. Representatives from the District and the USACE are members of the team.

FDEP – Florida Department of Environmental Protection

Local Sponsor – the agency responsible for matching the Federal funding available for a project. The South Florida Water Management District (SFWMD) is the local sponsor for the majority of CERP projects.

Matrix – refers to the material from which the sample is taken, such as surface water, ground water, pore water, sediment, soil or air.

Monitoring – all of the activities required to acquire, process, store, retrieve and analyze data used to assess the status of water resources. It includes data collection, data analysis, data validation, and data management.

Monitoring Data – data that are collected for the purpose of determining the water quality and hydrologic conditions/effects for CERP projects at a given location.

Monitoring Plan – the plan to acquire additional meteorological, hydrologic, hydraulic or water quality data. It includes considerations of sampling location, frequency, method, parameters and duration. It should be based on the elements identified in the development of data quality objectives for the project.

MOSCAD – MOtorola SCADa (SCADA – Supervisory Control And Data Acquisition). An intelligent communications device used in data acquisition and remote system control.

Objective – a measurable element of the goal(s) of a project or plan. Project objectives and constraints are identified in the Project Management Plan (PMP).

Permit Requirement – certain analytes are sampled, tested and results reported to state and/or federal agencies as a condition of a permit to build or operate a project.

PLMP – Project-Level Monitoring Plan

Project-level – A project has a defined scope, quality objectives, schedule, and cost. Project-level activities refer to those that are within the scope of a specific project.

QA – Quality Assurance: the system of management activities and quality control procedures implemented to produce and evaluate data according to preestablished data quality objectives.

QAPP – Quality Assurance Project Plan, a QA plan written for a specific project outlining data quality objectives, sampling and analytical protocols and QC measures needed to satisfy the intended uses of the data.

QAOT – Quality Assurance Oversight Team, comprised of representatives from USACE, SFWMD, FDEP, and USEPA, ultimately responsible for implementation of the QASR for CERP.

QASR – Quality Assurance System Requirements, a CERP manual that establishes minimum criteria for environmental data quality.

QC – Quality Control: The system of measurement activities used to document and control the quality of data so that it meets the needs of data users as specified by pre-established data quality objectives.

QA/QC – Quality Assurance and Quality Control. A process that insures that the data available for assessment is of an acceptable level of quality.

RACU – Remote Acquisition and Command Unit. A device used for data acquisition and remote system control.

RECOVER – REstoration COordination and VERification (RECOVER) evaluates and assesses CERP performance by linking scientific and technical information throughout the planning and implementation period to ensure that a system-wide perspective is maintained throughout the restoration program.

RECOVER AT - The RECOVER Assessment Team is a standing, interagency, interdisciplinary team of scientists and resource specialists who are responsible for achieving the five primary tasks of RECOVER: 1) create, refine and provide documentation for a set of conceptual ecological models for the total system and a set of attribute-based biological performance measures for the Comprehensive Plan; 3) design and review the system-wide monitoring and data management program needed to support the Comprehensive Plan; 4) use the information coming from the system-wide monitoring program to assess actual system responses as components of the Comprehensive Plan are implemented and produce an annual assessment report describing and interpreting these responses; and 5) coordinate all scientific peer reviews of RECOVER documents.

Sampling Frequency – how often samples are collected.

Sampling Methods – the methods used to collect samples in the field. The methods should be standard methods, methods based on a standard operating procedure, or a method that has been approved by the participating agencies.

SFWMD – South Florida Water Management District

USACE – U. S. Army Corps of Engineers

WBS – Work Breakdown Structure: The WBS specifies a hierarchy of tasks and activities necessary to fulfill the objectives of the project. The WBS is structured in levels of work detail, beginning with the deliverable itself, and is then separated into identifiable work elements.

Zone of Influence – the area over which a project alters or impacts the environment.

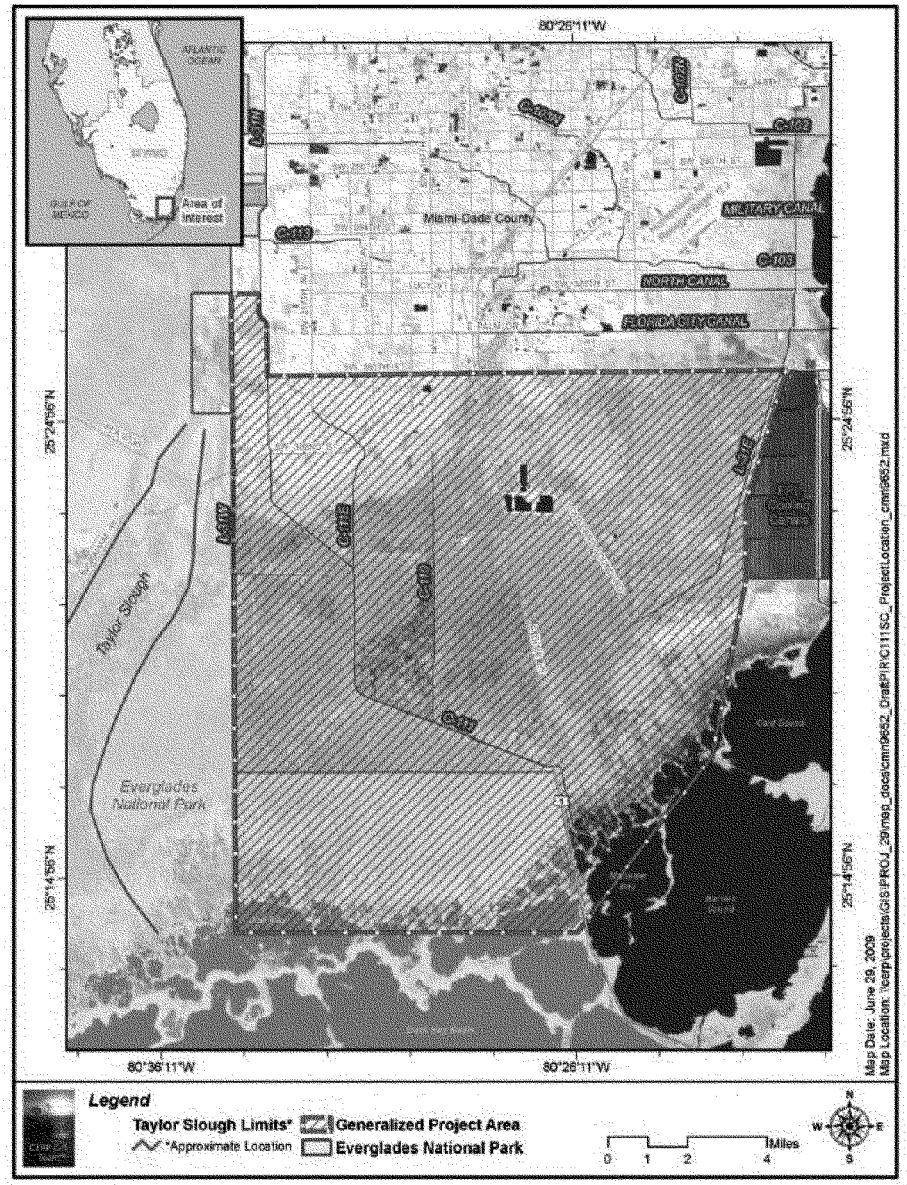
Additional terms and definitions for CERP can be found in CGM 13 - Acronyms and Glossary of Terms. http://www.cerpzone.org/documents/cgm/cgm_013.03.pdf

E PART I: HYDROMETEOROLICAL MONITORING PLAN

E.1 PROJECT DESCRIPTION

E.1.1 Introduction and Background

This document serves as a reference for hydrologic and meteorological data management for the C-111 Spreader Canal Western project. The overarching goal of the C-111 SC project is to restore the quantity, timing, and distribution of water delivered to Florida Bay via Taylor Slough of ENP. Also included in the project are features that will improve ecological conditions within the areas known as the Southern Glades and Model Lands. Additionally, salinities in the downstream areas of Florida Bay (from Taylor Slough) would be reduced as a result of the proposed project. The C-111 SC Western project area includes the area from the Atlantic Coastal Ridge south to Florida Bay, from Taylor Slough to Card Sound Road (***FIGURE E-1***).


80°26'11"W
Area of Interest
Miami-Dade County
MILITARY CANAL
NORTH CANAL
FLORIDA BAY CANAL
C-111
C-103
C-105
C-107
C-108
C-109
C-110
C-113
C-113A
C-113B
C-113C
C-113D
C-113E
C-113F
C-113G
C-113H
C-113I
C-113J
C-113K
C-113L
C-113M
C-113N
C-113O
C-113P
C-113Q
C-113R
C-113S
C-113T
C-113U
C-113V
C-113W
C-113X
C-113Y
C-113Z
C-114
C-115
C-116
C-117
C-118
C-119
C-120
C-121
C-122
C-123
C-124
C-125
C-126
C-127
C-128
C-129
C-130
C-131
C-132
C-133
C-134
C-135
C-136
C-137
C-138
C-139
C-140
C-141
C-142
C-143
C-144
C-145
C-146
C-147
C-148
C-149
C-150
C-151
C-152
C-153

The C-111 SC Western project will include a 590-acre infiltrating detention area within the unused portions of the Frog Pond, extend and modify the existing Aerojet Canal, construct an intermediate Water Control structure (S-198) between S-18C and S-197, construct a permanent plug in the L-31W Canal near S-20A, construct earthen plugs at key locations along C-110 Canal, increase the open and close triggers at S-20 by 0.5', and implement incremental increases in the current open and close triggers at S-18C.

The proposed Frog Pong Detention Area (FPDA) will be served by a 225 cfs pump station (S-200) to be constructed along the C-111 Canal between structures S-176 and S-177. As designed there will be no direct discharges to Everglades National Park, and any emergency overflows will direct flow back to the L-31N Canal.

The proposed Aerojet Canal feature will be created by extending the existing Aerojet Road Canal north towards Ingraham Highway (SR 9336), berming the perimeter of the canal, and constructing a new 225 cfs pump station (S-199) immediately upstream of S-177.

The guidance contained in this document will assist in maintaining consistency in methodology, parameter lists and frequencies as well as providing documentation of the project scope and an ongoing historical perspective. Prior to implementation of any aspect of this monitoring plan signature approval of the plan is required by the project manager, and representatives of the monitoring departments or divisions of the sponsoring agencies.

E.1.2 Purpose and Scope

The monitoring sites described in this document are to be established to satisfy requirements of the Savings Clause provisions contained within Sections 601(h)(5)(A) and 601(h)(5)(B) of WRDA 2000, as well as the State water availability and flood protection requirements set forth in FS 373.1501(5)(d).

Section 601(h)(5)(A) of the WRDA requires that "Until a new source of water supply of comparable quantity and quality as that available on the date of enactment of this Act (December 11, 2000) is available to replace the water to be lost as a result of implementation of the Plan, the Secretary and the non-Federal sponsor shall not eliminate or transfer existing legal sources of water, including those for:

(i) an agricultural or urban water supply;
(ii) allocation or entitlement to the Seminole Indian Tribe or Florida under Section 7 of the Seminole Indian Land Claims Settlement Act of 1987 (25 U.S.C. 1772e);
(iii) the Miccosukee Tribe of Indians of Florida;

(iv) water supply for Everglades National Park; or,
(v) water supply for fish and wildlife."

Section 601(h)(5)(B) of the WRDA requires that implementation of the Plan shall not reduce levels of service for flood protection that are;

(i) in existence on the date of enactment of this Act; and
(ii) in accordance with applicable law.

Similar to the Federal protections described above, Florida Statute 373.1501(5)(d) requires that CERP project sponsors "provide reasonable assurances that the quantity of water available to existing legal users shall not be diminished by implementation of project components so as to adversely impact existing legal users, that existing levels of flood protection will not be diminished outside the geographic area of the project component, and that water management practices will continue to adapt to meet the needs of the restored natural environment."

In an effort to improve water flow to Taylor Slough, the current distribution of water and certain water management practices will be adaptively managed as outlined in the Draft Project Operating Manual to quantify the added potential environmental benefits that could be achieved for Taylor Slough. The hydrometerological monitoring proposed in this section is specifically designed to provide the reasonable assurances for protection of environmental resources dependent on existing water flows and sources for maintenance of ecological functions, as well as, protection of agricultural uses within the basin that could potentially be adversely impacted by changes in water management practices.

E.1.3 Active Mandates and/or Permits

In addition to being mandated by Sections 601(h)(5)(A) and 601(h)(5)(B) of WRDA 2000, and by State water availability and flood protection requirements set forth in FS 373.1501(5)(d), the project will be responsible for meeting the specific monitoring requirements which will be contained within the yet to be applied for State CERPA permit and USACE Section 404 permit.

E.2 DATA COLLECTION

Hydrologic and meteorological data will be collected in a timely manner and disseminated to various groups pursuant to their intended purpose. Data will be collected by various types of instrumentation and transmitted via Remote Terminal Units (RTU's) to databases where they will be archived. The two most predominant types of RTU's are Campbell Scientific CR1000 and Motorola SCADA (MOSCAD) units. These two represent the latest technologies in the data collection industry; both offer increased remote water-control device access

and data retrievability. The data are disseminated for the purposes of water control operations and for archival data storage for later analysis. The Quality Assurance System Requirements (QASR) manual establishes quality assurance protocols for hydrologic and meteorological data. These protocols are an attempt to establish operating standards for the collection of a variety of data types that relate to the hydrologic system. The purpose of these protocols is to provide for the efficient and effective analysis of data collected by the various agencies in central and south Florida. The standardized protocols allow users of these data to do so with some degree of confidence that the data was collected with similar accuracy and processing standards across various agencies. In addition, these protocols provide guidance, with respect to accuracy and precision and to those involved with establishing new monitoring stations.

The scope of these procedures is focused on hydrologic and meteorological data types, such as water level, rainfall, structure discharge, groundwater levels, etc. The approach is to provide broad guidelines that establish criteria for accuracy and precision for each data type. The actual procedures for calibrating and using the wide variety of instruments that may be deployed to actually measure, record and transmit these data are beyond the scope of the QASR manual. However, sensor and/or measurement device documentation will be reviewed to ensure that the sensor is capable of achieving the accuracy and precision specified in this manual.

E.2.1 Monitoring Data Elements

The hydrologic and meteorological monitoring network will have the ability to collect several data elements. Hydrologic monitoring generally involves the measurement of surface water levels, ground water levels, and/or flow rates, while meteorological monitoring generally involves the measurement of weather characteristics (e.g. rainfall). The hydrologic and meteorological parameters to be measured, by site are listed in tables within the sections described below.

E.2.2 Monitoring Locations

There are a total of ten (10) new monitoring locations, eight (8) enhanced monitoring locations, and forty five (45) existing monitoring locations where data would be evaluated under this plan. ***FIGURES E-1*** to ***E-5*** provides the GPS coordinates for each of the monitoring locations. The locations of all the monitoring sites are depicted on ***FIGURE E-3*** to ***E-8***.

E.2.3 Data Collection Frequency and Parameter Lists

The data collection frequency and parameters for the required monitoring sites are also provided in ***TABLE E-1***, ***E-2, E-4***, and ***E-5***, which follow.

There are several areas of interest where additional hydrometerological monitoring is required to relate operational changes with local hydrologic conditions; Frog Pond Detention Area, Aerojet Canal, Agricultural lands between S-177 and S-178 water control structures, Southern Glades wetlands (east and north of the C-111 Canal), Taylor Slough, the Everglades National Park Panhandle, and the Model Land wetlands west of US-1 (***FIGURE E-2***). Each of these regions may be influenced by proposed operational changes and adaptive management of the regional water resources proposed in the Draft Project Operating Plan. A monitoring network of surface and ground water levels, structure flow rates, canal stages, rainfall, and weather will be maintained within the basin to measure water conditions. A significant hydrometerological network already exists (***FIGURE E-8***) and is maintained by a number of state and federal agencies. Gaps in the data collection effort have been identified for certain parameters of concern and will be addressed through additions under this project monitoring plan.

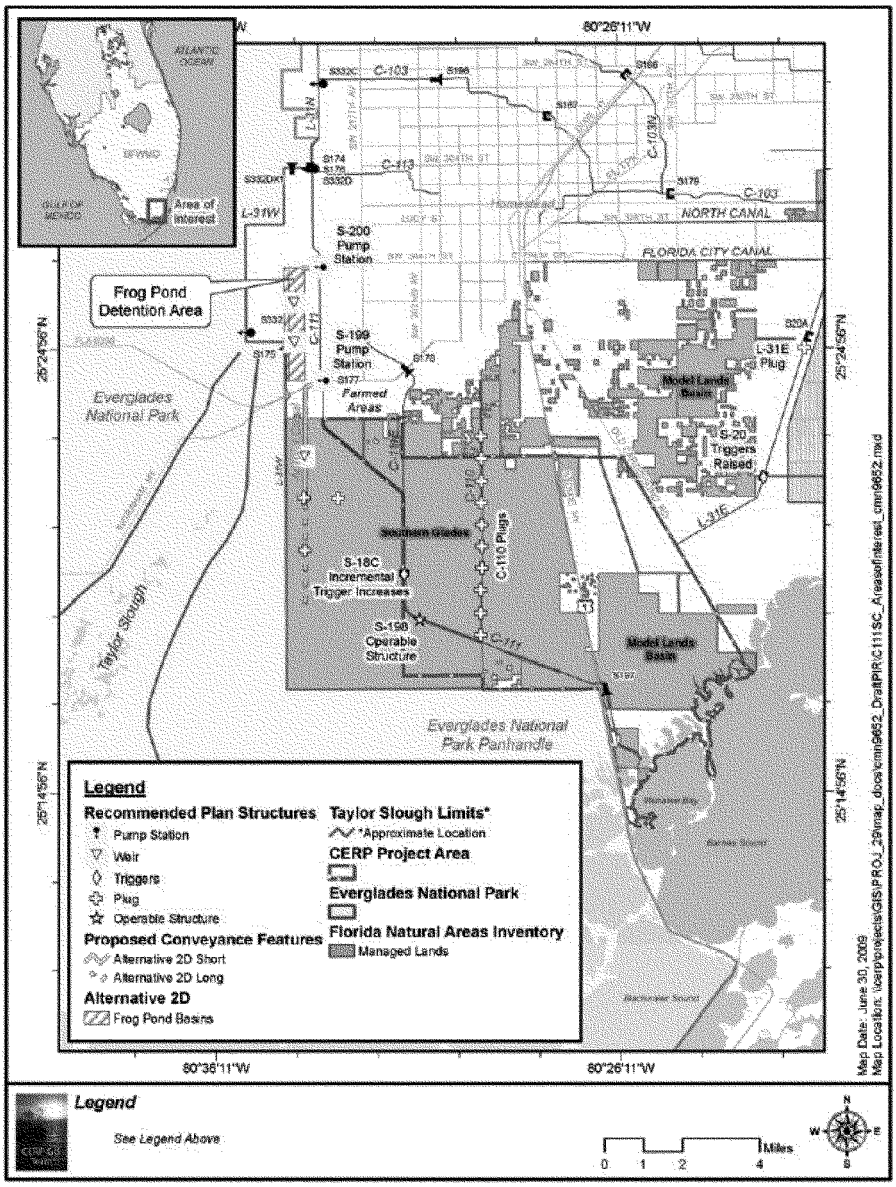


FIGURE E-2: PROJECT FEATURES AND RELATED AREAS OF INTEREST

E.2.3.1 Surface Water Level Monitoring

FIGURE E-3 displays the existing surface water monitoring network within the project area. This network includes a number of monitoring stations maintained by SFWMD and Everglades National Park. Daily water level records from these sites are maintained in the SFWMD DBHYDO database. ***TABLE E-1*** lists the gauge site and parameters monitored. Each of the identified sites has a historical record extending back to the year 2000, or farther. These data records provide a baseline of the hydrologic conditions within the basin in response to seasonal and inter-annual variations in climatic conditions.

There are three (3) new sites proposed for monitoring surface water levels within the project area and are identified on the map as new gauge sites 1-3. These new sites will be installed to improve monitoring of potential water levels changes associated with the operations of the Frog Pond Detention Area and Aerojet Canal features on Cape Sable seaside sparrow, the increased water control levels at the S-20 structure, and affects of the partial plugging of the C-110 Canal.

There are also one (1) new site proposed for monitoring surface water levels within the near the southern end of the proposed Aerojet Road Canal feature, and one new site proposed for monitoring surface water levels within the southernmost portion of the Frog Pond Header Canal (***FIGURE E-3***). As described in the Draft Project Operating Manual (DPOM), each of these is intended to shut off the appropriate supply pump (S-199 or S-200), should water levels reach thirty inches (30") above adjacent natural grades.

The equipment type and sensors to be installed will be similar to existing sites. Because only water levels approaching 30" above natural grade are of interest at the sites described as New Frog Pond Header Canal Site and New Aerojet Canal Site, these two sites will include just a stilling well encased float and tape. All other sites described within this section will contain both the stilling well (to measure above ground stages, and shallow well pressure transducers, to measure bellow ground water stages. At all surface water level stations, water levels will be recorded at 15 minute intervals on Campbell Scientific CR1000 units and data retrieved telemetrically. All data will be subjected to required QA/QC review and then incorporated into the SFWMD DBHYDO database.

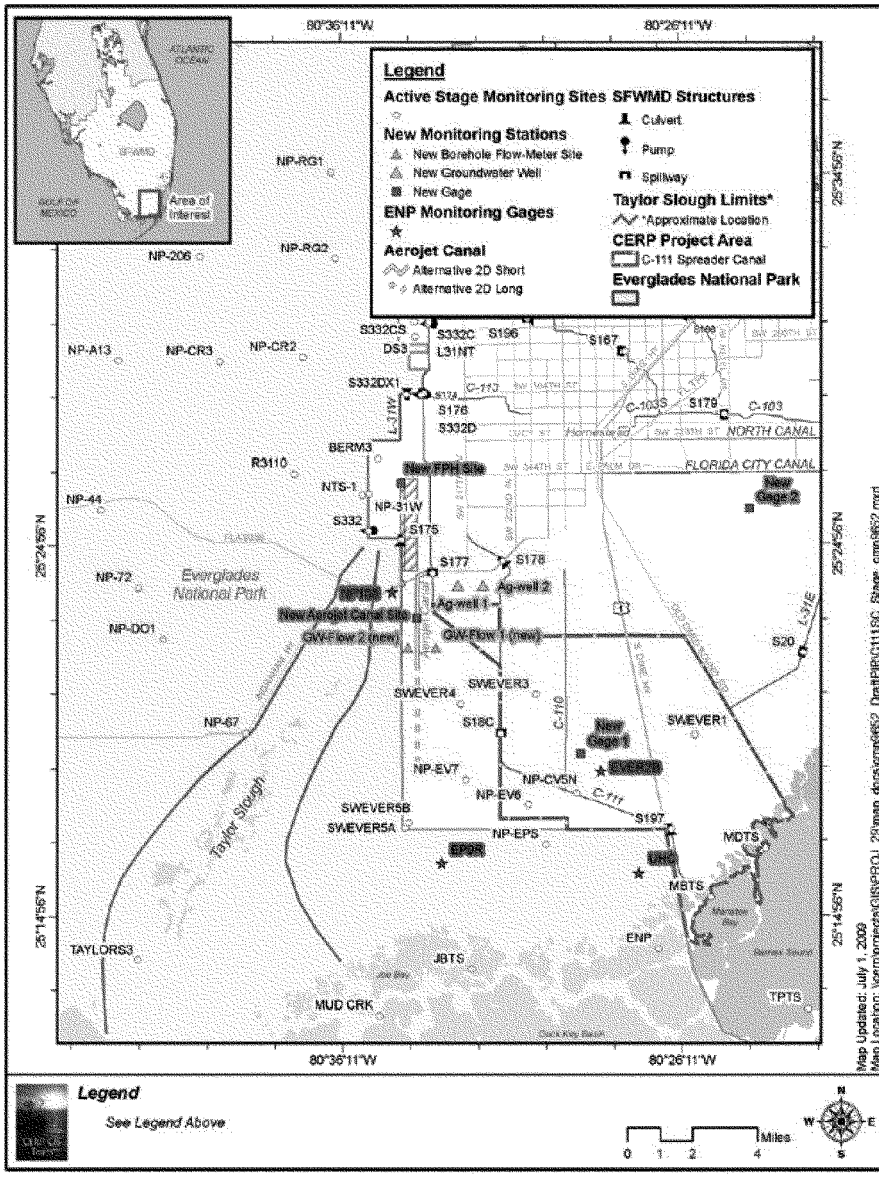


FIGURE E-3: SURFACE WATER LEVEL (STAGE) MONITORING SITES

TABLE E-1: SURFACE WATER DATA REPORTING FREQUENCY BY SITE

Station	Coordinate (x,y)	Agency	Group	Parameter	Reporting Frequency	Sensors
NP-31W	791537.38 401866.50	ENP	Hydrologic	Stage	Daily	
NTS-1	791537.38 401866.5	ENP	Hydrologic	Stage	Daily	CR-10 w incremental encoders
R3110	779472.71 405151.4	ENP	Hydrologic	Stage	Daily	CR-10
BERM3	793115.91 407656.27	SFWMD	Hydrologic	Stage	Daily	CR-10 w incremental encoders
NPDO1	758215.22 378154.72	ENP	Hydrologic	Stage	Daily	CR-10
NP-67	771654.64 362682.98	ENP	Hydrologic	Stage	Daily	CR-10
NP-44	748091.57 399272.28	ENP	Hydrologic	Stage	Daily	CR-10
NP-72	754172.48 386362.83	ENP	Hydrologic	Stage	Daily	CR-10
NP-EPS (EPSW)	820332.81 344511.01	ENP	Hydrologic	Stage	Daily	CR-10
SWEVER-3	818720.25 369047.22	ENP	Hydrologic	Stage	Daily	CR-10
SWEVER-4	806413.24 367430.85	ENP	Hydrologic	Stage	Daily	CR-10
SWEVER-1	844507.49 362528.85	ENP	Hydrologic	Stage	Daily	CR-10
NP-EV6	817482.04 351014.86	ENP	Hydrologic	Stage	Daily	CR-10
NP-EV7	807280.528 355218.847	ENP	Hydrologic	Stage	Daily	CR-10
NP-CR3	767337.04 423524.45	ENP	Hydrologic	Stage	Daily	CR-10
NP-CR2	780880.71 424246.2	ENP	Hydrologic	Stage	Daily	CR-10
NP-A13	750936.06 423689	ENP	Hydrologic	Stage	Daily	CR-10
DS-3	799081.87 427634.17	ENP	Hydrologic	Stage	Daily	CR-10
NP-CV5N	825367.06 353063.23	ENP	Hydrologic	Stage	Daily	CR-10
NP-N10	786470.409 410373.52	ENP	Hydrologic	Stage	Daily	CR-10
UHC	835442.004 340016.900	ENP	Hydrologic	Stage	Daily	CR-10
EP9R	803471.85 341476.92	ENP	Hydrologic	Stage	Daily	CR-10
Ever2B	829319.089 356750.585	ENP	Hydrologic	Stage	Daily	CR-10
NP-158	795423.230 385876.508	ENP	Hydrologic	Stage	Daily	CR-10

Station	Coordinate (x,y)	Agency	Group	Parameter	Reporting Frequency	Sensors
GW-Flow1	802471.662 376820.694	SFWMD	Hydrologic	Stage	Daily	CR-1000 w incremental encoder
GW-Flow2	797978.376 367356.781	SFWMD	Hydrologic	Stage	Daily	CR-1000 w incremental encoder
New Gage 1	826023.123 359531.636	SFWMD	Hydrologic	Stage	Daily	CR-1000 w incremental encoder
New Gage 2	853374.017 399662.184	SFWMD	Hydrologic	Stage	Daily	CR-1000 w incremental encoder
CSSS Unit 2	782496.311 399470.033	SFWMD	Hydrologic	Stage	Hourly	CR-1000 w incremental encoders
CSSS Unit 3	802024.611 365196.605	SFWMD	Hydrologic	Stage	Hourly	CR-1000 w incremental encoders
New Frog Pond Header Canal Site	796800 403700	SFWMD	Hydrologic	Stage	Hourly	CR-1000 w incremental encoders
New Aerojet Canal Site	799450 381680	SFWMD	Hydrologic	Stage	Hourly	CR-1000 w incremental encoders

The surface water level monitoring sites NP-67 and NP-EPS (also known as EPSW) are particularly important as a reference for water level changes in Taylor Slough and in the eastern panhandle of Everglades National Park. As outlined in the Draft Project Operations Plan, diversion of water to the Frog Pond and Aerojet Canal is expected to influence water flow and levels in Taylor Slough. Conversely, water levels at NP-EPS in the northeast panhandle of the park could experience slightly lower water levels with the proposed operational changes compared with the existing conditions. Consequently, both monitoring sites will be upgraded with additional equipment to provide real time measurement of water level changes, including data uplinks to a cellular connection or through the existing District telemetry system. This will provide operations managers the ability to access the status of the water levels in the Taylor Slough marsh and eastern panhandle daily as the dry season approaches so that water control structure operations can be adjusted to prevent abnormal recession rates in the marsh water levels. Sudden reversals in the marsh water levels have contributed to disruptions in the feeding and nesting cycles of local wading bird populations resulting in poor reproductive success.

Additional surface water stage monitoring is also proposed for the Cape Sable seaside sparrow (CSSS) Habitat Monitoring due to the proximity of these habitats to the project (***FIGURE E-4***). As outlined in the DPOM, project

operations will be modified whenever certain water level conditions are detected within the CSSS habitats. A continuous water level recorder will be installed together with a Campbell Scientific CR1000 data logger and water levels recorded at 15 minute intervals. Real time water level will additionally be accessible through cellular or the District telemetry links. This information will be relayed to the District operations control room to provide water managers direct feedback on the change in CSSS habitat conditions during the nesting season (February 1–July 15).

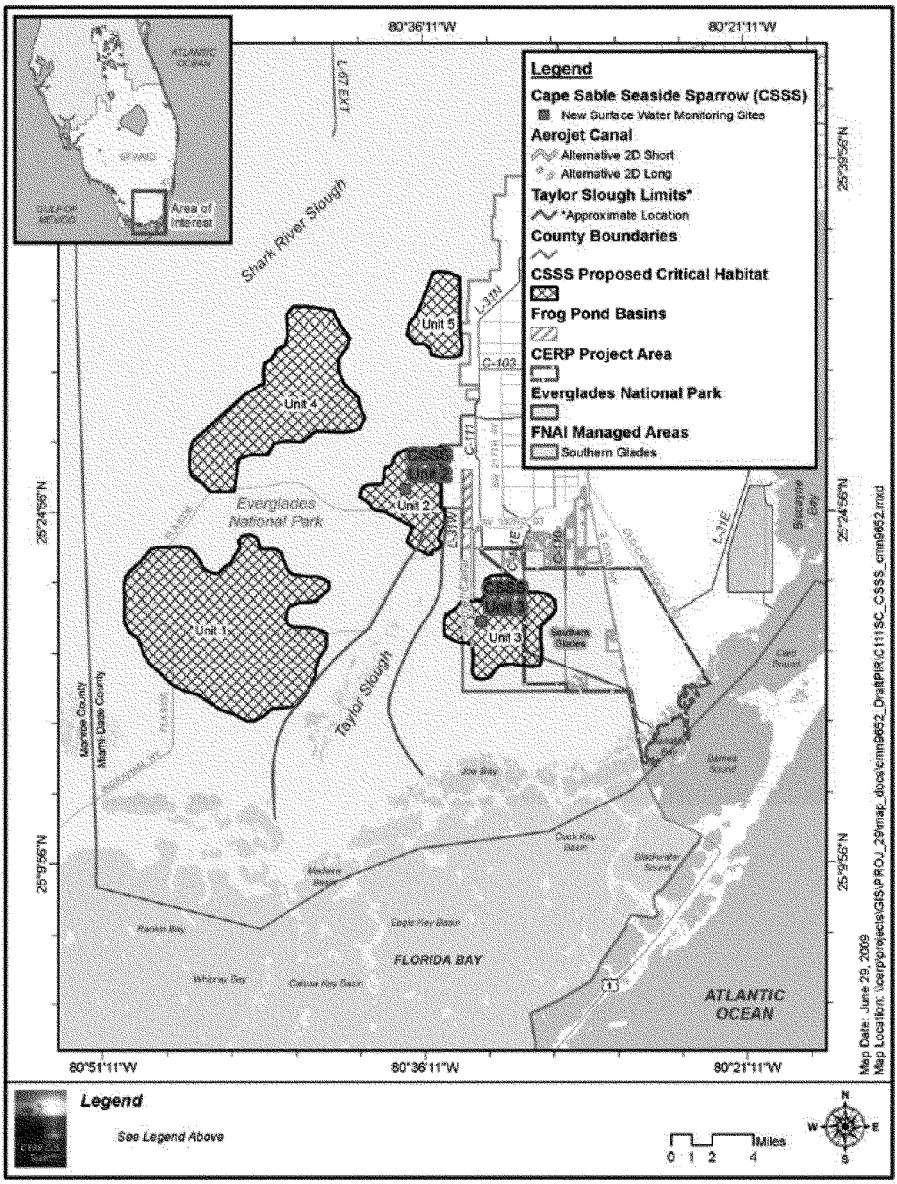


FIGURE E-4: ADDITIONAL SURFACE WATER MONITORING SITES WITHIN CAPE SABLE SEASIDE SPARROW DESIGNATED CRITICAL HABITAT UNITS 2 AND **3**

E-2.3.2 Groundwater Level and Flow Monitoring

FIGURE E-5 depicts the existing ground water monitoring network within the C-111 Spreader Canal project area. ***TABLE E-2*** provides details regarding individual monitoring sites including coordinates, parameters, and frequency of data collections. As shown, existing monitoring sites are grouped around the canal infrastructure. Well depths vary along with the type of parameters monitored within the vicinity. Similar to the surface monitoring sites, these well sites provide are part of the long term network maintained to evaluate regional water management practices and provide a baseline for ground water conditions prior to implementation of the project.

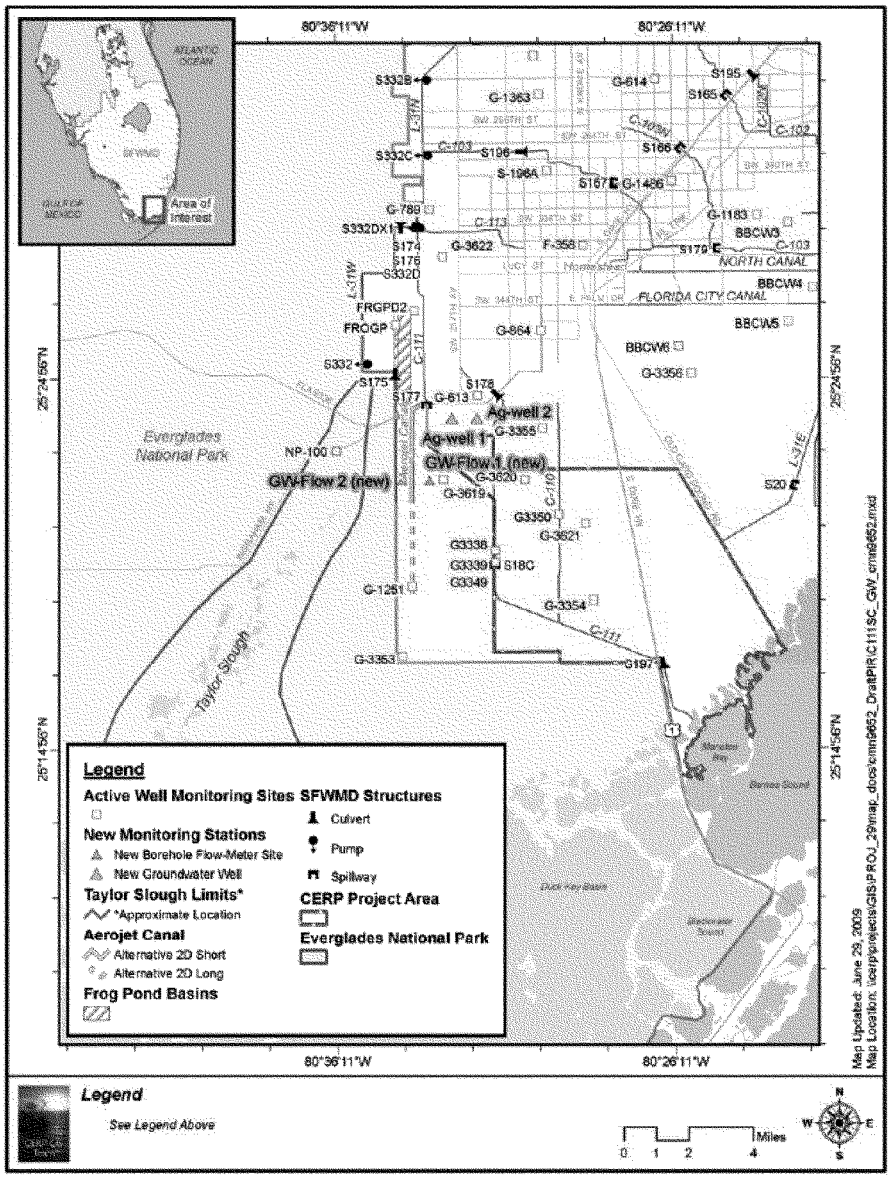


FIGURE E-5: GROUND WATER LEVEL (STAGE) AND FLOW MONITORING SITES

TABLE E-2: GROUND WATER LEVEL AND FLOW MONITORING SITES REPORTING FREQUENCY OF DATA COLLECTION

Station	Coordinate (x,y)	Agency	Group	Parameter	Reporting Frequency	Sensors
NP-100	787244.43 381470.63	SFWMD	Hydrologic	Ground water	Daily	CR-10 w pressure transducer
G-613	810205.84 390419.11	SFWMD	Hydrologic	Ground water	Daily	Unknown
G-1251	798731 359935.18	USGS	Hydrologic	Ground water	Daily	Unknown
G-3353	798126.79 348021.22	USGS	Hydrologic	Ground water	Daily	Unknown
G-3354	829224.78 357174.43	USGS	Hydrologic	Ground water	Daily	Unknown
G-3355	820842.26 385249.56	USGS	Hydrologic	Ground water	Daily	Unknown
G-3619	799739.73 380360.62	USGS	Hydrologic	Ground water	Daily	Unknown
G-3620	817956.5 377020.18	USGS	Hydrologic	Ground water	Daily	Unknown
G-3621	823553.85 374143.3	USGS	Hydrologic	Ground water	Daily	Unknown
FrogP	796945.08 402126.72	SFWMD	Hydrologic	Ground water	Daily	CR-1000 w Incremental encoder
FrgPD2	799962.58 404458.33	SFWMD	Hydrologic	Ground water	Daily	CR-1000 w Incremental encoder
GW-Flow 1 (new)	802471.662 376820.694	SFWMD	Hydrologic	Ground water	Daily	CR-1000 w Incremental encoder
GW-Flow 2 (new)	797978.376 376820.694	SFWMD	Hydrologic	Ground water	Daily	CR-1000 w Incremental encoder
Ag Well-1	806069.814 386827.238	SFWMD	Hydrologic	Ground water	Daily	CR-1000 w Incremental encoder
Ag Well-2	810163.234 386841.331	SFWMD	Hydrologic	Ground water	Daily	CR-1000 w Incremental encoder

Two new well sites (designated Ag Well-1 and Ag Well-2 on ***FIGURE E-5***) are proposed for installation within the agricultural area between the S-177 and S-178 structures to specifically monitor ground water changes in relation to

adaptive water management practices at S-18C. This farming area is unique in its geographic location at the foot of the coastal bench and is considerably lower in land elevation than surrounding farm areas just to the north. Changes in the water table can impact local root crops causing reductions in crop yields or complete loss of crops. Real time monitoring sensors will be installed to measure these changes in ground water levels and uplink the data into the SFWMD telemetry system or provide direct communications through a cellular link. This will provide operations staff in West Palm Beach the ability to directly evaluate ground water changes in response to local rain events and current water management operations.

Ground water level measurements for new agricultural sites will be outfitted with pressure transducers and data loggers to record changes in water level fluctuation at roughly 15 minute intervals. Approximately 8 inch diameter wells will be installed below the existing ground surface and screened in order to measures the full range of anticipated ground water fluctuations within the agricultural fields. Although categorized as groundwater stations, sites Ag Well-1 and Ag Well-2, in addition to being outfitted with pressure transducers, will also each contain a float and tape stilling well to measure above ground stages.

There is concern on how the planned rise in water elevation in the local canals (due to change in operation of S-18C) will influence the usability of adjacent land for agricultural purposes. Currently, agriculture located in the adjacent land is primarily composed of vegetable and ornamental nursery crops. Vegetables are predominantly grown during the dry season while ornamental nursery crops are produced year round. Nursery crops may be containerized or may be planted in the field. Additional testing of the soil properties will be conducted within the agricultural lands above to monitor flooding risk and develop criteria relating operations to soil conditions that may provide an early signal to modify operations and lower the impacts of higher ground water stages.

Soil water retention curves for each of three local soil types will be determined to increase understanding their soil water holding capacity and drainage characteristics. The soil water retention curve provides a relationship between the soil suction or tension and the soil water volumetric content. The soil water retention curve is developed in the laboratory. This relationship is used to understand soil water dynamics in the field, where real-time soil moisture data at specific sites is collected using soil moisture sensors. A series of 6 soil moisture sensors (2 in each of the three representative soil types) will be installed and monitored by the University of Florida Institute of Food and Agricultural Sciences within the local agricultural fields at predetermined sites (sites will be determined based on distribution of the target soils obtained during field recon).

The soil moisture data collected will be correlated with measured groundwater level using hydrostatic assumptions and groundwater level data (Barquin et al., 2008, on-going research). It is also possible to develop a relationship between groundwater level and canal level (Ritter and Muñoz-Carpena, 2006, Journal of Hydrology). The development of these hydrologic relationships depends on the collection and evaluation of quality, geo-referenced soil moisture, groundwater level, and canal stage data. All wells will be installed with continuous data loggers and data downloaded on a routine basis by the IFAS staff.

After the initial first year of field monitoring, the IFAS staff will provide an assessment relating the soil characteristics correlated to water management operations and recommend criteria for operational adjustments to protect crops from high ground water stages. Monitoring will continue into the first year of increased stage control at S-18C to evaluate, verify, and revise the protection criteria, if needed.

Borehole groundwater flowmeters will also be installed at two locations near the Aerojet Canal to record ground water flow velocities and directions induced by the project operations. These wells will provide direct physical evidence of the change in ground water flow direction and velocity induced as a result of pumping into the Aerojet Canal. It is expected that groundwater seepage from Taylor Slough will be reduced by the counterbalance of a higher groundwater head on the Aerojet Canal, resulting in a net increase in water flow down Taylor Slough compared to the existing conditions.

The borehole flowmeter installation will employ a heat pulse flowmeter that emits a heat pulse and sensors to measure the dissipation over a specific distance. The data output includes an estimated direction of the water flow and uncorrected velocity. This technology is identical to the flowmeters that are currently in use for the L-30 Seepage Pilot Test. Efforts are underway to determine a velocity correction to the raw data output for flowmeters installed in the L-30 Seepage Pilot Test that will take into account the frictional losses of the local geology that would normally influence ground water velocities. Corrections for the geology within the Aerojet Canal vicinity will be similarly developed.

Flowmeter wells will be screened at and installed to a depth necessary to monitor near surface ground water flow. To aid in the interpretation of the data derived from these borehole flowmeters, a physical video log will be recorded for each of the installed wells and a flow velocity measured for each strata/zone identified in the well. This will identify any preferential flow spaces within the shallow geology of the well that would influence ground water flow velocities. Monitoring sensors for continuous measurement of ground water flow will be positioned in the well to represent the dominant geological characteristics influencing flow.

Monitoring wells were previously installed around the proposed Frog Pond Detention Area to gather baseline data on the quality of the ground water within the area. The locations of these wells are depicted on ***FIGURE* E-6** while construction details are provided in ***TABLE E-3***. A series of 8 wells (2 inch diameter) have been installed and can continue to be monitored as part of the post construction operations. The existing wells were constructed of 10 feet of 0.010 slot screen and 5 feet of solid PVC riser. The upper case was grouted with cement. Wells MW-1, MW-2, MW-4, MW-7 and MW-8 currently contain stage recorders to monitor the change in groundwater levels using a pressure transducer and level data logger.

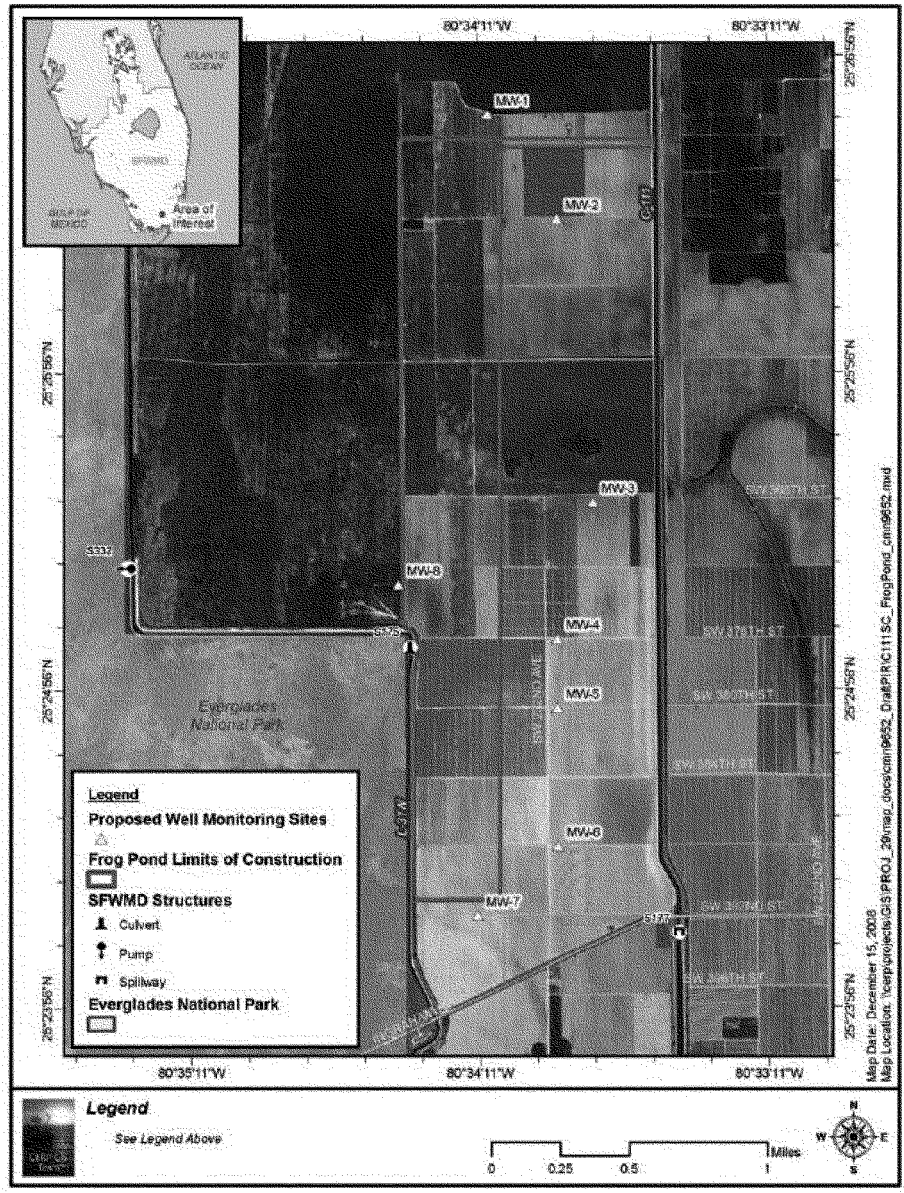


FIGURE E-6: GROUNDWATER STAGE MONITORING WELLS NEAR THE FROG POND DETENTION AREA.

TABLE E-3: WELL CONSTRUCTION DETAILS FOR GROUNDWATER MONITORING WELLS INSTALLED ADJACENT TO THE PROPOSED FROG POND DETENTION AREA

WELL NO.	DATE INSTALL	METHOD	TOP OF CASING ELEVATION (NGVD)	DEPTH (FEET)	INTERVAL (FBLS)*	DIAMETER (INCHES)	LITHOLOGY OF SCREENED INTERVAL
MW-1	6/12/08	Hollow Stem Auger	8.12	15.15	5.15-15.15	2.0	Light gray sandy clay with limestone rocks followed by brownish orange sandy clay with limestone fragments followed by light brown to tan sandy clay with limestone fragments followed by white solid limestone
MW-2	6/12/08	Hollow Stem Auger	7.74	15.15	5.15-15.15	2.0	Dark gray sandy clay with limestone rocks followed by light gray sandy clay with limestone rocks followed by white solid limestone
MW-3	6/12/08	Hollow Stem Auger	6.43	15.15	5.15-15.15	2.0	Dark gray sandy clay with limestone rocks followed by light gray sandy clay followed by light gray to white sandy clay with limestone fragments followed by white solid limestone
MW-4	6/12/08	Hollow Stem Auger	7.33	15.15	5.15-15.15	2.0	Light to medium gray sandy clay with limestone fragments followed by light gray sandy clay with limestone fragments followed by white solid limestone
MW-5	6/13/08	Hollow Stem Auger	7.35	15.15	5.15-15.15	2.0	Medium gray sandy clay with limestone rocks followed by light gray sandy clay with limestone fragments followed by white solid limestone
MW-6	6/13/08	Hollow Stem Auger	7.85	15.15	5.15-15.15	2.0	Medium gray sandy clay with limestone rocks followed by light gray sandy clay with limestone fragments followed by white solid limestone
MW-7	6/13/08	Hollow Stem Auger	6.67	15.15	5.15-15.15	2.0	Medium to light gray sandy clay with limestone rocks followed by light gray to white sandy clay with limestone fragments followed by white solid limestone
MW-8	6/12/08	Hollow Stem Auger	7.34	15.08	5.08 - 15.08	2.0	Medium gray sandy clay with limestone fragments followed by light gray sandy clay with limestone fragments followed by very hard limestone followed by white solid limestone

*FLBS = feet below land surface

All readings are referenced to National Geodetic Vertical Datum (NGVD). Recorded ground water information will be used to assess the overall effectiveness of the detention area to create the desired hydrologic barrier between the C-111 Canal and the headwaters of Taylor Slough.

Frog Pond groundwater stages are continuously recorded and stored on data loggers. Information will continue to be retrieved monthly and processed for storage in the District DBHYDO database.

Planned operational testing and monitoring of water level changes at S-18C could increase the potential risk of flooding within certain agricultural lands

E-2.3.3 Surface Flow Monitoring

FIGURE E-7 depicts the current surface water flow monitoring network within the C-111 Spreader project area, while ***TABLE E-4*** provides details regarding location, monitoring parameters, and frequency of data collection. Surface water flows through the water control structures are calculated as a daily average flow rate. A daily surface water flow rate at the Taylor Slough Bridge is also calculated based on cross-sectional area of the river channel at the bridge and surface water stage. These daily flow rates are only estimates but they are periodically calibrated by field measurement of the channel flows within the canals. These flow estimates provide a generalized budget of the water volume moving through the system. The rates of flow at S-177 and S-18C are expected to be reduced as water is diverted to the Frog Pond Detention Area and Aerojet Canal feature. Correspondingly, the rate of flow is expected to increase at the Taylor Slough Bridge as the seepage return back to the C-111 Canal is reduced by higher ground water heads within the Frog Pond Detention Area and Aerojet Canal.

Flow measurements at S-332 and S-175 will not be reported in the future at these locations as this section of the L-31W Canal will be backfilled and no longer convey water as it does currently. This backfill is planned under the South Miami-Dade C-111 Project.

To better quantify the increase in net flow to Taylor Slough, index flow meters will be installed at the Taylor Slough Bridge and be maintained through the duration of the adaptive operations testing period. Flow measurements will be calibrated periodically with field measurements of the channel cross-section flows.

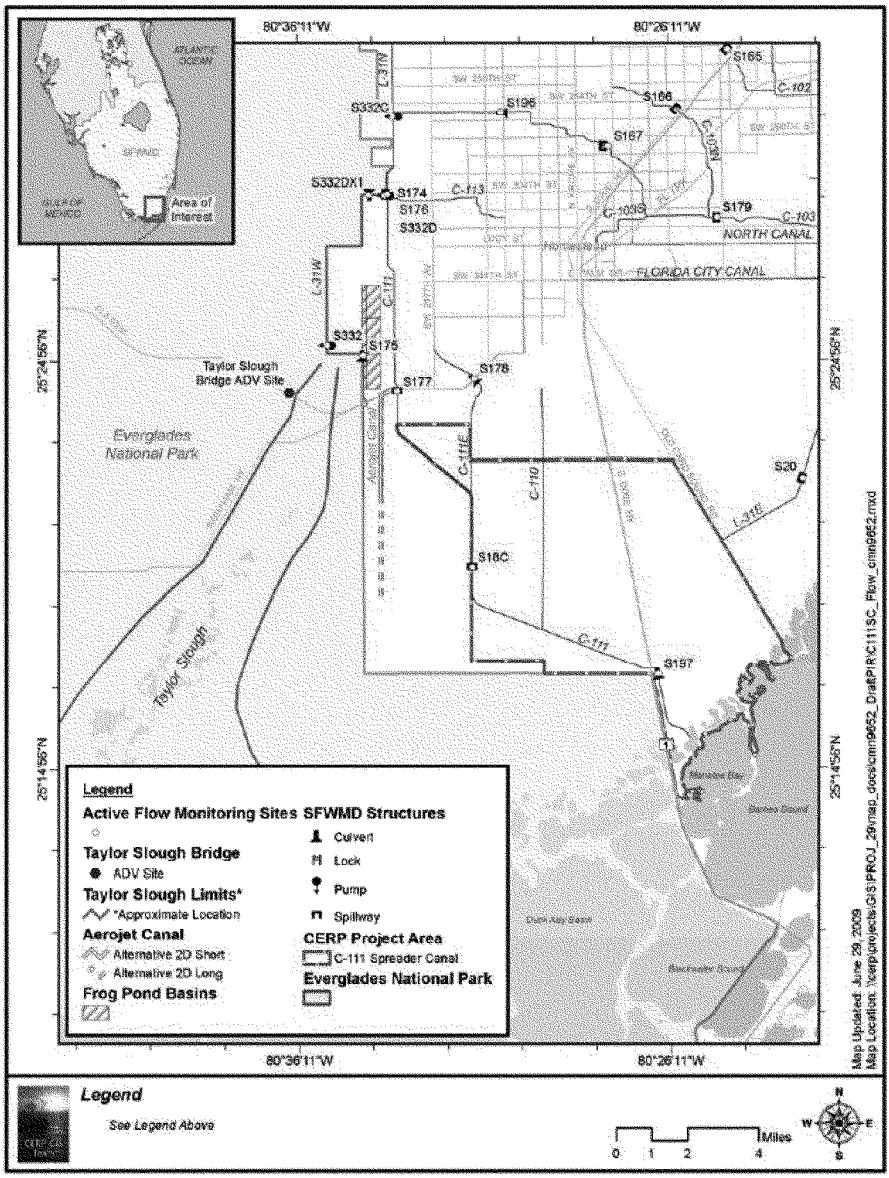


FIGURE E-7: SURFACE FLOW MONITORING SITES

TABLE E-4: SURFACE FLOW MONITORING SITES

Station	Coordinate (x,y)	Agency	Group	Parameter	Reporting Frequency	Sensors
S-175	796873.88 394326.97	SFWMD	Hydrologic	Stage Gate Opening	Daily	CR-10
S-177	801947.88 388873.35	USGS	Hydrologic	Stage Gate Opening	Daily	CR-10
S-178	813302.39 390875.38	USGS	Hydrologic	Stage Gate Opening	Daily	CR-10
S-18C	813035.4 362709.17	USGS	Hydrologic	Stage Gate Opening	Daily	CR-10
S-197	840561.25 347070.25	USGS	Hydrologic	Stage Gate Opening	Daily	CR-10
S-332D	800067.8 418011.07	USGS	Hydrologic	Stage Gate Opening	Daily	CR-10
S-20	862040.63 376161	USGS	Hydrologic	Stage Gate Opening	Daily	CR-10
S-179	849325.05 414843.23	USGS	Hydrologic	Stage Gate Opening	Daily	CR-10
S-167	833153.53 425274.46	SFWMD	Hydrologic	Stage Gate Opening	Daily	CR-10
Taylor Slough Bridge	785947.438 388664.972	SFWMD	Hydrologic	Flow	Daily	Index Flowmeter w/CR-1000

E-2.3.4 Meteorological Monitoring

FIGURE E-8 depicts the current meteorological monitoring network within the C-111 Spreader Canal project area, while ***TABLE E-5*** provides details provides details regarding location, monitoring parameters, and frequency of data collection. As evident from the table, rainfall is measured at all the major water control structures within the project area and includes several rainfall stations in coastal Biscayne Bay and Florida Bay. Based on the coverage of this network, no additional stations are recommended.

