MAY 1994

CENTRAL AND SOUTHERN FLORIDA PROJECT

FINAL
INTEGRATED GENERAL REEVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

CANAL 111 (C-111) SOUTH DADE COUNTY, FLORIDA

US Army Corps of Engineers
Jacksonville District
South Atlantic Division

CENTRAL AND SOUTHERN FLORIDA PROJECT
FLOOD CONTROL AND OTHER PURPOSES

CANAL 111 (C-111)
SOUTH DADE COUNTY, FLORIDA

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AND
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JACKSONVILLE DISTRICT
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Responsible Agencies: The responsible lead agency is the U.S. Army Corps of Engineers, Jacksonville District. The responsible cooperating agencies are the U.S. Park Service, the U.S. Fish and Wildlife Service, the South Florida Water Management District, and the Florida Game and Fresh Water Fish Commission.

Abstract: The Canal 111 (C-111) Basin is located in southern Florida. The basin's short-hydroperiod, Everglades ecosystem and its environmental values have deteriorated as the cumulative results of local and Federal modifications for water resources development. The purposes of the study include protection of the natural values associated with the Everglades National Park and maintenance of flood damage prevention within the C-111 basin. All evaluated alternatives provide net flood protection benefits to agricultural activities, as well as partial restoration of environmental values. Alternative 6A produces the most benefits indicative of overall habitat quality improvement, and it provides beneficial effects for indicator species used in the evaluation. Alternative 6A provides about 397 square miles of Everglades habitat in the Shark Slough and C-111-Taylor Slough basins with longer hydroperiods at beneficial depths, and produces 100 percent improvement over base conditions. With alternative 6A in place, and with a modified water operation schedule, a significant degree of restoration appears likely.

THE OFFICIAL CLOSING DATE FOR THE RECEIPT OF COMMENTS IS 30 DAYS FROM THE DATE ON WHICH THE NOTICE OF AVAILABILITY OF THIS FINAL REPORT-EIS APPEARS IN THE FEDERAL REGISTER.

If you require further information on this document, contact:

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NOTE: This report includes an integrated environmental impact statement (EIS) within the report text; paragraphs required for compliance with the National Environmental Policy Act (NEPA) are noted by an asterisk in the Table of Contents.

CENTRAL AND SOUTHERN FLORIDA PROJECT FOR FLOOD CONTROL AND OTHER PURPOSES

CANAL 111 (C-111) SOUTH DADE COUNTY, FLORIDA

FINAL INTEGRATED GENERAL REEVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

SYLLABUS

The comprehensive Central and Southern Florida (C&SF) Flood Control Project was authorized by the Flood Control Act of 1948 and modified by subsequent acts, as a plan of improvement for flood control, drainage, and other purposes covering a 16,000 square mile area of both central and southern Florida. The Canal 111 (C-111) project, located in southeastern Dade County Florida, adjacent to the eastern boundary of Everglades National Park (ENP), was authorized as an addition to the C&SF Project by the Flood Control Act of 1962.

In 1968, Congress authorized modification of the C-111 project for construction of the ENP-South Dade Conveyance Canals to provide water supply to Dade County as well as Everglades National Park. The project included enlarging existing canals and construction of new structures and pump stations. For this study, it is assumed that the volume of water in C-111 will not increase. However several projects including the Modified Water Deliveries to Everglades National Park Project, C&SF Restudy, South Florida Water Management District's (SFWMD) Lower East Coast Water Supply study and the ongoing Everglades litigation may impact the operations in the C-111 basin.

The Everglades National Park Protection and Expansion Act of 1989 further stipulated that preparation of the General Design Memorandum for project works within the C-111 basin should include all measures which are feasible and consistent with the purposes of the project to protect natural values associated with Everglades National Park. The Act further stated that the report will provide the status of the natural resources of the C-111 basin and functionally related lands.

This General Reevaluation Report (GRR) provides a reformulation and assessment for completing the authorized project within the C-111 basin. This GRR integrates a feasibility report level of documentation with an Environmental Impact Statement (EIS) to produce a single decision document. The purpose of this report is to provide an assessment of the authorized project works to assure that measures recommended for implementation are feasible and consistent with the purposes of the

C&SF Project. These purposes include protection of the natural values associated with the Everglades National Park, and maintenance of flood damage prevention within the C-111 basin, east of L-31N and C-111.

An array of alternative plans have been formulated and evaluated in coordination with our study partners, the South Florida Water Management District, Everglades National Park and US Fish and Wildlife Service. The plans have undergone extensive coordination with representatives of environmental groups and individuals and agricultural interests in the determination of measures which will satisfy the project objectives.

As a result of this coordination effort, the recommended plan consists of both structural and non-structural modifications to the existing project works within the C-111 basin. Structural components of the plan consist of the construction or modification of nine canals, the construction of a L-31 Tieback levee and S-332D Tieback levee, construction of five pump stations, and replacement of the existing bridge over Taylor Slough within the Park. The plan calls for the removal of existing materials placed along the southerly leg of C-111 with these materials to be used as fill for the L-31W Tieback levee. Non-structural components of the plan include the acquisition of over 11,866 acres of land, including the Frog Pond and Rocky Glades, and the relocation of approximately four residential structures which are expected to be impacted by project implementation.

The recommended plan is expected to restore the natural values of Everglades National Park, and maintain flood protection within the C-111 basin east of L-31N and C-111. The wide aerial extent of the water distribution capability of alternative 6A restores the hydrology in 128 square miles of the Taylor Slough and its headwaters in the Rocky Glades. In addition, the hydroperiod and depths in 1027 square miles of Shark River Slough are beneficially impacted by the higher stages in the Rocky Glades, resulting in a net increase in water volume within Shark River Slough. Restoration of hydrologic conditions which reflect the characteristics of historic water conditions within the study area is expected to provide the framework necessary for natural reestablishment of an ecosystem which existed prior to construction of the basin's flood control project. The recommended plan will provide adequate operational flexibility to incorporate management strategies that will evolve as a result of continued monitoring and studies.

The estimated total cost of the recommended plan is approximately $121,400,000; average annual costs are estimated to be $12,000,000 (May 1993 price levels).

Consideration has been given to all significant aspects of the recommended plan in the overall public interest, including engineering feasibility, and economic, social, and environmental effects. The recommended plan described in this report provides the best solution to the water resources needs within the C-111 basin at this time.

CENTRAL AND SOUTHERN FLORIDA PROJECT FOR FLOOD CONTROL AND OTHER PURPOSES

CANAL 111 (C - 111) SOUTH DADE COUNTY

FINAL INTEGRATED GENERAL REEVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

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SECTION 1

INTRODUCTION

The Canal 111 (C-111) Basin, as shown in Insert "A" on Figure 1-1, is located in southern Florida. The area of focus in this report is located in southeastern Dade County, adjacent to the eastern boundary of the Everglades National Park (ENP). In the 1960's, the area was channelized as part of the comprehensive Central and Southern Florida (C&SF) Flood Control Project. This effort has involved years of extensive work by the US Army Corps of Engineers (Corps), the South Florida Water Management District (SFWMD), and the National Park Service/Everglades National Park, South Florida Center for Science and Natural Resources, as well as continuing participation by a variety of interests in Florida and throughout the Nation.

The study focuses on water supply to ENP, environmental restoration and flood protection for the agricultural activities in the C-111 basin.

This section of the report describes the study's authority, partners, purpose and scope; discusses compliance with the National Environmental Policy Act; and provides a brief overview of the C-111 basin, and other studies, reports and existing projects within the area of study.

1.1 STUDY AUTHORITY

In 1968, the ENP-South Dade Conveyance Canals Project was authorized by PL 90-483, Flood Control Act of 1968. The Act authorized modifications to the existing Central and Southern Flood Control Project as authorized by the 1948 Flood Control Act and 1962 Flood Control Act in the interest of improved conservation and distribution of available water and extended flood protection. A major purpose of this project was for conservation and conveyance of water supplies to meet the long-term needs of urban and agricultural users and the ENP. Improvements to the L-31N borrow canal and a new pump station S-331 enabled delivery of water to Taylor Slough, via L-31W and a new pump station S-332, and the Park's eastern panhandle, via C-111, to meet minimum water deliveries to ENP mandated by PL 91-282. No improvements were required in C-111 to handle the increased water supply. The portion of the 1968 Act which is pertinent to the subject area is quoted as follows:

> *...The project for Central and Southern Florida, authorized by the Flood control Act of June 30, 1948, is further modified in accordance with the recommendations of the Chief of Engineers in Senate Document Numbered 101, Ninetieth Congress, ... and in accordance with House Document Numbered 369, Ninetieth Congress.*

Specific authorization from River Basin Monetary Authorization and Miscellaneous Civil Works Amendments Act of 1970 (PL 91-282) stipulated construction of specifically named canals and other works to deliver water to Taylor Slough and the eastern panhandle of the park. The Act further provided for the delivery to ENP a minimum of 315,000 acre-feet of water according to a monthly distribution.

1.2 PROJECT PARTNERS

The South Florida Water Management District has expressed its intent to be the project sponsor. The SFWMD's outstanding assistance and cooperation contributed greatly to the completion of the study and this general reevaluation report.

In addition to the SFWMD, the ENP, South Florida Center for Science and Natural Resources, and the US Fish and Wildlife Service (FWS) actively participated in the study by assisting in the evaluation of alternatives for the environmental restoration of the C-111 study area.

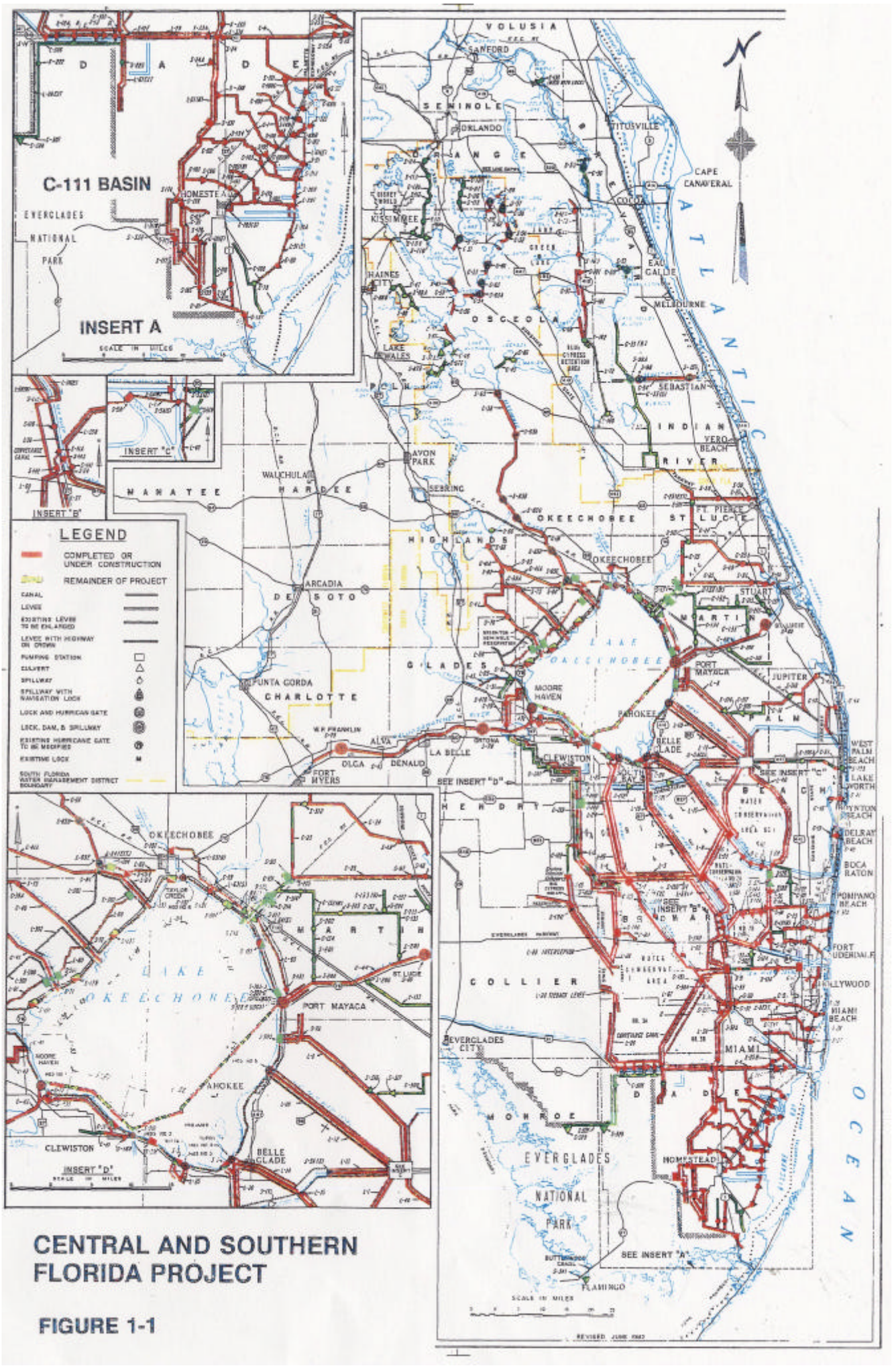
1.3 STUDY PURPOSE AND SCOPE

1.3.1 Study Purpose

This report covers the Canal 111 (C-111) basin and other parts of the Central and Southern Florida Project which affect flows to and through the basin including the borrow canal to L-31N and the borrow canal to L-31W. The purpose of this general reevaluation report (GRR) is restoration of the ecosystem in Taylor Slough and the eastern panhandle of ENP that were affected by construction of the flood control project in the C-111 Basin. The study also focuses on preserving the current level of flood protection for the agricultural activities in the C-111 basin.

This report provides a recommended solution to these problems which will provide both flood protection and vastly increase management options for the benefit of the environment and the economy. It is the intent of this report to select a plan that will have the operational capability and flexibility to provide restoration of the ecological integrity of Taylor Slough and the eastern panhandle areas of the Everglades and flood protection to the agricultural interests adjacent to C-111.

The GRR is the first step in a two-phase design process. The focus of the GRR is to develop the structural plan which provides the greatest flexibility in providing environmental restoration of the study area while maintaining flood control. The second phase will consist of detailed design studies and development of an operational plan. While a preliminary operational plan will be submitted with this report, a refined operation plan will be developed in coordination with ENP, FWS, SFWMD and



CENTRAL AND SOUTHERN FLORIDA PROJECT

FIGURE 1-1

other agencies prior to project construction. The study has been conducted in accordance with current Federal water resources planning procedures and guidelines, with assistance and support from numerous Federal and State agencies, and other interests.

1.3.2 Study Area

The area of focus in this report is located in southeastern Dade County and is depicted in Figure 1-2. The study area's northern boundary is a line drawn east from S-331, the divide control structure, and west on the southern limit of the eight-and-one-half square mile area and west by Shark River Slough located in ENP. The eastern boundary varies generally along a line through the ridge structures S-194 and S-196 to Homestead and then parallels Card Sound Road. The southern boundary is Florida Bay. The area is low with the land surface south of Homestead generally sloping to the southeast. Ground elevations range from just above sea level to 7.0 feet, NGVD.

The C-111 study area basin includes the borrow canal to L-31N south of S-331, the borrow canal to L-31W, and canals 111, 110, and 109.

1.4 NATIONAL ENVIRONMENTAL POLICY ACT REQUIREMENTS

The National Environmental Policy Act of 1969 (NEPA), as amended, is the nation's charter for environmental protection. NEPA establishes policy, sets goals, and provides means for carrying out the policy. Section 102(2) of the Act contains action-forcing provisions to make sure that Federal agencies act according to the letter and spirit of the Act, including a provision to prepare a detailed statement - now called an environmental impact statement (EIS) - on the effects of a major Federal action that significantly affects the human environment. The Federal regulations for implementing the procedural provisions of NEPA were published by the Council on Environmental Quality (CEQ) in the Code of Federal Regulations (CFR) as 40 CFR Parts 1500-1508 (43 Federal Register 55978-56007, November 29, 1978).

This report documents the Corps study of environmental restoration and maintenance of flood control in the C-111 basin in compliance with NEPA requirements. It employs two concepts established in CEQ's NEPA regulations - integration and tiering - that are appropriate to the planning and design process and schedule for the C-111 basin.

Integration is based on the CEQ provision to combine documents, which states that *"any environmental document in compliance with NEPA may be combined with any other agency document to reduce duplication and paperwork"* (40 CFR 1506.4). Corps regulations permit an EIS ("environmental document") to be either a self-standing document combined with and bound within a feasibility report ("agency document"), or an

integration of NEPA-required discussions in the text of the report. In view of the environmental nature of the C-111 basin, and to consolidate documentation into one consistent report, the Corps elected to integrate discussions that could have appeared as an EIS with the feasibility report. Sections in this integrated report that include NEPA-required discussions are marked with an asterisk in the Table of Contents to assist readers in identifying such material.

Tiering was established by CEQ to provide *coverage of general matters in broader environmental impact statements (such as national program or policy statements) with subsequent narrower statements or environmental analyses (such as regional or basin-wide program statements or ultimately site-specific statements).... Tiering is appropriate when the sequence of statements or analyses is...from an environmental impact statement on a specific action at an early stage (such as need and site selection) to a supplement (which is preferred) or a subsequent statement or analysis at a later stage....Tiering in such cases is appropriate when it helps the lead agency to focus on the issues which are ripe for decision and exclude from consideration issues already decided or not yet ripe* (40 CFR 1508.28 and 1502.20). Tiering has been applied to proposed Federal actions for the reevaluated C-111 portion of the C&SF Project as follows:

- The C-111 project will be formulated in two stages: the facilities planning stage and the operation planning stage. The facilities plan formulation for locations and capacities of pumps, canals, levees and required appurtenances is reported in this integrated GRR-EIS for approval in 1994. The GRR-EIS is, therefore, a programmatic EIS and a site-specific EIS.

- Selection of the preferred plan of operation of the project facilities will be accomplished during 1994-1996, and the impacts of the recommended operation will be published in a supplement to the final GRR-EIS. The Supplement to the EIS will be published prior to completion of construction.

1.5 HISTORY OF THE AREA

The existing Canal 111 (C-111) and adjacent canals are the result of a number of changes from the initially conceived plan for this area. It is part of the Central and Southern Florida Project which had its genesis as a multipurpose water resources project initiated in the 1940s.

The initial concept for South Dade County contained in the 1947 comprehensive report called for the area to be protected by a levee. This levee would protect the area on the east and south from ocean tides driven by hurricanes. On the west, the levee would protect the area from flood waters in the Everglades. Spillways and culverts in the east and south walls of the levee would control discharge from the canals and maintain canal water levels high enough to prevent salt water intrusion. At that time, it was envisioned that the C-111 basin would become developed.

Boundary, and hydrology data provided by South Florida Water Management District.
Land cover data provided by Florida Game and Fresh Water Fish Commision.
Projection: Zone 17, Universal Transverse Mercator.
Mapscale 1:225000 (1" = 3.55 mi).
Plot date: 12 May 94 12:41:55 Thursday

SYMBOLS
- Canals and Levees
- Major Roads
- Existing Gauge
- Existing Spillway
- Existing Culvert
- Existing Pump Station
- Proposed Spillway
- Proposed Culvert
- Proposed Pump Station
- Proposed Plug

EVERGLADES NATIONAL PARK
WCA-3A
WCA-3B
ENP 1989 EXPANSION
Shark River Slough
Taylor Slough
Tamiami Trail
Degraded Levee
Seepage Levee
Florida Bay
Manatee Bay
Barnes Sound
Card Sound Road
Biscayne Bay
Krome Avenue (SR 9336)
US 1
North
P-33
G-3115
G-789
G-211
S-332
S-175
S-174
S-176
S-178
S-18C
S-197
S-173
S-331
S-357
S-355
S-349
S-345
S-336
C-111
C-110
C-109
C-113
C-103
C-102
C-1W
C-1N
C-100
C-2
L-31W
L-31N
L-67 EXT
L-67A
L-67C
L-29
L-30

C-111 BASE MAP
FIGURE 1-2

Later analysis led to a revision of the project. A series of canals, C-107 through C-112, were proposed in lieu of the southern portion of the levee. This iteration was contained in the Survey Review Report for South Dade County published in November 1959. These canals were proposed to go to tidewater: C-107 and C-108 to Card Sound, C-109 to Barnes Sound, and C-110 through C-112 to Long Sound and Florida Bay. Salinity control structures were included between the one- and two-foot contour. The US Fish and Wildlife Service recommended that Canals 108 through 111 be terminated at the 1-foot contour to allow the water to spread over a wider front and flow more gradually through ENP in accordance with the natural condition. The problem with this proposal was that the canals would not carry the design discharge unless excavated to open water on the coast. The staff of the FWS further suggested an east-west canal connecting the ends of C-111 and C-110 with C-109 as a possibility. The staff of the ENP was less specific but wanted to hold southward extension of C-110 and C-111 to a minimum to facilitate the spread of water over Park lands as it flowed toward Florida Bay.

Further changes were made during preparation of the General Design Memorandum (GDM). The Park wanted C-110 through C-112 terminated at the Park boundary. The Fish and Wildlife Service was still requesting termination of the canals at the 1-foot contour. Also during this period a private firm, Aerojet General Corporation, purchased a large tract of land in the area. At the time, this corporation was to construct a rocket engine testing facility (which was completed later). Since the canal would be large enough to convey barges carrying the rockets to Cape Canaveral, the firm also supported connecting the canal to C-109. The resultant alinement of C-111 was a trade-off with the existing diagonal configuration being more cost effective. This alinement is shown in Figure 1-3. The Aerojet facilities are no longer in operation.

One other change made during project construction has had a significant effect on operation of the system. The original design included S-18C, located upstream from the coast with the end of the canal open to Barnes Sound, as the canal's downstream salinity barrier. Concerns were raised feared that salt water would move up the canal and possibly contaminate the freshwater aquifer or spill over the south bank through the gaps, destroying the portion of ENP south of C-111. During construction of the canal, these interests became very vocal and mounted a national campaign to construct a structure at the end of the canal. As part of the construction procedure, a bypass for US Highway 1 was used while the bridge over C-111 was constructed. About the time the bypass was to be removed, the controversy over the open end of the canal reached a peak. As a temporary solution, a plug and culvert structure were placed in the canal immediately downstream of the US Highway 1 bridge. The plug was to be removed for flood control purposes and also for

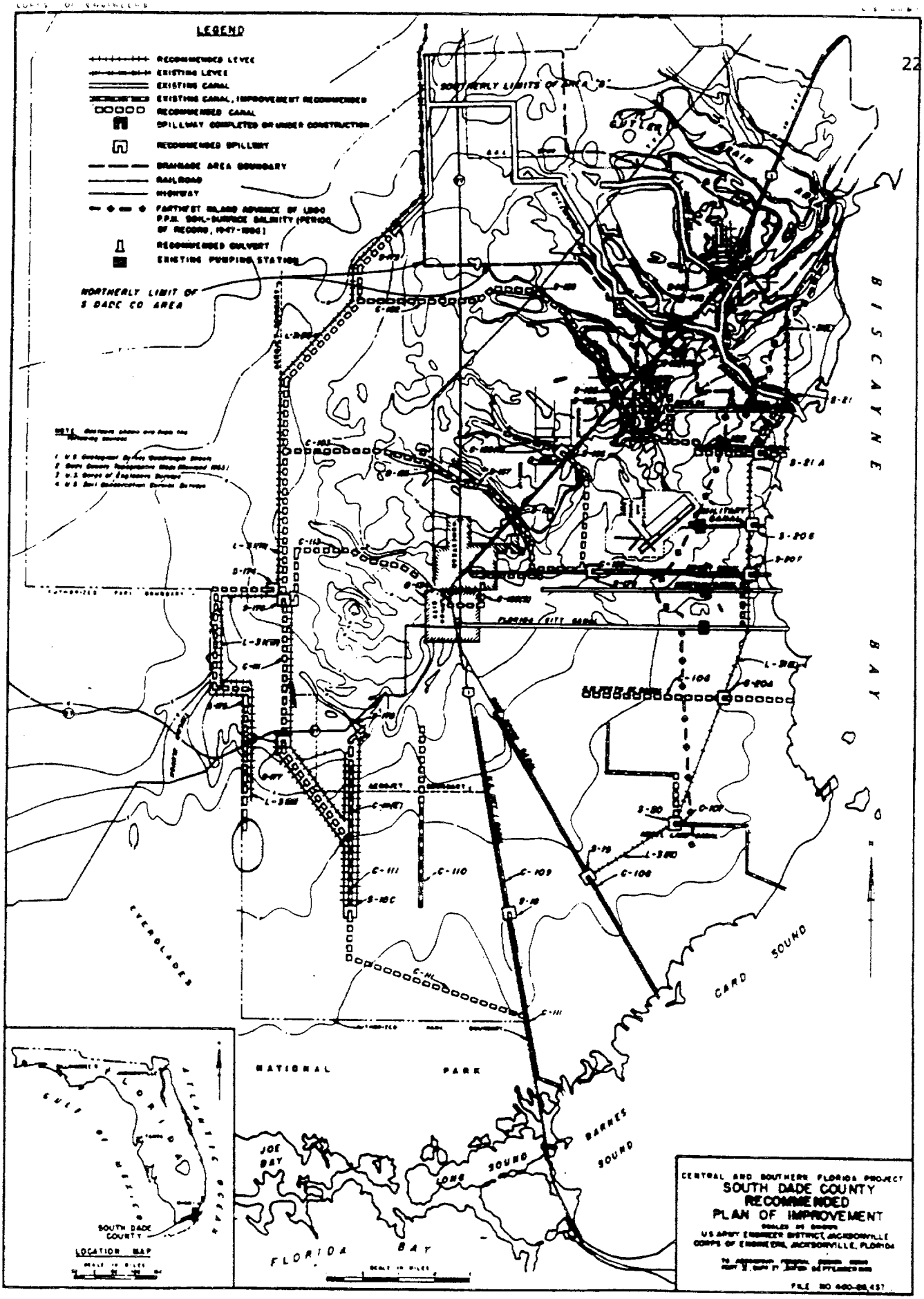

LEGEND
RECOMMENDED LEVEE
EXISTING LEVEE
EXISTING CANAL
EXISTING CANAL, IMPROVEMENT RECOMMENDED
RECOMMENDED CANAL
SPILLWAY COMPLETED OR UNDER CONSTRUCTION
RECOMMENDED SPILLWAY
DRAINAGE AREA BOUNDARY
RAILROAD
HIGHWAY
RECOMMENDED CULVERT
EXISTING PUMPING STATION
NORTHERLY LIMIT OF S DADE CO AREA
BISCAYNE BAY
FLORIDA CITY CANAL
EVERGLADES
NATIONAL PARK
CARD SOUND
JOE BAY
JOHN SOUND
BARNES SOUND
FLORIDA BAY
SOUTH DADE COUNTY
LOCATION MAP
CENTRAL AND SOUTHERN FLORIDA PROJECT
SOUTH DADE COUNTY
RECOMMENDED
PLAN OF IMPROVEMENT
U.S. ARMY ENGINEER DISTRICT, JACKSONVILLE
CORPS OF ENGINEERS, JACKSONVILLE, FLORIDA

FIGURE 1-3

passage of Aerojet barges. However, the plug was never removed for navigation purposes.

Another change made during the GDM was based on ENP's goal to receive as much water as possible from the C&SF Project. The ENP requested that excess water from the western portion of south Dade County be provided to the Park through Taylor Slough. L-31W was added for this purpose to provide gravity flow.

A number of other changes to the C&SF Project upstream of C-111 have had an impact in the C-111 basin. In 1968, the ENP-South Dade Conveyance Canals were authorized (PL 90-483). A major purpose of this system was to promote conservation and conveyance of water supplies to ENP and to the expanding agricultural and urban areas of south Dade County. As a part of the conveyance system, necessary modifications to the C&SF Project were constructed upstream of L-31W (including improvement of the L-31N borrow canal upstream of its confluence with C-103 and addition of the pump station S-331) to enable adequate delivery of water to Taylor Slough and the Park's eastern panhandle. No canal improvements were made to the borrow canal for L-31W or C-111 as a part of the conveyance system. However, S-332 was added as a part of the system to provide water deliveries to Taylor Slough from the L-31W borrow canal. The S-332 pump capacity is 165 cfs and it is operated to satisfy the minimum monthly water delivery requirements of Taylor Slough as specified in PL 91-282. In 1976, the specific operation of S-332 was agreed upon in an Agreement and Permit signed by the Corps, National Park Service, and the C&SF Flood Control District (now SFWMD). Although the total annual volume of 37,000 acre-feet to be delivered to Taylor Slough remained the same, the monthly distribution used in the agreement varied slightly from that prescribed by PL 91-282. Since construction of S-332 was completed in 1980, water deliveries have been provided to Taylor Slough to satisfy the minimum delivery requirements of the 1976 Agreement and Permit.

By the early 1980's, it was becoming clear that the structural and operational water management system had significantly contributed to the decline of the Park's natural resources. However, there were not adequate hydrologic or ecologic data available to fully define the hydrologic needs of the ecosystem nor to determine how the water management system should be modified. In order to allow collection of the required data, Congress enacted the Experimental Program of Modified Water Deliveries to ENP (PL 98-181), which allowed the minimum delivery schedule to be temporarily abandoned in order to test alternative plans for delivering water to the Park.

The test is being conducted through an iterative process with each step building on information obtained in previous iterations. The first test was initiated in 1985 when a Letter of Agreement (LOA) was signed by the Corps, SFWMD, and ENP to change the experimental program started in 1983. To date there have been six

Addenda to the LOA and five associated iterations of testing.. Addendum 1 presented the operational procedures used in a 2-year test of the rain-driven plan for water deliveries to the ENP that ended on June 14, 1987. Addendum 2 prescribed operational procedures for the rain-driven plan used through July 10, 1988. Addenda 3, 4, and 5 represented continuation of the operational procedures contained in Addendum 2. On July 12, 1985, an agreement was reached between the SFWMD and the Frog Pond farmers in response to the Kendall et. al. v. Marsh, et. al. lawsuit. This agreement permitted the experimental program to continue without further litigation.

Section 107 of P.L. 102-104 authorized continuation of the experimental program until modifications to the C&SF project, authorized by Section 104 of Public Law 101-229 (Everglades National Park Protection and Expansion Act of 1989), are completed and implemented.

From 1983-1988 a GDM was prepared. The purpose of the study was to complete the authorized plan of improvement for flood control, environmental enhancement and water management in the C-111 basin as constructed. The recommended plan focused on preventing large, damaging discharges to Barnes Sound via S-197 and to increase flows to northeast Florida Bay via flows from lower C-111.

From 1988 to 1990, several actions developed which changed the scope and schedule for completion of the C-111 report. Seagrass die-offs were observed in portions of Florida Bay although the precise causes were unknown. As a result, ENP requested that additional studies be performed to more fully evaluate potential means of restoring natural hydrologic conditions to Taylor Slough.

In 1989 the Everglades National Park Protection and Expansion Act was enacted. Under Section 104 (j): Protection of Natural Values, *The Secretary of the Army is directed in analysis, design and engineering associated with the development of a general design memorandum for works and operations in the "C-111 basin" area of the East Everglades, to take all measures which are feasible and consistent with the purposes of the project to protect natural values associated with Everglades National Park.* This Act authorized the construction of modifications to the Central and Southern Florida Project to improve water deliveries to the Park, and to the extent practicable, permits steps to restore the natural hydrologic conditions within the Park. The Act states that these modifications are "justified by the environmental benefits to be derived by the Everglades ecosystem in general and the Park in particular".

The FWS submitted a proposal in 1989 to revise their Fish and Wildlife Coordination Act (FWCA) report, including an assessment of benefits and impacts to fish and wildlife resources. They again proposed a structural feature to complement the preferred alternative in the GDM. The FWS proposed an east-west spreader canal between C-111E and US Highway 1. The FWS also proposed the plugging of

C-109 and C-110 to promote sheetflow and to provide dry season refugia. Sheetflow would be provided by overflows from C-111 through gaps in the southern spoil mound.

In June 1993, the Corps, ENP, and SFWMD initiated the Experimental Program of Water Deliveries to Everglades National Park - Taylor Slough Iteration, the sixth iteration of the experimental testing program. This test will continue water deliveries to northeast Shark River Slough and increase water deliveries to Taylor Slough at S-332 up to 500 cubic feet per second (cfs).

From 1989 to the present, the Corps has worked diligently with the SFWMD, FWS and ENP to address plans which would protect the natural values associated with ENP.

1.6 PRIOR STUDIES, REPORTS AND EXISTING PROJECTS

1.6.1 Modified Water Deliveries to Everglades National Park

The Modified Water Deliveries to Everglades National Park project was authorized by the Everglades National Park Protection and Expansion Act, Public Law 101-229. The purpose of the project is to provide for structural modifications to the C&SF Project to enable the restoration of more natural water flows to Shark River Slough in ENP. The project is being implemented by the Corps in conjunction with the acquisition of about 107,600 acres of land by the Department of Interior. These lands will be incorporated into ENP as shown in Figure 1-4.

The General Design Memorandum for the project was approved by the Assistant Secretary of the Army (Civil Works) in May 1993. The Record of Decision for the Environmental Impact Statement was also executed in May 1993. Currently, detailed engineering and design is underway. The first of five Feature Design Memoranda was approved in December 1993. Land acquisition for the levee, canal, and pump station for the flood mitigation system in the 8.5-square-mile area is underway. The project construction is scheduled for completion in 2003. A more detailed project description is in section 3.2.

1.6.2 South Florida Water Management District Interim Plan for C-111 Basin

In 1989, the South Florida Water Management District proposed the Interim Plan for the C-111 basin. The objectives of the plan were to (1) reduce the duration of large discharge events at S-197 associated with removal of the earthen plug, (2) increase the frequency and distribution of flow to the ENP Panhandle by increasing flow through the gaps in the C-111 canal, (3) raise the canal stage in L-31N between S-335 and C-1W to reduce seepage into L-31N canal and enhance the hydroperiod in Northeast Shark River Slough, and (4) maintain existing levels of flood protection.

The objectives were accomplished by specific structural additions and/or changes in operational criteria that included the following: (1) addition of 10 - 84 inch gated culverts at S-197, (2) modification of gaps in C-111 south bank spoil mound to enhance flow of water to ENP eastern panhandle, and (3) installation of a new gated structure G-211 immediately south of the junction of L-31N canal and C-1.

1.6.3 Everglades SWIM Plan

The Surface Water Improvement and Management (SWIM) Plan for the Everglades was published by the South Florida Water Management District on March 13, 1993. The SWIM plan for the Everglades describes the Everglades development and management history, summarizes present knowledge, and provides an overview of current conditions. The plan then integrates proposed and existing programs to address various aspects of water resource management in the Everglades, such as water quality, water quantity (hydroperiod), flood control, control of exotic plants and environmental enhancement. The plan also provides a funding strategy for the Everglades restoration initiative which deals largely with improving the quality of water entering the Everglades as agricultural runoff from the Everglades Agricultural Area.

The SWIM plan has been further strengthened with the passage of the "Everglades Forever" Act in May 1994.

1.6.4 Frog Pond Reconnaissance Report

This study was authorized by PL 100-676 for the purpose of determining the need for an internal drainage system in the Frog Pond Agricultural area in South Dade County. The purpose of the study was to evaluate the feasibility and Federal interest of resolving agricultural flood control problems in the Frog Pond. Approximately 80 percent of the Frog Pond is used for agricultural purposes, mainly tomato farming. The area of Frog Pond not used for farming consists of upland tree hammocks and wetlands.

Although economically feasible plans were identified in this study, the District Engineer recommended that no further Federal action be undertaken at this time for two policy reasons. First, the requirements for local cooperation for the C-111 project, as well as for other elements of the C&SF Project stipulate that local interests are responsible for construction and maintenance of lateral drainage facilities as necessary to realize the benefits made available by the improvements in south Dade County. Secondly, a plan to reduce flood damage in the Frog Pond would violate Federal regulations restricting the provisions of benefits for a single property owner, in this case, the South Dade Land Corporation. No further evaluation was conducted to determine whether the plans were implementable with respect to environmental

Boundary, and hydrology data provided by South Florida Water Management District.
Road data extracted from USGS and TIGER digital line files.
Projection: Universal Transverse Mercator, Zone 17. NAD 27
Mapscale 1:225000 (1" = 3.55 mi).
Plot date: 11 May 94 16:13:20 Wednesday

AREA SHADES
- 8.5 sq Mile Area
- Rocky Glades
- Frog Pond
- Model Lands
- Southern Glades

LINE SYMBOLS
- Canals and Levees
- Major Roads

MARKER SYMBOLS
- Existing Gauge
- Existing Spillway
- Existing Culvert
- Existing Pump Station
- Proposed Spillway
- Proposed Culvert
- Proposed Pump Station

EVERGLADES NATIONAL PARK
WCA-3A
WCA-3B
ENP 1989 EXPANSION
Shark River Slough
Tamiami Trail
(US 41)
Lower Taylor Slough
Taylor Slough (Middle)
Upper Taylor Slough
Taylor Slough Headwaters
P-33
G-3115
G-789
L-67 EXT
Degraded Levee
L-67A
L-67C
L-29
S-349
S-355
S-345
S-356
S-357
Seepage Levee
S-173
S-331
L-31N
L-31W
S-332
S-175
S-174
S-176
S-177
S-18C
C-111
C-111E
C-110
C-109
S-178
S-196
C-103
C-113
S-197
US 1
Card Sound Road
Krome Avenue
(SR 9336)
L-30
C-102
C-1W
C-1
C-1N
C-2
C-4
S-167
S-166
S-179
S-20
L-31E
S-20A
North

LANDS MAP
FIGURE 1-4

impacts. Refer to section 2.2.2 of this report for more detailed information on the Frog Pond area.

1.6.5 Central and Southern Florida Project Comprehensive Review Study

The Central and Southern Florida (C&SF) Project Comprehensive Review Study was authorized by Section 309(l) of the Water Resources Development Act of 1992 and by two resolutions of the Committee on Public Works and Transportation, United States House of Representatives, dated September 24, 1992. These authorizations direct that the Corps reexamine the C&SF Project to determine if modifications should be made to the project in the interest of environmental quality, water supply, and the Everglades and Florida Bay ecosystems.

The study will generally include the entire C&SF Project with the exception of the Upper St. Johns River basin, which is a separate hydrologic basin not considered part of the Everglades ecosystem. Two of the most critical areas to be addressed concern the environmental conditions of the Everglades and Florida Bay. The study will reexamine the C&SF Project in light of current demands to determine the feasibility of structural or operational changes to restore the Everglades and Florida Bay ecosystems while providing for other water related demands. The reconnaissance study was initiated in June 1993 and will be completed in 18 months.

1.6.6 Florida Department of Transportation US 1 South

The Florida Department of Transportation (FDOT) is in the process of widening US 1 from Key Largo to Card Sound Road (Florida City, Florida). The plan involves widening the existing road for another 2 lanes to and from the Florida Keys. The plan is under development and construction is currently scheduled for 1995. The FDOT plans to restore Canal 109 and Canal 110 and the adjacent disposal mounds to natural ground. This will restore sheetflow. Twenty two-foot diameter culverts under US Highway 1 are planned.

1.6.7 Hole-In-the-Donut Restoration

The ENP has submitted a dredge and fill permit under Section 404 of the Clean Water Act for restoration of the Hole-in-the-Donut (See Figure 1-5). The Hole-in-the-Donut area was used for agriculture until the 1970's when it was incorporated into the park. Since that time, it has been overgrown with Brazilian pepper trees that have completely eliminated the native habitat. ENP has unsuccessfully attempted a number of methods to eliminate the trees and restore the natural conditions. The only method found to be successful is to remove the "rock plowed" soil (about 9") down to the native limestone rock. The disposal area identified for this project is the eastern half of the Frog Pond, approximately 3,083 acres. The disposal material will

add approximately 2 to 3 feet of elevation to this area of the Frog Pond. Early estimates for completion of the project are approximately 15 years.

1.6.8 Save Our Rivers Program

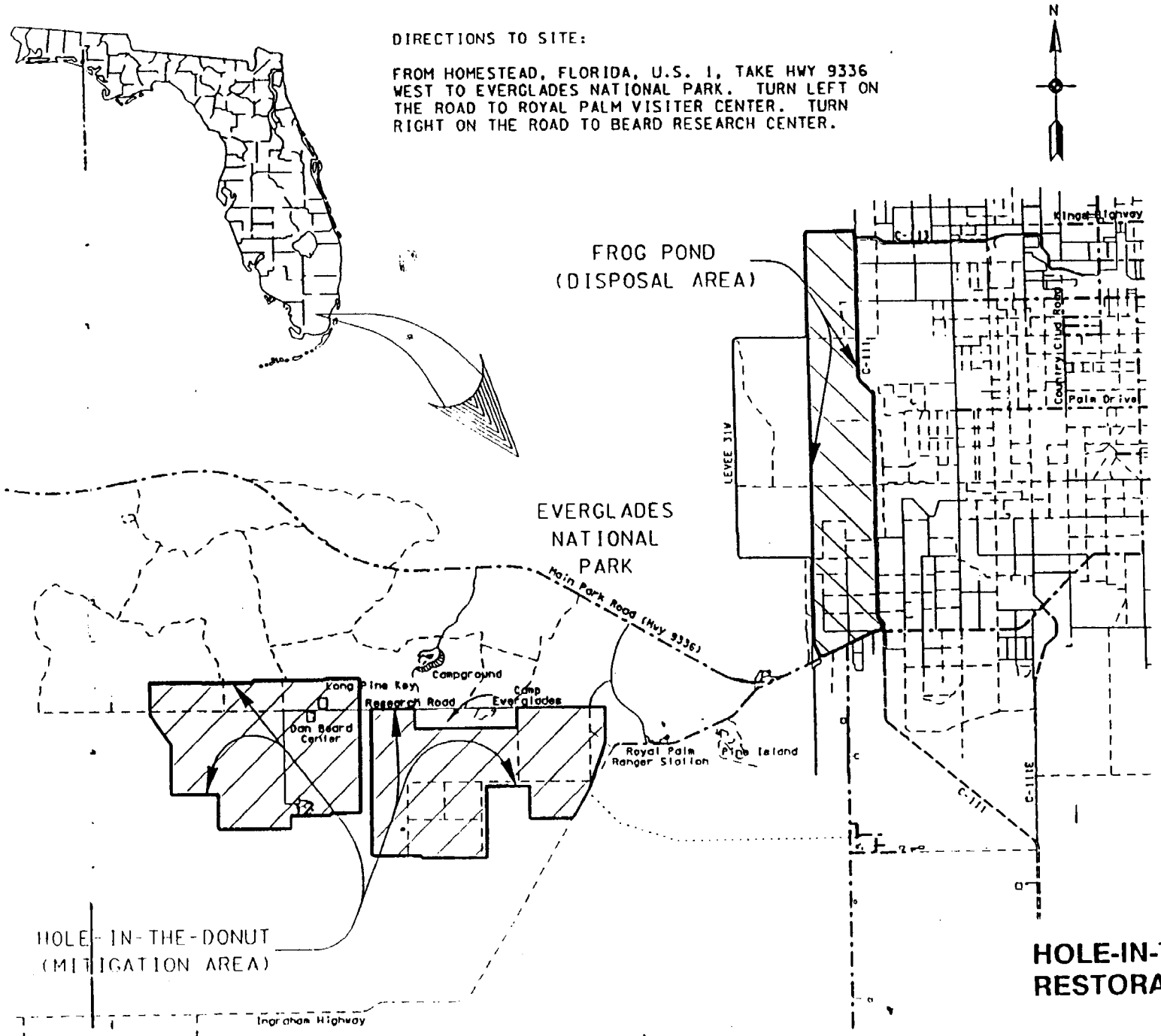
The State of Florida's Save Our Rivers (SOR) Program uses bond proceeds, supported by the general revenue portion of the State's Documentary Stamp Tax, to acquire lands for the purposes of water management, water supply, and the conservation and protection of the State's water resources. Manageability, surface and ground water systems, and the formation of corridors for the critical interaction of wildlife populations are major considerations in the land acquisition process. Prime requisites in managing these public lands are to ensure that the water resources, fish and wildlife populations, and native plant communities are maintained in an environmentally acceptable manner, and made available for appropriate outdoor recreational activities consistent with their environmental sensitivity. Figure 1-4 shows lands contained in this program for the C-111 basin.

The Florida Legislature approved the Southern Glades (C-111) for land acquisition under the SOR Program. The SFWMD is responsible for acquiring critical water resource lands for the SOR Program in the C-111 basin. Land acquisition in the C-111 basin began in the 1980's, and as of 1993, approximately 27,850 acres have been acquired as part of the Southern Glades program. At the present time, about 3,260 acres remain to be acquired under this program.

Additional property within the C-111 basin is being pursued under the Save Our Rivers Program including the "Frog Pond" area and the transitional land (Rocky Glades).

DIRECTIONS TO SITE:

FROM HOMESTEAD, FLORIDA, U.S. 1, TAKE HWY 9336 WEST TO EVERGLADES NATIONAL PARK. TURN LEFT ON THE ROAD TO ROYAL PALM VISITER CENTER. TURN RIGHT ON THE ROAD TO BEARD RESEARCH CENTER.



HOLE-IN-THE-DONUT RESTORATION

FIGURE 1-5

SECTION 2

EXISTING CONDITION/AFFECTED ENVIRONMENT

This section provides an overview of the resources that currently exist within the C-111 basin.

2.1 GEOLOGY AND SOILS

The unconfined Biscayne Aquifer underlies an area of about 3,000 square miles in southeast Florida extending from southern Palm Beach County southward through Broward County to South Dade County. The aquifer is wedge-shaped in section with its deepest portions about 100 to 400 feet in depth along the coast, thinning to a few feet in thickness along the western limits of these coastal counties. This huge fresh water storage reservoir is highly productive everywhere along the coastal ridge and for a considerable distance to the west. The permeable limestone of the aquifer is shielded against upward intrusion of saline water from the Floridan Aquifer by relatively impermeable beds of clay and marl. However, there is no shield against the encroachment of sea water near the coast.

Groundwater in the aquifer flows primarily west to east. However, the direction of flow may be influenced by rainfall, drainage canals, or well fields. Fluctuations in groundwater levels are seasonal. Groundwater levels in the study area are influenced by water levels in adjacent canals.

The surficial soils of south Dade County are distinctly related to the natural province in which they occur. Soils of the poorly drained lowlands of the Mangrove Swamp and Coastal Marshes are composed largely of peat and muck. Calcitic marl is also dominant in the Everglades.

In the study area, the Biscayne aquifer is composed of permeable limestones of the Miami Oolite Formation, which is underlain by marls, limestones, and sandstones (Fort Thompson Formation), and the Tamiami Formation. All three geologic formations are highly permeable with varying transmissivities.

The Miami Oolite (Pleistocene age) is a soft, white, solution riddled limestone formation. The solution holes give the limestone a honeycombed pattern which makes the formation highly permeable. The solution holes are often filled with silt, clay, or sand.

The Fort Thompson Formation (Pleistocene age) consists of a series of alternating layers of marine, brackish water and freshwater limestones. The Fort

Thompson Formation is a pale orange to yellowish gray, porous to very porous limestone.

The Tamiami Formation (Miocene to Pliocene age) consists of a number of different lithologies. The top of the formation is characterized by low permeability, soft limestones, dolosilts, and calcareous sands, all underlain by sandy, fossiliferous limestone.

Although no new subsurface investigations were performed for this report, numerous core borings were obtained previously along the alignment of L-31W borrow canal, C-111, and across the alignment of the canals in the vicinity of S-174, S-175, S-176, S-331, S-332, and S-177. These borings, which are representative of the area's geologic conditions, show highly porous, solution - riddled limestone at or near the surface overlying 10 to 30 feet of medium-hard to hard oolitic limestone.

A subsurface investigation will be performed during the detailed design phase to supplement existing data. A minimum of two holes per pump station and one hole per culvert structure will be drilled. Core borings will be drilled where needed for any proposed canals and levees. Further geologic information can be found in this report in Appendix B, Geotechnical Investigations.

2.2 WATER MANAGEMENT

2.2.1 Plan For Water Control - ENP-South Dade Conveyance System.

2.2.1.1 South Dade County

The purposes of the project works in South Dade County are to remove the 40-percent standard project flood runoff from the effective drainage area, to reduce depth and duration of larger floods; provide water control to prevent overdrainage in the area; prevent saltwater intrusion; and provide facilities to convey up to 500 cfs to Everglades National Park when normal runoff is available. The ENP-South Dade Conveyance System modified the existing project works in South Dade County.

2.2.1.2 Water Supply

The ENP-South Dade Conveyance System was authorized for the purpose of improving the supply and distribution of water supplies to Everglades National Park, 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. The design optimums were established as shown below in Table 2-1. The above does not include the upstream reaches of the coastal salinity control structures where the design optimum will be maintained.

Table 2-1

Optimum Stages in ENP-South Dade Conveyance System

Canal	Reach	Elevation * (Feet, NGVD)
Levee 31(N) Borrow Canal	U.S. 41 to S-331	5.0
Levee 31(N) Rem. Borrow Canal	S-331 to S-176	5.5
Canal 111	S-176 to S-177	4.5
Canal 111	S-177 to S-18C	2.0
Levee 31(W) Borrow Canal	S-174 to S-175	4.5
Canal 103	L-31(N) Rem. to S-167	5.5
Canal 103	S-167 to S-179	3.5
Canal 103	S-179 to S-20F	2.0
Canal 102	L-31(N) Rem to S-165	5.5
Canal 102	S-165 to S-21A	2.0
Canal 1	S-319(N) to S-148	5.0
Canal 1	S-148 to S-21	2.0

* All elevations shown above and hereafter are reference to National Geodetic Vertical Datum (NGVD).

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. Optimum water levels in the project canals are periodically adjusted based on operating experience, changed land uses and to better meet project objectives and changing conditions.

2.2.2 Overall Plan For Water Control - Everglades National Park.

In House Document 90-369 preservation of Everglades National Park was recognized as a project purpose and that available water should be provided on an equitable basis with other users. A minimum water supply to Everglades National

Park (ENP) from the C&SF Project was guaranteed in June 1970 by PL 91-282. This law stipulated that a annual minimum of 315,000 acre-feet would be distributed to the Park and specified the monthly allocation. This included 270,000 acre-feet to Shark River Slough via the S-12's, 37,000 acre-feet to Taylor Slough at S-332, and 18,000 acre-feet to the Eastern Panhandle at S-18C. Senate Document 91-895, which accompanied the law, provided a formula for deciding when the 16.5 percent quantity applied. The formula was found to be faulty and hasn't been applied since the earliest months of the application of this Act. PL 91-282 did not specify the origin of ENP water deliveries, but guaranteed the quantity to be delivered. Discharges are allocated from Lake Okeechobee. Transfers from WCA No. 3A conveyed to Taylor Slough and the Eastern Panhandle whenever local runoff is insufficient to meet the minimum monthly release criteria at S-332 and S-18C, respectively.

PL 98-181, and subsequent acts, have authorized the Corps of Engineers to modify the schedule of water deliveries to ENP and to conduct the Experimental Program of Modified Water Deliveries to Everglades National Park. The Experimental Program has consisted of a series of iterative field tests for the purpose of collecting hydrologic and biologic data with the ultimate goal being the development of an optimum water delivery plan for ENP. The Experimental Program is providing a degree of immediate improvement in water deliveries and is also allowing collection of hydrologic and ecological data. This data will be used to identify correlations between water management and the ecological well-being of Everglades National Park. A General Design Memorandum (GDM) for Modified Water Deliveries to Everglades National Park has been approved. This report describes the Corps plan for modifying the existing water management system to enable improved water deliveries to the park. The project was designed to provide maximum operational flexibility so that as more is learned about the best water management operation for restoration, the project's structural features can be operated accordingly. Currently, the project is being implemented in conjunction with the Experimental Program of Modified Water Deliveries.

ENP-South Dade County Conveyance System was authorized by PL 90-483, 90th Congress, 2d Session, Flood Control Act of 1968. The Conveyance System was authorized for the purpose of conservation and conveyance of water supplies to ENP, and for expanding agricultural and urban needs. As a part of the Conveyance System necessary modifications to the C&SF Project were constructed upstream of L-31W (including improvement of the L-31N Borrow Canal upstream of its confluence with C-103) to enable adequate delivery of water to Taylor Slough and the Park's Eastern Panhandle. No canal improvements were made to L-31W or C-111 as a part of the conveyance system. However, S-332 was added as a part of the system to pump water deliveries to Taylor Slough from L-31W borrow canal. S-332 is operated to satisfy the minimum delivery requirements of Taylor Slough as specified in PL 91-282. In 1976, the specific operation of S-332 was agreed upon in an Agreement and Permit signed by the Corps, National Park Service and the C&SF Flood Control District (now

SFWMD). Although the total annual volume of 37,000 acre-feet to be delivered to Taylor Slough remained the same, the monthly distribution used in the agreement varied slightly from that prescribed in PL 91-282. The average monthly flows in cubic feet per second shown in Table 2-2 are the minimum pumping rates governing the operation of Pumping Station 332 and are subject to the availability of water in the system. During flood periods such rates may be exceeded, up to the capacity of the pumping station, upon mutual agreement of the National Park Service, the SFWMD, and the Corps of Engineers. Construction of S-332 was completed in 1980.

Table 2-2

Minimum Monthly Delivery Schedule At Taylor Slough

Month	Percent of Annual Flow	Monthly Flow Acre-Feet	Average Daily Flow Cubic Feet per Second
January	2.0	740	12.0
February	1.0	370	6.7
March	0.5	185	3.0
April	0.5	185	3.1
May	1.0	370	6.0
June	18.0	6,600	112.0
July	20.0	7,400	120.0
August	8.0	2,960	48.0
September	16.0	5,920	100.0
October	21.0	7,770	126.0
November	10.0	3,700	62.0
December	2.0	740	12.0
TOTAL	100.0	37,000	

The original operational plan for L-31W calls for leaving S-175 and S-176 closed during normal wet seasons to provide sufficient head for the discharge of water from L-31W into Taylor Slough. Provided that L-31N borrow canal could be maintained at 6.5 ft. under these conditions, 500 cfs capacity could be discharged from L-31W to the

slough. However, under flood conditions when S-176 would be open, L-31N would be drawn down to elevation 6.0 ft. Since 500 cfs of flood flows were to be discharged via L-31W and since stages in the L-31W borrow canal would be about 5.2 ft. - at which stage only limited flows would pass to the slough - S-175 would be the major outlet for design flood flows. Consequently, S-175 was designed to provide up to 500 cfs capacity.

The area between L-31W and C-111 also known as the "Frog Pond" was considered to be included in the C-111 basin. Therefore, secondary drainage of this area (when constructed) would discharge into C-111, not the L-31W borrow canal. At this time only limited secondary drainage works have been constructed.

The Frog Pond consists of 5,200+ acres located between L-31W and C-111. A portion of the area, lying along the eastern edge adjacent to C-111 has been used for seasonal agriculture since the 1920's. Winter crops were planted after water naturally receded to acceptable levels. Prior to 1981, there were no water management manipulations of canals to lower water levels below their optimum levels to benefit agriculture in the Frog Pond. In 1981, following severe flooding associated with Tropical Storm Dennis, the SFWMD, ENP, and the farmers developed operating criteria that constituted the basis for water management in 1982 and 1983. These criteria called for maintaining a wet season stage of 4.5 ft. upstream of S-175 and S-177. During the dry season, supplemental water deliveries would be made as necessary to prevent these stages from falling below 3.0 ft., if sufficient water was available. There were no intentional lowering of canal stages for the benefit of agriculture. The criteria stated that after stages had receded naturally and tomatoes were planted, S-175 and S-177 discharges would be made following large rainfall events to alleviate flooding.

In 1984, farmers stated that market competition required earlier land preparation and planting in the Frog Pond. After a series of coordination meetings between the ENP and the farmers, an agreement was reached to conduct a one-year test to evaluate the impacts of the Frog Pond drawdown on Taylor Slough. The criteria called for L-31W and S-177 headwater stages to be lowered to 3.5 ft., NGVD by October 15. This stage was to be maintained in L-31W throughout the growing season. After the tomatoes were planted, the S-177 headwater was to be maintained at 3.7 ft. until crops were harvested. The Frog Pond drawdowns were conducted in 1984, and continued in 1985, and 1986.

During this same time, the Rain-Driven Water Deliveries to ENP test was being conducted. The congressionally mandated Experimental Program of Modified Water Deliveries to Everglades National Park (Public Law 98-181, Section 1302), passed by Congress in December 1983, authorized the Corps of Engineers, with the concurrence of the National Park Service and the South Florida Water Management District (SFWMD) to conduct an experimental program of water deliveries from the

Central and Southern Florida (C&SF) project. The Act further authorized the Secretary of the Army to acquire interest in lands currently in agricultural production and to construct necessary flood protection measures for homes impacted by any modification of the water delivery schedule to the Park. In the Conference Report (98-551) Congress stated that the change in water delivery could have an adverse impact on privately owned lands east of the Park and recognized the need to address and resolve this situation and treat fairly private land owners whose properties may be affected as a result of water delivery modifications necessary to protect ENP.

On July 12, 1985 an agreement was reached between the SFWMD and the Frog Pond farmers in response to the Kendall et. al. v. Marsh, et. al lawsuit. This agreement permitted the Water Delivery Experiment program to continue without further litigation by the farmers in exchange for lower canal levels during the growing season. In 1985 the Corps of Engineers performed an Environmental Assessment and filed a Finding Of No Significant Impact (FONSI) dated June 7, 1985 for the Experimental Program. On July 24, 1985 a Letter of Agreement between the Corps ENP, and SFWMD for the testing process was signed. To date there have been 6 Addenda to the original Letter of Agreement. Addendum 1 presented the operational procedures used in a 2-year test of the Rain-Driven plan for Water Deliveries to the ENP that ended on June 14, 1987. Addendum 2 prescribed operational procedures for the Rain-Driven Plan used through July 10, 1988. Addenda 3, 4, and 5 represent continuation of the operational procedures contained in Addendum 2. Section 107 of Public Law 102-104 authorized continuation of the Experimental Program of Water Deliveries to ENP until the modifications to the C&SF Project authorized under Section 104 of Public Law 102-229 are completed and implemented.

In June 1993, the U.S. Army Corps of Engineers, SFWMD, and ENP began another iteration of the Experimental Program known as the "Taylor Slough Demonstration Project". In addition to carrying on the Rain-Driven Water Deliveries to Shark River Slough, the Taylor Slough Demonstration Project increased L-31N Borrow Canal stage between S-331 and S-176 from 4.5 ft. to 5.0 ft. during the wet season. This was done to reduce seepage losses from Taylor Slough into the canals. In addition several portable diesel pumps were added to S-332 to bring the current pumping capacity to 465 cfs. Operating criteria for this test is contained in Addendum 6 of the Letters of Agreement. In November 1993, the Frog Pond farmers filed a complaint against the SFWMD and the Corps seeking a preliminary injunction to stop the test. The court denied this request and litigation is now proceeding in a routine manner. The farmers claimed that the higher water levels during the test are preventing them from preparing and planting their crops.

2.2.3 Water Deliveries to the Eastern Panhandle of ENP via C-111

The purpose of S-18C is to maintain desirable water levels in the upstream reach of Canal 111, pass flood flows up to 40 percent SPF without exceeding design

stages upstream, and act as a control point for water deliveries to the Eastern Panhandle of ENP. Gate operations are remotely controlled to maintain an optimum range between 2.0 and 2.4 feet above the structure while making minimum monthly water releases for ENP as shown on Table 2-3.

Table 2-3

Minimum Monthly 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 optimum water control stages in the upstream section of Canal 111 to prevent saltwater intrusion. Most of the time S-197 is closed to promote discharges from S-18C to spill from the canal banks into the panhandle of the Everglades National Park. S-197 releases water only during major floods. During a flood event, the plan of operation was to remove the earthen plug and allow full canal flow. The plug would remain out of the canal until much of the upstream drainage basin had drained and it was possible to close S-18C and S-177. These structures had to be closed to stop high water velocities in the canal and enable replacement of the earthen plug. It has been necessary on 5 occasions to remove the S-197 plug. The large volumes of water that were discharged to Manatee Bay/Barnes Sound have caused substantial environmental damage associated with reduced salinity.

Attempts have been made to limit the need for S-197 discharges. Following a major S-197 discharge in 1988, SFWMD constructed 10 additional culverts in the S-197 plug adjacent to the existing 3 culverts. This has provided the operational flexibility to limit the total volume of S-197 discharges required during a storm.

Additionally, SFWMD has constructed a new 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 will be a reduction in the need for S-331 discharges. With G-211 in place, S-331 will only pump water levels in the canal immediately

adjacent to the 8.5-square-mile area in order to drain groundwater from the area. Previously, S-331 had to pump water levels in the L-31N canal all the way upstream to U.S. Highway 41. However, as previously noted, the future "without project" condition does not include the Experimental Program.

2.2.4 Modified Water Deliveries General Design Memorandum (GDM)

The Everglades Protection and Expansion Act of 1989 authorized acquisition of approximately 107,600 of the East Everglades for incorporation into the park. This Act also authorized the construction of modifications to the Central and Southern Florida Project to improve water deliveries to the park and to the extent practicable permits steps to restore the natural hydrological conditions within the park. The GDM, approved in 1992, presents a structural plan that will allow adequate operational flexibility to satisfy environmental objectives without adversely impacting developed areas. These modifications are "justified by the environmental benefits to be derived by the Everglades ecosystem in general and the park in particular". The plan will also restore water flows through WCA No. 3B that would more closely match the pre-project conditions. Along with the C-111 plan, the structural features of the plan would enable enough operational flexibility to accomplish a wide range of operational strategies for meeting project objectives and environmental restoration.

Currently, the Corps of Engineers is implementing the Modified Water Deliveries to Everglades National Park plan. The proposed structural features will permit S-331 to return to its design purpose of providing water supply deliveries southward to Everglades National Park. The approved Modified Water Delivery plan provides flood mitigation to the residents of the 8-1/2-square-mile area by the addition of a seepage levee and canal and a pump station to prevent increased flooding in the area. If pending legislation is enacted, the 8 1/2-square-mile area would be acquired and the recommended structural features would not be constructed.

The purpose of S-331 is to function as a component of the conveyance canal system to Everglades National Park. The system is designed to provide supplemental water from Water Conservation Area No. 3A to satisfy peak dry season demands of ENP and south Dade County agricultural users during a 1-in-10 year drought. S-331 is required to lift water to obtain adequate hydraulic head in the L-31N borrow canal to enable the southward conveyance of water. S-331 would be operated as necessary when stages in the downstream conveyance canals recede 1.5 ft. below their design optimums.

However, concerns over increased water deliveries to Northeast Shark River Slough (NESRS) as a part of the Experimental Program prompted a change in the way S-331 is operated. For the Experimental Program, S-331 has been used to provide flood mitigation for the 8-1/2 square mile area. In the flood mitigation mode, discharge is performed in response to the stage at a groundwater monitoring well

known as Angels Well. If the stage at Angels Well is below 6.0 ft. discharges through S-173 and, if necessary, S-331 will be made so as to maintain an average headwater of 5.0 ft. If the stage at Angels Well exceeds 6.0 ft., discharge is made to maintain an average headwater stage of 4.5 ft., until Angels Well drops to 5.7 ft., whereupon the S-331 headwater is allowed to rise to 5.0 ft. During any of these operations, the discharge of S-331 will be limited so as to not to cause downstream structures to exceed their design stages.

2.2.5 Salinity Intrusion

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 35 to 40 miles inland. This aquifer and other surficial aquifers in Palm Beach County provide water for municipal and industrial water supply and agricultural irrigation along the southeast coast. Seepage and water supply releases from the Water Conservation Areas 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-South Dade Conveyance System.

2.3 WATER QUALITY

Water quality has been a major concern in the Everglades for many years. Mercury and excess nutrients are the most frequently cited sources of concern. Elevated mercury levels have resulted in recommendations for restricted human consumption of fish from even the most remote portions of the area. There is a lack of agreement on the source of the mercury problem; however, oxidation of peat, agricultural chemicals, refuse incineration and contamination of regional airsheds are frequently mentioned.

