

**WATER MONITORING STATIONS
(North Section)**

- Station Symbols
- NPS Active
 - NPS Proposed
 - ◊ NPS Active (missing data)
 - BB SFWMMD Active
 - SFWMMD Proposed
 - ◻ SFWMMD Active (missing data)
 - ▲ NBS Proposed
 - ▼ HA Associates Active
 - Big Cypress Preserve
 - ▽ COE Proposed
 - ◆ DERANUSGS Existing
 - ✕ NPS Proposed (new)
 - + USGS Active
 - ⊠ USGS Active (missing data)

Boundary and hydrology data provided by South Florida Water Management District.

Roads were extracted from USGS and TIGER digital line files.

Projection: Universal Transverse Mercator, Zone 17, North American Datum of 1983.

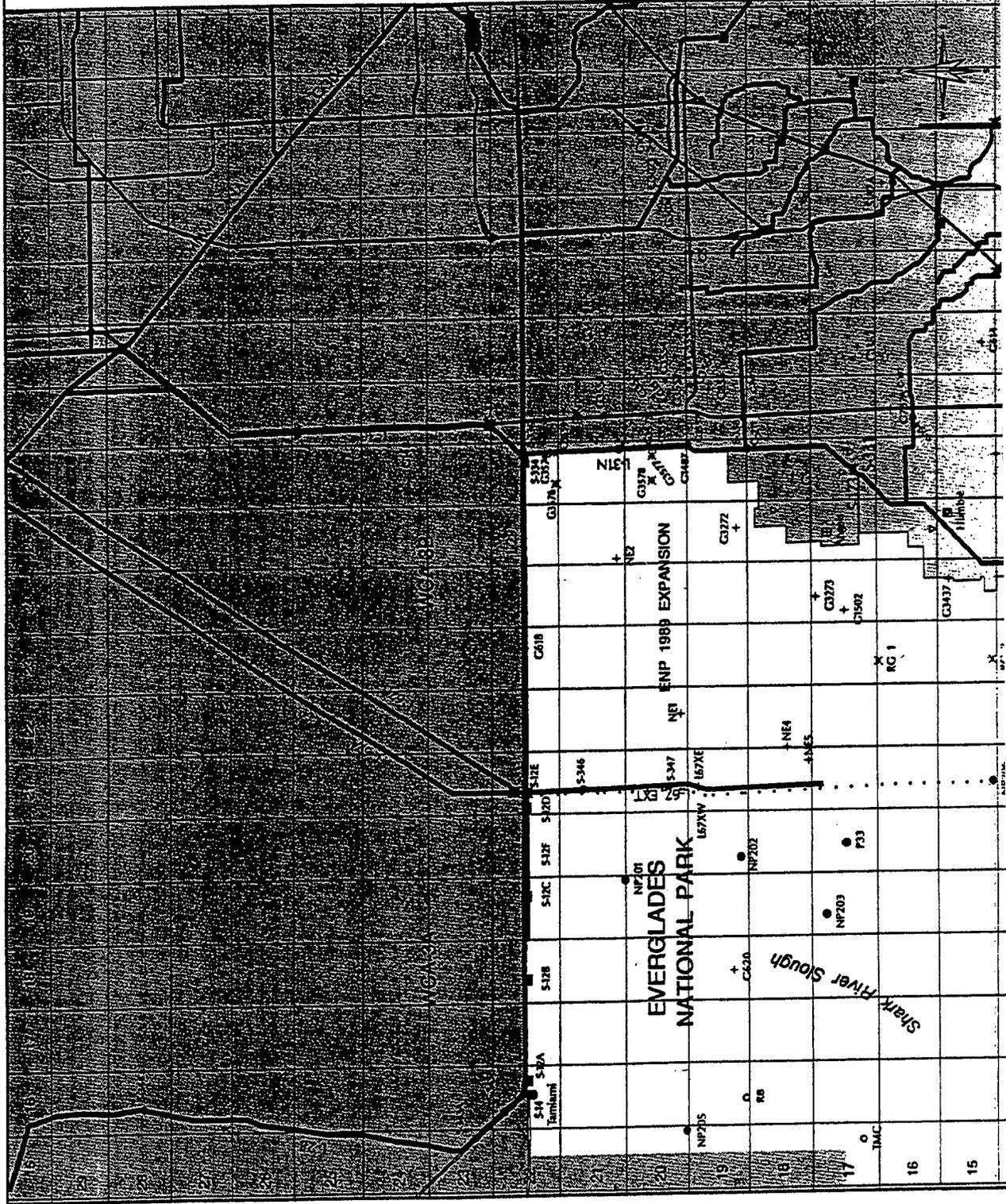


Figure 1A. Location Map

WATER MONITORING STATIONS (South Section)

- Station Symbols
- NPS Active
 - NPS Proposed
 - NPS Active (missing data)
 - BB SFWMD Active
 - SFWMD Proposed
 - SFWMD Active (missing data)
 - ▲ NBS Proposed
 - ▼ HA Associates Active
 - Big Cypress Preserve
 - ▽ COE Proposed
 - DERWADUSGS Existing
 - ✱ NPS Proposed (new)
 - + USGS Active
 - ⊠ USGS Active (missing data)

Boundary and hydrology data provided by South Florida Water Management District.
 Roads were extracted from USGS and TIGER digital line files.
 Projection: Universal Transverse Mercator, Zone 17 - North American Datum of 1972.