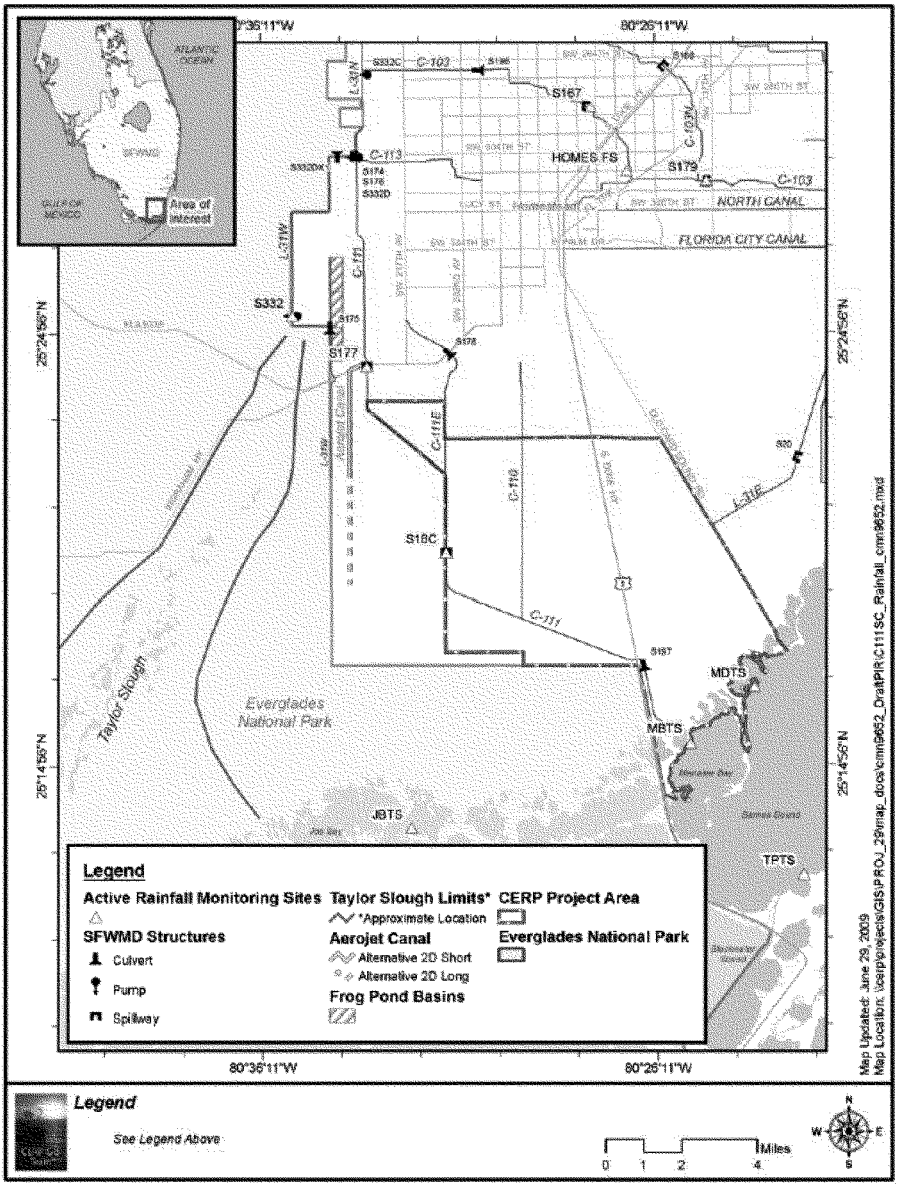


FIGURE E-8: METEOROLOGICAL MONITORING SITES WITHIN THE PROJECT AREA

TABLE E-5: METEOROLOGICAL MONITORING SITES WITHIN THE PROJECT AREA

Site	x/y coordinate	Group	Parameter	Unit of Measure	Frequency *	Record	Starting Date
S-177	801947.88 388873.35	Meteorological	Rainfall	inches (in)	Day	CR10	18-Mar-91
S-18C	813035.4 362709.17	Meteorological	Rainfall	inches (in)	Day	CR10	10-Jun-03
S-20	862040.63 376161	Meteorological	Rainfall	inches (in)	Day	CR10	24-May-68
JBTS	808212.7 324129.73	Meteorological	Rainfall	inches (in)	Day	CR10	23-May-91
	808212.7 324129.73		Air Temperature	Degree Celsius	Day	CR10	23-May-91
	808212.7 324129.73		Barometric pressure	MM Mercury	Day	CR10	23-May-91
	808212.7 324129.73		Evapotranspiration Potential, MM	Millimeters	Day	CR10	23-May-91
	808212.7 324129.73		Relative Humidity	Percent	Day	CR10	23-May-91
	808212.7 324129.73		Photosynthetic Radiation	Micromole/M^2/S	Day	CR10	23-May-91
	808212.7 324129.73		Total solar Radiation	Kilowatt/M^2	Day	CR10	23-May-91
	808212.7 324129.73		Vector Wind Speed'	MPH	Day	CR10	23-May-91
MDTS	856060.29 344004.29	Meteorological	Rainfall	inches (in)	Day	CR10	11-Oct-91
MBTS	847098.13 336191.63	Meteorological	Rainfall	inches (in)	Day	CR10	31-May-96
	847098.13 336191.63		Photosynthetic Radiation	Micromole/M^2/S	Day	CR10	13-Jun-91
	847098.13 336191.63		Vector Wind Speed	MPH	Day	CR10	1-Jan-92

E.2.4 Instrumentation/Programming

The hydrologic and meteorological data collection instruments utilized for this project will be installed as part of the construction contract or under separate contract. Flow calculation equations that are used to compute flow on site with certain instrument types, such as the CR1000 programmable data logger, will be developed under the supervision of the sponsoring agencies hydrology and hydraulics monitoring units during the execution of this monitoring plan.

E.2.5 Elevation Survey of Monitoring Site Installations

Hydrometerological parameters such as surface and ground water stages require accurate estimates of the water elevation height compared to a known reference. All new surface and ground water monitoring installations will be surveyed to a first order accuracy using the nearest geodetic benchmark. Reference elevations will be reported in both NAVD 88 and NGVD 29 datum.

E.3 DATA VALIDATION, DATA STORAGE AND ARCHIVAL

Guidelines for Quality Control and Quality Assurance of Hydrologic and Meteorological Data – Volume 2: Data Management (2000) prepared by the St. Johns River, South Florida, Southwest Florida and Suwannee River Water Management Districts contains detailed general procedures for validation, verification and correction of hydrologic and meteorological data collected through every means of data collection known by these agencies. This document is referenced in the QASR Manual. Specific guidance with respect to data management is provided in CGM 040.00, Project-level Water Quality and Hydrometeorologic Monitoring and Assessment, and the PMP for Data Management. Some of the most common data management methods are:

- a standard for formatting electronic data files: raw data and data intended for archive will be submitted using an approved, prescribed format
- commonly known and used units of measurement for the types of data that are collected are shown in ***TABLE E-6*** below
- scientifically-based, robust quality assurance and data validation procedures: all data submitted for archive will undergo a QA/QC review
- common and standard naming conventions for data collection locations: station and site names for new monitoring will be approved and registered prior to use in the database
- preservation and storage of raw data values: all raw data will be maintained and archived by the agency/organization responsible for its generation

E.3.1 Raw Data

For the purposes of this section, raw data is defined as any hydrologic or meteorological data described in this document that has been collected from a field data installation location. The methods of collection vary from random, periodic, or distance to water readings to satellite-based collection platforms reporting data values on a real time basis. In order to be considered as raw data, the data must be such that is has not been altered in any fashion by manual or electronic means after it was collected.

E.3.2 Validated Data

For the purposes of this section, validated data is defined as any hydrologic or meteorological data described in this document that has been collected from a field data installation location and passed through a set of quality assurance and data validation procedures. There are a variety of validation checks that are performed on hydrologic and meteorological data. The following is a list and explanation of a basic set of validation checks.

- Data recorder location – Data recorders may be designated by several databases descriptors for identification. Among these descriptors are parameters, stations or sites. In order to avoid database degradation, a unique name is established for every recorder location regardless of which designation is used. This name is validated to assure that data collected is attributed to the appropriate station.
- Period of record – The start date of an incoming period of record is checked against the end date of the last period of record received. This check serves two purposes. First, the continuity of the period of record is maintained. Gaps or overlaps in the period of record are identified and resolved. Second, unmatched end-to-start dates of consecutive periods of record might be an early indication that the periods of record may not have been collected at the same location.
- Minimum and maximum values – Although, a very high or very low data value may not necessarily indicate an anomaly, each location should have a range of expected values. Any exceedance of these values is at least flagged for further investigation.
- Data units – Consistency in using the appropriate data units needs to be maintained. Errors or inconsistencies are magnified due to a series of rounding of numbers and conversions from one unit of measurement to another.

E.3.3 Data Storage and Archival – DBHYDRO Database

After data had been validated and all data anomalies have been investigated and resolved, the data will be loaded in a sponsoring agency-approved database and be available for dissemination to users. This database at the present time is DBHYDRO.

E.4 QUALITY ASSURANCE AND QUALITY CONTROL

Quality Assurance (QA) and Quality Control (QC) involves the review, interpretation, processing, analysis, and validation of hydrologic and meteorological data collected. Specifically, QA and QC is a set of activities that are performed on raw time-series data so that the data obtained can be relied upon when making day-to-day operational decisions, and for other project related initiatives. The data collected will undergo specific sets of validation processes for each type of data to ensure that the values are reasonable and accurate. Many of these procedures and processes are automatic and are done with various software applications.

The data processing system checks and validation procedures will include:

> Verification of the identifiers used to distinguish a data collection location from all others, assuring an accurate historical record of hydrologic and meteorologic events for each location. Recorded data values are checked against maximum and minimum allowable values facilitating the identification of data outliers. All data values are time stamped assuring that the time stamps on recorded values are continuous with previously recorded values already in the database. Continuous data values are checked to assure that the rate of change between them does not exceed allowable maximum and minimum values.
>
> The data will be also reviewed spatiotemporally (space-time) in comparison to other hydrologic and meteorologic events. The review processes assure that data values are scientifically reasonable and accurate. Many of these procedures and processes are automatic and all are done with software applications.

Although certain raw data may necessarily be utilized from time to time, when considered within the context of other reliable information, to support near-real-time decisions, only after validation, verification, and other review processes have been completed satisfactorily, will data be uploaded to the database, and made available for reporting.

E.5 COST ESTIMATES

The majority of the hydrometerological monitoring cited above will be supported by the existing monitoring network maintained by SFWMD, ENP, USGS or others. Several new monitoring sites are proposed for the installation to gather additional baseline and to conduct the operational testing proposed under the Draft Project Operations Manual. These new monitoring sites would remain active until it is demonstrated they are no longer needed for the adaptive operations testing or otherwise incorporated into the C-111 Spreader Canal Eastern project monitoring plan.

Installation costs include equipment and all necessary installation costs such as platforms, protective housings, cellular or telemetry communications electronics where required for real time data access, labor and any required testing as needed to demonstrate operational readiness (***TABLE E-6***). The estimated costs associated with data processing, including QA/QC, have been provided in ***TABLE E-7***, while ***TABLE E-8*** lists the total estimated hydrometeorological monitoring costs for a five year monitoring period. The estimated costs associated with the proposed agricultural soil water retention investigation, which were not included within ***TABLE E-8***, have been provided in ***TABLE E-9***. It is important to note that a minimum 60 day operational testing period will be required for all new installations to verify correct operation of mechanical and electrical components.

TABLE E-6: NEW HYDROMETEOROLOGICAL MONITORING SITE INSTALLATION COST ESTIMATE

Monitoring Type	Parameters	Sensor Type	Installation Costs	Annual Maintenance Costs	Notes:
Surface Water New Site 1	Stage	Use incremental encoders.	$40,825.00	TBD	New site. Located in marsh. Platform installation. Cost using helicopter.
Surface Water New Site 2	Stage	Use incremental encoders.	$40,825.00	TBD	Located in marsh. Platform installation. Cost using helicopter
NP-67* Surface Water Site	Stage	*enhanced communications upgrade only	$40,825.00	TBD	Existing ENP site. Cost to change out RTU and all instrumentation. Located in marsh. Platform installation. Remove debris. Cost using helicopter. Use incremental encoders.
NP-EPS *Surface Water Site	Stage	*enhanced communications upgrade only	$40,825.00	TBD	Existing ENP site. Cost to change out RTU and all instrumentation. Located in marsh. Platform installation. Remove debris. Cost using helicopter. Use incremental encoders.
Surface Water New Site Frog Pond Detention	Stage	Use incremental encoders with enhanced communications	$40,825.00	TBD	New site. Located in Frog Pond header canal and used to trigger shut-off of pumping activity at a prescribed stage. Platform installation. Cost using truck.
Surface Water New Site Aerojet Canal	Stage	Use incremental encoders with enhanced communications	$40,825.00	TBD	New site. Located in Aerojet Canal and used to trigger shut-off of pumping activity at a prescribed stage. Platform installation. Cost using truck.
Surface Water New Site CSSS Unit 2	Stage	Use incremental encoders with enhanced communications	$40,825.00	TBD	New site. Located in marsh. Platform installation. Cost using helicopter.
Surface Water New Site CSSS Unit 3	Stage	Use incremental encoders with enhanced communications	$40,825.00	TBD	New site. Located in marsh. Platform installation. Cost using helicopter.
Ag Well New Site -1	Ground water stage	Use incremental encoders with enhanced communications	$24,150.00	TBD	New site. Located in agricultural field. Platform installation. Cost using 4x4 truck. Use PT.

Monitoring Type	Parameters	Sensor Type	Installation Costs	Annual Maintenance Costs	Notes:
Ag Well New Site -2	Ground water stage	Use incremental encoders with enhanced communications	$24,150.00	TBD	New site. Located in agricultural field. Platform installation. Cost using 4x4 truck. Use PT.
Frog Pond Monitor Well -1, 2, 4, 7, 8**	Ground water stage	Pressure Transducer	$120,750.00	TBD	Existing sites. Located in Frog Pond. Well installation already completed. Replacement costs for equipment.
GW Flow Site-1 and Stage	Ground water flow & stage	Use incremental encoders with enhanced communications	$81,000.00	TBD	New site. Located in marsh. Platform installation. Cost using helicopter. Use PT and incremental encoder. Include two additional enclosures, conduit, large solar array, extra batteries for flow meter installation. Costs include flow meters
GW Flow Site-2	Ground water flow	Use incremental encoders with enhanced communications	$71,750.00	TBD	New site. Located in marsh. Platform installation. Cost using helicopter. Use PT. Include two additional enclosures, conduit, large solar array, extra batteries for flow meter installation. Costs include flow meters
Surface Flow Site TSB	Surface Flow	ADCP – continuous flow	$30,000		
Survey New Sites	Surface and Ground water		85,000		
		TOTAL	$804,225.00	$0.00	
		TOTAL + 10%	$884,647.50		

* Costs assume replacement of existing equipment used by ENP. Communications upgrades could potentially be made using the existing equipment.
** Costs are for monitoring equipment replacement only. Wells were previously installed as part of a baseline collection

TABLE E-7: ESTIMATED COSTS FOR DATA PROCESSING (INCLUDING QA/QC) FOR NEW HYDROMETEOROLOGICAL SITES

Monitoring Type	Parameters	Data Capture Type	Number of Sites	Annual Processing Costs	Expected 5 yr costs
Surface Water Sites	Stage	CR-1000	9	$4,300	$193,500
Ground Water Site s	Stage	CR	9	$5,538	$249,210
Ground Water Flow Sites	Stage	CR	2	$1,200	$12,000
Surface Water Sites	Stage	ADCP – with CR-1000	1	$ 615	$3,075

[1] Costs include equipment and installation materials, labor, transportation, and testing.

TABLE E-8: TOTAL ESTIMATED HYDROMETEOROLOGICAL MONITORING COSTS FOR A FIVE YEAR MONITORING PERIOD

Parameter	Installation	O&M	Data Processing	Notations – 5 Yr costs
Surface Stage	$367,425	$149,800.00	$193,500	O&M includes monthly site visits by helicopter to conduct maintenance
Ground water Stage	$169,050	$93,000.00	$249,210	O&M includes monthly site visits by helicopter to conduct maintenance
Ground Water Flow	$152,750	$37,000.00	$12,000	O&M includes monthly site visits by helicopter to conduct maintenance
Surface Water Flow	$30,000	$20,000.00	$3,075	Drive to site for maintenance
Site Surveys	$85,000			
Sub-total	$804,225.00	$299,800.00	$457,785.00	
Total				$1,561,810.00

The cost estimate for soil water retention study within agricultural fields (***TABLE E-8***) is based on a contract for services to the University of Florida Food and Agricultural Sciences. The duration of this field monitoring is expected to be 2-years and could be renewed for an additional year or longer depending on the climatic conditions and the test outcomes.

TABLE E-9: COSTS FOR AGRICULTURAL SOIL WATER RETENTION STUDY

Budget Item	Year -1	Year -2	Year -3
Staff	$48,708	$50,169	$51,675
Equipment Costs	$41,639.	$3,000	$3,000
Admin Costs	$28,837	$19,542	$19,919
Sub-Total	$77,550	$72,711	$74,594
Total			$224,855

Total projected hydrometeorological monitoring costs for a five year period is estimated to be $1,786,665.

E.6 FUTURE REVISION NOTES AND MODIFICATIONS

[This page is intentionally left blank for use by the project manager to track changes to this document between revisions. These notes are maintained in the PROJECT BINDER by the project manager.]

ANNEX E
PROJECT MONITORING PLAN

PART II: WATER QUALITY AND REGULATORY COMPLIANCE

TABLE OF CONTENTS

E PART II: WATER QUALITY AND REGULATORY COMPLIANCE ..... Annex E Part II--E-1
E.1 INTRODUCTION AND BACKGROUND ..... Annex E Part II--E-1
E.1.1 Active Mandates and Permits ..... Annex E Part II--E-2
E.1.2 Purpose and Scope ..... Annex E Part II--E-3
E.1.3 Duration ..... Annex E Part II--E-3
E.1.4 Initiation Conditions ..... Annex E Part II--E-3
E.1.5 Modification or Termination Conditions ..... Annex E Part II--E-3
E.2 GEOGRAPHIC LOCATION ..... Annex E Part II--E-3
E.2.1 Regional Area ..... Annex E Part II--E-3
E.3 SAMPLING LOCATIONS ..... Annex E Part II--E-4
E.4 ACCESS AND AUTHORITY ..... Annex E Part II--E-4
E.5 PROJECT ORGANIZATION AND RESPONSIBILITIES ..... Annex E Part II--E-5
E.6 FIELD ACTIVITIES ..... Annex E Part II--E-7
E.6.1 Monitoring Frequencies by Site and Parameters ..... Annex E Part II--E-7
E.7 PROJECT SPECIFIC GUIDELINES ..... Annex E Part II--E-7
E.8 GRAB SAMPLING PROCEDURES ..... Annex E Part II--E-8
E.9 FIELD TESTING PROCEDURES ..... Annex E Part II--E-8
E.10 FIELD QUALITY CONTROL REQUIREMENTS ..... Annex E Part II--E-8
E.11 AUTOSAMPLERS ..... Annex E Part II--E-8
E.11.1 Sample Submission ..... Annex E Part II--E-8
E.12 SEDIMENT MONITORING OF THE INFILTRATION/DETENTION BASIN ..... Annex E Part II--E-9
E.13 DATA QUALITY OBJECTIVES ..... Annex E Part II--E-9
E.13.1 Data Uses ..... Annex E Part II--E-9
E.13.2 Data Quality ..... Annex E Part II--E-9
E.14 COMPLETENESS TARGETS ..... Annex E Part II--E-10
E.15 DATA AND RECORDS MANAGEMENT ..... Annex E Part II--E-10
E.15.1 Data Deliverables ..... Annex E Part II--E-11
E.15.2 Data Storage ..... Annex E Part II--E-11
E.16 COST ESTIMATE ..... Annex E Part II--E-11
E.17 REVISIONS AND MODIFICATIONS ..... Annex E Part II--E-12
E.18 REFERENCES ..... Annex E Part II--E-13
E.19 GLOSSARY ..... Annex E Part II--E-14

LIST OF TABLES

Table E-1: Grab Sample Parameters And Frequency ..... Annex E Part II--E-7
Table E-2: Field Analytical Parameters Collection ..... Annex E Part II--E-8
Table E-3: Pie Auto-Sampler Parameters And Frequency ..... Annex E Part II--E-8

LIST OF FIGURES

Figure E-1: Project Location.....Annex E Part II--E-1
Figure E-2: Structure Monitoring Stations Associated With The Frog Pond Detention Area and Aerojet Canal .....Annex E Part II--E-6

E PART II: WATER QUALITY AND REGULATORY COMPLIANCE

E.1 INTRODUCTION AND BACKGROUND

This document serves as a reference for surface water quality monitoring and regulatory compliance for the C-111 Spreader Canal Western project. The overarching goal of the C-111 SC project is to restore the quantity, timing, and distribution of water delivered to Florida Bay via Taylor Slough of ENP. Also included in the project are features that will improve ecological conditions within the areas known as the Southern Glades and Model Lands. Additionally, salinities in the downstream areas of Florida Bay (from Taylor Slough) would be reduced as a result of the proposed project. The C-111 SC Western project area includes the area from the Atlantic Coastal Ridge south to Florida Bay, from Taylor Slough to Card Sound Road (***FIGURE E-1***).

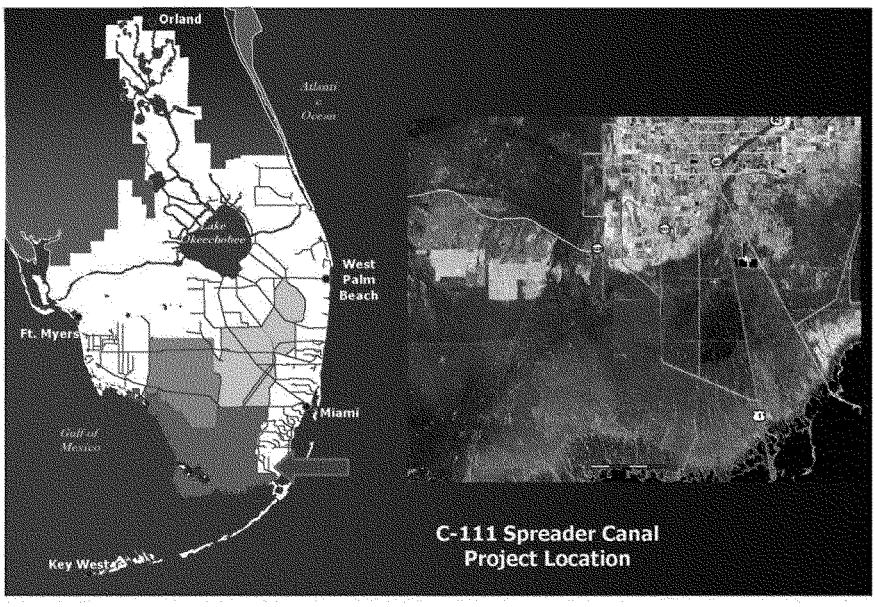


FIGURE E-1: PROJECT LOCATION

Specific goals of the C-111 SC Western project include the following;

The C-111 SC Western project will include a 590-acre detention area within the Frog Pond lands (Frog Pond Detention Area or FPDA), convert the existing Aerojet Canal into a detention area, construct an intermediate Water Control structure between S-18C and S-197, construct a permanent plug at S-20, construct earthen plugs at key locations along C-110 Canal, and implement incremental increases in the current open and close triggers at S-18C and S-20A. It is important to note that these project components lie within the footprint of the existing Park Inflows East (PIE) monitoring plan which is a program that monitors surface water discharges in the area directly east of ENP in a comprehensive manner. Consequently, the monitoring of features associated with these projects may be absorbed into the PIE monitoring plan.

The FPDA will be served by a 225 cfs pump designated S-200 along the L-31N between S-176 and S-177. As designed there will be no direct discharges to ENP, and any emergency overflows will direct flow back to the L-31N canal. No nutrient removal or water quality impacts are expected from this project. Given these factors and taking into account the extensive monitoring at S-176 and S-177, monitoring at S-200 should be minimal.

The Aerojet Canal detention area will be created by extending the canal north so as to be able to receive water from upstream of S-177, and berming the perimeter of the canal. It will be served by a 225 cfs pump. The pump will be located immediately upstream of S-177, and the new pump station will be designated S-199. Given their close proximity S-177 should function as a surrogate compliance station for S-199.

A secondary goal of this plan is to support monitoring of downstream areas that may be impacted by changes in flows and associated water quality. Towards this end this document calls for the addition of NH_4, a parameter of interest in Florida Bay, at two critical stations in the project area.

E.1.1 Active Mandates and Permits

The C-111 Spreader Canal- Phase I Project will require permits from FDEP and USACE for the construction of the various features. The District as the local sponsor of this project has applied for permits with the various regulatory agencies and they are currently being processed for issuance prior to start of construction in September 2009. The permits that are currently pursued include the following: CERPRA permit File No: 293559-001 with FDEP, and Section 404 Department of the Army Permit File No: SAJ-2005-9856 (IP-AAZ).

E.1.2 Purpose and Scope

The water quality data obtained under this program will be used to:

1. Evaluate water quality status and trends
2. Assess compliance with federal and state water quality statutes, the Everglades Forever Act, and the Settlement Agreement
3. Support the determination of impacts to areas downstream of the project

E.1.3 Duration

Because this plan is intended to address regulatory permitting requirements, the duration of this monitoring shall be as required by applicable permits. The monitoring plan will be periodically reviewed for effectiveness and modified. It is fully expected that the requirement to monitor certain parameters, or groups of parameters, may be reduced following demonstrations that a parameter or group of parameters no longer represent a source of concern. Modification of the permit, by letter modification or other means, may be used to effectively modify the duration of monitoring for a given parameter, or group of parameters.

E.1.4 Initiation Conditions

In order to establish a baseline dataset sampling of NH_4 at two stations will be initiated in October 2009.

Monitoring of structure S-200 will be initiated with the issuance of an operating permit.

E.1.5 Modification or Termination Conditions

The mandated monitoring described in this document will be continued indefinitely in response to the Settlement Agreement and the NECP permit.

E.2 GEOGRAPHIC LOCATION

E.2.1 Regional Area

The proposed project contains operational changes at structure S-20 and an earthen plug near un-used structure S-20A. These features are intended solely to improve wetland hydroperiods, do not involve any new sources of water, and, although they may potentially play some role in slowing the progression of salt water intrusion, are anticipated to be neutral with respect to water quality.

All remaining proposed project features are related to the existing C-111 Canal. As shown on Figure E-1, the C-111 Canal is the southernmost canal of the Central and South Florida (C&SF) Flood Control project and is located in south

Miami-Dade County. The canal serves a basin of approximately 100-square-miles and functions primarily to provide flood protection and drainage for the agricultural areas to the west and south of Homestead, Florida.

Southwest of Homestead and Florida City and just south of the agriculturally developed area, the C-111 Canal is joined by C-111E and courses south to southeast through extensive marl wetland prairie and coastal mangrove marsh before it ends in Manatee Bay. The C-111 Canal and S-18C (located just south of the confluence of C-111E and C-111) were completed in 1966 and the S-197 structure was completed in 1970.

S-197 provides a gravity outlet for stormwater runoff during flood conditions and acts as a barrier to prevent saltwater intrusion into the freshwater wetlands of the Southern Glades Wildlife and Environmental Area (SGWEA) located to the north of the Everglades National Park's (ENP) eastern panhandle.

The C-111 Canal is also the final segment of the South Dade Conveyance System (SDCS) for maintaining water supply and flood protection. The C-111 Canal also provides a means to deliver water to ENP's Taylor Slough and the eastern panhandle area to meet the minimum water delivery schedule, under Federal Statute (Public Law [P.L.] 91-282).

The Park Inflows East (PIE) monitoring network which is described in Section E.1, and on which this project largely depends, is located on the eastern edge of Everglades National Park (ENP) and extends from structure S-331 south to structure S-197.

E.3 SAMPLING LOCATIONS

There are a total of five monitoring stations which are of interest to this project. Two of the stations (S-177, and S-332DX) currently exist and are being routinely monitored as part of the Park Inflows East (OIE) network. The remaining three stations (S-200, FPDA Header, and AJ Canal) will be implemented in support of the project, and the results of all five stations will be used to determine project effects. Details regarding monitoring frequency, by parameter have been provided in ***TABLE E-1***.

E.4 ACCESS AND AUTHORITY

All stations are located outside the boundaries of ENP. Entry and sample collection are not regulated, but require the appropriate SFWMD gate key.

E.5 PROJECT ORGANIZATION AND RESPONSIBILITIES

Overall project organization and responsibilities are detailed in the SFWMD Environmental Resource Assessment Quality Management Plan (ERA QMP). Field activity responsibilities are detailed in the District's Field Sampling Quality Manual (FSQM). Laboratory analysis and data validation responsibilities are detailed in the District's Chemistry Laboratory Quality Manual (CLQM).

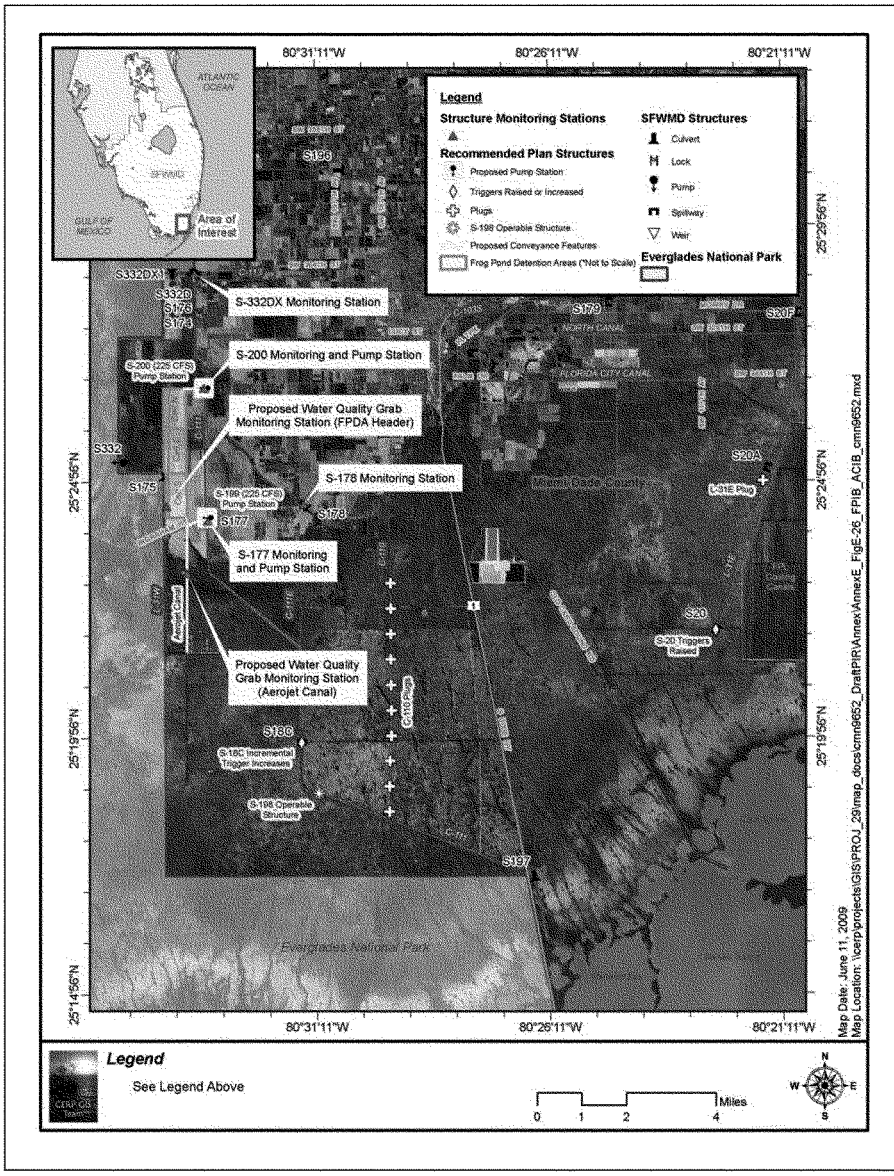


FIGURE E-2: STRUCTURE MONITORING STATIONS ASSOCIATED WITH THE FROG POND DETENTION AREA AND AEROJET CANAL

E.6 FIELD ACTIVITIES

E.6.1 Monitoring Frequencies by Site and Parameters

All samples required for collection by grab sampling are depicted in ***TABLE E-1.***

TABLE E-1: GRAB SAMPLE PARAMETERS AND FREQUENCY

Station	Matrix	Type	Parameters	Frequency
S-332DX	SW	Grab	DO, pH, CONDUCTIVITY, TEMPERATURE, TSS, TPO_4, OPO_4, TKN, NO_X, Chloride, Calcium	Weekly if flowing, otherwise Monthly
			Turbidity, SO_4, THg, Pesticide suite (FDEP Group AA), DOC	Quarterly
S-177	SW	Grab	DO, pH, CONDUCTIVITY, TEMPERATURE, TSS, TPO_4, OPO_4, TKN, NO_X, Chloride, Calcium Add NH_4	Weekly if flowing, otherwise Monthly
			Turbidity, SO_4, Pesticide suite (FDEP Group AA)	Quarterly
S-200	SW	Grab	DO, pH, CONDUCTIVITY, TEMPERATURE, TSS, TPO_4, OPO_4, TKN, NO_X, Chloride, Calcium	Weekly if flowing
FPDA Header	SW	Grab	DO, pH, CONDUCTIVITY, TEMPERATURE, TSS, TP, OPO4, TKN, NOX, Cl, Ca, Zn, Cu	Quarterly when sufficient depth exists
AJ Canal	SW	Grab	DO, pH, CONDUCTIVITY, TEMPERATURE, TSS, TP, OPO4, TKN, NOX, Cl, Ca, Zn, Cu	Quarterly when sufficient depth exists

E.7 PROJECT SPECIFIC GUIDELINES

S-332 DX is a sampling point that serves S-332 D and S-176. The determination of the need for a grab sample is based on flow from either of these structures.

E.8 GRAB SAMPLING PROCEDURES

Sample collection for this project shall follow the procedures and requirements found in the Field Sample Collection Procedures Section of the District's FSQM. All samples are collected on the upstream side of the structure.

E.9 FIELD TESTING PROCEDURES

Field testing procedures shall follow the procedures and requirements found in the Field Testing Section of the District's FSQM. The field parameters for this project are described below.

TABLE E-2: FIELD ANALYTICAL PARAMETERS COLLECTION

Parameter	Resolution	Accuracy
DO	0.01 mg/L	0-20 mg/L, +/- 0.2 mg/L
Conductivity	0.001 mS/cm	+/- 0.5% of reading +0.001 mS/cm
Temp	0.01° C	+/- 0.15°C
pH	0.01 unit	+/- 0.2 unit

E.10 FIELD QUALITY CONTROL REQUIREMENTS

Field quality control requirements shall follow the procedures found in the Quality Control Section of the District's FSQM.

E.11 AUTOSAMPLERS

TABLE E-3 presents the details of the S-332 DX auto-sampler.

TABLE E-3: PIE AUTO-SAMPLER PARAMETERS AND FREQUENCY

Station	Matrix	Type	Parameters	Frequency
S-332 DX	SW	Time proportional discrete autosampler	TPO_4, TKN, NOx	Sampler set to sample every three hours, collected weekly.

E.11.1 Sample Submission

Following completion of sample collection for each day, the samples are transported in coolers with wet ice at 4° Celsius to the laboratory for analysis. Samples are submitted to the laboratory on the same day as collection or via

courier the following day. Samples are submitted according to the requirements outlined in the District's FSQM. If samples are submitted to other than the District's in house laboratory, the laboratory must be a District approved laboratory. Requirements for sample handling, custody and analysis holding times are detailed in the District's CLQM.

E.12 SEDIMENT MONITORING OF THE INFILTRATION/DETENTION BASIN

To ensure the proper management and maintenance of the Infiltration/Detention Area, it is necessary to determine the rate at which sediments and chemical constituents will be accumulating. Initial design criteria suggest that the area will be scrapped clean of existing sediment. However, the accumulation of sediment will be monitored for two events, one to establish baseline, and one to establish conditions after five years of operation. Samples will be analyzed for TP, bulk density, SO_4, DOM (dissolved organic matter), and pesticides.

E.13 DATA QUALITY OBJECTIVES

E.13.1 Data Uses

The data from PIE is compiled and reported in the District's Annual South Florida Environmental Report (SFER) and the quarterly Settlement Agreement report. The SFER Report can be found at www.sfwmd.gov/sfer/.

E.13.2 Data Quality

While it is recognized that data quality objectives (DQOs) are typically developed separately for each specific monitoring project, all mandated monitoring conducted by the District must meet the objectives conveyed in the FDEP's Quality Assurance Rule, 62-160 F.A.C. Over the years, the District's field collection staff and chemistry laboratory, and their contractors, have met or exceeded these data quality objectives, as reflected in their respective quality manuals, for all data generated. As a result, unless otherwise specified, the District has adopted a uniform set of DQOs following criteria detailed within the "Analytical Methods and Default QA/QC Targets" table of the District's Chemistry Laboratory Quality Manual (CLQM). For those samples analyzed by the FDEP Laboratory, the District has adopted the DQOs within the most recent version of the FDEP's Laboratory Chemistry Quality Manual.

Surface water samples, including field testing and field quality control samples, are collected in accordance with the FDEP Quality Assurance Rule, 62-160 F.A.C. and the current version of the FSQM. Applicable sections of the FSQM include, but are not limited to, field sample collection procedures, decontamination procedures, field testing and quality control requirements.

The data quality objectives of the field testing parameters for this project are covered by the table Field Quality Assurance Objectives in the field testing section of the FSQM. This manual is updated annually, and therefore, the most recent version of the District's FSQM details the specific field testing data quality objectives for this project at the time of sample collection.

Samples are analyzed according to the provisions within the FDEP Rule 62-160 F.A.C. and the CLQM. The CLQM details analytical procedures, preventative maintenance, calibration procedures and frequency, laboratory QC procedures, performance and system audits, corrective actions, data reduction, data verification and calculation of data quality indicators. This manual is annually updated, and therefore, the most recent version of the CLQM details the specific laboratory analyses' DQOs for this project at the time of sample collection

Data not meeting the quality objectives must be qualified using standard FDEP qualifier codes (F.A.C. 62-160) or corrective actions may be taken as outlined in the CERP Quality Assurance Systems Requirements (QASR) Manual Chapters 3 through 5. Data are qualified in accordance with the District's FSQM and CLQM data validation and reporting sections.

E.14 COMPLETENESS TARGETS

For each project, monitoring parameters and frequencies will be registered in LIMS. This process aids in the creation of header sheet templates, quality assurance and determining completeness. Completeness targets, meaning the number of samples successfully collected and analyzed, are set at 95 percent annually for this project.

E.15 DATA AND RECORDS MANAGEMENT

After the data validation process, all data are maintained so that end users can retrieve and review all information relative to a sampling event. Field notes are maintained on an internal server either by scanning actual field note pages or by uploading narratives from field computers path to server. All analytical data and field conditions are sent to a database (DBHYDRO) for long-term storage and retrieval.

The collecting agency shall maintain records of field notes and copies of all records relative to the chain of custody and analytical data. It is the responsibility of the collection agency to maintain both current and historical method and operating procedures so that at any given time the conditions that were applied to a sampling event can be evaluated. Upon completion of the project, the collecting agency shall provide all original field notes to the District's WQMD for permanent archival.

Records shall be maintained for the life of the project and five years thereafter, in a manner that will protect the physical condition and integrity of the records. Storage shall follow the District's records storage procedure. Access to archived methods shall be through designated records custodian. Corrections of data or records shall follow the District SOP's.

E.15.1 Data Deliverables

The laboratory data shall be submitted to the District in the ADaPT format as specified in CGM-40. The laboratory shall evaluate the data in accordance with the data quality objectives stated in the District's CLQM and FSQM. All data submittals shall conform to existing District guidelines or other format as requested by the District.

E.15.2 Data Storage

After the data validation process, all data are maintained so that end users can retrieve and review all information relative to a sampling event. Field notes are maintained on an internal server either by scanning actual field note pages or by uploading narratives from field computers [hyperlink] http:\\ha2-fs1\kb_wqm\fieldnotes\. All analytical data and metadata are sent to DBHYDRO for long-term storage and retrieval.

E.16 COST ESTIMATE

Total estimated budget for this project is 35,000 per year or 175,000 for five years. Following is a break-down of the estimated costs:

<u>Surface Water Analytical Cost Estimates</u>
Routine Nutrient analysis cost $90 per sample
CU and Zn plus hardness cost $40 per sample
Assume 20% QA

Automated Sampler
Purchase and Install: $25,000
Maintenance Supplies: $1,000/year
TP only $10/sample x 52 samples/yr x 120% = $624/yr

FPDA Inflow
Nutrients $90/sample x 52 samples/yr x 120% = $5616/yr
Metals $40/sample x 4 samples/yr x 120% = $192/yr

FPDA Interior (3 stations) and Aerojet Interior (1 station)
Nutrients $90/sample x 4 samples/yr x 120% x 4 stations = $1728/yr
Metals $40/samples x 4 samples/yr x 120% x 4 stations = $768/yr

Sediment Monitoring
Pesticides Analysis cost $1400 per sample
Assume 20% QA
$1400/sample x 2 samples x 120% = $3360

Annual Analytical costs = $13,288

Labor
Staff time is estimated at $20,000 per year to collect samples service the automated sampler, validate and report the data.

E.17 REVISIONS AND MODIFICATIONS

Date	Section	Page Number(s)	Change From	Change To	Reason

E.18 REFERENCES

FDEP (Florida Department of Environmental Protection). 2008. Quality Assurance Rule, 62-160 Florida Administrative Code (F.A.C.), Effective 12/03/2008.

SFWMD (South Florida Water Management District), 2008. Chemistry Laboratory Quality Manual, Revision No. 08-01, SFWMD-LAB-QM-08-01, March 2008 or a newer version if available.

SFWMD (South Florida Water Management District), 2009. Field Sampling Quality Manual, Version 5.0. SFWMD-FIELD-QM-001-05. Effective 02/06/09, or a newer version if available.

SFWMD (South Florida Water Management District). 2007. Environmental Resource Assessment Department Quality Management Plan, version 1.0, Effective 10/31/07, or a newer version if available.

WRDA (Water Resources Development Act), 2000, Water Resources Development Act of 2000. 114 STAT. 2573. Public Law 106-541-DEC. 11, 2000.

E.19 GLOSSARY

ARCLIF	Aerojet Canal into a Linear Infiltration Feature
CERP	Comprehensive Everglades Restoration Plan
CGM	CERP Guidance Memorandum
CLQM	Chemistry Laboratory Quality Manual
DBHYDRO	SFWMD Environmental and Hydrological Database
DO	Dissolved Oxygen
DOM	Dissolved organic matter
DQOs	Data Quality Objectives
EFA	Everglades Forever Act
ENP	Everglades National Park
F.A.C.	Florida Administrative Code
FDEP	Florida Department of Environmental Protection
FSQM	Field Sampling Quality Manual
LIMS	Laboratory Information Management System
NECP	Non-Everglades Construction Project Permit
PMP	Project Management Plan
PIE	Park Inflows East
PIR	Project Implementation Report
QASR	Quality Assurance Systems Requirements
RECOVER	Restoration, Coordination, and Verification
SFER	South Florida Environmental Report
SFWMD	South Florida Water Management District
SOP	Standard Operating Procedure
WCA	Water Conservation Area
WQMD	Water Quality Monitoring Division
WRDA	Water Resources Development Act

SFWMD-FIELD-MP-0XX-01

Monitoring Plan

For

C-111 SC Western project

Effective Date: Upon Final Approval

Linda Crean, Water Quality Monitoring Division Director	**Date**
David Struve, Water Quality Analysis Division Director	**Date**
Julianne LaRock, Water Quality Assessment Division Director	**Date**
Ming Chen, ERA Quality Assurance Administrator	**Date**

ANNEX E
PROJECT MONITORING PLAN

PART III: ECOLOGICAL MONITORING PLAN

TABLE OF CONTENTS

E PART III: ECOLOGICAL MONITORING PLAN ..... Annex E Part III--E-1
E.1 Introduction and Background ..... Annex E Part III--E-1
E.1.1 Structure of the Plan..... Annex E Part III--E-2
E.1.2 Monitoring Application to Project Objectives..... Annex E Part III--E-3
E.1.3 Monitoring Duration ..... Annex E Part III--E-3
E.2 Physical-Chemical Parameters: Hydrology, Salinity, Water Quality..... ..... Annex E Part III--E-4
E.3 Wetland Stage and Freshwater Discharge ..... Annex E Part III--E-4
E.3.1 Justification and Relevance to Project ..... Annex E Part III--E-4
E.3.2 Project-Level Monitoring for Wetland Stage and Freshwater Discharge..... ..... Annex E Part III--E-5
E.3.3 MAP Component for Wetland Stage and Freshwater Discharge Monitoring .... Annex E Part III--E-7
E.3.4 Comparison between Preferred Project-Level Monitoring and the Monitoring and Assessment Plan for Wetland Stage and Freshwater Discharge Monitoring ..... Annex E Part III--E-8
E.3.5 Data Management Quality Assurance/Quality Control for Wetland Stage and Freshwater Discharge..... Annex E Part III--E-8
E.3.5.1 Data Management ..... Annex E Part III--E-8
E.3.5.2 Quality Assurance/Quality Control for Wetland Stage and Freshwater Discharge ..... Annex E Part III--E-9
E.3.6 Monitoring Cost Estimates for Wetland Stage Monitoring and Freshwater Discharge ..... Annex E Part III--E-9
E.4 Salinity and Water Quality Monitoring ..... Annex E Part III--E-10
E.4.1 Background ..... Annex E Part III--E-10
E.4.2 Justification and Relevance to the C-111 SC Western Project .... Annex E Part III--E-11
E.4.2.1 Salinity ..... Annex E Part III--E-11
E.4.2.2 Water Quality..... Annex E Part III--E-12
E.4.3 Project-Level Component for Salinity and Water Quality Monitoring .... Annex E Part III--E-13
E.4.4 Monitoring and Assessment Plan Component for Salinity and Water Quality Monitoring ..... Annex E Part III--E-18
E.4.5 Comparison between Preferred Project-Level Monitoring and the Monitoring and Assessment Plan for Salinity and Water Quality Monitoring..... ..... Annex E Part III--E-22
E.4.6 Data Management Quality Assurance/Quality Control for Salinity Monitoring ..... Annex E Part III--E-23
E.4.6.1 Data management..... Annex E Part III--E-23
E.4.6.2 Quality Assurance/Quality Control for Monitoring... Annex E Part III--E-23
E.4.7 Cost Estimates for Salinity and Water Quality Monitoring..... ..... Annex E Part III--E-23
E.5 Vegetation Reponses..... Annex E Part III--E-23
E.5.1 Justification and Relevance to the C-111 SC Western Project .... Annex E Part III--E-23

E.5.2 Project-Level Component for Vegetation ..... Annex E Part III--E-25
E.5.3 Monitoring and Assessment Plan Component for Wetland Vegetation and Submerged Aquatic Vegetation ..... Annex E Part III--E-26
E.5.4 Other Ongoing Monitoring of Wetland Vegetation and Submerged Aquatic Vegetation ..... Annex E Part III--E-28
E.5.5 Other Wetland Monitoring Projects ..... Annex E Part III--E-30
E.5.6 Comparison between Project-Level Monitoring and the Monitoring and Assessment Plan Monitoring for Wetland Vegetation and Submerged and Aquatic Vegetation ..... Annex E Part III--E-33
E.5.7 Data Management Quality Assurance/Quality Control for Submerged Aquatic Vegetation ..... Annex E Part III--E-34
E.5.7.1 Data Management ..... Annex E Part III--E-34
E.5.7.2 Quality Assurance/Quality Control for Wetland Vegetation and Submerged Aquatic Vegetation Monitoring ..... Annex E Part III--E-34
E.5.8 Monitoring Cost Estimates for Wetland Vegetation and Submerged Aquatic Vegetation Monitoring ..... Annex E Part III--E-34
E.6 Fauna ..... Annex E Part III--E-35
E.6.1 Freshwater Wetland Prey Base Monitoring ..... Annex E Part III--E-35
E.6.1.1 Justification and Relevance to the C-111 Spreader Canal Western Project ... . Annex E Part III--E-35
E.6.1.2 Project-Level Component for Freshwater Wetland Prey Base Monitoring.... ..... Annex E Part III--E-36
E.6.1.3 Monitoring and Assessment Plan Component for Freshwater Wetland Prey Base Monitoring ..... Annex E Part III--E-36
E.6.1.4 Comparison between Project-Level Monitoring and the Monitoring and Assessment Plan for Freshwater Wetland Prey Base Monitoring .... Annex E Part III--E-36
E.6.1.5 Data Management/Quality Assurance Quality Control for Freshwater Wetland Prey Base Monitoring ..... Annex E Part III--E-36
E.6.1.6 Data Management ..... Annex E Part III--E-37
E.6.1.6.1 Quality Assurance/Quality Control for Freshwater Wetland Prey Base Monitoring ..... Annex E Part III--E-37
E.6.1.7 Cost Estimates for Freshwater Wetland Prey Base Monitoring .... Annex E Part III--E-37
E.6.2 Saline Wetland Prey Base Monitoring ..... Annex E Part III--E-37
E.6.2.1 Justification and Relevance to the C-111 Spreader Canal Western Project ... . Annex E Part III--E-37
E.6.2.2 Project-Level Component for Saline Wetland Prey Base Monitoring..... ..... Annex E Part III--E-38
E.6.2.3 Monitoring and Assessment Plan Component for Saline Wetland Prey Base Monitoring ..... Annex E Part III--E-39
E.6.2.3.1 Comparison between Project-Level Monitoring and the Monitoring and Assessment Plan for Saline Wetland Prey Base Monitoring .... Annex E Part III--E-40
E.6.2.4 Data Management Quality Assurance/Quality Control for Saline Wetland Prey Base Monitoring ..... Annex E Part III--E-40

E.6.2.4.1 Data Management ..... Annex E Part III--E-40
E.6.2.4.2 Quality Assurance/Quality Control for Saline Wetland Prey Base Monitoring ..... Annex E Part III--E-40
E.6.2.5 Estimated Monitoring Cost for Saline Wetland Prey Base Monitoring ..... Annex E Part III--E-41
E.6.3 Estuarine Fish and Invertebrate Monitoring ..... Annex E Part III--E-41
E.6.3.1 Justification and Relevance to the C-111 Spreader Canal Western Project ... Annex E Part III--E-41
E.6.3.2 Project-Level Component for Estuarine Fish and Invertebrate Monitoring ... Annex E Part III--E-42
E.6.3.3 Monitoring and Assessment Plan Components for Estuarine Fish and Invertebrate Monitoring ..... Annex E Part III--E-42
E.6.3.4 Other Ongoing Monitoring for Fish and Invertebrate Monitoring ..... Annex E Part III--E-44
E.6.3.5 Comparison between Project-Level Monitoring and the Monitoring and Assessment Plan for Estuarine Fish and Invertebrate Monitoring ..... Annex E Part III--E-45
E.6.3.6 Data Management Quality Assurance/Quality Control for Estuarine Fish and Invertebrate Monitoring ..... Annex E Part III--E-45
E.6.3.6.1 Data Management ..... Annex E Part III--E-45
E.6.3.6.2 Quality Assurance/Quality Control for Estuarine Fish and Invertebrate Monitoring ..... Annex E Part III--E-45
E.6.3.7 Monitoring Cost Estimates for Estuarine Fish Monitoring ..... Annex E Part III--E-46
E.6.4 Cape Sable Seaside Sparrow Monitoring ..... Annex E Part III--E-46
E.6.4.1 Justification and Relevance to Performance Measures ..... Annex E Part III--E-46
E.6.4.2 Project-Level Component for Cape Sable Seaside Sparrows ..... Annex E Part III--E-49
E.6.4.3 Monitoring and Assessment Plan Component for Cape Sable Seaside Sparrows ..... Annex E Part III--E-54
E.6.4.4 Comparison between Preferred Project-Level Monitoring and the Monitoring and Assessment Plan for Cape Sable Seaside Sparrows ..... Annex E Part III--E-55
E.6.4.5 Data Management Quality Assurance/Quality Control for Cape Sable Seaside Sparrows ..... Annex E Part III--E-55
E.6.4.5.1 Data Management ..... Annex E Part III--E-55
E.6.4.5.2 Quality Assurance/Quality Control for Cape Sable Seaside Sparrows Monitoring ..... Annex E Part III--E-56
E.6.4.6 Adaptive Assessment and Management for Cape Sable Seaside Sparrows ... Annex E Part III--E-56
E.6.4.7 Estimated Monitoring Cost Estimates for Cape Sable Seaside Sparrows ..... Annex E Part III--E-57
E.6.5 Spoonbill Nesting Success Monitoring ..... Annex E Part III--E-59
E.6.5.1 Justification and Relevance to Performance Measures ..... Annex E Part III--E-59

E.6.5.2 Project-Level Component for Spoonbill Nest Monitoring ..... Annex E Part III--E-59
E.6.5.3 Monitoring and Assessment Plan Component for Spoonbill Nest Monitoring ..... Annex E Part III--E-60
E.6.5.4 Comparison between Preferred Project-Level Monitoring and the Monitoring and Assessment Plan for Spoonbill Nest Monitoring..... Annex E Part III--E-61
E.6.5.4.1 Data Management Quality Assurance/Quality Control for Spoonbill Nest Monitoring ..... Annex E Part III--E-61
E.6.5.4.2 Data Management ..... Annex E Part III--E-61
E.6.5.4.3 Quality Assurance/Quality Control for Spoonbill Nest Monitoring..... Annex E Part III--E-61
E.6.5.5 Cost Estimates for Spoonbill Nest Monitoring..... Annex E Part III--E-61
E.6.6 Wading Bird Monitoring..... Annex E Part III--E-62
E.6.6.1 Justification and Relevance to Performance Measures..... Annex E Part III--E-62
E.6.6.2 Project-Level Component for Wading Bird Monitoring ..... Annex E Part III--E-62
E.6.6.3 Monitoring and Assessment Plan Component for Wading Bird Monitoring . ..... Annex E Part III--E-62
E.6.6.4 Other Ongoing Monitoring for Wading Birds ..... Annex E Part III--E-63
E.6.6.5 Comparison between Preferred Project-Level Monitoring and the Monitoring and Assessment Plan for Wading Bird Monitoring..... Annex E Part III--E-64
E.6.6.6 Data Management Quality Assurance/Quality Control for Wading Bird Monitoring ..... Annex E Part III--E-64
E.6.6.6.1 Data Management ..... Annex E Part III--E-64
E.6.6.6.2 Quality Assurance/Quality Control for Wading Bird Monitoring..... Annex E Part III--E-64
E.6.6.7 Monitoring Cost Estimates for Wading Bird Monitoring..... Annex E Part III--E-64
E.6.7 Juvenile Crocodile Monitoring ..... Annex E Part III--E-65
E.6.7.1 Justification and Relevance to Performance Measures..... Annex E Part III--E-65
E.6.7.2 Project-Level Component for Crocodile Monitoring Annex E Part III--E-65
E.6.7.3 Monitoring and Assessment Plan Component for Crocodile Monitoring ..... Annex E Part III--E-66
E.6.7.4 Comparison between Preferred Project-Level Monitoring and the Monitoring and Assessment Plan for Crocodile Monitoring..... Annex E Part III--E-68
E.6.7.5 Data Management Quality Assurance/Quality Control for Crocodile Monitoring ..... Annex E Part III--E-68
E.6.7.5.1 Data Management ..... Annex E Part III--E-68
E.6.7.5.2 Quality Assurance/Quality Control for Crocodile Monitoring..... Annex E Part III--E-68

E.6.7.6 Monitoring Cost Estimates for Crocodile Monitoring ..... Annex E Part III--E-68
E.7 Summary of C-111 SC Western Project Ecological Monitoring Recommendations and Costs ..... Annex E Part III--E-68
E.8 Conclusion ..... Annex E Part III--E-70
E.9 Literature Cited ..... Annex E Part III--E-71

LIST OF TABLES

Table E-1 Cross Reference of Project Objectives and Applicable Document Sections ..... Annex E Part III--E-3
Table E-2 Cost Estimates for Wetland Stage Monitoring ..... Annex E Part III--E-9
Table E-3 Cost Estimates for Salinity and Water Qulality Monitoring ..... Annex E Part III--E-23
Table E-4 Cost Estimates for Wetland Vegetation and Submerged Aquatic Vegetation Monitoring ..... Annex E Part III--E-34
Table E-5 Cost Estimates for Freshwater Wetland Prey Base Monitoring ..... Annex E Part III--E-37
Table E-6 Cost Estimates for Saline Wetland Prey Base Monitoring Annex E Part III--E-41
Table E-7 Summary of Basin Location for The Everglades National Park-Florida Fish and Wildlife Commission ..... Annex E Part III--E-45
Table E-8 Cost Estimates for Estuarine Fish Monitoring ..... Annex E Part III--E-46
Table E-9 Cost Estimates for Cape Sable Seaside Saprrows ..... Annex E Part III--E-57
Table E-10 Cost Estimates for Spoonbill Nest Monitoring ..... Annex E Part III--E-61
Table E-11 Cost Estimates for Wading Bird Monitoring ..... Annex E Part III--E-64
Table E-12 Cost Estimates for Crocodile Monitoring ..... Annex E Part III--E-68
Table E-13 Summary of Project-Level Monitoring Cost Estimates the C-111 Spreader Canal Western Project for One Year ..... Annex E Part III--E-69
Table E-14 Summary of Project-Level Monitoring Cost Estimates for the C-111 Spreader Canal Western Project for Five Years ..... Annex E Part III--E-70

LIST OF FIGURES

Figure E-1 RECOVER Coastal Gradient Transects ..... Annex E Part III--E-2
Figure E-2 Monitoring and Assessment Plan Sampling Locations for Wetland Stage Monitoring ..... Annex E Part III--E-6
Figure E-3 U.S. Geological Survey Coastal Gradients Monitoring Stations, in Part Supported by RECOVER Monitoring and Assessment Plan ..... Annex E Part III--E-7
Figure E-4 Long-Term Hydrologic, Salinity, and Water Quality Monitoring Sites ..... Annex E Part III--E-15
Figure E-5 Proposed Project-Level Sampling of Wetland Salinity and Nutrients ..... Annex E Part III--E-16
Figure E-6 U.S. Geological Survey Salinity (or Specific Conductivity), Hydrologic, or Nutrient Monitoring Stations ..... Annex E Part III--E-19

Figure E-7 Continuous Salinity Monitoring Sites in The Everglades National Park Marine Monitoring Network ..... Annex E Part III--E-20
Figure E-8 Biscayne Bay Salinity Monitoring Network Sites Located Near The C-111 SC Project ..... Annex E Part III--E-20
Figure E-9 Coastal Water Quality Monitoring Network for Card Sound, Barnes Sound, Manatee Bay, and Florida Bay ..... Annex E Part III--E-21
Figure E-10 Site Map-Everglades National Park Submerged Aquatic Vegetation Monitoring in the Lakes Region ..... Annex E Part III--E-22
Figure E-11 Audubon Submerged Aquatic Vegetaion Monitoring Transects: Proposed Project-Level Sites ..... Annex E Part III--E-26
Figure E-12 Monitoring and Assessment Plan Showing Spatial Extent of the RECOVER Monitoring and Assessment Plan Vegetation Mapping.... Annex E Part III--E-27
Figure E-13 RECOVER Funded SAV Monitoring Areas (FHAP), Along with Complementary Miami-Dade Derm Areas ..... Annex E Part III--E-28
Figure E-14 Current Audubon Submerged Aquatic Vegetation Monitoring Transects .... Annex E Part III--E-30
Figure E-15 Locations of Transects and Plots for Vegetation Monitoring in Taylor Slough by Everglades National Park ..... Annex E Part III--E-32
Figure E-16 Location of Monitoring Sites within the Cape Sable Seaside Sparrow Habitat Sampled in 2006 ..... Annex E Part III--E-33
Figure E-17 Audubon of Florida Tavernier Science Center's Current and Proposed Monitoring Sites ..... Annex E Part III--E-39
Figure E-18 Location of Monitoring and Assessment Plan-National Marine Fisheries Service Trawl Stations by Area ..... Annex E Part III--E-44
Figure E-19 Location of Cape Sable Seaside Sparrow Critical Habitat Annex E Part III--E-48
Figure E-20 Location of Cape Sable Seaside Sparrow Critical Habitat, Survey Sites, Numbers Observed, and Relationship To C-111 Spreader Canal Project (Western PIR) Changes from Ecological Condition Base in Hydroperiod Days ..... Annex E Part III--E-49
Figure E-21 Location of Existing (Red) And Recommended (Green) Additional Vegetation Transects and Existing (Ever4) and Recommended (White) Stage Monitoring Wellpoints ..... Annex E Part III--E-54
Figure E-22 Crocodile Monitoring Station Locations in The C-111 Spreader Canal Western Project Area ..... Annex E Part III--E-67

E PART III: ECOLOGICAL MONITORING PLAN

E.1 INTRODUCTION AND BACKGROUND

This document serves as a reference for ecologic monitoring parameters and protocols for the C-111 SC Western project. This project-level ecological monitoring plan has been designed to provide the ecological information base needed to evaluate the project's performance in progressing toward restoration goals and to facilitate effective, science based management decisions concerning project design and operation. Specifically, the recommended ecological monitoring will determine if restoring beneficial patterns of freshwater flow, salinity, and water quality to nearshore waters and adjacent wetlands of Florida Bay will achieve the expected community structure, distribution, abundance, and viability SAV, wetland vegetation, and associated biota. The ecological monitoring plan is designed to provide critical information for adaptively managing the project, which is consistent with the NRC's recent (2006) recommendation for the IAR approach for CERP. Because this project is being planned as two PIRs, the ecological monitoring information will not only be used to adaptively manage the first phase of the project, but it will provide critical information for planning and constructing subsequent phases.