The Everglades is a naturally low-nutrient system, and man-induced sources of nutrients result in changes in vegetation patterns and periphyton communities. Of primary concern in recent years has been the introduction of phosphorus through agricultural practices in the northern Everglades. The most visual result is the conversion of thousands of acres of native sawgrass communities to cattail communities. The recent die-off of vast areas of seagrass in Florida Bay and the persistence there of a very damaging algae bloom is considered by some to be a result of nutrient pollution.

Lawsuits, agreements, meditations, research legislation and a Surface Water Improvement and Management (SWIM) plan have forwarded philosophy that water

entering the Everglades should be near natural background. Increasingly diligent efforts are being undertaken to reduce nutrient input, however, loading from the Everglades agricultural area remains far above natural background. Lower in the system, at the entry points of water into Everglades National Park, nutrient levels are mandated to be near natural background.

Natural background level for total phosphorous in the Everglades is less than 10 parts per billion (ppb). Criteria for total phosphorus input, computed on an annual flow weighted basis, at the S-12 structures are 9-14 ppb in 1997, and 8-13 ppb in 2002. At the S-332, S-175 and S-18C structures the input is mandated to be 8-13 ppb by 2002 (US vs SFWMD et al. Settlement Agreement 11 July 1991).

The levels of phosphorous input at the S-12 structures is expected to progressively decline as control procedures are implemented in the agricultural areas to the north. Phosphorous levels at S-332, S-175 and S-18C are low but have been increasing in recent years, and now frequently exceed target levels. This is believed to be a result of increasing agricultural use and changes in land use in the Taylor Slough Watershed.

2.4 ENVIRONMENTAL RESOURCES

The historic Everglades was a broad, shallow wetland flowing very slowly over 3,900 square miles from Lake Okeechobee to the mangrove zone at the southern tip of Florida. The source of water was rainfall; only in extremely wet years did water overflow from Lake Okeechobee into the Everglades (Leach, Klein and Hampton, 1972). In wet years, notable lateral discharge to the Atlantic Ocean occurred through the New River, the Miami River, and through the transverse glades across the coastal ridge. Thickly growing vegetation in the Everglades and the relatively small surface relief allowed only very slow rates of flow. Slow flow rates and high evapotranspiration rates probably prevented any water from Lake Okeechobee from reaching the Tamiami Trail, even in excessively wet years (ibid). The southeastern Everglades, therefore, were dependent for water upon local rainfall and that falling nearby to the north. High rainfall years produced elevated water levels, and low rainfall resulted in lowered water levels. Presently, water can be delivered to the southern glades from Lake Okeechobee via the Miami Canal and the L-67A canal, or water can flow overland as sheet flow through Water Conservation Area No. 3A and 3B.

2.4.1 Everglades National Park

Recognized by the U.S. Congress as a nationally and internationally significant resource (Everglades National Park Protection and Expansion Act of 1989), Everglades National Park (ENP) lies at the southern extremity of the Everglades and below the south end of the C&SF Project. ENP provides habitat for about 25

terrestrial species and two aquatic species of mammals. The avian fauna of the Park is especially rich; over 300 species of birds have been identified. South Florida's location makes it a migratory crossroads for West Indian and Central and South American birds; numerous North American species are residents. The majority of this continent's species of wading birds, shorebirds, and waterfowl are found within the Park at some time of the year. One of the key reasons for the establishment of the Park was to protect the nesting areas and feeding grounds of wading birds such as herons, egrets, and ibis.

The known herptiles of the region include 2 species of crocodilians, 3 or 4 species of salamanders, 6 species of lizards, 10 species of land and freshwater turtles, 5 species of sea turtles, 12 species of frogs, and 23 species of snakes. The waters of the Everglades and the Park support a large variety of fish in both freshwater and estuarine habitats. Fish provide a major part of the diet of most of the other vertebrate animal inhabitants.

2.4.2 Shark River Slough East and West Basins

Shark River Slough (SRS) is the southern, relatively deep, Everglades flow-way entering the Park from the north and flowing across the Park to Florida Bay. (The slough is east of the area of outflow from Big Cypress Swamp). The seasonal expansion and contraction of water supply to SRS provided the dynamic pulses of expanding aquatic flora and fauna to which responded the Everglades panoply of wading birds, bald eagles, alligators, and characteristic mammals.

Historically, SRS flowed between the present L-30--Tamiami Trail area and the 40-mile bend at L-28, and the volume and rate of flow occurred in response to rainfall. Annual water flow volumes varied through wet and dry years from essentially zero to 1,181,000 acre feet; the reported median was 311,201 acre feet (van V. Dunn, 1961). Fifty-eight percent entered Shark River Slough during September through November. About 66 percent of the average annual flow passed through the eastern one-half of the Slough (L-67A to L-30, i.e., Northeast Shark River Slough--NESRS), and the remainder entered western SRS between L-67A and L-28 (Leach, Klein, and Hampton, 1972). These proportions were changed after 1961 by water management practices following completion of L-29 and L-67A (Table 2-4).

Table 2-4
Changes in Flow Past the Tamiami Trail Culverts Before and After Construction of L-29 and L-67A
(after Leach, Klein, and Hampton, 1972)

Period of Record	Levee 30 to L-67A (Northeast Shark River Slough)	L-67A to L-28 (Western Shark River Slough)
1. 1941 - 1961	average 252,600 ac-ft/yr	average 128,900 ac-ft/yr
2. 1962 - 1968	average 63,200 ac-ft/yr	average 323,600 ac-ft/yr
3. Modified Rain Driven	average 384,000 ac-ft/yr	average 297,000 ac-ft/yr

Note: 1962 is after construction of L-29; water volume to NESRS by seepage, only.
Sources: Rows 1 and 2, Leach, Klein and Hampton, 1972; row 3, USACE, 1992.

Water management practices (prior to the SFWMD Interim Plan for C-111 Basin; paragraph 1.6.2) prevented any correlation between rainfall and water levels in Shark River Slough and Taylor Slough, except in extreme flood periods and drought periods (Van Lent and Johnson, 1993). Implementation of the Modified Water Deliveries to Everglades National Park could deliver 56 percent of average annual SRS flows through NESRS. Annual average flow through NESRS would be 384,000 acre-feet, while flow through the L-67A to L-28 reach would be about 297,000 acre-feet (USACE, 1992).

Environmentally beneficial hydroperiods (periods when water levels are at or above ground level) are interrelated in eastern and western Shark River Slough (SRS), the Rocky Glades, Taylor Slough (including the southeastern Frog Pond), and the western and eastern C-111 basins.

"(W)hen water levels over the (5.2 to 5.5 feet) peat surfaces of the Shark Slough (as measured at Well P-33 [in the center of the slough]) rise about one foot there begins an easterly flow of water into the microkarst, or pinnacle rock, terrain surrounding Taylor Slough. With a rise at P-33 to a level of 6.5 feet the Taylor Slough and Shark Slough surfaces become one across the tops of most of the intervening rock pinnacles and strong southerly flow is established through both systems. Early rainy season local recharge (i.e. April-June) will have normally elevated groundwater in Taylor Slough to or slightly above marl surface in lower elevations. This rise would have been augmented from June through November by strong southeasterly spill-over flow out of the Shark Slough. Thus, the hydroperiod

duration of Taylor Slough normally would have extended from June through November, or about 7 months, and maximum depths would be expected to range from 3 or 4 inches in the northern shallowest ends of Taylor Slough headwater areas to about 20 inches near the Park entrance" (TBI, 1990).

Critical to Taylor Slough--C-111 environmental restoration is restoration of the seasonal overflow of water from SRS. Under the Modified Rain Driven Plan proposed for delivery of water to ENP (USACE, 1992), the overflow stage of 6.5 feet in SRS at P-33 would occur during 12 years of the 14-year period of record (1969-1982). The stage at P-33 reached 6.5 feet in 12 years of the 14 under without modified deliveries, but seasonal timing and durations differed. Under the Modified Rain Driven Plan, the overflow stage of 6.5 feet at P-33 in Shark River Slough would be exceeded about 25 percent of the time, with smooth within-season transitions between wet and dry conditions. Before the interim plan (par. 1.6.1), P-33 water levels were at or above 6.5 feet only 15 percent of the time, and water levels were subject to erratic pulsations. Alternatives 4, 6, and 6A of this study raise water levels in Shark Slough. The cumulative effect, under adequate water supply and judicious water management, may be similar to that of the natural overflow.

The rising water pattern historically has generated southeasterly flow of groundwater through the porous, oolitic, limestone ridge east of Taylor Slough. As groundwater passes through it, the limestone dissolves and is entrained in the water as calcium carbonate. When the calcium carbonate-saturated water issues from the ground at lower elevations along the coastal plain, periphyton extracts and precipitates calcium carbonate as marl. In the coastal plain, "there is no sign that surface flows were ever significant in quantity due to the extreme porosity of the oolite" (TBI, 1990).

2.4.3 The Rocky Glades

Rocky glades is a term for a wet, transitional area between deep peat or marl wetlands and seldom flooded uplands. In the study area the term is applied to the slight topographic rise north of Taylor Slough and south and east of Shark River Slough. The Rocky Glades is a hydrologic barrier that separates surface waters of Shark River Slough on the north from the headwaters of Taylor Slough on the south (SFWMD, 1992). Ground elevation is generally higher than in the wetlands, and hydroperiods, depending on ground elevation, range from 6 months to less than 1 month (Robertson and Frederick, 1994).

Original rocky glades vegetation included plant associations adapted to an environment of alternating, seasonal periods of shallow flooding and desiccation. Fires presumably occurred only during the driest years. Vegetative communities are dominated by sedges or grasslike plants in fairly thin, short stands, interspersed with patches of exposed limestone rock or limy mud (SFWMD, 1992). Dominant types

include sparse sawgrass (Cladium jamaicense), spikerush (Eleocharis cellulosa), and beakrush (Rhynchospora spp.) meadows, in association with muhly grass (Muhlenbergia sp.) prairies. Associated broadleafed species, locally called "flags," include arrowheads and water hyssop (Sagittaria and Bacopa spp.) Sawgrass growing over marl tends to form a thin and open cover type, in contrast to the dense, tall sawgrass meadows of the deeper water areas of Shark River Slough. The rocky glades may provide significant feeding habitat to widely ranging wading birds as water recedes and small fish and invertebrates are trapped in drying pools.

In the C-111 study area, the Rocky Glades on the upland periphery are farmed or used for homesites. The 8.5-square-mile area is in the Rocky Glades

2.4.4 Taylor Slough

Headwaters of Taylor Slough provide the main inflow to eastern Everglades National Park. Its headwaters begin in the southern East Everglades below the Rocky Glades and include the southeastern portion of the Frog Pond. The Slough extends more than 20 miles to the coastal mangrove fringe along Florida Bay (SFWMD, 1992). Under natural conditions, Taylor Slough is the major source of fresh water flow into northeast Florida Bay. A significant portion of the annual flow of water in Taylor Slough is related to hydrological events in Shark River Slough (Section 2.4.2)

2.4.5 The Frog Pond

The agricultural area east of L-31W is farmed with the technique called rock plowing. The limestone rock is broken, pulverized, fertilized, and cultivated to grow food crops, mainly tomatoes. About 20 percent of the frog pond is too low (i.e., too wet) for cultivation. Of the higher, cultivated portion, much of the land in the Frog Pond agricultural area originally supported South Florida slash pine (Pinus elliotii *var.* densa) stands. The effect of rock plowing is to even out the topography over large areas. The tops of the rocky pinelands are scraped off and most of the lower areas are filled. The artificial "soil" created by the practice of rock plowing and fertilization apparently is inhospitable to most native plant species, even many years after agricultural abandonment, when virtually nothing but solid stands of Brazilian pepper (Schinus terebinthifolius) will colonize. As wildlife habitat, abandoned rockplowed uplands are of little value.

A few relict wet "tree islands" remain undisturbed within about 389 acres inside the Frog Pond Agricultural area, protected by legal covenants with Dade County (FWS, 1991). When surveyed by FWS in early 1991, these wet hammocks were dominated by red bay (Persea borbonia), sweet bay (Magnolia virginiana), wax myrtle (Myrica cerifera), cabbage palm (Sabal palmetto) strangler fig (Ficus aurea), cocoplum (Chrysobalanus icaco), and the invasive exotic Brazilian pepper (Schinus

terebinthifolius). Tree hammocks, wet or dry, are significant wildlife habitat, providing refuge from ground-based predators and from the heating and drying effects of the sun.

2.4.6 The Marl Glades

Of the two main types of Everglades wetlands soils (peat and marl) only marl soils occur in the C-111 study area. Marl forms only under intermittent shallow surface flooding conditions in carbonate-saturated water. In south Florida, marl formed adjacent to large exposures of soft limestone, such as the Miami oolite, under alternating wet and dry seasons of about equal length, when blue-green algal mats on the rock surface and on plant stems precipitated calcium carbonate crystals from the carbonate-rich surface water. Over geologic time the carbonate accumulated along with organic plant remains to form marl soil. The specific set of hydrologic conditions in which the southeast Everglades marl formed (TBI, 1990) are taken to indicate desirable water regimes for wetland ecosystem restoration, and to assist in selecting the environmental quality plan from among alternatives (Section 6). Studies indicate that a relatively short hydroperiod (5-7 months), water depths ranging from 3 to 21 inches, and a water table that seldom drops more than 30 inches below the soil surface are required to support marl-forming wetlands (TBI 1990).

The original wetlands plant associations of the area are similar to those described under rocky glades or wet prairie. Hydroperiods now are generally shorter, flooding is less deep, and fires more frequent, than prior to human alteration of drainage. Shorter recent hydroperiods have favored the expansion of shrub communities, including native willow (Salix caroliniana), red bay, dahoon holly (Ilex cassine) and the exotics Brazilian pepper and melaleuca (Melaleuca quinquenervia). Cattails (Typha domingensis) have become more prominent in some areas where agricultural drainage contributes to surface flows. Wet prairies, including the marl glades, are habitat for a distinctive assemblage of native fish during the wet season. When the prairies dry out in winter months, fish populations are concentrated in pot-holes or ponds, or emigrate towards the deeper, central Everglades, attracting large numbers of fish-eating resident and migrant wading birds, including the endangered wood stork. As desiccation continues, fish stocks survive in pot-holes and sinkholes in the porous limestone. If the wet prairie hydroperiod is reduced too much, or too little water is delivered, the ground water table will sink below -30 inches, and even the pot holes and remnant ponds will dry out. When this occurs, no fish stocks may be available to repopulate the flooded prairie during the next wet season.

2.4.7 Florida Bay

Florida Bay is the large, shallow, coastal lagoon lying between the southern tip of the mainland of Florida and the Florida Keys. It is of great national significance for several reasons. Florida Bay, the nearby terrestrial and wetland environments of

southern Florida, and the Florida Keys and associated coral reefs together constitute the only tropical environments in the continental United States. Essentially the entire Bay is under direct management responsibility of the Federal Government, either as part of the Everglades National Park managed by the National Park Service, or as part of the Florida Keys National Marine Sanctuary managed by the National Oceanic and Atmospheric Administration. This ecosystem harbors various threatened or endangered plants, fishes, birds, mammals and reptiles and supports a major sport and commercial fishery.

Florida Bay is a dynamic ecosystem and has undergone great natural variation over the past thousands of years due to long-term changes in climate and sea level and, during this century, as a result of climatic cycles and storms. Substantial disturbance, both from hurricanes and variations in freshwater inflow, is, in fact a natural part of the ecology of Florida Bay. However, the changes that have been observed in Florida Bay from at least the late 1980s have been unprecedented within the period of recorded observation and reflect a degradation of the ecosystem in terms of its productivity of living resources, biodiversity, and stability.

Beginning about 1987, seagrasses, large vascular plants rooted in bottom sediments which carpet the bottom of most of the Bay, began to die. This die-off continues and has now affected an area as large as 100,000 acres (40,000 hectares or about 18 percent of the total area of the Bay. Blooms of microscopic algae suspended in the water have occurred with increasing frequency, intensity, extent, and duration, turning the once-clear waters a turbid green. Populations of water birds, forage fish, and juveniles of game fish species seem to have been significantly reduced in the eastern portions of the Bay where fresh water flowing from the Everglades is normally mixed with saline Bay water. Catches off the Tortugas of pink shrimp, which spend their early life in Florida Bay and other shallow water regions, have declined dramatically. Many large sponges attached to the Bay bottom died, potentially threatening a significant decline in the catch of spiny lobsters, the juveniles of which use the sponges as critical habitat.

Several scientists and other observers have argued that most of these changes are related, one causing another, and have as a root cause changes in the freshwater flow--both its quantity and timing--through the Everglades into Florida Bay. Other scientists have suggested that the changes may be manifestations of natural cycles, including the frequency of hurricanes; may be related to filling in and development of the Florida Keys; or are caused by greater infusion of plant nutrients, particularly forms of nitrogen and phosphorous, from the watershed.

The most likely explanation for the changes observed in the Bay is that several impacts are working synergistically to produce a much more profound result than that which might be expected from individual insults to the system. Restoration of a more natural hydrology will correct one of the major problems in the Bay. It is not known

whether this alone will restore Florida Bay, but it is unlikely that restoration will occur without the natural fresh water increment from the Everglades.

2.4.8 Barnes Sound

Barnes Sound, at the northeastern end of Florida Bay (see Figure 1-2), receives the outflow from C-111 through Manatee Bay when the culverts at S-197 are opened for flood damage control following major storm events. SFWMD (1992) summarizes information on Manatee Bay and Barnes Sound, emphasizing the geological distinction between these sounds and the rest of Florida Bay. These are completely enclosed hydrographic basins dependent on local climatological factors (rainfall and canal discharge rates). Circulation is wind and tide driven except when fresh water inflow influences circulation. Historically, salinity concentrations rose as the need for fresh water increased during the dry season. The massive displacement of fresh water southward, discussed in Section 2.4.2 of this report, helped maintain the fresh water-salt water balance. Reduced fresh water flow under present conditions presumably exacerbates the tendency toward hypersalinity, and flood releases prior to installation of the culverts at S-197 caused fresh water to flow over the denser, saline water of Manatee Bay. Seagrass die-offs in the Bay have been speculatively linked to such flood releases, but there appear to be other, unknown factors at work (Boesch et al., 1993).

2.4.9 Coastal Mangrove Fringe

Vegetation of the lowermost C-111 basin is estuarine: it is influenced by tidal flooding, saline ground water or occasional salt deposition during storms. As one moves southward and eastward down the canal, south of the agricultural area, the wet prairies grade into mangrove swamps. Mangroves are salt-tolerant trees, reaching heights of up to 30 feet in the study area, that can survive permanent or intermittent flooding, but cannot tolerate desiccation. Many fresh water emergent marsh species (including sawgrass and cattail) can tolerate low dissolved salt concentrations (below about 0.5%), but die if salinity increases or persists throughout the growing season. Mangroves can grow in fresh water, but are believed to dominate only where salinity is high enough to stress fresh water vegetation and reduce its competitive advantage. Because of these overlapping tolerances, the transition zone or ecotone from fresh water associations to brackish water associations in the Everglades is broad. Historic reduction of freshwater recharge into the lower C-111 marshes is believed to have played a role in fostering salinization of shallow groundwater and northward expansion of the estuarine, or mangrove zone. Mangroves first appear at the inland edge of the brackish marshes, in association with sawgrass and black needle rush (Juncus roemerianus), as isolated individuals or small tree islands. Usually these pioneer hammocks are made up of red mangrove, Rhizophora mangle, or white mangrove (Laguncularia racemosa). In low salinity areas where drying is frequent, buttonwood mangrove (Conocarpus erectus) dominates. The isolated hammocks

eventually coalesce into a wide band of red, black (Avicennia germinans) or mixed mangroves.

Mangrove islands and the mangrove fringe that lines Florida Bay are extremely valuable wildlife and fish habitat. Small fish are generally abundant. Herons, egrets, and other wading birds use mangrove habitats for both feeding and nesting habitat. Especially during dry years, mangrove nesting habitat may be critical to maintain populations of herons, ibis and wood storks unable to nest in freshwater habitats. Raptors, including the bald eagle, osprey and migrant peregrine falcon, use the mangrove fringes as nesting or roosting habitat. Mangroves support estuarine fisheries through export of both particulate and dissolved organic matter, and serve as spawning grounds or nursery areas for almost all of the commercially significant salt water fish species harvested around south Florida (W.E. Odum et al 1982).

2.4.10 Fauna

Fauna characteristic of the C-111--Taylor Slough basin range widely over all the recognized drainage sub-basins and vegetation communities. The entire basin may be thought of as a diverse habitat, with its various parts used seasonally by wide-ranging prey and predators. Faunal groups of the study area are discussed below.

2.4.10.1 Fish

Fishes of the East Everglades-C-111 basin are small to medium-sized. Flagfish (Jordanella floridae) and the mosquito fish (Gambusia affinis) comprise the largest portion of recent samples taken by the SFWMD (SFWMD, 1992). Thirty-nine other species were identified, including killifish, topminnows, bullhead catfish, several species of sunfish, including largemouth bass, and exotic cichlids.

The fish community is limited by hydroperiod. A reservoir of breeding fish is required to seasonally colonize the short-period wetlands of the study area. In periods when surface water is maintained without interruption from year to year, as may happen occasionally in Taylor Slough, fishes may increase in density and biomass. As the wetlands dry, fish unable to find refuge in Taylor Slough become concentrated in pools and are preyed upon by foraging birds. Extremely dry conditions and rapid drying rates result in high densities of fish concentrated in refuge pools where the fish subsequently become prey, or they become carrion after dissolved oxygen is depleted.

Estuarine fishes occur in higher numbers and biomass during the dry season in the mainland estuary in the lower C-111 basin when relatively deeper flooding occurs during the September-October time period (ENP data, unpublished).

2.4.10.2 Birds

Birds are arguably the most conspicuous and publicly recognized wildlife resource of the Everglades ecosystem. The avifauna of South Florida includes nearly 400 species, about 40% of them year-round residents and the rest migratory. However, migratory and resident wading birds are the resource of greatest concern in the present study, since they both depend upon and can serve as indicators of the environmental quality of the C-111–Taylor Slough wetlands. The extensive use of the C-111 basin by migrant wading birds as forage habitat was summarized by SFWMD (1992). A combination of short- and long-hydroperiod marshes and sloughs provide excellent foraging habitat for wading birds. The annual cycle of fish production begins when, in response to early-season rains, flooding extends out from the permanent sloughs into the wet prairie. Fish populations increase rapidly. As the rainy season ends, evaporation of standing water reduces the flooded area, and fish are concentrated along the drying edges of prairies, or in potholes and ponds, where they become easy prey for foraging waders, including the endangered wood stork. Wading birds generally nest in colonies in forested swamps, freshwater marsh tree islands or in coastal mangroves, but successful reproduction depends upon finding sufficient food resources, at the appropriate season, to allow nesting, egg-laying, and fledgling of young, which require large energy inputs. Significant numbers of the following wading birds still utilize the sloughs and wet prairies near C-111 during wet years: the endangered wood stork (Mycteria americana), white ibis (Eudocimus albus), great egret (Casmerodius albus), cattle egret (Bubulcus ibis, glossy ibis (Plegadis falcinellus), and the black-necked stilt (Himantopus mexicanus) (FWS, 1991).

In 1969-1970, coincidentally with a drop in water level in the northern part of Taylor Slough, abrupt changes is timing of nest initiation occurred in wood stork colonies; ENP reported that the change adversely affected nesting success. From 1981 to 1993, Cape Sable sparrow nesting attempts declined by 75 percent; sparrow habitat had been invaded by woody vegetation. Roseate spoonbill colonies have diminished since the early 1980s.

2.4.10.3 Mammals

Mammals known or potentially found in the study area include the Florida panther (Felis concolor coryi), river otter (Lutra canadensis), oppossum (Didelphis virginiana, marsh rabbit (Sylvilagus palustris) racoon (Procyon lotor), striped skunk (Mephitis, bobcat (Lynx rufus), white-tailed deer (Odocoileus virginianus), round-tailed muskrat (Neofiber alleni) and less conspicuous small terrestrial mammals such as weasel, voles, shrews, mice and rats, and several species of bats. Florida manatee (Trichechus manatus) occur in coast reaches of canals, mangrove tidal creeks and Florida Bay. The panther and the manatee are listed as endangered. Scrub thickets, tree islands, and remnant pine groves provide the only adequate cover for larger terrestrial mammals in the rockplowed agricultural areas.

2.4.10.4 Reptiles

Notable reptiles include the endangered American crocodile (Crocodylus acutus) and the American alligator (Alligator mississippiensis). The alligator is discussed in Section 6.4. American crocodiles range from southern Biscayne Bay south and west through eastern and central Florida Bay, including Manatee Bay and Barnes Sound. Nesting sites are on small sand beaches at the edge of hardwood thickets and on high marl banks of coastal creeks (Pritchard, 1978). Reasons for the population not increasing have been listed as (1) accidents and poaching in the Key Largo area, (2) hatching failure of eggs, and (3) low nest temperatures in shaded areas (Ogden, 1978a,b). Heavy metal burdens in crocodile eggs have been reported (Stoneburner and Kushlan, 1984, Ogden et al., 1974). Crocodile sensitivity to heavy metals is not known.

2.4.10.5 Threatened or Endangered Species

Endangered bird species that may be in the area include the Cape Sable seaside sparrow (Ammodramus maritimus mirabilis), snail kite (Rostrhamus sociabilis plumbeus), wood stork (Mycteria americana), and bald eagle (Haliaeetus leucocephalus). Federally listed reptile species include the American alligator (Alligator mississippiensis; listed as Threatened due to similarity in appearance to the American crocodile); the endangered American crocodile (Crocodylus acutus) and the endangered eastern indigo snake (Drymarchon corais couperi). The southern part of C-111 is within Critical Habitat for the endangered American crocodile (Crocodylus acutus), and two of the three known breeding areas border this region. Listed mammals include the endangered Florida panther (Felis concolor coryi) and the West Indian Manatee (Trichechus manatus). No panthers are known to be present in the C-111/Taylor Slough area. Manatees are observed in mangrove tidal creeks and Florida Bay near the southern end of C-111. The roseate spoonbill (Ajaia ajaja), while not federally listed, is a Florida State Species of Special concern (SSC) that utilizes wet prairies seasonally.

2.5 POPULATION

The 1990 census reports that Dade County, covering 1,955 square miles is the third largest county in land area in the State and ranks first in population with over 1.9 million residents for the 1990 census year. The county also ranks third for population density. In 1980, persons per square mile were 908. 1990 census reports an increase of approximately 83 more persons (991) per square mile. OBERs 1990 population projections for Dade County reports an increase in population of approximately 243,906 persons between 1990 and 2010. This will represent an annual growth rate of 0.6 percent. The median age for Dade County is 34.2 years.

2.5.1 Homestead

The 1990 permanent population for Homestead was 26,866. Between 1980 and 1990, the city's population increased by 6,198 residents. The median age in 1990 was 28.2 years, indicating a relatively young populace.

2.5.2 Florida City

The 1990 permanent population for Florida City was 5,808. Between 1980 (population was then 6,174) and 1990, the city's population decreased by 366 residents. The median age in 1990 was 26.5 years, also indicating a relatively young populace.

2.6 PERSONAL INCOME

Total personal income for Dade County in 1989 was approximately $33 billion, the largest among all Florida's Counties, which represents an average annual increase of 8.4 percent during the 1979-1989 period. Per capita personal income rose from $9,272 to $17,963, a 6.8 percent average annual gain. The median household income for Dade County in 1990 was $26,909. There were 341,261 persons for whom poverty status was determined in 1990. This represents 17.6 percent of the county's 1990 population with earnings below the established U.S. poverty level of $12,675.

2.6.1 Homestead

The median household income for the City of Homestead was $20,594. There were 7,843 persons for whom poverty status was determined in 1990. This represented 29.2 percent of Homestead's 1990 population with earnings below the established U.S. poverty level of $12,675.

2.6.2 Florida City

The median household income for Florida City was $15,917. There were 2,131 persons for whom poverty status was determined in 1990. This represented 36.7 percent of Florida City's 1990 population with earnings below the established U.S. poverty level of $12,695.

2.7 LABOR FORCE

Dade County's labor force totaled 1,519,969 persons 16 years of age or older in 1990. Total employed was 982,191, which represented a 64.6 percent participation rate for all persons in this broad age category. Government workers (116,428) represented about 11.9 percent of civilian employment. The unemployment rate was 7.7. percent.

2.7.1 Homestead

The total civilian labor force in Homestead, 16 years and older, was 19,222 in 1990. Total employed was 12,413, which is about 64.6 percent of the civilian labor force. Government workers (1,693) represented about 13.6 percent of civilian employment. The unemployment rate was 7.3 percent.

2.7.2 Florida City

The total civilian labor force in Florida City, 16 years and older, was 3,842 in 1990. Total employed was 2,355, which is about 61.3 percent of the civilian labor force. Government workers (443) represented about 18.8 percent of civilian employment. The unemployment rate was 16.4 percent.

2.8 CLIMATE

General climatic conditions along the Lower East Coast of Florida to the Florida Keys are sub-tropical to tropical. The chief factors of climatic control are latitude, proximity to the Atlantic Ocean and Gulf of Mexico, and numerous inland lakes. Summers are long, warm, and relatively humid. Winters, although punctuated with periodic invasions of cool to occasionally cold air from the north, are mild because of the southern latitude and relatively warm adjacent ocean waters. The Gulf Stream, which flows around the western tip of Cuba through the Straits of Florida and northward along the lower east coast, exerts a warming influence to the southern east coast largely because the predominant wind direction is from the east. Coastal weather stations throughout the State average slightly warmer in winter and cooler in summer than do inland weather stations at the same latitude. South Florida receives the highest percentage of possible sunshine of any part of the United States east of the Great Plains. Winter sunshine is especially high in comparison to other areas, being about 65-percent of possible in January. The high sunshine level results in extremely moderate temperatures, with conditions favorable for plant growth during winter and spring months. This has made year-round agriculture possible, particularly truck crops.

2.8.1 Temperature

Mean annual temperatures in the lower east coast area range in the mid 70's with January and February being the coolest months and July and August the warmest. There is about a 20 Fahrenheit degree average temperature range during the year with the temperature averaging in the mid-60's during the winter and the mid-80's during the summer. The summer heat is tempered by sea breezes along the coast and by frequent afternoon or early evening thunderstorms in all areas. During the warm season, sea breezes are felt almost daily within several miles of the coast and occasionally 20 to 30 miles inland. Thundershowers, which on the average occur

about one-half of the days in summer, frequently are accompanied by as much as a rapid 10-20 degree drop in temperature, resulting in comfortable weather for the remainder of the day. Gentle breezes occur almost daily in all areas and serve to mitigate further the oppressiveness that would otherwise accompany the prevailing summer temperature and humidity conditions. Because most of the large-scale wind patterns affecting Florida have passed over water surfaces, hot drying winds seldom occur. Table 2-5 contains the average temperatures for NOAA stations along the lower east coast.

2.8.2 Rainfall

Although Florida enjoys abundant rainfall, a distinct wet season occurs between May and October. The wet season receives approximately 75 percent of the annual rainfall of 60 inches. In general, the winter months constitute the dry season and rainfall is associated with mid-latitude systems (fronts and low pressure centers) and is spatially distributed in a relatively uniform pattern. The summer months comprise the wet season and rainfall is closely associated with convective activity. These rainfall events are normally of short duration and amounts are quite variable spatially. During the summer there is about a 50 percent chance that measurable rain will fall on a given day. Much of the volume of summer rainfall occurs on a few disturbed days when the rain is more uniformly distributed. Even in the wet season, much of the seasonal rainfall variation over peninsular Florida is due to the large-scale regional and synoptic flow patterns affecting the sea-breeze and other local conditions.

Even though annual average rainfall is relatively large in the dry season well defined, rainfall over the basin can be quite varied both in annual amount and seasonal distribution. Table 2-5 contains precipitation data for NOAA stations along the lower east coast. Eight typical rainfall producing patterns have been identified over Florida.

(1) Isolated air mass. Local convective showers due to daytime heating. Generally, if rain occurs it is limited to a small area and short duration.

(2) Sea Breeze. Sea breeze generally occurs on undisturbed days during the warm months. Associated showers form along the coast and move inland during the day. There are many types of disturbance including cold air aloft and weak cyclonic flow.

(3) Sea Breeze and Disturbances. If sea breeze is associated with a larger scale disturbed pattern, more widespread rain is possible.

Table 2-5

Representative Climatological Stations

Stations	Normal Precipitation (inches)	Temperatures (F°)		
		Average January	Annual Mean	Average July
Miami (Dade)	46.29	69.1	76.2	82.3
Miami WSCMO Airport (Dade)	59.76	66.9	75.1	81.3
Miami (12 mi. SSW)	57.48	66.5	74.8	81.6
Homestead Experimental Sta	64.69	65.9	73.7	80.2

* Data from National Oceanographic and Atmospheric Administration (NOAA) stations.

(4) Meso-scale Thunderstorms and Showers. These systems area often perturbations along old frontal troughs. Meso-scale shower and thunderstorms are quite common over Florida in the summer months, usually due to cold air aloft.

(5) Squall Lines. Not common in Florida, lines of thunderstorms are sometimes along a cold front and act like a squall line.

(6) Warm and Cold Fronts. Frontal passages normally occur in the winter months. Frontal passages do not guarantee rain. During the summer months it is more common to have weak frontal zones that act as convergence zones and have few of the characteristic of winter fronts.

(7) Tropical and Sub-tropical Cyclones. A significant portion of wet season rainfall is associated with tropical systems. The amount of rainfall is not necessarily related to strength or classical structure of the system. Hurricanes and tropical storms account for some wet season rainfall. Tropical cyclones consist of tropical waves, tropical depressions, tropical storms, and hurricanes. See section 2.6.5 for more information.

(8) Stationary Upper Level Low Pressure Systems. Truly stationary upper level low pressure systems are rare. Over Florida, these systems are usually found in June, September, or early October. Upper level low pressure systems combined with a front can produce heavy, sustained rain over a widespread area. Large rainfalls in the dry season are usually due to these systems.

2.8.3 Evapotranspiration

Evapotranspiration accounts for the major portion of rainfall loss and its evaluation is necessary in order to determine the amount of rainfall excess available for other purposes. Total losses from land areas depend on both losses from vegetation (transpiration) and losses from saturated ground and open-water areas (evaporation). Climatic influences on evapotranspiration (ET) include radiation, temperature, humidity, and wind. The losses from evaporation pans and open-water areas are fairly uniform due to continuous supply of water. Losses from land areas may vary widely because of the greater variations in the amount of water available for ET. In a report entitled "Report of Runoff Investigations in Certain Florida East Coast Drainage Districts" determined that evapotranspiration losses increase at a diminishing rate when rainfall exceeds the normal evapotranspiration requirements. During dry periods, transpiration is limited by the moisture available in the root zone, and evaporation from the soil is limited to moisture brought to the surface by capillary action. In the Lower East Coast area evapotranspiration losses are estimated to be about 88 percent of the total rainfall over the area.

2.8.4 Wind

Prevailing winds over the southern peninsula are southeast and east. Wind directions are influenced locally by convectional forces inland and by the land-and-sea breeze-effect near the coast. Consequently, prevailing directions are somewhat erratic, but, in general, follow a pattern from the north in winter and from the south in summer. The windiest months are March and April. High local winds of short duration occur occasionally in connection with thunderstorms in summer and with cold fronts moving across the State in other seasons.

2.8.5 Tropical Cyclones

The most severe floods in the area are usually associated with storms or sequences of storms which produce widespread rainfall of one week to several months duration. June through October is the most probable period for heavy rainfall, but floods may occur during other times of the year. Stationary low pressure systems combined with fronts, and tropical and subtropical cyclones are systems capable of producing large amounts of rain over widespread areas. The region is subject to tropical cyclones from June through November. NOAA classifies tropical cyclones as follows:

(1) Tropical Disturbance: rotary circulation slight or absent at surface but sometimes better developed aloft: no closed isobars and no strong winds; also known as a tropical wave or easterly wave.

(2) Tropical Depression: one or more closed isobars and some rotary circulation at the surface, highest wind speed 39 m.p.h.

(3) Tropical Storm: closed isobars, distinct rotary circulation, wind speed 39 to 73 m.p.h.

(4) Hurricane: closed isobars, strong and very pronounced rotary circulation, wind speed 74 m.p.h. or greater.

2.9 STORMS AND FLOODS

The wet season in peninsular Florida normally begins in May and continues through October. During the summer months thunderstorms are common and are a result of small isolated cells directed by low-intensity pressure gradients. Most Florida localities have, at one time or another, experienced 2-hour rainfalls in excess of 3 inches and 24-hour amounts of near or greater than 10 inches. Nearly all localities have had within a single month from one-third to one-half as much rain as will fall during an entire average year. Occasionally, tropical storms or hurricanes produce copious rainfall over relatively large areas. Rainfall of over 20 inches in 24 hours is not uncommon within tropical storms or hurricanes, however, the average hurricane rainfall in Florida usually does not exceed 6 to 8 inches in a 24-hour period.

2.9.1 Floods of 1871 and 1898 - Greater Miami Area

These floods in the Greater Miami area were equal to or greater than the floods of 1929 and 1947, but detailed records of these earlier floods are not available.

2.9.2 Floods of 1926 and 1928 - Greater Miami Area

Exceptionally severe flooding occurred during 1926 and 1928. No reliable estimate of flood damages was made of the 1928 flood, which apparently exceeded the 1947 flood in depth, area of inundation and duration. During that flood, a maximum stage of 8.4 feet was observed at Hialeah, and flood waters were on low-lying areas for 105 days.

2.9.3 Flood of 1947 - Greater Miami Area

A comprehensive survey of damages sustained in the area followed the flood of September and October 1947. A large portion of the area experienced depths of flooding of 4 feet. Because several months passed before flood-waters completely subsided, damages to agriculture, residential property and highways was extensive. In addition to direct rainfall, flooding in 1947 was aggravated by inflows of large

magnitude from the Everglades which resulted from breaks in the Dade-Broward and Golden Glades levees.

2.9.4 Floods of 1948, 1952 and 1953 - Greater Miami Area

Since local levees had been repaired prior to occurrence of these three floods, only seepage water entered the Greater Miami area from the Everglades. Flooding resulted from accumulated rainfall and lack of adequate drainage facilities. By 1952, L-30 and L-31 had been constructed, thus affording increased protection of the coastal area. The 1948 flood was the most severe of these three, but it was lesser in degree than the 1947 flood both in rainfall intensity and antecedent storage accumulation. Although the 1952 and 1953 floods were comparatively minor, considerable damage resulted since recent development had greatly increased the damage possibilities.

2.9.5 1960 Flood

September 1960 was one of the wettest months within the history of the Central and Southern Florida Flood Control District. The major causes were rainfalls resulting from hurricane Donna and the effects of tropical storm Florence. This rainfall created extensive flooding throughout much of the area. Approximately 20 to 40 inches of rainfall occurred over the greater portion of central and southern Florida for the period 21 July to 30 September.

2.9.6 Tropical Storm Dennis, August 16-18 1981

Areas affected by Tropical Storm Dennis include S-20, S-22, S-28, Florida City, Homestead, and South Miami. The Homestead and Florida City area reported 20 inches or more of rainfall, and the S-28 gage registered 18.82 inches. Rainfall in the area of Florida City and Homestead slightly exceeded the 1 in 100-year return frequency. Prior to the storm, the east coast had received abnormally low rainfall and regional water storage levels were low. Due to low water levels in the WCA's and the lack of normal wet season rainfall prior to the storm, canals stages were being maintained somewhat above optimum, to conserve water and to prevent further salt water intrusion. No controllable discharges were being made to tide water and all east coast salinity control structures were closed. Storm data show that for the most critical structures, peak stages occurred (generally 12 or more hours) after the structures were opened. Peak stages were sufficient to bypass the ridge and divide structures and were a result of rainfall quantities exceeding design by a large margin. The rainfall quantities associated with the storm greatly exceeded the quantities of water that the system was designed to accommodate. Design discharges were exceeded at all control structures, as were design stages. Isolated flooding occurred in Palm Beach and Broward Counties, with Dade County experiencing heavy flooding in many areas. In some areas, SPF stages and discharges were exceeded. The capacity of the south Dade facilities to remove runoff was greatly exceeded by the

rainfall and associated runoff. Design rainfall amounts, structure discharge rates, and stages were exceeded without system failure. The system was operated and performed as designed.

2.9.7 Storm of April 23-24, 1982

The torrential rainstorm that occurred during April 23-24, 1982 was the second heavy rainstorm within a month that flooded houses and mobile homes, forced the closing of streets, and caused electric power loss in thousands of homes in the lower east coast area. Maximum rainfalls of 15.82 inches were reported in Dade County. Rainfall in the greater Miami area, including Miami, Miami Springs, Hialeah, areas between Hialeah Gardens and Sweetwater west of Miami International Airport, and Coral Gables, had a recurrence interval of between 5 and 10 years. Rainfall in the area south of Sweetwater and the area west of south Miami had a recurrence interval of between 25 and 50 years. The torrential rainstorm was the result of a warm front moving from Straits of Florida at 10 mph, in conjunction with a very large high pressure system located off the Carolinas. Flood waters had receded from most of the flooded areas in the morning of April 25, 1982. The flooding in several areas was worse than that caused by March's storm even though the total rainfall was less. This was due to the most intensive rain occurring in a rather short time, and the fact that many secondary and tertiary drainage systems had not been cleaned out after the March 28,29, 1982 storm and were clogged with debris and sedimentation.

2.9.8 Storms of June 1988

A succession of heavy rainfall events in south Dade County created local flooding in rural areas around Homestead during June. Pump station S-331 located along L-31N, recorded 16.8 inches of precipitation during the month. The lack of an adequate secondary drainage system and continued rains caused flooding in the East Everglades Area from June 7 to about June 20 and in the area east of L-31N and north of C-103. Many requests were made of the SFWMD to remove the plug at S-197. However, the plug was not removed for the following reasons: the effect on the stage in the flooded areas would have been minimal; removing the plug would cause extensive large environmental damage in Barnes Sound; and the operational criteria for plug removal were not reached. Minimal pumping was done at S-331 throughout the storm event as long as all stages south of the station were not exceeded. The question arises why flooding occurred when the design stages were not exceeded. First, the design stages in L-31N are close to the natural ground elevation and secondly, there is an almost complete lack of a secondary drainage system in the area.

2.9.9 Storms of August 1988

During August 1988 Pump Station S-331 recorded cumulative precipitation of over 18 inches. Successive storm events and resulting high stages in the C-111 basin

necessitated the removal of the earthen plug at S-197 on August 15. Continued rains precluded replacement of the plug for seven days. The removal of the earthen plug allowed approximately 45,000 acre-feet of fresh water into the Manatee Bay/Barnes Sound marine environment. As a result of the exceptionally high rainfall in the early summer months and the discharge of freshwater from C-111, a massive die-off of benthic fauna and flora occurred. S-331 was operated to facilitate seepage of flood waters from the East Everglades Area whenever possible. This procedure was suspended, however, whenever the primary areas protected by the C&SF Project were endangered. Releases through S-333 were terminated during the third week of August as groundwater levels in the monitoring wells surpassed thresholds. As the stage rose in Water Conservation Area No. 3A into the Zone A Flood Operations, the gates at the S-12 structures were opened fully. After two weeks of fully open-gate operations, the stage finally reversed its upward trend.

2.10 LAND USE

Existing land uses are primarily agricultural in the northern and central portions of the C-111 basin, with moderately urbanized areas near Florida City and Homestead. Ground level contours range from 1 to 10 feet NGVD with most of the active agricultural and urban land use at land elevations of 5 feet and above. The southern-most portion of the basin is characterized by abandoned farmland and natural wetlands sloping gradually to Florida Bay.

An estimated 36,800 acres are utilized for fruit tree groves, row and field crops, and plant nurseries. The limestone rocklands, which account for most of the agricultural acreage, and marl soils are prepared for multiple varieties of subtropical and tropical fruits grown in south Dade County.

The original tabulation of land use acreage within the C-111 basin was conducted in 1986. While agricultural activity in the region was severely impacted by Hurricane Andrew in August 1992, agricultural production is recovering quickly after the event. There is currently approximately 42,700 acres of land within the economic study area of which approximately 36,800 acres or 86% are utilized for agricultural purposes. Tropical fruit groves and nurseries accounted for some 13,600 acres, with vegetable tracts, field crops, and fallow areas accounting for the remaining acreage. Within the area of economic analysis, urban land accounted for a little more than 4% of the land use activity, with wetlands and other open lands accounting for almost 10% of the area. More detailed information on land use within the study area can be found in this report in Appendix E, Economic Analysis.

2.11 RECREATION

Fishermen use the existing canals and waterways for fishing access. Although structures such as pumping stations and culverts prevent linear use of the entire

drainage system, there are some stretches where boaters can travel for several miles from their entrance point. Not all portions of the drainage system are accessible, since highways and/or boat launching ramps are not available and culvert structures obstruct water travel. Airboats, capable of traveling across the marshes, can gain entry to some of these isolated stretches of water. Those stretches outside the park which are accessible by boat or by road do sustain an active use by fishermen. However, in the C-111 system, there is very little boating or fishing use except downstream of the coastal structures.

Hunters make some use of the project area during the appropriate hunting seasons throughout the year. A variety of birds and small game is taken by the hunters using sites designated for this activity.

Birdwatching is a year-round activity which occurs in the project area also. This non-consumptive activity is enjoyed by many people because of the variety of birdlife available in the Everglades and south Florida.

2.12 CULTURAL RESOURCES

Human occupation of Everglades National Park area is documented to have occurred only within the last 2,000 years, although evidence of occupation in other parts of South Florida dates back to over 10,000 years ago (Griffin 1988). An archeological survey was conducted by Carr (1983) in Dade County, near the project area as part of an application for rock plowing. One potentially significant archeological site, Da3218, was identified on a tree island during the survey. Three additional tree islands near site Da3218 were not investigated, but were identified as having the potential to also contain significant archeological resources. The few known archeological sites in Taylor Slough are isolated from the major districts of settlement in the Everglades, in the Ten Thousand Islands area and Shark River Slough. Three earthen midden sites, Paradise Key I, Taylor Slough #1, and Taylor Slough #2, and one subsurface site, the Anhinga Trail site, are recorded in Taylor Slough. The National Register eligibility of these sites has not been assessed, but several of the sites probably meet the eligibility criteria. The project area has not been subjected to systematic cultural resources survey, and other unrecorded historic properties may be present. Required surveys will be conducted following project design, and before construction.

2.13 AESTHETICS

The agricultural lands, canals, levees and control structures provide a human contrast with the marshes which are also found in this section of the state. The majority of the areas which will be impacted by this project have been altered by man over a relatively long period of time. Aesthetically, the area has a positive value

because of the abundant wildlife and extensive waterways and marshes. Even the agricultural lands have a mixed variety of wildlife on them.

2.14 AIR QUALITY

Air quality is that of a rural, non-industrial area. Principal agricultural activity is winter vegetable production. Pesticides may be applied from the air, but there are no air quality issues.

SECTION 3

FUTURE "WITHOUT PROJECT" CONDITION

This section provides a forecast of future conditions in the C-111 Basin that are likely to occur if no Federal project is implemented. The future "without project" condition is synonymous with the "no action" alternative required pursuant to the National Environmental Policy Act of 1969, as amended. It is also referred to as the Base Condition in other sections of this report.

3.1 C-111 PROJECT

In the future "without project" condition, the existing C-111 project for flood control and other purposes would remain in place and would continue to be operated and maintained. The "without project" condition for this study assumes, however, that the Modified Water Deliveries to Everglades National Park (MWD to ENP) Project, authorized in 1989 by PL 98-181, is in place and operating. The without project canal stages would return to the optimum stages as listed in Table 2-1.

3.2 MODIFIED WATER DELIVERIES TO EVERGLADES NATIONAL PARK

The future "without project" condition includes structural and operational modifications to the water management system that are included in the Modified Water Deliveries to ENP Project. This project is in the design and construction phase. It consists of structural modifications to the C&SF Project to provide more natural flows to Shark River Slough in ENP. Water flows will be spread across a broader section of Shark River Slough to include the East Everglades, between L-67 Extension and L-31N. In conjunction with the MWD to ENP project, Department of Interior is acquiring about 107,600 acres in the East Everglades for incorporation into the park. These lands are identified in Figure 1-4.

Structural components of the plan are also shown in Figure 1-4. The project consists of the addition of water control structures to reestablish the natural distribution of water within Water Conservation Area (WCA) No. 3A (S-349A, B, and C) and culverts to restore flows into WCA No. 3B (S-345A, B, and C). Outlets from WCA No. 3B (S-355A & B) will be constructed to discharge into Northeast Shark River Slough. An existing levee and canal (L-67 Extension) along the eastern edge of the existing ENP boundary will also be removed. A Miccosukee Indian camp will be floodproofed to avoid periodic flooding that would otherwise be caused by the project.

As a part of the project design process, the L-67 Pilot Test is being conducted. This test is to obtain data that will help identify the most cost effective alternative

plan for discharging water from WCA No. 3A to WCA No. 3B, while still accomplishing the project objectives. Depending on the results of the pilot test, the recommended plan may be modified to replace the construction of the S-345's and S-349's with a less costly alternative.

In order to prevent adverse flood impacts to the 8.5-square-mile residential area, the project includes the construction of a seepage levee and canal around the western and northern edges of the area and a pump station (S-357) to remove excess seepage water. These project features are designed to maintain the existing level of flood protection in the residential area after the MWD to ENP project returns water levels in Northeast Shark Slough to natural (slightly higher) levels. A second pump station (S-356) would be constructed to pump excess seepage water from the L-31N borrow canal and residential area into the L-29 borrow canal. This water will then flow through culverts under US Highway 41 into Northeast Shark River Slough.

Legislation has been approved by Congress (Feb 94) and signed by the President that authorizes the Department of Interior to utilize existing appropriations to contribute up to 25% of the cost of acquiring the 8.5-square-mile area, the Rocky Glades Agricultural Area, and the Frog Pond. Acquisition will be performed by the South Florida Water Management District with contributions from the State and Dade County, in addition to the Department of Interior. Once acquired, the lands would be managed by SFWMD. The legislation would not require acquisition of all these lands. It would provide the opportunity to acquire the lands if the participating agencies agreed. If the 8.5-square-mile area were to be acquired, the proposed levee, canal, and pump included in the Modified Water Deliveries to ENP Project would not be constructed. However, the remainder of the project features in the Modified Water Deliveries to ENP Project would be constructed and the project would function as intended.

Operating studies are being conducted during design and construction of the project to identify the optimum operating plan. The structural modifications were designed to provide for maximum operational flexibility so that as more is learned through the continued iterative testing program, the operation of the project can be adjusted accordingly.

3.3 WATER MANAGEMENT

3.3.1 Plan for Water Control - ENP-South Dade County Conveyance System

Authority for conducting the Experimental Program for Modified Water Deliveries to ENP expires upon completion of construction of the Modified Water Deliveries to ENP Project. The future "without project" condition calls for the ENP-South Dade County Conveyance System canals and structures to be operated in accordance with the original design criteria, as described in Table 2-1. The timing,

volume, and specific location of water deliveries from the C&SF Project to Shark River Slough will be made in accordance with the operating plan developed during project design and construction. S-331 is the divide structure between the Northeast Shark River Slough and South Dade County drainage areas. It will no longer be utilized to pump flood waters out of the Shark River Slough basin to prevent flood damages in the 8.5-square-mile area. It will be used, as designed, for water supply deliveries to South Dade County during drought conditions.

3.3.2 Flood Control

Without the C-111 project, the basin will continue to experience substantial agricultural flood damage. Agricultural flood control in South Dade County is impacted by the adjacent canal water levels that exist prior to, and during a storm event. As a part of the Experimental Program for Modified Water Deliveries to ENP, optimum canal stages have been lowered for selected canal segments. The existing condition includes the Experimental Program which calls for an optimum canal level in L-31N, between S-331 and S-176, of 5.0 ft. This is 0.5 ft lower than the design optimum. In the future "without project" condition, this canal will be operated at the original design optimum canal stage of 5.5 ft. Because this canal segment is immediately adjacent to large agricultural areas, there will be some reduction in flood protection in the future "without project" condition, relative to the existing condition.

During a flood event, S-331 (and S-173 which is adjacent to S-331) will be utilized as a divide structure. It will separate the Shark River Slough basin north of S-331 from the Taylor Slough basin runoff to the south. Excess flood water south of S-331 will be discharged at S-175, S18C, and under extreme conditions, at S-197. The future "without project" condition will result in flood discharges to Taylor Slough via S-175 that bypass the center of the flowway.

Occasional flood discharges to Barnes Sound will continue to be necessary to the detriment of native flora and fauna. However, the frequency of such discharges should be significantly reduced. SFWMD has modified the plug at S-197 by adding 10 culverts adjacent to the existing three culverts. This will provide the operational flexibility to limit S-197 discharges to non-damaging levels during most storm events.

3.3.3 Water Supply

3.3.3.1 Agricultural and Urban Water Supply

The ENP-South Dade County Conveyance System will function, as designed, to provide supplemental water supply deliveries during drought conditions. Groundwater recharge from the canals should not change significantly in the future "without project" condition. Coastal salinity control structures will continue to be operated in accordance with the design operating criteria. Therefore, upstream canal

stages should remain unchanged and saltwater intrusion is not expected to become more of a problem as a result of the project. However, a continued rise in sea level may make it necessary to operate the canals at higher levels to avoid saltwater intrusion in the future. No significant changes in the project's ability to provide for agricultural and urban water supply are anticipated in the future "without project" condition.

3.3.3.2 ENP Water Supply

The future "without project" condition will include restoration of more natural flows to Shark River Slough (Modified Water Deliveries to ENP Project). Since the operation of L-31N and C-111 will be in accordance with the original design criteria, large volumes of water will continue to be drained from Northeast Shark River Slough and northern Taylor Slough into the canals. This will continue the current trend of degradation of ENP's natural resources caused by alterations to the natural hydrology.

The Modified Water Deliveries to ENP Project will result in higher water levels in northeast Shark River Slough which will cause increased seepage into the L-31N borrow canal. Under a flood condition, this seepage will be pumped northward and returned to Shark River Slough from the L-29 borrow canal through culverts under US Highway 41. This is necessary to avoid having to discharge to the south which could exacerbate flooding in the C-111 basin. During normal (non-flood) conditions, excess seepage water could be discharged southward under some circumstances. This would enable greater discharges to Taylor Slough via S-332 in the future "without project" condition.

Operation of the system could be adjusted slightly to take advantage of additional water deliveries from upstream of S-331. However, the existing physical water management system is not designed to provide sufficient distribution and operational flexibility to fully take advantage of the additional water. Although operational criteria for the existing structures and canals can be modified, it is unlikely that significant changes could be made without causing adverse impacts to adjacent agricultural lands. Since overdrainage of the Everglades by seepage into project canals dominates the hydrology in this area (Van Lent and Johnson 1993), under "without project" conditions it is not expected that the additional water would significantly contribute to restoration of more natural hydrology.

3.4 CLIMATE

There will be no further effect on climate in the without project condition.

3.5 LAND USE

The future "without project" condition includes continuation of agricultural usage of the Frog Pond and Rocky Glades agricultural area. Projections of future land use in the study area would indicate some growth of residential areas with little or no growth in agricultural acreage. Tracts utilized for tropical fruit groves, Cuban vegetables, specifically guava and papaya, and ornamental horticulture are expected to replace some of the more traditional vegetable acreage used for tomatoes, beans, corn, and squash. Market price is excellent for these commodities, production practices are improving and new methods have been developed to make these crops more disease resistant.

Open rockland soil areas bordered by C-111, L-31W, and State Road 27 will continue to be utilized for nontropical row crops, particularly tomatoes. Urban development around Homestead and Florida City should show controlled growth of low to low-medium density residential areas with an upper limit of 13 dwelling units per acre. New residential development should include single family homes, townhouses, or small apartments after recovery from Hurricane Andrew.

Hurricane Andrew destroyed most of the fruit trees in the Canal 111 study area in 1992. At present, an exact estimate of the acreage of fruit trees that will be replanted is unknown. Most of the fruit crop acreage affected by Hurricane Andrew has already been replanted west of Levee 31N. East of the levee, discussions with the Dade County Extension Office and the United States Department of Agriculture (USDA) indicate that 50% to 100% of the trees will be replanted. These new trees will continue to mature and reach full production during the project life.

Operating conditions in the C-111 basin have been below optimum levels for several years due to the Experimental Program of Modified Water Deliveries to ENP. A return to optimum stages in the canal system will primarily affect two areas. The Rocky Glades area west of Levee 31N is located in the East Everglades Area. Much of the agricultural acreage is utilized for fruit production and little, if any existing water control exists. A return to authorized stages will worsen conditions to agriculture in this area. The second affected area includes the Frog Pond adjacent and east of Levee 31W and selected areas south. Effects upon crops in this area will depend upon seasonal regulation of canal stages. Tomatoes are grown during the dry winter months generally from November to March but land preparation can begin as early as late August and early September. Returning to authorized stages in the canal system during this period will inhibit production practices in this area.

3.6 RECREATION

Without the project, the hunting, fishing, boating and wildlife viewing will continue. In all likelihood, an increase in these activities will occur in direct proportion to the growth in population in the south Florida area.

3.7 WATER QUALITY

Agricultural and urban areas in the northern Everglades are expected to continue to influence water quality in the study area and Everglades National Park if no further action is taken. If the Everglades litigation is resolved, flood runoff from the Everglades Agricultural Area will meet all applicable water quality standards before it is discharged into the WCA's. As a result, discharges from WCA No. 3A to the ENP-South Dade County Conveyance System will be of sufficient quality to insure no degradation to Everglades habitat.

It is likely that further research will be conducted to determine the cause of high Mercury levels in Everglades water. It is also likely that restrictions will continue on human consumption of fish removed from the Everglades.

3.8 ENVIRONMENTAL RESOURCES

Prevalent hydrology, different from the historic natural (Section 3.3.3.2), will continue to characterize the Taylor Slough--C-111 basin. Seasonal overflow of water from Shark River Slough (SRS) into the Taylor Slough basin would increase under the Modified Water Deliveries to Everglades National Park Project (USACE, 1992), but large volumes of water will continue to be drained from Northeast Shark River Slough and northern Taylor Slough into the L-31N borrow canal and C-111. Water levels in the Taylor Slough basin would continue to be largely unrelated to rainfall, drier-than-natural conditions would continue, and undesirable vegetative trends would continue.

Present vegetative trends in the study area include an invasion of native and exotic woody plants into the historic sawgrass-spikerush prairies. The invader plants, willow, primrose, myrtle, find suitable footholds where the wet prairie has become dry at the surface for extended periods annually. This conversion of habitat type is symptomatic of a fundamental change in the ecosystem from an Everglades wet prairie system toward a mesic prairie system. This trend would continue under the "without project" flow regime.

In Manatee Bay, Barnes Sound, and Florida Bay, cycles of unnatural salinity conditions will likely continue. Discharges of large flow volumes to coastal receiving waters will occur within short time periods following major storms. This will result in significant swings in salinity, from 0 to levels well in excess of seawater salinity. The impact on the area biota will continue to be significantly negative.

3.9 MANAGEMENT

The Everglades will survive only as a managed system. In order to restore and maintain a naturally functioning biosystem coexisting with an intensively used human system, the water resource must be protected and directed. The water supply comes from rainfall, but it will continue to be managed by man as it is allocated among potential users.

SECTION 4

PROBLEMS AND OPPORTUNITIES

This section will address problems and opportunities associated with flood damage reduction, environmental resources, and alteration of the natural hydrology.

4.1 FLOOD DAMAGE REDUCTION

One of the primary purposes of the South Dade County portion of the C&SF Project is flood protection. The project was authorized to remove 40-percent Standard Project Flood flows. This purpose remains an important objective because of the agricultural intensity within the study area. Land use in the original project was predicted to show an increase in agriculture and urban development in the Homestead and Florida City area, and industrial development further south. The industrial development did not take place, but considerable agricultural and some urban development has occurred. Intensified agricultural land use activities within the basin necessitates an improved water management capability. Extended durations of flooding have adversely impacted basin agricultural productivity.

In the design of the original flood control project for the C-111 basin, it was assumed that the basin would be developed for seasonal row crops. As a result, flood control would be required only for the winter growing season which coincides with south Florida's dry season. Row crops only require protection of root zones which generally extend slightly below the ground surface. However, tree crops have been planted in the basin. The amount of fruit tree crops and general horticultural activity have increased substantially since the 1960's. Many of these, such as avocado and lime trees, are very susceptible to inundation of their root zones, and require year-round flood control for root zone depths of 2 to 4 feet. As these activities have longer root zones they are more susceptible to damage from high water tables in the area, even when planted on higher ground or on mounds.

Ground elevations in the C-111 basin are extremely flat, ranging in elevation from just above sea level to above 7 feet, NGVD. Agricultural lands in the basin are generally located on land above 5 feet, NGVD, although there is some agriculture, particularly in the Frog Pond at lower elevations. The C&SF Project features provide flood control by draining groundwater from agricultural lands to minimize or avoid root zone inundation. This is done by operating canal stages below the adjacent groundwater elevations to create a flow gradient toward the canal. These flows are collected in the canals and are discharged, for the most part to Taylor Slough (at S-332), to the park's panhandle via S-18C and lower C-111, and to Manatee Bay/Barnes Sound under extreme conditions.

The same physical processes that drain water from agricultural lands during flood conditions also drain water from Taylor Slough, west of L-31N and L-31W. There has been a conflict between agricultural needs (predictable canal levels that are not allowed to rise during the growing season) and the needs for restoration of Taylor Slough (levels that fluctuate naturally in response to rainfall patterns).

Flood damage susceptibility is measured without and with proposed alternatives. The differences represent the inundation reduction benefits of the proposed project. A detailed explanation of procedures used in the determination of these damage estimates is presented in Appendix E, Social and Economic Analysis.

The basin experiences substantial agricultural flood damage. The evaluation in Appendix E demonstrates that under existing land use conditions, flood damages are estimated to range from $2.3 million (4,500 acres) during a 2-year storm frequency, $8.0 million (7,600 acres) during the 10-year storm frequency to $93.6 million (31,700 acres) during the standard project flood (SPF) event.

4.2 ENVIRONMENTAL RESOURCES

4.2.1 Everglades National Park

ENP personnel have found that *the ecological integrity of the entire Everglades ecosystem has declined over the past several decades. This is evidenced by a 90 percent decline in the number of nesting wading birds, changes in the historical distribution and abundance of higher trophic-level consumer populations, reduced hydroperiods, loss of marsh productivity, increased frequency of alligator nest flooding, and an overall loss of wetland habitats. The general health and continued survival of native wildlife populations within Everglades National Park is at risk unless restoration of naturally functioning ecological processes can be attained* (National Park Service, 1990). ENP relates these problems to the reduced area and changed timing of surface inundation resulting from the C&SF Project.

4.2.2 Manatee Bay/Barnes Sound

On five occasions since construction of S-197 in the mid 1960's, it has been necessary to remove the earthen plug adjacent to the S-197 culverts in order to provide full canal conveyance for flood control. The most recent removal of the plug was in 1988. Forty-five thousand (45,000) acre-feet of water were discharged to Manatee Bay/Barnes Sound (SFWMD 1988). Salinities in this lagoon area generally range from 30 - 40 ppt, but were much lower (about 20 ppt) than normal due to exceptionally high rainfall in the early summer months prior to the plug removal in August. These lowered salinities caused the Manatee Bay/Barnes Sound system to be in a "stressed" condition. Following the removal the plug, salinity in Manatee Bay was reduced from 20 ppt to a low of only about 1 ppt. The salinity in the larger, more distant Barnes Sound declined to a low of about 15 ppt. In 1988, the discharges from

C-111 were sufficient to lower salinities below 15 ppt in a 25-square-mile area. A massive die-off of flora and fauna occurred in Manatee Bay/Barnes Sound (ibid).

A major problem at S-197 was the inflexibility of discharge capability. With the plug in place, only minimal discharges were possible through the 3 culverts at S-197. When a major flood occurred, there was no option but to remove the plug for maximum discharges. The earthen plug adjacent to the 3 culverts at S-197 has been replaced with 10 additional culverts. This will allow earlier discharges at lower rates that will preclude the need for making maximum discharges in many circumstances. Most importantly, the culverts will enable minimizing the total volume of discharges to Manatee Bay/Barnes Sound during all events. However, during major storms, it will still be necessary to make large discharges through the culverts.