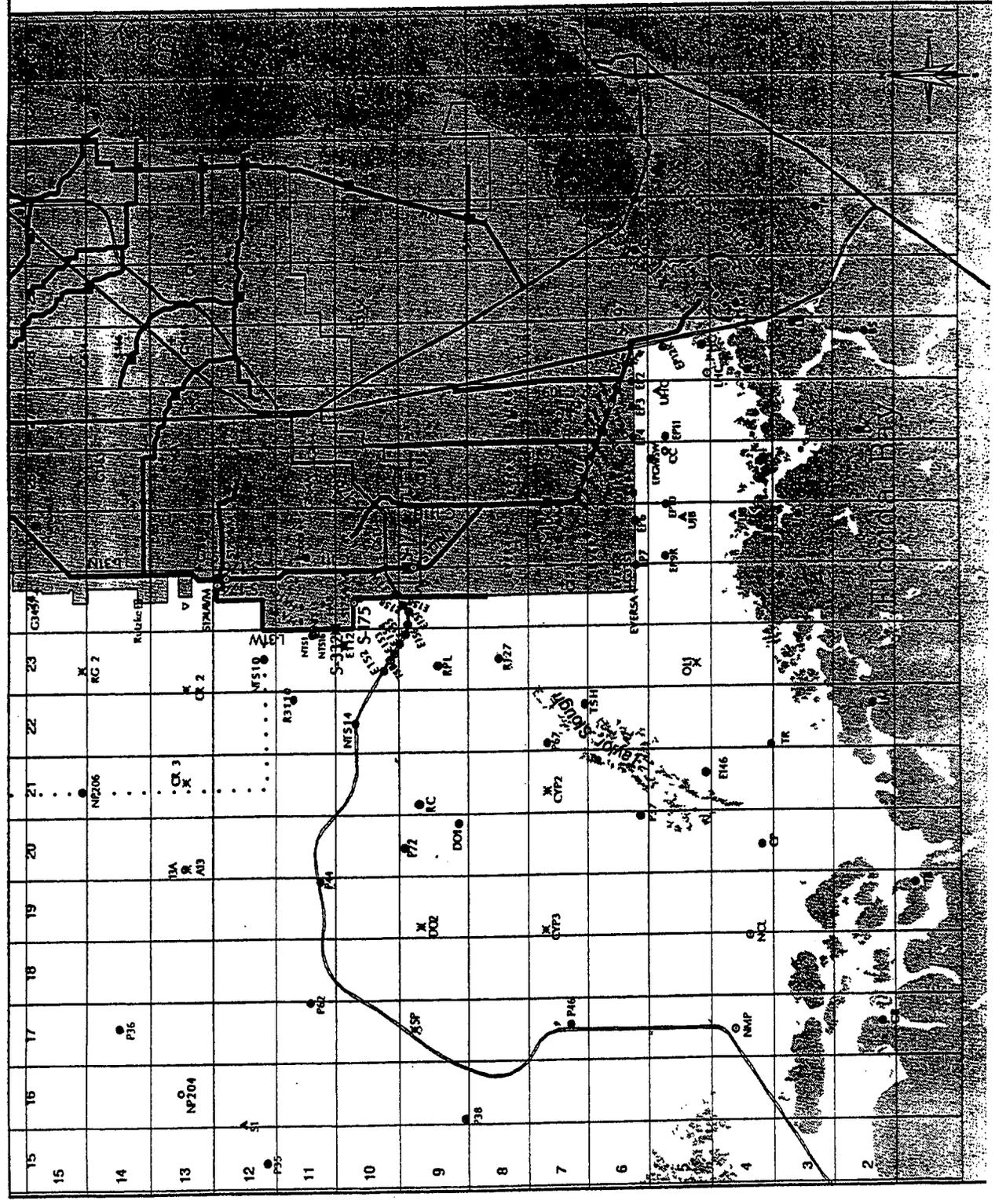


Figure 1B. Location Map

CONCURRENCE WITH THE TEST 7 MONITORING PLAN

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SUB - APPENDIX B

Test 7 Iteration Years One through Four Hydrologic Monitoring Report

October 2000

Draft Report

**TEST ITERATION 7,
YEARS ONE THROUGH FOUR
HYDROLOGIC MONITORING REPORT**

Prepared for



**U.S. Army Corps of Engineers
Jacksonville District
Jacksonville, Florida**

Prepared by



**Engineering Division
Baton Rouge, Louisiana**

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EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

This report is prepared in accordance with the commitment made in the October 1995 Environmental Assessment (EA) and Finding of No Significant Impact (FONSI) for Test Iteration 7 of the Experimental Program of Water Deliveries to Everglades National Park (Test 7 EA). The purpose of this report is to review the four years of Test 7, November 1, 1995 through October 31, 1999, to determine if the objectives stated in the operating criteria section of the Test 7 EA were met and to evaluate the operations.

Test Iteration 7 components included water deliveries into Northeast Shark River Slough (NESRS), reduction of seepage along L-31N, increased water deliveries to Taylor Slough through increased water levels in L-31W, and minimized utilization of S-197 for flood operations.

The purpose of increasing water deliveries to NESRS was to restore a more natural hydroperiod (depth and duration of water) to both NESRS and Western Shark River Slough (WSRS). Reduction of seepage along L-31N was to be achieved by raising the gate closure level for structure