The guidance contained in this document will assist in maintaining consistency in sampling locations, parameter lists and frequencies as well as providing documentation of the project scope. The C-111 SC Western project ecological monitoring plan will be closely coordinated with the CERP RECOVER MAP to ensure that measures and targets selected by the project teams are consistent with system-wide measures and that duplication of effort is avoided. Because the MAP is designed to detect system-wide or regional changes, only certain parameters are to be measured, and they will be measured across large spatial scales. The C-111 SC Western project ecological monitoring plan will ensure temporal and spatial coverage of monitoring parameters that are appropriate to detect changes at the project level, which will likely mean filling gaps in the MAP monitoring parameters and adding additional project-level parameters not included in the MAP. Thus, the project-level monitoring plan will likely have greater spatial and temporal resolution in its monitoring data, which should enable detection of ecological changes resulting from project-level implementation in order to adaptively manage the project and to evaluate project success.

The C-111 SC Western project ecological monitoring plan will utilize sampling designs, protocols and results of the MAP whenever possible. One project within the MAP is particularly relevant to the C-111 SC Western project: the RECOVER Coastal Gradients Transect project (***FIGURE E-1***). This project will focus on the functional linkage of the Everglades ecosystem and associated estuarine ecosystems, documenting the hydrologic and ecologic characteristics of

the salinity transition zone between the Everglades and the estuaries and how this transition zone changes with CERP implementation. A set of nine sampling transects have been designed and the four eastern transects of this set are within the C-111 SC Western project domain. To the extent possible, project-level monitoring will utilize this design and provide a critical complement to RECOVER data derived from this MAP assessment.

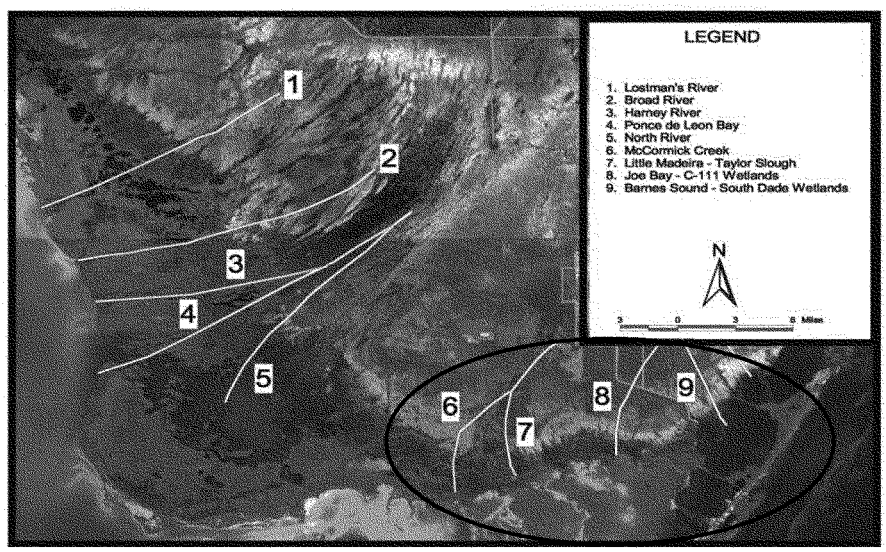


FIGURE E-1: RECOVER COASTAL GRADIENT TRANSECTS
Note: Transects relevant to the C-111 SC project are circled

E.1.1 Structure of the Plan

Because of the complexity of planned monitoring in the C-111 SC Western project area, the ecological section of the monitoring plan is sub-divided into three monitoring components: (1) physical and water quality parameters, (2) flora, and (3) fauna. The physical and water quality parameter component will include monitoring wetland stage, freshwater discharge to the estuaries, salinity in both the wetlands and estuarine waters, and water quality within the wetlands and estuaries. Flora monitoring parameters will include emergent wetland vegetation and SAV responses. Fauna monitoring will consist of wetland prey base, aquatic invertebrates, estuarine invertebrates and fish, CSSSs, spoonbill nesting success, wading birds, and juvenile crocodiles. Project objectives applicable to each component are identified, and the monitoring parameters that will assess the extent to which each objective is achieved are

presented. For each monitoring parameter, the following information is provided: (1) justification in relation to project objectives (2) description of the project-level monitoring component, (3) MAP monitoring component, (4) comparison of project-level and MAP components, (5) data management and QA/QC, and (7) monitoring cost estimates.

E.1.2 Monitoring Application to Project Objectives

The three primary objectives that the C-111 SC Western project is designed to achieve are provided in ***TABLE E-1.*** Sections of the ecological monitoring plan that are designed to evaluate each objective are included in the table as a cross reference.

TABLE E-1: CROSS REFERENCE OF PROJECT OBJECTIVES AND APPLICABLE DOCUMENT SECTIONS

Project Objective	Applicable Document Sections
1. Restore the quantity, timing, and distribution of water delivered to Florida Bay via Taylor Slough to levels nearest as possible to the pre-drainage model runs.	E.2.3 Wetland stage E.2.4 Salinity and WQ E.2.5 Vegetation and SAV E.3.3 Estuarine fish and invertebrates E.3.7 Juvenile crocodiles
2. Improve hydroperiods and hydropatterns in the southern Everglades and Model Lands. The hydroperiods will be improved to optimal levels to support historical vegetation patterns nearest as possible to the pre-drainage model runs; Hydropatterns will be restored to historical sloughs and associated tributaries.	E.2.3 Wetland stage E.2.4 Salinity and WQ E.2.5 Vegetation and SAV E.3.1 FW Prey Base E.3.2 SW Prey Base E.3.5 Spoonbill Nesting Success E.3.6 Wading Birds
3. Return coastal zone salinities in western Florida Bay to levels as close as possible to pre-drainage scenario model runs by restoring upstream water levels in eastern Everglades National Park.	E.2.4 Salinity and WQ E.2.5 Vegetation and SAV E.3.3 Estuarine fish and invertebrates E.3.7 Juvenile crocodiles

Key:
FW freshwater
SAV submerged aquatic vegetation
SW saltwater
WQ water quality

E.1.3 Monitoring Duration

In most instances, project-level monitoring for the C-111 SC Western project should be conducted for five consecutive years and then reassessed to determine

if monitoring should continue. It may be beneficial to stagger the monitoring of some parameters for a longer period of time, because of some of the expected response times of some of the ecological monitoring parameters to changes in hydrology and water quality. For example, some wetland plants may respond in three to five years, but many species of wetland vegetation will take years, if not decades, to respond to changes in water levels, hydroperiod, and salinity. Monitoring these parameters for only five years post-construction may not allow enough time to observe changes and to adaptively manage for lack of change or inappropriate change. Additionally, even though the physical parameters recommended for monitoring (e.g., stage and salinity) may respond more quickly to the implemented project, these parameters can be affected significantly by natural drivers (e.g., rainfall, sea level rise). The Atlantic Oscillation in particular is a primary driver of rainfall patterns and occurs on the order of decades. The salinity record from Biscayne Bay and Florida Bay confirms this influence indicating an overall salinity low in 1995 and high in 2004. Fluctuations of these physical monitoring parameters due to annual variations in the natural drivers should ideally be monitored for enough time to adequately determine if the project is resulting in the desired hydropatterns and salinity regimes. Results from the Chesapeake Bay restoration effort indicate that some responses typically have a five to ten-year lag between indicator response and restoration of natural salinity patterns.

Despite the potential need to track some ecological changes over many years, monitoring must remain flexible and adaptive. Therefore, in addition to an annual review, a major reassessment should be conducted at the end of five years of monitoring. It is likely that certain parameters can be scaled back both temporally and spatially after a few years of initial post-project monitoring, or eliminated once targets are attained for given parameters.

E.2 PHYSICAL-CHEMICAL PARAMETERS: HYDROLOGY, SALINITY, WATER QUALITY

E.3 WETLAND STAGE AND FRESHWATER DISCHARGE

E.3.1 Justification and Relevance to Project

The features of the C-111 SC Western project will provide environmental restoration in the Everglades via hydrologic change. Monitoring wetland stage and the discharge of fresh water from the wetland to the estuaries within the project domain, from the Model Lands to the western boundary of Taylor Slough's influence, is essential in order to document project effects. Time series of stage at stations throughout the domain are needed to determine changes in hydroperiods and hydropatterns. Time series of the discharge of fresh water flow through creeks to Florida Bay and Manatee Bay/Barnes Sound is needed to determine changes in the quantity, timing, and distribution of flow to these

estuaries. These flow measurements are also necessary to calculate nutrient loads to the estuaries to ensure that the project does no harm to downstream water quality (see below). All three Project objectives are directly linked to hydrologic conditions and flow; wetland stage and freshwater discharge data are needed to document changes in the quantity, timing, and distribution of water in the Southern Everglades and Model Lands, as well as document hydroperiods and hydropatterns.

E.3.2 Project-Level Monitoring for Wetland Stage and Freshwater Discharge

An extensive network of hydrologic monitoring, including stage and discharge monitoring currently exists in the C-111 SC project domain (***FIGURE E-2***). Most hydrostations are supported and operated by SFWMD, ENP, or U.S. Geological Survey (USGS), but additional stations operated by Audubon and university programs (e.g. the FIU Long Term Ecological Ecosystem Research Program, funded by NSF). USGS has developed a statistical interpolation of this interagency network's values (the "EDEN" network) such that real-time stages can be estimated throughout the southern Everglades (although not including the entire coastal mangrove zone). A detailed description of existing and proposed new project-level hydrologic monitoring is provided in the Hydrometeorologic Monitoring Plan of this PIR. Freshwater flow into Florida Bay, Manatee Bay, and Barnes Sound is measured by USGS (see below). This set of proposed and existing stations is expected to be sufficient to assess C-111 SC downstream effects and no further project-level monitoring of stage or discharge is proposed here.

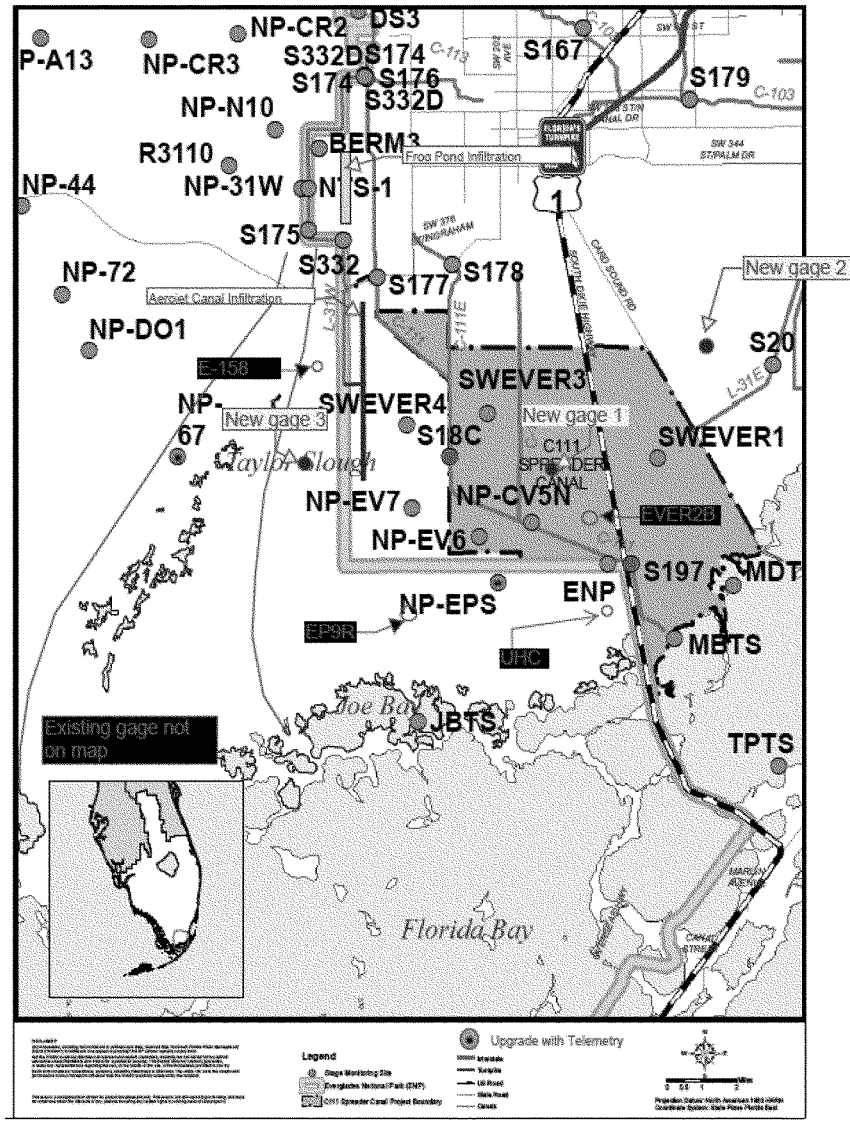


FIGURE E-2: MONITORING AND ASSESSMENT PLAN SAMPLING LOCATIONS FOR WETLAND STAGE MONITORING
(From Hydrometeorological Monitoring Plan)

E.3.3 MAP Component for Wetland Stage and Freshwater Discharge Monitoring

The RECOVER MAP recognizes the importance of wetland stage monitoring, but largely relies upon the existing non-CERP funded interagency monitoring network. Measurement of freshwater flow into the southern estuaries throughout the C-111 SC domain, as well as some stage measurement, is incorporated within the USGS Coastal Gradients of Flow, Salinity, and Nutrients Project, which is partly funded by RECOVER (***FIGURE E-3***). This Project will be the primary data source to determine C-111 SC project effects on freshwater discharge.

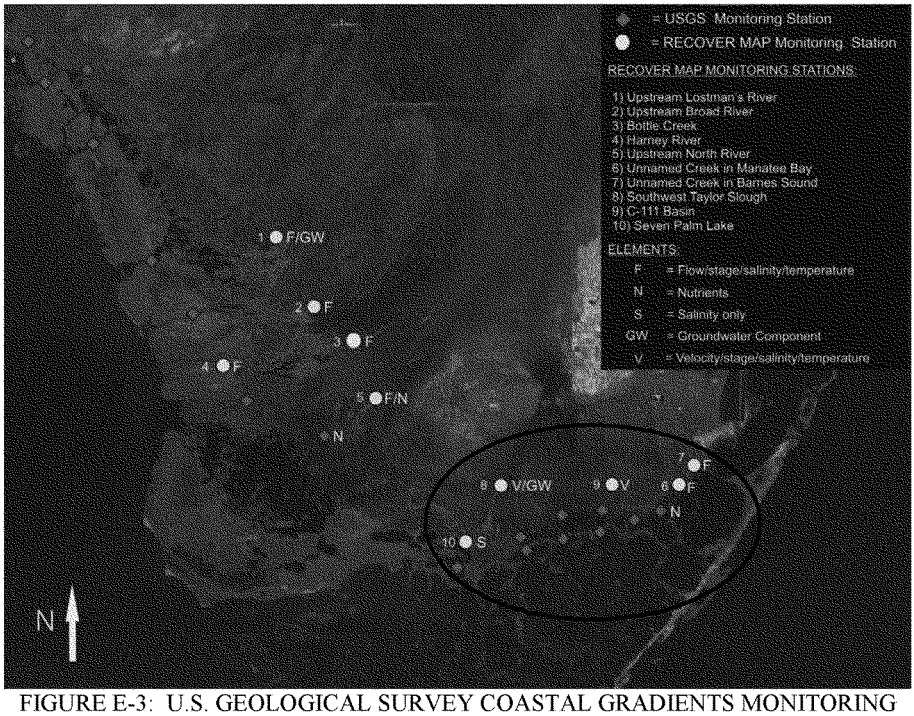


FIGURE E-3: U.S. GEOLOGICAL SURVEY COASTAL GRADIENTS MONITORING STATIONS, IN PART SUPPORTED BY RECOVER MONITORING AND ASSESSMENT PLAN

Note: Circled stations are relevant to the C-111 SC project and stage is measured at almost all stations

E.3.4 Comparison between Preferred Project-Level Monitoring and the Monitoring and Assessment Plan for Wetland Stage and Freshwater Discharge Monitoring

There is no overlap between RECOVER MAP and project-level stage and flow monitoring (see Hydrometeorologic Monitoring Plan for details). Both RECOVER and this project largely depend on non-CERP hydrologic monitoring for stage data.

E.3.5 Data Management Quality Assurance/Quality Control for Wetland Stage and Freshwater Discharge

E.3.5.1 Data Management

Chapter 10 in the CERP Quality Assurance Systems Requirements (QASR) Manual (http://www.evergladesplan.org/pm/program_docs/qasr.cfm) states that the CERP Data Management Plan (February 26, 2002) will provide for coordinated management and integration of all CERP information with a program-level strategy. The CERP Data and Information Management Team will interact with the CERP Quality Assurance Oversight Team, as necessary in order to:

1. Review and comment on all data-related technical specifications
2. Ensure that a proper data QA/QC process will be in place, particularly for data-acquisition contracts
3. Review contract SOWs for environmental monitoring before they are issued

Chapter 10 in the QASR Manual further states that since data will be collected for a variety of uses within the CERP, including permits and other legal mandates, the data management system must follow NELAC standards, Florida Department of Environmental Protection (FDEP) standards as specified in Chapter 62-160, F.A.C., CERP Data Management Plan requirements, and any other applicable regulations specific to the monitoring of different projects. In addition, data management should follow implementation guidelines being developed in the RECOVER MAP, which will provide more details on information and data management procedures. Other relevant CERP Guidance Memoranda references for CERP information and data management and standardization are as follows:

- CGM 002 provides guidance for project names convention.
- CGM 028 provides guidelines and recommendations covering all CERP GIS data sets standards. GIS documentation standards should be in compliance with the Federal Geographic Data Committee (FGDC)

documentation for the data to be included in the CERP Enterprise GIS database.

- CGM 040 provides guidance on project-level water quality and hydrometeorological monitoring and assessment to ensure data generated is comparable among different projects.
- CGM 041 provides guidance on agency responsibility and coordination for CERP data validation and management.

In addition, Chapter 10 in the QASR Manual provides guidance and protocols on how to handle data types, elements, and standards; project identifiers; field identifiers; laboratory identifiers; field data elements; data file format and content assessment; change control and tracking of issues; records management storage and access; records QA measures; records custody, security, and access; documentation; and tracking revisions/corrections.

E.3.5.2 Quality Assurance/Quality Control for Wetland Stage and Freshwater Discharge

QA/QC for wetland stage and freshwater discharge monitoring will conform to the guidance and protocols provided in the CERP Quality Assurance Systems Requirements (QASR) Manual (RECOVER 2004b). Chapter 6 in this manual provides details on water level QA/QC requirements, including: (1) accuracy, precision, and resolution requirements for water stage sensors, (2) datum, and (3) sampling frequency.

E.3.6 Monitoring Cost Estimates for Wetland Stage Monitoring and Freshwater Discharge

It is assumed that the monitoring costs for existing SFWMD, ENP, and USGS gauges within the project domain will continue to be partially funded by these agencies and co-funded by this project. Some project-level costs are described in the Hydrometeorological Monitoring Plan.

TABLE E-2: COST ESTIMATES FOR WETLAND STAGE MONITORING

	Estimated Project Cost
Year 1	$9,000 (Agency Co-Funded)
Years 1-5	$45,000 (Agency Co-Funded)

E.4 SALINITY AND WATER QUALITY MONITORING

E.4.1 Background

The C-111 SC Western project is expected to improve water deliveries to Florida Bay via Taylor Slough, reduce or eliminate ecologically damaging flows to Manatee Bay, Barnes Sound, and the northeastern Florida Bay coastline, and improve hydroperiods and hydropatterns in the southern Everglades and model lands. These changes are expected to produce more natural salinity patterns in coastal wetlands and estuaries, in turn producing ecological benefits without compromising water quality (especially regarding algal blooms in Florida Bay).

To document the effects and benefits of the project, monitoring should include measurement of salinity and water quality within the coastal wetlands, fresh water discharge through creeks to Florida Bay (see hydrologic section above), nutrient loads associated with this discharge, and salinity and water quality (nutrient concentrations, chlorophyll a, and water clarity) of open waters in the project region. These metrics are performance measures of the Southern Estuaries or Greater Everglades Modules of RECOVER. An additional consideration here is the scarcity of information regarding the nutrient-rich coastal lakes that may be increasingly influenced by flows from western Taylor Slough.

Restoration of the ecological structure and function of the southern Everglades and associated estuaries has a strong dependency on restoring coastal wetlands – a salinity transition zone that historically was one of the most productive portions of region, supporting fish, wading birds, and other fauna, including alligators and crocodiles. Historic water diversion, combined with sea level rise, has increased salinity levels and variability and the spatial extent of salinity intrusion into the fresh water Everglades. This change has resulted in the expansion of a low productivity "white zone" along the southeastern Everglades coast (an area with low vegetation and high reflectance). It is expected that the C-111 SC project will improve the hydrology of the southern Everglades and the salinity transition zone to re-establish a broad zone of low salinity (an oligohaline marsh) and reverse white zone expansion. Restoration of salinity patterns includes a decrease in magnitude and extending the duration of seasonally fresh-oligohaline conditions into the late fall and early winter, associated with the restoration of the Everglades as a hydrologic buffer.

This hydrologic and salinity restoration is expected to enable the restoration of ecological structure and function in the region, particularly with regard to the productivity of periphyton and macrophytes that provide a food base and habitat for fish and wildlife. Critical links in this food web are the production of a fish and invertebrate prey base for wading bird foraging and population success. Additionally, this restoration is expected to help counter sea level rise by

increasing soil elevation. Soil saturation and low nutrient conditions in the southern Everglades slows organic matter decomposition and enhances below-ground production. Resultant changes in soil elevation have been recognized by RECOVER as being one of the most important factors that will influence the response of the entire Everglades system to sea-level rise–and the front line of this response is in the salinity transition zone.

Hydrologic and salinity restoration must also include protection of the oligotrophic (low nutrient) status of the southern Everglades and downstream estuaries. Water quality measurements are not just needed for to ensure regulatory protection, but also to understand the effect of C-111 SC project implementation on nutrient supply, storage, and transport through natural areas–i.e. sustaining natural patterns of nutrient availability to support ecosystem productivity without un-natural enrichment (e.g. resulting in algal blooms). Both phosphorus (P) and nitrogen (N) are important in this region because of local P limitations and stronger N limitations in downstream estuarine waters.

E.4.2 Justification and Relevance to the C-111 SC Western Project

E.4.2.1 Salinity

The ecological effects of the C-111 SC Western project within the coastal wetlands and estuaries will largely be driven by changing salinity. Each of the project's hydrologic objectives has direct consequences regarding salinity magnitude, distribution, seasonality, and rates of change and each of these salinity attributes has strong biological consequences. Thus, salinity is a primary RECOVER performance measure for restoration in this region and the C-111 SC Western project is expected to produce more natural salinity patterns in the coastal wetlands, Florida Bay, Manatee Bay, and Barnes Sound. However, the C-111 SC Western project is focused on improvement of Taylor Slough and receiving coastal waters. Given this focus and a concern that this improvement could yield decreased flow and increased salinity in the eastern project area (ENP panhandle and Model Lands), salinity monitoring needs not only to document the effects of the project in Taylor Slough and its zone of influence, but also document effects to the east.

As it is operated now, the C-111 Canal drains Taylor Slough and the eastern Everglades and discharges this water through the levee removal zone on the southern edge of the C-111 Canal or to tide through the S-197 structure. Such operations have changed freshwater delivery to the estuarine areas, disrupting hydropatterns throughout the area and leading to an overall increase in salinity in all the estuaries. Furthermore, changes in the timing and distribution of fresh water inflow have changed salinity variability patterns, increasing large salinity fluctuations in some areas (especially close to C-111 Canal releases),

decreasing the range of salinities in other areas (e.g. making estuaries more marine to hypersaline), causing rapid salinity shifts from wet season to dry season (with less hydrologic buffering in the Everglades), and inducing long periods of hypersalinity in Central Florida Bay.

RECOVER performance measures for the Southern Estuaries and Greater Everglades call for restoration of salinity magnitude, timing and distribution. This includes a call to "provide less abrupt and less extreme decreases in salinity in the northeastern bay. Reduce the frequency, duration, magnitude, and extent of hypersaline conditions throughout the bay. Increase the frequency and extent of lower salinity conditions in the bay. Restoration of timing entails restoration of fresh water flows that continue after the end of the rainy season. This is associated with restoration of the wetland's function as a hydrologic buffer. In the mangrove estuarine areas, lower salinity to oligohaline levels in coastal lakes and basins." The Greater Everglades module also calls for restoration of freshwater flow to sustain a broad oligohaline zone (decreasing the "white zone", described above), despite sea level rise.

This includes a call to "provide less abrupt and less extreme decreases in salinity in the northeastern bay. Reduce the frequency, duration, magnitude, and extent of hypersaline conditions throughout the bay. Increase the frequency and extent of lower salinity conditions in the bay. Restoration of timing entails restoration of fresh water flows that continue after the end of the rainy season. This is associated with restoration of the wetland's function as a hydrologic buffer. In the mangrove estuarine areas, lower salinity to oligohaline levels in coastal lakes and basins." The Greater Everglades module also calls for restoration of freshwater flow to sustain a broad oligohaline zone (decreasing the "white zone", described above), despite sea level rise.

Salinity performance is particularly important because it is a primary driver of habitat quality and distribution in the wetland, coastal ponds and lakes, and estuaries. In coastal ponds and estuaries, increased fresh water flow is expected to improve SAV habitat for fauna. Spatially distributed salinity data will be required to detect whether wetland and estuarine conditions becomes more favorable for habitat and associated fauna.

E.4.2.2 Water Quality

Restoration of the Everglades-estuarine ecosystem via hydrologic and salinity restoration can only be successful if water quality is maintained or improved in the process (i.e. the C-111 SC Western project does no harm via water quality change). For Florida Bay, a central concern has been that increased fresh water flow may increase nutrient loads, stimulate algal blooms, and decrease water clarity such that SAV habitat is threatened. RECOVER has funded analyses of this issue and while some evidence supports inferences regarding nutrient

loading as a cause of concern, evidence is not sufficiently strong to alter CERP at this time–an adaptive approach remains prudent.

Recognizing such concerns, RECOVER specified the water quality performance measures for the freshwater Everglades and the Southern Estuaries. This includes nutrient concentrations and the use of periphyton tissue nutrients as a water quality indicator in the Everglades, targets for nutrient loads from mangrove creeks, and estuarine nutrient concentrations, chlorophyll a (an indicator of phytoplankton bloom density), and light extinction (water clarity). A Greater Everglades module performance measure specifically focuses on nitrogen loading to the coastal zone from the Everglades. Measurement of both water discharge and nutrient concentration (phosphorus and nitrogen) in mangrove creeks are necessary to estimate nutrient loads. An expectation is that the C-111 SC Western project may change the distribution of nutrient inputs to Florida Bay, but not increase these loads, and that consequent effects on bay water quality will be negligible.

However, a new spatial consideration for the C-111 SC Western project is that increasing fresh water flow through western Taylor Slough will likely increase discharge through the ENP lakes region (from Seven Palm Lake to as far west as West Lake, with outputs through McCormick Creek and Alligator Creek), increasing flushing of this region. Little baseline water quality information exists on this lakes region, but it appears to be phosphorus-rich (total phosphorus concentrations up to 100 parts per billion [ppb]) with high chlorophyll a (up to 40 μg/L). Because of the likely importance of this region as a nursery ground for many estuarine fish and potential for both benefits and negative downstream effects (even if short-term) derived from the C-111 SC, special attention should be paid to monitor this region and it's downstream zone of influence in the bay. Most importantly, nutrient export from this region should be monitored and improved understanding of how the project's hydrologic modifications affect this export is needed in order to guide operations during and after project implementation and the second C-111 SC PIR.

E.4.3 Project-Level Component for Salinity and Water Quality Monitoring

A number of long-term monitoring projects have been established by various governmental agencies in the southeastern Everglades wetlands, Florida Bay and its adjacent embayments, lakes, and ponds, as well as in Manatee Bay, Barnes Sound, and Card Sound (***FIGURE E-4***). Most notable is the RECOVER Coastal Gradients project (***FIGURE E-1***, ***FIGURE E-3***), which is implemented by USGS. This transect design provides a sound basis for monitoring wetland salinity, water quality (including nutrient loading), and ecological responses. Within the estuaries, an extensive network of salinity and water quality monitoring already exists, funded largely by SFWMD and ENP.

Project-level needs for salinity and water quality data not met by existing monitoring are within in the following components: 1) spatial mapping of wetland salinity conditions to document shifts in salinity zones near the coast; 2) near-shore salinity at up to two sites in Florida Bay; 3) nutrient status at sites downstream of freshwater inflow to the wetlands (from canals or detention areas) and along select sites of the Coastal Gradients transects, including nutrient concentrations in a subset of creeks with USGS flow monitoring to estimate nutrient loading; 4) assessment of project effects on freshwater input/output and nutrient export from western Taylor Slough lakes. Each of these components is described below.

Spatial mapping of salinity: Few stations in the southern Everglades wetlands include measurements of conductivity (salinity). In order to determine the spatial distribution (mapping) of salinity changes in the coastal wetlands, rapid surveys (likely two or three days per survey) of surface water and shallow porewater (likely 0-20 centimeters deep) will be measured three times per year. Porewater provides an integrated measure of surface water salinity intrusion to the wetland and strongly affects plant community composition and productivity. Samples will be taken via helicopter, with small diameter (likely 2.5 cm diameter) cores collected along north-south transects that bracket the salinity transition zone from the Model Lands to western Taylor Slough (yellow circles, depict potential locations in *FIGURE E-5*).

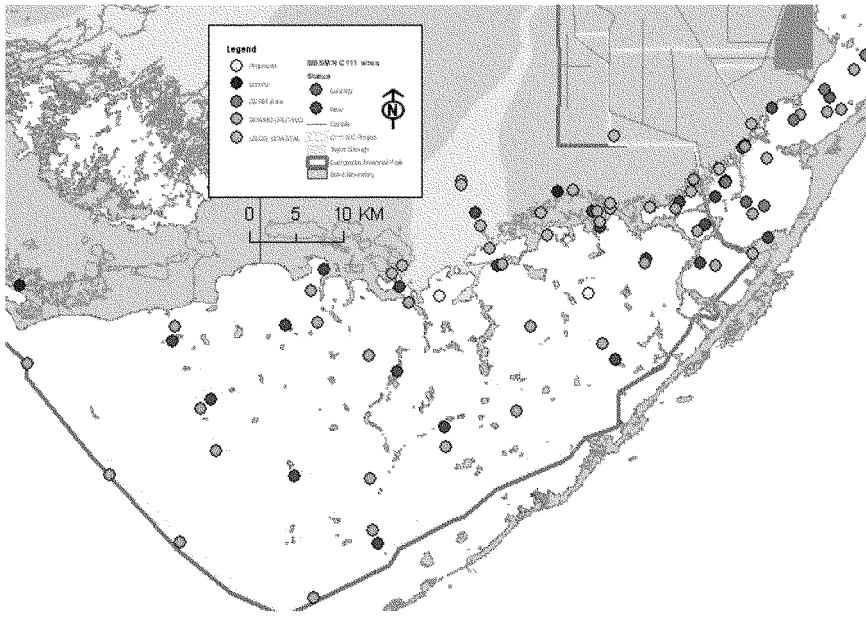


FIGURE E-4: LONG-TERM HYDROLOGIC, SALINITY, AND WATER QUALITY MONITORING SITES

Sites most relevant to the C-111 SC project are circled

Dot code:

Pink USGS Coastal Gradients

Blue ENP Marine Monitoring Network

Green SFWMD Coastal Water Quality Network

Yellow Proposed near-shore salinity stations

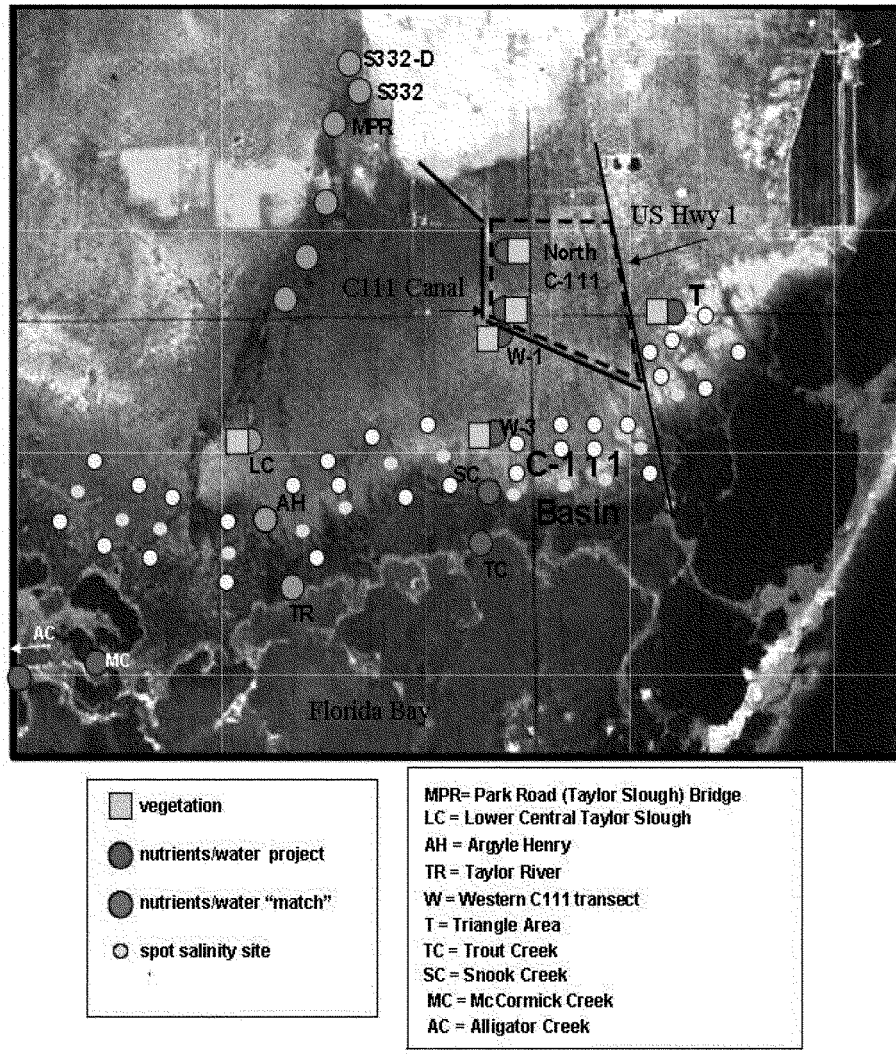


FIGURE E-5: PROPOSED PROJECT-LEVEL SAMPLING OF WETLAND SALINITY AND NUTRIENTS

Yellow Circles	Potential Salinity Sites
Red Circles	Nutrient Sites (Including 4 at USGS Creek Flow Meter Sites)
Orange Circles	FIU's Long-Term Ecological Research Program (NSF Funded) Sites

Near-shore salinity: Monitoring coverage in the estuarine area of the project is extensive and largely sufficient. However, up to two new continuous salinity monitoring sites are proposed to detect changes due to the C-111 SC Western project. Specific locations are to be determined by an analysis of existing fine-scale spatial mapping data, but Madeira Bay and Nest Key Basin are candidate sites. Madeira Bay, located on the western side of Taylor Slough, has no monitoring sites. The area is currently restricted to small amounts of overland flow; however, it might be possible that freshwater deliveries to Madeira Bay may increase with CERP implementation. This basin is part of the RECOVER SAV monitoring network (FHAP). Nest Key Basin has long been acknowledged to be an important area for water transport in Northeast Florida Bay. The only monitoring currently present is on the northwestern edge of the basin at Mud Creek (a USGS flow meter station). These are the only two basins in northeastern Florida Bay with no monitoring sites and both are likely to be impacted by CERP activities.

Nutrients in wetlands and loading from creeks: Nutrient assessment in the wetlands and major mangrove creeks within the C-111 SC Western project domain follows both the salinity mapping design described above (*FIGURE E-5*) and the transect design of the RECOVER Coastal Gradients project (as implemented by USGS). Project specific monitoring proposed here complements RECOVER/USGS measurements. Within the freshwater wetlands, nutrient status will documented via periphyton tissue nutrients (total phosphorus, total nitrogen), which provides a temporally integrated indication of nutrient status in the wetland. This metric has been adopted as a RECOVER Greater Everglades Module performance measure. Concurrent with salinity mapping of the wetlands via helicopter, periphyton samples will be taken from the freshwater and seasonally oligohaline marshes twice per year. Additionally, direct sampling of phosphorus and nitrogen in surface water will be performed at a small set of sites by auto-sampling of total nutrients (each sample pooled over three-day period) and grab sampling (monthly) for inorganic species. Nine sites are proposed (*FIGURE E-5)*, five in marshes and four on mangrove creeks flowing into Florida Bay. These creek sites have USGS flow-meters, such that nutrient loading can be calculated at these sites Snook Creek in northeastern Joe Bay; Trout Creek, the main outlet of Joe Bay and largest single source of freshwater to Florida Bay; McCormick Creek, the outlet of western Taylor Slough and Seven Palm Lake; and Alligator Creek, a potential outlet of western Taylor Slough and West Lake. The latter two creeks flow from lakes with higher nutrient concentrations than other wetlands or estuaries in the region. Note that other programs (USGS and FIU's LTER) measure nutrients for load calculation in central Taylor Slough (Taylor River) and at the eastern project boundary near US Highway 1 and Card Sound Road (Highway Creek, Manatee Creek, Card Sound Canal).

The five wetland sites are in the eastern project area, near C-111 Canal. Two sites are downstream of C-111 Canal and the Aerojet Canal (sites W1 and W3 in (*FIGURE E-5*), two sites are between the C-111 Canal and the C-111 SC Pilot Study canal, and one site is in the triangle area east of US Highway 1. Little baseline data are available near the three latter sites (north of C-111 Canal and the triangle area) and data will not be used to assess the C-111 SC Western project, but also provide a baseline for the second PIR. Note that these sampling sites are not only complementary of USGS Coastal Gradient hydrologic and salinity sites, but complementary of the FIU LTER mash sites in Taylor Slough (orange dots in (*FIGURE E-5).* The combination of sites will provide a basis for comparing ecological change associated with shifting water toward Taylor Slough.

Western Taylor Slough lakes hydrology and nutrient assessment: Little baseline information is available from this region, but grab sampling associated with a SAV monitoring project (by ENP) has found extremely high nutrient and chlorophyll concentrations from West Lake to Seven Palm Lake. The hydrologic connectivity of these lakes with Taylor Slough is not well established, but when the project shifts the distribution of regional water toward Taylor Slough, flow through these lakes may increase, potentially causing downstream water quality problems.

A baseline study of water and nutrient sources and export from this region, focusing on water flowing into Seven Palm Lake and West Lake and out of McCormick Creek and Alligator Creek is proposed. Creek flow is gauged by USGS at these two sites (and nutrient sampling in the creeks is described above). Lake measurements would include estimates of lake depth and water level to estimate water volume changes, local rainfall, and seepage measurements using tracers (likely SF6), concurrent with nutrient sampling. It is notable that the bottom of these lakes is mostly porous rock, so long-term changes in ground-water inputs and associated nutrients are possible. A preliminary baseline water and nutrient budget will be estimated from this effort to estimate project effects and particularly whether the project increases nutrient export to Florida Bay and if so whether this is a temporary "flushing" mechanism or a more long-term problem. Documenting water and nutrient sources in the lakes is a first step to provide this information.

E.4.4 Monitoring and Assessment Plan Component for Salinity and Water Quality Monitoring

Salinity and water quality monitoring described in the RECOVER MAP is predominantly funded by non-RECOVER resources. The only RECOVER funded project (also funded by USGS) is the USGS Coastal Gradients Project, which focuses on hydrology and salinity (stage, temperature, conductivity; freshwater discharge at nine mangrove creek stations; precipitation at three sites), but

measures nutrients (TKN and TP via auto-sampling) at Highway Creek adjacent to US Highway 1, Manatee Creek at the shoreline of the Triangle area, and Card Sound Canal (***FIGURE E-6***). There are two nested groundwater wells in lower Taylor Slough that measure water level, specific conductance, and temperature every 15 minutes. Integrating the MAP network with the existing USGS monitoring network provides information across several generalized coastal gradients or transects.

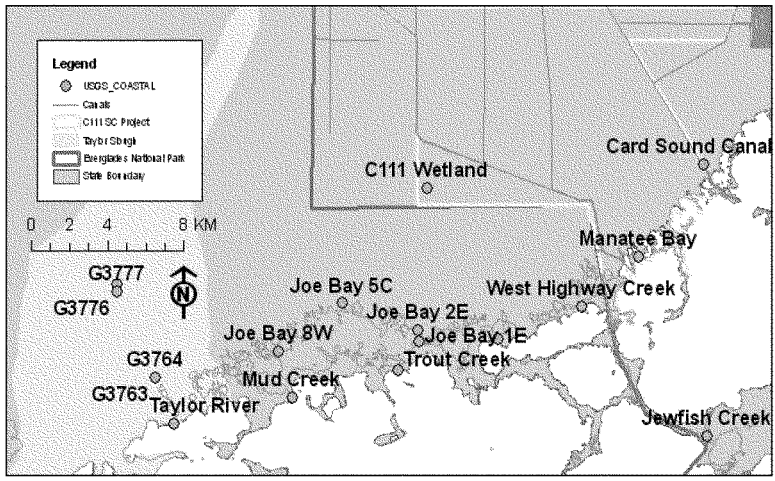


FIGURE E-6: U.S. GEOLOGICAL SURVEY SALINITY (OR SPECIFIC CONDUCTIVITY), HYDROLOGIC, OR NUTRIENT MONITORING STATIONS

Other projects described in the MAP, but not CERP funded include: the ENP Marine Monitoring Network, which measures near-continuous salinity and (for most stations) precipitation at fixed stations in Florida Bay (***FIGURE E-7***); a similar network in Biscayne Bay conducted by Biscayne National Park, but with both top and bottom water salinity measurements at fixed stations (***FIGURE E-8***); the SFWMD Coastal Water Quality monitoring network (formerly via a contract with FIU) (***FIGURE E-9***), NOAA bi-monthly fine-scale water quality mapping in Florida Bay; and Miami-Dade DERM water quality sampling in Biscayne Bay (partially SFWMD funded).

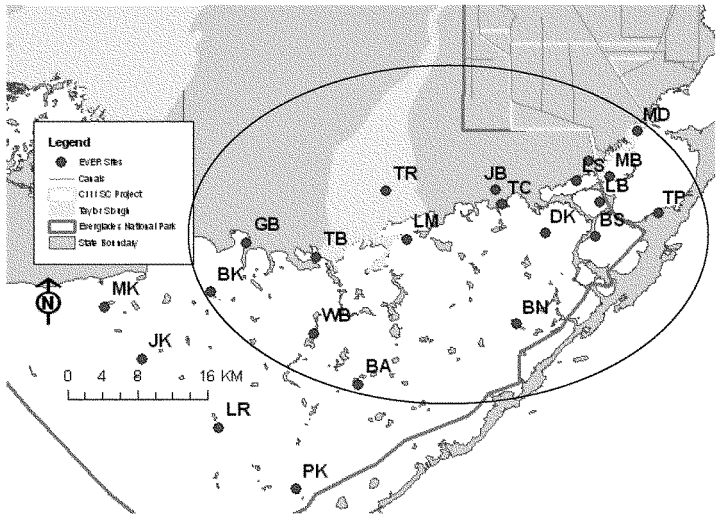


FIGURE E-7: CONTINUOUS SALINITY MONITORING SITES IN THE EVERGLADES NATIONAL PARK MARINE MONITORING NETWORK

Note: Stations most relevant to the C-111 SC are circled

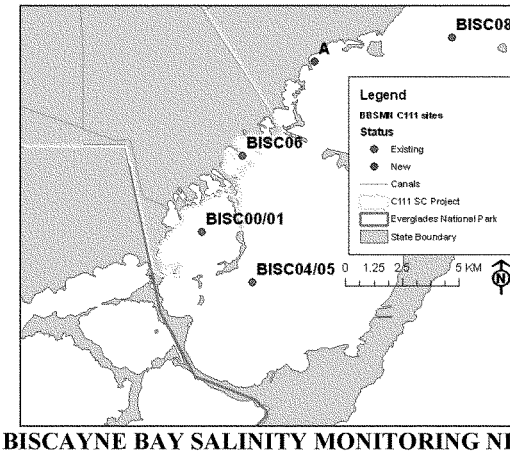


FIGURE E-8: BISCAYNE BAY SALINITY MONITORING NETWORK SITES LOCATED NEAR THE C-111 SC PROJECT

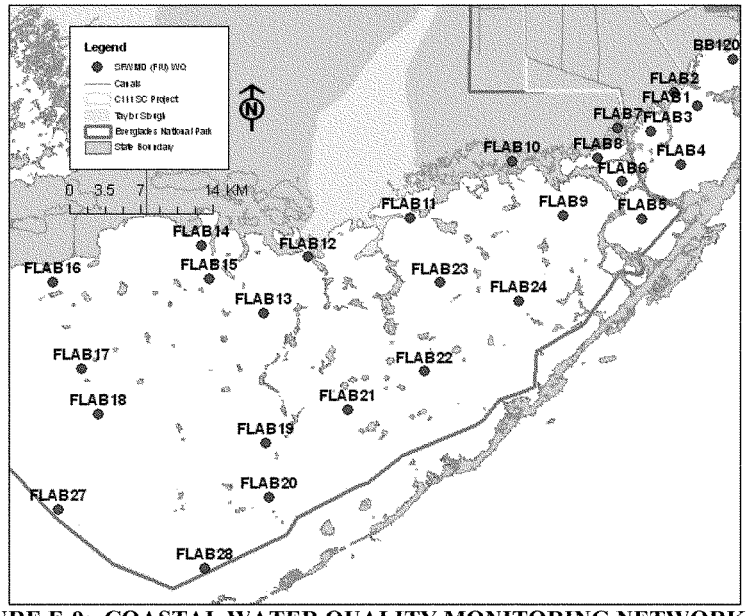


FIGURE E-9: COASTAL WATER QUALITY MONITORING NETWORK FOR CARD SOUND, BARNES SOUND, MANATEE BAY, AND FLORIDA BAY

Two other notable monitoring efforts are neither funded nor coordinated by RECOVER. The NSF funded Coastal Everglades–Long Term Ecological Research (FCE-LTER) program, operated by FIU and other universities and agencies, collects extensive data relevant to the C-111 SC project (***FIGURE E-5***, orange dots). Nutrient sampling at two USGS flow meter sites along Taylor River is of primary importance. The ENP funded (contract to FIU through 2008) SAV and Physiochemical Monitoring in the Florida Bay Mangrove Zone measures salinity and monthly chlorophyll a and nutrients (total phosphorus and total nitrogen) in grab samples associated with SAV surveys in the ENP lakes (***FIGURE E-10***). This effort complements the proposed project-level lakes hydrology and nutrient assessment described above.

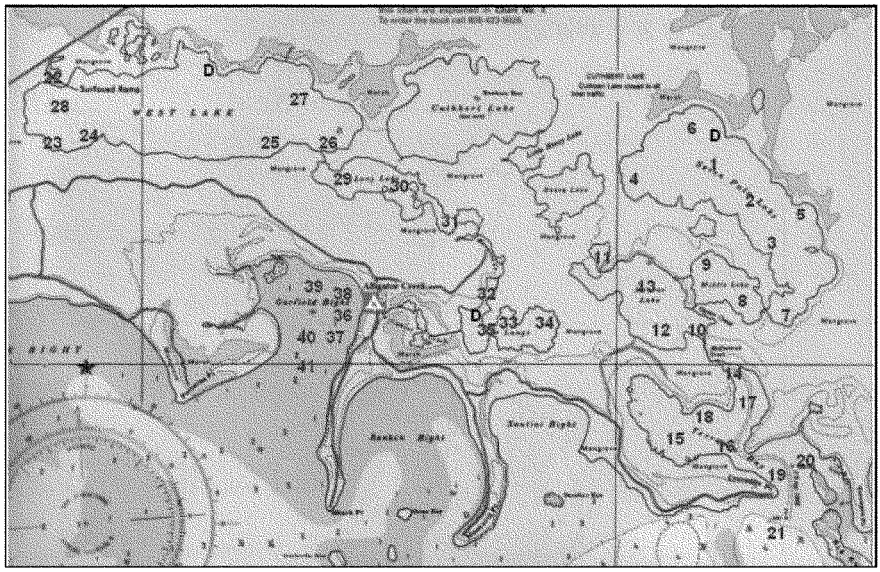


FIGURE E-10: SITE MAP-EVERGLADES NATIONAL PARK SUBMERGED AQUATIC VEGETATION MONITORING IN THE LAKES REGION

(With benthic macrophyte and monthly water quality sites enumerated in red)

*"D" designates continuous salinity, water level, and temperature monitoring sites.

