CENTRAL AND SOUTHERN FLORIDA PROJECT

KISSIMMEE RIVER
HEADWATERS REVITALIZATION PROJECT

INTEGRATED PROJECT MODIFICATION REPORT AND SUPPLEMENT TO THE FINAL ENVIRONMENTAL IMPACT STATEMENT

US Army Corps of Engineers
Jacksonville District
South Atlantic Division

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CENTRAL AND SOUTHERN FLORIDA PROJECT
FOR FLOOD CONTROL AND OTHER PURPOSES

KISSIMMEE RIVER, FLORIDA
HEADWATERS REVITALIZATION

INTEGRATED PROJECT MODIFICATION REPORT
AND
SUPPLEMENTAL 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. The Kissimmee River Basin flood control works was authorized as an addition to the C&SF Project by the Flood Control Act of 1954.

In the 1992 Water Resources Development Act (WRDA), Congress jointly authorized the ecosystem restoration of the Kissimmee River and the Kissimmee River Headwaters Revitalization Project. Modifications in the Kissimmee Upper Basin were deemed necessary for the successful restoration of the Lower Basin ecosystem. The 1992 WRDA also stipulates that construction of Kissimmee River Headwaters Revitalization Project will be based on the recommendations provided in the Project Modification Report contained herein. The cost-sharing requirements applicable to this project were established as 50 percent Federal and 50 percent non-Federal. On March 22, 1994, a Project Cooperation Agreement was executed between the Department of the Army and the South Florida Water Management District (SFWMD), which combined the two authorized construction segments into one project, the Kissimmee River, Florida Project.

This Project Modification Report (PMR) provides formulation and assessment for completing the authorized project purposes within the Kissimmee River Upper Basin. These purposes include providing necessary flows for the restoration of the Kissimmee River ecosystem and maintenance of the existing level of flood control within the Kissimmee River Basin. An objective of the study was established to, (a) develop a plan which provides the necessary storage and regulation schedule modifications to approximate historical flow characteristics to achieve or exceed the benefits ascribed to Kissimmee River Restoration, and (b) increase the quantity and quality of the wetland habitat in the Upper Basin lake littoral zones to benefit fish and wildlife.

An array of alternative plans have been formulated and evaluated in coordination with our study partners, the South Florida Water Management District. The plans have undergone extensive coordination with representatives of the U. S. Fish and Wildlife Service and the Florida Game and Freshwater Fish Commission in the determination of measures which will satisfy the project objectives.

The recommended plan consists of both structural and non-structural modifications to the existing project works within the Upper Kissimmee River Basin. Non-structural components consist of the modification of the existing Lake Kissimmee regulation schedule in order to restore the Kissimmee River and to expand the Upper Kissimmee Basin lake littoral zones. Acquisition of approximately 20,800 acres of land bordering the affected lakes, Lake Hatchineha, Lake Kissimmee, Lake Cypress, and Lake Tiger is required to provide the necessary storage requirements for Kissimmee River restoration and expansion of the Upper Basin wetlands. Structural flood control measures were necessary to maintain the existing level of flood protection. Because of the increased tailwater flood stages at S-65 resulting from the modified regulation schedule, the flood control canals connecting Lake Kissimmee to Lake Hatchineha (C-37), and Lake Hatchineha to Lake Cypress (C-36) will have to be enlarged to flatten the flood profile through the upper lakes and prevent excessive flooding. Modifications to the existing Lake Kissimmee water control structure is required to reduce higher flood stages in Lake Kissimmee and to provide higher discharge capacity.

The recommended plan is expected to at least achieve and probably exceed the environmental benefits assigned to the Kissimmee River Restoration Project which were documented in House Document 102-286, March 17, 1992. In the Upper Basin, the modified Lake Kissimmee regulation schedule will provide both greater, and more natural fluctuations of water levels in the lakes expanding the existing peripheral marsh habitats. The USFWS has predicted that the implementation of the recommended lake regulation schedule would increase the amount of littoral wetlands by 7,236 acres in Lakes Kissimmee, Hatchineha, Cypress, and Tiger. The recommended plan will provide adequate operational flexibility to incorporate management strategies that will allow the project to meet or exceed the varying and unforseen needs of the Kissimmee River Upper and Lower Basin.

The estimated total cost of the recommended plan is $78,356,300; average annual costs are estimated to be $6,170,800 (January 1996 price levels).

Consideration has been given to all significant aspects of the recommended plan in the overall public interest, including engineering feasibility, economic, social, and environmental effects. The recommended plan described in this report provides the best solution to the water resources needs within the Kissimmee River Upper and Lower Basins at this time. The two construction components, Upper and Lower Basin, were formulated as dependent features of the Kissimmee River Project. If, for any reason, the Lower Basin project should not be constructed, the Headwaters Revitalization Project will not be initiated as a stand alone project.

CENTRAL AND SOUTHERN FLORIDA PROJECT FOR FLOOD CONTROL AND OTHER PURPOSES

KISSIMMEE RIVER HEADWATERS REVITALIZATION PROJECT

INTEGRATED PROJECT MODIFICATION REPORT AND SUPPLEMENT TO THE FINAL ENVIRONMENTAL IMPACT STATEMENT

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SECTION 1

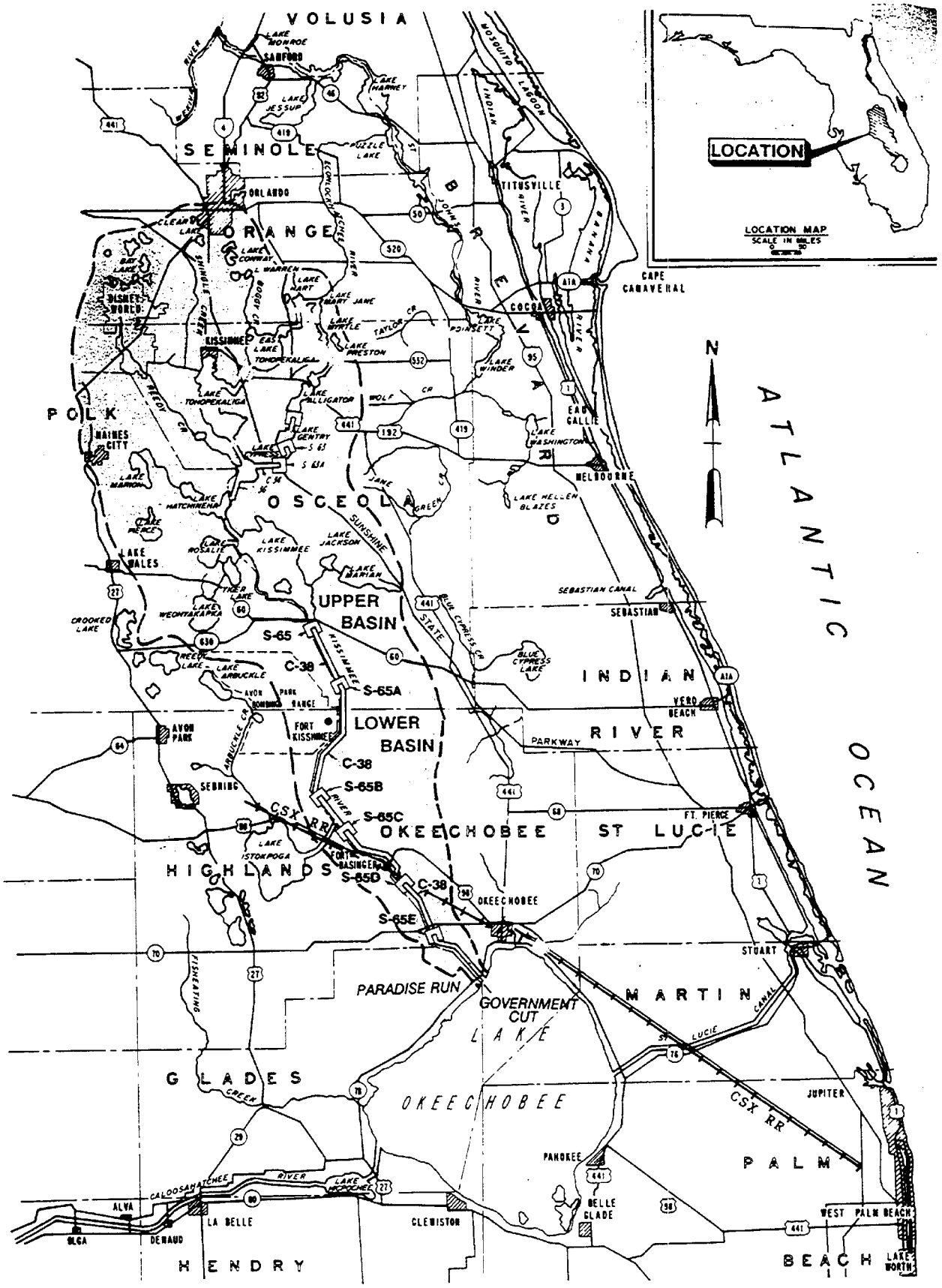
INTRODUCTION

The Kissimmee River Basin (Figure 1-1) is located in central Florida and is comprised of the Upper and Lower Basins. While the Kissimmee River Valley makes up the Lower Basin, the Upper Basin, which is the focus of this report, forms the headwaters of the Kissimmee River and is comprised of the Kissimmee Chain of Lakes, (PLATE 1-1, Study Area Map).

In the 1960s, the Kissimmee River was channelized and water control structures were constructed within the Upper and Lower Kissimmee Basins as part of the comprehensive Central and Southern Florida (C&SF) Flood Control Project (Figure 1-2). Even as channelization was being completed in 1971, a movement was underway to restore the Kissimmee River and regain lost environmental values.

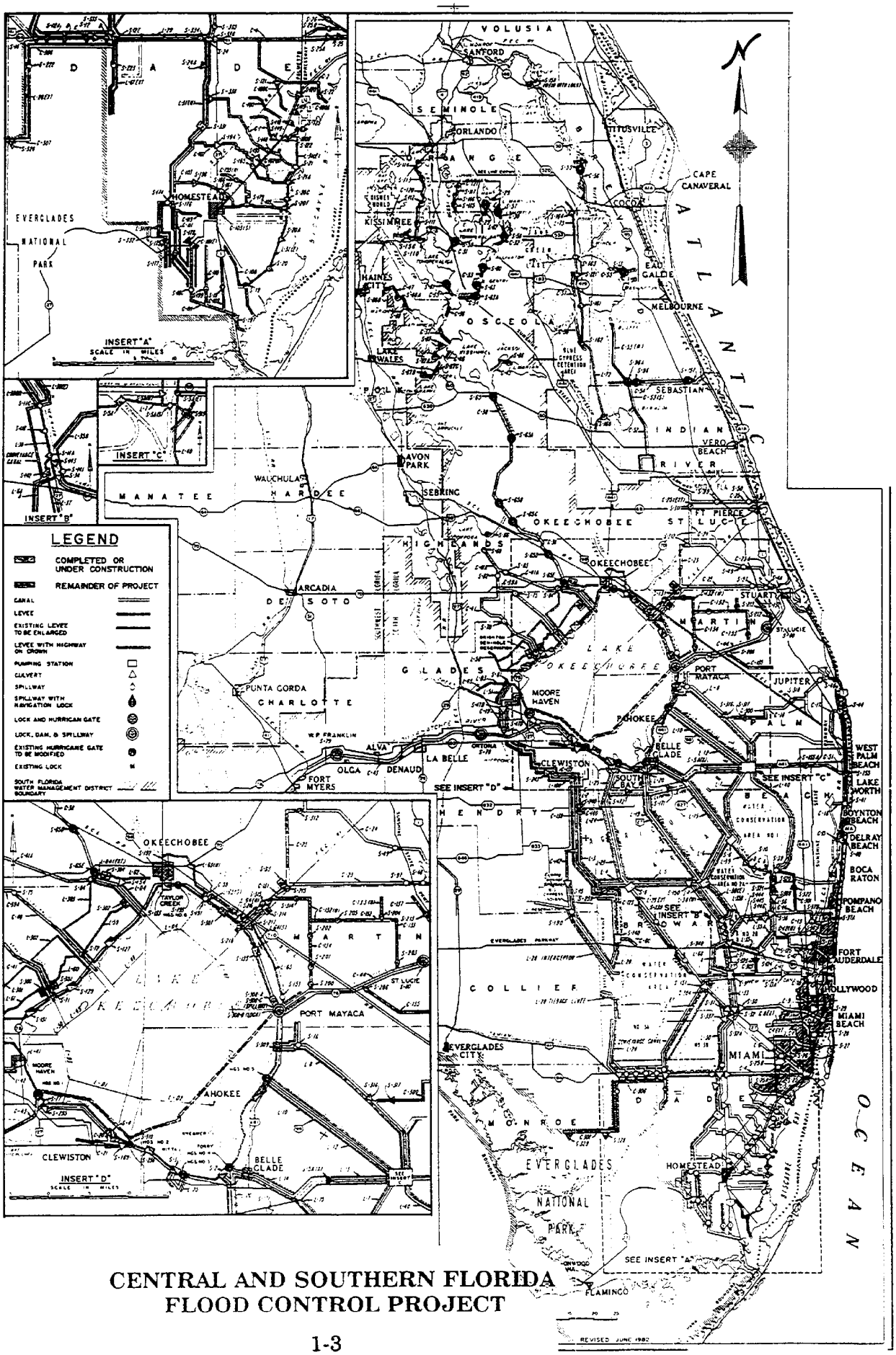
In the 1992 Water Resources Development Act, Congress authorized construction of the project to restore the ecosystem of the Kissimmee River including the Kissimmee River Headwaters Revitalization Project. Authorization of the Headwaters Revitalization component was justified based on it being a prerequisite for successful restoration of the Lower Basin ecosystem. This Project Modification Report has been prepared to document the conclusions of the Headwaters Revitalization Study.

The Kissimmee River Headwaters Revitalization Project was addressed programmatically in the Final Integrated Feasibility Report and Environmental Impact Statement (EIS) on Environmental Restoration, Kissimmee River, Florida, and was filed with the U.S. Environmental Protection Agency (EPA) January 17, 1992. The present document supplements the programmatic report-EIS under the concept of "tiering" (paragraph 1.4). Certain information presented in the former document is only summarized in this document, which concentrated on issues specific to the Headwaters Revitalization. The former report-EIS is available from the U.S. Army Corps of Engineers (Corps) at the address listed on the cover sheet of this document.



KISSIMMEE RIVER BASIN

Figure 1-1



CENTRAL AND SOUTHERN FLORIDA FLOOD CONTROL PROJECT

Figure 1-2

This section describes the study's authority, partners, purpose, and scope, discusses compliance with the National Environmental Policy Act, and provides a brief overview of the Upper Basin of the Kissimmee River.

1.1 STUDY AND PROJECT AUTHORITY

The Kissimmee River Headwaters Revitalization Project was authorized with the Kissimmee River Restoration Project by Section 101 of the Water Resources Development Act of 1992 (Public Law 102-580, October 31, 1992). On March 22, 1994, a Project Cooperation Agreement was executed between the Department of the Army and the South Florida Water Management District (SFWMD). This agreement successfully combined the two authorized construction segments, the Kissimmee River Restoration Project and the Kissimmee River Headwaters Revitalization Project into one project, the Kissimmee River, Florida Project. Section 101 of the Water Resources Development Act of 1992 states:

..."the following projects for water resources development and conservation and other purposes are authorized to be carried out by the Secretary ....

KISSIMMEE RIVER RESTORATION, FLORIDA *- The project for the ecosystem restoration of the Kissimmee River, Florida: Report of the Chief of Engineers, dated March 17, 1992, at a total cost of $426,885,000, with an estimated Federal cost of $139,943,000 and an estimated non-Federal cost of $286,942,000. The Secretary is further authorized to construct the Kissimmee River Headwaters Revitalization Project in accordance with the report prepared under section 1135 of the Water Resources Development Act of 1986 (100 Stat. 4251-4252) for such headwaters project and any modifications as are recommended by the Secretary based on the benefits derived for the environmental restoration of the Kissimmee River Basin, at a total cost of $92,210,000, with an estimated Federal cost of $46,105,000 and an estimated non-Federal cost of $46,105,000. The Secretary shall take such action as may be necessary to ensure that implementation of the project to restore the Kissimmee River will maintain the same level of flood protection as is provided by the current flood control project."*

Section 1135 of the 1986 WRDA (Public Law 99-662) allows for project modifications in existing water resources projects. Subsection (a) authorizes the Secretary to review the operation of water resource projects constructed by the Secretary to determine the need for modifications in the structures and operations of such projects for the purpose of improving the quality of the environment in the public interest.

1.2 STUDY PARTNERS

The SFWMD, an agency of the State of Florida, is the project sponsor for the Kissimmee River, Florida Project. The SFWMD's assistance and cooperation contributed greatly to the completion of this project modification report. The SFWMD's prior and continuing research efforts for restoring the Kissimmee River, including the report titled *Kissimmee River Restoration, Alternative Plan Evaluation and Preliminary Design Report,* dated June 1990, has been used extensively in the preparation of this report.

In addition to the SFWMD, other State agencies have actively participated in conducting this study, in particular the Florida Game and Fresh Water Fish Commission (FGFWFC) and the U.S. Fish and Wildlife Service (USFWS). The USFWS provided updated information using the Habitat Evaluation Procedures (HEP) to determine habitat values for individual species in the Upper Kissimmee River Basin floodplain.

1.3 STUDY PURPOSE AND SCOPE

1.3.1 Study Purpose

The 1992 WRDA authorizes the construction of Kissimmee River Headwaters Revitalization Project based on the recommendations of the project modification report. Justification of the authorized Headwaters Revitalization Project was based on the benefits provided by the restoration of Kissimmee River. The purpose of this preconstruction planning and engineering study is to establish the details of the physical and financial components of the recommended project modification and to ready the project for construction.

1.3.2 Scope

The study objective was to formulate a plan which (a) provides the necessary storage and regulation schedule modifications to approximate historical flow characteristics to achieve or exceed the benefits ascribed to Kissimmee River Restoration and (b) increases the quantity and quality of the wetland habitat in the Upper Basin lake littoral zones to benefit fish and wildlife. Environmental enhancement in the Upper Basin requires reestablishing the frequency of lake stage fluctuations above 52.0 feet National Geodetic Vertical Datum (NGVD). Restoration in the Lower Basin requires (a) continuous but varied flow in the river channel, and (b) flood plain inundation frequencies and recession rates comparable to pre-channelization periods. The

major constraint of project design and implementation was the requirement to maintain the same level of flood protection as provided by the current flood control project. Another design constraint was to maintain existing navigation conditions.

The scope of the analyses and studies summarized in this report were of the level required to:

(1) design the physical features of the project, based on established environmental, flood control and navigation criteria, and develop the most cost effective and functional combination of these features from the alternative plans studied;

(2) coordinate the project design with other involved governmental agencies and local interests;

(3) undertake, where necessary, the updating or modification of environmental documentation and economic and social impact evaluations;

(4) provide the basis for a firm, current estimate of project cost;

(5) provide the basis for any required non-Federal cooperation and acquisition of easements and lands, and for negotiation of relocation agreements;

(6) establish operating and maintenance requirements and determine that the project will meet such requirements;

(7) facilitate the orderly scheduling and programming of funds for design and construction of the project.

Consistent with the above-cited authorities, the Corps and the State of Florida, with the USFWS as a cooperating agency, have studied alternative modifications to the regulation schedule and water control structures of lakes in the Upper Kissimmee River Basin. The study has been conducted in accordance with current Federal water resources planning procedures and guidelines, with assistance and support from numerous State and Federal agencies and other interests.

1.4 STUDY AREA

The Kissimmee River Basin, as shown in Figure 1, is the largest watershed providing surface water to Lake Okeechobee, the second largest freshwater lake in the United States. The entire Kissimmee River Basin comprises 3,013 square miles. The Lake Istokpoga area (622 sq. miles), Lower Kissimmee River Basin (758 sq. miles), and the Upper Kissimmee Basin (1633 sq. miles) make up the principle divisions in the watershed. The Upper Basin, also referred to as the "Headwaters" in this report, is comprised of numerous lakes regulated by a system of canals and water control structures managed by the SFWMD. The Upper Basin, which is located in Orange, Polk, and Osceola Counties, is bounded to the south by State Road 60. It is here where the basin's largest lake, Lake Kissimmee, discharges into the channelized Kissimmee River. At this point, the Kissimmee River becomes a canal feature of the basin's flood control project referred to as Canal 38 or C-38. The Lower Basin includes the tributary watersheds of the channelized Kissimmee River between the outlet of Lake Kissimmee and Lake Okeechobee.

The Upper Basin includes the "Kissimmee Chain of Lakes" (Plate 1-1). The Kissimmee Chain of Lakes consists of Lakes Tohopekaliga, East Tohopekaliga, Hart, Mary Jane, Myrtle, Preston, Alligator, and Gentry in the upper region. The lower portion of the chain includes Lakes Cypress, Hatchineha, Kissimmee, Pierce, Marion, Rosalie, Weohyakapka, Tiger, Jackson, and Marian. These lakes range in size from a few acres to 55.5 square miles. Studies for this report were primarily focused on those lakes affected by the proposed project modification, namely Lakes Kissimmee, Hatchineha, and Cypress and the tributary lakes - Lakes Rosalie, Tiger, and Jackson.

The Upper Basin is the more heavily populated and intensively developed part of the watershed. Principal municipalities within the Upper Basin are the southern half of Orlando, Kissimmee, which is the hub of the cattle industry in central Florida, St. Cloud, and Haines City. Walt Disney World is located in the Reedy Creek Improvement District in the upper portion of the basin.

1.5 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 NEPA contains action-forcing provisions to make sure that Federal agencies act according to the letter and spirit of the Act. The Act includes a provision for preparation of a detailed statement, now called an Environmental Impact Statement (EIS), on the effects of a proposed major Federal action that will

significantly affect 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 measures for optimizing environmental enhancements in the Upper Kissimmee Basin while reestablishing adequate flow to achieve restoration of the Lower Kissimmee Basin. It employs two concepts established in the Council on Environmental Quality's regulations implementing National Environmental Policy Act procedures: (1) integration and (2) tiering.

Integration is based on the CEQ provision 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 this study, and to consolidate documentation into one consistent report, the Corps elected to integrate discussions that could have appeared as an EIS with the Section 1135 Report. Sections in this integrated report that include CEQ-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 was applied to the study of Federal actions for the environmental restoration of the Kissimmee River (Lower Basin). The integrated report-EIS on restoration of the Kissimmee River was the early stage statement, and this integrated report-EIS on Upper Basin restoration is the supplement.

1.6 PRIOR STUDIES AND REPORTS

Large amounts of data have been gathered and analyzed in conjunction with studies of the Kissimmee River Basin. The studies deal with a wide range of subjects including environmental concerns, economics, water quality, recreation, hydrology, and sources of water pollution. A few selected studies are listed and briefly described in the following sections.

* **"Part II, Supplement 5, General Design Memorandum, Kissimmee River Basin, 1958 - Central and Southern Florida Project for Flood Control and Other Purposes"** - This report presented the results of hydrologic and hydraulic investigations for development of the plan of improvement for the Kissimmee River Basin. It presented the hydraulic criteria and supporting recommendations relative to the construction of the Kissimmee flood control works.

* **The Fish and Wildlife Service**, as part of the FY-79 Coordination agreement with the Corps, prepared a reconnaissance report on the fish and wildlife resources in the Kissimmee area. The report was completed in August 1979.

* **"Central and Southern Florida, Kissimmee River, Florida - Final Feasibility Report and Environmental Impact Statement", 1985** - This Corps' report evaluated the feasibility of modifying the existing flood control system in the Kissimmee River Basin. Numerous alternatives were considered to address the primary objectives of improving water quality, enhancing fish and wildlife resources, maintaining the flood damage prevention capabilities, providing water supply, and increasing recreational opportunities in the basin. Based on the limits of existing water resource authority, the report determined that there was no justification for Federal participation in the modifications of the Kissimmee River portion of the C&SF project.

* **"Kissimmee River Restoration - Alternative Plan Evaluation & Preliminary Design Report"** - This study was developed by the SFWMD and published in June 1990. This study adopted a broader, single goal - to restore the ecological integrity of the Kissimmee River. Whereas the previous Corps' feasibility study had focused on component parts of the environment, primarily wetlands and water quality, and how to improve each part individually, the SFWMD focused on restoration of the entire natural system, including its component parts and the interactions among them - the ecosystem. Flood control and navigation were to be maintained, while water quality and water supply should not be adversely affected. SFWMD concluded that the Level II Backfilling Plan was the best

approach to restore the integrity of the Kissimmee River ecosystem. The report also concluded that some alteration of the Upper Lakes regulation schedule must be implemented for restoration of the Kissimmee River to be successful.

* **"Feasibility Report and Environmental Impact Statement - Environmental Restoration of the Kissimmee River, FL, 1992"** - The Congressional authority for the Corps' second feasibility study of the Kissimmee River directed that the study be based on implementing the SFWMD's Level II Backfilling Plan. With the tiering concept established by CEQ, this programmatic document addressed restoration of both the Upper Basin, through the "Headwaters Revitalization Project," and the Lower Basin, through the South Florida Water Management District's (SFWMD) "Level II Backfilling Plan." The study focused on the Lower Basin alternatives and presented recommendations ready for decision in 1992. Four Lower Basin restoration alternatives previously developed by the SFWMD were evaluated by the Corps. The Level II Backfilling Plan recommended by SFWMD was selected for further evaluation and development. A modified Level II Backfilling Plan was recommended for restoration of the ecological integrity of the Lower Kissimmee River Basin. The recommended plan called for a more natural physical environment in the lower Kissimmee River by backfilling 29 miles of C-38 and excavating 11.6 miles of new river channel. This would restore about 50 square miles of river floodplain ecosystem.

1.7 EXISTING PROJECT AUTHORIZATIONS

Kissimmee River, Florida, Navigation Project - In 1902, Congress authorized the Corps to construct a navigation project on the Kissimmee River. The project consisted of a channel with a required depth of three feet at normal stages and a width of 30 feet. It extended about 109 miles from the town of Kissimmee down the Kissimmee River to Fort Basinger, and includes a side channel along the Istokpoka Canal to Lake Istokpoka.

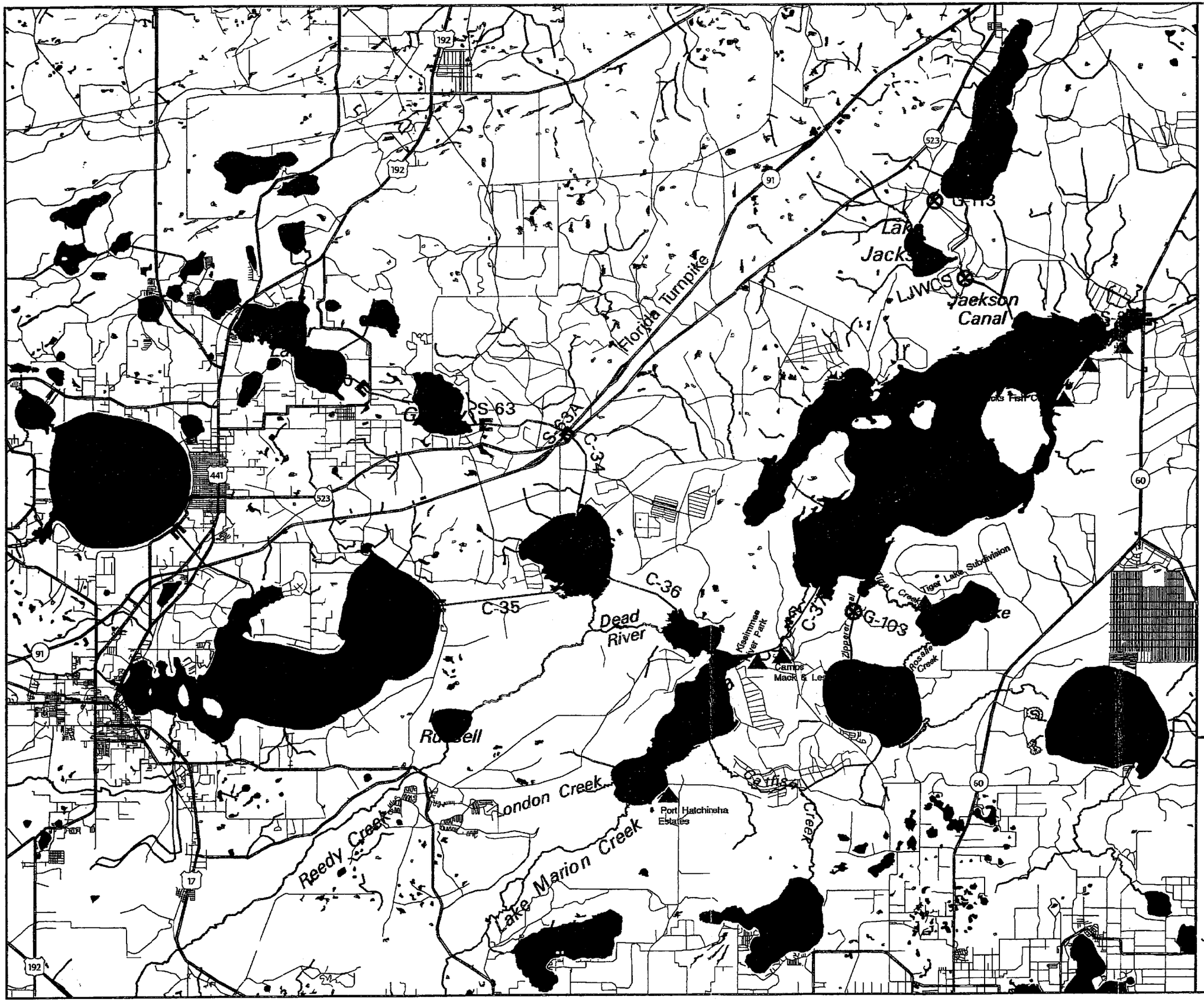
Kissimmee River Basin, Central and Southern Florida Project for Flood Control and Other Purposes - The Kissimmee Basin Project is a segment of the authorized C&SF project for flood control and other purposes. The Kissimmee River Basin flood control works were authorized by the Rivers and Harbors Act of 1954, (Public Law 780, 83rd Congress) as presented in House Document No. 643, Eightieth Congress. Figure 1 details the components of the authorized project. The Kissimmee River and Lake Istokpoga Basins portion of the project have several purposes, as specified below:

a. Flood Control - Protection of lands adjacent to the lakes and along the Kissimmee River from frequent and prolonged flooding.

b. Water Supply - Provision of water supply for agricultural uses within the Kissimmee River and the Kissimmee lakes.

c. Navigation - Provide for navigation on the Kissimmee River and all lakes in the Upper Kissimmee River Basin. Locks are provided at control structures on the main watercourse between Lake Tohopekaliga and Lake Okeechobee.

d. Fish and Wildlife - Maintenance of lake stages at a desirable level for fish and wildlife purposes and for recreational purposes.



LEGEND

- Gated spillway
- Non-Federal control structure
- Major Residential Area
- Major road
- Road
- Canal or stream
- Other hydrographic feature
- Water body

North

Miles
1 0 1 2 3 4 5

CENTRAL AND SOUTHERN FLORIDA PROJECT

KISSIMMEE RIVER

HEADWATERS REVITALIZATION

SECTION 1135

STUDY AREA MAP

DEPARTMENT OF THE ARMY

JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

JACKSONVILLE, FLORIDA

DATED, JULY 1995

AML:/DATA/RINGO3/KISSIM/UTM/study_area_map

SECTION 2

HISTORIC CONDITION

This section provides an historic overview of the Upper Kissimmee River Basin as well as the Upper Basin's important relationships with the Lower Kissimmee River Basin.

2.1 HYDROLOGY

The Kissimmee River Basin is the largest watershed providing surface water delivery to Lake Okeechobee. The total basin encompasses 3,013 square miles. The major lakes within the 1,633 square-mile Upper Basin are Lakes Tohopekaliga and East Tohopekaliga in the upper chain of lakes, and Lakes Marion, Hatchineha, Pierce, Rosalie, Cypress, Weohyakapka, Tiger, Marian, Jackson, and Kissimmee in the lower chain of lakes. The Lower Basin includes the Kissimmee River and tributary watersheds. Plates A-1 and A-2, Appendix A, show the Upper and Lower Kissimmee Basins in their entirety.

The Upper Kissimmee Basin is characterized by numerous lakes ranging in size from a few acres to the 55 square-mile Lake Kissimmee. The total surface area of these lakes at normal water surface elevations was more than 10 percent of the total area in the Upper Basin. The normal stages and corresponding surface areas of the main lakes affected by this study, as presented in the 1956 C&SF General Design Memorandum, are provided below.

TABLE 2-1
HISTORIC LAKE STAGES AND SURFACE AREAS

LAKE	NORMAL STAGE (FT)	SURFACE AREA (SQ MILES)
CYPRESS	52.8	10.5
HATCHINEHA	51.8	18.8
KISSIMMEE	50.8	55.5
TIGER	51.0	4.8
ROSALIE	53.5	9.1

* Normal stage - stage equaled or exceeded 50 percent of time based on 1942-1954 record (mean sea level)

The headwater lakes are thought to have once been the deeper portions of a vast marsh complex. During the wet summer months and periods of heavy rainfall, natural drainage occurred by the overtopping of the upper lakes and the overflow of water across the wide shallow marshes into the lower lakes (Parker et al., 1955). Historically, drainage and land reclamation programs which were initiated as early as 1860 had a pronounced effect on land use in the headwaters by lowering water levels and water tables. Most of the broadleaf marsh and wet prairie communities that once dominated the floodplain have been drained for grazing and agriculture purposes, leaving the headwater lakes occupying only the deepest depressions of a once vast marsh complex.

Under natural conditions, the lake stages in the Kissimmee Basin fluctuated seasonally about 2 to 10 feet. The historic outlet capacities were limited and the lakes functioned as natural detention reservoirs which stored large quantities of water during the wet season. Discharges typically increased up to a wet season peak in October or November and declined through the dry season. (Figure 2-1).

Historically, hydrological connections between the lakes were cyclical in response to periods of high and low rainfall. Stages in Lake Kissimmee, the primary source of the Kissimmee River, historically ranged up to 56 ft NGVD and down to around 45 feet, (Figures 2-2 and 2-3). During wet periods, water levels in the lakes rose and overflowed, creating broad, marshy connections between the lakes. During dry periods, little to no surface hydrological connections existed between lakes. The low periods provided time for drying and oxidation of bottom sediments, and during high periods, fish and wildlife used the flooded vegetation for spawning and foraging.

Flows through the Upper Kissimmee Basin originated in the vicinity of Alligator Lake and flowed northward through the East Chain of Lakes to Lake Hart, then flowed southward to Lakes East Tohopekaliga, Tohopekaliga (Toho), Cypress, Hatchineha, and Kissimmee to the Kissimmee River. The natural meandering connections between the lakes were dredged during the late 1800's to early 1900's for the purposes of drainage and navigation. The historic entrance into Lake Cypress, as well as Lake Kissimmee, was actually towards the east of the present canal locations.

KISSIMMEE HISTORICAL DISCHARGES

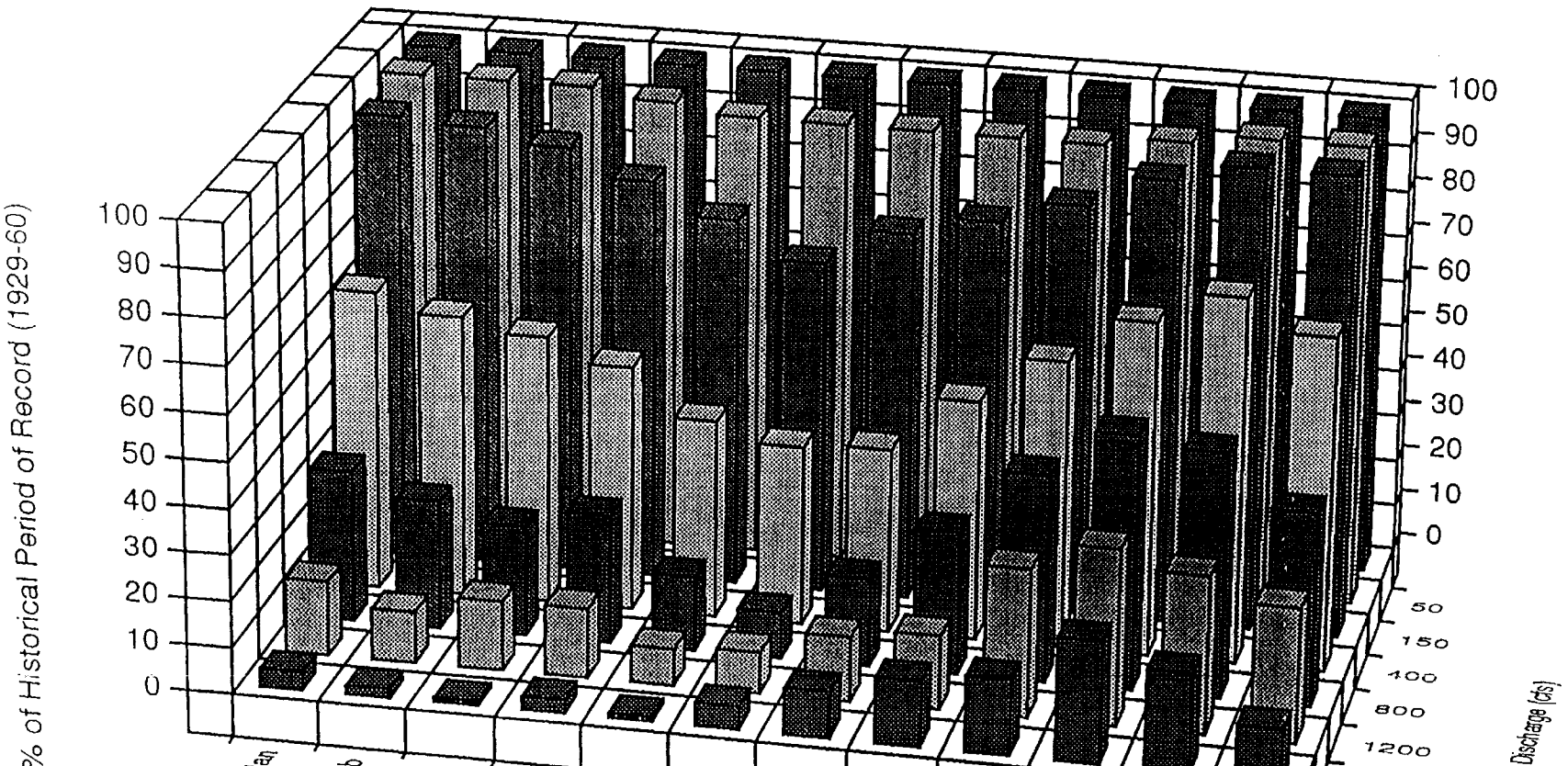


Figure 2-1

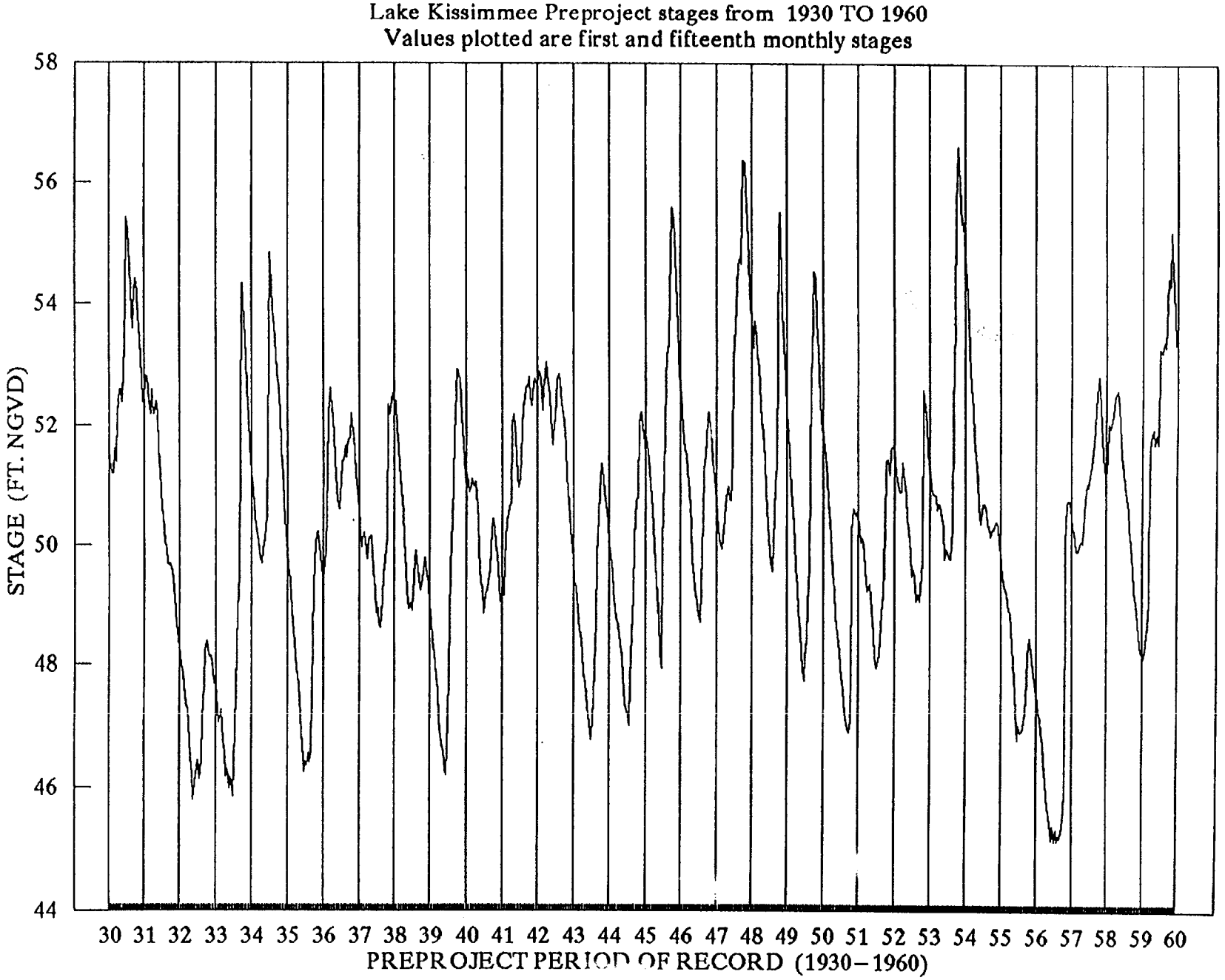
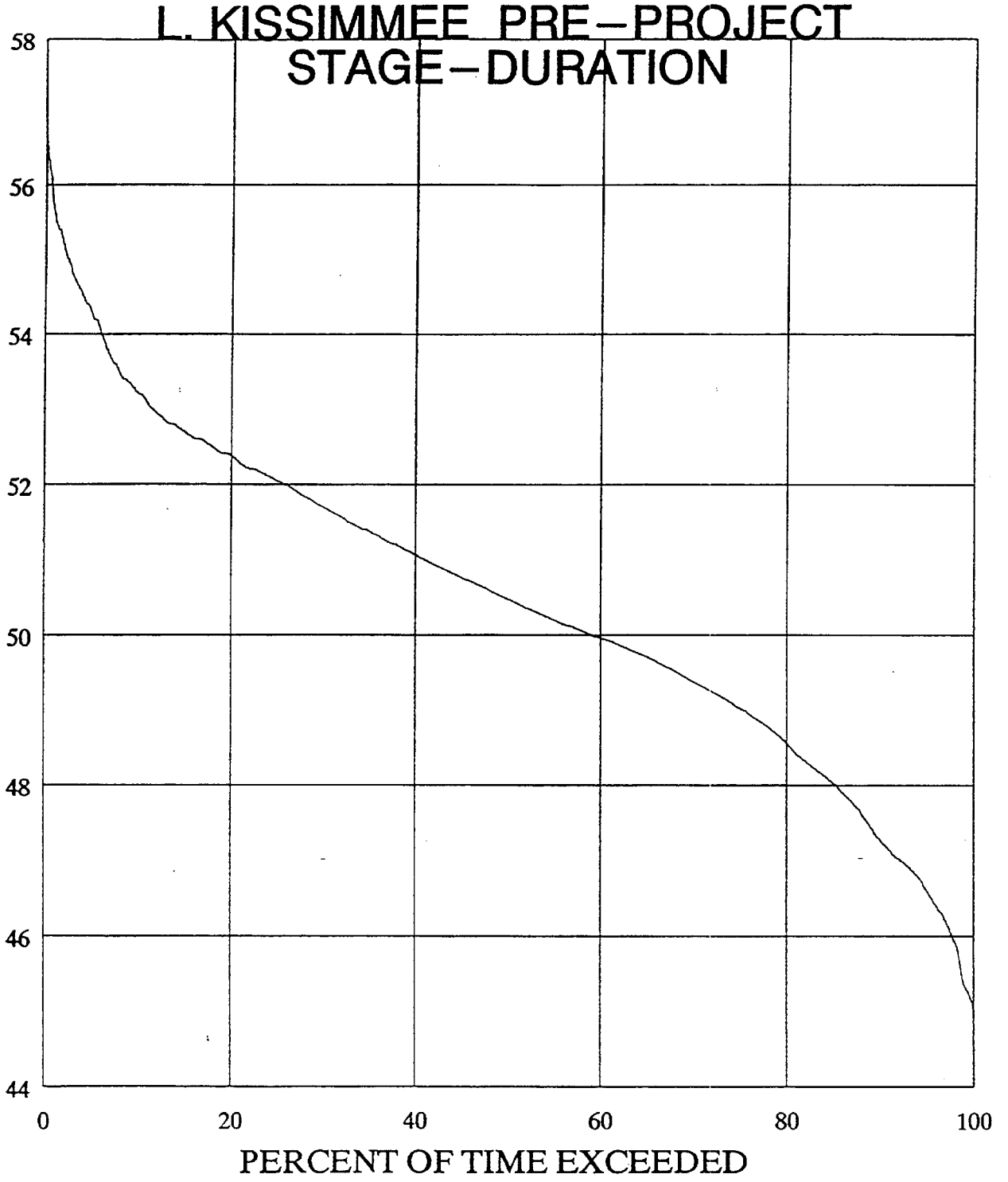

Lake Kissimmee Preproject stages from 1930 TO 1960
Values plotted are first and fifteenth monthly stages
STAGE (FT. NGVD)
58
56
54
52
50
48
46
44
30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60
PREPROJECT PERIOD OF RECORD (1930–1960)

Figure 2-2



LAKE KISSIMMEE STAGE DURATION PREPROJECT
PERIOD OF RECORD 13 AUG 1929 – 31 DEC 1959

Figure 2-3

Lake Tohopekaliga was connected to Lake Cypress by the Southport Canal (C-35). Lake Cypress, the collector lake for inflow from the east and west chains of lakes, normally discharges to Lake Kissimmee by way of Cypress-Hatchineha Canal (C-36), Lake Hatchineha, and Hatchineha-Kissimmee Canal (C-37). However, during flood periods considerable overflow from Cypress Lake reached Lake Kissimmee directly by overland flow through marsh areas between the two lakes. A drainage canal, known locally as the Short Canal, was constructed during the 1930's and 40's within these marsh areas but was never completed to connect Lake Cypress to Lake Kissimmee.

Several important lakes in the Upper Kissimmee River Basin are not included in the main chain of lakes, but are tributaries. Lake Marion Creek is the main tributary feeding water to Lake Hatchineha, along with flow from Lake Cypress. Lakes Marion and Pierce are both tributary to Lake Hatchineha from the west. Lake Marion has an outlet on its north side by way of Lake Marion Creek, which flows southeasterly about 8 miles to the northwest corner of Lake Hatchineha. Reedy Creek, which discharges into Lakes Cypress and Hatchineha, is the largest tributary, with a drainage area of 207 square miles. Standing water remained on low-lying lands and the marshy areas of Reedy Creek Basin most of the year at depths of as much as 3 to 4 feet. Flow from Lake Pierce enters the southwest side of Lake Hatchineha by way of Catfish Creek which flows about 7 miles east and northeast from Lake Pierce. In the area west of Lake Kissimmee, Lakes Weohyakapka, Rosalie, and Tiger form a secondary chain of lakes which discharge generally north and east to Lake Kissimmee. Lakes Marian (not to be confused with Marion) and Jackson discharge into the east side of Lake Kissimmee through Jackson Canal. Lake Marian is connected to Lake Jackson by a channel less than 2 miles long; however, during times of high water, overflow from lake Marian bypasses south of Lake Jackson and flows directly to Lake Kissimmee.

From Lake Kissimmee, the historic Kissimmee River naturally meandered approximately 103 miles within a one to two mile wide floodplain. The flood plain was about 56 miles in length and gradually sloped from an elevation of 51 feet at Lake Kissimmee to an elevation of 15 feet at Lake Okeechobee. Under historic conditions, river flows generally exceeded 250 cubic feet per second (cfs) 95 percent of the time, while overbank flooding occurred when flows exceeded 1,400 cfs in the upper reaches to 2,000 cfs in the lower reaches. The river moved very slowly, with normal river velocities averaging less than two feet per second.

2.2 NAVIGATION

With the conclusion of the Third Seminole War, in 1858, small numbers of settlers began moving into the Kissimmee Basin area. The earliest settlers were ranchers and farmers, but soon turpentine and timber industries became the major economic enterprises. As more people moved into the area, wetlands were drained to open up room for development. This movement was accelerated by the Swamp and Overflowed Land Grant Act of 1850 which encouraged development and expansion by transferring Federal lands to the State.

The reclamation project was spurred by the State's proposal to raise revenues by selling swamp and overflowed lands to interested entrepreneurs willing to drain such wetland areas for agricultural use. In the late-1800's, Hamilton Disston, an industrialist from the northeast, began a ditching and drainage project in central Florida. As part of his plan to convert some four million acres of wetlands into productive farmland, Disston connected many of the Upper Kissimmee Basin lakes and began dredging and clearing a navigable route from the Gulf of Mexico into Lake Okeechobee, along the Caloosahatchee River. As a result of this action, water levels within the Upper Kissimmee Basin dropped approximately six feet or more.

After dredging was completed by the Atlantic and Gulf Coast Canal and Okeechobee Land Company in the 1890's, navigation was possible in the upper chain of lakes from Lake Tohopekaliga through East Lake Tohopekaliga, and continuing to Lake Gentry (and possibly at times to Lake Cypress). In the nineteenth century, commerce on the Kissimmee River gained impetus with the availability of new lands from drainage and from the connection of waterbodies by canal systems.

To aid navigation along the river, in 1902 Congress authorized a Federal navigation project to create and maintain a 30 feet wide and 3 feet deep channel from the Town of Kissimmee to Fort Basinger. The length of the project was about 109 miles, including 9.4 miles in Istokpoga Creek. Figure 2-4 shows the extent of the navigation project. The development of railroads, and later highway systems, in the early and mid-twentieth century led to greatly reduced use of the river for commerce. By the 1920's, railroads had replaced most of the commercial traffic on the river. The last Federal maintenance under the Kissimmee River navigation authority was in 1927.

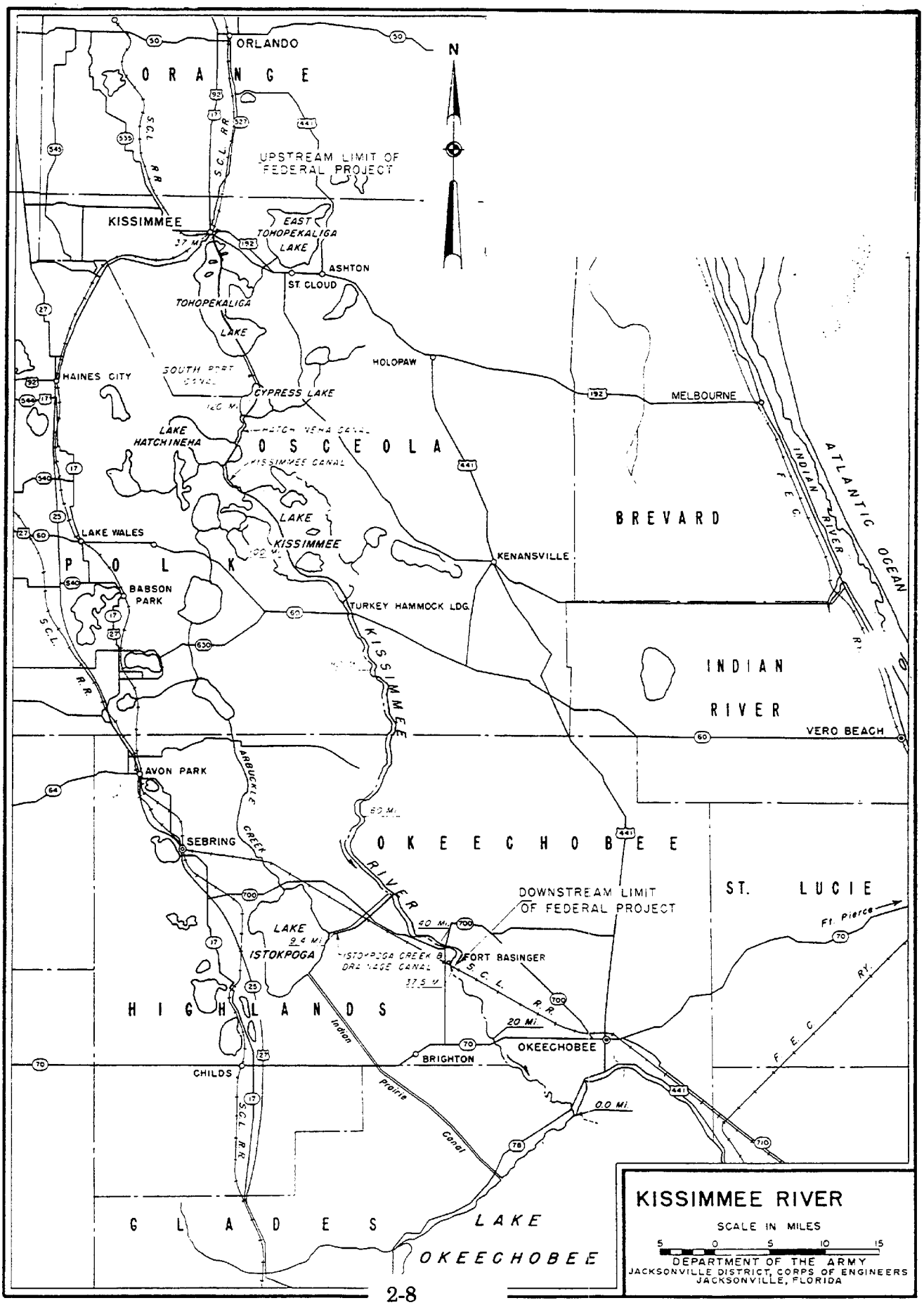

ORLANDO
ORANGE
N
UPSTREAM LIMIT OF FEDERAL PROJECT
KISSIMMEE
EAST TOHOPEKALIGA LAKE
ASHTON
ST. CLOUD
TOHOPEKALIGA LAKE
HOLOPAW
HAINES CITY
CYPRESS LAKE
MELBOURNE
LAKE HATCHINEHA
OSCEOLA
KISSIMMEE CANAL
LAKE KISSIMMEE
BREVARD
ATLANTIC OCEAN
INDIAN RIVER
LAKE WALES
KENANSVILLE
POLK
BABSON PARK
TURKEY HAMMOCK LDG.
KISSIMMEE
INDIAN RIVER
VERO BEACH
AVON PARK
ARBUCKLE CREEK
SEBRING
OKEECHOBEE
RIVER
DOWNSTREAM LIMIT OF FEDERAL PROJECT
ST. LUCIE
Ft. Pierce
LAKE ISTOKPOGA
ISTOKPOGA CREEK DRAINAGE CANAL
FORT BASINGER
HIGHLANDS
Indian Prairie Canal
OKEECHOBEE
BRIGHTON
CHILDS
GLADES
LAKE OKEECHOBEE
KISSIMMEE RIVER
SCALE IN MILES
5 0 5 10 15
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

Figure 2-4

2.3 NATURAL ENVIRONMENT

2.3.1 Upper Basin

Florida's cyclic rainfall pattern historically produced a wide range of water level fluctuations (Figure 2-2) in all lakes of the Upper Basin. Wildlife, waterfowl, fish, and aquatic plant populations evolved under this cyclic hydrological pattern, with periodic extreme water fluctuations playing an important role in maintaining healthy ecosystems by enhancing and maintaining habitat diversity. The wide, flat, marshy areas around some of the lakes and their interconnecting sloughs and channels were nurseries and feeding grounds for many species of fish, as well as the nesting areas of numerous wading and water birds.

The historic Kissimmee River Basin harbored a large and diverse wintering waterfowl population, including ring-necked ducks, American widgeon, northern pintail, and blue-winged teal. Five lakes (Kissimmee, Tohopekaliga, Cypress, Istokpoga, and Hatchineha) and the Kissimmee River averaged 1,442,732 waterfowl days per winter from 1949-1957. (Waterfowl days equal the average observed daily waterfowl multiplied by the number of days in the study period). Peak waterfowl populations generally occur in January and the highest peak on record was approximately 40,000 individuals (FGFWFC, 1957). Deer, turkeys, and squirrels were found in the cypress, gum, and pine forests of the Upper Basin. Overflows of the lakes during the wet season inundated the large adjacent marsh areas from three to five months on the average, and as long as ten months during wet years. Wet prairie was the most valuable of the wetland communities to waterfowl. Under historic hydrologic conditions, wet prairies were typically dry from spring through early summer, allowing annual plants such as wild millet to germinate and produce seed. Fall and early winter flooding made these wet prairies attractive feeding sites for resident and wintering waterfowl.

By incorporating the same assumptions presented by the USFWS in their 1994 Coordination Act Report (CAR), which determined the amount of existing wetlands, we determined the amount of historic wetlands that should have existed within the study area. The minimum hydrologic regime for defining wetlands is generally accepted as continuous saturation for at least 5% of the growing season. Assuming that the growing season is year-round in the study area, which equates to 18 days of continuous saturation, the USFWS determined that the present upper end of the wetlands is approximately elevation 52.0 feet. Using these same assumptions, 18 days of continuous saturation, with the historic stage hydrograph (Figure 2-3) for the period 1929 through 1959, the historic boundary of wetlands extended to elevation 54.5

NGVD. Based on the area between elevation 52.0 and 54.5, approximately 39,000 additional acres of wetlands existed between 1929 and 1960 compared to the present. Based on the historical stage versus percent exceedance relationship (Figure 2-5) for the historical period of record, the lower limit of wetlands was approximately elevation 48.0 feet. The amount of wetlands that existed prior to the flood control project was estimated to be 55,000 acres. This was estimated by adding the amount of land between the 48.0 and 52.0 foot elevations, 16,000 acres, to the area between 54.5 feet and 52.0, or 39,000 acres.

Throughout the early 1900's, canals were dredged to drain marsh areas for agriculture and development. Impacts of channelization on these wetlands have had wide-ranging ecological consequences, including loss of fish and wildlife habitat. As channelization between lakes redirected flows, the large marsh area found along the lake shore was replaced by a narrow littoral zone. Water levels were constricted within a reduced range of fluctuation. As plant habitats changed, so did the species that inhabited them. The environment, responding to altered conditions, began to change. Native vegetation was replaced by species that were suited to the drier conditions, causing fish and wildlife to move to more suitable surroundings. Water quality deteriorated as a result of stable water levels along with high nutrient inflows from urban runoff and sewage treatment plants.

2.3.2 Relationship to Lower Kissimmee River

Historic seasonal flows out of Lake Kissimmee lead to fluctuating water levels within the meandering river channel, oxbows, and natural river floodplains within the Lower Kissimmee Basin. This enhanced and maintained habitat diversity, including diverse plant communities within the river valley. Within the historic floodplain, wildlife, waterfowl, fish, and other biological components were once part of a river floodplain ecosystem. The river and floodplain were not discreet and independent ecosystems, and the ebb and flow of their life was closely interrelated with the level of water levels within their boundaries. In November, ducks and probers, such as snipe and ibis, fed in the sloughs, potholes and wet prairies in upland areas near the tree line. Many of the same populations used the potholes, oxbows, backwaters, and marshes of the floodplain in February, and the river and the deepest marshes and cypress swamps near the river in May. In the 1950's, peak populations of ducks and wading birds centered in and around Lake Okeechobee, saw the Kissimmee area as habitat where water and feeding conditions were favorable.

The historic floodplain of the Lower Basin contained approximately 44,000 acres of wetlands (USFWS, 1991). Major plant communities found within these wetlands included maidencane and beakrush wet prairies, broadleaf marsh, and woody shrub (Pierce et al., 1982). Other plant communities common on the floodplain, but not distributed extensively, included wetland hardwoods, cypress stands, oak-cabbage palm hammocks, switchgrass, sawgrass, and floating mats or tussocks (Pierce et al.,1982). Distribution and maintenance of plant communities within the floodplain wetlands depended on prolonged inundation and seasonally fluctuating water levels (Dineen et al., 1974; Toth, 1991). Besides being a popular feeding site for wintering waterfowl, the floodplain also provided flooded vegetation to be used by fish and wildlife for spawning and foraging. The floodplain supported one of the most abundant population of wading birds in the world. The number of wading birds in the Kissimmee River floodplain before channelization was estimated about 18,000 birds (USFWS, 1991).

2.4 STORMS AND FLOODS

Prolonged seasonal rainfall, coupled with limited outlet capacity, resulted in almost yearly flooding of large areas in the Kissimmee Basin. About 70 percent of the annual rainfall occurs during the rainy season, a five month period from June to October. During this time, the region is subject to tropical hurricanes which bring intense rainfall, often aggravating a flood situation already serious from heavy seasonal rainfall. Annual damages, a result of long-duration flooding, were relatively high as soaked pasture lands could not be used for farming or grazing. Substantial damages resulted from flood conditions, notably those of 1945, 1947, 1948, and 1953. PLATE 2-1 shows the areas flooded by the 1947 storm. Table 2-2 presents a summary of stage data and other pertinent information on the major floods of record in the Kissimmee Basin.

TABLE 2-2

Pertinent Historic Flood Data
for Upper Kissimmee River Basin

ITEM	SEPT. 1945	SEPT. 194[illegible]	OCT. 1948	OCT. 1953
Flooded Area (sq mi)	346	386	--	408
Peak Stage (ft)				
Alligator Lake	66.0	66.0	66.2	66.3
Lake Mary Jane	--	--	--	--
Lake Hart	65.3	63.6	64.6	64.0
E. Lake Tohopekaliga	61.8	60.8	61.5	62.0
Lake Tohopekaliga	58.3	58.5	57.6	58.6
Cypress Lake	56.4	57.4	56.3	57.2
Lake Hatchineha	56.1	56.8	56.0	56.8
Lake Kissimmee	55.7	56.7	55.7	56.7
Peak Discharge (cfs)				
Lake Kissimmee outlet	6,130	6,870	8,820	7,170
Kiss Riv near Lk Okeechobee	11,700	13,000	17,400	17,800
Estimated Actual Damages ($)	--	2,300,000	--	2,285,000
Estimated Frequency (yr) *	8	20	7	15

NOTES: * Based on volume and duration of flooding.

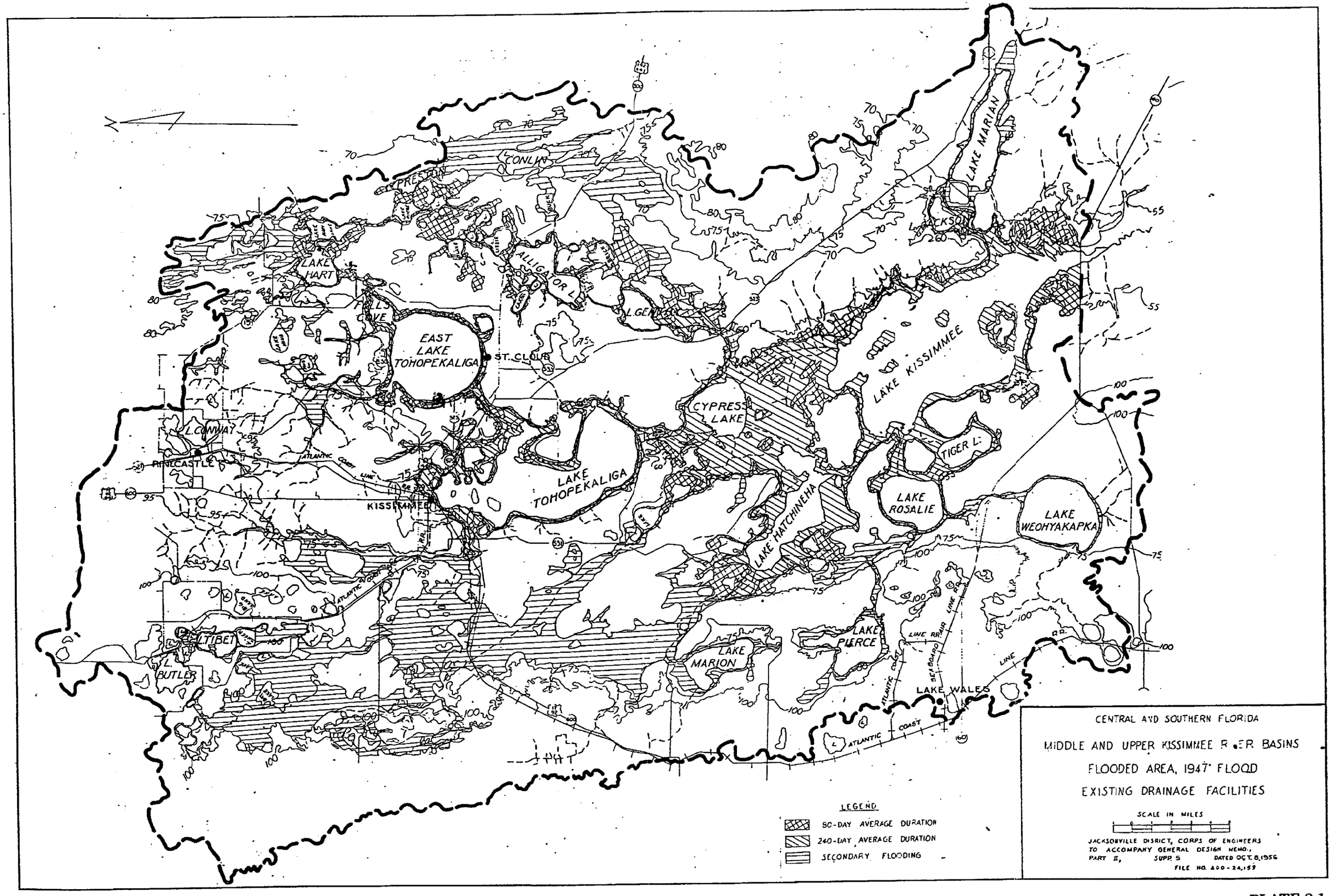

CENTRAL AND SOUTHERN FLORIDA
MIDDLE AND UPPER KISSIMMEE RIVER BASINS
FLOODED AREA, 1947 FLOOD
EXISTING DRAINAGE FACILITIES
SCALE IN MILES
JACKSONVILLE DISRICT, CORPS OF ENGINEERS
TO ACCOMPANY GENERAL DESIGN MEMO.,
PART II, SUPP. 5 DATED OCT. 8, 1956
FILE NO. 400-24,159
LEGEND
90-DAY AVERAGE DURATION
240-DAY AVERAGE DURATION
SECONDARY FLOODING
LAKE MARIAN
LAKE KISSIMMEE
TIGER L.
LAKE ROSALIE
LAKE WEOHYAKAPKA
LAKE HATCHINEHA
LAKE PIERCE
LAKE WALES
LAKE MARION
CYPRESS LAKE
LAKE TOHOPEKALIGA
EAST LAKE TOHOPEKALIGA
ST. CLOUD
KISSIMMEE
ALLIGATOR L.
L. GENTRY
LAKE HART
L. CONWAY
PINECASTLE
L. TIBET
L. BUTLER
CONLIN
PRESTON
JACKSON
ATLANTIC COAST LINE RR
SEABOARD AIR LINE RR

PLATE 2-1

SECTION 3

FLOOD CONTROL PROJECT

3.1 FLOOD CONTROL

Creation of the Everglades Drainage District by the State of Florida in 1907, and passage of the State's General Drainage Act in 1913, encouraged development in central and south Florida. Resulting development, coupled with inadequate hurricane protection, led to the loss of three thousand lives around Lake Okeechobee during storms in 1926 and 1928. In response, Congress authorized the Corps to modify the Kissimmee navigation project to include flood control. The modified plan, described in a report titled *Caloosahatchee River and Lake Okeechobee Drainage Areas,* included numerous levee and channel improvements to reduce flood damage primarily throughout the lower basin.