G-211 from 5.0 to 5.5 ft-NGVD. Increased water deliveries to Taylor Slough, through increased water levels in L-31W, was to be achieved by following a rainfall/canal stage model developed by Everglades National Park-South Florida Natural Resources Center (ENP-SFNRC) and elimination of the planting season drawdown. The goal of rehydration of wetlands adjacent to Taylor Slough and the Eastern Panhandle and minimized use of S-197 for flood operations was to increase freshwater flows towards Florida Bay.

Test 7 operations were divided into two district phases, Phase I and Phase II. Phase I consisted of operations while structural components of Phase II were put in place. Phase II included operation of new components. These components included installation of an electric pump at S-331 to permit operational flexibility (up to 125 cfs) and pumps at S-174 (S-332D) to pump up to 500 cfs into the Park, and provide flood protection to the L-31N Basin. This report covers both operations during the four-year test period.

Rainfall is a primary input to the Everglades system. Test 7 Year One rainfall, both for the dry and wet season, were near average as characterized by stations selected to represent basin rainfall. Year Two of Test 7 was below average for the dry season but the wet season was very "wet." Year Three of Test 7 was above average for the hydrologic year. The dry season was above average and the wet season was below average. The dry season in Year Four of Test 7 was below average and the wet season was above the average. The average for the year was below average. One year of the four years of Test 7 was below average and three years were above average.