E.4.5 Comparison between Preferred Project-Level Monitoring and the Monitoring and Assessment Plan for Salinity and Water Quality Monitoring

Proposed project-level monitoring called for here is complementary of the RECOVER/USGS Coastal Gradients project, using the RECOVER transect design. Project-level monitoring will provide finer scale salinity maps (surface and porewater) throughout the saline wetlands, necessary to document changes in the salinity transition zone. Also provided will be nutrient data at sites that follow the USGS transects but are further inland, in freshwater marshes closer to the C-111 Canal, and collect nutrient data at mangrove creek sites in Joe Bay (currently the largest source of freshwater for Florida Bay) and further west, where nutrient concentrations are much higher than at eastern sites. Proposed project-level monitoring is complementary of other non-RECOVER funded efforts that are described in the RECOVER MAP. The project will rely heavily on these efforts (notably the ENP Marine Monitoring Network and SFWMD Coastal Water Quality Monitoring Network) to assess project effects.

E.4.6 Data Management Quality Assurance/Quality Control for Salinity Monitoring

E.4.6.1 Data management

See *SECTION E.2.3.5.1*

E.4.6.2 Quality Assurance/Quality Control for Monitoring

QA/QC for monitoring in the C-111 SC Western project should conform to the guidance and protocols provided in the CERP Quality Assurance Systems Requirements (QASR) Manual (http://www.evergladesplan.org/pm/program_docs/qasr.cfm; RECOVER 2004b). Chapter 3 (Water Quality Field Sampling) is especially relevant to collecting salinity data. Special considerations for QA/QC for laboratory, field and data management operations are necessary. A valuable reference for salinity data QA/QC is the annual report from Biscayne National Park to the U.S. Army Corps of Engineers (NPS 2006).

E.4.7 Cost Estimates for Salinity and Water Quality Monitoring

TABLE E-3: COST ESTIMATES FOR SALINITY AND WATER QULALITY MONITORING

	Estimated Project Cost
Year 1	$200,000
Years 1-5	$550,000

E.5 VEGETATION REPONSES

E.5.1 Justification and Relevance to the C-111 SC Western Project

Emergent vegetation in the Everglades and coastal marshes, and SAV in coastal ponds, lakes, and estuaries constitutes the primary habitat for fauna within the project area. The project's modification of hydropattern and salinity are expected to lead to ecological change toward RECOVER restoration goals and this change will largely occur via changes in plant community structure and cover, which are primary RECOVER performance measures.

Within the wetlands, major vegetation changes have occurred in the C-111 SC project area over the past century in response to hydrologic changes. These hydrologic changes include significant modifications to the hydropatterns and salinity regime in the coastal wetlands-both are major drivers of vegetation communities in the coastal wetlands of south Florida. Historically, in addition to Taylor Slough, shorter hydroperiod freshwater marl marsh extended eastward

across most of project area and were bounded on the south with a narrow band of mangroves at the shoreline of Florida Bay. As a result of increased salinity in the wetlands along the coast, mangrove communities migrated inland, displacing the freshwater marl marsh community. This displacement of coastal communities has occurred at a rate ranging from 3-30 meters per year over the last several decades (Ross et al., 2000; Gaiser et al., 2006a). Presently, mangrove forest, including extensive spatial coverage of dwarf mangroves, extends well inland from the shoreline. Marl marshes, dominated by periphyton mats, have generally transitioned into a mixture of shrub and forested wetlands, sometimes with an understory of sawgrass or cattails (*Typha domingensis*). Non-native trees, particularly Brazilian pepper and Australian pine (*Casuarina equisetifolia*), are prevalent in these areas as a result of physical disturbance or hydrologic isolation.

Seagrasses are the dominant biological community in Florida Bay. SAV serves several important ecosystem functions. These benthic plants serve as a highly productive base of the food web both through direct consumption and through detrital production. They also provide vital habitat that supports critical life stages of a variety of ecologically important and commercially or recreationally valuable species. SAV stabilizes the sediment reducing re-suspension and provides a strong nutrient sink for nitrogen and phosphorus in the water column, reducing algae blooms and increasing water clarity.

Distribution of seagrass species is generally related to water clarity and quality, substrate, salinity levels and salinity variability. Currently, Thalassia testudinum is the dominant species in northeastern Florida Bay and southern Biscayne Bay, where salinity is in the 20-40 psu range and nutrient levels are low. Ruppia maritima and the macroalgae Chara spp. are dominant in the coastal ponds and the lower salinity embayments such as Long Sound and Joe Bay. Although R. maritima is tolerant of a wide range of salinity (Koch et al., 2007), it has been observed to thrive only in areas of persistent, low salinity regimes (likely because of salinity effects on reproduction) and has, therefore, been used as an indicator of a low salinity, estuarine condition (Hunt et al., 2006).

The distribution and abundance of seagrass species and other benthic flora and fauna in the project of Florida Bay is expected to be influenced by changes in hydrology resulting from hydrologic restoration. The premise of the C-111 SC project and CERP is that restoring hydrology will improve the overall health of the various ecological communities in the estuary. Progress toward restored natural hydropatterns and salinity in the C-111 SC project area per the project objectives include: 1) reduction of the intensity, frequency, and duration of hypersaline events, 2) an increase in the frequency and duration of brackish (estuarine) conditions in coastal embayments and nearshore areas; and

3) elimination of harmful, suddenly released fresh water into the coastal zone. Changing distribution of freshwater in the project area should affect SAV through changes in species distribution and relative abundance in the species composition in coastal ponds, lakes, embayments, and the northeastern and central parts of Florida Bay.

Seagrasses act as indicator species for estuarine conditions, since they provide direct links to the stressors on the system (Rudnick et al., 2005). The ecological premise behind the monitoring of seagrasses for the project is that through the more diffused and prolonged delivery of freshwater to the bay (i.e., more similar to conditions that existed prior to upstream water management), a more stable estuarine salinity gradient, with fewer and less extreme variations, will be restored in the coastal environments of Florida Bay. Such conditions may provide a broader coverage of a more diverse seagrass community. Macroalgae are present in this area and can be important components of the SAV community, especially in areas not conducive to seagrass development (e.g. due to inappropriate substrate type) such as several of the coastal ponds and embayments. Macroalgae tend to respond more rapidly to changing water clarity and quality causing high variability in the data and less reliability as an ecological indicator. However, consistently increasing trends in macroalgal cover in areas where seagrasses typically dominate can warn of deteriorating water quality before detectable declines in seagrasses occur.

E.5.2 Project-Level Component for Vegetation

Limited project-level wetland vegetation monitoring is proposed, with sampling along transects in the eastern portion of the project domain, including both saline coastal marshes and freshwater marshes (***FIGURE E-5,*** green squares). For each site, plant community composition, biomass, and productivity will be measured annually in at least nine plots. A similar set of measurements is being made in Taylor Slough as part of FIU's LTER program, enabling assessment of the effects of changing water distribution across the project area. Stations W1 and W3 below C-111 Canal and LTER stations in Taylor Slough have a seven- to ten-year period record, while other project-level stations have a one to three year record.

Project-level SAV monitoring will be limited to measurements of cover and species composition in ponds and creeks of the saline wetland of Taylor Slough and the eastern project area, as a component of Audubon's prey base (fish) monitoring in the salinity transition zone. Changes in SAV (along with hydrology and salinity) are needed to understand causes of prey base change. SAV monitoring is proposed at four Audubon sites that currently lack such sampling (***FIGURE E-11***). Because of relatively rapid salinity and SAV changes in this region, sampling is every six weeks. Additional SAV and vegetation

monitoring data needed for the C-111 SC project will be provided by RECOVER and other organizations (see below).

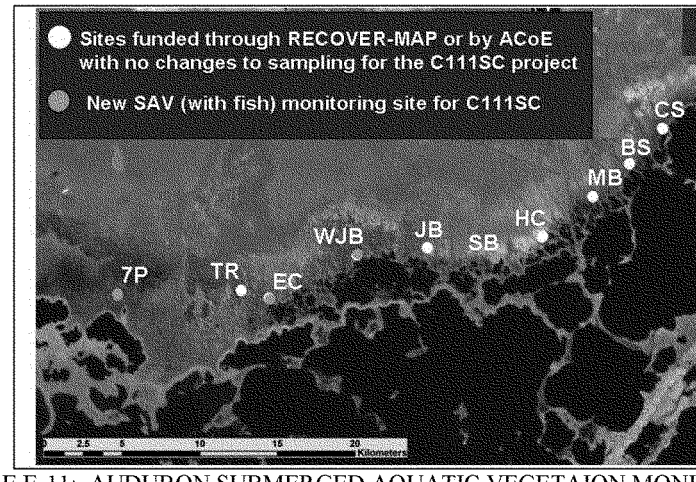


FIGURE E-11: AUDUBON SUBMERGED AQUATIC VEGETAION MONITORING TRANSECTS: PROPOSED PROJECT-LEVEL SITES
(Co-located with fish sampling)

E.5.3 Monitoring and Assessment Plan Component for Wetland Vegetation and Submerged Aquatic Vegetation

An objective of the MAP vegetation monitoring is to produce a spatially and thematically accurate vegetation map of the Everglades ecosystem. Vegetation mapping will monitor the spatial extent, pattern, and proportion of plant communities within major landscape regions of the Greater Everglades Wetlands. Mapping is done by classification from aerial photographs combined with ground-truth sampling (over approximately five year intervals). The MAP requires areas to be mapped have been divided into general zones (***FIGURE E-12***). Specific landscape changes to be monitored in the MAP that pertain to the C-111 SC project area (sector 1 in ***FIGURE E-12***) include: (1) changes in the distribution and configuration of tidal creeks, salt marshes, and mangrove forests, and (2) changes in the extent and distribution of exotic plant communities.

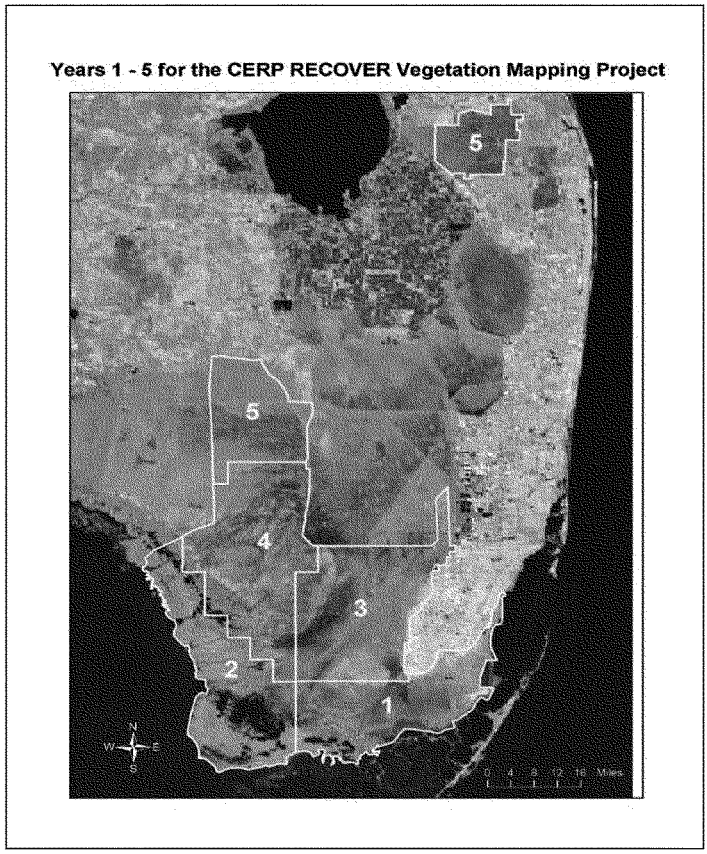


FIGURE E-12: MONITORING AND ASSESSMENT PLAN SHOWING SPATIAL EXTENT OF THE RECOVER MONITORING AND ASSESSMENT PLAN VEGETATION MAPPING

Extensive SAV monitoring in Florida Bay and Biscayne (South Florida Fish Habitat Assessment Program, FHAP) is currently supported by RECOVER. FHAP uses visual methods to estimate benthic macrophyte cover, and coring to estimate seagrass shoot densities and biomass. FHAP quantifies spatial and temporal changes in macrophyte communities through the production of distribution and abundance maps, change maps, and summary graphics and tabular products to support seagrass, landscape, and higher-trophic-level models. FHAP quantifies benthic cover annually in 20 sampling basins (30 random sites per basin with eight replicates per site) extending from Lostman's River to central Biscayne Bay.

Of their 20 site locations, 16 are within the project area for the C-111 SC project (***FIGURE E-13***). This SAV monitoring is coupled with the fish and invertebrate monitoring (FIAN) described in ***E.3.3 Estuarine Fish and Invertebrate Monitoring***. FHAP has samples at 15 transects (all within the project area) twice a year using more intensive methods to quantify seagrass shoot densities and biomass as well as benthic cover. This program is scheduled to be renewed in FY2009.

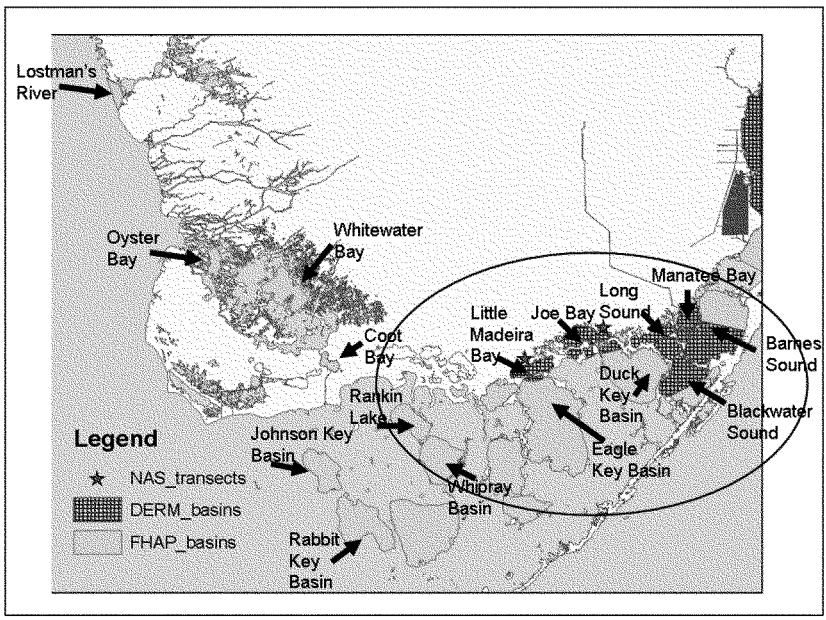


FIGURE E-13: RECOVER FUNDED SAV MONITORING AREAS (FHAP), ALONG WITH COMPLEMENTARY MIAMI-DADE DERM AREAS

Note: Basins most relevant to the C-111 SC are circled.

E.5.4 Other Ongoing Monitoring of Wetland Vegetation and Submerged Aquatic Vegetation

The Miami-Dade Department of Environmental Resource Management (DERM), through a contract with the SFWMD, monitors benthic communities downstream of the C-111 Canal/Taylor Slough watershed (***FIGURE E-13***). Their study area includes northeast Florida Bay, from Little Madeira Bay eastward to US Highway 1 as well as Manatee Bay, Barnes Sound, and the main body of Biscayne Bay. In Florida Bay, Manatee Bay, and Barnes Sound, DERM estimates benthic cover quarterly within their sampling basins (4 or 12 sites

within each basin depending on basin size and four replicates per site) and monitors their fixed sites twice a year for benthic cover, seagrass shoot density, and biomass. In Biscayne Bay, both the random sampling and the fixed sites are monitored annually. This study will be continued until June 2010.

SAV is monitored in the coastal lakes region of Florida Bay by ENP, in cooperation with Florida International University (Dr. James Fourqurean and Dr. Thomas Frankovich). The study area (***FIGURE E-10***) includes two adjacent lake systems or freshwater flows paths that drain into the bay: 1) Seven Palms Lake, Middle Lake, Monroe Lake, and Terrapin Bay, and 2) West Lake, Long Lake, The Lungs, and Garfield Bight. SAV species composition and abundance (percent cover) are measured at each site quarterly, along with water chemistry (i.e. nutrients). This study is funded through 2008.

Transects through eastern coastal ponds and creeks are being monitored by Audubon of Florida's Tavernier Science Center with funding from the Army Corps of Engineers. Currently, benthic macrophyte cover is estimated every six weeks along six transects which start in the coastal/mangrove ponds and end in the coastal embayments (***FIGURE E-15***). Current transects are Card Sound, Barnes Sound, Manatee Bay, Highway, Joe Bay, and Taylor River. This SAV sampling is coupled with Audubon's fish sampling described in ***E.3.3 Estuarine Fish Monitoring***.

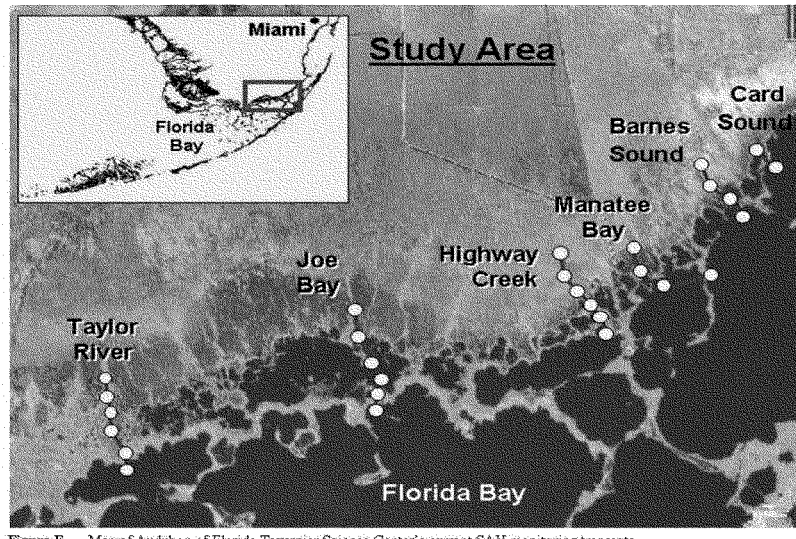


Figure E - . Map of Audubon of Florida Tavernier Science Center's current SAV monitoring transects (map provided by P. Frezza of Audubon).

FIGURE E-14: CURRENT AUDUBON SUBMERGED AQUATIC VEGETATION MONITORING TRANSECTS

E.5.5 Other Wetland Monitoring Projects

Systematic vegetation monitoring in Taylor Slough was initiated in 1978 by ENP. At present, the vegetation community in six transect-plot sites are being monitored (***FIGURE E-15***) in Taylor Slough. Metrics include total vegetation cover, species composition, and percent cover (alive and dead) for each species identified. This is an ongoing project that seeks to conduct surveys every three years, depending on funding availability. The last set of observations for the transects was in 2006-2007 (Hoffman et al., 2008). This long-term study provides baseline information that could be used to determine project effects on marl prairie and slough vegetation if it were continued after construction of the project. Data from transects 1, 2, 3, and 6 provide particularly useful baseline information on the wetland vegetation community in the vicinity of the C-111 SC Western project.

Another project that is relevant to vegetation monitoring in the C-111 SC project area was initiated in 2003 in an effort to evaluate the potential effects of hydrologic restoration on the habitat of the CSSS (Ross et al.; 2003, 2004, 2006). The project includes detailed vegetation analyses and monitoring at sites that are in eastern Taylor Slough where effects of the C-111 SC project may affect

vegetation (***FIGURE E-15***). Vegetation metrics include identification, cover estimates, and biomass. The transect and census plots were established for all sub-populations of the sparrow; for the purposes of this project, existing sites for sub-population F, C, and D would be most relevant to the project. This project will conclude in 2009 and provides additional baseline marl prairie and CSSS habitat information. Similar surveys conducted after project operation in the areas used by sub-populations C and D (***FIGURE E-16***) would provide the basis for determining project effects on marl prairie vegetation and CSSS habitat adjacent to the C-111 SC Western project.

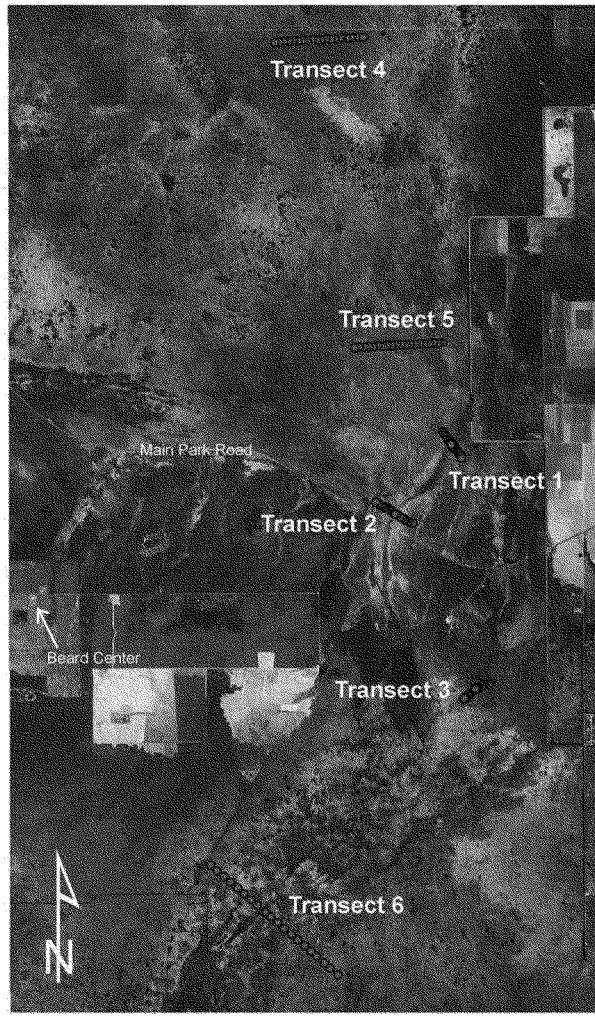


FIGURE E-15: LOCATIONS OF TRANSECTS AND PLOTS FOR VEGETATION MONITORING IN TAYLOR SLOUGH BY EVERGLADES NATIONAL PARK

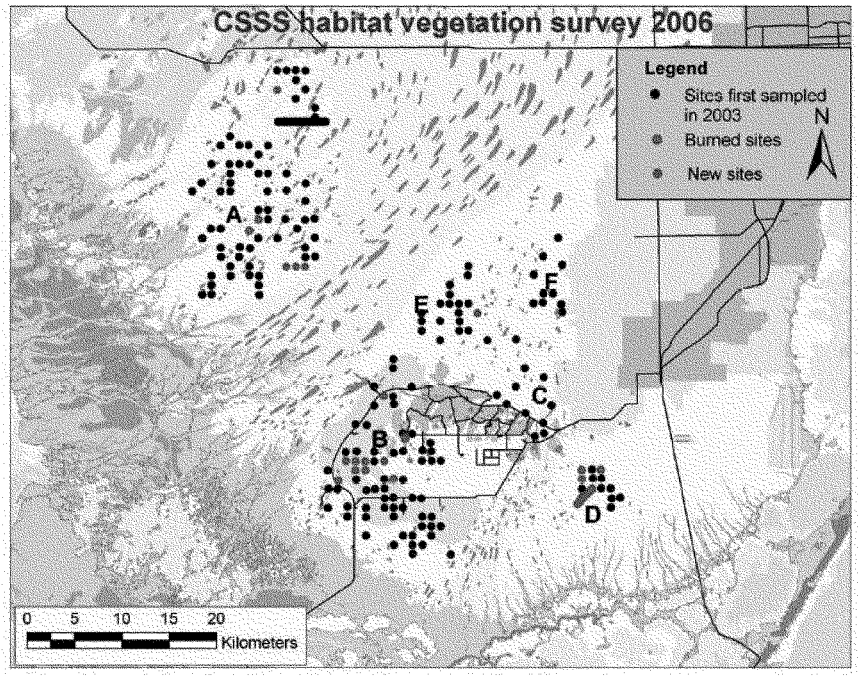


FIGURE E-16: LOCATION OF MONITORING SITES WITHIN THE CAPE SABLE SEASIDE SPARROW HABITAT SAMPLED IN 2006

E.5.6 Comparison between Project-Level Monitoring and the Monitoring and Assessment Plan Monitoring for Wetland Vegetation and Submerged and Aquatic Vegetation

The C-111 SC Western project will be highly dependent on implementation of MAP vegetation mapping, with appropriate ground-truth data collection (likely including assessment along transects as described in the MAP). This mapping assessment should include all of Sector 1 (***FIGURE E-12***) in order to provide information for both this C-111 SC Western PIR and a more easterly baseline (Model Lands) for the second PIR. Project-level emergent vegetation assessment complements the RECOVER assessment by providing time-series at a set of sites, mostly along a transect near the C-111 Canal (complemented by FIU-LTER sites along a Taylor Slough transect).

SAV cover and species composition are monitored in most of the project area of interest by MAP or other existing SAV programs. FHAP, with an annual time-step, provides a basis for documenting the long-term benefits of the project. Nearshore SAV monitoring by DERM and inshore SAV monitoring by the

Audubon, while not RECOVER funded, provide vital and rapid information for the C-111 SC Western project. The limited project-level SAV sampling proposed here will augment the Audubon network at four sites where fish data are collected and that are vital to this first phase of the project.

It is notable that inshore SAV monitoring, in western Taylor Slough coastal lakes, is scheduled to end in 2008; if ENP funding is not renewed, there will be a gap in SAV monitoring in the lakes region and the mangrove transition zone.

E.5.7 Data Management Quality Assurance/Quality Control for Submerged Aquatic Vegetation

E.5.7.1 Data Management

See ***SECTION E.2.3.5.1***

E.5.7.2 Quality Assurance/Quality Control for Wetland Vegetation and Submerged Aquatic Vegetation Monitoring

QA/QC for wetland vegetation monitoring in the C-111 SC Western project should conform to the guidance and protocols provided in the CERP QASR Manual (http://www.evergladesplan.org/pm/program_docs/qasr.cfm; RECOVER 2004b). Appendix K in the document provides methods, references, and reporting units for conducting monitoring of various wetland vegetation parameters and SAV. Some of the parameters provided in Appendix K that may be relevant to the proposed project-level monitoring include percent cover of herbaceous vegetation, stand density, tree diameter, plant community cover, wetlands vegetation mapping, canopy cover, leaf area index, SAV growth, production, biomass, coverage via fixed transects; and SAV distribution and abundance using the BBCA method.

E.5.8 Monitoring Cost Estimates for Wetland Vegetation and Submerged Aquatic Vegetation Monitoring

TABLE E-4: COST ESTIMATES FOR WETLAND VEGETATION AND SUBMERGED AQUATIC VEGETATION MONITORING

	Estimated Project Cost
Year 1	$22,000
Years 1-5	$110,000

E.6 FAUNA

E.6.1 Freshwater Wetland Prey Base Monitoring

E.6.1.1 Justification and Relevance to the C-111 Spreader Canal Western Project

The loss of wading bird populations across the southern Everglades has been attributed to a reduction in numbers and changes to patterns of distribution and seasonal concentration of wetland prey base fish and invertebrates. Small marsh fish and invertebrates (particularly crayfish) are also important to the diets of other higher vertebrates, such as alligators and a variety of longer-lived fish species (such as largemouth bass). Hydrology has a marked effect on the abundance, distribution, and availability of these prey base organisms in Everglades wetlands. Drydown events act as disturbances that negatively impact small fishes whose survival is dependent on finding limited refuge areas that are inundated (Loftus and Eklund, 1994; Nelson and Loftus, 1996). While water level recession occurs naturally each dry season, the duration and spatial extent of these events have increased across ENP, including in the wet season. There is a positive association between prey fish density and long-term average hydroperiod in ENP (Trexler et al, 2005). Moreover, the availability of these prey base organisms to wading birds and other terrestrial predators is dependent on the degree to which drydown can proceed in a natural manner, aimed at avoiding increases to water levels from water management activities during the dry season. Restoring natural hydroperiods in the southern Everglades wetlands should increase the number of high-quality foraging areas for wading bird populations when they nest in the dry season (Gawlik, 2002).

Redistribution of freshwater inflow from the C-111 SC Western project is expected to re-establish a more natural hydropattern in the southern Everglades marshes. These hydrologic changes are anticipated to increase the diversity and abundance of wetland prey base fish and invertebrates. An increase in the biomass and community composition of these intermediate-level consumers are factors that influence the success of indicator species that comprise the biological performance measures currently defined for CERP by RECOVER. These performance measures include those found in the Greater Everglades Performance Measures group:

- Wetland Trophic Relationships–Regional Populations of Fishes, Crayfishes, Grass Shrimp and Amphibians (RECOVER, 2006a)
- Wetland Trophic Relationships–Wading Bird Foraging Patterns on Overdrained Wetlands (RECOVER, 2006b)
- Wetland Trophic Relationships–Wading Bird Nesting Patterns (RECOVER, 2006c)
- Roseate Spoonbill Nesting Patterns (RECOVER, 2006d)

- Wetland Trophic Relationships–American Alligator Distribution, Size, Nesting and Condition (RECOVER, 2006e)

E.6.1.2 Project-Level Component for Freshwater Wetland Prey Base Monitoring

No project-level monitoring is proposed here. See RECOVER section below for description of relevant monitoring.

E.6.1.3 Monitoring and Assessment Plan Component for Freshwater Wetland Prey Base Monitoring

RECOVER partially funds monitoring of the regional population densities and distributions of marsh fishes and associated aquatic invertebrates using a probabilistic stratified random sampling design. Areas within the C-111 SC Western project footprint are subdivided into landscape units (landscape subregions) that represent distinct landscape patterns and/or management units. Within each subregion, replicate tessellated hexagonal cells are randomly selected for sampling with one meter square throw traps (Jordan et al., 1997; Chick et al., 1992; Kushlan, 1981). Throw trap samples are collected from the randomly selected sites within areas of sparse emergent macrophytes that are delineated for each cell. Parameters measured from throw trap samples include the density, species composition, and size class distribution of fishes and associated fauna.

Throw trap samples are collected annually during the late wet season (September-November) to provide an estimate of the net production of marsh fishes and other fauna at the end of the wet season. This represents the prey base that is available for concentration and wading bird consumption as water levels recede during the dry season. Wetland prey concentrations during the dry season are sampled from randomly selected cells in a subset of the landscape units where wet season prey base populations are monitored. These monitoring efforts are conducted by researchers from both FIU (Trexler lab) and FAU (Gawlik lab) in areas relevant to the C-111 SC Western project.

E.6.1.4 Comparison between Project-Level Monitoring and the Monitoring and Assessment Plan for Freshwater Wetland Prey Base Monitoring

Presently, the MAP provides partial funding for aquatic prey base monitoring in the C-111 SC Western project area.

E.6.1.5 Data Management/Quality Assurance Quality Control for Freshwater Wetland Prey Base Monitoring

Because MAP monitors aquatic fish and invertebrates in the C-111 SC Western project area, monitoring for these species of special concern will rely on this MAP

component. Detailed descriptions of this monitoring can be found under MAP Activity Number 3.1.3.10 and 3.1.3.11 in the Greater Everglades Module of the MAP.

E.6.1.6 Data Management

See *SECTION E.2.3.5.1*

E.6.1.6.1 Quality Assurance/Quality Control for Freshwater Wetland Prey Base Monitoring

QA/QC for aquatic prey base monitoring in the C-111 SC Western project should conform to the guidance and protocols provided in the CERP QASR Manual (http://www.evergladesplan.org/pm/program_docs/qasr.cfm; RECOVER, 2006i).

E.6.1.7 Cost Estimates for Freshwater Wetland Prey Base Monitoring

TABLE E-5: COST ESTIMATES FOR FRESHWATER WETLAND PREY BASE MONITORING

	Estimated Project Cost
Year 1	$37,000 (MAP Co-Funded)
Years 1-5	$185,000 (MAP Co-Funded)

E.6.2 Saline Wetland Prey Base Monitoring

E.6.2.1 Justification and Relevance to the C-111 Spreader Canal Western Project

The salinity transition zone, along the coastal shoreline that will by strongly affected by C-111 SC Western project modification of freshwater flow, hydropattern, and salinity, is a region that was highly productive, providing a major prey base for Everglades wading bird populations. An expectation of the C-111 SC Western project is that it will improve conditions such that this prey base increases and wading birds (particularly Roseate Spoonbills) benefit. In addition, many fish are the prey base for larger fish (including sport fish), alligators, and crocodiles. Like SAV, small prey-base fishes are appropriate ecological indicators because with quick growth and generation times, they are able to demonstrate a response to hydrologic and habitat conditions in a timeframe appropriate for water management.

Redistribution of freshwater inflow from the C-111 SC project is expected to re-establish a positive salinity gradient along a greater portion of the shoreline and to re-establish estuarine conditions in northeastern Florida Bay. These hydrologic changes are expected to increase the diversity, abundance, and biomass of fish in the ponds, creeks and flats of the salinity transition zone.

Such a response is described in biological performance measures currently defined for CERP by RECOVER. These performance measures include those found in the Greater Everglades Performance Measures group:

- Wetland Trophic Relationships–Regional Populations of Fishes, Crayfishes, Grass Shrimp and Amphibians (RECOVER 2006a)
- Wetland; and Trophic Relationships–Wading Bird Foraging Patterns on Overdrained Wetlands (RECOVER 2006b)
- Wetland Trophic Relationships–Wading Bird Nesting Patterns (RECOVER 2006c)
- Roseate Spoonbill Nesting Patterns (RECOVER 2006d)
- American Crocodile–Juvenile Growth and Survival (RECOVER 2006e)

In addition, invertebrate biomass and community composition is directly related to a performance measure found in the Southern Estuaries Performance Measures group:

- Southern Estuaries Juvenile Pink Shrimp and Associated Epifauna (RECOVER 2004f)

E.6.2.2 Project-Level Component for Saline Wetland Prey Base Monitoring

A network of prey base sampling in the ponds, creeks, and saline marshes near the shoreline of Florida Bay, Manatee Bay, Barnes Sound, and Card Sound is monitored by Audubon of Florida. Project-level funding is proposed here to: 1) improve the spatial coverage of this network such that it encompasses the broad east-west domain of the C-111 SC project; 2) provides data along north-south salinity transects of eastern Joe Bay and Taylor River (following the main Coastal Gradients design of this Monitoring Plan, and benefits from other sampling along these same transects); and 3) adds missing sampling parameters (hydrologic, SAV, fish) such that the sampling matrix of each site with fish sampling is complete. The current network is funded by RECOVER MAP (see below) and the USACE in support of the Modified Water Deliveries Project. Project-level additions to this network are shown in ***FIGURE E-17***, with new fish sampling at six stations: above western Long Sound (station SB), down-stream eastern Joe Bay (DS-JB), upper western Joe Bay (WJB), upper East Creek north of Little Madiera Bay (EC), down-stream Taylor River (DS-TR), and at the southern boundary of the Craighead Basin (western Taylor Slough) above Seven Palm Lake (7P).

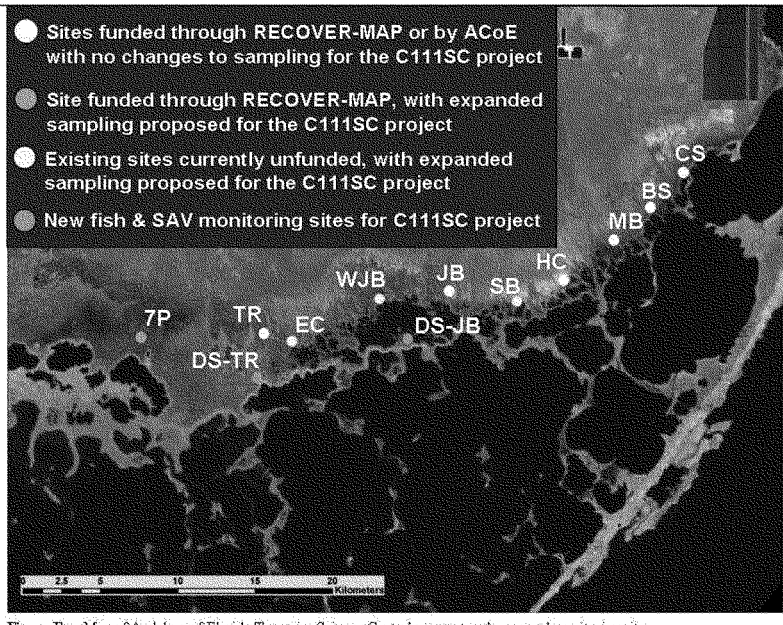


Figure E-. Map of Audubon of Florida Tavernier Science Center's current and proposed monitoring sites.

FIGURE E-17: AUDUBON OF FLORIDA TAVERNIER SCIENCE CENTER'S CURRENT AND PROPOSED MONITORING SITES

E.6.2.3 Monitoring and Assessment Plan Component for Saline Wetland Prey Base Monitoring

Audubon of Florida's Tavernier Science Center has an integrative monitoring network in the mangrove transition zone north of Florida Bay that is well-poised to examine effects from the C-111 SC project (***FIGURE E-17***). Hydrologic data (salinity, water level, water temperature, and dissolved oxygen) are collected on continuous basis at the most upstream sites, co-located with stations at which demersal prey-base fishes have been sampled since the late-1980s. In addition, SAV communities have been surveyed by the Audubon Society across these areas, along upstream-downstream transects to encompass salinity gradients (described in Section E.2.5 above). Fish samples are taken eight times per year, focused on the dry season period (November–April) during which receding water levels act to concentrate small fishes, making them more available for predators such as wading birds. Samples are taken in both coastal creek and wetland flat habitats using 9 m2 drop traps (methods described in Lorenz, 1999; Lorenz and

Serafy, 2006). The MAP supports a portion of the fish sampling effort (with other projects, discussed below, that provide funds for other parameters and stations). Collected data are summarized and analyzed to (1) quantify the biomass and composition of the fish prey base, (2) establish year-to-year trends, and (3) determine abundance and distribution of fish that comprise the prey base in relation to environmental variables, especially water level (which determines available habitat, especially in peripheral flats), and salinity. This project addresses the CERP premise that changes in salinity and water level will lead to increases in the relative and absolute abundance of estuarine fish in the mangrove transition zone.

E.6.2.3.1 Comparison between Project-Level Monitoring and the Monitoring and Assessment Plan for Saline Wetland Prey Base Monitoring

Project-level monitoring proposed here provides complementary data to MAP and Mod Waters funded components of the Audubon network. This network expansion will ensure sufficient spatial coverage, characterization of the prey base response in areas with different salinity regimes, and full supporting hydrologic and SAV data sets (filling current data gaps) to assess causes of prey base change and provide a basis for future modeling.

E.6.2.4 Data Management Quality Assurance/Quality Control for Saline Wetland Prey Base Monitoring

E.6.2.4.1 Data Management

See *SECTION E.2.3.5.1*

E.6.2.4.2 Quality Assurance/Quality Control for Saline Wetland Prey Base Monitoring

QA/QC for wetland fish monitoring in the C-111 SC project should conform to the guidance and protocols provided in the CERP QASR Manual (http://www.evergladesplan.org/pm/program_docs/qasr.cfm; RECOVER, 2004b). Appendix L in the document provides methods, references, and reporting units for conducting monitoring of fish. Some of the parameters provided in Appendix L that may be relevant to the proposed project-level monitoring include the use of dip nets, artificial substrate, cores, dredges, funnel nets, vertical tows with plankton nets, and throw trapping.

E.6.2.5 Estimated Monitoring Cost for Saline Wetland Prey Base Monitoring

TABLE E-6: COST ESTIMATES FOR SALINE WETLAND PREY BASE MONITORING

	Estimated Project Cost
Year 1	$138,000
Years 1-5	$500,000

E.6.3 Estuarine Fish and Invertebrate Monitoring

E.6.3.1 Justification and Relevance to the C-111 Spreader Canal Western Project

The faunal assemblages of Florida Bay are largely made up of fish and invertebrates that depend on both estuarine and marine habitats. An increase in the diversity and abundance of the estuarine component of this assemblage (i.e., the euryhaline fauna) and a decrease in abundance of the purely marine forms would indicate progress toward the desired estuarine conditions in nearshore Florida Bay within the project area. As components of the nearshore food web, estuarine fish and invertebrate species support the diet of recreationally and commercially important species that spend all or a part of their life in the bay, especially in juvenile stages. In addition, many fish are the prey base for wading birds, alligators, and other higher consumers. Like SAV, small prey-base fishes are appropriate ecological indicators because with quick growth and generation times, they are able to demonstrate a response to hydrologic and habitat conditions in a timeframe appropriate for water management.

Redistribution of freshwater inflow from the C-111 SC project is expected to re-establish a positive salinity gradient along a greater portion of the shoreline and to re-establish estuarine conditions in northeastern Florida Bay. These hydrologic changes are expected to increase the diversity and abundance of estuarine fish and invertebrates in shallow nearshore waters. An increase in the biomass and community composition of estuarine fishes are factors that influence the success of indicator species that comprise the biological performance measures currently defined for CERP by RECOVER. These performance measures include those found in the Greater Everglades Performance Measures group:

- Wetland Trophic Relationships–Regional Populations of Fishes, Crayfishes, Grass Shrimp and Amphibians (RECOVER, 2006a)
- Wetland; and Trophic Relationships–Wading Bird Foraging Patterns on Overdrained Wetlands (RECOVER, 2006b)

- Wetland Trophic Relationships–Wading Bird Nesting Patterns (RECOVER, 2006c)
- Roseate Spoonbill Nesting Patterns (RECOVER, 2006d)
- American Crocodile–Juvenile Growth and Survival (RECOVER, 2006e)

In addition, invertebrate biomass and community composition is directly related to a performance measure found in the Southern Estuaries Performance Measures group:

- Southern Estuaries Juvenile Pink Shrimp and Associated Epifauna (RECOVER, 2004f)

Another RECOVER performance measure, Southern Estuary Module–Fish (RECOVER 2007) addresses fish in Florida Bay. This performance measure documents the importance of mangrove fish and juvenile spotted seatrout (Cynoscion nebulosus) as important indicators of ecosystem health within the C-111 SC project area of interest in Florida Bay. Both depend on estuarine conditions, particularly juvenile seatrout, which serves to represent the many species of game and non-game fish that depend on stable estuarine conditions for nursery habitat.

A common theme in ecological hypotheses that have been posed by RECOVER for recovery of upper trophic level indicator species is the recovery of prey densities that is anticipated to occur with restoration of a more natural hydrologic pattern. Estuarine fishes, an important part of the prey base, are therefore important indicators of restoration.

E.6.3.2 Project-Level Component for Estuarine Fish and Invertebrate Monitoring

No project-level monitoring is proposed here. See RECOVER section below for description of relevant monitoring.

E.6.3.3 Monitoring and Assessment Plan Components for Estuarine Fish and Invertebrate Monitoring

The MAP is funding a project in Florida Bay called the "Fish and Invertebrate Assessment Network (FIAN)", which is employing throw-trap gear in habitats (seagrass-associated) with fish and invertebrates (i.e., caridean and penaeid shrimp, crabs). FIAN is particularly focused on monitoring pink shrimp, Farfantepenaeus duorarum, which are considered a representative indicator species for aquatic invertebrates in Florida Bay and are represented in a RECOVER performance measure (RECOVER, 2004f). Larval shrimp reach internal Florida Bay through oceanic currents and tidal circulation; however, most of the area of interest in Florida Bay (northeastern and north central Bay) does not have tidal circulation and therefore low shrimp densities. Other

invertebrate data collected by FIAN will be useful to the C-111 SC Western project. However, FIAN does not provide collect samples in the embayments and nearshore habitats that are most likely to be influenced by the C-111 SC project.

Nineteen locations are sampled within three south Florida regions: Biscayne Bay, Florida Bay, and the southwest mangrove coast including Whitewater Bay. This project is quantifying fish species abundance and community composition along with measures of SAV abundance and composition. FIAN samples twice annually, at the end of the dry season and at the end of the wet season. These techniques address the CERP premise that changes in salinity lead to increases in shoal grass enhancing productivity and resulting in increases in the relative and absolute abundance of estuarine fish and invertebrates. Comparisons with location as a factor in addition to habitat and salinity assess regional patterns in these relationships. This project intends to integrate faunal sampling with the concurrent seagrass monitoring. Data collected is summarized and analyzed to (1) quantify the composition of the faunal assemblages present; (2) determine spatial distributions in relation to environmental variables, especially salinity; and (3) track change over time in distributions, abundance, and species assemblages.

The MAP supports a project to monitor distribution and abundance of juvenile seatrout in Florida Bay, currently conducted by the National Marine Fisheries Service (Powell, 2005). Surveys are conducted monthly May-November using a 3.6 meter otter trawl in the western and central Florida Bay (***FIGURE E-18***). Trout that are less than 100 millimeters in total length are enumerated, providing the primary metric for the survey, density (number of fish 1000 m-2), as an index of abundance. SAV biomass and environmental variables for each trawl sample are also measured. Surveys are not conducted further east, since eastern Florida Bay does not appear to produce year-1 seatrout. Data collected is summarized and analyzed to (1) quantify the status of year-1 juvenile seatrout densities and the annual trend; (2) determine spatial distributions in relation to environmental variables, especially salinity.

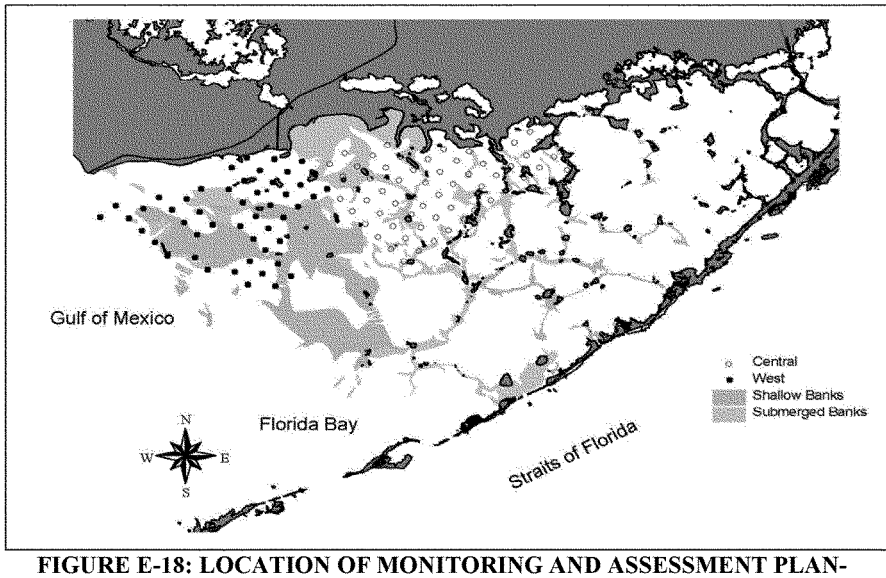


FIGURE E-18: LOCATION OF MONITORING AND ASSESSMENT PLAN-NATIONAL MARINE FISHERIES SERVICE TRAWL STATIONS BY AREA (WEST AND CENTRAL) IN FLORIDA BAY FOR MONITORING JUVENILE SPOTTED SEATROUT

* Symbols are centered in a cell 1800m on a side.

E.6.3.4 Other Ongoing Monitoring for Fish and Invertebrate Monitoring

ENP, in cooperation with the Fisheries Independent Monitoring (FIM) Program of the Florida Fish and Wildlife Conservation Commission's Fish and Wildlife Research, are conducting fisheries-independent monitoring (FIM) that is necessary for the establishment of baseline conditions. Two metrics are used: size-specific catch-per-unit-effort (CPUE) and catch per unit area sampled. A stratified-random sampling (SRS) design is used for the sampling effort in embayments and sub-basins in eastern Florida Bay, where changes in inflows are anticipated from CERP. The area sampled by this program includes eleven basins (*TABLE E-7*). Surveys have been conducted seasonally (spring, summer, and fall) since 2006, using a multi-gear approach which includes using a 21.3 meter seine, a 183 meter seine, and a 6.1 meter otter trawl. This approach provides data on important small benthic fishes such as pinfish, mojarras, and gobies, as well as data on larger resident and transient species such as snapper, seatrout, redfish, and sharks. Data collected is summarized and analyzed to (1) characterize and the nearshore and open water fish and invertebrate community in terms of species composition, abundance, and distribution; (2) establish seasonal and year-to-year trends of fish and invertebrates in these

communities; and (3) determine abundance and distribution of fish and invertebrates in relation to environmental variables, especially salinity. It should be noted that the area in north central Florida Bay, an area of interest to the C-111 SC Western project, is not included in the survey. The project will be continued through 2009, after which additional funding will be required for continuance.

TABLE E-7: SUMMARY OF BASIN LOCATION FOR THE EVERGLADES NATIONAL PARK-FLORIDA FISH AND WILDLIFE COMMISSION FLORIDA BAY STRATIFIED-RANDOM SAMPLING OF FISH AND MACROINVERTEBRATES

Basin	Basin Name
7	Long Sound
8	Little Blackwater Sound
9	Blackwater Sound
12	Nest Keys Basin
13	Joe Bay
14	Little Madeira Bay
15	Eagle Key Basin
23	Crocodile Dragover
24	Madeira Bay
46	Butternut Key Basin
47	Duck Key Basin

E.6.3.5 Comparison between Project-Level Monitoring and the Monitoring and Assessment Plan for Estuarine Fish and Invertebrate Monitoring

Presently, the MAP provides funding for fish and invertebrate monitoring in most estuarine portions of the C-111 SC project area. No additional project-level monitoring is proposed.

E.6.3.6 Data Management Quality Assurance/Quality Control for Estuarine Fish and Invertebrate Monitoring

E.6.3.6.1 Data Management

See ***SECTION E.2.3.5.1***

E.6.3.6.2 Quality Assurance/Quality Control for Estuarine Fish and Invertebrate Monitoring

QA/QC for estuarine fish and invertebrate monitoring in the C-111 SC Western project should conform to the guidance and protocols provided in the CERP QASR Manual (http://www.evergladesplan.org/pm/program_docs/qasr.cfm;

RECOVER 2004b). Appendix L in the document provides methods, references, and reporting units for conducting monitoring of fish and benthic macro-invertebrates. Some of the parameters provided in Appendix L that may be relevant to the proposed project-level monitoring include the use of dip nets, artificial substrate, cores, dredges, funnel nets, vertical tows with plankton nets, and throw trapping. Appendix L also provides methods, references, and reporting units for monitoring estuarine fish abundance and the distribution of faunal assemblages in relation to bottom habitat, salinity, and freshwater inflow.

E.6.3.7 Monitoring Cost Estimates for Estuarine Fish Monitoring

TABLE E-8: COST ESTIMATES FOR ESTUARINE FISH MONITORING

	Estimated Project Cost
Year 1	$0 (MAP Funded)
Years 1-5	$0 (MAP Funded)

E.6.4 Cape Sable Seaside Sparrow Monitoring

E.6.4.1 Justification and Relevance to Performance Measures

The CSSS, *Ammodramus maritimus mirabilis*, is an endangered species currently distributed as six sub-populations (A-F) in the Southern Everglades shown in the critical habitat recently designated in ***FIGURE E-19***. Sub-populations B through F are located east of Shark River Slough, while sub-population A is located west of the slough. The majority of sub-population D is located just west of the C-111 SC project and east of the Aerojet Road. Several birds have been located within the Southern Glades Management Area in previous years.

CSSS can nest between February and July (Fish and Wildlife Service, 1983) but the majority of nesting occurs in the dryer spring season. Nests are constructed close to the ground (average 17–21 cm, Lockwood et al, 2001) and preferably in mixed marl prairie habitat. Pimm et al. (2002) estimates the nest cycle of CSSS to range from 34 to 44 days, when totaling the number of days required for all the nesting stages (egg laying, incubation, nestling, and fledgling). If water levels rise above the mean height of the nests during this period the CSSS will cease breeding (Lockwood et al, 1997, 2001). A measure of the potential for CSSS nesting success is the number of consecutive days between March 1 and July 15 that water levels are below ground surface. This range of dates incorporates most of the time-frame when CSSS have been observed nesting (Lockwood et al; 1997, 2001) and is an indirect measure of the number of days

potentially available for sparrow courtship and nesting (Van Lent et al, 1999; DOI, 2001).

Modeling of CSSS reproductive potential (Pimm and Bass, 2001; Walters et al, 2000) supports the general recommendation for evaluation for nesting condition availability, which states that forty consecutive days for eight out of ten years is considered favorable for CSSS population persistence, 40 days for seven out of ten years is considered borderline for persistence, 80 days for seven out of ten years is favorable, and 80 consecutive days for eight out of ten years is considered very favorable.

CSSS nesting habitat studies indicate a preference for nest sites that provide specific vegetative characteristics. Nests are built where vegetative litter is moderately high (25-50 percent). The presence of specific grasses such as *Muhlenbergia filipes*, *Schizachyrium rhizomatum*, and *Schoenus nigricans* appear to be cues for nest placement. These species show an optimal preference for sites that characteristically have a discontinuous hydroperiod (water above ground level) in the range of 60 to 180 days. Habitat averaging longer hydroperiods than this range are generally dominated by species such as sawgrass (*Cladium jamaicense*).

The Recommended Plan for the C-111 SC Western project based on the latest modeling runs and comparing the ecological condition base to the initial operations regime with project, will increase discontinuous hydroperiod in critical habitat for CSSS subpopulation D. Initial analyses of MODBRANCH model data output indicates that up to 16 percent of critical habitat acreage in CSSS subpopulation D will no longer support a hydroperiod in the 60 to 180 day window preferred by plant species favored by CSSS for nesting. ***FIGURE E-20*** illustrates the location of these changes for the 1978 (average) MODBRANCH model year output in reference to the locations and frequency of CSSS in subpopulation D.

Monitoring of hydroperiod, water depth and vegetative community composition needs to be an integral part of the baseline and post construction and operation ecological monitoring plan.