Settlers attempted to drain portions of the upper basin lakes to create well drained pasture and agricultural lands, but were unsuccessful. The drought of 1944-45 and the hurricane of 1947, which caused wide-spread flooding of some 600,000 acres in the Kissimmee Basin illustrated the lack of drought and flood protection. Flooding conditions in the Kissimmee River Basin were the result of runoff accumulation on the flat lands of the basin and the subsequent rise of lake levels within the Upper Basin, which remained at high levels because of poor outlet capacity. In addition to flooding from runoff, hurricane winds over Florida create problems of tide generation on the larger lakes which added to the local flooding.

Increasing population growth and developmental pressures, primarily in the Upper Basin, intensified public pressure to reduce the threat of flood damage. As a result, the State of Florida requested the Federal Government to prepare a plan for flood control for the central and southern part of the state. In response to this request, the Corps prepared a comprehensive plan for the area in 1947. Congress authorized the Corps to undertake construction of the Central and Southern Florida (C&SF) Project for flood control and other purposes in 1948. Figure 1-2 shows the features of the overall project. The C&SF Project resulted in a series of reports and design memoranda used in planning and designing the comprehensive flood control and water management system now in place in south Florida.

In 1954, Congress specifically authorized the construction of the Kissimmee River portion of the C&SF Project, which was subsequently planned and designed between 1954 and 1960. The purpose of this plan was to relieve flooding and minimize flood damages in the Kissimmee Basin. This was to be accomplished partially by flood storage in the Upper Basin lakes and partially by providing the capability to rapidly remove flood waters from the basin when necessary. Channelization of the river was selected as the means for flood damage reduction within the lower basin primarily because of the plan's cost effectiveness. The report to Congress clearly stated that complete flood protection could not be provided, but that reasonable flood protection would result from such a plan. The plan of improvement was designed to provide flood damage prevention for thirty percent of the standard project flood (SPF) (which equates to somewhere between a five to ten year level of protection depending on location). For storms greater than the 30 percent SPF, the depth and duration of flooding in the Upper Basin would be reduced by the project features. The plan of improvement, as described in the 1956 General Design Memorandum, was designed to provide the following:

a. Remove runoff from a design storm equal to 30 percent of the standard project flood from the project area between Lake Kissimmee and Lake Okeechobee.

b. Provide sufficient regulation capacity for each of the lakes in the middle and upper Kissimmee Basin to limit the rise in lake stage during the design storm (30 percent S.P.F.) to 2 feet or less.

c. Provide sufficient regulation capacity for Lake Kissimmee to prevent maximum stages resulting from occurrence of the standard project flood from exceeding those that could be expected under existing conditions. That capacity would reduce the stage and duration of all floods below the magnitude of the standard project flood.

d. Provide capacity in Kissimmee River for the design discharge from canal 41A (Lake Istokpoga regulation outlet), developed in Part II, Supplement 2 (reference 3b).

e. Provide water control for the project area by control structures to maintain, insofar as practicable, the lakes at desirable elevations, approximating the present mean stages and water levels in the canals at the optimum elevations.

f. Provide for navigation on Kissimmee River and all lakes in the middle and upper Kissimmee River Basin. Locks would be provided at each control structure on the main watercourse between East Lake Tohopekaliga and Lake Okeechobee.

g. Maintain levels in the lakes of middle and upper Kissimmee River Basin in consideration of the interests of recreation and the preservation of fishery resources.

Work in the Upper Basin was started in the early 1960's. The major lakes of the Upper Basin, which were used for water storage, were connected by channels. In most cases, these were the same channels excavated by Hamilton Disston in the 1880's, but enlarged to varying degrees under the Congressionally authorized plan. Work within the Lower Basin, which included channelization of approximately 48 miles of the river and floodplain (C-38) from Lake Kissimmee to Lake Okeechobee was initiated in 1962 and completed in 1971. Water control structures were also constructed with small boat locks, providing continuous navigation along the length of the new canal, but limited to daylight hours. Combined with Government Cut, a previously channelized section of the lower Kissimmee River (Figure 1-1), C-38 provided complete channelization of the river between Lakes Kissimmee and Okeechobee, a distance of 56 miles.

3.2 UPPER BASIN

3.2.1 Development of Plan

The flood control plan for the upper Kissimmee lakes is a combined system of flood storage capabilities and outlet discharge capacities. Lakes levels are prevented from exceeding stages represented by a seasonal plan known as a regulation schedule which represent the seasonal and monthly limits of water levels needed to obtain the flood protection designed into the project.

Under natural conditions, the lakes in the Kissimmee River Basin fluctuated seasonally through a range in stage varying from about 2 to 10 feet. The existing outlet capacities were limited and the lakes functioned as natural detention reservoirs which stored large quantities of water during the wet season and was released during dry periods. With the increased outlet capacities of the project, the lakes are regulated to prevent much of the fluctuation that occurred under natural conditions. Table 3-1, shows the following data for Lakes Cypress, Hatchineha, and Kissimmee: (1) the historical 15 percentile, 50 percentile (median), and 85 percentile stages (based on the 24 years of record prior to institution of regulation), and (2) maximum and minimum daily stages and differences between the record extremes,

TABLE 3-1
Historic Lake Stages

	CYPRESS	HATCHINEHA	KISSIMMEE
15 Percentile (ft.msl.)	54.2	53.2	52.6
Median (ft.msl.)	52.5	51.3	50.4
85 Percentile (ft.msl.)	50.3	49.1	47.7
Maximum (ft.msl.)	57.2	56.8	56.6
Minimum (ft.msl.)	48.0	47.3	44.2
Difference (ft.)	9.2	9.5	12.4

The data shows that prior to regulation, Cypress Lake stage was about one foot higher than Lake Hatchineha stage and two feet higher than Lake Kissimmee stage. Despite the large range in extreme stages, the data shows that 70 percent of the time, under pre-regulation conditions, Cypress and Hatchineha stages fluctuated within a four foot range while Lake Kissimmee fluctuated within a five foot range.

Under the Kissimmee flood control project, the lakes are regulated to prevent much of the fluctuation that occurred under natural conditions (Table 2-1). The fluctuation of Lake Cypress, Hatchineha, and Kissimmee was set within a four foot range. According to the original General Design Memorandum plan, Lakes Hatchineha and Cypress were to be regulated together between 49 to 53 feet NGVD, and independently of Lake Kissimmee by a structure (S-64) between Lakes Hatchineha and Kissimmee. Lake Kissimmee was to be regulated between 48 to 52 feet NGVD.

However, in a letter to the Chief of Engineers in 1961, the District Engineer recommended eliminating S-64 and regulating Lakes Kissimmee, Cypress, and Hatchineha between 48.5 to 52.5 feet. It was determined that Lake Kissimmee could be regulated approximately one half foot higher and Lakes Cypress and Hatchineha could be regulated one half foot lower than proposed in the General Design Memorandum (Part II, Supplement 5). The flood storage in Lakes Kissimmee, Hatchineha, and Cypress would not appreciably change with this modification. This eliminated the need for the control structure, S-64, at the outlet of Lake Hatchineha. The Chief of Engineers concurred with the elimination of S-64 from the authorized project as recommended by the Jacksonville District.

The 15 and 85 percentile stages of all three lakes prior to construction were used to represent a measure of historical high and low water conditions. The regulated minimum of 48.5 feet is about 9 inches higher than the historical low for Lake Kissimmee. For Lake Hatchineha, the regulated maximum and minimum are about 7 to 8 inches lower than the natural high and low water level. Although the regulated range of four feet reflects the natural fluctuation of Lake Cypress, the effects of regulation have shifted the lake stage regime downward by almost two feet.

3.2.2 Implementation of Upper Basin Features

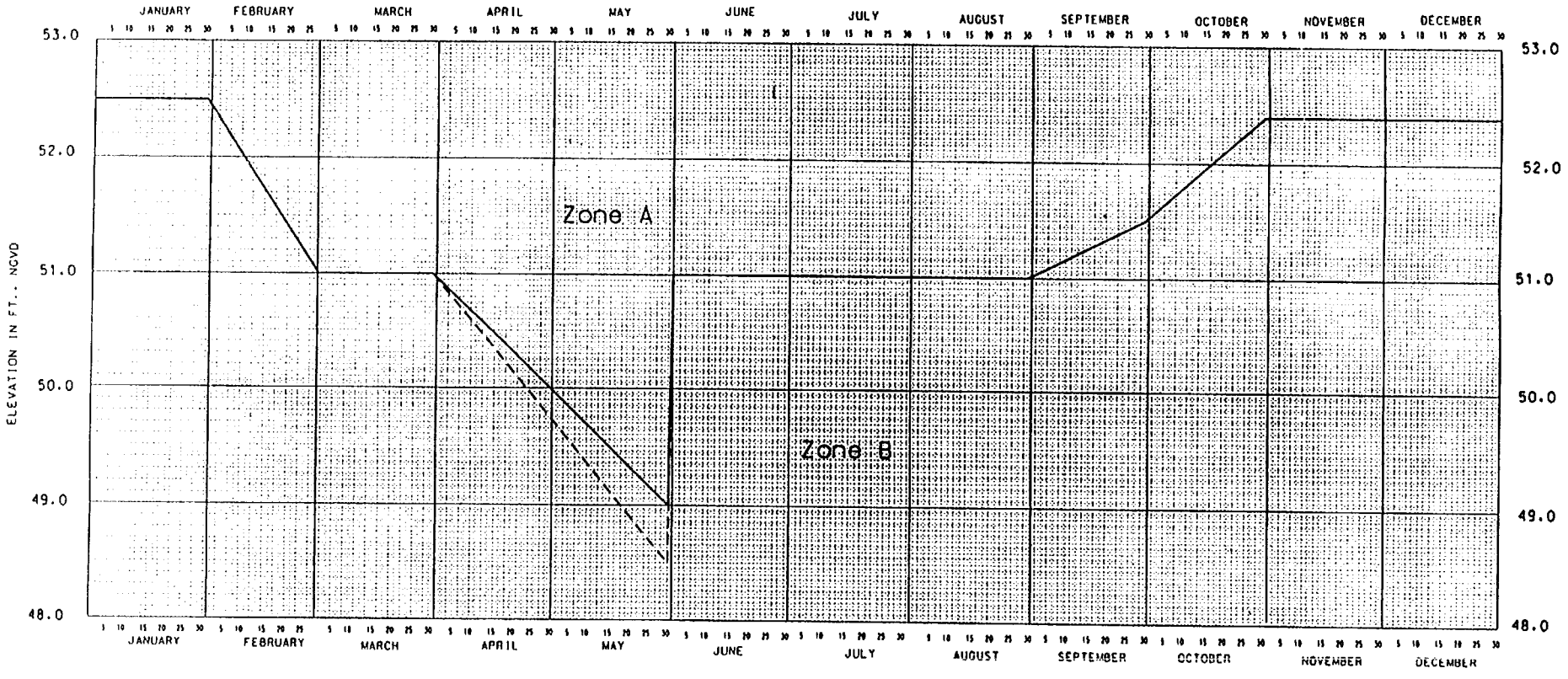
Construction within the Kissimmee Lakes took place over a 6 year period from 1964 to 1970. During this period, interim regulation schedules were adopted upon completion of individual lake outlet works, with the intention to implement permanent schedules upon completion of all works, including the Kissimmee River (C-38). Work began with East Lake Tohopekaliga and proceeded down the west chain of lakes to Lake Kissimmee. Work on the west chain of lakes through Lake Kissimmee was complete by 1965. Work then proceeded up the east chain of lakes reaching Lake Alligator by 1967. By 1970, work was completed in the east chain of lakes, from Alligator to East Lake Tohopekaliga.

Numerous efforts were made to develop permanent regulation schedules within the Upper Basin lakes, however, a decision could not be reached by the parties involved in the decision process. Each effort usually ended by recommending the current interim schedule until the results of additional studies were made. In 1975, after a comprehensive hydrologic study of the Kissimmee Basin and two public meetings, the Central and Southern Florida Flood Control District prepared a report titled, *Report to the Governing Board on Regulatory Levels for Lakes in the Upper Kissimmee Basin.* The schedules put forth in this report were approved by the Corps and implemented in 1976. In 1981, following more public meetings, the SFWMD recommended revisions to the regulation schedules, and the changes were implemented in April, 1982. The revised interim Lake Kissimmee, Hatchineha, and Cypress regulation schedule was implemented in April 1982. This schedule, which is also the current operating schedule, is shown in Figure 3-1.

3.2.3 Operation of Lake Kissimmee Regulation Schedule

Lakes Kissimmee, Hatchineha, and Cypress are regulated by a single structure, S-65 located at the outlet of Lake Kissimmee, at the head of C-38. The lakes are currently regulated between elevations 48.5 and 52.5 feet according to the seasonally varying schedule. The present regulation schedule for flood protection of the Kissimmee River valley uses the storage capacity in Lakes Kissimmee, Hatchineha, and Cypress above elevation 51.0 feet to temporarily store floodwaters from the upper lakes. The design discharge of 11,000 cfs from Lake Kissimmee is restricted to a firm capacity of 3,000 cfs until flooding recedes along the lower river; usually less than two weeks. When the river recedes to a point where the Kissimmee River structures can discharge their design flow at design stages, the discharge from Lake Kissimmee is increased to 11,000 cfs. For floods less than about 10-year recurrence frequency, the inflow hydrograph into Lakes Kissimmee, Hatchineha, and Cypress has already passed the peak and has dropped to below 11,000 cfs before S-65 is opened up to the 11,000 cfs maximum discharge. Therefore, the peak stage in Lake Kissimmee would occur at the time discharge at S-65 is increased to 11,000 cfs. Before C-38 was built, the outlet capacity of Lake Kissimmee was impacted by backwater effects from the reach of Kissimmee River immediately downstream of the lake. The maximum discharge recorded from Lake Kissimmee prior to the project was 8,800 cfs and occurred during the 1948 flood at a peak stage of about 57.0 feet. Today, the 11,000 cfs outlet capacity is available any time there is a 2.5-foot head differential across S-65. During floods, the full capacity usually becomes available on a rising stage in Lake Kissimmee at about 51 feet.

LAKES KISSIMMEE, HATCHINEHA, AND CYPRESS
INTERIM REGULATION SCHEDULE



ZONE	RELEASES
A	3,000 CFS UP TO DESIGN CAPACITY(11000) WITHOUT EXCEEDING DESIGN CONDITIONS DOWNSTREAM. WHEN THE LAKE IS WITHIN 0.5 FEET OF SCHEDULED STAGE FORECASTS WILL BE MADE AND RELEASES STARTED TO RETURN THE LAKE TO SCHEDULE WITHIN 15 DAYS
B	TO MAINTATIN MINIMUM FLOWS

CENTRAL AND SOUTHERN FLORIDA
INTERIM REGULATION SCHEDULE
KISSIMMEE RIVER BASIN
LAKES KISSIMMEE, HATCHINEHA, AND CYPRESS

Figure 3-1

3.2.4 Physical Features

Nine water control structures and seven canals were constructed in the Upper Basin from Lake Hart to Lake Kissimmee as part of the flood control project. The structures and canals are shown in Figure 3-2 and described below.

a. Structure 57 (S-57). S-57 is located in C-30, connecting Lakes Myrtle and Mary Jane, about 6200 feet downstream from Lake Myrtle. S-57 is a double-barreled corrugated metal pipe culvert, with discharge controlled by stem operated vertical lift gates. Operation of the gates is manually controlled or by telemetry in accordance with the seasonal operational criteria.

b. Structure 58 (S-58). S-58 is located in C-32 which connects Lakes Trout and Joel, about 3200 feet downstream from Trout Lake. S-58 is a double barreled corrugated metal pipe culvert, with discharge controlled by stem operated vertical lift gates. Operation of the gates is manually controlled or by telemetry in accordance with the seasonal operational criteria.

c. Structure 59 (S-59). S-59 is located in C-31 between East Lake Tohopekaliga and Lake Tohopekaliga at the outlet of East Lake Tohopekaliga. S-59 is a reinforced concrete, gated spillway with discharge controlled by a vertical lift gate. Operation of the gate is manually controlled or by telemetry in accordance with seasonal operational criteria.

d. Structure 60 (S-60). S-60 is located in C-33 between Lakes Alligator and Gentry about 1,500 feet upstream from State Road and 3,700 feet downstream from Alligator Lake. S-60 is a reinforced concrete, gated spillway with discharge controlled by a stem operated, vertical lift gate. Operation of the gate is manually controlled or by telemetry in accordance with seasonal operational criteria.

e. Structure 61 (S-61). S-61 is located in C-35 at the south shore (outlet) of Lake Tohopekaliga. S-61 is a reinforced concrete, gated spillway with discharge controlled by a vertical lift gate, and a reinforced concrete lock structure with two pairs of sector gates. Operation of the spillway gate is manually controlled in accordance with seasonal operational criteria.

f. Structure 62 (S-62). S-62 is located in C-29 at the outlet of Lake Hart which discharges into Lake Ajay. S-62 is a reinforced concrete, gated spillway with discharge controlled by a vertical lift gate. Operation of the gate is manually controlled in accordance with the seasonal operational criteria.

g. Structure 63 (S-63). S-63 is located in C-34 about 2000 feet downstream from Lake Gentry. S-63 is a reinforced concrete, gated spillway with discharge controlled by a stem operated vertical lift gate. Operation of the gate is manually controlled in accordance with the seasonal operation criteria.

h. Structure 63A (S-63A). S-63A is located in C-34, about 2.25 miles upstream from Lake Cypress. S-63A is a reinforced concrete, gated spillway with discharge controlled by two stem operated vertical lift gates. Operation of the gates is automatically controlled in accordance with the seasonal operational criteria.

i. Structure 65 (S-65). S-65 is located at the outlet of Lake Kissimmee at the head of C-38. S-65 is a reinforced concrete, gated spillway with discharge controlled by three vertical lift gates, and a reinforced concrete lock structure with two pairs of sector gates.

3.2.5 Lower Basin (Canal 38)

Canal 38 (C-38) was designed between 1954 and 1960 and constructed between 1962 and 1971. There are six water control structures, S-65, S-65A, S-65B, S-65C, S-65D, and S-65E, each with tieback levees, that divide the river into five pools. S-65 is the outlet structure from Lake Kissimmee and uses the S.R. 60 road embankment as a tieback levee. Pool A is between S-65 and S-65A; Pool B is between S-65A and S-65B; Pool C is between S-65B and S-65C; Pool D is between S-65C and S-65D, and Pool E is between S-65D and S-65E. Structure 65E is located eight miles north of Lake Okeechobee.

The Kissimmee structures are designed to step down the 36-foot drop of the river in six-foot increments. The canal is designed to pass the outflow from Lake Kissimmee plus local inflow for a storm equal to 30 percent of the SPF. The 30 percent SPF discharge capacity at Lake Kissimmee represents a 25 percent increase over historical capacity, thus, providing flood protection to the Upper Chain of Lakes. In the lower C-38 basin, the design channel is capable of passing the twin-peaked hydrograph produced by the local inflow and the delayed peak from the upper basin. Even with higher inflow discharges, the C-38 project significantly reduced flood stages in the lower valley because of the reduction in surface friction and hydraulic conveyance provided by the canal.

SECTION 4

EXISTING CONDITION/AFFECTED ENVIRONMENT

This section provides an overview of resources that currently exist within the Upper Kissimmee River Basin. These resources will be assessed according to the potential for altering the existing condition relative to the recommended restoration measures.

4.1 GEOLOGY AND SOILS

Soils found throughout the Kissimmee River Basin are sandy with poor to moderate drainage due to organic hardpans found 1 to 2 feet below the surface. The majority of soil types found in the Upper and Lower Basin's are classified under the Smyrna-Myakka-Basinger soil association. Other predominant classifications are the Myakka-Basinger category and the Myakka-Immokalee-Basinger category. Weathering, erosion, climatic conditions, vegetation effects, and topographical locations of resident soils have resulted in the numerous differences in soil characteristics. These characteristics are undergoing continual alteration due to normal seasonal climatic conditions and longer term climatic changes.

The study area also has soils with hardpan one to two feet below the surface. Over the long period of natural evolution of these soils, organic and mineral materials leached downward and accumulated at the top of the locally prevailing water table. In the early history of the Kissimmee River Basin, there were extensive areas of wetlands. Agriculture and other land use activities over the past 100 years have drained these wetlands by surface drainage systems and by breaking up the original hardpan. As a result of this process, the high organic fraction of these original soils has been rapidly oxidized by exposure to the air and soils now act as well-drained soils, creating better drainage during high rainfall but a need for more irrigation during periods of lesser rainfall. The fresh water swamps, where the groundwater is 15 inches or less beneath the surface, were at one time under water 9 to 12 months of the year. Additional information may be found in the Geotechnical Investigations section, Appendix C, of this report.

4.2 HYDROLOGY

The Upper Kissimmee Basin encompasses approximately 1,600 square miles in Osceola, Polk, Orange Counties and includes 26 lakes, 18 of which are controlled by structures and canals operated by the SFWMD, in accordance with regulations prescribed by the Secretary of the Army. The system of water control works now in place in the Kissimmee Basin conforms closely with the general plan outlined in the 1948 report to Congress and authorized for construction in 1954. A description of the existing structures is provided in the Flood Control Project section, Section 3, of this report.

In addition to the flood control structures identified in Section 3, several locally constructed control structures are located in the Upper Basin. Lake Rosalie has a steel sheet pile weir, G-103, which partially separates Lake Rosalie from the canal connecting it with Lake Kissimmee. The natural outlet of Lake Rosalie, however, is Rosalie Creek, a meandering stream at the south end of the lake, which discharges into Lake Tiger. The water levels of Lake Jackson are also controlled separately from Lake Kissimmee by a control structure on the Lake Jackson canal. The structure was recently completed by the FGFWFC and SFWMD.

The flood control plan for the upper Kissimmee lakes is a combined system of flood storage capabilities and outlet discharge capacities. Water levels in between Lakes Hatchineha, Cypress, Kissimmee and its tributary, Lake Tiger are controlled with a single outflow structure at the south end of Lake Kissimmee, S-65. Inflow into these lakes from Lake Tohopokeliga and Lake Gentry is controlled by structures S-61, S-63 and S-63A. Details of the S-65 and other structure operational criteria are described in the Water Control Plan (Appendix B).

Lake levels are prevented from exceeding stages represented by a regulation schedule designed to provide the designed level of flood protection into the project. Lakes Kissimmee, Hatchineha and Cypress are currently regulated between 48.5 to 52.5 feet NGVD according to a seasonally varying operation schedule (Figure 3-1). The schedule varies from 52.5 feet during the driest months to 51.0 feet during the wet season. The schedule is lowest in the wet season to obtain the storage capacity in Lakes Kissimmee, Hatchineha, and Cypress above elevation 51.0 feet to temporarily store floodwaters from the upper lakes. The schedule stage is highest during the dry season because both the probability of extreme rainfall and ground water storage in the basin are low.

Due to the flood control schedules and operation rules that are used to regulate stages in the headwater chain of lakes, discharge regimes from the Upper Basin have been greatly altered compared to historical conditions. Prior to regulation the river received continuous inflows from the Upper Basin, with lowest discharge typically occurring during the winter-spring, dry season and steadily increasing to an end of the wet season (November) peak. Since regulation, the natural seasonality of high and low flow periods has been reversed and there are extended periods during each year when there is no discharge from the upper lakes to the lower basin. Low or no discharge is common during most of the wet season months (June-November), however the wet season discharges are required about 35 percent of the time to keep Lake Kissimmee stages from rising above schedule. Highest annual flows often occur during the dry season months (particularly February-May) as stages in the upper lakes are lowered to provide storage for flood control (Figure 4-1). Both of these changes to historical flow regimes impact the potential for restoring fish and wildlife habitat in the river and its bordering floodplain.

Flood control regulation has also reduced the range of water level fluctuations and maximum annual lake stages in the Upper Basin (Figure 4-2). The curves, based on actual daily gage values over the period, reflect a wider fluctuation in lake stage for the pre-project or unregulated period. The larger variation in the natural system was due primarily to a less efficient outlet from Lake Kissimmee in the form of the meandering Kissimmee River and the absence of the S-65 control structure operating in conjunction with an established regulation schedule. Flood and wet season stages are now reduced because of the improved outlet capacity at S-65 and the downstream conveyance of C-38 while dry season stages tend to be higher because releases from S-65 are curtailed when the lake is below schedule.

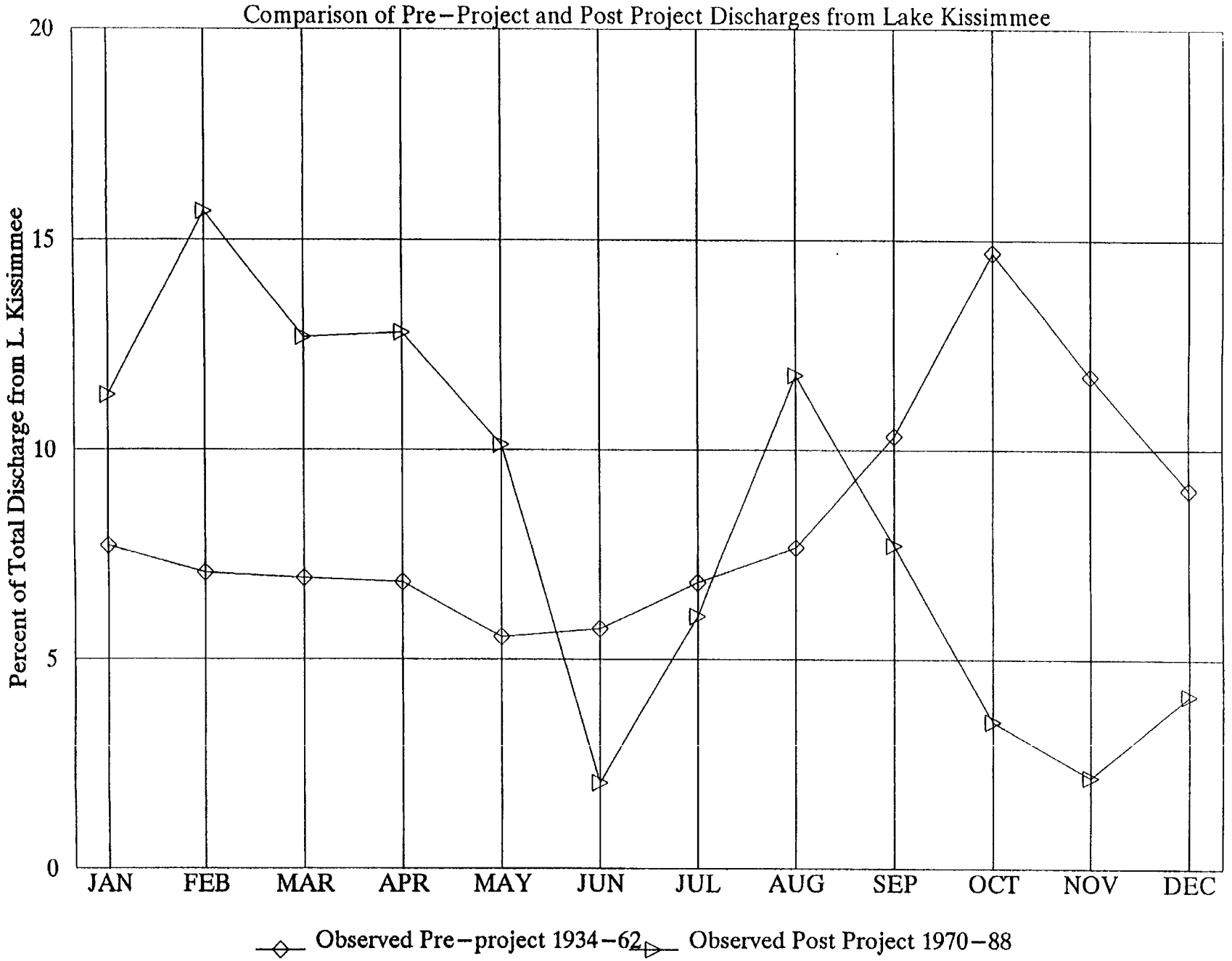

Comparison of Pre-Project and Post Project Discharges from Lake Kissimmee
Percent of Total Discharge from L. Kissimmee
20
15
10
5
0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
Observed Pre-project 1934-62
Observed Post Project 1970-88

FIGURE 4-1

LAKE KISSIMMEE HISTORIC STAGE–DURATION COMPARISONS
(EXISTING VS. PRE–PROJECT)

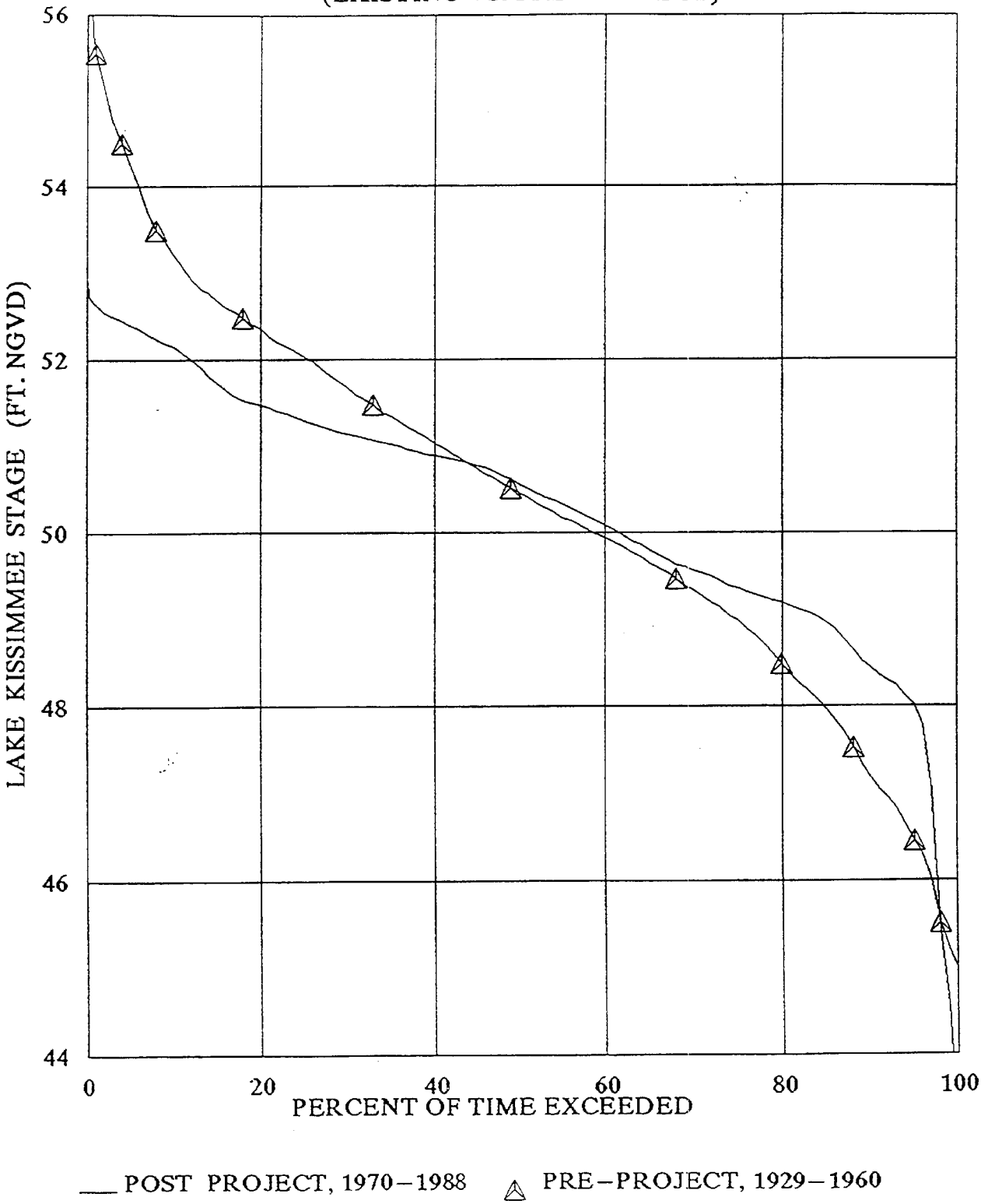


Figure 4-2

4.3 EXISTING FLOOD LEVELS

The existing Kissimmee flood control project was not designed and constructed to provide complete flood protection for the Kissimmee Basin. The plan of improvement was designed to provide flood damage prevention for thirty percent of the standard project flood (SPF) for the Upper and Lower Basins (five to ten year flood event, depending on location). In the Upper Basin, the depth and duration of flooding would be reduced by the project features for storms greater than the 30 percent SPF.

Theoretically, floods can occur almost any time. Therefore, the probability of a specific flood stage in Lake Kissimmee is a joint probability of antecedent lake stage and rainfall. Specifically, the total probability is the integral summation of the product of all the possible combinations that would produce that stage. The more traditional approach has been to start the storm at an average lake level which is usually represented by the 1 September stage on the regulation schedule. This was the approach followed in the 1990 and 1991 feasibility reports and all prior studies of the Kissimmee River Basin. However, the capabilities of the UKISS and UNET models enabled a joint probability approach to be used for the first time during the current study for the Upper Basin flood routings (see Appendix A., Hydrology and Hydraulic Analyses).

UNET, a one-dimensional unsteady flow program, was the dynamic-routing model used to simulate flood flows and stages in a fully developed network of open channels and storage areas. Both the Corps' 1991 Feasibility Report and the 1990 SFWMD Report utilized CHANOP as the Upper Basin hydraulic routing model and DWOPER as the Lower Basin model. The current study utilizes UNET exclusively in both the Upper and Lower Basins. UNET is particularly superior to CHANOP in simulating the dynamic interplay between flow and stage for the various interconnecting lakes in the Upper Basin. Unlike CHANOP, UNET allowed the three main stem lakes (Kissimmee, Hatchineha, and Cypress) to be modeled as separate entities thereby identifying the respective headlosses between the lakes and ultimately leading to an optimization of design channel enlargements for Canals 35, 36, and 37. Due to modeling constraints and a lack of topographic information in the canals, previous studies in 1990 and 1991 had computed a common peak flood stage for the three lakes. Figure A-1 shows a schematic of the UNET models for the Upper Basin under existing and with-project conditions. Figures A-2 and A-3 show schematics of the Lower Basin UNET model. The Lower Basin model essentially consists of one reach, C-38, which extends from S-65 to S-65D.

The existing conditions flood routing model accounts for the fluctuation of starting water surface elevations on Lakes Kissimmee, Hatchineha, Cypress, and Tiger between elevations 49.0 to 51.0 feet. Although there are additional lakes in the Middle Basin, only the lakes which would potentially be impacted by a change in the Lake Kissimmee regulation schedule are included in the UNET model. However, hydrology and HEC-1 flood routings were also developed for the other major lakes (i.e., Lakes Weohyakapka, Marion, and Pierce) and input as upstream boundary hydrographs into the UNET model shown. The previous hydrologic modeling for the Upper Basin chain of lakes was included in the current UNET model as upstream boundary hydrographs at the S-61 and S-63A locations.

The fully-integrated model includes the Upper and Lower Basin UNET models joined together at S-65. S-65 is modeled as a submerged rating curve (maximum capacity of 11,000 cfs at head of 2.5 feet) which computes discharge based on headwater and tailwater; however, discharge is restricted to 3,000 cfs when tailwater exceeds elevation 49.0 feet. S-65A, S-65B, and S-65C are also modeled as submerged rating curves with their full-height tieback levees represented with cross-sections. A downstream rating curve is used to simulate outflow from the model at S-65D. Canals 35, 36, and 37 are represented with existing bottom widths and side slopes and the Lake Kissimmee SWSEL for the flood event fluctuates between elevation 49.0 to 51.0 feet. C-38 is left intact (no backfill) and Mannings "n" values of 0.03 and 0.15 used for the channel and overbanks, respectively. Peak stage results for the integrated UNET existing conditions model is shown in Table 4-1 for the Upper and Lower Basins. Peak stages shown for the Lower Basin, below S-65, are tentative at this time. The stages will be revised as new topographic information for Pools A, B, C, and D continue to be incorporated into the model when they become available.

TABLE 4-1
KISSIMMEE RIVER UPPER AND LOWER BASIN
EXISTING PEAK FLOOD STAGES (FT)

PEAK STAGE FT.	RETURN PERIOD IN YEARS				
LOCATION	5-YEAR	10-YEAR	25-YEAR	50-YEAR	100-YEAR
S-61 TW	53.91	54.53	55.96	56.77	57.22
S-63A TW	53.85	54.53	56.01	56.84	57.46
CYPRESS	53.47	54.16	55.71	56.56	57.04
HATCHINEHA	52.87	53.69	55.42	56.41	56.99
KISSIMMEE	51.77	52.41	53.96	55.13	56.18
TIGER	52.39	52.93	54.08	55.15	56.18
JACKSON	56.8	57.4	58.1	58.4	58.7
ROSALIE	56.1	56.3	56.6	56.8	57
MARIAN	61.4	61.7	62.1	62.4	62.7
S-65 TW	49.51	49.66	49.83	49.92	49.99
S-65A HW	48.04	48.14	48.59	48.87	49.02
S-65A TW	44.18	44.55	45.47	46.16	46.22
S-65B HW	42.86	43.16	44.51	45.36	45.43
S-65B TW	35.4	35.92	36.06	36.47	36.47
S-65C HW	34.35	34.85	35.12	35.61	35.61

4.4 NAVIGATION

The C&SF project works improved navigation opportunities originally provided in the Congressional Act of 1902. The waterway now provides year-round navigation from Lake Kissimmee to Lake Okeechobee with interpool navigation being limited to daylight hours only. The navigation features of the project are now part of a more extensive flood control project that has provided a broader and deeper waterway. Current usage of those waters is in the form of recreational boating. Vessel registration for 1995 in Osceola and Polk Counties show 6,370 and 24,905 recreational vessels, respectively. These two counties have over 660 commercial vessel registrations. Post-regulation invasion of the exotic hydrilla has impacted the Upper Basin lakes navigation,

though, particularly in shallow water. Some small boat owners are no longer using the Kissimmee Chain due to their difficulty or inability to get through the dense mats of hydrilla.

4.5 NATURAL ENVIRONMENT

4.5.1 Vegetation

The littoral zones of the lakes are among the most significant resources in the Upper Kissimmee River Basin. The distribution of plants is a result of a history of inundation, fire, grazing, nutrient input and soils. Cypress swamp, shrub swamp or emergent fresh water swamp make up the dominant vegetation communities in the littoral zones.

Flooding stage and duration are the dominant influences on vegetation composition. Flood control regulation has impacted environmental resources in the Upper Basin. Because the range of water level fluctuations and maximum annual lake stages have been reduced (Figure 4-2), the outer fringe of littoral wetlands surrounding the lakes has been drained and associated fish and wildlife values have diminished. PLATE 4-1 depicts a transformation from historic littoral conditions (1958) to the post-Kissimmee flood control project conditions (1984) at Lake Hatchineha. The photographs show a definite reduction in wetland fringe from 1958 to 1984.

The lakes are general surrounded by pine flatwoods, dry and wet prairies, and cypress domes. The tributaries have swamp hardwood bottomlands adjoining them, and in the case of Reedy Creek, swamp hardwood bottomlands exist for more than 25 miles to the north.

Where the cypress swamp prevails, it exists in pure stands in peripheral parts of the lakes, with little understory vegetation. The shrub swamp is dominated by willow (Salix spp.), buttonbush (Cephalanthus occidentalis), Carolina bay (Persea sp.) and primrose willow (Ludwigia peruviana). The emergent marsh is dominated by various grasses: torpedo grass (Panicum repens), maidencane (Panicum hemitomon), and cord grass (Spartina bakeri). Smartweed (Polygonum spp.), pickerelweed (Pontederia cordata), arrowhead (Sagittaria latifolia), sawgrass (Cladium jamaicense), cattail (Typha spp.), various rushes (Juncus spp.) and sedges compete with the grasses. Deeper parts of the littoral zone contain water lily (Nymphaea odorata), spatterdock (Nuphar luteum), bulrush (Scirpus spp.), and cattail. Hydrilla (Hydrilla verticillata) is a dominant submerged aquatic plant, and American lotus (Nelumbo lutea) is locally abundant.

The zone around the present emergent marsh is largely pasture land dominated by short-growing carpet grass, with little cordgrass, and is subject to cattle grazing. Where cattle are excluded, the area is dominated by other grasses, such as torpedo grass. If the upper marsh has not been burned and cattle are excluded, it is dominated by broomsedge (Andropogon virginicus), dog fennel (Eupatorium capillifolium), sesbania (Sesbania punicea), goldenrod (Solidago fistulosa), and wax myrtle (Myrica cerifera).

The wet prairie is typically inundated about 1.5 months to 5 months each year. It is dominated by grasses and rushes, such as wiregrass (Aristida stricta), maidencane, spikerush (Eleocharis spp.), beakrush (Rhynchospora microcarpa), and cordgrass (Spartina bakeri).

Reduced or eliminated water level fluctuations has been implicated by many authors as a major cause of undesirable changes in lake and wetland communities (Perrin, 1982). Such changes involve the accelerated accumulation of unconsolidated bottom sediments, declines in dissolved oxygen, nutrient enrichment, vegetation changes in the upper littoral zone, and ultimately the reduction of fish and wildlife populations.

In six places, on the east and west shore of Lake Kissimmee, on the southwest, northwest and east shore of Lake Hatchineha, and on the northwest shore of Lake Cypress near C-35, land owners have constructed farm levees to reduce flooding of pasture land. The levees inhibit flooding of about 3,000 acres that, historically, were marsh, contiguous with the lakes during high water periods.

This reduction in the size of the littoral zone marshes has reduced the total area for recruitment of forage to the in-lake fishery and diminished the shallow, useful zone for wading bird foraging. The present day marsh zone is approximately 16,000 acres. This is approximately a 71% reduction in marsh area compared to the historical extent of wetlands surrounding these lakes.

On occasion these lakes are drawn down several feet in cooperation with the FGFWFC as a fisheries management measure to consolidate organic sediments and to permit removal of muck and debris from the littoral zones. They attempt to hold water levels down for at least 90 days, starting February 1. For Lake Kissimmee, water levels should remain below 45 feet for a minimum of 90 consecutive days for effective treatment. Extreme drawdowns were completed for Lake Tohopekaliga in 1971, 1974, and 1987, and East Lake Tohopekaliga in 1989. A drawdown of Lake Kissimmee was completed in 1977. Although it did not include mechanical removal of muck, it was still beneficial for the consolidation of organic sediment. Another drawdown is underway for Lake Kissimmee which started in late 1995 and will continue through 1996.

The purpose of this extreme drawdown will be to compact lake bottom sediments and stimulate growth of desirable aquatic vegetation. This action will increase the overall quality of fish and wildlife populations in Lake Kissimmee.

4.5.2 Fish and Wildlife

The fluctuating waters of the lake littoral zone are important for overwintering waterfowl, which utilize these lakes during migrational periods. Coots (Fulica americana), ring-necked ducks (Aythya collaris), American widgeon (Anas americana), pintails (Anas acuta) and blue-winged teal (Anas discors) are the major species (Joe Carroll, USFWS. Pers. comm., 1992). The native Florida, or mottled duck (Anas fulvigula) also breeds and is resident in the shoreline marshes. Normally, the common snipe (Gallinago gallinago) is also found in these areas in the fall and winter months.

Post-regulation waterfowl use in the Upper Basin, i.e., Lakes Kissimmee, Hatchineha and Cypress, has averaged 3,405 waterfowl days based on eight surveys between 1965 and 1980. Pre-regulation waterfowl usage, based on three surveys between 1954 and 1957, had a mean of 4,360 waterfowl days. This is a 22% decrease in waterfowl day usage since lake level regulation was imposed on the lakes (Perrin et al., 1982). Presently, i.e., 1994-1995, a mid-winter waterfowl survey by the Florida Game and Fresh Water Fish Commission (FGFWFC) on lakes Kissimmee, Cypress, Hatchineha and Tohopekaliga estimated approximately 56,402 individuals were utilizing the lakes. This would represent an increase of approximately 16,000 individuals over the historic peak of 40,000 individuals since lake level regulation has been imposed. However, in comparing the data found in Perrin et al. (1982) against the 1994-95 mid-winter survey by FGFFC this increase is attributed to the significant increase in the populations of coots on the lakes. Lake Kissimmee had a pre-regulation (1954-1957) population mean of 2,532 ducks and 959 coots during winter surveys, while the post-regulation (1965-1980) mean population had changed to 1,437 ducks and 1,203 coots. The FGFWFC found in their mid-winter survey of Lake Kissimmee that ducks numbered approximately 3,185 whereas coots had increased to 14,010. This change in species abundance from ducks to coots is exhibited on all the lakes of the Upper Basin. The changes in duck and coot populations on the lakes has occurred following implementation of regulated water level schedules. One of the main factors related to these changes would be the decrease in the zone of fluctuation surrounding the headwater lakes. The zone of fluctuation which provides important waterfowl habitat was reduced by 5,600 acres for all upper basin lakes following water level regulation (Heaney et al., 1975). Due to topographical characteristics, the reduction of high water stages had the greatest impacts upon the low lying marshes bordering Lakes Kissimmee,

Hatchineha and Cypress than the other lakes of the Upper Basin. The vegetation change resulting from regulated water level schedules and construction of local farm levees has resulted in conditions that favor coot utilization over ducks.

Wading birds use the littoral zone as important feeding habitat. The great egret (Casmerodius albus), snowy egret (Egretta thula), great blue heron (Ardea herodias), tricolor heron (Egretta tricolor), and little blue heron (Egretta caerulea) are among those that benefit from the littoral zone. White ibis (Eudocimus albus) and glossy ibis (Plegadis falcinellus) also feed there. All are dependent on forage organisms produced in the littoral zone; i.e., fishes, reptiles, amphibians and invertebrates. One of the main reasons for recent declines in wading bird populations has been attributed to nesting failures due to inadequate food production (Ogden 1978). Ultimately, this lack of food production is attributed to increased marshland destruction and alteration of hydrological patterns (Kushlan and White 1977, Ogden 1978). Based on aerial surveys conducted over the upper and lower Kissimmee Basins by FGFFC from November 1978 through October 1980, wading bird population levels in the survey area seemed to reflect the degree to which wetlands habitat had been degraded. Number of species, density, and diversity of wading birds generally were lower in the Lower Basin (Kissimmee River) system than in the lake marshes of the Upper Basin.

Sport fishing constitutes the largest use of any species in the Upper Basin area (Section 4.11). The primary quarry sought by anglers on Lake Kissimmee is the largemouth bass (Micropterus salmoides). From 1987 to 1991, anglers exerted 59 percent of the total fishing effort on bass, 24 percent on black crappie (Pomoxis nigromaculatus) and 17 percent on bream (Lepomis spp.). Miscellaneous species, such as channel catfish (Ictalurus punctatus), brown bullhead (Ictalurus nebulosus) and chain pickerel (Esox niger) also were targeted. The effects of stabilized water levels, loss of littoral wetland habitat and the increased nutrient loadings are displayed in the accumulation of muck in the littoral zones. Increased rates of organic matter deposition and flocculation of decaying plant matter have reduced the food availability for fish, limiting the habitat for fish spawning and larval and juvenile fish.

The American alligator (Alligator mississippiensis) is a dominant reptile in the region. The alligator scavenges for carcasses of birds and hunts for fish in the deep water canals and ponds within the marsh zone.

Vectors in the study area include ticks, mosquitoes, biting flies and midges. These vectors may transmit Lyme's disease (ticks), encephalitis (mosquitoes and flies), and malaria (Anopheles mosquitoes); rabies is present to varying degrees among wild mammals; notably raccoons, skunks and foxes.

While these vectors or hosts are likely present in the study area, there are no known public health problems related to vectors in the basin.

4.5.3 Endangered or Threatened Species

The Corps, in consultation with the USFWS (Annex D), has identified the bald eagle (Haliaeetus leucocephalus), Audubon's crested caracara (Polyborus plancus), Florida snail kite (Rostrhamus sociabilis), Florida grasshopper sparrow (Ammodramus savannarum), wood stork (Mycteria americana) and eastern indigo snake (Drymarchon corais) as occurring in the drainage basin.

The bald eagle is primarily riparian and is usually found nesting near bodies of water where it feeds on fish. Historically, the bald eagle was a common nesting species in the southeast, inhabiting areas on the coastal plain and along major lakes and rivers. Osceola County currently has 103 active bald eagle territories, concentrated in the upper Kissimmee Chain of Lakes, with a cluster of active nests on Brahma Island in Lake Kissimmee (USFWS, Annx D).

The snail (Everglade) kite, (Rosthrhamus sociabilis plumbeus) inhabits shallow, open, wetlands containing sufficient emergent vegetation to support its primary food source, the apple snail (Pomacea paludosa). Such communities are usually situated in large marshes of sawgrass, wet prairie, or cattails with scattered shrubs, small trees, or tree islands. Snail kites are opportunists that will find new areas of suitable habitat when necessary.

The wood stork (Mycteria americana) is a large wading bird, Federally listed as endangered. The wood stork's tactile feeding strategy requires a concentration of fish in receding pools, and they are particularly dependent on consistent availability of such feeding areas within range of the nesting rookeries. They have been observed feeding up to 80 miles from their nesting rookery. Relative to the project area, the nearest active wood stork colony is located west of Lake Cypress and north of Lake Hatchineha, along Reedy Creek.

The Florida grasshopper sparrow (Ammodramus savannarum floridanus) is a strictly non-migratory resident of central Florida. The Florida subspecies requires a habitat with saw palmetto and, at times, dwarf scrub oak cover, as well as grasses. The main cause of decline is considered to be conversion of native range to intensely managed, improved pasture and other uses. The subspecies finds suitable habitat where a management plan includes grazing, chopping, and fire, stimulating plant succession. The subspecies is documented as occurring in the Avon Park bombing range, close to the Kissimmee River flood plain, approximately 8 miles from Lake Kissimmee.

The eastern indigo snake (Drymarchon corais couperi) is a large, black to glossy blue-black snake. Indigo snakes prefer sandy uplands, but can be found in many kinds of habitats, including certain canal banks. Generally, it can be found using gopher tortoise burrows for shelter. The collecting of tortoises for food and gassing of burrows for rattlesnakes have diminished the population of indigo snakes.

Audubon's crested caracara (Polyborus plancus auduboni) is a raptor with opportunistic feeding habits. It feeds on both carrion and living prey. It prefers open, dry prairie and pasture and scattered cabbage palm clumps for nesting. Live oak hammocks are also often present in preferred habitat. Caracara fly over improved pasture lands and forage over shallow ponds and sloughs. The distribution of the Florida population of this subspecies was once more widespread, including all of the prairie region of central Florida, but the bird is now mostly confined to the several counties north and west of Lake Okeechobee. The Kissimmee Prairie region is the core of the present range of the species. Sightings of caracara have been reported in the project area. Nesting was also reported in the vicinity of the study area, near the edge of the floodplain.

A population of whooping cranes (Grus americana) is the subject of an experimental introduction into the Three Lakes Wildlife Management Area, east of the project. The USFWS, in cooperation with the FGFFC, is conducting the program. The population, classified as a nonessential population, is not expected to be affected by the project.

4.5.4 State Listed Species of Special Concern

The sandhill crane (Grus canadensis pratensis) is state listed as threatened (T). A characteristic species of the basin, the cranes feed in pastures adjacent to the lakes and the upper littoral zone. Nesting by resident cranes occurs in the potholes dotted throughout the Kissimmee Prairie.

Other state listed species in the study area include the American alligator, categorized as a species of special concern (SSC), the least tern (Sterna antillarum)(T), limpkin (Aramus guarauna)(SSC), snowy egret (SSC), little blue heron (SSC), and tricolored heron (SSC).

4.6 WATER QUALITY

The majority of the Upper Kissimmee Basin exhibits fair to good water quality with the exception of Lake Tohopekaliga, which is classified as having

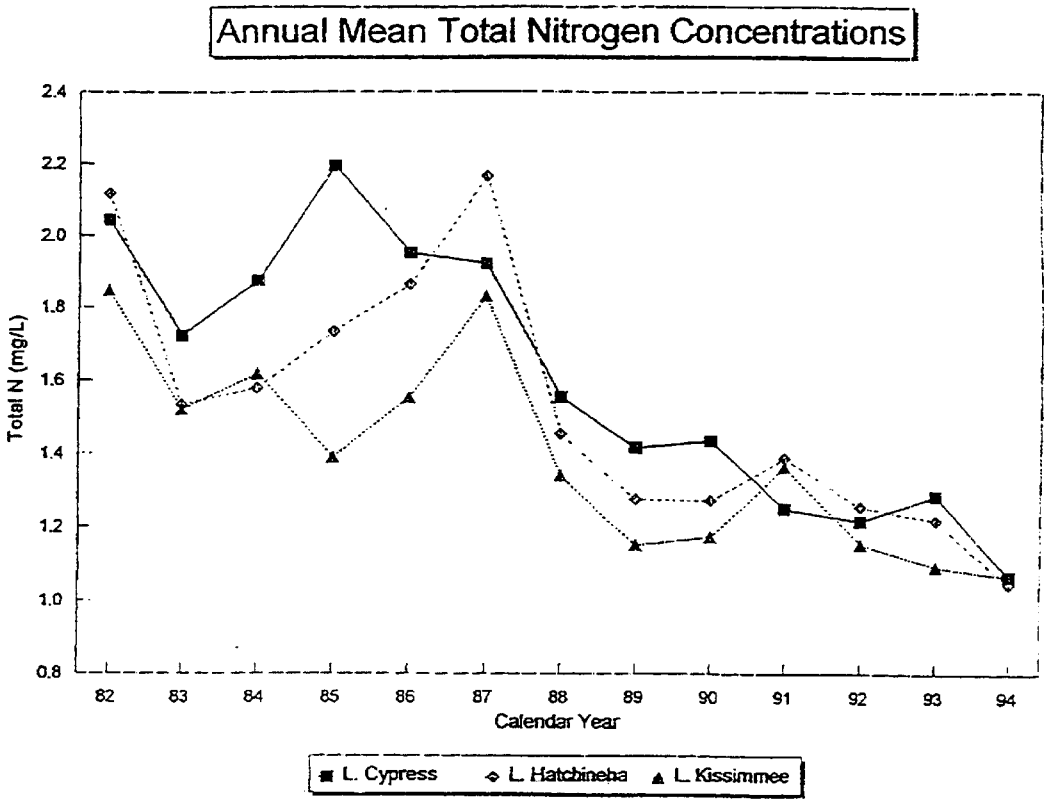
poor water quality. The other main problem areas are Shingle and Reedy Creeks. Shingle Creek and Reedy Creek have water quality problems associated with wastewater treatment plant (WWTP) effluent and urban runoff. Due to the reduction and elimination in both point and non-point source discharges water quality is improving. Lake Tohopekaliga has a history of poor water quality due to large nutrient inputs from WWTPs and non-point source urban and agricultural runoff. However, water quality in the lake is showing improvement due to reductions in WWTP discharges and lake drawdowns. The water quality downstream from Lake Tohopekaliga has suffered due to large nutrient loads leaving Lake Tohopekaliga. These areas are also showing improvements in water quality which may be a result of the reduced nutrient loads entering Lake Tohopekaliga. Water quality data for Lakes Cypress, Hatchineha and Kissimmee are presented in Figure 4-3.

4.7 AQUATIC PLANT CONTROL

Water quality degradation by nutrients and reduced water-level fluctuation have created conditions that are favorable to foster the nuisance growths of aquatic plants, such as the American lotus (Nelumbo lotus), and cattail and exotic plants such as, hydrilla (Hydrilla verticillata), waterlettuce (Pistia stratiotes) and water hyacinth (Eichhornia crassipes). The effects of stabilizing water levels and the increased nutrient loadings are displayed in the accumulation of muck in the littoral zones and by the rapid proliferation of nuisance aquatic plants. Increased rates of peat deposition and flocculation of decaying plant matter have limited the habitat for fish spawning.

Aquatic plant control is used as an integral component of ecosystem management in the Upper Kissimmee Basin. Current aquatic plant control programs within the Kissimmee Basin include herbicide treatment and other programs coordinated with lake level manipulations used in an effort to control floating exotic species such as water hyacinth, water lettuce, and the submersed exotic hydrilla. In these lakes, approximately 6.2 million dollars were spent between 1985 and July 1994, managing over 28,000 acres of the invasive non-native aquatic plants, hydrilla, waterhyacinth, and waterlettuce.

Hydrilla, which was previously introduced into the subject area, is the most problematic submersed exotic threatening the basin's water resources. All three major lakes in the Upper Basin have experienced typical exponential growth rates since the species was first discovered (Lake Hatchineha-1983, Lake Kissimmee-1984, and Lake Cypress-1986) and this threat is expected to continue. During the time period from 1988 to 1993, a total of $4.38 million was expended for control of hydrilla on these lakes, or an average of about $730,000 per year.


Annual Mean Total Nitrogen Concentrations
Total N (mg/L)
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
82
83
84
85
86
87
88
89
90
91
92
93
94
Calendar Year
L. Cypress
L. Hatchineha
L. Kissimmee

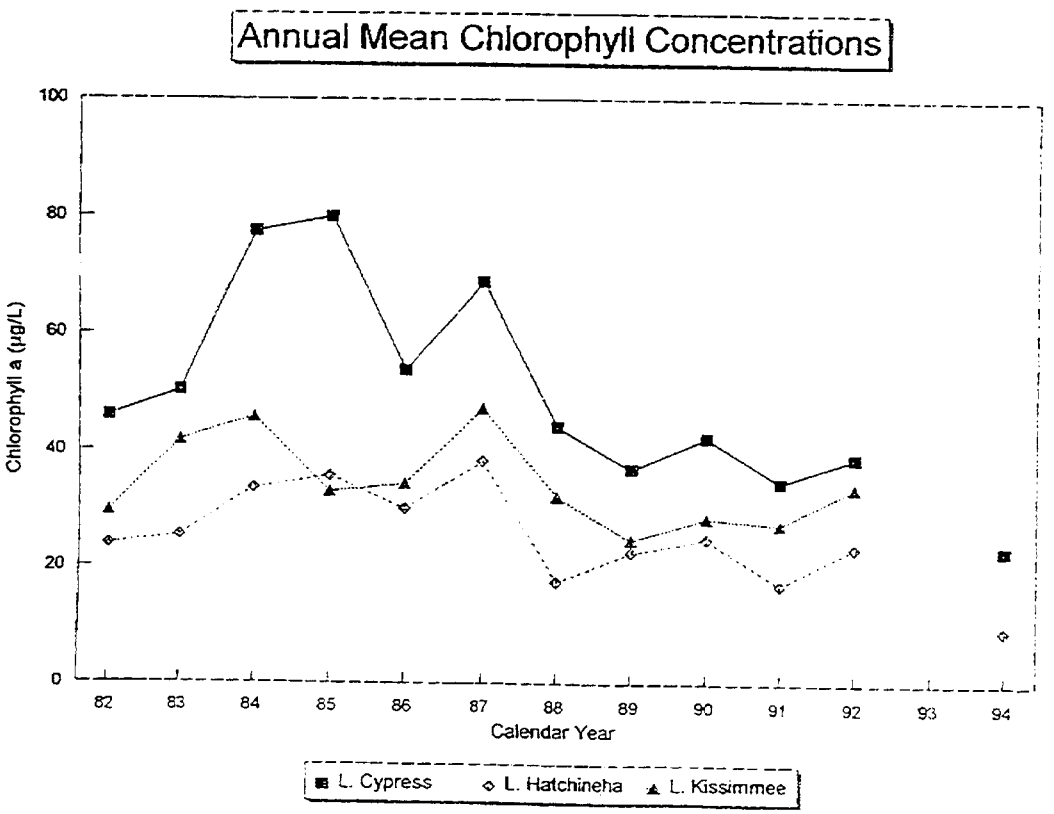
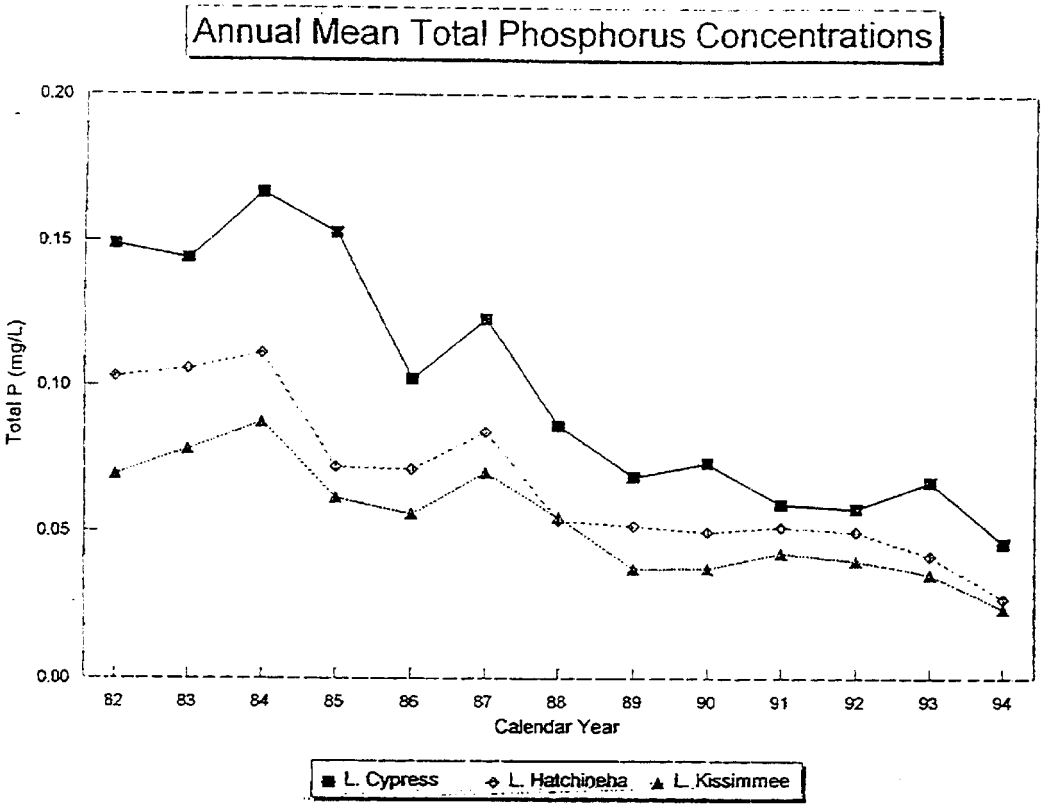

Annual Mean Chlorophyll Concentrations
Chlorophyll a (µg/L)
100
80
60
40
20
0
82
83
84
85
86
87
88
89
90
91
92
93
94
Calendar Year
L. Cypress
L. Hatchineha
L. Kissimmee

Figure 4-3


Annual Mean Total Phosphorus Concentrations
Total P (mg/L)
0.20
0.15
0.10
0.05
0.00
82
83
84
85
86
87
88
89
90
91
92
93
94
Calendar Year
L. Cypress
L. Hatchineha
L. Kissimmee

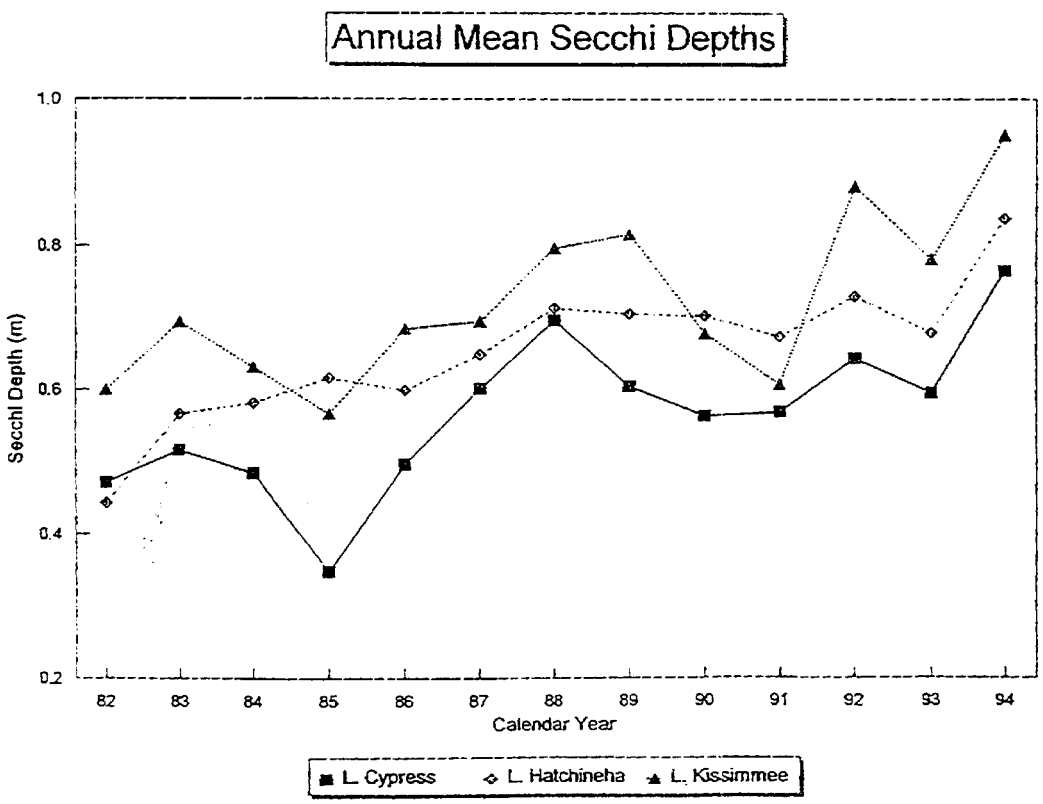

Annual Mean Secchi Depths
Secchi Depth (m)
1.0
0.8
0.6
0.4
0.2
82
83
84
85
86
87
88
89
90
91
92
93
94
Calendar Year
L. Cypress
L. Hatchineha
L. Kissimmee

Figure 4-3

4.8 HAZARDOUS, TOXIC OR RADIOACTIVE WASTES

The U.S. Army Corps of Engineers performed a HTRW Civil Works Audit in conformance with ER 1165-2-132. This audit covers property impacted by the Kissimmee River Headwaters Revitalization consisting of approximately 20,800 acres to be acquired on land bordering the affected lakes; i.e., Lake Hatchineha, Lake Kissimmee, Lake Cypress and Lake Tiger.