It is important to emphasize that during hydrologic year 1995, Test 6 and Test 6 extended, period of record maximum monthly water levels were attained during every month of the year at the majority of the monitoring stations within ENP. Also, during hydrologic year 1995, record discharges for many of the structures were recorded. This above average antecedent rainfall to Test 7 sustained high water levels well into the average rainfall Year Two dry season.

Water Conservation Area 3A (WCA-3A) water levels remained high due to antecedent rainfall, upstream inflows, and restrictions on the use of S-333. Large regulatory releases through the S-12

structures occurred during both hydrologic year 1995 and 1996 of Test 6 and Test 7, respectively. During hydrologic year 1995 of Test 6, nearly 95 percent of the total surface flows delivered to Shark Slough were to WSRS and during hydrologic Year One of Test 7, nearly 88 percent of the total surface flows delivered to Shark Slough were to WSRS. During Years Two, Three, and Four the percent of the total surface flows delivered to WSRS were 87 percent, 81 percent, and 88 percent, respectively. Historically, WSRS received only 45 percent of the total flow.

Water levels in the reach of L-31N canal north of structure G-211 were to be held between 5.5 and 6.0 ft-NGVD, to limit drainage impacts in NESRS. Due to the antecedent wet conditions, excess seepage waters from NESRS were still required to be discharged to the east coast through structure S-338. In addition, the high water levels associated with the antecedent wet conditions in the East Everglades resulted in flood operation at S-331 through the early part of the 1996 dry season. As soon as the flood control operations ended, water supply releases began. Dry season and wet season average stage levels for the four years of Test 7 were very similar. In the dry season the average stage level varied from 5.67 feet to 5.88 feet, and in the wet season the average ranged from 5.78 feet to 6.21 feet. In three of the four years the wet season average stage was greater than 6.0 feet.

Water levels in the L-31W canal were maintained according to a rainfall/canal stage model designed to correlate water levels to a historical rainfall and stage relationship. The planting season drawdown was eliminated and an upper and lower limit for canal stages were set at 4.7 and 3.0 ft-NGVD, respectively. The canal stages were maintained by pumping at S-332 and operation of S-174. Use of the model resulted in positive hydrologic benefits in Taylor Slough adjacent to and south of the Frog Pond. Higher water levels in L-31W resulted in higher water levels in the marsh to the west L-31W in the early dry season. Further improvements in Taylor Slough hydroperiod were constrained by keeping L-31W water levels at or below the upper limit of 4.7 ft-NGVD. At S-175 dry season average stage levels were 3.65, 3.21, 4.17, and 3.66 feet, respectively for the four years 1996 through 1999. The averages for the wet season were 4.27, 4.55, 4.10, and 4.64 feet, respectively.

Three rainfall events triggered the opening of structure S-197 during hydrologic year 1996. The opening of S-197 at the onset and close of the wet season damps the natural and characteristic response of water levels to basin rainfall. The October 1996 opening of S-197, associated with Hurricane Lili, resulted in removal of water from storage for later in the dry season. S-197 was opened in June 1997, September 1997 which extended through early December 1997, in September and November 1998, and September and October 1999.

During the four years of Test 7, operational criteria, as defined in the Test 7 EA and FONSI, were followed as closely as possible with a few deviations. It was not possible to meet the goal of providing 45 percent of the total Shark Slough flow through S-12 and 55 percent through S-333 due to above regulation water levels in WCA-3A and limitations on discharges from WCA-3A imposed by both structural constraints and the current operational criteria of the Rainfall Plan. At times it was not possible to maintain the average daily headwater at S-331 according to the Angels well criteria due to the current pump discharge configuration. Through inter agency coordination, the S-12 structures, S-343A and B and S-344, were closed when water levels in WCA-3A had receded to levels not requiring regulatory releases through the S-12 structures. This was done in order to lessen impacts on Cape Sable Seaside Sparrows nesting on the fringes of WSRS. In April, water was diverted from L-31W through C-111 in order to facilitate the nesting of a subpopulation of sparrows

south of S-175. In October, changes to the operating criteria were made to ensure flood protection to the adjacent agricultural community in anticipation of rainfall associated with Hurricane *Lili*.