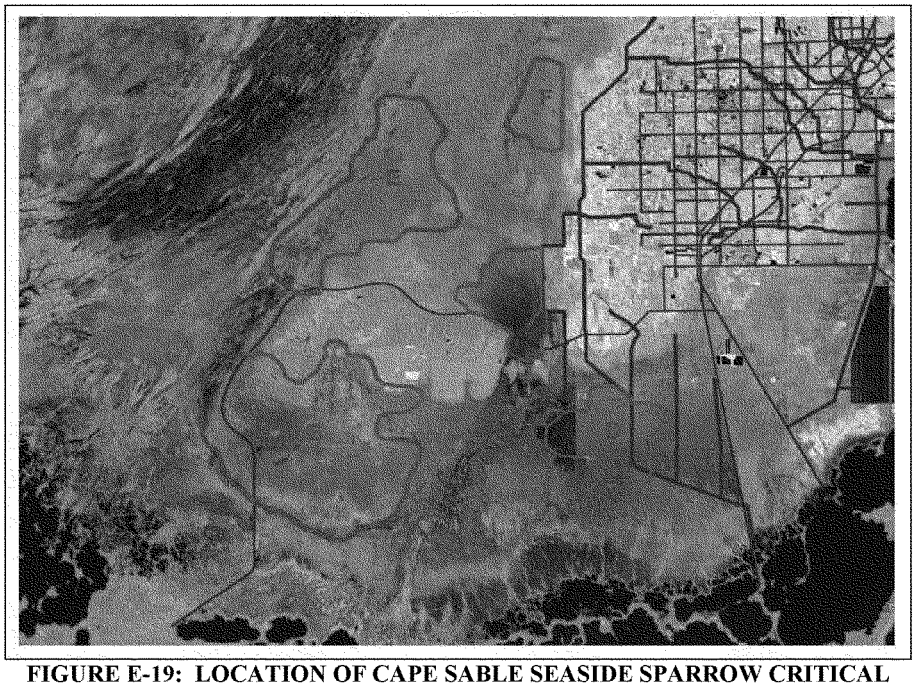


FIGURE E-19: LOCATION OF CAPE SABLE SEASIDE SPARROW CRITICAL HABITAT

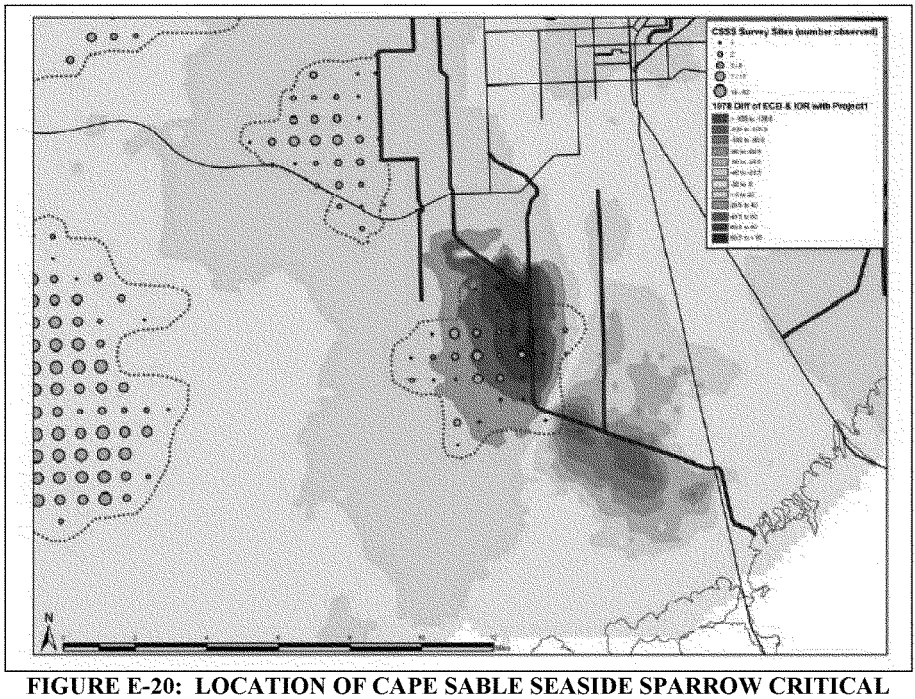


FIGURE E-20: LOCATION OF CAPE SABLE SEASIDE SPARROW CRITICAL HABITAT, SURVEY SITES, NUMBERS OBSERVED, AND RELATIONSHIP TO C-111 SPREADER CANAL PROJECT (WESTERN PIR) CHANGES FROM ECOLOGICAL CONDITION BASE IN HYDROPERIOD DAYS

E.6.4.2 Project-Level Component for Cape Sable Seaside Sparrows

The objective of the C-111 SC Western PIR Ecological and Water Quality Monitoring Plan is to determine if restoring beneficial patterns of freshwater flow, salinity, and water quality through Taylor Slough to the near shore waters of Florida Bay will achieve the expected distribution, community structure and viability of estuarine ecosystems and associated biota. The plan will monitor ecosystem responses to changes in hydroperiod depth and duration within the coastal wetlands that are expected to provide ecological conditions suitable for expanded and intensified wildlife utilization through improvements in wetland habitat functional quality, and improvements in native plant and animal species diversity and abundance. Because of the uncertainties inherent in any effort to restore such a complex and altered system such as the C-111 SC Western project area, the performance targets and the measures of success can only be broadly stated. Nevertheless, these targets and measures need definition to design a monitoring program that is well focused and efficient, thereby ensuring that it

will provide the kind of information necessary for the implementation of an adaptive assessment and management strategy.

CSSS sub-population D exists at a keystone location in the C-111 SC project study area. Habitat conditions needed (i.e. shallower and drier) are converse to those being emphasized in the remainder of the study area (restore flows and longer hydroperiod). It is therefore an ideal indicator of the species diversity represented.

Surveys conducted to date for occurrence of CSSS have provided valuable information and need to be continued. This includes helicopter surveys being conducted by ENP along an existing grid network (***FIGURE E-21***) as well as more intensive ground tracking and banding surveys (Lockwood et al., 2006). Vegetation surveys are being conducted by Florida International University (Ross et al., 2003) and need to be continued. These surveys include transects that include observations of vegetation, periphyton, soils, and topography. ***FIGURE E-21*** illustrates the location of the vegetation transect that has been sampled in subpopulation D. Helicopter surveys for CSSS occurrence conducted by ENP are scheduled to be continued. These surveys have often been concentrated primarily in locations where CSSS have recently been detected and consideration may need to be given to broadening the survey effort.

The Corps and/or District, and hereafter throughout this section referred to as the "applicant" will ensure that monitoring is sufficient to track the nature, amount, and extent of take in subpopulation D resulting from implementation of the C-111 SC Phase 1 project. This monitoring will document baseline conditions, be implemented upon initiation of operations, and continued throughout phase 1 operations or until reconsultation under the Endangered Species Act is required by implementation of future projects. Monitoring will utilize existing ongoing studies and comparable methodologies when appropriate unless otherwise stated. This includes, at a minimum:

a. Vegetation – (a.) Documentation of the baseline status of sparrow subpopulation D habitat; and (b.) After implementation of project operations, biannual (every 2 years) documentation of the status of sparrow subpopulation D habitat and any vegetative shifts that may occur within those habitats (***FIGURE E-21*** provides the location of existing vegetation transect studies). Due to the anticipated changes of the C-111 SC Western project indicated by model output, the survey transects monitoring vegetation, periphyton, soils, and topography in subpopulation D will be expanded to increase coverage in areas that will be impacted by hydroperiod changes as well as to better monitor areas currently being utilized by CSSS. ***FIGURE E-21*** illustrates the additional transect locations that are conceptualized based on potential project impacts,

field observations of existing CSSS habitat, and habitat use. The transects surveyed to date by FIU will continue to be monitored.

b. Sparrow Status – Annual determination of the number and locations of sparrows, nesting efforts, and the success rate of those nesting efforts in subpopulation D.

The applicant will provide annual reports for a period of 10 years following initiation of operations, evaluating the relationship of project operations to the following habitat and nesting criteria to determine whether project effects have exceeded those analyzed in the Biological Opinion for this project.

a. Annual discontinuous hydroperiod at monitored existing and new wellpoints as defined below, at other locations as deemed appropriate, and estimated acreage affected by hydroperiod greater than 180 days in sparrow subpopulations C and D.

b. Maximum continuous dry period in days during the period from March 1 to July 15 at the above locations, and estimated acreage which remains dry for 40 to 60 continuous days, 60 to 80 continuous days, and greater than 80 continuous days in sparrow subpopulations C and D.

c. Analysis at the above locations of the frequency and duration that depth exceeds 20 centimeters during the period from March 15 to June 30, and the total acreage exceeding 30 continuous days in subpopulations C and D. Following the 10 year reporting period the applicant and Service will reevaluate the need to continue this reporting requirement.

The USGS, EVER4 water level gauging station is centrally located in subpopulation D critical habitat and can continue to be used for monitoring purposes. Historical data provided by the gage compared to MODBRANCH model output does not indicate a reliable and consistent association. Examination of field conditions and ground elevation at the gage compared to other habitat areas in subpopulation D suggests that additional monitoring points would be needed to sufficiently characterize and monitor habitat conditions needed by the CSSS in subpopulation D. Additional water level gauging stations need to be established with daily output of stage to be used to better establish the relationship with the existing EVER4 station as well as for adaptively managing and calibrating project operations to minimize effects on the CSSS. ***FIGURE E-21*** shows conceptualized locations for these additional water level gauging stations in subpopulation D, and for which the final locations will need to be further analyzed and determined.

The applicant will continue to evaluate and adjust criteria if needed for project operations in relationship to trigger cell locations in subpopulations C and D, in partnership with the Service and other agencies, in anticipation of full implementation of the C-111 SC Phase 1 Project. This will include:

a. Documentation of daily operation stage at existing project structures (S-18C, S-197, S-198 when constructed, S-176, S-177, S-178, S-332D and S-174) and resultant stage at the trigger cell locations in both subpopulation C and D. Data will be made available on a website that consolidates this information.

b. Documentation of daily stage at the trigger cell locations in both subpopulations with daily stage at existing wells (EVER4, EVER7, NTS1, NTS10, R3110, E112) and additional wellpoints installed in subpopulation D (Figure 21 provides the location of existing wellpoints and recommended new locations in subpopulation D). Data will be made available on a website that consolidates this information.

c. Establishment of the relationship of 2a and 2b above with above ground depth and duration (discontinuous hydroperiod) in sparrow subpopulations C and D.

d. The above evaluations should be based on a minimum of 5 years of existing data collected at existing structures and at least 1 year of data collected at the proposed new wells prior to project operations to establish baseline conditions, and continue throughout the implementation of phase 1 which will facilitate recommendations for implementation of Phase 2 if proposed and authorized.

e. The applicant will provide annual reports to the Service for a period of 10 years documenting the above requirements as well as conducting meetings as needed to facilitate and discuss implementation, development, and review of the above data.

The applicant will conduct additional surveys necessary to more accurately document existing topography in subpopulations C and D. The applicant will provide a methodology to accomplish this for approval by the Service within 6 months of receipt of this Biological Opinion. The surveys will be accomplished prior to initiation of the operation of project features. The purpose of these surveys is to correlate stage data collected at the monitoring wells with acres of inundation caused by project operations within subpopulations C and D.

The applicant has committed to working in cooperation with the Service, FWC, ENP, and other applicable land management agencies to develop a conceptual

habitat improvement plan and implement habitat improvements for approximately 1,600 acres in or around Cape Sable seaside sparrow subpopulation D and other areas as appropriate. The conceptual sparrow management plan will be submitted for review and approval by the Service within one year of the date of the Biological Opinion for this project. The agreed upon final management plan will include estimated costs and time frames for completion of agreed upon actions. This plan will focus on identification of potential sparrow habitat improvements on public lands or with willing private property owners. The management plan should include consideration of measures such as: 1. woody vegetation removal and control; 2. a prescribed and natural/human caused fire management plan; 3. manipulation of soil elevation and possibly plantings/seeding to encourage plant species preferred by sparrows; 4. creation of pockets of deeper sawgrass refugia for shelter and prey production; and 5. a monitoring plan for all areas included. The management plan should also consider the potential relationship that future projects such as the C-111 SC Project (Eastern) Phase 2 and other CERP projects could have on areas that will be enhanced under the sparrow management plan.

Monitoring being conducted by ENP for CSSS occurrence combined with vegetation monitoring proposed in the MAP, given the current project configuration and anticipated effects in sub-populations B and C appears to be adequate to monitor CSSS occurrence and habitat changes in those sub-populations for purposes of project monitoring. Currently available water level gauging stations in sub-population C may be sufficient for use in adaptively managing and calibrating project operations to minimize effects on CSSS. If further analysis of any changes in project configuration and additional model output indicates otherwise, it may be necessary to locate an additional water level gauging station in this sub-population.

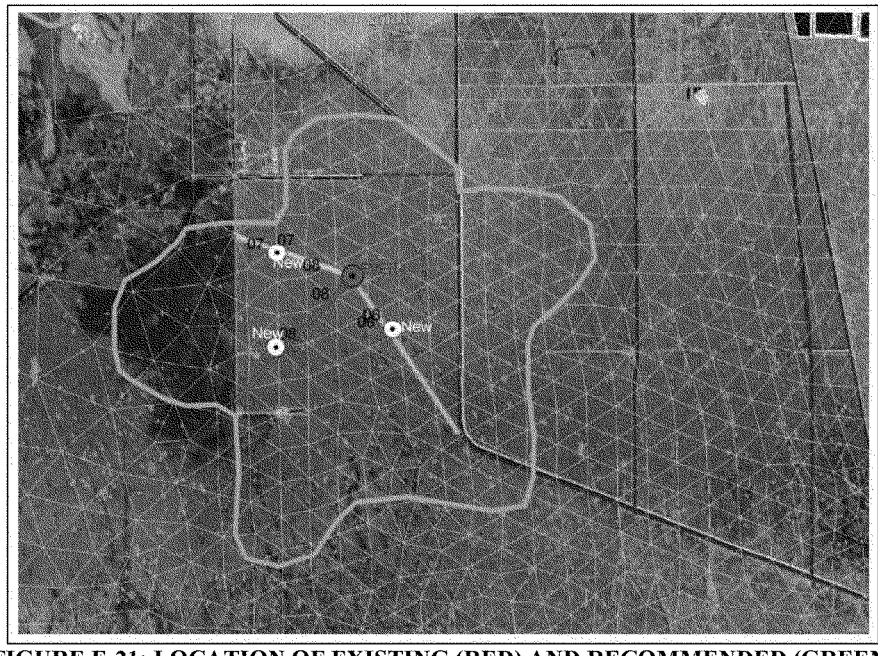


FIGURE E-21: LOCATION OF EXISTING (RED) AND RECOMMENDED (GREEN) ADDITIONAL VEGETATION TRANSECTS AND EXISTING (EVER4) AND RECOMMENDED (WHITE) STAGE MONITORING WELLPOINTS

*Numbers (06-08) show locations of CSSS nesting attempts documented by Lockwood et al., 2006 within the CSSS subpopulation D critical habitat area. CSSS helicopter monitoring grid points (+) and the SFWMD, Regional Surface Model cell mesh grid is also illustrated.

E.6.4.3 Monitoring and Assessment Plan Component for Cape Sable Seaside Sparrows

The current MAP does not specifically provide for monitoring of occurrence and nesting of CSSS. It does include a monitoring component for landscape pattern to include marl prairie and slough gradients. Hydrologic and plant community gradients will be monitored to supplement vegetation mapping and document the trade-off between slough habitat restoration and the extent and quality of habitat in adjacent marl prairies in the southern Everglades. The goal is to maintain the short-hydroperiod, tussock-growth habitats in the marl prairies while restoring long-hydroperiod habitats in adjacent sloughs. Two east-west vegetation transects will run through southern marl prairies and adjacent slough, traversing the three marl prairie nesting habitats for the major breeding populations (A, B, C, and E), of the CSSS. Plant community species composition, cover and density will be monitored annually.

An additional monitoring component included in the MAP is vegetation mapping for landscape pattern. Vegetation mapping will monitor the spatial extent, pattern, and proportion and changes in plant communities in calcitic wetlands, including tussock-forming Muhlenbergia and sawgrass communities in the major breeding locations (A, B, C, and E), of the CSSS, as hydrologic gradients change.

E.6.4.4 Comparison between Preferred Project-Level Monitoring and the Monitoring and Assessment Plan for Cape Sable Seaside Sparrows

The MAP does not provide for occurrence and nesting of CSSS in any sub-population within the project study area (B, C, and D). The current level of this type of monitoring being conducted by ENP is considered acceptable at this point to monitor species occurrence in sub-populations B and C for purposes of project monitoring. These monitoring efforts need to be continued throughout the term of this ecological monitoring plan.

The MAP as discussed above does not include monitoring for habitat, occurrence, or nesting of CSSS in sub-population D. This subpopulation is located in recently designated critical habitat in an area that will be heavily influenced by the C-111 SC Western project. Recent monitoring of habitat and species occurrence and nesting has indicated that this population is declining and habitat suitability is degrading. Previous vegetation studies conducted by Florida International University in this habitat area need to be continued and additional vegetation transects as illustrated in ***FIGURE E-21*** located and monitored.

In addition, based on the tentatively selected plan and Draft Project Operations Manual for the C-111 SC Western project, operations of key structural components will be tied to key indicator points that are proposed for new water level gauging stations in sub-population D and possibly in CSSS subpopulation C.

E.6.4.5 Data Management Quality Assurance/Quality Control for Cape Sable Seaside Sparrows

MAP will provide a portion of the habitat monitoring for CSSS in the C-111 SC Western project area. Detailed descriptions of this monitoring can be found under MAP Activity Number 3.1.3.4, and 3.1.3.5 in the Greater Everglades Module of the MAP. Other data management/QAQC will be contained in conditions to be included in project agreements and specifications.

E.6.4.5.1 Data Management

See ***SECTION E.2.3.5.1***

E.6.4.5.2 Quality Assurance/Quality Control for Cape Sable Seaside Sparrows Monitoring

QA/QC for CSSS occurrence and habitat monitoring in the C-111 SC Western project study area should conform to the guidance/protocols provided in CERP Quality Assurance Systems Requirements (QASR) Manual (http://www.evergladesplan.org/pm/program_docs/qasr.cfm; RECOVER 2004b).

E.6.4.6 Adaptive Assessment and Management for Cape Sable Seaside Sparrows

Adaptive assessment of project effects on CSSSs should consider: Will the restoration achieved through implementation of the C-111 SC Western project by increasing flows through Taylor Slough have measurable negative or positive impacts on sparrow occurrence, nesting and habitat quality in the project study area. The adaptive management question that follows is: if measurable negative impacts are determined, how can the project be modified, what changes in flow, stage, and hydroperiod can be executed, and/or what should be implemented as part of the second phase to reverse these effects to not only prevent conversion of marl prairie habitat to marsh, but to promote sparrow survival and reproduction.

E.6.4.7 Estimated Monitoring Cost Estimates for Cape Sable Seaside Sparrows

TABLE E-9: COST ESTIMATES FOR CAPE SABLE SEASIDE SPARROWS

BIOLOGICAL ASSESSMENT TERMS & CONDITIONS	EQUIPMENT	INSTALLATION (labor & hardware)	SURVEY COSTS	MAINTENANCE & CALIBRATION (10 yrs; labor & hardware)	DATA COLLECTION, QA & ENTRY	STAFF COSTS (10 Yrs)	TOTAL COSTS
1. Annual Reports (10)						$80,000.00	$80,000.00
2. Evaluate Operations (Add Wellpoints)							
CSSS 2 Well Station	Transducer and well materials	$40,825.00	$10,000.00	$30,000.00	$30,000.00	Included	$110,825.00
CSSS 3A Well Station	Transducer and well materials	$40,825.00	$10,000.00	$30,000.00	$30,000.00	Included	$110,825.00
CSSS 3B Well Station	Transducer and well materials	$40,825.00	$10,000.00	$30,000.00	$30,000.00	Included	$110,825.00
CSSS 3C Well Station	Transducer and well materials	$40,825.00	$10,000.00	$30,000.00	$30,000.00	Included	$110,825.00
Web Reporting		$20,000.00		$40,000.00		Included	$60,000.00
3. Topographical Surveys							
Survey Sub-Pop C & D			$200,000.00			$12,000.00	$212,000.00
4. Habitat Improvement Measures (50K/Yr)		$500,000.00				Included	$500,000.00
Sparrow Mgt Plan		Included				$80,000.00	$80,000.00
ID Public/Private Lands		Included				$8,000.00	$8,000.00
Woody Veg Control		Included (≈$110 per acre)					
Fire Mgt. Plan		Included					

Seeding/Planting		Included					
Refugia Creation		Included					
5. Interagency Conference Calls & AM						$20,000.00	$20,000.00
6. Monitoring:							
Veg Surveys (6)			$120,000.00			$16,000.00	$136,000.00
CSSS Surveys (11)			$550,000.00				$550,000.00
Total		$683,300.00	$910,000.00	$160,000.00	$120,000.00	$216,000.00	$2,089,300.00
Total + 10% Cont.		**$751,633.30**	**$1,001,000.00**	**$176,000.00**	**$132,000.00**	**$247,600.00**	**$2,298,230.00**

E.6.5 Spoonbill Nesting Success Monitoring

E.6.5.1 Justification and Relevance to Performance Measures

Roseate spoonbills (Ajaja ajaja) are listed by the state of Florida as a "Species of Special Concern." Florida Bay represents one of the primary spoonbill nesting areas in the state (Bjork and Powell, 1994). Strategies such as nesting away from mainland predators, employing a feeding strategy that requires shallow water, and timing their nesting period with the seasonal drawdown of water in the coastal wetlands, have narrowed their ecological niche and facilitated their use as a sentinel species of south Florida's changing ecosystem.

Lorenz et al, (2002) described how habitat loss and water manipulations in spoonbill foraging areas have played a major role in affecting the location, abundance, and success of their nests. The distribution of nesting by roseate spoonbills has shifted from northeastern Florida Bay to the western Bay since the advent of the South Dade Conveyance System. Recreating historic distribution of flows (temporally and spatially) through the C-111 Basin coastal wetlands should improve the reliability of food supplies, and result in an escalation of spoonbill nesting effort and success in the northeastern colonies.

Redistribution of freshwater inflow from the C-111 SC Western project is expected to reestablish a positive salinity gradient along a greater portion of the shoreline and to reestablish estuarine conditions in northeastern Florida Bay. These hydrologic changes are expected to increase the diversity and abundance of prey base fish in shallow nearshore waters, including areas used for spoonbill foraging. Restoring more natural hydrologic patterns , including a natural recession of water levels in the dry season and reduction in water management-induced reversals, should allow for improved foraging conditions for spoonbills and an increase in nest productivity, goals explicitly described in the RECOVER Greater Everglades module Performance Measure for roseate spoonbills (Roseate Spoonbill Nesting Patterns; RECOVER, 2006d).

E.6.5.2 Project-Level Component for Spoonbill Nest Monitoring

Audubon of Florida's Tavernier Science Center is responsible for much of the roseate spoonbill nest monitoring in Florida Bay. Between November and April, Audubon staff visit 34 keys historically used as nesting colonies in Florida Bay. These colonies are divided into five distinct nesting sub-regions, based on each colony's primary foraging location (Lorenz et al, 2002). Nests are counted by entering an active colony and thoroughly searching for nests on foot. Nesting success is also estimated for the four active sub-regions through mark and re-visit surveys of the most active colony within the sub-region. These surveys entail marking between 15 and 50 nests shortly after full clutches had been laid and re-visiting the nests on an approximate two week cycle to monitor chick

development. In order to build relationships between hydrologic conditions, prey availability, and spoonbill nest productivity, Audubon also routinely samples the mainland prey base for the northwest and northeast Florida Bay colonies and continuously monitors hydrologic conditions at stations in the southern Everglades (efforts described in E.2.4.3 and E.2.4.4, Estuarine Fish Monitoring).

In addition, roseate spoonbills and their nests are counted during serial reconnaissance flight (SRF) surveys conducted by ENP staff in areas of the southern Everglades C-111 SC project footprint (Lone Pine Key/South Taylor Slough Mangrove and Eastern Panhandle Mangrove Estuary, see Figure 2 in Alvarado and Bass, 2007). Aerial surveys by fixed-wing aircraft are conducted by ENP staff in the dry season, typically between December and July across large areas of the Greater Everglades. Transects are flown in an E-W direction, at a separation distance of approximately 2 km and an altitude of approximately 60 m above ground surface. All wading birds, including spoonbills, are counted, identified, and located by GPS. The amount of surface water available for foraging is also described as part of the surveys. The SRF database extends back into the mid-1980s, facilitating its use to examine long-term trends across a range of hydrologic conditions.

E.6.5.3 Monitoring and Assessment Plan Component for Spoonbill Nest Monitoring

Presently, the MAP provides partial funding for spoonbill nest monitoring in the C-111 SC Western project area. Between November and April, Audubon of Florida's Tavernier Science Center surveys roseate spoonbill nests on 34 Florida Bay keys that were historically used as nesting colonies. These colonies are divided into five distinct nesting sub-regions, based on each colony's primary foraging location (Lorenz et al, 2002). Nests are counted by entering an active colony and thoroughly searching for nests on foot. Nesting success is also estimated for the four active sub-regions through mark and re-visit surveys of the most active colony within the sub-region. These surveys entail marking between 15 and 50 nests shortly after full clutches had been laid and re-visiting the nests on an approximate two week cycle to monitor chick development. In order to build relationships between hydrologic conditions, prey availability, and spoonbill nest productivity, Audubon also routinely samples the mainland prey base for the northwest and northeast Florida Bay colonies and continuously monitors hydrologic conditions at stations in the southern Everglades (efforts described in ***E.2.4.3*** and ***E.2.4.4, ESTUARINE FISH MONITORING***).

In addition, roseate spoonbills and their nests are counted during serial reconnaissance flight (SRF) surveys conducted by ENP staff in areas of the southern Everglades C-111 SC project footprint (Lone Pine Key/South Taylor Slough Mangrove and Eastern Panhandle Mangrove Estuary, see Figure 2 in Alvarado and Bass, 2007). Aerial surveys by fixed-wing aircraft are conducted by ENP staff in the dry season, typically between December and July across

large areas of the Greater Everglades. Transects are flown in an E-W direction, at a separation distance of approximately 2 km and an altitude of approximately 60 m above ground surface. All wading birds, including spoonbills, are counted, identified, and located by GPS. The amount of surface water available for foraging is also described as part of the surveys. The SRF database extends back into the mid-1980s, facilitating its use to examine long-term trends across a range of hydrologic conditions.

E.6.5.4 Comparison between Preferred Project-Level Monitoring and the Monitoring and Assessment Plan for Spoonbill Nest Monitoring

Because MAP monitors spoonbill nests in the C-111 SC Western project area, monitoring for these species of special concern will rely on this MAP component. Detailed descriptions of this monitoring can be found under MAP Activity Number 3.1.3.14 in the Greater Everglades Module of the MAP.

E.6.5.4.1 Data Management Quality Assurance/Quality Control for Spoonbill Nest Monitoring

E.6.5.4.2 Data Management

See *SECTION E.2.3.5.1*

E.6.5.4.3 Quality Assurance/Quality Control for Spoonbill Nest Monitoring

QA/QC control for spoonbill nest monitoring in the C-111 SC Western project area should conform to the guidance and protocols provided in the CERP Quality Assurance Systems Requirements (QASR) Manual (http://www.evergladesplan.org/pm/program_docs/qasr.cfm; RECOVER 2006i). Appendix O in the document provides methods, references, and reporting units for monitoring spoonbill nesting.

E.6.5.5 Cost Estimates for Spoonbill Nest Monitoring

TABLE E-10: COST ESTIMATES FOR SPOONBILL NEST MONITORING

	Estimated Project Cost
Year 1	$61,000 (MAP Co- Funded)
Years 1-5	$305,000 (MAP Co- Funded)

E.6.6 Wading Bird Monitoring

E.6.6.1 Justification and Relevance to Performance Measures

Over the past several decades, numbers of wading birds have dramatically declined across the Greater Everglades (Ogden, 1994). Changing water management strategies for south Florida, which have coincided with decreases in colonial wading bird populations, affect many of the processes implicated in these declines, including the reduction of available prey base fauna (described in E.3.5). The historic numbers and locations of wading bird breeding colonies are a defining characteristic of the Everglades ecosystem and restoration of these colonies is one of the primary objectives of CERP (Weaver and Brown, 1993).

Redistribution of freshwater inflow from the C-111 SC project is expected to reestablish a more natural hydropattern in southern Everglades' marshes. These hydrologic changes are anticipated to increase the diversity and abundance of wetland prey base fish and invertebrates. Restoring more natural hydrologic patters, including a natural recession of water levels in the dry season and reduction in water management-induced reversals, should allow for improved foraging conditions for wading birds and an increase in nest productivity, goals explicitly described in the following RECOVER Greater Everglades module Performance Measures:

- Wetland Trophic Relationships–Wading Bird Foraging Patterns on Overdrained Wetlands (RECOVER, 2006b)
- Wetland Trophic Relationships–Wading Bird Nesting Patterns (RECOVER, 2006c)

E.6.6.2 Project-Level Component for Wading Bird Monitoring

No project-level monitoring is proposed here. See RECOVER section below for description of relevant monitoring.

E.6.6.3 Monitoring and Assessment Plan Component for Wading Bird Monitoring

The following projects are supported under the MAP and help address the two RECOVER performance measures noted above, as well as the wading bird monitoring needs of the C-111 project. Systematic (serial) Reconnaissance Flights (SRFs) are conducted to document the distribution and abundance of foraging birds by month. This occurs through an agreement between DOI, USACE, and SFWMD. Dave Nelson et al will continue flights North of Tamiami trail while ENP/DOI performs comparable flights south of Tamiami trail covering the area of interest for the C-111 project (Bass and Alvarado).

In addition to the foraging bird counts, nest counts are made between approximately February through June (March in 2009) in specific wading bird colonies within Everglades National Park (Bass and Oberhoffer) as well as in the Water Conservation Areas (WCAs) (Frederick et al). Nesting of six wading bird species is monitored: wood stork, white ibis, roseate spoonbill, snowy egret, great egret, and great white heron. These are the species for which the best historical comparisons exist (Ogden, 1994; Frederick et al., 1996). Nesting will be monitored between approximately January and late June of each year, with the exception of Florida Bay (November through June). (However, there is the possibility that monitoring in the mainland areas will need to be expanded if wood storks begin nesting earlier than January. Evidence of early nesting (eggs or young) is likely to be discovered on January surveys, and timing of surveys will be adjusted accordingly).

Lastly, the MAP supports two projects that address foraging and prey abundance under varying hydrologic conditions. The work of Trexler et al is conducted throughout ENP as well as in the WCAs. This work is conducted in the wet season and early dry season. Throw traps are used to characterize prey/fauna abundance through space and time. Prey abundance is then related to nesting and foraging success. A similar project is conducted during the dry season by Gawlik et al and this work is focused on the concentrating mechanisms that affect prey abundance and availability for wading birds. Both of these efforts are based on the RECOVER landscape design, and sampling is conducted using a spatially-balanced or generalized random tessellation sampling (GRTS) design (Stevens and Olsen 2004, see MAP and SSR). The full panel of sample units (which covers the entire GE domain) is covered once every 5 years.

E.6.6.4 Other Ongoing Monitoring for Wading Birds

Serial reconnaissance flight (SRF) surveys conducted by ENP staff are the primary method of monitoring numbers of wading birds and nests in areas of the southern Everglades C-111 SC project footprint. The SRF database extends back into the mid-1980s, facilitating its use to examine long-term trends across a range of hydrologic conditions.

Aerial surveys by fixed-wing aircraft are conducted by ENP staff in the dry season. These flights are made on a monthly basis between December and May across large areas of ENP to count numbers of wading birds (Alvarado and Bass 2007), and between February and July at specific colonies to count numbers of wading bird nests (Oberhofer and Bass, 2007). Of interest for the C-111 SC Western project are basins identified as Lone Pine Key/South Taylor Slough Mangrove and Eastern Panhandle Mangrove Estuary (see Figure 2 in Alvarado and Bass, 2007) and the nesting colonies identified as Lower Taylor Slough, Cuthbert Lake, and Paurotis Pond (see Table 1 in Oberhofer and Bass, 2007).

Transects are flown in an E-W direction, at a separation distance of approximately 2 km and an altitude of approximately 60 m above ground surface. All wading birds and their nests are counted, identified, and located by GPS during the flights. The amount of surface water available for foraging is also described as part of these surveys.

E.6.6.5 Comparison between Preferred Project-Level Monitoring and the Monitoring and Assessment Plan for Wading Bird Monitoring

Presently, the MAP provides partial funding for monitoring of wading birds in the C-111 SC Western project area that is consistent with the project-level monitoring parameters and protocols recommended in ***Section E.3.6.4***

E.6.6.6 Data Management Quality Assurance/Quality Control for Wading Bird Monitoring

Because MAP monitors nesting wading birds in the C-111 SC Western project area, monitoring will rely on this MAP component. Detailed descriptions of this monitoring can be found under MAP Activity Number 3.1.3.12, 3.1.3.13, and 3.1.3.14 in the Greater Everglades Module of the MAP.

E.6.6.6.1 Data Management

See ***SECTION E.2.3.5.1***

E.6.6.6.2 Quality Assurance/Quality Control for Wading Bird Monitoring

QA/QC for wading bird monitoring in the C-111 SC Western project area should conform to the guidance and protocols provided in the CERP Quality Assurance Systems Requirements (QASR) Manual (http://www.evergladesplan.org/pm/program_docs/qasr.cfm; RECOVER 2006i). Appendix O in the document provides methods, references, and reporting units for surveying nesting wading birds.

E.6.6.7 Monitoring Cost Estimates for Wading Bird Monitoring

TABLE E-11: COST ESTIMATES FOR WADING BIRD MONITORING

	Estimated Project Cost
Year 1	$64,000 (MAP Co-Funded)
Years 1-5	$320,000 (MAP Co-Funded)

E.6.7 Juvenile Crocodile Monitoring

E.6.7.1 Justification and Relevance to Performance Measures

Historically, Miami-Dade County was at the core of the American crocodile geographic range in the United States (Kushlan and Mazzotti, 1989), with the coastal wetlands along the shores of Biscayne Bay parts of Florida Bay providing important habitat. The shoreline, canals, and ponds of southern Biscayne Bay, Card Sound, Barnes Sound, Manatee Bay, and Long Sound provide essential habitat for juvenile and sub-adult crocodiles. Together with the nesting areas at the Florida Power and Light (FP&L) Turkey Point Power Plant (TPPP) and the U.S. Fish and Wildlife Service (FWS) Crocodile Lakes National Wildlife Refuge (CLNWR) these habitats meet all of the life stage requirements to support the continued recovery of this endangered species.

The TPPP and CLNWR contain the fastest growing component of the Florida population of American crocodiles. However, nearshore areas and coastal wetlands have relatively high salinity that severely reduces the suitability of these areas for juvenile crocodiles, which require relatively low salinity for proper growth and development (Mazzotti et al., 2002). Restoration of oligohaline and mesohaline conditions along the mangrove shoreline of Florida Bay should provide better quality hatchling and juvenile crocodile habitat.

Monitoring crocodiles addresses the project objective of reducing hypersaline conditions in the estuaries by evaluating the extent to which suitable nursery habitat for hatchling and juvenile crocodiles is restored in the nearshore waters and mangrove wetlands of the project area. Suitable nursery habitat includes maintaining salinity regimes conducive to the growth and survival of these life stages. Crocodile monitoring will also address the project objective of improvement of the quantity, timing, and distribution of freshwater to Florida Bay.

E.6.7.2 Project-Level Component for Crocodile Monitoring

Diurnal and nocturnal surveys for crocodiles and nests will be conducted annually. All mangrove shorelines, creeks and canals will be surveyed by spotlight during nocturnal hours from Shoal Point south and west along the coastline to US Highway 1; southwest through Barnes Sound; extending along the coastal shoreline to Madeira Basin. Spotlight surveys of the shoreline will be conducted from a small, shallow-draft skiff using a 200,000 candlepower blue spotlight. For canals, creeks, and smaller inland bodies of water, less powerful 50,000 candlepower head lamps will be used. The night spotlight count method was chosen because of its effectiveness in habitats where other survey methods are logistically impractical (Woodward and Moore, 1993). The reflective tapetum of a crocodilian's eye glows red in a spotlight and can be seen from a considerable

distance (Magnusson, 1982; O'Brien, 1990). For consistency, surveys will be started at approximately the same time after sundown each sampling night whenever possible.

All crocodilians will be approached as closely as possible to positively identify the species, and to attempt capturing. Locations and times of sightings of crocodiles and crocodile activity (especially nesting activity) will be recorded along with a detailed description of the habitat (type of water body or wetland, substrate, vegetation, water depth and salinity, and air and water temperatures). Crocodiles will be captured, measured and marked (if necessary) whenever possible. Capture will be either by hand, with tongs, or with a self-locking wire noose. When possible, size estimates will be made for animals that cannot be caught. The following information will be recorded for captured animals: previous tail marking, total length, snout vent length (measured from the tip of the snout to the posterior end of the vent), weight, and sex. If no previous tail marking is found the animal will be marked according to the system described by Mazzotti (1983).

Suitable nesting habitat within the study area will be searched on foot during daylight hours during the period of nest preparation (spring). Areas where signs of nests were reported, including a mound, eggshells, or digging activity, will also be investigated. Confirmed nest sites will be visited from July 15 until hatching. Hatchlings will be located at night by flashlight or during the day by searching the immediate vicinity of the nest. Hatchlings will be captured by hand or with tongs, and the same data will be recorded as for other captures described above.

E.6.7.3 Monitoring and Assessment Plan Component for Crocodile Monitoring

Presently, the MAP is conducting crocodile monitoring in the C-111 SC Western project area that is consistent with the project-level monitoring parameters and protocols recommended in ***SECTION E.3.7.2*** above.

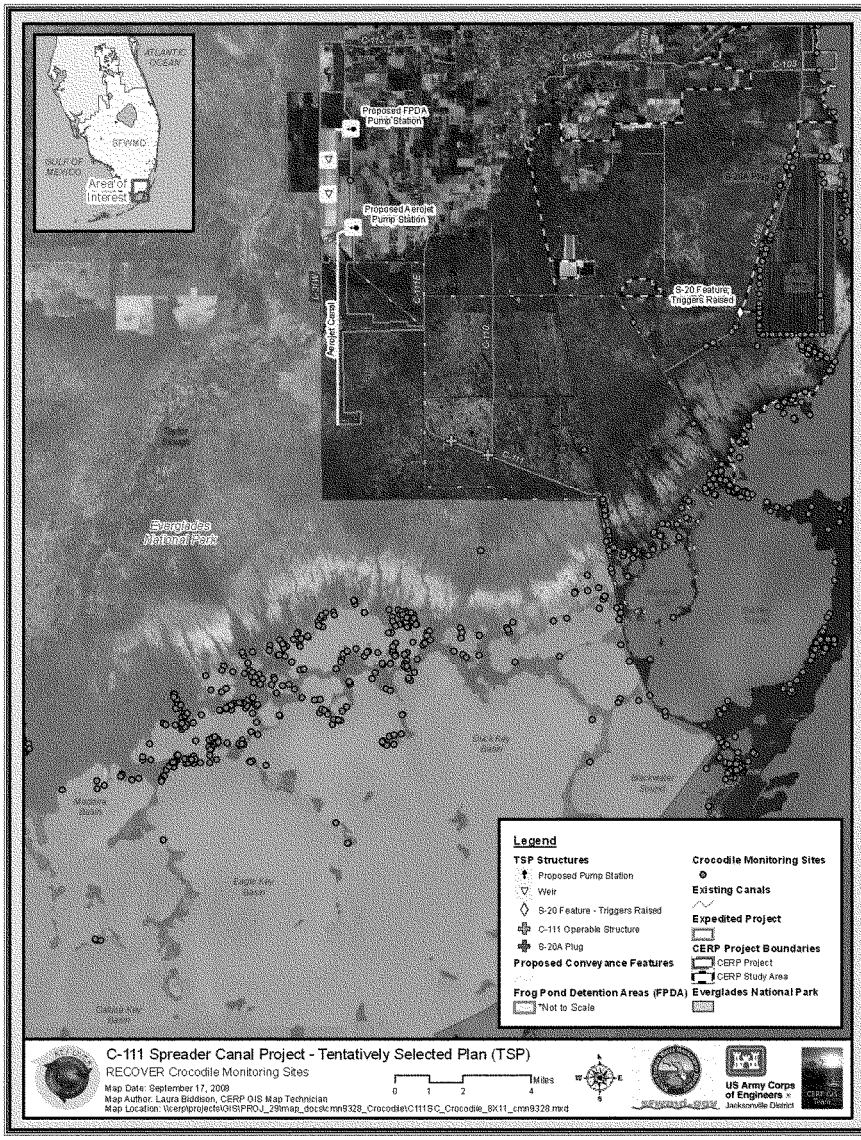


FIGURE E-22: CROCODILE MONITORING STATION LOCATIONS IN THE C-111 SPREADER CANAL WESTERN PROJECT AREA

E.6.7.4 Comparison between Preferred Project-Level Monitoring and the Monitoring and Assessment Plan for Crocodile Monitoring

Because MAP monitors for crocodiles in the C-111 SC Western project area, monitoring for this endangered species will rely on this MAP component. Detailed descriptions of this monitoring can be found under MAP Activity Numbers 3.1.3.15 and 3.1.3.16 in the Greater Everglades Module of the MAP.

E.6.7.5 Data Management Quality Assurance/Quality Control for Crocodile Monitoring

E.6.7.5.1 Data Management

See ***SECTION E.2.3.5.1***

E.6.7.5.2 Quality Assurance/Quality Control for Crocodile Monitoring

QA/QC for wetland crocodile monitoring in the C-111 SC Western project area should conform to the guidance and protocols provided in the CERP Quality Assurance Systems Requirements (QASR) Manual (http://www.evergladesplan.org/pm/program_docs/qasr.cfm; RECOVER 2004b). Appendix O in the document provides methods, references, and reporting units for monitoring reptiles and amphibians. Metadata requirements associated with crocodiles nest searching includes; location coordinates (with projection), temperature, salinity (psu), habitat category, dominant vegetation, species, substrate, distance from water, nest dimensions, fertility, success/failure, sex, total length (TL), snout-vent length (SVL), weight (g or kg), head length (HL) (cm), tail girth (TG), (cm) measured at the 3rd scute row posterior of legs.

E.6.7.6 Monitoring Cost Estimates for Crocodile Monitoring

TABLE E-12: COST ESTIMATES FOR CROCODILE MONITORING

	Estimated Project Cost
Year 1	$68,000 (MAP Co-Funded)
Years 1-5	$340,000 (MAP Co-Funded)

E.7 SUMMARY OF C-111 SC WESTERN PROJECT ECOLOGICAL MONITORING RECOMMENDATIONS AND COSTS

The C-111 SC project is to be constructed over time utilizing two PIRs. The first phase, the Western PIR will include the development of a hydraulic ridge between Taylor Slough and the C-111 Canal, which will reduce seepage from Taylor Slough, and from its headwaters. The seepage reducing hydraulic ridge will be established by diverting water that is currently being discharged through

S-177, S-18C and S-197 into two separate linear infiltration basins to be constructed within SFWMD owned lands. Further reductions will be realized by constructing an intermediate water control structure on the lower C-111 Canal, and/or through operational changes at structure S-18C. A network of override stage triggers will be established in order to meet project constraints such as flood-damage reduction, and Endangered Species Act compliance. No improvements will be made to the Model Land basin or Barnes Sound. Monitoring should be modified to reflect project phasing. Some reduction in cost and level of effort is possible for the salinity, SAV, crocodile, fish, wetland stage, and wetland vegetation parameters.

Fish monitoring is needed by RECOVER for broader scale purposes, and is funded under MAP; therefore, no change in cost is expected. A revised estimated budget for Phase 1 ecological monitoring is provided in ***TABLE E-13*** and ***TABLE E-14*** below:

TABLE E-13: SUMMARY OF PROJECT-LEVEL MONITORING COST ESTIMATES FOR THE C-111 SPREADER CANAL WESTERN PROJECT FOR ONE YEAR

Monitoring Parameter	Estimated Project Cost
Wetland Stage	$9,000 (Agency Co-Funded)
Salinity & Water Quality	$200,000
Wetland Vegetation & SAV	$22,000
FW Wetland Prey Base	$37,000 (MAP Co-Funded)
SW Wetland Prey Base	$138,000
Estuarine Fish & Invertebrates	$0 (MAP Funded)
CSSSs (year one)	$1,159,168
Spoonbill Nesting Success	$61,000 (MAP Co-Funded)
Wading Birds	$64,000 (MAP Co-Funded)
Juvenile Crocodiles	$68,000 (MAP Co-Funded)
Total	**$1,758,168**

TABLE E-14: SUMMARY OF PROJECT-LEVEL MONITORING COST ESTIMATES FOR THE C-111 SPREADER CANAL WESTERN PROJECT FOR FIVE YEARS

Monitoring Parameter	Estimated Project Cost
Wetland Stage	$45,000 (Agency Co-Funded)
Salinity & Water Quality	$550,000
Wetland Vegetation & SAV	$110,000
FW Wetland Prey Base	$185,000 (MAP Co-Funded)
SW Wetland Prey Base	$500,000
Estuarine Fish & Invertebrates	$0 (MAP Funded)
CSSSs (ten year period)	$2,298,233
Spoonbill Nesting Success	$305,000 (MAP Co-Funded)
Wading Birds	$320,000 (MAP Co-Funded)
Juvenile Crocodiles	$340,000 (MAP Co-Funded)
Total	**$4,653,233**

E.8 CONCLUSION

The goal of the ecological monitoring plan is to assist in measuring predicted project-level hydrological and ecological restoration benefits for the C-111 SC Western project. This plan will also establish ecological baselines, support development of restoration targets for subsequent PIR's, and may identify additional management options that may be needed to address CERP restoration goals and objectives.

Extensive hydrological, water quality, and ecological monitoring presently existing in the project area is supported by organizations and funds external to CERP and this project.

The overall success of this plan is predicated on the availability of future funding for the continuation of these long-term, high priority monitoring efforts along with protocols to assess the project's performance status or respond to any unanticipated ecological changes.

E.9 LITERATURE CITED

Browder, J.A., Z. Zien-Eldin, M.D. Criales, M.B. Robblee, and T.J. Jackson. 2002. Dynamics of pink shrimp recruitment in relation to Florida Bay salinity and temperature. Estuaries 25: 1335-1371.

Cahoon, D. R., P. Hensel, J. Rybczyk, K. L. McKee, C. E. Proffitt, and B. C. Perez. 2003. Mass tree mortality leads to mangrove peat collapse at Bay Islands, Honduras after Hurricane Mitch. Journal of Ecology 91:1093-1105.

Cahoon, D. R., J. C. Lynch, P. Hensel, R. Boumans, B. C. Perez, B. Segura, and J. W. Day. 2002a. High-precision measurements of wetland sediment elevation: I. Recent improvements to the sedimentation-erosion table. Journal of Sedimentary Research 72:730-733.

Cahoon, D. R., J. C. Lynch, B. C. Perez, B. Segura, R. D. Holland, C. Stelly, G. Stephenson, and P. Hensel. 2002b. High-precision measurements of wetland sediment elevation: II. The rod surface elevation table. Journal of Sedimentary Research 72:734-739.

CERP. 2002. Florida Bay and Florida Keys Feasibility Study: Project Management Plan. Accessed 8/12/09 from: http://www.evergladesplan.org/pm/studies/fl_bay.aspx

CERP. 2004a. Mangrove Estuarine Transition Conceptual Ecological Model . CERP

Monitoring and Assessment Plan, Appendix A: Conceptual Ecological Models. pp. A-53 to A-78.

CERP. 2004b. Southern Estuaries Module. CERP Monitoring and Assessment Plan. pp. 3-59 to 3-103.

DOI. 2001. Final Fish and Wildlife Coordination Act Report for the Interim Operating Plan. Ecological Services, U.S. Fish and Wildlife Service, U.S. Department of Interior, Vero Beach, FL. and South Florida Natural Resources Center, Everglades National Park, U.S. Department of the Interior, Homestead, FL.

Durako, M. J. and M. O. Hall. 2007.

Fourqurean, J.W., J.C. Zieman, and G.V.N. Powell. 1992. Phosphorous limitation of primary production in Florida Bay: evidence from the C:N:P ratios of the dominant seagrass Thalassia testudinum. Limnology and Oceanography 37(1): 162-ű.

Fourqurean, J.W., M.J. Durako, M.O. Hall, and L.N. Hefty. 2002. Seagrass distribution in south Florida: A multi-agency coordinated monitoring program. In, J.W. Porter and K.G. Porter (eds.), The Everglades, Florida Bay, and Coral Reefs of the Florida Keys: An Ecosystem Sourcebook, pp. 497-522. CRC Press.

Fourqurean, J.W., J.N. Boyer, M.J. Durako, L.N. Hefty, and B.J. Peterson. 2003. Forecasting responses to seagrass distributions to changing water quality using monitoring data. Ecological Applications 13: 474-489.

Hoffman, J.M, K. Bradely, G. Gann, H. Cooley, M. Rugge. 2008. Everglades National Park – Taylor Slough Vegetation Transects. Report to Everglades National Park. March 27, 2008.

Kushlan, J.D., O.L. Bass Jr. and L.C. McEwan. 1982. Wintering Waterfowl in Everglades National Park. South Florida Research Center Report T-670, Everglades National Park.

Ley, J.A. and C.C. McIvor. 2002. Linkages between estuarine and reef fish assemblages: enhancement by the presence of well developed mangrove shorelines. In, J.W. Porter and K.G. Porter (eds.), The Everglades, Florida Bay, and Coral Reefs of the Florida Keys: An Ecosystem Sourcebook, pp. 539-562. CRC Press.

Lockwood, J.L., K.H. Fenn, J.M. Caudill, D. Okines, O.L. Bass, Jr., J.R. Duncan, and S.L. Pimm. 2001. The implications of Cape Sable seaside sparrow demography for Everglades restoration. Animal Conservation 4: 275-281.

Lockwood, J.L., K.H. Fenn, J.L. Curnutt, D. Rosenthal, K.L. Balent, and A.L. Mayer. 1997. Life history of the endangered Cape Sable seaside-sparrow. Wilson Bulletin 109(4): 720-731.

Lockwood, J.L., D.A. La Puma, B. Baiser, M. Boulton, and M.J. Davis. 2006. Detailed study of Cape Sable seaside sparrow nest success and causes of nest failure. 2006 annual report. U.S. Fish and Wildlife Service, Vero Beach, Florida.

Pimm, S.L. and O.L. Bass, Jr. 2001. Range-wide risks to large populations: the Cape Sable seaside sparrow as a case history. Pages 406-424 in Beissinger, S.R., and D.L. McCullough, editors. Population viability analysis. The University of Chicago Press, Chicago, Illinois.

Pimm, S.L., J.L. Lockwood, C.N. Jenkins, J.L. Curnutt, M.P. Nott, R.D. Powell, and O.L. Bass, Jr. 2002. Sparrow in the grass: a report on the first 10 years of research on the Cape Sable seaside sparrow (Ammodramus maritimus mirabilis). Unpublished report to Everglades National Park; Homestead, Florida.

Powell, Allyn B. 2005. Seatrout Monitoring in Florida Bay, Everglades National Park Annual Report: September 2004-November 2005.

Madden, C.J., A. McDonald, M. Hunt, W.M. Kemp, and D. Gruber. 2003. Ecosystem Process Models of Seagrass Communities in Florida Bay. Unpublished report, South Florida Water Management District, West Palm Beach, Florida.

Matheson, E. and R. McMichael. 2006. Monitoring Populations of Fish and Macroinvertebrates in Florida Bay. Comprehensive Annual Report, Everglades National Park.

McIvor, C.C., J.A. Ley and R.D. Bjork. 1994. Changes in freshwater inflow from the Everglades to Florida Bay including effects on biota and biotic processes. In: S.M. Davis and J.C. Ogden, eds. Everglades: The Ecosystem and Its Restoration, pp. 117-146. St. Lucie Press.

McMichael, R.H. 1991. Florida's marine Fisheries-Independent Monitoring program. In. Treat, S. F. and P. A. Clark eds. Proceedings, Tampa Bay Area Scientific Information Symposium 2 (BASIS). 1991 February 27- March 1, Tampa, Florida. 528 p.

Montague, C.L., E. Chipouras, and L.M. Jones. 1998. Responses of Submerged Macrophytes to Freshwater Inflow to Florida Bay. Final field studies research report prepared for South Florida Water Management District. University of Florida. 149 pp.

Morrison, D. and D.L. Bean. 1997. Benthic Macrophyte and Invertebrate Distribution and Seasonality in the Everglades-Florida Bay Ecotone. Final report prepared for Everglades National Park. National Audubon Society. Miami, FL. 67 pp.

Nuttle, W.K. and R.S. Teed. 2002. Version 1: Wetland Hydrology and Estuarine Salinity Models for the Taylor Slough/ C-111 Area. Final report prepared for Everglades National Park. The Cadmus Group. 44 pp.

Ogden, J.C. 1994. A comparison of wading bird nesting colony dynamics (1931-1946 and 1974-1989) as an indication of ecosystem conditions in the southern Everglades. In: S.M. Davis and J.C. Ogden, eds. Everglades: The Ecosystem and Its Restoration, pp. 533-570. St. Lucie Press.

RECOVER. 2004b. Quality Assurance Systems Requirements (QASR) Manual (http://www.evergladesplan.org/pm/program_docs/qasr.cfm;)

RECOVER 2006a. RECOVER: CERP System-wide Performance Measures. Wetland Trophic Relationships - Regional Populations of Fishes, Crayfish, Grass Shrimp and Amphibians. Accessed 8/1/08 from: http://www.evergladesplan.org/pm/recover/recover_docs/ret/pm_ge_fish_cray_shrimp.pdf

RECOVER 2006b. RECOVER: CERP System-wide Performance Measures. Wetland Trophic Relationships – Wading Bird Foraging Patterns on Overdrained Wetlands Accessed 8/1/08 from: http://www.evergladesplan.org/pm/recover/recover_docs/ret/pm_ge_wadingbirdforaging.pdf

RECOVER 2006c. RECOVER: CERP System-wide Performance Measures. Wetland Trophic Relationships – Wading Bird Nesting Patterns Accessed 8/1/08 from: http://www.evergladesplan.org/pm/recover/recover_docs/ret/pm_ge_wadingbirdnesting.pdf

RECOVER 2006d. RECOVER: CERP System-wide Performance Measures. Roseate Spoonbill Nesting Patterns. Accessed 8/1/08 from: http://www.evergladesplan.org/pm/recover/recover_docs/ret/pm_ge_roseatespoonbillnesting.pdf

RECOVER 2006e. RECOVER: CERP System-wide Performance Measures. American Crocodile – Juvenile Growth and Survival. Accessed 8/1/08 from: http://www.evergladesplan.org/pm/recover/recover_docs/ret/pm_ge_americancroc.pdf

RECOVER 2006f. RECOVER: CERP System-wide Performance Measures. Southern Estuaries Juvenile Pink Shrimp and Associated Epifauna. Accessed 8/1/08 from: http://www.evergladesplan.org/pm/recover/recover_docs/ret/pm_se_juvenilepinkshrimp.pdf

RECOVER 2006g. RECOVER: Greater Everglades Performance Measures. Wetland Landscape Patterns – Freshwater and Estuarine Vegetation Mosaics. Accessed 8/1/08 from: http://www.evergladesplan.org/pm/recover/recover_docs/ret/030807_ge_veg_mosaics.pdf

RECOVER 2006h. RECOVER: Southern Estuaries Performance Measures. Southern Estuaries Suberged Aquatic Vegetation. Accessed 8/1/08 from: http://www.evergladesplan.org/pm/recover/recover_docs/ret/pm_se_sub_aqua_veg.pdf

RECOVER 2006i. RECOVER: Southern Estuaries Performance Measures. Southern Estuaries, Appendix O, Birds.

RECOVER. 2007. Southern Estuaries Performance Measures. Southern Estuary Module – Fish. Accessed 8/12/08 from: http://www.evergladesplan.org/pm/recover/recover_docs/ret/pm_se_fish_community.pdf

Robblee, M. B., S. D. Jewell, and T. W. Schmidt. 1991. Temporal and spatial variation in the pink shrimp, Penaeus durarum, in Florida Bay and adjacent waters of Everglades National Park. SFNRC, Everglades National Park, Homestead Florida. Annual Report. 28 pp.

Robblee, M. B., T.R. Barber, P.R. Carlson, M.J. Durako, J.W. Fourqurean, L.K. Muehlstein, D. Porter, L.A. Yarbro, R.T. Zieman, and J.C. Zieman. 1991. Mass mortality of the tropical seagrass Thalassia testudinum in Florida Bay (USA). Marine Ecology Progress Series. 71: 297-299.

Ross, M.S., J.P. Sah, P.L. Ruiz, D.T. Jones, H. Cooley, R. Travieso, J.R. Snyder, and C. Schaeffer. 2003. Effect of hydrologic restoration on the habitat of the Cape Sable seaside sparrow. 2003 annual report. U.S. Fish and Wildlife Service, Vero Beach, Florida.

Ross. M.S. J.P. Sah, P.L. Ruiz, D.T. Jones, H.C. Cooley, R. Travieso, J.R. Snyder, and C. Schaeffer. 2003. Effect of Hydrology Restoration on the Habitat of the Cape Sable Seaside Sparrow. Report to Everglades National Park. June 30, 2003.

Ross. M.S. J.P. Sah, P.L. Ruiz, D.T. Jones, H.C. Cooley, R. Travieso, J.R. Snyder, and S. Robinson. 2004. Effect of Hydrology Restoration on the Habitat of the Cape Sable Seaside Sparrow. Report to Everglades National Park. November 30, 2004.

Ross. M.S. J.P. Sah, P.L. Ruiz, D.T. Jones, H.C. Cooley, R. Travieso, J.R. Snyder, and D. Hagayari. 2006. Effect of Hydrology Restoration on the Habitat of the Cape Sable Seaside Sparrow. Report to Everglades National Park. February, 2006.