The record search was conducted over the period of 20 November 1994 to 3 February 1995. Several aerial photographs were reviewed for the purpose of delineating the actual property for detecting any signs that would indicate past activity that could have resulted in the existence of a current hazard. A South Florida Water Management District Environmental Audit determined that two inactive cattle dipping vats were identified on the concerned property. A phase II site investigation is required to quantify residue contaminates left by these cattle dipping vats.

A site investigation was performed February 9-10, 1995, on the properties impacted by the Kissimmee River Headwaters Revitalization Project. The properties indicated in the aerial photography consisted of fish camps and several residential areas, covered primarily with typical native marshlands vegetation. The site investigation of selected areas did not reveal hazardous, toxic or radioactive wastes. During the property acquisition, the real estate agent should pursue with the landowner if any undocumented disposal actions occurred on the property.

4.9 WATER SUPPLY

The total volume of water delivered to Lake Okeechobee from the entire Kissimmee Basin has experienced a decline in recent years due to the long-term variation in the wet/dry cycle. The majority of the flow reduction has occurred in the Upper Basin and can be seen at the gage site near S-65 where the average discharge has declined from 1,180 cfs to 664 cfs. The Lower Basin discharge, after adjusting Lake Istokpoga outflow, has remained virtually unchanged.

4.10 CLIMATE

Since 1970, the entire south Florida region has experienced an apparent change in rainfall characteristics. Average annual rainfall has been below normal in most of the twelve basins within the boundaries of the SFWMD over the period 1970-1985. The Upper and Lower Kissimmee Basins were among

the basins where the reduction was most evident. The Lower Basin received below normal wet season rainfall in eleven consecutive years beginning in 1975. The reduction has been attributed to drier, shorter wet seasons, less heavy storms, and less rainfall associated with tropical storms. The Kissimmee Basin has not experienced a major tropical storm since 1969 until 1994 when Tropical Storm Gordon caused minor flooding.

4.11 POPULATION

The 1990 Census indicated that the population of Polk County was 405,382, Osceola County's was 107,728, and the population of the State of Florida was 12,937,900. Population projections from the Florida Statistical Abstract, 1993, 27th Edition, indicate that the rate of population growth in Osceola County is expected to greatly exceed that experienced by Polk County and Florida as a whole. The major factor in Osceola County's population increase of over 100 percent between 1980 and 1992 was development of the Kissimmee-St. Cloud area as a result of Orlando's Disney World and other area tourist attractions. Additional population and demographic data can be found in the Socio-Economics Appendix (Appendix G).

4.12 LAND USE

Cattle and citrus are historic mainstays of the basin economy. The citrus industry in the Kissimmee Basin is located principally north of Cypress Lake. Cattle ranches and sod farms dominate a large portion of the land use in the Upper Basin. Today, tourism is replacing citrus as the major economic factor in the Upper Basin.

Land uses in the Upper Basin around the perimeters of Lakes Kissimmee, Hatchineha, Cypress, Rosalie, Tiger and Jackson are primarily pasture, some agriculture, and a large amount of wetlands (PLATE 4-2). Marinas, fish camps, and various public facilities, such as boat launching sites and picnic areas, are located around the lakes. Lake Kissimmee State Park is on the extreme northwestern periphery of Lake Kissimmee. Three Lakes Wildlife Management Area and Prairie Lakes Preserve border the southeastern half of Lake Kissimmee. Small residential and commercial areas are also scattered around most of the lakes. Development is more intense upstream of Cypress Lake, particularly in the Lake Tohopekaliga - East Lake Tohopekaliga chain.

Residential developments within the project area are located primarily around Lake Kissimmee and Lake Hatchineha. The largest development is located at Hatchineha Estates on the west side of Lake Hatchineha. This area

consists of approximately 300 lots with the majority of them developed. The lots are arranged along a system of canals so that each lot has water frontage. Almost all have docks or boat shelters. The other major residential areas, south to north from Lake Kissimmee to C-37, include Grape Hammock Fish Camp, Shady Oaks Fish Camp, Rocks Fish Camp, Kissimmee River Park and Camps Mack and Lester. The general location of these can be seen on the Study Area Map (see PLATE 1-1, Section 1).

Over the past twenty years, the northern portion of Osceola County, above S-61 (Lake Cypress) has become increasingly urbanized. The major factor in Osceola County's population increase of over 100 percent between 1980 and 1992 was the development of the Kissimmee-St. Cloud area as a result of Orlando's (Orange County) Disney World and other tourist attractions. Any increase in flood levels above S-61 created by a new project proposal would have the potential for substantial increases in flood damages to Upper Basin residential areas. For this reason, impacts by restoration project proposals were constrained to areas below S-61.

4.13 RECREATION

The three counties in which the upper Kissimmee Basin is located are in two different regions according to the State Comprehensive Outdoor Recreation Plan, published in 1989. Orange and Osceola are in Region VI; Polk is in Region VII. The large urban populations around Orlando, the Tampa Bay area, and the central coastal cities are all within a one- to two-hour drive from the project area. The main highways leading to the project area are heavily traveled and well maintained. The main constraint to access lies with the condition of the secondary service roads leading from the main highways to the upper chain of lakes and the large amount of private property which is in agricultural use around some of the lakes.

Recreation in the upper Kissimmee River basin is moderate to heavy with emphasis on Recreational Vehicle (RV) camping, general boating, and boat and bank fishing. Channelization and water control provide year-round navigable water levels for recreational boating, canoeing, and fishing. During high water conditions, airboats are able to traverse many of the marshes and flooded pastures around the chain of lakes.

Marinas, fish camps, and various public facilities such as boat launching sites and picnic areas are located around the lakes. There are six public and 14 commercial boat ramps around the upper chain of lakes which occur within the region affected by headwaters revitalization. The commercial boat ramps are associated with RV parks, marinas and fish camps located on the lakes. All

but two of these commercial operations charge fees for use of their launching facilities.

Lake Kissimmee State Park encompasses over 13,000 acres along the extreme northwestern periphery of Lake Kissimmee. Lake Kissimmee State Park, located on the shores of Lakes Kissimmee, Tiger and Rosalie, offers outstanding fishing and water access, picnicking, bird watching and boating. Thirty campsites with water and electrical hookups are available. The park has 13 miles of hiking trails which offer hikers the possibility of seeing whitetail deer, bald eagles, sandhill cranes, turkeys and bobcats. Plans to rework the park boat ramp are being developed by the State.

The Three Lakes Wildlife Management Area, located in Osceola County, is an 8,200 acre tract of land adjacent to Lakes Kissimmee, Jackson and Marian. This area is traversed by the Florida Trail. Picnicking facilities are available and primitive camping is allowed at designated campsites along the trail except during established hunting seasons for the area. Camping permits are required, but these are issued at no cost to the camper. This area has a boat ramp which can provide access to the Kissimmee chain of lakes via Lake Jackson. Parking at the ramp should not be affected by higher water conditions. The access road into the site may be subject to overtopping, however.

A large number of out-of-state visitors bring their boats with them to spend the winter in this portion of the State. During their stay, they participate in fishing and boating activities in and around the interconnected chain of lakes in the Upper Kissimmee Basin. Rental boats are available at many of the fish camps and marinas found along the edge of many of the lakes. Resident boat owners intensify the use of these lakes. The combined acreage of the Upper Basin lakes, plus the miles of waterways in between, offer recreational boating and fishing unlimited opportunities for residents and visitors alike.

Heaviest boat usage occurs within the Lake Kissimmee and Lake Okeechobee areas, located at the northern and southern ends of C-38. This is most likely the result of the larger numbers of boat owners who keep their boats at marinas on these lakes, more waterfront property owners with their own moorage facilities, and more convenient access to these larger water bodies than to the river. Although fishing occurs on a year round basis, heaviest fishing use occurs during the four to five months from late fall to early spring.

Recreational fishing is the largest use of species in the lakes. Based on creel data collected by the FGFFC, effort expended to fishing in Lake Kissimmee over the five year period, 1987-1991, averaged 451,582 hours per year. The primary quarry sought by anglers on Lake Kissimmee is the largemouth bass. From 1987 to 1991, anglers exerted 59 percent of the total fishing effort on bass, 24 percent on black crappie and 17 percent on bream. Miscellaneous species, such as channel catfish, brown bullhead and chain pickerel also were targeted. The only creel survey conducted in Lakes Hatchineha and Cypress was during the spring of 1986. The total fisherman effort was 40,832 hours at Hatchineha and 18,007 hours at Lake Cypress. As a comparison, fishermen in Lake Kissimmee fished for 213,921 hours during the same spring quarter (February 21 to May 15, 1986). Lakes Rosalie and Tiger are also popular with fishermen, but no creel census on these waters were available for this report. Lake Jackson has been a popular fishing spot in the past, but aquatic vegetation problems periodically cause fishing effort to be low.

As discussed in Section 4.5, these lakes are drawn down several feet on occasion to consolidate organic sediments and to permit removal of muck and debris from the littoral zone. Water levels are lowered for several months at a time during the draw down period. During this period the major problem in affected lakes is temporary loss of navigational access due to low water.
The organized Kissimmee Boat-A-Cade utilizes the Kissimmee channel for an annual floating pilgrimage in December from the City of Kissimmee through Lake Okeechobee to the coast. The 1995 Boat-A-Cade was canceled because of the drawdown currently underway on Lake Kissimmee.

4.14 AESTHETICS

With the exception of some limited pockets of development, the majority of the Upper Kissimmee Basin is either wooded or primarily in agricultural and pasture use. Open vistas can be found around the lakes and viewed from roadways crossing the basin. This patchwork type of development allows those who use the lakes the opportunities to view a tremendous variety of wildlife from short distances away from shorelines. Large tracts of undeveloped land, used by wildlife for roosting, feeding and nesting, are interspersed along stretches of the lakes and are more extensive than the developed shorelines. Towering cypresses and other hardwoods combine with hammock vegetation to provide roosting and nesting sites for a variety of bird species. The typical mammals and reptiles associated with marsh, lake and riparian environments can be often seen by boaters on the lakes. The upper chain of lakes provides an excellent example of the contrasts between development and a more natural lacustrine environment.

4.15 CULTURAL RESOURCES

Although the Upper Kissimmee Basin has received little systematic, professional cultural resources investigation, and few historic properties are recorded, the area has the potential to contain significant cultural resources. During a recent cultural resources survey of the project area, one prehistoric archeological site was identified along the canals. Two additional natural levee land forms near the canal have the potential to contain historic properties. Previous investigations have been confined to small archeological surveys in discreet project areas, designed to take into consideration the effects of specific development projects on cultural resources in compliance with the National Historic Preservation Act and other State and Federal laws. Local written histories and the collections of county historical societies provide insights into the historical development of the region and address the impacts of specific periods such as the Seminole War period and industries such as turpentining and cattle ranching as they relate to cultural resources.

The earliest widely accepted occupation of Florida, classify as the Paleoindian period, dates from approximately 10,000 B.C. to 6500 B.C. (Milanich, 1994). No Paleoindian archeological sites are recorded in the study area. During the Archaic period, ca. 6500 B.C. - ca. 1200 B.C., native groups exploited a wider range of resources than Paleoindians and probably utilized a more restricted territory. Archaic period sites become more numerous through time. The Transitional Stage, ca. 1200 B.C. - ca. 500 B.C. is characterized by changes in technology and lifestyles. A profusion of stone tool types and ceramic styles in this stage indicates increased population movement and social interaction, and a more complex political and religious community organization. The St. Johns culture begins about 500 B.C. and lasts into the historic period about A.D. 1500. Changes in ceramic technology appear to reflect variations in the degree of interaction with indigenous groups from northern Florida through time. Limited horticulture is assumed to be established by the beginning of the St. Johns, although abundant marine food resources appear to be the staple throughout the 2000 year time span.

During the early historical period, beginning with the first Spanish colonial period (1513 - 1763), European contacts were limited to the coastal areas. Native Florida tribes were decimated by European diseases and conflict, and by the 18th century, migrants from the Creek and other southeastern groups were moving into the vacated interior Florida. These migrants eventually coalesced into the Seminole tribe. The Seminoles lived in dispersed hamlets and farmed, hunted, and raised cattle. Following the Third Seminole War in 1858, the Upper Kissimmee River Basin was settled by cattle ranchers and farmers. Railroads and draining of swampland opened up the area to more homesteaders. The turpentine and timber industries made a significant economic impact on the region.

4.16 RELATION TO LOWER RIVER BASIN

One of the key findings of the planning studies that have been conducted for the Kissimmee River restoration project is that dechannelization alone, that is backfilling of C-38, is not sufficient to accomplish ecological restoration of the river/floodplain ecosystem. Based upon a review of historical U.S. Geological Survey (USGS) data, the overall volume of waters, under similar hydrologic conditions, delivered to Lake Okeechobee from the Upper Basin lakes and Lower Kissimmee basin via the completed project was found to be relatively the same as those volumes experienced under pre-project conditions. However, the timing of those water deliveries has been changed which is reflective of the current water management practices for flood control and water conservation purposes within the basin. At certain times, when required for flood protection in the Upper Basin, water is released to the Lower Basin in sudden pulses. During the post-project regulated period, no releases were made to the Lower Basin about 50 percent of the time.

These changes to historical flow regimes would have impacted biological resources, functions and values in the river and its adjacent floodplain even if the river was never channelized. Whereas historically, large portions of the floodplain were exposed to prolonged hydroperiods, the extended, post-regulation periods of no inflow from the upper basin would have kept most of the floodplain dry during the wet season months. In the SFWMD 1990 Restoration Study, a relationship was developed by linear regression between historical stages at the Fort Kissimmee gage and the discharges from Lake Kissimmee. Based upon this relationship, daily discharges from Lake Kissimmee were translated into hypothetical Lower Basin stage hydrographs and associated floodplain inundation frequencies for the regulated 18-year period of record. Results indicate the entire floodplain would have been dry greater than 70 percent of the time during the wet season, whereas approximately 80 percent of the floodplain was inundated greater than 70 percent of the time during these months prior to flood control regulation (Figure 4-4). Even during particularly wet years pulsed discharges would lead to only short-term floodplain inundation followed by rapid drainage, which generally would preclude utilization of the floodplain by fish, wading birds and waterfowl. The reduced hydrologic connectivity between the river and floodplain also would have largely eliminated nutrient and sediment filtration processes once provided by the floodplain wetlands. The seasonal shift of high flow periods from the summer/fall to late winter/spring months likely would have interfered with fish reproduction and recruitment. The spawning and reproductive habits of Kissimmee River fish species make their eggs and young vulnerable to high flows during spring months.

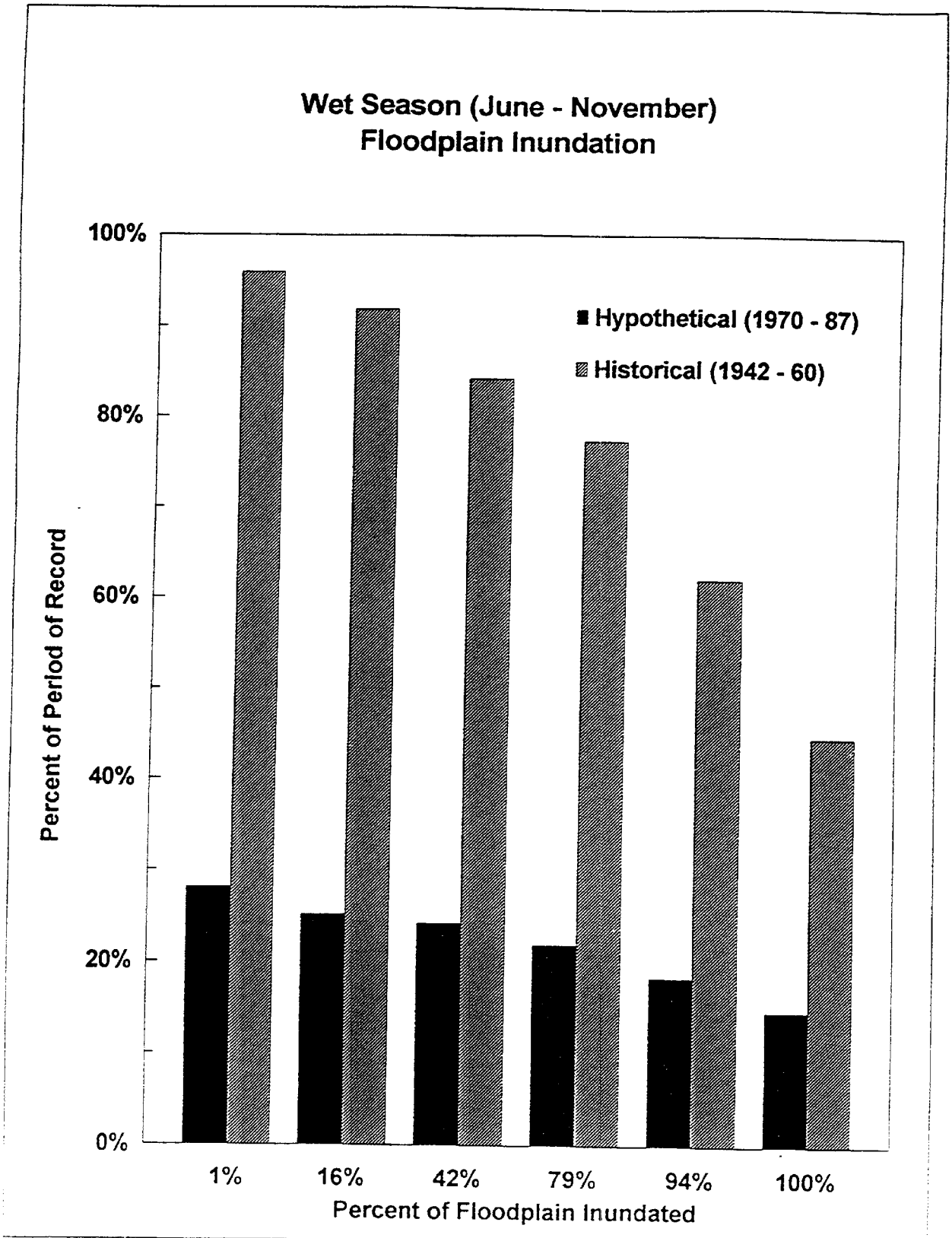

Wet Season (June - November)
Floodplain Inundation
100%
80%
60%
40%
20%
0%
Percent of Period of Record
Hypothetical (1970 - 87)
Historical (1942 - 60)
1%
16%
42%
79%
94%
100%
Percent of Floodplain Inundated

FIGURE 4-4

SECTION 5

FUTURE "WITHOUT PROJECT" CONDITION

This section provides a forecast of future conditions in the Kissimmee Basin, including the Upper and Lower Basin, that are likely to occur if no Federal project is implemented in Upper Kissimmee Basin. 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. In the future, without project condition (without a Headwaters Revitalization Project), the existing Kissimmee River Project for navigation and flood control would remain in place and would continue to be operated and maintained. The existing flood control features within the Upper Basin and existing operating schedules would remain intact.

5.1 KISSIMMEE RIVER PROJECT

If the Headwaters project is not implemented, the hydrologic conditions required for successful restoration of the Lower Basin ecosystem could not be achieved. Specifically, an Upper Basin project is necessary to meet two of the five hydrologic conditions (criteria) that must be reestablished to restore the Lower Basin ecosystem. These conditions are the reestablishment of continuous flow with duration and variability characteristics comparable to prechannelization records, and reestablishment of stage hydrographs that result in floodplain inundation frequencies comparable to prechannelization hydroperiods, including seasonal and long-term variability characteristics. These conditions can only be met, and Lower Basin restoration will only be successful, if an Upper Basin project is implemented. Thus, without Upper Basin modifications, a Lower Basin project would be largely ineffective and its construction would be unjustified. Therefore, the basic without project assumption is that, in the absence of the headwaters project, there will be no Kissimmee River Restoration Project, i.e., the flood control canal, C-38 would remain along with existing water control structures. Likewise, since the primary purpose of the Upper Basin project is restoration of the Lower Basin ecosystem, if for some reason the Lower Basin project is not implemented, the Upper Basin project would not be initiated as a stand alone project.

Management of the water resources within the basin would continue as presently managed, with strict adherence to current lake regulation levels and structure design discharge criteria. Continuation of these water management practices are not expected to improve the basin's ecological resources.

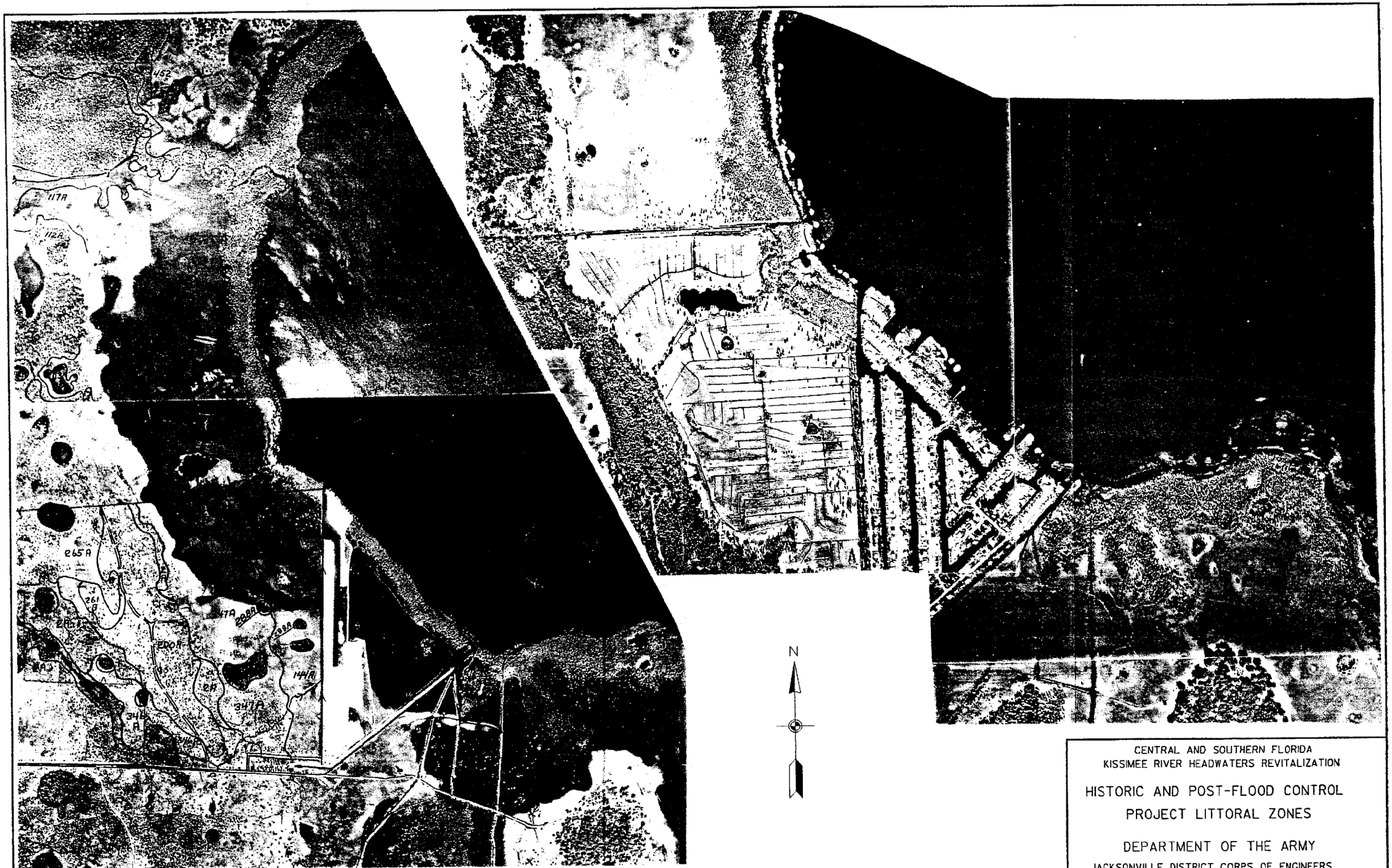
5.2 NATURAL ENVIRONMENT

The condition of the lakes, without the Upper Basin Revitalization Project would remain similar to the present condition. Management measures are taken to limit impacts of flood control regulation on existing natural resources. The effects of reduced range of water level fluctuations are evidenced by nuisance vegetation growth (e.g. tussocks) and accumulation of organic muck in littoral zones. Rapid proliferation of exotic plants are controlled with chemical applications coordinated with lake level manipulations. Extreme lake level drawdowns are conducted periodically to revitalize littoral wetlands by consolidating sediments and providing conditions favorable for germination of wetland plant species. These measures need to be continued to maintain existing fisheries and wildlife values. These values are below those possible in a system with a wider-range of water levels. The areas on private lands, formerly marshes contiguous with lake littoral zones, are drying behind dikes and becoming brushy pastures. These habitats will become increasingly undesirable for fish and wildlife.

Immediate environmental impacts associated with construction of flood control works within the Lower Kissimmee Basin have stabilized, however, long-term effects are expected to continue to degrade the fish and wildlife resources in the basin. Water level stabilization, continued deposition of organic matter within remnant river channels, and continuation of low dissolved oxygen levels in C-38, are likely to further degrade the natural resources in the basin.

Maintenance of stable water levels is expected to lead to continued deterioration of wetland communities and associated fish and wildlife resources within impounded portions of each pool. Stable pool stages will facilitate continued buildup of plant litter and thereby accelerate succession from a wetland to terrestrial environment. Although the rate at which this transition to a non-wetland state is occurring has not been determined, the without project condition will eventually result in a steady elimination of the existing 14,000 acres of wetlands. As the acreage of wetlands declines, there will be a coincident loss of fish and wildlife habitat, including a decrease in the estimated 3,500 wading birds and 140 waterfowl which currently utilize the floodplain. Thus, the without project condition can be expected to exacerbate the long-term decline of wading bird and waterfowl populations in the southeast.

In the absence of flow, the without project condition also will allow for continued deposition of dead plant litter, and as a result, a similar loss of wetland (open water) habitat in remnant river channels. Although these remnant channels are currently in a degraded state, they provide some fish habitat during winter and spring months, when dissolved oxygen levels are



LAKE HATCHINEHA 1958 SHORELINE

LAKE HATCHINEHA 1984 SHORELINE

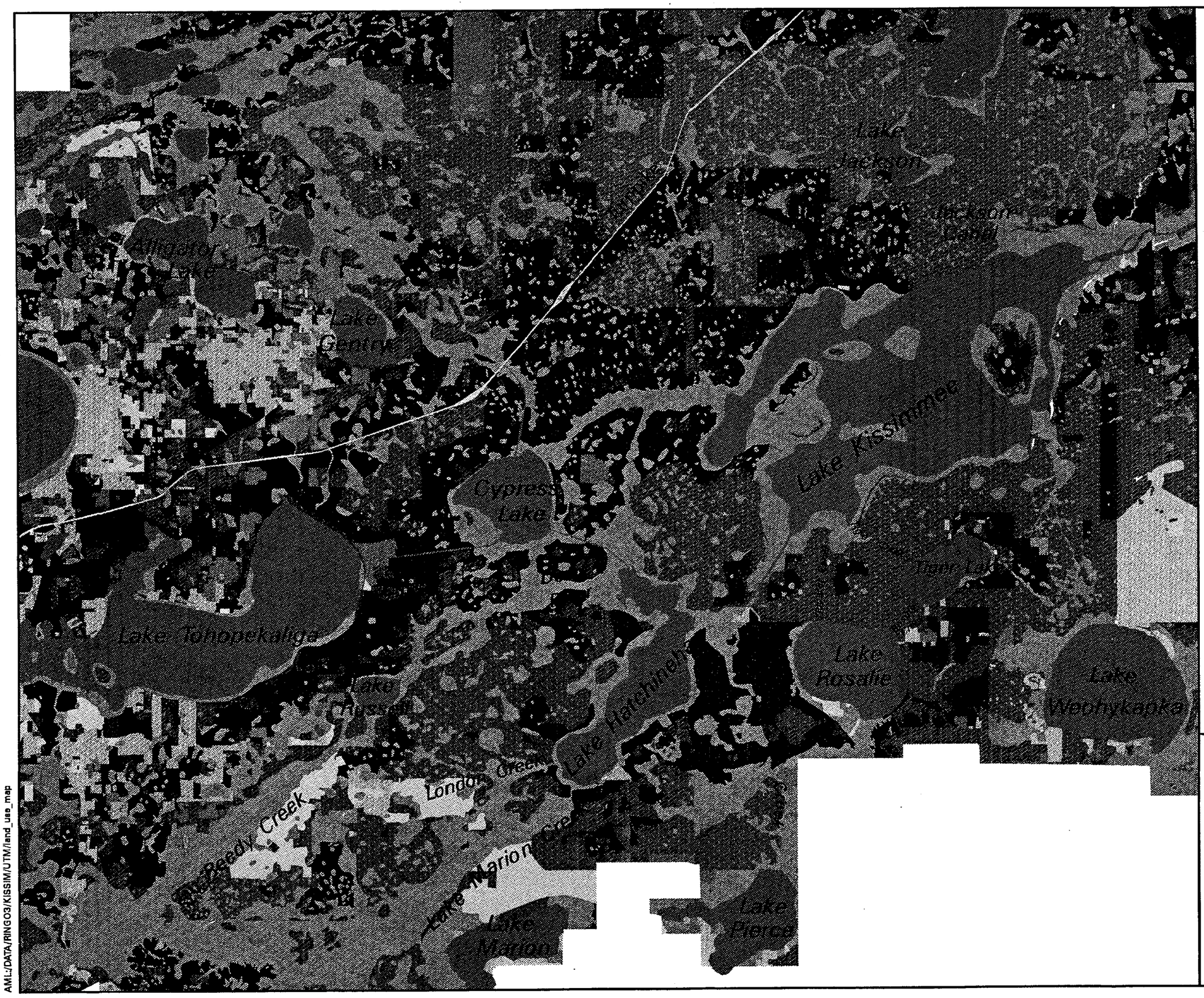
CENTRAL AND SOUTHERN FLORIDA
KISSIMEE RIVER HEADWATERS REVITALIZATION

HISTORIC AND POST-FLOOD CONTROL
PROJECT LITTORAL ZONES

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

SECTION 1135 PROJECT MODIFICATION REPORT

DATED: JULY 1995 D.O. FILE NO. 400-36,826



LEGEND

- CROPLAND AG
- GROVE & NURSERY AG
- PASTURE AG
- BARREN LAND
- FOREST
- WATER
- RANGELAND
- COMMERCIAL URBAN
- INDUSTRIAL URBAN
- OTHER URBAN
- RESIDENTIAL URBAN
- WETLAND
- NO DATA FOR REGION

Summary of land use within the impacted area of the Kissimmee basin. The impacted area consists of lands having an approximate elevation between 52.5 ft and 54.0 ft. or which have been delineated by SFWMD to be included in the inundation area.

Land use	Acres
WETLAND	3677.310
GROVE & NURSERY AG	13.726
PASTURE AG	7578.690
FOREST	636.113
RANGELAND	2328.171
WATER	42.582
RESIDENTIAL URBAN	20.702
COMMERCIAL URBAN	1.806
INDUSTRIAL URBAN	0.605
OTHER URBAN	1.700
TOTAL	14301.405

Source: South Florida Water Management District land use codes 1 and 2 for Polk and Osceola Counties, 1988.

North

Miles
1 0 1 2 3 4 5

CENTRAL AND SOUTHERN FLORIDA PROJECT

KISSIMMEE RIVER

HEADWATERS REVITALIZATION

LAND USE MAP

DEPARTMENT OF THE ARMY

JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

JACKSONVILLE, FLORIDA

DATED, JULY 1995

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suitable. If remnant river channels are allowed to eventually fill with organic deposits, the resultant loss of open water habitat will reduce the fish carrying capacity of the system.

Degradation of remaining natural resources also could result from future developmental encroachment and/or land use modifications in the basin. Further loss of the basin's natural resources could be expected in the without project condition, unless action is taken to prevent intensive development and/or land use changes, such as conversion of more of the floodplain or tributary watersheds to improved pasture.

5.3 CLIMATE

For planning purposes of the environmental restoration, a conservative assumption has been made that there will be a continuation of the dry period through the period of analysis. Hydrological modeling conducted during this study was based on a period of record between 1970 and 1987. A return to "normal" rain patterns would enhance restoration benefits. While this dry cycle from 1970 through 1987 was used for hydroperiod predictions for restoring ecosystem values, the entire period including all of the hurricanes was used for the flood control portion of the analysis.

5.4 POPULATION

Each of the two Counties in the Kissimmee Upper Basin study area, Osceola and Polk, are expected to continue the population growth experienced in recent years. Table 5-1 shows expected growth by county over the period of analysis. The center of regional growth is expected to remain around the Orlando area, just north of the study area in Orange County. Other major growth areas are expected to remain in the Upper Basin chain of lakes, primarily in Orange and Polk Counties.

TABLE 5-1
PROJECTED POPULATION
KISSIMMEE RIVER UPPER BASIN

COUNTY	1995	2000	2005
ORLANDO	1,426,888	1,618994	1,802,504
OSCEOLA	137,595	165,098	191,603
POLK	443,802	478,002	510,202

Source: *Florida Statistical Abstract, 1993, 27th Edition.* Bureau of Economic and Business Research, College of Business Administration, University of Florida and University of Florida Press.

5.5 LAND USE

In the Upper Kissimmee Basin, the expanding economic base of the Orlando area is expected to continue to place increased demands on the area's resources. Cattle ranches and orange groves will continue to give way to suburban subdivisions. Metropolitan development is rapidly moving toward the Cities of Kissimmee and St. Cloud in Osceola County. This urban development is expected to continue in the Upper Basin as the population continues to expand.

5.6 FLOOD DAMAGE REDUCTION

The existing level of flood protection in the Kissimmee Basin would be expected to be maintained under the without project condition. The current project provides flood damage prevention for thirty percent of the standard project event, or approximately between a 5 and 10 year event. Structural components in the Lower Kissimmee River Basin, C-38 and the existing water control structures, would continue to maintain water level control within that basin; prescribed regulation schedules and operation of discharge structures would maintain flood damage reduction in the Upper Basin lakes.

5.7 RECREATION

Large urban populations around Orlando, the Tampa Bay area, and the central coastal cities are all within a one to two hour drive of the Kissimmee River study area. As such, it is expected that the basin will experience increasing demand for recreational opportunities. The current, predominant

recreational use in the study area is recreational boating, and fishing from both boats and adjacent banks of the basin's lakes. Both public and private recreational facilities are available, offering camping, picnicking, fishing, hiking, and boating opportunities. Demand for these types of recreational opportunities are expected to increase with greater population growth in the region.

5.8 WATER QUALITY

Water quality concerns are expected to continue to focus on two areas: (1) the nutrient content of the basin's waters and effects of those nutrients on Lake Okeechobee, and (2) low dissolved oxygen levels in C-38 and remnant channels of the Kissimmee River. Existing low dissolved oxygen levels in C-38 and remaining river remnants are expected to continue in the without project condition. Adverse ecological effects associated with low dissolved oxygen would therefore continue to degrade the basin's natural resources.

5.9 AQUATIC PLANT MANAGEMENT

The ongoing control effort which includes C-38, portions of the old Kissimmee River runs and oxbows, is expected to continue in the same magnitude as at the present time. Current funding levels are insufficient to treat all of the hydrilla present in the subject area and hydrilla can be expected to increase in coverage. The invasive nature of these plants mandates continued control to avoid adverse impacts to navigation, flood control, recreation, wildlife habitat, as well as public health and safety within the Kissimmee Basin.

SECTION 6

NEEDS AND OPPORTUNITIES TOWARDS PLAN DEVELOPMENT

Construction of C-38 and the regulation of the Upper Basin lakes has reduced the flood threat in the Lower and Upper Kissimmee River Basin, enabling more intensive land uses to occur. However, it also led to a number of environmental impacts, such as a loss of fish and wildlife habitat.

This section discusses problems and opportunities relating to the ecological degradation of the Kissimmee Chain of Lakes and the Lower Kissimmee River Basin, through the planning process that resulted in the selection of the recommended plan for the Upper and Lower Basin restoration. Key events in the overall process are shown in Table 6-1.

A more complete discussion of the plan formulation process is included in the 1991 *Integrated Feasibility Report and Environmental Impact Statement*, which is the foundation of this report. This report is incorporated by reference and may be consulted for more detailed descriptions and explanations of the plan formulation process.

6.1 RESTORATION MOVEMENT

While the flood control project had been requested and supported by the State of Florida, there was some opposition to the project even before construction began. Concerns centered on fear of environmental damage that the project, primarily channelization, might cause. Although initially poorly organized, a grassroots movement to restore the Kissimmee River developed during project construction. Early issues in the restoration movement centered around aesthetic impacts and physical alterations caused by C-38 excavation and placement of excavated materials on the adjacent floodplain.

TABLE 6-1

KISSIMMEE RIVER RESTORATION TIMELINE

FEDERAL	STATE OF FLORIDA	SOUTH FLORIDA WATER MANAGEMENT DISTRICT
1948 Central and Southern Florida (C&SF) Project Authorized for Construction		
1954 Kissimmee River Flood Control Project Authorized for Construction		
1961 Construction Started		
1971 Construction Finished	1971 Governor's Conference on Water Management in South Florida Identified Environmental Concerns	
1971 U.S. Geological Survey report identified environmental concerns	1972 First Public Meeting on Environmental Concerns	
	1976 Florida's "Kissimmee River Restoration Act"	
First Corps Feasibility Report	1976 Kissimmee River Coordinating Council (KRCC) Established	
1978 Congressional Study Authority	1981 Florida's "Save Our Rivers" Program Initiated	
	1983 Governor's "Save Our Everglades" Plan Released	
	1983 KRCC Endorsed Canal Backfilling	
	1983 Governor's Executive Order- Kissimmee River - Lake Okeechobee Everglades Coordinating Council (KOECC) Established	SFWMD Restoration Study
1985 Final District Report Objectives: Wetlands and River Restoration Water Quality Improvement Alternatives: Partial Backfill Combined Wetlands Demonstration Project Pool Stage Manipulation Paradise Run Best Management Practices Recommendations: No Federal Action Congressional Authority of 1135	1985 Governor's "Kissimmee River Restoration Strategy" Released	1984 - 1989 Demonstration Project Construction and Monitoring 1986 - 1989 Model Study 1988 Kissimmee Restoration Symposium
	1990 Governor Endorsed Level II Backfilling	1990 Restoration Report
Current Corps Feasibility Study 1990 WRDA 90 Study Authority 1991 Feasibility Report and EIS Objectives: Determine Federal Participation in Level II Backfilling Alternatives: Weirs Plugging Level I Backfilling Level II Backfilling Modified Level II Backfilling Recommendation: Modified Level II Backfilling Headwaters Revitalization		Objective: Ecosystem Restoration Alternatives: Weirs Plugging Level I Backfilling Level II Backfilling Recommendation: Level II Backfilling
1992 WRDA Kissimmee River Project Authorization of Kissimmee River Restoration Authorization of Headwaters Revitalization 1994 Test Fill Construction Kissimmee River		

The interests that were to provide the drive and foundation for both progress and controversies over the Kissimmee River evolved through the early 1970's. Support for river restoration came from numerous individuals and groups, including national environmental advocate groups, which desired return of the river's ecological and aesthetic values, and saw refilling of C-38 as the means to achieve that return. Opposition to river restoration came primarily from agricultural interests, including dairy and beef cattle ranchers and farmers. Concern also was expressed by developers, homeowners and other property owners, and boaters. These groups were concerned that restoration would create an unfair hardship on them. Residents of the Upper Basin were concerned that modifications to C-38 might threaten their level of flood control. Land owners and other users along C-38 were concerned about the loss of their uses of the floodplain due to re-flooding from restoration. Boaters were concerned about the loss of the enlarged waterway.

The first steps toward restoration of the Kissimmee River occurred in 1971. The U.S. Geological Survey released a report that concluded that Lake Okeechobee was experiencing accelerated eutrophication as a result of high nutrient loading. In September 1971, one hundred and fifty experts from the fields of science, government, agriculture, and conservation participated in the Governor's Conference on Water Management in south Florida. While the conference focused on water quality problems, it requested that, *"action should be taken to restore fish resources and wildlife habitats,"* in the Kissimmee Valley.

In 1972, the Central and Southern Florida Flood Control District (now the SFWMD), conducted the first public hearing concerning possible environmental damage resulting from Kissimmee River channelization. Major public concerns were water quality and potential increased rates of eutrophication of Lake Okeechobee, and the loss of environmental values within the lower Kissimmee River Basin, specifically wetlands reduction. The Flood Control District's resulting recommendations included, among others, creation of an interdisciplinary team to help determine if additional restoration was necessary.

Throughout the mid-1970's, many debates occurred over the environmental effects of the Kissimmee River project, and what could and should be done about them. As discussed above, the earliest impetus to restore the river focused on possible effects on water quality entering Lake Okeechobee. It was believed that C-38 had acted as a conduit, speeding pollution from the urbanizing Upper Basin into Lake Okeechobee.

In 1976, after several years of public debate, the Florida Legislature passed the *"Kissimmee River Restoration Act"*. The Act created the Coordinating Council on the Restoration of the Kissimmee River and Taylor Creek-Nubbin Slough Basin (known as the Kissimmee River Coordinating Council, or KRCC).

The KRCC was charged with broad responsibilities to solve many of the region's water resources problems, including development of measures *"to minimize and ultimately remove threats to the agricultural industry, the wildlife, and the people of central and southern Florida posed by land use and water management practices"*. The KRCC was specifically directed to:

* Restore the natural seasonal water level fluctuations in the lakes of the Kissimmee River and in its natural floodplains and marshlands.

* Recreate conditions favorable to increases in production of wetland vegetation, native aquatic life, and wetland wildlife.

* Utilize the natural and free energies of the river system to the greatest extent possible.

Between 1976 and 1983, the State of Florida, through the KRCC, funded a variety of studies designed to evaluate different Kissimmee River restoration approaches. These studies improved understanding of hydrologic, biological, and water quality issues in the basin. As a result, many early hypotheses about basin conditions were validated or discarded. Especially important were clarifications of water quality issues (most Lake Okeechobee water quality problems were not originating in the Upper Basin), and establishment of restoration of lost environmental values through habitat restoration as a primary goal.

As early as April 1977, the KRCC's First Annual Report to the Florida Legislature recommended several specific projects to analyze the most effective way to deal with basin water quality problems, and presented two restoration alternatives, one calling for partial backfilling of C-38, and the other calling for creation of wetlands along the canal.

6.2 KISSIMMEE RIVER RESTORATION PLANNING STUDIES

In response to the growing concern about the effects of the Kissimmee River Flood Control Project, three major planning studies were undertaken by the Corps or the SFWMD since 1978. The studies, each with a different purpose, represented milestones in the development of the final restoration and headwaters projects. Each study, in addition to building on the previous study, also responded to new concerns and moved forward with an improved understanding of the values and complexities of environmental resources.

6.2.1 First Federal Feasibility Study (1978-1985)

The primary objectives of this study were to restore the values of specific components of the Kissimmee River and its wetlands, and to improve water quality within the river basin. More specifically, the study goals included restoration of wetland vegetation and improvement of water quality, particularly concerning nutrient levels. A wide range of plans were developed for evaluation, and these plans became the basis for current and future evaluations. Although several plans were formulated for these objectives, the study did not recommend Federal participation in solutions to these concerns because of the policies in effect at that time.

6.2.2 SFWMD Restoration Study (1984-1990)

As a result of the KRCC recommendations, the SFWMD designed and constructed a demonstration project intended to determine the feasibility of dechannelization. During the course of the demonstration project a goal of restoring the ecological integrity of the Kissimmee River was adopted. Whereas the previous Corps feasibility study had focused on component parts of the environment, primarily wetlands and water quality and how to improve each part individually, the SFWMD focused on restoration of the ecosystem as a whole by incorporating the component parts of the natural system and the interactions among them. This ecosystem approach included consideration of wetlands and water quality, as well as all of the many other elements that comprise the natural environment. However, the ecosystem approach recognized that numerous individual components collectively comprise the ecosystem and operate synergistically, making it difficult to define the relative importance of individual parts, as well as to define and address the requirements of each individual part. Furthermore, while requirements of many components are compatible, others would be in conflict, and meeting the needs of one could impact another. Therefore, the ecosystem approach looked at ways to holistically recreate more natural physical and hydrologic characteristics that would support and provide suitable conditions for the Kissimmee River plant and animal communities to again flourish.

Based on these ecological guidelines and the determinants of ecological integrity, the study concluded that the primary restoration objective was to reestablish pre-channelization hydrologic characteristics in as much of the river and floodplain ecosystem as possible, including 35 miles of river channel and 7,000 acres of floodplain that were directly impacted by construction of C-38.

This objective was further defined through five criteria that collectively measure hydrologic conditions that must be recreated in order to restore the rivers pre-channelization ecological integrity. Evaluations of performance

relative to these criteria could be used to compare alternative restoration plans. The following hydrologic criteria need to be recreated to restore the ecological integrity of the Kissimmee River:

* continuous flow with duration and variability characteristics comparable to pre-channelization conditions;

* average flow velocities between 0.8 and 1.8 feet per second when flows are contained within the river banks;

* a stage-discharge relationship that results in overbank flow along most of the floodplain when discharges exceed 1,400 to 2,000 cubic feet per second;

* stage recession rates on the floodplain that typically do not exceed 1 foot per month;

* stage hydrographs that result in floodplain inundation frequencies comparable to pre-channelization hydroperiods, including seasonal and long-term variability.

By providing proper land and water conditions, the entire spectrum of the living environment will return naturally and maintain itself as it had done before C-38 was constructed. This assumption was verified by results of the demonstration project from 1984 through 1989. In order to achieve the proper water conditions, a new component of the restoration project was developed as part of the SFWMD restoration study. This Upper Basin component, entitled "Headwaters Revitalization", is a mechanism to achieve two of the five hydrologic criteria as described above; the criteria are the reestablishment of stage hydrographs and the reestablishment of continuous flows that are comparable to pre-channelization hydroperiods.

In an effort to provide conditions necessary to restore more natural flows in the Kissimmee River, the SFWMD developed a proposal to modify seasonal water storage operations in the Upper Basin (Figure 6-1). Appendix E provides documentation describing the early development of the preliminary Lake Kissimmee Regulation Schedule modification which was presented in the 1991 Federal feasibility study. The regulation schedule, which was developed by the SFWMD, was used as the base for the development of the recommended plan presented herein. This component was a critical part of the alternative evaluation process, as it was evident that the restoration of the Lower Basin hinged upon the successful implementation of the Upper Basin project.

Following additional extensive analyses, the SFWMD concluded that backfilling a long continuous reach of C-38 (Level II Backfilling Plan) was the best approach to restore the integrity of the Kissimmee River ecosystem.

6.2.3 Second Federal Feasibility Study (1990-1992)

The Congressional authority for the Corps' second feasibility study of the Kissimmee River directed that the study be based on implementing the SFWMD's Level II Backfilling Plan. Therefore, there was no need to develop new planning objectives or alternative plans.

While the SFWMD followed the common planning process in conducting its restoration study, its work addressed that agency's decision making needs and was not intended to address the full range of Federal requirements that are normally imposed on Corps water resource planning. Therefore, the second Corps feasibility study required several additional analyses to establish the extent of Federal participation in the Level II Backfilling Plan. The report also recognized that the implementation of the Headwaters Revitalization Project was critical to achieving the recommended plan's fish and wildlife restoration outputs as described in the report.

The recommended plan proposed in the Feasibility Study, referred to as the Modified Level II Backfilling plan, consisted of backfilling about 29 miles of C-38; excavating about 11.6 miles of new river channel; constructing a bypass weir and channel at S-65; shallowing and construction of weirs in the Lake Kissimmee outlet channel reach; modifications of the Pool B weirs, and S-65A and S-65E structures; construction of containment levees, bridge crossings at U.S. Highway 98 and the CSX Transportation Railroad, and new structures in Pool E; removing the existing S-65B, S-65C and S-65D structures, and local levees; and installation of navigation channel markers. About 67,843 acres of land was estimated to be acquired in fee or easement to meet restoration needs and preserve flood control in the Lower Basin. The shallowing and weir construction and modification of Pool B weirs and backfilling south of S-65D were designated as locally preferred options with no Federal participation. The study did not demonstrate sufficient Federal justification for these options. The estimated cost of the Recommended Plan was $426,885,000. Based on a 50-50 cost sharing of the total costs, less the cost of the locally preferred options, the Federal share was $139,943,000.

6.2.4 Anticipated Environmental Outputs

Based upon the preliminary recommendations for the modifications of the regulation schedule for the lakes, the expected environmental outputs of the Kissimmee River Project, the Modified Level II Backfilling plan recommended in the feasibility report, are provided below in Table 6-2. As stated before, these outputs are dependent on the successful implementation the Headwaters Revitalization component of the project. The environmental conditions within the Lower Basin waterway for the Historic or Pre-channelization river and the existing channel are provided for comparison.

TABLE 6-2
ENVIRONMENTAL OUTPUTS OF KISSIMMEE RIVER RESTORATION

Environmental Outputs	River/Flood plain ecosystem (acres)	Wetlands (acres)	HEP habitat units	Instantaneous fish biomass (pounds)	Winter water (acres)	Ducks (winter population)	Wading birds (population; excluding
Pre-channelization Conditions	48,800	35,000	339,800	81,000	-----	12,500	18,000
Existing Conditions	0	14,000	123,443	3,000	27,000	140	3,500
Modified Level II Backfilling (Recommended Plan)	48,800	29,000	285,342	46,000	327,000	12,500	16,000

6.2.5 Authorized Kissimmee River Project (1992)

The 1992 Water Resources Development Act authorized the construction of the Headwaters Revitalization Project and the Kissimmee River Restoration Project (Modified Level II Backfilling Plan). Three portions of the project, if desired by the sponsor, are to be accomplished without Federal participation. Those portions, referred to as locally preferred options are: shallowing in Pool A; modification of existing weirs in Pool B; and backfilling south of S-65D. The Federal project encompasses the following components:

* Headwaters Revitalization component as detailed herein.
* Backfilling of 29 continuous miles of canal.
* Removing structures S-65B, S-65C and S-65D.
* Recreating 18 new river channels totaling approximately 11.6 miles.
* Construction of Lake Istokpoga containment levee.
* Modification of structure S-65 and S-65A.
* Grade control structure upstream of S-65E.
* Partial degradation of local farm levees and ditches within the floodplain.

6.3 BACKGROUND OF DEVELOPMENT FOR KISSIMMEE RIVER HEADWATERS REVITALIZATION COMPONENT

6.3.1 Background

Use of regulation schedule and operation rule modifications such as those proposed in the 1991 feasibility study for achieving the integrated environmental objectives for the upper and lower Kissimmee basins (see study goal) is based upon the established premise that the basin's environmental restoration objectives will be met by reestablishing key hydrologic characteristics. Hydrologic restoration criteria for the lower basin require reestablishment of continuous inflows from the upper basin, particularly during July-October, natural seasonality of high and low inflow regimes, and a wide range of stochastic, discharge variability.

The primary criterion for achieving environmental improvements in the upper basin is to increase the maximum extent and frequency of high lake stages. The basic strategy is to modify the regulation schedule and operation rules to allow lake stages to fluctuate more naturally with rainfall and associated inflows from the upper basin watershed, and to reestablish outflow regimes that reflect historic (pre-regulation) stage-discharge relationships for the headwater lakes. Figure 3-1 provides the pre-regulation and regulated lake stage frequency relationship. The flood control lake schedule has eliminated the range of peak lake stages by 2 to 3 feet. More natural rainfall-driven fluctuations would lead to higher lake stages, increasing water storage and, thereby, accommodating maintenance of continuous inflows from the Upper to Lower Basin.

6.3.2 SFWMD Development

In an effort to provide conditions necessary to restore more natural flows in the Kissimmee River, the SFWMD developed a proposal to modify seasonal water storage operations in the Upper Basin (Figure 6-1). Appendix E provides documentation describing the early development of the preliminary Lake Kissimmee Regulation Schedule modification which was presented in the 1991 Federal feasibility study. The regulation schedule, which was developed by the SFWMD, was used as the base for the development of the recommended plan presented herein.

1991 REGULATION SCHEDULE

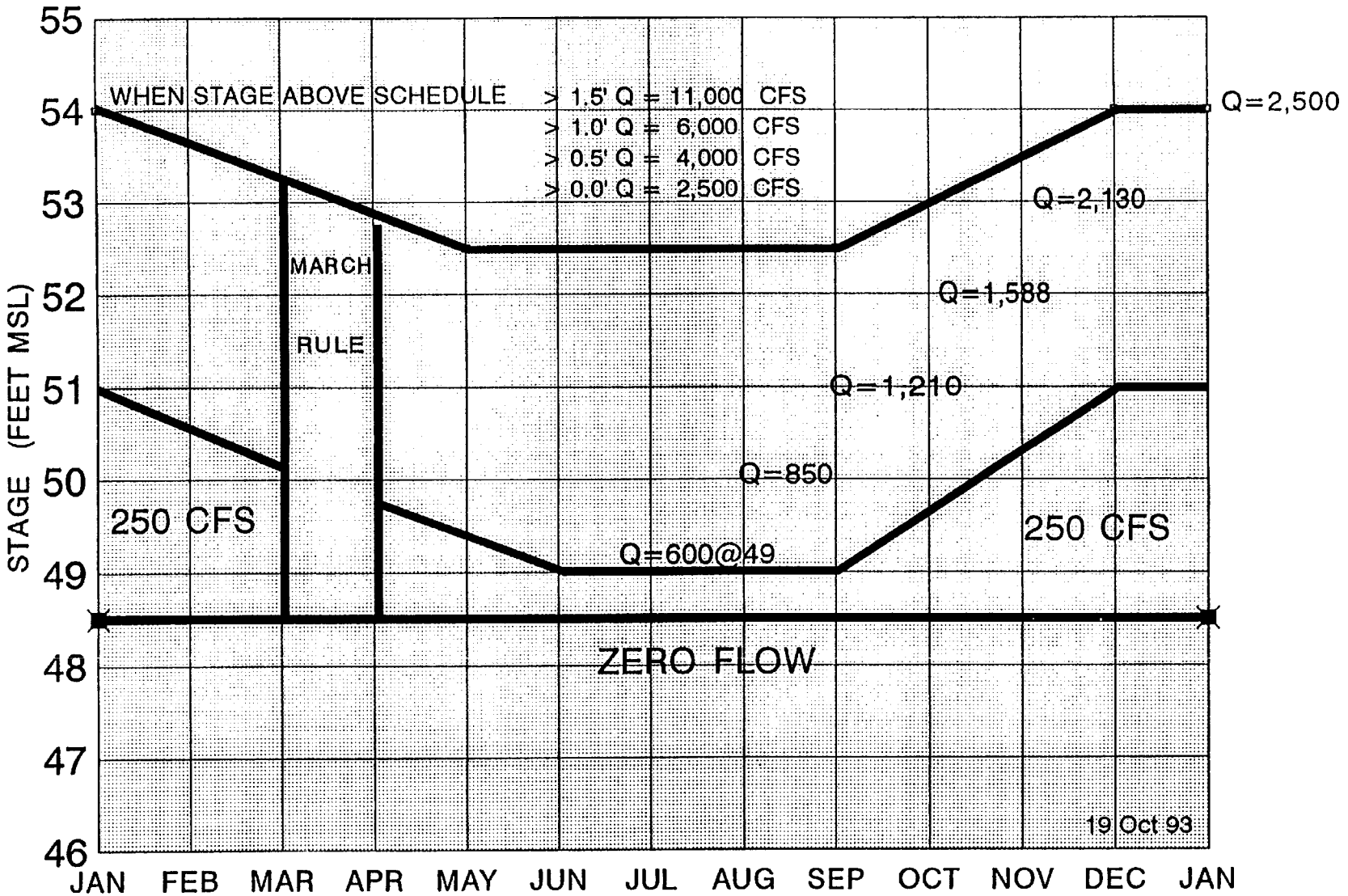


Figure 6-1

6.3.3 Development of Lake Regulation Schedule

The design of the proposed regulation schedule was based on 3 criteria: (1) to eliminate the on again/off again or pulsing effect of the existing regulation schedule, (2) to provide more natural seasonal distributions of water releases, and (3) to increase the frequency and extent of high water fluctuations. Under natural conditions, the lake surface had a range of fluctuation of approximately 6 feet 75 percent or more of the time. The current regulation schedule is regulated over a 4 foot range. The on again/off again pulsing affect was to be corrected by zoned discharges.

In order to provide more natural flow conditions, the seasonal water storage had to be increased. Based on a sensitivity study that was conducted by the SFWMD team, approximately 100,000 acre-feet of additional water storage was required to provide for longer durations and seasonal variability of flow to the lower river basin. The top water surface elevation of 54 feet was developed by determining the increase in elevation, starting from the top of the existing lake regulation schedule or 52.5 feet which would provide the storage requirements of approximately 100,000 acre-feet. (See Plate 6-1, Storage - Elevation and Area - Elevation Relations, C&SF, Part II, Kissimmee River Basin and Related Areas, Suppl. 5, GDM, dated Oct 8, 1956). The total storage for lakes Kissimmee, Hatchineha and Cypress at 52.5 feet is 440,000 acre-feet. The storage available at 54 feet is 545,000 acre-feet. The difference is approximately 100,000 acre-feet. The upper limit of water levels or increased storage capability was also controlled by flood protection constraints. The stage corresponding to 30 percent of the Standard Project Flood (design flood elevation) under natural conditions at Lake Kissimmee was 54 feet.

The top of the proposed schedule was lowered to 52.5 feet during the wet season to allow for additional flood control storage. The scheduled drop during the wet season also corresponds to the top of the existing regulation schedule or 52.5 feet. If the top of the schedule was lowered below 52.5 feet, say to 52 feet, changes in the desired stage durations in the Upper and Lower Basin would occur. The idea was to allow for more availability of water throughout the year for the lower river restoration project. If the top of the lake schedule was lowered below 52.5 feet, we might over discharge to the river too early, especially during a normal to dry wet season. Additionally, stages in the Upper Basin lakes would be driven lower for a longer period of time.

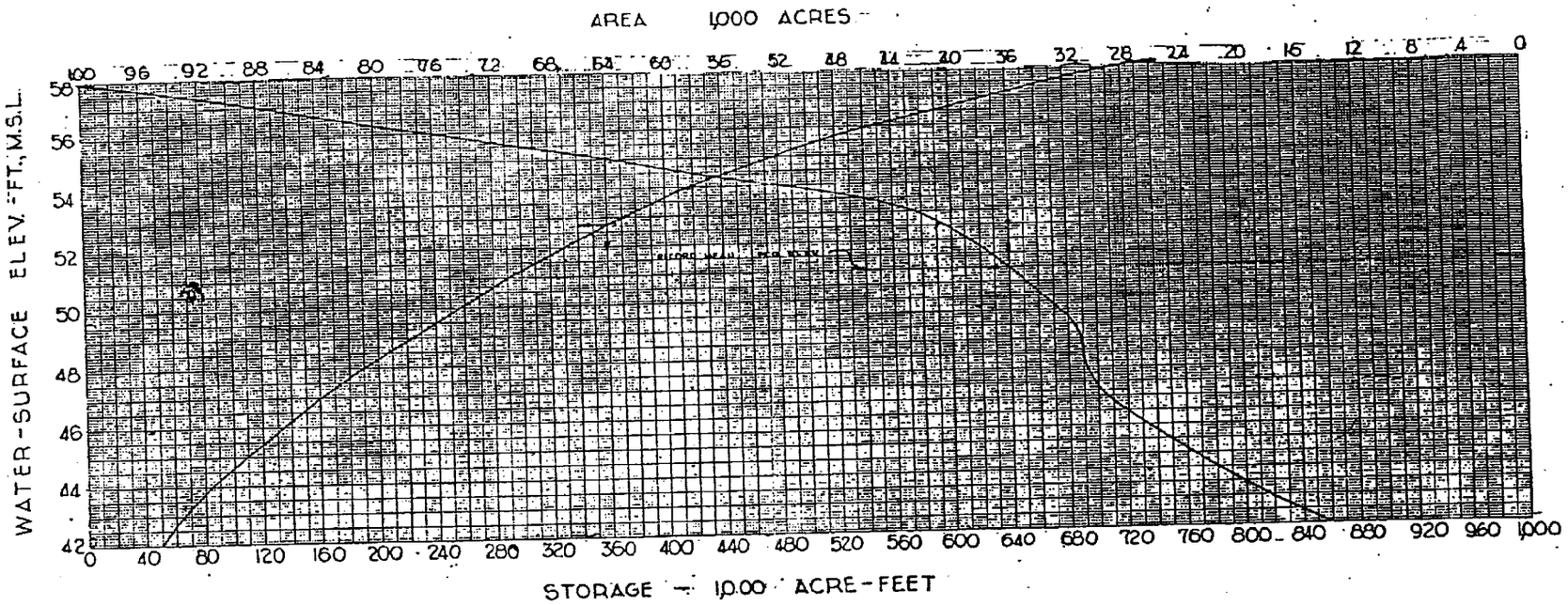


FIG. 1 LAKE KISSIMMEE

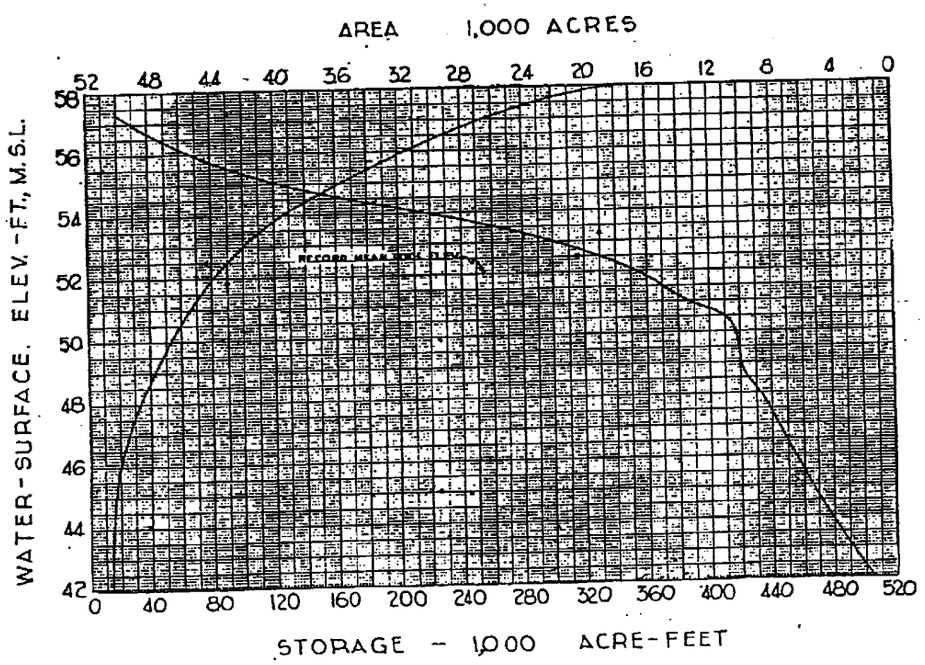


FIG. 2 LAKES CYPRESS & HATCHINEHA

CENTRAL AND SOUTHERN FLORIDA
MIDDLE KISSIMMEE RIVER BASIN
STORAGE-ELEVATION AND
AREA-ELEVATION RELATIONS
SCALES AS SHOWN
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
TO ACCOMPANY GENERAL DESIGN MEMO.,
PART II, SUPP. 5 DATED OCT. 8, 1956
FILE NO. 4-00-24,153

SECTION 7

DEVELOPMENT OF PROJECT MODIFICATION

7.1 PLANNING PROCESS

7.1.1 Federal Objective

The Water Resources Development Act (WRDA) of 1992 authorizes the Assistant Secretary of the Army to construct the Headwaters Revitalization Project in accordance with a report prepared under Section 1135 based on the benefits derived for the environmental restoration of the Kissimmee River. The Headwaters Revitalization Project is unique in that a larger project, the Kissimmee River Restoration Project, relies upon the successful implementation of the Headwaters element.