Based on this analysis of the hydrologic data for the four years of Test 7, progress was made toward the program objective of "Evaluating methods to restore a more natural hydroperiod to ecosystems within Everglades National Park (ENP) including NESRS and Taylor Slough." Even though the historical distribution of flow between WSRS and NERSR was not achieved, NESRS was slightly wetter relative to the 1985-1995 period of record. There was positive hydrologic benefit in Taylor Slough adjacent to and south of the Frog Pond. Higher water levels in L-31W resulted in higher water levels in the marsh in the early dry season. This, in turn, increased hydroperiods in Taylor Slough. However, there was little improvement in hydroperiods in the headwaters to Taylor Slough, located west of L-31N between the 8.5 Square Mile Area and the Frog Pond. Water levels in L-31N preclude significant surface water formation in the late wet season and early dry season.

In the second objective of "Enhancement of flow to Florida Bay via Taylor Slough, as well as reduce large freshwater discharges through S-197 into Manatee Bay and Barnes Sound," Year One of Test 7 was consistent with the Test 6 Taylor Slough objective of improving the relative distribution of flows westward into Taylor Slough vs. southward into C-111. During Year One of Test 7 about two-thirds of the L-31N outflow was diverted into Taylor Slough, while one-third was sent down C-111. This represents an improvement in the distribution of flows into Florida Bay. Using the annual flows at S-174 and S-176 the percentages of flow diversion into Taylor Slough by way of S-174 for Years Two, Three, and Four was 53 percent, 48.9 percent, and 48.5 percent, respectively. The operation of S-197 during of Test 7 indicates that closer adherence to the operational criteria for each of the events that triggered the use of S-197 could have resulted in earlier closures of the structure.

The analysis of the impacts on agricultural areas and urban/residential areas indicate the need for more data collection at the field level and analyses before any possible cause-and-effect relationship between Test 7 operational criteria and observed water levels can be established. In addition, the very wet antecedent conditions prior to Year One prohibit the establishment of cause-effect relationships between Test 7 operational criteria and higher water levels in residential areas. Maintaining the S-331 upstream stage within the specified half-foot range based on the water levels at Angels well was not always possible with the current S-331 pump configurations. Compared to the historical period of record, higher water levels were observed during the four years of Test 7 in portions of the 8.5 square mile area (SMA) and Bird Drive Basin.

HYDROLOGIC MONITORING REPORT

INTRODUCTION

This report is prepared in accordance with the commitment made in the October 1995 Environmental Assessment and Finding of No Significant Impact for Test Iteration 7 of the Experimental Program of Water Deliveries to Everglades National Park (Test 7 EA).

The purpose of this report is to review the four years of Test 7, November 1, 1995 through October 31, 1999, to determine if stated objectives were met and to evaluate the operations. Reference is made to *Test Iteration, Year One, Hydrologic Monitoring Report*, draft dated August 29, 1997. Much of that report has been lifted out and included in this report. This includes introductory paragraphs, technical paragraphs and graphs for Year One of Test 7.

The four years of Test 7 (hydrologic years 1996, 1997, 1998, and 1999) are referred to as Year One, Year Two, Year Three, and Year Four throughout this report.

This report has been jointly prepared and includes contributions from the following agencies: U.S. Army Corps of Engineers (USACE), Jacksonville District and the South Florida Water Management District (SFWMD).