Rybczyk J M, Callaway J C and Day J W 1998 A Relative Elevation Model for a Subsiding Coastal Forested Wetland Receiving Wastewater Effluent. Ecological Modelling 112, 23-44.

Salinity Models for the Taylor Slough/ C-111 Area. Final report prepared for Everglades National Park. The Cadmus Group. 44 pp.

Service. 1983. Cape Sable Seaside Sparrow Recovery Plan. U.S. Fish and Wildlife Service, Atlanta, GA. 52 pp.

Smith, T.M., J. Zieman, and K. McGlathery. 2002. A Landscape Seagrass Model for Florida Bay. Progress report prepared for Everglades National Park. University of Virginia.

South Florida Natural Resources Center (SFNRC). 2002. Physical Science Inventory and Monitoring Program, Marine Monitoring Network, Data Summary for Calendar Year 2001. Everglades National Park.

Stumpf, R.P., M.L. Frayer, M.J. Durako, and J.C. Brock. 1999. Variations in water clarity and bottom albedo in Florida Bay from 1985 to 1997. Estuaries 22: 431-444.

Van Lent, T.R., W. Snow, and F.E. James. 1999. An examination of the modified water deliveries project, the C-111 Project, and the experimental water deliveries project: Hydrologic analyses and effects on endangered species. South Florida Natural Resources Center, Everglades National Park, Homestead, FL.

Walters, J.R., S.R. Beissinger, J.W. Fitzpatrick, R. Greenberg, J.D. Nichols, H.R. Pulliam, and D.W. Winkler. 2000. The AOU Conservation Committee Review of the biology, status, and management of Cape Sable seaside sparrows: Final Report. The Auk 117(4):1093-1115.

ANNEX E
PROJECT MONITORING PLAN

PART IV: NUISANCE AND EXOTIC VEGETATION CONTROL PLAN

TABLE OF CONTENTS

E PART IV: NUISANCE AND EXOTIC VEGETATION CONTROL PLAN ..... ANNEX E PART IV--E-1
E.1 INTRODUCTION ..... ANNEX E PART IV--E-1
E.2 MANAGEMENT OBJECTIVES ..... ANNEX E PART IV--E-2
E.3 CURRENT VEGETATIVE CONDITIONS ..... ANNEX E PART IV--E-4
E.4 ANTICIPATED EFFECTS OF HYDROLOGIC RESTORATION ON NUISANCE AND EXOTIC PLANT POPULATIONS ..... ANNEX E PART IV--E-7
E.5 SPECIFIC PLAN GOALS ..... ANNEX E PART IV--E-10
E.6 CONTROL METHODS ..... ANNEX E PART IV--E-11
E.7 SURVEY FOOTPRINT AREAS AND MAP EXOTIC/NUISANCE VEGETATION ..... ANNEX E PART IV--E-13
E.8 ASSESS EFFECTIVENESS OF EXOTIC CONTROL EFFORTS ..... ANNEX E PART IV--E-14
E.9 ESTIMATED PLAN COSTS ..... ANNEX E PART IV--E-14

LIST OF TABLES

Table E-1 Common Vegetation Within Ecological Zones ..... Annex E Part IV--E-6
Table E-2 Effects Of Hydrologic Restoration On Nuisance And Exotic Plant Populations In The SDWMA ..... Annex E Part IV--E-8

LIST OF FIGURES

Figure E-1 Project Area Showing South Florida Water Management District Owned Lands Included In This Plan ..... Annex E Part IV--E-3
Figure E-2 Ecological Zones Within The Project Region ..... Annex E Part IV--E-5
Figure E-3 Invasive Plant Infestation Levels For Lands Included In This Invasive And Nuisance Control Plan ..... Annex E Part IV--E-9

C-111 Spreader Canal Western Project
Nuisance and Exotic Vegetation Control Plan

October 2009

E PART IV: NUISANCE AND EXOTIC VEGETATION CONTROL PLAN

E.1 INTRODUCTION

The purpose of this document is to provide a framework for making decisions related to nuisance and exotic vegetation control on project lands associated with the C-111 Spreader Canal Western project. While the plan presents specific *Management Objectives*, these objectives were developed in large part to assist in estimating the costs associated with optimal land management practices with respect to current known exotic and nuisance vegetation threats. While the plan represents its authors' best attempts to capture anticipated costs, the costs presented herein could escalate due to numerous reasons including unanticipated spread of exotic and/or nuisance species, increased labor costs, increased chemical costs, etc. Conversely, the overall cost associated with implementation of this plan could also be reduced for similar reasons. Costs might also be reduced if the agencies are successful at partnering, and/or establishing other means to accomplish the plan, thereby lessening the Federal and non-Federal sponsors' financial obligation for exotic and nuisance vegetation management.

This plan should be considered a living document and should be periodically updated to reflect changes occurring and/or anticipated to occur over the project lands. More importantly, it needs to be noted that the suggested management actions described herein are not self-executing, and the decision to implement a given action would be at the discretion of the leadership of the U.S. Army Corps of Engineers (USACE), and the Governing Board of the South Florida Water Management District (SFWMD), and will necessarily be made based on consideration of other agency restoration and water management priorities, and the availability of state and Federal funds.

In defining the C-111 Spreader Canal's project study area, the Project Delivery Team (PDT) identified approximately 155,000 acres of uplands, freshwater wetlands, and estuarine wetlands that could have potentially been affected by the proposed project (***Figure E-1***). The ecological indicator zones for the region are shown in ***Figure E-2***, with general description of floristic composition of these zones described in ***TABLE E-1***. This extremely large study area was established based on the recognition that, because the project diverts, rather than augments, existing water deliveries, it would be necessary to identify both the positive and negative effects of the project. Within this large study area, the recommended plan is expected to improve between 10,000 and 20,000 acres of

wetlands, generally located in close proximity to the recommended project features.

While managing nuisance and exotic vegetation over the entire 155,000 acre study area would extend well beyond the scope of this restoration project, it will be important to manage, under this project, those areas over which benefits were contemplated, and equally important to manage any areas which potentially could be adversely affected by the proposed project. ***Figure E-1*** identifies lands currently owned by the SFWMD within the study area boundaries. These areas along with the Frog Pond Detention Area are the subject of this invasive and nuisance vegetation control plan. The SFWMD has worked closely with other public land owners in the study area (e.g., Miami-Dade County) in an effort to coordinate control efforts in a cost-effective and regionally-oriented manner. Continued interagency coordination of land management activities in the study area is vital to long-term success of this project.

E.2 MANAGEMENT OBJECTIVES

Establishment of conditions, which are favorable to long-term maintenance control of non-native species, and the re-establishment of native flora represent the primary objectives of this effort. To achieve these goals, this work plan is proposed to complete both initial and long-term invasive plant control efforts necessary to achieve maintenance control levels of invasive vegetation within the project area. The objective of the initial phase is to reduce invasive species cover to no more than 5%. Following this initial, intensive phase, periodic sweeps are performed by ground crews to spot treat smaller infestations. In many cases, prescribed fire can be utilized to help keep exotic or nuisance species in check.

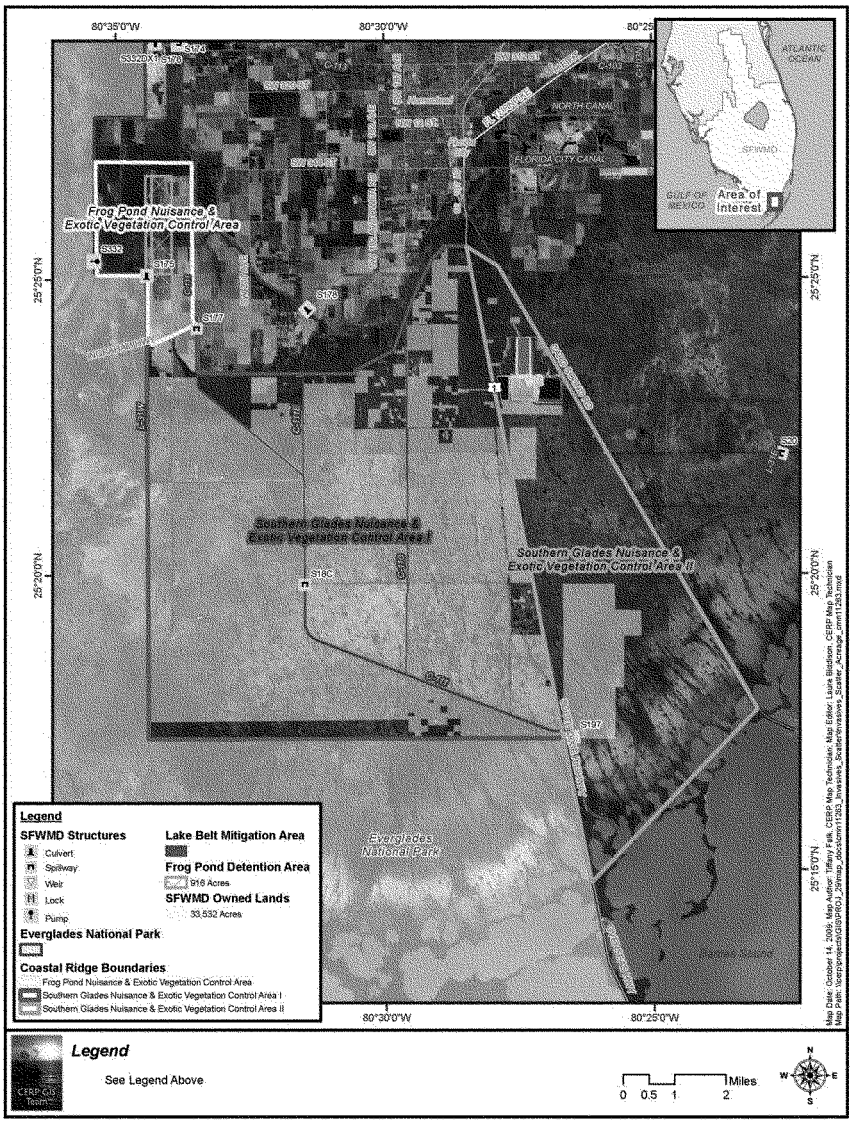


FIGURE E-1: PROJECT AREA SHOWING SOUTH FLORIDA WATER MANAGEMENT DISTRICT OWNED LANDS INCLUDED IN THIS PLAN

It is important to note that those areas with past substrate disturbance, such as the Frog Pond Detention Area (FPDA) will likely require substrate removal in order to re-establish biogeochemical conditions necessary for native plant communities to recover. Without substrate removal, many invasive species would have a competitive advantage over native flora and very frequent herbicide applications would be required.

Monitoring for nuisance and exotic vegetation is an important component of this plan. Without detailed information concerning the type and spatial extent of invasive plant populations, strategic planning for their control is likely to be ineffectual. Maps based on current surveys will improve decision making and planning during initial control efforts while longer term monitoring efforts are needed to maintain populations at the lowest feasible levels.

E.3 CURRENT VEGETATIVE CONDITIONS

The South Dade Wetlands (SDW) are located in the extreme southeastern lobe of the Everglades system. The land is low-lying and very flat, with natural elevations generally less than one meter above sea level. The soils are predominantly marls, mixed with and grading into peat soils near the coastline. Undeveloped areas contain predominantly wetland vegetation, plus disturbed, rural upland areas with roads, levees and other man-made features. The region supports a variety of wetland dependent wildlife, including several state- and federally-listed endangered and threatened wildlife species.

As a consequence of past and current water management practices, land development, and sea level rise, freshwater wetlands in the project area have been reduced in aerial extent, altered and degraded. Currently much of this area is drained. Water elevations are generally held close to or below land surface in the northern project area. In other areas, water is diverted by drainage structures toward other basins. The current operation of the systems has resulted in an inland migration of saline conditions in both the groundwater and surface waters such that the expansion of moderate to high salinity zones have diminished the spatial extent of freshwater wetland habitats, and have allowed the landward expansion of saltwater and mangrove wetlands, including low-productivity, sparsely vegetated dwarf mangroves communities typical of the hypersaline "white zone." Some wetlands have been impacted by invasive exotic vegetation, often as a result of physical disturbance and/or hydrologic isolation.

The primary factors influencing the distribution of vegetation in this region are hydropattern, salinity, previous disturbance, and to a lesser extent, nutrient loading and soil type. The C-111 Spreader Canal, including both the Western and Eastern project areas, is divided into five ecological/vegetation zones (***FIGURE E-1***). Ecological Zone 1 is considered to be the most developed area

north of the Model Lands and Southern Glades, consisting of residential and agricultural areas, and the business communities of Florida City and Homestead; within this zone, certain tracts have been purchased by Miami-Dade County for conservation or recreation or those preserved as buffer lands for the Florida Keys Aqueduct Authority. Ecological Zone 2 is a shrub-dominated freshwater marsh. At this highest elevation, the sawgrass prairie alternates with forested wetlands. This zone is heavily impacted with a large number of invasive plant species. Ecological Zones 3 and 4 are various sawgrass communities, showing the transition from more freshwater to higher salinity water. The dominant vegetation community in the region is a matrix of sawgrass prairie with tree islands (Ecological Zone 3). The tree islands vary in vegetation composition, depending upon elevation. Some tree islands in Ecological Zone 4 have freshwater species in the interior section, and are ringed with mangrove or salt-tolerant species. At the lowest elevations near the coast mangroves replace the freshwater wetlands. The transition zone between the mangroves and the freshwater prairie is a needle rush-salt grass zone on the freshwater side, but stunted scrub mangrove on the coastal side. Ecological Zone 5 is the hypersaline "white zone," notable due to its appearance on remotely-sensed images as a white band, and sparse vegetation with stunted mangroves.

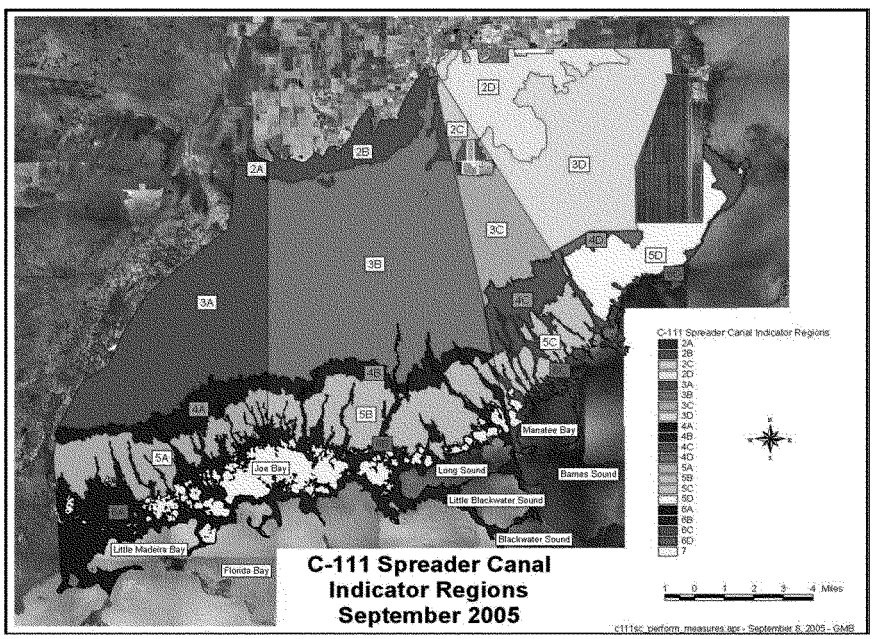


FIGURE E-2: ECOLOGICAL ZONES WITHIN THE PROJECT REGION

Recent (2000) studies in this area indicate that the inner boundary of the white zone has moved inland by an average of one and a half kilometers since 1940 and the zone is expanding. The most significant changes have occurred on the Biscayne Bay side of U.S. Highway 1. The low productivity of the white zone may be primarily due to wide seasonal fluctuations in salinity and moisture content and the absence of freshwater input from upstream sources. ***TABLE E-1*** lists the commonly found plant species in Ecological Zones 2 through 5.

TABLE E-1: COMMON VEGETATION WITHIN ECOLOGICAL ZONES

Zone	Landscape	Common Plants Found in Zones
2	Shrub dominated forested wetland	Brazilian pepper (*Schinus terebinthifolius*), Australian pine (*Casuarina* spp.), shoebutton Ardisia (*Ardisia elliptica*), dahoon holly (*Ilex cassine*), bishopwood (*Bischofia javanica*), swamp bay (*Persea palustris*), and willow (*Salix caroliniana*).
3	Sawgrass	Sawgrass (*Cladium jamaicense*), muhly grass (*Muhlenbergia capillaris*), swamp bay, dahoon holly, wax myrtle (*Myrica cerifera*), willow, and cocoplum (*Chrysobalanus icaco*), sweet bay, myrsine (*Rapanea guianensis*), bald cypress (*Taxodium distichum*), and pond apple (*Annona glabra*)
4	Mixed graminoid with mangroves	Sawgrass, swamp bay, dahoon holly, wax myrtle, cocoplum, myrsine, poisonwood (*Metopium toxiferum*), buttonwood (*Conocarpus erectus*), red mangrove (*Rhizophora mangle*), stoppers (*Eugenia* spp.), spicewood (*Calyptranthes pallens*), and cocoplum
5	White zone ecotone	Dwarf red mangroves, sparse graminoids
6	Coastal forest	Red mangrove, white mangrove (*Laguncularia racemosa*), Brazilian pepper, Australian pine, wax myrtle, poisonwood, buttonwood, spicewood, myrsine, stoppers, white indigo berry (*Randia aculeata*)

Plant community composition can strongly influence wildlife composition and patterns of utilization. The plant community types present in the SDW Management Area (SDWMA) include sawgrass glades, spike rush and beak rush flats, muhly prairie, cypress stands, native dominated forested wetlands, tree islands, mangrove flats, hydric hammocks, and exotic-dominated forests. Natural disturbances, such as fire, play an important role in maintaining a diverse mosaic of vegetation communities. Altered hydroperiods, wildfire

suppression and human caused fires have disrupted the natural frequency and pattern of fires in the region.

Invasive species present in the SDWMA include melaleuca, Australian pine, Brazilian pepper, shoebutton Ardisia, bishopwood, and Old World climbing fern (*Lygodium microphyllum*), among others. The heaviest impacts from invasive species tend to occur in disturbed areas within the SDWMA, such as abandoned farmland and lands in the immediate vicinity of roads and berms. Such areas are frequently dominated by nearly monotypic stands of invasive plants. Elsewhere, these invasive plants are present in smaller, but no less important numbers in tree islands, marshes, and mangrove forests as a result of long distance seed dispersal. In other regions of the county, such outlier populations have rapidly expanded to create additional problems when left untreated.

E.4 ANTICIPATED EFFECTS OF HYDROLOGIC RESTORATION ON NUISANCE AND EXOTIC PLANT POPULATIONS

Restored hydroperiods, and the restoration of more natural sheet flow are changes that will benefit native vegetation and in most cases reduce the invasiveness of exotic species. The effects of the restoration on invasive plant species result primarily from altered hydrology and, in the case of the Frog Pond area, mechanical disturbance of soils. These restoration effects may reduce or increase the "invasiveness" of a given species, because each species has unique environmental requirements and ecological impacts. Many of the invasive, non-indigenous species present in the project area will be less capable of dominating native plant communities as hydroperiods are restored, primarily due to intolerance of prolonged inundation. However, hydroperiod is not always the major driver of an exotic species' potential invasiveness. Species with wide tolerances of environmental conditions, which overlap pre- and post-restoration conditions, may continue to spread or maintain populations despite efforts to reverse hydrologic disturbances. The predicted effects of hydrologic restoration on invasive exotic species in SDWMA are summarized in ***Table E-2*** below.

There is currently limited spatial information for nuisance and exotic plant species in the SDWMA. Some aerial and ground-based assessments have occurred in recent years, but no detailed surveys focused on specific species and their infestation levels are available. ***FIGURE E-3*** includes a preliminary assessment of infestation levels utilizing previous mapping information from Miami-Dade County and SFWMD land managers and supplemental aerial reconnaissance prior to developing this plan. This information was utilized to prepare the implementation strategy and estimate control costs. More refined spatial data is needed prior to initiating control efforts in order to facilitate sound decision making and assess progress (see ***SECTION 7***).

TABLE E-2: EFFECTS OF HYDROLOGIC RESTORATION ON NUISANCE AND EXOTIC PLANT POPULATIONS IN THE SOUTH DADE WETLANDS MANAGEMENT AREA

Species	Restoration Effect	Management Impacts
Australian Pine (*Casuarina* spp.)	Minimal Decrease	Casuarina does not tolerate prolonged flooding, but it will continue to invade canal banks, spoil piles, and other elevated soils
Brazilian Pepper (*Schinus terebinthifolius*)	Minimal decrease	Mature plants may survive wetter conditions, but growth rates and seedling survival would likely decrease.
Bishopwood (*Bischofia javanica*)	Decrease	Cannot tolerate flooding. However, likely to persist in disturbed areas with shorter hydroperiods, particularly in Zone 1.
Burma Reed (Neyraudia reynaudiana)	Decrease	Tolerant of a wide range of environmental conditions, but is most invasive in open, dry, and sunny sites.
Cattail* (*Typha* spp.)	Increase	In areas with increased hydroperiods and elevated nutrient regimes, cattails may become dominant and displace sawgrass and mixed graminoid plant communities.
Cogongrass (*Imperata cylindrica*)	Decrease	Increased inundation will reduce suitable habitat for cogongrass, but drier, disturbed soils associated with the construction footprint may be vulnerable to infestation.
Lead Tree (*Leucaena leucocephala*)	Decrease	Cannot tolerate flooding. However, likely to be found in disturbed, upland areas near the construction footprint. Will be a consistent invader in the Frog Pond area.
Melaleuca (*Melaleuca quinquenervia*)	None Expected	This species will continue to be a serious threat in all areas of the project area, regardless of changes in hydrology.
Napier Grass (*Pennisetum purpureum*)	Increase	Has created problems in flood-control systems by blocking access to canals and reducing water flows.
Old World Climbing Fern (Lygodium microphyllum)	None Expected	Experience at Loxahatchee NWR and other management areas suggest that this highly invasive plant will continue to be a serious threat following restoration.
Primrose Willow (*Ludwigia peruviana*)	Increase	Tolerant of sustained flooding and very competitive in nutrient-rich soils.
Torpedograss (*Panicum repens*)	Increase	Soil disturbance associated with the restoration is likely to spread torpedograss. In some areas increased hydroperiod will promote torpedograss and make control more difficult and costly.
Tropical American watergrass (*Luziola subintegra*)	None expected	Due to the wide hydroperiod tolerances, restoration is not expected to affect spread.

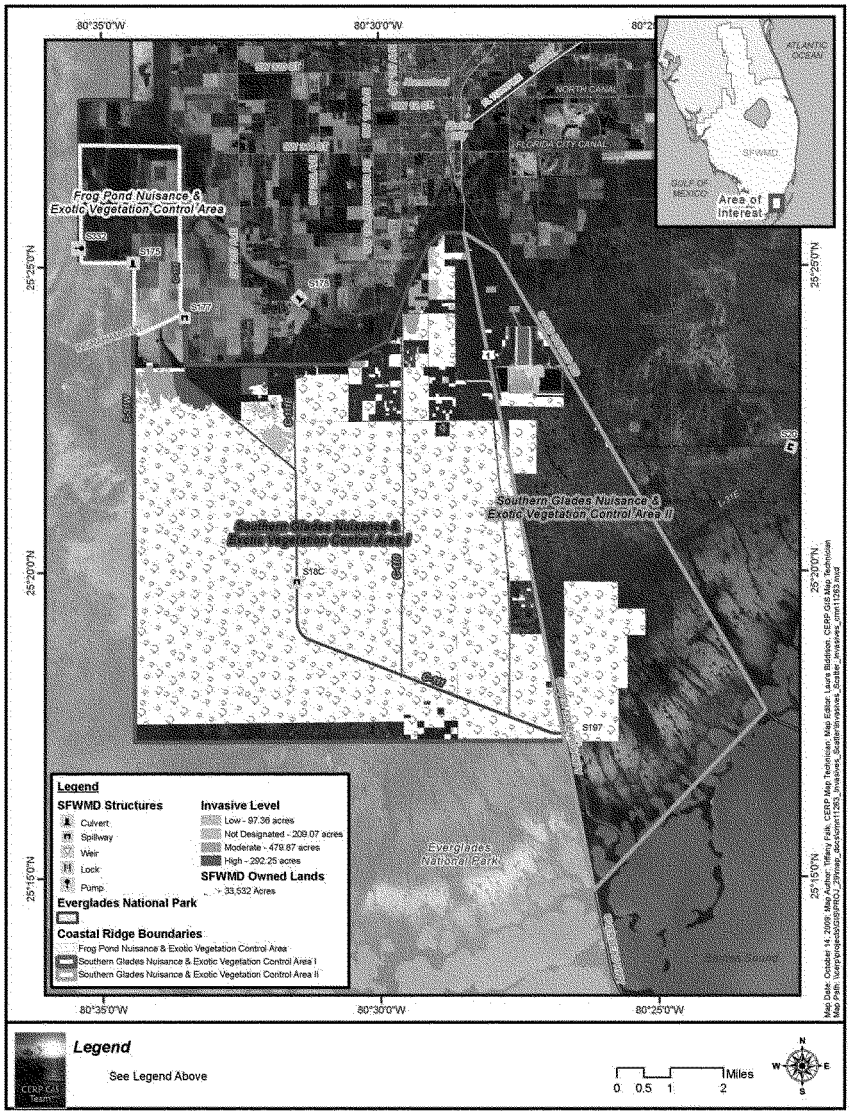


FIGURE E-3: INVASIVE PLANT INFESTATION LEVELS FOR LANDS INCLUDED IN THIS INVASIVE AND NUISANCE CONTROL PLAN
Source: Miami-Dade County, SFWMD

E.5 SPECIFIC PLAN GOALS

While this plan's broad objectives are described in Section 2, the specific focus of this plan must necessarily focus on the following specific goals;

1. Implement a "Quarantine Strategy" for the natural areas of the project area, which focuses initial control efforts in areas with light infestations and move systematically towards areas with heavy infestations.
2. In tandem with quarantine efforts, initiate more intensive (albeit slower) control efforts of heavy infestations in the northern forested fringe (Ecological Zone 2) beginning at the western project boundary (ENP border) and proceeding eastward.
3. Maximize burnable/manageable acreage, where prescribed burns could be employed to restore native groundcover.
4. Maintain low infestation levels where initial control efforts have succeeded in reducing invasive plant populations at maintenance control levels. Maintenance control will be defined as less than 5% total cover of all invasive species.
5. Maintain low infestation levels in the construction footprint (e.g. Frog Pond Detention Area). In areas where substrate removal is needed in order to minimize the costs of vegetation management during the OMRR&R phase, incorporate the substrate into the construction contract.

Implementation of a quarantine strategy will begin on the southern and western boundaries at the border of Everglades National Park (ENP) boundary and proceed to the northeast toward the heavily infested forested fringe areas. Where practical, efforts should be taken to reduce heavy infestations away from shared borders of both private and other public managed lands within the project footprint. The quarantine approach is a proven strategy for halting the spread of invasive plants and reducing overall impacts from invasive species (as well as unavoidable impacts associated with vegetation management activities in densely infested areas). Control efforts are expected to move more quickly in these areas and removal of targeted species can be accomplished with fewer impacts to native plant species.

By far, the greatest ecological impacts from invasive plant species occurs in the forest fringe region, which makes up the northern edge of the project area. The high degree of infestation in these areas necessarily requires more costly and time consuming control efforts. This plan proposes to initiate these efforts first on the western side of the project area in order to provide the most rapid reduction of propagule pressure to ENP wetlands. These efforts would move systematically to the east, northeast. As stated above, biogeochemical disturbances are key drivers to plant invasions in this region. As such, these

areas are expected to be vulnerable to reinvasion over the long-term. Without significant removal of disturbed soils in regions with past agricultural, residential, and industrial land use, intensive invasive species management will be required on a nearly annual basis. This long-term requirement for costly vegetation management makes the case for additional restoration efforts in this region, specifically substrate removal.

The project construction footprint (e.g. FPDA) is particularly vulnerable to invasion by undesirable plant species because of historical farming practices. Without benefit of substrate removal, conditions within the Frog Pond Detention Area would undoubtedly favor species adapted to soil disturbance and/or altered hydroperiods, including Brazilian pepper, cattail, torpedograss, and Burma reed.

E.6 CONTROL METHODS

There are five primary methods that will be employed for nuisance and exotic control in the SDWMA and FPDA: substrate removal, mechanical/manual control, herbicidal control, biological control, and physical control. Biological control efforts will not be specifically funded through this project as it is a system-wide tool and is proposed for full implementation by the Comprehensive Everglades Restoration Plan (CERP) through the Melaleuca and Other Exotic Plants Implement Biological Control Project.

As described previously, removal of the substrate is a cost-effective engineering approach for avoidance of future O&M costs associated with controlling invasive exotic vegetation within the FPDA. In order to minimize the potential for recruitment of exotic or nuisance vegetation, as part of the construction specifications, the contractor will be directed to remove all loose soils to the top of the limestone cap rock below. Tolerances shall be set based on what is typically achievable by bladed mechanical equipment (e.g. front end loader).

Mechanical/Manual control methods will be used primarily in the northern forested fringe area where invasive plant densities are high and standing biomass will limit accessibility and the ability to restore fire to the system. This method utilizes mowers, choppers, "feller-bunchers", chippers, chainsaws, and other machines. In natural areas, the advantages of using machines include immediate removal of unwanted biomass, selective removal of noxious tree species, and opening the canopy for increased light penetration and recruitment of native understory species. Disadvantages include increased cost of operations compared with using herbicidal methods, soil disturbance, slow progress through a site, and accessibility and logistical problems.

Herbicidal control involves the judicious application of chemicals to the targeted plants or underlying soil. This practice is a complex, training-intensive, sometimes controversial, but economically effective technique. Some advantages of this type of control are that herbicides can be selectively used to remove only targeted species; they can be applied more uniformly without producing viable plant fragments; they can achieve longer lasting control; more area can be treated per day; and they are easier and less costly to apply than other controls. Disadvantages include a period of unsightliness in the treated area; treated areas may be temporarily restricted from certain uses by the public; and applicators must be thoroughly trained. When used in accordance with all label statements and all applicable federal and state regulations, the risk to the environment as well as the applicator is minimal.

Herbicides used for vegetation management activities are generally available in three formulations: water soluble, oil soluble, and dry, such as pellets of wettable powders. There are different methods of applying these products based partly on the formulation used, composition of the community of vegetation in which the target plants are growing (selective treatment) and efficiency of covering a given treatment site. For aquatic applications the primary methods include spraying with a handgun or a boom apparatus mounted on a truck, boat or helicopter. Dry formulations can be applied through a spreader device or blower. In terrestrial applications, herbicides may be applied with handgun mounted on a truck (or even a boat), aerial application, backpack sprayer, or from a squirt bottle.

Biological control refers to the use of living organisms which will feed upon, kill, or interfere with the target organism's life processes resulting in the decline of the target species population. Many nuisance plants are not native to the state and therefore have no natural enemies to check their growth and reproductive capabilities. Advantages of using biocontrol agents are that they potentially need only one introduction to provide long-term control. The primary disadvantages are that it requires a significant commitment of initial funding over many years to gain approval for release, it takes a long time for control to be effected and control may not be realized. More information on biological control and its use in the South Florida environment can be found at the CERP website Melaleuca Eradication and Other Exotic Plants Implement Biological Controls - Draft Project Implementation Report - Feb 2009 website. This information, and information on other CERP Projects, can be found at www.evergladesplan.org.

Physical control, or cultural control, is sometimes referred to as environmental manipulation and is practiced in both aquatic and upland situations. In the aquatic environment methods such as drawdowns or water level fluctuation, bottom barriers or shading, species competition, and aeration are used. These

control methods are typically used in cases where there are additional reasons besides vegetation management for their use. For example, in the case of drawdowns, vegetation management is generally secondary to sediment consolidation and oxidation, and fisheries enhancement. One major disadvantage of drawdowns is the waterbody is not useable by the public for an extended period of time. When a drawdown occurs there needs to be a receiving area for the water that is evacuated, and all inlets need to be blocked. For some water bodies this is not always possible or feasible. Shading or the use of water-soluble dyes provides aesthetic considerations and may help retard the growth of vegetation. This method has not been very effective for controlling weeds in southern Florida. Species competition has been useful in some restoration programs. For upland communities controlled burning is a physical means of controlling unwanted vegetation. It has been successfully used in aquatic and wetland areas when conditions become conducive to its application. Although it is normally considered as a component of natural systems management, it can be useful as an invasive species management tool.

The SFWMD uses a combination of these methods in order to maintain nuisance invasive exotic species at the lowest feasible levels. Work will be carried out by SFWMD's contractors following the Vegetation Management Division's Contractor Standard Operating Procedures.

E.7 SURVEY FOOTPRINT AREAS AND MAP EXOTIC/NUISANCE VEGETATION

Monitoring and mapping of nuisance and invasive plant species is a key component of this plan. An effective monitoring program will be cost-efficient, relatively rapid, and contain sufficient spatial information direct vegetation management crews to infestations. To meet these needs, a combination of aerial and ground surveys will be conducted on a two-year cycle during initial plan implementation. The SFWMD and other regional land managers currently utilize an aerial mapping technique known as digital aerial sketch mapping (DASM) to locate invasive plant infestations over large, remote areas. DASM involves "mapping on the fly" with global positioning system (GPS)-linked computers on board low-flying aircraft, typically a helicopter. Flights are conducted on east/west transects on one-kilometer intervals, allowing for a complete census of the land management area. This relatively inexpensive mapping technology (~$0.07/acre) is currently utilized throughout the Greater Everglades, so inclusion of the SDWMA would be a logical extension of this regional, biennial mapping effort.

DASM is not an effective method for detecting small, incipient populations, especially when the invasive plant occupies understories of forested plant communities. Therefore, ground-based monitoring will also be utilized to locate less visible infestations. Given the large size of the management area, a

complete census is not feasible for ground-based monitoring. Instead, land managers must implement a strategic sampling protocol which integrates other data sources (e.g., DASM) knowledge of weed infestation patterns, and priority regions. Land managers should also coordinate with vegetation management crews, field biologists, and others who frequently traverse the landscape to promote efficient communication regarding invasive species locations.

All spatial data for invasive plant infestations will be maintained in a geodatabase and will be linked to the SFWMD's WEEDAR database, which tracks invasive plant treatment activities. A user-friendly map (ArcGIS geodatabase format) using points, lines and polygons of exotic and nuisance vegetation recorded during survey efforts will be produced to facilitate control efforts. Point data will be utilized for less commonly observed species while polygon and polyline data will be presented for more extensive infestations.

E.8 ASSESS EFFECTIVENESS OF EXOTIC CONTROL EFFORTS

Spot assessments will be conducted roughly three to four months following treatments to generally evaluate control methods on target species. Contractor Daily Progress Reports, notes on treatments, and the map of exotic/nuisance species will be used to conduct follow-up evaluation of treatment efforts in a qualitative manner. Emphasis will be on identifying problems and successes in order to better strategize for future control efforts.

E.9 ESTIMATED PLAN COSTS

Removal of the topsoil substrate from the three cells which make up the proposed 583 acre FPDA is estimated to cost $616,400. Based on the infestation levels shown in ***FIGURE E-3***, it is estimated that approximately 1079 acres of the SDWA will require intensive initial and follow-up treatments to reach maintenance level conditions. The estimated unit cost for these intensive control efforts is $4200/acre. The remaining 33,532 acres containing widely-scattered infestations will also require initial and follow up treatment, but at much lower per acre costs. An estimated unit cost of $50/acre will be required for these areas. Based on current resource capabilities, it is estimated that the initial control effort will take six years at a total cost of $6,824,800. It is recommended that removal of the FPDA topsoil, and the first three years of the initial control effort be completed during the period of construction, and the $3,720,600 cost be shared as a project construction cost. It is recommended that remainder of the six year initial effort, be completed after the project becomes operational, that its $3,104,200 cost be divided equally over each of the first there years of operation, and that these costs be shared as a project operation, management, repair, restoration and rehabilitation (OMRR&R) cost. Following the initial six year effort, the 34,611-acre management area will require annual inspections and low-intensity herbicidal and cultural controls (e.g. prescribed fire) to keep

invasive plants at maintenance control levels. Based on an estimated unit cost of $10/acre for this level of treatment, it is estimated that the annual maintenance costs (after the first six years) will be $350,000/year. This estimate also includes monitoring costs, which are necessary to identify and prioritize management needs, and primarily consists of flight services for digital aerial sketch mapping (discussed in Section 7). It is recommended that the estimated $350,000/year annual costs, for maintenance after the six year initial effort be cost shared as project OMRR&R costs.

The SFWMD and other agencies have conducted numerous management trials in the area to develop more financially-efficient methods for invasive plant control. For example, mechanical shredding of dense, monotypic stands of invasive species may substantially reduce long-term control costs and achieve management goals in less time. The SFWMD will continue to evaluate management approaches to reduce costs as the project moves forward.

ANNEX F
REPORTS PROVIDED BY RECOVER TO SUPPORT THE PROJECT IMPLEMENTATION REPORT

TABLE OF CONTENTS

F.1 C-111 SPREADER CANAL PROJECT DRAFT SYSTEM-WIDE EVALUATION REPORT UPDATE (February 27, 2007) F-1
APPENDIX B – PERFORMANCE MEASURE DESCRIPTIONS F-13
F.2 C-111 SPREADER CANAL RECOVER EVALUATION TEAM REGIONAL EVALUATION REPORT TRANSMITTAL LETTER F-15
F.3 C-111 SPREADER CANAL RECOVER PROJECT SYSTEM-WIDE EVALUATION REPORT ADDENDUM FINAL F-19
F.4 C-111 SPREADER CANAL RECOVER CONSISTANCY REVIEW OF PROJECT-LEVEL PERFORMANCE MEASURES (Final June 21, 2004) F-39
F.5 C-111 SPREADER CANAL RECOVER CONSISTENCY REVIEW OF PROJECT-LEVEL MONITORING AND RECOMMENDATIONS FOR INCLUSION INTO THE MONITORING AND ASSESSMENT PLAN F-65

F.1 C-111 SPREADER CANAL PROJECT DRAFT SYSTEM-WIDE EVALUATION REPORT UPDATE (FEBRUARY 27, 2007)

1.0 Introduction and Purpose of Evaluation Update

REstoration COordination and VERification (RECOVER) reviewed the C-111 Spreader Canal (C-111 SC) Project Team final array of alternative plans and developed a system-wide evaluation report in August 2007. The Project Delivery Team (PDT) has requested an update to the system-wide evaluation to address several changes

1. Model Assumptions: recent model assumption changes were limited to comparing two versions of alternative 2D, 2DS (short) that contains an approximately 2 mile aerojet canal and 2DL (long) that contains an approximately 4 mile long aerojet canal. Another model assumption change was restricted to the amount of water routed to the aerojet vs. the rest of the C111. All other model assumptions and post processing techniques have remained the same.
2. New System-wide Insights: The PDT asked if the RECOVER system-wide planning, evaluation, monitoring and assessment efforts had improved our understanding of the contributions the C-111 SC Western Project would make at the system scale.

Due to the limited amount of time allowed to address these two issues, this draft update of the system-wide evaluation only focuses on a general clarification of the project's goals and objectives, new system-wide insights and how the Western PIR, the Eastern PIR and the C-111SC project as a whole fit into the overall adaptive management (AM) approach for CERP. A final draft will incorporate RECOVER's review of the updated modeling output and verify the contributions of the Western PIR to system-wide performance.

1.1 RECOVER and Regional Evaluation Description

The role of RECOVER is to organize and apply scientific and technical information in ways that are most effective in supporting the objectives of the Comprehensive Everglades Restoration Plan (CERP or Comprehensive Plan). One of the primary missions of RECOVER is to work with the project team to evaluate and maximize the contribution made by each project to the system-wide performance of the CERP. The RECOVER Evaluation Team (ET) is charged with the responsibility of conducting system-wide evaluations (previously termed regional evaluations).

The ET is an interagency and interdisciplinary scientific and technical team charged with developing and using performance measures for evaluating alternative plans developed for Project Implementation Reports (PIRs). The purpose of the ET evaluation is to ensure that alternative plans are consistent with the goals and purposes of the CERP. For its evaluations, the ET has developed a suite of approximately 40 ecological performance measures and 8 water supply and flood protection performance measures. Output from the South Florida Water Management Model (SFWMM), which is the primary hydrologic simulation model for the CERP, is used to produce performance measure output. The SFWMM is a regional-scale model that provides simulations of hydrologic conditions at a 2-mile by 2-mile spatial resolution. Because of the large-scale resolution of the model and the relatively small

hydrologic influence of some CERP projects, ET performance measures may not always reveal differences in system-wide performance of project alternative plans. In these cases, RECOVER uses other scientific information to evaluate the potential performance of project alternatives on the system. In the case of hydrologically isolated projects, which is the case for C-111 SC that is at the end of the system, RECOVER can not rely only on regional modeling results for projects. For this project, the scope of RECOVER's evaluations includes reviewing project-level model results and applying best professional judgment.

RECOVER offers four types of evaluations for PDT's: (1) Consistency review of project goals and objectives with the goals and objectives of CERP, (2) Consistency review of project performance measures with RECOVER system-wide performance measures, (3) a system-wide evaluation (formerly "regional evaluation") of the project, and (4) a monitoring plan review. For the purpose of this report, the ET system-wide evaluation does the following[1]:

1. compares the proposed project alternative plans with the expectations of the CERP;
2. describes the performance of each alternative at the system scale using system-wide performance measures, project performance measures, and best professional judgment;
3. identifies improvements to project performance that might improve its system level performance; and
4. provides decision-makers with scientific information needed to recognize the regional performance expectations of specific projects in combination with other CERP projects.

This system-wide evaluation focuses on the Western C-111SC project as the first phase of the project with the understanding that both Western and Eastern phases must be implemented for the project to meet the restoration goals and objectives outlined in the CERP.

2.0 Project Background and General Description of Alternative Plans

2.1 Project Goals and Objectives and Consistency with CERP Goals and Objectives

The C-111 Spreader Canal project was one of the ten projects conditionally authorized for implementation by Section 601(b)(2)(C) of the Water Resources Development Act (WRDA) 2000. The original purposes of the C-111 Spreader Canal Project as stated in the Yellow Book are:

RECOVER System-wide evaluation standard operating procedure: http://www.evergladesplan.org./pm/recover/recover_docs/et/rec_sop_reg_eval_current.pdf

1. improve deliveries and enhance the connectivity and sheetflow in the Model Lands and Southern Glades areas,
2. reduce wet season flows in C-111, and
3. decrease potential flood risk in the lower south Miami-Dade County area.

The original project objectives developed by the PDT consistent with the goals above were as follows:

- Improve flow patterns, hydroperiods, and ecological connectivity of the Southern Glades, Model Lands and adjacent natural areas
- Improve habitat, functional quality of existing natural areas and increase spatial extent where practicable
- Improve native plant and animal species abundance and diversity
- Reserve sufficient water for the restoration of the natural system
- Eliminate ecologically damaging flows through C-111 Basin to Barnes Sound and Florida Bay
- Provide ecologically compatible water quality consistent with restoration goals and federal and state requirements applicable to the Southern Glades, Model Lands and ENP

Due to stakeholder concerns and a number of decision-critical uncertainties associated with the entire C-111 SC project, the proposed project was split into two separate projects; the C-111 SC Western project and the C-111 SC Eastern project (see section 4 and 5 of the C-111 SC Western PIR). The Western PIR is intended to help address the following objectives related primarily to increasing flows to Florida Bay via Taylor Slough:

- Restore the quantity, timing, and distribution of water delivered to Florida Bay via Taylor Slough to historic levels derived from the pre-drainage models;
- Improve hydroperiods and hydropatterns in the Southern Glades and Model Lands. The hydroperiods will be improved to optimal levels to support historical vegetation patterns as derived from the pre-drainage models; Hydropatterns will be restored to historical sloughs and associated tributaries.
- Return coastal zone salinities to historical, recorded conditions through the redistribution of water that is currently discharged to tide.

The CERP Plan specified ecological, economic, and social well being goals. These include enhancing ecological values by increasing spatial extent of natural areas, improving habitat and functional quality, improving native plant and animal species abundance and diversity; and enhancing economic values and social well being by increasing available fresh water, providing recreational and navigation opportunities, and protecting cultural and archaeological resources and values (USACE and SFWMD, 1999). The CERP Plan also recognized that there were several performance issues that needed to be addressed during detailed project planning and design, including:

1. The plan needs to increase total overland flow to Florida Bay, northeast Shark River Slough and Taylor Slough to fully meet Natural System Model depth and duration targets;
2. The plan needs to improve ecological performance in the Water Conservation Areas by eliminating damaging high and low water conditions;
3. The plan should improve ecological conditions in Biscayne Bay by restoring more natural freshwater inflows;
4. The risks and uncertainties associated with using wastewater reuse as a water source for Biscayne Bay should be closely examined;
5. Restoration targets in the St. Lucie Estuary should be more closely met; and
6. The plan needs to improve ecological performance in the Model Lands and C-111 Basins by providing adequate freshwater to maintain target hydropatterns

The Western PIR's objectives are consistent with the need to increase total overland flow to Taylor Slough by ensuring current and future flows developed by the remaining CERP projects maintained in Taylor Slough. They are also consistent with the desired restoration condition identified in Southern Estuaries salinity performance measure for Florida Bay.

> "Provide less abrupt and less extreme decreases in salinity in the northeastern bay. Reduce the frequency, duration, magnitude, and extent of hypersaline conditions throughout the bay. Increase the frequency and extent of lower salinity conditions in the bay. Restoration of timing entails restoration of fresh water flows that continue after the end of the rainy season. This is associated with restoration of the wetland's function as a hydrologic buffer. In the mangrove estuarine areas, lower salinity to oligohaline levels in coastal lakes and basins."

They are also consistent with more specific goals and objectives defined by the yellow book for the C-111 SC (see Appendix A). However, achievement of these goals and objectives by the C-111 SC project will require several other key CERP and non-CERP projects described in Table 2.

Table 2: CERP and Non-CERP Projects that Influence C-111 SC Benefits

1. Modified Water Deliveries to Everglades National Park Project,	2. Conveyance between Water Conservation Area 3A and Water Conservation Area 3B,
3. Conveyance between Water Conservation Area 3B and Northeast Shark Slough (Tamiami Trail),	4. 8.5 Square Mile Area,
5. Interim Structural and Operation Plan (ISOP) and Interim Operational Plan (IOP),	6. Combined Structural and Operational Plan (CSOP),
7. Biscayne Bay Feasibility Study,	8. Biscayne Bay Coastal Wetlands Project (BBCW),
9. Florida Bay & Florida Keys (FB&FK) Feasibility Study,	10. Save Our Rivers Model Lands and Southern Glades Projects,
11. Florida Power & Light Company South Dade Mitigation Bank,	12. RMC South Florida, Inc. Mitigation Area, and
13. West Dade Wastewater Reuse Technology Feasibility Study	

2.2 Additional Project Background

A PDT was formed to prepare a PIR for the implementation of the proposed C-111 SC project. The PDT determined that the proposed project as originally described in the YB could not meet the goals and objectives envisioned for the C-111 SC project (See section 5.2 of the draft Western PIR). The PDT reformulated the proposed project, developing more specific goals and objectives for the planning process that would maximize environmental restoration potential within the project area and that are consistent with CERP restoration goals and objectives. Management measures were formulated that included Stormwater Treatment Areas, canal construction and backfilling, detention areas, and pump stations. Management measures were combined to produce 21 alternative plans that were screened based on constraints such as environmental impacts to adjacent areas, redundancy with other alternatives, costs significantly above projected levels, etc. Subsequent screening of the alternative plans produced a final array of 7 plans that were based on reducing seepage from Taylor Slough and early benefits in Southern Glades/Model Lands.

A major complication to the C-111 SC project is the fact that the 1994 C-111 South Dade General Reevaluation Report (GRR), initiated by the U.S. Army Corps of Engineers and the South Florida Water Management District, was not constructed. The 1994 GRR was focused on four main objectives

- restoration of hydrologic conditions in the C-111 Basin (Taylor Slough and eastern panhandle of ENP);
- projection of Natural Values associated with the ENP;
- elimination of damaging freshwater flows to Manatee Bay/Barnes Sound; and,
- maintenance of flood protection for the C-111 Basin, east of L-31N and C-111.

The following features recommended in the 1994 GRR have not been constructed:

- A spreader canal from C-111 to U.S. Highway 1
- A 50 cfs spreader canal pump
- 10 plugs in the C110
- Backfill the L31W from S176 west to S332

2.3 Adaptive Management Approach

An adaptive management approach was developed to address these decision-critical uncertainties over the course of implementing both C-111 SC PIRs

1. What is the volume (and timing) of water which will be available for the spreader canal from S-177 discharges following implementation of all C 111 South Dade/MWD features, and C-111 SC Western features?
2. Based on the amount of water available for the spreader canal, what are the most appropriate alignment and design for the spreader canal in order to maximize ecological restoration without adversely impacting privately owned lands?
3. Will present trends in S-178 water quality improvement continue, or would an infiltration basin and/or source controls be required to sufficiently improve the quality of S-178 discharges to the degree necessary to ensure that water discharged from the future spreader canal is "marsh ready?"
4. How can drainage features best be eliminated for restoration without causing flooding impacts to agricultural lands in the project area?

The Western PIR incorporates the principles of incremental adaptive restoration in the 2006 and 2008 National Research Council (NRC) biennial report on Everglades restoration progress. The principles state that projects faced with decision-critical uncertainties should design project increments to achieve early restoration benefits and learning benefits critical to completing the full project or grouping of projects needed to achieve system-wide restoration performance. The C-111 SC approach is compatible with the overall CERP AM approach supported by the NRC and summarized as follows:

1. The answer to uncertainty #1, specifically, "What is the volume (and timing) of water which will be available for the spreader canal from S-177 discharges following implementation of all C-111 South Dade/MWD features, and C 111 SC Western PIR features?" will become clear following completion of the South Dade/MWD and C-111 SC Western PIR features.
2. The answer to uncertainty #2, specifically, "What is the most appropriate alignment and design for the spreader canal in order to maximize ecological restoration without adversely impacting privately owned lands?" will be answered through construction of a reduced scale spreader canal design test feature (C-111 SC Design Test), which is currently being formulated as a separate project, and documented under a separate NEPA document.
3. The answer to uncertainty #3, specifically, "Will present trends in S-178 water quality improvement continue, or would an infiltration basin and/or source controls be

required to sufficiently improve the quality of S-178 discharges to the degree necessary to ensure that water discharged from the future spreader canal is marsh ready?" will be answered over time. Ongoing monitoring of S-178 discharges will be continued even beyond initiation of the subsequent C-111 SC Eastern PIR. If improvements in water quality over time do not appear to be sufficient to provide reasonable assurances that water discharged from the future spreader canal will be marsh ready, a reduced scale test feature and/or source control program, which would be formulated as separate projects, and documented under a separate NEPA document, will be recommended.

4. To answer uncertainty #4, Western PIR intends to reduce seepage from Taylor Slough and increase more natural flows to Eastern Florida Bay via Taylor Slough. Learning opportunities contained in the operation of the Frog Pond and Aerojet canal will be focused on addressing constraints related to Cape-Sable Seaside Sparrow, agriculture, and potential unintended impacts, as well as through passive AM application coupled with RECOVER/project joint monitoring and assessment, determine how much additional water may be needed to reach full system-wide goals and objectives for Taylor Slough and Florida Bay.

2.4 General Description of Alternative Plans

The C-111 SC Project identified their final array of seven project alternative plans.

Alt1C	Includes FPDB and pump for FPDB, consistent with the State Expedited Construction plan; FPDB is approximately 530 acres; the FPDB pump intercepts two thirds of S-176 flow; FPDB maximum depth of 3 feet
Alt1D	Same as Alt1C, plus: two operable structures in the lower C-111, one plug at S-20A, and operational changes at S-20.
Alt2DS and 2DL	Includes FPDB approximately 530 acres with maximum depth of 3 feet, pump for FPBD intercepts one third of S-176 flows, gravity structure upstream of S177 to discharge into Aerojet Canal., two operable structures in the lower C-111, one plug at S-20A, and operational changes at S-20. Alt 2DS and 2DL differ in the length of the Aerojet Canal.
Alt3D	Includes FPDB approximately 530 acres with maximum depth of 3 feet, pump for FPDB intercepts one third of S176 flows, pump upstream of S-177 to discharge into Aerojet Reservoir , two operable structures in the lower C-111, one plug at S-20A, and operational changes at S-20.
Alt4D	Increase pumping at S-332D (maximum of 1,000 cfs), two operable structures in the lower C-111, one plug at S-20A, and operational changes at S-20.
Alt6D	Construct seepage barrier from northern portion of L-31W (just west of S-332D) south along FPDB to the southern end of Aerojet Canal, two operable structures in the lower C-111, one plug at S-20A, and operational changes at S-20.

After the first increment (Western PIR), the PDT will use information feedback from the AM approach to determine the proper trade-offs in restoring the Southern Glades and the Model Lands and better develop the second PIR (eastern). Both PIRs have features that will compete for the overall amount of water being delivered to the project area. The opportunity exists for more water to be available to the project from the implementation of future CERP projects.

3.0 Evaluation Methodology and Information Considered

A final array of alternative plans has been modeled using the MODBranch model. All alternatives use the 2050B3 SFWMM as a boundary condition. Plan evaluation was performed by comparing the alternatives with the aforementioned boundary condition to the future without project condition. This comparison included the current authorized features for the 1992 Modified Water Deliveries General Design Memorandum as well as the 1994 C-111 GRR features completely built out (including the 50 CFS S332E pump at C-111N) and land use updated to 2050. The Combined Structural and Operational Plan (CSOP) was

not included in the comparison since it is not currently approved. The following rationale also was considered.

- The location of the CERP C-111 SC project is located at the bottom of the regional water system, therefore, does not affect features upstream. In other words, the spreader project is the receiving body of CERP flows through the S177 structure.
- The SFWMM flows from the future without CERP projects are similar to the with CERP projects at the S177 (critical structure used to determine flows to the spreader canal) (Figure 2). This means that whether or not CERP boundary conditions (system evaluation) or future without boundary conditions are used, similar results should be obtained in the overall evaluation and comparison of alternatives.

4.0 System-wide Performance of Alternatives Plans

As indicated above, the PDT used an existing MODBranch model to conduct simulations during the PDT's alternative plan evaluation efforts. The existing MODBranch model was developed to simulate three individual years intended to be representative of average (1978), dry (1989), and wet (1995) conditions. As such, the PDT's evaluations are limited to comparisons of each alternative plan to a "pre-drainage" target condition (i.e., canals and structures removed from model domain) for each of the referenced single-year simulations within/near the C-111 basin.

The PDT used three performance measures most closely associated with the reframed subset of project objectives for the western PIR for purposes of quantifying differences between the plan alternatives. Appendix B contains the specifics of the following performance measures: 1) Flow Timing and Distribution; 2) Hydroperiods; and 3) Stage-Based Estuarine Salinity Estimates. Due to project performance dependencies on other CERP projects and the fact that this project does not create any additional "pulls" of water, the performance of each plan alternative is difficult to differentiate.

However, the RECOVER Band 1 system-wide planning and evaluation effort, simulated by the South Florida Water Management Model (SFWMM) version 5.7, includes performance of 10 initial CERP projects anticipated to be implemented in the 2015 timeframe, including the C-111 SC Western PIR. Performance in the southern estuaries subteam area indicates slight decreases of salinity in the Taylor River and Little Madeira Bay, which are downstream of Taylor Slough. This suggests that the performance of C-111 SC Western PIR coupled with the other initial CERP and foundation projects (Modified Waters Deliveries, Rain Driven Operations, and Everglades Agricultural Area Reservoir), reduces in both duration and intensity the peak high salinities that are occurring now and are projected to worsen in the future. This is expected to improve conditions within the estuarine community and contribute to the overall ecological health of the region, consistent with the desired restoration conditions stated above. There are uncertainties related to when those projects will be completed and assumption is made that they will be in time.