Historically, 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. In accordance with Section 1135 guidance and the 1992 authorization, the objective of the project modification is to improve the quality of the environment by the restoration or improvement of degraded habitats to their natural integrity, productivity, stability, and biological diversity. Furthermore, based on Section 907 of the 1986 WRDA, environmental benefits attributable to projects with the purpose of improving the Nation's environment were deemed to be at least equal to the costs of providing such projects. Because of the environmental nature of this project, an analyses in support of an NED Plan was not conducted for this study. An environmental restoration plan is presented which maintains the flood damage prevention for the study area.

7.1.2 Federal Policy

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.

The plan that reasonably maximizes our project environmental goals, consistent with the Federal objective, is the goal of the Federal plan formulation and analysis process. In addition, the most cost effective way of constructing the authorized project is determined. Only modifications that could potentially optimize the cost and benefits of the authorized project were considered. Federal planning concerns other than environmental enhancement include environmental protection, human safety, social well being, and cultural and historic resources. Modifications to the authorized project were formulated in consideration of these four criteria:

(1) Completeness. The extent to which a given modification of the authorized project provides and accounts for all necessary investments or other actions to ensure the realization of environmental benefits.

(2) Effectiveness. The extent to which a given modification of the authorized project contributes to a solution to the degradation of the environment and achieves protection from flood induced storm damages.

(3) Efficiency. The extent to which a given modification of the authorized project is the most cost effective means of protecting the Nation's environment.

(4) Acceptability. The viability of a given modification to the authorized project and its acceptance by the non-federal project sponsor, state entities, and the public, and compatibility with existing laws, regulations, and public policies.

The Corps' policy usually requires an incremental cost analysis to be performed for all plans recommending Federal participation in a water resources development project for fish and wildlife restoration projects. The purpose of such analyses is to assure that all features of the Recommended Plan are justified based on both monetary (dollars) and non-monetary (environmental quality) factors. Incremental analysis requires that fish and wildlife resources be inventoried and grouped into resource categories as meaningful indicators of their relative significance from a national, regional and local perspective. Planning objectives are developed to reflect specific problems and opportunities to be addressed during the study.

Planning objectives of the Headwaters Revitalization study were developed based upon the 1991 feasibility study and by the 1992 project authorization. The authorization noted that the Upper Basin project was justified based on the Lower Basin benefits. Thus the primary purpose of the Upper Basin project is to provide the necessary discharges to obtain the environmental benefits for the Kissimmee River Restoration project. Modification of the existing Lake Kissimmee regulation schedule is the only alternative which achieves this objective.

In this instance, the objective of the study is to determine the most cost effective, justified means to restore degraded ecological conditions (expressed in fish and wildlife habitat quality) of the Kissimmee River. While a quantitative environmental incremental analysis cannot be performed for this project due to the lack of separable environmental project features, a modified qualitative analysis is provided which describes potential for increases in environmental performance for various lake regulation schedules. Likewise, the plan formulation process will be provided to clarify the process for developing the measures for maintaining the required levels of flood protection in the Upper Kissimmee Basin.

7.1.3 Environmental Compliance

The Final Environmental Impact Statement (FEIS) for the Kissimmee River, Florida Environmental Restoration project was completed in December 1991 (USAED, Jacksonville). The Supplement to the Final EIS is integrated into this project modification report and will be coordinated with the appropriate local, State, and Federal agencies in the fall of 1995. The results of this coordination will be contained in the Final Supplement to the FEIS integrated within this report. This document describes the environmental impacts of the authorized project modifications and summarizes compliance with the Federal statutes and regulations.

The Corps considers and seeks to balance the environmental and development needs of the Nation in full compliance with NEPA and other authorities provided by Congress and the Executive Branch. Alternative means of meeting competing demands generated by human water resource needs are examined and their environmental values examined fully, along with the economic, engineering, and social factors. Significant environmental resources and values that would likely be impacted, favorable as well as adversely, by alternatives being considered are identified early in the planning process. All plans are formulated to avoid, to the fullest extent practicable, any adverse impact on significant resources.

7.2 PLAN FORMULATION

7.2.1 Kissimmee River Restoration

Feasibility studies for the authorized Kissimmee River Project were completed in 1991 (USAED, Jacksonville). An assortment of alternatives were examined as possible solutions for the restoration of the degraded Kissimmee River ecosystem (see Section 6, Needs and Opportunities). Detailed analyses of these plans were developed based on an assortment of evaluation accounts,

including social, environmental, and economic impacts. As a result of this and earlier studies, mainly the SFWMD 1990 Kissimmee River Report, the Modified Level II Backfill Plan met the Federal objectives of river restoration in the most economically efficient and environmentally acceptable manner.

The Headwaters project is an authorized component of the larger Kissimmee River Project. Specific project outputs of the Headwaters component were tied directly to the outputs of the Kissimmee River Restoration Project as detailed in the 1991 Federal feasibility study. As such, plan development for the Headwaters study, presented herein, was centered around the development of a modified Lake Kissimmee regulation schedule and operational criteria which would first achieve the environmental benefits associated with the restoration of the lower Kissimmee River and as documented in the 1991 feasibility report. The plan that achieves Lower Basin outputs can then be modified to improve environmental conditions within the Upper Basin.

The Headwaters Revitalization Project was formulated to produce hydrologic characteristics that are critical to successful ecosystem restoration. in the Lower Basin. Hydrological, hydraulic, and ecological analyses of alternative Lower Basin restoration plans by the SFWMD (1990) produced evidence that the combination of backfill in the Lower Basin and Headwaters Revitalization would reestablish continuous flow and stage characteristics that are needed to achieve river restoration objectives. Maintenance of continuous flows would produce the physical aeration and mixing that is needed to restore favorable dissolved oxygen regimes in the restored river channel. Reestablished discharge characteristics from Lake Kissimmee also would improve habitat diversity in the 56 miles of restored river channel, and provide water that is necessary to restore about 50 square miles of river floodplain wetlands and associated fish and wildlife values.

If a Headwaters project is not implemented, the hydrologic conditions required for successful restoration of the Lower Basin ecosystem could not be achieved. Thus, without Upper Basin modifications, a Lower Basin project would be largely ineffective and its construction would be unjustified. Therefore, modification of the Lake Kissimmee regulation schedule was presented as a necessary component of river restoration.

7.2.2 Project Goal

WRDA 1992 authorizes the Secretary of the Army to construct the Headwaters Revitalization project and other project modifications based on the benefits derived for the environmental restoration of the Kissimmee River

basin. Based on WRDA 1992, the Headwaters Revitalization is justified on the merits of the Lower Basin project. Therefore, the objective of the Headwaters Revitalization Project must first recognize the primary goal of Kissimmee River restoration.

To be consistent with guidance concerning Section 1135, the emphasis of the proposed modifications in the Upper Kissimmee Basin should be to restore or otherwise improve degraded habitats to their natural integrity, productivity, stability, and biological diversity. Therefore, based on Section 1135 guidance and WRDA 1992, the District established a goal for the Headwaters Revitalization Project. The primary project goal was to reestablish discharges to the Lower Basin that are necessary to restore the ecological integrity of the Kissimmee River while optimizing environmental improvements to the Kissimmee Upper Basin.

7.2.3 Development of Planning Objectives

A plan formulation objective was established for the Headwaters Revitalization study during the Kissimmee feasibility phase and subsequent review conferences. In January 1993, representatives from the Corps, including the Jacksonville District, South Atlantic Division, and Chief of Engineer's office met with the SFWMD in a special Review Conference to discuss policy and procedural issues regarding the study. The following planning objectives were established to address the requirements of the Upper Basin project and to serve as guidelines for the formulation and evaluation of alternative plans:

(a) provide necessary storage and regulation schedule modifications to approximate historical flow characteristics to achieve or exceed the benefits intended for Kissimmee River restoration;

(b) increase the quantity and quality of the wetland habitat in the Upper basin lake littoral zones to benefit fish and wildlife; and

(c) provide increased potential for recovery of several endangered and threatened species, while not jeopardizing any listed species.

7.2.4 Environmental Planning Objectives

Water levels in Lakes Kissimmee, Cypress, and Hatchineha have been maintained within a narrow range of fluctuations relative to the natural conditions. Because of existing structural limitations and limited real estate interests, it is not possible to allow water levels to exceed the top of the

regulation schedule (elevation 52.5 feet, NGVD) without flood control releases from the lakes. This resulted in substantial loss of good quality peripheral marsh habitat around the lakes.

The regulation schedule for Lakes Kissimmee, Cypress, and Hatchineha requires that water levels be drawn down in advance of the wet (hurricane) season and that water levels be allowed to rise prior to the dry season. Consequently, discharges to the lower basin are generally limited during the wet season and extended periods of no flow are common as water is being stored in the upper lakes. Discharges increase during the dry season as water levels in the lakes are being drawn down. Also, when water levels rise above the regulation schedule (dry season or wet season), flood control discharges are required. Following flood releases, it is common for discharges to decline rapidly. The existing project has caused substantial alteration of the seasonal flow patterns, increased the frequency of low or no flow conditions, and has created the existence of harmful pulse like discharges.

The proposed project would result in hydrologic alterations that would provide environmental benefits in both the Upper and Lower basins. The recommended plan would increase the range of water level fluctuations in the Upper Basin. As a result, there would be an increase in the size and quality of the peripheral marshes for the benefit of fish and wildlife. Environmental benefits in the Lower Basin would result by reestablishment of more natural timing of discharges from the Upper basin. The U.S. Fish and Wildlife Service has determined that Headwaters Revitalization will benefit the endangered bald eagle, snail kite, and wood stork. The increased storage capacity and expanded littoral zone would result in expanded riparian and wetland feeding habitat and increased food supply for the eagle, kite and wood stork.

7.2.5 Plan Coordination

In the interest of interagency coordination for planning studies and trying to avoid issues arising very late in the planning process, the appropriate Federal and state agencies were invited to participate in the planning and review process for the development of the recommended plan detailed herein. Jacksonville District, SFWMD, USFWS, and Florida Game and Freshwater Fish Commission (FGFWFC) personnel met periodically to develop and review the alternative Lake Kissimmee regulation schedules. On January 24, 1995, an in-progress review conference was held in the Jacksonville District with the SFWMD, USFWS, FGFWFC, and Jacksonville District personnel in attendance. The meeting was held to discuss the final selection of alternative regulation schedules and to resolve project related issues.

On September 20, 1994, a Planning Conference was held in the Jacksonville District to present details of the project recommendations to the South Atlantic Division office. The purpose of the conference was plan coordination and to provide a forum for resolution of any project conflicts with District higher authority. Based on the results of the conference, there were no conflicts with the Jacksonville District's approach to plan development.

7.3 PLANNING SCOPE AND CONSTRAINTS

The study area for the Headwaters project was confined within the hydrologic limits of Lake Kissimmee, Lake Hatchineha, Lake Cypress and Lake Tiger. The remaining Upper Basin lakes bordering these lakes are separated from the Kissimmee chain-of-lakes by water control structures. Originally, Lake Jackson was included within the study area, but the recent completion of the Lake Jackson control structure by the Florida Game and Freshwater Fish Commission between Lake Jackson and Lake Kissimmee allows regulation of Lake Jackson apart from Lake Kissimmee. Therefore, Lake Jackson was removed from the study area.

Based on the 1992 authorization, there are certain limitations which must be considered in evaluating any plan for possible implementation. The January 1993 project review conference, (see Section 7.2.3), provided additional guidance on developing project constraints and helped to define the limits of the study planning evaluations. The following planning constraints were established to serve as guidelines for formulating and evaluating alternative plans.

(a) maintain the existing level of flood protection in the Headwater Lakes;

(b) avoid any adverse impact to existing flood protection upstream of C-34 and C-35 (Lake Gentry and Lake Tohopekaliga, respectively);

(c) insure continuous flow in the Kissimmee River with duration and variability characteristics comparable to pre-channelization records; and

(d) reestablish water schedules that result in floodplain inundation frequencies and recession rates comparable to pre-channelization hydroperiods.

(e) avoid impacts to existing Federal navigation project

One exception to normal evaluation requirements, was that traditional economic benefit-cost analysis would not be required for this environmental restoration project in accordance to the authorized project purposes. While an

economic benefit cost analysis was not conducted for this project, economic and social impacts as a result of increased water levels were documented (see Appendix G). Instead of the traditional economic benefit-cost analysis, a combination of methods for measuring environmental improvements were used in determining the impacts of the final array of alternatives. This evaluation included comparison of historical flows, prediction of wetlands, and a prediction of habitat units by HSI models.

7.4 DEVELOPMENT OF PROJECT MODIFICATION

7.4.1 Establishment of the Recommended Project Modification

Detailed analyses were conducted on proposed modifications to the existing flood control project. Additive alternative measures which did not fully address the planning objectives were either not considered or not retained for further evaluation analysis. Planning objectives discussed earlier were the basis for the selection of alternative plans used for development of intermediate level of analysis.

Modifications of the existing Lake Kissimmee regulation schedule were considered for meeting the stated Kissimmee River environmental goals and objectives. Variations of lake stage-discharge schemes or operational criteria were analyzed to optimize project environmental outputs for the Upper and Lower Basins. Once the optimum schedule was selected, multiple combinations of structural and non-structural flood control options were investigated to determine the most effective method of maintaining the existing level of flood protection. Finally, various measures of land acquisition were considered as part of the plan to obtain environmental benefits and provide for flood storage in the Upper Basin.

The possible solutions considered in the first step of project formulation are listed below. The considered alternative plans are: (a) "no action," i.e., leaving the existing Upper Basin works in place and operating with the present schedules, and (b) water schedule and structure modifications to achieve the restoration objectives for the Kissimmee River while optimizing fish and wildlife benefits in the Upper Basin. The development and evaluation of alternative lake regulation schedules are discussed in Section 7.5 and Appendix F of the report. Separable measures considered in combination with the recommended alternative regulation plan included enlargement of interconnecting canals and outlet structures, levee breaching combinations, and various combinations of land acquisition measures. The alternative of taking no action must be included throughout the planning process. The "No Action" plan is developed to allow comparisons with the proposed authorized project.

7.4.2 NO ACTION Plan

Plan Description. Because Kissimmee River restoration is dependent upon the implementation of a Headwaters project, this alternative assumes that the authorized Kissimmee Restoration Project will not be implemented. No solutions or remedial measures, for example river backfilling, would be implemented or constructed in either the Upper or Lower Basins. While the existing level of flood protection in the Kissimmee chain of lakes would not be altered, opportunities for expansion of the existing lake littoral zones would not be pursued. Likewise, the ecosystem of the river valley would continue to degrade. The existing and forecast resource conditions without project construction of the authorized project are described in more detail in the "Existing" and "Future Without Project" condition sections, Section 4 and 5, of the report. This alternative does not fulfill the stated objectives for the river or the Upper Basin lakes.

Implementation Responsibilities. There would be no Federal responsibility in the implementation of this alternative. This alternative plan is considered in relation to the effects of construction of the authorized project.

Local Sponsor's Views. The local sponsor has indicated in numerous letters a commitment to implementation of the overall restoration project and, therefore, the NO ACTION PLAN is unacceptable.

7.4.3 The 1991 Feasibility Report Headwaters Revitalization Plan (Regulation Schedule Alternative RS1, RS1-A, RS1-B) -

The 1991 Feasibility Report and Environmental Impact Statement provided a recommendation consisting of specific changes to the existing Lake Kissimmee regulation schedule and operating rules for the restoration of the Kissimmee River. The upper level of the preliminary schedule would be increased from elevation 52.5 feet to elevation 54.0 feet, and the schedule would be zoned to provide varying discharges based on season and water levels. The revised schedule would seasonally reflood land between elevations 52.5 and 54.0 feet in Lakes Kissimmee, Hatchineha, and Cypress. It was expected that flood damage reduction afforded by the existing Kissimmee River Flood Control Project could be maintained with implementation of a zoned schedule. The revised schedule would increase seasonal water storage capacity by 100,000 acre-feet, according to studies by the SFWMD. Figure 6-1 shows the alternative Lake Kissimmee regulation schedule presented in the 1991 report. The plan also consisted of channel enlargements, modification of existing water control structures, and land acquisition. The plan was developed primarily for river floodplain restoration. Upper Basin benefits or potential degradation of the Upper Basin environment were not evaluated in detail.

7.4.4 Modification of the Existing Lake Regulation Schedule Operational Rules (Regulation Schedule Alternative RS2) -

Modifications of the operating rules of the existing flood control regulation schedule were also considered. Historic discharge characteristics were added below the top of the schedule where normally a no flow regime exists. This alternative was dropped as a potential plan during the early screening of alternative regulation schedules, see Section 7.5 and Appendix F, based on its inability to provide required discharges for river restoration.

7.4.5 Addition of Bypass Channel with Fixed Weir Lake Kissimmee outlet (Regulation Schedule Alternative RS5) -

The SFWMD study proposed a by-pass spillway as the primary spillway to discharge at a rate that closely approximates the pre-project stage-discharge rating for lake stages above the crest elevation of 51.0 feet. A lake regulation schedule option which calls for the addition of a fixed weir and bypass channel around the S-65 outlet structure was considered to provide the operational requirements of the proposed schedule. The weir elevation would be set at an elevation to pass the minimum flows of 250 cfs when stages are above the elevation of the weir. Discharges above the weir were based on the rating curve, Figure A-2, from the 1991 feasibility report proposed bypass weir at S-65. This alternative was dropped as a potential plan during the early screening of alternative regulation schedules, see Section 7.5 and Appendix F, based on its inability to meet the required discharges for river restoration.

7.4.6 Modification of the Operation Rules of the Proposed 1991 Lake Kissimmee Regulation Schedule -

Modification of the Upper Chain of Lakes' regulation schedule proposed in the 1991 feasibility report would restore the ability to simulate the historic seasonal flow from Lake Kissimmee to the Lower Basin, and provide higher fluctuations of water levels in the lakes. Eighteen modifications of the 1991 regulation schedule were developed and evaluated based on their ability of achieving the 1991 schedule discharge requirements and improving Upper Basin lake stages.

7.4.7 Structural Flood Control Measures -

Based on the requirements of the existing authorization, any new project proposal must maintain the existing level of flood protection. Because project impacts on residences and structural improvements could significantly increase if the frequency of water levels were raised above 54.0 feet, a decision was made by the Jacksonville District that the maximum extent of project related

hydrologic impacts will be held at the 54.0 foot elevation. The criteria for acceptability in the Upper Basin was to have no increase in the peak flood stage above 54.0 feet for any flood frequency. Because of the planned acquisition of lands below 54.0 feet, any increases in peak flood stages below 54.0 feet would be acceptable. Potential flood impacts above 54.0 feet would be addressed through an engineering solution (i.e. their will be no flood induced impacts above 54.0 feet and no additional land requirements above 54.0 feet). Modification of the lake regulation wet season rule curve and reduction of the backfill length would not meet the authorized environmental outputs and were subsequently eliminated.

a. Enlarge C-34, C-35, C-36, C-37, and Replace S-61 - If water levels in Lake Kissimmee are increased, additional land interest and structural modifications may be required to maintain the existing flood protection north of Lake Cypress. These canals could be enlarged to flatten the flood profile through the upper lakes and prevent increasing flood stages. By enlarging canals C-34, C-35, C-36, C-37, the tailwaters of Lakes Tohopekaliga and Gentry could be reduced to prevent the need for structural modifications or real estate acquisition upstream of Lake Cypress. Canal bottom-widths from 20 feet to 160 feet were tested. The need to replace S-61 to further reduce the impact on tailwater at Lake Tohopekaliga was also considered.

Evaluation of whether deepening the canals would be a viable alternative to widening for flood control purposes was also considered. Based on the hydraulic performance of a deepened channel option, the deepening option was not carried forward in the plan development stage.

b. S-65 Structure Modification or Addition of Bypass Spillway and Gate Extensions - Modifications to the existing S-65 structure could be needed to provide larger discharge capacity because of the higher stages in Lake Kissimmee and to overcome the discharge capacity affected by higher tailwater elevations below S-65. Several versions of these measures were tested. Various enlargement options at S-65 were tested in conjunction with the various canal configurations and simulated floods up to the Standard Project Flood.

c. Alignment Option for Canal Widening - Alternative options for the widening of C-34, C-35, C36 and C-37 were considered. Potential acres of wetlands affected on the either the right or left side of the canals were provided by the USFWS. Based on this information, alignment options which reduce the environmental impacts were considered.

d. Create a Canal Using the Alignment of Short Canal - Excavation of a canal along the alignment of Short Canal, a shallow drainage canal between Cypress Lake and Lake Kissimmee, could reduce the amount that C-36 and C-37 would have to be enlarged. Short Canal, however, is now little more than a depression through a marsh. Because enlargement would require extensive excavation and removal of excavated material away from the marsh at considerable expense, this alternative was dropped from further consideration.

7.4.8 Additional Structural Plans

a. Removal of S-65A - The study addressed the removal of S65A as an alternative for eliminating the additional land requirements in Pool A in the Kissimmee River and for reducing or eliminating any structural improvements at S-65. A preliminary assessment of the S65A removal alternative, both financial and hydrologic, was initiated in order to determine the viability of the proposal. Because of the combination of high costs associated with the S65A removal option, potential negative environmental and navigational impacts associated with river overdrainage and the desirability of the operational flexibility of the gated spillway structure, it was recommended that the removal of S65A not be considered as a project feature. The S-65A option is discussed further in the flood control design section, Section 7.7, of this report.

b. Increase Flow-ways Between Tributary Lakes and Lake Kissimmee - Increasing the regulation schedule of Lake Kissimmee will effect runoff from the tributary lakes. Lake Tiger is connected to Lake Kissimmee through Tiger Creek, a small, mildly meandering natural stream which flows through a flat, swampy expanse of marshes over a distance of 9,000 feet. Since Lake Tiger and Lake Kissimmee are at approximately the same natural ground elevation and are hydraulically connected by Tiger Creek, the peak flood stages for the two lakes are intrinsically linked and are nearly identical for floods above elevation 54 feet. Effects could be mitigated by acquisition of real estate interests, or by structural modifications to improve conveyance. In order to eliminate the need to acquire real estate interest around the Lake Tiger by increasing Lake Kissimmee's regulation schedule, an option was considered for improving the flow-way between the lake and Lake Kissimmee to permit additional water storage.

c. Addition of Weir or Flap Gated Culverts and Pump Station between Lake Tiger and Lake Kissimmee - This alternative included channel widening options, the addition of weirs or culverts with flap gates and pump station alternatives between Lakes Kissimmee and Tiger in order to avoid acquisition of lands around Lake Tiger. Based on the analyses, there

were no feasible structural alternative for reducing or eliminating the requirement of land acquisition at Lake Tiger. The analysis is described in more detail in the Flood Control Design Optimization section.

d. Addition of a New Water Control Structure - The Florida Game and Freshwater Fish Commission requested that a water control structure at the northern end of C-36 to regulate Lake Cypress at levels closer to the historic conditions be considered. The alternative was considered, but it was expected that the added structure and the loss of initial storage in Lake Cypress would have an adverse impact on flood stages upstream of the proposed structure and that it may interfere with the required operational criteria for the river restoration project. Since monitoring and evaluation of operation criteria will be an ongoing process after implementation of the Kissimmee River Project, the Jacksonville District proposes to defer any investigation of a new control structure.

7.4.9 Land Acquisition Requirements - Acquire Property Rights in Fee Verses Easement

The environmental benefits achieved, in both the Upper and Lower Basin, by modifying the regulation schedule would be affected by how the land is used with the project. A range of real estate acquisition possibilities were evaluated for securing various levels of land use controls over the floodplain around the headwater lakes. Acquisition of real estate interests in fee simple versus easement rights were compared with potential fish and wildlife benefits and project requirements for flood control storage. It was recognized that agricultural uses compatible with seasonal flooding, such as cattle grazing, might also be compatible with, or beneficial to, fish and wildlife uses. With the U.S. Fish and Wildlife Service and the Florida Game and Fresh Water Fish Commission, we considered the beneficial uses of grazing and fire as part of a wildlife management plan for the Headwaters.

If the land is acquired in fee, which would be a higher cost than if the land were acquired in easement, the use of the land acquired in fee would be limited to project purposes and would not be disturbed in such a way that could be damaging to the environment. If the land is acquired in a lesser easement, the environmental benefits may not be fully achieved, nor would we have the flexibility to modify or deviate from the proposed lake regulation schedule for future environmental or flood control purposes.

7.5 EVALUATION OF LAKE KISSIMMEE REGULATION SCHEDULE ALTERNATIVES

7.5.1 Development of Alternatives

The 1991 feasibility study demonstrated that discharges required to accomplish ecological restoration of the lower basin could be provided by modifying the flood control regulation schedule and operation rules for the lower group of headwater lakes (i.e., Kissimmee, Hatchineha, and Cypress). The proposed modifications (Figure 6-1) provided required inflow regimes for the lower basin restoration, including relatively continuous discharges, with rates that varied with lake stages. These modifications to the operation rules, along with proposed provisions to raise the upper level of the regulation schedule to 52.5 during May-September and between 52.5-54 ft during the remaining months of the year, also have the potential for increasing the range and temporal dynamics of water level fluctuations in the lakes. An associated expansion of littoral wetlands and increased quality and productivity of littoral habitat surrounding the lakes was suggested, but not rigorously evaluated.

The first component of plan formulation for the Headwaters study was centered around the development of a Lake Kissimmee regulation schedule which would meet or exceed the environmental benefits which were attributed to the restoration of the lower Kissimmee River as shown in the 1991 authorizing document. Key components of the regulation schedule and operation rule modifications in the 1991 feasibility study were used as a template for developing alternative Upper Basin water management schemes for meeting the restoration criteria and environmental objectives of the river and headwater lakes. However, the potential for modifying the Upper Basin regulation schedule and operation rules was limited by flood control and navigation constraints, which establish an upper and lower envelop for lake stages and discharge manipulations.

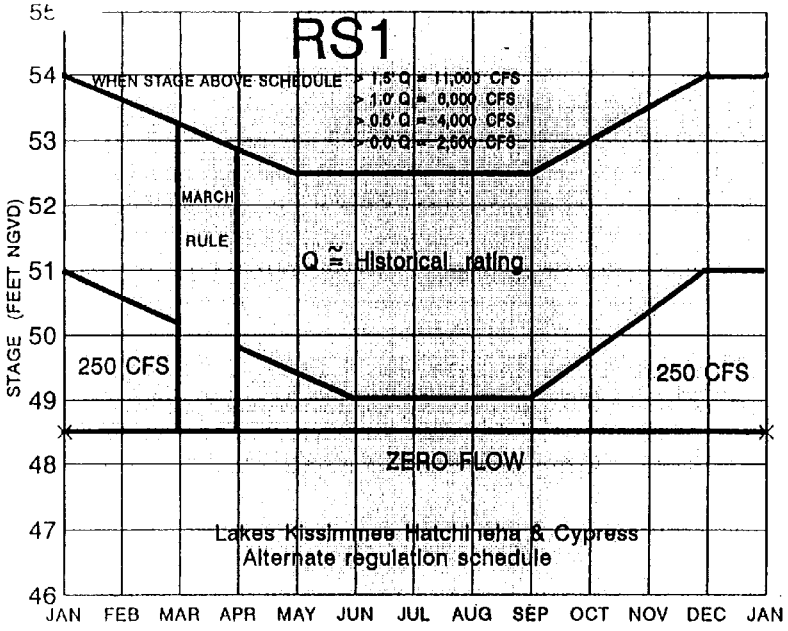
Between August 1993 and November 1993, the SFWMD and the Corps developed 21 alternative lake regulation schedules (Table 7-1 and Figures 7-1). During this iterative design process, an interagency environmental team, consisting of the USFWS, the Florida Game and Freshwater Fish Commission, the SFWMD and the Corps members reviewed and screened the alternatives based on their conformance to project related goals for the Lower and Upper Basins. Appendix F provides a detailed explanation of the process which lead to the development and evaluation of the 21 alternative schedules.

TABLE 7-1
REGULATION SCHEDULE ALTERNATIVES
(See Figures in Appendix F.)

ALTERNATIVE	OPERATION RULES
RS1 (SFWMD 1990 AND 1991 FEASIBILITY STUDY SCHEDULE)	Three discharge zones bounded by an upper flood control regulation zone when lake stages exceed 52.5-54 ft and a lower no discharge zone when lake stages are < 48.5 ft. Within this envelop no discharges are made during March; during other months discharges either vary according to the historic (pre-regulation) stage-discharge relationship or are maintained at 250 cfs, depending upon lake stages.
RS1-A	Same as RS1 with slight modifications to historic stage-discharge rating curve.
RS1-B	Same as RS1 without March no discharge zone.
RS2	Same discharge zones as RS1-B except upper flood control regulation zone is bounded by existing regulation schedule elevations.
RS3	Same as RS1-B with slightly higher flood control envelop during May.
RS4	Same as RS3 except 250 cfs zone changed to 400 cfs zone.
RS5	Two discharge zones bounded by the same flood control and lower no discharge zones as RS4. Within this envelop discharges are maintained at 250 cfs when lake stages are < 51.68 ft or unregulated flow as lake stages overtop a weir with a fixed crest of 51.68 ft.
RS6	Two discharge zones bounded by the same flood control and lower no discharge zones as RS4. Within this envelop discharges are maintained at 150 cfs when lake stages are < 49 ft or vary according to a new outlet rating curve (RC-A rating curve from Appendix F).
RS7	Same as RS6 with the addition of a 400 cfs discharge zone when lake stages fall within designated ranges during November-May.
RS8	Same as RS6 with a different stage-discharge rating curve (RC-B rating curve from Appendix F).
RS9	Same as RS6 with the addition of a 400 cfs discharge zone that occurs at different lake stages than the RS7 400 cfs discharge zone

TABLE 7-1
REGULATION SCHEDULE ALTERNATIVES
(See Figures in Appendix F.)

ALTERNATIVE	OPERATION RULES
RS9-A	Same as RS9 with a modification to the 400 cfs discharge zone
RS9-B	Same as RS9 with a modification to the 400 cfs discharge zone different from that of RS9-A
RS9-C	Same as RS9 with a modification to the 400 cfs discharge zone different from that of RS9-A and RS9-B
RS9-D (T400C150RR in USFWS CAR)	Same as RS9-C with elimination of 400 cfs discharge zone during November-December
RS10	Same as RS9-A with historical stage-discharge rating curve.
RS10-A	Same as RS9-B with historical stage-discharge rating curve.
RS10-B	Same as RS9-C with historical stage-discharge rating curve.
RS10-C	Same as RS9-D with historical stage-discharge rating curve.
RS11	Same as RS9-C and RS10-B with RS8 stage-discharge rating curve during January-June and historical stage-discharge rating curve during July-December.
RS11-A (T1000HISRR in USFWS CAR)	Same as RS11 with elimination of 400 cfs discharge zone during November-December.


RS1
WHEN STAGE ABOVE SCHEDULE > 1.5' Q = 11,000 CFS
> 1.0' Q = 8,000 CFS
> 0.5' Q = 4,000 CFS
> 0.0' Q = 2,500 CFS
MARCH
RULE
Q = Historical rating
250 CFS
250 CFS
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
STAGE (FEET NGVD)
55
54
53
52
51
50
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48
47
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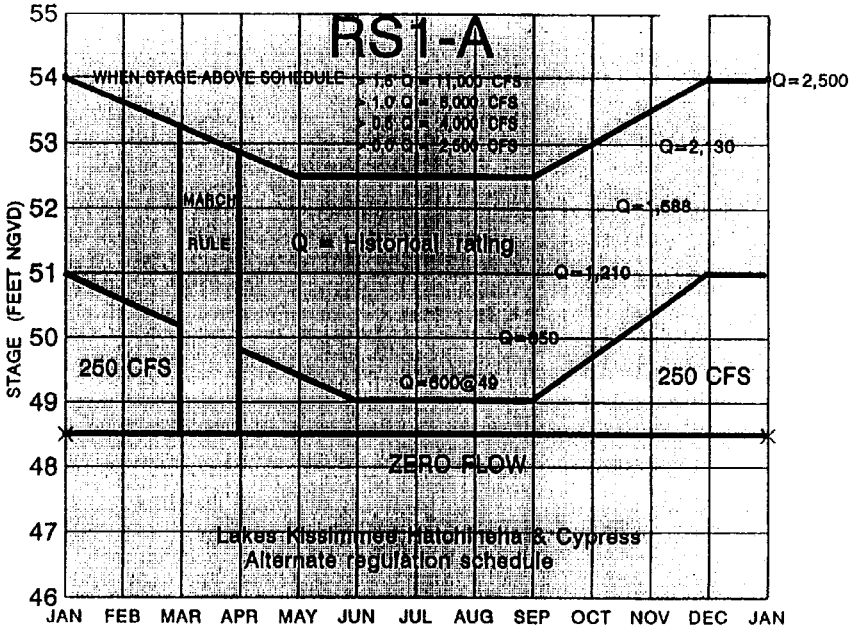
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN


RS1-A
WHEN STAGE ABOVE SCHEDULE > 1.5' Q = 11,000 CFS
> 1.0' Q = 8,000 CFS
> 0.5' Q = 4,000 CFS
> 0.0' Q = 2,500 CFS
Q=2,500
Q=2,130
Q=1,588
Q=1,210
Q=850
Q=600@49
MARCH
RULE
Q = Historical rating
250 CFS
250 CFS
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
STAGE (FEET NGVD)
55
54
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48
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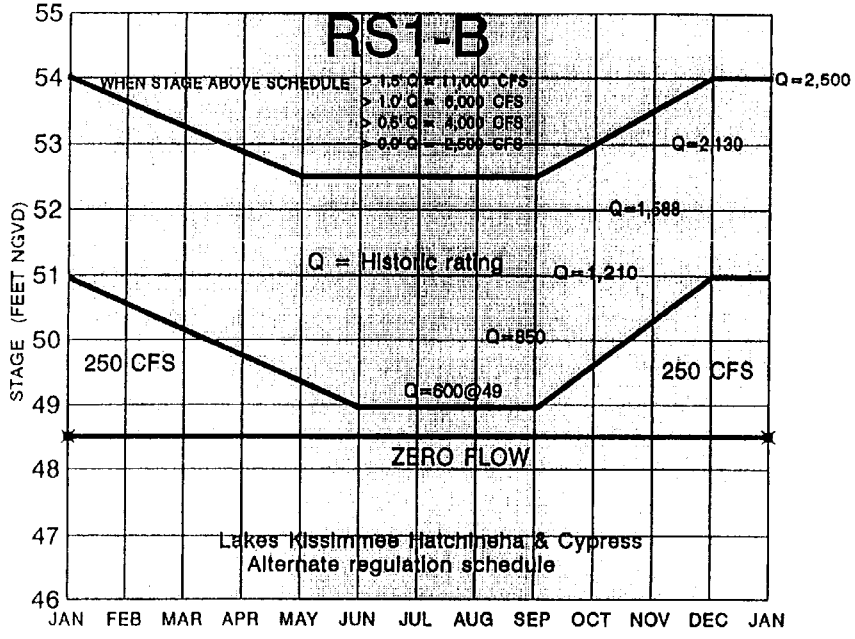
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN


RS1-B
WHEN STAGE ABOVE SCHEDULE > 1.5' Q = 11,000 CFS
> 1.0' Q = 8,000 CFS
> 0.5' Q = 4,000 CFS
> 0.0' Q = 2,500 CFS
Q=2,500
Q=2,130
Q=1,588
Q=1,210
Q=850
Q=600@49
Q = Historic rating
250 CFS
250 CFS
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
STAGE (FEET NGVD)
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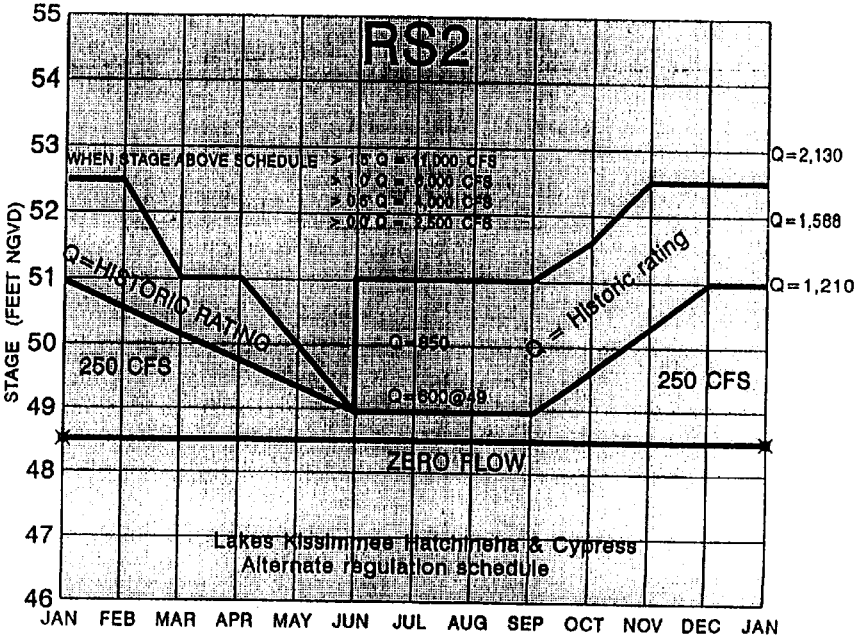
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN


RS2
WHEN STAGE ABOVE SCHEDULE > 1.5' Q = 11,000 CFS
> 1.0' Q = 8,000 CFS
> 0.5' Q = 4,000 CFS
> 0.0' Q = 2,500 CFS
Q=2,130
Q=1,588
Q=1,210
Q=850
Q=600@49
Q=HISTORIC RATING
Q = Historic rating
250 CFS
250 CFS
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
STAGE (FEET NGVD)
55
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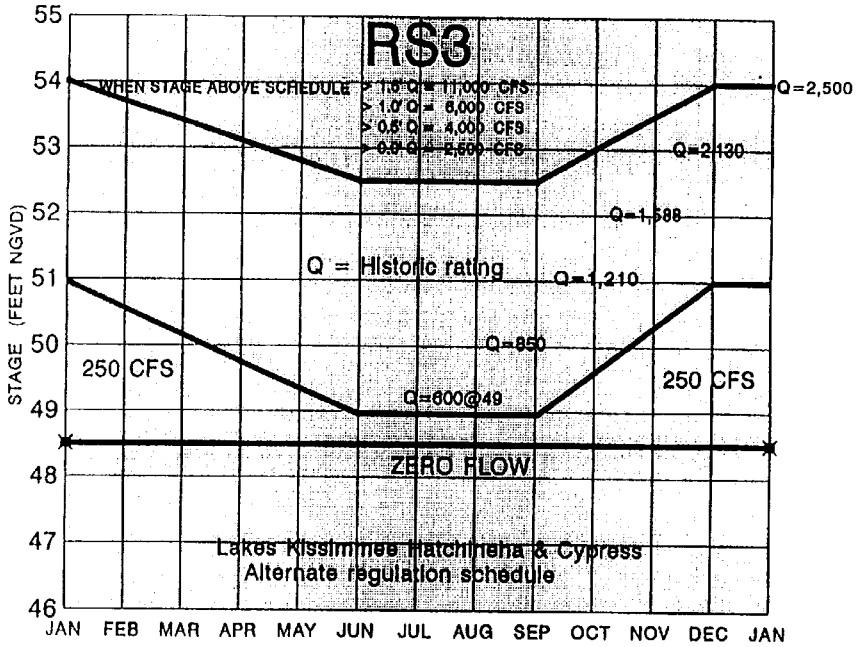
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN

FIGURE 7-1(a)


RS3
WHEN STAGE ABOVE SCHEDULE
> 1.5' Q = 11,000 CFS
> 1.0' Q = 6,000 CFS
> 0.5' Q = 4,000 CFS
> 0.0' Q = 2,500 CFS
Q=2,500
Q=2,130
Q=1,588
Q = Historic rating
Q=1,210
Q=850
250 CFS
250 CFS
Q=600@49
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
STAGE (FEET NGVD)
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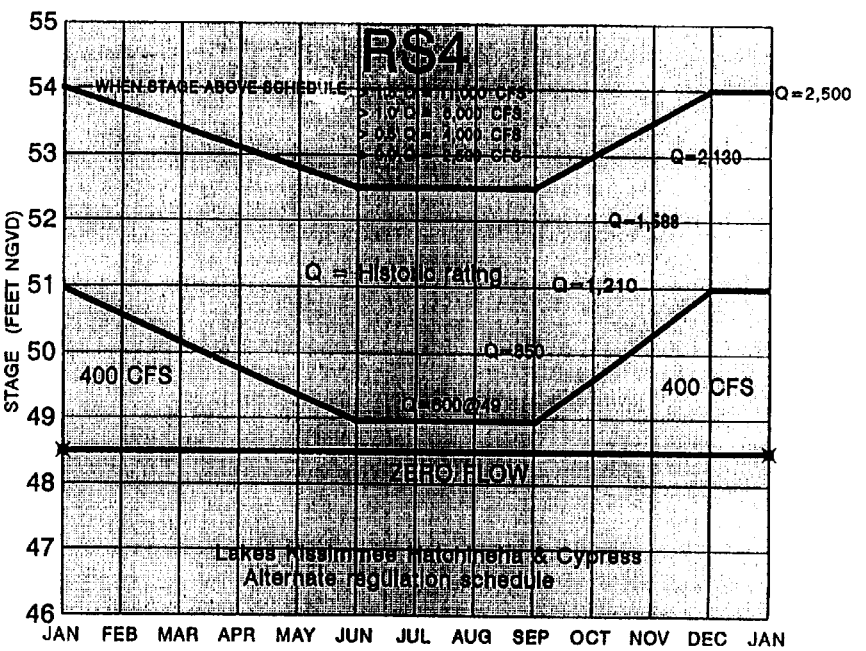
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN


RS4
WHEN STAGE ABOVE SCHEDULE
> 1.0' Q = 6,000 CFS
> 0.5' Q = 4,000 CFS
Q=2,500
Q=2,130
Q=1,588
Q = Historic rating
Q=1,210
Q=850
400 CFS
400 CFS
Q=600@49
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
STAGE (FEET NGVD)
55
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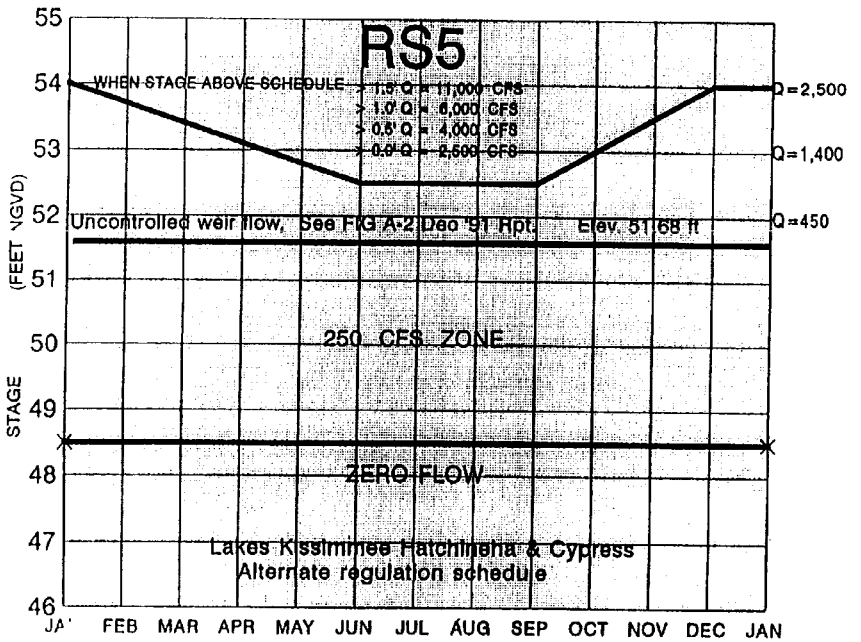
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN


RS5
WHEN STAGE ABOVE SCHEDULE
> 1.5' Q = 11,000 CFS
> 1.0' Q = 6,000 CFS
> 0.5' Q = 4,000 CFS
> 0.0' Q = 2,500 CFS
Q=2,500
Q=1,400
Q=450
Uncontrolled weir flow, See FIG A-2 Dec '91 Rpt. Elev. 51.68 ft
250 CFS ZONE
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
STAGE (FEET NGVD)
55
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48
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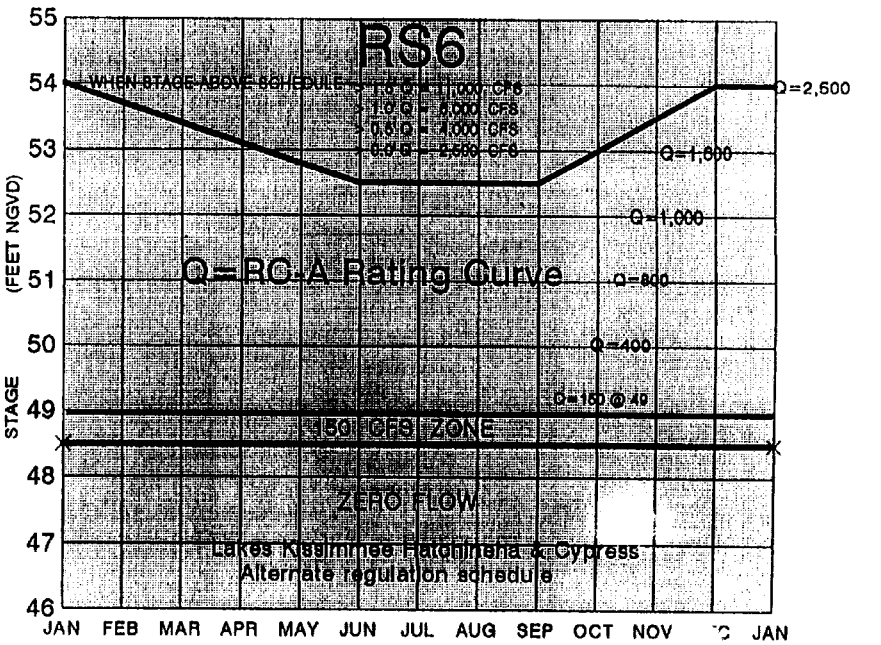
FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN


RS6
WHEN STAGE ABOVE SCHEDULE
> 1.0' Q = 6,000 CFS
> 0.5' Q = 4,000 CFS
Q=2,500
Q=1,800
Q=1,000
Q = RC-A Rating Curve
Q=800
Q=400
Q=150 @ 49
350 CFS ZONE
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
STAGE (FEET NGVD)
55
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51
50
49
48
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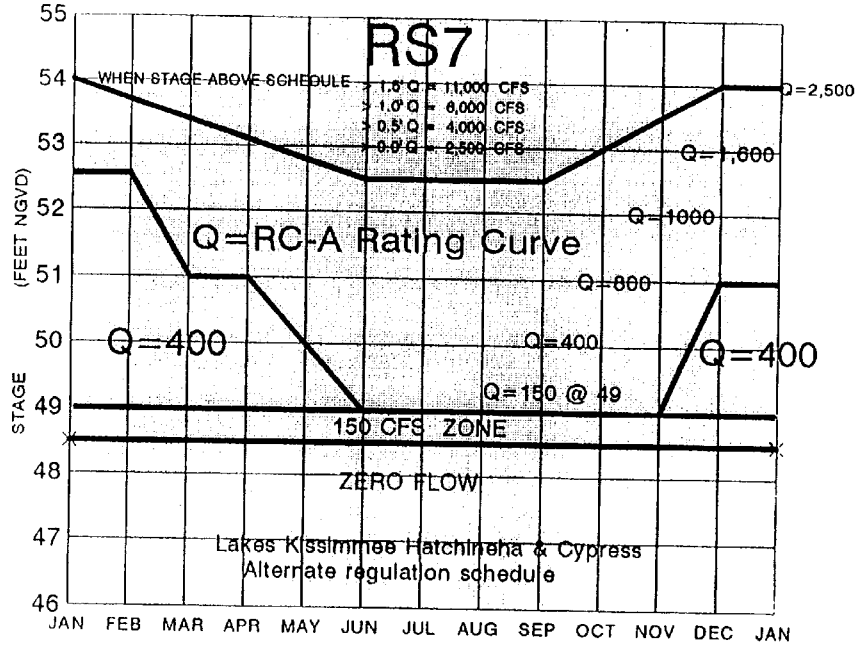
46
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV JAN

FIGURE 7-1(b)


RS7
WHEN STAGE ABOVE SCHEDULE
> 1.5' Q = 11,000 CFS
> 1.0' Q = 6,000 CFS
> 0.5' Q = 4,000 CFS
> 0.0' Q = 2,500 CFS
Q=2,500
Q=1,600
Q=1000
Q=800
Q=400
Q=400
Q=400
Q=150 @ 49
150 CFS ZONE
ZERO FLOW
Q=RC-A Rating Curve
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
STAGE
(FEET NGVD)
55
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52
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48
47
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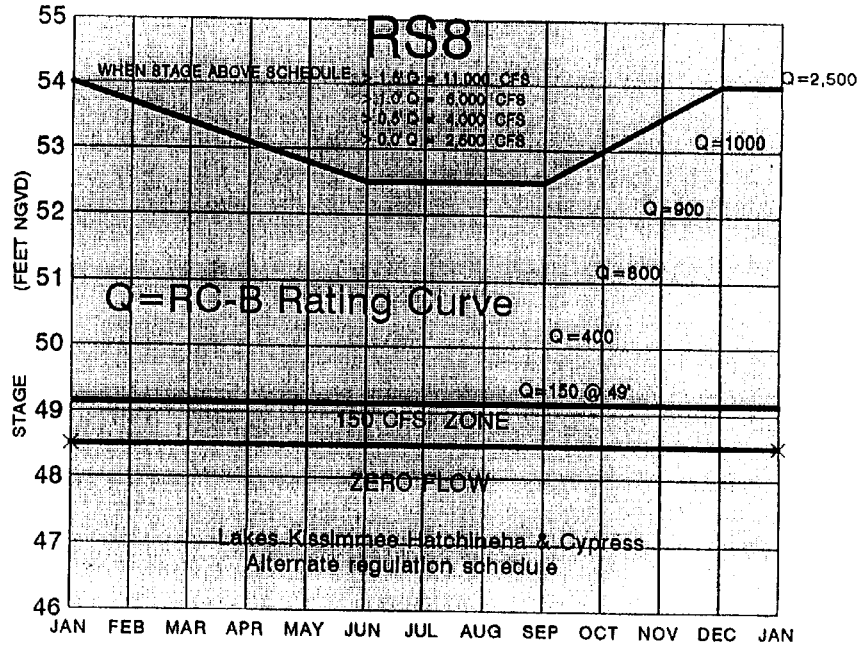
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN


RS8
WHEN STAGE ABOVE SCHEDULE
> 1.5' Q = 11,000 CFS
> 1.0' Q = 6,000 CFS
> 0.5' Q = 4,000 CFS
> 0.0' Q = 2,500 CFS
Q=2,500
Q=1000
Q=900
Q=800
Q=400
Q=150 @ 49'
150 CFS ZONE
ZERO FLOW
Q=RC-B Rating Curve
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
STAGE
(FEET NGVD)
55
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53
52
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48
47
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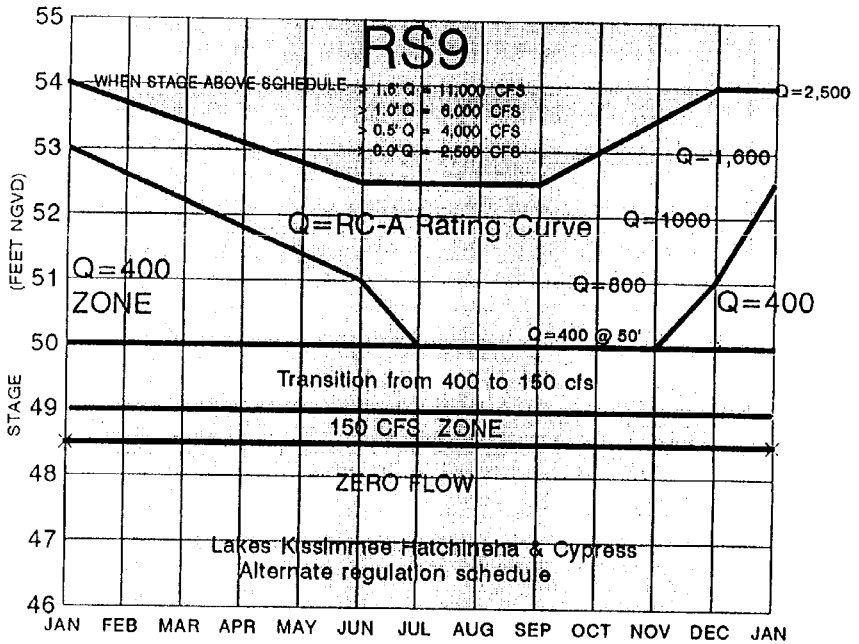
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN


RS9
WHEN STAGE ABOVE SCHEDULE
> 1.5' Q = 11,000 CFS
> 1.0' Q = 6,000 CFS
> 0.5' Q = 4,000 CFS
> 0.0' Q = 2,500 CFS
Q=2,500
Q=1,600
Q=1000
Q=800
Q=400
Q=400 @ 50'
Q=400
ZONE
Q=RC-A Rating Curve
Transition from 400 to 150 cfs
150 CFS ZONE
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
STAGE
(FEET NGVD)
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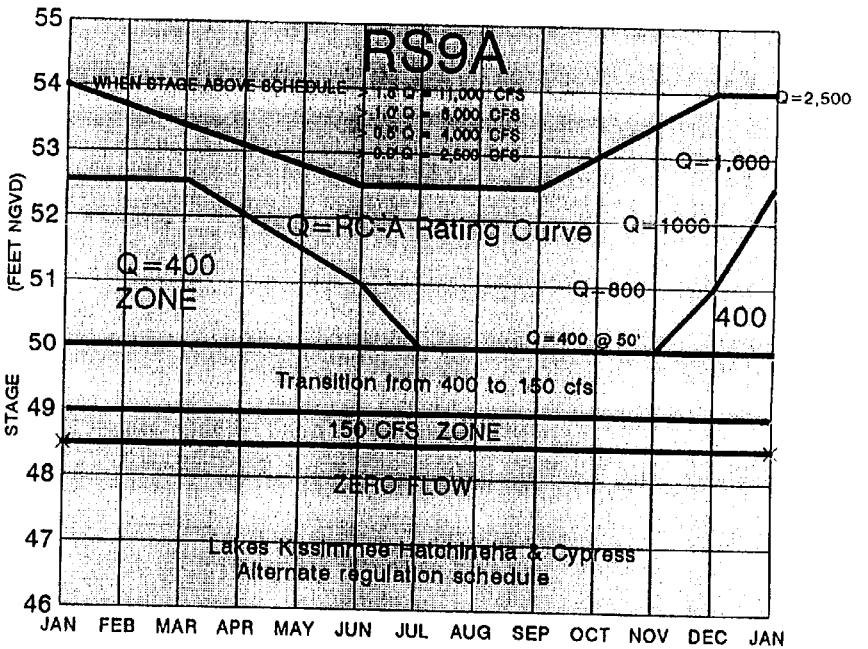
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN


RS9A
WHEN STAGE ABOVE SCHEDULE
> 1.5' Q = 11,000 CFS
> 1.0' Q = 6,000 CFS
> 0.5' Q = 4,000 CFS
> 0.0' Q = 2,500 CFS
Q=2,500
Q=1,600
Q=1000
Q=800
Q=400
Q=400 @ 50'
400
Q=400
ZONE
Q=RC-A Rating Curve
Transition from 400 to 150 cfs
150 CFS ZONE
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
STAGE
(FEET NGVD)
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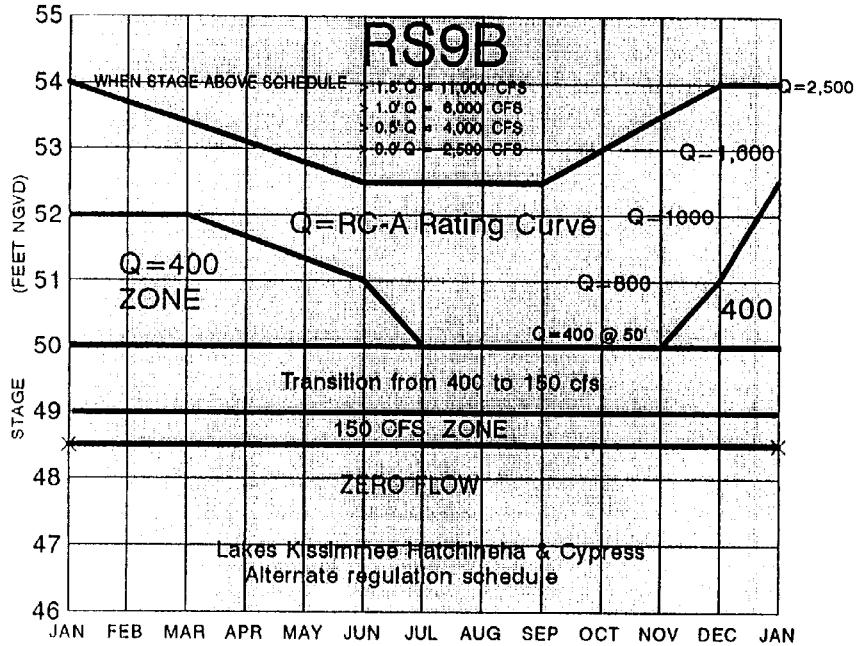
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN

FIGURE 7-1(c)


RS9B
WHEN STAGE ABOVE SCHEDULE
> 1.5' Q = 11,000 CFS
> 1.0' Q = 6,000 CFS
> 0.5' Q = 4,000 CFS
> 0.0' Q = 2,500 CFS
Q=2,500
Q=1,600
Q=1000
Q=800
Q=400 @ 50'
Q=RC-A Rating Curve
Q=400
ZONE
400
Transition from 400 to 150 cfs
150 CFS ZONE
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
STAGE
(FEET NGVD)
55
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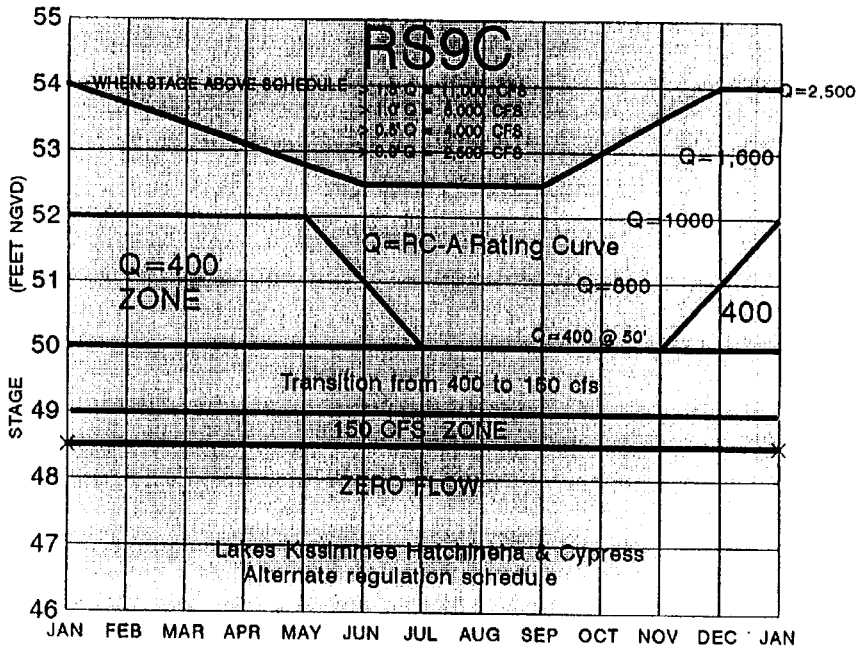
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN


RS9C
WHEN STAGE ABOVE SCHEDULE
> 1.5' Q = 11,000 CFS
> 1.0' Q = 6,000 CFS
> 0.5' Q = 4,000 CFS
> 0.0' Q = 2,500 CFS
Q=2,500
Q=1,600
Q=1000
Q=800
Q=400 @ 50'
Q=RC-A Rating Curve
Q=400
ZONE
400
Transition from 400 to 150 cfs
150 CFS ZONE
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
STAGE
(FEET NGVD)
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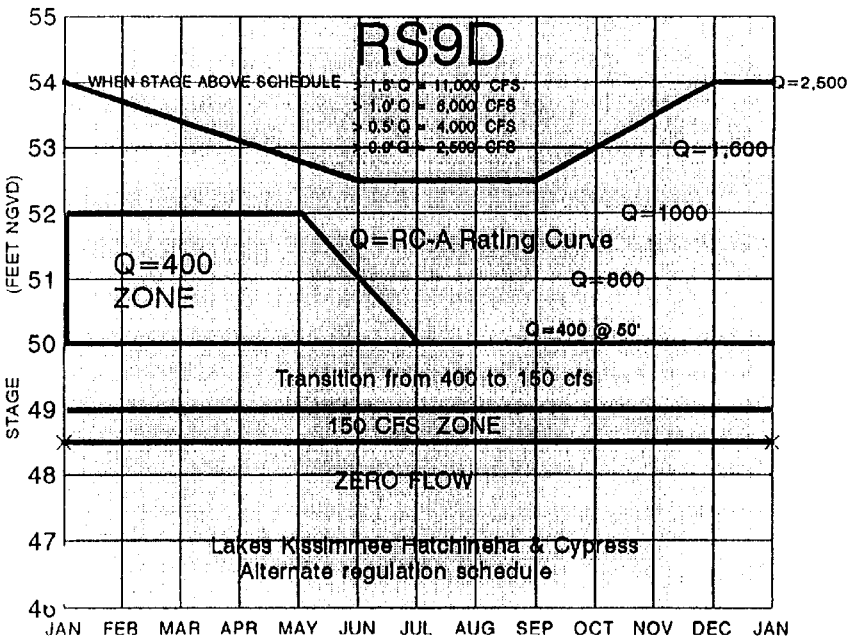
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN


RS9D
WHEN STAGE ABOVE SCHEDULE
> 1.5' Q = 11,000 CFS
> 1.0' Q = 6,000 CFS
> 0.5' Q = 4,000 CFS
> 0.0' Q = 2,500 CFS
Q=2,500
Q=1,600
Q=1000
Q=800
Q=400 @ 50'
Q=RC-A Rating Curve
Q=400
ZONE
Transition from 400 to 150 cfs
150 CFS ZONE
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
STAGE
(FEET NGVD)
55
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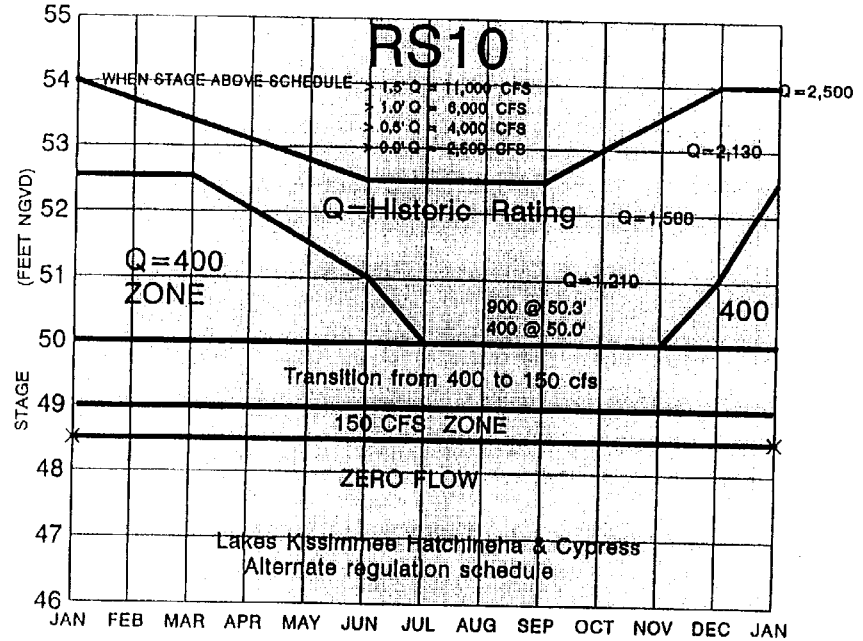
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN

FIGURE 7-1(d)


RS10
WHEN STAGE ABOVE SCHEDULE
> 1.5' Q = 11,000 CFS
> 1.0' Q = 6,000 CFS
> 0.5' Q = 4,000 CFS
> 0.0' Q = 2,500 CFS
Q=2,500
Q=2,130
Q=Historic Rating
Q=1,560
Q=1,210
900 @ 50.3'
400 @ 50.0'
Q=400
ZONE
400
Transition from 400 to 150 cfs
150 CFS ZONE
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
STAGE
(FEET NGVD)
55
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53
52
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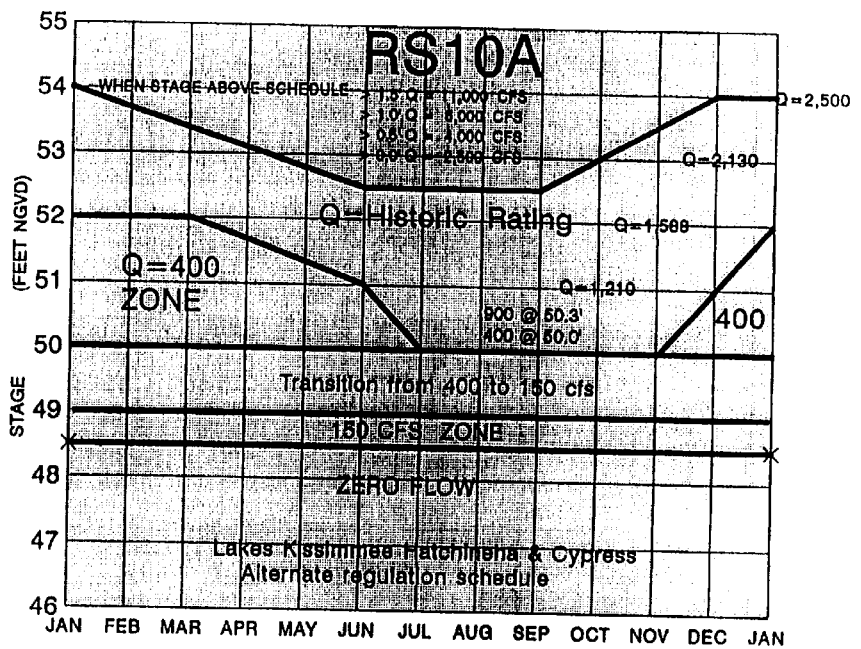
50
49
48
47
46
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN


RS10A
WHEN STAGE ABOVE SCHEDULE
> 1.5' Q = 11,000 CFS
> 1.0' Q = 6,000 CFS
> 0.5' Q = 4,000 CFS
> 0.0' Q = 2,500 CFS
Q=2,500
Q=2,130
Q=Historic Rating
Q=1,560
Q=1,210
900 @ 50.3'
400 @ 50.0'
Q=400
ZONE
400
Transition from 400 to 150 cfs
150 CFS ZONE
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
STAGE
(FEET NGVD)
55
54
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52
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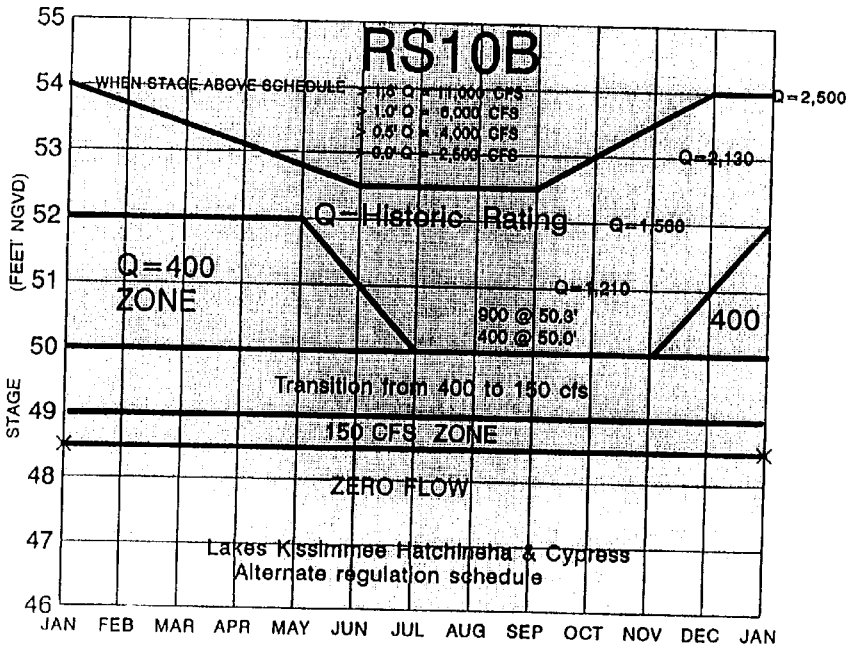
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN


RS10B
WHEN STAGE ABOVE SCHEDULE
> 1.5' Q = 11,000 CFS
> 1.0' Q = 6,000 CFS
> 0.5' Q = 4,000 CFS
> 0.0' Q = 2,500 CFS
Q=2,500
Q=2,130
Q=Historic Rating
Q=1,560
Q=1,210
900 @ 50.3'
400 @ 50.0'
Q=400
ZONE
400
Transition from 400 to 150 cfs
150 CFS ZONE
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
STAGE
(FEET NGVD)
55
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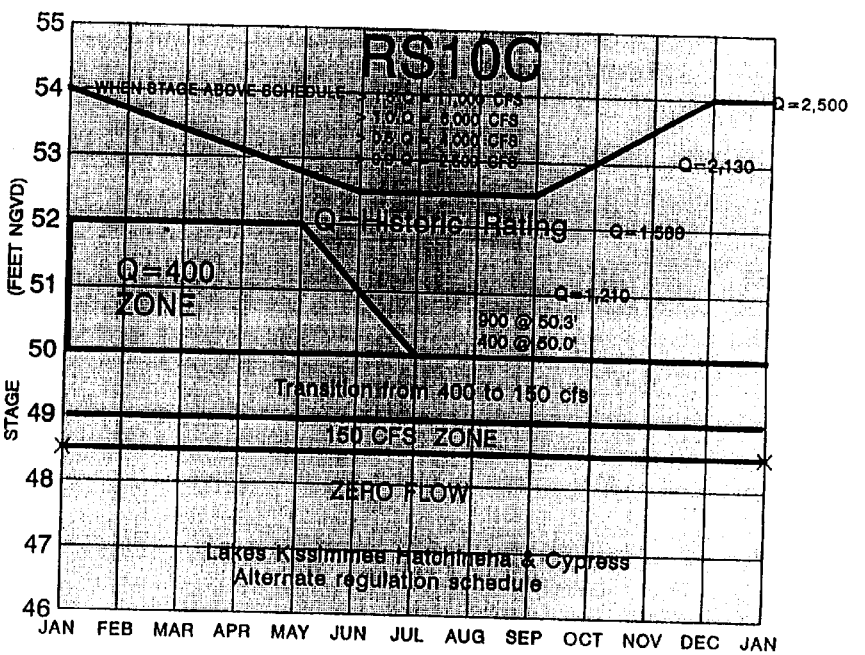
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN


RS10C
WHEN STAGE ABOVE SCHEDULE
> 1.5' Q = 11,000 CFS
> 1.0' Q = 6,000 CFS
> 0.5' Q = 4,000 CFS
> 0.0' Q = 2,500 CFS
Q=2,500
Q=2,130
Q=Historic Rating
Q=1,560
Q=1,210
900 @ 50.3'
400 @ 50.0'
Q=400
ZONE
Transition from 400 to 150 cfs
150 CFS ZONE
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
STAGE
(FEET NGVD)
55
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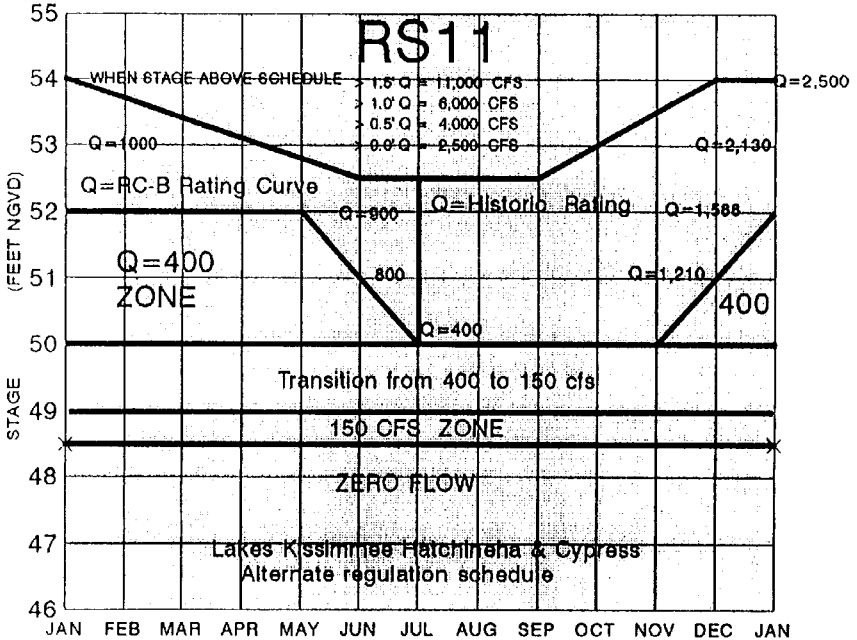
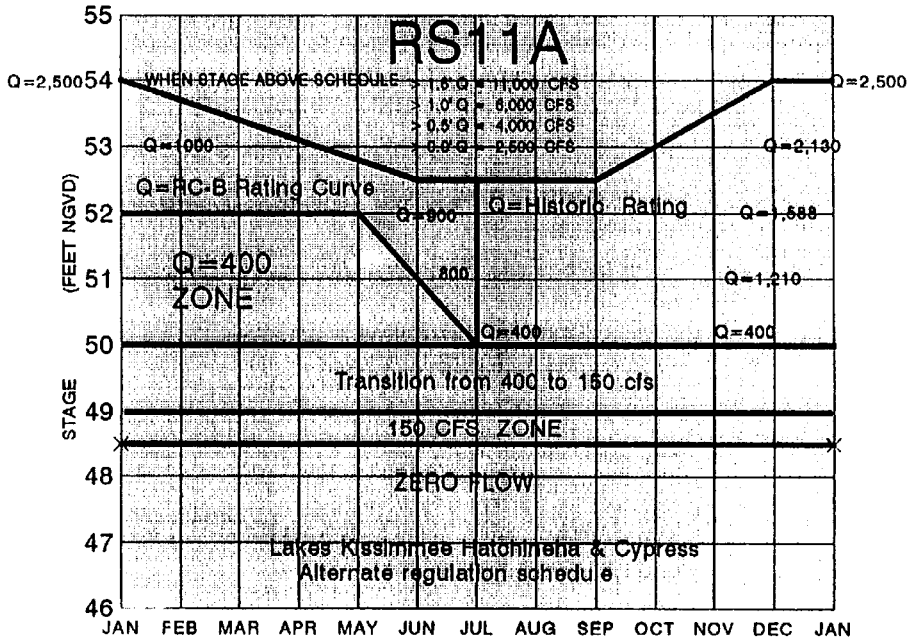
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN

FIGURE 7-1(e)


RS11
WHEN STAGE ABOVE SCHEDULE
> 1.5' Q = 11,000 CFS
> 1.0' Q = 6,000 CFS
> 0.5' Q = 4,000 CFS
> 0.0' Q = 2,500 CFS
Q=2,500
Q=1000
Q=2,130
Q=RC-B Rating Curve
Q=900
Q=Historic Rating
Q=1,588
Q=400
ZONE
800
Q=1,210
400
Q=400
Transition from 400 to 150 cfs
150 CFS ZONE
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
STAGE (FEET NGVD)
55
54
53
52
51
50
49
48
47
46
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN


RS11A
Q=2,500
WHEN STAGE ABOVE SCHEDULE
> 1.5' Q = 11,000 CFS
> 1.0' Q = 6,000 CFS
> 0.5' Q = 4,000 CFS
> 0.0' Q = 2,500 CFS
Q=2,500
Q=1000
Q=2,130
Q=RC-B Rating Curve
Q=900
Q=Historic Rating
Q=1,588
Q=400
ZONE
800
Q=1,210
Q=400
Q=400
Transition from 400 to 150 cfs
150 CFS ZONE
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
STAGE (FEET NGVD)
55
54
53
52
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48
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46
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN

FIGURE 7-1(f)

Initial alternatives were developed and improved through the addition or variation of one or several discharge zones. Upper level discharge zones were developed based on the historic rating curve in order to provide opportunities to achieve historic flow patterns. Because modelling outputs suggested the potential for overdrainage of Upper Basin lakes when historic discharges were used, two reduced stage-discharge rating curves, RC-A and RC-B, were developed as alternatives (see Figure C3, Appendix F for rating curves). In order to avoid reduction of higher water levels in the lakes, schedules were eventually modified by inserting a transitional zone with discharges between 400 cfs and 150 cfs. Minimum discharges of 150 cfs were incorporated within the schedules during low lake level periods.

7.5.2 Evaluation Process

The hydrologic performance of these alternatives was modeled over a 18-year, (1970-87) post-channelization simulation period, using a modified version of a continuous simulation model (Fan, 1986) for the upper chain of lakes (UKISS model). Environmental analyses of the alternatives focused on comparisons of their simulated hydrologic performance with the established restoration criteria. Lower Basin environmental requirements were based upon the simulated discharge regimes of the alternatives. Simulated Lake Kissimmee outflows for each alternative were compared to discharge characteristics of the RS1 schedule, because the 1991 feasibility study demonstrated that the hydrologic performance of this schedule met the criteria for restoration of the lower basin ecosystem and was used as a basis for the restoration project's authorization.

New alternatives were considered acceptable if their simulated discharge characteristics equalled or exceeded the hydrologic performance of the RS1 schedule. Comparisons were based upon monthly discharge exceedence data (i.e., discharges that were exceeded during various percentages of the simulation period). The continuous flow criteria was evaluated by determining monthly discharges that were exceeded during 90 percent of the simulation period. The degree to which the alternatives reestablished discharge variability and natural seasonal distributions of high and low flow periods was evaluated by monthly discharges that were exceeded during 10, 25, 50, and 75 percent of the simulation period. These percentages were chosen to represent magnitudes of discharges that could be expected during low (discharge exceeded during 75% of simulation period), average (discharge exceeded during 50% of simulation period), high (discharge exceeded during 25% of simulation period) and peak (discharges exceeded during 10% of simulation period) flow periods.

Upper Basin environmental analyses were based upon comparisons of observed and simulated stage duration curves for the post-channelization period. During the 1934-60 period of record, Lake Kissimmee stages exceeded 54 ft approximately 7 percent of the time and were less than 48.5 ft approximately 19 percent of the time. Because frequencies of lake stages between 49.6 ft and 50.8 ft were similar for the observed post-regulation period and historical period, and the primary environmental objective for the Upper Basin is to reestablish littoral wetlands that were drained by lowered lake stages, Upper Basin analyses focussed on the degree to which the alternatives increased frequencies of lake stages between 50.8 and 54 ft.

7.5.3 Initial Screening of Alternatives

Initial screening of the hydrologic performance of each alternative indicated that nine schedules failed to meet the minimum requirements of the Upper or Lower Basin restoration criteria. Five alternatives, the RS1, RS1-A, RS1-B, RS3, and RS4 schedules, were eliminated because simulations indicated these alternatives would result in Upper Basin water levels that would be consistently lower than stages produced by the existing regulation schedule. The RS2, RS5, RS6, and RS8 alternatives were eliminated because their discharge characteristics during average flow periods were inadequate for Lower Basin restoration. Simulations indicate that 50 percent of the time the RS2 and RS5 schedules would produce inflows of only 250 cfs. The RS6 and RS8 alternatives produced higher discharges, but were less than 600 cfs during most months, including much of the wet season. Based upon Lower Basin stage and Upper Basin discharge relationships, inflows produced by these schedules would consistently inundate only 50 percent or less of the river's floodplain. Table 7-2 summarizes the screening process for the first 8 regulation schedule options. The RS7 alternative was the only alternative that met both the Upper and Lower Basin objectives.

TABLE 7-2
INITIAL SCREENING OF ALTERNATIVES

OPTION	ACHIEVE LOWER BASIN FLOODPLAIN INUNDATION	LAKE KISSIMMEE STAGE ABOVE OBSERVED PERIOD (1970-88)	MAINTAIN FOR NEXT PHASE OF REVIEW
RS1	ACHIEVED	POOR	NO
RS1-A	ACHIEVED	POOR	NO
RS1-B	ACHIEVED	POOR	NO
RS2	NOT MET	POOR	NO
RS3	ACHIEVED	POOR	NO
RS4	ACHIEVED	POOR	NO
RS5	NOT MET	POOR	NO
RS6	NOT MET	FAIR	NO
RS7	ACHIEVED	FAIR	YES
RS8	NOT MET	GOOD	NO

7.5.4 Intermediate Development of Alternatives

The RS9, RS10, and RS11 series of alternatives were developed through sequential modifications of the RS7 schedule. Modifications involved adjustments of the location of the 400 cfs discharge zones and changes to the upper zone discharge rating curve. The main difference in the RS9 schedules is the addition of a 400 to 150 cfs transition zone from the 50 foot to 49 foot lake stages. The RS10 series also include the 400 cfs transition zone, but uses the historic rating curve above the 50 foot stage instead of the RC-A rating curve. RS11 and RS11A include the 400 cfs transition zone below 50 feet, but incorporate a combination of the Historic and RC-B rating curves in the upper discharge zones.

RS7, RS9, RS9-A through D, RS10, RS10-A through C, RS11, RS11-A produced discharge regimes that met the Lower Basin restoration criteria and improved upon the hydrologic performance of the RS1 schedule. Compared to the RS1 schedule, these alternatives had lower frequencies of no flow periods, increased the magnitude of low flows during wet season months and average flows during dry season months, and redistributed average and high flow volumes in a more natural seasonal pattern.

The simulated effects of these 12 schedules on lake stages were compared to observed lake stage frequencies between 1970-88. The schedules were grouped into three separate classes based upon their characteristics of stage/discharge over the period of record. Alternatives RS10, RS10-A, RS10-B, and RS10-C resulted in frequencies of lake stages > 51.5 feet that were similar to that produced by the current regulation schedule, but significantly lower frequencies of stages between 49.5-51.5 feet. Alternatives RS7, RS11, and RS11-A resulted in slightly higher frequencies of stages >52.5 feet and lower frequencies of stages between 50-51 feet than the current schedule. Alternatives RS9, RS9-A, RS9-B, RS9-C, and RS9-D produced the greatest increase in frequencies of lake stages >51 feet, and had frequencies of stages between 49-51 feet similar to observed frequencies of these stages during the 1970-88 simulation period.

During an interagency meeting in November 1994, the last two schedules, RS9-D and RS11-A, were selected to be evaluated further by the USFWS. While the hydrologic performance of the RS9 type schedules would be similar for both the Upper and Lower Basins, the RS9-D has less operation constraints. Because this alternative does not have a zone that limits discharges to 400 cfs when lake stages are between 50-52 feet during November-December, it would produce more natural inflows to lower basin during these months. Therefore, the RS9-D was selected for its overall performance for both the Upper and Lower Basins. The RS11-A schedule was selected based on its potential to increase the upper end of the Upper Basin wetlands. Table 7-3 summarizes the selection of the final two alternatives.

TABLE 7-3
EVALUATION OF INTERMEDIATE ALTERNATIVES

OPTION	ACHIEVE LOWER BASIN FLOODPLAIN INUNDATION	FREQUENCY OF LAKE KISS STAGE ABOVE 52.5 FEET (1970-88)	LAKE STAGE ABOVE OBSERVED 49-51 FT (1970-88)	MAINTAIN FOR FINAL PHASE OF REVIEW
RS7	ACHIEVED	GOOD	POOR	NO
RS9	ACHIEVED	FAIR	GOOD	NO
RS9A	ACHIEVED	FAIR	GOOD	NO
RS9B	ACHIEVED	FAIR	GOOD	NO
RS9C	GOOD	FAIR	BEST	NO
RS9D	BEST	FAIR	BEST	YES
RS10	ACHIEVED	POOR	POOR	NO
RS10A	ACHIEVED	POOR	POOR	NO
RS10B	ACHIEVED	POOR	POOR	NO
RS10C	ACHIEVED	POOR	POOR	NO
RS11	ACHIEVED	GOOD	POOR	NO
RS11A	ACHIEVED	BEST	POOR	YES

7.5.5 Detailed Evaluation and Selection of Final Plan

The USFWS conducted detailed analyses of the final two alternatives, RS9-D and RS11-A, based on the addition of several new evaluation criteria. (Note: USFWS Coordination Act Report calls the alternatives by their original model designation; RS9-D is 400C150RR, and RS11-A is T1000HISRR). The stage-exceedence curves used in the initial screening of alternatives only indicated the percent of time over the period of record that a certain water level would be exceeded; it did not indicate the duration of each occurrence. The average duration of flooding and drying events was judged to be more significant, because it correlates better with the suitability of flooded areas as wildlife habitat and with the beneficial effects of routine low water levels. For this reason, seven criteria were developed for comparing the final alternatives. Three quantitative criteria were developed for evaluating the Upper Basin outputs. Four criteria were used for measuring the performance of the alternatives in achieving river restoration. The seven criteria are:

* average duration, in days, of water levels greater than 52.5 feet, the present regulated maximum of the lakes;

* average duration of water levels lower than 49 feet;

* coefficient of variation of the daily records over the 18 period of record - provides a measure of overall variability of water levels from the mean;

* average duration (days) with greater than 90 percent floodplain inundation in the wet season (June 1 - Oct 31);

* average duration (days) less than 200 cfs flow at S-65, in wet season;

* average duration (days) with greater than 25 percent floodplain inundation, Jan 1 - May 31;

* average duration (days) less than 200 cfs flow at S-65, Jan 1 - May 31.

A formula was devised to provide an overall ranking of the final two alternatives and to compare these alternatives with the period of record. The overall ranking (R) equals the weighting factor (W) for each criterion times the individual ranking value (r) for each criterion, summed across the 7 criteria:

$$R = W_{c1} x r_{c1} + W_{c2} x r_{c2} + \ldots \; W_{c7} x r_{c7}$$

The individual ranking value (r) for each criterion is a value from 0 to 1, based on the range of values observed for the alternatives and the observed values in the reference periods of record. For criteria 1, 2, 3, 4, and 6, high values are more desirable, and r is calculated as follows:

$$r = \frac{X}{X_{max}}$$

where X_{max} is the highest value for each criterion among the alternatives or the period of record.

For criteria 5 and 7, lower values are more desirable, and r is calculated as follows:

$$r = 1 - \frac{X}{X_{max}}$$

Evaluation team members assigned weighing factors, based on the following premises that account for institutional priorities. The preliminary review of water regulation schedules was based on evaluation of the timing and volume of discharges to the Kissimmee River. Although lower basin criteria was included in the final selection of the preferred schedule, it was decided that greater weight should be given to the factors relating to the Headwater lakes, that is, higher water levels and greater water level fluctuation. For the Lower Basin criteria, delivery of water to the Kissimmee River during the wet season months was considered more important than providing floodplain inundation and avoidance of low flow in the dry season.

Therefore, among the 7 criteria, the average number of days with water levels above 52.5 feet (criterion 1) and the overall variability in water levels (criterion 3) were considered most important to the evaluation for the Chain of Lakes, and were assigned a weighting factor of 2. The effects on the Lower Basin during the dry season (criteria 6 and 7) were considered relatively less important, and were assigned a weighting of 0.5. The other three criteria (2, 4, and 5) were considered to be intermediate in importance, and were assigned a weighting factor of 1.

Table 7-4 provides the ranking of the final two schedules as detailed by the USFWS in their 1994 Coordination Act Report. The RS9-D alternative rated higher than the RS11-A schedule for 5 of the 7 criteria. Although the average duration of water levels above 52.5 feet, criteria 1, is lower for RS9-D, the RS9-D schedule produces the greatest increase in frequencies of stages above 51 feet. A comparison of the observed period of record and the RS9-D stage and percent of time exceedence relationship is provided in Figure 7-2. On January 24, 1994, an Interagency Review Conference was held in the Jacksonville District for the project to discuss the results of the Service's community-level evaluation of the final alternatives. Based on the performance of the schedules, a joint decision was made by the group that the RS9-D regulation schedule was the best alternative for achieving the integrated environmental restoration objectives of the Upper and Lower Basins. Subsequently, the USFWS used individual species models on the preferred alternative to determine the potential for habitat improvements within the Upper Kissimmee Basin.

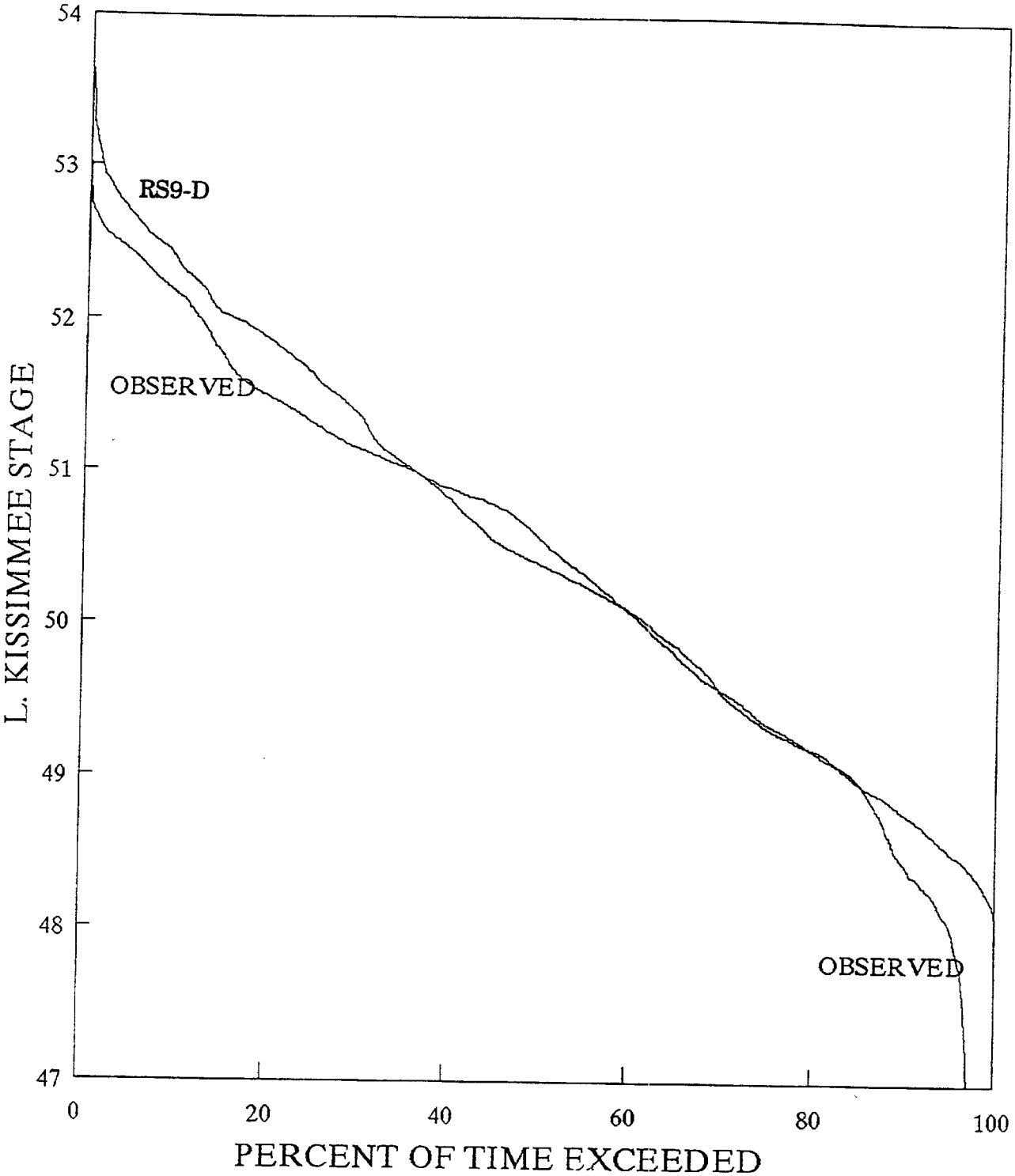
TABLE 7-4
RANKING OF THE FINAL TWO LAKE SCHEDULE ALTERNATIVES

CRITERIA	WT FACTOR (W)	"HISTORIC"			"OBSERVED"			"RS9D"			"RS11-A"		
		OUTPUT	(r)	SCORE (W)*(r)	OUTPUT	(r)	SCORE (W)*(r)	OUTPUT	(r)	SCORE (W)*(r)	OUTPUT	(r)	SCORE (W)*(r)
1	2	64.30	1.000	2.000	4.90	0.076	0.152	23.30	0.362	0.725	24.90	0.387	0.774
2	1	87.50	1.000	1.000	38.70	0.442	0.442	85.30	0.975	0.975	63.10	0.721	0.721
3	2	4.35	1.000	2.000	3.08	0.708	1.416	2.60	0.598	1.195	2.57	0.591	1.182
4	1	76.50	0.990	0.990	31.00	0.401	0.401	77.30	1.000	1.000	70.80	0.916	0.916
5	1	50.30	0.108	0.108	56.40	0.000	0.000	38.20	0.323	0.323	52.50	0.069	0.069
6	0.5	114.90	1.000	0.500	50.30	0.438	0.219	102.90	0.896	0.448	80.70	0.702	0.351
7	0.5	4.00	0.956	0.478	41.40	0.542	0.271	90.40	0.000	0.000	71.90	0.205	0.102
TOTAL SCORE				7.076			2.902			4.665			4.116

NOTES:

1 CRITERION 1 = AVE duration (days) water levels exceed 52.5 ft (Positively correlated, with weighting factor = 2)
CRITERION 2 = AVE duration (days) water levels below 49 ft. (Positively correlated, with weighting factor = 1)
CRITERION 3 = Coefficient of variation of water levels over 18-year period. (Positively correlated, with weighting factor = 2)
CRITERION 4 = AVE duration (days) with greater than 90% floodplain inundation in the wet season (June 1 – Oct 31) (Positively correlated, with weighting factor = 1)
CRITERION 5 = AVE duration (days) with less than 200 cfs flow at S-65, in the wet season. (Inversely correlated, with weighting factor = 1)
CRITERION 6 = AVE duration (days) with greater than 25% floodplain inundation, Jan 1 – May 31. (Positively correlated, with weighting factor = 0.5)
CRITERION 7 = AVE duration (days) with less than 200 cfs flow at S-65, Jan 1 – May 31. (Inversely correlated, with weighting factor = 0.5)

2 NOTE: (r) = individual ranking value
3 NOTE: HISTORIC PERIOD (1939-42; 1945-58)
4 NOTE: OBSERVED (1970-1988)
5 NOTE: REFER TO TEXT FOR EXPLANATION OF CRITERIA AND THE CALCULATION OF THE TOTAL SCORE



RS9-D
15 Nov 93

FIGURE 7-2

7.6 ENVIRONMENTAL RESTORATION ANALYSIS OF THE RECOMMENDED LAKE REGULATION SCHEDULE

7.6.1 Wetland Restoration

In their 1994 report, the USFWS conducted an analysis to determine the extent of additional acreage of wetlands that would be restored by higher water levels in Lakes Kissimmee, Hatchineha, and Cypress once the recommended schedule was implemented. According to the Service's report, the waterward edge of the marsh around the lake shores should not change as a result of the proposed project because of the predominance of highly tolerant wetland plants at the waters edge. The minimum hydrologic regime for determining wetlands is generally accepted as continuous saturation for at least 5 percent of the growing season. Assuming that the growing season is year-round in the study area (the most rigorous standard), this equates to 18 days of continuous saturation.

All durations were derived from model simulations over an 18 year, post-channelization (1970-87) period. The model has been calibrated for stage, but underestimated discharge during the simulation period by approximately 20 percent. During the 18-year period used for model simulations, the Upper Basin received approximately 10 percent less rainfall, and as a result, contributed 40 percent less average annual runoff to the Lower Basin than during the pre-regulation period of record (Obeysekera and Loftin, 1990).
As a result of using a drier period of the historical hydrological record, the wetland outputs are considered conservative. During periods of normal or above normal rainfall both basins would attain significantly greater benefits then the simulation model predicted. The observed 1970-1988 period had an average duration of 18.2 days saturation at an elevation of 52.19 feet. While the RS9-D alternative provided an average duration of 19.25 days saturation at 52.87 feet. The Service generalized the findings of the hydrologic analyses and assumed that the present upper end of wetlands is approximately 52 feet and the with project upper end of wetlands would be 52.5 feet. Based on the Service's evaluation, the revised lake regulation schedule would restore about 5,939 acres of additional littoral marsh relative to the present condition excluding the breaching of local farm levees. If all three of the local farm levees, which were identified by the USFWS, adjacent to the shorelines of Lakes Kissimmee, Hatchineha, and Cypress are breached about 7,236 of acres of marsh would be restored.

7.6.2 Fish and Wildlife Habitat Modelling

As a cooperating agency with the U.S. Army Corps of Engineers in this study, the U.S. Fish and Wildlife Service (USFWS) gathered data and constructed models of the habitat requirements (species models) of representative faunal species in the Upper Basin (Annex D). The models were used with a grid-cell-based Geographical Information System (GIS) to quantitatively evaluate the final alternative lake regulation schedule. As a result of using a drier period of the historical hydrological record (see Paragraph 7.6.1), the habitat unit outputs are considered conservative. During periods of normal or above normal rainfall both basins would attain significantly greater benefits then the simulation model predicted. Evaluation species were those listed below:

1. Snail kite (Federally endangered)
2. Florida sandhill crane (State threatened)
3. Bald eagle (Federally endangered)
4. Audubon's crested caracara (Federally threatened)
5. Wood stork (Federally endangered)
6. Florida mottled duck (resident game species)
7. Snowy egret (State species of special concern)
8. Largemouth bass (sport fish species)
9. Great egret (widely ranging, opportunistic predator)
10. Ring-necked duck (migratory game species)

Table 7-5 presents the results of the species models in terms of habitat units for the recommended lake regulation schedule. The total reflects that local farm levees surrounding the effected lakes will be breached to hydrologically connect the existing wetlands with the lakes and allow additional restoration. Section 7.6.3 presents an analysis which demonstrates the cost effectiveness of breaching the local farm levees to obtain the full potential for environmental benefit in the Upper Basin.

TABLE 7-5
HABITAT UNITS (ACRES X HSI)
FOR EXITING AND RECOMMENDED PLAN

SPECIES	WITHOUT PROJECT	WITH PROJECT	CHANGE
FLORIDA DUCK	6,755	9,119	2,364
RING-NECK DUCK	11,516	15,015	3,499
SNAIL KITE	659	839	180
GREAT EGRET	17,619	21,509	3,890
SNOWY EGRET	13,943	16,501	2,558
WOOD STORK	16,491	18,353	1,862
LARGEMOUTH BASS	38,174	38,937	763
BALD EAGLE	31,827	32,102	275
SANDHILL CRANE	63,452	63,208	(244)
CRESTED CARACARA	41,486	41,618	132
ALL SPECIES	241,923	257,201	15,278

7.6.3 Levee Breaching Cost Effectiveness Analysis

Lands up to the 54 foot elevation will be periodically reflooded with the implementation of the recommended lake regulation schedule. Throughout Lakes Kissimmee, Hatchineha and Cypress, several farm levees were constructed adjacent to the lakes by land owners prior to implementation of the flood control project. Plate 8-1, Project Plan Plate, shows the location of five local farm levees which are within the influence of the proposed regulation schedule. Three were identified by the USFWS in their Coordination Act Report. Two more where identified later in the study. These levees have encroached upon the historic lake littoral zone, separating the large, historic, lake bottom marshes from the lakes. In each case, either drainage canals or pump stations are in place to drain surface water run-off into the adjacent lake.

Because the levees encroach within the boundaries of the storage requirements of the proposed lake regulation schedule, e.g. 54 feet, and the levees would not provide adequate protection for lands behind the levees, lands located behind levees will be inundated as part of the project requirements. Lands located behind farm levees are not beyond the impacted areas of the proposed regulation schedule and are not considered as separable project areas. For this reason, an incremental analysis was not possible or appropriate for determining the justification for reflooding these lands. While a quantitative environmental incremental analysis cannot be performed for this project due to the lack of separable project environmental features, a modified qualitative analysis was done which describes the potential for increases in environmental performance for the recommended lake regulation schedules.

Lands behind all of the levees, are required as part of the water storage needs for the restoration of the Lower Kissimmee River Basin and would provide additional areas for environmental enhancement in the Upper Basin. A sixth levee, referred to as the Exposition levee, located along the western shore of Lake Hatchineha, was also identified, but was found to be adequate for protection against a 10 year or project level flood based on a geotechnical investigation performed by the Jacksonville District. Approximately 220 acres of land would need to be acquired if we use the land for project environmental and storage purposes. Because the cost of acquiring the land located behind the levee and degrading the levee, $451,000, was considered too high compared to the limited storage and environmental benefit, the District recommended not to acquire lands located behind the Exposition levee.

Since these levees would provide a hindrance against the hydrologic influence of the proposed lake regulation schedule, the removal of these levees would provide the full storage capacity required for maintenance of the existing project flood control project and for Kissimmee River environmental

restoration. The removal or partial removal of locally constructed levees would enhance the hydroperiod on the interior portions of the property presently being protected by the levees, allowing for expansion of the lake littoral zone in the Upper Basin. Breaching of the levees was considered as a more viable alternative to degradation of the entire levee. The breach was estimated based on providing a minimum of 100 foot gaps at approximately every one thousand feet along the levee alignment. This alternative would be less expensive than degrading the entire levee, and would provide areas for upland habitat to remain.

An analysis was performed to demonstrate the cost effectiveness of degrading five local farm levees located adjacent to Lakes Cypress, Hatchineha, and Kissimmee. Table 7-6 describes the levees and the analysis based on the value of wetlands expected for degrading the levee and on the expected Habitat value outputs as detailed by the USFWS in their Coordination Act Report. Out of the ten species modelled by the USFWS, only five showed significant changes after the project is implemented. These five species, the Florida Duck, Great Egret, Snowy Egret, Wood Stork, and the Bald Eagle, were selected for the cost effectiveness analysis. Degrading the five local levees is recommended to improve project storage capability for the Lower Basin restoration and for increasing the level of environmental enhancement in the Upper Basin. Breaching of the levees would restore an additional 1,350 acres of marsh. The total additional littoral marsh added relative to the existing condition would be 7,236 acres.

TABLE 7-6
COST EFFECTIVENESS OF BREACHING
LOCAL FARM LEVEES

							ADDITIONAL BENEFITS IF LEVEES BREACHED			
LOCAL FARM LEVEES	LENGTH (FT)	LANDS BETWEEN 52.5 & 54 FT (ACRES)	PROJECT STORAGE (ACRE-FT)	LAND REQUIRED FOR PROJT STORAGE	COST OF LAND ($1,000's)	COST TO GAP LEVEE ($1,000's)	ADDED WETLANDS PRODUCED (ACRES)	ADDED HABITAT (IN HABITAT UNITS)	TOTAL PROJECT COST	LOCAL LEVEE PROJECT RECOMMENDATIONS
LAKE CYPRESS										
1 BRONSON	13,000	700	1,110	YES	$674	$26	166	210	$700	GAP LEVEE
LAKE HATCHINEHA										
2 SPARKS CANDLER	15,000	500	810	YES	$707	$26	31	39	$733	GAP LEVEE
3 ROLLING MEADOWS	22,000	1,826	2,550	YES	$5,480	$30	1028	1511	$5,510	GAP LEVEE
LAKE KISSIMMEE										
4 OVERSTREET	14,000	171	525	YES	$274	$22	103	180	$296	GAP LEVEE
5 OASIS	2,500	205	375	YES	$256	$10	22	38	$266	GAP LEVEE

7.7 FLOOD CONTROL DESIGN OPTIMIZATION

The structural components of the recommended plan were not formulated as a measure for achieving a given level of project environmental outputs. The structural components of the plan are required to maintain the existing level of flood protection in the Upper Basin. They were not proposed as additional options for obtaining additional project environmental outputs, but necessary features of the recommended plan.

Based on our January 21, 1994, Review Conference which was held in the Jacksonville District with the South Florida Water Management District, a decision was made by the Jacksonville District to limit project induced flood impacts to the top of the proposed new Lake Kissimmee regulation schedule or 54 feet. This decision was established based on the requirements from the project authorization that is, to limit or reduce the potential for project induced flood damages on adjacent residential areas. Potential increases in post-project flood stages above 54 feet were addressed through proposed structural modifications of the existing flood control canals and outlet structure at Lake Kissimmee.

Hydrologic analyses were undertaken to define the limits of flood impacts in the Upper Basin chain of lakes. Once these impacts were developed, modelling efforts were continued to define a project design which would meet our recommended flood control constraints. The flood control design was constrained by the top of the proposed lake regulation schedule or 54.0 feet NGVD. Based on this design constraint, our modelling indicates that there will be no project induced flood impacts above the 54 foot contour. Furthermore, these flood impacts will not extend beyond the boundaries of the S-61 and S-63A control structures due to the extensive amount of residential development that is presently located and expanding in north Osceola County.

7.7.1 Design and Hydrologic Modelling Methodology

The primary purpose of the rainfall runoff modeling in this study was to analyze and compare the hydrologic effects of the existing and proposed new regulation schedules, to insure that the Kissimmee project continues to function, and to maintain the same level of flood protection in the Upper Kissimmee Basin as it was originally designed for all lands above 54.0 feet elevation.

The existing flood control project is designed to convey a 30 percent SPF (approximately a 7-year event) flood event within the C-38 canal, which translates to approximately an 11,000 cfs peak flowing in Pool A. The local

sponsor currently owns the lands necessary to withstand the 11,000 cfs flow in Pool A at a design headwater of elevation 46.3 feet at S-65A (translates to about elevation 49.5 feet at S-65 tailwater). S-65 is operated such that the total discharge at S-65A (S-65 releases plus local inflow into Pool A) does not exceed 11,000 cfs and therefore maintains flood stages within available sponsor-owned lands. Under the with-project conditions, backwater effects from the restored river section in Pool B under a 30 percent SPF flow translates to a peak stage at the S-65 tailwater of about elevation 52 feet. Any attempt to maintain a tailwater comparable to existing conditions would require the reduction of S-65 releases to less than 5,000 cfs, which in turn would lead to an unacceptable rise in the Lake Kissimmee and Upper Basin lake stages. Therefore, in order to maintain the existing level of flood protection upstream of S-65, S-65 must be operated to make full available discharges to the Lower Basin. This was the operating criteria that was used for all flood control alternatives described in this section.

The Upper and Lower Kissimmee basins were analyzed as a fully-integrated hydraulic system with the Corp's one-dimensional unsteady flow routing model, UNET. UNET provides the analytical tool for designing the structural modifications (i.e., improved canals, increased structural capacity) necessary to maintain existing flood control criteria upstream of S-65 for the recommended project. Appendix A, Hydrology and Hydraulic Analyses, provides a detailed documentation of the modelling effort and the optimization of the flood control design features.

With the combined capabilities of the UKISS and UNET models, the study allowed flood control features to be designed through a coincident frequency approach whereby flood stages are considered to result from the joint probabilities of starting water surface elevation and rainfall frequency. The starting water surface elevations for flood events vary according to the stage-duration relationship generated by the UKISS period of record routing model. The joint probability approach provided a statistical basis for the flood control project and resulted in design optimization and cost reduction of certain project features. The alternatives which were considered for flood control design optimization are described below:

a. Alternative 1 (With backfill and new regulation schedule) is the condition of restoration of the Kissimmee River and installation of the new schedule without any other structural modifications.

b. Alternative 2 (With backfill, new schedule, and enlarged canals) is the same as Alternative 1 but with enlargement of the canals C-36 and C-37 connecting Lakes Kissimmee, Hatchineha, and Cypress. The plan for C-36 calls for an increase in canal width from 48 feet to 60 feet. C-37 will be widened

from 70 feet to 90 feet. Enlargement of the canals C-34 and C-35 was found to be not necessary in order to maintain the current level of flood protection.

c. Alternative 3 (Plan 2) is the same as Alternative 2 but with an increase of 33 percent in the Lake Kissimmee outlet capacity by enlarging S-65 from a 3-bay to a 4-bay structure.

d. Alternative 4 (Plan 1) is the same as Alternative 2 but with an increase of 67 percent in the Lake Kissimmee outlet capacity by enlarging S-65 from a 3-bay to a 5-bay structure.

7.7.2 Optimization of Flood Control Design for Upper Basin

For each of the six locations (Kissimmee, Tiger, Hatchineha, Cypress, S-61 tailwater, and S-63A tailwater) shown to be affected by the regulation change, stage frequency relationships were examined for the four alternatives. Table 7-7 shows peak flood stages for the Existing Conditions and the four alternatives described in Section 7.7.1 using the proposed regulation schedule. Figures A-10 through A-21 of the Hydrology and Hydraulics Appendix also show plots of the stage-frequency curves for existing conditions and the four alternatives using the proposed regulation schedule. Review of the stage-frequency table and stage-frequency curves leads to several conclusions:

1. Alternative 1 satisfied the stage-frequency criteria for Lake Kissimmee, however, the increased stages at the upstream locations, S-61, S-63A and Lake Cypress made it necessary to improve downstream conveyance by enlarging canals C-36 and C-37.

2. Alternative 2 satisfied the stage-frequency criteria for Lakes Cypress and Hatchineha, but the improved downstream conveyance increased the level of flood stages in Lake Kissimmee above elevation 54 feet for the 25-year frequency storm.

3. Alternative 3 (S-65: 4-bay) does not restrict stage impacts on Lake Kissimmee to below elevation 54 feet for the 25-year frequency storm.

4. Alternative 4 (S-65: 5-bay) limits stage impacts at all six locations to elevation 54 feet or below (see 5. below). Alternative 4 is the recommended flood control design solution.

5. Although the S-61 and S-63A tailwater locations show minor stage impacts (0.1 feet) above elevation 54 for the recommended plan, maintenance dredging of Canals 35 and 34 to their as-built templates will eliminate these impacts.

TABLE 7-7
PEAK STAGES FOR ALTERNATIVES
FOR OPTIMIZATION OF UPPER BASIN FLOOD CONTROL DESIGN

PEAK STAGE (EL. FT)	EXIST CONDI-TIONS	ALT. #1	VS. EX.	ALT. #2	VS. EX.	ALT. #3	VS. EX.	*ALT #4	VS. EX.
5-YEAR FREQ									
S-61 TAILWATER	53.91	54.53	0.6	54.11	0.2	54.05	0.1	54.01	0.1
S-63A TAILWTER	53.85	54.49	0.6	54.03	0.2	54.01	0.2	53.98	0.1
CYPRESS	53.47	54.15	0.7	53.67	0.2	53.63	0.2	53.58	0.1
HATCHINEHA	52.87	53.82	1.0	53.39	0.5	53.35	0.5	53.3	0.4
KISSIMMEE	51.77	52.73	1.0	52.83	1.1	52.83	1.1	52.77	1.0
TIGER	52.39	52.99	0.6	53.03	0.6	52.99	0.6	52.99	0.6
JACKSON	56.8	56.8	0.0	56.8	0.0	56.8	0.0	56.8	0.0
ROSALIE	56.1	56.1	0.0	56.1	0.0	56.1	0.0	56.1	0.0
MARIAN	61.4	61.4	0.0	61.4	0.0	61.4	0.0	61.4	0.0
10-YEAR FREQ									
S-61 TAILWATER	54.53	54.96	0.4	54.47	-0.1	54.47	-0.1	54.38	-0.1
S-63A TAILWTER	54.53	54.94	0.4	54.50	-0.0	54.49	-0.0	54.43	-0.1
CYPRESS	54.16	54.62	0.5	54.09	-0.1	54.09	-0.1	53.99	-0.2
HATCHINEHA	53.69	54.29	0.6	53.85	0.2	53.85	0.2	53.74	0.1
KISSIMMEE	52.41	53.09	0.7	53.29	0.9	53.29	0.9	53.17	0.8
TIGER	52.93	53.35	0.4	53.46	0.5	53.44	0.5	53.37	0.4
JACKSON	57.4	57.4	0.0	57.4	0.0	57.4	0.0	57.4	0.0
ROSALIE	56.3	56.3	0.0	56.3	0.0	56.3	0.0	56.3	0.0
MARIAN	61.7	61.7	0.0	61.7	0.0	61.7	0.0	61.7	0.0

1. Alternative 1. - Proposed Regulation Schedule with no structural modifications.
2. Alternative 2. - Proposed Regulation Schedule with enlarging canals C-36 and C-37.
3. Alternative 3. (Plan 2) - Proposed Regulation Schedule with enlarging canals C-36 and C-37 and increasing S-65 outlet from 3 to 4 bays.

*4. Alternative 4. (Plan 1) - The Recommended Plan - Proposed Regulation Schedule with enlarging canals C-36 and C-37 and increasing S-65 outlet from 3 to 5 bays.

TABLE 7-7 (continued)
PEAK STAGES FOR DESIGN ALTERNATIVES
FOR OPTIMIZATION OF UPPER BASIN FLOOD CONTROL DESIGN

PEAK STAGE (EL. FT)	EXIST CONDI-TIONS	ALT. #1	VS. EX.	ALT. #2	VS. EX.	ALT. #3	VS. EX.	ALT. #4	VS. EX.
25-YEAR FREQ									
S-61 TAILWATER	55.96	55.91	-0.0	55.35	-0.6	55.33	-0.6	55.22	-0.7
S-63A TAILWATR	56.01	55.92	-0.1	55.37	-0.6	55.36	-0.6	55.27	-0.7
CYPRESS	55.71	55.59	-0.1	55	-0.7	54.98	-0.7	54.88	-0.8
HATCHINEHA	55.42	55.3	-0.1	54.85	-0.6	54.82	-0.6	54.68	-0.7
KISSIMMEE	53.96	53.79	-0.2	54.21	0.3	54.14	0.2	53.95	0.0
TIGER	54.08	53.96	-0.1	54.25	0.2	54.2	0.1	54.05	0.0
JACKSON	58.1	58.1	0.0	58.1	0.0	58.1	0.0	58.1	0.0
ROSALIE	56.6	56.6	0.0	56.6	0.0	56.6	0.0	56.6	0.0
MARIAN	62.1	62.1	0.0	62.1	0.0	62.1	0.0	62.1	0.0
50-YEAR FREQ									
S-61 TAILWATER	56.77	56.45	-0.3	55.88	-0.9	55.79	-1.0	55.44	-1.3
S-63A TAILWATR	56.84	56.45	-0.4	55.89	-1.0	55.82	-1.0	55.5	-1.3
CYPRESS	56.56	56.19	-0.4	55.58	-1.0	55.5	-1.1	55.12	-1.4
HATCHINE[illegible]	56.41	55.94	-0.5	55.49	-0.9	55.39	-1.0	54.93	-1.5
KISSIMMEE	55.13	54.34	-0.8	54.88	-0.3	54.68	-0.5	54.08	-1.0
TIGER	55.15	54.44	-0.7	54.88	-0.3	54.71	-0.4	54.23	-0.9
JACKSON	58.4	58.4	0.0	58.4	0.0	58.4	0.0	58.4	0.0
ROSALIE	56.8	56.8	0.0	56.8	0.0	56.8	0.0	56.8	0.0
MARIAN	62.4	62.4	0.0	62.4	0.0	62.4	0.0	62.4	0.0

7.7.3 S65A REMOVAL OPTION

The removal of S65A was considered by the 1985 Kissimmee River Final Feasibility Report, the SFWMD's 1990 "Kissimmee River Restoration Alternative Plan Evaluation and Preliminary Design Report" and the 1991 Kissimmee River Restoration Feasibility Study. The option was never pursued because of the uncertainty of the potential overdrainage of the Pool A floodplain. The current combined Upper and Lower Basin UNET modelling indicates that flood stages will be higher in Pool A of the Kissimmee River than originally modelled for the 1991 feasibility study. The S65A removal option resurfaced for this study as a possible measure for reducing the additional land requirements in the Kissimmee River Pool A and for reducing or eliminating any structural improvements at S-65.

The UNET model was used to assess the potential overdrainage problem arising from the removal of S65A. Flood flows, average daily flows and low flow conditions out of S65 were modelled to determine the range of potential stage impacts in Pool A.

The removal of S65A appears to lower Lake Kissimmee and Pool A stages during the extreme flood flows (25 year and larger). Lower stages during average daily flow conditions indicate possible overdrainage of the Pool A floodplain. Water levels in Pool A could be lowered as much as 2 to 5 feet, depending on the average daily flows. The lower stages would likely overdrain the surrounding floodplain and adjacent tributaries resulting in a reduction in available groundwater. As such, the projected environmental outputs of the authorized recommended plan will be reduced. Potential environmental and navigational impacts would necessitate implementation of engineering and/or mitigation measures to reduce or avoid project induced damages.

Based on the U. S. Fish and Wildlife Service's 1991 Coordination Act Report, maintaining the gated spillway structure could provide the operational flexibility desired for the accomplishment of pool stage fluctuation and a flow-through impounded marsh in the Pool A area. The marsh feature would add approximately 3,214 acres of wetlands to Pool A. Based on a preliminary UNET model evaluation, the removal of S65A does not remove the requirement to increase the outlet capacity at S65. The model indicates that the S65A removal alternative would result in a net increase in flood stages above 54 feet. Therefore, the S65 structure would have to be modified to compensate for the increase in flood stages.

In order to determine the cost effectiveness of the S65A removal alternative, cost estimates were developed for comparison to the recommended plan. Annual operation and maintenance costs were not included in the comparison. The cost of the S65 structural improvements including the additional land requirements in Pool A (above 1991 feasibility levels) were compared with the option of S65A removal and tieback levee degradation. Table 7-8 summarized the S65A analysis. The cost of the recommended S65 structural improvements is approximately $3.0 million. The cost to provide the S65A removal option, excluding overdrainage or environmental mitigation measures, is approximately $3.7 million. Additive measures, whether levee impoundments or small weirs in the tributary areas to hold water levels up in Pool A, would increase the cost further. Therefore, this option was not considered further.

TABLE 7-8
COST COMPARISON OF RECOMMENDED S65 IMPROVEMENTS AND S65A REMOVAL ALTERNATIVE

ITEM	COST OF RECOMMENDED PLAN	COST OF S65A REMOVAL
S65 MODIFICATIONS	$3,000,000	$2,000,000
LANDS	$ 365,000	UNKNOWN
REMOVE S65A AND TIEBACK LEVEES		$1,105,000
CONTROL WEIR		$ 620,000
ENVIRONMENTAL MITIGATION MEASURES		UNKNOWN
TOTALS	$3,365,000	$3,725,000

1. S65A ESTIMATE BASED ON UPDATED COST TO REMOVE S65B.
2. WEIR COSTS BASED ON UPDATED COST FROM 1990 SFWMD KISSIMMEE RIVER REPORT.

7.7.4 Tributary Impact Analyses of Recommended Flood Control Plan

Lakes Jackson, Tiger, and Rosalie and are connected directly to Lake Kissimmee either through natural tributaries or man-made canals. Hydraulic analyses were conducted to determine if and to what extent an increase in the Lake Kissimmee regulation schedule would impact the flood stages in the three lakes and tributaries.

a. Lake Jackson - Lake Jackson is connected to Lake Kissimmee through Jackson Canal, a man-made canal approximately 2.75 miles in length. The Lake Jackson Water Control Structure (LJWCS), installed in 1994, was designed to maintain Lake Jackson at a higher stage (elevation 53.5 feet) in order to improve the aquatic habitat of the lake. Although the peak stages in Lake Jackson increased after the LJWCS was installed, these impacts are attributable to the structure itself and to the higher regulation schedule for Lake Jackson. These locations are sufficiently elevated to remain unaffected by the changes in the Lake Kissimmee regulation schedule and S-65 capacity. Stage impacts resulting from the increased Lake Kissimmee regulation schedule were limited to river mile 6.0 to 6.5 along Jackson Canal and would be on the magnitude of only 0.1 feet. Lake Kissimmee is considered to be at river mile 5.25 and LJWCS at river mile 7.5.

b. Lake Tiger - Lake Tiger is connected to Lake Kissimmee through Tiger Creek, a small, mildly meandering natural stream which flows through a flat, swampy expanse of marshes over a distance of 9,000 feet. Since Lake Tiger and Lake Kissimmee are at essentially the same natural ground elevation and since no water control structure is currently installed on Tiger Creek, the peak flood stages for the two lakes are intrinsically linked and are nearly identical for floods above elevation 54 feet. Under normal stage and flow conditions, the head loss through Tiger Creek generally results in Lake Tiger exhibiting a 0.1 to 0.5 feet higher water stage than Lake Kissimmee. The head loss may increase to over 1 foot in the early phases of a flood when discharges through Tiger Creek are high and the Lake Kissimmee stage is still relatively low (i.e., less than elevation 51 feet). However, as the stage in Lake Kissimmee rises due to a larger flood event and approaches or exceeds 54 feet, the head difference between the two lakes is reduced to 0.1 feet or less. Since the Lake Tiger flood stage is intrinsically linked to the Lake Kissimmee flood stage, outside of isolating Lake Tiger and installing a substantial pump station, there is no structural measure to insure that the Lake Tiger with-project stages can be reduced below those of Lake Kissimmee. The Lake Tiger evaluation is described in the following paragraphs.

Several structural alternatives and combinations of the alternatives were considered and evaluated for construction at the Tiger Creek location to reduce flood stages in Lake Tiger. Since the Lake Tiger flood stage is intrinsically linked to the Lake Kissimmee flood stage, the only structural alternative to reduce with-project flood stages below Lake Kissimmee is isolating Lake Tiger and installing a substantial pump station.

Sizing of the pump station based on the critical 25-year flood frequency indicate that a 1650 cfs capacity pump station would be required at the Tiger Creek outlet of Lake Tiger. A preliminary cost estimate for a 1650 cfs pump station was prepared. Estimated cost is $10,647,000. The estimated cost of land acquisition at Lake Tiger, including the costs of lands, administration, and contingencies is $3,000,000. Additional costs associated with the station superstructure, inlet and outlet channels, culverts and tieback levees extending to high ground would escalate the total cost of the pump station even higher. Furthermore; annual operating and maintenance costs as well as environmental mitigation are additional considerations making the pumping option even less attractive.

Therefore, the flood control solution for Lake Tiger must be similar to that already recommended for Lake Kissimmee, which is a combination of implementing Plan 1 (C-36 and C-37 improvements, S-65 enlargement) and acquiring interest in lands to elevation 54 feet around Lake Tiger.
Project lands lying between the 52.5 foot contour and the 54 foot contour would need to be acquired based on a flowage easement. A perpetual flowage easement is being recommended over fee acquisition due to the limited post-project environmental benefits within the Lake Tiger littoral zone.

TABLE 7-9
ELIMINATION OF LAKE TIGER TRIBUTARY IMPACTS

ALTERNATIVE MEASURE	PLAN 1	PLAN 2
1. FLOWAGE EASEMENT AROUND LAKE TIGER	$3,000,000	NO COSTS
2. INSTALL 1650 CFS PUMP STATION BETWEEN LAKE TIGER AND KISSIMMEE	NO COSTS	$10,647,000
3. INSTALL CULVERTS AND TIEBACK LEVEES	NO COSTS	NOT ESTIMATED
TOTAL COSTS	$3,000,000	$10,647,000 +

c. Lake Rosalie - Lake Rosalie is connected to Lake Kissimmee through Zipperer Canal, a man-made canal about 2.0 miles in length. G-113, a SFWMD weir structure is installed in the canal about 1.6 miles downstream from Lake Rosalie and maintains Lake Rosalie at a higher stage, normally between elevation 54.0 to 54.5 feet. The natural outlet of Lake Rosalie, however, is Rosalie Creek, a meandering stream at the south end of the lake, which discharges at a natural sill elevation of 50 feet downstream to Lake Tiger. The weir will prevent any backwater effects due to an increased Lake Kissimmee regulation schedule from impacting stages in Lake Rosalie.

7.8 UPPER BASIN FLOOD CONTROL DESIGN

The plan developed in Section 7.7 was designed to meet the requirements of maintaining the existing level of flood in the Upper Basin. The plan calls for widening the flood control canals C-36 and C-37 by 12 and 20 feet, respectively and increasing the outlet capacity of water control structure S-65 by 2 bays. There will be no project induced flood damages above elevation 54 feet around those lands surrounding Lakes, Cypress, Hatchineha, Kissimmee and Tiger. Lands in the Upper Basin above the S-61 and S63A water control structures will not be impacted by the recommended project. Therefore, the existing level of flood protection provided by the current flood control project will be maintained. Table 7-10 provides a comparison of the existing flood stages based on the existing conditions with the flood stages expected with the proposed lake regulation schedule and accompanying flood control measures. Based on the Table 7-10, the project will have no impact on flood stages above 54-foot elevation during severe or catastrophic events, for example, the 50 or 100 year storm events. In fact, based on the results of the hydrologic modelling, areas surrounding Lakes Cypress, Hatchineha, Kissimmee and Tiger should expect an increase in the level of flood protection based on the reduction of the 100-year flood stage.

TABLE 7-10
KISSIMMEE RIVER UPPER BASIN
EXISTING VERSUS PROJECT PEAK FLOOD STAGE COMPARISON (FT)

PEAK STAGE (FT)	RETURN PERIOD OF FLOOD EVENT IN YEARS									
	5-YEAR FREQ		10-YEAR FREQ		25-YEAR FREQ		50-YEAR FREQ		100-YEAR FREQ	
	EXIST COND.	PLAN	EXIST COND.	PLAN	EXIST COND.	PLAN	EXIST COND.	PLAN	EXIST COND	PLAN
S-61 TAILWATER	53.91	54.01	54.53	54.38	55.96	55.22	56.77	55.44	57.22	55.86
S-63A TAILWATER	53.85	53.98	54.53	54.43	56.01	55.27	56.84	55.5	57.46	55.89
CYPRESS	53.47	53.58	54.16	53.99	55.71	54.88	56.56	55.12	57.04	55.57
HATCHINEHA	52.87	53.3	53.69	53.74	55.42	54.68	56.41	54.93	56.99	55.44
KISSIMMEE	51.77	52.77	52.41	53.17	53.96	53.95	55.13	54.08	56.18	54.58
TIGER	52.39	52.99	52.93	53.37	54.08	54.05	55.15	54.23	56.18	54.69
JACKSON	56.8	56.8	57.4	57.4	58.1	58.1	58.4	58.4	58.7	58.7
ROSALIE	56.1	56.1	56.3	56.3	56.6	56.6	56.8	56.8	57	57
MARIAN	61.4	61.4	61.7	61.7	62.1	62.1	62.4	62.4	62.7	62.7

7.9 EVALUATION OF REAL ESTATE REQUIREMENTS

7.9.1 Development of Project Real Estate Requirements

As a result of the recommended regulation schedule, lands between the existing 52.5 foot regulation schedule and the proposed 54.0 foot regulation schedule will be periodically flooded. This will require acquisition of land to insure the minimum project requirements are obtained. Land acquired under the provisions of a flowage easement will generally not address the requirements of the Headwaters Revitalization Project. To achieve project environmental goals and to assure that flexibility is available to operate the regulation schedule, as necessary, to achieve the greatest environmental benefits without impacting flood control, it was determined that adequate interests in lands should be acquired to provide for flexibility in post project hydrology and to assure the full realization of fish and wildlife project potentials.

The environmental benefits achieved by modifying the regulation schedule may be affected by how the acquired land is used. If the land is acquired through minimal flowage easements, the land will be available for use by land owners during dry periods. The availability of project lands to land owners for farming and other uses could greatly reduce the environmental potential for the project. Undeveloped lands between the 52.5 foot and the 54 foot contour will require restrictions of detrimental activities, operations and structures to insure that the full project environmental objectives of the Kissimmee Headwaters Revitalization Project are met. Fee is required in agricultural areas where land uses would be detrimental to the environmental benefits being achieved for this project. The restrictions required to achieve the environmental goals would prohibit fertilizing, chopping, mowing, weeding, and cultivating practices which would render the lands unusable for highest and best use which is agricultural.

Environmental resource agencies have stated the desire to increase the duration of flooding at the 54 foot elevation. The Fish and Wildlife Coordination Act Report dated April 1994 and cover letter dated June 30, 1994, from U. S. Department of the Interior, recommends operational flexibility to increase periods of inundation between the 52.5 and 54-foot contours to increase environmental benefits. Coordination with Fish and Wildlife and the South Florida Water Management District Environmental biologists resulted in a determination by the Corps of Engineers that it will be beneficial to extend duration of water storage at the 54 foot regulation schedule when this can be accomplished without detrimental impacts to flood control. This will increase wetlands and provide even greater environmental benefits in the Upper Basin.

The U.S. Army Corps of Engineers concurs with USFWS's recommendation. The evaluation of alternative schedules will be an ongoing process after implementation of the Headwaters Revitalization Project and the Kissimmee River Restoration. Given the uncertainties of the simulations resulting from incomplete model calibration (i.e., underestimated discharge) and the relatively dry simulation period, it may be possible to modify the schedule to maintain higher lake stages for longer durations and still provide the necessary inflows to achieve restoration of the river/floodplain ecosystem. By increasing the depth to 54 feet for a longer period of time, wetlands will be restored to higher elevations than the simulations indicate. Alternatively, minor adjustments may be required to facilitate restoration of the river.

Based on the requirements of Draft Chapter 12, ER 405-1-12, and Draft Interim EC 1105-2-206, which provides guidance on acquisition of lands for environmental project modifications, fee title will be required for all lands needed to support implementation and operation of a project modification. A standard flowage easement does not provide for the restrictions of land use detrimental to the environmental aspects of the upper and lower basins. As such, the majority of lands necessary for the Kissimmee River Headwaters Revitalization Project will be acquired in fee. Justification for fee title acquisition will be for the purposes of insuring that all project environmental benefits can be obtained for the Kissimmee River Project, while including the expansion of the Upper Basin littoral zone and the restoration of the lower Kissimmee River valley, and to provide the required flood storage necessary for limiting flood induced damages to below the 54 foot contour. For this reason, project lands will be acquired in fee to insure the achievement of project environmental goals. Therefore, acquisition in fee will be required for obtaining the necessary rights to periodically reflood lands, achieving optimal environmental benefits and for insuring future operational flexibility.

Approximately 5,986 acres of land below 52.5 feet NGVD, located between Lakes Cypress and Kissimmee were previously made available for the existing Flood Control Project by Perpetual Flowage Easements. These lands are now required in fee to support the operational flexibility of the schedule and environmental restoration purposes of the project. The lands are upland and surrounded by elevations exceeding 52.5 feet NGVD. These lands have been determined not to be subject to navigational servitude as they are not hydrologically connected to the lakes. With the increase in regulation schedule and inundation of these as well as surrounding lands to 54.0 feet, it is now necessary to include these lands in acquisition of fee for the water storage requirements and to comply with environmental restoration of the project. The valuation will be for the difference between the value of interest previously provided and the value of the required fee estate.

Exceptions to fee acquisition should only be pursued in a few areas where it would be more advantageous to the government to obtain a restrictive flowage easement. These areas include, but are not limited to; existing mitigation project lands, highly developed subdivisions, and lands surrounding Lake Tiger.

7.9.2 Justification for Real Estate Interests Less Than Fee in Residential Areas

Perpetual Conservation and Flowage and Perpetual Inundation easements are recommended only where fee acquisition is not required to provide maximum environmental benefits. These areas include residential areas, State of Florida Trustee of the Internal Improvement Funds (T.I.I.F.) lands, and mitigation lands owned by the Celebration for Disney, Inc. The Perpetual Conservation/Flowage easements are recommended in densely populated areas to prohibit activities on easement lands that would be detrimental to or interfere with the Federal project.

(1) A perpetual conservation/flowage easements is recommended in dense residential areas and on State park lands (Three Lakes Management Area and Lake Kissimmee State Park). The portion of Three Lakes Management Area that is within the project and consists of 1,261.51 acres and is owned in fee by the State of Florida. Lake Kissimmee State Park is also owned in fee by the State of Florida and contains approximately 472.20 acres within the project area. It has been determined based on conclusions in the Attorney's Opinion dated January 1996, that Perpetual Conservation and Flowage Easement are recommended for acquisition in these areas. Existing uses of the lands and management practices by the Trustees of the Internal Improvement Fund (State of Florida) are not available for flood control nor environmental benefits between the 52.5 and 54.0 foot contours.