4.3 ALTERATIONS OF THE NATURAL HYDROLOGY

Restoration of Taylor Slough and Florida Bay is dependent, in large part, upon restoration of the natural hydrologic conditions under which the ecosystem evolved. Construction and operation of the C&SF Project have resulted in substantial changes to the natural hydrology of Taylor Slough. Satisfying the Congressionally authorized project purposes of flood control and water supply required alterations to the natural hydrology. Satisfying the Congressionally authorized project purpose of protecting the area's fish and wildlife resources depends upon allowing the natural hydrologic variations to occur between flood and drought.

4.3.1 Taylor Slough Hydrology

Taylor Slough can be divided into four physiographic sub-zones; the headwaters, upper, middle, and lower zones. The headwaters can be defined as the area bordered on the north by the 8.5-square-mile area and extending southward to the Frog Pond. The upper zone extends from S-332 southward past the park road to the area of Anhinga Trail. The middle zone extends from Anhinga Trail southward approximately four miles to the general location of the Madeira ditches. The lower zone refers to the segment from the Madeira ditches to the mangrove fringe along Florida Bay.

Soil descriptions prepared by the University of Florida and USDA (Leighty et al. 1954) indicate that under natural conditions essentially all of the study area, except the higher elevated Atlantic Coastal Ridge, was subjected to seasonal flooding due to low ground surface elevations and the close proximity to the Everglades. At Tamiami Trail, the concave depression that shaped the "River of Grass" is constricted, forming a narrow southwesterly trending arc of continuous wetlands which define the Shark River Slough drainage. Shark River Slough represents the southern extension of the Everglades trough, which originates outside of the Park in the wetlands of WCA No. 3. To the northwest of Shark River Slough, the bedrock of the Everglades rises

gradually into the sandy marl prairies of the Big Cypress basin. This area extends well south of Tamiami Trail, forming the transitional and short hydroperiod marshes to the west of the L-67 Extension borrow canal. These marl prairies occur on slightly higher bedrock elevations, and were originally only seasonally inundated.

To the southeast of Shark Slough is a large area of transitional (less than 3 months hydroperiod) and short hydroperiod (3 to 5 months hydroperiod) wetlands referred to as the Rocky Glades. The Rocky Glades includes the headwaters and a portion of upper Taylor Slough and extends east of L-31N for several miles.

Maximum inundations in the Rocky Glades occurring after the peak of the rainy season, formed a natural buffer separating the deeper Everglades marshes from the higher elevated, and drier areas along the Coastal Ridge. During the wet season, the Rocky Glades would receive runoff from the western portion of the Coastal Ridge, while additional surface water would spill over from the expanding Shark Slough wetlands. The shallow soils and exposed limestone bedrock in the Rocky Glades make it an important area of direct recharge to the underlying aquifer, which supplies groundwater flows to the adjacent eastern developed areas as well as the downstream Everglades.

The Rocky Glades are hydrologically significant, since the southern portion of this area drains to the southeast, where it forms the headwaters of the Taylor Slough watershed. The marl soils in upper Taylor Slough extend eastward, covering much of the Frog Pond, and northward along the western flank of the Coastal Ridge. Under natural conditions, this region captured wet season runoff from the western Coastal Ridge and directed it westward into Taylor Slough, where it would be slowly released into the downstream marshes and Florida Bay. Construction of the L-31N, C-111, and L-31W levees has isolated much of the historical contributing area to Taylor Slough, and excess wet season runoff from this region is now rapidly drained via the canal systems eastward to Biscayne Bay or southward into the lower C-111 basin. These C&SF Project features contribute to the drainage problems in the eastern wetlands within ENP.

4.3.2 Past Hydrologic Changes in Southwestern Dade County

The earliest C&SF Project construction in southwestern Dade County began in 1951, with the completion of L-30 and the northern portion of the L-31N levee. These levees were originally built as part of the Eastern Protective Levee System, to protect the expanding developed areas of the Lower East Coast from Everglades flooding. This levee system also established the land use plan for western Dade County and areas to the north, by defining the western limit of flood protection.

The original plan of improvement for southwestern Dade County also anticipated that the majority of the low-lying areas east of the L-31N and C-111 levees

and adjacent to the Everglades would be developed for seasonal agriculture (U.S. Army Corps of Engineers 1961). This plan called for gravity drainage of an area of 227 square miles of southwestern Dade County using a system of 12 primary canals. Although it was recognized that the natural drainage in the western portion of the Coastal Ridge was to the southwest (into Taylor Slough), gravity drainage primarily to the east and south (into Biscayne Bay, Barnes Sound, and Florida Bay) was found to be most practical, particularly with the continuing pattern of declining groundwater levels in the Coastal Ridge.

Runoff from the east of L-31N and north of Homestead was to be drained eastward into Biscayne Bay via six proposed canals (C-101 through C-106). The area south of Homestead was to be drained southward into Florida Bay and Barnes Sound via six proposed canals (C-107 through C-112). During project review, the National Park Service concurred with the plan for eastern Dade County, but requested that the area west and northwest of Homestead be drained westerly into Taylor Slough, to reduce the drainage effects of the C&SF Project improvements. The National Park Service and the Fish and Wildlife Service also objected to the southerly extension of the proposed C-109, C-110, C-111, and C-112 canals to tidewater, and requested that the canals be terminated at the one-foot contour to promote sheetflow, and reduce the effects of direct freshwater inflows to the downstream estuaries.

The 1961 plan was modified in the South Dade County GDM (US Army Corps of Engineers 1963) so that the L-31N canal would be used "to provide southerly drainage to ENP in Taylor Slough for the westerly portion of south Dade County". The L-31W canal was specifically added as part of the 1963 GDM so that during the design storm approximately 28 square miles of land adjacent to the C-102 and C-103 canals would be drained westward into Taylor Slough. The first proposed operating criteria for the southern reach of the L-31N borrow canal would have allowed wet season canal stages to rise as high as 6.5 feet, NGVD to promote the discharge of water into Taylor Slough via the L-31W borrow canal. Later, when more detailed topographic data were available, the design optimum canal stage was changed to 5.5 feet, NGVD. However, the intent was to maintain canal stages as high as possible to enhance water supply for ENP. Water would spill overbank from the L-31W borrow canal into Taylor Slough. Under flood conditions, up to 500 cfs would be discharged into the L-31W canal and pass southward via S-175, to maximize Taylor Slough inflows.

Prior to construction of the C&SF Project, the farming practices in this region had been adapted to the natural cycle of Everglades flooding and drying. Land preparation and planting would begin after wet season water levels naturally receded. Agricultural practices were thus in tune with the natural variability in seasonal rainfall and water levels. During the 1980's, agricultural practices in the region began to change, in part due to a lower than normal decade of rainfall. Grove crops, which require low ground water levels throughout the year, expanded into the western

portions of the basin. In addition, economic pressures forced south Dade farmers to plant their row crops earlier in the season to compete with growers from other areas. Both of these changes prompted additional demands to lower canal operational stages. This would increase groundwater storage potential so there would be a readily available area to absorb the stormwater runoff. As a result, the risk of flooding of the root zones would be reduced.

The operational levels maintained in the L-31N, L-31W, and C-111 borrow canals are also extremely important to the natural areas in the eastern section of the Park. These canals traverse the Rocky Glades and canal water levels largely control the magnitude of groundwater losses from the Northeast Shark Slough and Taylor Slough basins. The underlying limestone of the Rocky Glades is the most permeable bedrock found in South Florida. Minor reductions in canal water levels drain tremendous quantities of surface and ground water from the wetlands. Maintenance of higher surface and ground water levels in this area is pivotal to the restoration of flows throughout Northeast Shark Slough, Taylor Slough, and into the downstream estuaries of the Gulf of Mexico and Florida Bay.

The immediate loss of stormwater runoff to tide during the rainy season and the continued drainage of the wetlands and stored groundwater into the dry season not only cause the loss of natural hydroperiods in the uplands, but also cause a drastic reduction of freshwater flow into the downstream estuaries during the remainder of the dry season. The resulting reduction in groundwater levels further aggravate the problem when the early spring rains arrive. Rainfall must first fill up the depleted groundwater regime before surface water flow can resume, and transport freshwater into the downstream marshes and estuaries.

4.3.2.2 The Impacts of Water Management in the Rocky Glades

The impacts of water management changes in the Rocky Glades most likely date back to the beginning of drainage activities in the Everglades watershed in the early 1900's. Unfortunately, little hydrologic information exists for the pre-drainage Everglades. Water level recording gages G596 and G789 are long-term monitoring stations in the Rocky Glades. They were installed in the late 1940's and mid 1950's (see Figure 1-4 for locations) after significant drainage activities had already taken place. Even with this late start, the gage data indicate that the transitional wetlands in these areas were routinely subjected to short periods of seasonal flooding until approximately 1962, when L-29 was completed, enclosing WCA No. 3.

Table 4-1 provides a brief summary of the water level and hydroperiod changes that have occurred in the Rocky Glades area. Prior to 1962, average wet season water levels exceeded 6.9 feet at the G596 gage, and exceeded 5.80 feet at the G789 gage. After 1962, average October water levels dropped by 1.2 to 1.5 feet at these gages. Similar reductions have occurred in average water levels during the late dry season.

The reduced water levels have had a profound affect on hydroperiods in the Rocky Glades. Prior to 1962, surface water inundations occurred on average, 13 to 14 percent of the time. After 1962, surface water inundations occurred less than 1 percent of the time. More importantly, groundwater levels have become so low that much of the Rocky Glades has water levels several feet below the ground surface throughout the year. Under these conditions, rainfall rarely raises water levels to the point where surface water flows are produced, so the Rocky Glades have lost much of their ability to contribute flows to the Taylor Slough watershed, except under extreme rainfall events.

Table 4-1

Water Level and Hydroperiod Changes in the Rocky Glades
(Key Stages are 6.0 feet at G596 and 5.0 feet at G789)

	PRE-1962		POST-1962	
SITE NAME	AVERAGE OCTOBER WATER LEVEL	AVERAGE APRIL WATER LEVEL	AVERAGE OCTOBER WATER LEVEL	AVERAGE APRIL WATER LEVEL
G596	6.93	4.96	5.71	3.47
G789	5.82	3.22	4.35	2.03
SITE NAME	PERCENT TIME GREATER THAN KEY STAGE	PERCENT TIME GREATER THAN GROUND SURFACE	PERCENT TIME GREATER THAN KEY STAGE	PERCENT TIME GREATER THAN GROUND SURFACE
G596	57	13	11	<1
G789	41	14	7	<1

Wet season water levels show a further reduction in the early 1970's. The reduced water levels in the 1970's are thought to be a primary factor responsible for the increased agricultural and residential development throughout the low-lying areas of western Dade County. This has even allowed development to expand into the unprotected areas west of the Eastern Protective Levee System. This area remained relatively dry throughout the 1970's, as a result of a long period of lower than normal rainfall, the continued diversion of sheetflow away from NESRS, and slightly improved drainage from the adjacent canals to the east. In spite of this, the agricultural and urban areas west of the L-31N are extremely susceptible to flooding, since the C&SF Project has no project features or provisions to provide flood protection in these areas.

4.3.2.3 The Impacts of Water Management in Taylor Slough

Water level monitoring stations in the Taylor Slough basin were also installed well after the start of drainage activities in the Everglades. The earliest monitoring data for the upper Taylor Slough area began at the bridge over Taylor Slough in late 1960. Monitoring began in the lower Taylor Slough area in early 1953. Table 4-2 provides a brief summary of the water level and hydroperiod changes at these two monitoring sites. The comparison in table 4-2 breaks the record based on the start of construction of L-31N and C-111 in early 1965. Note that average wet season water levels at Taylor Slough Bridge and at P-37 show very little change. During the late dry season, water levels at the Taylor Slough Bridge have increased, as a result of supplemental water deliveries from the ENP-South Dade County Conveyance Canal system. Station P-37 shows no apparent water level or hydroperiod changes because it is located in the lower portion of the watershed, and the effects of local rainfall and its close proximity to tide, overshadow the impacts of upstream water management.

Table 4-2

Water Level and Hydroperiod Changes in the Taylor Slough Basin
(Key Stages are 3.0 feet at TSB and 0.8 feet at P-37)

	PRE-1965		POST-1965	
SITE NAME	AVERAGE OCTOBER WATER LEVEL	AVERAGE APRIL WATER LEVEL	AVERAGE OCTOBER WATER LEVEL	AVERAGE APRIL WATER LEVEL
TSB	3.83	0.54	3.71	1.24
P-37	1.67	0.24	1.62	0.25

SITE NAME	PERCENT TIME GREATER THAN KEY STAGE	PERCENT TIME GREATER THAN GROUND SURFACE	PERCENT TIME GREATER THAN KEY STAGE	PERCENT TIME GREATER THAN GROUND SURFACE
TSB	41	24	41	28
P-37	76	76	74	74

4.3.2.4 Restoration Goals for the Rocky Glades, Taylor Slough, and Florida Bay

The wetlands throughout the Rocky Glades and Taylor Slough have experienced major changes in their original patterns of seasonal flooding and sequential drying as a result of reduced surface water inflows, the redirection of

stormwater runoff to the eastern coastal canals, and the drainage effects of the canal system along the Park's eastern boundary. These hydrologic alterations have subsequently led to a reduction in the spatial scale of these wetlands, a loss of habitat heterogeneity, and declines in ecosystem productivity, that can be seen in many of the key plant and animal communities within the Park and adjacent natural areas. The current plan for Modified Water Deliveries to Everglades National Park is designed to address many of these concerns through the re-introduction of sheetflow, and restoration of more natural water depths and hydroperiods in Northeast Shark Slough. This effort to re-establish higher surface water levels and longer hydroperiods in the deeper slough is crucial to increasing ecosystem productivity and maintaining adequate freshwater flows to the west coast estuaries and Florida Bay, but these changes alone will not totally restore natural ecological function of the entire southern Everglades system.

Restoring more natural hydrologic conditions in the transitional wetlands of the Rocky Glades is also an essential component of this ecosystem restoration program. Without simultaneously raising groundwater levels and reinstating the historical seasonal inundations in the higher elevated prairies of the Rocky Glades, a key component of the natural diversity of habitats that are needed to sustain the wide range of animal species adapted to the natural Everglades Ecosystem will be lost.

Reestablishing pre-project water levels and the gradual marsh wetting and drying patterns (particularly in the Taylor Slough headwaters) is the most reliable way of restoring the natural timing and distribution of sheetflows throughout Taylor Slough and downstream into Florida Bay. The highest priority for hydrologic restoration must be focused on reestablishing the hydrologic conditions in those areas of the Park that show the greatest impacts due to drainage and altered water management. The transitional wetlands of the Rocky Glades have experienced the most significant water level reductions, and essentially a complete loss of their natural surface water inundations, due to the diversion of surface water inflows from the Northeast Shark Slough basin, and the drainage effects of the adjacent canal system.

The lower canal stages contribute to a loss of sheetflow and natural dry season ponding in Northeast Shark River Slough, increase groundwater losses and shortened hydroperiods in the headwaters of the Taylor Slough basin, and reduce freshwater inflows into the downstream estuaries of Shark Slough and Florida Bay. Reductions in water levels in the adjacent L-31N, L-31W, and C-111 borrow canals, have also altered the operation of the ENP-South Dade County Conveyance System, and limited the capability to provide supplemental flows to restore the hydrology of the Taylor Slough watershed. Water levels, not flow volumes, are the most tangible measure of hydrologic restoration of the wetlands in the Park. Restoring more natural water levels will result in a reestablishment of both the timing and distribution of surface water flows throughout Taylor Slough and into the Florida Bay.

4.3.3 East/West Spreader Canal Lands

The lower C-111 or ENP Eastern Panhandle basin is part of the Southeast Coastal Glades, which are underlain by a mixture of freshwater marls in the areas adjacent to the Coastal Ridge. This area is referred to elsewhere in this report as the east/west spreader canal lands. Near the coast, freshwater marls transition into marine marls (Leighty et al. 1954). Under natural conditions, the lower C-111 basin received the bulk of its runoff from the southern portion of the Atlantic Coastal Ridge. These surface and groundwater flows constitute the primary source of freshwater inflows to the northeastern portion of Florida Bay.

Today much of the southern Coastal Ridge has been developed, and a significant portion of this natural runoff has been diverted eastward into Biscayne Bay. In the mid 1960's, when the C-111 canal was constructed, it formed a breach between the Coastal Ridge and the marl prairies. This has allowed wet season runoff from northern Taylor Slough (and at times runoff from Northeast Shark River Slough) to be transferred into the lower C-111 basin. At the same time, the natural marsh sheetflow was altered by the lower C-111 levees impounding water to the north of the canal which led to overdrainage of the marshes south of the canal.

The southward diversion of runoff from the areas north of the Frog Pond increased freshwater inflows into the lower C-111 marshes and downstream Florida Bay during the 1980's, but the source of most of this water is drainage of the upstream wetlands (Northeast Shark River Slough and the Rocky Glades) within the Park. Thus, the water draining from these areas is transferred through the canal system and re-introduced into the wetlands at a lower point. Recent acquisition by the State of a large tract of the marsh lands north of the lower C-111 basin has led to increased pressure to reintroduce surface water inflows as far north as possible. This has the benefits of maximizing natural marsh sheetflow, and mitigating damaging freshwater releases into the downstream estuaries during periods of high wet season runoff.

SECTION 5
FORMULATION OF ALTERNATIVE PLANS
GENERAL REEVALUATION REPORT

5.1 FEDERAL OBJECTIVE

The Federal objective of water and related land resources planning is to contribute to national economic development (NED) consistent with protecting the nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements.

"Principles and Guidelines" published on 10 March 1983 (referred to as "P&G"), specify the rules to be followed by Federal agencies in planning water resources projects. P&G requires that *"the alternative plan with the greatest economic benefit consistent with protecting the Nation's environment (called the national economic development plan, or NED plan) is to be selected unless the Secretary of a department or head of an independent agency grants an exception when there is some overriding reason for selecting another plan, based upon other Federal, State, local and international concerns".*

Water and related land resource plans are to be formulated to alleviate problems and take advantage of opportunities that occur at the national, state and local levels in ways that contribute to the NED objective. The additional considerations of environmental quality (EQ), regional economic development (RED), and other social effects (OSE) are also evaluated. The environmental quality (EQ) account displays nonmonetary effects on significant natural and cultural resources. The regional economic development (RED) account registers changes in the distribution of regional economic activity that results from each alternative plan. The OSE account registers plan effects from perspectives that are relevant to the planning process, but are not reflected in the other three accounts.

Because of the environmental nature of this reevaluation report, the determination of an NED plan which is normally required for a flood damage prevention project, will not be accomplished within this report. An environmental restoration plan is presented which maintains the flood damage prevention for the study area.

5.2 PLANNING GOALS AND OBJECTIVES

The goal of this study is to formulate a plan of improvement that would restore more natural hydroperiods to Taylor Slough in Everglades National Park and the

lower section of C-111, and address flooding problems in the adjacent urban and agricultural areas of the basin in an acceptable and implementable manner.

The following planning objectives were established to address the problems and realize the opportunities identified in the C-111 basin and to serve as guidelines for the formulation and evaluation of alternative plans.

a. Restoration of historic hydrologic conditions in the C-111 basin,

b. Protection of natural values associated with the Everglades National Park,

c. Elimination of damaging freshwater inflows to Manatee Bay/Barnes Sound, and

d. Maintain flood protection for the C-111 basin, east of L-31N and C-111.

It is the policy of the Corps of Engineers to consider in the planning process all practicable and relevant alternatives applicable to sound water resources management. No one alternative is to be pre-judged superior to any other. The fundamental goal is to develop, define, and recommend a solution that has public and institutional support, that is engineeringly feasible and cost effective, and environmentally acceptable.

In this report, the recommended plan is the plan which provides the greatest flexibility to restore the ecological resources within the study area, and minimizes the economic impact to adjacent agricultural land use activities by maintaining flood damage protection.

5.2.1 Restoration of Historic Hydrologic Conditions

Restoration of natural hydrologic conditions in Taylor Slough requires satisfying four requirements: proper volumes, locations, timing, and suitable quality of water flows. This project addresses the reestablishment of more natural volumes, locations, and timing of water flows.

The headwaters and upper portions of Taylor Slough are of particular concern since they make up a large proportion of the original short hydroperiod wetlands remaining within ENP. Short hydroperiod wetlands in the Everglades represent the habitat type that has been most seriously degraded by construction of the water management features (see Tables 4-1 and 4-2). Reestablishing pre-project water levels and the gradual marsh wetting/drying patterns, particularly in the Taylor Slough headwaters and upper zones, is the most reliable way of restoring the natural timing and distribution of sheet flows throughout Taylor Slough.

Figure 5-1 is a schematic diagram of the surface water and groundwater conditions along a transect from the Rocky Glades to Florida Bay (Van Lent and Johnson 1993). It graphically illustrates why it is important to restore natural water levels along the ENP boundary, particularly in the headwaters zone. Restoration of water levels in this area will also lead towards restoration of significantly increased overland sheet flows to the lower portions of Taylor Slough.

An important step in recreating natural marsh habitat is managing water levels to behave in harmony with south Florida's seasonal and annual rainfall variations. Water level fluctuations along the ENP boundary and discharges into ENP must directly correspond to rainfall patterns in the basin.

Restoration of the historic water delivery volumes is important to creating healthy marsh conditions. Optimal utilization of the rainfall runoff in the C-111 basin (south of S-331) is critical for hydrologic restoration. Operational studies to be conducted subsequent to this report will address further enhancing project benefits through inter-basin transfers of supplemental water.

5.2.2 Protection of Natural Values

The primary goal of creating more natural hydrologic conditions in Taylor Slough and the C-111 basin is to restore the historic diversity and abundance of native Everglades flora and fauna.

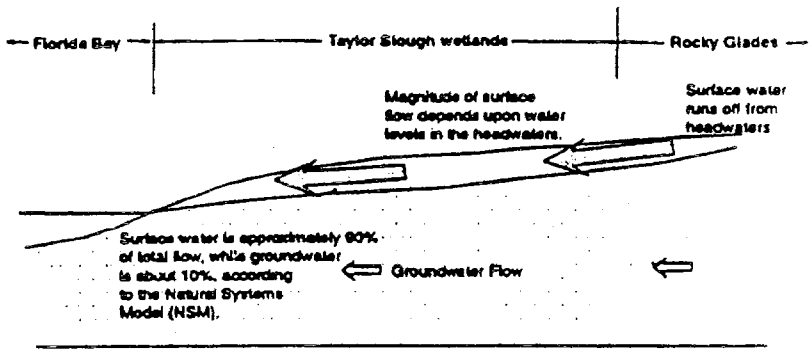
5.2.3 Eliminate Damaging Freshwater Discharges to Manatee Bay/ Barnes Sound

As discussed in Section 4.2.2, the earthen plug adjacent to the S-197 culverts was removed on five occasions. The most recent removal was in 1988 which caused the salinity in Manatee Bay to drop from 20 ppt to a low on only about 1 ppt. The salinity in Barnes Sound declined to about 15 ppt. A massive die-off of flora and fauna occurred in Manatee Bay and Barnes Sound. Also discussed in Section 4.4.2, the earthen plug has been replaced with 10 culverts by the SFMWD in 1990. In 1992, all 13 culverts were opened and no major damage was recorded.

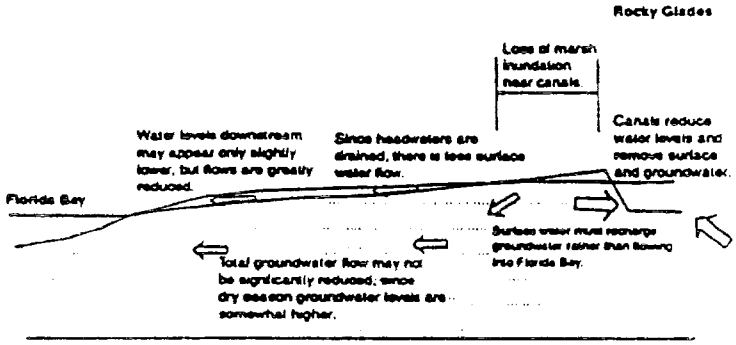
The goal of this objective is to reduce the number of occurrences of major releases at S-197. Additionally, daily flows could be diverted, if available and desired, to the marsh east of C-111.

5.2.4 Maintain Flood Protection

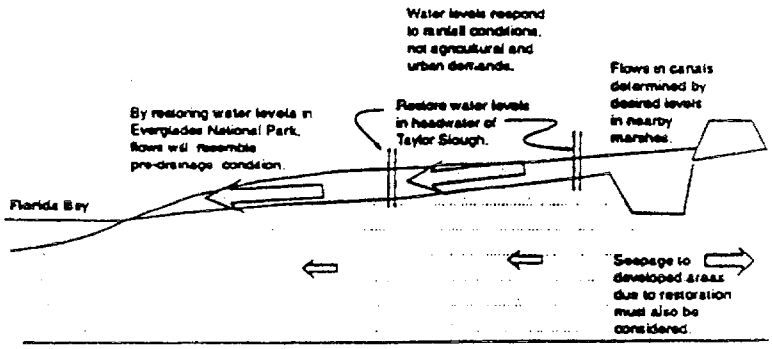
An objective of this project is to preserve the existing level of flood protection for agriculture in the C-111 basin east of L-31N and C-111. Original project canal



(a) Pre-drainage Condition



(b) Drained Condition



(c) Restored Condition

FIGURE 5-1 Restoring water levels in overdrained areas is the key to reestablishing historical flow patterns.

operating levels and structure discharge capacities were intended to provide flood protection for storms up to 40 percent of the Standard Project Flood. This objective involves maintaining the original design canal stages and discharge capacities while restoring more natural hydrologic conditions within ENP.

5.3 PLANNING CONSTRAINTS

While the planning objectives describe the goals of the study, there are certain limitations which must be considered in evaluating any plan for possible implementation. A primary planning constraint within this study is the development of an implementable water management plan which provides both flood damage protection and environmental restoration within the study area.

Since 1988, there has been growing evidence of environmental problems in Taylor Slough and Florida Bay. These problems have been attributed, at least in part, to the operation of the water management system. Because of these concerns, a plan of action has been developed that will enable a timely solution to these problems; thereby minimizing additional degradation. This plan of action calls for separating consideration of structural and operational modifications. This GRR addresses structural modifications to the water management system that will enable greater operational flexibility. Evaluation of the structural plans contained in this report are based on continued use of the existing operating guidelines. Subsequent studies will develop an operating plan that will optimize environmental benefits of the recommended plan.

5.4 PROJECT OPERATIONS FOR ALTERNATIVE PLANS

All alternatives addressed in this report are evaluated using the design operating criteria for flood control and water supply. In order to satisfy the project objective of preserving agricultural flood protection in the C-111 basin, all existing canals and structures are evaluated based on maintaining design optimum canal stages under flood conditions. Furthermore, during drought, supplemental water deliveries are made in accordance with the design operations. The specific design operating criteria are described in detail in Section 2.2.

No additional inter-basin transfers of supplemental water from upstream are made as a part of the operation of any alternatives. Water deliveries to ENP are made when flood control discharges are necessary or in accordance with minimum delivery requirements of PL 91-282. Supplemental water deliveries are made into the C-111 basin only during drought conditions when canal levels drop 1.5 feet below the optimum levels. These deliveries are made to maintain canal stages and are not discharged into Taylor Slough.

Studies will be conducted for the recommended plan during the design and construction phase to identify the optimum operating strategy for C-111 and the Modified Water Deliveries to ENP Projects. The components of the alternative plans are designed so that the design discharge capacities of the various canal segments are maintained for flood control. The critical issues for restoring water flows to Taylor Slough require maintenance of normal day to day discharges and water levels in the proper locations, with the proper timing. The discharge capacity of a system designed for flood control will also have adequate capacity to pass the historic volumes of water. However, the structural system must also be designed to accomplish the remaining hydrologic objectives related to timing and location of water deliveries to Taylor Slough.

5.5 EVALUATION FACTORS

In order to accomplish the goals and objectives of this study, the following evaluation factors will be utilized. These factors are not considered all inclusive.

a. Operational flexibility of the proposed plan of action

b. Cost effectiveness of the plan

c. Environmental benefits

d. Economic evaluation of flood control impacts

5.5.1 Operational Flexibility

The following evaluation criteria are utilized to demonstration each alternative's effectiveness at providing operational flexibility:

a. Maintain natural (higher) water levels along the ENP boundary at the headwaters and upper portion of Taylor Slough

b. Provide ability to control the discharge of water uniformly into the headwaters, upper, and middle portions of Taylor Slough

c. Provide the ability to control the timing of water discharges into the headwaters, upper, and middle portions of Taylor Slough

d. Provide the capacity to restore more natural water flows through the east/west spreader canal

e. Minimize the need for flood control discharges to Manatee Bay/Barnes Sound

f. Enable uniform sheetflow into the lower portion of Taylor Slough

g. Increase hydroperiods in the headwaters and upper portions of Taylor Slough

h. Increase average water depths in the headwaters and upper portions of Taylor Slough.

i. Maintain flood control for the area east of L-31N and C-111.

5.5.2 Cost Effectiveness

Cost effectiveness is evaluated by comparing the total project costs of alternatives that meet the project objectives.

5.5.3 Environmental Benefits

The following evaluation criteria are utilized to demonstrate each alternative's effectiveness at providing environmental benefits:

a. Recreate hydrohabitat units that are closer to historic levels. Hydrohabitat units are a measure of hydrologically modeled outputs of alternatives relative to historic conditions deduced from marl measurements. They depict how well an alternative's hydrology supports the natural values associated with the sawgrass-on-marl ecosystem.

b. Recreate species compatibility indices that are closer to historic levels. These indices are founded on hydrologic habitat criteria defined by ENP staff as favorable to selected indicator species.

5.5.4 Flood Control Economic Impacts

Flood damages reduction benefits are compared with the no-action plan.

5.6 ALTERNATIVES

5.6.1 Background

From 1983-1988 a Supplemental GDM was prepared. The purpose of the study was to complete the authorized plan of improvement for flood control, environmental enhancement and water management in the C-111 basin as constructed in the 1960's. The recommended plan focused on preventing large, damaging discharges to Manatee Bay/Barnes Sound via S-197 and to increase flows to northeast Florida Bay via flows

from lower C-111. Details of the plan formulation from this 1988 report are included in Appendix F.

Following completion of the 1988 Supplemental GDM discussed above, the Jacksonville District worked with the staff of the SFWMD and the ENP, to develop plans which would solve problems inherent with the uncompleted project, and the need to improve the area's water management system to meet the study objectives.

In 1990, preliminary plans were coordinated with the SFWMD and the ENP as discussed below. From 1990 to 1992, the Corps utilized an older version of the South Florida Water Management 1x1 Model to evaluate these preliminary alternatives. In order to prepare a Fish and Wildlife Coordination Act Report more detailed hydrologic analysis of the ecosystem was required. With this hydrologic data, the staff of the Everglades National Park was to assess the impacts of proposed alternatives on key ecological, hydrological and biological components, including endangered species, in the C-111 and Taylor Slough basins, northeastern Florida Bay, Manatee Bay, and Barnes Sound. These assessments were to compare the impacts of the alternatives to ecological restoration of the study area. The data produced by ENP was to be utilized by the U.S. Fish and Wildlife Service to prepare a Fish and Wildlife Coordination Act Report.

As originally planned, ENP studies to be utilized in the GRR would have included data collection, development of several species models, and use of the models to evaluate alternatives. This evaluation would have included both structural and operational plan components. However, these studies would have extended the study duration by more than 1 year. Therefore, early in 1993, a decision was made in consultation with SFWMD and ENP to formulate a recommended structural plan. It was also agreed to develop a plan for the operation of the project during design and construction. ENP studies that are underway will be utilized in the operational studies. This strategy enables the most timely resolution of the ecosystem degradation problems in Taylor Slough and Florida Bay.

5.6.2 Preliminary Alternatives

From 1990 to 1992 meetings were held between the agencies participating in the study, to narrow the list of alternative plans and to focus on a solution to the water resources problems within the C-111 basin. These preliminary plans were modeled using the older version of the South Florida Water Management Model 1x1 at the design optimum base condition prior to the interim tests and also with what is considered to be the current condition (prior to the June 1993 test). A description of the plans is provided in the following section of this report.

5.6.2.1 Alternative A

Alternative A as shown in Figure 5-2 includes the diversion of excess floodwater to Taylor Slough and to the C-111E basin. S-174 and the L-31W borrow canal would be enlarged to enable the diversion of an additional 500 cfs to Taylor Slough. S-332 would be enlarged to pass the first 500 cfs of flow and the remainder would be discharged southward via the existing S-175. A new east/west canal would be constructed from C-111E (just north of its intersection with C-111) to US Highway 1. A new pump station would also be constructed to pump excess floodwater from C-111 into the new canal. Water would overflow the canal banks and would sheetflow southward across the southern C-111E basin. The C-111E land area that would be impacted is currently owned by SFWMD. Existing culverts through the north levee along C-111 would pass water southward across C-111 and into ENP. The south C-111 levee between S-18C and S-197 would be removed as a part of this plan to facilitate southward flow.

5.6.2.2 Alternative B

Alternative B as shown in Figure 5-3 includes all of the features of alternative A, but would also include a new canal connecting C-111 (just north of S-177) to the L-31W borrow canal just south of S-175). The purpose of the canal would be to enable additional diversion of excess water to ENP. A determination would be made as to whether a structure in the canal would be required.

5.6.2.3 Alternative C

Alterative C as shown in Figure 5-4 would include all of the features of alternative A, and a new structure between S-18C and S-197. The purpose of the structure would be to hold higher upstream water levels to force more flow into ENP from the western portion of this canal section. Currently, the vast majority of flows to ENP are from the east end of the canal section near S-197.

5.6.2.4 Alternative D

Alternative D as shown in Figure 5-5 is identical to alternative A except that S-197 is never opened.

5.6.2.5 Evaluation of Preliminary Alternatives

As the preliminary alternatives were being evaluated, the project objectives were also being more clearly defined. Consequently, none of the plans were formulated to fully met the current objectives. ENP evaluations of the impacts of seepage from the headwaters and upper portions of Taylor Slough into the L-31N borrow canal emphasized the importance of restoration of these areas to the all of

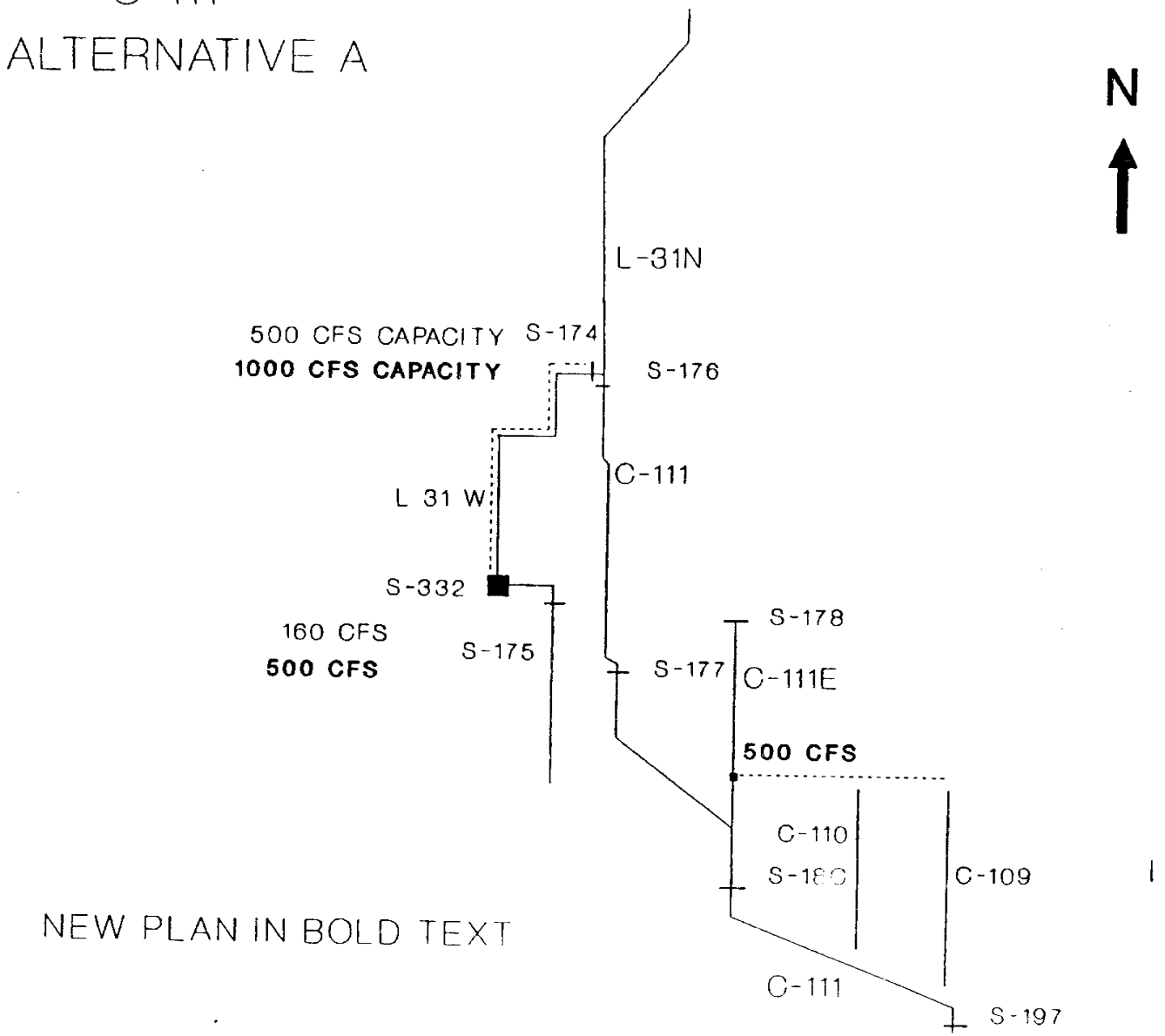

C-111
ALTERNATIVE A
N
L-31N
500 CFS CAPACITY
S-174
1000 CFS CAPACITY
S-176
C-111
L 31 W
S-332
160 CFS
500 CFS
S-175
S-178
S-177
C-111E
500 CFS
C-110
S-18C
C-109
C-111
S-197
NEW PLAN IN BOLD TEXT

FIGURE 5-2

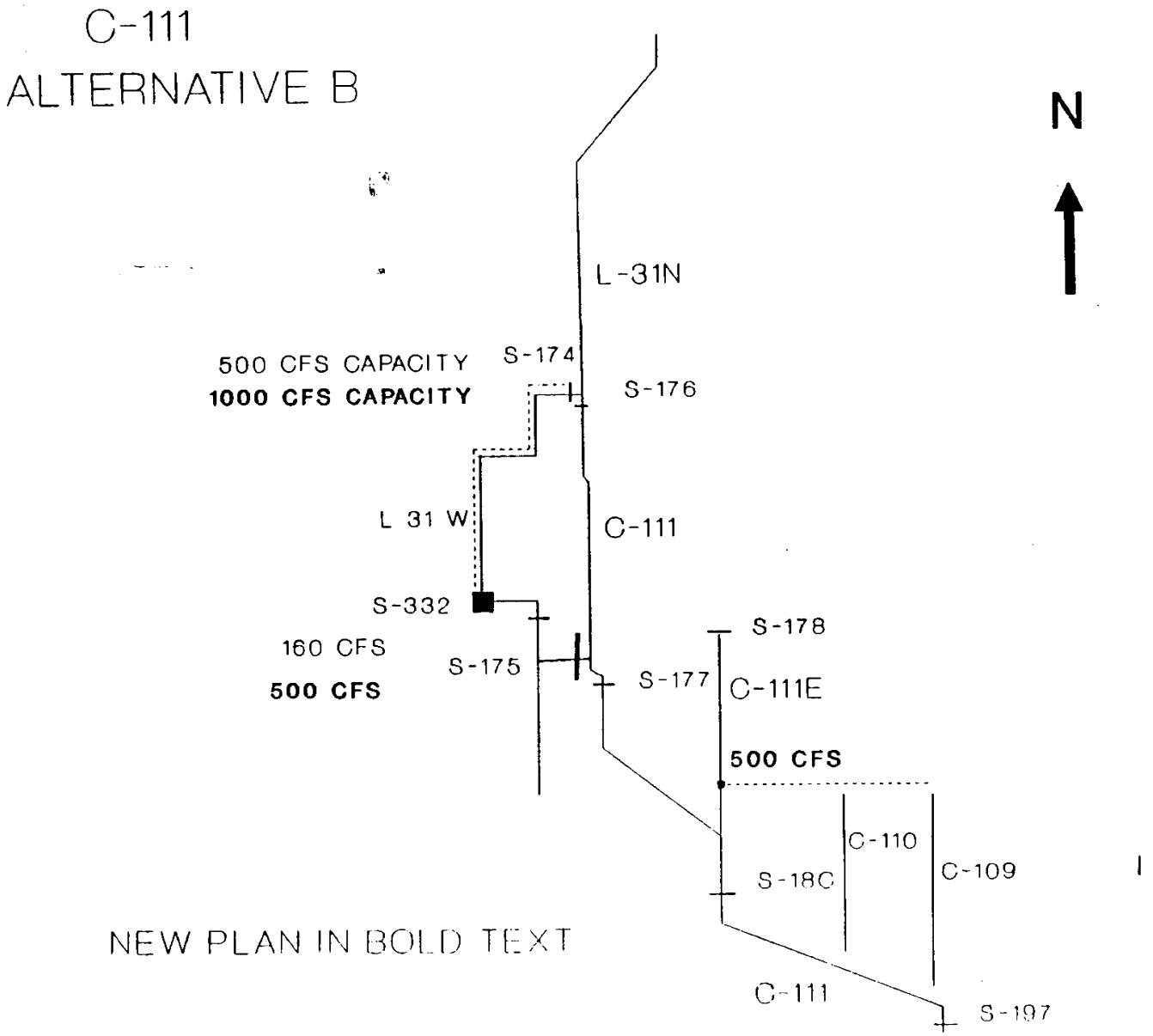

C-111
ALTERNATIVE B
N
L-31N
500 CFS CAPACITY
1000 CFS CAPACITY
S-174
S-176
L 31 W
C-111
S-332
160 CFS
500 CFS
S-175
S-177
S-178
C-111E
500 CFS
C-110
C-109
S-18C
NEW PLAN IN BOLD TEXT
C-111
S-197

FIGURE 5-3

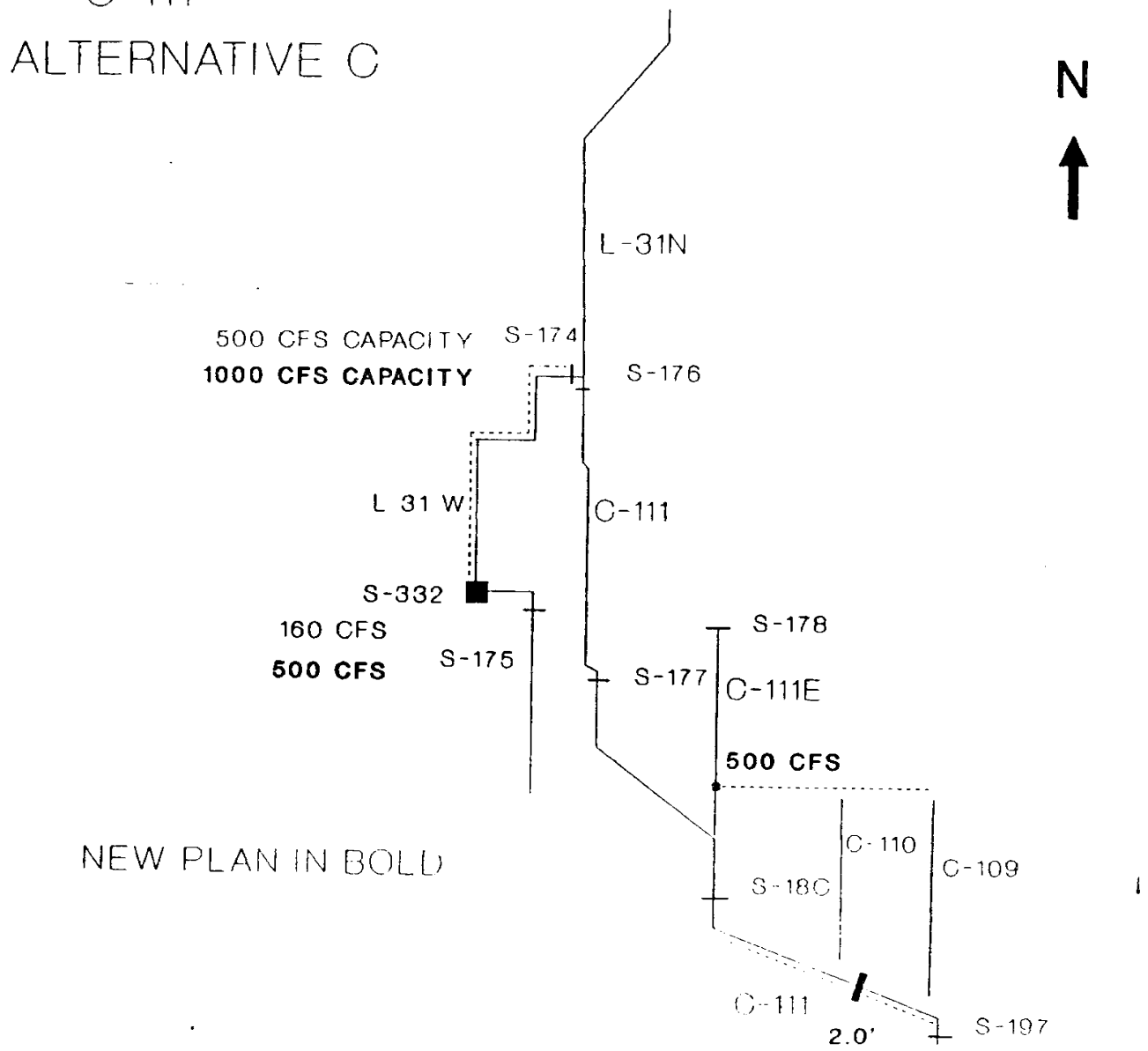

C-111
ALTERNATIVE C
N
L-31N
500 CFS CAPACITY
1000 CFS CAPACITY
S-174
S-176
L 31 W
C-111
S-332
160 CFS
500 CFS
S-175
S-178
S-177
C-111E
500 CFS
C-110
C-109
S-18C
NEW PLAN IN BOLD
C-111
2.0'
S-197

FIGURE 5-4

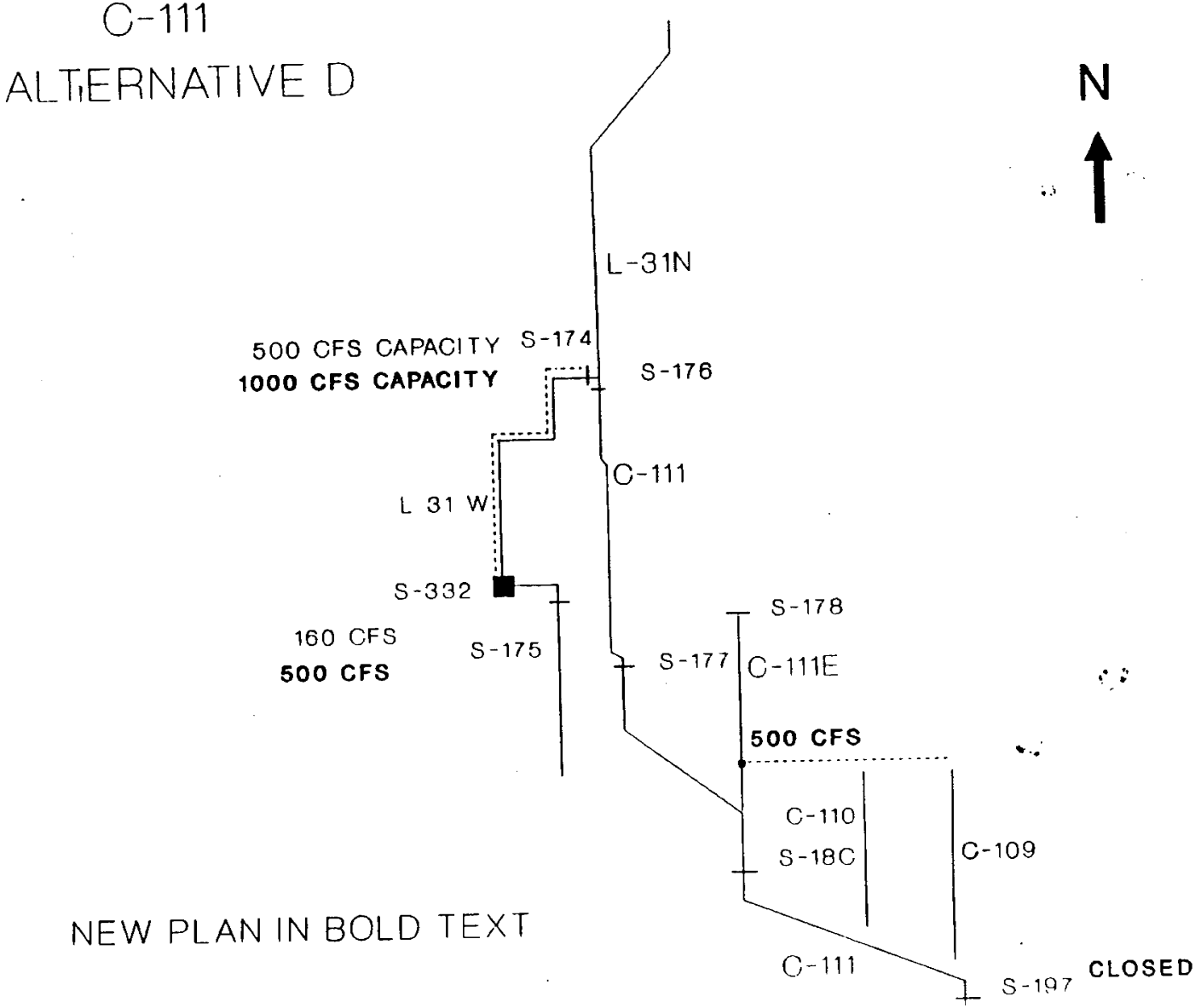

C-111
ALTERNATIVE D
N
L-31N
500 CFS CAPACITY
1000 CFS CAPACITY
S-174
S-176
C-111
L 31 W
S-332
160 CFS
500 CFS
S-175
S-178
S-177
C-111E
500 CFS
C-110
S-18C
C-109
C-111
S-197
CLOSED
NEW PLAN IN BOLD TEXT

FIGURE 5-5

Taylor Slough. In later phases of plan formulation, this became a major objective of hydrologic restoration.

All of the plans provided structural modifications that would restore large flows to the middle portion of Taylor Slough. All of the plans would provide alternative discharge capacity of floodwaters that would reduce the need for S-197 discharges to Manatee Bay/Barnes Sound. All of the plans would maintain flood protection in the C-111 basin. Also, all of the plans would provide for restoration of natural flows through the SFWMD wetlands east of C-111. However, the plans would maintain the L-31N borrow canal as the border between the ENP and agriculture. As a result, there would be continued groundwater seepage from the headwaters and upper portions of Taylor Slough into the canal. None of the plans provided a mechanism for reestablish of the natural timing and location of discharges to the headwaters and upper portions of Taylor Slough.

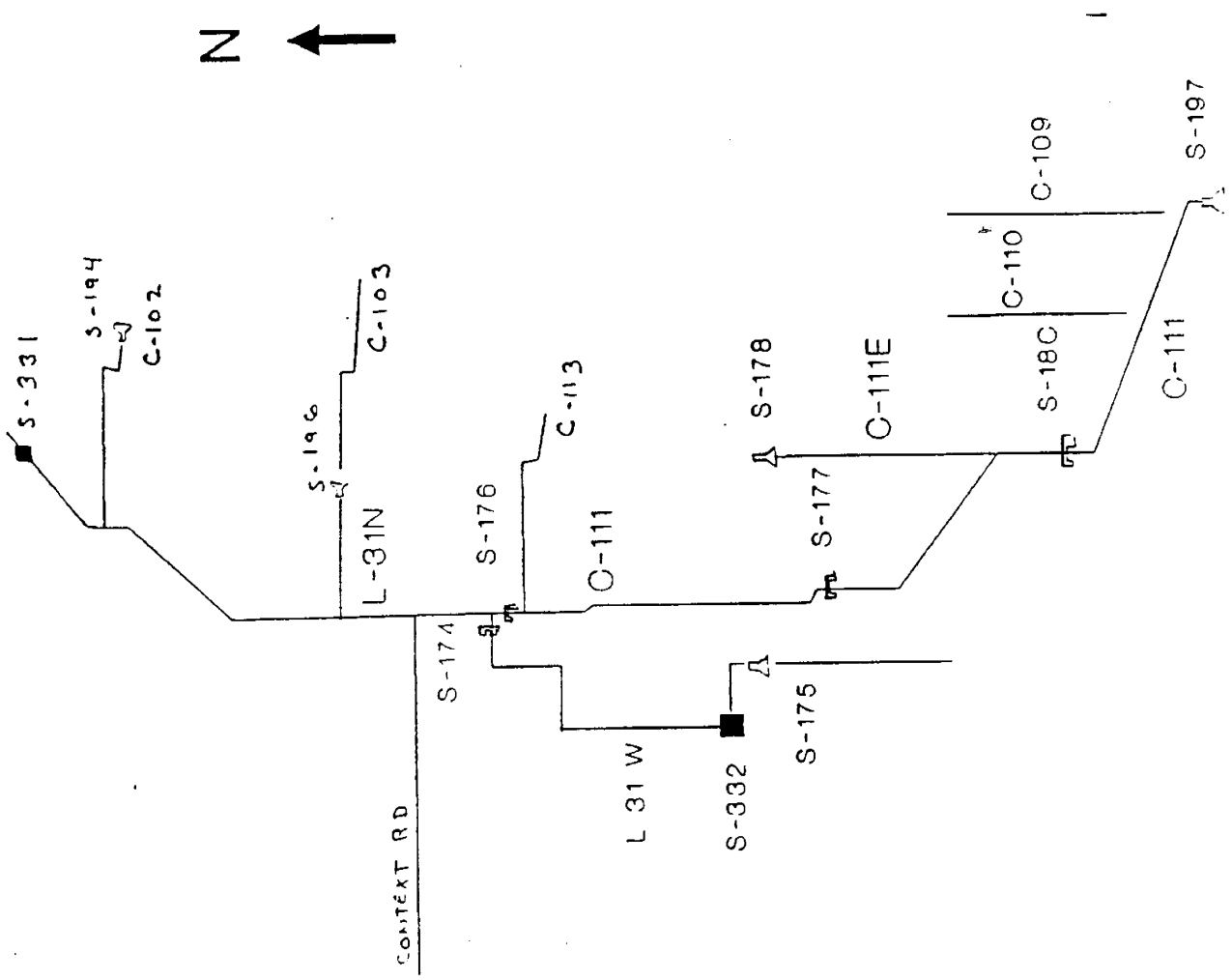
5.6.3 Refined Preliminary Plans

In March 1993, the Corps met with the SFWMD and the ENP to formulate new, more comprehensive alternatives to solve the problems identified within the C-111 basin. The objective of the meeting was to scope various alternatives which would provide full restoration to that portion of the Everglades National Park adjacent to the C-111 study area, while maintaining the overall objectives of the reevaluation report. A total of twelve conceptual project components were proposed. Five alternative plans were formed by combinations of the various plan components. These alternative plans are discussed below. Additional features including a low flow pump at Context Road to rehydrate upper Taylor Slough, and the enlargement of Loveland Slough to provide additional water to the east-west spreader canal area were also discussed as possible measures for evaluation.

5.6.3.1 Plan 1

This was considered a non-structural plan which called for only operational changes to system management. The project would be operated to maintain the design optimum conditions as described in Section 2.2.1.2. This plan is shown in Figure 5-6.

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. Optimum water levels in the project canals are periodically adjusted based on operating experience, changed land uses and to better meet project objectives and changing conditions.



PLAN 1
C-111

FIGURE 5-6

5.6.3.2 Plan 2

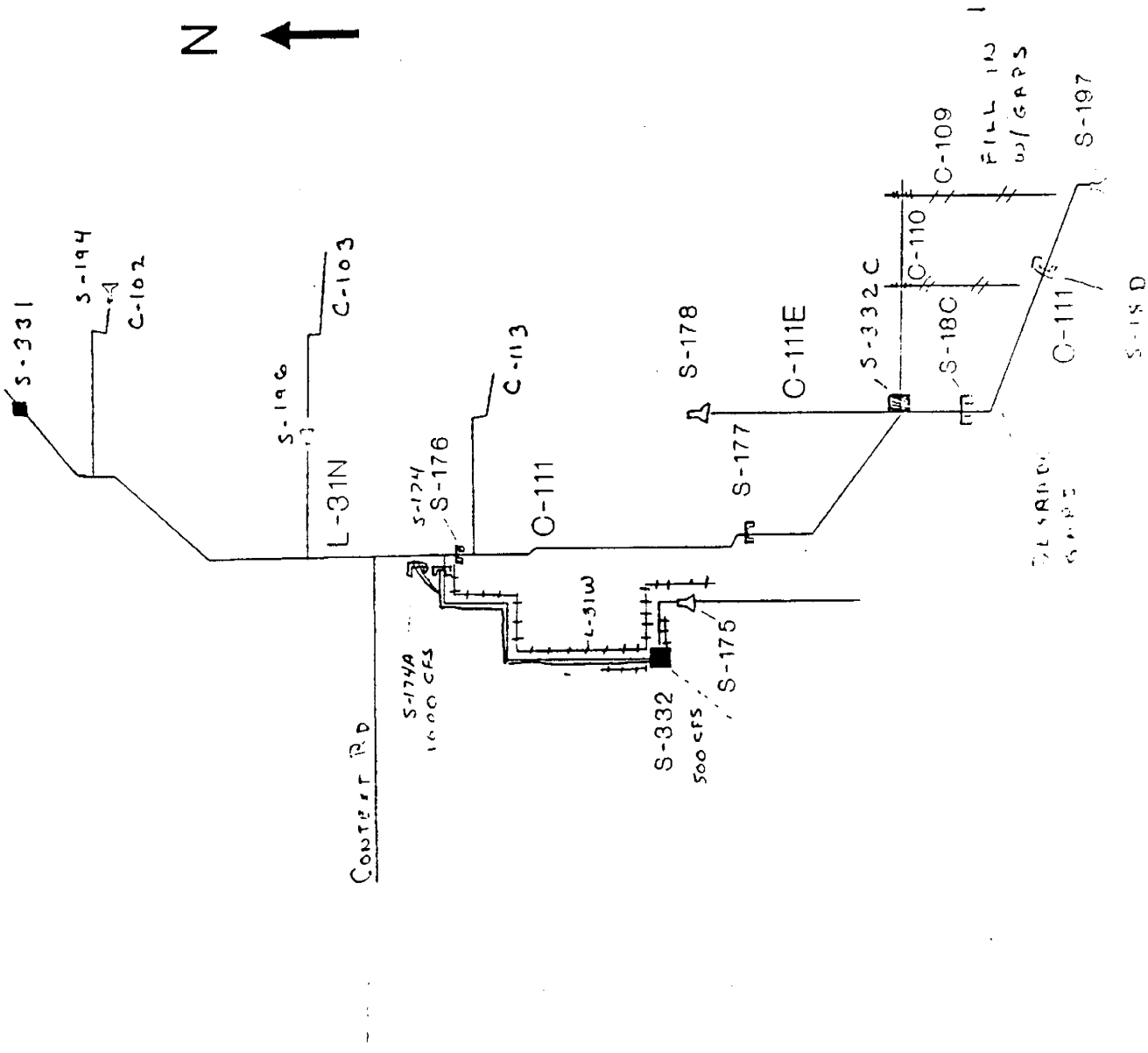
Plan 2 would similarly maintain the design optimum canal stages, however structural modifications are proposed to provide flow to Taylor Slough. This plan has been subdivided into plans 2A and 2B which increase capacities of pump structures S-332, and S-174. Both plans call for the construction of an East-West spreader canal,and a 2-mile trapezoidal channel just south of Context Road. Also contained in both plans is a trapezoidal canal through Loveland Slough which will include a new gravity flow structure designed to pass 500 cfs. This plan would remove structure S-178. Details of plans 2A and 2B are shown in Figure 5-7 and Figure 5-8, respectively.

5.6.3.3 Plan 3

Plan 3, as with plan 2, maintains design optimum canal stages and calls for structural modifications for improved water deliveries. This plan, however, includes acquisition of the western Frog Pond. As with plan 2, plan 3 includes the East-West Spreader Canal, the Context Road Channel, and the Loveland Slough Canal. Plan 3 has also been subdivided into plans 3A and 3B which assess 500 cfs and 1,000 cfs structure capacities, respectively, associated with a new canal from L-31N to L-31W just north and west of structure S-174. Plans 3A and 3B would fill L-31W north leg, and east of structure S-332. The S-332 pumps would be removed. Plans 3A and 3B are shown in Figure 5-9 and Figure 5-10, respectively.

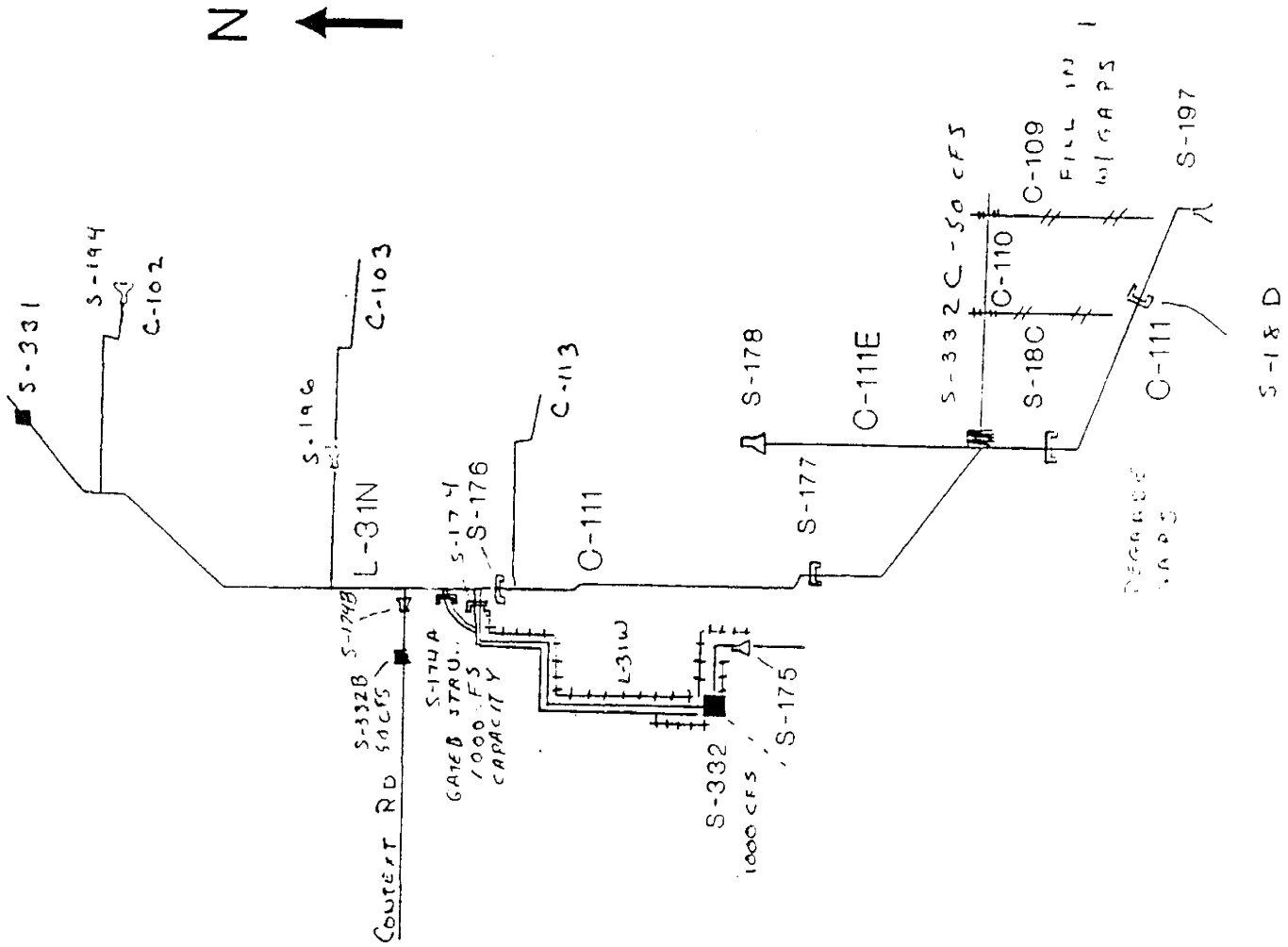
5.6.3.4 Plan 4

Plan 4 as shown in Figure 5-11 includes the construction of a surge pool on the east side of the Frog Pond. Culverts would pass flows from the surge pool into and out of the Frog Pond. Also included in this plan is a 1630 cfs pump station at S-174, and a new structure between S-18C and S-197. Levees downstream of C-111E would be degraded. It is expected that ground water in the surge pool would flow east into C-111, possibly adversely affecting the current levels of flood damage reduction provided to the agricultural area east of C-111 and the Frog Pond.