5.0 Conclusions

As indicated before, this updated system-level evaluation does not include an evaluation of the new modeling output, therefore the following August 2007 conclusions are considered to be draft. RECOVER used tools that the PDT developed to evaluate the Western PIR of the C-111 SC project because the model that RECOVER prefers for evaluating systemwide performance operates at too gross of a scale to perceive the differences between project alternatives. RECOVER has reviewed the performance measures selected by the PDT and finds them adequate for evaluating the difference between alternative plans and generating the benefits of the alternative plans.

RECOVER recommends clearly linking the project monitoring plan to the second PIR (eastern PIR) schedule to ensure that information will be available in time to improve the second PIR. The monitoring plan should also link to potential management actions associated with both PIRs that may be taken to adjust the project based on the new information.

RECOVER encourages the PDT to begin planning for the eastern PIR because the full benefits of the C-111 SC project will not be achieved without the construction of the eastern PIR. RECOVER also encourages the completion of the many projects listed above which CERP and the C-111 SC depends on for the achievement of the project goals and objectives.

RECOVER recommends that future program-level evaluations review additional water to be made available to the suite of Biscayne Bay and Florida Bay projects including this project.

6.0 References

USACE and SFWMD, 1999, Central and Southern Florida Project Comprehensive Review Study Final Integrated Feasibility Report and Programmatic Environmental Impact Statement, U.S. Army Corps of Engineers Jacksonville District, Jacksonville, Florida and South Florida Water Management District West Palm Beach, Florida.

Appendix A: C-111 Spreader Canal Project Goals and Objectives

Project Goals

1. **Improve habitat and functional quality.** Healthy freshwater wetlands in the Southern Glades will be preserved and productive freshwater wetlands will be established in the Model Lands area. Improvements to Manatee Bay and Barnes Sound will require the establishment and maintenance of a freshwater/salinity balance that will sustain estuarine ecosystems.
2. **Improve native plant and animal species abundance and diversity.** Project design and implementation must seek to balance potentially competing needs of plants and animals that are characteristic of freshwater wetlands with requirements of seagrasses and saltwater fishes. Attention will be given to impacts to endangered species such as the indigo snake, Cape Sable Seaside Sparrow, and manatee that may be present in the project area. Efforts will also be directed to the control of exotic plants and animals, e.g. melaleuca, Brazilian pepper, grass carp and Asian eel.
3. **Reserve sufficient water for the restoration of the natural system.** This goal will be addressed by looking at the seasonal water availability, seasonal salinity fluctuations in Manatee Bay, and the impact of the C-111 Spreader Canal project within the existing, regional water budget. Sufficient water will be defined in terms of both quantity and timing of delivery.

Project Objectives

1. **Restore more natural flow patterns, hydroperiods and ecological connectivity between the Southern Glades, Model lands and adjacent natural areas.** Hydrologic targets and performance measures will be developed to guide project planning and design. This includes the establishment of site-specific flow patterns and water depth needed to create or sustain freshwater wetlands. Impediments to ecological connectivity, such as berms and roadways, will be evaluated.
2. **Eliminate project-induced ecologically damaging flows through C-111 to Barnes Sound and Florida Bay.** Hydrologic targets and performance measures will be developed to address the distribution between overland flow and tidal creeks and to account for the effect of sea level changes. The need for a transition zone model will be considered. Achievement of this objective is to be accomplished by the backfilling of existing canals and removal of water control structures. Project planning and design phases will evaluate how to implement these components without sacrificing operational flexibility, efficiency and effectiveness.
3. **Provide ecologically compatible water quality consistent with Federal and state requirements applicable to the Southern Glades, Model Lands and Everglades National Park.** Although water quality within the C-111 basin currently meets established water quality standards, the C-111 Spreader Canal project will modify the direction and volume of flow in ways that may result in unacceptable changes to the water quality. Project implementation will involve tasks to: identify the water quality needs of the various wetland, marsh and estuarine ecosystems within the project area, assess potential adverse impacts, and evaluate ways to deliver water of acceptable quality to the natural systems. Efforts to determine applicable Federal, state and local regulatory

requirements will be undertaken. Permitting requirements and associated compliance monitoring regimes will be identified.

Appendix B – Performance Measure Descriptions

The **flow timing and distribution** performance measure is very similar to that being considered for adoption by RECOVER's Greater Everglades Subteam. The timing element of the PM quantifies the volume discharged across the transect as a percentage of the total volume discharged across the transect over the coarse of one year. The distribution element of the PM quantifies the volume discharged across the transect as a percentage of the entire volume being discharged across all transects (i.e., all water flowing to tide) during an individual day, for each day of the year. For MODBRANCH, this "mapping" of the transect's the annual discharge and contribution to the total volume being discharged to tide are performed for each of the three single-year simulations. The charted relative contributions for each alternative are compared against that of the "pre-drainage" condition for the like year. The degree to which the alternative's discharges across the transect exhibit a larger/lesser contribution than that of the target is then used to compute an index on a scale from 0.0 to 1.0 (0 deviation from target yields a score of 1.0).

The **hydroperiod performance measure** characterizes the range of hydroperiods experienced within each landscape-scale indicator region (expressed in terms of 30-day classes) and characterizes the relative presence of each hydroperiod class within the indicator region (expressed in terms of percent-area experiencing a hydroperiod within the noted hydroperiod class). This performance measure is intended to be an indicator of (or surrogate for) vegetation community type. Therefore, charted values are discontinuous hydroperiods. The differences in percent-area between the target condition and each alternative are computed for each hydroperiod class. The degree to which the percent area experiencing a given hydroperiod class differs from that of the target condition is then used to compute an index on a scale from 0.0 to 1.0 (0 deviation from target yields a score of 1.0). If the relative abundance/presence of hydroperiods within the indicator region is identical to that of the target condition, the total deviation from target = 0 (and would yield an index score of 1.0).

The **salinity performance measure** is based on stage-salinity relationships/formulae provided by ENP researchers. The performance measure characterizes the range of salinities experienced within each of several estuarine/marine sub-basins (e.g., Long Sound, Joe Bay, Manatee May, Barnes Sound, etc.) in terms of salinity class (at 5 ppt intervals) and duration. The basin and year-specific salinity durations exhibited for each alternative are compared against those yielded by the target condition. The degree to which the salinity durations for the alternative differ from that of the target condition is then used to compute an index on a scale from 0.0 to 1.0 (0 deviation from target yields a score of 1.0).

F.2 C-111 SPREADER CANAL RECOVER EVALUATION TEAM REGIONAL EVALUATION REPORT TRANSMITTAL LETTER

REstoration COordination and VERification (RECOVER)
Evaluation Team, Regional Evaluation Report

TRANSMITTAL LETTER

March 27, 2009

Project Managers and Planning Technical Leads
C-111 Spreader Canal Project
Comprehensive Everglades Restoration Plan

Dear Project Team Managers and Planning Technical Leads,

RECOVER has completed its regional evaluation of the C-111 Spreader Canal Project (C-111 SC) alternative plans. The attached addendum should be used in conjunction with the initial report delivered on February 27, 2009.

RECOVER's evaluation of project alternatives fulfills the following requirements as prescribed by the Programmatic Regulations:

1. Support project teams to achieve consistency with the CERP's goals and objectives;
2. Document the performance of the project alternative plans using RECOVER approved system-wide performance measures, project performance measures (when appropriate), and best professional judgment. RECOVER determines the ability of each alternative plan to meet the targets established for each performance measure and describes the resulting effects upon the natural system. When appropriate, RECOVER evaluations include a qualitative analysis on how the project fulfills CERP goals and objectives;
3. Suggest improvements to the project, which if pursued could improve project performance or enhance benefits to the natural system;
4. Provide insight, if possible, and alert the project teams of any inconsistent modeling assumptions for the project as originally modeled in the CERP.

Recommendations discussed within the RECOVER regional evaluation report generally fall into one of three categories:

1. Recommendations that can easily be incorporated into the plan formulation process;
2. Recommendations that are more conceptual in nature, which the Project Team may select to incorporate into preliminary designs to improve project performance; and
3. Recommendations that are crucial to the project, but cannot be addressed prior to the AFB meeting.

Concerning the latter category, RECOVER significantly expedited its regional evaluation to satisfy the need for timely reporting, while bringing forward as much science as possible. Therefore, RECOVER may provide additional information supporting and refining the original regional evaluation, if additional information becomes available from the Project Delivery Team.

Best regards,

RECOVER Evaluation Team

F.3 C-111 SPREADER CANAL RECOVER PROJECT SYSTEM-WIDE EVALUATION REPORT ADDENDUM FINAL

C-111 Spreader Canal Project
System-wide Evaluation Report Addendum*

Prepared by RECOVER Evaluation Team (ET)

Contributors: Andy Gottlieb and Dan Nehler

March 27, 2009

** This document should be used in conjunction with the updated regional evaluation report provided to the PDT on February 27, 2009.*

The following document is a brief addendum to the updated C-111Spreader Canal (SC) Regional Evaluation provided by RECOVER to the C-111SC Project Delivery Team (PDT). This addendum is focused on three components of the updated Western Project Implementation Report (PIR) (phase I): 1) Specific Performance Measures (PMs) selected and relevance to project and CERP goals, 2) changes in model assumptions, project objectives and related operations, and review of project alternative performance, and 3) new information available from RECOVER including relationship of phase 1 of C-111SC performance within the context of CERP performance under Band 1 conditions (see MISP http://www.evergladesplan.org/pm/pm_docs/integrated_schedule/022708_task_mtg/2e_2005_misp.pdf and Draft RECOVER Band 1 report for details). A fourth section identifies minor updates from the previous evaluation. (Feb 2009).

In the first regional evaluation RECOVER included a short description of the alternatives (C series) and the relationship to system-wide goals of CERP (August 2007). The updated regional evaluation was requested because the C-111SC PDT split the project into two separate PIRs (Western PIR and Eastern PIR) prompting the development of additional model runs including the 2D alternative. During the second round of modeling, alternative 2D was optimized to make better use of available water and two alternatives were created (2DL long and 2DS short). Alternative 2DL is the same as the original 2D alternative, while 2DS is an optimized version of 2D using only one-half of the Aerojet Canal feature.

The following information should be used in conjunction with the draft report provided to the PDT in February 2009.

I) The three hydrologic PMs utilized by the C-11SC PDT, as noted in RECOVER's PM consistency review (http://www.evergladesplan.org/pm/recover/recover_docs/et/et_reviews/et_rev_c-111_pm_review.pdf), are generally consistent with the CERP system-wide goals and objective and relevant to the C-111SC goals. Although the PIR is now phased and the current objectives focus primarily on Taylor Slough and the western components, the PMs selected are still relevant tools to be used with comparisons of alternative performance.

   a. General Comments:

      i. Uncertainty- The project team characterized uncertainty with the MODBRANCH model. Little discussion of uncertainty regarding PM targets was provided beyond that of ranking PMs. The RECOVER PM documentation sheets (http://www.evergladesplan.org/pm/recover/eval_team_perf_measures.aspx), the model uncertainty report (2002), and the model needs document

2

(2005) all provide additional discussion regarding PM and model uncertainty.

ii. Evaluation of Benefits- Although the methods are described sufficiently, little direct link between the specific change in salinity, flow, or stage is provided. RECOVER reviewed the specific flow and salinity changes in the intermediate spreadsheets noted in the benefits analysis and has included this linkage to provide a better understanding of the relative magnitude of change in performance and the actual projected or estimated conditions (Flow and salinity discussion in section III of this addendum).

b. PM specific comments:

i. Coastal zone Salinity PM (2.4) and associated acreages used- The focus of phase 1 of the C-111SC project is on Taylor Slough (TS). This is an area of hypersalinity and one of the key reasons to redistribute flows (Lee et al. 2006). Deliveries to TS also directly affect FBs larger acreage (Nuttle et al. 2000). This larger acreage was not used in the calculation of benefits (HUs). Given that changes in TS are the greatest and the focus of the project, and benefits translate directly downstream, it is likely that some portion of the FL Bay acreage should be included in the benefits estimate (Figure 1- salinity series). As noted in the Band 1 figure, benefits likely fall somewhere in between the coastal fringe noted by the project team specific results (Figure 1) and the Band 1 estimated far field effects (Figure 2). This is likely a significant underestimate of the benefits to FL Bay given the constraint of acreage to Barnes Sound, TS, Little Madeira, Blackwater Sound, and Long Sound)

ii. Location of Flow Transects Used (PM 1.5)- Similar to the issue noted above, the goals of the project related to flow are to redistribute flows from E to W and to provide a temporal shift in flows toward dry season deliveries. Given that phase one is focused on benefits to TS, one should expect a shift in deliveries to the West (w/corresponding reductions to the east). Because no additional water is available a corresponding reduction of inflows to the east should be expected (Figure 3- Transects T3 and T4).

iii. Vegetation Hydroperiods (PM 2.1)- A project goal identified in the Restudy is to improve deliveries and enhance hydraulic connectivity and sheetflow in the Model Lands and Southern Glades areas. The objective of this metric is to minimize each alternative's deviation from the target.

3

The resulting measure of agreement with the Target condition was expressed as an index of 0.0 to 1.0 (with 1.0 representing an ideal match to the target, 0.0 representing little/no resemblance to the target condition) for each indicator region for the Baseline condition and each Project Alternative condition. As noted in the RECOVER PM consistency review there are some small differences between this PM and RECOVER PM targets thou they are generally consistent. The linear function used to describe benefits is useful but ongoing project monitoring should help to reduce uncertainties regarding specific vegetation community optima and tolerances and their response to changing hydroperiods. Hence, with additional input from ongoing vegetation monitoring being conducted in the Greater Everglades, refinements to the existing linear assumption can be made and applied to future efforts.

II) Changes in Model Assumptions and Related Alternative Performance:

In the first regional evaluation RECOVER included a short description of the alternatives (C series) and the relationship to system-wide goals of CERP (August 2007). The updated regional evaluation was requested because additional model runs were conducted including the 2D short and 2D long alternatives. The 2 D long alternative was added during the second round of modeling. This alternative differs from the short alternative by extending the Aerojet canal by an additional 2 miles (see table 2 of main report for list of alternative descriptions).

a. Results of the previous model runs are similar to current (Figures 1A-1F) except for the addition of both the 2D long and 2D short alternatives.
b. The following review of alternative performance focuses on the updated modeling and analysis conducted by the PDT.
    i. Salinity PM- As noted by the project evaluation of benefits (Table 1), alternatives 2DL, 2DS and 6D perform the best. Although formulation without (FWO) and Existing CERP Baseline (ECB) perform well overall, they do not provide additional benefit to TS which is the focus of phase 1 of the C-111SC project. The actual magnitude of change in salinity is noted in figures 1D-1F for a subset of the basins under the dry year condition (1989). Taylor Slough and Little Madeira show a reduction in the total number of days experiencing the highest (undesirable) salinity classes.

    ii. Flow PM- Table 2 displays the calculation of benefits associated with the flow PM. Because limited additional storage is available under the with

4

project scenarios, gains on distribution are expected over those of timing. alternatives 2DS, 2DL and 6D perform the best regarding shifting the distribution of flows to match natural system conditions. RECOVER linked the relative changes noted in the project benefits analysis to the actual magnitude in changes in flow. Figures 4A-4C characterize cumulative flow across transects (Figure 3) for the three best alternatives. There is an approximate 40-50 K acre-ft increase in overall flows under the 2DS and 2DL alternatives which add to the distribution and timing benefits noted in table 2.

Although the project team expressed concerns over high flows at the S-197, it is unclear whether these flows are damaging flows to the estuary. Understanding the return frequency of such events relative to the Natural System Model targets is important to obtaining ecological health. The discussion of the importance of understanding annual and inter-annual variability continues in section C below.

iii. Vegetation PM- Table 3 displays the calculation of benefits conducted by the PDT. As measured using this metric, under average hydrologic conditions, all of the with project alternatives provide improved vegetation hydroperiod conditions relative to the No Action Alternative. Under dry year conditions, the with-project alternatives are only slightly better than the No Action Alternative. This is not surprising since during dry years there is very little water available to be diverted or detained by project features. Under wet year hydrologic conditions, most of the with-project alternatives provide slightly worse vegetation hydroperiod conditions as measured by this performance metric. Alternative 6D provides the most lift under average and wet year conditions while 2D short provides the best conditions for dry years.

c. PMs and scoring

i. As noted in the previous evaluation and in the project documentation, the MODBRANCH model run is based on three years (wet, dry and average). In most cases (Flow and Salinity) the project team looked at average annual performance for all three years combined. Although perfectly acceptable, average year potentially underestimates or masks seasonal benefits (and does not allow one to understand return frequencies of specific types of events). Hypersalinity and reduced flows are more of an

issue in dry years. Additionally, within year benefits may be masked as well (see Figures 6A and 6B Southern Estuaries salinity figures from Band 1 where average annual decrease in salinity is approximately 1.1 ppt while monthly shifts may be as high as 4.5 ppt). Either method of analysis is valid given the many ways to divide up or weight the PMs and their components. Looking at annual and interannual variation adds to the ecological intent of the PMs.

III) New information related to system wide goals of CERP:

a. Other potential information (beyond existing monitoring, etc)- the recent Band 1 model run conducted by RECOVER suggests that C-111 in combination with a suite of 10 projects (identified as Band 1 projects in the MISP*) produces substantially more benefit over a much larger area (Figure 2- Map identifying far field effects of Band 1 in FL Bay). The C-111 project is an important component in the Band 1 model run helping to increase flows to Taylor Slough and E marshes of the Greater Everglades (Figures 7 and 8- Transect 23 flows and Transect map) and correspondingly start to reduce salinities in FL Bay (Figures 6A and 6B). (Additional model output for the entire suite of RECOVER salinity stations is available for the Band 1 effort is desired. The figures presented identify the far field effects (of band 1) thereby establishing the larger domain benefited by contributions of the C-111 SC project. Both the transect flow results and the salinity results in Band 1 are consistent with the PDT benefits analysis.

IV) Clarifications to February 2009 evaluation:

a. S-177 Flow assumptions:
   Although the S-177 flows under Cerp0 and 2050B3 condition are nearly the same, many of the components of the future without project condition have not yet been implemented (as detailed in the February 2009 report). It is likely more appropriate to compare to existing conditions to determine the differences between with project conditions with CERP and the no action alternative. This will provide a more realistic comparison based on current projects and operations. This has implications on the Greater Everglades boundary model conditions as can be seen by the magnitude of change in flow at the S-177 (Figure 9).
b. With and without project assumptions and affects on boundary conditions.
   i. The previous evaluation clearly described that the C-111 SC project is at the lower end of the Greater Everglades System feeding into Southern Estuaries. Because the project is at the end of the GE flowpath, there are

6

minor effects on the boundary conditions of the Greater Everglades. In general the differences in the split of water between the alternatives (1/3 and 2/3rd split) and the effectiveness of the seepage buffer are the two factors effecting the eastern edge of the GE within Everglades National park. Later components of the C-111 SC are expected to provide water to the eastern most components of the Greater Everglades domain (Model lands). As noted in the project flow and salinity documents, the GE boundary provides inflows in to the estuarine component of the project domain.

Conclusions:

This addendum to the regional evaluation characterizes changes in model alternative assumptions as well as corresponding performance of the alternatives, and links alternative performance to the system-wide goals of CERP. The PMs selected are consistent with the goals and objectives of the C-111SC project as well as the overarching system-wide goals and objectives of the CERP. The C-111SC PDT documented that due to differences in hydrologic model codes (SFWMM versus Modbranch), scale (regional versus local), temporal and spatial resolution (coarse versus fine), and simulated period of record (36-year continuous versus three individual average, wet, and dry-year simulations), RECOVER system-wide performance measures developed for application with the SFWMM could not be used directly with the Modbranch model. As a result, PMs were designed to detect intended and unintended effects within the study area associated with greater retention and improved distribution of water in eastern ENP. The PDT developed performance metrics that would be capable of measuring ecologically-significant hydrologic stressors which are embedded in RECOVER performance measures, but at a project-level scale and in a manner that is more appropriate for the finer-resolution, basin-specific Modbranch model application being used by the PDT. The applied performance metrics identified by the PDT [Sheetflow timing and distribution (PM 1.5); Hydroperiod-inferred vegetation communities (PM 2.1); and Stage-inferred coastal zone salinities (PM 2.4)] measure changes in the timing of overland flow distribution to Taylor Slough, and hydroperiods and water depths/stages within the study area.

The C-111SC is primarily intended to improve the quantity, timing, and distribution of water delivered to Florida Bay via Taylor Slough. It is anticipated that these improvements can be realized through the establishment of a hydraulic ridge between Taylor Slough and the C-111 Canal, to reduce seepage from Taylor Slough, and its headwaters. The hydraulic ridge will be established by combining operational changes within the lower C-111 Canal (south of S-177), and the diversion of water that is currently being discharged through S-177, S-18C and S-197 to the existing Aerojet Canal, and an above ground detention area, to be constructed within the SFWMD owned Frog Pond lands. Marsh stage triggers in Taylor Slough, and elsewhere in the

adjacent basin, will be used to manage pumping rates, and to increase the net water distributed west of the existing C-111 Canal system. Although the recommended plan's primary focus is on improvements to Florida Bay, the plan is also intended to improve hydroperiods within the wetlands of the Southern Everglades and Model Lands. This will largely be accomplished by proposed modifications to current operations at structure S-20, installation of an earthen plug in the L-31E Canal near structure S-20A, installation of earthen plugs in the C-110 Canal, in combination with later phases of C-111 and Biscayne Bay Coastal Wetlands projects.

Project model results indicated that Alt 2D (L&S) and Alt 6D provide the greatest restoration benefit to the area in question. Although using three proxy years (Wet, dry and average) is acceptable given the multiple means of evaluating performance, additional benefit will likely be achieved seasonally that can be masked by the average annual performance (see discussion and figures noted above). Because the focus of Phase 1 of C-111 SC project is Taylor Slough and the downstream receiving estuary, the team should recognize the potential additional benefit provided to Florida Bay currently not included in the benefits area calculations. Although the project modeling stops at the coastline, RECOVER Band 1 model run indicates that the C-111 project contributes to the system wide goals of CERP further reducing FL Bay salinities (see transect 23 flows and salinity estimate figures for FL Bay stations). As noted above, the C-111SC is now a phased project. It is important to remember the original goals of the project to rehydrate the Model Lands and Southeastern edge of the Greater Everglades to ultimately achieve the larger system-wide goals and benefits outline in the Yellow Book.

8

References Cited

1) RECOVER C-111SC Performance Measure Consistency review, 6-21-2004, http://www.evergladesplan.org/pm/recover/recover_docs/et/et_reviews/et_rev_c-111_pm_review.pdf.

2) RECOVER Regional Evaluation of C-111 SC project, 2006.

3) RECOVER regional Evaluation of C-111SC project (Phase I), February 2009.

4) Upmanu Lall, Donald L. Phillips, Kenneth H. Reckhow and Daniel P. Loucks (Chair), Quantifying and Communicating Model Uncertainty for Decision Making in the Everglades Report of the Comprehensive Everglades Restoration Plan's Model Uncertainty Workshop, U.S. Army Corps of Engineers and South Florida Water Management District, West Palm Beach, FL, January 15 – 17, 2002.

3) RECOVER performance measures http://www.evergladesplan.org/pm/recover/eval_team_perf_measures.aspx

4) Report on Evaluation Tools, Models, Work Plans, and Budgets, Report of the Restoration Coordination and Verification (RECOVER) Evaluation Team, December 2005, http://www.evergladesplan.org/pm/recover/system_wide_modeling.aspx.

5) Lee, N.L., Johns, E., Melo, N., Smith, R.H., Ortner, P., and Smith, Dewitt, On Florida Bay Hypersalinity and Water Exchange, Bulletin of Marine science, 79(2): 301-327, 2006.

6) Nuttle, W. K., Fourqurean, J. W. Crosby, B. J., Zieman, J. C., and Roblee, M. B., Influence of Net Freshwater Supply on Salinity in Florida Bay, Water Resources Research, Vol. 36, No. 7, 1805-1822, 2000.

Tables

Results for Performance Metric 2.4 Coastal Salinities (from project benefits analysis)

Scenario	Scenario HU Score	Barnes Sound	Manatee Bay	Joe Bay	Little Madeira Bay	Long Sound
Pre-Drainage/Target	27,302	16,902	2,497	3,385	2,361	2,153
FWO	21,938	78%	72%	88%	89%	87%
ECB	21,752	78%	75%	85%	85%	84%
Alt_1C	19,375	63%	66%	89%	90%	90%
Alt_1D	18,623	59%	62%	89%	91%	90%
Alt_2DS	19,602	64%	66%	90%	91%	90%
Alt_2DL	19,796	65%	67%	90%	91%	90%
Alt_3D	19,408	63%	65%	90%	91%	90%
Alt_6D	20,975	72%	75%	88%	88%	87%

Results for Performance Metric 1.5 Flow Timing, Distribution and Volume

Scenario	Scenario HU Score	Taylor Slough Timing	Taylor Slough Distribution
Pre-Drainage/Target	98,472	100%	100%
FWO	64,142	93%	37%
ECB	65,976	95%	39%
Alt_1C	68,312	92%	47%
Alt_1D	68,935	93%	47%
Alt_2DS	68,724	89%	50%
Alt_2DL	68,394	88%	50%
Alt_3D	67,163	90%	47%
Alt_6D	70,976	93%	51%

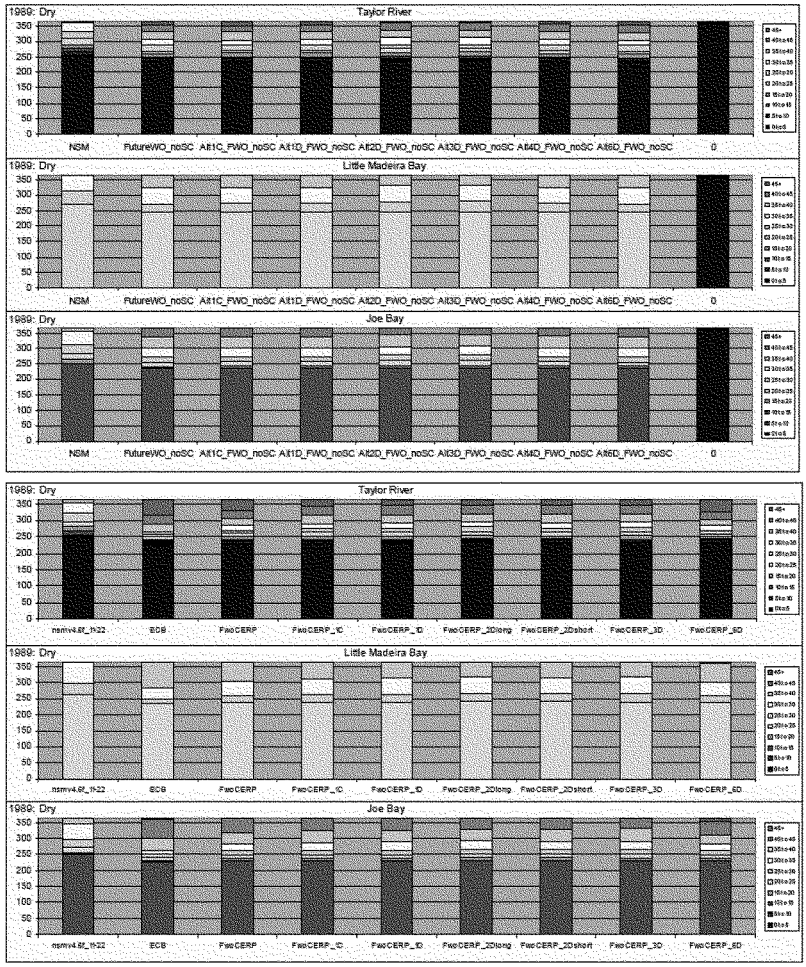
Results for Performance Metric 2.1 Vegetation Hydroperiod

Scenario	Scenario HU Score	Average Year (1978)	Dry Year (1989)	Wet Year (1995)
Pre-Drainage/Target	155,098	100%	100%	100%
FWO	74,619	40%	59%	45%
ECB	75,186	41%	59%	45%
Alt_1C	73,339	42%	59%	40%
Alt_1D	74,275	44%	61%	39%
Alt_2DS	78,805	46%	62%	44%
Alt_2DL	77,081	45%	61%	43%
Alt_3D	76,786	45%	60%	43%
Alt_6D	80,454	47%	60%	48%

Figures

11

Figures 1A-1F: Alternative Salinity in Taylor Slough, Little Madeira, and Taylor River during dry years (Figures A-C are based on old model runs and D-F are based on the current alternative runs).



12

Figure 2: Spatial extent of C-111 project effects within the context of Band 1. C-111 project effects are noted by coastaline polygons while ellipses represent the far field effects of Band 1.

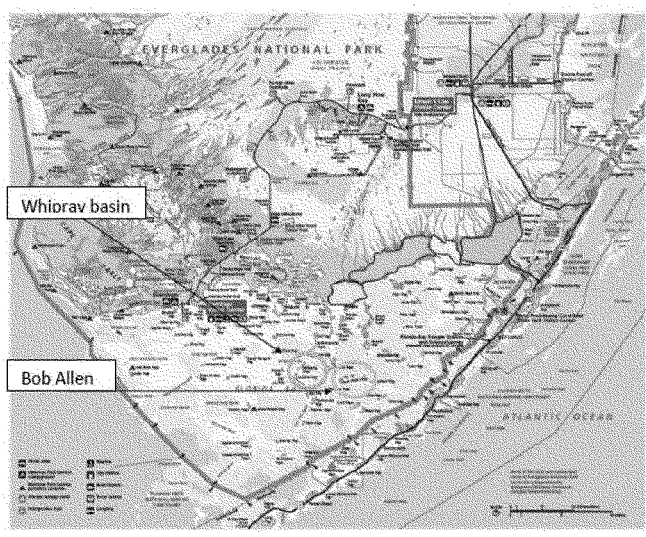
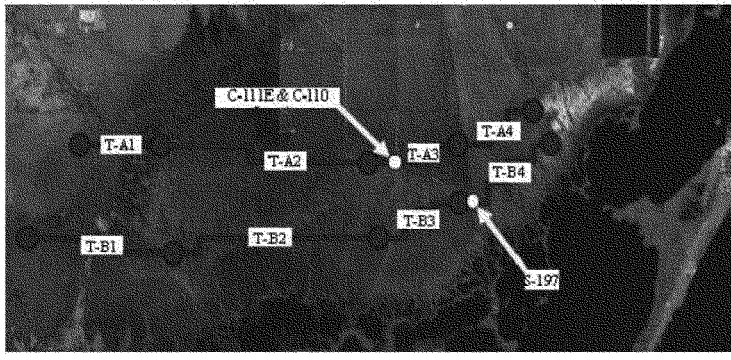


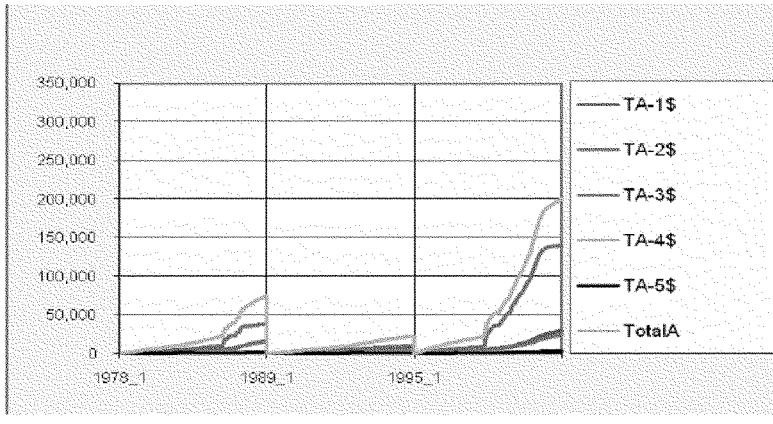
Figure 3: Transect Locations



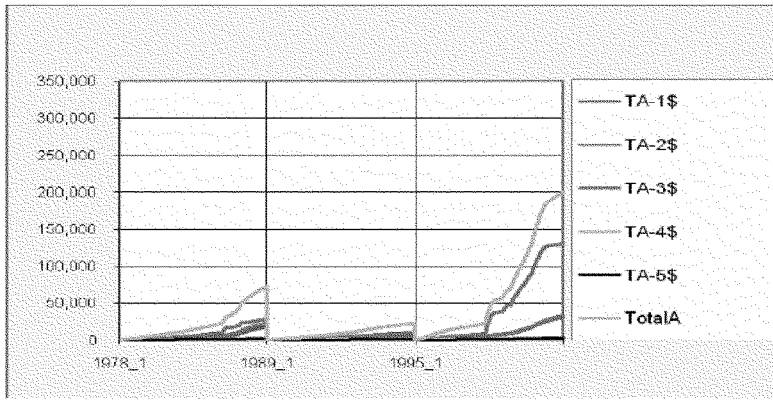
13

Figures 4 (A-C): Transect flow volumes

4A- Alt 2DShort transect flow volumes:



4B- Alt 2DL transect volumes:



14

4C- Alt 6 D transect volumes:

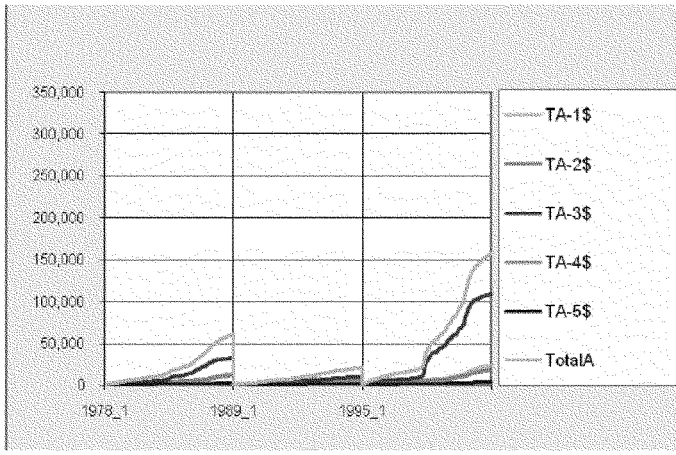
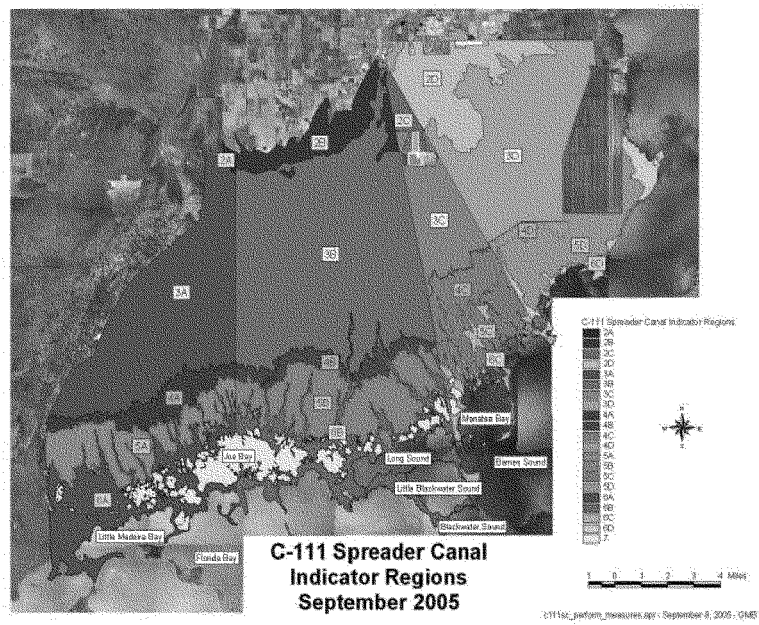


Figure 5: Indicator regions applied to C-111SC project vegetation PM (2.1)



15

Figure 6 (A and B): Band 1 Monthly mean and average annual salinity

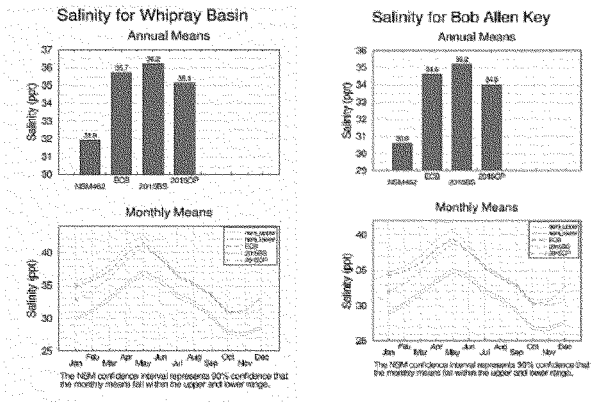
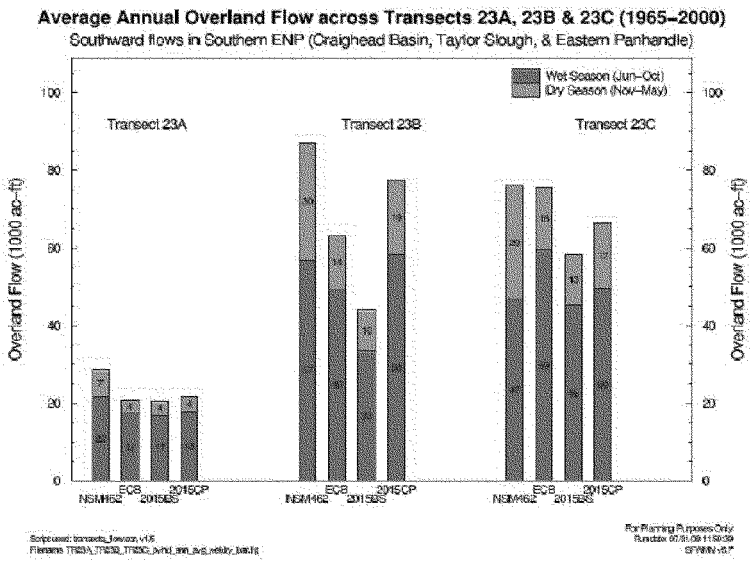
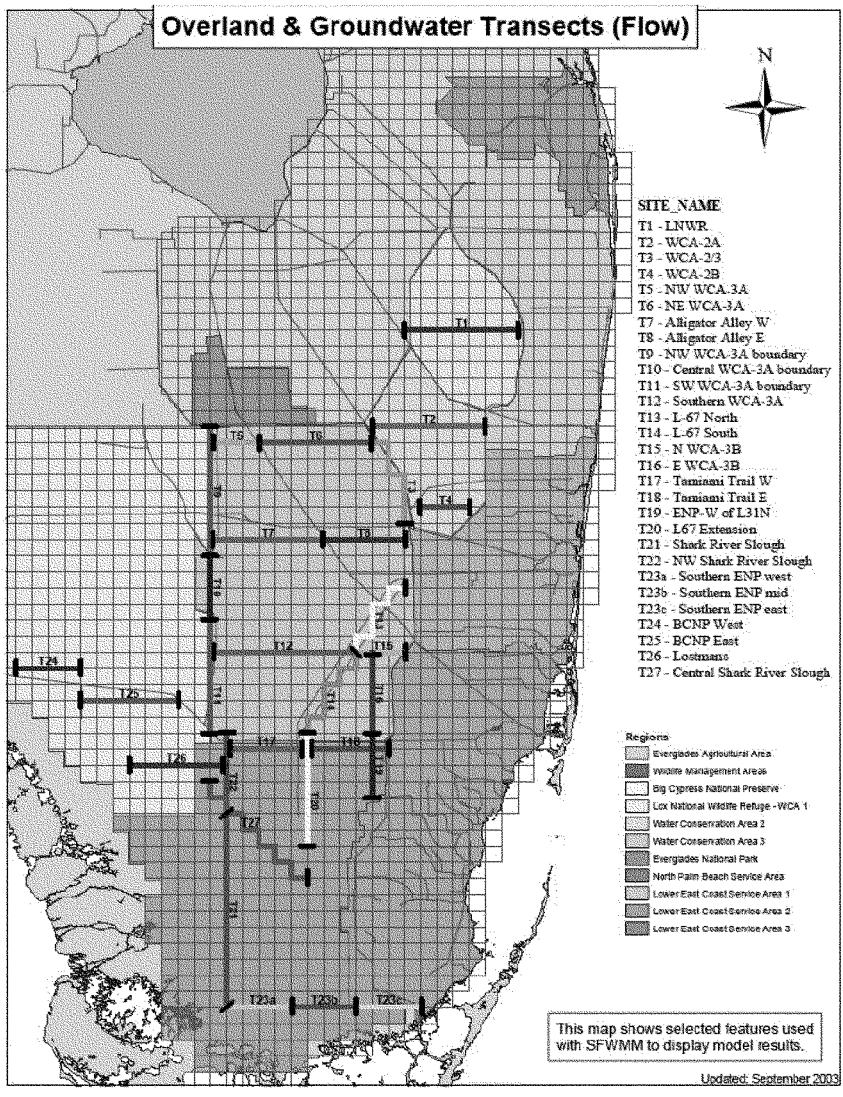


Figure 7- Flow transects from Band 1 model run:



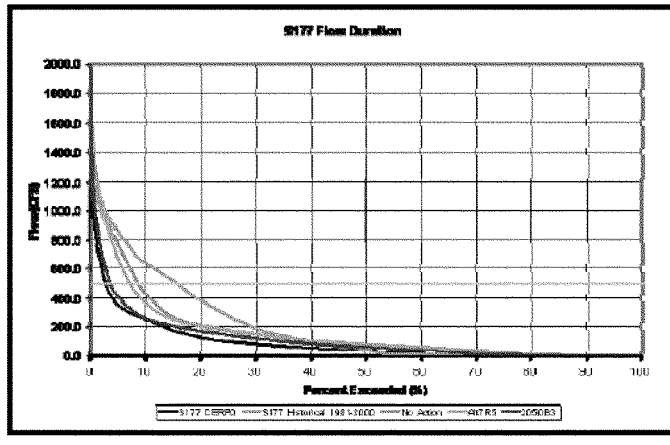
16

Figure 8- Map with location of flow transects



17

Figure 9- SFWMM flows through the S-177



18

F.4 C-111 SPREADER CANAL RECOVER CONSISTANCY REVIEW OF PROJECT-LEVEL PERFORMANCE MEASURES (FINAL JUNE 21, 2004)

FINAL RECOVER PM Consistency Review Final 6/21/04

C-111 Spreader Canal (C-11 SC) Project
RECOVER EVALUATION OF PROJECT-LEVEL PERFORMANCE MEASURES (Final 062104)

Prepared by the Regional Evaluation Team (RET) and Water Quality Team (WQT

Contributors: Steve Traxler (FWS), Eric Hughes (EPA), Tom Schmidt (NPS), Gwen Burzycki (Miami-Dade DERM), Patrick Pitts (FWS), Sandra Sneckenberger (FWS), Cheryl Buckingham (Corps), Orlando Ramos-Gines (Corps

1.0 INTRODUCTION

The role of the Restoration Coordination and Verification (RECOVER) team is to organize and apply scientific and technical information in ways that are most effective in supporting the objectives of the Comprehensive Everglades Restoration Plan (CERP). RECOVER links science and the tools of science to a set of system-wide planning, evaluation and assessment tasks. These links provide RECOVER with the scientific basis for meeting its overall objectives of evaluating and assessing Comprehensive Plan performance and refining and improving the plan during the implementation period. RECOVER fulfills this role by working with the project delivery teams (PDTs) to help them meet CERP's system-wide goals and objectives. Specifically, RECOVER reviews the performance measures for project-level evaluation of alternatives for consistency with the system-wide evaluation performance measures developed by RECOVER.

The purpose of this performance measures consistency review is: 1) to identify general compatibility of project-level performance measures with applicable system-wide performance measures, and 2) to provide information to project mangers and others, as appropriate, regarding compatibility of project-level and system-wide performance measures of the C-111 SC as submitted to RECOVER in April 2004. RECOVER recognizes and appreciates the time and effort that went into developing these performance measures. The review comments below are intended to enhance the existing set of performance measures. Comments on the specific project-level performance measure are presented in the attached table (Attachment A).

2.0 GENERAL DOCUMENT COMMENTS

The C-111 SC PMs are generally well developed. RECOVER does however have suggestions regarding the potential redundancy of PMs, the differentiation between evaluation criteria and performance measures, and areas to provide additional information for document reviewers and developers.

Redundancy and Conflict among PMs – Several C-111 SC PMs address the hydropattern and inundation patterns of the Greater Everglades (GE) wetlands. EC 1.1 (Annual Inundation Patterns), EC 2.1 (Improve Marl Prairie Vegetation Mosaic), and EC 3.7 (Maintain or

Increase Habitat Suitable for Periphyton) all address hydroperiod with different inundation patterns as the targets. RECOVER suggests the PDT examine these PMs for redundancy or conflict with each other. For example, what if WASH shows pre-drainage conditions (the target for EC 1.1) have hydroperiods of less than 130 days (target for EC 2.1) in places where freshwater graminoid marsh is desired.

Additionally, EC 3.2 (Improve Marsh Recession Rates to Support Successful Nesting and Foraging for Wading Birds) and EC 3.5 (Wetland Aquatic Fauna) have identical targets and both identify the aquatic fauna as prey for wading birds. RECOVER suggests the PDT examine these PMs for redundancy.

Utility of PMs and ECs in Evaluating Project Alternatives – RECOVER recognizes that the C-111 SC PDT has done an excellent job of differentiating between performance measures, which will be used to evaluate alternative plans, and evaluation criteria, which will be used as constraints during the screening process. Those designated as performance measures have numeric targets conducive to making decisions in distinguishing between alternatives. Those indicators that use such terms as "minimize", "maximize", "increase", and "no significant decrease" have been designated as evaluation criteria for use in screening alternatives. RECOVER commends the PDT on recognizing and differentiating the use of performance measures and evaluation criteria

Additional Documentation Performance Measure Documentation Sheets (Fact Sheets) – C-111 SC PM fact sheets are generally well developed; RECOVER does however have some suggestions to improve the clarity of some fact sheets. Documentation could be added to several of the PM fact sheets to define terminology, indicate why particular target ranges were chosen, and reference why certain targets were selected (i.e. scientific studies, best professional judgment, etc.). Specific comments on documentation and references are included in Attachment A.

3.0 CONSISTENCY WITH RECOVER SYSTEM-WIDE EVALUATION PERFORMANCE MEASURES

There seems to be general compatibility in intent between the project-level performance measures developed by the PDT for the C-111 SC Project and the system-wide evaluation performance measures developed for the Comprehensive Plan by RECOVER. RECOVER does however have suggestions regarding the content, target and classification for several of the performance measures/evaluation criteria. General comments of significance are noted below, while comments on each specific project-level performance measure are presented in the attached table (Attachment A).

WASH targets vs. NSM targets – For several hydroperiod PMs, there are slight differences between the targets for C-111 SC PMs and those for RECOVER PMs. Although generally consistent, these differences are noted below:

In EC 1.2 (Reestablish Amplitude and Interannual Water Levels that Reflect Natural Conditions-PM) the C-111SC PM utilizes percent difference from pre-drainage conditions

and uses indicator regions, whereas the GE-E4 targets depend on habitat type of interest (e.g., for ridge and slough/sawgrass plains and marl marsh areas, an envelope is developed using NSM4.6 for amplitude; for Big Cypress the target is to match NSM 4.6 output indicator region by indicator region).

In EC 1.3 (Extreme High and Low Water Depths-PM) the C-111 SC PM defines extreme high and low water events based on the WASH123 model rather than the NSM 4.6.

In EC 4.1 (Reestablish Seasonal and Annual Inflow Volumes That Reflect Natural Conditions-PM), the C-111 SC PM target specifies minimum differences in flow between NSM (pre-drainage) and the alternative, regardless of compatibility with other hydrologic PMs. By comparison, the RECOVER PM GE-E5 target specifies qualified similarity. (RECOVER would also like to note that GE-E5 has been tabled due to the large amount of uncertainty associated with sheetflow calculated by the SFWMM.)

Ecologic and Biologic PMs – In general, the intent of C-111 SC ecologic and biologic PMs were consistent with RECOVER PMs; however, RECOVER noted several ecologic and biologic PMs with slightly different targets. These differences are noted below:

RECOVER recognizes that RECOVER targets for WCA-3 are based on hammock tree islands rather than bayhead tree islands; however, it is important to note the target for this PM is slightly different than RECOVER's GE-E15. GE-E15's target is to minimize deviation from NSM, whereas the C-111SC PM utilizes hard numbers of hydroperiod and water depth for targets.

Documentation in C-111 SC EC 3.1 (Improve Habitat for American Crocodile-PM) is slightly inconsistent with work proposed by Dr. Frank Mazzotti, University of Florida. Dr. Mazzotti's work indicates a target of less than or equal to 20 ppt for the wet season and the first part of the dry season for crocodiles.

EC 3.2 (Improve Marsh Recession Rates to Support Successful Nesting and Foraging for Wading Birds-PM) is generally consistent with RECOVER PM GE-E20 (Long Legged Wading Bird Foraging Conditions). RECOVER does not have PM's that specifically address recession rates. RECOVER PM GE-E20 will utilize the ATLSS wading bird model; the C-111 SC PM will utilize watershed model for water levels, recession rates

EC 3.3 (Cape Sable Seaside Sparrow Nesting Condition Availability) PM is not inconsistent with RECOVER PMs. RECOVER does not have a CSSS PM but has identified Special Issue Indicator Regions for the Sparrow sub-populations. RECOVER chose not to pursue the draft performance measure but it's graphics for Sub-population D indicates the 40 to 80 days are to be between February 15 and July 15 instead of March 1 to July 15.

Salinity – RECOVER has identified two potential areas of inconsistency between C-111 SC PMs and RECOVER PMs with regard to salinity targets. Both are noted below:

Although there is no corresponding RECOVER PM for comparison with EC 2.4 (Restore Historic Spatial Extent and Distribution of Oligohaline, Mesohaline, and Estuarine Marsh Flats-PM), this PM is consistent with RECOVER SE PMs in concept. RECOVER suggests coordinating with RECOVER RET SE sub-team when model output describing the pre-drainage salinities are obtained to make targets are consistent with RECOVER targets.

The targets set for EC 5.1 (Minimize Impacts to Eastern Barnes Sound Hard Bottom Communities-PM) are inconsistent with those of RECOVER PM SE-E4 (Salinity Patterns in, and Timing of Freshwater Inputs to, Manatee Bay and Coastal Embayments of Barnes Sound). To review RECOVER PM targets for SE-E4 please visit http://www.evergladesplan.org/pm/recover/ret_perf_measures.cfm for the most recent documentation sheet.

Flood Protection and Water Supply – Targets for C-111 SC evaluation criteria EC 8.1 through 8.4 and EC 9.1 appear to be inconsistent with RECOVER PMs for flood protection and water supply. The targets for RECOVER flood protection PMs are based on 1983-1993 conditions, years when performance was considered adequate. Additionally, RECOVER PMs WS-E2 (Frequency of Water Restrictions for the Lower East Coast) and WS-E8 (Duration and Severity of Water Restrictions for the Lower East Coast) should be consulted for consistency.

Terminology – RECOVER recognizes that EC 2.4 (Restore Historic Spatial Extent and Distribution of Oligohaline, Mesohaline, and Estuarine Marsh Flats-PM) includes salinity classifications of oligohaline, mesohaline, etc. This terminology is normally associated with the Venice classification system. However, the Venice system defines mesohaline as a range of 5 to 18 ppt and polyhaline as 18 to 30 ppt; the C-111SC PM defines mesohaline as 6 to 15 ppt and estuarine (polyhaline) as 16 to 30 ppt. RECOVER suggests using consistent terminology and salinity ranges with the Venice system.

Additionally, RECOVER suggests the C-111 SC PDT clarify in EC 6.1, EC 6.3, EC 6.4, and EC 6.5 that discharges entering natural areas are from STAs/reservoirs rather than untreated water.

Models – For EC 3.8 (Maintain or Increase American Alligator Production), RECOVER recognizes the PDT is using RECOVER PM GE-E23; however, RECOVER suggests the PDT consider whether the ATLSS model may be unable to use WASH123 output as its input. The PDT should ensure these models are consistent.

Uncertainty and CERP Influences – Some C-111 SC PMs and ECs may be inappropriate for the project, as a number of influences other than those imposed by the project may have significant impacts on the parameters. For example, there are non-CERP influences that significantly impact water quality in the project area. For example, in EC 6.3 (Reduce N levels in Discharges Entering Natural Areas [from STAs/Reservoirs]-PM) it may be worthwhile for the PDT to determine where numeric TN load reduction is expected and if it is applicable to STA's within the project area. If the project is not expected to affect N concentrations, it may be more appropriate to use this as a screening criterion with the target

of "no increase". Additionally, EC 6.2 (Maintain desirable phosphorus target concentration in natural system areas-PM) and EC 6.5 (Meet Class III WQ Standards from CERP Facilities to natural areas [from STAs/Reservoirs]) appear to be governed by non-CERP influences capable of affecting parameters that the project will be treating/affecting. It may be more appropriate to make these EC a project constraint with the expectation "not to make worse".

Consistency Among Projects and RECOVER – There are several metrics within the BBCW suite of PMs that are also present in neighboring projects like the Florida Bay / Florida Keys Feasibility Study (FBFKFS) and Biscayne Bay Coastal Wetlands (BBCW) Project. RECOVER suggests the PDT review these project PMs, as well as RECOVER PMs to ensure that PM targets, metrics, and evaluation methodologies are consistent. This will enable the comparison of evaluation data among projects and RECOVER.

4.0 CONCLUSIONS

There is general compatibility of intent between the project-level performance measures and evaluation criteria developed for the C-111 SC and the system-wide performance measures of the Comprehensive Plan. Some revisions are suggested to increase the degree of consistency between project and system-wide performance measures. RECOVER suggests reviewing several PMs for redundancy and the additional documentation. Additionally, RECOVER suggests that some of the C-111 SC PMs be reviewed for applicability, uncertainty, and consistency with neighboring projects and RECOVER.

ATTACHMENT A: C-111 SPREADER CANAL PROJECT PM CONSITENCY REVIEW RECOVER COMMENTS

CERP Goal: Enhance Ecologic Values
Project Objective/Constraint: Improve flow patterns, hydroperiods and ecological connectivity between the Southern Glades, Model Lands, and adjacent natural areas
EC 1.1 Annual Inundation Patterns (Performance Measure) **Target:** The target is the range of weeks of inundation and the number of inundation events or an envelope for the duration and number of inundation events that approximate the Wash123D pre-drainage model output for cells in the model categorized by landscape type (vegetation zone) requirements of depth of water table and surface water flow. **Evaluation Method:** Wash123D
Is this PM consistent with RECOVER PMs? (GE- E2 Inundation Pattern in the Greater Everglades Wetlands) This PM is consistent with RECOVER GE-E2, including the target and definition of "inundation event"; however, it is unclear if the PM applies to the entire project area or only to the freshwater wetlands in the project area (i.e. marl prairies, forested wetlands, etc.). It may be appropriate to develop and use indicator regions the same as or similar to those developed for the Greater Everglades for use in evaluation of this PM. RECOVER suggests language be added to this PM to show both freshwater and tidal wetland landscape types will be evaluated.

CERP Goal: Enhance Ecologic Values
Project Objective/Constraint: Improve flow patterns, hydroperiods and ecological connectivity between the Southern Glades, Model Lands, and adjacent natural areas
EC 1.2 Reestablish amplitude and interannual water levels that reflect natural conditions (Performance Measure) **Target:** The target is zero percent difference from pre-drainage seasonal variation of stage for each indicator region. Seasonal variations that are closest to the pre-drainage values are considered more likely to support native vegetation, aquatic fauna and to support the freshwater flows for Florida Bay. **Evaluation Method:** Wash123
Is this PM consistent with RECOVER PMs? (GE-E4 Seasonal Amplitude and Interannual Variability of Water Levels in the Greater Everglades Wetlands) This PM is generally consistent with RECOVER PM GE-E4; however, the target is slightly different. GE-E4 targets depend on habitat type of interest (e.g., for ridge and slough/sawgrass plains and marl marsh areas, an envelope is developed using NSM4.6 for amplitude; for Big Cypress the target is to match NSM 4.6 output indicator region by indicator region). The C-111SC PM utilizes percent difference from pre-drainage conditions and uses indicator regions. Additionally, RECOVER suggests defining to which areas within the C-111SC project area this PM applies.