HISTORY OF THE EXPERIMENTAL PROGRAM OF WATER DELIVERIES TO EVERGLADES NATIONAL PARK

Appropriations Act of 1984, Public Law 98-181 (Section 1302), passed in November 1983, authorized the Secretary of the Army to conduct an experimental program of water delivery to Everglades National Park (ENP). This allowed the USACE the authority to initiate a series of iterative field tests with the SFWMD and ENP concurrence, to collect and analyze hydrological and ecological data. The program began in March 1984 with a 30 day dry season test of flows into Northeast Shark River Slough (NESRS) via S-333. In July 1984 a 90 day wet season test was conducted. This set the stage for the iterative testing program beginning with Test Iteration 1 in 1985. The program was re-authorized every two years and became a permanent authority in 1991 with the passing of Public Law 102-104. PL 102-104 amended Section 1302 of PL 98-181 to allow the continuation of the Experimental Program until the structural modifications to the Central and Southern Florida (C&SF) project are completed and implemented. The proposed structural modifications are as follows: Construction of three gated culvert structures at intervals along L-67A between S-151 and S-333 (S-345A, B, and C), three gated concrete headwall structures (S-349A, B, and C), and two spillway structures in L-29 between L-67 and L-30 (S-355A and B). The construction of S-355A and B began in October of 1996.

Beginning in the early 1980s, in response to large regulatory water releases to Western Shark Slough, ENP requested several immediate measures be taken to protect the Park. These measures consisted of both structural and water management modifications to the C&SF Project, among them was the long recognized need to modify the Minimum Delivery Schedule (MDS) of water deliveries to the Park.

These initial modifications to the system and their subsequent field-testing also allowed for the development of a more climatologically based plan for the future water deliveries to the park. Through the series of legislatively mandated initiatives discussed above and the cooperation of numerous local, state, and federal agencies, as well as the private sector, the Experimental Program of Water Deliveries to Everglades National Park began in June 1985. As initially implemented, the experimental program consisted of a field test, Test Iteration 1, with the following components:

- Implementation of the rainfall based water delivery plan (Rainfall Plan) for Shark Slough to more closely synchronize water releases to Shark Slough to more natural climatological variability rather than entirely in response to water management.
- Modification of the regulatory water levels in Water Conservation Area 3A (WCA 3A) to include transitional levels thereby averting the need for large regulatory water releases to the Shark Slough.
- Redistribution of water releases to the Shark Slough to include releases to the NESRS via Structure S-333 as well as to West Shark Slough via the four S-12 Structures including limitations on the use of S-333 by downstream trigger wells.

Test Iterations 2 through 5 extended the experimental testing program with no significant changes in the Test 1 operating criteria for NESRS. Test Iteration 6, also known as the Taylor Slough Demonstration Project, began in July 1993 and was authorized to continue through June 1995. Test 6 was extended from July 1995 through October 1995. Test 6 included the elements contained in the previous five tests with addition of two new components:

- The stage in the L-31N Borrow Canal was raised from elevation 4.5 feet (ft) to 5.0 ft-NGVD, during the wet season.
- Three 100 cubic feet per second (cfs) diesel pumps were placed at S-332 to increase pump discharge from 165 cfs up to a total of 465 cfs into Taylor Slough.

Concurrent with the Experimental Program of Water Deliveries to Everglades National Park, changes were made in the operations of L-31W and C-111 due to concerns on the agricultural community in South Florida. June 4, 1985 began an experimental growing season drawdown in L-31W and C-111 (1984-1985 growing season, October 1984 – April 1985). This drawdown was continued through October 1985 – April 1986; October 1986 – April 1987; and October 1987 – April 1988. In addition, the approved design optimum level in L-31N canal between S-335 and S-331 of 5.0 ft-NGVD was lowered to 4.5 ft-NGVD, and between S-331 and S-176 from 5.5 to 4.5 ft-NGVD, to mitigate for the test operations. Limits were placed on the use of S-333 to mitigate for high water level in the park affecting private property in the East Everglades.

In addition to the operational changes, several structural modifications have been implemented since 1985 in the Test 7 study area. Culvert structure G-211 was constructed in the L-31N canal between S-335 and S-331 and became operational in 1991. G-211 allowed the canal stage in L-31N, north of C-1W, to be raised to reduce seepage into L-31N and enhance the hydroperiod on NESRS. Gaps were cut in the south bank of the C-111 levee between S-18C and S-197 to increase the frequency

and distribution of flow to the Eastern Panhandle area of ENP. Ten gated culverts were added to the three existing culverts at S-197.

A list of reference sources for detailed background and history of the Experimental Program of Water deliveries to Everglades National Park is at the end of this report.