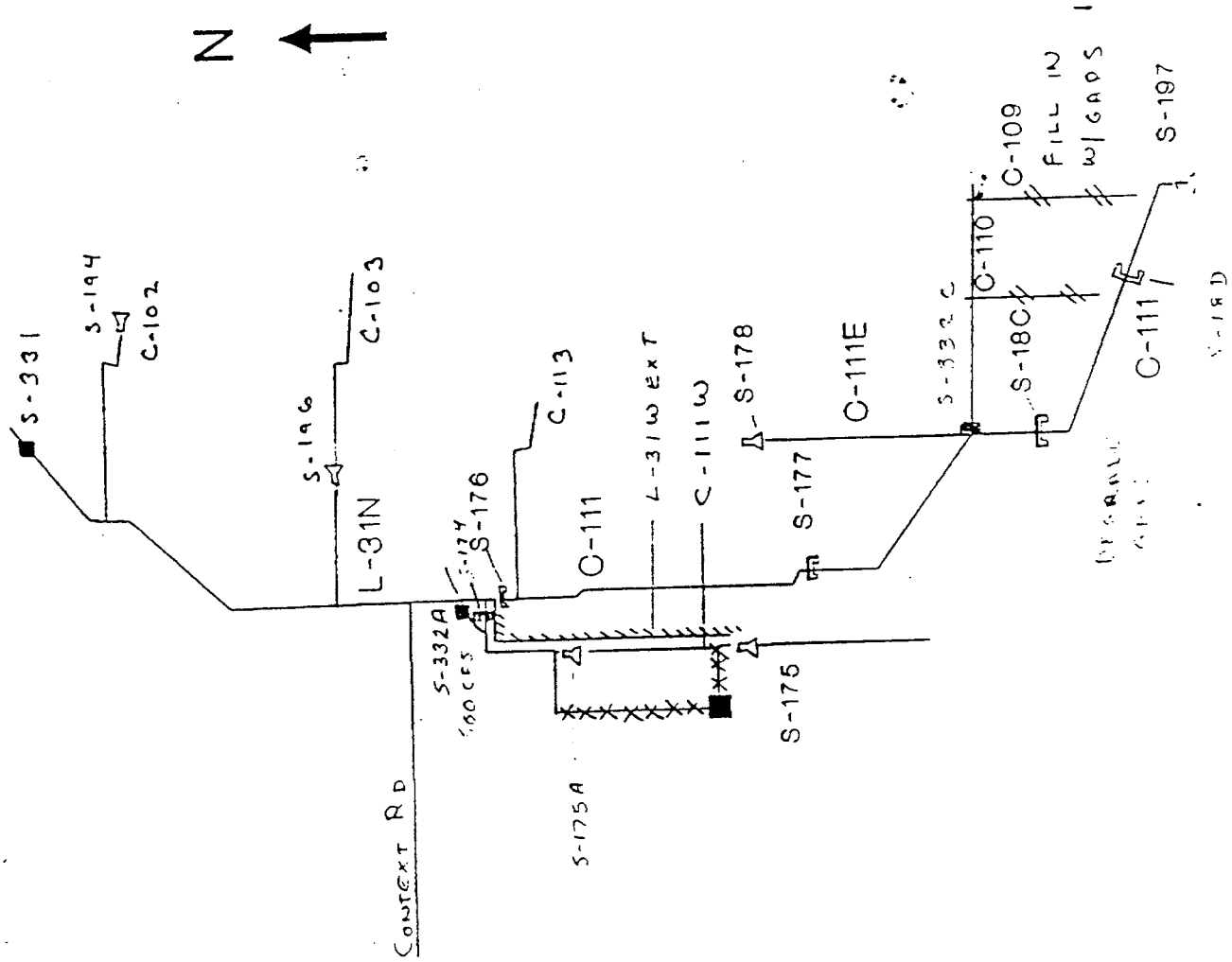
PLAN 2A
C-111

FIGURE 5



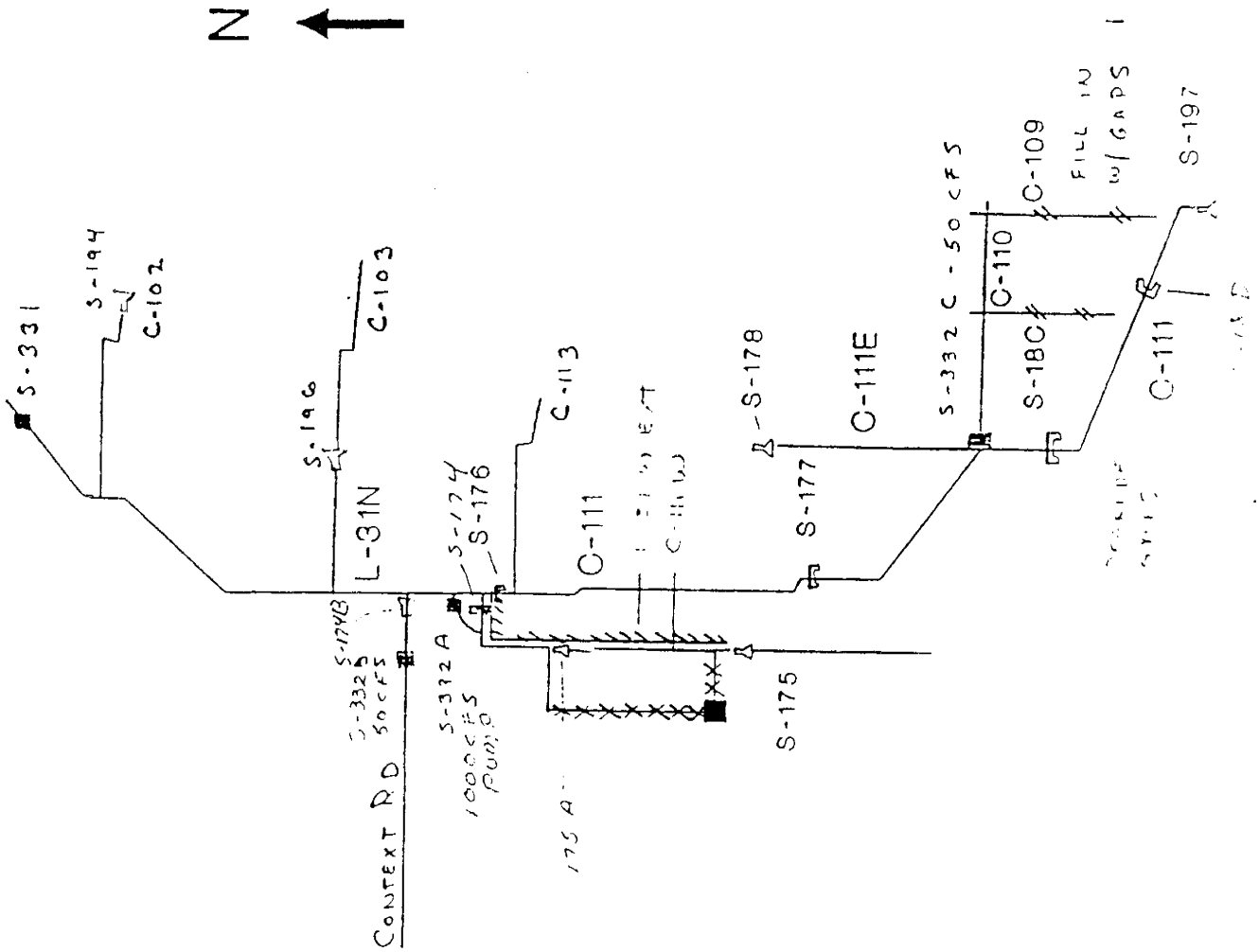
PLAN 2
C-111

FIGURE 5-8



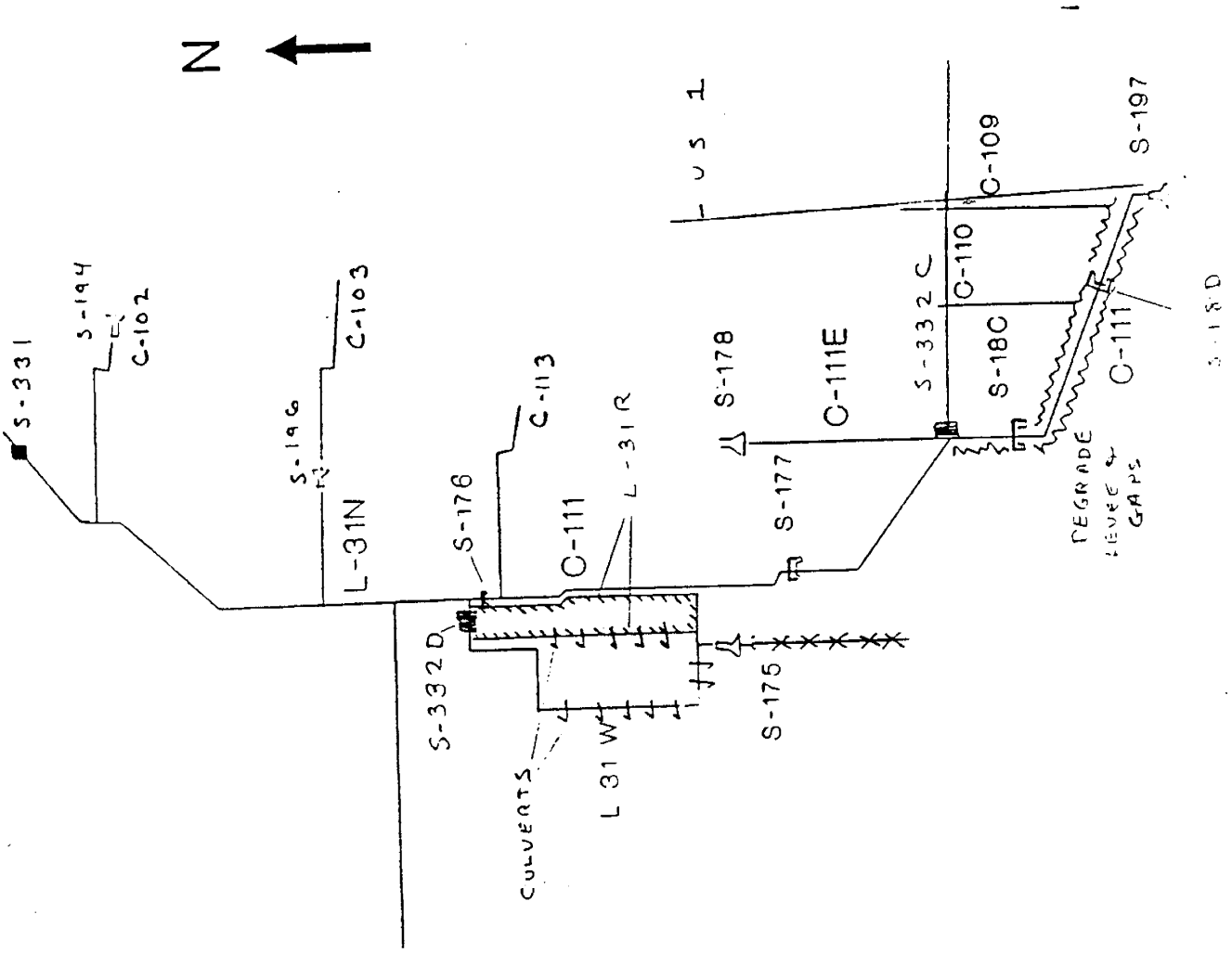
PLAN 3A
C-111

FIGURE 5



PLAN 3b
C-111

FIGURE 5-10



PLAN 4
C-111

FIGURE 5-11

Table 5-1
Refined Preliminary Alternatives

	ISSUES AND CONCERNS						
Plans	Operational Flexibility	"Full" Restoration	Reduced Flow to Manatee Bay/Barnes Sound	Cost (Lands)	Cost (Construction)	Flood Control	Florida Bay Improvement
1	0	+	0	+	+ +	-	+
2A	+	+	+	+	-	+	+
2B	+	+	+	+	-	+	+
3A	+	+	+	-	=	+	+
3B	+	+	+	-	=	+	+
4	+	+	+	-	=-	?	+
5	=	+ +	+ +	= =	-	0	+
Context Road	+	+	+	-	-	+	+
Loveland Slough	+	0	0	-	-	+	+

LEGEND:

+ Good

- Bad

0 No Change

5.6.3.5 Plan 5

Plan 5 as shown in Figure 5-12, is the "Full Restoration" plan and returns the system back to natural conditions. This plan would cease operations of existing structures and backfills all canals below structure S-331. Canals C-102, 103, and 113 would be backfilled in those portions west of the divide structure. This plan basically eliminates the means to provide water conveyance for any purpose.

5.6.3.6 Evaluation

The group members at the March 1993 meeting rated the alternatives in terms of issues and concerns and this is presented in Table 5-1. No firm data existed for the alternatives, but experience working in the area was utilized for the analysis. Other additional alternatives were added as shown in Figure 5-13, like Loveland Slough bypass and a low flow pump at Context Road. Loveland Slough was dropped from consideration since there was concern over future operating criteria that would flood agricultural interests adjacent to the slough and there was no support.

Issues and concerns were items that the group decided would be important to the overall selection of a plan. These areas were: operational flexibility, full restoration, minimum flow to Manatee Bay/Barnes Sound, the cost of lands, cost of construction, flood control and Florida Bay improvements.

Operational flexibility was used in terms of movement of flood water or minimum deliveries to various parts of the basin. Full restoration was the idea of what the Everglades system was considered to be like before the C&SF canals were constructed. Reduced (minimum) flow to Manatee Bay/Barnes Sound was addressed through the operation of S-197. The cost of lands were considered due to the large areas which would be required as a project cost. The cost of construction is always considered and is usually proportional to the scope of construction features included in the plan. Flood control was evaluated for neighboring agricultural activities. Florida Bay was not a direct objective to the study, however, the restoration of more natural fresh water flows Taylor Slough and C-111 would eventually benefit Florida Bay.

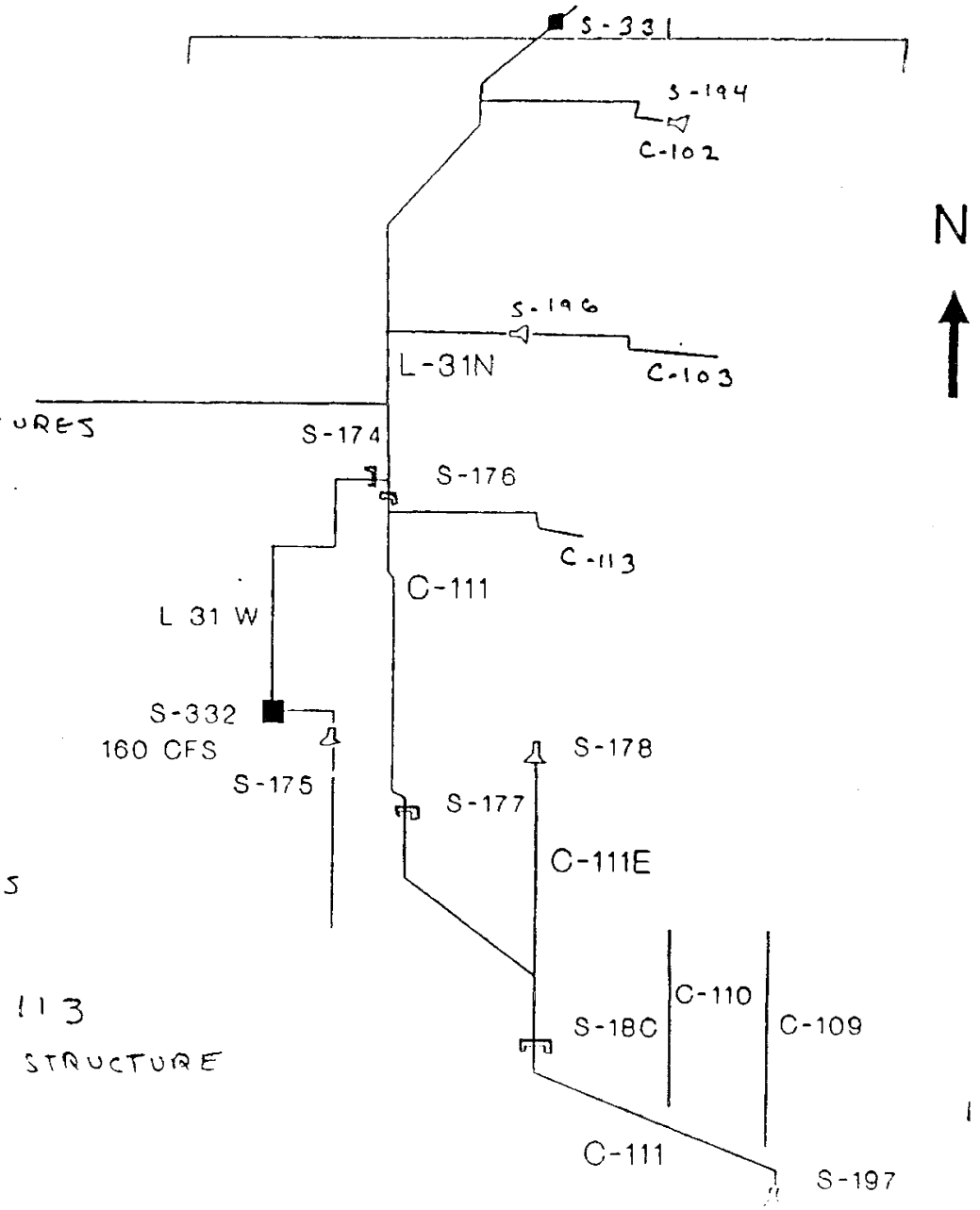
The team members subsequently consulted with their respective offices to arrive at a consensus on the final array of plans to be evaluated. As a result of this consensus, plan 1 was designated as the "no-action" plan as it consisted of no structural modifications. Plan 2A was dropped in favor of plan 2B, since plan 2B provided more capability of fresh water to Taylor Slough than plan 2A. Plan 3B was chosen over plan 3A for the same reason as plan 2B over 2A. Plan 4 was retained for further study. Plan 5 was dropped since this plan ceases all operations of structures and fills in all the canals, and basically eliminates any means to provide any additional water.

1. NO OPERATION OF STRUCTURES

S-174	S-18C
S-175	S-194
S-176	S-196
S-177	
S-178	
S-197	

2. BACKFILL ALL CANALS below S-331.

3. BACKFILL C-103, 102, 113 WEST OF DIVIDE STRUCTURE



PLAN
C-111

FIGURE 5-12

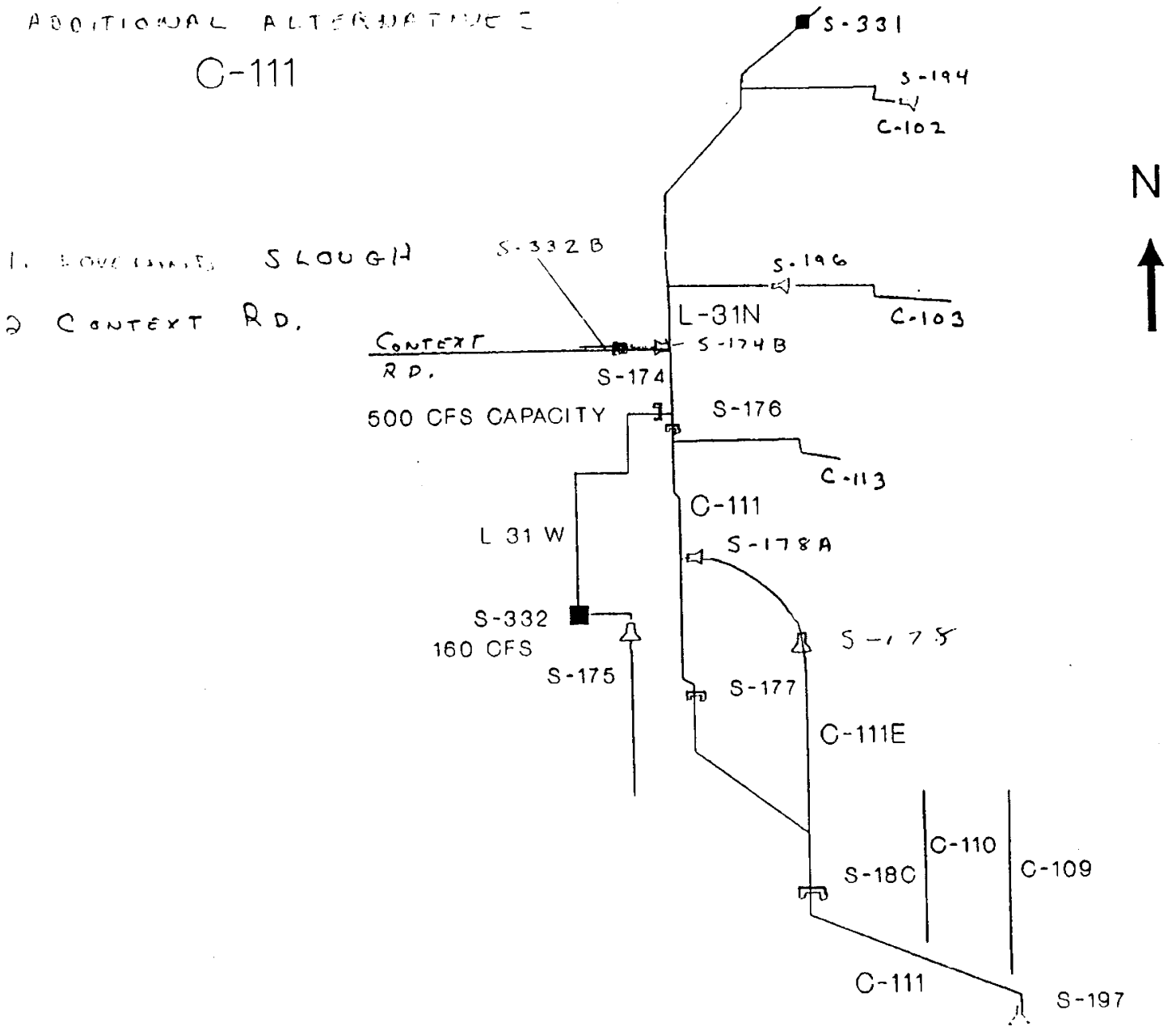

ADDITIONAL ALTERNATIVE 2
C-111
1. [illegible] SLOUGH
2 CONTEXT RD.
S-331
S-194
C-102
N
S-332B
S-196
L-31N
C-103
CONTEXT RD.
S-174B
S-174
500 CFS CAPACITY
S-176
C-113
C-111
L 31 W
S-178A
S-332
160 CFS
S-175
S-175
S-177
C-111E
C-110
S-180
C-109
C-111
S-197

FIGURE 5-13

5.6.4 Final Alternatives

The final array of alternatives evolved through further discussions with study participants. Preliminary alternative plans were reassessed and modified for evaluation as a means of selecting a recommended plan of action to meet the study objectives. For the final assessment, plan 1 became the "no action" alternative, plan 2B became alternative 1, plan 3B became alternative 2, and plan 4 became alternative 3. Minor modifications deleted the structure on the lower end of C-111 in alternative 1 and 2, due to cost. The staff at the ENP recommended another plan, alternative 4, and the staff at the SFWMD recommended another plan, alternative 5. Additional refinements were made to alternative 4 to produce alternative 6 and alternative 1A is a refinement of alternative 1.

Alternative 8 was recommended for consideration by ENP as a result of their evaluation of hydrologic impacts of alternatives 1 through 7 (see Annex F). Alternative 7 is a modification of alternative 1 and has been renamed alternative 1A. Alternative 6A was developed as an refinement of alternative 8. Alternative 9 was added at the suggestion of south Dade County agricultural interests.

These plans were modeled using the most current version of the South florida Water Management Model (SFWMM) one mile by one square mile model with the existing canals and structures operating at the design optimum level prior to the interim tests. Pumping rates for the West Dade Wellfields were assumed at 40 million gallons per day and applied to the program. The final alternatives are discussed in the following paragraphs. All alternatives wee designed to provide approximately the same level of flood protection.

5.6.4.1 "No Action" Alternative

The "no action" alternative would consist of reverting back to the minimum delivery schedule. That is: discontinue the experimental deliveries to Northeast Shark River Slough, return to the minimum delivery schedule for deliveries to ENP, and return canal stages to their optimum design levels. The ENP and other resources agencies have determined that detrimental impacts to the ecosystems of the ENP have occurred as a result of the minimum water delivery schedule.

This alternative is the same as the future "without project" condition. It is also referred to as the base condition.

5.6.4.2 Alternative 1

The objective of alternative 1 as shown in Figure 5-14, is to put as much water as possible into Taylor Slough while avoiding impacts to the agricultural areas in the Frog Pond. A new canal, designated Context Road Canal, and a new pump station,

S-332B, would be located upstream of S-176 and west of L-31N borrow canal. The 50 cfs pump station would divert water from L-31N borrow canal to Context Road canal. Water would sheet flow from the Context Road canal southward into the headwaters of Taylor Slough and to Everglades National Park. This was intended to address the project objective of restoring natural hydrologic conditions in the headwaters and upper portions of Taylor Slough.

Adjacent to existing S-174, a new, slide-gated structure designated S-174A would provide for a combined discharge to L-31W borrow canal of 1,500 cfs. The L-31W borrow canal capacity would be increased to convey 1,500 cfs to S-332. S-332 would be enlarged to a pump station consisting of six pumps with a total discharge capacity of 1,000 cfs. Tieback levees adjacent to S-332 would prevent flow back into L-31W. A discharge channel on the downstream side of S-332 would provide conveyance away from the pump. These project features were intended to address the project objective of maintaining flood control by providing additional outlet capacity of flood waters into Taylor Slough. They also apply toward the project objective of restoring more natural flows to the middle portion of Taylor Slough.

A new canal would be constructed in the lower C-111 area to supply water for environmental restoration of the area served by C-109 and C-110. The new canal, the east/west spreader canal, would receive water from C-111E via a 50 cfs pump and provide conveyance east across canals C-109 and C-110. C-109 and C-110 would be plugged with material from spoil banks remaining along both sides of each canal. Nine plugs, each about 200 feet long, would be constructed up to ground level in C-109, and ten plugs in C-110. To allow overland flow from east to west and to prevent water from entering the unplugged canal sections, the spoil banks remaining at the end of each plug would be connected. Together, these features were intended to address the project objective of restoring more natural overland flows and water conditions in the east/ west spreader canal lands.

A large mound of material excavated in the construction of C-111 remains on the canal's south bank. The spoil mound would be leveled to natural ground to allow sheet flow southward. This would address the project objective of reducing S-197 flood discharges to Manatee Bay/Barnes Sound. Flood discharges at S-18C would more efficiently spill over the southern bank of C-111, thereby reducing the need for passing these flows through S-197. Additionally, the increased capacity to discharge floodwaters through the L-31W borrow canal and S-332 would also reduce the need to utilize S-197.

5.6.4.3 Alternative 1A

Alternative 1A, as shown in Figure 5-15, is very similar to alternative 1, but eliminates the east-west spreader canal. This alternative is single purpose flood

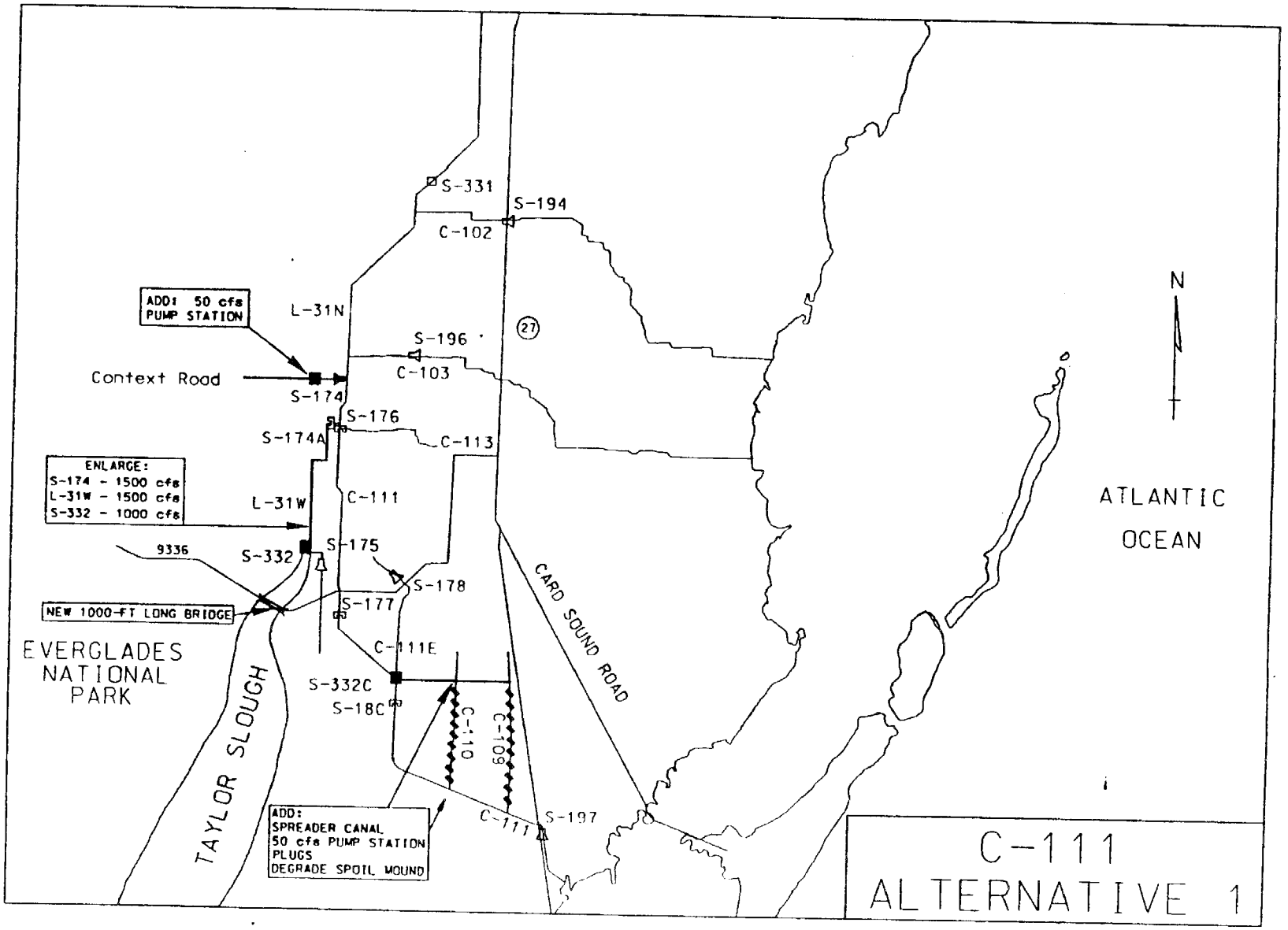

S-331
S-194
C-102
ADD: 50 cfs
PUMP STATION
L-31N
S-196
C-103
Context Road
S-174
S-176
S-174A
C-113
ENLARGE:
S-174 - 1500 cfs
L-31W - 1500 cfs
S-332 - 1000 cfs
L-31W
C-111
9336
S-332
S-175
S-178
S-177
NEW 1000-FT LONG BRIDGE
EVERGLADES
NATIONAL
PARK
C-111E
S-332C
S-18C
TAYLOR SLOUGH
C-110
C-109
CARD SOUND ROAD
ADD:
SPREADER CANAL
50 cfs PUMP STATION
PLUGS
DEGRADE SPOIL MOUND
C-111
S-197
N
ATLANTIC
OCEAN
C-111
ALTERNATIVE 1

FIGURE 5-14

control alternative, in that, the pump at S-332 is utilized for flood control purposes. There are no water supply features to this plan. Other than the east-west spreader canal, plugs and spoil mounds, which are not included in this plan, it is the same as alternative 1.

This plan was designed for flood control only to determine the least cost flood control alternative. This plan was not analyzed for environmental outputs and benefits, since it is an unsupported environmental plan.

There are no separable elements with alternative 1A. While the pump stations provide water supply to the ENP, their primary function is to provide the necessary flood protection to the agriculture community.

5.6.4.4 Alternative 2

Alternative 2, as shown in Figure 5-16, would have the objective of delivering more water to Taylor Slough and its headwaters and restoring sheet flow to the lower canal area. In common with alternative 1, the Context Road structures and the spreader canal, plugs, and gapped lower C-111 disposal mound would be used. Differences include the impact on the Frog Pond, partial filling of L-31W borrow canal, abandonment of S-332, provision of a new pump station, S-332A, and a new levee and borrow canal, L-31W Extension.

The Context Road and east/west spreader canal was intended to address the project objective of restoring natural hydrologic conditions in the headwaters and upper portions of Taylor Slough.

Flood water in excess of the capacity of the proposed Context Road pump station and canal would be pumped from L-31N borrow canal to L-31W borrow canal by a new pump station that would be constructed adjacent to the S-174 gated spillway. The new pump station, S-332A, would include 6 pumps with a total discharge capacity of 1,000 cfs.

L-31W would be extended directly southward (L-31W Extension) across the Frog Pond from the north to S-175, on the south. The portion of L-31W that forms the western and southern borders of the Frog Pond would be degraded to fill the L-31W borrow canal in that reach, and S-332, at the point where L-31W crosses Taylor Slough, would be abandoned. The effect would be that of moving a 3-mile, north-south segment of the L-31W canal and levee about one mile eastward. Passage of water into the new borrow canal would be controlled by a new, slide-gated culvert, S-175A, capable of passing 500 cfs. The part of the Frog Pond that would be isolated west of L-31W Extension would be purchased for the project.

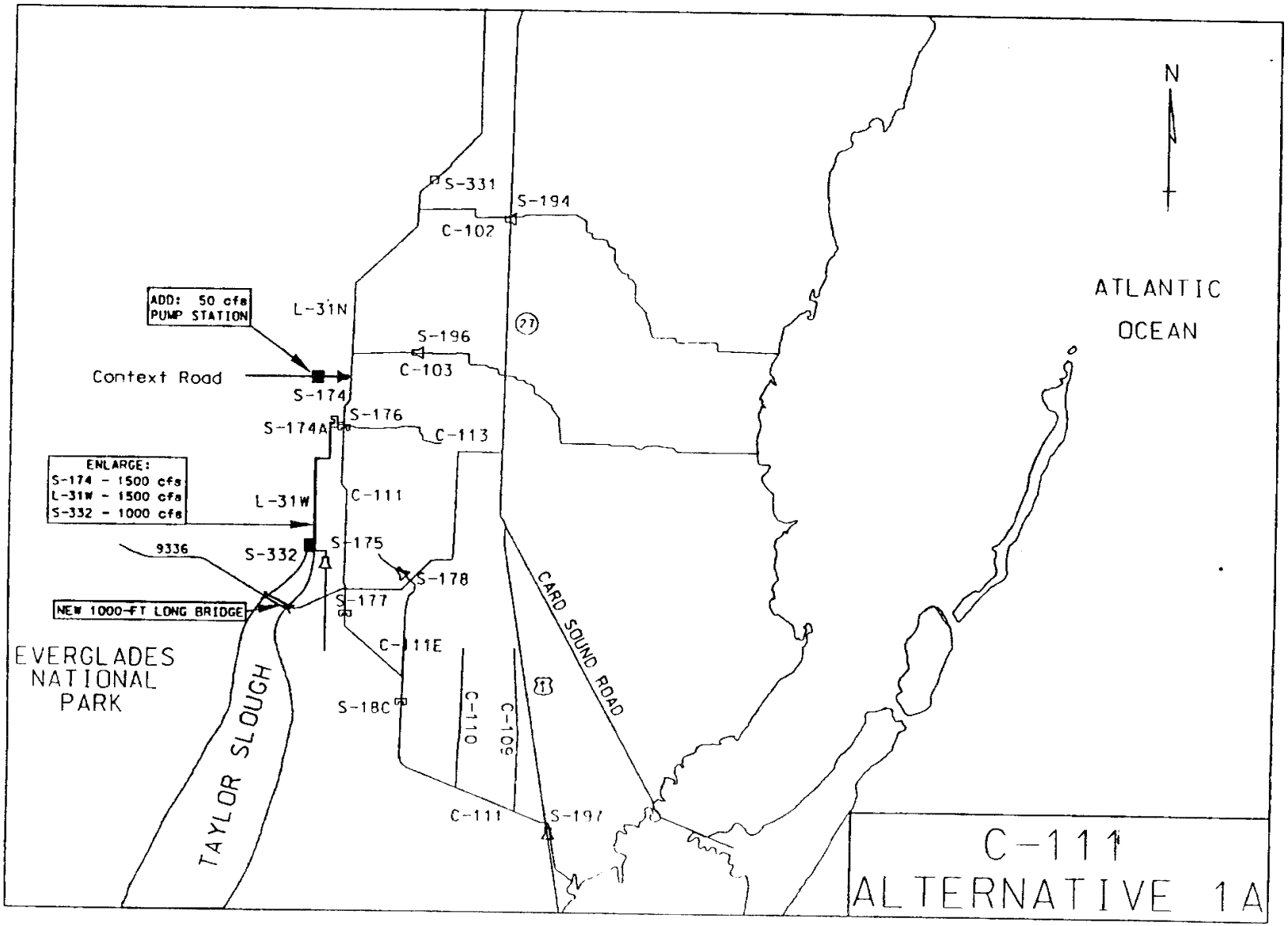

N
ATLANTIC
OCEAN
S-331
S-194
C-102
ADD: 50 cfs
PUMP STATION
L-31N
S-196
C-103
Context Road
S-174
S-176
S-174A
C-113
ENLARGE:
S-174 - 1500 cfs
L-31W - 1500 cfs
S-332 - 1000 cfs
L-31W
C-111
9336
S-332
S-175
S-178
S-177
NEW 1000-FT LONG BRIDGE
C-111E
EVERGLADES
NATIONAL
PARK
TAYLOR SLOUGH
S-18C
C-110
C-109
CARD SOUND ROAD
C-111
S-197
C-111
ALTERNATIVE 1A

FIGURE 5-15

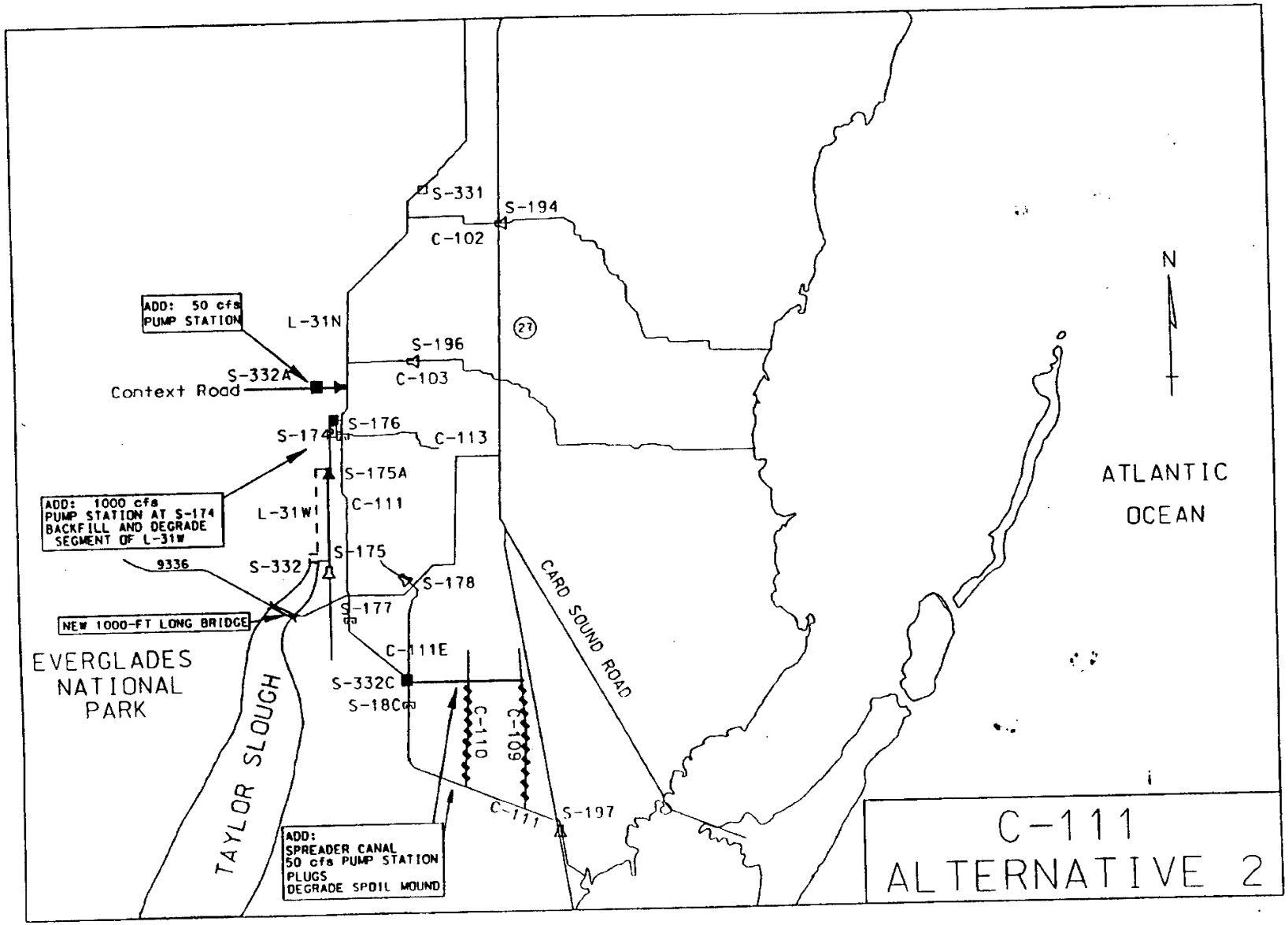

S-331
S-194
C-102
ADD: 50 cfs
PUMP STATION
L-31N
S-196
C-103
S-332A
Context Road
S-176
S-174
C-113
S-175A
ADD: 1000 cfs
PUMP STATION AT S-174
BACKFILL AND DEGRADE
SEGMENT OF L-31W
L-31W
C-111
S-175
9336
S-332
S-178
S-177
NEW 1000-FT LONG BRIDGE
C-111E
EVERGLADES
NATIONAL
PARK
S-332C
S-18C
TAYLOR SLOUGH
C-110
C-109
C-111
S-197
ADD:
SPREADER CANAL
50 cfs PUMP STATION
PLUGS
DEGRADE SPOIL MOUND
CARD SOUND ROAD
ATLANTIC
OCEAN
N
C-111
ALTERNATIVE 2

FIGURE 5-16

The L-31W features would address the project objective of maintaining flood control by providing additional flood discharge capacity. They would also apply toward the objective of restoring natural flows to the middle portion of Taylor Slough. Additionally, these features would provide an alternative flood control discharge capacity that would reduce the need for S-197 discharges.

In the lower canal area, the spreader canal, a 50 cfs pump station (S-332C), plugs in C-109 and C-110, and degradation of the disposal mound south of C-111 would provide overland flow into the Eastern Panhandle of the park. This would address the project objective of restoring natural flows and water conditions in SFWMD wetlands east of C-111.

5.6.4.5 Alternative 3

Alternative 3 provides for flood water retention and settling in a detention pool and storm water detention area, which would be constructed in the Frog Pond. The spreader canal feature in the lower canal area would be augmented by filling C-111 between S-18C and S-197. C-109 and C-110 would be plugged as in the first two alternatives. The Context Road features are not part of alternative 3. The detention pool and storm water detention area (SDA) are shown as alternative 3 in Figure 5-17. The detention pool would be formed by constructing a new levee directly south across the Frog Pond from L-31W on the north side to S-175 on the south, and constructing closure on the south between L-31W and C-111. The new levee and L-31W would enclose the storm water detention area to be located on the west side of the reservoir. The L-31W borrow canal would be filled on the south from S-332 to its terminus downstream of S-175. S-332 and S-175 would no longer be used.

Normal discharge of waters to the detention pool would be via a new pump station adjacent to S-174. The new pump structure, designated S-332A, would have a capacity of 1,630 cfs and would be operated in conjunction with S-174. A range of flows from low to flood could be alternatively routed (a) through the L-31W borrow canal to outflow overland from near the northwest corner of the pool, and/or (b) through S-332A into the pool.

Additional pump capacity at S-332A would address the project objective of maintaining flood control discharge capacity. Furthermore, the pump capacity was designed to divert all flood discharges that would otherwise be discharged into the lower C-111 via S-176. This addresses the project objective of reducing the need for S-197 food discharges. The detention pool addresses the objective of providing more natural timing of water deliveries to Taylor Slough. Excess water could be temporarily stored in the area and released in the desired rates.

Normal discharge from the detention pool to the detention area would be through 10 culverts located in the levee dividing the detention pool from the

detention area. Water would flow from the detention area through 10 culverts to be constructed in L-31W, and it would flow southward toward Taylor Slough. Excess flood waters would be discharged through an emergency spillway on the south side of the pool. This would address that project objective of providing a more natural location of water deliveries by spreading flows across a broad front. The stormwater detention area would also provide some incidental water quality benefits by passing water deliveries through a shallow wetlands prior to discharge into ENP.

In the lower canal area, C-111 downstream of S-18C to S-197 would be backfilled with spoil material located on the southwestern canal bank. Water would be pumped from C-111E through a 500 cfs pump station, S-332B, via the Spreader Canal, across C-109 and C-110, through a 100 cfs culvert under U.S. Highway 1, and into the triangle between U.S. 1 and Card Sound Road. C-109 and C-110 would be plugged as described under the previous alternatives.

The features in the lower C-111 segment would address the objective of eliminating S-197 discharges. They would also restore natural hydrologic conditions and water flows in the SFWMD wetlands east of C-111.

5.6.4.6 Alternative 4

The objective of alternative 4 is to deliver more water to and create longer hydroperiods in the area north of Taylor Slough and the adjacent Rocky Glades west of L-31N. To provide for higher stages and longer hydroperiods in the marshes, a buffer zone would be created for protection of the developed areas east of L-31N. The buffer zone would extend from the 8.5-Square-Mile-Area through the Frog Pond to its south end. All of the Frog Pond and land in the newly created buffer zone would be required for this alternative.

A plan view is shown as alternative 4 in Figure 5-18. A new levee system with four pump stations (S-332A, S-332B, S-332C, and S-332D) would be constructed roughly parallel to L-31N and C-111, creating a buffer zone. At the south end of the buffer zone the new levee would turn eastward and tie to the C-111 levee. The cut off portion of L-31W to the west of the levee, and the part of L-31W south of the new levee would be filled to ground level.

The north end of the new levee would tie to the south end of the seepage levee near S-357, a structure in the 8.5-Square-Mile Area that is authorized as part of the Modified Water Deliveries to Everglades National Park project. For this alternative, S-357 is modified for 300 cfs capacity. The remainder of S-357's 533 cfs capacity proposed without alternative 4, would be pumped southward from the 8.5-Square-Mile-Area via this alternative's pump station S-332A.

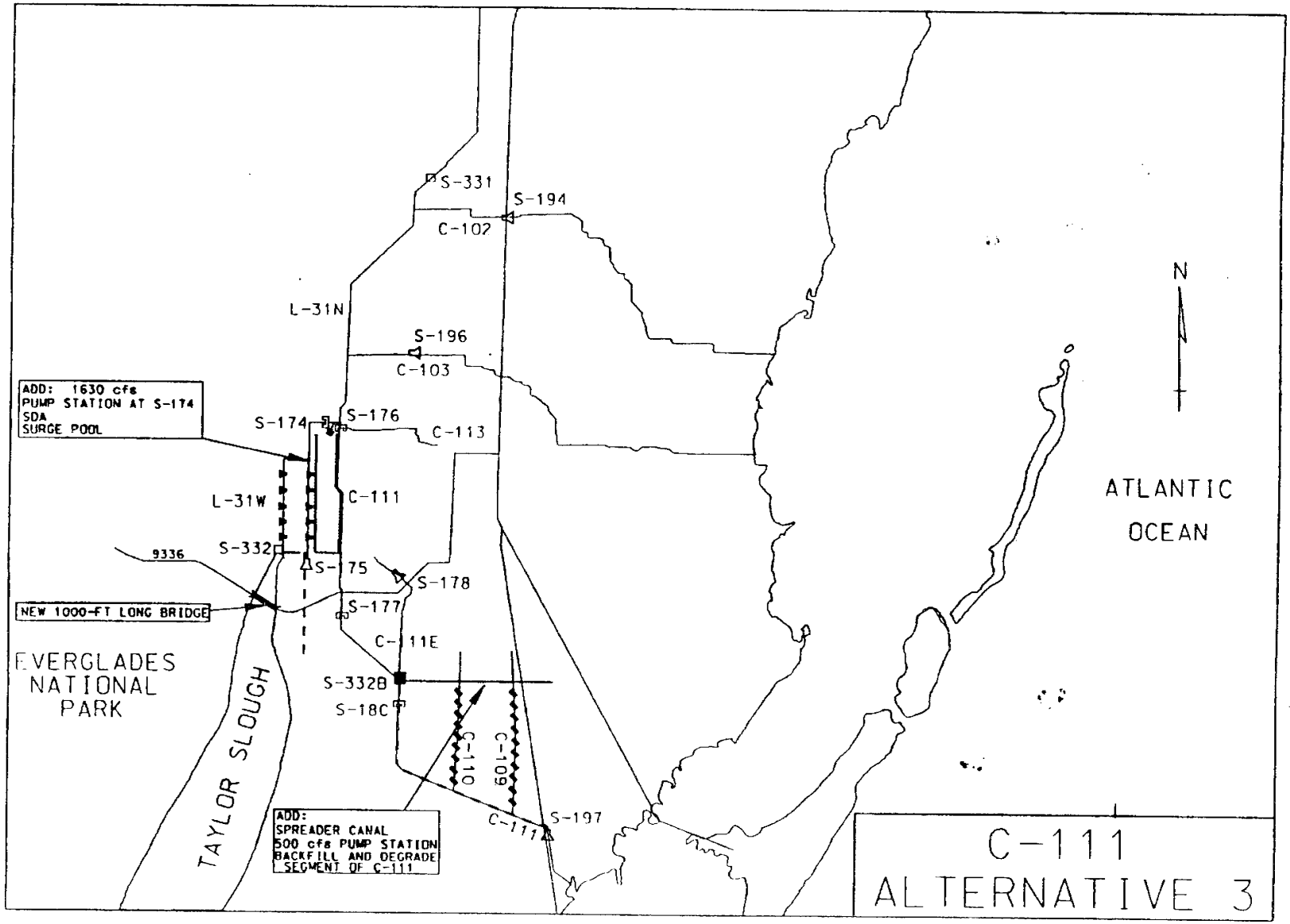

S-331
S-194
C-102
L-31N
S-196
C-103
ADD: 1630 cfs
PUMP STATION AT S-174
SDA
SURGE POOL
S-174
S-176
C-113
L-31W
C-111
9336
S-332
S-175
S-178
NEW 1000-FT LONG BRIDGE
S-177
C-11E
EVERGLADES
NATIONAL
PARK
S-332B
S-18C
TAYLOR SLOUGH
C-110
C-109
C-111
S-197
ADD:
SPREADER CANAL
500 cfs PUMP STATION
BACKFILL AND DEGRADE
SEGMENT OF C-111
N
ATLANTIC
OCEAN
C-111
ALTERNATIVE 3

FIGURE 5-17

Pump station S-332A would be located at the end of the seepage levee at the juncture with the new, alternative 6 levee. This and the three other pump stations would have four 75-cfs pumps. Each of the 300-cfs capacity stations would have a discharge sump on the outlet side; the sump would be 300 feet wide by 50 feet long, and have a depth of 5 feet.

S-332B and S-332C would draw water through flap-gate controlled culverts at the eastern end of connector canals from canal L-31N. The connector canals would also receive water drained from the buffer area through culvert/risers on each side of the connector canals.

S-332D pump station would be placed in the L-31W borrow canal downstream (west) of S-174, and would pump water from the L-31W canal west of S-174. Pump station S-332 would remain in service and be connected to C-111 via a new east-west connector canal. A flap-gate controlled culvert would divert water from C-111 to the connector canal. The connector canal would receive water from the buffer area via culvert/risers.

The pumps, canals, and levees forming the buffer strip features would address the project objective of restoring more natural location of water deliveries into the headwaters and upper portions of Taylor Slough. They would also address the objective of maintaining flood control capacity.

In the southern canal area, C-111 would be backfilled from its junction with C-111E to S-197. The Spreader Canal would be served by a 500 cfs pump station, S-332E, at the end of C-111E. The Spreader Canal would pass under U.S. Highway and provide up to 100 cfs to the triangle lands. Canals C-109 and C-110 would be plugged as described above to provide sheet flow from west to east along the alignment of the spreader canal. These features would address the project objective of restoring more natural flows and water conditions in the SFWMD wetlands east of C-111. Additionally, they would address the objective of reducing S-197 flood discharges to Manatee Bay/Barnes Sound.

5.6.4.7 Alternative 5

This alternative, as shown in Figure 5-19, requires fewer structures but requires purchase of the Frog Pond west of C-111 and east of L-31W. The lower end of L-31W would be filled, and structures S-332 and S-175 would be abandoned. A new 1,000 cfs pump station at S-174, designated S-332A, would push water from upper L-31W into the middle portion of Taylor Slough. This would be facilitated by degrading to adjacent grade any material along the west bank of the canal, including the tie-back levee from pump station S-332.

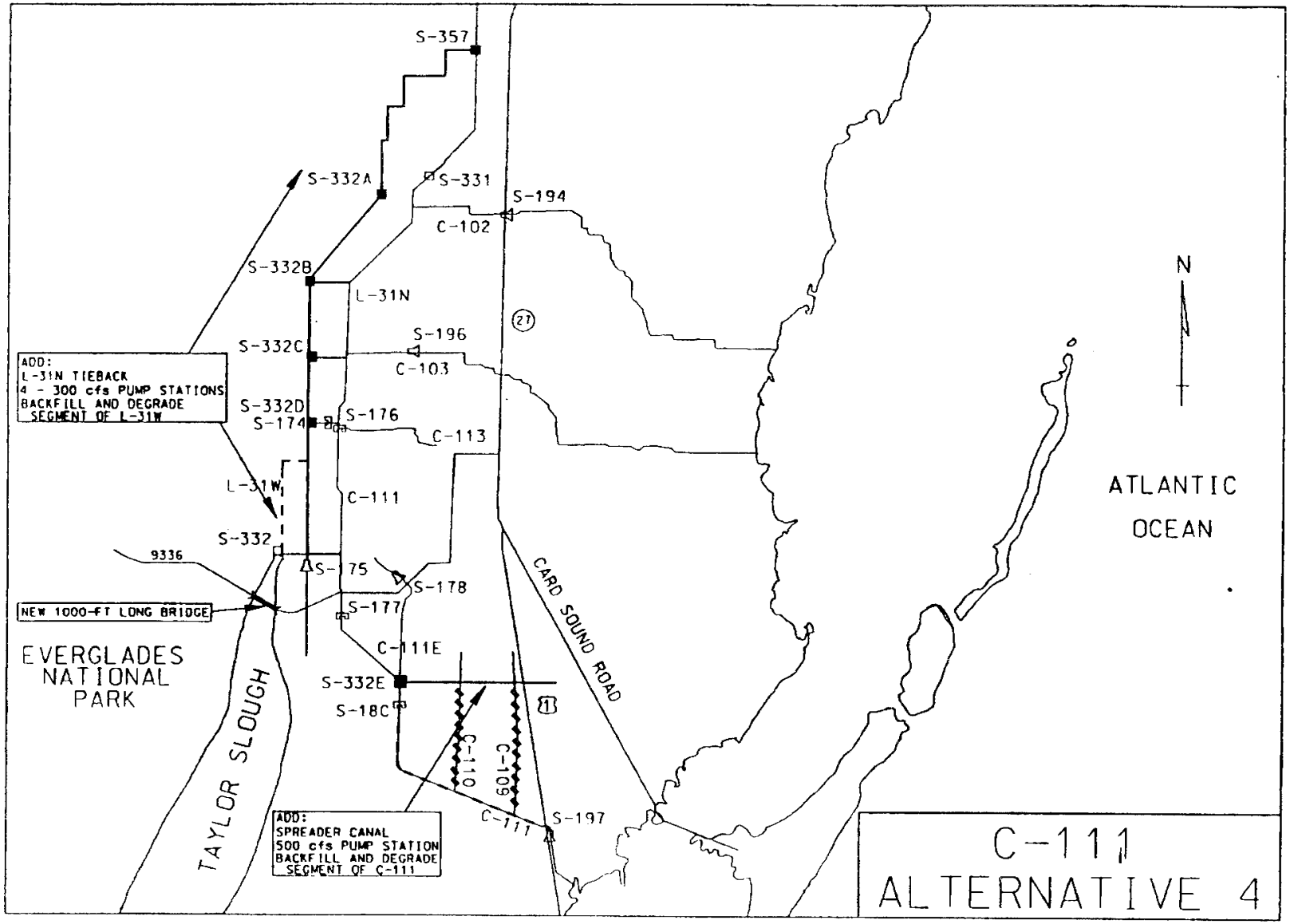

S-357
S-332A
S-331
S-194
C-102
S-332B
L-31N
S-196
C-103
S-332C
ADD:
L-31N TIEBACK
4 - 300 cfs PUMP STATIONS
BACKFILL AND DEGRADE
SEGMENT OF L-31W
S-332D
S-174
S-176
C-113
L-31W
C-111
S-332
9336
S-175
S-178
S-177
NEW 1000-FT LONG BRIDGE
EVERGLADES
NATIONAL
PARK
C-111E
S-332E
S-18C
TAYLOR SLOUGH
CARD SOUND ROAD
C-110
C-109
C-111
S-197
ADD:
SPREADER CANAL
500 cfs PUMP STATION
BACKFILL AND DEGRADE
SEGMENT OF C-111
N
ATLANTIC
OCEAN
C-111
ALTERNATIVE 4

FIGURE 5-18

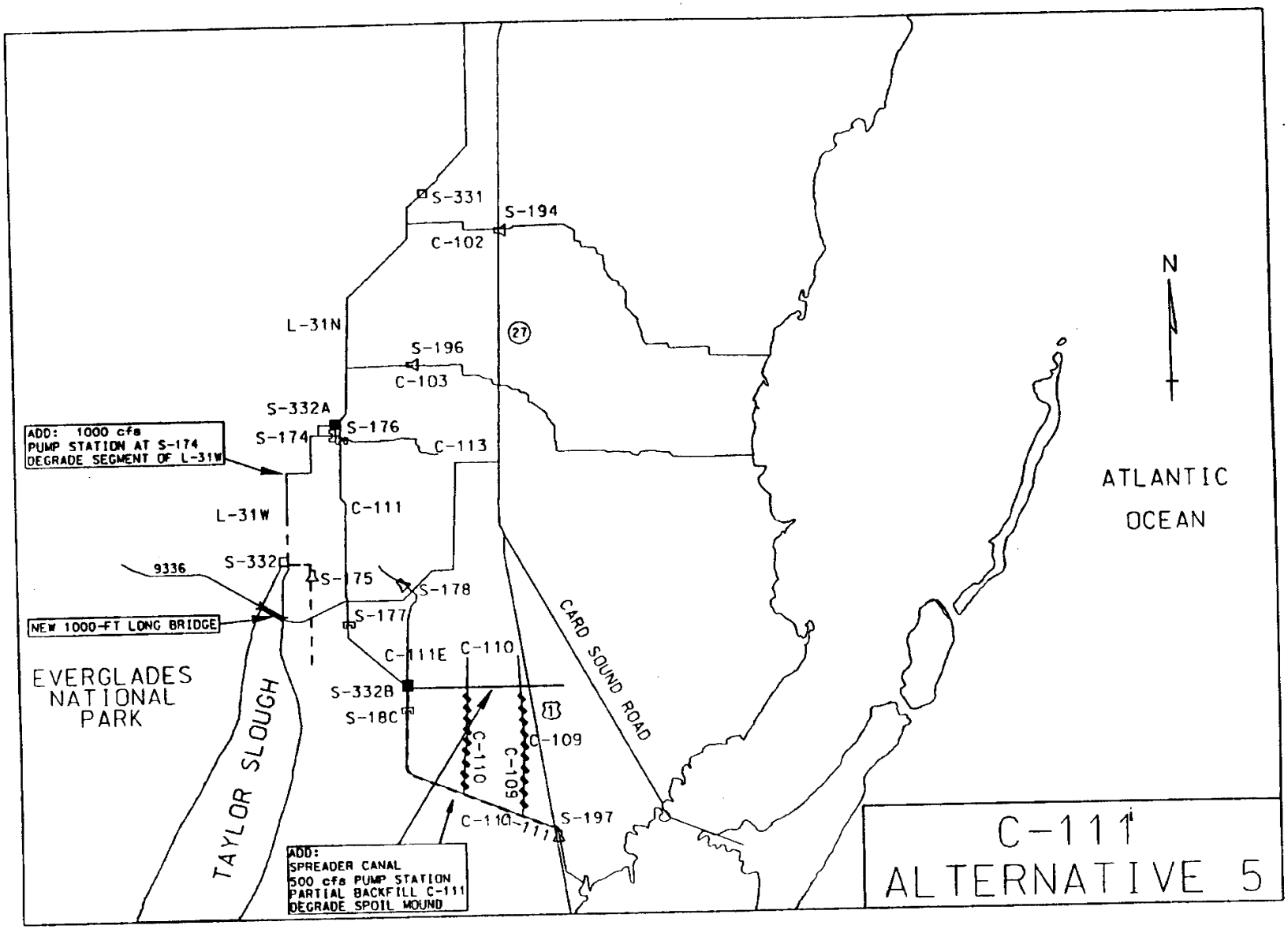

S-331
S-194
C-102
L-31N
27
S-196
C-103
S-332A
S-174
S-176
C-113
ADD: 1000 cfs
PUMP STATION AT S-174
DEGRADE SEGMENT OF L-31W
L-31W
C-111
9336
S-332
S-175
S-178
S-177
NEW 1000-FT LONG BRIDGE
C-111E
C-110
EVERGLADES
NATIONAL
PARK
S-332B
S-18C
11
C-109
C-110
C-109
TAYLOR SLOUGH
CARD SOUND ROAD
C-110-111
S-197
ADD:
SPREADER CANAL
500 cfs PUMP STATION
PARTIAL BACKFILL C-111
DEGRADE SPOIL MOUND
N
ATLANTIC
OCEAN
C-111
ALTERNATIVE 5

FIGURE 5-19

S-332A and the L-31W canal modifications would be intended to answer the project objective of restoring more natural flows across a broad area into the middle portion of Taylor Slough. This plan would have the additional benefit of minimizing additional physical disruption of existing wetlands caused by construction of new water management facilities. Additionally, these features would address the project objective of maintaining flood control capacity.