(2) The lands north of Lake Hatchineha known as Celebration lands (Walker Ranch) are owned by the Celebration Company a subsidiary of the Disney Corporation as mitigation lands for other lands of the Celebration Company and other subsidiaries of the Disney Corporation. The conditions of a Department of the Army permit and Department of Environmental Protection Permit issued December 1992, required the Celebration Company to purchase these lands in fee for mitigation purposes. The lands are to be managed by the Nature Conservatory, a non-profit corporation with fee title being conveyed to the Nature Conservatory in stages. The permit also required the Celebration Company to convey a Perpetual Conservation Easement to the State, South Florida Water Management District, Florida Game and Freshwater Fish Commission, and the Nature Conservation. The Celebration

Company conveyed a perpetual conservation easement to the Nature Conservatory, the SFWMD, the FGFWFC and the State of Florida Department of Environmental Regulation. This easement restricts the use of the property for environmental purposes. The additional right to flood, flow and store water on the property for flood control purposes is required for the Kissimmee Headwater Revitalization Project; therefore, a Perpetual Flowage Easement is recommended for the Celebration lands.

(3) The acquisition of a perpetual flowage easements is recommended for lands surrounding Lake Tiger where environmental benefits will be minimal or not realized in the areas between 52.5 and 54.0 feet impacted by the recommended regulation schedule. These lesser estates have been coordinated [illegible] Fish and Wildlife to assure that they would not be detrimental to [illegible]onmental purposes.

(4) Land requirements are also necessary in areas where ground water elevation will impact septic tanks in isolated areas requiring Water Inundation Easements (see Section 8, Recommended Plan).

7.9.3 Acquisition of Lands Behind Local Farm Levees

The acquisition of lands behind five local farm levees surrounding Lakes Kissimmee, Hatchineha and Cypress is recommended for obtaining needed water storage in the Upper Basin and to obtain the requirements for both Upper and Lower Basin environmental restoration. The lands are not a separable element of the hydrologic influences of the proposed lake regulation schedule. The levees have encroached upon the historic marsh littoral zone of the subject lakes partially impeding the designed hydrologic influences of the proposed lake regulation schedule up to the 54 foot elevation. Furthermore, the existing levee systems would be inadequate to protect lands behind the levee from the project induced inundation. Section 7.6.3 describes the additional Upper Basin environmental benefit for breaching the five levees. Plate 8-1, Project Plan Plate, shows the location of the levees.

A sixth levee, referred to as the Exposition levee, located along the western shore of Lake Hatchineha was also evaluated. Approximately 220 acres of land would need to be acquired if we use the land for project environmental and storage purposes. Jacksonville District performed a geotechnical investigation of the levee and found the levee to be adequate for protection against a 10 year or project level flood. Because the cost of acquiring the land located behind the levee and degrading the levee, $451,000, was considered too high compared to the limited storage and environmental benefit, the District recommended not to acquire lands located behind the Exposition levee.

SECTION 8

THE RECOMMENDED PLAN

8.1 RECOMMENDED PLAN HEADWATERS REVITALIZATION PROJECT

Based on the performance of the alternatives, the recommended plan for the Headwaters Revitalization Project includes the following features:

* Modification of the existing Lake Kissimmee regulation schedule. Modification of the regulation schedule is necessary for the restoration of the Kissimmee River and to expand the upper Kissimmee Lake littoral zones. (see Figure 3-1 for details).

* Acquisition of approximately 20,800 acres of land bordering the affected lakes, Lake Hatchineha, Lake Kissimmee, Lake Cypress, and Lake Tiger (PLATE 8-1, Project Area Map).

* Widening of upper basin flood control canals, C-36 and C-37. Because of the increased tailwater flood stages at S-65 resulting from the modified regulation schedule, the flood control canals connecting Lake Kissimmee to Lake Hatchineha, C-37, and Lake Hatchineha to Lake Cypress, C-36 will have to be enlarged to flatten the flood profile through the upper lakes and prevent excessive flooding.

* Increase outlet capacity at water control structure S-65. Modifications to the existing S-65 structure will be needed to reduce flood stages in Lake Kissimmee and to provide adequate discharge capacity.

* Degradation of local levees. Reflooding of lands up to the 54 foot elevation will be partially impeded by local farm levees that have been constructed within the historic lake littoral zone. Breaching of five local levees is recommended for obtaining the water storage required for achieving Lower Basin and Upper Basin restoration. Approximately 1 mile of levee sections or about 60,000 cubic yards will be degraded by backfilling adjacent borrow ditches. The five levees are located on the east and southwest side of Lake Kissimmee, north side of Lake Cypress, and the south and north side of Lake Hatchineha.

8.2 MODIFICATION OF LAKE KISSIMMEE REGULATION SCHEDULE

Modifications to the existing Lake Kissimmee regulation schedule are necessary to meet two of the five hydrologic conditions (criteria) that must be reestablished to restore the Lower Basin ecosystem. These conditions are the reestablishment of continuous flow with duration and variability characteristics comparable to prechannelization records; and reestablishment of stage hydrographs that result in floodplain inundation frequencies comparable to prechannelization hydroperiods, including seasonal and long-term variability characteristics. Increasing the upper level of lake regulation will provide an opportunity to expand the littoral zone of the upper Kissimmee basin lakes. Modification of the regulation schedule for the Upper Chain of Lakes will provide both greater, and more natural fluctuations of water levels in the lakes enhancing the peripheral marsh habitats. The beneficial effects include expansion of lake littoral zones up to approximately 14,000 acres and increased spatial and temporal dynamics produced by long term fluctuations in seasonal water levels. These dynamics are expected to increase the overall quality and productivity of littoral habitat, and create significant area of wetlands.

The upper level of the recommended lake regulation schedule will increase from elevation 52.5 feet to elevation 54.0 feet, and the schedule will be zoned to provide for a variable discharge scheme based on season and water level conditions. Even though the upper end of the schedule was expanded, the lake stages will not fluctuate within the entire 5.5 foot range every year. During wet years the upper end of the zone will be used, while the lower end will be used in dry years. The proposed schedule will seasonally reflood lands between elevations 52.5 and 54.0 feet in Lakes Kissimmee, Hatchineha, Cypress, and Tiger increasing the seasonal water storage capacity by about 100,000 acre-feet. Figure 8-1 provides a description of the recommended lake regulation schedule and operation rules.

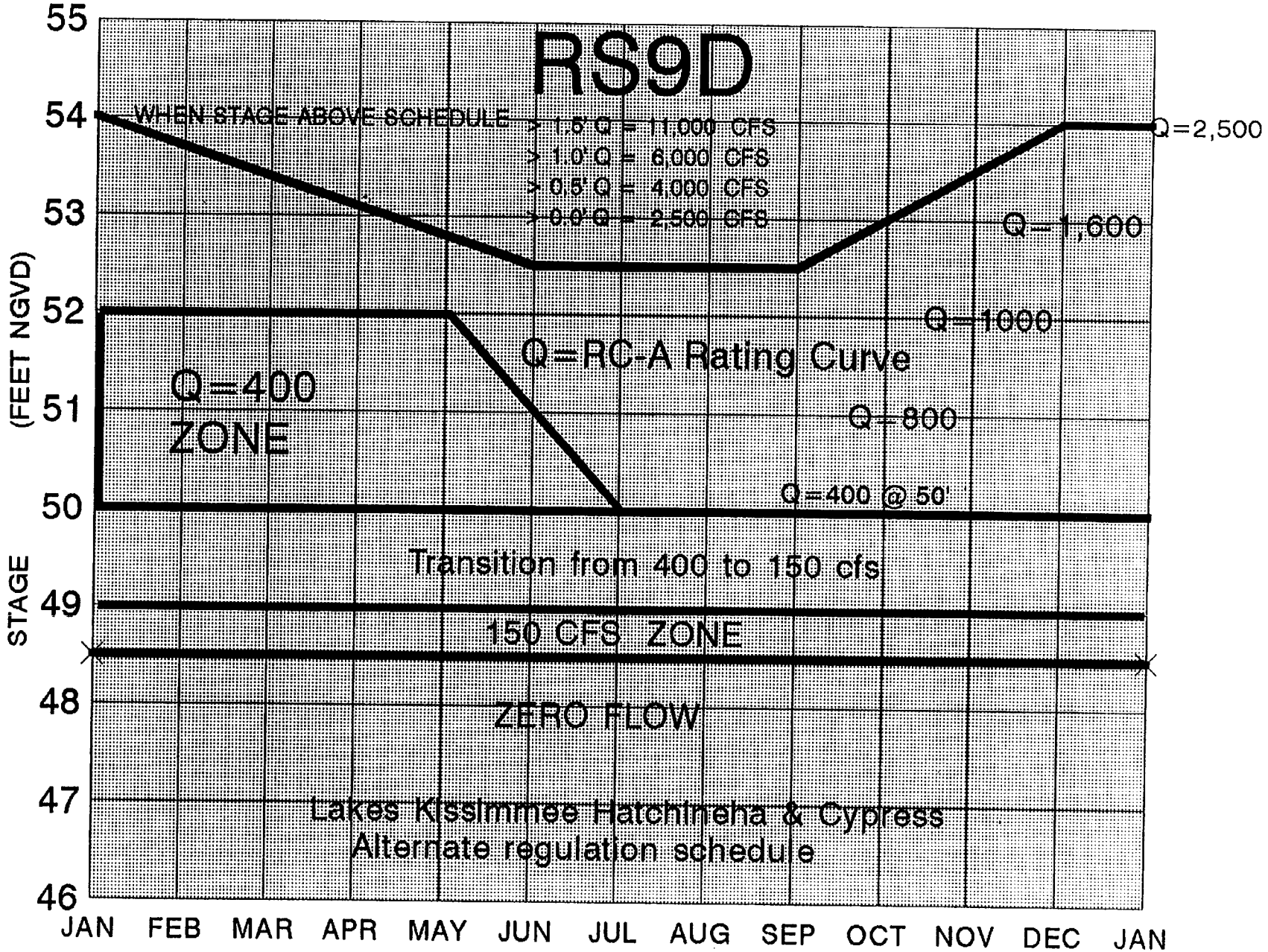

RS9D
WHEN STAGE ABOVE SCHEDULE
> 1.5' Q = 11,000 CFS
> 1.0' Q = 6,000 CFS
> 0.5' Q = 4,000 CFS
> 0.0' Q = 2,500 CFS
Q=2,500
Q=1,600
Q=1000
Q=RC-A Rating Curve
Q=400
ZONE
Q=800
Q=400 @ 50'
Transition from 400 to 150 cfs
150 CFS ZONE
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
STAGE (FEET NGVD)
55
54
53
52
51
50
49
48
47
46
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
JAN

FIGURE 8-1

8.3 LAND ACQUISITION

The environmental benefits achieved by modifying the regulation schedule may be affected by how the land is used with the project. If the land is acquired through minimal flowage easements, the land will be available for use by land owners during dry periods. The availability of project lands to land owners for farming and other uses could greatly reduce the environmental potential for the project. For this reason, project lands will be acquired in fee to insure the achievement of project environmental goals. Therefore, acquisition in fee will be required for obtaining the necessary rights to periodically reflood lands, achieving optimal environmental benefits and for insuring future operational flexibility. The operational flexibility to store water to the revised regulation schedule of 54.0 on an "as needed" basis requires acquisition of land in fee to insure the minimum project requirements are obtained. As a result of the recommended regulation schedule, lands between the existing 52.5 foot regulation schedule and the proposed 54.0 foot regulation schedule will be flooded when necessary to obtain water storage required to meet Lower Basin and Upper Basin requirements.

Reflooded lands affected by the lake regulation schedule below elevation 54.0 feet will have to be acquired to insure that the minimum project requirements are obtained. Approximately 20,800 acres of affected lands surrounding Lakes Kissimmee, Tiger, Hatchineha, and Cypress will be acquired based on achieving the full potential of project purposes. Approximately 5,986 acres of this land, located below 52.5 feet elevation between Lakes Cypress and Kissimmee, were previously required and made available for the existing flood control project. These lands are now required in fee to allow the operational flexibility to meet the storage requirements in the Upper and Lower Basin for environmental restoration. The lands are upland and surrounded by elevations exceeding 52.5 feet NGVD. These areas were inundated when the lake stage was raised up to 52.5 feet and were, therefore, required previously for flood control purposes. With the increase in regulation schedule and inundation of these as well as surrounding lands to 54.0 feet, it is now necessary to include these lands in acquisition of fee for the environmental restoration project. The valuation will be for the difference between the value of flowage easement previously provided and the value of the required fee estate. Appendix H, Real Estate Supplement provides a detailed description of land requirements. Lands surrounding Lake Jackson and Lake Rosalie will not be required for project purposes.

Lands located below 54.0 feet behind local farm levees will be flooded and additional environmental benefits achieved. Lands will be acquired in fee in these areas except for lands north of Lake Hatchineha known as Celebration lands owned by the Disney Corporation as mitigation lands for Disney World.

The interest in these lands will be a Perpetual Conservation and Flowage Easement.

The following estates are required: fee title; fee title with reservations of riparian rights as well as grazing (beef cattle only); fee title with reservations of riparian rights as well as road access in several parcels; a perpetual flowage easement over the Celebration lands; perpetual conservation/flowage easements in dense residential areas and on State park lands (Three Lakes Management Area and Lake Kissimmee State Park); perpetual conservation/ flowage easements with the right to prohibit, remove or fill septic systems in Hatchineha Estates; Water Inundation Easements; and perpetual flowage easements surrounding Lake Tiger where environmental benefits will not be realized in the areas between 52.5 and 54.0 feet impacted by the recommended regulation schedule. Land acquisition of approximately 20,800 acres bordering the four lakes impacted by the increased storage and restoration will be required.

8.4 ENGINEERING ALTERNATIVES FOR IMPACTED RESIDENTIAL SEPTIC SYSTEMS

8.4.1 Septic System Impacts

All of the homes and businesses in the lakeside study area use septic tanks with drain fields to dispose of their sewage. Most are individual on-site below-ground installations with both the tank and the drain field below the general ground level. There are a few cluster systems in place where the effluent from several sources is disposed of in a common drain field. There are also a few mounded drain fields in the area.

To function properly, typical septic systems should have the discharge pipe invert at least two feet lower than the top of the septic tank and resting on at least six inches of gravel. The gravel layer should be at least one foot above the "seasonal high water table". If the lake elevation is increased to 54 feet MSL for part of the year, it would likely cause septic systems whose tanks/drain fields are too low to malfunction. This would create an intolerable health hazard as untreated sewage would be discharged to the Kissimmee.

Based on the criteria developed by the Corps and the SFWMD, septic systems with a top of tank elevation of 56 feet or lower would be considered impacted under the operation of the modified lake regulation schedule. This is based on application of the vertical clearance requirement of 3.5 feet from the seasonal high water level. The seasonal high water level was taken to be the maximum scheduled lake elevation during the wet season, or 52.5 feet. All

septic tanks located with top of tank below the 56-foot elevation must be replaced with mounded septic tanks or if onsite cure is not possible, be acquired in fee. An engineering analysis was completed by the Jacksonville District of several alternatives.

Mounded systems are proposed as replacements in those areas where basic criteria for their use can be met. The criteria are: sufficient land to site a mounded system; mound could be sited with at least five-foot setbacks from property lines; and mound could be sited at least 150 feet from delineated bodies of water. The proposed repair methods are as follows:

1. On-site mounded system: The repair for an impacted lot will require installation of a four-foot diameter manhole, a dosing pump station, and a raised mound. This repair is feasible if the raised 34'x44' mound can be sited on the lot and maintain 150-foot setbacks from water courses.

2. Off-site mounded system: In situations where the site did not meet setback requirements from bodies of water or the lot was too small, the raised mound could be sited on a vacant lot.

3. Cluster Systems: When several adjacent lots are too close to a water body or lot sizes are too small, a remote cluster system can be used. In this design, a mounded system is located off-site with a dosing pump station. Sewage effluent from two to six residences would be pumped to this central dosing pump station.

Table 8-1 describes the number of likely impacted systems and the possibility for using mounded systems in different locations. Parcels in areas where an onsite cure is permittable and feasible (mounded septic tanks) were appraised using the Water Inundation Easement. Parcels which cannot be cured would be acquired in fee.

TABLE 8-1
SEPTIC SYSTEM IMPACTS

Fish Camps	Total Lots	Estimated Total Lots Impacted by Lake Operation Over 52.5 feet	Can Be Corrected by On-Site Mounded System	Can Be Corrected by Off-Site Mounded Systems	Off-site Cluster System (No. of lots)	Sewered Lots
Shady Oaks	107	85	58	8	7(19)	0
Rocks Fish	116	77	49	2	9(26)	0
Grape Hammock	127	12	4	0	2(8)	0
Hatchineha Estates[1]	306	61	0	0		61
The Oasis	6	6	0	0	1(6)	0

[1]Note the only method of correction is to connect the impacted lots to a sewer system.

8.4.2 Hatchineha Estates

There are approximately 306 lots in Hatchineha Estates with an estimate of 61 impacted with no means of an onsite cure. This subdivision consists of waterfront lots situated on man-made canals, and 150-foot setbacks cannot be achieved. In addition, there are no vacant lots where off-site mounded systems could be placed. These septic systems do not meet current permitting criteria, but were "grandfathered" in for zoning purposes because they were built long before the zoning laws were developed. For purposes of the project cost estimate, these parcels were appraised in fee acquisition.

The non-Federal sponsor has indicated a preference to construct a sewer system in lieu of acquisition. Construction of a sewer treatment system was determined to be a feasible alternative to land acquisition for Hatchineha Estates based on a cost comparison. If constructed, the construction of the facilities will be a non-Federal responsibility. A perpetual conservation/flowage easement with the right to prohibit existing and future septic tanks, and the right to fill and remove exiting septic tanks, as well as a release will be acquired from landowners required to participate in the hookup to the recommended sewer treatment plant.

The estimated construction cost including construction, supervision and inspection and contingencies is $2,834,000 for the residences impacted versus estimated real estate costs of acquisition, 91-646 relocation, administration and contingencies totalling $9,260,000. The construction cost estimate is based on a Jacksonville District Corps of Engineers analysis. The sponsor will receive credit for fee acquisition if the sewer treatment system is not implemented. The project sponsor may receive LERRD's credit as a "cost to cure", if the sewer treatment system is implemented. The maximum will be set at the Corps estimate for construction of the sewer treatment plant .

8.5 ENLARGE FLOOD CONTROL CANALS

A design constraint was placed on the restoration objective to insure that the same level of flood protection was maintained in the Upper Kissimmee Basin once the project was implemented. Additionally, the proposed regulation schedule would not adversely impact existing flood protection upstream of C-34 and C-35 (i.e., Lakes Gentry and Tohopekaliga, respectively).

Hydrologic modelling was completed to detail the affects of the proposed Lake Kissimmee Regulation Schedule. Based on the results of the model, flood stages would be substantially increased at Kissimmee, Hatchineha, and Cypress. By enlarging canals C-36 and C-37, flood impacts in Lake Hatchineha and Cypress were reduced to levels below the 54 foot elevation. The canal enlargements also reduced the tailwaters at S-61 and S-63A such that the flood impacts from the proposed Lake Kissimmee regulation schedule did not extend upstream of the spillways (i.e., into Lakes Tohopekaliga and Gentry, respectively). Modifications to canals C-34 and C-35 were not found to be necessary. However, excess shoal material presently existing within the canals should be removed.

C-36 will be widened from 48 feet to 60 feet, requiring the excavation and disposal of 125,000 cubic yards of material. Widening and disposal will be performed on the canal's west bank in order to avoid impacts to existing cypress trees on the eastern bank. Canal widening would increase the canal's discharge capacity by about 15 percent for a 10-year event. Likewise, C-37 will be widened from 70 feet to 90 feet, requiring the excavation and disposal of approximately 330,000 cubic yards of material. Canal widening would be performed on the canal's east side only. C-37 widening would increase the canal's discharge capacity by about 20 percent for a 10-year event. All dredged material will be placed on the existing canal spoil areas within the adjacent right-of-ways. Typically, the cut sections will be excavated on a 1 vertical to 2.5 horizontal slope.

In addition to these design quantities, approximately 700,000 cubic yards of excess shoal material will need to be removed in area canals. Canals C-35, C-36 and C-37 will require the removal of 170,000 cubic yards, 160,000 cubic yards, and 373,000 cubic yards, respectively, of shoal material. The costs of removing the excess material will be included as part of the sponsor's responsibility for operation and maintenance.

8.6 STRUCTURE S-65 MODIFICATIONS

In order to maintain the existing level of flood protection above 54 feet the outlet capacity of the existing S-65 gated spillway structure will be increased by about 66 percent. The increase in outlet capacity will be provided by the addition of two concrete bays on the east side of the existing three bay structure. The discharge capacity will be increased from a maximum of 11,000 cfs to about 18,000 cfs. In addition to the structural modification, the existing entrance and exit channels to the structure will be enlarged to realign with the new structure configuration. The modified channel will be designed to reduce scour and provide adequate getaway capacity from the structure.

Although the S-65 discharge capacity will be increased by 66 percent, the probability of ever being able to discharge 18,000 cfs for an extended period is remote. Under a relatively small flood, the amount of inflow to the lake and the insufficient head differential across S-65 (because of tailwater elevation) will result in sustained maximum discharges of less than 11,000 cfs. It will not be until larger floods, when Lake Kissimmee approaches elevation 54 feet and continues to rise, that the advantage of the increased outlet capacity will be realized. Only under an extreme or nearly catastrophic event would there be sufficient head across the structure (i.e. Lake Kissimmee stages greater than 56 feet) to discharge 18,000 cfs to the Lower Basin.

8.7 DEGRADE LOCAL LEVEES

The breaching of locally constructed levees and dikes will increase the hydroperiod on interior portions of land presently being protected by levees. In order to insure adequate project water storage requirements, project design integrity, and to increase Upper Basin project environmental outputs, five local farm levees (spoil mounds) within the project area have been designated for degradation.

Levees will be degraded by pushing the mounded fill back into the adjacent borrow source ditches. The earth will be graded to the extent necessary to restore the area to its natural ground elevation. No offsite

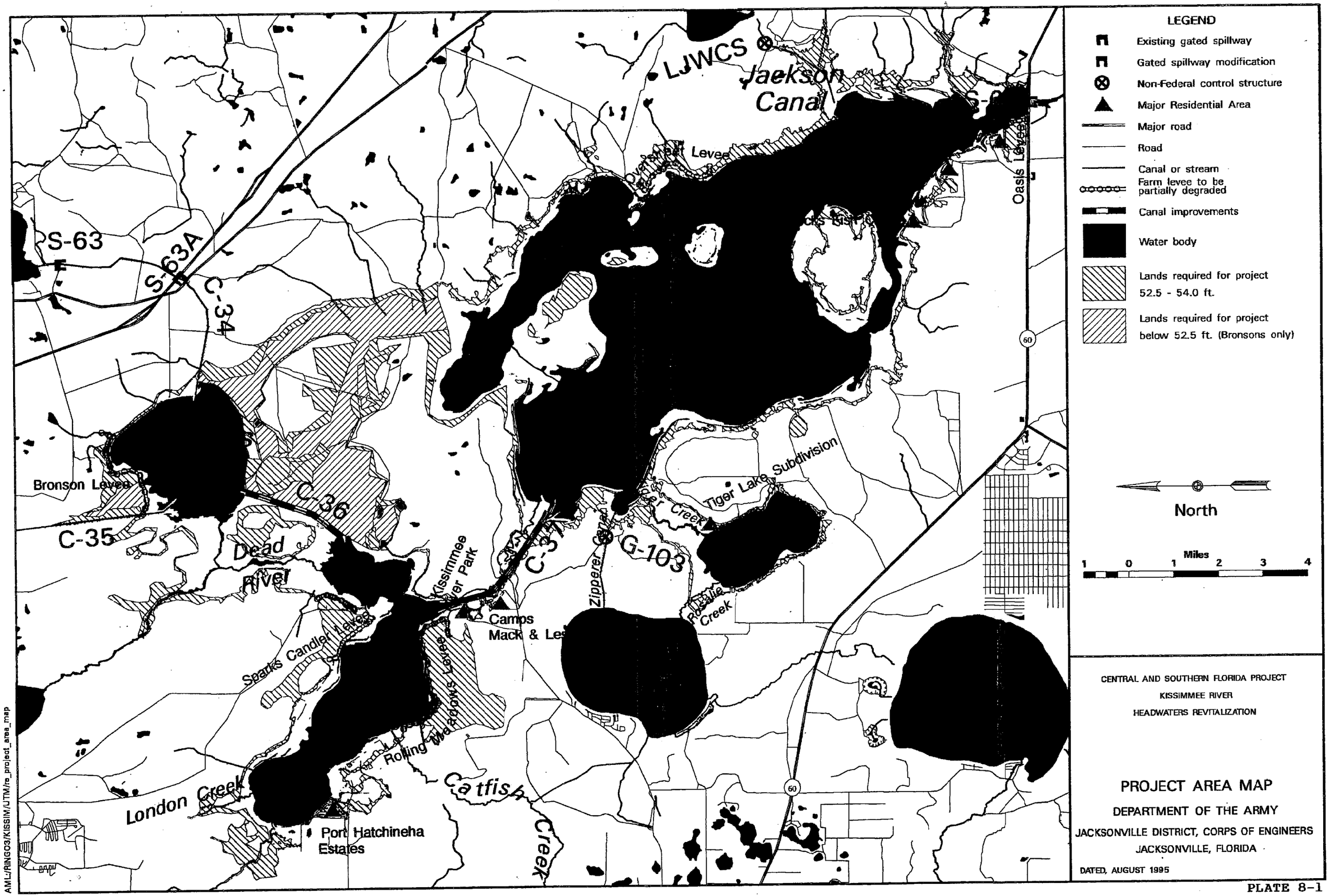
disposal areas will be required for the operation. The levees will be breached in a series of 1 hundred foot gaps without substantially impeding the flow of flood waters landward of the levees. Gaps will be spaced at approximately 1,000 foot intervals. Gap spacing will be optimized to correspond with degrading low lying areas first and to avoid areas with large trees. Tree lined areas will remain intact to maintain patches of upland habitat.

8.8 SUMMARY OF RECOMMENDED PLAN COMPONENTS

A summary of the recommended plan features is provided in Table 8-2 below. The table includes all project features necessary for implementation of the Headwaters Revitalization component of the Kissimmee River Project.

TABLE 8-2
SUMMARY OF RECOMMENDED PLAN FEATURES

PROJECT FEATURE	PURPOSE	LOCATION OF BENEFIT
1. Modified Lake Kissimmee Regulation Schedule and Operation Rules	Kissimmee River restoration and expansion of Upper Basin littoral wetlands	Upper and Lower Kissimmee Basin
2. Acquisition of 20,800 acres of land bordering Lakes Kissimmee, Hatchineha and Cypress	Environmental restoration, Flood Control, Operational Flexibility	Upper and Lower Basin
3. Widen Canals C-36 and C-37	Flood Control	Upper Basin
4. Increase Outlet capacity of Lake Kissimmee water control structure, S-65	Flood Control	Upper Basin
5. Breaching of five local farm levees	Flood Control Storage, Environmental Restoration	Upper and Lower Basin
6. Construction of Hatchineha Estates Package Sewage Treatment Facility	Mitigation for flood impacts	Upper Basin



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SECTION 9

EVALUATION OF ENVIRONMENTAL EFFECTS OF RECOMMENDED PLAN

9.1 EFFECTS ON LOWER BASIN

Hydrological, hydraulic, and ecological analyses of alternative restoration plans by the SFWMD (Toth, 1991; US Army Corps of Engineers, 1991) produced evidence that the combination of backfill in the Lower Basin and restored flow from the Upper Basin would provide the necessary conditions to restore the ecological integrity of the river/floodplain ecosystem. Wetland plant communities would become reestablished on reflooded former spoil sites and drained sections of floodplain. The recommended plan was determined to be the best plan to achieve the desired effects in the Lower Basin while meeting the needs of the Upper Basin, i.e., flood control and navigation.

Discharges provided by the recommended modifications to the Lake Kissimmee regulation schedule and operation rules will be an integral component of the restoration of ecological integrity within the Lower Basin ecosystem. As described in the 1991 Feasibility Study, specific Lower Basin environmental benefits linked to restored inflow characteristics include:

(1) maintenance of favorable river channel dissolved oxygen regimes during summer and fall months;

(2) provision of non-disruptive river flows for fish species during their spring reproductive period;

(3) restoration of temporal and spatial aspects of river channel habitat heterogeneity;

(4) reestablishment of the full range of physical, chemical and biological interactions between the river and floodplain;

(5) reestablishment of 26,500 acres of wetlands with a complete complement of functional values, including, nutrient and sediment filtration processes, a productive food web and feeding, reproductive, nursery and refuge habitat for fish, wading birds and waterfowl.

By providing for a more natural seasonal distribution of high and low flow periods and less frequent no flow periods, the recommended plan will result in environmental benefits in the lower basin that will at least equal and probably exceed the environmental outputs documented for the preliminary schedule modifications that were described in the 1991 Feasibility Study. Figure 9-1 compares the simulated monthly Lake Kissimmee discharge characteristics (based on percentage of total volume) for the proposed regulation schedule against the historic or pre-project period from 1934 to 1962, and the post-regulation (1970-88) period. The proposed schedule redistributes average and high flow volumes in a more natural seasonal pattern similar to the pre-project conditions. The percentage of discharges during the wet season are shown higher in the proposed project compared to the pre-project conditions because of the flood control restraints.

Restoration of the structure and function of the river's floodplain wetlands requires reestablishment of historical floodplain inundation characteristics and recession rates. Based on the dechannelization of the Kissimmee River, the historic Lake Kissimmee discharge/ Fort Kissimmee stage relationships were used to generate expected stage hydrographs and associated floodplain inundation from 15-day moving averages of simulated daily discharges from the headwater lakes, Figure 9-2. Figure 9-2 shows that even during the relatively dry simulation period, the new regulation schedule and operation rules produced inundation frequencies comparable to the historical period over 80 percent of the floodplain.

Restoration of the altered physical and hydrologic determinants of ecological integrity, through backfilling and the other features and operation of the modified plan, will lead to reestablishment of the natural structure and functioning of the Kissimmee River ecosystem. This, in turn, will lead to reestablishment of most of the fish and wildlife and other biological attributes of the pre-channelization ecosystem. The plan will reestablish the ecological integrity of the Kissimmee River by restoring the river's pre-channelization form and more natural hydroperiod and flow discharge characteristics over about fifty square miles of the river and floodplain ecosystem in the Lower Basin. The restored ecosystem will include 56 continuous miles of rejuvenated or recreated river channel, which will provide flow over reestablished floodplain wetlands. Levees, disposal piles, and other obstructions to movements of water, energy and biological components will be removed; and biological, chemical, and hydrological interactions between the river and its floodplain will be reestablished. Restoration of physical form and hydrologic conditions will lead to reestablishment of the dynamic food webs, habitat heterogeneity, water quality, energy flow, and other 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 diverse communities that historically constituted the Kissimmee River ecosystem will redevelop. Tables 9-1 and 9-2

summarize the expected environmental outputs for the Lower Basin based on implementing the proposed lake regulation schedule with the Kissimmee River restoration project.

The Jacksonville District is currently revising the Lower Basin hydrologic model based on new topographic data. Because of potential flooding to residences, the downstream limit of backfilling, which at first was to be located in Pool E, has been changed to Pool D. Also, the structure S-65D, which was originally recommended for removal, will remain. While the Lower Basin plan has not significantly changed, the results of the current modeling will be included in future FDM's and environment outputs and real estate requirements will be verified.

TABLE 9-1
PHYSICAL CHARACTERISTICS OF LOWER BASIN

Physical Characteristics	Historic Condition	Existing Condition	Recommended Plan
length of river, canal, and oxbows (miles)	103 river (continuous) 8 canal 0 oxbows	0 river 56 canal 68 oxbows	56 river (continuous) 22 canal 13 oxbows
depth of river, canal, and oxbows (feet)	2-8 river when within bank; 4 average	30 canal 1-6 oxbows 0-8 river remnants	30 canal 1-6 oxbows 2-8 river
top width of river, canal, and oxbows (feet)	50-300 river	225-425 canal 25-100 oxbows	225-425 canal 25-100 oxbows 50-300 river
SPF flooded area (acres)	--	38,292	69,461

TABLE 9-2
ENVIRONMENTAL OUTPUTS FOR LOWER BASIN

Environmental Outputs	Historic Condition	Existing Condition	Without Project Condition	Recommended Plan
River/Flood plain ecosystem (acres)	48,800	0	0	48,800
wetlands (acres)	35,000	14,000 (impounded)	14,000 (impounded)	26,500
HEP habitat units	339,799	123,443	< 123,443	250,789
Instantaneous fish biomass (lbs)	81,000	3,000	3,000	46,000
winter water (acre-days)	unknown	27,000	27,000	327,000
ducks (winter population)	12,500	140	140	12,500
wading birds (population, excluding cattle egrets)	18,000	3,500	< 3,500	18,000

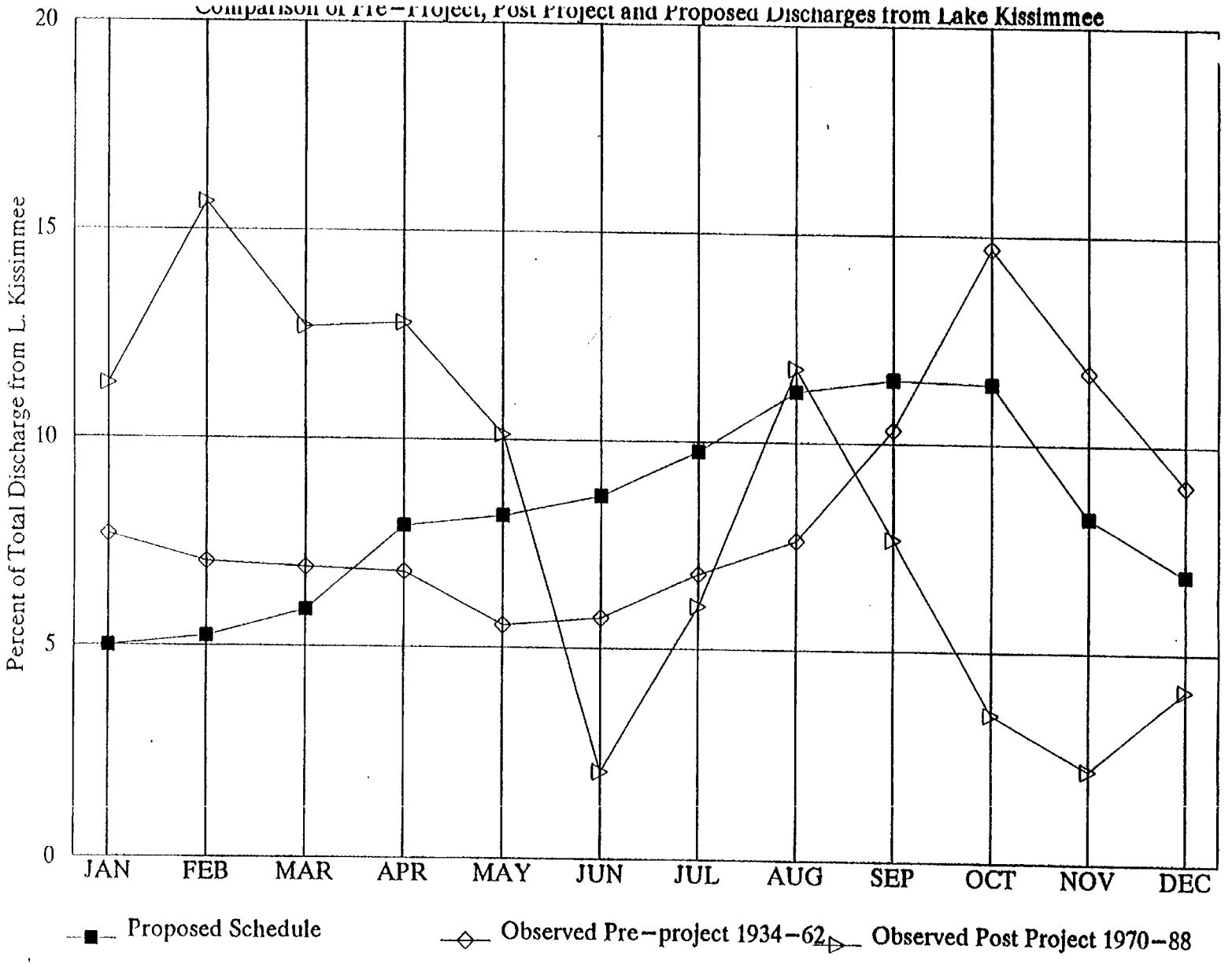
Comparison of Pre-Project, Post Project and Proposed Discharges from Lake Kissimmee
Percent of Total Discharge from L. Kissimmee
20
15
10
5
0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
Proposed Schedule
Observed Pre-project 1934-62
Observed Post Project 1970-88

FIGURE 9-1

communities. As a result, most of the diverse communities that historically constituted the Kissimmee River ecosystem will redevelop. Tables 9-1 and 9-2 summarize the expected environmental outputs for the Lower Basin based on implementing the proposed lake regulation schedule with the Kissimmee River restoration project. The Jacksonville District is currently revising the Lower Basin hydrologic model based on new topographic data. While the Lower Basin plan has not significantly changed, the results of the current modeling will be included in future FDM's and environment outputs and real estate requirements will be verified.

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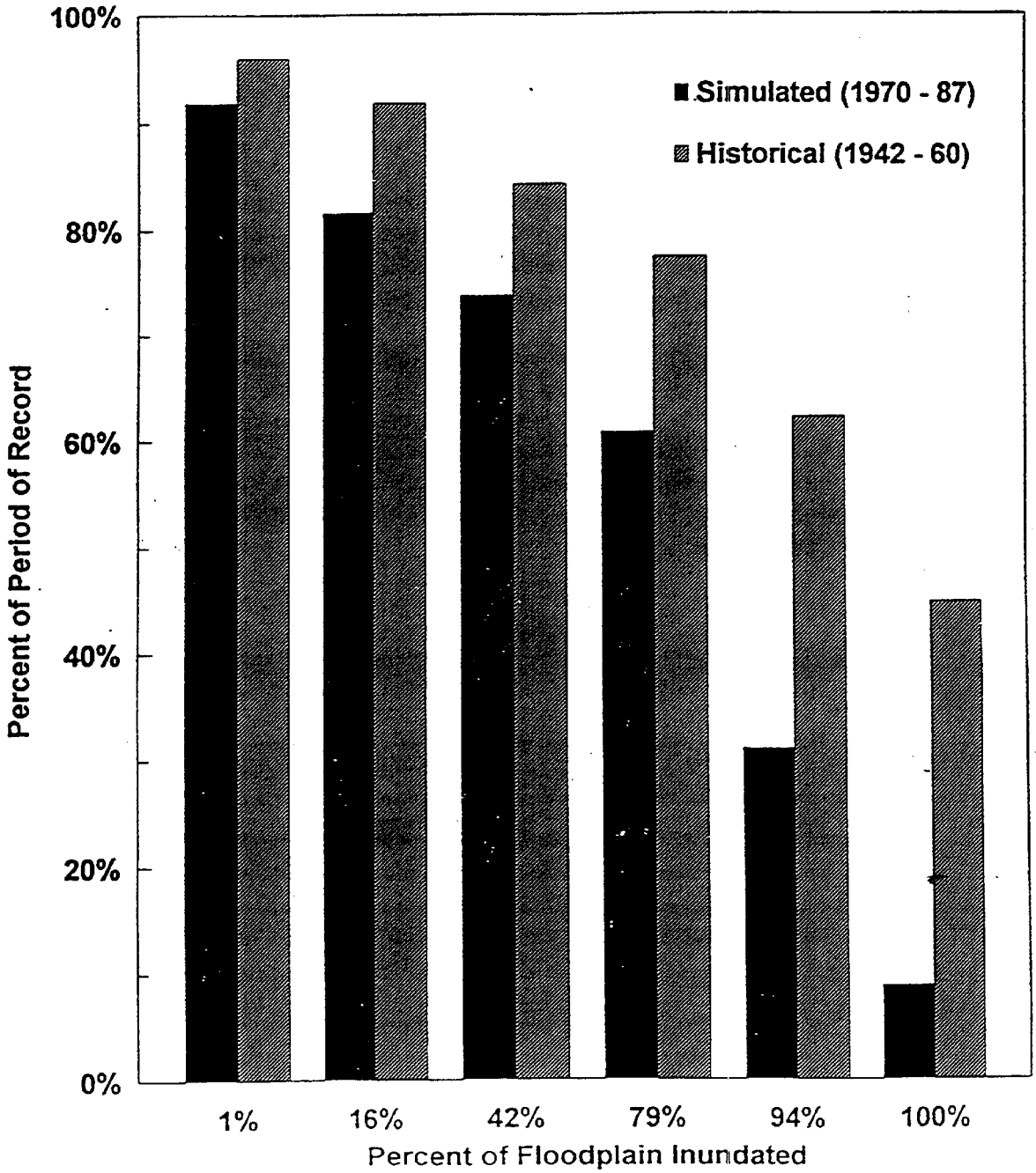
Wet Season (June - November)
Floodplain Inundation
100%
80%
60%
40%
20%
0%
Percent of Period of Record
Simulated (1970 - 87)
Historical (1942 - 60)
1%
16%
42%
79%
94%
100%
Percent of Floodplain Inundated

FIGURE 9-2

9.2 EFFECTS IN THE UPPER BASIN

9.2.1 Effects of Lake Level Regulation

In the Upper Basin, a water schedule operated according to the recommended plan, RS9-D (see Figure 8-1, Section 8), would result in greater frequency of high-water stages, compared to the existing schedule (see Section 3, Figure 3-1). During normally wet months (e.g., August-September), water levels under the recommended schedule would range from 0.5 to 1.0 foot higher than they do now, up to 20 percent of the time, and they would drop about 0.5 foot lower about 60 percent of the time. During normally dry months (e.g. April-May), the recommended schedule would produce up to 2 feet higher water levels up to 40 percent of the time, but could allow as much as 2.5 feet lower levels 60 percent of the time. A wider range between high water levels and low water levels would characterize the recommended schedule.

Modification of the Lake Kissimmee Regulation schedule would provide greater fluctuations of water levels in the lakes. The beneficial effects include expansion of lake littoral wetlands and increased spatial and temporal dynamics produced by long term fluctuations in seasonal water levels. These dynamics are expected to increase the overall quality and productivity of littoral habitat, and create significant area of wetlands. Table 9-3 summarizes the benefits for the Kissimmee Upper Basin.

TABLE 9-3
ENVIRONMENTAL OUTPUTS FOR UPPER BASIN

Environmental Outputs	Historic Condition	Existing Condition	Without Project Condition	Recommended Plan
Littoral Zone (acres)	20,000	16,000	16,000	20,000
Wetlands/Flood storage (acres)	55,000	16,000 (impounded)	16,000 (impounded)	30,000
HEP habitat units	-	241,923	241,923	257,201

All HEP habitat units were derived from model simulations over an 18 year, post-channelization (1970-87) period. The model was calibrated for stage, but appeared to underestimate discharge during the simulation period by

9.2 EFFECTS IN THE UPPER BASIN

9.2.1 Effects of Lake Level Regulation

In the Upper Basin, a water schedule operated according to the recommended plan, RS9-D (see Figure 8-1, Section 8), would result in greater frequency of high-water stages, compared to the existing schedule (see Section 3, Figure 3-1). During normally wet months (e.g., August-September), water levels under the recommended schedule would range from 0.5 to 1.0 foot higher than they do now, up to 20 percent of the time, and they would drop about 0.5 foot lower about 60 percent of the time. During normally dry months (e.g. April-May), the recommended schedule would produce up to 2 feet higher water levels up to 40 percent of the time, but could allow as much as 2.5 feet lower levels 60 percent of the time. A wider range between high water levels and low water levels would characterize the recommended schedule.

Modification of the Lake Kissimmee Regulation schedule would provide greater fluctuations of water levels in the lakes. The beneficial effects include expansion of lake littoral wetlands and increased spatial and temporal dynamics produced by long term fluctuations in seasonal water levels. These dynamics are expected to increase the overall quality and productivity of littoral habitat, and create significant area of wetlands. Table 9-3 summarizes the benefits for the Kissimmee Upper Basin.

TABLE 9-3
ENVIRONMENTAL OUTPUTS FOR UPPER BASIN

Environmental Outputs	Historic Condition	Existing Condition	Without Project Condition	Recommended Plan
Littoral Zone (acres)	20,000	16,000	16,000	23,236
Wetlands/Flood storage (acres)	55,000	16,000 (impounded)	16,000 (impounded)	30,000
HEP habitat units	-	241,923	241,923	257,201

All HEP habitat units were derived from model simulations over an 18 year, post-channelization (1970-87) period. The model was calibrated for stage, but appeared to underestimate discharge during the simulation period by

approximately 20 percent. During the 18-year period used for model simulations, the Upper Basin received approximately 10 percent less rainfall, and as a result, contributed 40 percent less average annual runoff to the Lower Basin than during the pre-regulation period of record (Obeysekera and Loftin, 1990). As a result of using a drier period of the historical hydrological record the habitat unit outputs are considered conservative. During periods of normal or above normal rainfall both basins would attain significantly greater benefits than the simulation model predicted.

9.2.2 Cultural Resources

Effects to historic and prehistoric archeological sites and standing structures, engineering structures and architectural features will be evaluated during on-going and future cultural resources investigations. Effects from the proposed project, if any, are anticipated to come from channel widening and construction.

It has been determined that modifications to the S-65 structure will have no effects on historic properties. Assessments will be made of the architectural and historic significance of residential and commercial structures to be affected by the project. An archeological survey has been undertaken along the C-36 and C-37 canals. One prehistoric archeological site has been identified. The site does not appear to meet the criteria of eligibility for inclusion in the National Register. Two additional natural levee land forms near the canal have the potential to contain historic properties.

In consultation with the State Historic Preservation Officer (SHPO), the Corps will apply the criteria of effect and adverse effect (36 CFR 800.9) for historic properties that meet the criteria of eligibility to the National Register of Historic Places. For those historic properties which will be adversely affected, mitigation plans will be developed by the Corps, in consultation with the SHPO and the Advisory Council on Historic Preservation, to mitigate adverse effects. The Corps will implement the mitigation plans prior to initiating any ground disturbing activities. Collections from cultural resources investigations will be curated in repositories meeting the standards established by the Corps and the National Park Service.

9.2.3 Water Quality

Water quality impacts of the proposed project will be limited to increased turbidity during dredging, filling, and construction activities associated with widening of the C-36 and C-37 canals, degradation of the local farm levees, and construction from the enlargement of the S-65 structure. However, the

suspended material from these activities will settle quickly after construction ceases and the turbidity will return to normal in a very short time.

The increased area of marshlands inundation resulting from project implementation will result in improvement in overall water quality due to the wetlands acting as filters. The low water velocities in the expanded littoral zone will allow suspended material to settle rapidly and wetland vegetation will physically trap particulates and absorb nutrients as water flows through the inundated areas. Other contaminants such as pesticides and petroleum products will also be removed by the filtering action of increased wetland contact and decomposed by chemical and biological processes in the littoral zone.

The increased area of littoral wetland inundation resulting from project implementation may result in improvement in overall water quality due to increase sediment and nutrient filtration. Other contaminants such as pesticides and petroleum products will also be removed by the filtering action of increased wetland contact and decomposed by chemical and biological processes in the littoral zone.

9.2.4 Vegetation

Aquatic plants, as a result of water quality degradation by nutrients and water level stabilization, have flourished in the Upper Basin lakes. The effects of stabilized water levels and the increased nutrient loadings are displayed in the accumulation of muck in the littoral zones and by the rapid proliferation of nuisance aquatic plants. Increased rates of peat deposition and flocculation of decaying plant matter limit fish spawning. Increasing the range of fluctuation from 4 feet to 5.5 feet will restore some of the natural fluctuation and essentially remove some of the effects of over-stabilization. It is expected that this increase in fluctuation will aid the control of aquatic plants, reduce attendant costs of control and generally improve the open water habitat of these lakes for fish and wildlife. Increased seasonal fluctuation would allow for more frequent and greater natural removal of organic sediments from the lakes through oxidation and wind erosion over dried lake bottom sediments during low water levels.

Widening of the C-36 and C-37 canals will directly impact approximately 10 and 19 acres, respectively, of a mixture of fresh water marsh and upland grass vegetation along the backside of the levees. The C-36 canal will be widened to the west and the dredged material will be placed within the right-of-way of the west levee. The C-37 canal will be widened to the east and the dredged material will be placed within the right-of-way of the east levee.

Erosion control measures will be implemented along the new levees until they become stabilized with vegetation.

Implementation of the recommended lake regulation schedule and degradation of the local farm levees would increase the amount of littoral wetlands by 7,236 acres. Approximately 5,019 acres of the total acreage restored would be converted to high quality wetlands from present-day grasslands (3,663 acres) and shrub/brushland (1,356 acres). The remaining 2,217 acres would be converted to moderate quality wetlands from what is now classified as dry prairie (1,616 acres), pineland (369 acres), or barren areas (231 acres). For a detailed explanation of how these acreage were calculated refer to the USFWS Coordination Act Report, date April 1994 (Annex D). The overall result of the recommended lake regulation schedule would be to increase the total amount of wetlands that meet the criteria of continuous saturation for at least 5% of the growing season, with the assumption that the growing season is year-round in the study area, to 23,236 acres (16,000 existing plus 7,236) or a 45% increase in wetlands subject to seasonal flooding over what currently exists.

Increasing the range of water level fluctuation from 4 feet to 5.5 feet will restore some of the natural fluctuation and remove some of the negative impacts of over-stabilization. Increased seasonal fluctuation would allow for more frequent and greater natural removal of organic sediments from the lakes through oxidation and wind erosion over dried lake bottom sediments during low water levels.

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9.2.5 Fish and Wildlife

Ecological benefits to the Upper Basin include expected expansion of the littoral zones by up to 14,300 acres between 52.5 feet and 54.0 feet, and associated benefits to fish and wildlife on Lakes Kissimmee, Hatchineha, Cypress and Tiger. This expanded littoral zone would include the 7,236 acres of seasonally flooded wetlands described in Section 8.2.4, and the additional wetlands between elevation 52.5 and elevation 54.0, which are needed for flood storage. Total wetlands surrounding the lakes would increase to 30,300 acres or 55% of the historical wetlands before lake level regulation was imposed for flood control. Additional benefits are expected because of increased spatial and temporal dynamics produced by long-term fluctuations of seasonal water levels. The entire, regulated, potential fluctuation zone of 5.5 feet (vertically) would not be inundated every year. In wet years, the zone could be flooded to its upper end, while in dry years only the lower end of the zone might be inundated. These added dynamics, introducing instability and diversity into the system, are expected to increase the overall quality and productivity of the littoral habitat. The USFWS conducted an evaluation model for wading birds against the different lake regulation schedules. The results of the evaluation are contained in the Final Fish and Wildlife Coordination Act Report. The USFWS concluded that the RS9-D lake regulation schedule would benefit the wading birds evaluated and would be neutral to the rest of the evaluation species.

Ecological benefits to the Upper Basin include the potential to expand the littoral zone by up to 14,300 acres between 52.5 feet and 54.0 feet, with associated benefits to fish and wildlife on Lakes Kissimmee, Hatchineha, Cypress and Tiger. This expanded littoral zone would include the 7,236 acres of seasonally flooded wetlands described in Section 8.2.4, and the additional wetlands between elevation 52.5 and elevation 54.0, which are needed for flood storage. Total wetlands surrounding the lakes would increase to 30,300 acres or 55% of the historical wetlands before lake level regulation was imposed for flood control. Additional benefits are expected because of increased spatial and temporal dynamics produced by long-term fluctuations of seasonal water levels. The entire, regulated, potential fluctuation zone of 5.5 feet (vertically) would not be inundated every year. In wet years, the zone could be flooded to its upper end, while in dry years only the lower end of the zone might be inundated. These added dynamics, introducing instability and diversity into the system, are expected to increase the overall quality and productivity of the littoral habitat. The USFWS conducted an evaluation model for wading birds against the different lake regulation schedules. The results of the evaluation are contained in the Final Fish and Wildlife Coordination Act Report. The USFWS concluded that the RS9-D lake regulation schedule would benefit the wading birds evaluated and would be neutral to the rest of the evaluation species.

9.2.6 Endangered or Threatened Species

The following is a summary of impacts anticipated from the proposed project:

* Bald Eagle - The project will increase feeding areas for bald eagles, and would beneficially affect the bald eagle by providing new foraging habitat that could accommodate more nesting.

* Snail Kite - The project will increase feeding areas for snail kites, and would beneficially affect the snail kite by providing new foraging habitat that could accommodate more nesting. However, it is recognized that the new lake regulation schedule will allow greater lake fluctuations than the existing schedule. This fluctuation along with the potential for future extreme drawdowns for aquatic weed control and fisheries management could adversely affect the species if these activities are not coordinated in a timely manner. The recommended lake regulation schedule may also have the additional benefit of reducing the need for future extreme drawdowns as a result of greater lake level fluctuations.

* Wood Stork - The project will increase feeding areas for wood storks, and would beneficially affect the wood stork by providing new foraging habitat that could accommodate more nesting.

* Florida Grasshopper Sparrow - The project is not likely to adversely affect the Florida grasshopper sparrow. The sparrow is normally found at higher elevations in dwarf scrub oak and palmetto grassland which will be unaffected by the changes in the lake regulation schedule.

* Eastern Indigo Snake - The project, i.e., adjusted lake regulation and restoration of the littoral zone, is not likely to affect the indigo snake. However, construction activities along the canal banks during the widening of the C-36 & C-37 canals and the degrading of the local levees could adversely effect the species. To assist in the protection of the species that may be found during earth work activities the USFWS has provided conservation recommendations. These recommendations include that all construction personnel involved in this project be informed of the possible presence of the indigo snake in the area, its recognition, and the possible civil and criminal penalties resulting from the unauthorized take (harming, harassing, killing, or collection) of a listed species.

* Audubon's Crested Caracara - The project will result in the conversion of 5,510 acres of potential foraging habitat, i.e., 1,616 acres of dry prairie, 231 acres of barren ground, and 3,663 acres of grassland, unimproved pasture, and sod farms. However, dry prairie and grassland habitat types near the present shoreline of the lakes would be converted to seasonally flooded wet prairie or marsh which also provides habitat for the caracara. As a result, the USFWS species model predicted no significant change in overall habitat value for the caracara.

9.2.7 State Listed Species of Special Concern

The sandhill crane was one of the evaluation species used by the USFWS for this project, and is listed by the State of Florida as threatened. The snowy egret, another evaluation species, is listed as a species of special concern. Based on the evaluation modelling, the USFWS predicted a likely benefit for the snowy egret, and no significant affect on the sandhill crane.

Other species of special concern that occur in the study area are: gopher tortoise, osprey, burrowing owl, limpkin, little blue heron, and tricolored heron. Based on the USFWS modelling of effects on wading birds, the Service anticipates that the last three species are likely to benefit from the project, because they are wetland or wetland-dependent wading birds. The Corps does not anticipate a significant adverse affect to the other State listed species of special concern.

9.2.8 Hazardous, Toxic, or Radioactive Wastes

The U.S. Army Corps of Engineers performed a HTRW Civil Works Audit in conformance with ER 1165-2-132. This audit covers property impacted by the Kissimmee River Headwaters Revitalization consisting of approximately 20,800 acres to be acquired on land bordering the affected lakes; i.e., Lake Hatchineha, Lake Kissimmee, Lake Cypress and Lake Tiger. The nature of the work involved is such that contamination by HTRW is unlikely, and the probability of contamination by HTRW is considered negligible. Contractors will be advised that they should use caution with fuel containers and tanks and that they will be held liable for accidental spills. However, if additional HTRW contamination is found during land acquisition activities, remediation to Florida DEP regulator levels will be required before project implementation.

The relocation of electrical structures (Appendix D) such as generators, step-up transformers and other similar items, have been evaluated. The proper execution of this relocation does not pose a hazardous and toxic waste concern because there are no underground storage tanks (UST's) at the site. An above

ground storage tank (AST) provides liquid natural gas (LNG) fuel to the generator. Federal Law requires that abandoned equipment or other debris left behind during site relocations be free of contamination. PCB's have been phased out from Corps of Engineers projects. In recent years, Corps of Engineers scopes of work have included in the project specifications requirements for contractors to remove all hazardous wastes generated during construction. The hazardous wastes generated would be disposed of in a proper manner.

The sponsor is conducting comprehensive environmental assessment of each individual tract prior to acquisition. These assessments are being conducted according to ASTM procedures and standard industry practice, in a phased approach. Phase I assessment typically consists of aerial reconnaissance, ground survey, review of current/historical aerial photographs, review of regulatory database and interviews with individuals knowledgeable of site activities. Areas of potential environmental concern identified through the Phase I process are evaluated through Phase II sampling, which defines presence (or absence) of suspected contaminants. Phase III assessment delineates the extent of contaminated areas.

To date, environmental impairment identified through this process in the subject area consists of point-sources of contamination, with limited areal extent. In the majority of these instances, the sponsor is requiring the property owner to complete remediations of impacted areas prior to acquisition. An exception to this circumstance are former cattle dipping vat sites, which are being characterized and remediated by the sponsor with Florida Department of Environmental Protection concurrence. Funding source for cattle dipping vat remediation is the Water Management Lands Trust Fund. All required corrective actions will be completed prior to certification of lands by the sponsor.

9.2.9 Land Use

In the Upper Kissimmee Basin, the expanding economic base of the Orlando area is expected to continue to place increased demands on the areas resources. Cattle ranches and orange groves will continue to give way to suburban subdivisions. Metropolitan development is rapidly moving towards the cities of Kissimmee and St. Cloud in Osceola County. This urban development is expected to continue in the Upper Basin as the population continues to expand.

The proposed Kissimmee Headwaters project would acquire either as easements or in fee approximately 20,800 acres (includes 14,300 acres between 52.5 feet and 54.0 feet, 5,986 acres below 52.5 feet and other lands above 54.0

feet). Approximately 7,578 acres are in unimproved pasture, and approximately 4,008 acres are in sod production or other agricultural crops. These lands are behind locally constructed dikes which will be breached so that they are hydrologically connected to the lakes. The connections will convert the land from its present use to littoral wetlands.

The conversion of these lands has been coordinated with the Soil Conservation Service (SCS) to determine if any are classified as prime or unique. By letter dated April 18, 1995, the SCS concluded that there are 202 acres of unique farmlands in the project area, based on soil potential, that will be directly impacted by recommended lake regulation schedule.

9.2.10 Navigation Impacts

Potential problems areas are most likely to occur at extreme high water above 53.0 feet NGVD and extreme low water below 48.5 feet NGVD. The extreme high water condition is the top of the lowest boat ramps in the impacted area. The extreme low water condition comes from interview information obtained during field investigation. Based on an investigation to determine the net impacts of the proposed regulation schedule (Appendix J., Navigation Impacts Study), the proposed lake regulation schedule should have minimal adverse impacts on navigation when compared to the observed period of flood control regulation (1970-88). Those impacts that do occur would occur during extreme high water conditions above lake levels of 53 feet NGVD.

The estimated impacts involve ramps and covered boat slips. Lake Cypress has a public boat ramp impacted during high waters. Usable alternative boat ramps are available for access. They are within a 30 minute drive from the impacted boat ramp. High water impacts occur at lake levels exceeding 53 feet. Based on an analysis of the stage-exceedance relationship for the proposed regulation schedule, the ramp on Lake Cypress could have 21 more days of high water impacts with the proposed schedule than the observed period of record. About 20 covered slips in Lake Hatchineha and C-37 would have a net impact of 2 days a year with the proposed schedule. Such an impact appears minor with the availability of alternative berthing.

Navigational impacts to Lake Kissimmee with the proposed schedule could involve overtopping a public boat ramp, isolating a private commercial boat ramp, and raising water levels sufficiently to impact about five covered slips. The boat ramp impacts are estimated to occur about 5 days a year on Lake Kissimmee during high water above 53 feet. The private commercial boat ramp could experience inundation of the public access (paved road) with high water which would make it unusable for boating. Covered slips on the

southwest side of the lake could experience less impacts but have alternative berthing options to minimize the problem.

9.2.11 Recreation

Fishing and other recreational experiences, i.e., birding, water sports, duck hunting, etc., will not be affected by the proposed lake regulation schedule. Boating and fishing will continue to increase in direct relation to an increase in population in the market area. Use demand on existing facilities will increase as well. Hunting may increase more than these other activities since some lands being acquired by the local sponsor for the project may be made available for this purpose. The wider range of water level regulation, from the present range of 3.5 feet to the proposed range of 5.5 feet, will increase the areas available for boating and fishing during high water conditions. Only during low water conditions would any effects be noticed by boaters and anglers, and these will not be significant or of long duration.

9.2.12 Effects on Aesthetics

The natural aesthetic quality of the Upper Kissimmee Basin will not be affected by the proposed lake regulation schedule. The expansion of the littoral zones and associated benefits to fish and wildlife on Lakes Kissimmee, Hatchineha, Cypress, Tiger, and Jackson will have positive benefits by providing the potential for increased utilization of the area by fish and wildlife, which increases the opportunity for the public to enjoy a positive aesthetic experience.

9.2.13 Vectors

The project should have no effect on vectors related to the cattle population in the headwaters basin. Ticks will continue to be carried in the wild animal populations. No significant incidence of Lyme's disease is recorded for the Upper Kissimmee Basin, and the project is unlikely to produce a significant change in this condition. Mosquitoes and biting flies spend part of their life-cycle in standing water, and the project will increase the area of standing or slow moving water. Concurrently, increased populations of mosquito fish (Gambusia) and other insectivorous fishes, as well as insectivorous insects and spiders, are expected in the restored littoral zone. Swallows, swifts, and bats will take their toll on flying insects. The net effect is expected to be a dynamic balance, very similar to existing conditions. The Upper Kissimmee Basin has a sparse human population, and no human health problems related to vectors are expected.

9.2.14 Effects on Aquatic Plant Control Program

It is expected that the increase in lake level fluctuation, i.e., during normally wet months (e.g., August-September), water levels under the recommended schedule would range from 0.5 to 1.0 foot higher than they do now, up to 20 percent of the time, and they would drop about 0.5 foot lower about 60 percent of the time. During normally dry months (e.g. April-May), the recommended schedule would produce up to 2 feet higher water levels up to 40 percent of the time, but could allow as much as 2.5 feet lower levels 60 percent of the time. This fluctuation will aid the control of aquatic plants, reduce the attendant costs of control, and generally improve the open water habitat of the lakes for fish and wildlife.

While it is anticipated that the proposed water control plan will provide enhanced treatment opportunities, it is also recognized that under some conditions, additional water control activities and temporary regulation schedule modifications will be required. Water control plan flexibility for the maintenance of the ongoing aquatic plant management program and for extreme drawdowns will be referenced in the Water Control Plan for the lakes. The extreme drawdowns will be coordinated with the USFWS, FGFWFC, SFWMD and the USACOE's aquatic plant control program. However, with greater fluctuating water levels, extreme drawdowns may not be needed as frequently.

9.2.15 Air Quality

The short term impact from emissions by construction equipment associated with the Upper Kissimmee River Restoration Project will not significantly impact air quality. Osceola County is an attainment area and the Department of Environmental Protection does not regulate mobile emission sources in attainment areas. Air pollution associated with the creation of airborne particles will be effectively controlled through the use of watering or other dust suppression alternatives. No permits are required for this project.

9.2.16 Noise Pollution Effects

The short term impact of noise by construction equipment associated with the Upper Kissimmee River Restoration Project will not significantly impact the surrounding area. All construction equipment will be maintained to minimize noise intrusion to the surrounding environment.

9.2.17 Social-Economic Effects

Successful implementation of the Kissimmee River Restoration Project is dependent on successfully completing work on the lakes in the Upper Basin and modifying the regulation schedule in order to be able to store more water for release as needed. This would require increasing the authorized lake elevations by 1.5 feet more than current conditions. Approximately 20,800 acres would need to be acquired for flowage rights. Lakeside residences and businesses would be impacted by having some outbuildings and other facilities subject to inundation. These would be floodproofed by being elevated. No primary structures would be flooded. However, all septic systems with top-of-tank elevation at or below 56 feet would have to be replaced with mounded systems or with centralized package systems (see Section 8.4, Septic System Impacts).

The Project Modification Report was coordinated with the South Florida Water Management District who has held public meetings with landowners potentially being impacted by the implementation of the project. It has also been coordinated with other agencies, including the Fish and Wildlife Service. The attitudes of the landowners in the upper basin have been varied. The residents are generally receptive, with several expressing concerns for the detrimental impacts to their land use. In areas where less restrictive easements could be utilized without detrimental impact to the environmental benefits, the non-standard estates were developed to meet the needs of the public as well as the landowners.

Flooding range land would reduce cattle production by an estimated $200,000 to $400,000, annually. Approximately $25,000 per year in taxes on undeveloped land will be lost to the counties. Marinas and fish camps may be stressed by changes to their properties required by the increase in lake levels. Options exercised by owners to adjust to changed conditions are problematic. If individual businesses close, they will be replaced at some time by a similar business if the demand for the service is great enough. No residences or occupants will be displaced if mounded septic systems or centralized package sewage systems are installed. Project construction, floodproofing, and septic system replacement will generate an estimated 80-160 man-year of direct employment. Induced employment could range from 300-680 man-years. Because of the large construction work force, relatively unskilled nature of much of the work, and relatively high unemployment in Polk County, no large influx of workers is anticipated. Construction payrolls will help the local economy, particularly the retail sector. Effects may be well dispersed throughout Polk, Osceola, and Orange Counties.

No impact is foreseen on police, fire, emergency services, schools, hospitals, or other institutions in the region as a result of the project. Project activities may act as a catalyst to increase community cohesion. Exposure to flooding from the lakes will be reduced slightly because of higher discharge capacity with no change in the 100 year flood stages. Public Health would benefit if either mounded septic systems or centralized sewage treatment plants are installed. Property values and aesthetics would be better served by the centralized systems.