TEST ITERATION 7 BACKGROUND

In October 1995, a concurrency agreement between the USACE, ENP, and the SFWMD was signed for the Operating Criteria for Test 7. The test goal is to deliver water to NESRS and Taylor Slough in balance with rainfall to the degree possible without compromising the flood control functions; try to maintain desirable canal stages and pass as much excess water as possible westward into the L-31W Canal and Taylor Slough. During storm events, the flood control criteria will override normal operations.

TEST 7 OBJECTIVES

The Test 7 objectives remain consistent with the previous iterations of the Experimental Program of Water Deliveries to Everglades National Park. The purpose of collecting hydrologic and biological data under different operational schemes with the ultimate goal of improving the timing, volume and location of water deliveries to ENP to more closely reflect natural pre-development flows remains the same and is summarized as follows:

- Evaluate methods to restore a more natural hydroperiod to ecosystems within ENP including NESRS and Taylor Slough.
- Enhancement of flow to Florida Bay via Taylor Slough, as well as reduce large freshwater discharges through S-197 into Manatee Bay and Barnes Sound.

PHASES OF OPERATION

Test 7 operations were divided into two sections, Phase I and Phase II. Phase I consisted of operations while structural components of Phase II were put in place. Phase II included operation of new components. These components included installation of an electric pump at S-331 to permit operational flexibility (up to 125 cfs) and pumps at S-174 (S-332D) to pump up to 500 cfs into the Park, and provide flood protection to the L-31N Basin. This report covers all operations during the four-year period.

PROJECT MODIFICATIONS

Items of note, or major events, which have occurred in the Test 7 study area during Test 7 include the following:

- Acquisition of all eight sections of the Frog Pond in June 1995 has allowed elimination of the growing season drawdown in the L-31W borrow canal and has permitted the construction of Phase II pump station S-332D adjacent to S-174.

- The Rain Based Water Delivery Schedule for Taylor Slough was implemented and followed.
- L-31W Drawdown Test took place from January 22, 1996 through February 1, 1996.
- May 11, 1996 a ValuJet Airplane crashed into the area between L-67A and L-67C. This suspended the L-67 Pilot Test, which had been a part of Test 6.
- Operations were modified at the S-12 structures and in L-31W when necessary during the Cape Sable Seaside Sparrow (CSSS) nesting season, from January through June, during the four-year period.
- Construction of Phase II pump station S-332D was completed in December 1997.
- Construction of S-335 A and B between S-333 and S-334, portions of the Modified Water Deliveries to Everglades National Park Project, was completed in September 1998.

HYDROLOGIC MONITORING PROGRAM

Hydrologic monitoring data have been collected for four years as required in the Test 7 EA. The existing gaging network has been added to by installation of several new gages and upgrading many existing gages. The intent of the data collection during Test 7 is to use the data to measure the hydrologic response of the system to the changed operating conditions.

NETWORK DESCRIPTION

An extensive network of water elevation recorders, rain gages and groundwater monitoring well exists in South Florida area, Figure 1. Data collection is made by ENP, SFWMD, USACE, the U.S. Geologic Survey (USGS), and the National Oceanic and Atmospheric Administration (NOAA).

DATA DESCRIPTION

Data used in this report were obtained from data archives available at ENP, SFWMD, USGS, and NOAA. Data are provisional and subject to revision.

RAINFALL CONDITIONS

For the purpose of this report, the dry season is from November 1 to May 31 (7 months), and the wet season is from June 1 to October 31 (5 months). This delineation of the climatological seasons is consistent with other analyses of South Florida and fits very well into the analysis of Test 7, which began on November 1, 1995. May and October are often considered transition months and May 1996 was a classic transition from the dry season to the wet season with a daily cycle of afternoon seabreeze thunderstorms from May 22 through May 27. The rainfall stations used for analysis of Year One were Tamiami at 40 Mile Bend (NOAA), Royal Palm Ranger Station (ENP), S-336 (SFWMD), S-18C (SFWMD), and Homestead Field Station (SFWMD). There are missing data