In the southern canal area, C-111 would be partially backfilled to -6.0 feet from C-111E to S-197. Fill would be taken from both banks. On the southeastern bank, the spoil would be removed so as to widen the existing gaps. On the northeastern bank, gaps would be created in the spoil adjacent to the existing culverts. The width of the gaps would be selected by balancing cut and fill requirements. These features would respond to the project objective of providing more natural water conditions through SFWMD wetlands east of C-111. They would also reduce the physical capacity to discharge flood waters to Manatee Bay/Barnes Sound.

Operation capability of S-18C would be retained by not filling the canal within 300 feet on the upstream or downstream sides. From these points fill would be placed on a 1 on 10 bed slope up to the fill elevation of -6.0 feet.

As in alternative 4, the Spreader Canal would be served by a 500 cfs pump, S-332B, providing 100 cfs to the triangle lands. C-109 and C-110 would be plugged as described in alternative 4 to provide sheet flow from west to east along the alignment of the spreader canal. The Spreader Canal and S-332B would serve two of the project objectives, reducing S-197 flood water discharges to Manatee Bay/Barnes Sound by providing alternative discharge capacity and restoring more natural flows through the SFWMD wetlands east of C-111.

5.6.4.8 Alternative 6

This plan combines the flexibility of alternative 4 in the upper area of Taylor Slough, coupled to the flexibility of alternative 1 in the lower C-111 basin as seen in Figure 5-20.

In common with alternative 4 is the objective to deliver more water to and create longer hydroperiods in the area north of Taylor Slough and the adjacent Rocky Glades west of L-31N. To provide for higher stages and longer hydroperiods in the marshes, a buffer zone would be created for protection of the developed areas east of L-31N. The buffer zone would extend from the 8.5-Square-Mile-Area through the Frog Pond to its south end. All of the Frog Pond and land in the newly created buffer zone would be required for this alternative.

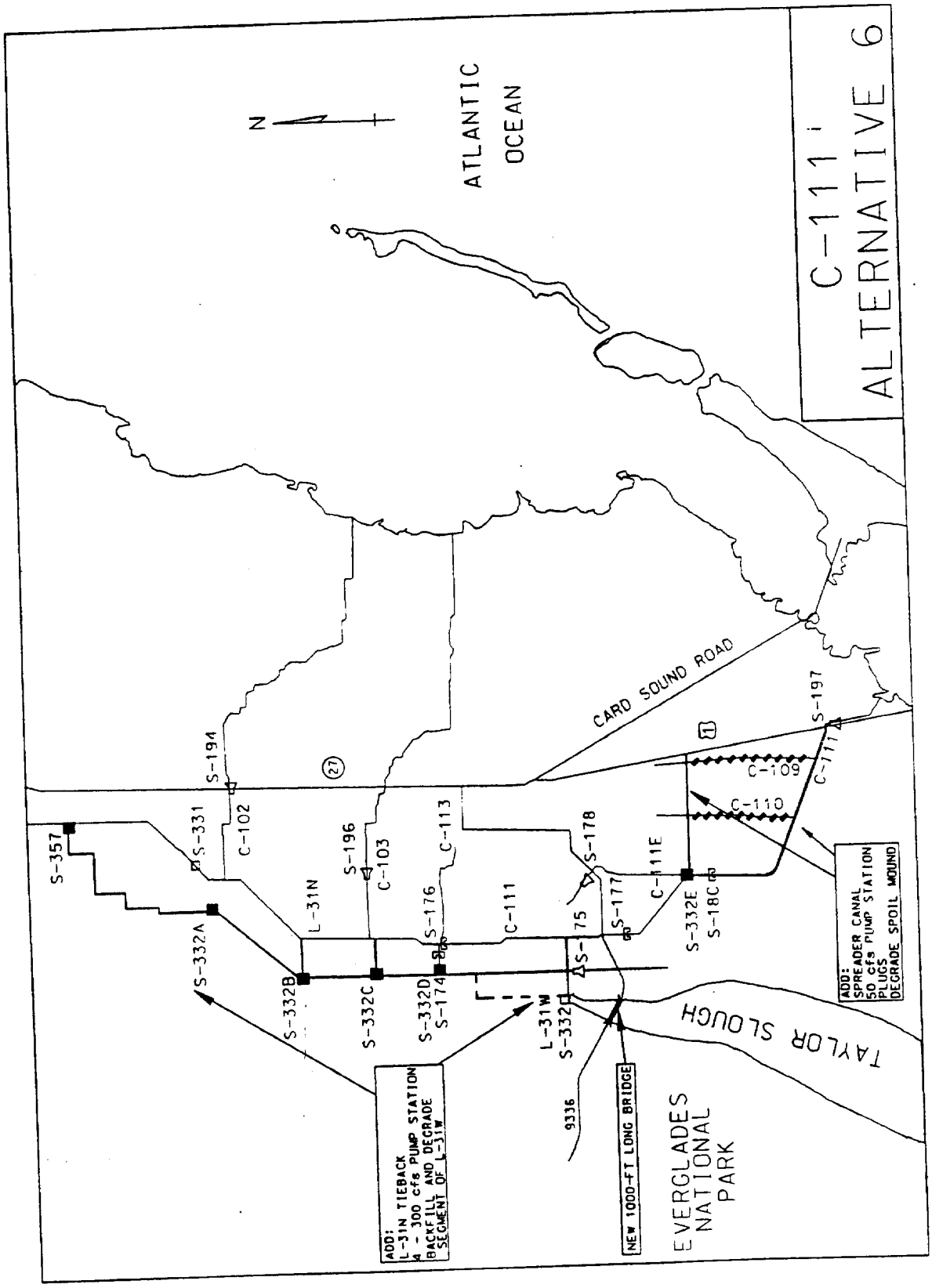

C-111
ALTERNATIVE 6
ATLANTIC
OCEAN
N
CARD SOUND ROAD
27
1
S-194
S-331
C-102
S-357
S-332A
L-31N
S-196
C-103
C-113
S-176
C-111
S-178
S-177
S-175
C-111E
S-332E
S-18C
C-109
C-110
C-111
S-197
S-332B
S-332C
S-332D
S-174
L-31W
S-332
9336
ADD:
L-31N TIEBACK
4 - 300 cfs PUMP STATION
BACKFILL AND DEGRADE
SEGMENT OF L-31W
NEW 1000-FT LONG BRIDGE
ADD:
SPREADER CANAL
50 cfs PUMP STATION
PLUGS
DEGRADE SPOIL MOUND
TAYLOR SLOUGH
EVERGLADES
NATIONAL
PARK

FIGURE 5-20

A new levee system with four pump stations (S-332A, S-332B, S-332C, and S-332D) would be constructed roughly parallel to L-31N and C-111, creating a buffer zone. At the south end of the buffer zone the new levee would turn eastward and tie to the C-111 levee. The cut off portion of L-31W to the west of the levee, and the part of L-31W south of the new levee would be filled to ground level.

The north end of the new levee would tie to the south end of the seepage levee near S-357, a structure in the 8.5-Square-Mile Area that is authorized as part of the Modified Water Deliveries to Everglades National Park project. For this alternative, S-357 is modified for 300 cfs capacity. The remainder of S-357's 533 cfs capacity proposed without alternative 6, would be pumped southward from the 8.5-Square-Mile-Area via this alternative's pump station S-332A. These features would address the project objectives of restoring natural hydrologic conditions to the headwaters and upper portions of Taylor Slough. Pump station S-332A would be located at the end of the seepage levee at the juncture with the new, alternative 6 levee. This and the three other pump stations would have four 75-cfs pumps. Each of the 300-cfs capacity stations would have a discharge sump on the outlet side; the sump would be 300 feet wide by 50 feet long, and have a depth of 5 feet.

S-332B and S-332C would draw water through flap-gate controlled culverts at the eastern end of connector canals from canal L-31N. The connector canals would also receive water drained from the buffer area through culvert/risers on each side of the connector canals.

S-332D pump station would be placed in the L-31W borrow canal downstream (west) of S-174, and would pump water from the L-31W canal west of S-174. Pump station S-332 would remain in service and be connected to C-111 via a new east-west connector canal. A flap-gate controlled culvert would divert water from C-111 to the connector canal. The connector canal would receive water from the buffer area via culvert/risers. By constructing four pump stations, water deliveries can be spread relatively uniformly across the entire border of the upper and middle portions of Taylor Slough.

The major difference in this alternative and alternative 4 is lower end of C-111. The flexibility to utilize lower C-111 for flood control discharges would be retained with alternative 6. Most flood control discharges would be made with S-197 closed. Flows would spill over the southern bank of C-111 and would pass through overland sheetflow across the park's panhandle area into northeast Florida Bay. Although the need to utilize S-197 would be greatly reduced with this alternative (because alternative discharge capacity is provided at S-332A, B, C, and D), there may still be a need to utilize the structure under extreme circumstances.

Identical to the lower basin of alternative 1 are the spreader canal, a 50 cfs pump station (S-332E), plugs in C-109 and C-110, and degradation of the spoil mound

south of C-111 which would provide overland flow into the Eastern panhandle of the park.

5.6.4.9 Alternative 8

Subsequent to release of the preliminary draft report, the staff at the Everglades National Park recommended a conceptual plan, alternative 8, which includes features similar to those in alternatives 3, 4, and 6. Alternative 8 is shown in Figure 5-21. The main goal of this plan is the restoration of the stages in the headwaters and upper portions of Taylor Slough. This was accomplished in alternative 8 by pumping from L-31N borrow canal into the buffer strip rather than directly into the Park to the west. Evaluation of alternatives 1 through 6 showed that maintaining higher water levels along the border of ENP in this area is critical.

This plan is fully described in Annex F. It includes creation of a large buffer strip along the ENP boundary from Tamiami Trail southward to, and including the Frog Pond. The buffer strip includes the 8.5-square-mile and a strip of land to the north that extends eastward beyond Krome Avenue. Water would be discharged from the water management system into the buffer strip and water levels would be allowed to fluctuate in accordance with seasonal and annual rainfall cycles.

The concept includes operation targets for stages in the headwaters of Taylor Slough that would be achieved by strategically releasing water from the buffer strip into Taylor Slough. The plan would address the project objectives regarding restoration of natural hydrologic conditions in Taylor Slough, including the headwaters and upper portions and maintaining flood protection.

The lower portion of C-111 would be backfilled and a spreader canal and pump station would be constructed to discharge water into the east/ west spreader canal lands. This would address the project objectives of restoring natural hydrologic conditions in this area and eliminating S-197 discharges to Manatee Bay/Barnes Sound.

The major difference between alternative 8 and alternatives 4 and 6 is that it enables maintaining higher water levels along the boundary of ENP. The other alternatives call for pumping excess water at four discrete locations directly into the park but the hydrologic boundary is still the L-31N borrow canal. Since the canal stages cannot be raised without adversely impacting privately owned agricultural lands to the east, the problem of groundwater drainage from Taylor Slough into the canal would still exist. As a result, much of the water pumped into the park would return to the canal through seepage. Alternative 8 would involve pumping into the buffer strip and allowing water levels to be raised, thereby reducing seepage losses from Taylor Slough.

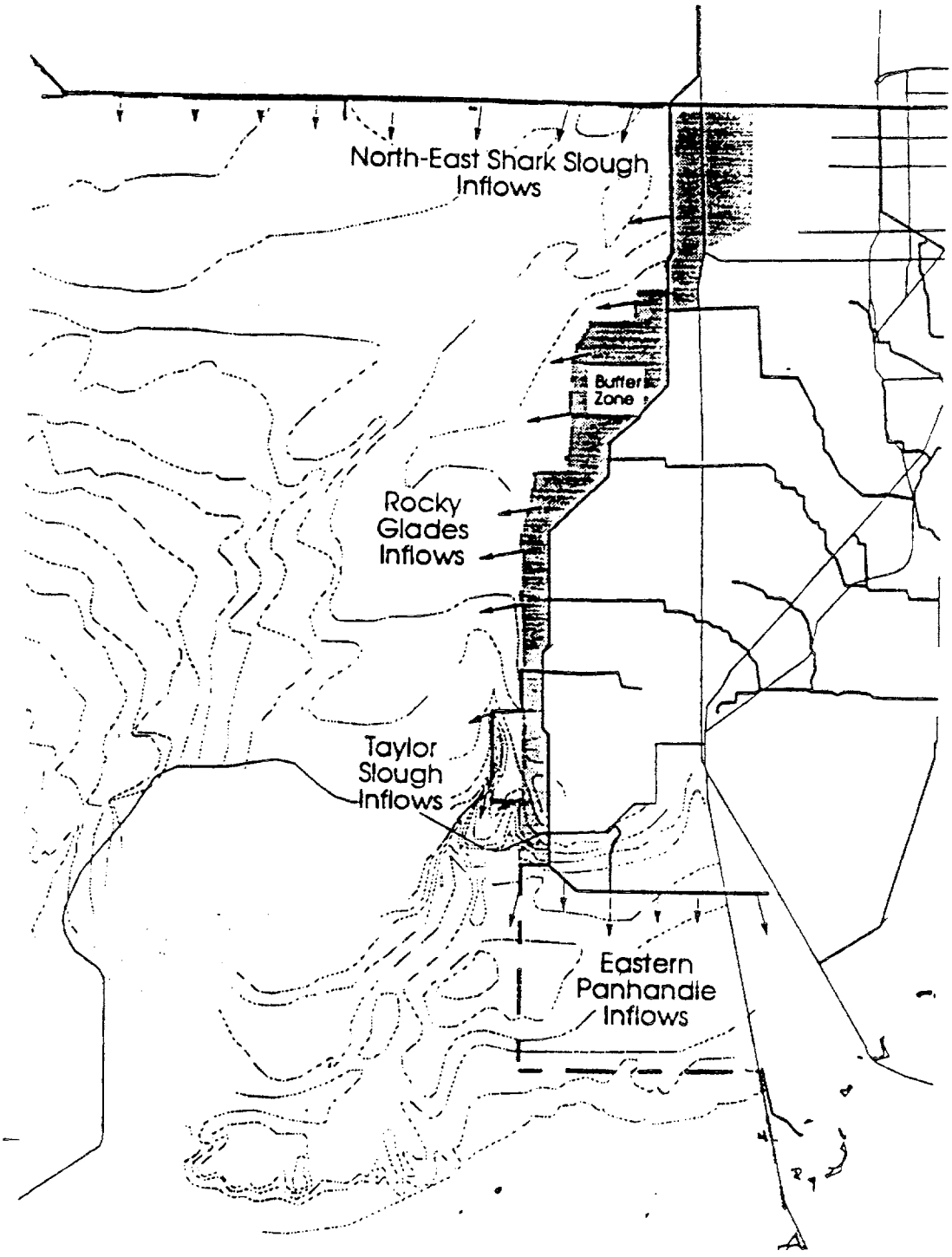


FIGURE 5-21 Proposed Alternative 8

Conceptually, alternative 8 offers distinct advantages over prior alternatives. However, as it is presented, alternative 8 includes features that are outside the scope of the C-111 project. Acquisition and utilization of lands in the 8.5-square-mile area and lands east of L-31N would not be within the available authority for the C-111 Project. Therefore, alternative 8 was refined so that it was within the scope of existing authority. Additionally, with input from ENP and SFWMD, engineering design refinements were also made. The new version of alternative 8 is alternative 6A.

5.6.4.10 Alternative 9

Another alternative was recommended by the South Dade Land Corporation and is shown as alternative 9 in Figure 5-22. This plan would surround the agricultural areas with a seepage curtain wall. The curtain wall extends the entire depth of the Biscayne aquifer, a depth of about 60 feet. All other features of the plan are identical to alternative 6 except that agricultural lands in the Rocky Glades agricultural area and the Frog Pond would not be acquired.

The purpose of this proposal was to create a seepage barrier between ENP and the farm land. The goal would be to enable higher water levels in Taylor Slough without impacting water levels in the adjacent agricultural areas. Seepage losses from ENP towards L-31N would be reduced considerably. As a result, project objectives of restoring natural hydrologic conditions in Taylor Slough and maintaining flood control would be addressed.

Several alternative designs for the curtain wall were developed, including metal and plastic sheetpile and a slurry trench. The most cost-effective method was a Gundwall plastic sheetpile with hydrotite, which costs approximately $6,623,000 per mile. Using a curtain wall alignment along the west boundary of the Frog Pond and extending northward along the western boundary of the Rocky Glades agricultural area for 16.3 miles, the cost of the installed sheetpile wall was approximately $108,000,000. The cost of purchasing these lands is $50,690,000. Other methods of installation are continuing to be evaluated, however, due to the high cost of installing the curtain wall in limestone, this alternative is still too costly for consideration.

The Corps has continued to assess the curtain wall technology. A 2-dimensional finite element program was used to calculate the depth of the curtain wall (See Appendix C). It was determined that the impermeable cutoff must extend the full depth of the aquifer to be effective. If the cutoff partially penetrates the aquifer, additional pump stations would be required to handle the resulting backseepage. This additional cost would make a partially penetrating cutoff much more expensive than a fully penetrating one. While this technology appears to be engineeringly feasible, the most difficult and potentially expensive portion of this work is the excavation of a trench through the limestone to the base of the aquifer. Although the technology

currently exists to excavate the rock to the depths required for placement of the cutoff, the cost of this type of equipment is extremely variable. Estimates from various contractors involved with this type of work range from $15 to $20 per square foot of wall placed. However, all of the contractors contacted during this investigation have stated that trenches have not been excavated to the depths required by this project in rock materials.

5.6.4.11 Alternative 6A

A modification was performed to alternative 6 to bring in the major features of alternative 8, except backfilling the lower portion of C-111. Alternative 6A is shown on Figure 5-23. Alternative 8 was modified to include a sub-divided buffer strip. A central north/south levee is added to create a detention/retention zone in the west half of the area and a transition zone in the east half.

The detention/retention zone would be utilized for temporary storage of excess flood water before discharge into Taylor Slough. S-332A, B, C, and D would be pump stations designed to pump water across the transition zone via lined canals into the detention/retention zone. A battery of culverts and an overflow spillway would be constructed along the western levee of the detention/retention strip. Project objectives of restoring natural timing, location, and volumes of water flows to the headwaters, upper, and middle portions of Taylor Slough can be addressed by these features. Additional capacity at S-332A, B, C, and D could address the project objective of maintaining flood control capacity.

The transition zone would lie between the agriculture communities to the east and the detention/ retention zone to the west. This area would reduce the slope of the groundwater gradient from high water conditions in Taylor Slough and the L-31N borrow canal stage, thereby reducing seepage losses out of the wetlands.

Pump station S-332A, S-332B and S-332C would be located adjacent to L-31N levee. Each pump station would have four 75-cfs pump units. A concrete lined canal will be connected to the outlet side and discharge 1/2 mile west beyond the new L-31W tieback levee.

S-332D pump station would be placed in the L-31W borrow canal, west of S-174, and would pump water through a concrete lined canal connected to the outlet side of S-332D and discharge 0.5 mile west through the new S-332D Tieback levee into the new retention/detention zone. Pump station S-332 would remain in service and be connected to C-111 via a new east-west connector canal. A flap-gate controlled culvert would divert water from C-111 to the connector canal. The connector canal would convey runoff from the detention/retention area via culvert/risers.

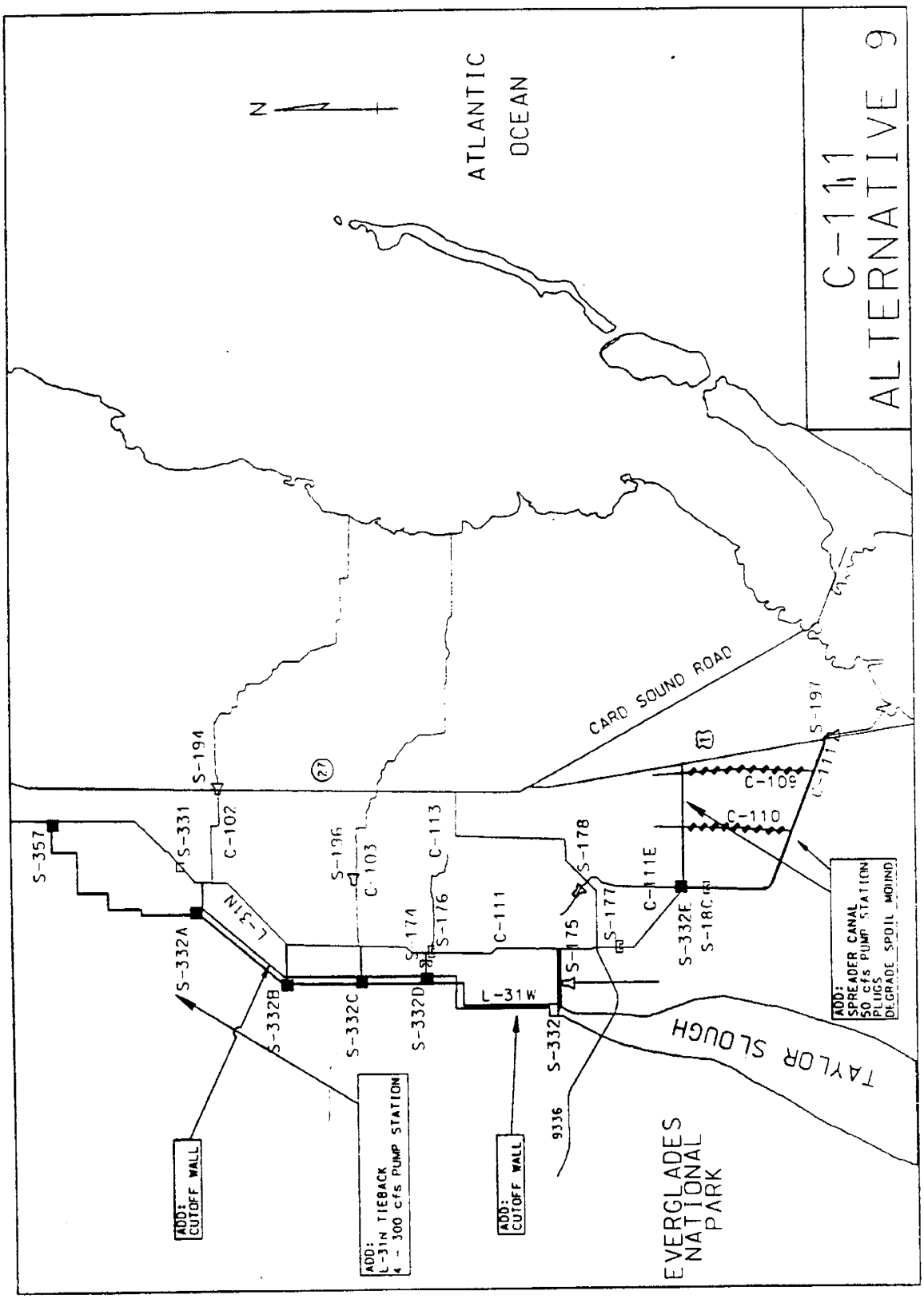

C-111
ALTERNATIVE 9
ATLANTIC
OCEAN
N
CARD SOUND ROAD
S-194
S-331
C-102
S-357
L-31N
S-332A
S-332B
S-136
C-103
S-332C
S-174
S-176
C-113
C-111
S-332D
L-31W
S-175
S-178
S-177
C-111E
S-332E
S-180
S-332
C-109
C-110
S-197
C-111A
ADD:
SPREADER CANAL
50 cfs PUMP STATION
PLUGS
DEGRADE SPOIL MOUND
ADD:
CUTOFF WALL
ADD:
L-31N TIEBACK
4 - 300 cfs PUMP STATION
ADD:
CUTOFF WALL
TAYLOR SLOUGH
9336
EVERGLADES
NATIONAL
PARK

FIGURE 5-22

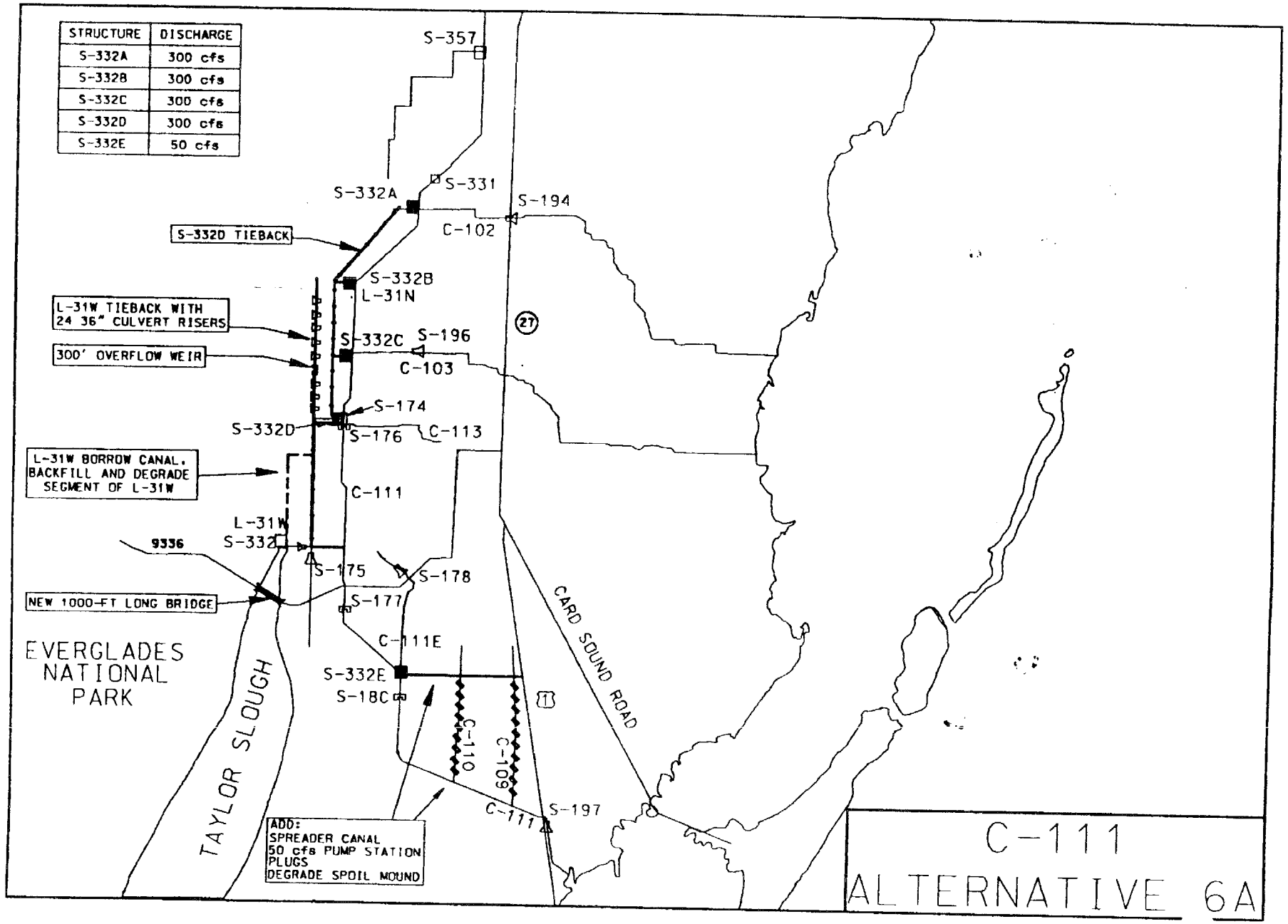

STRUCTURE | DISCHARGE
S-332A | 300 cfs
S-332B | 300 cfs
S-332C | 300 cfs
S-332D | 300 cfs
S-332E | 50 cfs
S-357
S-331
S-194
C-102
S-332A
S-332D TIEBACK
S-332B
L-31N
L-31W TIEBACK WITH 24 36" CULVERT RISERS
300' OVERFLOW WEIR
S-332C
S-196
C-103
S-174
S-332D
S-176
C-113
L-31W BORROW CANAL, BACKFILL AND DEGRADE SEGMENT OF L-31W
C-111
L-31W
S-332
9336
S-175
S-178
S-177
NEW 1000-FT LONG BRIDGE
C-111E
EVERGLADES NATIONAL PARK
S-332E
S-18C
TAYLOR SLOUGH
C-110
C-109
C-111
S-197
CARD SOUND ROAD
ADD:
SPREADER CANAL
50 cfs PUMP STATION
PLUGS
DEGRADE SPOIL MOUND
C-111
ALTERNATIVE 6A

FIGURE 5-23

Identical to the lower basin of alternative 6 are the spreader canal, a 50 cfs pump station (S-332E), plugs in C-109 and C-110, and degradation of the spoil mound south of C-111 which would provide overland flow into the Eastern panhandle of the park.

5.7 SECTION 122 EFFECTS

Effects of the alternatives on air, noise and water pollution, natural resources, and other types of resources listed in Section 122 of the 1970 River and Harbors and Flood Control Act are displayed in Table 5-2.

5.8 PRINCIPLES AND GUIDELINES EFFECTS

Effects of the alternatives on endangered and threatened species, historic and cultural properties, and other types of resources listed in the P&G are displayed in Table 5-3.

5.9 EVALUATION ACCOUNTS

Table 5-4 displays effects of the alternatives in the four evaluation accounts listed in the P&G - national economic development, environmental quality, regional economic development, and other social effects.

Table 5-2
Effects Evaluation:
Categories of Effects Listed in "Section 122"*

CATEGORIES OF EFFECTS	HISTORIC CONDITION	EXISTING CONDITION	"WITHOUT PROJECT" CONDITION (NO ACTION)	ALT 1	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6	ALT 1A	ALT 8	ALT 9	ALT 8A
Air Pollution	L	L	L	0	0	0	0	0	0	0	N/A	0	0
Noise Pollution	L	L-M	L-M	0	0	0	0	0	0	0	N/A	0	0
Water Pollution	L	M**	M**	0	0	+	+	0	+	0	N/A	+	+
Man-made Resources	L	M	M	0	-	-	–	-	–	0	N/A	0	–
Natural Resources	H	M	L	+	+	+	+	+	+	+	N/A	+	+
Aesthetic Values	H	M	L	+	+	+	+	+	+	+	N/A	+	+
Community Cohesion	L	M	M	0	-	-	-	-	-	0	N/A	0	-
Public Facilities and Services	L	M	M	0	0	0	0	0	0	0	N/A	0	0
Employment	L	M	M	0	-	–	–	–	–	0	N/A	0	–
Tax Values	L	M	M	0	+	+	+	+	+	0	N/A	0	+
Property Values	L	M	M	0	+	+	+	+	+	0	N/A	0	+
Displacement of People	N/A	N/A	N/A	0	-	-	–	-	–	0	N/A	0	–
Displacement of Businesses	N/A	N/A	N/A	0	-	-	-	-	-	0	N/A	0	-
Displacement of Farms	N/A	N/A	N/A	0	-	–	–	–	–	0	N/A	0	-
Desirable Community Growth	N/A	N/A	N/A	0	0	0	0	0	0	0	N/A	0	0
Desirable Regional Growth	N/A	N/A	N/A	0	0	0	0	0	0	0	N/A	0	0

*"Section 122" is included in the River and Harbor Act of 1970.
** Phosphorus routinely measured at S-332

Historic, existing and "without project" conditions display estimates of each resources relative values : H = high, M = moderate, L = low.
Plans' effects are estimates of net overall changes from the "without project" condition:

+ = beneficial change
0 = no change
- = adverse change
– = very adverse change
N/A = not applicable

Alternative 8 was outside scope.

Table 5-3
Effects Evaluation:
Categories of Natural and Cultural Resources Effects Listed in the "Principles and Guidelines"

CATEGORIES OF EFFECTS	HISTORIC CONDITION	EXISTING CONDITION	"WITHOUT PROJECT" CONDITION (NO ACTION)	ALT 1	ALT 1A	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6	ALT 8	ALT 9	ALT 6A
Air Quality	Good	Good	Good	No change	No change	No change	No change	No change	No change	No change	No change	No change	No change
Areas of particular concern within the coastal zone	None	None	None	Minor change with introduction of fresh water.									
Endangered and threatened species	Not applicable	2 species	2 species	No effect pending the U.S. Fish and Wildlife Service concurrence. USFWS will provide an evaluation of the effects and this will be shown in the final document.									
Historic and cultural properties	Not applicable	Few known sites		Possible effects to unknown resources on tree islands.									
Prime and unique farmlands	Not applicable	No change	No change	No change	No change	Loss of 1800 acres (Western Frog Pond)	Loss of 5255 acres (Frog Pond)	Loss of Frog Pond and portion of Rocky Glades	Loss of 5255 acres (Frog Pond)	Loss of Frog Pond and portion of Rocky Glades			Loss of Frog Pond and portion of Rocky Glades
Water Quality	Good	"Fair" Potential Phosphorus problems	"Fair" Potential Phosphorus problems	"Fair" Potential Phosphorus problems	"Fair" Phosphorus problems	"Fair" Potential Phosphorus problems	"Fair - good" Potential Phosphorus problems. Could improve WQ.	"Fair" Potential Phosphorus problems	"Fair" Potential Phosphorus problems	"Fair" Potential Phosphorus problems	N/A	"Fair" Potential Phos. problems	"Fair - Good" Potential Phosphorus problems
Wild and scenic rivers	Not applicable	0 miles	0 miles	No change	No change	No change	No change	No change	No change	No change			No change

* Not accurate representation. Corps had authority to raise water levels to optimum levels prior to enactment of this Act. Unique farm land created from lowered canal stages and tropical climate.

N/A Alternative 8 was not evaluated due to its scope.

Table 5-4
Effects Evaluation:
Evaluation Accounts Listed in the "Principles and Guidelines"

EVALUATION ACCOUNTS	HISTORIC CONDITION	EXISTING CONDITION	"WITHOUT PROJECT" CONDITION (NO ACTION)	ALT 1	ALT 1A	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6	ALT 8	ALT 9	ALT 6A
NATIONAL ECONOMIC DEVELOPMENT ACCOUNT													
Project Cost ($million)[1]	NA	NA	NA	$36.8	$26.5	$45.7	$74.8	$128.3	$62.1	$121.9	NC	$179.2	$121.4
Annual Benefits	NA	NA	NA	$3.2	$3.2	$3.0	$2.9	$2.9	$2.9	$2.9	NC	NC	$2.9
Annual Costs (8%)	NA	NA	NA	$4.1	$3.0	$4.8	$7.7	$12.9	$6.4	$12.2	NC	$14.2	$12.0
The flood control component of all plans is 1.05 to 1.0.													
ENVIRONMENTAL QUALITY ACCOUNT													
Ecological Value	high	low	low	min effect - low	min effect - low	min effect - mod.	improv. mod - high	improv. high	improv. mod to high	improv. high	NC	improv. high	improv. high
Cultural Value	high	high	high	Water levels or volumes may impact tree islands or oak hammocks which may be adversely affected and require compliance.									
Aesthetic Value	high	low	low	Construction will have some negative impacts for a short time.			Construction will have some negative impacts for a short time. Former agricultural lands will enhance the overall visual experience of visitors to the park.				NC	Same as alt 1	Same as alt 6

[1] May 1993 price levels

NA - not applicable

Flood Control - All plans provide approximately the same level of flood protection with no adverse impact to the environment. Alternative 1A, the flood control plan is implementable, but not acceptable to the sponsor. The construction features are the basis for flood control in all plans.

N/C - Not included

Table 5-4 (Continued)
Effects Evaluation:
Evaluation Accounts Listed in the
"Principles and Guidelines"

EVALUATION ACCOUNTS	HISTORIC CONDITION	EXISTING CONDITION	"WITHOUT PROJECT" CONDITION (NO ACTION)	ALT 1	ALT 1A	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6	ALT 8	ALT 9	ALT 6A
REGIONAL ECONOMIC DEVELOPMENT ACCOUNT													
Regional income	low	moderate	moderate	min. effect	minimum effect	mod. neg. effect	mod. neg. effect	Major neg. effect due to loss of ag. lands	mod. neg. effect	Major neg. effect due to loss of ag lands	NA	min effect	Major neg. effect due to loss of ag lands
Regional employment	low	moderate	moderate	min. effect	minimum effect	mod. neg. effect	mod neg. effect	mod - major neg. effect	mod. neg. effect	mod.- major neg. effect	NA	min effect	mod. - major neg.. effect
OTHER SOCIAL EFFECTS ACCOUNT	NA	NA	NA	minimal land purchase	minimal land purchase	purchase west Frog Pond	purchase all Frog Pond	purchase all Frog Pond and Rocky Glades	purch. all Frog Pond	purch. all Frog Pond and Rocky Glades	NA	min. land purch.	purch. all Frog Pond and Rocky Glades

[1] May 1993 price levels
NA - not applicable

5.10 ENVIRONMENTAL EVALUATION OF ALTERNATIVES

Environmental impacts of alternatives were evaluated on two levels:

1) evaluation of the alternative's potential for meeting the planning objectives described in section 5.2.

2) assessment of the direct effects of construction of the recommended plan on the important environmental resources in the area.

The latter required an enumeration and comparison of the quantities of aquatic and wetland habitats that would be changed. The results of this evaluation are presented in Table 5-5. Because alternative 9 is not cost effective, environmental benefits were not computed. The difference between alternative 6 and 6A are minor. The physical differences are within the 1-square-mile grid size used for the hydrologic model used for the evaluation. Therefore, the outputs for both alternatives are the same.

Alternatives' potential for restoring historic hydrological conditions and protecting or restoring natural values associated with ENP were evaluated by comparing modern historic conditions with projected alternative conditions. Modern historic conditions are those under which marl soil was formed and is maintained in the study area. They include the geological, hydrological and biological processes summarized in Section 2.4.

The comparison of projected alternative conditions with the historic hydrological determinants that produced Everglades habitat and natural values required consideration of (a) the expanse of area that would get more or less water in appropriate time frames, and (b) the degree of restoration of the historic hydrology in which the marl soil habitat was formed and maintained (Section 2.5).

A marl model (hydrohabitat model) incorporating these two considerations was developed. Independently of the marl model, a species compatibility index was used to gauge the restoration of projected natural habitat values under the alternatives.

♦ Use of the marl model involved calculations of a hydrohabitat index (HhI) for each alternative. The HhI is an evaluation of the habitat value of projected water levels and durations in square-mile cells. The HhI was combined with the total area of hydroperiod change to produce a hydrohabitat unit (HhU) value for each alternative. The HhU value is a measure of how well an alternative's hydrology supports the natural values associated with the sawgrass-on-marl ecosystem.

♦ Species compatibility indices are founded on species habitat requirements in the natural, fresh water ecosystem of ENP. Hydrological criteria defined by the ENP staff as favorable to selected indicator species were incorporated with the output of

Table 5-5
Summary of Environmental Impacts from Construction
of the Recommended Plan

Features	Wetlands:Loss (Gain)		Agriculture Lands: Loss (Gain)	
	Dredge (acres)	Fill (acres)	Dredge (acres)	Fill (acres)
Pump Sta (S-332 A, B, C) Discharge Canals	-	-	15	-
Connecting Canal C-111 to S-332/S-175	-	-	11	-
S-332D Tieback	-	7	-	383
L-31N Tieback N. of S-332D S. of L-31W	- -	7 -	- -	9 15
Spreader Canal	61	-	-	-
L-31W	-	15	-	-
C-111 spoil removal	(61)	-	-	-
Net Quantities	0	29	26	407
Ag Land Made Fallow	-	-	-	9000
Totals	**29**		**9,433**	

hydrological modeling of alternatives, using the authorized optimum water stages within the C-111 system. The resulting values represent the extent to which an alternative protects or restores the selected species's habitat requirements for reproductive success.

The methods are discussed in following paragraphs and in Annex G. The evaluations of finally considered alternatives are presented in section 5.14 and in tables 5-6 and 5-7.

5.10.1 Marl Soil Ecosystem Criteria

The environmental effects of each alternative plan were evaluated based, in part, on the similarity of projected hydrological conditions to historic conditions deduced from marl measurements (Annex G). For this portion of the evaluation, the study area was considered as 2 basins: the east basin, south of the spreader canal between a line extended south from C-111E and Card Sound Road, and the remaining west basin (Figure 5-24).

The following characteristics of the marl soil area of the East Everglades (TBI, 1990) were used to construct a marl model for rating projected alternative water levels against reported historic conditions:

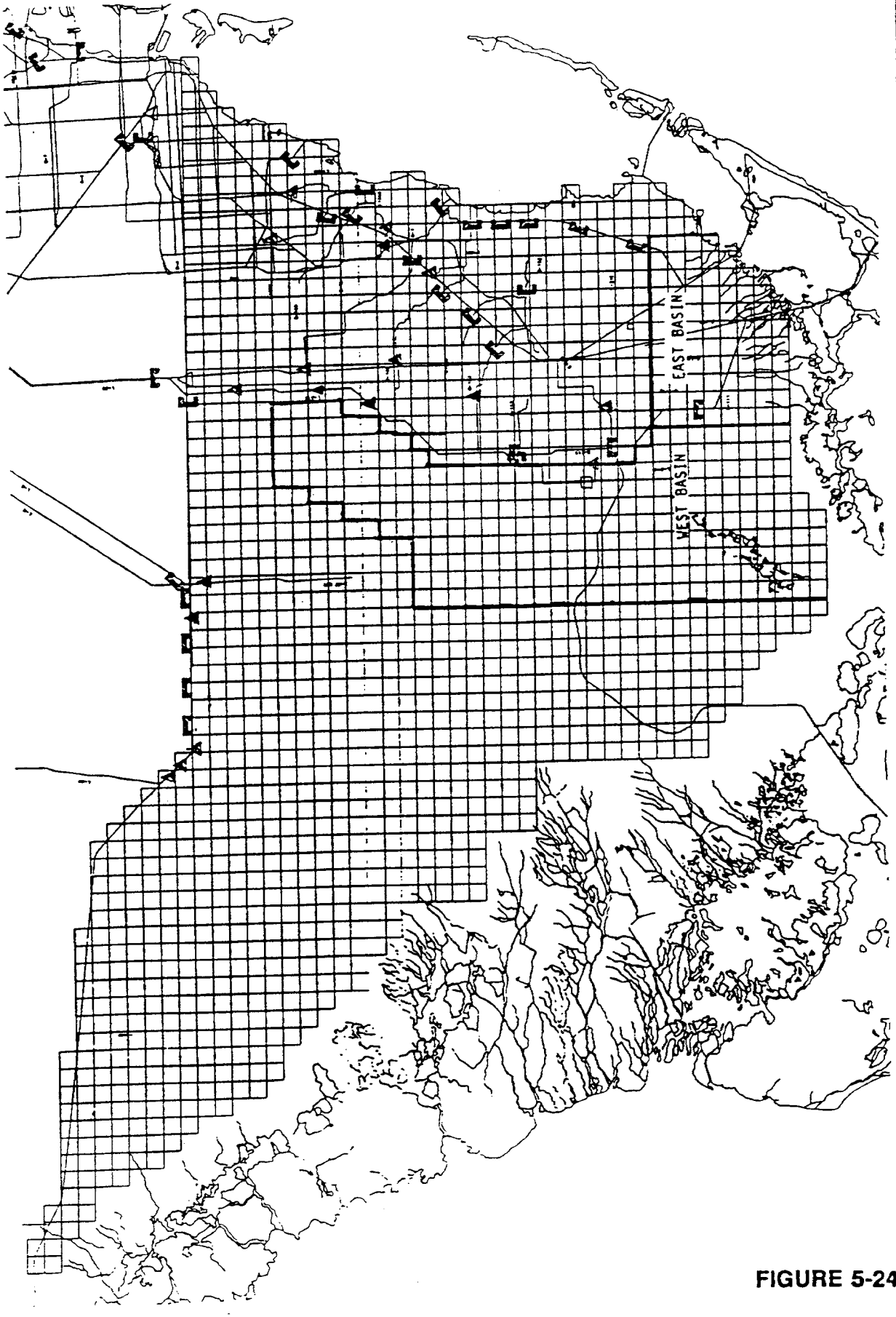
- Marl soils were formed and maintained under an average hydroperiod of about 7 months.

- Water levels may have reached lows of 20-30 inches below ground level. Water recession of from 24 inches to 30 inches below ground level might cause rapid and complete loss of water from marl soils and death of hydric, vascular plants.

- The average depth of flooding was 8.5 inches over marl soil and ranged from 3.2 inches to 20.9 inches.

The marl model (Annex G) was used to objectively assign a value between zero (0.00) and one (1.00) to projected water regimes under each alternative plan. The values, termed hydrohabitat indices (HhI), were derived as follows.

Using the marl model, alternative plans were rated for the west basin and for the east (lower C-111) basin by calculating an intermediate hydrohabitat index (HhI) value for each of 3 inundation conditions modeled on the period of record: wet (10 percent exceedance), dry (90 percent exceedance), and average (50 percent exceedance). These values were combined to produce an HhI for each basin under each alternative (the cube-root of the product of the three values).



C-111: East Basin and Maximum West Basin Areas

FIGURE 5-24

The marl model was capable of providing the maximum hydrohabitat index (HhI) value of 1.0 for water depths and conditions as follows:

- Depths no less than 0 inches (ground level) would be exceeded 90 percent of the time, and
- Depths no less than 8.5 inches would be exceeded 50 percent of the time, and
- Depths up to 21 inches may be reached 10 percent of the time.

A zero HhI value would result from a water level of -30 inches (below ground). Higher water levels that are less than optimum in a basin (east or west) cause alternatives to receive HhI values between 0.99 and 0.10.

The product of a basin's HhI and its affected area (square miles) is that basin's hydrohabitat unit (HhU) value. The sum of an alternative's east and west basin HhU values is the alternative's HhU.

The affected area of each basin is different under each alternative. The affected area for the base condition is the total area with a hydroperiod of 6 months or more: 687 square miles in the west basin and 71 in the east basin. (Table 9, Annex F, shows, for an average year, 758 square miles of the study area with a hydroperiod of 6 months or more. A count of square-mile units in the east basin showing a 6-month or greater hydroperiod--using a 5-color version of Plate 9, Annex F--yields the above-mentioned 71 square miles in the east basin, leaving 687 square miles in the west basin). The affected area for each alternative was determined similarly.

The total, potentially affected area, 1,557 square miles (1,471 sq. mi. west basin and 86 sq. mi. east), represents the maximum conceptual HhU. This is for average conditions over the historic period--greater than the period of rainfall record.

The HhU value is regarded as a gauge of how well an alternative's hydrology supports the sawgrass-on-marl ecosystem, compared to the base and other alternative conditions. Table 5-6 contains a comparison of HhU values for each basin under each alternative.

Alternatives 6 and 6A show over 100 percent improvement in hydrohabitat quality over the base condition. The alternative showing the next most improvement, alternative 4, improves habitat quality over base condition by 97 percent. Alternatives 6 and 6A have the potential for delivering water high in the rocky glades, into Taylor Slough, and south of lower C-111 in quantities and with the timing that contribute to 100 percent-improved habitat quality. These alternatives maintain dry season, sub-surface water at higher elevations in both east and west basins and increase water supply to the north part of the west basin.

Table 5-6
C-111
Hydrohabitat Indices, Area and Hydrohabitat Units For Restored, Existing and Alternative Conditions

	MAXIMUM CONCEPTUAL SCORE	EXISTING CONDITION	ALT 1	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6
HYDROHABITAT INDICES								
WEST BASIN	1.0	0.19	0.27	0.15	0.25	0.26	0.26	0.27
EAST BASIN	1.0	0.39	0.44	0.46	0.43	0.39	0.411	0.43
SQUARE MILES								
WEST BASIN	1471	687	829	829	917	1034	938	1027
EAST BASIN	86	71	118	130	127	116	123	128
HYDROHABITAT UNITS (HhU)								
WEST BASIN	1486	131	242	124	229	269	244	273
EAST BASIN	71	28	52	60	55	45	50	55
TOTAL HhU	1557	159	294	184	284	314	294	332

As measured, using the design water management schedule, all alternatives produce drier than optimum marl habitat conditions. In the dry season, water levels drop at least 12 inches below the ground surface, where water is held in solution cavities, in water control-structure receiving basins, and, perhaps, in alligator holes.

5.10.2 Species Compatibility Index

Eight species and biological communities were selected jointly by ENP, the USFWS, the Florida Game and Fresh Water Fish Commission, and the US Army Corps of Engineers as indicator species whose habitat requirements could be used to evaluate alternative plans. The species are the wood stork, roseate spoonbill, Cape Sable sparrow, and American alligator. Additionally, fresh water fish communities in Taylor Slough and in the marl prairie, the estuarine fish community and emergent plants were selected.

Optional hydrological criteria for the indicator species in the study area were defined by the ENP staff, as follows:

ENP data indicate that wood storks begin breeding colony formation earlier in years when extensive areas of higher-elevation, marl prairie are flooded in the early dry season (November-December). Based on the hypothesis that colonies that form earlier are more likely to be successful than those that form later, ideal conditions are defined as those that produce the greatest area of surface water flooding during November and December.

Data on the roseate spoonbill compiled by ENP suggest hydrological limitations that define best conditions for reproductive success. Colony success appears greatest when adult birds can find adequate feeding conditions in the mainland wetlands mostly east of US Highway 1 and in the lower portions of the C-111-Taylor Slough basin.

Ideal foraging conditions are created by extensive flooding early in the nesting season months of November and December, followed by moderate, regional drying patterns during the nestling season through March. Drying that is too slow does not adequately concentrate prey, and when it is too rapid, the adult birds must fly greater distances to find foraging sites. Ideal conditions would have the largest, lower basin land area flooded during November, and 50-75 percent of the area dry by the end of March. These conditions occur infrequently in the C-111 study area, which provides only the western extremity of the spoonbill's present foraging range.

Cape Sable sparrow data suggest that nesting is reduced when surface water is present in the colony sites during the February to June nesting season. The best condition has the smallest flooded area in the marl prairie habitats during the nesting months.

ENP data suggest that the number of adult female alligators that initiate nesting during June each year is proportional to the area of surface flooding in the sloughs during the courtship period in April and May. The ideal condition has the most land area flooded during April and May.

Emergent aquatic plants in the marl prairie-Taylor Slough area are reported to be stressed or killed when the water level recedes to greater than 24-30 inches below ground surface. Best habitat conditions are those with a minimum of area with subsurface drying greater than 30 inches for two or more consecutive months per year.

Criteria for fresh water fishes in Taylor Slough are specified as the largest spatial area with uninterrupted, year-to-year flooding. In the marl prairie area, ideal habitat conditions are (a) the maximum land area in the marl prairie where (b) water depths are less than 1 meter below ground (c) 12 months per year.

Estuarine fishes have habitat requirements that ideally provide (a) the largest land area in lower C-111 and Taylor Slough basins with (b) surface water depths greater than 0.5 feet (c) during the late wet season months of September-October.

The criteria were incorporated with the output of hydrological models of alternative plans under the schedule of optimum water levels prior to the interim test (base condition) to produce a compatibility index for each species under each alternative. An alternative's species compatibility index is the product of the time period in months and the number of square-mile cells that coincidentally meet the optimum habitat conditions for a species. The resulting numbers represent the areal extent and frequency with which an alternative meets a faunal species's or a plant community's hydrological requirements for optimal reproductive success. The output numbers are shown in Table 5-7. Because alternative 9 was not cost effective, a species compatibility score was not computed.

These groups have differing, in some cases competing, seasonal habitat requirements. The differences are magnified when ideal reproductive conditions for each group are compared. The competing requirements, perhaps, contribute to causing the Species Compatibility scores to show small differences between alternatives. Alternatives show notable improvements for one or two indicator groups, but poor potential for other groups. This is to be expected among competing groups.

Table 5-7
C-111
Species Compatibility Scores
For
Restored, Existing and Alternative Conditions

SPECIES OR COMMUNITIES	MAXIMUM CONCEPTUAL SCORE	EXISTING CONDITION	ALT 1	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6 and 6A
WOOD STORK	458	41	44	45	59	62	51	59
ROSEATE SPOONBILL	17	8	8	9	4	5	4	9
CAPE SABLE SPARROW	1145	350	354	356	409	348	349	361
AMERICAN ALLIGATOR	172	50	51	50	51	51	50	51
FRESH W. FISH TAYLOR SLOUGH	86	8	8	8	8	8	7	8
FRESH W. FISH MARL PRAIRIE	2748	2356	2360	2370	2370	2357	2386	2379
ESTUARINE FISH	344	211	219	224	240	232	223	228
EMERGENT AQUATIC PLANTS	172	71	72	76	77	74	76	74

An independent analysis was performed by ENP staff, using 5 of the species and communities. The ENP report of its analysis is included as Annex F. The ENP analysis and that of the Corps are similar.

5.10.2.1 Emergent Plant Criteria

Considering only the depth limit of low ground water tolerated by emergent plants in the study area and ignoring high water limitations and hydroperiod, alternative 3 is a 9 percent improvement over the existing condition. Other alternatives allow ground water to drop below 30 inches below ground level more often or in a larger area. Alternative 5 produces only 8 percent improvement over the existing condition, and other alternatives provide less improvement (Table 5-7).

5.10.2.2 Estuarine Fish Criteria

Surface water greater than 0.5 foot during the late wet season months, September and October, optimum for estuarine fishes, probably was a common historic occurrence in the lower C-111 and Taylor Slough basins (section 2.5). As modeled under the base condition, alternatives 3, 4, and 6/6A have the greatest tendency toward the criteria condition, improving the existing condition by amounts from 8 percent (alternatives 6/6A) to 14 percent (alternative 3). Alternative 1 contributes least toward benefiting estuarine fishes (4 percent improvement over the existing condition).

5.10.2.3 Fresh Water Fish, Marl Prairie Criteria

Conditions that favor fresh water fish in the marl prairie would have (a) the minimum land area in the marl prairie where (b) water depths are 1 meter or more below ground (c) for one or more months during the year. Alternatives except 1 and 4 provide marginal improvement over existing conditions. The other two alternatives provide less than 1 percent improvement, but under all alternatives water is present in subsurface refugia to at least 0.6 meter below ground level.

5.10.2.4 Fresh Water Fish, Taylor Slough Criteria

Uninterrupted surface flooding over an extended time period, i.e., consecutive years, is the condition that favors increasing density and biomass of fishes. Only a small area in Taylor Slough is capable of providing an area of such flooding. Alternatives 1 and 4 produce a 5 percent increase over existing condition, and alternative 6 produces a 3 percent increase in such an area. All other alternatives decrease the area of interannual flooding.

5.10.2.5 Wood Stork Criteria

ENP observations support the hypothesis that stork colonies in ENP form earlier in years when extensive areas of the higher elevation, marl prairie marshes are flooded in the early dry season (November-December), and form later in years when the prairies are dry during those months. Such conditions are improved under alternative 4 by 49 percent and under alternatives 3, and 6 by 43 percent over the existing condition. Alternative 5 represents a 42 percent improvement, and alternatives 1 and 2 provide 5 percent to 8 percent improvement, respectively.

5.10.2.6 Roseate Spoonbill Criteria

Spoonbills nest along the mainland coastal wetlands and rear the young from January through March. Ideal foraging conditions are created by extensive flooding early in the nesting season (November-December), followed by moderate, regional

drying patterns through March. Ideal reproductive conditions are those with the greatest land area flooded in the lower basins during November, with 50-75 percent of the map-cells dry by the end of March (ENP). The alternatives with lower C-111 left unplugged, alternatives 6 and 2, provide a 12 percent improvement, modeled with the base condition. The others provide no improvement or worsen conditions compared to the existing condition.

5.10.2.7 Cape Sable Sparrow Criteria

With acceptance of data that suggest that Cape Sable sparrow nesting effort is reduced in colony sites when surface water is present during the February to June nesting season, alternatives 4 and 5 may be ranked as favorable. These alternatives cause the known colony sites to be surface dry in the nesting season and are an improvement over the existing condition. Under alternatives 6 and 6A, 0.1 feet of water may cover a portion of the southern nesting area in the early part of the nesting season, and deeper water (0.4 feet) may be present under the other alternatives.

5.10.2.8 Alligator Criteria

Conditions providing for surface flooding in the sloughs during the alligator courtship period in April and May favor alligator reproduction. None of the alternatives, as modeled under the base condition, improve upon existing conditions by more than 3 percent.

5.11 SALTWATER INTRUSION

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 is about 200 feet thick at the coast but thins to a few feet thick near its western boundary 35 to 40 miles inland. This aquifer, and surficial aquifers in Palm Beach County, provide water for municipal and industrial water supply, and agricultural irrigation along the southeast coast. Seepage and water supply releases from the WCA prevent saltwater intrusion along the coast and recharge the surficial aquifers. The original design of the ENP-South Dade County Conveyance Canal system considered that, except at coastal salinity structures, canal stages would be permitted to recede approximately 1.5 feet below the optimum levels before supplemental water was introduced into the ENP-South Dade County Conveyance Canal system. The alternative plans use this operating criteria, therefore, it is anticipated that there would be no change in salinity encroachment problems.

5.12 PLANNING CRITERIA

Performance of the alternatives with respect to planning criteria, including the planning objectives, planning constraints, evaluation factors and the four P&G criteria of completeness, effectiveness, efficiency, and acceptability, is displayed in Table 5-8.

5.13 PUBLIC VIEWS

There are a few general themes that persist throughout public sentiment with regard to the alternative plans. Among the environmental community, there is a need to restore the flow of water to Everglades National Park, through Taylor Slough and the Eastern panhandle of the Everglades. Surface waters flow southward from Taylor Slough before merging into Florida Bay via a number of small creeks and channels. Taylor Slough was historically a major contributor of freshwater to Florida Bay. The slough is also an important ecosystem in its own right, providing critical habitat for a variety of native Everglades flora and fauna.

Conversely, the agricultural community is concerned that project modifications for water delivery to the park will adversely impact agriculture production within the C-111 study area. Agricultural productivity requires lower canal stages during the planting season. If canal stages are too high, row crops cannot be planted early enough for the crops to be marketed within the optimum time frame. High canal stages can also damage the root zones of tree crops which can lead to loss of the crop and/or death of the tree.

5.14 EVALUATION OF ALTERNATIVE PLANS

The evaluation factors described in Section 5.5 were utilized to measure each alternative plan's effectiveness at satisfying the project objectives described in Section 5.2. Inasmuch as the C&SF Project impacts hydrologic conditions in Taylor Slough and Florida Bay, the principle objective of this project is the restoration of hydrologic conditions in the C-111 basin, including Taylor Slough. If this objective is accomplished, the project objective of protecting the natural resources of ENP will also be satisfied.

Table 5-8
Planning Criteria Evaluation

PLANNING CRITERIA	"WITHOUT PROJECT" CONDITION (NO ACTION)	ALT 1	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6 and 6A	ALT 1A
OBJECTIVES:								
Restoration of historic hydrologic conditions	0	+	+	+	+	+	+	+
Protection of natural values associated with ENP	0	+	+	+	+	+	+	+
Elimination of excess freshwater inflow to Manatee Bay/Barnes Sound	0	+	+	++	++	+	+	+
Maintain flood protection for agriculture	0	+	+	+	+	+	+	+
EVALUATION FACTORS:								
Operational Flexibility	0	+	+	+	+	+	++	+
Cost Effective	0	+	+	+	+	+	+	+
Environmental Outputs	0	+	+	++	++	+	++	+
Flood Control Impacts	0	+	+	+	+	+	+	+
P&G FOUR CRITERIA								
Completeness	Not applicable	High	High	High	High	High	High	High
Effectiveness	Not applicable	Low	Low	Moderate	High	Moderate	High	Low
Efficiency	Not applicable	Low	Low	Moderate	Moderate	Moderate	High	Low
Acceptability	Not applicable	Low	Low	Low	High	Low	High	Low

Plans effects are estimates of net overall changes from the "without project" condition:

++ very beneficial change
+ beneficial change
0 no change
– very adverse change
- adverse change

5.14.1 Operational Flexibility Evaluation of Alternative Plans

The operational flexibility factors are measures of each alternative plan's abilities to satisfy the project objectives of restoration of historic hydrologic conditions in Taylor Slough, the elimination of damaging freshwater discharges to Manatee Bay/Barnes Sound and maintaining flood protection for the C-111 basin east of L-31N and C-111. There are 11 separate, but related, measures that were utilized to judge each plan's responsiveness to the operational flexibility evaluation factor as shown in Table 5-9. Alternative 8 was developed in conceptual detail only and was outside the scope of this project. Therefore, it was not evaluated as proposed. The plan was modified and is evaluated as alternative 6A.

All alternative plans restore more natural flows to the middle and lower portions of Taylor Slough. However, this area has been least impacted by the C&SF Project construction and operation.

All alternative plans will substantially reduce or eliminate the need for damaging freshwater discharges to Manatee Bay/Barnes Sound. Alternatives 1, 1A, 2, 6, 9, and 6A provide additional flood control discharge capacity at alternative locations upstream of S-176. As a result, flows into the lower section of C-111 will be reduced, thereby reducing the need for S-197 discharges. Additionally, all of these plans except alternative 1A include degrading the spoil mounds on the south bank of C-111 between S-18C and S-197. This also provides additional outlet capacity upstream of S-197. Alternatives 3 and 4 totally backfill lower C-111. Alternative capacity is provided at the east/ west spreader canal. This will have the effect of eliminating all S-197 discharges. Alternative 5 includes partial backfilling of lower C-111 with alternative discharge capacity provided at the east/west spreader canal. This will reduce the physical capacity for discharging water at S-197. Also, this plan includes increased upstream discharge capacity that would reduce inflows to the lower C-111.

Restoration of the headwaters and upper portions of Taylor Slough is critical to achieving overall restoration of historic conditions in all of Taylor Slough. This involves restoring the location, timing, and volumes of flows into this area. Alternatives 3 and 5 include no means of discharging water into the headwaters and upper Taylor Slough and therefore, do not satisfy this measure. Alternatives 1, 1A, and 2 include a small pump and canal at the location of Context Road to address this goal. However, the single location of discharges, the inability to control the timing of discharges, and the inadequate capacity resulted in these alternatives not satisfying this evaluation measure.

Table 5-9
Alternative Plan Evaluation Matrix

Evaluation Factors	Alternative Plans									
	1	1A	2	3	4	5	6	8	9	8A
OPERATIONAL FLEXIBILITY *	Not met	Not met	Not met	Not met	Met	Not Met	Met	NA	Met	Met
a. Maintain Natural Water levels along boundary of headwaters and upper Taylor Slough.	N	N	N	N	N	N	N	NA	N	Y
b. Control location of flows into: - Taylor Slough headwaters/upper - Taylor Slough middle portion	N Y	N Y	N Y	N Y	Y Y	N Y	Y Y	NA NA	Y Y	Y Y
c. Control timing of flows into: - Taylor Slough headwaters/upper - Taylor Slough middle portion	N N	N N	N N	N Y	N N	N N	N N	NA NA	N N	Y Y
d. Control flows to east-west spreader canal lands	Y	N	Y	Y	Y	Y	Y	NA	Y	Y
e. Minimize flows to Manatee Bay/Barnes Sound	Y	Y	Y	Y	Y	Y	Y	NA	Y	Y
f. Uniform sheetflow to lower Taylor Slough	Y	Y	Y	Y	Y	Y	Y	NA	Y	Y
g. Increase hydroperiods in headwaters and upper Taylor Slough	N	N	N	N	Y	N	Y	NA	Y	Y
h. Increase average depths in headwaters and upper Taylor Slough	N	N	N	N	Y	N	Y	NA	Y	Y
i. Maintain flood control in C-111 basin east of L-31N & C-111	Y	Y	Y	Y	Y	Y	Y	NA	Y	Y
ENVIRONMENTAL BENEFITS										
a. Increase hydrohabitat units	65%	NA	16%	79%	97%	85%	109%	NA	NA	109%
b. Increase species compatibility indices	7%	NA	10%	44%	51%	24%	44%	NA	NA	44%
COST EFFECTIVENESS Total Annual Cost ($ MILLION)	4.1	3.0	4.8	7.7	12.9	6.4	12.2	NA	14.6	12.0
FLOOD CONTROL IMPACTS Annual Flood Damage Reduction ($ MILLION)	3.2	3.2	3.0	2.9	2.9	2.9	2.9	NA	NC	2.9

* Operation flexibility evaluation factors are noted as follows:

N - Alternative plan does not satisfy evaluation factor

Y - Alternative plan does satisfy evaluation factor

NA - Not Applicable

NC - Not Computed

Alternatives 4, 6, and 9 include additional pumps that provide the ability to restore the historic location of flows to the headwaters and upper portions of Taylor Slough. These plans would, at least partially restore longer hydroperiods and water depths in the headwaters and upper portion of Taylor Slough. Alternative 6A also includes features that would enable the discharge of historic volumes of water at the proper locations into the area. It is the only alternative that would also enable maintaining higher water levels along the boundary of the headwaters and upper portion of Taylor Slough. This would be accomplished by allowing higher water levels and a wider range of water level fluctuations in the detention/retention area located adjacent to the ENP boundary. Alternative 6A is also the only alternative that would enable restoration of the historic timing of flows into the headwaters and upper portions of Taylor Slough. Water could be temporarily retained in the detention/retention area and discharged into Taylor Slough as appropriate.