A complete social impact assessment for the Upper Kissimmee Basin Project can be found in Appendix G.

9.3 RELATIONSHIP BETWEEN SHORT-TERM USES OF THE HUMAN ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

The comparatively short project construction period will produce several unavoidable effects, such as increases in turbidity, disruption of habitat, and other resources, as previously described. Such immediate adverse effects will be avoided where possible, and where unavoidable, mitigated to the extent possible. In the long term, restoration of physical form and hydrologic conditions will lead to reestablishment of the dynamic food webs, habitat heterogeneity, water quality, energy flow, and other complex physical, chemical, biological interrelationships and processes that support the historic ecosystem's high levels of resilience, and allowed for persistence of highly diverse biological communities. As a result, most of the diverse communities that historically constituted the Upper Kissimmee Basin ecosystem will redevelop, and the restored littoral zone ecosystem can be expected to again support populations of many fish and wildlife species.

9.4 IRREVERSIBLE OR IRRETRIEVABLE COMMITMENTS OF RESOURCES

Construction and ongoing operation and maintenance will require the expense of time and resources, such as labor, energy, and project materials, purchased with the Federal and sponsor's financial contributions. Once used, these resources could not be recovered.

In a larger sense, the Upper Kissimmee River Basin restoration represents a recovery - a practicable reversal and retrieval - of natural resources that had been lost or degraded with the commitment of lands and improvements for the flood control project over twenty years ago. Although it is not possible with existing constraints to fully restore an identical pre-channelization littoral zone

ecosystem around the lakes, the restoration project will provide more natural conditions that will facilitate the reestablishment and long-term maintenance of a full range of physical, chemical, and biological characteristics necessary for a resilient ecosystem.

9.5 CUMULATIVE EFFECTS

The Upper Kissimmee River Basin is the headwaters origin of the unique and complex regional ecosystem of central and southern Florida that extends from the Upper Kissimmee chain of lakes through Lake Okeechobee and culminates in the Everglades at the southern tip of the State. The Kissimmee Basin is a critical link in that overall system, providing both hydrological and ecological inputs. Restoration of the Upper Kissimmee Basin will ensure that the larger system can function in a more natural manner, reflecting its historic values. The beneficial environmental effects of restoration will make important contributions to many significant resources which require cumulative efforts to preserve their values, including:

* restoration of Atlantic flyway habitat of critical concern as recognized by the international North American Waterfowl Management Program;

* improvement of the quality of Kissimmee River waters will benefit the clean up of Lake Okeechobee;

* increased wading bird populations will assist wading bird recovery in the southeast landscape.

Restoration of the Upper Kissimmee River Basin littoral wetlands also will make contributions to both the State's environmental protection and conservation objectives, such as the Save Our River's Program, as well as National environmental goals, such as the long-term goal to increase the quality and quantity of the Nation's wetlands, as established in Section 307 of the Water Resources Development Act of 1990.

9.6 SUSTAINABLE DEVELOPMENT

Restoration of the wetlands and fish and wildlife values of the Upper Kissimmee River Basin will be accomplished in a manner that is compatible with the original, traditional project purposes of navigation (authorized in 1902) and flood control (authorized in 1954). The canals and related structures that have successfully fulfilled these purposes for many years will be replaced, by a modified project that will not only continue to meet navigation and flood

control needs, but will make a significant contribution to the Nation's environment. The project will serve the full range of the water resource needs, both providing developmental services and sustaining environmental values in the central and southern Florida region.

SECTION 10

COMPLIANCE WITH ENVIRONMENTAL STATUTES

10.1 *National Environmental Policy Act of 1969*, as amended.

Environmental information on the project has been compiled and the draft Supplemental Environmental Impact Statement (SEIS), Kissimmee River Headwaters Study, dated September 1995, has been prepared as a supplement to the Final Environmental Impact Statement (FEIS), Central and Southern Florida Project, Environmental Restoration of the Kissimmee River, Florida, dated December 1991. A systematic interdisciplinary approach to planning has been utilized; alternatives have been studied, developed, and described; and ecological information has been developed and utilized. This integrated feasibility report and draft SEIS will be circulated prior to finalization in accordance with the National Environmental Policy Act.

10.2 *Archeological and Historic Preservation Act*, as amended.

The study is in full compliance at this stage. Cultural resources investigations have and will preserve historic and archeological data that would otherwise be lost as a result of this project. The cost of preservation of archeological and historic data will not exceed one percent of the total estimated Federal appropriation required for construction of this project.

10.3 *Clean Air Act*, as amended.

Coordination on December 14, 1994, with the Department of Environmental Protection, Air Quality Division determined the proposed project is in partial compliance with the Clean Air Act. No permits will be required for this project. Full compliance will be achieved with receipt of comments on the final SEIS from the U.S. Environmental Protection Agency.

10.4 *Clean Water Act (Federal Water Pollution Control Act)*, as amended.

The study is in partial compliance. Full compliance will be achieved with issuance of a Section 401 permit from the State of Florida. A Section 404(b) Evaluation is included in this report as Annex B.

10.5 *Coastal Zone Management Act of 1972*, as amended.

The study is in partial compliance at this time. Full compliance will be achieved with receipt of comments from the State Clearinghouse. A federal consistency determination in accordance with 15 CFR 930 Subpart C is included in this report as Annex C.

10.6 *Endangered Species Act of 1973*, as amended.

Formal consultation was initiated on December 3, 1993 and completed on March 28, 1994. This project was fully coordinated under the Endangered Species Act; therefore, this project is in full compliance with the Act.

10.7 *Estuary Protection Act.*

This act is not applicable, since no estuaries will be affected by this project.

10.8 *Federal Water Project Recreation Act*, as amended.

The project is in full compliance at this stage. The effects of the proposed action on outdoor recreation have been considered. Continued recreation planning will be performed during project engineering and design.

10.9 *Fish and Wildlife Coordination Act*, as amended.

In response to the requirements of this Act, the Jacksonville District has and will continue to maintain continuous coordination with the USFWS during all stages of the planning and construction process. On June 30, 1994, the USFWS submitted a final Fish and Wildlife Coordination Act Report, which is included in this report as Appendix G.

* Recommendation #1 - Lands up to the 54 feet in elevation located behind the three levees at Lakes Hatchineha, Kissimmee, and Cypress should be added to the ongoing fee title acquisition of lands around the lakes. The levees should then be breached to hydrologically connect existing wetlands with the lakes and allow additional restoration of wetlands. These actions will realized the full potential of habitat restoration available in the upper basin and provide additional areas to buffer flood risk during storm events. Among the evaluation species, the Florida duck, great egret snowy egret, and wood stork are likely to benefit from the additional wetlands that would be restored by breaching the levees. A variety of other wetland-dependent wildlife would also most likely benefit from this action. Direct hydrological connection of the wetlands with the lakes would increase the flow of nutrients and promote movement of aquatic animals; the wetlands behind the levees are now

generally isolated from the lakes. Acquisition of the area behind the levees would also ensure that existing wetlands behind the levees are not pumped dry by more intensive agricultural practices on private lands.

The U.S. Army Corps of Engineers concurs with USFWS's recommendation #1. Lands up to 54 feet in elevation located behind the local levees at Lakes Hatchineha, Kissimmee, and Cypress will be acquired and these levees will be breached to hydrologically connect existing wetlands with the lakes.

* Recommendation #2 - Periodic extreme drawdowns should be superimposed on the normal regulation schedule and should be referenced in the operational notes for the schedule. This action is an essential habitat management tool for the entire lake ecosystem, particularly with respect to the sport fishery. Field research has demonstrated substantial increases in the yield of the sport fishery for several years after an extreme drawdown. The periodic reduction in density of vegetation in the littoral zone is also beneficial to the ecosystem as a whole. The frequency and timing of these drawdowns should be fully coordinated to minimize adverse effects on nesting of snail kites.

The U.S. Army Corps of Engineers concurs with USFWS's recommendation #2. While it is anticipated that the proposed water control plan will provide enhanced treatment opportunities, it is also recognized that under some conditions, additional water control activities and temporary regulation schedule modifications will be required. Water control plan flexibility for the maintenance of the ongoing aquatic plant management program and for extreme drawdowns will be referenced in the Water Control Plan for the lakes. The extreme drawdowns will be coordinated with the USFWS, FGFWFC, SFWMD and the USACOE's aquatic plant control program. However, with greater fluctuating water levels, extreme drawdowns may not be needed as frequently.

* Recommendation #3 - Spoil material excavated during widening of C-36 and C-37 should be confined to the existing spoil banks within the right-of-way. If filling of wetlands beyond the toe of the existing spoil mounds is unavoidable, the Corps should develop, during detailed project design, a plan to compensate for losses of wetlands. The Corps should investigate redirecting flow to the remnant river run adjacent to C-37. After widening the canals, the banks should be replanted with cypress trees, and a littoral shelf should constructed and planted with desirable aquatic plants such as bulrush.

The U.S. Army Corps of Engineers concurs with USFWS's recommendation #3. Placement of spoil material excavated during widening of C-36 and C-37 has been coordinated with the USFWS. The material will be confined to the existing spoil banks within the right-of-way.

* Recommendation #4 - The Corps should develop an aquatic plant management plan, including funding projections, to address control of Hydrilla, floating plants, and tussocks in the lakes.

The U.S. Army Corps of Engineers does not concurs with USFWS's recommendation #4. Aquatic plant management for the lakes is out of the scope of this project. The USACOE and its partner the State of Florida have an active aquatic plant management program.

* Recommendation #5 - The Interagency Review Team used to prepare this evaluation should continue to meet after implementation of the new water regulation schedule. This will allow evaluation of its effectiveness in reaching restoration goals for the upper basin and the Kissimmee River. Environmental monitoring studies should be planned and funded. Iterative testing of modified water regulation schedules should be conducted if it appears that the project is not fully realizing potential benefits. In particular, the review agencies should revisit the issue of attempting to provide flooding of longer duration between elevations of 52.5 and 54 feet in the upper basin, if this can be achieved without increasing flood risks upstream.

The U.S. Army Corps of Engineers concurs with USFWS's recommendation #5. The evaluation of alternative schedules will be an ongoing process after implementation of the Headwaters Revitalization Project and the Kissimmee River Restoration. Given the uncertainties of the simulations resulting from incomplete model calibration (i.e., underestimated discharge) and the relatively dry simulation period, it may be possible to modify the schedule to maintain higher lake stages for longer durations and still provide the necessary inflows to achieve restoration of the river/floodplain ecosystem. Alternatively, minor adjustments may be required to facilitate restoration of the river.

* Recommendation #6 - The Service recommends that the Corps evaluate the feasibility and benefits of adding a water control structure/lock at the northern end of C-36 to enable separate water regulation of Lake Cypress at levels closer to the historic condition. Lake Cypress appears to be more adversely affected by water levels held below historic conditions, as exhibited by reduction of the littoral fringe and dense growth of aquatic weeds. Although separate regulation of this lake was not proposed in our Scope of Work, the Service is confident that a separate regulation at levels higher than

Lakes Hatchineha and Kissimmee would greatly enhance the environmental benefits of the currently proposed plan. We would be willing to prepare a Scope of Work to quantify these additional environmental benefits.

The U.S. Army Corps of Engineers does not concur with USFWS's recommendation #6. The alternative was considered, but it was expected that the added structure and the loss of initial storage in Lake Cypress would have an adverse impact on flood stages upstream of the proposed structure and that it may interfere with the required operational criteria for the river restoration project. Since monitoring and evaluation of operation criteria will be an ongoing process after implementation of the Kissimmee River Project, the Jacksonville District proposes to defer any investigation of a new control structure.

* Recommendation #7 - The Service continues to support the proposed Level II Backfilling Plan for the Kissimmee River restoration, a restoration project adjacent to, and hydrologically connected with, the Kissimmee Headwater Lakes Revitalization Project.

The U.S. Army Corps of Engineers concurs with USFWS's recommendation #7. The Corps will continue to support the authorized plan for the Kissimmee River Restoration.

10.10 ***Land and Water Conservation Fund Act of 1965*, as amended.**

The study is in full compliance. No funding under this act is involved. No properties affected by this act are involved in the recommended project area.

10.11 ***Marine Protection, Research, and Sanctuaries Act of 1972*, as amended.**

Ocean disposal of dredged material is not proposed.

10.12 ***National Historic Preservation Act of 1966*, as amended.**

The study is in partial compliance at this stage. Consultation with the Florida State Historic Preservation Officer (SHPO) has been initiated. Cultural resources investigations are ongoing to determine effects to historic properties. When completed, results will be coordinated with the SHPO and the Advisory Council on Historic Preservation.

10.13 ***Coastal Barrier Resources Act.***

The study area is not in a designated CBRA unit.

10.14 ***Rivers and Harbors Appropriation Act of 1899.***

The study is in full compliance. The proposed work would not obstruct navigable waters of the United States.

10.15 ***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.

10.16 ***Resource Conservation and Recovery Act of 1976.***

This law has been determined to be not applicable as there are no items regulated under this act either being disposed of or affected by this project.

10.17 ***Toxic Substances Control Act of 1976.***

This law has been determined to be not applicable as there are no items regulated under this act either being disposed of or affected by this project.

10.18 ***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 restores and preserves the natural and beneficial values of the base flood plain.

10.19 ***Executive Order 11990, Protection of Wetlands.***

The study is in full compliance. By nature of the project, 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.

10.20 ***Executive Order 12114, Environmental Effects Abroad of Major Federal Actions.***

This executive order is not applicable to this study.

SECTION 11

PLAN IMPLEMENTATION

The recommended restoration plan for the Upper Basin is basically an expansion of the Kissimmee River Modified Level II Backfilling Plan (or "Recommended Plan") as presented in the Corps second feasibility study of the Kissimmee River Environmental Restoration. The entire Headwaters project results from the necessity for an alternate lake regulation schedule to compensate for the new flow requirements of the restored Kissimmee River, while maintaining the existing level of flood protection within the Upper Basin. Additionally, optimization of environmental outputs throughout the project area was a vital consideration during the planning of the project. The suggested plan, shown in PLATE 8-1, Section 8, consists of construction components, real estate requirements, ecological monitoring, and operations and maintenance for the completed project.

11.1 CONSTRUCTION COMPONENTS

Included within the construction components portion of the plan are discussions of the following: dredging of canals C-35, C-36, and C-37 to include both maintenance and new work excavation; breaching of five locally built levees; structural additions to the existing gated spillway S-65; structural integrity analysis of existing spillways S-63 & S-61; adding a steel sheet pile wall to an existing embankment; removal and relocation of various mechanical and structural items in conjunction with the S-65 modifications; placement of mechanical equipment within the additional spillway structure; addition, replacement, or removal of various electrical and power components associated with the structural changes; and finally, relocation of utility and telephone lines.

11.1.1 Canal Dredging

Following the change in lake regulation schedule and subsequent analysis of potential flood conditions, it was determined that dredging of three canals is necessary in order to achieve sufficient flow and storage capacities between the lakes. Three canals C-35, C36, and C-37 are required to be excavated for maintenance and widening purposes. A total of 1,158,000 cubic yards, 703,000 cubic yards of maintenance material and 455,000 cubic yards of new work will be removed from the canals. The non-Federal sponsor, the SFWMD, will be responsible for any existing maintenance requirements needed for the flood

control canals. Because of lower volume requirements between Lake Cypress and Lake Hatchineha, it was determined that C-35 would require removal of excess shoal material only. Spoil material will be placed on existing spoil mounds to either side of the canals. Typical canal sections are shown in PLATE D-1 of **Appendix D**. A brief description of each canal is as follows:

C-35 - Begins at spillway and lock structure S-61 on the southern tip of Lake Tohopekaliga and extends approximately 3.6 miles south to Lake Cypress. Lake Cypress has no control structures regulating flow to or from the lake. An estimated 170,000 cubic yards of shoal material is to be removed from the canal.

C-36 - Covers nearly 2.5 miles from Lake Cypress south to the northeast portion of Lake Hatchineha. The canal will be dredged to elevation 31.3 feet and widened to 60 feet from the original 48 feet. The estimated total volume of material for removal is 285,000 cubic yards (160,000 maintenance & 125,000 new work).

C-37 - Runs between Lake Hatchineha and Lake Kissimmee for a distance of roughly 3.9 miles. The canal design specifies widening from 70 feet to 90 feet and deepening to average elevation of 26.8 feet. An estimated 703,000 cubic yards of material (373,000 maintenance & 330,000 new work) is required to be removed from the canal and placed into a spoil location on the east bank of the canal.

The material taken from each canal will be placed to one side of the canal only, and will begin at a distance of approximately 25 feet from the top of the canal and will continue to no further than 15 feet inside the right-of-way line. The disposal areas were previously used for spoil placement from the original canal construction and are estimated to have sufficient capacity for this project. Spoil mounds currently exist on both sides of the canals, but only one side of each canal will be used, and this is the side to which the widening will occur. During construction, attempts will be made to minimize impacts to the vegetated regions that have developed along the canals since their construction. Visual inspections prior to dredging will identify any vegetation that might be impacted. Stabilization of the spoil mounds will be accomplished through grass seeding.

11.1.2 Local Levees

Five levees, which were designed and built by local property owners, are planned for partial destruction to allow for unobstructed flooding of the lands behind the levees. The levees - Lake Kissimmee Levee, Cypress Lake Levee,

Sparks Chandler Levee, Rolling Meadows Levee, and Oasis Levee are to have a series of breaches cut in them which will permit lake levels above the 52.5 feet elevation to inundate the newly accessed regions and achieve the desired lake capacities. The breaches will occur approximately every 1,000 feet and will be 100 feet in length (see Plate D-2). Approximately 75,000 cubic yards of material will be graded to existing ground elevations at about 50 feet NGVD. The material cut from the levees will be placed and graded within the original borrow canals on either side of the levees.

11.1.3 Structural Modifications to S-65

In order to achieve a historical flow output from Lake Kissimmee into the Kissimmee River (currently C-38) of the Lower Basin, an additional two bay spillway structure is proposed for construction. The new structure, identified as S-65X, will be placed immediately adjacent to S-65 to the east, and will be of the same design specifications as S-65. The combination of structures S-65 and S-65X will be better able to balance the adjusted upstream lake levels and downstream flow releases following implementation of the new Upper Basin lake regulation schedule. Furthermore, the new spillway will permit the expected discharge rate to closely correspond to the prechannalization stage-discharge rating for lake Kissimmee.

Relocation of the spillway operators generator house, antenna tower and guy wires will be required during construction of the S-65 addition. The new locations of these items will be identified during plans and specifications. Minor modifications to the upstream and downstream wingwalls of S-65 are necessary in order to tie them into new spillway. The existing safety barriers will be extended to incorporate both S-65 and S-65X. A cofferdam will be constructed at the S-65X location for dewatering purposes. A stability analysis was done on S-65X, S-61, and S-63 by placing various loading conditions on the structures to see they responded (PLATES S-6 though S-9). The structures were analyzed for overturning and flotation stability, and the uplifting forces that would cause overturning or sliding were assumed to occur over the entire base of the structure. The stability results can be found in **Appendix D**. The vertical lift gates are to be 27 ft. wide by 14.2 ft high and will be of the same design specifications as the existing gate structure. A steel sheet pile retaining wall will be added to stabilize an embankment to the east side of the spillway near the operator's dwelling. Several loading conditions were incorporated into the analysis of the retaining wall.

11.1.4 Mechanical Modifications to S-65

The project's mechanical design consists mainly of additions within the new spillway structure, S-65X, with minor modifications. No modifications are anticipated for the existing structure as design analysis revealed that it would continue to operate adequately under the modified conditions, although it was evident that it may be deficient in some areas based on current standards. The mechanical equipment to be used for the new spillway will include horizontal hydraulic cylinders as part of the hoisting units to raise each vertical lift gate. The cylinders will be operated by a motor-driven hydraulic power unit. Commercial power will be used to operate the gate hoist, and a gas generator will serve as a backup. The general design of the gate operation machinery is comparable to the original design. Other items that require mechanical manipulation include the lawn sprinkler system which will need to be replaced, the aboveground and underground storage tanks will have to be relocated, and the generator house and its contents must also be moved prior to construction. For details of these items, see Appendix D., Design and Cost Estimates.

11.1.5 Electrical Modifications to S-65

Local power will service the new gated spillway, as it does with the existing spillway. For the combined S-65 and S-65X structures, the current service will be upgraded from 200 to 300 amps, resulting in necessary modifications to the manual transfer switch, the step up transformer, and associated equipment. A control center will be added to the control building and will house the electronic relay and transfer controls. Push button controls are provided for the manual operation of the gates, and they will be located in both the structure and the control house. The lighting, wiring, and grounding details are discussed in **Appendix D.**

Relocation or removal of various existing electrical components will be required during construction. Peace River Corporation, the local electric company that will serve the electricity, will do the power line relocation work. The local telephone company, General Telephone Company, will provide telephone line relocation at no cost.

11.2 REAL ESTATE

11.2.1 Lands and Easements

Lands needed for the purpose of ecosystem restoration and flood control will be acquired in fee or easement to ensure that they will continue to be available solely for that purpose over the life of the project. This will require acquisition

in fee of flood plain acreage from the 52.5 feet to 54.0 feet elevation around the four impacted lakes (Kissimmee, Cypress, Hatchineha, and Tiger). The total land acquisition area up to 54.0 feet is approximately 20,800 acres. Approximately, 5,986 acres of these lands are below the 52.5 feet elevation that were previously utilized under flowage easements, but must now be purchased in fee to support the environmental effort. A large tract of land, lying to the north of Lake Hatchineha, falls below the 54' elevation, but will not be acquired in fee because it is owned by the Disney Corporation as mitigation property. For this land a Perpetual Conservation Easement is currently in effect. The additional right to flood, flow and store water on the property is required for project purposes, therefore a Pertual Flowage Easement is recommended for this property. For Lake Tiger, perpetual flowage easements are necessary due to the minimal environmental benefits anticipated from the project.

All construction areas and disposal areas for the project are located with existing right-of-ways or in proposed acquisition limits, and therefore, land easements will not be required for construction purposes. If necessary, temporary road access easements will be obtained for the canal dredging and disposal operations.

11.2.2 Relocation Assistance (*Public Law 91-646*)

Preliminary estimates identified 123 residences and 8 commercial buildings which will be acquired. Relocation assistance will be provided to affected owners in accordance with the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, as amended.

11.2.3 Construction Relocations

The only structural relocations necessary for the project are 61 septic systems located within the Hatchineha Estates and Grape Hammock. All septic tanks located below the 56 feet elevation must be relocated to higher ground or replaced with aboveground tanks. In the event the tanks cannot be replaced with aboveground tanks, the land parcels containing tanks will be acquired in fee. Those parcels in which the tanks can be replaced with aboveground tanks will require a Water Inundation Easement. The sponsor has the option of installing a sewer system instead of acquiring the parcels. A sewer system would require only Water Inundation Easements for all of the parcels and would be the least expensive of the alternatives. The sponsor will be given credit for the least cost option.

11.3 MONITORING

Monitoring programs will be conducted during construction and following construction. These programs are intended to evaluate the success of the project and to check both areas of success and uncertainty. Based on the results of the monitoring studies, refinements and adjustments can be made to the long-term operations and management of the regulation schedule. Further justification for each of the monitoring programs is given in the following sections.

11.3.1 Vegetative Monitoring

Plant communities should be monitored to evaluate the Project's success in restoring former wetlands around the lakes. This monitoring should focus on lands Surrounding Lakes Kissimmee, Tiger, Cypress, and Hatchineha up to the 54 feet elevation. The study's goal would be to document changes in vegetation patterns around these lakes and compare them with the predictions of the Fish and Wildlife Coordination Act Report on the Kissimmee Headwaters Revitalization Project. That report estimates that the new schedule will help restore over 7,000 acres of marsh.

Vegetation community types within the submergent and littoral zones will be mapped using aerial photography and ground truthing. Because certain wetland species are present already in some of these areas, quantitative methods should be developed to assess changes in species composition. These methods will be detailed in the Restoration Evaluation Report as prepared by the sponsor.

The aerial photography will be infrared color photos with 60 percent forward overlap at a scale of 1:8,400. The flight lines will generously cover the perimeters of the lakes as well as and all other impacted areas within the Upper Basin. Surveys would be conducted every two to three years. The first survey would be done in 1995 to document conditions existing before the 1995-96 extreme drawdown of Lake Kissimmee and before the implementation of the new regulation schedule in 1997. The next survey would be conducted in 1997, one year after the Lake Kissimmee drawdown. This would be followed by more surveys in the years 2000 and 2003, at which time the need for further monitoring would be determined.

To aide with the comparison between present and future wetland conditions, some regions between the 52 foot and 53 foot elevations will have temporary ground transects established. The areas selected for placement of transects will reside within regions expected to have moderate to significant vegetative changes. The regions of high impact were previously recognized

during the 1994 Fish and Wildlife Coordination Act Report, which depicted all anticipated wetland increases between the 52 and 54 foot contours. The transects will be identified, and marked and surveyed prior to the commencement of the project and are to be maintained throughout the monitoring study.

11.3.2 Mercury Study

The bioaccumulation of organic mercury in fish and wildlife has become an important ecological and health issue in Florida. With regard to the Headwaters Revitalization Project, there is some public concern that the expanded lake stage regulation schedule could increase mercury mobilization and subsequent bioaccumulation in predatory fish and wildlife. According to some sources, periodic drying and flooding of wetlands and croplands can promote the methylation of mercury in the soil. Soil disturbances and wetland creation also have a potential to mobilize mercury. However, the production of high levels of methylmercury is usually restricted to water bodies with organic sediments, low productivity, and slight acidity.

Because of the eutrophic nature of the headwater lakes and the predominance of sandy soils, there is no compelling evidence to suggest that the revitalization project could cause a mercury problem in the headwater lakes. Yet, little information exists from the region to form a conclusive judgement. Although data on existing levels of mercury contamination in fish from the region are available, further field research would help in predicting the effect of lake stage changes on fish tissue concentrations.

Therefore, to obtain field data useful for predicting future conditions, soil samples would be collected from the lands around Lakes Cypress, Hatchineha, Kissimmee, and Tiger that will be reinundated under the new Lake regulation schedule. From the analysis of mercury concentrations in these soils, future rates of methylmercury production in these reinundated areas could be estimated. Once these rates are calculated, the potential change in fish methylmercury concentrations could be approximated with more certainty.

In addition to the soil sampling, samples of fish, water and sediment would be taken from Lake Kissimmee to document current conditions. This sampling would be done before and after the extreme drawdown of the lake in 1996 in an effort to distinguish any drawdown effects from subsequent effects of the modified stage regulation schedule.

Sampling would begin in the summer of 1995 and would be repeated over several more years. Lake Kissimmee would be sampled again in 1997 (one year after the drawdown) and every two years thereafter until 2003 so that trends can be examined. The soils around the headwater lakes would be sample again in 1999 and 2003 (two and six years after stage regulation schedule modification).

11.3.3 Water Quality

Some monitoring will be expected due to localized increases in turbidity during construction. An accurate evaluation of turbidity impacts will be required. Best management practices would ensure that turbidity is kept to a minimum by the placement of turbidity barriers during canal dredging. Therefore, no inordinate amounts of suspended solids are expected to occur within the canals or lakes downstream during or following construction.

11.3.4 Hydraulic Monitoring

Water level monitoring locations will be established in Lakes Kissimmee, Hatchineha, Cypress, and Tiger in order to better manage future operations in the Upper Basin. More gage locations will avoid existing problems with wind setup in the lakes which can cause erroneous estimates of average lake stage. Lake regulation schedules are based on stages of hypothetically flat lake surfaces; therefore, average lake stages are preferable for use in daily operations. The gages will also verify or refute the accuracy of the hydrological models, which are based on historical data and show expected lake stage durations for an average calendar year.

Monitoring within the Lower Basin (below S-65) will provide valuable hydraulic data that will aid in the management and operation of the Upper Basin regulation schedule. The same is true for the Upper Basin data which will assist with future analysis of the Lower Basin operations. Other hydrologic monitoring ongoing in the basin will continue. Rainfall gages presently located at S-65 structures will relocated during construction.

11.3.5 Stability Monitoring

While the constructed features of this project will be subjected to normal inspections, including quality assurance (quality control) and "as-built" comparisons to specifications, some long-term monitoring is necessary for some of the construction features of the project. Features normally submerged and

subjected to erosional forces will be monitored to determine stability. Concerns include armoring, unprotected soil in abutment areas, and gross stability of slopes and structural mass. Also, revegetated areas will be monitored for survivability of plants and overall coverage for erosion protection.

11.4 OPERATION, MAINTENANCE, AND MANAGEMENT

11.4.1 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. Long term study of the effects that the proposed regulation schedule has on the Upper and Lower Basins will govern the adjustments to the schedule that may be necessary.

11.4.2 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, while maintaining the new discharge rates. However, some land management practices, including prescribed burning, limited livestock grazing, and fencing and posting to prevent trespassing, may be necessary.

11.4.3 Aquatic Plant Control

The primary goal of aquatic plant control in the Kissimmee River Basin is restriction of the hydrilla plant and various other non-native floating plant species such as waterlettuce, water hyacinth and floating mats of vegetation called tussocks. Hydrilla is considered to be highly intrusive to littoral aquatic regions. It is also very problematic for boaters and water control structures. The growth rate of hydrilla and other non-native plant species within the lake system is significant, and measures to control these plants must be continued and expanded if necessary.

The potentially lower lake stages in the winter, as evidenced in the stage hydrographs from H&H Branch, could provide optimal conditions for the chemical (fluridone) removal of the exotic hydrilla plant. Because the hydrilla eradication requires low water levels over a multi-week period, the lower winter lake elevations would grant an ideal time frame for this task when

necessary. It is currently unknown as to whether the newly inundated areas will provide suitable or unfit habitat for the nuisance plants. Initial thoughts are that increased water surface area will allow the exotics to increase their coverage proportionally. To verify the extent to which the exotic plant species have either flourished or diminished under the new lake regulation schedule, aerial photography and ground truthing methods will be utilized on a predetermined schedule (see 11.3.1 Vegetative Monitoring).

11.4.4 Structures

The only structure of the completed project that will require routine inspection is the S-65 spillway addition. This structure, in addition to the existing S-65 structure, will be operated in accordance with the operation manuals described above. The maintenance of the structures includes activities such as periodic inspection and maintenance of mechanical and electrical equipment; sand blasting and painting gates; and ensuring inlet and outlet channels are clear of snags.

11.4.5 Navigation

Following completion of the project, the hydraulic characteristics of the lakes will change slightly, resulting in minimal impacts to navigation within the lakes and channels. The new lake regulation schedule could potentially limit access to and from certain portions of the lakes.

Types of maintenance for the navigational channel include clearing snags and sandbars, maintaining a navigational markers system, and providing advisories to navigators on water conditions such as flood stages, currents, bridge clearance, and drought and draft clearances. Maintenance of disturbed areas will be limited to the degree necessary to meet minimal navigation needs to limit influences to the natural environmental progression of the lake system.

11.5 PROJECT IMPLEMENTATION

11.5.1 Project Management Plan

A Project Management Plan is being prepared for the Kissimmee River, Project, including the Lower and Upper Basin projects, to identify specific tasks to be accomplished during the next preconstruction engineering and design (PED) phase, and to identify specific contracts and construction management activities for the construction phase.

11.5.2 Construction Sequencing

The implementation plan and schedule will be refined during later preconstruction engineering and design studies. It is intended that the Headwaters Project be at or near completion, with a fully operational S-65, prior to construction in the Lower Kissimmee Basin. The lake elevations will likely fluctuate for a while depending on the weather patterns and the outflow requirements at S-65. It is anticipated that the Upper Basin will have stabilized by beginning of construction on C-38. Construction is expected to begin at the end of FY 96 and continue for two years. At this time, the construction is expected to proceed generally as follows:

* Real estate must be provided by the sponsor prior to each separable phase of construction, including land acquisitions (both fee title and easement purchases) and relocations of houses, septic systems, other structures, utilities, and recreational facilities. Construction of the Hatchineha Estates Sewer Treatment Facility (see Section 8, Recommended Plan) should be completed.

* Monitoring network sites will be established prior to construction. Prior to any change in lake stages, an evaluation of existing vegetative communities and wildlife habitats must be accomplished. This evaluation will include vegetation mapping in the form of aerial photography and ground surveys (see 11.3.1 Vegetative Monitoring).

* The sequence of construction, including the change in regulation schedule, will generally be as follows:

1. All construction and non-construction relocations must be accomplished prior to the construction phase.

2. Most of the construction work can occur concurrently, with the exception of the implementation of the new regulation schedule, which will be the final portion of the Headwaters Project.
3. Canal dredging, levee degradation, and structural modifications can be performed through single or multiple contracts.

11.5.3 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. Since the Kissimmee Basin surface and subsurface groundwater are separated from the underlying deep aquifer by impervious geological strata, the potential for pollution of groundwater used for human consumption is not a concern. 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.

11.6 COST ESTIMATE

11.6.1 Investment Costs

11.6.1.1 Initial Costs

The total estimated cost of the Headwaters Project is $78,356,300 at January 1996 price levels. The M-Cases detailed cost breakdown is shown in Appendix D. A summary of project costs is shown in Table 11-1. The costs of channels and canals does not reflect the cost to remove approximately 703,000 cubic yards of spoil material from C-35, C-36 and C-37 (see Section 11.1.1, Canal Dredging). The estimated cost to remove this maintenance dredging quantity, $1.4 million, is a non-Federal responsibility.

Table 11-1
Project Cost Estimate

FEATURE ACCOUNT	PROJECT COST
01 - Lands, Damages, Relocations Assistance	$ 71,566,600
02 - Construction Relocations	$ 83,224
06 - Fish and Wildlife Monitoring	$ 838,738
09 - Channels and Canals	$ 1,721,159
11 - Levees and Floodwalls	$ 102,548
15 - Floodway Control-Diversion Structure	$ 3,022,742
30 - Planning, Engineering, and Design	$ 545,380
31 - Construction Management (S&I)	$ 475,920
TOTAL FOR HEADWATERS PROJECT	**$ 78,356,300**

11.6.1.2 Interest Costs

The computation of interest during construction (IDC) is based on scheduled construction expenditures (structures, canal, levees, relocations). Calculation of IDC assumes equal construction expenditures in each month of the 2 year construction period. It is assumed that environmental benefits will be realized during the construction period, specifically after the new regulation schedule is implemented. At 7.625 percent the IDC for the Headwaters plan is $ 455,471 (annually = $ 35,634).

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

Annual operation and maintenance costs were estimated for the components of the Headwaters Project. Replacement costs at 25 years were calculated for the structural and mechanical equipment contained in the S-65 additional spillway structure. The total estimated OMRR&R costs over the life of the Headwaters Project were estimated at $ 5,000 annually.

11.6.3 Project Annual Costs

Total investment costs (initial + IDC) were converted to annual costs using an interest rate of 7.625 percent and a project life of 50 years to compute interest and amortization. Annual operation and maintenance costs were then added to the annualized total investment costs to determine the average total project annual cost, which is $ 6,170,800 for the Headwaters Project.

11.7 COST SHARING

Responsibilities for implementing the Headwaters Project 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 in the 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.

Based on the project authorization, the local sponsor shall contribute 50 percent of total project costs. The local sponsor contributions are to be in accordance with the provisions of the Project Cooperation Agreement between the sponsor and the Federal government. The Local Sponsor is providing for and will receive credit for all LERRD's (lands, easements, rights-of-way, relocations and including suitable borrow and dredged or excavated disposal areas) determined by the Government to be necessary for construction, operation, and maintenance of the project. Furthermore, the Government has determined that the Local Sponsor shall receive credit for approved in-kind services or services requested by the Government for completion of the project. For the Headwaters Revitalization component, the sponsor will be allowed credit for their effort on completing the Upper Basin Residential Impact Evaluation and completed and continuing SFWMD staff support for the Upper Basin study and project. The affording of such credit shall be subject to an inspection as appropriate by the Government to verify that the work was accomplished in a satisfactory manner and is suitable for inclusion in the project. The actual amount of credit shall be subject to an audit to determine the reasonableness, allocability, and allowability of costs in accordance with the Project Cooperation Agreement.

Table 11-2 contains an estimated apportionment of project costs between the Federal government and the local sponsor based on the project cost sharing provisions, excluding costs for the Local Sponsor's in-kind services. The Government will reimburse the Local Sponsor for that portion of the contributions which exceeds 50 percent of the total project costs. Because the

estimated value of the LERRD provided by the sponsor, $71,566,600, exceeds 50 percent of the total project costs, $78,356,300, the table demonstrates that all the construction costs will be born by the Government. The Federal share of the total project cost is approximately $39,178,150. The sponsor's (SFWMD) share is $ 39,178,150. The sponsor will be expected to bear 100 percent of all OMRR&R expenses after the project is completed.

TABLE 11-2
Cost Apportionment of Headwaters Revitalization Plan

ITEM	FEDERAL $ (USACE)	SPONSOR $ (SFWMD)	TOTAL $
Construction and Monitoring	$ 6,789,700		$ 6,789,700
Real Estate Costs	$ 32,388,450	$ 39,178,150	$ 71,566,600
TOTAL	**$ 39,178,150**	**$ 39,178,150**	**$ 78,356,300**

Table 11-3 below shows a preliminary cost estimate comparison for the Headwaters Revitalization Project. The estimate details current project cost against those developed in the 1991 Feasibility Study for the Kissimmee River Restoration. Many of the differences in the two estimates can be attributed to changes in design, real estate, and monitoring requirements since the original plan formulation.

TABLE 11-3
Headwaters Revitalization Project
Preliminary Cost Estimate Comparison

FEATURE ACCOUNT	1991 REPORT	1995 REPORT
01 - Lands and Damages	$ 74,776,000	$ 71,566,600
02 - Construction Relocations		$ 83,224
06 - Fish & Wildlife Monitoring	$ 180,000	$ 838,738
09 - Channels and Canals	$ 12,652,000	$ 1,721,159
11 - Levees and Floodwalls		$ 102,548
15 - Flood Control Diversion Struc.		$ 3,022,742
30 - Planning, Engineering, Design	$ 2,796,000	$ 545,380
31 - Construction Management (S&I)	$ 886,000	$ 475,920
TOTAL	**$ 91,290,000**	**$ 78,356,300**

11.8 FINANCIAL ANALYSIS

The non-Federal sponsor, the SFWMD, has the capability to provide the required local cooperation for the Headwaters Project. A financial analysis was previously conducted for the Kissimmee River Restoration Project to assess the SFWMD's capability to financially participate in the Headwaters Project. The SFWMD provided a statement of financial capability prior to the execution of the Project Cooperation Agreement for the Kissimmee River Project.

11.9 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. The sponsor is also required to pay all costs, if any, that are associated with locally preferred features of the Headwaters Plan.

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. On March 22, 1994, a PCA was executed between the Department of the Army and the South Florida Water Management District for the Kissimmee River Project. This agreement successfully combined the two authorized construction components, the Kissimmee River Restoration Project and the Kissimmee River Headwaters Revitalization Project into one project. The PCA assigned Federal and non-Federal responsibilities, which, includes the following items of local cooperation:

a. The Local Sponsor shall contribute 50 percent of total project costs.

b. The Local Sponsor shall provide all lands, easements, rights-of-way, including suitable borrow and dredged or excavated disposal areas, and perform all relocations determined by the Government to be necessary for construction, operation, and maintenance of the Project.

c. Hold and save the Government free from all damages arising from the construction, operation, maintenance, repair, replacement, and rehabilitation of the Project and any Project related betterments, except for damages due to the fault or negligence of the Goverment or the Government's contractors.

d. Operate, maintain, repair, replace, and rehabilitate the completed Project, or functional portion of the Project, at no cost to the Government, in accordance with applicable Federal and State laws and specific directions prescribed by the Government in an OMRR&R Manual and any subsequent amendments thereto.

e. Participate in and comply with applicable Federal floodplain management and flood insurance programs;

f. Publicize floodplain information in the area concerned and shall provide this information to zoning and other regulatory agencies for their use in preventing unwise future development in the floodplain and in adopting such regulations as may be necessary to prevent unwise future development and to ensure compatibility with protection levels provided by the Project.

g. 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.

h. Provide 100 percent of the costs to remove excess spoil material from the flood control canals, C-35, C-36 and C-37.

11.10 SPONSOR VIEWS

The SFWMD developed and recommended the Level II Backfilling Plan upon which the Recommended Plan for the Lower Basin is based. The Headwaters Revitalization is directly linked to the Recommended Plan; the Recommended Plan cannot succeed without first implementing the Headwaters Plan. As the non-Federal sponsor of this feasibility study, the SFWMD has worked very closely in partnership with the Corps to ensure that the study and this report fairly and accurately reflected their views. On November 19, 1991, the SFWMD provided a Letter of Intent which indicated their strong support for the Recommended Plan (which included the Headwaters Revitalization Plan) and their desire to continue discussions to develop a cost sharing formula acceptable to the State of Florida and the Federal Government. The non-Federal sponsor agrees to assume responsibility for the removal of the excess spoil material from the flood control canals, C-35, C-36 and C-37.

SECTION 12

PUBLIC INVOLVEMENT, REVIEW, AND CONSULTATION

This section describes the public involvement activities conducted by the Corps and the SFWMD in conjunction with the Headwaters Revitalization component of the Kissimmee River Restoration project.

12.1 PUBLIC INVOLVEMENT PROGRAM

Extensive public involvement activities have been integral to all work since the existing Kissimmee River project was completed in 1972. Complete descriptions of the public involvement programs that preceded the 1992 Kissimmee River feasibility study are available in the following documents:

* *Central and Southern Florida, Kissimmee River, Florida, Final Feasibility Report and Environmental Impact Statement, Appendix F.* (Jacksonville District, U.S. Army Corps of Engineers. September 1985.) - Appendix F, Public Involvement, Views and Responses, describes public involvement during the Corps' first Federal Feasibility study of the Kissimmee River, covering the period 1978 - 1985.

* *Kissimmee River Restoration, Alternative Plan Evaluation and Preliminary Design Report, Appendix B.* (SFWMD. June 1990.) - Appendix B, Public Input Survey/Questionnaire Results, summarizes the results of a June 1989 public opinion survey concerning restoration of the Kissimmee River.

* Letter of July 9, 1991, SFWMD to Jacksonville District, U.S. Army Corps of Engineers, subject: "Public Involvement Appendix and Monitoring Program, Kissimmee River Restoration Feasibility Study" - An enclosure to the letter describes public involvement since the project was completed, particularly during the SFWMD restoration study from 1984-1990.

* *Central and Southern Florida, Kissimmee River, Florida, Final Integrated Feasibility Report and Environmental Impact Statement Section 11 and Annex A.* (Jacksonville District, U.S. Army Corps of Engineers. March 1992.) -Section 11, Public Involvement, Review and Consultation, describes public involvement during the Corps' Final Federal Feasibility study of the Kissimmee River, covering the period 1990 - 1992. Annex A, Public views and comments, includes the public comments received during the review process. Since the authorization of the Kissimmee River Restoration Project, the

SFWMD has continued to have public meetings to provide progress reports to the local community and governments.

12.2 REVIEW CONFERENCES

Six review conferences involving various study interests were conducted during the Kissimmee River Restoration feasibility study to review work and decide courses of action related to specific policy and technical issues. Subsequently, the Headwaters Revitalization component of the restoration project has undergone checkpoint conferences and a review conference on the Draft Project Modification Report. These conferences were:

* **Special Resolution Conference (SRC),** February 6-7, 1991, Jacksonville, Florida. Representatives of the SFWMD, the Office of the Assistant Secretary of the Army for Civil Works, and the Corps met to resolve policy and procedural issues regarding the Kissimmee River Section 1135 proposal and the feasibility study authorized by the Water Resources Development Act of 1990.

* **Interagency Environmental Planning Conference,** April 10, 1991, Jacksonville, Florida, and April 11-12, 1991, River Ranch, Florida. Representatives of the SFWMD, the Florida Game and Fresh Water Fish Commission, the U.S. Fish and Wildlife Service, and the Corps met to discuss technical aspects of the project's environmental analyses.

* **Hydrology and Hydraulics Technical Review Conference,** May 15-16, 1991, River Ranch, Florida, and May 20-22, 1991, Berkeley, California. Representatives of the SFWMD and the Corps met to discuss technical aspects of project hydrology and hydraulics, including a demonstration of the Kissimmee River Pool B physical model at the University of California at Berkeley.

* **Checkpoint Conference**, June 20, 1991, Jacksonville, Florida. Representatives of the SFWMD, the Assistant Secretary of the Army for Civil Works, and the Corps met to review study progress in implementing guidance developed during the Special Resolution Conference.

* **Meeting of the Scientific Advisory Panel for Environmental Monitoring of Kissimmee River Restoration**, July 16-18, 1991, River Ranch, Florida. Representatives of the SFWMD, the Florida Department of Natural Resources, the Florida Department of Environmental Regulation, the Florida Game and Fresh Water Fish Commission, the U.S. Fish and Wildlife Service, and the Corps met to better define monitoring of project environmental effects.

* **Feasibility Review Conference,** September 5-6, 1991, Jacksonville, Florida. Representatives of the SFWMD, the Assistant Secretary of the Army for Civil Works, the U.S. Fish and Wildlife Service, the Florida Game and Fresh Water Fish Commission, the Florida Department of Natural Resources, and the Corps met to provide the sponsor with as much assurance as possible about the Army position of the study recommendations, to facilitate Federal agency review, and to obtain Washington-level commitment to the recommendations.

* Kissimmee River Headwaters Revitalization, In-Progress Review Conference, January 1994, Jacksonville, Florida. Representatives of the SFWMD, the U.S. Fish and Wildlife Service, the Florida Game and Fresh Water Fish Commission and the Corps met to discuss issues and evaluation procedures for Headwaters Revitalization component of the Kissimmee River Project.

* Kissimmee River Headwaters Revitalization, Draft Project Modification Report, Review Conference, October 26, 1995. Representatives of the SFWMD, the Assistant Secretary of the Army, and the Corps met to discuss the draft report and recommendations for the Kissimmee Headwaters Revitalization Project.

12.3 CONTINUING COORDINATION

Continuing coordination has been maintained in two special areas of the study. First, frequent communication has been maintained with the SFWMD, as the study's non-Federal cost sharing partner, on day-to-day progress and general questions concerning the previous restoration study. The sponsor has generously provided assistance in attending meetings, writing draft materials, and other activities in accordance with the Project Cooperation Agreement.

Second, continuing coordination was maintained with various experts in biological sciences representing interested environmental agencies, including the SFWMD, the Florida Game and Fresh Water Fish Commission, the U.S. Fish and Wildlife Service, and the Corps in conducting environmental studies, such as the habitat evaluation procedures analysis and forecasting future environmental conditions. Coordination has occurred over a series of meetings and through frequent exchanges of correspondence and conversations among the involved experts. Results of this coordination are documented in the Fish and Wildlife Coordination Act Report in Annex E.

12.4 SCOPING

Scoping was accomplished in accordance with the requirements of the Council on Environmental Quality's regulations implementing the procedural provisions of the National Environmental Policy Act (NEPA) of 1969, as amended (40 CFR 1501.7).

12.5 OTHER REQUIRED COORDINATION

In addition to the scoping required by NEPA, coordination required by other Federal laws and regulations has been conducted with the following agencies:

* U.S. Fish and Wildlife Service - A final Fish and Wildlife Coordination Act Report has been prepared and is included at Annex E.

* Florida Game and Fresh Water Fish Commission - Commission representatives participated with the U.S. Fish and Wildlife Service in preparing the Coordination Act Report.

* Florida State Historic Officer (SHPO) - Coordination has been ongoing with the SHPO in accordance with the Advisory Council on Historic Preservation's procedures.

12.6 REVIEW OF THE DRAFT INTEGRATED PROJECT MODIFICATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

The draft integrated report and environmental impact statement will be sent to numerous local, State and Federal agencies and private interest groups for review and comment in accordance with the Council on Environmental Quality's NEPA regulations and related Corps guidance. Comments received during the review will be considered in preparing the final study documents, and will be considered by subsequent reviewers and decision makers in the Washington level Federal review process.

12.6.1 Report and EIS Recipients

The following agencies, groups and individuals will be sent copies of the draft integrated project modification report and EIS.

Federal Agencies

Department of Agriculture
Department of the Air Force
U.S. Department of Commerce
U.S. Fish and Wildlife Service
Department of Energy
Department of Health and Human Services
Department of Housing and Urban Development
Department of the Interior
Environmental Protection Agency
Federal Emergency Management Agency
Advisory Council on Historic Preservation

State and Local Government

Florida State Clearinghouse
Florida Office of Planning and Budgeting
Florida Division of Historical Resources - SHPO
Florida Department of Environmental Regulation
Florida Department of Transportation
Florida Game and Fresh Water Fish Commission
South Florida Water Management District
Osceola County
Polk County
Okeechobee County
Highlands County

Groups

Miccosukee Tribe of Indians of Florida
Dairy Farmers, Inc.
State Wetland Managers Association
National Audubon Society
Florida Audubon Society
Environmental Defense Fund
Izaak Walton League of America, Inc.
Florida Wildlife Federation
Florida Defenders of the Environment
The Wilderness Society
Sierra Club, Florida Chapter
1000 Friends of Florida
Nature Conservancy, Florida Chapter
Florida Lake Management Society

Okeechobee Homeowners Association
River Acres Homeowners Association
Chain of Lakes Property Owners, Inc.

Individuals

A list of individuals who will receive the draft integrated report and EIS is on file in the Jacksonville District at the address shown on the cover page of this document.

12.7 PUBLIC MEETINGS

Three public meetings were 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' 1991 feasibility study. These meetings were held as follows:

October 1, 1991, at the Okeechobee Civic Center.

October 2, 1991, at the Kissimmee City Hall.

October 3, 1991, at the Sebring City Hall.

The meeting in Okeechobee was attended by over 200 people. Many of the speakers were landowners whose homes, farms, or businesses would be impacted as part of the recommended plan and they expressed their opposition to the project. Residents of the Hidden Acres and River Acres communities were opposed to their communities being acquired either partially or fully. Representatives and owners of dairy farms were concerned that their businesses would be adversely affected. Many of the speakers expressed concern about adverse effects on the local economy such as jobs which would be lost. There was also concern about the large amount of land that would be removed from the tax rolls and the adverse effect that would have. The Okeechobee County manager presented a resolution from the County Board of Commissioners opposing the project. A number of speakers also were concerned about the cost of the project. Representatives of environmental groups expressed support for the recommended plan.

The meeting in Kissimmee was attended by about 60 people. Many of the speakers expressed concern about the Headwaters Revitalization project and its effect on flood control and navigation. Specifically, there was concern about the results of regulation schedules for the Kissimmee group of lakes and the backfilling in the Lower Basin and the affect to the existing level of flood

control. Navigation interests were opposed to the project due to the possible impact to navigation. There was also a concern that some of the larger boats would not be able to navigate the meandering river. A number of speakers also expressed concern about the cost of the recommended plan. Representatives of environmental groups expressed support for the recommended plan.

The meeting in Sebring was attended by about 45 people. Many of the speakers were concerned about the effect on property owners. Specifically, they feel properties needed for the Recommended Plan would be acquired at a token of their values, and the State may claim properties without compensation. Agricultural representatives were concerned about the effects on agriculture in the study area. A number of speakers were concerned about the cost of the project. Navigation interests were opposed to the project due to the possible impact on navigation. A concern was expressed that the regulation schedules for the Kissimmee group of lakes would adversely effect the existing level of flood protection. Fishermen spoke out against the project stating that since the demonstration project, the fishing resources has declined substantially. Individuals from surrounding communities expressed support for the recommended plan.

In addition to the three public meetings for the Kissimmee River Restoration Project, a public meeting for the Kissimmee River Headwaters Revitalization Project was held in Lorida, Florida on March 6, 1996 to present the findings of the recommended plan to residents of the Upper and Lower Basins. Also, the details of the plan and potential impacts of the project were presented in a public forum to the Osceola County Board of Commission on March 4, 1996. Particular areas of concern are presented in Annex A, Public Views and Comments.

SECTION 13

RECOMMENDATIONS

I recommend that the Central and Southern Florida Project be modified to allow for the Headwaters Revitalization Project, described in the chapter of this report entitled "The Recommended Plan", be implemented as a Federal project with such modifications thereof as in the discretion of the Chief of Engineers may be advisable. The total estimated cost of the recommended plan is $78,356,300. The estimated Federal cost is $38,356,300 and the estimated non-Federal cost is $78,356,300.

I also recommend that the non-Federal sponsor be authorized credit for the value of lands, easements, rights-of-way, relocations, and disposal areas provided for Headwaters Revitalization Project.

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:

a. Contribute 50 percent of total project costs.

b. Provide all lands, easements, rights-of-way, including suitable borrow and dredged or excavated disposal areas, and perform all relocations determined by the Government to be necessary for construction, operation, and maintenance of the Project.

c. Hold and save the Government free from all damages arising from the construction, operation, maintenance, repair, replacement, and rehabilitation of the Project and any Project related betterments, except for damages due to the fault or negligence of the Goverment or the Government's contractors.

d. Operate, maintain, repair, replace, and rehabilitate the completed Project, or functional portion of the Project, at no cost to the Government, in accordance with applicable Federal and State laws and specific directions prescribed by the Government in an OMRR&R Manual and any subsequent amendments thereto.

e. Participate in and comply with applicable Federal floodplain management and flood insurance programs;

f. Publicize floodplain information in the area concerned and shall provide this information to zoning and other regulatory agencies for their use in preventing unwise future development in the floodplain and in adopting such regulations as may be necessary to prevent unwise future development and to ensure compatibility with protection levels provided by the Project.

g. 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.

h. Provide 100 percent of the costs to remove excess spoil material from the flood control canals, C-35, C-36 and C-37.

The report states that the Headwaters Revitalization Project will be completed, or nearly so, with a fully operational modified Lake Kissimmee outlet structure prior to implementing construction for the Lower Basin project. If, for any reason, the Lower Basin project is not constructed, the Headwaters Revitalization Project will not be initiated as a stand alone project.

TERRY L. RICE
Colonel, Corps of Engineers
Commanding

SECTION 14

LIST OF PREPARERS

The people who were primarily responsible for contributing to preparing this Environmental Impact Statement are listed in Table 14-1.

TABLE 14-1

KISSIMMEE RIVER RESTORATION
LIST OF PREPARERS

NAME	DISCIPLINE/ EXPERTISE	EXPERIENCE	ROLE IN PREPARING DOCUMENT
Peter Besrutschko	Environmental Engineer	20 years experience chemical, petro and environmental engineering	Hazardous and Toxic Waste Assessment
Annon I. Bozeman, Jr	Outdoor Recreation Planner	15 years recreation design, construction and development	Aesthetics and Recreation
Brian Brodehl	Civil Engineer	2 years civil engineering	Report preparation
David L. McCullough	Archeology	13 years environmental and cultural resources assessment	Cultural Resources evaluation, coordination
Sheri Miller	Student Environmental Engineer	1 year water resources/ project management	Report preparation
Robert Pace	Biology	USFWS, Vero Beach	Fish and Wildlife Coordination Act Report, Planning Partner
William Porter	Ecologist	15 years environmental planning	EIS preparation
Glenn R. Schuster, P.E.	Environmental Engineer/Biologist	18 years environmental engineering	Water quality assessment
Michael A. Smith, P.E.	Civil Engineer	9 years water resources planning, Corps of Engineers	Report-EIS preparation: study manager
Patricia Strayer	Civil Engineer	South Florida Water Management District	Report Review
Louis A. Toth	Aquatic Ecology	South Florida Water Management District	Report Review and Ecosystem assessment of alternatives

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KISSIMMEE RIVER
HEADWATERS REVITALIZATION PROJECT

ANNEX A

PUBLIC VIEWS AND COMMENTS

United States Department of the Interior

OFFICE OF THE SECRETARY
OFFICE OF ENVIRONMENTAL POLICY AND COMPLIANCE
Richard B. Russell Federal Building
75 Spring Street, S.W.
Atlanta, Georgia 30303

March 7, 1996

ER-96/73

Mr. Michael A. Smith
U. S. Army Corps of Engineers
P. O. Box 4970
Jacksonville, FL 32232-0019

Dear Mr. Smith:

The Department of the Interior has reviewed the Integrated Project Report and Supplemental Final Environmental Impact Statement for the Kissimmee River Headwaters Revitalization project, as requested.

General Comments

The Department is pleased that the Corps of Engineers followed the recommendations provided in the Fish and Wildlife Service (FWS) Coordination Act Report. Specifically, we strongly endorse selection of the project alternative that includes breeching the levees on the Overstreet, Rolling Meadows, and Bronson tracts. This plan will maximize environmental benefits in the Kissimmee Chain of Lakes, while providing suitable water flow to promote restoration of the Kissimmee River.

Specific Comments

Section 9-2.6, Endangered or Threatened Species, Pp. 9-11 and 9-12. The FWS agrees with the general statements on the effect of the project on threatened and endangered species, except that the paragraph on Audubon's crested caracara should be revised. The current wording indicates that the FWS considers the loss of 5510 acres of potential feeding habitat to be insignificant. This is not the case. If the project involved total loss of habitat value, for example, conversion of dry prairie and grasslands to urban development, this would constitute a significant loss of caracara habitat. In this case, however, dry prairie and grassland habitat types near the present shoreline of the lakes would be converted to seasonally flooded wet prairie or marsh which also provides habitat for the caracara. As a result, our species models predicted no significant change in overall habitat value for the caracara. Even if an environmental restoration project were to result in a significant adverse effect (short of the jeopardy threshold) for a listed species, a restoration project would be justified if the selected alternative optimized benefits to the greatest number of listed species. This is the rationale for ongoing efforts by the

FWS to produce a multi-species recovery plan for south Florida. The FWS finds that the selected alternative for the Kissimmee Headwaters Revitalization Project will optimize benefits for a variety of wildlife, including threatened and endangered species.

In summary, we recommend that the Corps of Engineers incorporate the above suggested clarification in the Final Environmental Impact Statement.

Thank you for the opportunity to review the document. If there are questions related to fish and wildlife resources, please call Jon Andrew at 404/679-7123, or Tom Grahl at 407/562-3909.

Sincerely,

James H. Lee

James H. Lee
Regional Environmental Officer

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 4
345 COURTLAND STREET, N.E.
ATLANTA, GEORGIA 30365

MAR 18 1996

Mr. A.J. Salem
Chief, Planning Division
Jacksonville District, Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232

Subject: Draft Supplement to the Environmental Impact Statement (DSEIS) for the Kissimmee River, Headwaters Revitalization Project, Florida

Dear Mr. Salem:

Under the authority of Section 309 of the Clean Air Act and Section 102(2)(C) of the National Environmental Policy Act (NEPA), EPA, Region 4 has reviewed the subject document which discusses the consequences of the proposed structural and nonstructural plan. Specifically, the recommended plan will modify the Kissimmee regulation schedule, acquire adjacent acreage to the involved lakes (Cypress, Hatchineha, etc.), widen upper basin flood control canals (C-36 and C-37), increase outlet capacity at S-65 to reduce higher flood stages, and degrade selected local levees to provide water storage.

These modifications are projected to restore a more historical condition to the watershed's hydrology (including lake fluctuations) while improving its wetland function. There are some unavoidable losses associated with this proposal, e.g., widening of Canals 36 & 37 will destroy approximately 30 acres of fresh water wetlands. However, on balance the positive aspects of this plan more than offset its ramifications.

On the basis of the information provided, we have no significant environmental objections to implementation of this project. Therefore, a rating of LO (Lack of Objections) has been assigned. We appreciate that additional monitoring/modelling will be necessary to fine tune this action; however, the preliminary results appear very promising as a means to restore a semblance of the historic hydrology of the basin.

If we can be of further assistance in this matter, Dr. Gerald J. Miller (404-347-3555 VM 6853) will serve as initial point of contact in regard to NEPA matters whereas Mr. Jose Negron (404-347-2126) should be contacted on Section 404 issues.

Sincerely yours,

Heinz J. Mueller, Chief
Environmental Policy Section
Federal Activities Branch

STATE OF FLORIDA
DEPARTMENT OF COMMUNITY AFFAIRS

EMERGENCY MANAGEMENT • HOUSING AND COMMUNITY DEVELOPMENT • RESOURCE PLANNING AND MANAGEMENT

LAWTON CHILES
Governor

JAMES F. MURLEY
Secretary

April 10, 1996

Mr. A. J. Salem
Department Of The Army
Jacksonville District
Corps of Engineers
Post Office Box 4970
Jacksonville, Florida 32232-0019

RE: Protecting, Clearing and Straightening Channels - Kissimmee River Headwaters Revitalization Project - Appendices to the Integrated Project Modification Report and Supplement to the Final Environmental Impact Statement - Osceola County, Florida
SAI: FL9208251487CR

Dear Mr. Salem:

The Florida State Clearinghouse, pursuant to Presidential Executive Order 12372, Gubernatorial Executive Order 95-359, the Coastal Zone Management Act, 16 U.S.C. §§ 1451-1464, as amended, and the National Environmental Policy Act, 42 U.S.C. §§ 4321, 4331-4335, 4341-4347, as amended, has coordinated a review of the above-referenced project.

The Department of Environmental Protection (DEP) has provided several comments, as enclosed and summarized below, which should be considered as the project's planning and design proceed. The DEP suggests that 1) the lands which will be re-inundated be inventoried to determine whether pesticides or other soil contamination exists; 2) ditch dredging design and activities utilize enhancement of the existing natural waterway features to minimize impacts to the natural systems and environmentally sensitive areas; 3) the ecological connections to the river/lake/wetland system be re-established by breaching levees in multiple locations and other innovative measures; 4) creative solutions be developed for addressing aquatic plant problems; 5) the U. S. Army Corps of Engineers (Corps) determine whether the increased tailwater due to higher water levels in

Lake Hatchineha will impact the water quality treatment capacity of Marion Creek Swamp and, if so, the Corps consider providing treatment in upland locations; 6) the discharge from the increased capacity of the S-65 structure be used to restore the adjacent floodplain and to provide flood control.

The DEP also indicates that the application for an environmental resource permit, along with consent to use sovereign submerged lands is currently being processed by the DEP. Because this complex project requires integration with a number of other ecosystem restoration, flood and stormwater management concerns, the DEP requests the opportunity to work with the Corps and the South Florida Water Management District in consideration of any environmental design modifications. Close coordination with the DEP's Intergovernmental Coordination Office and Central District's ecosystem management coordinator is recommended. Please refer to the enclosed DEP comments for further details.

The Game and Fresh Water Fish Commission (GFWFC) suggests that a water level schedule for Lakes Cypress, Hatchineha and Kissimmee which provides high water levels closer to the historic conditions would enhance the project's benefits to fish, wildlife and wetland habitat. Therefore, the GFWFC recommends modification of the proposed schedule to allow for a longer duration of water levels between 52.5 and 54 feet mean sea level (msl). The GFWFC also suggests that the enlargement of canal C-37 include restoration of the adjacent historic Kissimmee River channel by degrading the canal's levee and the use of aquatic plant management.

Additionally, the GFWFC notes that the widening of C-37 may exacerbate existing navigation problems within the oxbows of the old river channel. The GFWFC suggests deepening of the oxbows on the northwest side of the canal to provide low-water navigation improvements and to allow for a schedule of lower lake levels. To maximize the positive environmental benefits of the proposed project, the lake levels in Lakes Kissimmee, Cypress and Hatchineha should fluctuate below 48.5 feet msl during dry periods. Periodic low water levels in Lakes Cypress and Hatchineha would allow for implementation of lake bottom restoration activities, further enhance aquatic habitat, and

provide increased storage capacity for flood control. Please refer to the enclosed GFWFC comments for further details.

Based on the information contained in the above-referenced documents and the enclosed comments provided by our reviewing agencies, the state has determined that, at this stage, the project is consistent with the Florida Coastal Management Program (FCMP). All subsequent environmental documents prepared for this project must be reviewed to determine the project's continued consistency with the FCMP. The state's continued concurrence with the project will be based, in part, on the adequate resolution of issues identified during this and subsequent reviews.

Thank you for the opportunity to review this project. If you have any questions regarding this letter, please contact Ms. Keri Akers, Clearinghouse Coordinator, or Ms. Jasmin Raffington, Florida Coastal Management Program, at (904) 922-5438.

Sincerely,

G. Steven Pfeiffer
Assistant Secretary

GSP/rk

Enclosures

cc: Dan Pennington, Department of Environmental Protection
Bradley J. Hartman, Game and Fresh Water Fish Commission

Department of Environmental Protection

Lawton Chiles
Governor

Marjory Stoneman Douglas Building
3900 Commonwealth Boulevard
Tallahassee, Florida 32399-3000

Virginia B. Wetherell
Secretary

RECEIVED
MAR 21 1996
State of Florida Clearinghouse

March 20, 1996

Keri Akers
Department of Community Affairs
Suite 305
2740 Centerview Drive
Tallahassee, Florida 32399-2100

Re: SAI # FL9208251487CR, Kissimmee River, Florida Headwaters Revitalization Project, Supplement to the Final Environmental Impact Statement

Dear Ms. Akers:

The Department has reviewed the proposed project to develop a plan within the upper Kissimmee River Basin which would provide the necessary flows for the restoration of the Kissimmee River Ecosystem and maintenance of the existing level of flood control within the Kissimmee River Basin. The recommended plan consists of:

* Modification of the existing Lake Kissimmee River regulation schedule. Modification of the regulation schedule is necessary for the restoration of the Kissimmee River and to expand the upper Kissimmee Lake littoral zones.

* Acquisition of approximately 20,800 acres of land bordering the affected lakes, Lake Hatchineha, Lake Kissimmee, Lake Cypress, and Lake Tiger.

* Widening of upper basin flood control canals, C-36 and C-37. Because of the increased tailwater flood stages at S-65 resulting from the modified regulation schedule, the flood control canals connecting Lake Kissimmee to Lake Hatchineha, C-37, and Lake Hatchineha to Lake Cypress, C-36 will have to be enlarged to flatten the flood profile through the upper lakes and to prevent excessive flooding.

* Increase outlet capacity at water control structure S-65. Modifications to the existing S-65 structure will be needed to reduce flood stages in Lake Kissimmee and provide adequate discharge capacity.