ATTACHMENT A: C-111 SPREADER CANAL PROJECT PM CONSITENCY REVIEW RECOVER COMMENTS

CERP Goal: Enhance Ecologic Values

Project Objective/Constraint: Improve flow patterns, hydroperiods and ecological connectivity between the Southern Glades, Model Lands, and adjacent natural areas

EC 1.3 Extreme High and Low water depths (Performance Measure)

Target: The target is a range for the total duration of extreme high and low water events in weeks and the number of extreme high and low water events or an envelope of occurrences that meet the Wash123D pre-drainage model output for selected cells (groups of cells for different vegetation zones).

Evaluation Method: Wash123D

Is this PM consistent with RECOVER PMs?
(GE-E3 Extreme High and Low Water Levels in the Greater Everglades Wetlands)
This PM is generally consistent with RECOVER PM GE-E3; however, RECOVER has a definition for extreme high and low water events based on a Natural System Model envelope rather than the WASH 123. RECOVER also suggests defining criteria for extreme high and low water events (see GE-E3). Additionally, RECOVER suggests defining to which areas within the C-111SC project area this PM applies.

CERP Goal: Enhance Ecologic Values

Project Objective/Constraint: Improve flow patterns, hydroperiods and ecological connectivity between the Southern Glades, Model Lands, and adjacent natural areas

EC 1.4 Improve hydrologic connectivity between the Southern Glades, model Lands, and adjacent natural areas (Performance Measure)

Target: The target condition is water surface elevation differences across a selected set of barriers similar to that predicted by the pre-drainage model developed from Wash123D. Differences of more than one depth category from pre-drainage model predictions are considered poor.

Evaluation Method: Wash123D

Is this PM consistent with RECOVER PMs?
(TS-E1 Continuity-Water Surface Elevations Across Barriers)
This PM is generally consistent with RECOVER PM GE-E4. RECOVER suggests the phrase "groups of WASH mesh" be expanded to indicate whether it refers to groups of WASH model cells. Additionally, RECOVER suggests documenting if comparisons will be made based on average annual/seasonal differences, and on what time scales comparisons are made (days, weeks, seasons).

ATTACHMENT A: C-111 SPREADER CANAL PROJECT PM CONSITENCY REVIEW RECOVER COMMENTS

CERP Goal: Enhance Ecologic Values
Project Objective/Constraint: Improve habitat and functional quality of wetlands and natural areas & increase spatial extent where practicable
EC 2.1 Improve marl prairie vegetation mosaic (Performance Measure) **Target:** The restoration target is for the distribution and aerial extent of hydroperiods that would support Zone 3 graminoid-dominated freshwater wetlands to match pre-drainage conditions. The specific hydroperiod distribution for evaluation purposes will be determined by the pre-drainage modeling scenario, but it is expected that this scenario will yield results similar to the description in Egler (1952) and the depiction of the Desired Future Condition in Figure 1. Alternatives that maximize the spatial distribution of freshwater marshes and more closely approximate the distribution depicted in Figure 1 (Desired Future Conditions) would be preferred in the absence of a reliable pre-drainage scenario to provide comparisons. **Evaluation Method**: Model not specified and post-processing
Is this PM consistent with RECOVER PMs? The underlying concept behind this PM and the RECOVER PM's are consistent. RECOVER Indicator Regions 145 East Perrine Marl Marsh and 146 Model Lands Marl Marsh fall within the study area. GE-E2 Inundation Pattern has an inundation target of 140-168 days for IR-145 and 196-224 days for IR 146. They are similar but not identical to the targets in this PM. The purpose of this project PM is to increase spatial extent of marl prairie. The only time there could be a conflict would be if the increase in marl prairie were in a different location that did not include IR's-145 and 146. Although the targets for this PM are generally consistent with RECOVER PM GE-E2, this PM does not appear to differ significantly from EC1.1. Inundation (EC1.1) and hydroperiod (EC2.1) may be redundant. Additionally, this PM could possibly conflict with EC1.1. What if WASH shows pre-drainage conditions in places where freshwater graminoid marsh is desired that have a hydroperiod less than 130 days (minimum hydroperiod for freshwater graminoids)?

ATTACHMENT A: C-111 SPREADER CANAL PROJECT PM CONSITENCY REVIEW RECOVER COMMENTS

CERP Goal: Enhance Ecologic Values
Project Objective/Constraint: Improve habitat and functional quality of wetlands and natural areas & increase spatial extent where practicable
EC 2.2 Minimize loss of functional wetlands **Target:** The target is 0 acres (determined by calculating the acreage of canal and STA) of well-functioning wetland habitat lost. **Evaluation Method:** A wetland evaluation methodology (e.g.,W.A.T.E.R, HGM) will be used to compare baseline conditions in the surrounding wetlands with project plan alternatives. Other evaluation methods (soils, habitat suitability for particular species) for wetland function may be available to complement the chosen methodology.
Is this PM consistent with RECOVER PMs? This PM appears to be consistent with CERP goals, but there is not necessarily a corresponding RECOVER PM for comparison.

CERP Goal: Enhance Ecologic Values
Project Objective/Constraint: Improve habitat and functional quality of wetlands and natural areas & increase spatial extent where practicable
EC 2.3 Maintain bayhead tree island habitat (Performance Measure) **Target:** In Zone 3 (sawgrass with tree islands) of the Desired Future Condition for South Dade Wetlands MAP (Burzycki, In progress), hydroperiods within the bayheads should not exceed 4 months. Marsh water depths in Zone 3 should not exceed 1.5 ft except in the wettest years. The water table recession in Zone 3 should not exceed 1.5 ft below the ground surface. A duration of –1.5 ft for more than 30 days in any given year would be considered particularly detrimental. (The results of the tree island topographic surveys when available may be used to determine the relative island height at which the 4-month exceedence would be measured.) **Evaluation Method:** Model not specified
Is this PM consistent with RECOVER PMs? The targets for RECOVER PM GE-E3 Extreme High and Low Water Levels for IR's 145 and 146 are: IR-145. East Perrine Marl Marsh. No more than 7 high events >1.5 feet and >2 weeks duration. Minimize low events <1.0 foot IR-146. Model Lands Marl Marsh. No more than 7 high events >2.0 feet and >2 weeks duration. Minimize low events <1.0 foot RECOVER recognizes that RECOVER targets for WCA-3 are based on hammock tree islands rather than bayhead tree islands; however, it is important to note the target for this PM is slightly different than RECOVER's GE-E15. GE-E15's target is to minimize deviation from NSM, whereas the C-111SC PM utilizes hard numbers of hydroperiod and water depth for targets.

ATTACHMENT A: C-111 SPREADER CANAL PROJECT PM CONSITENCY REVIEW RECOVER COMMENTS

CERP Goal: Enhance Ecologic Values
Project Objective/Constraint: Improve habitat and functional quality of wetlands and natural areas & increase spatial extent where practicable
EC 2.4 Restore historic spatial extent and distribution of oligohaline, mesohaline, and estuarine marsh flats (Performance Measure) **Target:** The restoration target is for the coastal salinity pattern to match pre-drainage conditions. In the absence of both pre-drainage salinity data and supporting research that can correlate vegetation succession patterns with surface water salinity patterns, the following surrogate measure will be used: the distribution and aerial extent of wetlands limited by seasonal surface water salinity > 5 ppt (Figure 1, Zones 2-5) should match pre-drainage projections, and salinity contours in coastal wetlands should also follow pre-drainage projections. **Evaluation Method:** Model not specified
Is this PM consistent with RECOVER PMs? Although there is no corresponding RECOVER PM for comparison, this PM is consistent with RECOVER SE PMs in concept. RECOVER suggests coordinating with RECOVER RET SE sub-team when model output describing the pre-drainage salinities are obtained to develop targets that are consistent with RECOVER targets. Additionally, the evaluation method section for this PM includes salinity classifications of oligohaline, mesohaline, etc. This terminology is normally associated with the Venice classification system. However, the Venice system defines mesohaline as a range of 5 to 18 ppt and polyhaline as 18 to 30 ppt; the C-111SC PM defines mesohaline as 6 to 15 ppt and estuarine (polyhaline?) as 16 to 30 ppt. RECOVER suggests using consistent terminology and salinity ranges as Venice system.

CERP Goal: Enhance Ecologic Values
Project Objective/Constraint: Improve habitat and functional quality of wetlands and natural areas & increase spatial extent where practicable
EC 2.5 Migration of the saltwater intrusion line toward the coast (Performance Measure) **Target:** Saltwater intrusion (500 ppm groundwater chloride line) within the project boundary should be shifted toward the bay. **Evaluation Method:** Model not specified
Is this PM consistent with RECOVER PMs? This PM is generally consistent with RECOVER PM WS-E5, which is targeted towards preventing saltwater intrusion from moving further from the Bay.

ATTACHMENT A: C-111 SPREADER CANAL PROJECT PM CONSITENCY REVIEW RECOVER COMMENTS

CERP Goal: Enhance Ecologic Values
Project Objective/Constraint: Improve native plant and animal species abundance and diversity
EC 3.1 Improve habitat for American Crocodile (Performance Measure) **Target:** The target for this criterion is the establishment of seasonally brackish salinity in areas contiguous with the coastal mangrove fringe (Zone 8, Figure 2). Salinity should not exceed 15 ppt in this zone from June through October, or 20 ppt from November through January, based on requirements for estuarine fishes and juvenile crocodiles. Salinity should not exceed 36 ppt during the remainder of the year. Salinity should not change in this zone more than +/- 7 ppt per day during all parts of the year to minimize the potential for osmotic shock to plants and animals. **Evaluation Method:** Wash123D
Is this PM consistent with RECOVER PMs? This PM is generally consistent with salinity targets in RECOVER PMs for SE-E4 Barnes Sound/Manatee Bay and SE-E2, which includes Joe Bay. Documentation in this PM is unclear for 15 ppt June-Oct and 20 ppt Nov-Jan target. Frank Mazzotti's work indicates a target of less than or equal to 20 ppt for the wet season and the first part of the dry season for crocodiles. RECOVER suggests the PDT document the +/- 7 ppt per day target and its difference from previous scientific work.

ATTACHMENT A: C-111 SPREADER CANAL PROJECT PM CONSITENCY REVIEW RECOVER COMMENTS

CERP Goal: Enhance Ecologic Values
Project Objective/Constraint: Improve native plant and animal species abundance and diversity
EC 3.2 Improve marsh recession rates to support successful nesting and foraging for wading birds (e.g. roseate spoonbill) (Performance Measure) **Target:** Provision of acceptable feeding habitat for a sufficient period of time are defined as: 1.) Dry Season (Nov – Apr) surface water recession rates range between 1 to 4 cm/week. This recession rate assumes successful nesting (an average of at least 1 chick per nest) in at least 7 out of 10 years or 70% of the historical recession rate range, which will result in population growth (Lorenz, 2002). 2.) Major non-tidal water control related reversal periods in the dry season will be limited to a rise in surface water levels of 1.5 cm/day (daily average) and a period of 5 days (Frederick and Spalding, 1995). 3.) Wet Season water levels (June-October) should range from 0.12 to 0.6 meters in Zones 3-6 to accommodate good development of prey organisms. The target is restoration that would result in a range of rates, depths, and durations as described for freshwater/brackish non-STA wetlands. The degree to which the target is achieved would be measured based on achieving target hydropatterns within the described range for rates, depths, and duration. **Evaluation Method:** Specific watershed model not specified
Is this PM consistent with RECOVER PMs? This PM is generally consistent with RECOVER PM GE-E20 Long Legged Wading Bird Foraging Conditions. RECOVER does not have PM's that specifically addresses recession rates. RECOVER PM GE-E20 will utilize the ATLSS wading bird model; the C-111SC PM will utilize watershed model for water levels, recession rates. Additionally, RECOVER suggests that the justification section of the PM documentation sheet provide documentation for wet season water level targets of 0.12-0.6 meter in Zones 3-6.

ATTACHMENT A: C-111 SPREADER CANAL PROJECT PM CONSITENCY REVIEW RECOVER COMMENTS

CERP Goal: Enhance Ecologic Values
Project Objective/Constraint: Improve native plant and animal species abundance and diversity
EC 3.3 Cape Sable Seaside Sparrow nesting condition availability (Evaluation Criteria) **Target:** The evaluation target is 40-80 days between March 1 and July 15 that water levels are below ground in selected areas. **Evaluation Method:** Wash123D
Is this PM consistent with RECOVER PMs? This PM is consistent with RECOVER PMs. RECOVER does not have a CSSS PM but has identified Special Issue Indicator Regions for the Sparrow sub-populations. RECOVER has chosen not to pursue the draft performance measure but it's graphics for Sub-population D indicates the 40 to 80 days are to be between February 15 and July 15 instead of March 1 to July 15. Additionally, RECOVER suggests the PDT consider whether the target has a constraint of the number of years when the target is met.

CERP Goal: Enhance Ecologic Values
Project Objective/Constraint: Improve native plant and animal species abundance and diversity
EC 3.4 Assure the project contributes to the overall recovery goal for the Florida Panther of a viable population level in South Florida (Evaluation Criteria) The first measure will be the total combined acreage in the primary zone of all high and medium value Florida panther habitat greater than 2 hectares (ha) within the project study area and non-urban cover types less than 200 meters (m) from high habitat value cover. The second measure will be the total continuous acreage of the first measure that is also interconnected (no more than a 1 kilometer gap) with and included in the Primary Zone previously discussed and illustrated in Figure 4. The third measure will be the total combined acreage of tree islands greater than 0.5 ha in the primary zone. **Target:** The target for all three measures will be no loss of total acreage classified as either high or medium value. **Evaluation Method:** Model not specified
Is this PM consistent with RECOVER PMs? Although there is no corresponding RECOVER PM, this PM is consistent with RECOVER PMs. RECOVER notes, however, that targets and evaluation method may change significantly in response to recent panther habitat requirements controversy.

ATTACHMENT A: C-111 SPREADER CANAL PROJECT PM CONSITENCY REVIEW RECOVER COMMENTS

CERP Goal: Enhance Ecologic Values
Project Objective/Constraint: Improve native plant and animal species abundance and diversity
EC 3.5 Wetland aquatic fauna (Evaluation Criteria) **Target:** Wet Season water levels (June-October) should range from 0.12 to 0.6 meters in Zones 3-6 to accommodate good development of prey organisms. Dry Season (Nov – Apr) surface water recession rates range between 1 to 4 cm/week. **Evaluation Method:** watershed model not specified
Is this PM consistent with RECOVER PMs? RECOVER notes that this PM seems redundant to EC3.2. Both PMs have identical targets and both identify the aquatic fauna as prey for wading birds.

CERP Goal: Enhance Ecologic Values
Project Objective/Constraint: Improve native plant and animal species abundance and diversity
EC 3.6 Exotic Animal Species (Evaluation Criteria) **Target:** Zero acres in zones 2 through 6 (Figure 1), where water management feature depth is greater than the adjacent wetlands by more than 1 meter. **Evaluation Method:** Calculated using GIS applications that incorporate historic, baseline, and predicted wetland coverages to compare different plan alternatives.
Is this PM consistent with RECOVER PMs? There in no corresponding RECOVER PM for comparison. RECOVER suggests the PDT add documentation to describe the impact of the elimination of "deep" water habitat on native fishes. Additionally, RECOVER suggests adding documentation to describe the source of the "1 meter below adjacent wetland elevation" target.

ATTACHMENT A: C-111 SPREADER CANAL PROJECT PM CONSITENCY REVIEW RECOVER COMMENTS

CERP Goal: Enhance Ecologic Values
Project Objective/Constraint: Improve native plant and animal species abundance and diversity
EC 3.7 Maintain or increase percentage of habitat suitable for periphyton (Evaluation Criteria) **Target:** Maintain or increase aerial coverage of habitat suitable for benthic mat periphyton communities as defined by output from the Wash123D 2000 base condition. **Evaluation Method:** The Periphyton Habitat Suitability Index (PHSI) is a time-averaged, spatially-variable index that is a function of the average hydroperiod for the simulation period and is partitioned into three models: Benthic Periphyton Suitability Index (BPSI), Floating Periphyton Suitability Index (FPSI), and Epiphytic Periphyton Suitability Index (EPSI).
Is this PM consistent with RECOVER PMs? This PM is consistent with RECOVER PM GE-E11. RECOVER suggests the PDT consider whether this PM is redundant to or in conflict with EC1.1 and/or EC2.1. These PMs all address hydroperiod.

CERP Goal: Enhance Ecologic Values
Project Objective/Constraint: Improve native plant and animal species abundance and diversity
EC 3.8 Maintain or increase American Alligator production (Evaluation Criteria) **Target:** For the total CERP project, the evaluation target is to improve total alligator production scores relative to the 2050 base. For implementation runs, the evaluation target is to exceed 2000 base production scores. **Evaluation Method:** ATLSS Alligator Production Index Model
Is this PM consistent with RECOVER PMs? This PM is consistent with RECOVER PM GE-E23; however, RECOVER suggests the PDT investigate the ability for the ATLSS model to use WASH123 output as its input. The PDT should check to make sure models are consistent.

ATTACHMENT A: C-111 SPREADER CANAL PROJECT PM CONSITENCY REVIEW RECOVER COMMENTS

CERP Goal: Enhance Ecologic Values
Project Objective/Constraint: Reserve sufficient water for the restoration of the natural system
EC 4.1 Reestablish seasonal and annual inflow volumes that reflect natural conditions (Performance Measure and Evaluation Criteria) **Target:** Minimize differences in annual and seasonal flow between the modified and natural system, as determined by the WASH123D, or other appropriate, fine scale, hydrologic model, across specified transects. **Evaluation Method:** WASH123D, or other appropriate, fine scale, hydrologic model
Is this PM consistent with RECOVER PMs? (GE-E5 Seasonal and Annual Flow Volume in the Greater Everglades Wetlands) This PM is generally consistent with RECOVER PM GE-E5; however, the GE-E5 target is slightly different from the proposed PM. The GE-E5 target specifies qualified similarity; C-111SC target specifies minimum differences in flow between NSM (pre-drainage) and the alternative, regardless of compatibility with other hydrologic PMs. RECOVER also notes that GE-E5 has been put on hold because of the great amount of uncertainty inherent in this measure (flow) when calculated by the SFWMM. The goal of restoring flows is still consistent.

ATTACHMENT A: C-111 SPREADER CANAL PROJECT PM CONSITENCY REVIEW RECOVER COMMENTS

CERP Goal: Enhance Ecologic Values
Project Objective/Constraint: Eliminate ecologically damaging flows to Barnes Sound and Fl Bay
EC 5.1 Minimize impacts to Eastern Barnes Sound hard bottom communities (Performance Measure) **Target:** From 100 meters of mainland, maintain an east-west salinity gradient between US1 to the east and west to the C-107/FP&L outfall canals in Card Sound, of less than or equal to 30 ppt during the wet season (Jun-Nov) and greater than or equal to 30 ppt and less then or equal to 40 ppt during dry season months (Dec-May). **Evaluation Method:** Existing linear regression model developed by Alleman/Aguirre(RET Performance Measure, SE-E4) to link water levels in the watershed east of US 1 (near model node SWEVER 1) to monthly mean salinities in C-111 Geographical Zone 9b.
Is this PM consistent with RECOVER PMs? The justification and targets for this PM may be inconsistent with RECOVER PM SE-E4. RECOVER recommends that the PDT consider the targets set in SE-E4. SE-E4 for Manatee Bay/Barnes Sound has wet season (June to October) salinities within 5-15 ppt in coastal embayments and Manatee Bay, within 15-30 ppt at the mouths of coastal embayments and Barnes Sound, and within 15-30 ppt within Barnes Sound 90% of the wet season. Dry season (November-May) average salinity should be within 10-19 ppt in coastal embayments and Manatee Bay, within 20-32 ppt at the mouths of coastal embayments and Barnes Sound, and within 20-35 ppt within Barnes sound 90% of the time. Daily average salinity < 35 ppt at all location 95% of the dry season. Additionally, RECOVER suggests clarification should be added to describe where this PM applies with respect to the estuarine zone.

ATTACHMENT A: C-111 SPREADER CANAL PROJECT PM CONSITENCY REVIEW RECOVER COMMENTS

CERP Goal: Enhance Ecologic Values
Project Objective/Constraint: Provide ecologically compatible WQ consistent with restoration goals and federal and state requirements applicable to the Southern Glades, Model Lands, and Everglades National Park.
EC 6.1 Reduce phosphorus levels in discharges entering natural areas (Performance Measure) **Target:** Average flow- weighted mean concentration of approximately 10 ppb (EFA) for the surface and groundwater discharging to natural areas (Zone III of Desired Future Condition of Vegetation map) and 6 ppb (settlement agreement) in current existing Marsh Areas (Taylor Slough, Southern Glades, Model Lands, and Coastal Basins). **Evaluation Method:** DMSTA will be used for surface TP concentration evaluation, surface and groundwater flow will be evaluated with WASH123D, and TP in groundwater will be evaluated with WASH123D.
Is this PM consistent with RECOVER PMs? This PM appears to be generally consistent with RECOVER PM GE-E7; however, RECOVER suggests the title of this PM should be modified to read "...discharges from STAs/Reservoirs..."

CERP Goal: Enhance Ecologic Values
Project Objective/Constraint: Provide ecologically compatible WQ consistent with restoration goals and federal and state requirements applicable to the Southern Glades, Model Lands, and Everglades National Park.
EC 6.2 Maintain desirable phosphorus target concentration in natural system areas (Performance Measure) **Target:** Maintain a long-term TP concentration of 6 ppb for the annual (arithmetic or geometric) mean in current existing Marsh Areas at ponded water monitoring points (Taylor Slough, Southern Glades, Model Lands, and ENP Coastal Basins). **Evaluation Method:** ELM. (WASH123 output will be used as input for ELM west of US1)
Is this PM consistent with RECOVER PMs? There may be no corresponding RECOVER PM for this PM; however, since this appears to be governed by non-CERP influences and is not a parameter related to project constructed features (like STAs or reservoirs) it may be more appropriate to make this parameters a project constraint with the expectation "not to make worse".

ATTACHMENT A: C-111 SPREADER CANAL PROJECT PM CONSITENCY REVIEW RECOVER COMMENTS

CERP Goal: Enhance Ecologic Values
Project Objective/Constraint: Provide ecologically compatible WQ consistent with restoration goals and federal and state requirements applicable to the Southern Glades, Model Lands, and Everglades National Park.
EC 6.3 Reduce N levels in discharges entering natural areas (Performance Measure) **Target:** Reduce loads and concentrations of **Total nitrogen (TN)** concentrations to freshwater and estuarine wetlands to achieve the concentration targets (not exceed historical background) and a load reduction discharging to natural area (Zone III of Desired Future Condition of Vegetation map). **Evaluation Method:** Use Storm Water Management Model (SWMM) to evaluate the TN concentration at the effluent of water discharging to natural system areas. The flow for load calculation will be evaluated with WASH123D.
Is this PM consistent with RECOVER PMs? This PM appears to be generally consistent with proposed RECOVER PMs for the assessment of nutrient concentration and loading in the GE; however, it is important to note that increased flows to the area may not allow for reduction of TN load (depending on the reduction in TN concentration). It may also be worthwhile for the PDT to determine where numeric TN load reduction is expected and if it is applicable to STAs/reservoirs in the area. Additionally, RECOVER suggests the title of this PM should be modified to read "...discharges from STAs/Reservoirs..."

CERP Goal: Enhance Ecologic Values
Project Objective/Constraint: Provide ecologically compatible WQ consistent with restoration goals and federal and state requirements applicable to the Southern Glades, Model Lands, and Everglades National Park.
EC 6.4 Minimize TSS in water entering natural areas (Performance Measure) **Target:** median concentration of 3.0 mg/L as TSS target. **Evaluation Method:** SWMM
Is this PM consistent with RECOVER PMs? RECOVER suggests the title of this PM be modified to read "...natural areas from STAs/Reservoirs..."

ATTACHMENT A: C-111 SPREADER CANAL PROJECT PM CONSITENCY REVIEW RECOVER COMMENTS

CERP Goal: Enhance Ecologic Values

Project Objective/Constraint: Provide ecologically compatible WQ consistent with restoration goals and federal and state requirements applicable to the Southern Glades, Model Lands, and Everglades National Park.

EC 6.5 Meet Class III WQ standards for discharges from CERP facilities to natural areas (Evaluation Criteria)

Target:
The discharge of **toxicants/pathogens** to Natural system area should not increase due to redistribution of flows resulting from this project. Concentration of **metals** and **synthetic organic chemicals** in canal sediments should not exceed biological effects thresholds established by State (McDonald. 1994, Chapter 6) or EPA Region IV. **Bacteriological levels** should not exceed established state or local water quality standards (e.g., F.A.C. 62-302.530; Miami-Dade County Code: 24-11(4)).

Trace Metals-Total Cd, Total Cu, and Total Zn.
Meet Class III water quality standards/Non-ECP/modification structures (S177, S178, S-18C, S332E) Water Quality compliance requirements, No deterioration compared with "without project condition" in water discharging to natural system areas.

Pesticides/Herbicides:
Meet Class III water quality standards/Non-ECP/modification structures (S177, S178, S-18C, S332E) Water Quality compliance requirements, No deterioration compared with "without project condition" in water discharging to natural system areas.

Hg and MeHg: Bioaccumulation in fish Levels should not exceed biological effect thresholds established by State. (Mosquito fish (Gambusia spp): TL3- 0.077µg/g; Sun fish (Lepomis spp): TL3- 0.077µg/g; Warmouth (Lepomis gulosus): TL4--0.346 µg/g; Largemouth Bass- (Micropterus salmoides floridanus)-Human Health: TL5-300 µg/g.

Ammonia: Reduce ammonia concentrations from near toxic levels (up to 112 ppb) to concentrations not regarded as toxic (20-50 ppb).

Evaluation Method:
The transport of pollutants (pathogen, trace metals and pesticide/herbicides) of concerns discharged to Natural system areas will be evaluated with SWMM storage treatment module.

Is this PM consistent with RECOVER PMs?
There is no corresponding RECOVER PM for comparison. RECOVER suggests the title of this PM be modified to read "...natural areas from STAs/Reservoirs..." Additionally, the suite of WQ parameters involved with Class III WQ standards is extensive, and project features (such as STAs and reservoirs) may not influence all these WQ parameters. Based on this, the EC could be influenced by non-CERP influences. RECOVER suggests the PDT clearly describe this EC as a project constraint with the expectation "not to make worse". The project may also consider developing a risk analysis tool especially for endosulfates.

ATTACHMENT A: C-111 SPREADER CANAL PROJECT PM CONSITENCY REVIEW RECOVER COMMENTS

CERP Goal: Enhance Economic Values and Social Well Being
Project Objective/Constraint: Take advantage of recreational opportunities where available and consistent with environmental restoration goals
NOT TO BE REVIEWED BY RECOVER

CERP Goal: Enhance Economic Values and Social Well Being
Project Objective/Constraint: Maintain existing (Dec 2000) levels of flood protection to agricultural and urban lands
EC 8.1 Maintain Existing Urban Flood Protection (Evaluation Criteria) **Target:** Minimize the time and number of occurrences of water stages above ground and no worse than 1994 C-111 GRR Planning Condition **Evaluation Method:** MODBRANCH
Is this PM consistent with RECOVER PMs? The targets for RECOVER flood protection PMs are based on 1983-1993 conditions, years when performance was considered adequate.

CERP Goal: Enhance Economic Values and Social Well Being
Project Objective/Constraint: Maintain existing (Dec 2000) levels of flood protection to agricultural and urban lands
EC 8.2 Maintain Existing Agricultural Flood Protection –Damages to Combined Row and Truck Crops (Evaluation Criteria) **Target:** Condition not to be made worse than 1994 C-111 GRR planning condition **Evaluation Method:** SFWMM and MODBRANCH
Is this PM consistent with RECOVER PMs? The targets for RECOVER flood protection PMs are based on 1983-1993 conditions, years when performance was considered adequate.

ATTACHMENT A: C-111 SPREADER CANAL PROJECT PM CONSITENCY REVIEW RECOVER COMMENTS

CERP Goal: Enhance Economic Values and Social Well Being
Project Objective/Constraint: Maintain existing (Dec 2000) levels of flood protection to agricultural and urban lands
EC 8.3 Maintain Existing Agricultural Flood Protection – Damages to Fruit Trees (Evaluation Criteria) **Target:** Condition not to be made worse than 1994 C-111 GRR planning condition **Evaluation Method:** SFWMM and MODBRANCH
Is this PM consistent with RECOVER PMs? The targets for RECOVER flood protection PMs are based on 1983-1993 conditions, years when performance was considered adequate.

CERP Goal: Enhance Economic Values and Social Well Being
Project Objective/Constraint: Maintain existing (Dec 2000) levels of flood protection to agricultural and urban lands
EC 8.4 Maintain Existing Agricultural Flood Protection – Damages to Nursery Trees (Evaluation Criteria) **Target:** Condition not to be made worse than 1994 C-111 GRR planning condition **Evaluation Method:** SFWMM and MODBRANCH
Is this PM consistent with RECOVER PMs? The targets for RECOVER flood protection PMs are based on 1983-1993 conditions, years when performance was considered adequate.

ATTACHMENT A: C-111 SPREADER CANAL PROJECT PM CONSITENCY REVIEW RECOVER COMMENTS

CERP Goal: Enhance Economic Values and Social Well Being
Project Objective/Constraint: Maintain level of service for existing (Dec 2000) and legal users
EC 9.1 Municipal and Industrial Water Supply (Evaluation Criteria) **Target:** If MODBRANCH or comparable water budget model is utilized to measure changes in water deliveries with various demands not met in the basin, then the alternative should be no worse (adverse impact) than the without project condition. **Evaluation Method:** M+I demands will be measured as wellfield withdrawals in the model. Data input for this model will be produced from permitted water usage information provided by DERM.
Is this PM consistent with RECOVER PMs? RECOVER recommends that the PDT investigate compatibility with and use of the targets of existing RECOVER PMs. RECOVER PM WS-E2 (Frequency of Water Restrictions for the Lower East Coast Service Area) targets are to provide at least a 1-in-10 level of service as indicated three or less water years simulated with regionally significant water shortages in the 36-year evaluation period. RECOVER PM WS-E8 (Duration and Severity of Water Restrictions for the Lower East Coast Service Area) targets are for duration to be no more than 18 months with water shortages during the simulation period. Severity target is all water shortages to be Phase 1 "Moderate" Water Shortage in which overall reduction of use is up to 15%.

ATTACHMENT A: C-111 SPREADER CANAL PROJECT PM CONSITENCY REVIEW RECOVER COMMENTS

CERP Goal: Enhance Economic Values and Social Well Being
Project Objective/Constraint: Maintain level of service for existing (Dec 2000) and legal users
EC 9.2 Agricultural Water Supply (Evaluation Criteria) **Target:** If MODBRANCH or comparable water budget model is utilized to measure changes in water deliveries with various demands not met in the basin, then the alternative should be no worse (adverse impact) than the without project condition. **Evaluation Method:** The economic post-processor developed for SSFWMM will be used in this evaluation (MODBRANCH or similar)
Is this PM consistent with RECOVER PMs? RECOVER recommends that the PDT investigate compatibility with and use of the targets of existing RECOVER PMs. RECOVER PM WS-E2 (Frequency of Water Restrictions for the Lower East Coast Service Area) targets are to provide at least a 1-in-10 level of service as indicated three or less water years simulated with regionally significant water shortages in the 36-year evaluation period. RECOVER PM WS-E8 (Duration and Severity of Water Restrictions for the Lower East Coast Service Area) targets are for duration to be no more than 18 months with water shortages during the simulation period. Severity target is all water shortages to be Phase 1 "Moderate" Water Shortage in which overall reduction of use is up to 15%.

CERP Goal: Enhance Economic Values and Social Well Being
Project Objective/Constraint: Minimize impacts to cultural, historic, and archaeological resources.
NOT TO BE REVIEWED BY RECOVER

CERP Goal: Enhance Economic Values and Social Well Being
Project Objective/Constraint: Minimize adverse socioeconomic impacts on local and regional economics
NOT TO BE REVIEWED BY RECOVER

F.5 C-111 SPREADER CANAL RECOVER CONSISTENCY REVIEW OF PROJECT-LEVEL MONITORING AND RECOMMENDATIONS FOR INCLUSION INTO THE MONITORING AND ASSESSMENT PLAN

RECOVER Consistency Review of Project-Level Monitoring
And Recommendations for Inclusion into the Monitoring and Assessment Plan

C-111 Spreader Canal – Western Features

February 24, 2009

Introduction and Purpose of the Evaluation

RECOVER has been charged with evaluating project-level monitoring plans in regards to consistency with RECOVER's Monitoring and Assessment Plan (MAP 2004) and other relevant guidance (e.g., CGL 12/06), and to determine the need for additional ecological monitoring above and beyond what is already contained in the MAP. As Projects are typically not at the construction stage when this Review is prepared, and that a variety of changes may possibly occur between the above date and operational readiness of the Project, this Review should be considered an interim document. Future developments may require modification of monitoring plans and/or revision of this Review. This document provides RECOVER's recommendations to the Project PDT regarding incorporation of proposed monitoring into the MAP. Processes are in place through the RLG, DCT or QRB to resolve outstanding issues.

Adequate monitoring is needed in order to effectively carry out RECOVER's adaptive management (AM) mission (see AM strategy: http://www.evergladesplan.org/pm/program_docs/adaptive_mgmt.aspx). MAP related monitoring generally has as its goal the generation of long-term datasets of sufficient temporal and spatial scope to permit valid interpretation(s) and consequently facilitate effective adaptive management of system-wide restoration over the long-term. Proposed MAP monitoring, as envisioned by the project teams, is ambitious and the reality of finite resources and rising costs are additional considerations that must be included when prioritizing monitoring needs. Also, the degree to which proposed monitoring elements can be implemented, phased in, or ranked, cannot be fully defined outside the holistic MAP perspective and the prudent balance between cost and science. This review should not be construed as assessing the relative merit of monitoring elements proposed by the Projects. The objectives of the Review are to ensure holistic system-wide consistency, and to identify monitoring elements appropriate and necessary to be incorporated into the MAP to drive adaptive management and evaluate progress toward Interim Goals.

Project-level monitoring typically involves monitoring that is: 1) required by permit (implemented by the Project), 2) directly related to project operations (e.g., stage and flow),

and 3) to be used for assessing CERP performance and to adaptively manage individual projects and groups of projects into the future. Project-Level Monitoring Plan elements which address system level responses, and which are amenable to drive the adaptive management process would, as necessary and appropriate, be initiated and assessed under the aegis of RECOVER via incorporation into the MAP. Regulatory requirements may become part of the MAP only if they are consistent with MAP objectives; otherwise they would remain with and be funded by the Project. Incorporation of additional monitoring into the MAP presupposes that appropriate RECOVER funding is available at the time of the required inception of any such monitoring.

Objectives of the Monitoring and Assessment Plan

1. Provide data necessary and appropriate to detect and document restoration-induced change, including the evaluation of progress toward Interim Goals.
2. Provide data necessary and appropriate to implement effective Adaptive Management.

Background

Historically, flows from the eastern Everglades provided sufficient freshwater to sustain estuarine conditions in eastern Florida Bay that were amenable to utilization by mesohaline and oligohaline adapted faunal communities for refugia, reproduction, and general habitat. Estuarine environments are well-documented as being zones of intense productivity which provide benefits that extend beyond local improvement to provide positive support and sustenance to the wider marine and reef-based communities. In short, the eastern Florida Bay environment is a keystone environment having far-reaching consequence and support to a much broader and far-flung community of birds, fish, and invertebrates. Regional drainage, canal construction and operation that occurred in the last century has lowered groundwater levels, facilitated sprawling urban development, construction of roads, levees, and creation of other hydrologic barriers or redirections of surface flow that in consequence has altered the drainage pattern that had heretofore provided the foundation of the estuarine system. The objective of the C-111 Spreader Canal – Western Features project is to incrementally re-establish estuarine condition. The objective of the C-111 Project-Level Monitoring Plan (PLMP) is to provide the necessary science to guide and to learn from these efforts to restore a more natural pattern of freshwater flow. Properly understanding the balance that must exist between rehydration of coastal wetlands, nearshore salinity patterns, water quality (both nearshore and offshore), and structure and viability of associated floral and faunal communities is critical toward maximizing benefits and guiding future restoration efforts.

Consistency with the MAP

The C-111 Project Level Monitoring Plan (PLMP) is consistent with, and complimentary to the MAP, neither duplicating nor replacing this program. The plan acknowledges the guidance present in CGM40, CGM42, and the QASR. The plan details relevance to the performance measures developed by the PDT.

RECOVER Recommendations
Including
Incorporation of PDT-Proposed Monitoring into the MAP

Note: Monitoring not recommended for inclusion in the MAP does not imply a technical disagreement with the proposed monitoring element.

General Comments

Project Proposal – Adaptive Management

RECOVER Response

Incorporating AM linkages into the monitoring plan and PIR should greatly reinforce project's contributions to CERP restoration success. RECOVER objective 2 is to provide data necessary and appropriate to implement effective AM. Some if not all of the monitoring parameters could provide this information and some of the linkages are discussed in different sections of the monitoring plan, but the linkages only tie to specific AM decisions in the project operating manual to address the Cape Sable Seaside Sparrow, flood protection, and unacceptable impacts constraints. There is no mention of how the data will link back to management actions and decisions related to achieving restoration performance and overall CERP ecosystem restoration goals and objectives. With a lack of clarity in these monitoring to decision-making linkages, it is difficult to determine if the data is acceptable for AM. Also, for those elements deemed to be project-level monitoring the document is not clear about who is responsible for the data management, analysis, integration, reporting, and long-term "care and feeding" of these efforts. Inference is made that RECOVER would report project performance status as part of the System Status Report, but then indicates specific project-performance workshops will be held as necessary.

Input was previously provided towards incorporating some of these AM linkages, which have not been included in this monitoring plan version. Also, in early conversations the team was asked to use as a template the Biscayne Bay AM plan that incorporates their project level monitoring. In addition, a good reference would be the draft AM guidance manual that discusses the AM activities. Additional input to the ecological subteam has offered specific language to address these comments. Failure of the PIR and monitoring plan to address these AM linkages will result in missed opportunities towards refining and achieving restoration goals, and for cost effective monitoring and subsequent management actions to achieve desired performance.

Additional Cost to MAP

Effective AM principles and clear links to management actions should decrease project monitoring costs. Depending on how the data management, assessments, and reporting are handled, this could result in increased costs to MAP associated efforts.

Project Proposal - Duration

Project-level monitoring for the C-111 SC Western project should be conducted for five years and then reassessed to determine how and where monitoring should continue. It may be beneficial to monitor certain aspects for up to 20 years, because

response times of some ecological monitoring parameters to changes in hydrology and water quality are gradual and long-term.

RECOVER Response

Re-evaluating the monitoring plan on a routine schedule is a sound approach, and should help to best focus efforts and contain costs. If monitoring targets would be developed for each parameter; upon reaching the target, monitoring could be either discontinued or the effort reduced.

Additional Cost to MAP

Monitoring cost will appropriately reflect the phasing of the Project.

Physical and Water Quality Parameters

Project Proposal - Wetland stage

Monitoring wetland stage and the discharge of fresh water from the wetland to the estuaries within the project domain, from the Model Lands to the western boundary of Taylor Slough's influence, is essential in order to document project effects. Time series of stage at stations throughout the domain are needed to determine changes in hydroperiods and hydropatterns. Time series of the discharge of fresh water flow through creeks to Florida Bay and Manatee Bay/Barnes Sound is needed to determine changes in the quantity, timing, and distribution of flow to these estuaries. These flow measurements are also necessary to calculate nutrient loads to the estuaries to ensure that the project does no harm to downstream water quality.

RECOVER Response

An extensive network of hydrologic monitoring, including stage and discharge monitoring currently exists in the C-111 SC project domain. The set of existing and proposed stations in the hydrometeorologic monitoring plan is expected to be sufficient to assess C-111 SC downstream effects.

Additional Cost to MAP

Stage and water level monitoring are properly part of project monitoring, and not appropriate for inclusion in the MAP.

Project Proposal – Salinity

The C-111 SC Western project is expected to improve water deliveries to Florida Bay via Taylor Slough, reduce or eliminate ecologically damaging flows to Manatee Bay, Barnes Sound, and the northeastern Florida Bay coastline, and improve hydroperiods and hydropatterns in the southern Everglades and model lands. In order to determine the spatial distribution of salinity changes in the coastal wetlands, additional synoptic surveys of surface water and shallow porewater are proposed by the project team to be measured three times per year. Two additional continuous salinity monitoring stations are proposed in Madeira Bay and West Key Basin to complement and focus the extensive monitoring network already in existence.

RECOVER Response

- Synoptic surveys of salinity effects in the coastal wetlands three times per year may not be sufficient, and the adequacy of this approach should be evaluated annually to ensure that the types and quality of data necessary are in fact being generated.
- The two additional salinity monitoring sites are likely advisable.

Additional Cost to MAP

The existing salinity monitoring network is funded through a cooperative agreement between the District and ENP; significant cost-savings might be realized by expanding the existing network via the current funding source whose initiating goal was to detect and track the type of salinity changes being considered.

Project Proposal – Water Quality

Hydrologic and salinity restoration must also include protection of the oligotrophic (low nutrient) status of the southern Everglades and downstream estuaries. The project will likely result in increased flows through Taylor, McCormick and Alligator creeks, with the concomitant potential of increase loading. The project team proposes additional nutrient sampling within the freshwater wetlands via periphyton tissue nutrient analysis which provides a temporally integrated indication of nutrient status in the wetland. The proposed periphyton samples will be taken from freshwater and seasonally oligohaline marshes twice per year. Additionally, direct sampling of phosphorous and nitrogen in surface water will be performed at nine sites, five in marshes and four on mangrove creeks flowing into Florida Bay. The project team also proposes a baseline study of water and nutrient sources and export from the Western Taylor Slough lakes region, focusing on water flowing into Seven Palm Lake and West Lake and out of McCormick Creek and Alligator Creek.

RECOVER Response

- Utilization of periphyton nutrient content to evaluate wetland status is an appropriate, accepted approach.
- The adequacy of the proposed water-column nutrient sampling plan to estimate changes in loads should be evaluated on an annual basis to ensure that the types and quality of data necessary are in fact being generated – this information may be critical toward interpreting changes in the current estuarine nutrient regime as measured by the existing Florida Bay water quality monitoring network, in particular as an explanatory variable to either link or de-link restoration-induced effects from observed changes in algal bloom frequency or severity.
- Understanding the nutrient dynamics in the lakes may be secondary, and not as critical as adequately documenting the delivery of nutrients to the bay. The observed nutrient regime in long residency-time lakes may well be an artifact of exchange.
- Direct sampling of water quality via autosamplers in wetlands may not result in data which can be linked to Project operation, particularly as regards phosphorus. However this type of sampling may provide useful information for nitrogen, which will not be addressed by periphyton analysis. Caution may be advised in utilization of these data for adaptive management purposes.

Additional Cost to MAP

No additional monitoring is proposed for inclusion in the MAP.

Project Proposal – Wetland Soil Dynamics

Not in current monitoring proposal.

RECOVER Recommendation – Wetland Soil Dynamics

The PLMP presented to RECOVER for review did not propose monitoring that would document how the C-111 Project may affect change in wetland sediment surface elevation. Accretion rate has been identified by RECOVER as a crucial – and currently under-defined – factor in the long-term success and sustainability of the overall restoration effort as a function of sea-level rise. Understanding how improved hydroperiod may affect soil accretion rate, and the degree to which that rate may keep pace with sea-level rise will provide useful guidance to not only adaptively managing the C-111 Project, but other similar restoration efforts.

Additional Cost to MAP

Soil accretion is the end product of plant and biogeochemical processes and must be evaluated over a number of years to be reliably quantified. The additional cost to the MAP would be approximately $10,000 per year for ten years.

Flora Monitoring

Project Proposal – Wetland Vegetation and SAV

The project's modification of hydropattern and salinity are expected to lead to ecological change toward RECOVER restoration goals and this change will largely occur via changes in plant community structure and cover. Limited project-level wetland vegetation monitoring is proposed, with sampling along transects in the eastern portion of the project domain, including both saline coastal marshes and freshwater marshes. Six sites in which plant community composition, biomass and productivity will be measured annually is proposed. Project-level SAV sampling at four Audubon sites that lack measurements of cover and species composition are proposed to be sampled every six weeks due to the relatively rapid salinity and SAV changes in this region.

RECOVER Response

Specific landscape changes including changes in the distribution and configuration of tidal creeks, salt marshes, and mangrove forests and changes in the extent and distribution of exotic plant communities are needed. Changes in SAV are needed to understand causes of prey base change.

Additional Cost to MAP

The MAP currently funds vegetation monitoring to produce a spatially and thematically accurate vegetation map of the Everglades ecosystem. Extensive funding is currently being expended to evaluate SAV condition in Florida Bay and Biscayne Bay by the MAP. No additional monitoring is proposed for inclusion in the MAP.

Faunal Monitoring

Project Proposal - Freshwater Prey Base

Redistribution of freshwater inflow from the C-111 SC Western project is expected to re-establish a more natural hydropattern in the southern Everglades marshes and is anticipated to increase the diversity and abundance of wetland prey base fish and invertebrates. Currently the MAP provides funding for aquatic prey base monitoring

in the C-111 SC Western project area. The project proposes to continue existing MAP monitoring and no additional project-level monitoring is proposed.

RECOVER Response

Existing MAP monitoring for trophic level aquatic fauna in the C-111 SC Western project area is consistent with project-level monitoring parameters and recommended protocols and is sufficient if maintained at the current level for this area.

Additional Cost to MAP

No additional monitoring is proposed for inclusion in the MAP.

Project Proposal - Saltwater Prey Base

Project-level funding is proposed to improve the spatial coverage of the prey base sampling network such that it encompasses the broad east-west domain of the C-111 SC project, to provide data along the north-south salinity transects of eastern Joe Bay and Taylor River, and to add missing sampling parameters (hydrologic, SAV, fish) such that the sampling matrix of each site with fish sampling is complete. Six new fish sampling stations are proposed.

RECOVER Response

The proposed expansion of the network provides complimentary data and will ensure sufficient spatial coverage, characterization of the prey base response in areas with different salinity regimes, and fill data gaps to assess causes of prey base change.

Additional Cost to MAP

No additional monitoring is proposed for inclusion in the MAP

Project Proposal - Estuarine Fish and Invertebrates

Redistribution of freshwater inflow from the C-111 SC project is expected to re-establish a positive salinity gradient along a greater portion of the shoreline and to re-establish estuarine conditions in northeastern Florida Bay. These hydrologic changes are expected to increase the diversity and abundance of estuarine fish and invertebrates in shallow nearshore waters. The C-111 SC project proposes to continue existing MAP monitoring and no additional project-level monitoring is proposed.

RECOVER Response

Currently MAP provides funding for two projects that monitor estuarine fish and invertebrates in Florida Bay - the Fish and Invertebrate Assessment Network (FIAN) and a project monitoring the distribution and abundance of juvenile spotted seatrout. Existing MAP monitoring for estuarine fish and invertebrates in the C-111 SC Western project area is consistent with project-level monitoring parameters and recommended protocols and is sufficient if maintained at the current level for this area.

Additional Cost to MAP

No additional monitoring is proposed for inclusion in the MAP.

Project Proposal – Cape Sable Seaside Sparrows

The tentatively selected plan for the C-111 SC Western project based on the latest modeling runs and comparing the ecological condition base to the initial operations regime with project, will increase discontinuous hydroperiod in critical habitat for

Cape Sable Seaside Sparrow (CSSS) sub-population D. Surveys conducted to date for occurrence of CSSS have provided valuable information and need to be continued, including (a) helicopter surveys, intensive ground tracking, and banding surveys by Everglades National Park and (b) vegetation transects that annually observe vegetation, periphyton, soils, and topography by Florida International University. The C-111 SC project proposes two additional vegetation transects and three additional stage monitoring wellpoints to sufficiently characterize and monitor habitat conditions needed by the CSSS in sub-population D.

RECOVER Response

The current MAP does not specifically provide for monitoring of occurrence and nesting of CSSS, but it does include monitoring landscape patterns of include marl prairies and slough gradients that will supplement vegetation mapping and document the trade-off between slough habitat restoration and the extent and quality of habitat in adjacent marl prairies in the southern Everglades. The MAP monitors marl prairie and slough gradients which includes nesting habitats for the major breeding populations of the Cape Sable seaside sparrow. The MAP also includes a monitoring component of vegetation mapping for landscape pattern that includes tussock-forming *Muhlenbergia* and sawgrass communities in the major breeding locations of the Cape Sable seaside sparrow.

Additional Cost to MAP

Cape Sable Seaside Sparrow monitoring is properly part of project monitoring, and not appropriate for inclusion in the MAP. The current level of monitoring being conducted by ENP is considered acceptable at this point to monitor species occurrence, and additional vegetation transects were suggested for the FIU vegetation studies.

Project Proposal – Spoonbill Nesting Success

Redistribution of freshwater inflow from the C-111 SC Western project is expected to reestablish a positive salinity gradient along a greater portion of the shoreline and to reestablish estuarine conditions in northeastern Florida Bay. Restoring more natural hydrologic patterns , including a natural recession of water levels in the dry season and reduction in water management-induced reversals, should allow for improved foraging conditions for spoonbills and an increase in nest productivity. Audubon of Florida's Tavernier Science Center (partially funded by MAP) is responsible for much of the roseate spoonbill nest monitoring in Florida Bay; including monitoring 34 keys historically used as nesting colonies, routinely sampling mainland prey base for the northwest and northeast Florida Bay colonies, and continuously monitoring hydrologic conditions at stations in the southern Everglades. In addition, roseate spoonbills and their nests are counted during serial reconnaissance flight (SRF) surveys conducted by ENP staff (also partially funded by MAP) in areas of the southern Everglades C-111 SC project footprint. The C-111 SC project proposes to continue existing MAP monitoring and no additional project-level monitoring is proposed.

RECOVER Response

Existing MAP monitoring of spoonbill nests in the C-111 SC Western project area is consistent with the project-level monitoring parameters and protocols and is sufficient if maintained at the current level for this area.

Additional Cost to MAP

No additional monitoring is proposed for inclusion in the MAP.

Project Proposal - Wading Birds

Redistribution of freshwater inflow from the C-111 SC Western project is expected to reestablish a more natural hydropattern in southern Everglades' marshes. Restoring more natural hydrologic patters, including a natural recession of water levels in the dry season and reduction in water management-induced reversals, should allow for improved foraging conditions for wading birds and an increase in nest productivity. Serial reconnaissance flight (SRF) surveys conducted by ENP staff are the primary method of monitoring numbers of wading birds and nests in areas of the southern Everglades C-111 SC project footprint. The project proposes to continue existing MAP monitoring and no additional project-level monitoring is proposed.

RECOVER Response

Existing MAP monitoring for wading bird foraging distribution monitoring, wading bird nesting colony location, size and abundance monitoring and wood stork and roseate spoonbill nesting success monitoring in the C-111 SC Western project area is consistent with the project-level monitoring parameters and protocols and is sufficient if maintained at the current level for this area.

Additional Cost to MAP

No additional monitoring is proposed for inclusion in the MAP.

Project Proposal - Juvenile Crocodiles

Monitoring crocodiles addresses the project objectives of (a) reducing hypersaline conditions in the estuaries and (b) improvement of the quantity, timing, and distribution of freshwater to Florida Bay, by evaluating the extent to which suitable nursery habitat for hatchling and juvenile crocodiles is restored in the nearshore waters and mangrove wetlands of the project area. Diurnal and nocturnal surveys for crocodiles and nests will be conducted annually; crocodiles will be captured, measured and marked when possible; suitable nesting habitat will be searched on foot during the period of nest preparation; and hatchlings will be located, captured and measured. The C-111 SC project proposes to continue existing MAP monitoring and no additional project-level monitoring is proposed.

RECOVER Response

Existing MAP monitoring for crocodiles in the C-111 SC Western project area is consistent with the project-level monitoring parameters and protocols and is sufficient if maintained at the current level for this area.

Additional Cost to MAP

No additional monitoring is proposed for inclusion in the MAP.

Summary

Additional cost to MAP may arise from the need to address soil accretion which is a critical factor in the long-term success and sustainability of the overall restoration effort as a function of sea-level. All monitoring will need to be re-evaluated over time to determine if it is working as intended, if additional monitoring is advisable, if monitoring should be expanded or reduced in scope, or terminated or replaced by another monitoring element as the data and the changing landscape of restoration priorities so warrant. Processes are in place through the RLG, DCT or QRB to resolve outstanding issues.

RECOVER Project-Level Monitoring Plan Review Team

AT Chair	Concur	Do Not Concur	Comments
Gretchen Ehlinger, USACE	☒	☐	None.
Patty Goodman, SFWMD	☒	☐	None.
Greg Graves, SFWMD	☒	☐	None.
Jana Newman, SFWMD	☒	☐	The team did an excellent job of recognizing those areas where RECOVER MAP data provides data to support their analysis.
Jennifer Stiner, EPJV	☒	☐	None.

RECOVER Assessment Team Chair Approvals

AT Chair	Concur	Do Not Concur	Comments
Gretchen Ehlinger, USACE	☒	☐	None.
Greg Graves, SFWMD	☒	☐	None.
Patti Sime, SFWMD	☒	☐	A general issue is that for those elements deemed to be project-level monitoring, who is responsible for the data management, analysis, integration and long-term "care and feeding".
Steve Traxler, USFWS	☒	☐	Concurrence contingent upon adaptive management links to management actions are incorporated into the document. See the BBCW PIR AM plan and the draft AM manual.

Appendix – Overview of Existing MAP Monitoring Relevant to C-111 SC Western

The following monitoring elements are currently being addressed in the MAP:

- Interior Gradients of Water Quality (MAP Activity Number 3.1.3.1)
- Coastal Gradients of Flow, Salinity, and Nutrients (MAP Activity Number 3.1.3.3)
- Landscape Pattern – Vegetation Mapping (MAP Activity Number 3.1.3.4)
- Landscape Pattern – Marl Prairie/Slough Gradients (MAP Activity Number 3.1.3.5)
- Trophic Level – Aquatic Fauna Regional Populations (MAP Activity Number 3.1.3.10)
- Trophic Level – Aquatic Fauna Seasonal (MAP Activity Number 3.1.3.11)
- Trophic Level – Wading Bird Foraging, Distribution and Abundance (MAP Activity Number 3.1.3.12)
- Trophic Level – Wading Bird Nesting Colony Location, Size and Timing (MAP Activity Number 3.1.3.13)
- Trophic Level – Wood Stork and Roseate Spoonbill Nesting Success (MAP Activity Number 3.1.3.14)
- American Alligator Distribution, Size, Nesting and Hole Occupancy (MAP Activity Number 3.1.3.15)
- American Crocodile Juvenile Growth and Survival (MAP Activity Number 3.1.3.16)
- South Florida Fish Habitat Assessment Program (MAP Activity Number 3.2.3.3)
- South Florida Seagrass Fish and Invertebrate Assessment Network (MAP Activity Number 3.2.3.5)
- Juvenile Spotted Seatrout Monitoring in Florida Bay (MAP Activity Number 3.2.3.7)
- South Florida Surface Water Monitoring Network (MAP Activity Number 3.5.4.1)

US Army Corps of Engineers®

Jacksonville District

South Florida Water Management District

FOR CONTINUATION OF HOUSE DOCUMENT 112-132

CENTRAL AND SOUTHERN FLORIDA PROJECT:
COMPREHENSIVE EVERGLADES RESTORATION PLAN C-111
SPREADER CANAL WESTERN PROJECT

SEE VOLUME 4