Figures 5-25 through 5-36 provide graphical presentations of the base condition compared to alternative plans 1 through 6 with respect to water depth and hydroperiod. The data were derived using the SFWMM for 1976-1977, an average rainfall year. These data are summarized in Tables 5-10 and 5-11.

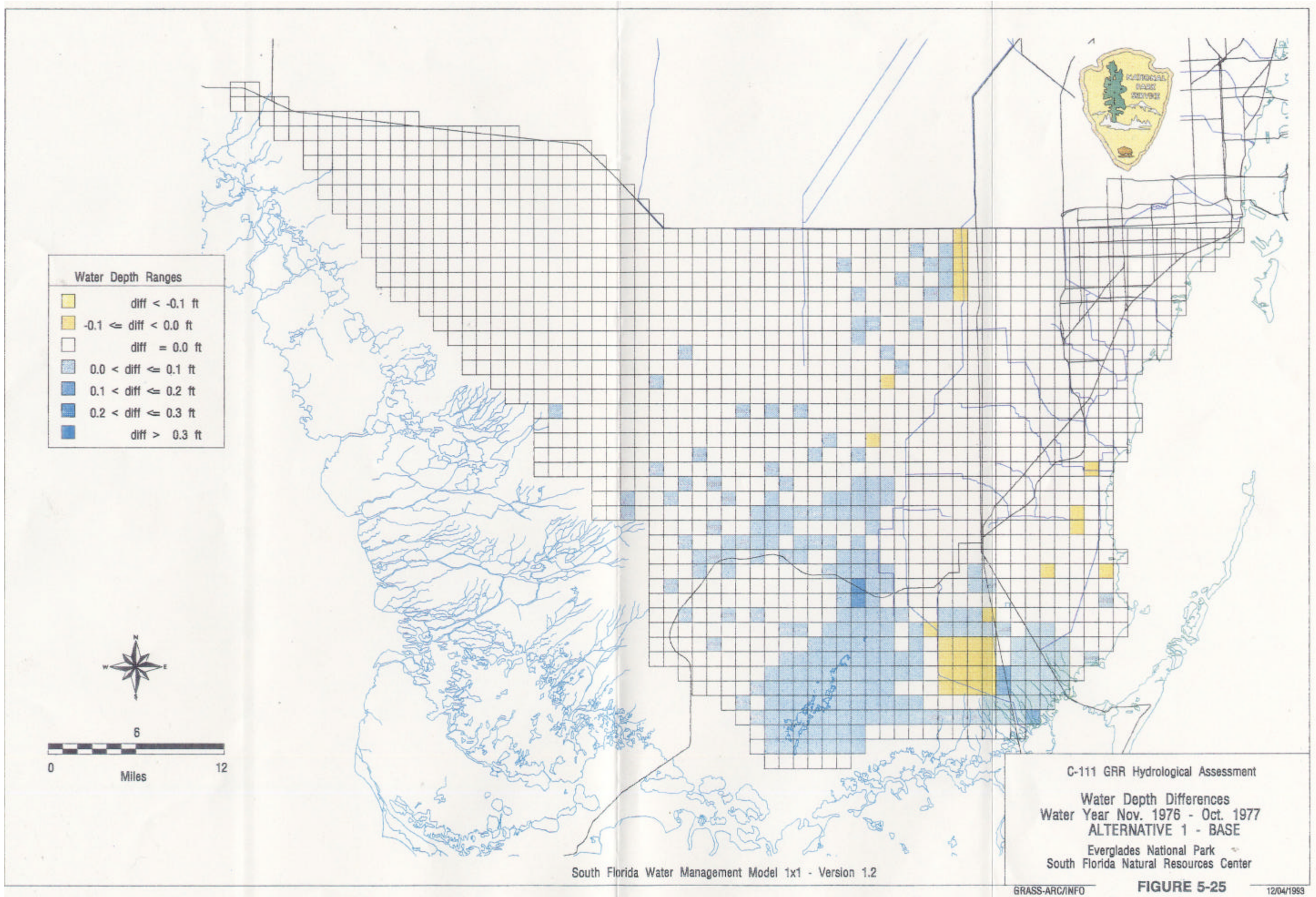
The differences between alternatives 6 and 6A are small enough that the hydrologic model utilized for this analysis cannot differentiate between them. The differences are within the one-square-mile grid size used for the model. Therefore, the model results for alternative 6 also apply to alternative 6A.

Table 5-10 shows that hydroperiods in Northeast Shark River Slough, Shark River Slough, and the Rocky Glades have been substantially increased with alternatives 4 and 6. Table 5-11 compares the Base Condition and alternatives 1,4, and 6 with respect to wet and dry season water depths. This table shows that both alternatives increase wet season water levels over a large area. However, dry season water levels are not greatly impacted.

Alternatives 4, 6, 9, and 6A, to varying degrees, enable restoration of historic flows to the headwaters and upper portions of Taylor Slough. Therefore, they all satisfy the evaluation measure for providing operational flexibility. Alternative 6A is the most effective at restoration of the headwaters and upper portions of Taylor Slough.

5.14.2 Cost Effectiveness Evaluation of Alternative Plans

The cost effectiveness of the alternative plans is measured by comparing the total annual costs. This includes the total project construction costs amortized over a 50-year project life and all annual operation, maintenance, repair, rehabilitation, and replacement costs. Table 5-12 summarizes the total annual costs of the alternative plans.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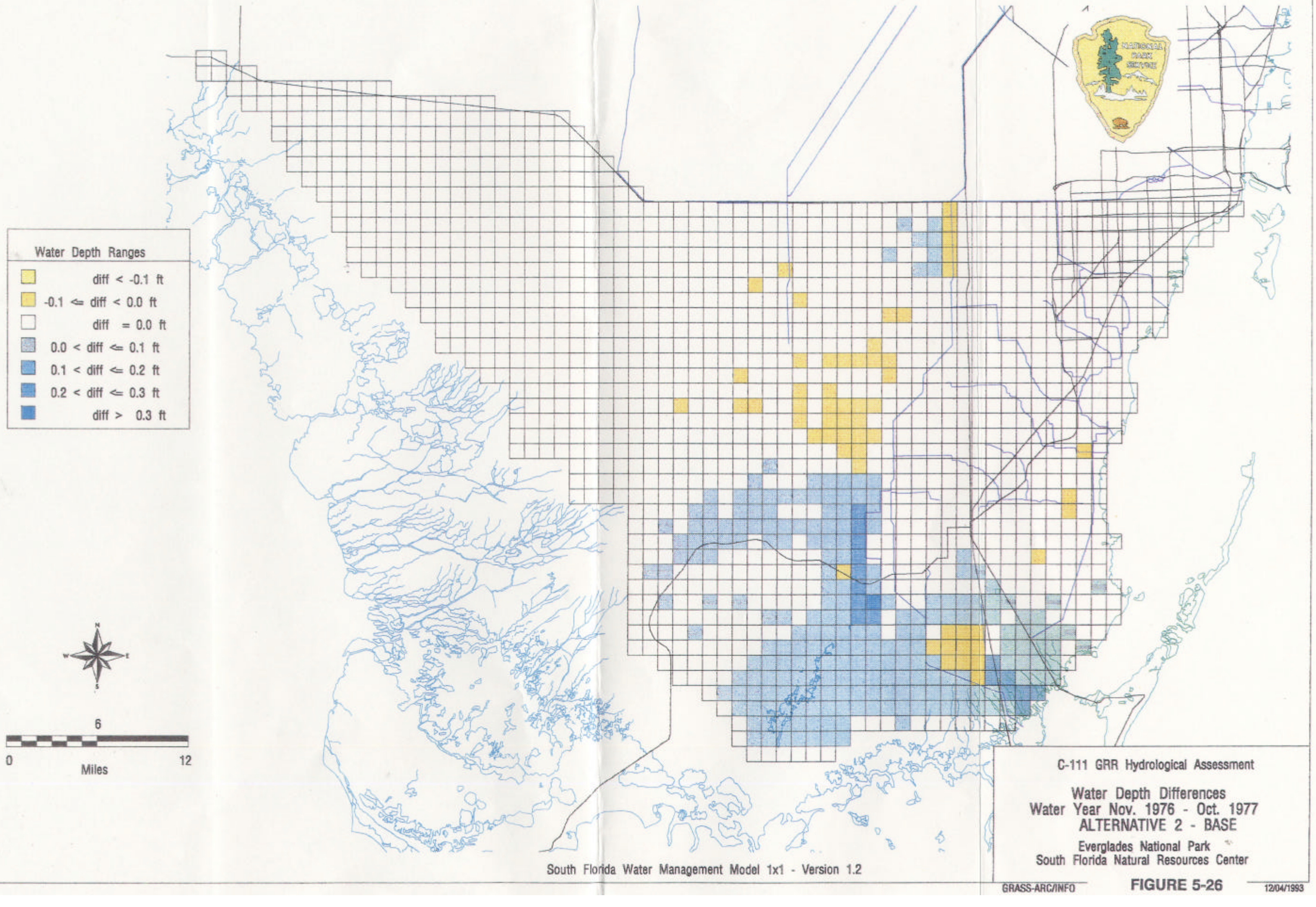
0.1 < diff <= 0.2 ft
0.2 < diff <= 0.3 ft
diff > 0.3 ft
N
W
E
S
6
0
Miles
12
NATIONAL PARK SERVICE
South Florida Water Management Model 1x1 - Version 1.2
C-111 GRR Hydrological Assessment
Water Depth Differences
Water Year Nov. 1976 - Oct. 1977
ALTERNATIVE 1 - BASE
Everglades National Park
South Florida Natural Resources Center
GRASS-ARC/INFO
FIGURE 5-25
12/04/1993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diff > 0.3 ft
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Miles
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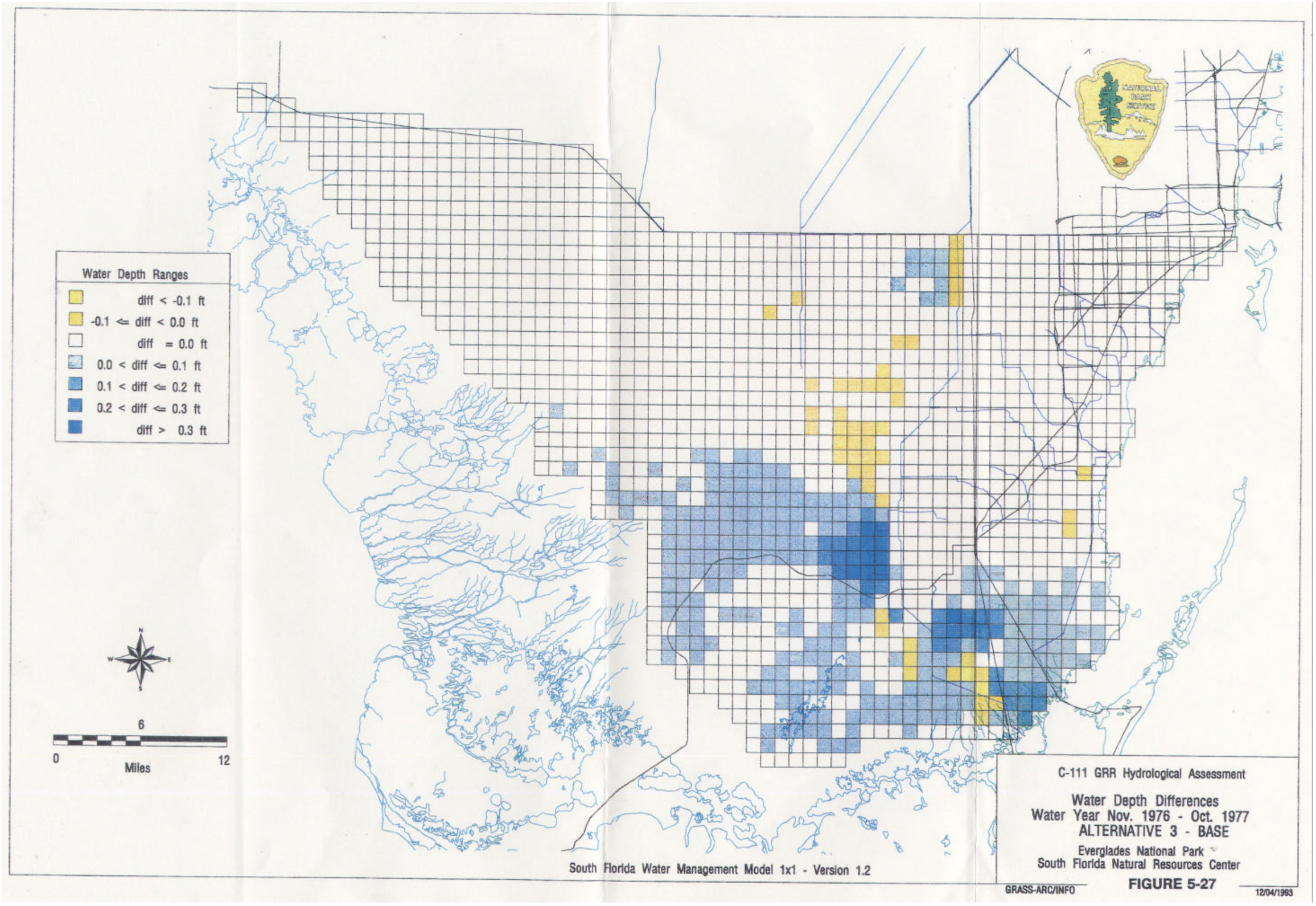
C-111 GRR Hydrological Assessment
Water Depth Differences
Water Year Nov. 1976 - Oct. 1977
ALTERNATIVE 2 - BASE
Everglades National Park
South Florida Natural Resources Center
South Florida Water Management Model 1x1 - Version 1.2
GRASS-ARC/INFO
FIGURE 5-26
12/04/1993


Water Depth Ranges
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0.1 < diff <= 0.2 ft
0.2 < diff <= 0.3 ft
diff > 0.3 ft
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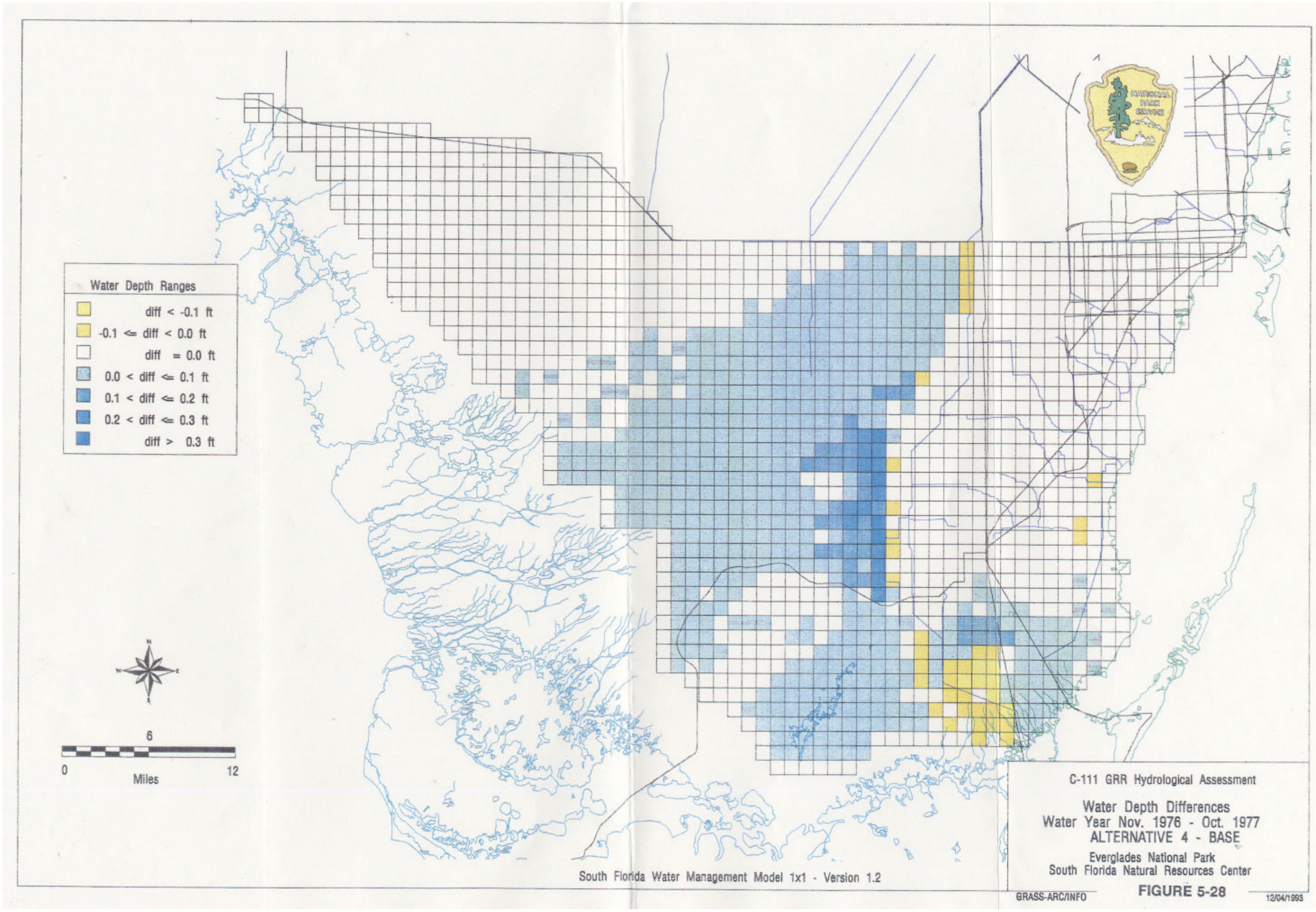
Miles
12
South Florida Water Management Model 1x1 - Version 1.2
C-111 GRR Hydrological Assessment
Water Depth Differences
Water Year Nov. 1976 - Oct. 1977
ALTERNATIVE 3 - BASE
Everglades National Park
South Florida Natural Resources Center
GRASS-ARC/INFO
FIGURE 5-27
12/04/1993


Water Depth Ranges
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0.1 < diff <= 0.2 ft
0.2 < diff <= 0.3 ft
diff > 0.3 ft
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Miles
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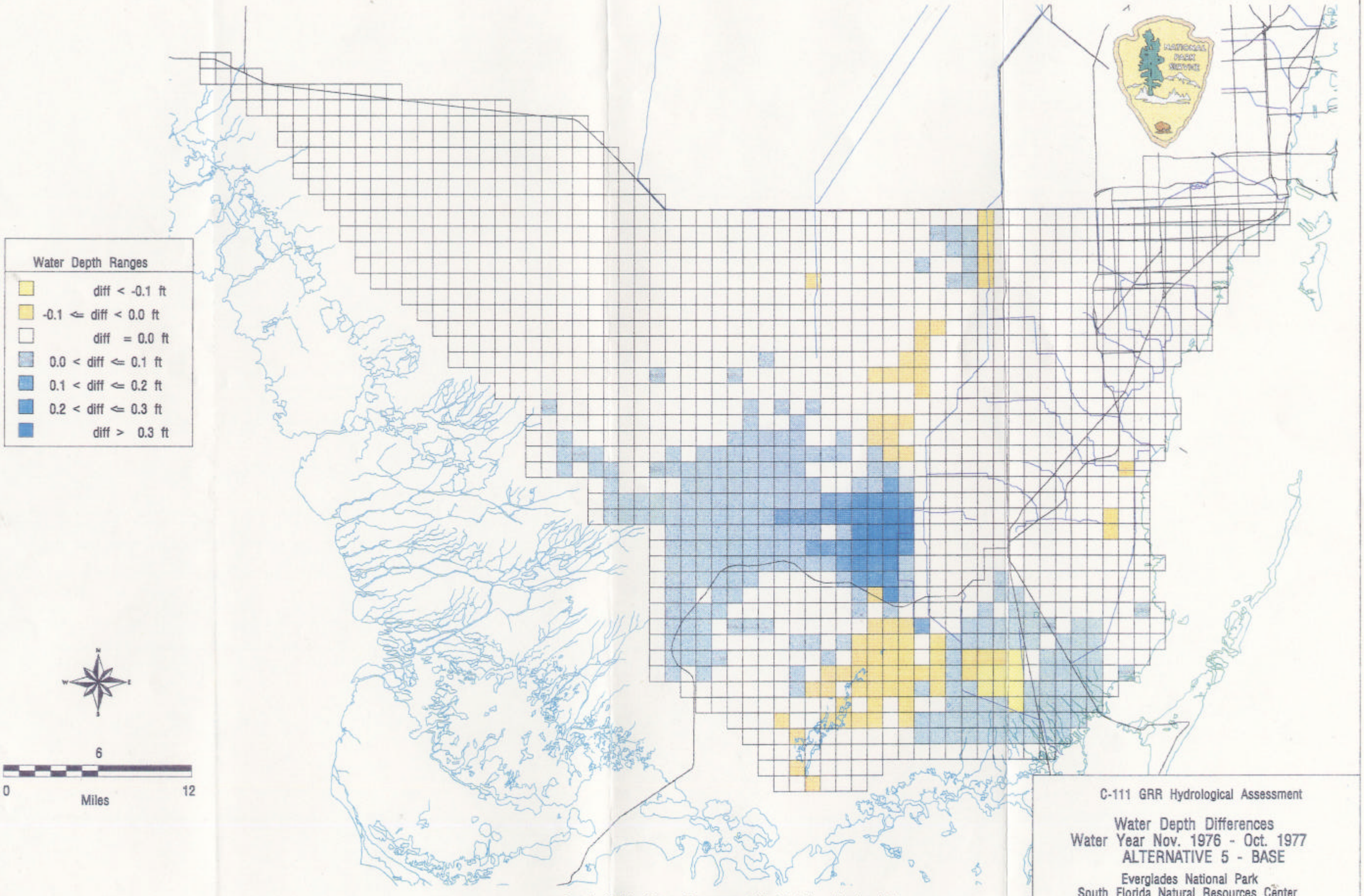
NATIONAL PARK SERVICE
South Florida Water Management Model 1x1 - Version 1.2
C-111 GRR Hydrological Assessment
Water Depth Differences
Water Year Nov. 1976 - Oct. 1977
ALTERNATIVE 4 - BASE
Everglades National Park
South Florida Natural Resources Center
GRASS-ARC/INFO
FIGURE 5-28
12/04/1993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0.0 < diff <= 0.1 ft
0.1 < diff <= 0.2 ft
0.2 < diff <= 0.3 ft
diff > 0.3 ft
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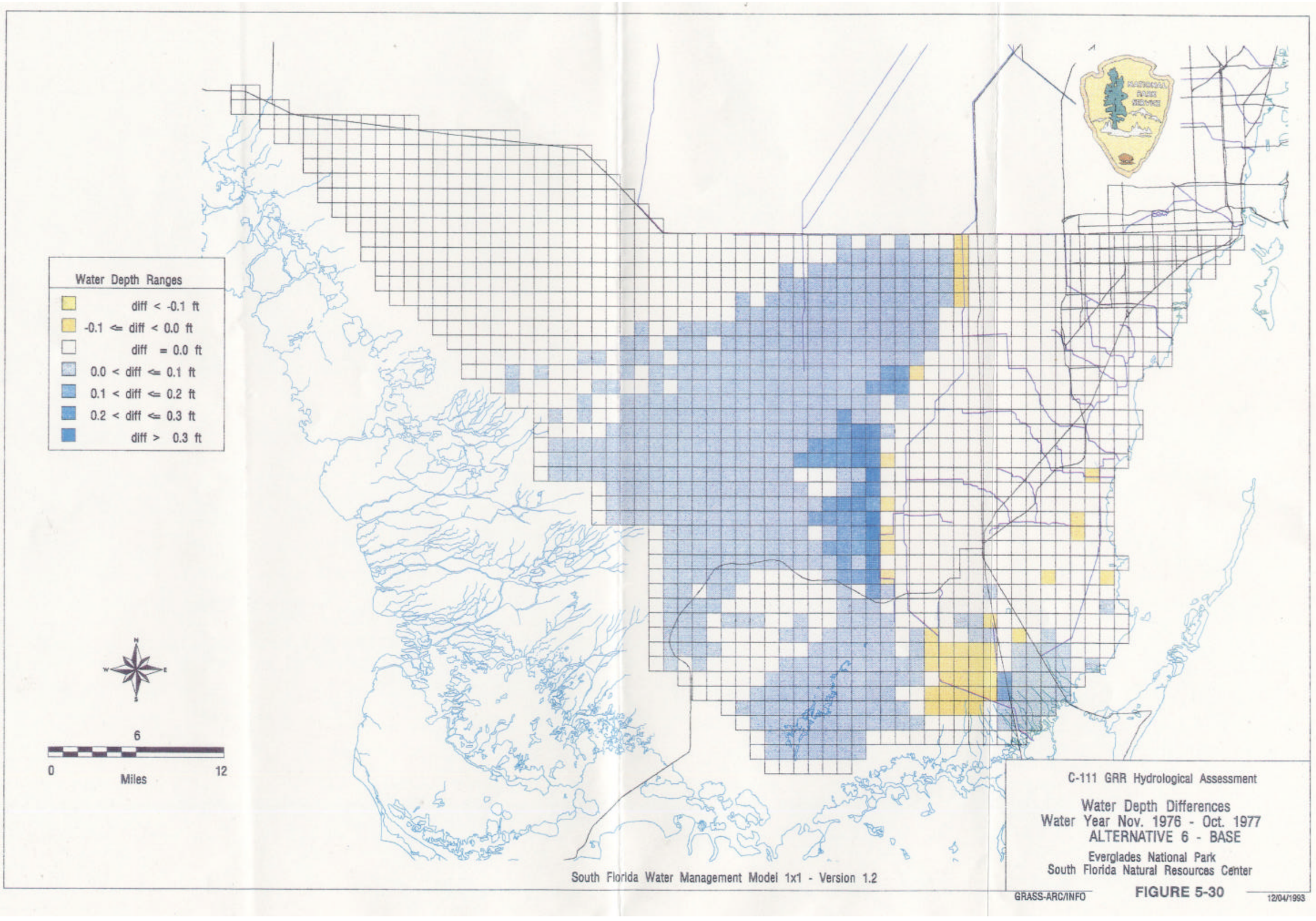
Miles
12
South Florida Water Management Model 1x1 - Version 1.2
C-111 GRR Hydrological Assessment
Water Depth Differences
Water Year Nov. 1976 - Oct. 1977
ALTERNATIVE 5 - BASE
Everglades National Park
South Florida Natural Resources Center
GRASS-ARC/INFO
FIGURE 5-29
12/04/1993


Water Depth Ranges
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-0.1 <= diff < 0.0 ft
diff = 0.0 ft
0.0 < diff <= 0.1 ft
0.1 < diff <= 0.2 ft
0.2 < diff <= 0.3 ft
diff > 0.3 ft
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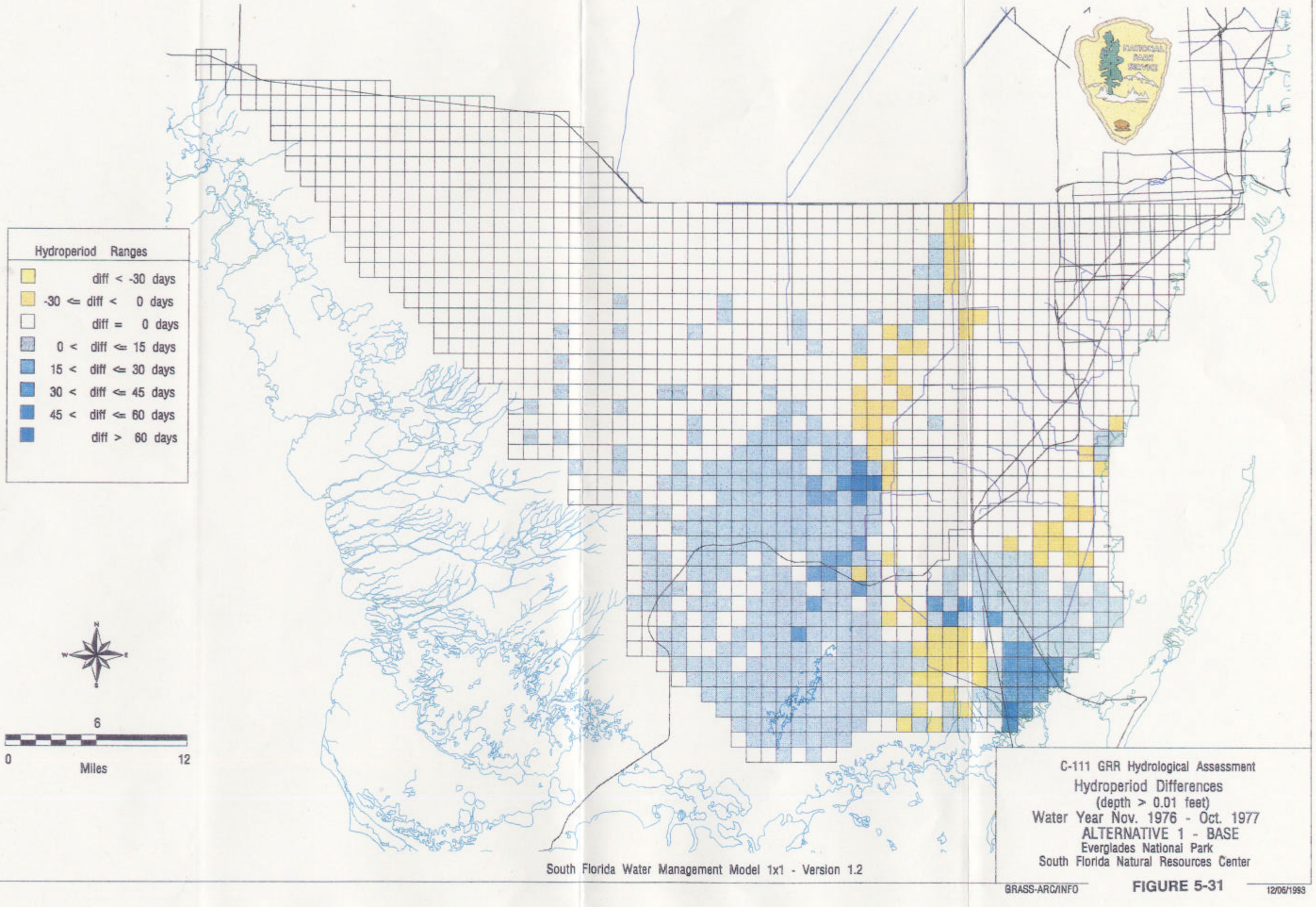
Miles
12
South Florida Water Management Model 1x1 - Version 1.2
C-111 GRR Hydrological Assessment
Water Depth Differences
Water Year Nov. 1976 - Oct. 1977
ALTERNATIVE 6 - BASE
Everglades National Park
South Florida Natural Resources Center
GRASS-ARC/INFO
FIGURE 5-30
12/04/1993


Hydroperiod Ranges
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-30 <= diff < 0 days
diff = 0 days
0 < diff <= 15 days
15 < diff <= 30 days
30 < diff <= 45 days
45 < diff <= 60 days
diff > 60 days
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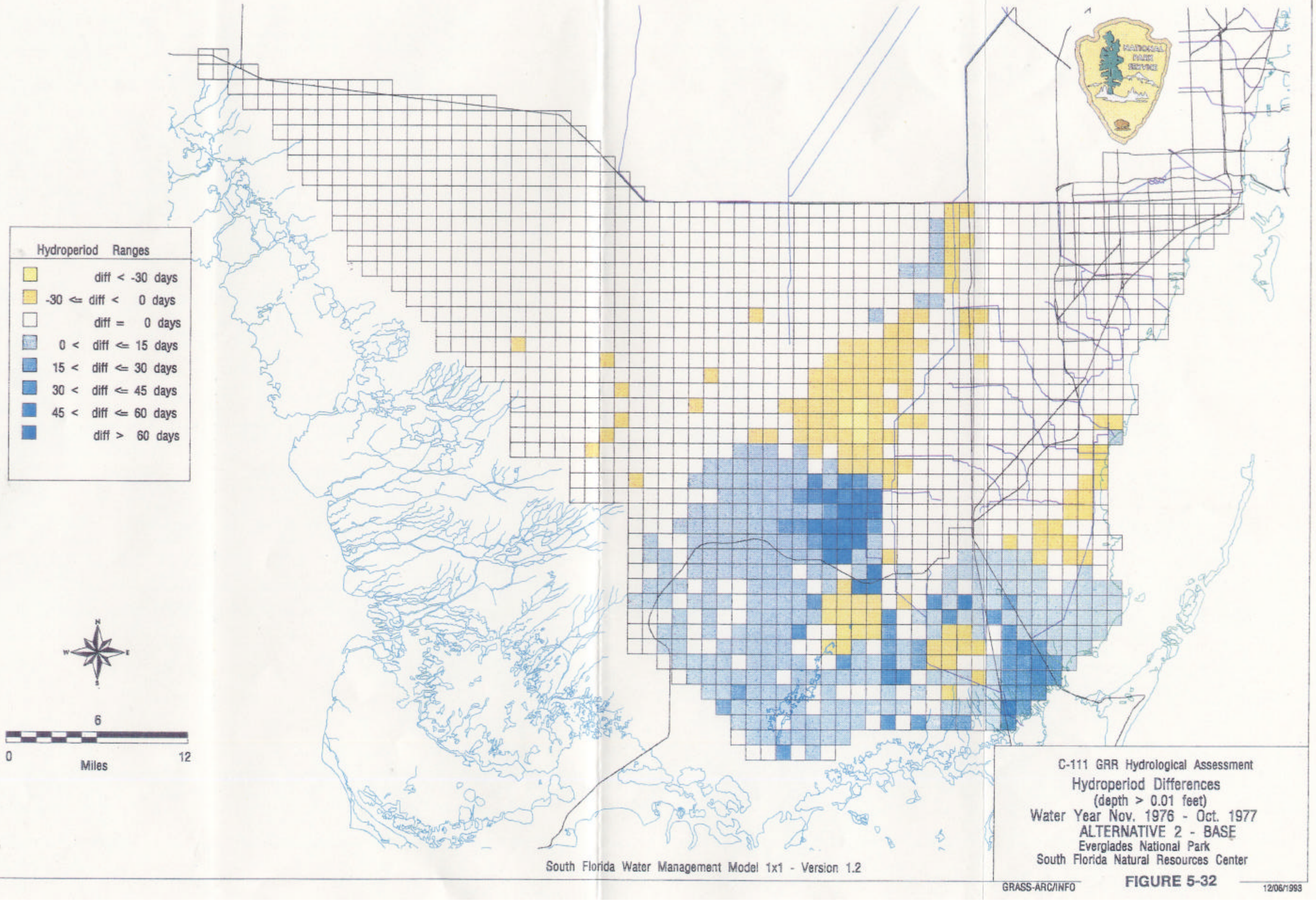
Miles
12
NATIONAL PARK SERVICE
South Florida Water Management Model 1x1 - Version 1.2
C-111 GRR Hydrological Assessment
Hydroperiod Differences
(depth > 0.01 feet)
Water Year Nov. 1976 - Oct. 1977
ALTERNATIVE 1 - BASE
Everglades National Park
South Florida Natural Resources Center
GRASS-ARC/INFO
FIGURE 5-31
12/06/1993


Hydroperiod Ranges
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-30 <= diff < 0 days
diff = 0 days
0 < diff <= 15 days
15 < diff <= 30 days
30 < diff <= 45 days
45 < diff <= 60 days
diff > 60 days
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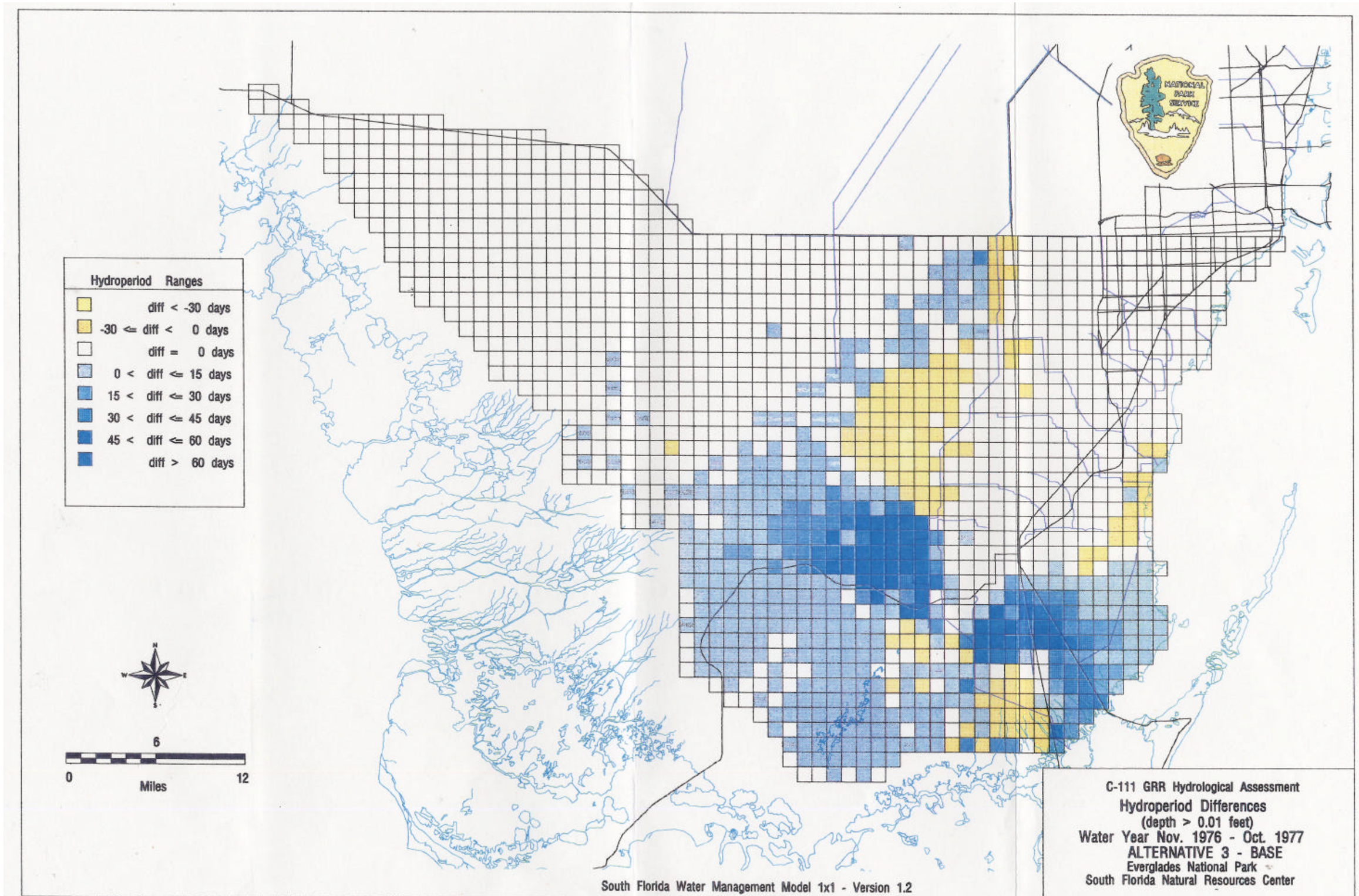
Miles
12
NATIONAL PARK SERVICE
South Florida Water Management Model 1x1 - Version 1.2
C-111 GRR Hydrological Assessment
Hydroperiod Differences
(depth > 0.01 feet)
Water Year Nov. 1976 - Oct. 1977
ALTERNATIVE 2 - BASE
Everglades National Park
South Florida Natural Resources Center
GRASS-ARC/INFO
FIGURE 5-32
12/06/1993


Hydroperiod Ranges
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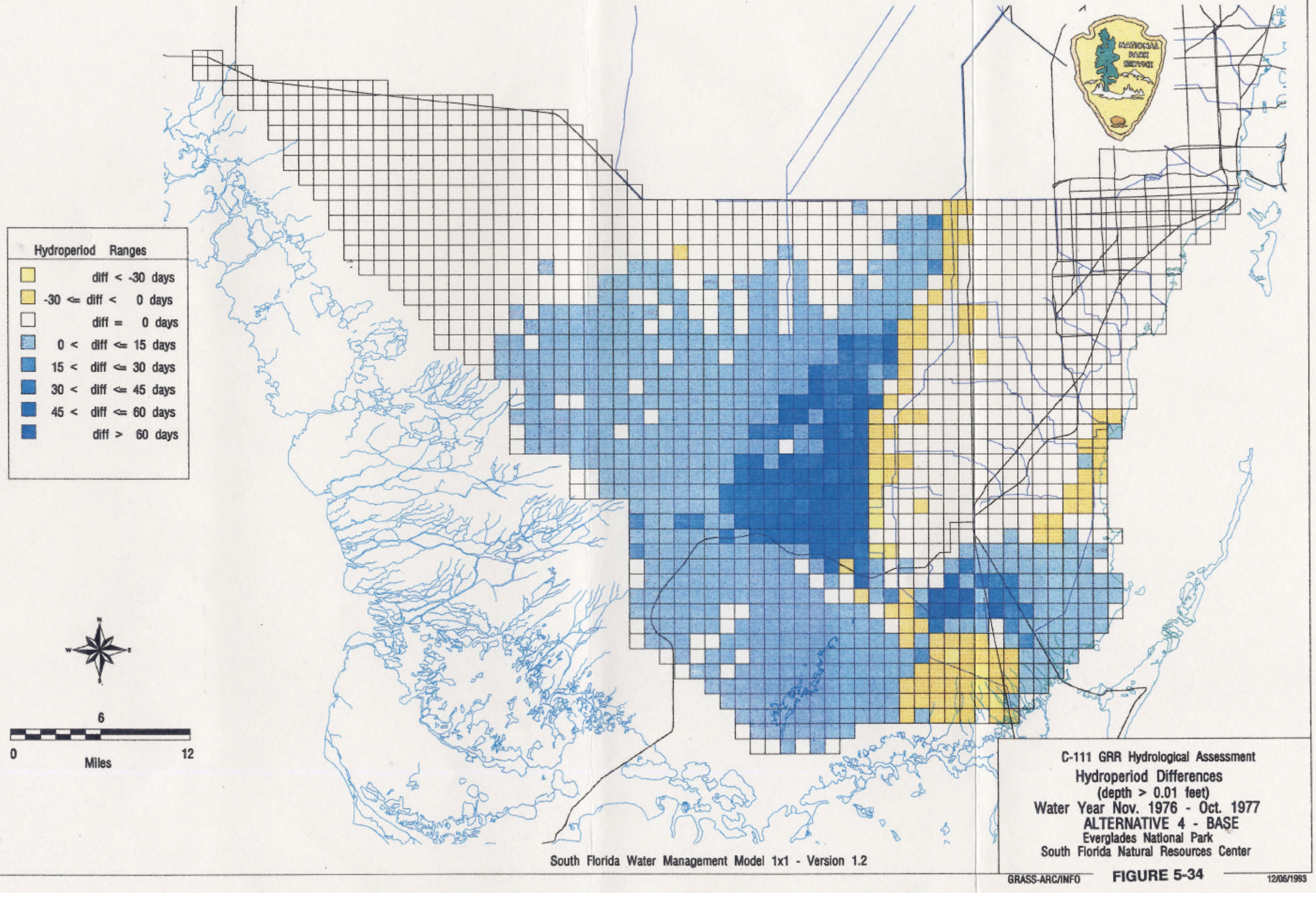
NATIONAL PARK SERVICE
C-111 GRR Hydrological Assessment
Hydroperiod Differences
(depth > 0.01 feet)
Water Year Nov. 1976 - Oct. 1977
ALTERNATIVE 3 - BASE
Everglades National Park
South Florida Natural Resources Center
South Florida Water Management Model 1x1 - Version 1.2
GRASS-ARC/INFO
FIGURE 5-33
12/06/1993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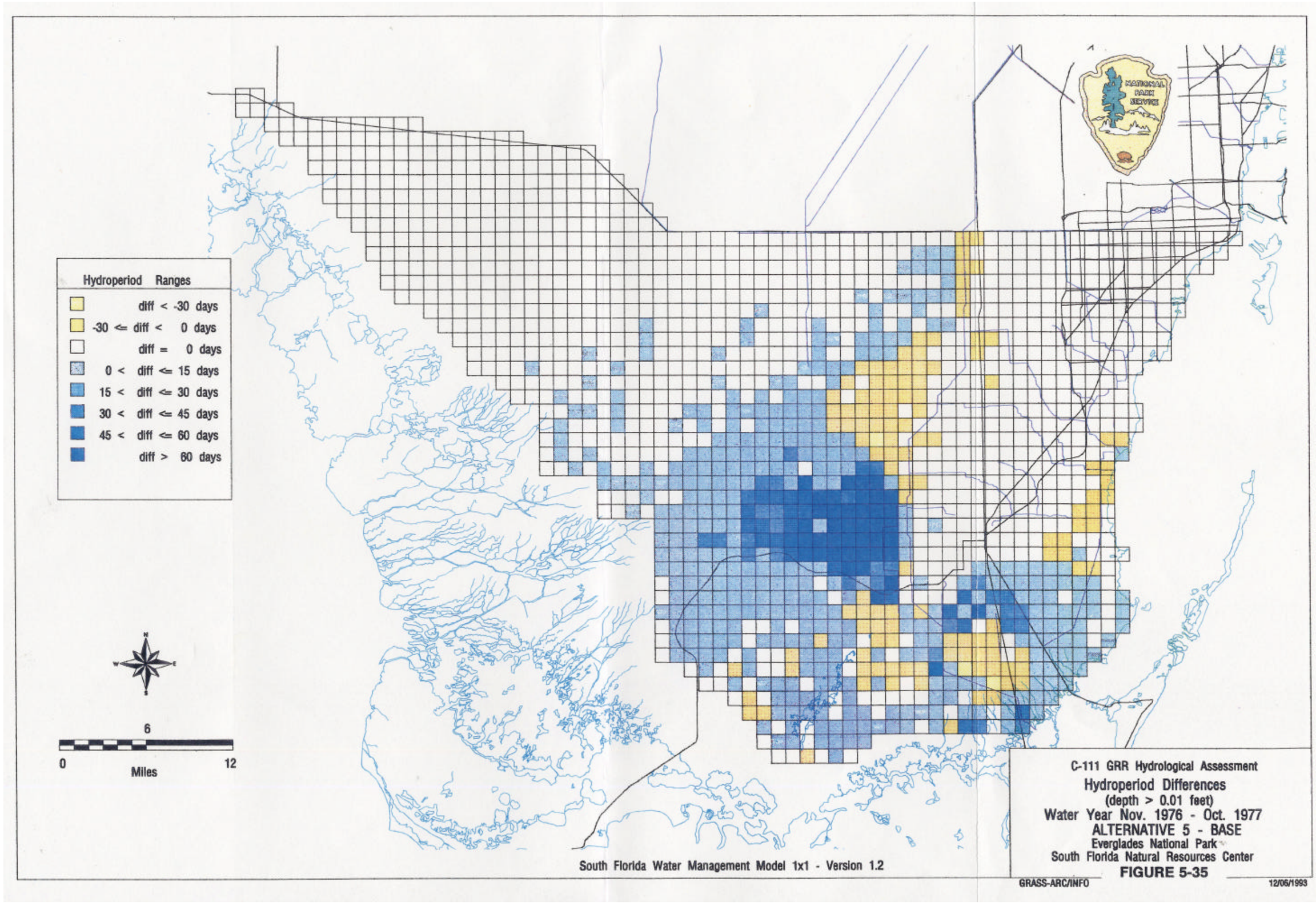
NATIONAL PARK SERVICE
South Florida Water Management Model 1x1 - Version 1.2
C-111 GRR Hydrological Assessment
Hydroperiod Differences
(depth > 0.01 feet)
Water Year Nov. 1976 - Oct. 1977
ALTERNATIVE 4 - BASE
Everglades National Park
South Florida Natural Resources Center
GRASS-ARC/INFO
FIGURE 5-34
12/06/1993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diff = 0 days
0 < diff <= 15 days
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Miles
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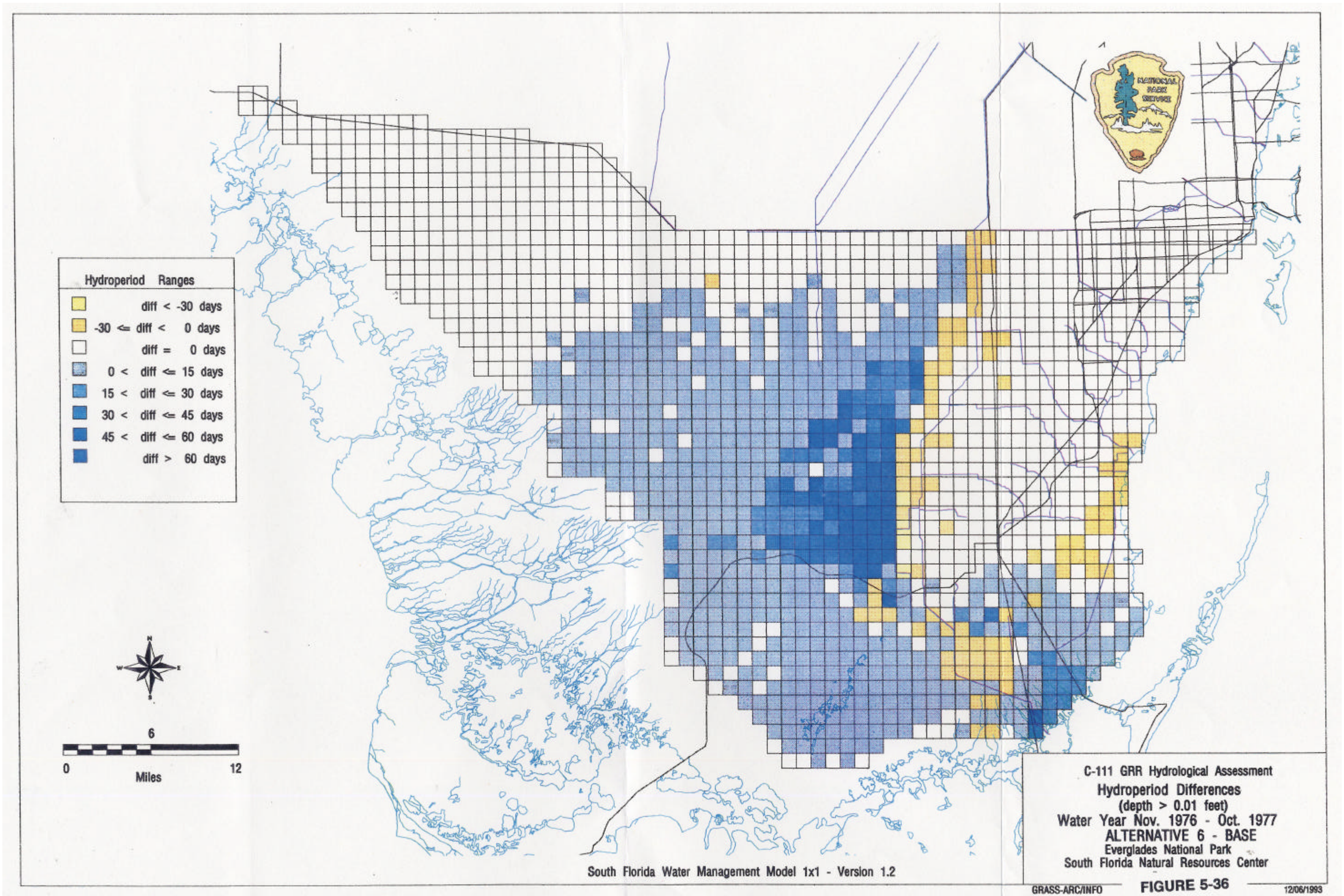
NATIONAL PARK SERVICE
South Florida Water Management Model 1x1 - Version 1.2
C-111 GRR Hydrological Assessment
Hydroperiod Differences
(depth > 0.01 feet)
Water Year Nov. 1976 - Oct. 1977
ALTERNATIVE 5 - BASE
Everglades National Park
South Florida Natural Resources Center
FIGURE 5-35
GRASS-ARC/INFO
12/06/1993


Hydroperiod Ranges
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NATIONAL PARK SERVICE
South Florida Water Management Model 1x1 - Version 1.2
C-111 GRR Hydrological Assessment
Hydroperiod Differences
(depth > 0.01 feet)
Water Year Nov. 1976 - Oct. 1977
ALTERNATIVE 6 - BASE
Everglades National Park
South Florida Natural Resources Center
GRASS-ARC/INFO
FIGURE 5-36
12/06/1993

Table 5-10
Hydroperiod Changes in the Subbasins

Average year 1976–1977 Depth > 0.01						
Change	A1-Bse	A2-Bse	A3-Bse	A4-Bse	A5-Bse	A6-Bse
	Northeast Shark Slough					
less	0	1	0	0	0	0
none	99	104	82	55	80	60
more	12	6	29	56	31	51
	Shark Slough					
less	0	3	0	0	0	0
none	53	63	34	2	20	2
more	25	12	44	76	58	76
	Rocky Glades					
less	12	53	46	9	34	9
none	53	34	22	4	9	5
more	69	47	66	121	91	120
	Upper Eastern Panhandle					
less	12	9	6	15	18	15
none	6	6	5	2	3	4
more	32	35	39	33	29	31
	Lower Eastern Panhandle					
less	10	2	13	23	6	7
none	11	10	6	1	7	3
more	15	24	17	12	23	26
	Upper Taylor Slough					
less	1	0	1	6	0	6
none	1	1	0	1	0	1
more	21	22	22	16	23	16
	Lower Taylor Slough					
less	0	14	7	1	19	4
none	3	15	8	5	17	3
more	81	55	69	78	48	77

Table 5-11
Changes in Ponding Depth in the Subbasins

Change	Average year 1976–1977 Water Depth					
	Dry Season - April			Wet Season - October		
	A1-Bse	A4-Bse	A6-Bse	A1-Bse	A4-Bse	A6-Bse
	Northeast Shark Slough					
less	0	0	0	0	0	0
none	108	79	86	73	1	1
more	3	32	25	38	110	110
	Shark Slough					
less	0	0	0	0	0	0
none	78	53	53	55	0	0
more	0	25	25	23	78	78
	Rocky Glades					
less	0	0	0	2	0	0
none	134	134	134	75	22	22
more	0	0	0	57	112	112
	Upper Eastern Panhandle					
less	0	0	0	15	11	24
none	50	50	50	9	4	9
more	0	0	0	26	35	17
	Lower Eastern Panhandle					
less	1	1	0	3	8	7
none	35	35	32	6	3	9
more	0	0	4	27	25	20
	Upper Taylor Slough					
less	0	0	0	2	4	4
none	23	23	23	4	2	2
more	0	0	0	17	17	17
	Lower Taylor Slough					
less	0	1	1	0	0	0
none	80	79	81	4	4	4
more	4	4	2	80	80	80

Table 5-12
Preliminary Analysis of Annual Benefits and Costs
Alternative Designs

ITEM	ALT 1	ALT 1A	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6	ALT 8	ALT 9	ALT 6A
Initial Cost	36,816,000	26,502,000	45,671,000	74,772,000	128,326,000	62,087,000	121,929,000	NC	179,196,000	121,413,000
Interest During Construction	8,024,000	5,760,000	8,506,000	12,070,000	17,053,000	9,283,000	15,648,000	NC	NC	15,534,000
TOTAL INVESTMENT COST	44,840,000	32,262,000	54,177,000	86,842,000	145,379,000	71,370,000	137,577,000	NC	NC	136,947,000
Interest & Amortization	3,665,000	2,637,000	4,429,000	7,099,000	11,884,000	5,834,000	11,246,000	NC	NC	11,194,000
Operation & Maintenance	358,000	354,000	385,000	536,000	935,000	479,000	892,000	NC	NC	748,000
Annualized Replacements	34,000	34,000	35,000	70,000	68,000	41,000	64,000	NC	NC	97,000
TOTAL ANNUAL COST	4,057,000	3,025,000	4,848,000	7,705,000	12,886,000	6,354,000	12,192,000	NC	14,648,000	12,039,000
TOTAL ANNUAL BENEFITS	3,179,000	3,179,000	2,969,000	2,906,000	2,906,000	2,906,000	2,906,000	NC	NC	2,906,000

5.14.3 Flood Control Impact Evaluation of Alternative Plans

Consistent with the original design of the south Dade County Flood control features and subsequent modifications to the system, the design of all alternatives utilize S-173/S-331 as a divide structure under flood conditions. All project features will convey runoff from the C-111 basin without inflows from S-331/S-173 during a design storm. During non-flood conditions, S-331 could pass flows into C-111.

All the alternatives were based on the premise that they would maintain the existing protection to the agricultural area. However, all alternative plans provide increased flood protection when compared to the existing project operated at the design optimum canal levels. Each of the seven alternatives basically provide similar hydrologic and hydraulic responses, therefore, only one major economic investigation was conducted. However, slight differences in flood damage effects for the plans are noted since some of the plans require different quantities of land purchases.

Alternative 1 requires no land purchases in the Frog Pond area. Alternative 2 is evaluated with the western three sections of the Frog Pond removed from production. Alternatives 3, 4, 5, 6, and 6A are evaluated with the entire Frog Pond removed from production. Alternatives 4, 6, and 6A also include the acquisition of the Rocky Glades (buffer zone) agriculture area. Alternative 1A is essentially the same as alternative 1 with the exception of the east-west spreader canal and plugs. An in-depth evaluation indicated that all alternatives would improve flood drainage in the study area and substantially reduce flooding durations, dollar damages, and crop land flooded during the 10-year and 2-year storm events. Since all alternatives provide the same level of flood protection, the flood damage reduction of all plans could be quantified using alternative 1A. Alternative 1A has a project cost of $26,502,000 with an annual cost of $3,025,000 at 8 percent and annual benefits of $3,179,000. The benefit to cost ratio of alternative 1A is 1.05 to 1.0.

A cost comparison of all alternatives is shown in Table 5-12.

5.14.4 Identification of the Recommended Plan

The plan that produces the greatest benefit to the environment while providing flood damage prevention capability within the study area is alternative 6A.

All alternative plans would satisfy the project objective of maintaining flood damage prevention capacities in the study area.

Satisfying the performance measure of operational flexibility is essential to meeting the project objectives of restoration of historic hydrologic conditions in the C-111 basin and Taylor Slough and reducing damaging freshwater discharges to Manatee Bay/Barnes Sound.

Four alternatives satisfied the operational flexibility measure, alternatives 4, 6, 9, and 6A. Of these alternatives, alternative 6A was the most effective by providing the ability to maintain higher water levels along the boundary of the headwaters and upper portions of Taylor Slough and by providing the capability to control the timing of discharges into Taylor Slough.

Of the four alternative plans that satisfied the operational flexibility criteria, alternative 6A was the least cost alternative. Therefore, it is judged to be the most cost effective.

SECTION 6

ENVIRONMENTAL EFFECTS OF RECOMMENDED PLAN

6.1 PHYSICAL FORM

The considered plans are intended to create a more natural physical environment in the Taylor Slough and C-111 basins. Water is to be held at optimum canal stages to prevent drainage of adjacent wetlands. Excess water will be pumped into the system above Taylor Slough so that it will sheet-flow southward, feed the slough, and restore a more natural hydroperiod to the marl prairie. Water will be allowed to drain southward into the lower C-111 basin. Provision of adequate water to the system, by means including the Modified Water Deliveries to Everglades National Park Project, will cause regeneration of the sawgrass-muhly grass prairies and reclamation of wet prairie land from invading exotic and native shrubs and trees. The restored physical habitat would make possible the return of masses of the wading birds that formerly inhabited the southeast Everglades.

6.2 HYDROLOGY

Hydrologic impacts of the recommended plan (Plan 6A) differed from the other plans most significantly by the physical distribution of the pump capacity along a north-south line of protection between the Everglades National Park and the agricultural lands east of L-31. Since the hydraulic gradient of the groundwater system slopes to the southeast, Shark River Slough discharges into the northern border of the Park are reduced as they transition from surface water flow below Tamiami Trail to groundwater flow in the Park. The impact of having an extended area of pumped discharges in Plan 6A causes higher groundwater levels along the eastern border of the Park with resultant loss in hydraulic slope away from Shark River Slough and an increase in total volume remaining in the slough.

Under existing conditions the C-111 area has about 2,765 cfs discharge capacity. During the 1988 flood control study, the selected plan raised this capacity to approximately 3,130 cfs. Plan 6A recommends 4,015 cfs, with the additional 400 cfs needed for seepage control along L-31. Soil moisture storage in the initial 1.5 feet of unsaturated ground above the water table provides about 3.6 inches of rainfall storage. The remaining volume of the 10-year, 5-day storm is removed by project structures.

The wide aerial extent of the water distribution capability of Alternative 6A restores the hydrology in 128 square miles of the Taylor Slough and its headwaters in the Rocky Glades. In addition, the hydroperiod and depths in 1027 square miles of Shark River Slough are beneficially impacted by the higher stages in the Rocky Glades, resulting in a net increase in water volume within Shark River Slough. The

aerial extent of the increase in hydroperiod is shown on Figure 5-36. During flood periods, the 1200 cfs of additional pump capacity will retain in Everglades National Park over 2300 acre feet per day of water that would have previously been diverted to tide water. These waters will eventually runoff into or infiltrate to Florida Bay at a rate more consistent with the historic natural timing.

6.3 ENVIRONMENTAL RESOURCES

6.3.1 Everglades National Park

The goal is restoration of the southeastern wet prairie Everglades, including southeastern Everglades National Park. The recommended plan would have the hardware and earthworks needed to provide for a 5 month to 7 month hydroperiod during which water covers the land surface to depths of 2 inches to 20 inches and seldom drops as much as 29-30 inches below ground surface. These conditions are those that produce abundant fresh water shrimp, crayfish and warm water fishes that proliferate during the wet season and become concentrated in drying pools during the dry season. Then they are prey for roseate spoonbills, wood storks, herons and egrets that may become re-established on their historic nesting and feeding grounds in and around Everglades National Park.

Improvements in the wet prairie ecosystem and in Taylor Slough attributable to Alternative 6A (Table 5-6) indicate that this alternative has the capacity to provide the hydrologic conditions requisite to a restored ecosystem in the southeastern Park. When modeled under the current design optimum water levels, (prior to the interim test), about 1,155 square miles of Everglades habitat, mostly within the Park, are benefitted by increased hydroperiod at optimum levels under Alternative 6A.

6.3.2 Shark River Slough East and West Basins

Alternative 6A has the capability, given an augmented water supply, of providing for the environmentally beneficial hydroperiods (periods when water levels are at or above ground level) that are interrelated in eastern and western Shark River Slough, the Rocky Glades, Taylor Slough (including the southeastern Frog Pond), and the western and eastern C-111 basins. Alternative 6A produces a 100 percent improvement over the base condition and maintains a slightly higher elevation of dry season, sub-surface water in both east and west basins. It also increases water supply to the expanded portion of ENP in the north part of the west basin.

Of the considered alternatives, the recommended plan, 6A, is that which would contribute most toward restoring the hydrological and ecological linkage between Shark River Slough and the Taylor Slough--C-111 basin. This alternative contributes positively to the hydroperiod and water depths, not only in the short-hydroperiod glades southeast of Shark Slough, but well into the Slough itself. Alternative 6A

provides for water distribution in the headwaters of Taylor Slough that is necessary for surface water inundation during wet periods when water in Shark Slough overflows the rocky ridges into Taylor Slough, thereby influencing the latter's hydroperiod. This would benefit species with relatively large spatial requirements (snail kite, wading birds) that are dependent on the combined habitat conditions of both basins for their survival. The short-hydroperiod marl prairies, with adequate water supply, could once again serve as essential early dry season foraging areas for Park-wide populations of wading birds.

6.3.3 The Rocky Glades

Restored water supply and Alternative 6A's capacity for distributing water into the Rocky Glades would help restore the Rocky Glades' function as hydrologic barrier between Shark Slough waters and the headwaters of Taylor Slough. The Rocky Glades would continue to represent a transition area between the deep slough areas and seldom flooded uplands. Those portions of the Rocky Glades that have been rock plowed, however, will not become useful wildlife habitat. The probable scenario in these short-hydroperiod, transitional wetlands is that they will be dominated with Brazilian pepper. Management and plant control efforts would be necessary.

6.3.4 Taylor Slough

The recommended alternative's capability of distributing restored water supplies with the natural timing associated with historical wet and dry seasons, can provide for sheetflows throughout Taylor Slough and into the downstream areas of Florida Bay. This assumes that restored water supplies are forthcoming as the cumulative effects of Modified Water Deliveries, augmented flow from Lake Okeechobee, and the C-111 project.

6.3.5 The Frog Pond

The portions of the Frog Pond that are removed from agriculture as a result of the C-111 project will likely be invaded by Brazilian pepper. The artificial "soil" created by the practice of rock plowing and fertilization apparently is inhospitable to most native plant species, even many years after agricultural abandonment. Virtually nothing but stands of Brazilian pepper (*Schinus terebinthifolius*) will colonize. As wildlife habitat, abandoned rockplowed uplands are of little value.

6.3.6 The Marl Glades

Alternative 6A has the potential for delivering water high in the Rocky Glades, into Taylor Slough and south of lower C-111 in quantities and with the timing that contribute to 100 percent-improved habitat quality. This alternative maintains dry season, sub-surface water at higher elevations in both east and west basins and

increases water supply to the north part of the west basin. As measured, using the design water management schedule, all alternatives produce drier than optimum marl habitat conditions. In dry season, water levels drop at least 12 inches below the ground surface, where water is held in solution cavities, in water control structure receiving basins, and, perhaps, in alligator holes. Even with a more natural water supply, the marl glades would dry out in winter months. Natural dry season events would result in a concentration of small fishes, frogs, and invertebrates that would attract concentrations of wading birds, including the endangered wood stork.

6.3.7 Florida Bay, Barnes Sound, and the Coastal Mangrove Fringe

The recommended alternative would substantially reduce or eliminate the need for damaging freshwater discharges to Manatee Bay/Barnes Sound. Water would be re-directed to northeast Florida Bay. With the availability of an adequate supply of water, the natural timing and distribution of sheetflows throughout Taylor Slough would benefit Florida Bay. Elevated ground water levels in the Taylor Slough basin would contribute to the reduction of the tendency toward hypersaline conditions in northern Florida Bay. Restoration of a more natural hydrology will correct one of the major problems in the Bay. It is not known whether this alone will restore Florida Bay, but it is unlikely that restoration will occur without the natural fresh water increment from the Everglades.

6.4 THREATENED OR ENDANGERED SPECIES

Cape Sable sparrow

ENP researchers have Cape Sable sparrow data that suggest that nesting is reduced when surface water is present in the colony sites during the February to June nesting season. The best condition has the smallest flooded area in the marl prairie habitats during the nesting months. These criteria are met fairly well under the existing condition, and none of the evaluated alternatives would change this very much. One to 2 square-mile cells may be flooded less than 0.5 inch deep during part of the nesting season now and under all the alternatives. None of the considered alternative actions would adversely affect the sparrow. The FWS, in its role under the Endangered Species Act, has found that the alternatives pose little threat to the sparrow, but the Service believes that consultation under the Act may be necessary when a detailed operational plan is formulated (Annex D).

Snail kite

The study area canals may provide foraging habitat for the snail kite, but potential nesting sites are restricted. The area is a short-hydroperiod habitat, not favorable for the snail's prey, the apple snail. None of the alternatives would change

this condition, and the snail kite will be essentially unaffected by the considered project. The FWS has found the alternatives not likely to affect the snail kite.

Wood stork

Alternative 6A provides more area with the wood stork's required hydroperiod by over 40 percent, compared to existing conditions. Although the habitat improvement is marginal, the considered alternatives will not affect the wood stork. The FWS concurs.

Bald eagle

Bald eagles nest in the southern part of the study area and feed along the coastal lagoons, bays and, probably, in the lower reach of C-111. Projected effects of considered alternatives would not adversely affect bald eagle habitat. Nesting sites, including coastal mangroves, would not be altered by project alternatives, nor would foraging areas be at all degraded. The FWS concurs with the Corps finding that there would be no effect on bald eagles from implementation of any of the alternatives.

Indigo snake

The eastern indigo snake inhabits high, dry, sandy areas also favored by gopher tortoises. The snake may hunt along canal banks and disposal berms. The considered alternatives are intended to restore historic Everglades habitat, and the snake does not use that aquatic environment to any great extent. The FWS concurs that no effect will occur to the eastern indigo snake as a result of the considered action.

Florida panther

The panther ranges within the Fakahatchee Strand, Big Cypress Fresh Water Preserve, and ENP. It is expected to habituate areas populated by whitetail deer, although it preys on upland mammals and birds, including armadillo, wild turkey and occasional domestic livestock. Considered alternative actions would not adversely modify habitat for panthers, and the considered project would have no effect. The FWS concurs.

American Crocodile

The studied alternatives are intended to provide more over land flow of fresh water into Florida Bay. To the extent that they do so, the alternatives would not cause adverse effects to the salinity regime in the crocodile's habitat. Flood-water releases through C-111 during the nesting season, April to August, could adversely affect nesting by drowning the nests, but the alternatives are intended to divert flood waters from C-111 to over land flows. Based on these considerations, we have

determined that the alternative actions would not affect the American crocodile, and the FWS concurs.

6.5 VECTORS

Mosquitoes and biting flies spend part of their life-cycle in water, and the studied project would increase the area of standing or slowly moving water. Concurrently, increased populations of mosquito fish (*Gambusia*) and other insectivorous fishes as well as insectivorous insects and spiders are expected in the slough and marl prairie. Swallows, swifts and bats will take their toll on flying insects. The net effect is expected to be a dynamic balance, not unusual in a natural system. Ticks will continue to be carried in the wild animal population. No significant incidence of Lyme's disease is recorded for the Taylor Slough and C-111 basins.

6.6 WATER QUALITY

As discussed in section 2.3, nutrient enrichment resulting primarily from agricultural runoff is the major water quality problem in the Everglades. Although nutrients levels are low in the Taylor Slough drainage they frequently exceed targets established for the input points at S-332, S-175, and S-18C. The water delivery systems discussed in this report are not specifically designed to address nutrients; however those that incorporate retention areas or flow-ways may have a beneficial water quality impact. Such benefits will not be those associated with conventional water retention bodies over classical soil types, since the subsurface in the study area is very porous, cavity-riddled, limestone. Only when the ground water is high would water stand on the surface, allowing nutrient-adsorbing particulates to settle from the water column.

6.7 WATER SUPPLY

Under present conditions, the entire study area suffers from inadequate water supply during average and dry periods. Under the study conditions, the alternatives at least partially restore historic water patterns. Alternative 6A restores needed water distribution patterns and improves the wet prairie habitat by 100 percent over existing conditions.

6.8 AGRICULTURE

Environmental benefits to the project objectives related to removing lands from agricultural production as a part of the recommended plan include enabling the maintenance of higher water levels along the boundary of the headwaters and upper portion of Taylor Slough; allowing the discharge of water to Taylor Slough in the historic locations; enabling the proper timing of water flows to Taylor Slough; and

reducing the drainage of Taylor Slough through seepage into the L-31N borrow canal. There may be incidental benefits to water quality related to removing the Frog Pond and Rocky Glades agricultural lands from agricultural production. The natural groundwater movement is through these agricultural areas to the southeast toward the canal. This water is collected in the canal and will be returned to ENP with the recommended plan. Therefore, if agricultural use of this land is increasing the nutrient concentrations, or otherwise contaminating water that enters the canal, the recommended plan will reduce these problems. Additionally, the detention/retention zone included in the recommended plan will be located on former agricultural land. It will provide for filtration of the water as it flows through wetland vegetation and groundwater movement before it is discharged into ENP.

Eliminating flood damages requires land purchases in the Frog Pond and Rocky Glades agricultural areas located in the south-west portion of the economic area. An in-depth evaluation indicated that the recommended plan would improve flood drainage in the study area and substantially reduce flooding durations, dollar damages, and crop land flooded during the 10-year and 2-year storm events.

It can be expected that canal stages will return to higher design levels with or without project implementation. Environmental restoration efforts will raise water levels in the ENP. With the recommended plan, the resultant hydrologic profile between the ENP and C-111 will be higher than the without project profile. The loss of groundwater storage from the higher profile will reduce the flood protection west of L-31N and the C-111 canal. Areas affected include the Frog Pond located just east of L-31W in the southwest area of the basin and the Rocky Glades area west of L-31N located in the East Everglades Area. Therefore, a requirement of the recommended plan is that these lands be purchased.

In the Frog Pond, acreage under cultivation has historically varied depending upon stages in the canal system. Information provided by Larsen and Associates used in this study shows the total acreage of the area to be somewhat higher than 4,900 acres with tree islands and sloughs omitted. Of this acreage, approximately 2,800+ acres are in tomato production.

If the Frog Pond is removed from production, it is estimated approximately 3,920,000 cartons or approximately 98,000,000 lbs, (980,000 CWT) of tomato production would be lost annually. This information is based upon an average Dade County yield of 1,400 cartons per acre at 25 lbs per carton. Direct losses to producers (profit) in the Frog Pond are estimated to be between $6.8 million and $10.8 million annually. This information is based upon a loss between $2,442 and $3,842 per acre at an average price of $8.95 per carton. These estimates can be interpreted as an average net return to land and management on a per acre basis with the exception that no managerial labor costs have been removed from these estimates. Although the average price per carton was $8.95 for Florida in 1991-1992, seasonal prices have

wide historical fluctuations which have extreme impacts upon net returns. Seasonal prices for tomatoes in Florida varied between $4.18 and $20.18 per carton ir 1991-1992. Cost and return information for Dade County indicate it is difficult to cover operating and fixed expenses at price levels below $6.00 a carton. [1]

The existing flood control project does not guarantee water control west of the levee in the Rocky Glades agricultural area. Since, additional drainage is not allowed in this area by the Dade County Comprehensive Development Master Plan, agricultural activity in this area is considered speculative. The Rocky Glades agricultural area includes approximately 5,320 acres. Land use statistics shown in the Modified Water Deliveries to Everglades National Park General Design Memorandum, June, 1992 indicate approximately 2,000 acres are in vegetable crop production and approximately 630 acres are in lime groves. Other tree crops in the area include mango, lychee, carambola, guava, and longon. The major vegetable crops acreage includes beans, squash and potatoes.

Average productive yields per acre for vegetable crops in Dade County are estimated to be 60 CWT for pole or snap beans, 116 CWT for squash and 200 CWT for potatoes.[2] Assuming equal quantities of the three major vegetable crops are being produced in the area and ignoring any potential multiple cropping production patterns, losses are estimated to be approximately 250,300 CWT per year. Potential production losses would be approximately 140,800 CWT per year when all trees in the area are mature. This is based upon one annual crop, an average yield of 254 boxes per acre and 88 lbs per box.[3] Information concerning direct losses to producers in the Rocky Glades area is not available at this time.

6.9 RECREATION

Hunting, fishing and birdwatching will not be adversely affected by the construction of this project. Hunting may have to be curtailed during construction for safety of the workers, but will be allowed to resume after it is completed. Waterfowl may be somewhat disturbed by construction activities. Bank fishing will continue unchanged at those accessible sites which currently exist. Use of the ramp at the lower end of C-111 near S-197 will continue unchanged. The sheet flow which will be established in the area served by these two canals will help airboaters access the

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[1] Current yield information and estimates of direct losses to producers (profit) is provided primarily by the Institute of Food and Agricultural Science (IFAS), Circular 1121, Production Cost for Selected Vegetables in Florida, 1992-1993, Scott A. Smith and Timothy G. Taylor. Other supporting information for current price per carton and price per CWT of tomato production is provided by the Florida Agricultural Statistics Service. Additional agricultural price information is provided by the United States Department of Agriculture (USDA).

[2] Yield information is provided by the Institute of Food and Agricultural Science (IFAS), Circular 1121, Production Cost for Selected Vegetables in Florida, 1992-1993. Scott A. Smith and Timothy G. Taylor. It is expected that 200 bushels of beans or 275 bushels of squash can be grown on an acre. A bushel of beans weighs approximately 30 lbs. A bushel of squash weighs approximately 42 lbs.

[3] Citrus Summary 1991-1992, Florida Agricultural Statistics Service, Orlando Florida.

pools which will be created between the plugs on these canals. Fish, wildlife and benthic populations will move into and around the spreader canal soon after work is completed.

6.10 DISPLACEMENT OF PEOPLE, BUSINESSES AND FARMS

It is anticipated that any displacement of people, businesses and farms would most likely occur only in the areas that are designated for land acquisition with the recommended plan. Two areas will be affected. These areas are the Rocky Glades agricultural area west of L-31N, located in the East Everglades Area and the Frog Pond located adjacent and east of L-31W.

The Rocky Glades area includes approximately 5,320 acres. Much of the agricultural acreage is utilized for fruit and vegetable production and little, if any existing water control exists. It can be expected that L-31N borrow canal stages between S-176 and S-331 will return to higher, design optimum levels with or without project implementation. However, the loss of groundwater storage expected with the recommended plan will reduce the flood protection west of L-31N and the C-111 canal. These combined effects will worsen conditions to agriculture in this area since no new secondary drainage is allowed in the area.

Field investigations indicate that 4 structures are located in the Rocky Glades agricultural area south of SW 168th street and north of the Frog Pond. The 8.5-square-mile residential area is located north of SW 168th street and any proposed land acquisitions are not part of the C-111 study.

To estimate the number of people displaced in this area, an estimate of people per household must be obtained. Since survey information was not available, the 1990 US Census was used. Census tract 115 includes the Rocky Glades Area, is 96% rural, and is located west of L-31N in Dade County from the Dade County - Broward County line south to State Highway 27. The average number of people per household for this census tract is 3.21. Using this information, it is anticipated that no more than 13 people would be affected by purchases in the Rocky Glades Area.

The number of affected farms has not been computed for the Rocky Glades Area. Land use statistics shown in the Modified Water Deliveries to Everglades National Park General Design Memorandum, June, 1992 are shown in Table 6-1.

No residences are located in the Frog Pond area. The area is owned by the South Dade Land Corporation which includes 6 owners. Total acreage of the area is in excess of 4,900 acres with tree islands and sloughs omitted. Of this acreage, approximately 2,800+ acres are in tomato production.

6.11 AESTHETICS

Construction for this project will have some negative impacts, but these are not expected to last for a sustained period of time. These impacts include soil disturbance, turbidity, noise, and exhaust from equipment. Access restrictions, noise and smoke associated with construction sites will interfere to an extent with enjoyment of the area and may disturb wildlife in the immediate area of the work. Once work is completed, wildlife will once again inhabit the area around the construction sites and restrictions on access will be lifted. Vegetation will quickly become established on disturbed soil areas and within a year will cover any remaining signs of the construction activity.

Table 6-1

Rocky Glades Agricultural Area
Land Use (in Acres)

Grid	Limes	Tree Crops	Vegetable Crops	Undeveloped Land	Total
7	35.9	0.00	249.20	336.81	621.91
10	0.00	23.31	15.91	493.28	532.50
13	0.00	5.35	0.00	125.97	131.32
14	0.00	0.00	304.74	308.49	613.23
16	206.30	10.30	161.65	97.01	475.26
18	105.22	34.13	267.53	85.99	492.87
19	0.00	0.00	30.54	318.93	349.47
20	63.56	0.00	358.46	180.60	602.62
21	40.19	7.15	222.98	92.87	363.19
24	1.32	1.70	9.94	123.22	136.18
25	139.57	22.52	110.03	310.04	582.16
33	40.46	40.40	276.04	65.22	422.12
Total	632.52	144.86	2,007.02	2,538.43	5,322.83

6.12 CULTURAL RESOURCES

In a letter dated January 20, 1993, the Florida State Historic Preservation Officer (SHPO) recommended that, if tree islands or oak hammocks will be affected by changes in water volumes or levels, those topographic features should be subjected to a systematic, professional archeological survey. The purpose of the survey will be to locate and assess the significance of historic properties and determine if the proposed project will adversely affect these properties.

Initially, survey will be accomplished by interpretation of aerial photographs to identify potentially habitable tree islands. Tree islands which have the potential to contain significant sites will be systematically shovel-tested to locate cultural resources. Assessment of effects to significant resources will involve determining how changes in water levels may create impacts.

If it is determined that significant historic properties will be adversely affected by the project, a mitigation plan will be developed, in consultation with the SHPO, and completed prior to construction. All work will be conducted in compliance with the National Historic Preservation Act of 1966, as amended (PL 89-655) and the Archeological and Historic Preservation Act, as amended (PL 93-291). Costs for the cultural resources survey are included in the project costs under Planning, Engineering and Design.

6.13 HAZARDOUS AND TOXIC WASTES

A preliminary evaluation of potential hazardous and toxic waste problems has concluded that potential contamination is negligible. This conclusion was based on consideration of the following;

There are few to no urbanized or modified areas that would have a potential for hazardous and toxic waste contamination. There are no landfills, industrial waste treatment plants, light industries, or other facilities likely to generate contaminants in the area of the proposed project.

Intensive agricultural practices in the area are thought to pose little or no threat due to the effects of weathering on applied insecticides or herbicides.

There is no evidence of any spill or contamination problems at any of the project structures. However, prior to purchase of lands now in agricultural production, a survey would be made of potential problem sites, e.g., chemical storage, handling areas. More intensive investigations will be completed before publication of the final integrated GRR/EIS.

6.14 AIR QUALITY

Fugitive dust from vehicular traffic and earth moving will be unavoidable but insignificant. There are no air quality issues in the study area.

6.15 UNAVOIDABLE ADVERSE ENVIRONMENTAL EFFECTS

The following unavoidable adverse effects are expected to occur with implementation of a construction plan:

- **Wetlands** - A limited number of acres of wetlands will be lost or disrupted at the sites of levees, pumps and related structures (Table 5-5).

- **Water Quality** - Turbidity will be temporarily elevated during construction, but will return to natural levels upon project completion.

- **Agriculture** - The level of flood protection to agriculture in the area will be maintained as authorized. Should compensation be required, a settlement at full market value will be made. Agricultural lands that will be made fallow will require management to control exotic plants. The lands will have no significant wildlife value.

- **Cultural Resources** - An unknown number of historic and/or archeological sites may be affected; later studies will identify significant sites and necessary mitigation.

- **Air Quality** - Fugitive dust from vehicular traffic and earth moving will be unavoidable but insignificant.

6.16 RELATIONSHIP BETWEEN SHORT TERM USES AND LONG TERM PRODUCTIVITY

Agricultural use in the project is maintained by intensive energy investment. The project would remove this short-term use for the sake of long-term productivity in a revitalized, natural system. The comparatively short project construction period would produce several unavoidable effects, such as short, localized turbidity and disruption of habitat. In the longer term, restoration of physical form and hydrologic conditions will lead to reestablishment of the complex physical, chemical, and biological interrelationships and processes that supported the historic ecosystem's high levels of resilience, and allowed for persistence of highly diverse biological communities. As a result, most of the ecosystem will redevelop, and the restored slough and prairie systems can be expected to again support diverse populations of fish and wildlife.

6.17 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

The studied flood protection project is intended to reverse recent trends in environmental degradation. Water would be restored to the area in near-historic quantities and extent of timing. The only irretrievable commitment of resources will be the expending of fossil fuels during construction and operation of the structures.

6.18 CUMULATIVE EFFECTS

6.18.1 Modified Water Deliveries to Everglades National Park

The Modified Water Deliveries to Everglades National Park Project is considered to be part of the base condition for planning purposes. That project's effects and the C-111 project effects form cumulative effects on the human environment. Analysis of hydrological data in conjunction with preparation of this report and EIS confirm that restoration of the Taylor Slough and C-111 basins is linked, both hydrologically and biologically, to restoration of the historic hydrology of the Shark River Slough area. The two areas were historically linked during wet periods when water in Shark Slough overflowed the rocky ridges into Taylor Slough, thereby influencing the latter's hydroperiod. They are linked biologically in that species with relatively large spatial requirements (snail kite, wading birds) are dependent on the combined habitat conditions of both basins for their survival. The short-hydroperiod marl prairies once served as essential early dry season foraging areas for Park-wide populations of wading birds.

The Modified Water Deliveries to Everglades National Park Project may permit a restoration of the historic link between the waters of the two project areas, to the benefit of the wide-ranging species that used both basins in historic times. During non-flood conditions, excess seepage water from Shark River Slough collected in L-31N borrow canal could be passed to the C-111 system for enhanced hydrologic restoration of Taylor Slough. Subsequent operational studies will verify and quantify the need for supplemental water in Taylor Slough. As a result, during non-flood conditions, the two projects would act synergistically: operating costs for Modified Water Deliveries to ENP Project would be reduced while the hydrologic restoration of Taylor Slough would be increased for the C-111 Project.

6.18.2 Central And Southern Florida Project Restudy

The Central and Southern Florida Project Comprehensive Review Restudy may also provide concepts that could contribute to restoration of the Everglades ecosystem from Lake Okeechobee, southward to include Florida Bay.

SECTION 7

RECOMMENDED PLAN

The recommended plan is alternative 6A. This plan, which is shown in Figure 7-1 and in detail in Appendix A, Hydrology and Hydraulic Analysis, consists of construction components, real estate requirements, construction monitoring, and operation and maintenance for the completed project.

7.1 CONSTRUCTION COMPONENTS

7.1.1 Bridge Crossings

One bridge crosses the flood plain of Taylor Slough, south of S-332 and physically located within Everglades National Park along State Road 9336. To establish historic sheet flow patterns in Taylor Slough, the existing bridge will be replaced by a longer bridge, elevated roadway, or series of culverts over Taylor Slough in order to achieve a more spatial distribution of the flow.

7.1.2 Pump Stations

Five pump stations are recommended as part of this plan. The stations are designated as S-332A, S-332B, S-332C, S-332D, and S-332E and shown in Figure 7-1. Details on the pump stations are located in Appendix D. All pumps at these stations will be powered by diesel engines so pumping capabilities will be available even during electrical power outages following major storms.

7.1.2.1 S-332A

Pump station S-332A is one of four new 300 cfs capacity structures that would pump water from L-31N borrow canal westward toward Everglades National Park. S-332A would be located near the junction of C-102 and the L-31N borrow canal. The pump station will discharge into a concrete lined canal extending west toward the ENP. S-332A will have a total capacity of 300 cfs using four 75 cfs pumps driven by diesel engines.

7.1.2.2 S-332B

Pump station S-332B is one of four new 300 cfs capacity structures that would pump water from L-31N borrow canal westward toward Everglades National Park. S-332B would be located midway between C-103 and C-102 along the L-31N borrow

canal. The pump station will discharge into a concrete lined canal extending west toward the ENP. S-332B will have a total capacity of 300 cfs using four 75 cfs pumps driven by diesel engines.

7.1.2.3 S-332C

Pump station S-332C is one of four new 300 cfs capacity structures that would pump water from L-31N borrow canal westward toward Everglades National Park. S-332C would be located near the junction of C-103 and the L-31N borrow canal. The pump station will discharge into a concrete lined canal extending west toward the ENP. S-332C will have a total capacity of 300 cfs using four 75 cfs pumps driven by diesel engines.

7.1.2.4 S-332D

Pump station S-332D is one of four new 300 cfs capacity structures that would pump water from L-31N borrow canal westward toward Everglades National Park. S-332D pump station would be placed in the L-31W borrow canal, west of S-174, and would pump water through a concrete lined canal connected to the outlet side of S-332D and discharge 0.5 mile west through the new S-332D Tieback levee into the new retention/detention zone. S-332D will have a total capacity of 300 cfs using four 75 cfs pumps driven by diesel engines.

7.1.2.5 S-332E

This pump station is located at the junction of the C-111 and C-111E canals. It has a 50 cfs capacity and will discharge into a spreader canal, C-111N, which will promote sheet flow south towards the panhandle of Everglades National Park. The pump is designed to be driven by a diesel engine.

7.1.2.6 S-332

Existing pump station S-332 would remain, with necessary appurtenances designed for the original 165 cfs capacity structure. This pump station would draw water from C-111, through an extension of the L-31W borrow canal.

7.1.3 Levees and Canals

7.1.3.1 Levee 31W Tieback

This new north-south levee would be constructed roughly parallel to existing L-31N beginning at L-31W near S-175 and extending northward approximately 9.25 miles to higher ground in the Rocky Glades area in the vicinity of S-332B to form the retention/detention area. The levee would be constructed with material obtained

Boundary, and hydrology data provided by South Florida Water Management District.
Road data extracted from USGS and TIGER digital line files.
Contours provided by Everglades National Park.
Projection: Universal Transverse Mercator, Zone 17. NAD27.
Plot date: 19 May 94 17:07:06 Thursday

North

Taylor Slough

Park Road (SR 9336)

C-111 Project Boundary

1000 ft BRIDGE

P-33

G-3115

G-789

S-332

S-175

L-31W

S-332D

RETENTION/DETENTION ZONE

L-31W TIEBACK

S-332D TIEBACK

S-177

S-174

S-176

C-111

BUFFER ZONE

L-31N

S-332C

S-332B

S-332A

BUFFER ZONE

S-18C

C-111E

S-178

S-332E

C-111

C-110

C-109

C-111N

DEGRADE SPOIL MOUND

S-197

G-113

G-103

S-196

SR 27

S-194

S-173

S-331

G-211

S-338

L-31N

S-24A

(SR 997)

Krome Avenue

S-167

S-166

US 1

Florida Turnpike

C-102

C-1W

C-1

C-1N

S-179

Card Sound Road

Manatee Bay

Barnes Sound

S-20

L-31E

AREA SHADES
- 8.5 sq Mile Area
- Rocky Glades
- Frog Pond
- Model Lands
- Southern Glades

LINE SYMBOLS
- Canals and Levees
- Major Roads
- Proposed Levee
- Proposed Canal
- Proposed Backfill Canal

MARKER SYMBOLS
- Existing Gauge
- Existing Spillway
- Existing Culvert
- Existing Pump Station
- Proposed Spillway
- Proposed Culvert
- Proposed Pump Station
- Proposed Plug

0.5 0 0.5 1 1.5 2
Miles

RECOMMENDED PLAN
FIGURE 7-1

from the degrading of the C-111 disposal mounds along the southern portion of the project. The levee crown width would be 15 feet with 1 vertical on 3 horizontal side slopes. Twenty-four 36-inch diameter CMP culverts with stoplog risers would be placed in the levee at approximate half-mile intervals. An emergency spillway would also be constructed in the tieback to prevent overtopping of the levee. The spillway would be 300 feet in length and bank protection would be provided along the downstream face.

7.1.3.2 S-332D Tieback

An additional new north-south levee would be created that would run parallel to L-31N, designated S-332D Tieback. It would be located about one-half mile west of L-31N, bisecting the lands between the existing L-31N and the proposed L-31W Tieback. The northern terminus of S-332D Tieback would tie into high ground in the Rocky Glades area. A southern segment of the levee would turn eastward and run parallel to L-31W about one-half mile west of L-31N, and tie into a new pump station that would be located immediately west of S-174. The levee top would be about three to four feet above existing ground elevations. Borrow material for this levee would come from either the existing disposal mounds along C-111, or an adjacent borrow canal. This borrow canal would not be continuous, and it would not carry flow.

7.1.3.3 Levee 31W Borrow Canal

The borrow canal along the portion of the existing L-31W between S-332 and the alinement for the new L-31W Tieback Levee would be filled by degrading the adjacent levee.

7.1.3.4 Discharge (Getaway) Canals at S-332A, S-332B and S-332C

Pump Stations S-332A, S-332B and S-332C will lift water from L-31N and direct it westward through 0.5 mile long concrete lined discharge canals to the retention/detention zone just west of the new levee, L-31W Tieback. Concrete lined canals would be provided to minimize return seepage to L-31N. Materials from canal excavation would be placed along both sides of each canal and graded to create berms of sufficient elevation and width to satisfy the hydraulic design requirements and to provide access for maintenance.

7.1.3.5 Discharge (Getaway) Canal at S-332D

Pump station S-332D would be placed immediately downstream of S-174, and discharge water into the existing L-31W Borrow Canal. This canal would be concrete lined and extend westerly from L-31N Borrow Canal for about one-half mile.

7.1.3.6 Pump Station S-332 Connector Canal

Existing pump station S-332 would remain in service. A connector canal from C-111 would provide water to the west (to S-332) and south (to S-175). The L-31W levee would be realigned as shown in Figure A-5. The excavated material would be sidecast along one side of the canal and graded to provide access for maintenance.

7.1.3.7 Eastern Spreader Canal (C-111N)

A canal would be constructed from the intersection of C-111 and C-111E and extend eastward toward US Highway 1. The excavated material would be sidecast along the north side of the canal and graded to form a continuous berm. The berm would provide maintenance access and help initiate sheetflow southward toward the panhandle of Everglades National Park. In addition, impacts on the state correctional institute property would be minimized.

7.1.3.8 Canal 109 and Canal 110 Plugs

Nine plugs would be constructed in C-109 and ten plugs would be constructed in C-110 to help promote sheet flow from north to south between these canals. Material for construction of the plugs would be obtained from the adjacent disposal mounds.

7.2 REAL ESTATE

7.2.1 Lands and Easements

Lands needed for the restoration of Taylor Slough will be acquired in fee to ensure that they will continue to be available solely for that purpose over the life of the project. This will require acquisition of the lands known as the Rocky Glades as well as the Frog Pond as shown in Figure 1-4 in Section 1. The retention/detention area is needed for storage and flow dispersion. The buffer zone may have some surface ponding near the detention area and will have higher groundwater levels than under pre-project conditions, thus increasing its susceptibility to flooding. This land will be used as a buffer zone between the agricultural community and the environmental community. The SFWMD already owns the lands to be affected by C-111N spreader canal. Acquisition of 11,866 acres are necessary for this plan. Of this, 1,078 acres have been acquired by the ENP for their 1989 expansion. The acquisition of land interests in the retention/detention area reflects damages from higher water levels.

All construction work areas, disposal areas and borrow areas for the lower C-111 Project are located within the proposed right-of-way limits. However, estates are provided in the event additional areas are required.

Appendix C contains a detailed Real Estate Plan.

7.2.2 Relocation Assistance (Public Law 91-646)

Based on information received from South Florida Water Management District, there are approximately 4 residences within the project area that will be affected by this project and will require relocation payments as specified under the provisions of Title II of Public Law 91-646.

Estimates of costs to comply with Public Law 91-646 total $90,000. This estimate represents a payment of $22,500 for each of the 4 owner-occupied residential relocations which includes expenses incurred for recording fees, transfer taxes and costs of prepayment for pre-existing mortgages incident to conveying real property to the local sponsor and the estimated costs with providing displaced persons with comparable decent, safe and sanitary replacement housing.

A preliminary survey of the area indicates that there appears to be sufficient decent, safe and sanitary replacement housing available for persons affected under the project.

7.2.3 Construction Relocations

7.2.3.1 Public Highways and Bridges

One bridge crosses the floodplain of Taylor Slough, south of S-332 and physically located within Everglades National Park along State Road 9336. Increased water from the alternative requires the bridge over Taylor Slough to be expanded. State Road 9336 will be permanently relocated adjacent to the existing road. The land needed for the new bridge is Federally owned and is not valued but has been included in the total project acreage.

7.2.3.2 Utilities Relocations

There are no known utilities affected by the project.

7.2.3.3 Relocations of Towns and Cemeteries

There are no known towns or cemeteries located within the project area.

7.3 MONITORING

Monitoring of indicators of environmental quality has begun. Under joint agreement between the U.S. Army Corps of Engineers, Everglades National Park, the South Florida Water Management District, and the U.S. Fish and Wildlife Service, in

cooperation with the Florida Game and Fresh Water Fish Commission, ENP personnel and contractors are conducting studies and developing monitoring criteria. The study plan will be refined during detailed design phase to produce a detailed ecological monitoring plan. Annex H contains an outline of the environmental monitoring plan.

Construction activities will be monitored to ensure prevention of environmental damage. The effectiveness of silt and sediment barriers, both in the water and on land, in preventing fugitive, water-borne material from covering valued resources would be checked and measured. All construction activities would be inspected for conformance to environmental protection specifications.

The Corps, ENP, SFWMD, and USFWS will continue monitoring cooperatively through the construction stage. It is expected that after construction appropriate monitoring will carried on by ENP and the SFWMD.

7.4 OPERATION, MAINTENANCE, AND MANAGEMENT

7.4.1 Water Management

Water Control and Operations and Maintenance Manuals will be prepared and provided to the non-Federal sponsor prior to final turnover of the project. During construction, interim water control plans will be prepared to ensure that project objectives are safely accomplished.

7.4.2 Land Management

Land management practices for the lands acquired for restoration shall be consistent with project purposes. As previously discussed, restoration will occur by allowing the system to return to as near a natural state, as hydrologically possible. However, some land management practices, including prescribed burning and fencing and posting to prevent trespassing, will be necessary. SFWMD will be responsible for managing lands within the buffer zone. This will require control and prevention of exotic plant invasions.

7.4.3 Structures

The structures of the completed project include the 5 pump stations, S-332A, S-332B, S-332C, S-332D and S-332E, and culverts on the connecting canals to the pumps. These structures will be operated in accordance with the operation manuals described above. The maintenance of these structures include activities such as periodic maintenance of mechanical equipment; sand blasting and painting gates; ensuring levees are grassed and mowed to prevent erosion and settling; periodic maintenance of electrical equipment; and ensuring inlet and outlet channels are clear of snags.

7.5 PROJECT IMPLEMENTATION

7.5.1 Project Management Plan

A Project Management Plan (PMP) has been prepared for the recommended plan. It identifies specific tasks to be accomplished during preconstruction engineering and design (PED) and specific contracts and construction management activities for construction.

7.5.2 Detailed Design

During the PED phase, three technical Feature Design Memorandums (FDMs) and a Real Estate Design Memorandum (DM) will be produced. Final designs will be developed for all project features as needed to meet the objectives of the C-111 project. Refinements in project features as to their exact location and design details will be made based on these detailed design analyses. FDM 1 will address project features such as the bridge (elevated roadway) across Taylor Slough and removal of spoil mounds along lower C-111 which can be fully designed based on existing hydraulic modeling. The United States Geological Survey (USGS), under contract to the Corps of Engineers, is now developing an advanced hydraulic model of the C-111 Basin for detailed analysis of surface and groundwater conditions. In FDM 2, this advanced hydraulic model will be used to determine the final hydraulic design requirements for the remaining project features. This advanced hydraulic model will also be used to evaluate in more detail the curtain wall proposal received during public comments on the C-111 GRR. Study results from FDM 2 will be the technical basis for preparation of the Real Estate DM and preparation of FDM 3 which will present the detailed technical design of remaining project features. Plans and specifications will be prepared for 4 construction contracts covering work items as detailed below.

7.5.3 Construction Sequence

Construction of C-111 is expected to be divided into 4 contracts. This will expedite construction of project features to be built on existing public lands and thus expedite hydrologic improvements in Everglades National Park. Construction will be initiated in FY 96. The availability of real estate is expected to control the construction sequence and schedule. Because of the anticipated lengthy real estate acquisition period, construction is expected to continue over about a five year period as shown in the PMP.

The first contract will be for construction of a bridge (elevated roadway) across Taylor Slough in Everglades National Park, removal of the existing roadfill which interrupts the natural sheetflow of water in this area, removal of spoil mounds along lower C-111 and plugs in canals C-109 and C-110. Contract 2 will be for construction

of pump station S-332E and associated spreader canal C-111N. Land acquisition is not required for Contracts 1 and 2.

Project works in the Frog Pond area will be performed under Contract 3. Most of the lands in this area are held by a few owners so land acquisition is expected to be faster than for the Rocky Glades area where there are approximately 300 owners. Work items to be completed under Contract 3 include portions of Levee L-31W Tieback, connector canal from existing S-175 to C-111, backfill L-31W borrow canal north of existing S-332 and construction of pump station S-332D.

Contract 4, for construction of project works in the Rocky Glades area, will complete the recommended works. Pump stations S-332A, B and C, associated concrete lined discharge channels, the remainder of L-31W Tieback and levee S-332D Tieback will be constructed under Contract 4.

7.5.4 Environmental Protection During Construction

Corps construction contract specifications include environmental protection requirements. These requirements cover prevention of environmental pollution and damage as a result of construction operations under the contract. Environmental pollution and damage are defined as the presence of chemical, physical, or biological elements or agents which adversely affect human health or welfare; unfavorably alter ecological balances of importance to human life; affect other species of importance to man; or degrade the utility of the environment for aesthetic, cultural and/or historical purposes. The control of environmental pollution and damage requires consideration of air, water, and land, and includes management of visual aesthetics, noise, solid waste, radiant energy and radioactive materials, as well as other pollutants. Staging, storage and vehicle routes and parking areas are subject to advanced planning and approval by the Corps and local sponsor. The transportation and storage of petroleum products for use during construction is regulated by existing laws and by Corps regulations and practice.

Within 20 calendar days after the date of the notice of award of a contract, the construction contractor is required to submit an environmental protection plan. The contractor cannot proceed with construction until the plan is approved. The environmental protection plan includes the following:

* A list of Federal, State and local laws, regulations, and permit requirements concerning environmental protection and pollution control and abatement that are applicable to the contractor's proposed operations, and the requirements imposed by those laws, regulations, and permits.

* Methods for protection of features to be preserved within authorized work areas. The contractor shall prepare a listing of methods to protect resources needing

protection, including: trees, shrubs, vines, grasses and ground cover, landscape features, air and water quality, fish and wildlife, soil, and historical, archeological and cultural resources.

* Procedures to be implemented to provide the required environmental protection and to comply with the applicable laws and regulations. The contractor shall provide written assurance that immediate corrective action will be taken to correct pollution of the environment due to accident, natural causes or failure to follow the procedures set out in accordance with the environmental protection plan.

* Permit or license and the location of the solid waste disposal area.

* Drawings showing locations of any proposed temporary excavations or embankments for haul roads, stream crossings, material storage areas, structures, sanitary facilities, and stockpiles of materials.

* Environmental monitoring plans for the job site, including land, water, air and noise monitoring.

* Methods of protecting surface and ground water during construction activities. Special measures shall be specifically addressed and shall include reduction of turbidity and aeration of discharge prior to waters being released into the canal.

* Oil and fuel spill contingency plan.

* Work area plan showing the proposed activity in each portion of the area and identifying the areas of limited use or non-use. The plan would include measures for marking the limits of use areas.

* Plan for any dewatering activities associated with borrow areas.

The above minimum environmental protection procedures are expected to completely prevent avoidable environmental damage during construction. Typical spill contingency plans and measures are intended to contain, absorb and remove pollutants from the ecosystem for disposal in previously identified approved disposal areas.

7.6 COST ESTIMATE

7.6.1 Initial Costs

The total estimated cost of the recommended plan is approximately $121,400,000, at May 1993 price levels. A Micro-Computer Aided Cost Estimating System (M-CACES) estimate is shown in Appendix D. A project cost estimate by feature is shown in Table 7-1.

Table 7-1
Project Cost Estimate

Feature Account	Project Cost
01 - Lands and Damages	$50,700,000
09 - Channels and Canals	$25,400,000
11 - Levees and Floodwalls	$2,200,000
13 - Pumping Plants	$20,700,000
15 - Floodway Control - Diversion Structure	$4,900,000
30 - Planning, Engineering, Design, Cultural Resources, and Monitoring	$12,200,000
31 - Construction Management (S&I)	$5,300,000
TOTAL	$121,400,000

7.6.2 Investment Costs

The computation of interest during construction (IDC) is based on scheduled construction expenditures. Calculation of IDC assumes equal construction expenditures in each month over the 5 year construction period. It is assumed that environmental benefits will be realized during the construction period, specifically after individual project features are completed. However, flood control benefits will not be realized until the entire project is completed. At 8 percent the IDC for the selected plan is $15,534,000.

7.6.3 Operation, Maintenance, Repair, Replacement, and Rehabilitation (OMRR&R) Costs

Annual operation and maintenance costs were estimated for the components of the selected plan. Replacement costs at twenty-five years were calculated for the mechanical equipment contained in the culverts and pump stations. The OMRR&R costs are provided in Table 7-2.

Table 7-2
Annual Operation, Maintenance, Repair, Replacement, and Rehabilitation Costs

Component	Average Annual Cost
Pump Stations Operating Costs: S-332A, S-332B, S-332C, S-332D, S-332E	$549,100
Pump Replacements	$39,900
Flap Gates	$7,900
Culvert Risers	$48,300
Canals	$900
Levees	$20,800
Land Management	$178,000
Total Annual OMRR&R	$844,900

7.6.4 Annual Costs

Investment costs were converted to annual costs using an interest rate of 8 percent and a project life of 50 years to compute interest and amortization. Annual operation and maintenance costs were then added to the interest and amortization costs to determine the average annual cost, which is $12,039,000 for the selected plan.

7.7 COST SHARING

7.7.1 Authority

Responsibilities for implementing the Recommended Plan will be shared by the Corps of Engineers, on behalf of the Federal government, and the local sponsor. The Corps will design the project and administer construction contracts to build the

project. The local sponsor will be involved in the project design and will share a portion of design and construction costs; furnish necessary lands, easements, rights of way, relocation, and disposal sites (collectively referred to as LERRD); and operate and maintain the completed project.

The authority to construct and to cost-share the C-111 project is the Flood Control Act of 1968. In 1968, the ENP-South Dade Conveyance Canals were authorized (PL 90-483). A major purpose of this system was for conservation and conveyance of water supplies to the eastern portion of the ENP and to the expanding agricultural and urban areas of south Dade County. The policy established in 1968 required the non-Federal sponsor contribute in cash 20 percent of the sum of the construction cost plus the costs of supervision and administration and provides all lands, easements, and right-of-way including suitable disposal areas determined by the Corps of Engineers, necessary for construction and maintenance of the project, and accomplish all relocations and alterations of structures, utilities, highways, and bridges and related and special facilities determined to be necessary for construction of the project.

Improvement of water quality is currently a non-Federal cost. If water quality treatment areas are warranted for the area, the cost will be a non-Federal cost.

The operation and maintenance cost of the project are a local responsibility, however, the Flood Control Act of 1968 specified the annual pumping costs, including fuel, lubricants, proportional depreciation and repairs, and operating labor for the pump stations are cost shared 60 percent Federal and 40 percent non-Federal.

The Department of Interior (DOI) legislation (P.L. 103-219) to amend the Everglades National Park Protection and Expansion Act of 1989 (P.L. 101-229), authorized the funding to acquire and cost share the lands in the Rocky Glades and Frog Pond through a 25 percent Federal (DOI) contribution.

An evaluation was made as to whether raising the Park road (SR 9336) was a relocations cost or a construction cost. Flow through the constriction of the road needs to pass at least 1000 cfs due to the new plan. This flow distribution system will involve either culverts or a bridge to spread the water over a wider range in Taylor Slough. The cost of passing additional water is a construction cost and not a relocations cost.

7.7.2 Federal and Non-Federal Shares

Cost sharing for the project is shown in Table 7-3. The Federal (USACE) share is $59,027,000. The non-Federal share is $62,386,000.

Table 7-3
Cost Apportionment for Recommended Plan

ITEM	TOTAL $	FEDERAL $ (USACE)	SPONSOR $
Construction (including channel, levee, Construction Mgmt, elevation of Park Road)	58,481,000	46,785,000 (80 %)	11,696,000 (20 %)
PED	12,242,000	12,242,000	0
Real Estate (including acquisition/admin costs)	50,690,000,	0	50,690,000 (100%) *
Subtotal	121,413,000	59,027,000	62,386,000

* Legislation (P.L. 103-219) signed on March 9, 1994 authorizes the Department of Interior to contribute 25 percent of the purchase price of these lands.

The Federal and non-Federal share of the operation, maintenance, repair, replacement and rehabilitation costs are shown in Table 7-4.

Table 7-4
Operation, Maintenance, Repair, Replacement and Rehabilitation Costs

ITEM	TOTAL $	FEDERAL $	SPONSOR $
WATER SUPPLY TO ENP	589,000	353,400 (60 %)	235,600 (40 %)
O&M REMAINING PROJECT	255,900	0	255,900 (100 %)
TOTAL	844,900	353,400 (42 %)	491,500 (58 %)

7.8 FINANCIAL ANALYSIS

It is expected that the SFWMD will have the capability to provide the required local cooperation for the Recommended Plan. A financial analysis will be conducted to assess the SFWMD's capability to financially participate in the Recommended Plan prior to signing of the PCA.

7.9 LOCAL COOPERATION

The project's non-Federal sponsor must provide its share of project costs, including LERRD and cash for construction and later OMRR&R costs, as described above. LERRD are to be furnished to the Federal government prior to the advertisement of any construction contract which involves those LERRD. In providing LERRD, the sponsor must comply with the provisions of the Uniform Relocations Assistance and Real Property Acquisition Policies Act of 1970 (Public Law 91-646), as amended. Any required cash payments for project construction costs are to be made during construction to allow expenditure at a rate proportional to Federal expenditures. The sponsor's share of preconstruction engineering and design costs will be repaid during the first year of construction. The sponsor is also required to pay all costs associated with locally preferred features of the Recommended Plan, such as the potential water quality treatment areas.

A project may be initiated only after the sponsor has entered into a binding project cooperation agreement (PCA) with the Department of the Army, which is normally negotiated during the preconstruction engineering and design phase. The PCA assigns Federal and non-Federal responsibilities, which, for this C-111 project, will include the following items of local cooperation as required in the 1968 Flood Control Act and modified by Executive Order:

a. Make a cash contribution of 20 percent of the contract price plus supervision and administration for all items of work to be provided by the Corps of Engineers, an amount presently estimated at $11,696,000 to be paid in a lump sum prior to start of construction or in installments prior to start of pertinent work items in accordance with construction schedules as required by the Chief of Engineers, the final allocation of costs to be make after the actual costs have been determined;

b. With appropriate jurisdiction, construct and thereafter maintain such canal facilities and other water control appurtenances as are necessary to realize the benefits from the improvements;

c. Provide without cost to the United States all lands, easements, and right-of way necessary for construction, operation and maintenance of the project, when and as required;

d. Assume the cost of construction of all non-Federal highway bridges, relocation of existing non-Federal highway bridges and alteration of utilities and other improvements except railroads, incident to construction of the project.

e. Hold and save the United States free from damages due to the construction, operation, and maintenance of the project works;

f. Participate in the National Flood Insurance Program and other applicable Federal flood plain management programs;

g. Provide guidance and leadership to prevent unwise future development in the flood plain;

h. Assume financial responsibility for all costs incurred in cleanup of hazardous materials located on project lands covered under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), for which no cost sharing credit shall be given, and operate, maintain, repair, replace, and rehabilitate the project in a manner so that liability will not arise under CERCLA;

i. Operate and maintain the pumping stations, levees, canals, and other appurtenant works herein, after completion of construction for flood control, navigation, and backpumping and delivery of water to Everglades National Park, the agricultural areas, and urban areas, in accordance with regulations approved by the Secretary of the Army. The Federal government, however, would reimburse local interests 60 percent of the annual pumping costs, including fuel, lubricants, proportional depreciation and repairs, and operating labor for all pump stations. All other operation and maintenance costs of the project will be borne by local interests.

7.10 INTEGRATION WITH MODIFIED WATER DELIVERIES TO ENP PROJECT

Operating studies are being performed for the Modified Water Deliveries to ENP Project to identify the optimum operating strategy to benefit hydrologic restoration of Shark River Slough. The physical water management system boundary between this project and the C-111 project features is S-331.

The structural features of the Modified Water Deliveries to ENP Project are designed so that during flood conditions, all excess water that reaches the L-31N borrow canal north of S-331 is returned northward to Northeast Shark River Slough via a new pump station, S-356. This avoids the potential for exacerbating concurrent flood problems in the C-111 basin to the south.

The recommended structural plan presented herein is not designed to discharge additional flood waters from upstream of S-331. Therefore, the structural modifications recommended for the Modified Water Deliveries to ENP Project will still be required to keep these drainage basins separate during a storm event.

During normal (non-flood) periods, however, there is great potential for the structural features of both projects to be operated for mutual benefits. A portion of the water to be returned to Northeast Shark River Slough via S-356 as a part of the Modified Water Deliveries to ENP Project could be discharged southward under some conditions. The average annual discharge at S-356 will be about 72,000 acre-feet (U.S.

Army Corps of Engineers 1992). This includes seepage water from Northeast Shark River Slough into the L-31N borrow canal that will occur under non-flood conditions. A substantial portion of this water would likely be available for supplemental flows to the C-111 basin. Such discharges could be made only when there would be no potential increase in flood risk in the C-111 basin.

Operating studies will be combined for both projects, Modified Water Deliveries to ENP and C-111. In this way, benefits derived from the C-111 project could be enhanced by an additional source of potentially substantial volumes of water from upstream. Diverting such discharges southward through gravity flow would benefit the Modified Water Deliveries Project by reducing operating costs associated with pumping at S-356. Operating studies will include an evaluation of the need for, and availability of supplemental water supplies for the C-111 basin.

If the 8.5-square-mile area is acquired as a result of the pending legislation, the seepage levee, seepage collection canal, and pump station currently proposed in the recommended plan for Modified Water Deliveries to ENP would not be constructed. The project would still function as designed. No significant changes in the C-111 recommended plan would be necessary.

7.11 SPONSOR VIEWS

As the non-Federal sponsor of this project, the South Florida Water Management District (SFWMD) has worked very closely in partnership with the Corps to ensure that the study and this report fairly and accurately reflected their views.

SECTION 8

PUBLIC INVOLVEMENT, REVIEW AND CONSULTATION

8.1 PUBLIC INVOLVEMENT

Public involvement in the planning process is continuing. Responses to information about this GRR-EIS have included correspondence (Annex A) and requests for meetings with individual agencies and groups. New alternatives are being advanced by several parties, and these will be considered prior to publication of a final report.

8.2 REPORT RECIPIENTS

A list of recipients of the draft report is in Annex H.

8.3 CONTINUING COORDINATION

Coordination continues with publication of the final GRR-EIS. The expedited schedule in concert with unexpected delays in development of needed information has delayed completion of the Fish and Wildlife Coordination Act Report. The Fish and Wildlife Coordination Act report consists of a letter dated January 19, 1994, from the U.S. Fish and Wildlife Service. The letter contains reference to the USFWS expectation of a more detailed report to be submitted in the Spring of 1994. The anticipated report was not completed, and by telephone communication, Mr. David Ferrell, Chief, USFWS Vero Beach Field Office, assured that his office continues to support the planning process. Lack of an operational plan prevents preparation of a fully responsible FWCA Report. The Corps agrees, and defers to the Department of the Interior's letter of comment, submitted in accordance with the Act.

Concerned and affected parties may continue to contact the U.S. Army Corps of Engineers at the address and telephone number listed on the cover sheet.

8.4 SCOPING

Scoping was initiated by letter to all known interests, including Federal, State and regional agencies, Native American tribes and groups, and organized citizen groups. The latter included agricultural interests, sporting interests, and conservation interests. Additionally, individuals known to interested in or affected by the studied work were contacted and kept informed.

Scoping continued throughout the planning phase with several meetings involving representatives of the Park, USFWS, Florida Game and Fresh Water Fish

Commission, the South Florida Water Management District, and Audubon Society. As a team effort alternative measures and plans were developed and the final array of feasible alternatives selected for evaluation.

Letters in response to scoping activities were received from:

National Audubon Society
National Marine Fisheries Service, SE Regional Office
Dade County, Florida Environmental Resources Management
Everglades National Park
U.S. Fish and Wildlife Service

Correspondents recommended that water quality problems be addressed and corrected in the study area. Selection of a preferred alternative by December, 1993, was urged. The preferred alternative should be flexible, so that a suitable operation for water supply to restore Everglades ecosystem may be possible. Replication of southern Everglades hydroperiod and all other ecologically important conditions, on a smaller geographic scale, was urged as a final goal. Monitoring during design and after construction to ascertain effects on biota and hydrology was recommended.

Water quality considerations are addressed in Section 2. Planning efforts have been directed toward optimal levels of hydrological and ecological restoration, the immediate goal being to identify an alternative structural plan that will provide most flexibility for re-establishing historic hydroperiods that supported the historic flora and fauna. Monitoring tasks are to be determined during design stage.

8.5 COMMENTS AND RESPONSES ON THE PRELIMINARY DRAFT INTEGRATED GENERAL REEVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

A preliminary draft version of this report was distributed for public review on December 23, 1993. Written comments on the report were received from the following:

Metropolitan Dade County
Florida Department of Environmental Protection
Florida Game and Fresh Water Fish Commission
Florida Division of Historical Resources
South Florida Regional Planning Council
Friends of Conservation
Ghioto and Associates
Hydrologic Associates U.S.A., Inc.
Florida Department of Transportation
National Audubon Society
Law Offices of John L. Polk, P.A.

Mr. Barney W. Rutzke
Institute of Food and Agricultural Sciences, University of Florida
U.S. Fish and Wildlife Service
U.S. Soil Conservation Service
Everglades National Park
Miami-Dade Water and Sewer Authority Department
Tropical Audubon Society, Inc.
State of Florida, Office of the Governor

The following discussion summarizes comments received during the preliminary review and provides responses and/or describes how the comments were addressed in this report.

8.5.1 Plan Formulation Comments/Responses

a. Scope of Project

Page 5 of the preliminary draft report was in error. The study basin's northern boundary is a line drawn east from S-331, the divide control structure, and west on the southern limit of the eight and one half square mile area. The map in Figure 1-2 correctly displays the study area.

The scope of the Federal Project is to restore more natural hydrologic conditions in the C-111 basin, including Taylor Slough while maintaining flood control capability. The Model Lands area (land between U.S. Highway 1 and Card Sound Road) are not within the study area.

b. Culvert under Highway 1

The single culvert in Alternative 4 will pass approximately 100 cfs from the east-west spreader canal to the extension east of U.S. Highway 1. A battery of smaller culverts will impede flow in the canal towards the lands east of U.S. Highway 1. It is assumed that the culvert under the highway will be constructed by Department of Transportation as a part of the construction of widening the highway. The culvert is not included as a C-111 project cost.

c. Water Quality

All measures will be taken during construction to minimize turbidity from existing surface waters.

d. S-197 Operation

A discussion was added to the revised draft report (see section 2.2.3), describing the operational plan is not to open S-197 unless absolutely necessary. Flows will be discharged at S-18C and will overflow the southern bank of C-111 into ENP. Construction of 10 additional culverts at S-197 by SFWMD has provided much greater operational flexibility. All alternative plans considered would reduce the potential need for sustained discharges through S-197 into Manatee Bay/Barnes Sound.

e. Proposed Alternative

In response to comments received from various agencies on the preliminary draft report, Alternative 6 has been modified to become 6A. This plan incorporates the same water detention/retention area as described in a proposed alternative to address the water quality concerns and the need to disperse flows across a broader spatial extent in the Taylor Slough headwaters. There is also a buffer zone to provide a transition between the Everglades National Park and the agricultural community on the east. The proposed plan is described in section 5.6.4.11.

f. New Plans

DEP's modified alternative 4 is very similar the Park's Concept 8. Alternative 6A was derived to address the same goals as these plans. Maintaining the lower section of C-111 will provide operational flexibility for discharge of excess flood waters or to provide supplemental discharges to northeast Florida Bay by keeping S-197 closed and allowing overflow from the canal. DEP's proposed plan calls for water to pass from C-111 to the surge reservoir and back to C-111. This water will not be sent to Taylor Slough which is one of the Federal objectives. Additionally, by attempting to store water immediately adjacent to L-31N, the seepage into the canal will be increased. This will require greater pump capacity and more frequent operation. By moving the detention/retention area to the west of L-31N as in alternative 6A, the hydraulic gradient towards the canal will flattened and seepage will be reduced.

The agricultural community has proposed a plan which would surround the agricultural areas with a curtain wall. This plan was evaluated as alternative 9 and is described in section 5.6.4.10. This curtain wall would have to extend through the Biscayne aquifer to a distance of about 60 feet. The purpose of this proposal was to create a barrier between ENP and the farm land, without taking the farmland out of production. Seepage losses from ENP towards L-31N would be reduced considerably. Several plans were developed, including metal and plastic sheetpile and a slurry trench. The most cost-effective method was a Gundwall plastic sheetpile with hydrotite, which cost approximately $6,623,000 per mile. Using lands developed under plan 6, the cost of the sheetpile wall was approximately $102,000,000 versus the cost of purchasing these lands at $50,690,000.

g. Hole-in-the-Donut Restoration

The ENP has filed for a dredge and fill permit for restoration of the Hole in the Donut lands. The disposal area identified for this project is the eastern half of the Frog Pond, approximately 3,083 acres. ENP has obtained approval of this plan from the owners of the Frog Pond, the South Dade Land Corp. Early estimates for completion of the project are 15 years.

h. Lower Canal Stages

This alternative, proposed by agricultural interests, is in contradiction of the objectives of the study to provide the operational flexibility to maintain higher water levels along the boundary of the headwaters and upper portions of Taylor Slough. Bringing current canal stages up to the authorized levels and pumping water to the west will begin to restore historic hydroperiods in Taylor Slough, an objective of the study.

i. Lining L-31W

The lower portion of the L-31W borrow canal lies within the drainage area of upper and middle Taylor Slough. This proposal by agricultural interests suggests that lining the L-31W borrow canal would minimize the drainage of Taylor Slough while allowing canal stages needed to provide flood protection to adjacent agricultural lands. The minimal seepage cutoff provided by lining the canal would be ineffective given the depth and very high permeability of the surficial aquifer in the study area.

j. Water Supply Preserves

The water supply preserves suggested by the National Audubon Society are outside the scope of the C-111 basin. Alternative 6A addresses their issues on a smaller scale, including water retention/detention, buffer zone, spatial distribution of water and water quality. Furthermore, if the water supply preserve plan is later adopted for implementation, the plan recommended in this report would be consistent with this concept and could be incorporated into a more comprehensive regional plan.

k. Scope

To rehydrate lands east of U.S. Highway 1 is outside the scope of this project. These lands are not part of water supply to Everglades National Park. Ideas developed outside the scope of the project can be addressed as locally preferred features of the selected plan at a 100 percent non-Federal cost. The Federal project is shown in Alternative 6A.

l. Backfill C-111

Preliminary data developed at the SFWMD showed that the backfilling of C-111 caused a reduction in water moved to the land south of the lower section of C-111. This in turn was detrimental to the ecological balance in lower C-111. It is unknown at this time if operational studies can rectify this situation, but the Corps will continue to investigate this possibility during the design phase. In 1990, the SFWMD replaced the plug in lower C-111 with 10 culverts. This action will greatly will greatly reduce the likelihood of major damaging discharges to Manatee Bay/Barnes Sound. All of the culverts have been opened once since their construction and no significant effect has been measure. Since groundwater flow is in a southeast direction, the flow of water in the lands north of C-111 will flow to the southeast and away from ENP, and not to the western portion of the eastern panhandle of ENP. In the operational phase, S-197 will be closed and water will gravity flow south across the ENP into Florida Bay.

m. Full Restoration

None of the plans modeled will achieve full restoration. The intent of this study was to analyze the best way of achieving the objectives by providing structural capability to control the location, timing, and quantity of discharges with available water. During the design phase of the study, and subsequent studies like the C&SF Comprehensive Review Study and Modified Water Deliveries to ENP, plans to bring more water to the C-111 basin will be developed, which will work towards restoration of the C-111 basin.

n. Operational Studies

Sections 5.4 was added to describe operational criteria used to evaluate all alternative plans. An important objective of this project is to provide a structural system that is adequate to provide the operational flexibility to restore more natural hydrologic conditions in Taylor Slough. Operational studies to identify an optimal operating plan will require additional data collection and evaluation. In order to expedite the resolution of environmental problems in the park, design and construction of the desired structural features will proceed while the operating plan is being defined. As described in a new section 7.9, the operating plan for Modified Water Deliveries Project will be coordinated with the C-111 operating studies.

o. Federal Objective

Both negative and positive impacts have been addressed in the report.

p. Flood Control

There are measurable flood damage reduction benefits for each plan.

q. 8.5-square-mile area

A more detailed description of the entire Modified Water Deliveries to ENP Project has been provided in the "Future Without Project Condition" section. Additionally, information has been added in a new section "Integration of the Recommended Plan with the Modified Water Deliveries to ENP Project." The recommended plan calls for construction of a levee, seepage collection canal, and a pump station, S-357, to prevent adverse impacts to the 8.5-square-mile area as a result of restoration of Shark River Slough. Legislation has been enacted authorizing the Department of Interior to utilize previously appropriated funds to contribute up to 25 percent of the cost of acquiring the 8.5-square-mile area, the Rocky Glades agricultural area, and the Frog Pond. The acquisition would be a cooperative effort by SFWMD, DOI, the State of Florida, and Dade County. If the land is acquired, there would be no adverse impact on the recommended plan.

r. S-331 operation for recommended plan

S-331 will be operated as it is designed with implementation of the recommended plan. It will be used for water supply deliveries to the ENP-South Dade County Conveyance Canal system when water levels drop 1.5 feet below their optimum levels in the downstream reaches. The pump will not continue to be used to prevent flood impacts in the 8.5-square-mile area.

s. Project purpose for acquisition of the Frog Pond

The purpose of acquiring the Frog Pond and the Rocky Glades agricultural areas as a part of the recommended plan is to enable the hydrologic restoration of the headwaters and upper portions of Taylor Slough.

8.5.2 Environmental Information and Evaluation Comments/Responses

a. Buffer Zone Management

Land management practices for lands acquired for project purposes are discussed in paragraph 7.4.2.

b. Treatment for Water Quality

The issue is discussed in Section 2.3 of the report. The proposed project will not adversely impact the quality of State waters or those of Everglades National Park.

The Corps of Engineers does not propose water treatment areas or facilities as part of the project.

c. Cultural Resources

The requested professional investigations of tree islands or oak hammocks, if any should be projected to be affected by construction or operation of the project, will be done. A more detailed description of these studies is provided in section 7.12.

d. Effects on Dissolved Phosphorus In Taylor Slough

Criteria for total phosphorus concentration input at S-332 of 8-13 ppb by 2002. The criteria cited are mandated by the United States vs SFWMD et al. Settlement Agreement

e. Water Spillover from Shark River Slough at 6.5 feet elevation

The information is developed and reported by Tropical Bioindustries (TBI, 1990). The author indicates that the information is based on topographic data. Examination of the most recent topographic data collected by the Corps, SFWMD, and ENP (compiled by ENP) confirms this conclusion.

f. Florida Bay Description

The section on Florida Bay (2.4.2) has been revised for more precision.

g. Low Water and Decreased Nesting

The statement is attributed to ENP biologists.

8.5.3 Hydrologic Issues and Evaluation Comments/Responses

a. Was the model calibrated?

The SFWMD 1x1 model was calibrated for the time period 1983 to 1986 and verified for the period 1987 to 1989. Predictive confidence of the model is as good as a one square mile cell size model can be expected to perform. The primary purpose of this model was to compare alternatives and select a plan for detail design. Further design work will utilize the SFWMM 1x1 model as well as more detailed ground water models.

b. How do the water level differences between alternatives compare with the range of errors during calibration?

Water level differences between alternatives tend to be very close as can be seen in Tables A-6 and A-7. High horizontal hydraulic conductivity along with flat topography limit differences in elevations to tenths of a foot.

c. Is there enough pumping capacity?

The recommended plan includes a 63 percent increase in the discharge capacity for the area above S-177. This capacity, along with the buffer area to reduce back-seepage, will provide the design level of flood protection.

d. Do we run the risk of continuous pumping to make up for seepage?

The buffer strip is designed to reduce back-seepage. During storm events, the system was designed to pump over a longer period of time and remove the total volume of the storm rainfall. Extended periods of discharge are expected and operating costs reflect these expectations. The environmental consequences of continuous discharge is expected to be positive and more closely approach historical conditions and more water will be retained in the system.

e. Why is the buffer area needed?

The acquisition of land interests in the detention/retention area reflects damages from higher water levels. The detention/retention area is needed for storage and flow dispersion. The buffer area may have some surface ponding near the detention/retention area and will have higher groundwater levels than under pre-project conditions, thus increasing its susceptibility to flooding.

f. Could a more passive alternative be implemented that would require less land and pumping?

A seepage cut-off curtain wall alternative was evaluated in the revised report (section 5.6.4.10). However, cost and constructability in the limestone made this alternative less cost effective than the recommended plan.

g. How does capillary action impact the performance of the plan?

The model does not account for capillary action. Because of the high porosity of the Miami Oolite formation due to large solution holes in the limestone, there is little capillary action in most of the aquifer. However, near the surface where there are deposits of peat or marl, there may be some capillary action under some conditions. This issue is common to the existing condition and all alternatives and would not impact the evaluation of alternatives.

h. Will water stored in the upper 1.5 feet remain in storage for the duration of the storm?

Yes, 1.5 feet of groundwater storage is required. Whether this is the upper 1.5 feet depends on the land elevation and season of the year. Lands with less than 1.5 feet below the root zone may have an incompatible land use. The original design for the C-111 basin required 1.5 feet of groundwater storage.

i. What effects do the higher water levels west have on the pump capacities?

The buffer zone is designed to reduce the backseepage from the higher water levels to the west. There is 63 percent more capacity planned for the basin. Detailed design, using groundwater models with finer grid spacing will more accurately define pump capacity.

j. How do alternatives 4 and 6 raise water levels in Shark River Slough?

Normal groundwater slope and resultant flow is to the southeast from Shark River Slough. Plans 4 and 6 raise groundwater levels along the eastern boundary of Shark River Slough and decrease the hydraulic gradient. More water stays in Shark River Slough and flows toward Florida Bay. The higher boundary condition from Plans 4 and 6 also cause a steeper gradient toward L-31N and C-111. The buffer strip helps to mitigate this backseepage to some extent. Backseepage that does return to the canal is picked up downstream and returned to Taylor Slough. The system of pumps and groundwater storage is intended to keep as much water in the system as possible and make releases over an extended period of time.

k. Will the increased water levels in northern Taylor Slough impact the flood protection to the 8.5-square-mile area or increase the seepage to L-31N?

Modeling has not shown an adverse impact on the 8.5-square-mile area. More detailed groundwater modeling will be used to further quantify impacts. Higher seepage rates to the lower L-31N canal are expected and are accounted for in the design.

l. Grossman Road borrow canal

The Grossman Road borrow canal is not included in the model that was utilized for this study. It may have some local hydrologic impacts but it does not significantly impact the water management system. As a part of detailed design for the Modified Water Deliveries to ENP Project, an evaluation will be done of the hydrologic impacts of all existing roads and canals that are within the ENP expansion area. If it is

determined that the roads or canals have a hydrologic impact on the natural conditions in the area, they will be restored to natural ground elevations.

m. Groundwater modeling for detailed design

As a part of the detailed design of the Modified Water Deliveries to ENP Project, the USGS has modified an existing model to provide adequate detail for the study area. The model is being utilized to predict seepage rates into the L-31N borrow canal that will occur as a result of restoration of Shark River Slough. The same model will be modified and utilized for the C-111 project detailed design studies.

8.5.4 Economic Evaluation Comments/Responses

a. Dade County Planning Department does not make recommendations on agricultural practices.

pg 2. paragraph 6, pg 3. paragraph 7. Concur. This reference has been deleted from the report. County polices listed in the Comprehensive Development Master Plan have been used, if appropriate to supplement the discussion on page E-2.

b. Personal income

In addition to reducing net benefits in the National Economic Development (NED) account, agricultural land purchases with project alternatives have regional (RED) effects. Direct losses which include loss of income and profit to producers and indirect losses which effect jobs, income, and employment in Dade County will occur. Estimates of direct losses to selected producers have been included in section 6.8 (Impacts on Agricultural Uses of Affected Lands) in the main report. Indirect effects are described in the "Effects Evaluation" table in section 5.9 of the main report. With the proposed plan the table indicates a moderate to major adverse effect upon regional income and employment.

c. Flood Damage Reduction (Problems and Opportunities)

The primary project purpose of the South Dade Conveyance System was to provide flood control protection to the South Dade County area. Even with authorized water levels in the canal system, one effect of project implementation was to reduce flood risk to the agricultural area. Shortly after implementation of the project, authorized stages were reduced in the canal system as a compromise action to further benefit the farming community. The Everglades restoration program was part of the original project authorization and not an afterthought as the original design was to allow for minimum water deliveries of 315,000 acre feet per year.

d. Agricultural encroachment

A better definition of agricultural encroachment is provided on page E-2. The encroachment discussed in the report is not caused by new agricultural development replacing existing wetlands. Two forms of encroachment are discussed. First with lower water levels, highly damage susceptible vegetable crops can be grown year around [illegible]her than just in the dry winter months which can increase flood damage susceptibility. Second, the amount of fruit tree crops and general horticultural activity have increased in the flood plain. Since these trees have longer root zones than other field crops, they are more susceptible to high water tables and to flooding than was the agricultural development in the 1960's. The paragraph in 4.3 will be revised to explain encroachment in these terms and delete the reference to agricultural expansion into wetlands. However, it should be noted that the original design of the C&SF Project for flood control in south Dade County did not intend to provide flood protection to any lands west of L-31N, i.e. the Rocky Glades agricultural area.

Agriculture is not bearing the blame for today's conditions. In fact, the reason for the flood control portion of the selected plan is to attempt to maintain flood control capacity for agriculture in the area east of C-111.

e. Root zone depth

A root zone depth of 2 foot for tree crops was used in the evaluation with a bedding height of 17 inches. Recent discussions with the IFAS in Homestead has indicated that fruit trees planted east of C-111 may have deeper root zone depths. If this is the case, there may be increased damage susceptibility east of C-111 that the project could prevent.

f. Federal Objective

The flood control feature of the NED account is improved since flood damage prevention increases with the selected plan. Positive flood control benefits accrue to the area east of C-111 when the without and with project alternatives are evaluated at authorized stage levels. Although project costs for environmental project purposes have been determined, NED benefits attributable to environmental purchases have not been determined. Therefore, the effect upon the entire NED account is not known. All costs and benefits that have been computed for the GRR will be shown in the Environmental Impact Statement under NEPA. The Other Social Effects account (OSE) and Regional Economic Development accounts (RED) are displayed and compared with the NED account in the "Effects Evaluation" table in section 5 in the main report. Negative effects attributable to agricultural land purchases are accounted for in the NED account. Lands purchased are a project cost and are displayed on an annual basis. The effect of increased project costs is to reduce the net

benefits to the project and reduce the corresponding benefit-to-cost (B/C) ratio of the flood control portion of the project.

NED impacts have not been ignored. Flood control is an important project purpose. The NED plan is not identified in this report because the report objectives are slightly different than in traditional reports. The objective is not to maximize flood control protection but rather to maintain the level of protection provided by the original project under changing land use conditions.

g. Evaluation Factors

The list of evaluation factors constitutes a general method of evaluating plan performance relative to the project objectives. While all care is taken to minimize adverse impacts to RED and OSE, improving these accounts is not a project objective. Therefore, these issues are not included in the section "Evaluation Factors". As stated previously, negative effects of agricultural land purchases are included in the NED account.

h. Preliminary Analysis of Annual Benefits and Costs

As mentioned previously, the objectives in this report are slightly different than in traditional reports. The flood control objective is to maintain the level of protection provided by the original project. All plans evaluated include a flood control component to provide the stated protection. Therefore, the flood control component benefit-to-cost ratio for all plans is close to identical to the B/C ratio computed for alternative 1A. Environmental benefits of the project cannot be quantified in terms of economic value. To compare total benefit-to-cost ratios without including environmental benefits would be misleading.

i. Effects Evaluation

The effect of land purchases is to remove cropland from production and therefore reduce damage susceptibility in the study area." This statement found on page E-2 of the report is incorrect. A procedural error in benefit calculation caused flood control benefits to increase. Flood damage susceptibility was calculated on purchased lands for the without condition. However, flood damage susceptibility on these lands were removed for the with project condition. The incorrect calculation of without project flood damage caused flood damages prevented (the difference between without and with project) to increase as additional lands were taken out of production. The damage reduction benefits shown for purchasing agricultural areas will be removed from the final report. However, this change will not affect Alternative 1A (flood control plan), or any economic conclusions in the report. The statement was not intended to imply that purchase of agricultural lands is the most cost effective means of achieving flood control.

j. Displacement of People, Businesses and Farms

Information has been added to this section of the draft report.

k. Maximization of net benefits

"All plans provide approximately the same net flood protection benefits. Therefore, the plan selection becomes totally a function of environmental efficiency.". The statement is found in the "Maximization of Net Benefits" subsection which describes a basis for plan selection for the NED account. The NED account properly identifies the adverse effect of land purchases by treating the purchases as project costs. Discussion of regional impacts is inappropriate in this section.

l. Economic evaluation of agricultural flood damages

The University of Florida Institute of Food and Agricultural Sciences (IFAS) provided valuable input to the development of the economic evaluation procedures used for this report. Comments were provided in response to a request for a preliminary review of the evaluation procedure. Although these comments were not directly related to the preliminary draft GRR, they are addressed below:

Part I - General Assumptions Concerning Damage Susceptibility.

1. "Although your assumption of an average 17 inch bedding elevation seems reasonable, under non-flooded conditions the tree will establish roots throughout the bed and to the bottom of the tree trenches (another 18-24 inches). Periodic and/or constant flooding (e.g., a periodic flood depth 6 inches up onto the bed) will stress and most likely kill all roots from the flood line down and drastically reduce the non-flooded root mass. This would result in the above ground part of the tree (the top) dieing back due to any number of factors including a lack of oxygen, water and nutrient uptake, and uptake of phototropic substances. In addition, the stability of the trees due to high winds or a hurricane would be drastically reduced.

Concur. The text discussion notes on page E-7 that root zones for fruit trees can generally range from 12 to 30 inches deep. A root zone depth of 2 foot was used in the evaluation with a bedding height of 17 inches. Therefore, the benefits are considered reasonable in respect to this assumption. Increasing root zone lengths for fruit trees east of L-31N would have the impact of increasing damage susceptibility under the without and with project conditions and increasing project benefits.

5. The assumption is made that operating costs for fruit trees per year are estimated to be approximately $100 more than land rent for all fruit tree classifications. "Not clear to me what you mean. The operating costs for fruit trees

per year are different for each fruit crop and are separate and do not include land rent charges." (referenced table not provided).

Concur. The Operating Costs provided in table 1 are utilized for fruit production losses. Additional operating costs for tree maintenance was the information provided.

8. Your letter includes the reference "Operating and fixed costs for mangos are higher than other crops due to increased need for insecticides and spraying". Please change first sentence to read: Operating and fixed costs for mangos are higher than other crops due to increase need for pesticides (fungicides in particular) and spraying."

Concur. Text refers to a supplemental information sheet not in the draft or final report.

10. Your letter includes the reference " A reasonable range of operating and fixed costs for carambola would be approximately $2,000 to $2,500 per acre. A value of $2,250 will be used in this analysis. The reason for the high cost is primarily due to proration of additional fixed costs for man-made windscreens necessary to keep crops from blowing over." Please change the third sentence to read: The reason for the high cost is primarily due to the proration of additional fixed costs for man-made windscreens necessary to keep crops from wind damage.

Concur. Text refers to a supplemental information sheet not in the draft or final report.

Part II - Other Considerations.

1. No where in you calculations do you indicate what the loss is to the producer for his/her sold product due to flooding. In other words, if a producer is getting $2.50/pound for their fruit and the trees are producing 100 pounds per tree and there are 120 trees/acre, that is a $30,000 loss. Furthermore, this income loss would increase substantially for fruit crops that normally bear more than on crop per year (e.g., limes, carambolas). In addition, trees that have withstood flooding previously may not produce a crop the following year or years depending upon the extent of damage due to the flooding.

An estimate of the value of the fruit crop on the tree (before harvesting costs) can be approximated by using operating costs, fixed costs, and land rental values to produce the crop. This is based upon the fact that production costs which include all land, labor, and capital costs and returns to land and management should be equal to the revenue produced. When fruit is harvested, production costs are recovered. Therefore it is inappropriate to claim both production costs and losses of the value of

the fruit. If a flood occurs before the fruit is harvested production costs or the value of fruit can be claimed but not both.

2. In general, fruit trees with fruit on the tree are generally more susceptible to flooding damage than trees that do not have fruit. In fact, the presence or absence of fruit may mean the difference between tree survival or death. An example is avocado. Observation has indicated, trees with fruit die more quickly or are more damaged due to flooded conditions.

Concur.

3. Trees that are damaged due to flooding are more susceptible to other environmental stresses (e.e., cold, drought, hurricane). A typical scenario is trees are flooded and their root system is damaged. During flooding, the tree top may have sustained some leaf drop, necrosis, and stem tieback. The flood water recedes and the soil profile is reoxygenated. However, even though the trees are no longer flooded the tree tops continue to drop leaves, stems die back or the tree dies. This is because during the flooding event water uptake is reduced due to necrosis of the root system and because physiologically the capacity of the root system to transport water is decreased or stopped. Subsequently when the soil is drained, the smaller root system does not have the capacity to move enough water to satisfy the demand of the top (leaves and stems) and the tree continues to die back or die all together.

Concur.

4. Trees that survive an environmental stress need non-stressed conditions, sound cultural practices, and time to recover. In general, if trees are repeatedly stressed (e.g., periodically flooded) they will be stunted in growth (non-vigorous) which will delay and/or prevent canopy development and thus the tree will never reach their fruit bearing potential, continue to die back slowly and/or eventually die, and remain more susceptible to other environmental stresses (i.e., freezes, hurricanes). Thus fruit production would be reduced or eliminated in subsequent years.

Concur. This is accounted for using the additional operating costs necessary to produce a healthy mature tree after a serious flood.

5. No where in your calculations are the management problems for the producers included. Tropical fruit crops have to be managed year round. Periodic flooding may cause problems which include inaccessibility to the grove for timely fertilizing, mowing, herbiciding, spraying (nutritional and pesticidal sprays), and harvesting; increased weed growth; increased chance for fertilizer leaching; delayed or prevented fruit harvesting; increased cost for control of root disease problems and; increased maintenance costs on machinery that gets wet or that works in excessively moist

conditions. All these problems would lead to reduced fruit production and profitability of the operation.

Concur. Managerial labor costs and returns to managerial efficiency are not included in production costs. Insufficient information exists as to the quantity of these costs.

6. Several producers in the affected area ('west of the dike') have indicated that the current increase in the water level (during 1993) has already affected their grove operations (e.g., equipment maintenance) and increased production costs.

Concur. Water levels west of L-31N have increased in CY-1993 due to the Taylor Creek Demonstration Project. Without additional drainage, higher water levels will cause additional problems and increase production costs.

7. Soil flooding constitutes excessive soil moisture (continuously at or above field capacity). The excessive soil moisture may be visible above ground or may be at or below soil level (perched water table). Flooding may occur periodically or continuously.

Concur. Flood damage susceptibility is measured at the bottom of the root zone.

8.6 COMMENTS AND RESPONSES ON THE DRAFT INTEGRATED GENERAL REEVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

The draft integrated general reevaluation report and environmental impact statement was sent to numerous local, State and Federal agencies and provide interest groups for review and comment in accordance with the Council on Environmental Quality's NEPA regulations and related Corps guidance on March 4, 1994. Comments received during the review were considered in preparing the final study documents, and will be considered by subsequent reviewers and decision makers in the Washington level Federal review process. A copy of these letters are located in Annex A of this report.

Written comments on the report were received from the following:

Federal Agencies

U.S. Department of Agriculture
U.S. Department of Commerce - Florida Keys National Marine Sanctuary
U.S. Department of Commerce - National Marine Fisheries Service
U.S. Department of Interior - Everglades National Park
U.S. Environmental Protection Agency

U.S. Fish and Wildlife Service
U.S. Soil Conservation Service

State Agencies

Florida Department of Community Affairs
Florida Department of Environmental Protection
Florida Game and Fresh Water Fish Commission
Florida Division of Historical Resources
Florida Department of Transportation

Local Governments

Metropolitan Dade County
Miami-Dade Water and Sewer Authority Department
Monroe County
South Florida Water Management District
South Florida Regional Planning Council
Institute of Food and Agricultural Sciences, University of Florida

Groups

Audubon Society of the Everglades
Everglades Coalition
Everglades Outward Bound Center
Environmental Defense Fund
Florida Lime and Avocado Administration Committees and South Dade Land Corporation (Ghioto and Associates)
Izaaak Walton League of America, Florida Division
Lake Region Audubon Society
National Wildlife Federation
Oklawaha Valley Audubon Society
Orange Audubon Society
Sanibel-Captiva Audubon Society
Sierra Club, Broward County Group
Sierra Club, Loxahatchee Group
The Nature Conservancy
Tropical Audubon Society, Inc.

Individuals

Over 120 individuals wrote the Corps during the NEPA review period to express their views on the C-111 project.

The following discussion summarizes comments received during the review and provides responses and/or describes how the comments were addressed in this report.

8.6.1 Plan Formulation Comments/Responses

a. Scope of Project

The study basin's northern boundary is a line drawn east and west from the southern boundary of the 8.5 square mile area as shown on Figure 7-1. The 8.5 square mile area is not part of this study.

The scope of the Federal Project is to restore more natural hydrologic conditions in the C-111 basin, including Taylor Slough while maintaining flood control capability. The Model Lands area (land between U.S. Highway 1 and Card Sound Road) are not within the study area.

Florida Bay is directly affected with restored natural flow to Taylor Slough and the east panhandle of the ENP, but is not an objective of this study. The reduced fresh water inflows from the C-111 system have been linked to the decline of Florida Bay and for this reason, the Corps is restoring flows to Taylor Slough and the eastern panhandle of the ENP. The C&SF Comprehensive Review Study, also conducted by the Corps, will address Florida Bay.

b. Culvert under Highway 1

It is assumed that the culvert under the highway will be constructed by Department of Transportation as a part of the construction of widening the highway. The culvert is not included as a C-111 project cost.

c. S-197 Operation

A discussion was added to the final report (see section 2.2.3), describing the operational plan is not to open S-197 unless absolutely necessary. Flows will be discharged at S-18C and will overflow the southern bank of C-111 into ENP. Construction of 10 additional culverts at S-197 by SFWMD has provided much greater operational flexibility. All alternative plans considered would reduce the potential need for sustained discharges through S-197 into Manatee Bay/Barnes Sound.

With the recommended plan, flow releases decreased by near 39 percent. Further reductions are likely through changes in operation for this structure.

Increasing the stage at which S-197 discharges flood waters would result in reductions in volume releases. Volumes not released by S-197 would increase sheet flows south of the lower C-111 canal thus bringing greater environmental benefits for this area.

d. Flow Across the "Gap" Area of Lower C-111

The spoil will be removed from the lower C-111 to promote sheetflow across this area. Where the current tendency is for water to exit the eastern gaps near US Highway 1, this will be modified to promote an even flow across the section.

e. Department of Environmental Protection (DEP) New Plan

DEP's modified alternative 6A is still very similar the Park's Concept 8. Alternative 6A was derived to address the same goals as this plan. Maintaining the lower section of C-111 will provide operational flexibility for discharge of excess flood waters or to provide supplemental discharges to northeast Florida Bay by keeping S-197 closed and allowing overflow from the canal. Also, gravity flow will be used to accomplish this, as opposed to pumping this water. The Corps disagrees with your plan to leave L-31W and cut off the natural flow of Taylor Slough. The size of the retention/detention zone will be optimized during the design phase of the project.

Canals C-109 and C-110 will be plugged in an effort to prevent shortcircuiting the wetlands, which is more inexpensive than total backfill.

The size and location of S-332E and the spreader canal (C-111N) will be optimized during the design stage of the Corps project to minimize adverse impacts on private lands.

DEP's proposed plan calls for water to pass from C-111 to the surge reservoir and back to C-111. This water will not be sent to Taylor Slough which is one of the Federal objectives.

f. Curtain Wall

The agricultural community has proposed a plan which would surround the agricultural areas with a curtain wall. This plan was evaluated as alternative 9 and is described in section 5.6.4.10. This curtain wall would have to extend through the Biscayne aquifer to a distance of about 60 feet. The purpose of this proposal was to create a barrier between ENP and the farm land, without taking the farmland out of production. Seepage losses from ENP towards L-31N would be reduced considerably. Several plans were developed, including metal and plastic sheetpile and a slurry trench. The most cost-effective method was a Gundwall plastic sheetpile with hydrotite, which cost approximately $6,623,000 per mile. Using lands developed under

plan 6, the cost of the sheetpile wall was approximately $102,000,000 versus the cost of purchasing these lands at $50,690,000.

A 2-dimensional finite element program was used to calculate the quantity of seepage beneath a fully and partially penetrating barrier. This analysis showed that an impermeable cutoff must extend the full depth of the aquifer to be effective. If the cutoff partially penetrates the aquifer, additional pump stations would be required to handle the resulting backseepage. This additional cost may make a partially penetrating cutoff much more expensive than a fully penetrating one.

The most difficult and potentially expensive portion of this work is the excavation of a trench through the limestone to the base of the aquifer. Estimates from various contractors involved with this type of work range from $15 to $20 per square foot of wall placed (without government E&D and S&A). Even these costs range from $71,000,000 to $95,000,000 for a 55 foot deep wall. However, all of the contractors contacted during this investigation have stated that trenches have not been excavated to the depths required by this project in rock materials.

This technology is new and the Corps will continue to assess its applicability to this or future work. Regional and local effects of this technology will be further assessed in the design phase of the project.

g. Hole-in-the-Donut Restoration

Early estimates for completion of the project are 15 years. With the uncertainty of this project, the fill material from this area was not considered for the proposed levees. Also future with and without project conditions did not consider this alternative.

h. Water Supply Preserves

The water supply preserves suggested by the National Audubon Society are outside the scope of the C-111 basin. Alternative 6A addresses their issues on a smaller scale, including water retention/detention, buffer zone, spatial distribution of water and water quality. Furthermore, if the water supply preserve plan is later adopted for implementation, the plan recommended in this report would be consistent with this concept and could be incorporated into a more comprehensive regional plan.

i. Scope

To rehydrate lands east of U.S. Highway 1 is outside the scope of this project. These lands are not part of water supply to Everglades National Park. Ideas developed outside the scope of the project can be addressed as locally preferred

features of the selected plan at a 100 percent non-Federal cost. The Federal project is shown in Alternative 6A.

j. Backfill C-111

Preliminary data developed at the SFWMD showed that the backfilling of C-111 caused a reduction in water moved to the land south of the lower section of C-111. This in turn was detrimental to the ecological balance in lower C-111. It is unknown at this time if operational studies can rectify this situation, but the Corps will continue to investigate this possibility during the design phase. In 1990, the SFWMD replaced the plug in lower C-111 with 10 culverts. This action will greatly will greatly reduce the likelihood of major damaging discharges to Manatee Bay/Barnes Sound. All of the culverts have been opened once since their construction and no significant effect has been measured. Since groundwater flow is in a southeast direction, the flow of water in the lands north of C-111 will flow to the southeast and away from ENP, and not to the western portion of the eastern panhandle of ENP. In the operational phase, S-197 will be closed and water will gravity flow south across the ENP into Florida Bay.

The lower C-111 canal provides gravity conveyance to the panhandle area of ENP both during droughts and during floods. Our period of record modeling indicates higher water table levels and longer hydroperiods in the panhandle with the existing canal in place. Also, during flood events the capacity of the gaps can be improved to retain the flood flows in the ENP and eventually add freshwater seepage into hypersaline eastern Florida.

k. Plugging C-109 and C-110

The proposed plan includes plugging of the C-109 and C-110 canals thus eliminating their function. With the proposed plan releases through S-197 will decrease considerably. Releases through S-197 depend on how the system is operated.

l. Full Restoration

None of the plans modeled will achieve full restoration. The intent of this study was to analyze the best way of achieving the objectives by providing structural capability to control the location, timing, and quantity of discharges with available water. During the design phase of the study, and subsequent studies like the C&SF Comprehensive Review Study and Modified Water Deliveries to ENP, plans to bring more water to the C-111 basin will be developed, which will work towards restoration of the C-111 basin.

m. Operational Criteria and Studies

Sections 5.4 was added to describe operational criteria used to evaluate all alternative plans. An important objective of this project is to provide a structural system that is adequate to provide the operational flexibility to restore more natural hydrologic conditions in Taylor Slough. Operational studies to identify an optimal operating plan will require additional data collection and evaluation. In order to expedite the resolution of environmental problems in the park, design and construction of the desired structural features will proceed while the operating plan is being defined. As described in a section 7.9, the operating plan for Modified Water Deliveries Project will be coordinated with the C-111 operating studies.

The GRR does contain operating criteria. All alternatives were evaluated using the design optimum canal stages for the South Dade Conveyance Canals. However, it is recognized that in order to maximize the environmental benefits while maintaining other authorized C&SF project purposes, additional studies are needed.

Operational studies will be coordinated as soon as the GRR is approved.

n. Evaluation of Alternative Plans

In the evaluation of plans, the objectives are discussed in Section 5.2 and described in Sections 5.2.1-5.2.4. The evaluation factors are discussed in Section 5.5 and described in Sections 5.5.1-5.5.4. Both Table 5-8 and 5-9 are used to select a plan. A plan was selected which met all the objectives and was the least cost.

o. Width of Levee Crown

Corps standards for levee construction include a crown width of 15 feet.

p. Federal Objective

Both negative and positive impacts have been addressed in the report.

q. Flood Control

There are measurable flood damage reduction benefits for each plan.

r. 8.5-square-mile area

A more detailed description of the entire Modified Water Deliveries to ENP Project has been provided in the "Future Without Project Condition" section. Additionally, information has been added in a new section "Integration of the Recommended Plan with the Modified Water Deliveries to ENP Project." The

recommended plan calls for construction of a levee, seepage collection canal, and a pump station, S-357, to prevent adverse impacts to the 8.5-square-mile area as a result of restoration of Shark River Slough. Legislation has been enacted authorizing the Department of Interior to utilize previously appropriated funds to contribute up to 25 percent of the cost of acquiring the 8.5-square-mile area, the Rocky Glades agricultural area, and the Frog Pond. The acquisition would be a cooperative effort by SFWMD, DOI, the State of Florida, and Dade County. If the land is acquired, there would be no adverse impact on the recommended plan.

s. S-331 Operation for Recommended Plan

S-331 will be operated as it is designed with implementation of the recommended plan. It will be used for water supply deliveries to the ENP-South Dade County Conveyance Canal system when water levels drop 1.5 feet below their optimum levels in the downstream reaches. The pump will not continue to be used to prevent flood impacts in the 8.5-square-mile area.

During non-flood conditions, excess seepage water from Shark River Slough could be pumped southward. S-331 is currently not operated like this.

t. Project Purpose for Flood Control

One of the objectives of this report is to maintain flood control in the C-111 basin east of L-31N and C-111. The use of the retention/detention area has been implemented to prevent release out of S-197. This improvement in outlet capacity is 39 percent increase over the existing condition.

u. Project Purpose for Acquisition of the Frog Pond and Rocky Glades

The purpose of acquiring the Frog Pond and the Rocky Glades agricultural areas as a part of the recommended plan is to enable the hydrologic restoration of the headwaters and upper portions of Taylor Slough.

v. Timing of Water Deliveries with Alternative 6A

The timing of water deliveries was not optimized at this stage. The use of culverts and the overflow weir will have the potential to return to a more natural timing of water releases to the ENP. Also, with the use of the pump stations, a seasonal distribution can be analyzed.

w. Concrete Lined Canal at S-332D

The concrete lined canal will be connected to the outlet side and discharge 0.5 mile west through the new S-332D tieback levee into the retention/detention zone.

x. Acquisition of Agricultural Lands

The acquisition of agricultural lands are not an objective of this report. The use of a curtain wall instead of acquiring the lands has not been ruled out.

y. River Basin Monetary Authorization & Miscellaneous Civil Works Amendments Act of 1970.

The reference to this act was not the canals, but the formula of delivering water to the ENP, specifically the use of 315,000 acre feet of water. The formula in the Act was never used and another formula was later developed. The canals in question were not built.

z. Prior Plan Formulation Studies

Prior plan formulation studies from the 1988 GDM are located in Appendix F.

aa. Damaging Fresh Water to Barnes Sound

Section 5.2.3 was inadvertently left out of the report and has been included in the final GRR.

ab. Flexibility

A flexibility to maintain flood control for the areas east of L-31N and C-111 was added to Section 5.5.1. Flood protection is evaluated for lands east of L-31N and C-111.

ac. Flows Collected in Canals

This paragraph, section 4.1, 3rd para., has been modified. These flows are collected in the canals and are discharges for the most part to Taylor Slough (at S-332), to the park's panhandle via S-18C and lower C-111, and to Manatee Bay/Barnes Sound under extreme conditions.

ad. Interim Plan

Section 1 of the GRR is an introduction. Canal stages are discussed in Chapter 2.

ae. Selection on Recommended Plan

Plan 6A was selected because it meets the overall objectives of maintaining flood control while permitting environmental restoration within ENP to occur.

af. Public Review and Meetings

The draft C-111 GRR and Integrated EIS was coordinated for review with federal, state, and local agencies, as well as the public between March 4, 1994 and April 18, 10994. Also when the operating plan for the structures is formulated, it will be coordinated for independent review. Agricultural and environmental interests have been included.

ag. Design of Recommended Plan

The design phase for the C-111 basin will address specific details and design issues. This study will include extension of the buffer strip, location of the spreader canal, size of S-332E, and plugging, filling, or other options for the lower C-111 reach. As well as potential impacts to Florida City.

ah. Miscellaneous Editorial and Printing Errors

The Corps has tried to correct the miscellaneous typographical, editorial, and printing mistakes.

8.6.2 Environmental Information and Evaluation Comments/Responses

a. Buffer Zone Management

Land management practices for lands acquired for project purposes are discussed in paragraph 7.4.2. A cost of $15 per acre per year was provided by the SFWMD for land management.

b. Treatment for Water Quality

The issue is discussed in Section 2.3 of the report. The proposed project will not adversely impact the quality of State waters or those of Everglades National Park. The Corps of Engineers does not propose water treatment areas or facilities as part of the project.

Water quality effects of detention/retention zones are addressed in Section 6.6. The subsoil in the Taylor Slough--C-111 area is highly porous and cavity-riddled limestone incapable of supporting surface water except when the ground water is at the surface.

c. Cause of Seagrass Die-off in Florida Bay Are Not Thoroughly Known.

Concur.

d. Statements in the document regarding effects in Florida Bay should be carefully qualified to avoid inferring unjustified blame:

Concur; inferences that may be perceived are not always anticipated.

e. Excessive phosphorous levels are "believed to be a result of increasing agricultural use and changes in land use in the Taylor Slough Watershed." Who believes? Documented fact? Are areas north of Tamiami Trail included in this reference?

This is hypothesis, referring to land uses in the entire Everglades watershed.

f. Impacts on listed endangered or threatened species:

Fish, wildlife, and endangered species responses to the recommended plan will depend on seasonal water availability. This will be forecast during operational studies. The recommended plan has the greatest potential for meeting the criteria.

g. Restoration of natural fire regimes:

To the extent that the objective (section 5.2) of restoring historic hydrologic conditions is reached, restoration of natural fire regimes will be possible.

h. Control of nutrients and other water pollutants:

The recommended alternative will not exacerbate water quality problems in Florida Bay.

i. Imposition of best management practices in Taylor Slough watershed:

Imposition of best management practices on agriculture in the area is not part of the plan recommended by the U.S. Army Corps of Engineers.

j. "Without project" effects on Florida Bay ecosystems:

As stated in Section 2.4.7, restoration of more natural hydrology in the Taylor Slough--C-111 basin would correct one of the major problems in Florida Bay. However, "without project" conditions probably do not include all the documented problems in Florida Bay.

k. Environmental benefits of various components of the integrated estuarine and marine ecosystem structure and functioning as evaluation criteria:

The environmental evaluation criteria presented in Section 5.5.3 are regarded as the basis for the adequate structure and function of the various components of the ecosystem. The components, such as mangroves, fringing marshes, and seagrass meadows, are not evaluation criteria because they are the results of, not the basis for, a more natural hydrological regime. As indicators of a healthy system, they are reliable, but slow in responding.

l. The desirability of natural fires vs prescribed burning:

The comment is noted for future reference in development of management and monitoring protocols.

m. Recommendation of a complete review and evaluation of all historical and current information to define natural ecological functions:

Such a review has been underway as a cooperative effort between ENP and the USACE. This is expected to continue as part of the operational evaluation phase.

n. Begin development of a fine scale natural systems model capable of providing an estimate of pre-project hydrologic conditions:

Such modeling has been underway cooperatively by the SFWMD and the ENP.

o. Create a comprehensive hydrologic and biologic monitoring program:

Concur that this is a high priority task during the operational evaluation phase. Funds have been added to create the monitoring program and an outline is included in Annex H.

p. Concerns over the actual functioning of the project to be developed:

All concerned agencies, including the EPA, will be kept informed and their counsel will be welcomed during the operational evaluation phase.

q. Water Spillover from Shark River Slough at 6.5 feet elevation

The information is developed and reported by Tropical Bioindustries (TBI, 1990). The author indicates that the information is based on topographic data. Examination of the most recent topographic data collected by the Corps, SFWMD, and ENP (compiled by ENP) confirms this conclusion.

r. Lack of Scientific Data linking water quality and agricultural practices in South Dade County

The Corps has no data that show a statistical correlation between South Dade County agriculture and water quality in the canals.

s. Positive Effects of Alternative 6A

The Everglades represents marginal habitat quality for most of the species of concern, and restoring the habitat to historic-like conditions of low nutrients and low productivity, although helpful to individual populations, would not greatly help the species.

t. Water Quality of Areas North of the Tamiami Trail

Water quality in the northern Everglades refers to areas north of the Tamiami Trail. The reference is made to water brought into Dade County from the north.

u. Specific question asks whether data support the inference that lowered water levels caused adverse changes in nesting success of wood stork, Cape Sable sparrow, and roseate spoonbill.

The conjecture is based on professional judgement expressed by ENP biologists.

v. Specific question asks (a) whether the cost of the proposed project is justified by the projected, small effects on species listed under the Endangered Species Act, and (b) asks for explanation of the statement in the report that proposed project works may give better results under "a different water control schedule."

(a) The Everglades represent marginal habitat quality for most of the species of concern, and restoring the habitat to historic-like conditions of low nutrients and low productivity would not greatly help the species. The C-111 restoration proposal, in itself, would not greatly favor one species or another, but would contribute to the recovery of the greater Everglades in combination with Modified Water Deliveries to ENP and associated effects in the Water Conservation Areas. Wide-ranging species, such as wading birds, would benefit from the wet-dry pulses in the greater restored portion of the Everglades.

(b) The quoted phrase was not found in the cited paragraphs, nor in adjacent ones in the draft GRR/EIS.

w. Specific question interprets a statement in the report to mean that South Dade agricultural practices and resources are one with those farther north, and expresses the opinion that retention areas or flow-ways would not function well in the C-111 area.

The Corps has no data that statistically link South Dade agricultural practice with water quality problems. Retention areas and flow-ways would be those, or similar to those, that are part of the Alternative 6A plan.

8.6.3 Hydrologic Issues and Evaluation Comments/Responses

a. Will increased water levels in northern Taylor Slough impact flood protection to the 8.5-square-mile area or increase the seepage to L-31N?

Modeling has not shown an adverse impact on the 8.5-square-mile area. More detailed groundwater modeling will be used to further quantify impacts. Higher seepage rates to the lower L-31N canal are expected and are accounted for in the design.

b. Grossman Road Borrow Canal

The Grossman Road borrow canal is not included in the model that was utilized for this study. It may have some local hydrologic impacts but it does not significantly impact the water management system. As a part of detailed design for the Modified Water Deliveries to ENP Project, an evaluation will be done of the hydrologic impacts of all existing roads and canals that are within the ENP expansion area. If it is determined that the roads or canals have a hydrologic impact on the natural conditions in the area, they will be restored to natural ground elevations.

c. Groundwater Modeling for Detailed Design

As a part of detailed design studies of the Modified Water Deliveries to ENP Project, the USGS modified an existing model to provide adequate detail for the study area. This model is used to predict seepage rates into the L-31N borrow canal that will occur as a result of restoration of Shark River Slough. The same model will be modified and utilized for the C-111 project detailed design studies.

d. Salt Water Intrusion

The South Dade Conveyance Canals were designed for a variety of purposes including the prevention of salt water intrusion. The operating criteria for those canals allow water to be brought in from other sources when the canal stage falls 1.5 feet below the design optimum stage. This operating constraint will be maintained. However, a detailed analysis of salt water intrusion in the C-111 system may be appropriate for the operation studies which follow the GRR.

e. Backpump Coastal Canals C-102 and C-103 for Additional Water

The proposal to backpump at the coastal canals C-102 and C-103 for additional water was investigated by the SFWMD for the Taylor Slough Demonstration Project. The SFWMD performed a field test at structures S-194 and S-196 in the spring of 1992 with portable pumps and concluded that backpumping was not very effective and therefore that increment was deleted from the test. However, in the operating studies which follow the GRR, it may be appropriate to assess that option for additional water.

f. Storms of June 1988

Although many secondary drainage systems rely on gravity, it may be appropriate to construct canals and pumping facilities to remove water in the area cited.

g. Storms of August 1988

The operating criteria used for S-331 during the August 1988 storms required it to pump in response to water levels at Angels Well. These operating criteria were developed as a result of the Kendall vs. Marsh litigation. It should be noted that if this test were not in place, then canal stages would have been at their design optimum stage in the southern portion of the C-111 basin and the results may have been the same in regards to the removal of the plug at S-197.

h. Optimum Water Levels

Table A-5 contains the design headwater and tailwater and optimum water levels used in the model.

i. Base Condition Used

The Base Condition used was selected based on the return to design optimum conditions upon completion of the Modified Water Delivery Project. At that point, Congress has mandated the Experimental Delivery Program will end. It should be noted all alternatives were evaluated using the same set of assumptions and compared to each other. The selected alternative 6a performed the best given this set of assumptions.

j. Inclusion of the 1992 Water Deliveries GDM

Agriculture moved in west of L-31N canal when water levels were lowered in response to the Kendall vs. Marsh litigation.

k. Inclusion of C-111 Interim Plan

Prior to the experimental program beginning and the Kendall vs. Marsh litigation, water levels in the South Dade Conveyance Canals were kept at their design optimum of base condition for the GRR. In response to the litigation, and to continue the experimental water delivery program, water levels in the southern portion of the C-111 basin were lowered as a trade-off for water deliveries into Shark Slough.

l. Operational Plan for Modified Water Deliveries to Everglades National Park

The approved Modified Water Deliveries General Design Memorandum (GDM) evaluated four operational schemes. Because there was no consensus it was decided to recommend structural features and refine the operating scheme. However on pg 59 of the GDM the following statement is made, "If an acceptable operational strategy has not been developed at the end of the iterative process, the Modified Rain Driven Operational strategy addressed in this report will be the water control plan when construction of the structural features is complete."

m. Retention/detention Area

The retention/detention area will serve several purposes. First, it will allow temporary storage of excess flood waters for use during times of deficient rainfall. Secondly, it will permit water managers the flexibility to release water into the ENP at various points in various quantities. Third, it will serve as a buffer area, maintaining high groundwater in the ENP to the west and allow the gradient to reduce to the east. Last, there are water quality benefits which have not been quantified in retaining the water prior to release into ENP.

Construction of a retention/detention area will be addressed during the design phase of C-111 project. One major issue concerning this measure is the high permeability of subsoil in the area. Soils of this type do not retain water for long periods of time. Another concern is potential flooding of areas upstream of a retention/detention area. When a ponding area is being filled, it creates a water mound that drastically reduces normal draining and produce longer hydroperiods in upstream areas. This effect was found during analysis of the retention/detention area west of L-31W in alternative 3.

n. Salt Water Intrusion

An important issue with a plan that includes a curtain wall for controlling seepage is the impact of salt water intrusion in the region. During droughts the fresh/salt water balance is sometimes upset and thus more salt water intrusion results from this imbalance. Numerical models used in the past and during the GRR

are not capable of handling variations in water density. Search for a suitable model that includes the effects of a curtain wall salt on water intrusion is already in motion.

o. Rehydration of Taylor Slough

Rehydration of Taylor Slough headwater is the project purpose. Delivery of enough water to rehydrate the headwaters area and keep flood flows within the system are the basis for design of the pumping system. Continuous pumping would result in overdraining of groundwater near the canals and a mining of water. Experience has shown at S-331 it is possible to overdraw local groundwater and artificially reduce canal levels. Operational studies are intended to set start/stop pump stages so that these conditions do not occur.

p. Use of the 1x1 Model

The 1x1 model was the best tool available to assess damages throughout the C-111 area. Although the model uses a one day time step and therefore will not predict a 12 hour flood behavior, stages in the area do not change rapidly. It takes days and sometimes weeks for stages to change significantly. Therefore, if damages were to occur in a specific area, the 1x1 would predict those damages with a good degree of accuracy.

The 1x1 model uses a one square mile gridcell as a unit value to simulate hydrologic changes in the C-111 area. Because of the unique subsurface soil in the area and a very flat ground surface, water stages whether below or above ground change very little from one grid cell to another in general. A one mile gridcell therefore is enough to estimate damages and rate alternatives.

q. Modeling of Channels

The 1x1 model still uses a single reach between structures to compute volumes of water in that particular reach. This is done to approximate a mass balance of water available for routing downstream. However, seepage inflows to a channel reach are computed on a gridcell by gridcell basis and considers canal stages at each gridcell. Canal stages in a particular reach represent the stage at the downstream end of the reach between two structures. Therefore, calibration of the model compares the headwater at the downstream structure for each reach between two structures.

r. Physical Model Input Data

The data in the model reflects average ground elevation. As mentioned before changes in ground elevation in the area is gradual with very mild slopes. Today, a model that would reflect a more accurate representation of the land elevations in the

area is not available. The 1x1 model is the best available tool for use in the C-111 area to evaluate alternative plans.

s. Boundary Conditions

Rainfall frequency storm events are modeled to assess their effects throughout a specific area. Boundary conditions do not include any effects of storm surges in the area, since it would worsen conditions for all conditions including the base. Storm surges would occur with and without the proposed plan and are not the focus of this study. A storm surge is another source of flooding. The focus of the study was to assess alternative plans and to insure private lands were not adversely impacted over the base condition.

t. Calibration and Verification

The 1x1 version used in the C-111 GRR was calibrated by the South Florida Water Management District in 1992. Historical and simulated stages at selected points were compared. Full details and results of the calibration runs can be obtained from the Lower District Planning Division of that agency.

u. Seasonal Flood Occurrence

The chance of damaging rainfalls occurring from November 1 through March 31 in any given year is the same with or without the project. During this period water deliveries to the C-111 basin are for water supply and for control of salt water intrusion. These dry season water deliveries do not increase the chance of flooding in the area.

v. 1x1 Modeling

Flood modeling utilized the most current version of the SFWMM 1x1. Canal conveyances are computed using existing canals (with South Dade Conveyance System completed). Plates showing canal dimensions were used to show typical canal/levee configurations and were not used for computations.

Concur - More detail models are needed to fully evaluate local impacts. Models used in this study were primarily used for alternative selection.

w. S-332E

Concerning S-332E, a similar effect was noted in areas north of the spreader canal. A sensitivity analysis of the pump station feeding this canal gave preliminary information about potential impact with a larger pump station. When S-332E capacity was increased from 50 to 100 cfs, backwater effects were found in areas up to five

miles north of the canal. This issue will be addressed during the design phase for C-111.

x. Canal Stage Operation

Under the Experimental Program for Water Deliveries to ENP, canal stages in the C-111 area in general are operated lower than authorized. Alternatives in the GRR were modeled to simulate conditions before the Experimental Program. All the alternatives in the GRR were modeled with a fixed amount of water deliveries to the basin. This was done to ease model output analysis. In the operations study water deliveries to the C-111 basin would vary. This will increase the chances of restoring Taylor Slough and the eastern panhandle of ENP.

With the proposed plan, S-332B, C, and D pumped water when the upstream stage of S-176 was higher than 5.1 feet, NGVD. To maximize environmental benefits in some areas, the pump stations could operate at different stages. The operations study will address these issues.

8.6.4 Economic Evaluation Comments/Responses

a. Calculation on Rocky Glades Population

The initial estimate for displacement of people in the Rocky Glades Area used in the draft report was based upon tax roll information provided by Dade County. The information showed 15 structures classified as single family residential in the affected area. However it was not known at that time how many structures were abandoned after Hurricane Andrew or how many were simply adjoining structures such as sheds or utility living quarters. Multiplying 15 X 3.21 people per household yields the 50 person estimate that is stated to be the maximum amount of people displaced by land purchases in the Rocky Glades area. Subsequent field investigations have been conducted since the publication of the draft report. The Real Estate Appendix C will indicate that there are 4 homes in the affected area. Using 3.21 people per household the estimate of people will be revised to 13.

b. Purpose of Study

Project formulation and evaluation in the document has given equal weight to both environmental and flood control concerns. Although the objectives for the formulation were to only maintain existing flood control protection, the recommended plan actually increases flood control protection in the form of decreased flood durations to agricultural land owners east of C-111. Benefits shown for alternative 6A in Appendix E reflect this increased protection.

c. Agriculture Statistics in Rocky Glades Area

The acreage of effected land use shown in Section 6.8 and in Table 6.1 of the draft report have been underestimated. The corresponding text in Section 6.8 (Agriculture) and a revised Table 6.1 will be provided in the final report. Increase in acreages between the draft report and the final report are due to a more accurate transcription of information from the Modified Water Delivery GDM. Information describing the types of tree crops located in the Rocky Glades area will also be added to paragraph 7.

d. Flood Control for Areas West of Protection Levee

The authorized project was never designed to provide flood control protection west of L-31N. Productive acreage west of L-31N is considered to be incompatible with optimum stage regulation authorized by the original flood control project. Plan alternatives which worsen conditions over optimum stage levels in this area include the purchase of these lands as a project component. Therefore flood damage effects to this land use are not considered.

e. Community Cohesion

Two separable effects are expected to occur in the Frog Pond and Rocky Glades Area. Optimum water levels will be re-established in the area whether or not the plan alternative is implemented. Therefore decreases in Community Cohesion caused by this action are not project related. However, marginal increases above optimum stage in this area caused by the proposed alternative would cause somewhat decreased effects in Community Cohesion. Table 5-2 will be revised to show these worsened conditions. No adverse condition is expected for alternative 1 or alternative 9.

f. Displacement of Business and Displacement of Farms

Indirect impacts to business will be affected by removing the Frog Pond and Rocky Glades from production. However, the quantification of these losses is unknown at this time. In addition, these losses may be somewhat offset by the increased flood control protection provided to agribusiness east of C-111. Table 5-2 will be revised to show worsened conditions. No adverse condition is expected for alternative 1 or alternative 9.

g. Economic Impacts

Table 5-3 entitled "Effects Evaluation; Categories of Natural and Cultural Resources Effects..." is not intended to address the economic effects of alternative plans. Economic effects, including effects on businesses, farms and the regional economy are addressed in tables 5-2 and 5-4. The categories described in Table 5-3 encompass and are consistent with the concept of human environment as used in

NEPA and the appropriate portions of the NEPA regulations established by the Council on Environmental Quality (CEQ) in 40 CFR Parts 1500-1508.

h. Economic Evaluation

The annual benefit row shown in Table 5-4 pertains only to the National Economic Development (NED) account. Negative effects attributable to agricultural land purchases are accounted for in the NED account as a project cost and are displayed on an annual basis. The effect of increased project costs for flood control would be to reduce the net benefits to the project and reduce the corresponding benefit-to-cost (B/C) ratio of the flood control portion of the project. Effects upon accessory industries is a regional impact which has not been ascertained. However this impact is not part of the NED account. Negative impacts of alternative plans are identified in the Regional Economic Development (RED) account in table 5-4.

i. Agricultural Economic Impact Study

Detailed studies to quantify regional impacts on the agricultural economy were beyond the scope of the General Re-evaluation Report (GRR). Impacts are addressed in qualitative terms in tables 5-2 and 5-4, and an estimate of direct losses to agriculture associated with land purchases is discussed in Section 6.8.

j. NED Analysis

The Canal 111 basin which includes the Frog Pond and the Rocky Glades Area has been farmed for at least 30 years. The District has no evidence that these agricultural activities are "unsustainable". The gains in biological diversity expected with the project are discussed as environmental restoration benefits. Because these gains are accounted for as benefits, they are excluded from cost considerations to avoid double counting. Regional income losses prevented cannot be claimed as NED benefits without detailed studies to demonstrate that these losses would not be made up elsewhere in the national economy (as is generally the case). Regarding the assertions that project implementation will have beneficial effects on regional income for sportfishing and tourism, a causative link between the project and these sources of regional income has not been demonstrated. The linkage between project implementation and losses to regional agricultural income is readily apparent. Based on the best currently available information, it appears that alternatives 4, 6, and 6A would have overall negative impacts on regional economic development.

k. Flood Damage Susceptibility

The statement, "Unless lands are taken out of production for future environmental acquisitions, the flood damage susceptibility will remain the same.", will be deleted from the text.

l. Federal Responsibility to Homeowners

Federal responsibility to homeowners, workers and businesses of the region in recognized in the recommended plan in the form of positive flood control benefits to the area east of C-111. In addition, responsibility to mitigate for adverse effects is the basis for some of the land acquisitions for the recommended plan.

m. Federal Objectives

The flood control feature of the NED account is improved since flood damage prevention increases with the selected plan. Positive flood control benefits accrue to the area east of C-111 when the without and with project alternatives are evaluated at authorized stage levels. Although project costs for environmental project purposes have been determined, NED benefits attributable to environmental purchases have not been determined. Therefore, the effect upon the entire NED account is not known. All costs and benefits that have been computed for the GRR will be shown in the Environmental Impact Statement under NEPA. The Other Social Effects account (OSE) and Regional Economic Development accounts (RED) are displayed and compared with the NED account in section 5 in the main report. Negative effects attributable to agricultural land purchases are accounted for in the NED account. Lands purchased are a project cost and are displayed on an annual basis. The effect of increased project costs is to reduce the net benefits to the project and reduce the corresponding benefit-to-cost (B/C) ratio of the flood control portion of the project.

NED impacts have not been ignored. Flood control is an important project purpose. The NED plan is not identified in this report because the report objectives are slightly different than in traditional reports. The objective is not to maximize flood control protection but rather to re-instate the protection provided by the original project under changing land use conditions. However, overall flood protection will increase, indicated by positive flood control benefits, for the area east of C-111 with the recommended plan when both conditions are evaluated at optimum stage levels.

n. Preliminary Analysis of Annual Benefits and Costs

The objectives in this report are slightly different than in traditional reports. The flood control objective is to re-instate the protection provided by the original project under changing land use conditions. All plans evaluated include a flood control component to provide the stated protection. Therefore, the flood control component benefit-to-cost ratio for all plans is close to identical to the B/C ratio computed for alternative 1A. A dollar value has not been assigned to the environmental benefits for this project. To compare total benefit-to-cost ratios without including environmental benefits would be misleading.

o. Displacement of People, Businesses and Farms

The negative effects of alternative plans on regional employment and income (i.e., ripple effects), are identified in table 5-4. Detailed analyses to quantify the number of jobs lost were beyond the study scope. Losses to businesses, etc., are addressed in qualitative terms in tables 5-2 and 5-4. Direct revenue losses to agriculture are discussed in section 6.8.

p. Flawed Flood Damage Assessment

Generalized criticism of flood damage evaluation is noted. Topographic information for the Frog Pond was provided by Ghioto & Associates in 1988.

q. Seasonal Adjustments for Field Crops

Seasonal Adjustments for Field Crops, in Appendix E has been revised in the final report to show increased probabilities of flooding during the period November 1 to March 31. Cumulative percentages increase from 0% to 7%.

r. Root Zone Depth

As noted, effects of capillary action to draw water into the root zones on flood damage susceptibility were not considered. Increasing root depth susceptibility would have the net effect of increasing field crop potential damage without and with project conditions. Since benefits are measured as the difference between without and with project conditions, flood damages prevented for the area east of C-111 would increase with this assumption for all alternatives evaluated.

8.6.5 Real Estate Comments/Responses

a. Fair Market Value for Lands

Land required for the project will be appraised at the fair market value. This appraisal will value all real property including existing crops, fruit trees, irrigation systems, structures, etc., that will not be relocated. Eligibility for relocation benefits as stated in Public Law 91-646, Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, as amended will be assessed.

b. Moving Costs

For the purposes of this planning report, the land values include crops and improvements currently on the property. There are four residences identified for Public Law 91-646 relocation payments which are discussed in Paragraph 7.2.2. and Appendix C, Real Estate Plan. There are no business relocation moving costs identified because the owners will be compensated for existing crops, fruit trees, irrigation systems, etc.

A real Estate Design Memorandum (REDM) will be prepared during the Planning, Engineering and Design phase. Additional relocations may be identified during this phase and will be included in the REDM.

c. Costs for appraisals

Additional appraisals will be covered by contingencies. The title work and environmental audits are included in the acquisition administrative costs.

8.7 PUBLIC MEETINGS

A public meeting was conducted during the draft report review period to provide all members of the public with an opportunity to better understand and discuss the results of the Corps' GRR. This meeting was held in Homestead, Florida on March 29, 1994 at the Homestead Senior High School. A transcript was made of the meeting and this will serve as the official record on the meeting. At the public meeting, background information on the study was presented and the recommended plan was described in detail. The public was then provided the opportunity to express their views on the GRR and to ask questions.

The meeting was attended by over 700 people. The speakers were divided into basically two groups, environmental groups in support for Florida Bay and the agricultural community requesting the use of a curtain wall to divide their land from the ENP.

In addition to the meeting, the SFWMD Florida Bay Subcommittee was briefed in December 1993 and again in February 1994, which provided the public with information concerning this study and afforded the public the opportunity to speak.

8.8 SUMMARY OF COMPLIANCE WITH APPLICABLE ENVIRONMENTAL REQUIREMENTS

1. Archeological and Historic Preservation Act, as amended. 16 U.S.C. 469 et seq., as amended by PL 96-515, December 12, 1980.

Full compliance. By letter dated March 21, 1994 the State Historic Preservation Officer concurred, pending on site surveys during detailed design phase.

2. Clean Air Act, as amended. 42 U.S.C. 7401 et seq.

Partial compliance at this time. Full compliance will be achieved through coordination of this integrated feasibility report and EIS with the Environmental Protection Agency, which will permit that agency to review and comment publicly on the environmental impacts of the alternatives, including the Recommended Plan.

3. Clean Water Act (Federal Water Pollution Control Act), as amended. 33 U.S.C. 1251 et seq. (PL 92-500).

Partial compliance at this time. Although this document meets the requirements of Section 404(r) of the Act (Annex B), a Section 401 State water quality certificate will be sought during the later preconstruction engineering and design phase.

4. Coastal Zone Management Act of 1972, as amended. 16 U.S.C. 1451 et seq.

The study is in compliance at this stage. A Federal consistency determination in accordance with 15 CFR 930 Subpart C is provided as Annex C. By letter dated April 29, 1994, the State found the draft GRR-EIS consistent with the State's Coastal Zone Management Plan and endorsed further planning and development of an operational plan.

5. Endangered Species Act of 1973, as amended. 16 U.S.C. 1531 et seq.

Full compliance at this time. The Corps of Engineers has determined that the alternative plans will not affect listed species nor their critical habitats. By letter of February 3, 1994, the Secretary of the Interior concurs with the Corps' determination, except for the Cape Sable sparrow. A USFWS Biological Opinion may be required for this species when operational plans are developed.

6. Estuary Protection Act. 16 U.S.C. 1221 et seq. (PL 9454, 3 August 1968).

Barnes Sound may be considered an estuary because it is subject to inflow from C-111. The flow is controlled and intermittent, however, and there is no true estuary in the study area. In the spirit of the Estuary Protection Act, however, this report is being submitted to the Secretary of the Interior for comment, including comment on the studied alternatives' effects on the lagoons and bays in the study area.

7. Federal Water Project Recreation Act, as amended. 16 U.S.C. 4601-12 et seq.

The study is in full compliance at this stage. Recreation planning and consideration will be continued during later stages of planning and design.

8. Fish and Wildlife Coordination Act, as amended. 16 U.S.C. 661 et seq.

The U.S. Fish and Wildlife Service and the Florida Game and Fresh Water Fish Commission have been cooperating agencies on the interagency planning team. They have participated in identification of environmental problems, formulation of alternatives, and assessment of impacts. Letters from the U.S. Department of the Interior Regional Environmental Officer are included with this report. Concurrence and support of the Department with the project purpose and the planning procedure

are indicated in the letter dated February 3, 1994. The later letter, dated May 13, 1994, contains an expression of support from the Department for the adoption and expedited implementation of the recommended Plan 6A. Department of the Interior support for Plan 6A is contingent on the inclusion of (1) the extension of the water detention/retention area on a north-south alignment through the central portion of the Frog Pond, (2) a connector canal to convey water from L-31W to C-111 below S-175 and S-177, and (3) an increase in the size of the S-332E pump station and considered location of the C-111N spreader canal.

The DOI letter of May 13, 1994, states that the U.S. Fish and Wildlife Service will supply a Fish and Wildlife Coordination Act Report (CAR) upon receipt of the results of environmental investigations by the National Park Service. An interim CAR supporting the project was received on May 31, 1994 and is included in Annex D. In accordance with the Scope of Work between the Corps of Engineers and the National Park Service, peer reviewed scientific studies now underway will form the basis of the Secretary of the Interior's report to Congress as required by Sec. 2(b) of the Act.

9. Land and Water Conservation Fund Act of 1965, as amended. 16 U.S.C. 4601-4 et seq.

No properties affected by this act are involved in the recommended project area.

10. Marine Protection, Research, and Sanctuaries Act of 1972, as amended. 33 U.S.C. 1401 et seq.

Ocean disposal of dredged material is not proposed.

11. National Environmental Policy Act of 1969, as amended. 42 U.S.C. 4321 et seq. PL 91-190, as amended.

The study is in compliance at this time. Comments on the draft GRR-EIS by Federal, State and regional agencies having jurisdiction or relevant expertise,s by affected parties and the interested publics are included in this document.

12. National Historic Preservation Act of 1966, as amended. 16 U.S.C. 470 et seq., as amended by PL 102-575, 2 Nov 92.

Consideration of effects on historic resources are addressed in the body of the EIS, and comments have been received from the State Historic Preservation Officer.

13. Coastal Barrier Resources Act.

The study area is not in a designated CBRA unit.

14. Rivers and Harbors Appropriation Act of 1899.

The study is in full compliance. The studied work would not obstruct waters of the United States.

15. Watershed Protection and Flood Prevention Act of 1954, as amended.

This is not applicable to U.S. Army Corps of Engineers projects.

16. Wild and Scenic Rivers Act of 1968, as amended.

The study is in full compliance. No rivers designated under the Act are in the study area.

17. Executive Order 11988, Flood Plain Management.

The study is in full compliance. The considered alternatives support avoidance of development in the flood plain, continue to reduce hazards and risks associated with floods and to minimize the impact of floods on human safety, health and welfare, and restore and preserve the natural and beneficial values of the base flood plain.

18. Executive Order 11990, Protection of Wetlands.

The study is in full compliance. The nature of the project is that it involves work in wetlands, and no practicable alternative to working in wetlands exists. Losses and degradation to the beneficial values of wetlands are minimized, and such values are preserved and enhanced. The public has been involved in early planning.

19. Executive Order 12114, Environmental Effects Abroad of Major Federal Actions.

This executive order is not applicable to this study.

SECTION 9

RECOMMENDATIONS

I recommend that the Central and Southern Florida Project be modified to allow for improved water deliveries to Everglades National Park in accordance with the 1968 Flood Control Act. The total estimated cost of the recommended plan is $121,413,000. The estimated Federal (USACE) cost is $59,027,000 and the estimated non-Federal cost is $62,386,000.

The above recommendations are made with the provision that prior to project implementation, the non-Federal sponsor shall enter into a binding agreement with the Secretary of the Army to perform the following items of local cooperation as required in the 1968 Flood Control Act and modified by Executive Order:

a. Make a cash contribution of 20 percent of the contract price plus supervision and administration for all items of work to be provided by the Corps of Engineers, an amount presently estimated at $11,696,000 to be paid in a lump sum prior to start of construction or in installments prior to start of pertinent work items in accordance with construction schedules as required by the Chief of Engineers, the final allocation of costs to be make after the actual costs have been determined;

b. With appropriate jurisdiction, construct and thereafter maintain such canal facilities and other water control appurtenances as are necessary to realize the benefits from the improvements;

c. Provide without cost to the United States all lands, easements, and right-of way necessary for construction, operation and maintenance of the project, when and as required;

d. Assume the cost of construction of all non-Federal highway bridges, relocation of existing non-Federal highway bridges and alteration of utilities and other improvements except railroads, incident to construction of the project.

e. Hold and save the United States free from damages due to the construction, operation, and maintenance of the project works;

f. Participate in the National Flood Insurance Program and other applicable Federal flood plain management programs;

g. Provide guidance and leadership to prevent unwise future development in the flood plain;

h. Assume financial responsibility for all costs incurred in cleanup of hazardous materials located on project lands covered under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), for which no cost sharing credit shall be given, and operate, maintain, repair, replace, and rehabilitate the project in a manner so that liability will not arise under CERCLA;

i. Operate and maintain the pumping stations, levees, canals, and other appurtenant works herein, after completion of construction for flood control, navigation, and backpumping and delivery of water to Everglades National Park, the agricultural areas, and urban areas, in accordance with regulations approved by the Secretary of the Army. The Federal government, however, would reimburse local interests 60 percent of the annual pumping costs, including fuel, lubricants, proportional depreciation and repairs, and operating labor for all pump stations. All other operation and maintenance costs of the project will be borne by local interests.

The recommendations contained herein reflect the information available at this time and current Departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to the Office of Management and Budget (OMB) as proposals for implementation funding. However, prior to transmittal to the OMB, the sponsor, the State, interested Federal agencies, and other parties will be advised of any modifications and will be afforded an opportunity to comment further.

TERRENCE C. SALT
Colonel, Corps of Engineers
Commanding

SECTION 10

LIST OF PREPARERS

The people who were primarily responsible for contributing to preparing this Environmental Impact Statement are listed in Table 10-1.

Table 10-1

C-111
List of Preparers

NAME	DISCIPLINE/ EXPERTISE	EXPERIENCE	ROLE IN PREPARING DOCUMENT
Gerald L. Atmar	Biology	15 years environmental impact assessment, Corps of Engineers	Report-EIS preparation; review and supervision
Annon I. Bozeman, Jr.	Outdoor Recreation Planner	14 years recreation design, construction and development	Aesthetics and Recreation
Joseph Carroll	Biology	USFWS, Vero Beach	Fish and Wildlife coordination Act Report, Planning partners
Robert J. Fennema	Hydrologist	Everglades National Park	EIS preparation
Lewis I. Hornung	Civil Engineer	17 years water resources planning, Corps of Engineers	Report-EIS preparation: project management
Robert A. Johnson	Hydrologist	Everglades National Park	EIS preparation
Janet Ley	Biology	South Florida Water Management District	EIS preparation
James McAdams	Environmental Engineer	12 years water resources planning, Corps of Engineers	Water quality assessment
David L. McCullough	Archeology	12 years environmental and cultural resources assessment	Cultural Resources evaluation, coordination
John C. Ogden	Biology	Everglades National Park	EIS preparation; study manager for ENP
Susan D. Olson	Civil Engineer	South Florida Water Management District	EIS preparation; study manager for SFWMD
Stephen T. Sutterfield	Civil Engineer	12 years water resources planning, Corps of Engineers	Report-EIS preparation: study manager

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