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* Degradation of local levees. Reflooding of lands up to the 54 foot elevation will be partially impeded by local farm levees that have been constructed within the historic lake littoral zone. Breaching of five local levees is recommended for obtaining the water storage required for achieving Lower Basin and Upper Basin restoration. Approximately 1 mile of levee sections or about 600,000 cubic yards will be degraded by backfilling adjacent borrow ditches. The five levees are located on the east and southwest side of Lake Kissimmee, north side of Lake Cypress, and the south and north side of Lake Hatchineha.

* Sewering of Hatchineha Estates to remove existing septic systems. Given the proposed changes to local hydrology resulting from this project, these septic systems would likely not remain functional and would create public health as well as water quality problems in this area.

This agency supports these proposed actions and is a proponent of the Kissimmee River restoration efforts, and of the entire Kissimmee-Okeechobee-Everglades restoration efforts. Nevertheless, these proposed actions, being a part of the larger, complex and coordinated ecosystem restoration effort, deserve our close attention. After recent discussions with the USACOE and the SFWMD about the specifics of the project we have prepared a number of suggestions that should be considered as this project proceeds:

1. Inventory lands to be re-inundated to be certain there are no pesticide problems, or other soil contamination issues. Work with us if so to remediate.

2. Be as creative as possible with ditch dredging design - make sure banksides are stabilized in an environmentally friendly way. Minimize impacts and/or work toward enhancement of the affected natural system wherever possible (e.g., along portions of C-37 where remaining natural waterway features still exist). A field investigation with DEP field biologist, engineer and our Central District's ecosystem management coordinator would be helpful at the earliest possible stages.

In addition, further dredging design considerations should be given to the hydraulic capacity of the canal system that could be achieved through deepening the canals rather then widening which would destroy adjacent wetland and swamp land. In less environmentally sensitive areas, widening of the canals would be preferred. A combination of deepening and widening to achieve the same hydraulic result with the least environmental damage would be the preferred design.

3. Emphasize that as many levees as possible be breached in multiple locations along their lengths. Look for other creative

ways to re-establish ecological connections to other parts of the river/lake/wetland system (e.g., breaching of Rolling Meadows Levee).

4. Look for creative ways to deal with aquatic plant problems.

5. Marion Creek flows through Marion Creek Swamp into Lake Hatchineha. In the early 1980's the SFWMD allowed the Poinciana Development to use the swamp as part of their stormwater treatment system. We have a concern/question relative to any impacts to the water quality treatment capacity of this area caused by the increased tailwater effects caused by higher levels in Lake Hatchineha. If there is any problem, the preferred correction would be to have the treatment occur in upland locations.

Involving the same issue, a breach of a levee north of Lake Hatchineha is mentioned. We are not clear if this is part of the containment of the Marion Creek Swamp? It may have no direct connection, but if it does, some of the same issues involving the stormwater treatment may apply.

6. Regarding the increased capacity of the S-65 structure, we are not clear where the increased discharge is to be directed? There have been suggestions that this modification of the structure be designed to also allow for the restoration of some of the adjacent floodplain. At the present time, this part of the floodplain would not be restored due to the continued existence of the C-38 Canal between the S-65 and S-65A structures. Without some redirection of flow into these areas, no restoration will occur there. If the design can accommodate both increased discharge for flood control purposes and redirection of flow to the dry floodplain for restoration purposes we could attain a double benefit.

Finally, we would like to note that an environmental resource permit (ERP) is required along with consent to use sovereignty submerged lands. The two processes are now linked. We have already received an application for a permit (File No. 49, 532831259) and have met with USACOE staff to review the project and request additional clarifying information.

Based on the initial review of the Supplemental EIS, and the information contained in the permit application along with more recent meetings to clarify our understanding of the project, we believe the proposed actions should have significant environmental benefits (e.g., restoration of former wetlands), and should contribute to the overall restoration/enhancement of the South Florida ecological system. Nevertheless, as mentioned above, this is a complex project that must integrate correctly with a number of other ecosystem restoration, flood and stormwater management concerns.

We appreciate the opportunity to comment on this proposed

project, and would like to work with the USACOE and the SFWMD in consideration of any environmental design modifications. If you have any questions please call me at (904) 487-2231.

Cordially,

Dan Pennington

Dan Pennington
Office of Intergovernmental
Programs

DP

cc: Gail Slone, DEP Ecosystem Management
Linda McCarthy, SEFDEP
Barbara Bess, CFDEP
Jim Carr, CFDEP
Michael Bateman, DEP-ERP
Lauren Milligan, DEP-ERP
Mike Ornella, USACOE
Brian Barnett, FG&FWFC
Patricia Strayer, SFWMD
Herb Zebuth, SEFDEP

FLORIDA GAME AND FRESH WATER FISH COMMISSION

JULIE K. MORRIS
Sarasota

QUINTON L. HEDGEPETH, DDS
Miami

MRS. GILBERT W. HUMPHREY
Miccosukee

THOMAS B. KIBLER
Lakeland

ALLAN L. EGBERT, Ph.D., Executive Director
WILLIAM C. SUMNER, Assistant Executive Director

OFFICE OF ENVIRONMENTAL SERVICES
BRADLEY J. HARTMAN, Director
FARRIS BRYANT BUILDING
620 South Meridian Street
Tallahassee, FL 32399-1600
(904) 488-6661
SUNCOM 278-6661
FAX (904) 922-5679
TDD (904) 488-9542

March 18, 1996

RECEIVED
MAR 19 1996
State of Florida Clearinghouse

Ms. Keri Akers
Florida State Clearinghouse
Department of Community Affairs
2740 Centerview Drive
Tallahassee, Florida 32399-2100

RE: SAI #9208251487CR, Kissimmee River Headwaters Revitalization Project, Integrated Project Modification Report and Supplement to the Final Environmental Impact Statement (DEP #49, 532831259)

Dear Ms. Akers:

The Division of Fisheries and Office of Environmental Services of the Florida Game and Fresh Water Fish Commission have reviewed the referenced document, and offer the following comments.

The U.S. Army Corps of Engineers (USCOE) has proposed the Kissimmee River Headwaters Revitalization Project, designed to complement the Kissimmee River Restoration Project by insuring flows to the River, and including restoration of 7,236 acres of previously converted wetlands from grass and scrub land to freshwater marsh. The plan involves the following: modification of the existing Lake Kissimmee regulation schedule; acquisition of about 20,800 acres of land bordering Lake Kissimmee, Lake Hatchineha, Lake Cypress, and Lake Tiger; widening of flood control canals C-36 and C-37; modifications to the existing S-65 structure to increase outlet capacity; and breaching five local levees in order to reflood lands up to the 54 feet msl contour.

8 Our agency strongly supports both the Kissimmee River Restoration and the Headwaters Revitalization projects. However, we believe that the fish and wildlife benefits of this project could be greatly enhanced if the water level schedule for Lakes Cypress, Hatchineha, and Kissimmee provided high water levels closer to the historic condition. The modest wetland habitat benefits of the USCOE proposed schedule could be dramatically improved with longer duration of water levels between 52.5 and 54 feet msl. The U.S. Fish and Wildlife Service

Kissimmee River during droughts would also provide environmental benefits to the Restoration Project. Another benefit of periodic low water levels in these lakes would be increased storage capacity for flood control.

Sincerely,

Bradley J. Hartman

Bradley J. Hartman, Director
Office of Environmental Services

BJH/JMW/EM/rs
ENV 2-6 and ENV 1-3-2
kisshead.sai

cc: Mr. Richard E. Bonner, U.S.A.C.O.E., Jacksonville
Mr. Jeremy Craft, FDEP, Tallahassee
Ms. Patricia Strayer, SFWMD, West Palm Beach

Coordination Act Report illustrates (Table 3) that the proposed schedule closely approximates historic low water stages, but provides only 36% of the historic high water levels. Therefore, we recommend that the schedule be modified (changes in discharge zones and/or the discharge rating curve) to achieve longer durations of high water, or made operationally flexible to allow discharge rate reductions based on real time conditions. By defining the desired percentage of marsh inundation along the Kissimmee River and applying rainfall quantities and flow rates from Lake Kissimmee, the schedule could be altered to provide extended periods of higher water levels for Lakes Kissimmee, Cypress, and Hatchineha. Thus our principal recommendation to the USCOE is to modify their proposed schedule to allow longer duration of water levels between 52.5 and 54 feet msl.

The enlargement of canal C-37 should include restoration of the historic Kissimmee River channel located just northeast of the lower end of this canal. Approximately 500 acres of river channel, oxbows, and floodplain wetlands have been degraded by channelization in this area. Aerial photographs from 1958 indicate that 4 to 5 miles of main river channel traverse the area between the Zipperer Bridge and Lake Kissimmee. Degrading canal C-37's east levee during construction should provide some flow to this section of the Kissimmee River, and intensive aquatic plant management (burning, chemical control, and harvesting) could open this portion of the river to navigation and allow reestablishment of productive fish and wildlife habitat.

When canal C-37 was constructed during the mid-1960s, oxbows of old river channel were left on the northwest side of the canal. The canal has reduced water flow in these oxbows, resulting in severe siltation and shallowing of water depth, with a negative impact on navigation for users of the fish camps and the residents on these oxbows. The enlargement of C-37 will exacerbate this problem by further reducing flow to the adjacent oxbows. We recommend that the navigation problems associated with the widening of C-37 be addressed during construction via deepening of the oxbows. A potential consequence of low-water navigation improvements in this area may be the ability to build lower lake levels into the schedule. Currently, lake levels below 49.0 feet msl restrict navigation from these oxbows. To maximize the positive environmental impacts associated with the Headwaters Project, lake levels in Lakes Kissimmee, Cypress, and Hatchineha should fluctuate below elevation 48.5 feet msl during dry periods. By lowering the zero discharge elevation from 48.5 feet msl to 47.0 or 47.5 feet, Lakes Cypress and Hatchineha could be lowered sufficiently within the range of the schedule that they would not need to be included in future extreme drawdowns of Lake Kissimmee. Periodic low water levels in these lakes would allow implementation of lake bottom restoration activities and further enhance aquatic habitat for the benefit for fish and wildlife. Additional minimum discharges to the

COUNTY: Osceola

DATE: 02/01/96
COMMENT DUE DATE: 02/15/96
CLEARANCE DUE DATE: 03/18/96
SAI#: FL9208251487C

STATE AGENCIES	LOCAL/OTHER	OPB POLICY UNITS
X Agriculture __ Community Affairs __ Environmental Protection __ Game and Fresh Water Fish Comm	__ South Florida WMD __ Southwest Florida WMD	__ Environmental Policy/C & ED

RECEIVED
FEB 09 1996
State of Florida Clearinghouse

The attached document requires a Coastal Zone Management Act/Florida Coastal Management Program consistency evalutation and is categorized as one of the following:

- Federal Assistance to State or Local Government (15 CFR 930, Subpart F). Agencies are required to evaluate the consistency of the activity.
- X Direct Federal Activity (15 CFR 930, Subpart C). Federal Agencies are required to furnish a consistency determination for the State's concurrence or objection.
- Outer Continental Shelf Exploration, Development or Production Activities (15 CFR 930, Subpart E). Operators are required to provide a consistency certification for state concurrence/objection.
- Federal Licensing or Permitting Activity (15 CFR 930, Subpart D). Such projects will only be evaluated for consistency when there is not an analogous state license or permit.

Project Description:

Headwaters Revitalization Project - Appendices to the Integrated Project Modification Report and Supplement To The Final Environmental Impact Statement - Kissimmee River, Osceola County, Florida.

To: **Florida State Clearinghouse**
Department of Community Affairs
2740 Centerview Drive
Tallahassee, FL 32399-2100
(904) 922-5438 (SC 292-5438)
(904) 487-2899 (FAX)

EO. 12372/NEPA

- ☑ No Comment
- ☐ Comments Attached
- ☐ Not Applicable

Federal Consistency

- ☑ No Comment/Consistent
- ☐ Consistent/Comments Attached
- ☐ Inconsistent/Comments Attached
- ☐ Not Applicable

om:
Division/Bureau: Forestry/FRP&SS
Reviewer: Ray Marc
Date: 02/06/96

COUNTY: Osceola

DATE: 02/01/96
COMMENT DUE DATE: 02/15/96
CLEARANCE DUE DATE: ~~03/18/96~~ 4/1/96
SAI#: FL9208251487CR

STATE AGENCIES	LOCAL/OTHER	OPB POLICY UNITS
__ Agriculture __ Community Affairs __ Environmental Protection __ Game and Fresh Water Fish Comm	__ South Florida WMD __ Southwest Florida WMD	X Environmental Policy/C & ED

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State of Florida Clearinghouse

The attached document requires a Coastal Zone Management Act/Florida Coastal Management Program consistency evalutation and is categorized as one of the following:

__ Federal Assistance to State or Local Government (15 CFR 930, Subpart F). Agencies are required to evaluate the consistency of the activity.

_X_ Direct Federal Activity (15 CFR 930, Subpart C). Federal agencies are required to furnish a consistency determination for the State's concurrence or objection.

__ Outer Continental Shelf Exploration, Development or Production Activities (15 CFR 930, Subpart E). Operators are required to provide a consistency certification for state concurrence/objection.

__ Federal Licensing or Permitting Activity (15 CFR 930, Subpart D). Such projects will only be evaluated for consistency when there is not an analogous state license or permit.

RECEIVED
FEB 23 1996
Office of Environmental Affairs

Project Description:

Headwaters Revitalization Project - Appendices to the Integrated Project Modification Report and Supplement To The Final Environmental Impact Statement - Kissimmee River, Osceola County, Florida.

To: **Florida State Clearinghouse**
Department of Community Affairs
2740 Centerview Drive
Tallahassee, FL 32399-2100
(904) 922-5438 (SC 292-5438)
(904) 487-2899 (FAX)

EO. 12372/NEPA

- [x] No Comment
- [ ] Comments Attached
- [ ] Not Applicable

Federal Consistency

- [x] No Comment/Consistent
- [ ] Consistent/Comments Attached
- [ ] Inconsistent/Comments Attached
- [ ] Not Applicable

From:
Division/Bureau: OPB/ENV
Reviewer: R. Smith
Date: 2/26/96

U.S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT

SOUTHEAST/CARIBBEAN
Richard B. Russell Federal Building
75 Spring Street, S.W.
Atlanta, Georgia 30303-3388

February 14, 1996

Mr. Michael A. Smith
U.S. Army Engineers
P.O. Box 4970
Jacksonville, Florida 32232-0019

This refers to your memorandum dated January, 1996, transmitting the Integrated Project Modification Report and Supplemental Environmental Impact Statement for the Central and Southern Florida Project, Kissimmee River, Florida Headwaters Revitalization.

Our review indicates there will be no significant adverse impact on any HUD programs as a result of this project.

Thank you for the opportunity to review and comment on your proposed project.

Sincerely,

Thomas A. Ficht

Thomas A. Ficht
Supervisory Environmental
Officer

FLORIDA DEPARTMENT OF STATE
Sandra B. Mortham
Secretary of State

DIVISION OF HISTORICAL RESOURCES
R.A. Gray Building
500 South Bronough Street
Tallahassee, Florida 32399-0250

Director's Office (904) 488-1480
Telecopier Number (FAX) (904) 488-3353

February 16, 1996

Mr. Michael A. Smith
Regulatory Division, Permits Branch
Jacksonville District, Corps of Engineers
P.O. Box 4970
Jacksonville, Florida 32232-0019

In Reply Refer To:
Frank J. Keel
Historic Sites Specialist
(904) 487-2333
Project File No. 960371

RE: Cultural Resource Assessment Request
Integrated Project Modification Report and Supplement to the Final Environmental Impact Statement, Kissimmee River Headwaters Revitalization Project

Dear Mr. Smith:

In accordance with the procedures contained in 36 C.F.R., Part 800 ("Protection of Historic Properties"), we have reviewed the referenced project(s) for possible impact to historic properties listed, or eligible for listing, in the *National Register of Historic Places*. The authority for this procedure is the National Historic Preservation Act of 1966 (Public Law 89-665), as amended.

After review of the referenced document, it is our opinion that the historical preservation concerns of this agency have been addressed. We note that assessments will be made for historical structures to be affected and an archaeological assessment of the C-37 and C-38 is being undertaking. Therefore, contingent upon the Corps of Engineers, in consultation with this office, appropriately avoiding, minimizing, or mitigating adverse project impacts, the project will have no effect on historic properties listed or eligible for listing in the *National Register of Historic Places*.

If you have any questions concerning our comments, please do not hesitate to contact us. Your interest in protecting Florida's historic properties is appreciated.

Sincerely,

for Laura A. Kammerer
George W. Percy, Director
Division of Historical Resources
and
State Historic Preservation Officer

GWP/Kfk

Post-it® Fax Note 7671	Date 3-18	# of pages ▶
To Mike Orsella	From P Strayer	
Co./Dept.	Co.	
Phone # 904-232-1600	Phone # 407 6876496	
Fax # 904-232-1213	Fax #	

March 13, 1996

Ms. Patricia Strayer
South Florida Water Management District
3301 Gun Club Road
West Palm Beach, Florida 33406

RE: Kissimmee River, Headwaters Revitalization Project

Dear Ms. Strayer:

I would like to thank the South Florida Water Management District and the U. S. Army Corp of Engineers for the presentation that you all made on the Kissimmee River, Headwater Revitalization Project to Osceola County on March 4th.

After hearing the presentation and reviewing the engineering report, I feel that there are still some issues that were not addressed by the U. S. Army Corp of Engineers' report. I have listed our comments below. It is my understanding that you will attach these comments with any the Water Management District may have and forward them to the U. S. Army Corp of Engineers.

12 1. Please explain how the increase in the peak regulation schedule stage will affect ground water levels in the areas surrounding Lakes Kissimmee, Cypress and Hatchineha.

13 2. Please explain how the loss of storage in Lakes Kissimmee, Cypress and Hatchineha will affect the level of protection from back to back major storm events.

14 3. The report states that the maximum discharge rate from Lake Kissimmee (Structure S-65) is 11,000 cfs but also states that additional bays will be added. Please provide the additional peak allowable discharge rate (within rip-rap control criteria) and the ultimate headwater/tailwater/discharge relationship so that I may compare it with the loss of 100,000 ac-ft of storage in Lake Kissimmee. Please also explain the effect this apparent increased discharge rate will have downstream.

15 4. Please confirm that the loss of soil storage and subsequent increased peak runoff rates and discharge volumes due to increased groundwater levels surrounding Lakes Kissimmee, Cypress and Hatchineha have been considered in the hydrologic/hydraulic analysis performed for this project.

BOARD OF COUNTY COMMISSIONERS

District I
Charles Owen

District II
Mary Jane Arrington

District III
John Pate

District IV
Larry Whaley

District V
Chuck Dunnick

County Manager

County Attorney
Neal Bowen

Osceola County

17 S. Vernon Ave.
Kissimmee, FL
34741-5468
(407) 847-1200
Fax (407) 847-1509

16 5. Please provide information on how the increased winter pool elevation will effect the discharge from Lake Tohopekaliga. I feel the level of protection will be diminished with this increased tailwater.

17 6. To truly evaluate the effects that the revitalization project will have on Lake Tohopekaliga (change in tailwater), the hydrology and hydraulics analysis should have included East and West Tohopekaliga.

18 7. Did the hydraulic analysis take into account the effects that hydrilla will have on the drainage system? Over the past years, we have seen that hydrilla will impede flow and reduce the efficiency of a storm water system.

Sincerely yours,

ENGINEERING DIVISION

Christopher K. Crowe

Christopher K. Crowe, P.E.
Assistant County Engineer - Drainage

CKC/smj
cc: Commissioner Owen
Commissioner Arrington
Commissioner Pate
Commissioner Whaley
Commissioner Dunnick
Rob Magnaghi, Acting County Manager
Larry K. O'Dell, Public Works Director
Howard F. Russell, County Engineer

National Audubon Society

Ordway-Whittell Kissimmee Prairie Sanctuary
17350 N.W. 203rd Ave.
Okeechobee, FL 34972
(813) 467-8497

Mr. Michael A. Smith
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019

March 18, 1996

Dear Mr. Smith:

This letter furnishes comments on the U.S. Army Corps of Engineers' (CORPS) Kissimmee River Headwaters Revitalization Project issued in January 1996. I have read the report, attended the public meeting in Lorida, Florida on March 6, and also saw your staff presentation to the South Florida Water Management District Governing Board in Okeechobee on March 13. I am impressed and encouraged by the work the CORPS is doing on this redesign of the system. The new outflow schedules from Lake Kissimmee (high flow in summer and continuous flows in spring) are an especially good idea.

My greatest concern is that the recommended schedule for Lake Kissimmee, schedule RS9-D, will not improve the health of the lake as much as is hoped. The hydrograph on page 2-4 shows a historic 10-11 foot fluctuation of water levels in Lake Kissimmee (roughly between 45 and 56 feet NGVD). Recent lake regulation schedules have allowed the lake only about a 2.5 foot fluctuation (between 49 and 52.5 feet NGVD) which has caused muck accumulation, tussock formation, and diminished productivity. The CORPS report recognizes these problems and recommends a regulation schedule (RS9-D) that increases the scheduled fluctuation to about 5 feet (between 49 and 54 feet NGVD). RS9-D is much better than the present schedule, and higher water will enhance productivity somewhat, but RS9-D still allows only half the historic fluctuation. Most importantly, RS9-D does not allow the lake to drop below 49 feet NGVD--4 feet above historic lows.

If Lake Kissimmee is not allowed to drop below 49 feet NGVD, the problems of muck accumulation, tussock formation and productivity stagnation will continue. Schedule RS9-D will not regularly expose bottom sediments to oxidation. Additionally, low water levels help remove underwater muck by allowing the wind and wave action of frontal systems to stir up unconsolidated organic sediments where they can flow downstream, or accumulate near shorelines and decompose. Frontal systems are common in Florida in the spring, when water levels are usually lowest.

Right now, several agencies are cooperating on an "extreme" drawdown of Lake Kissimmee. The drawdown will cost more than a million dollars and was needed to address these problems of muck accumulation, tussock formation and stagnated productivity. Work includes using bulldozers and trucks to remove muck and tussocks. Other lakes in the upper chain (e.g., Alligator Lake) have been nominated for this type of treatment because they too have suffered under stabilized lake levels. These projects would not be needed, and we could save a lot of money, if we scheduled regular drawdowns.

I request the CORPS formally consider setting the low end of the schedule to 47 feet NGVD, 2 feet lower than now proposed. Present plans to allow zero flow below 49 feet NGVD could be altered to allow slow flow down to 47 feet. No additional lands need be bought. The River would have more consistent flows. Low lake levels would not have to happen often (1 or 2 years in 10) to have great benefit. None of the schedules that were considered had levels below 49 feet NGVD (Figure 7-1). In talking with CORPS staff, I understand that part of the reason the lower end of the schedule still is 49 feet NGVD is in response to navigation requirements. These requirements seem outdated since there is little or no commercial shipping in the area.

Thank you for your work to enhance these lakes. If I can be of assistance, or clarify any of these points, please contact me.

Sincerely,

Paul Gray

Paul N. Gray, Ph.D.
Manager

cc: Dr. Stuart Strahl, NAS
Ms. Theresa Woody, Sierra Club

8. We were gratified to learn that all the lots in Hatchineha Estates will be sewered. We believe this statement should appear in the final study.

9. We believe that all definitions used in study by all sources used should be the same. If a wetland is defined as "continuous saturation for at least 5% of the growing season" by one study, this same criteria must be used in all studies. This will make for a much more understandable document and a wetland will be a wetland, a flood plain will be a flood plain, etc. You have enough engineers and other specialists that revising the acreage figures using like definitions can be accomplished for inclusion in the final document.

We do not accept that standard definitions were not used nor evidently required. This lack of standardization shows a rather lackadaisical approach to the scientific studies and does not reflect well on your agency or contributors to the studies.

10. Thank you for providing the copy of the Appendices to the Integrated project Modification Report.

11. Mercury as discussed in the meeting but not appearing in the handout presented to you by me at the meeting:

We are gravely concerned about mercury. It was our pleasure to provide you with a copy of the ROAR Mercury Study. However, we object to the remark made in the meeting about our study. Dr. Thomas Aiken, head of Mercury Studies for the State of Florida commented to us concerning our study that the only thing wrong with it was that it did not have his name on the cover as the author.

Section 8.0 of our study represents our stand on the mercury issue in the Headwaters and Kissimmee Basin:

"Although monitoring can define the occurrence and scope of changes in mercury mobilization, corrective actions would require broad strategies since mercury would not have a regulatable point source. Avoidance is more effective than mitigation."

Sincerely,

Carolyn Thullbery

Carolyn Thullbery, Secretary

COST:

Cost of Headwaters Project is on January 1996 price levels. Does not reflect cost to remove **700,000 cubic yards** excess shoal/spoil from C-35, C-36, and C-37 of **$1.4 million**, a non-Federal cost.(P8-9,11-13) Kissimmee River Non Federal cost quotes appear to include the entire project as originally proposed including the REMOVAL OF LOCK S-65D and BACKFILLING to LOCK E.(P6-7,6-8,7-4)

	Headwaters	Kissimmee River:	Total:
1991 Report:(P6-7,			
Federal------	$ 46,105,000 (P1-4)	$ 139,943,000((P1-4,P6-7)	$ 186,048,000
Non Federal--	46,105,000 (P1-4)	$ 286,942,000 (P1-4,P6-7))	$ 287,403,050
Total--------	$ 92,210,000 (P1-4)	$*426,885,000 *Less Locally Preferred	$ 519,095,000
Total -------	$ 91,290,000 (P11-17 Table 11-3)	*Options P6-7)	

1995 Report:	(P11-14,16 & 17, 13-1)	
Federal------	$ 38,356,300	The Federal Government is to pay 50%
Non Federal--	*78,356,300	[* *$38,356,300 x 2 = $76,712,600]*
Total--------	$*78,356,300	*[* $39,178,150 x 2 = $78,356,300]*
	(P13-1,13,14,16)	*[* There is an error in Col. Rice's]*
Total--------	*$ 39,178,150* (P11-16)	*[* math P13-1]*

State of Florida cost to remove approx. 703,000 cu.yd. spoil:
$ 1,400,000(P8-9,11-13)
[State of Florida cost should be $ 39,756,300?]
[Total cost should be ---------- $ 78,112,600?]

ENVIRONMENTAL STUDIES/BENEFITS & FISH/WILDLIFE

Studies employed two concepts (1) integration and (2) tiering.(P1-8)

LOWER BASIN - (1) Favorable dissolved oxygen during summer and fall months (2) Non-disruptive river flows for fish during spring reproductive period (3) restoration of temporal and spatial aspects of river habitat heterogeneity (4) Reestablishment of full range of physical, chemical and biological interactions between the river and floodplain (5) reestablishment of 26,500 acres of wetlands.(P9-1)

UPPER BASIN - **Post-regulation** Upper Basin average **waterfowl days 3,405**, **pre-regulation 4,360 days**, a 22% decrease.(P4-11) Habitat Units (Acres x HSI) for exiting and recommended plan appears in Table 7-5.(7.34) Cost estimate 1991 Report **fish and wildlife monitoring $180,000**, 1995 **report $838,738**.(P11-17) Project will impact 29 **acres of wetlands**.(Annex C-2, C-4) **HEP Team Report** appears in Annex D-27 through D-46; species models used for Table 7-5 appears in D-54 through D-64; and Endangered and special concerned species are discussed in Annex D-65 through D-67.

ENVIRONMENTAL STUDIES/BENEFITS & FISH/WILDLIFE, CONT.

The USFWS agrees with the Corps that the loss of 5,510 acres of foraging habitat would not adversely effect the species(P9-12) and have no significant effect on the sandhill crane (P9-13) or adverse effect on the gopher, tortoise, osprey, burrowing owl and limpkin.(P9-13) There will be no impacts on any threatened or endangered species.(Annex B-5) *[ROAR questions increase in Caracara Hawk (upland species) and decrease in Sand Hill Crane (upland species) and statement "no impacts on any threatened or endangered species in Annex B-5.]*

ROAR analysis of Table 7-5,P7-34:
*A total of 3 species of endangered birds, the Snail Kite, Bald Eagle and Wood Stork, are expected to show an increase in numbers to +2.317 (+5%) Federally threatened Audubon's Crested Caracara increase of +132 (+.3%) State threatened Florida Sand Hill decrease of -244 (-.4%), State special concern Snowy Egret increase of +2,558 (+15.5%), for a total of +4,763 (3.6%). Great Egret increase +3.890 (+18/1%). Two duck species increase to +5.863 (+24.3%). Wading Birds increase +8,310 (14.7%). Total bird increase +14,515 (+6.7%). Largemouth bass will increase +763 (+2.0) Total species increase +15,279 (*Error in their math= 1 critter)*

Cost per additional bird or fish in Headwaters Area = $5,128.70

FLOOD CONTROL & FLOODING

Induced flood impacts will be limited to the top of the proposed new LAKE KISSIMMEE regulation schedule or 54 ft. and will not extend beyond the boundaries of the S-61 and S-63A control structures due to residential development expanding in north Osceola County.(P7-38,P11-1) S-65 must make full available discharges to the Lower Basin in order to maintain existing level of flood protection upstream of S-65,(P7-39) and modification to S-65 will be needed to provide adequate discharge capacity.(P7-43,8-1,8-9,P11-1) A new structure S-65X will be placed immediately adjacent to S-65.(P11-3) Alternative 4 is the recommended flood control design solution.(P7-40,41,42,Table 7-7, Annex B-1,D-48,D-68)

There will be no project induced flood damages above elevation 54' in lands surrounding LAKES CYPRESS, HATCHINEHA, KISSIMMEE and TIGER and in Upper Basin Lands above S-61 and S-63A.(P7-47) The proposed lake regulation schedule will seasonally reflood lands between elevation 52.5 and 54.0' in LAKES KISSIMMEE, HATCHINEHA, CYPRESS and TIGER). (P8-2) The Fla. Game & Fish Comm. recommends evaluation of adding a water control structure at the northern end of C-36 to enable a separate water regulation of LAKE CYPRESS.Annex D-69)

Canals C-34,C-35 (i.e. LAKES GENTRY and TOHOPEKALIGA), C-36, C-37 will be widened(P7-11,8-1,P11-1,2) and S-61 may need to be enlarged.(P7-11,8-8,P11-1,2) By enlarging C-36 and C-37, flood impacts in LAKES HATCHINEHA and CYPRESS were reduced to levels below 54'.(P8-8) Removal of 700,000 cubic yards of excess shoal material will be included as part of the sponsor's responsibility.(P8-9, Annex B-1,D-48,D-68)

MERCURY STUDY

Due to public concern that the expanded lake stage regulation schedule could increase mercury mobilization and the fact that little information exists from the headwaters area field data will be collected from the lands around LAKES CYPRESS, HATCHINEHA, KISSIMMEE and TIGER. Sampling in LAKE KISSIMMEE will begin in 1996, sampled again in 1997 and very two years thereafter until 2003. The soils around headwaters lakes would be sampled again in 1999 and 2003.(P11-7,8)

NAVIGATION

The C&SF project works improved navigation opportunities originally provided in the *CONGRESSIONAL ACT of 1902*.(P4-8) The 1902 act required a 30' wide and 3' deep channel from the Town of Kissimmee to Ft. Basinger. Kissimmee River after restoration depth 2' to 8', width 50-300'. *[ROAR note - channel width not mentioned]*(P9-3 Table 9-3) The study is in full compliance with the *RIVER AND HARBORS APPROPRIATION ACT OF 1899*, work would not obstruct navigable waters of the United States.(P10-6)

Navigation impacts in the Headwaters Area are during high water and involve boat ramps and some public access roads.(P9-15, P11-10) Maintenance for navigation channel include clearing snags and sandbars, maintaining navigational markers. Maintenance of disturbed areas will be limited to the degree necessary to meet **MINIMAL NAVIGATION NEEDS TO LIMIT INFLUENCES TO THE NATURAL ENVIRONMENTAL PROGRESSION OF THE LAKE SYSTEM.**(P11-10)

PUBLIC MEETINGS & COMMENTS

The October 1, 1991 meeting at the Okeechobee Civic Center is not reported. (P12.6)*[*ROAR assumes this was intentionally left out because it was standing room only, and 99.9% of those in attendance opposed the project.*(P12.6) *Public views and comments do not include a breakdown of pro and con, obviously since there were more con than pro in the Corp's final feasibility study.P12.1]* ROAR and the County of Highlands were not sent an EIS report.(P12.5) The first page of Annex B states the Headwaters project is Osceola County, there is no mention of Polk County.

REAL ESTATE REQUIREMENTS-LAND ACQUISITION-ENGINEERING ALTERNATIVES

Lands between 52.5' and 54.0' will be periodically flooded.(P7-49) Fee Title will be required for all lands.(P7-50,P8-4,5) Exemptions will only be in a few areas where flowage easements will be more advantageous to the government. (P7-51)

Acquire approximately 20,800 acres surrounding LAKES KISSIMMEE, TIGER, HATCHINEHA, and CYPRESS.(P8-4) 5,986 acres of this land below 52.5' between LAKE CYPRESS and LAKE KISSIMMEE with current flowage easements are now required. Valuations will be difference between value of interest previously provided and value of fee estate.(P7-50,P8-4,Appendix H,P11-5) Acquire approximately 20,800 acres of land bordering LAKES HATCHINEHA, KISSIMMEE, CYPRESS and TIGER.(P8-1)

Degradation of 5 levees, approx. 1 mile, on LAKES KISSIMMEE, CYPRESS, and HATCHINEHA to reflood lands up to 54'.(P7-37,52,P8-1,4,9)[See ROAR Summary-Wetlands-Headwaters Levees Page 7]

REAL ESTATE REQUIREMENTS-LAND ACQUISITION-ENGINEERING, CONT.

Perpetual conservation/flowage easements are recommended in dense residential areas to prohibit activities on easement lands that would be detrimental to project.(P7-51) Flowage easements with the right to prohibit, remove or fill septic systems in HATCHINEHA ESTATES.(P8-5) Local sponsor has indicated a preference to construct a sewer system in lieu of acquisition. There are 306 lots, 61 will be sewered at a cost of $2,834,000 versus $9,260,000 for purchasing.(P8-7,8) A sewer system would require only Water Inundation Ea. .ments for all parcels.(P11-5)

Perpetual flowage easement surrounding LAKE TIGER where environmental benefits will not be realized in the areas between 52.5' and 54.0'.(P7-46,52,P8-5,P11-5)

Land requirements are necessary where ground water elevations will impact septic tanks in isolated areas.(P7-52) All septic tanks located with top of tank below 56' elevation must be replaced with mounded septic tanks or if an on-site cure is not possible be acquired in fee. Possibility for using mounded systems shown in Table 8-1 for SHADY OAKS, ROCKS FISH CAMP, GRAPE HAMMOCK, and the OASIS.(P8-6,8-7) 61 septic systems in HATCHINEHA ESTATES and GRAPE HAMMOCK will be relocated.(P11-5)

Lands surrounding LAKES JACKSON and ROSALIE will not be required.(P7-45,47)

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LAKE KISSIMMEE is currently regulated between elevation 49.5' and 52.5' (P3-6) RS9-D regulation schedule the best alternative.(P7-29) Regulation schedule design was based on 3 criteria: (1) eliminate on again/off again pulsing effect (2) provide more natural seasonal distributions of water releases (3) increase frequency and extent of high water fluctuations.(P6-11) Upper level of lake regulation schedule will increase from 52.5' to 54.0'.(P8-2)

The percentage of discharges during the wet season are higher in the proposed project compared to the pre-project conditions because of the flood control restraints.(P9-2)

SOCIAL-ECONOMIC EFFECTS

Lakeside residences and businesses would have some outbuildings and other facilities subject to inundation. They will be floodproofed by elevation. All septic systems with top-of-tank elevation at or below 56' would have to be replaced with mounded systems or centralized package systems, if installed no residences or occupants will be displaced. Cattle production will be reduced an estimated $200,000 to $400,000 annually. $25,000 estimated taxes per year on undeveloped land will be lost to the counties.(9-18)

Preliminary estimates identified 123 residences and 8 commercial buildings which will be acquired.(P11-5)

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TRIBUTARY IMPACT

LAKE JACKSON locations are sufficiently elevated to remain unaffected by the changes in LAKE KISSIMMEE regulation schedule.(P7-45) LAKE TIGER The flood control solution is a combination of Plan 1 and acquiring interest in lands to elevation 54'. Cost $3,000,000 (P7-46) LAKE ROSALIE The presently installed weir will prevent any backwater effects.(P7-47) Tributaries, creeks and canals connecting to the system are named in Annex D-4 but effects of the restoration on them was not mentioned.

VECTORS - ARTHROPODS

Increased areas of standing or slow moving waters will concurrently increase populations of mosquitoes and other insectivorous insects. No human health problems related to vectors are expected.(P9-16) The project would not further propagation of mosquitoes or pest arthropods.(Annex C-5)

WATER QUALITY

Upper Kissimmee Basin exhibits fair to good water quality with the exception of LAKE TOHOPEKALIGA.(P4-14) Water quality concerns focus on two areas (1) nutrient content and the effects of those nutrients on LAKE OKEECHOBEE and (2) low dissolved oxygen levels in C-38.(P5-5) Improvement of the quality of Kissimmee River waters will benefit the clean up of LAKE OKEECHOBEE.(P9-20) BMP's will ensure that turbidity is kept to a minimum.(P11-8)

WETLANDS-KISSIMME RIVER BASIN

Reestablish 26.500 acres of wetlands with complete functional values, currently 0 acres. (P9-1,P9-3 Table 9-1) Reestablish 48,000 acres River/Flood plain, currently 14,000 impounded acres.(P9-3 Table 9-1)

WETLANDS-HEADWATERS AREA

Wetlands prior to channelization 55,000 acres.(P2-10,P9-6 Table 9-3) Predominate land cover acres in the study area are (1) Grassland 48,900 (2) Open Water 39,373 (3) Dry Prairie 30,161 (4) Marsh/Wet Prairie 28,673 (5) Scrub Brush 13,860.(Annex D-12 Table 1)

Upper Kissimmee Basin-Present day marsh zone is approximately 16,000 acres, approximately a 71% reduction in marsh area (wetlands/flood storage) compared to historical extent of wetlands surrounding these lakes.(Page 4-10) Littoral Zone existing 16,000 acres, proposed 20,000 acres. Wetlands/Flood storage existing 16,000 acres, proposed 30,000 acres, historical 55,000 acres.(P9-6 Table 9-3) The result of the new lake regulation schedule will be increase total littoral wetlands by 45% or to 23,236 acres.(P9-9) [*ROAR note - acreage figures do not agree.]

It is assumed that the present upper end of wetlands is approx. 52' and the project upper end is 52.5 and will restore 5,939 acres of additional littoral marsh excluding the breaching of farm levees.(P7-32)

Modification of regulation schedule includes expansion of lake littoral zones up to approximately 14,000 acres.(P8-2)

WETLANDS-HEADWATERS LEVEES

Farm levees on LAKES KISSIMMEE (OVERSTREET & OASIS), HATCHINEAHA (SPARKS, CHANDLER & ROLLING ACRES), and CYPRESS (BRONSON)(P11-2,3) inhibit flooding of about 3.000 acres that historically were marsh in high water periods.(P4-10,P7-35,37) If the three local farm levees adjacent to LAKES KISSIMMEE, HATCHINEHA and CYPRESS are breached 7,236 acres of marsh will be restored.(P7-32,52,P8-1,9,10,P9-9)

Breaching of the levees would restore and additional 1,350 acres of marsh (P7-36). Land cost $7,391,000, construction cost $1,114,000.(P7-37 Table 7-6). Degradation of local farm levees would increase the amount of littoral wetlands by 7,236 acres, 5,019 acres would be converted to high quality wetlands from grasslands and shrub/brushlands, 2,217 acres converted to moderate quality wetlands.(P9-9)

The project will reconnect approximately 2,650 acres behind local farm levees. (Annex C-2,4) It is predicted restoration of about 5,939 acres of additional marsh without breaching of the levees, if all three are breached 7,236 acres of marsh will be restored.(Annex Diii) Additional acres of wetland to be produced without breaching levees 3,827, basic project and all 3 levees breached 5,019. (Annex D-52 Table 4) Acre Ft. project storage 5,370.(P7-37 Table 7-6)

Each levee was evaluated separately, the Fla. Fish & Game Comm. recommends the project sponsor take full advantage of restoration potential.(Annex D-7,8,15)

[ROAR note - acreage of the levee lands and the number of the levees do not agree in all parts of the study.]

KATE M. NEISWENDER
Attorney At Law
1575 Spinnaker Drive, Ste. 206
Ventura, California 93001
(805) 639-0035

February 27, 1996

Mr. Michael A. Smith
UNITED STATES ARMY CORPS OF ENGINEERS
P.O. Box 4970
Jacksonville, Florida 32232-0019

In Re: Central and Southern Florida Project
Kissimmee River Florida
Headwaters Revitalization

Dear Mr. Smith:

I represent Stephen C. Reddy, a landowner in the vicinity of Lake Tiger, Polk County, Florida. Mr. Reddy has asked that I comment upon the Headwaters Revitalization Project draft EIS on his behalf, which EIS was circulated for public review and comment in January of 1996. Please accept these comments for inclusion in the final EIS for the Revitalization Project.

Project Description

While we realize that this is part of a tiered project, the Revitalization EIS is inadequate in a number of respects. Perhaps the most obvious is that the project description is inadequate. It is our contention that the project should include the Lake Kissimmee Extreme Drawdown Project, which is being conducted concurrently and which is in fact discussed in the draft EIS is several places. Without a complete and adequate project description, the EIS is inadequate under NEPA.

Land Acquisition

The draft EIS specifically notes that certain lands are going to be obtained **in fee** through purchase. As noted in previous correspondence between Mr. Reddy and the Army Corps of Engineers, the South Florida Water Management District ("SFWMD") is already obtaining easements (not fee ownership) around Lake Tiger and some of the other lakes in the Kissimmee River chain. The documentation being distributed by SFWMD notes the easements are being obtained specifically for implementation of the Revitalization Project. Nevertheless, the Army Corps has taken the position that SFWMD is not subject to NEPA, even though the draft EIS notes that the SFWMD is a study partner, and without SFWMD's prior and continuing research efforts the draft EIS could not have been completed. Federal monies are being used for the project. SFWMD and the Florida Game and Fresh Water Fish Commission and U.S. Fish and Wildlife Service are in partnership with the Army Corps; despite

these facts, the Army Corps has taken the position that none of these agencies are subject to NEPA, which we believe is a legally insupportable position.

SFWMD does not have the legal justification for obtaining easements or fee ownership positions on land surrounding Lake Tiger, or any of the other Kissimmee River lakes until after the EIS is complete. For SFWMD to obtain these lands prior to completion of the EIS is putting "the cart before the horse." It is not legally supportable, and should be enjoined.

Archeological Resources

35 The conclusions on cultural and archeological resources of the area is not fully addressed in the draft EIS. It is noted on page 4-23 that the upper Kissimmee basin has received little systematic professional cultural resources investigation. However, (at the same page) it is noted that the area has the potential to contain significant cultural resources. Previous investigations were confined to small archeological surveys in discreet project areas; nevertheless, the conclusion of the draft EIS (at page 9-7) is that the project will not have an effect on cultural and archeological resources. The EIS also states "assessments will be made of the architectural and historic significance of residential and commercial structures to be affected by the project." An archeological survey is to be undertaken along certain of the canals (C-36 and C-37). This is interesting in that it again puts the proverbial cart before the proverbial horse. It is inappropriate and improper under NEPA to do studies and assessments after the EIS has been drafted and approved. When are these studies to occur? The assessment cannot come later in the process, because it negates the underlying purpose of NEPA: that is, to ensure the public has an active and defined role in environmental decision making prior to such decisions being made. The public's participation in the NEPA process should come as early in the decision-making process as possible, in order to effectuate the underlying public policy goals of the Act. By putting off archeological and cultural resource investigations until later in the process, the NEPA goals described herein have been thwarted.

Cumulative Affects

36 Just in the archeological/cultural resources section, the cumulative impact section is completely conclusorary and unsupported by evidence. The cumulative affects section is found

Kate M. Neiswender
Attorney At Law

at 9-19 through 9-20. There is less than a page of text on the cumulative impact of the project that will, theoretically, affect the entire middle section of Florida, running from Lake Kissimmee in the north to Lake Ochochobee in the south. Hundreds of thousands of acres will be affected, and it will theoretically cause a five fold increase in the number of migratory birds.

The only thing said in the cumulative impact section is that the environmental effects will be beneficial. Simply because environmental effects will be beneficial does not mean that there need not be any analysis. While there may be positive effects from the Revitalization Project, and we hope there will be, to dismiss all effects, simply because there will be an overall beneficial impact, is not proper under NEPA.

Endangered Species Issues

7 Regarding endangered species issues, the environmental documentation does not include any reference whatsoever to the Gopher Turtle, a rare and/or endangered species, which exists on the project site. By failing to name this species, the EIS is inadequate in its consideration of endangered species issues, and must be revised and recirculated to adequately address that species.

Further, the analysis for all endangered and/or threatened species is conclusory and unsupported by evidence.

Those are our main areas of concern, and we ask that you make certain that our comments are included in this final EIS. Mr. Reddy also hopes to make some statements at the March 6, 1996 hearing. Thank you for the opportunity to review and comment the draft EIS.

Sincerely,

Kate M. Neiswender

KMN:kj

March 8, 1996

U. S. Army Corps of Engineers
P. O. Box 4970
Jacksonville, Fl. 32232-0019

Ladies and Gentlemen:

Reference - Headwaters Revitalization Project

My husband and I have opposed the Level II Backfilling plan to restore the Kissimmee River since it was selected by the South Florida Water Management District. The selection was made on the basis of politics not on the wants of the people in the affected area.

There was no cost benefits study done. Much of the purchase of property appears to have been done through scare tactics using sovereign lands as a leverage point, although the State of Florida issued proper title deeds (patents) to the areas in question in the late 1800's.

Required public meetings were held. Even though at all meetings open and announced to the general public by vast majorities the citizens spoke openly in opposition to the Level II backfilling plan - bureaucrats and politicians simply went on their chosen way ignoring the wants of the people they represented.

Wading birds not people - special interest not the general public's mandate - wasteful spending not prudent spending - have been the trends followed and used by supporters of the project since the Level II Backfilling Plan's inception. It is time to reexamine this entire project and subject it to a Cost/Benefits Study.

I vote to stop the Level II Backfilling plan and choose one of the cheaper methods of restoring the Kissimmee River. Let's let this Headwaters Revitalization Plan become just another study placed on a shelf to gather dust.

Sincerely,

Mrs. Howard A. Thullbery, Jr.

Mrs. Howard A. Thullbery, Jr.
19590 NW 80th Drive
Okeechobee, Fl. 34972

18 MARCH 1996

DEAR SIR

I RECEIVED MY KISSIMMEE RIVER, HEADWATERS REVITALIZATION PROJECT, FROM THE U.S. ARMY CORPS OF ENGINEERS JANUARY 1996. I HAVE GONE OVER MOST OF THE INFORMATION. I HAVE SOME QUESTIONS FOR YOU. I THINK YOU SHOULD DO AWAY WITH THESE MAN-MADE PROJECTS ON RANCHES AND FARMS ALL TOGETHER. WE NEED TO GO BACK TO SHEET-FLOW, TO IMPROVE WATER QUALITY.

I THINK YOU NEED TO FILL IN THE C-36 AND THE C-37. LEAVE THE C-34 FOR FLOOD CONTROL AND IMPROVE THE SHORT CANAL TO FLOW. TRY THIS ON YOUR COMPUTER TEST AND SEE WHAT HAPPENS. LEVEES ARE GOOD ONLY TO CONTAIN HIGH PHOSPHORUS AREA FROM FLOWING WATER.

I SEE A WORD YOUR PEOPLE NEED TO DO AWAY WITH ALL TOGETHER, WHEN DEALING WITH HIGH PROBLEM AREA. (GRANDFATHERED IN) YOU WILL NEVER CLEAN A PROBLEM WITH THIS

THE WORD USED, TO, why
A problem Area is A problem.
PAGE 8-7 AREA 8.4.2. HATCHINEHA
ESTATES.

I LIVE IN OKEECHOBEE FLORIDA
AND THE WORD "GRANDFATHERED IN"
is A way of Life AROUND HERE.
To GET THE ECOSYSTEM BACK IN
LIVE, is To do AWAY with THIS
WORD AND MOVE ON TO IMPROVEMENTS:
WE THE PEOPLE of FLORIDA ARE
THE ONES THAT will HAVE NO WATER
To DRINK AND OUR GRANDFATHERS
ARE ALMOST GONE TO, AND THEN
THEY will NOT NEED WATER To DRINK,
WE will, SO LETS GO FORWARD AND
NOT BACK TO THE OLD WAY.

Robert M Norton
CONCERNED CITIZEN

P.S WE HAVE CAMP GROUNDS, AND FISH
CAMPS HERE ON THE EDGE OF LAKE
OKEECHOBEE ITSELF THAT FALL IN THE
AREA THAT 8-4 PAGE 8-7 IN YOUR

Kissimmee River Headwaters Revitalization Project, Public Meeting, Lorida, Fla., March 6, 1996

We are interested in your comments about the project. Submission of name and address information at the bottom of the form is optional. Please return this form by March 18, 1996.

March 14, 1996

The residents of Lorida and the southern part of the Kissimmee Valley appreciate the siting of this hearing, though it did not address their local concerns. This is a request for another such ~~meeting for that as an update on the current plans, schedules and~~ proposed changes in store for the area from SR 60 south; can we count on this type meeting sometime in mid-1996? As the newly elected president of the Realists Opposed to Alleged Restoration, ~~I am concerned that promisedm maps (by Director Sam Poole in 9/95)~~ have yet to be produced for the residents mentioned above. Please respond with this information.

Comments to be made part of the hearing section transcript would again warn that this is an untested idea to backfill the miles of healed river through this pristine country. Please note that the entire length of the Kissimmee River Basin lies along Highlands County's eastern border and yet little or no attention has been officially given residents and elected officials in the area. There should be some review now of the alternatives to this, the ~~most expensive alternative offered in the study. As you heard,~~ now that water QUALITY is not the issued, remember the backfill materials will filter down to Lake Okeechobee and Florida Bay. Our photographs submitted in 1995 to members of Congress clearly show ~~the test fill drift from the air. Any responses will be greatly~~ appreciated. Any mailings should be directed to Audrey Vickers, President, ROAR, 1825 Wright Lane, Lorida, 33857, as well as to Sec. Thullbery.

Name: AUDREY VICKERS Audrey Vickers Phone: 941-655-0625/FAX941-655-36

Address: 1825 Wright Lane, Lorida, Florida 33857 (Lakefront resident on Istokpoga)

Organization: ROAR/former Highlands County Commissioner 1990-94)

(Fold at dotted lines on reverse side, staple or tape, and return to address indicated.)

Kissimmee River Headwaters Revitalization Project, Public Meeting, Lorida, Fla., March 6, 1996

We are interested in your comments about the project. Submission of name and address information at the bottom of the form is optional. Please return this form by March 18, 1996.

ALL WHO WERE RESPONSIBLE FOR ORGANIZING + CONDUCTING THE MEETING HELD IN LORIDA, ARE TO BE COMMENDED FOR A JOB WELL DONE!

IN MY OPINION, IT WOULD BE VERY HELPFUL TO EDUCATE FOLKS IN + AROUND THE IMPACTED AREAS AS TO THE FACT THAT ~~THAT~~ THE AQUIFER WILL BE ENHANCED BECAUSE + AS A RESULT OF THE PROJECT. (I CERTAINLY HOPE THIS CAN BE VERIFIED!) I DON'T BELEIVE THIS POSITIVE NOTE HAS BEEN PUBLICIZED.

IT WOULD HAVE BEEN A GOOD MOVE ON THE PART OF THE CORP TO HAVE INVITED DR. PAUL GRAY TO PARTICIPATE IN THE MEETING, INASMUCH AS HE NOW RESIDES IN LORIDA. (DR. GRAY WAS WITH THE F.G.&F.W.F.C. IN 1994 WHEN HE WROTE TO DUKE HAMMOND - RE: KISSIMMEE HEADWATERS LAKES REVITALIZATION PROJECT.)

P.S. THE SOUND WAS GOOD COMING FROM PEOPLE WEARING MIKES, BUT THE HAND-HELD-PASSING-FROM-ONE-TO-THE-OTHER WASN'T TOO GOOD.

Name: HANK KOWALSKI Phone: (941) 465-6618

Address: 242 SERENADE DRIVE, LAKE PLACID, FL 33852-8581

Organization HIGHLANDS CNTY AUDUBON + HEARTLAND ENVIRONMENTAL INC.

(Fold at dotted lines on reverse side, staple or tape, and return to address indicated.)

MARCH 8, 1996

U.S. ARMY CORPS OF ENGINEERS
JACKSONVILLE DISTRICT
P. O. BOX 4970
JACKSONVILLE, FL 32232-0019

ATTN: MR. MICHAEL SMITH, PLANNING DIVISION

DEAR MR. SMITH,

WE ATTENDED YOUR MEETING IN LORIDA ON THE KISSIMMEE RIVER HEADWATERS REVITALIZATION PROJECT ON MARCH 6TH AND ALL THOUGH IT WAS INFORMATIVE AS TO YOUR PLANS WE ARE STILL NOT CONVINCED THAT THE MONEY NEEDED FOR THIS PROJECT SHOULD BE SPENT IN THIS MANNER. ESPECIALLY SINCE THE ECOMOMY SEEMS T BE IN SUCH DIRE STRAIGHTS. IT APPEARS THIS PROJECT IS CLEARLY A POLITICAL PLOY INSTEAD OF BEING OF ANY USE TO THE PROPOSED PURPOSE. WE BELIEVE THERE ARE A NUMBER OF UNDERLYING FACTORS INVOLVED WT THE DECISION OF RESTORING THE EVERGLADES. WE ALSO BELIEVE THE POLITICIANS ARE DECIVING THE GENERAL PUBLIC; OF WHICH VERY FEW ARE ADEQUATELY INFORMED TO THE TRUE FACTS. WE BELIEVE THERE MUST BE AN ALTERNATIVE METHOD OF "CLEANING UP THE EVERGLADES".

CONCERNED TAX PAYER AND VOTERS,

Juanita A. McGregor

JUANITA A. MCGREGOR
DONALD E. MCGREGOR
19455 NW 80TH DR.
OKEECHOBEE, FL 34972

17 April 1996

Dear Sir

I have been reading the Kissimmee River, Florida Headwaters Revitalization Project. I have some questions for you. Item 6.2.5 Authorized Kissimmee River project.

I agree on all these items your people have down on these things to do. (1) Removing S-65B and S65C and S65D, these are part of the problem we have in Lake Okeechobee now.

(2) Modification of S-65A and S-65 it self, we need more sheet flow.

(3) Grade control structure upstream of S-65.E. A.S.A.P.

(4) ~~Degrental~~ Degradation of local farm levees all of them around the Lake Kissimmee and farmer clean-up.

We need more wetlands, and greater sheet flow to filter water 9.2.9. Is a good item as it makes these people clean-up structure [illegible]

WE HAVE SOME OF THE SAME PROBLEMS AS DOES LAKE HATCHINEHA, AS WE HAVE R.V. PARKS AND SEPTIC WAST WATER PLANTS OR PONDS UP ON THE NORTH LAKE AT THE TAYLOR CREEK LOCKS AREA ON 441 S.E AT THE TAYLOR CREEK BRIDGE AREA.

THESE WAST WATER PONDS HAVE AT TIME RUN-OVER THEIR EDGES AND THEN INTO LAKE WATER IN TAYLOR CREEK AT THE LOCKS TO LAKE OKEECHOBEE. SOME TIME WHEN YOUR PEOPLE ARE IN THE AREA HAVE THEM TEST THE WATER AROUND THE TAYLOR CREEK BRIDGE AND THE RIM CANALS EAST AND WEST OF THE LOCKS AND SEE HOW MUCH THE SEPTIC SYSTEM HAVE ON THE WATER QUALITY THERE ("ALSO PHOSPHORUS LEVELS THERE")

I WOULD LIKE TO GET AN AERIAL MAP OF OKEECHOBEE COUNTY THE WHOLE AREA. AND A MAP OF CENTRAL AND SOUTHERN FLORIDA COMPREHENSIVE PLAN A NEW ONE [illegible] MAP NOW.

LAKE HATCHINEAA D.O. file No 400-36,826 PLATE 4-1 MAP Shows How From 1958- to 1984 THE Shore Line Has developed. As THESE people CAME TO florida from All OVER THE UNITED STATES THEY bring All THEIR OLD HABBITS with THEM. THEY DEVELOPE TO A POINT THAT your E.P.A. CAN NOT KEEP UP WITH THEM, AND THEN THE problems START.

WE IN florida have TO GET TO A POINT WHEN WE SAY DO NOT DEVELOPE BY THE DRINKING WATER. CROPLAND AG, GROVE AND NURSERY AG, PASTURE AG, RESIDENTIAL URBAN, All HAVE EFFECTS ON WATER Supply, WE DRINK. WHEN THE SFWMD AND THE FEDERAL GOVERMENT BUY THESE RANCHES AND THE FARM AND PASTURES. WHEN THE TIME FOR THE RANCHER TO MOVE DOES THE 9.2.9 MAKE THE PEOPLE CLEAN-UP THE OLD TRAILERS AND SEPTIC TANKS ON THE NEW LAND WE TAX [illegible] BUY. PLEAS LOOK INTO THIS [illegible]

I HAVE MORE TO READ ON THE KISSIMMEE HEADWATER PROJECTS, AND I AM SURE I WILL FINIS SOME MORE QUESTIONS FOR THE ECOSYSTEM POINTS.

WE HAVE MINEING OPERATIONS GOING ON AROUND THE LAKE OKEECHOBEE AREA, AND I AM SURE WE HAVE, ESTUARY INTRUSION, AS WELL AS SURFICAL AQUIFER INTRUSION AS WELL AS GROUND WATER INTRUSION ON THESE MINEING OPERATIONS OFF DARK HAMMOCK ROAD BY OUR CHAMBERS LAND FILL OPERATION. PLEASE LOOK INTO THIS FOR ME AS OUR ECOSYSTEM AND WATER QUALITY IS AT RISK WITH THESE OPERATIONS

Robert M Norton
CONCERNED CITIZEN

Wildlife Forever
Robert M. Norton
4200 Highway 441 SE
Okeechobee, FL 34974

A.F.Gagne, P.E.
2982 Knowles Blvd.
Kissimmee, FL 34741
Tel.(407)870-9533

DEPT. OF THE ARMY, JACKSONVILLE DIST. CORPS OF ENGINEERS
P.O.BOX 4970
JACKSONVILLE, FL 32232-0019

YOUR PUBLIC MEETING MAR. 6, KISSIMMEE
RIVER HEADWATERS REVITALIZATION PROJECT

Dear Engineers,

I wanted very much to attend this meeting (but could not) to express my strong aversion to this unjustified and horribly costly project. Originally the opposition to the canal arose, as we all know, because it was bringing down pollution to Lake Okeechobee and the Everglades. But while the problem was being studied over the next two decades, LO and BEHOLD! ...the pollution was corrected at its sources.

Now there was a political problem, because a lot of people (including Sen.Graham) had gone out on a limb pushing dechannelization. Could be, also, big money interests stood to lose fat contracts and were lobbying fiercely. A lot of plain people were suckered on this, with the Sierra Club folks writing in (per your 1991 final report, begging you to clean up the river and save the Lake, the Everglades, whatever. But I am totally unconvinced that there are any significant benefits now to proceeding, and I see some very serious disadvantages. Let me enumerate:-

1.Navigation. The old river was a terrible hazard to navigation, what with busted stern wheels and grounding. Now with the emergence of the hydrilla problem in the upper lakes, it is virtually certain that the shallow river-to-be will shortly become plugged with hydrilla and even more difficult to use. Nobody will want to spend the big bucks for control. RESULT: the river will be impassable to anything but an airboat. In contrast, the deep canal is immune to hydrilla growth.

2.Flood Control. With the canal, the Corps did a fine job of protecting the whole region against flooding...and then along came a prolonged dry period lasting into this decade. Nobody even thought about floods. Now the scientists are virtually unanimous in saying that the "greenhouse effect" is here and will push Florida into ever-worse storms, hurricanes and increased rainfall. It's a whole new ballgame; is this something to take chances with?

3."Big Ditch." Detractors are fond of this disparaging phrase, but it is quite inappropriate. In fact, people living along the canal tell us that the spoil banks have grown up with brush and trees, are full of game birds and desirable animals of all kinds. You have the letters. Fishing is said to be just fine. Dechannelization can only take us back to decades of raw earth and muddy waters.

4.Mosquitos. The older inhabitants wrote you of masses of biting insects:- the river area and adjacent swamps were not very pleasant places to be. Today we can expect some of these mosquitos will carry diseases like encephalitis, maybe even malaria or yellow fever. So why shoot ourselves in the foot? Why try to make Central Florida once again virtually unliveable?

5.Water supply to Okeechobee & Florida Bay. This seems to be a critical need. The

fact is, because of transpiration, it would appear that the re-consistuted wetlands surrounding the river would deliver less water downstream than the canal.

6. Efficiency of wetland restoration. With all the bulldozing and raw earth, it is certain, according to the experts, that only some of the re-constituted wetlands will actually work properly for a long time to come.

7.Cost. This is the final and biggest question. Why would anybody with clear vision and no axe to grind want to spend half-a-billion dollars on this project when there are so many other needs, INCLUDING BALANCING THE FEDERAL BUDGET ?? IF IT IS POSSIBLE POLITICALLY TO WAIT A BIT LONGER BEFORE PROCEEDING, AND FIRST TO PUT AVAILABLE DOLLARS INTO STRAIGHTENING OUT THE MESS SOUTH OF OKEECHOBEE, CAN YOU DO THIS? If nothing else, it would be a chance to prove the value of the canal in the big floods to come.

Thank for for "listening"...

A.F. Gagne

RESPONSES TO COMMENTS

FEDERAL

United States Department of the Interior

1. Section 9-2.6, Endangered or Threatened Species, Pp. 9-11 and 9-12, revise paragraph on Audubon's crested caracara.

Response: Concur, the suggestion was incorporated into the Final Environmental Impact Statement as requested.

STATE and LOCAL GOVERNMENTS

Department of Environmental Protection

2. Inventory lands to be re-inundated to be certain there are no pesticide problems, or other soil contamination issues.

Response: Prior to project implementation during the real estate acquisition by the local sponsor, a Phase II audit will be completed by the SFWMD. Any sites found to be contaminated with HTRW will be remediated.

3. Canal dredging design.

Response: Concur. Efforts will be made to minimize impacts and/or work toward enhancement of the affected environment wherever possible. Although, widening is normally preferred over deepening in rural areas because the existing side slopes can be maintained. Also, channel deepening may require that the canal side slopes be flattened in order to ensure the stability of the slope. Coordination with the DEP will continue during construction plans and specification development to optimize design opportunities. A field investigation with DEP representatives to consider design options would be an appropriate measure during the initiation of the detailed canal designs. Plans and specifications for the C-37 improvements are scheduled to start in December 1996 at which time the Corps plans a field trip to the site.

4. Emphasize that as many levees as possible be breached in multiple locations along their lengths. Look for other creative ways to re-establish ecological connections to other parts of the river/lake/wetland system (e.g., breaching of Rolling Meadows Levee).

Response: The U.S. Army Corps of Engineers has identified five farm levees around Lakes Kissimmee, Hatchineha and Cypress which will be breached in order to reflood lands behind the levees for environmental enhancement, water and floodwater storage purposes. All of these levees will be gapped approximately every 1000 feet with a gap width of 100 feet.

5. Look for creative ways to deal with aquatic plant problems.

Response: Concur.

6.

A. Marion Creek flows through Marion Creek Swamp into Lake Hatchineha. We have a concern relative to any impacts to the water quality treatment capacity of this area caused by the increased tailwater effects caused by higher levels in Lake Hatchineha. If there is any problem, the preferred correction would be to have the treatment occur in upland locations.

Response: The primary concern would be operation of the stormwater treatment system at lake levels between elevation 52.5 and 54.0 feet, stages experienced under the existing project only during flood conditions, but which will likely be occurring 10 percent of the time under the proposed project. The U.S. Army Corps of Engineers will contact the Poinciana Development to ascertain the impacts, if any, to their treatment system at these water stages.

B. Is the farm levee to be breached on the north side of Lake Hatchineha part of the containment of the Marion Creek Swamp?

Response: No.

7. Regarding the increased capacity of the S-65 structure, we are not clear where the increased discharge is to be directed? There have been suggestions that this modification of the structure be designed to also allow for the restoration of some of the adjacent flood plain. At the present time, this part of the flood plain would not be restored due to the continued existence of the C-38 canal between the S-65 and S-65A structures. Without some redirection of flow into these areas, no restoration will occur there. If the design can accommodate both increased discharge for flood control purposes and redirection of flow to the dry flood plain for restoration purposes we could attain a double benefit.

Response: The outflow from Lake Kissimmee discharge through the increased capacity S-65 will continue to be discharged directly into C-38. It will not be until larger floods, when Lake Kissimmee approaches elevation 54 feet and continues to rise, that the advantage of the increased outlet capacity will be realized. Only during these floods will there be an opportunity to discharge from S-65 more than the existing capacity of 11,000 cfs. There are several proposals to increase the extent of rewetting of the flood plain in Pools A and B during normal or everyday operations. These include degrading the remainder of the disposal mounds in Pools A and B, maintaining a Pool A stage of elevation 48.0 feet with S-65A, and retaining the levee along the east side of C-38 in the upper reach of Pool B which serves to extend the hydroperiod of the flood plain in that area.

Florida Game and Fresh Water Fish Commission

8. We recommend that the schedule be modified (changes in discharge zones and/or the discharge rating curve) to achieve longer duration's of high water, or made operationally flexible to allow discharge rate reductions based on real time conditions. By defining the desired percentage of marsh inundation along the Kissimmee River and applying rainfall quantities and flow rates from Lake Kissimmee, the schedule could be altered to provide extended periods of higher water levels for Lakes Kissimmee, Cypress, and Hatchineha. Thus our principal recommendation to the USCOE is to modify their proposed schedule to allow longer duration of water levels between 52.5 feet and 54 feet msl.

Response: The recommended lake regulation schedule and operation rules was designed to meet the primary objectives and requirements of the authorized Kissimmee River Project. That is, to reestablish the discharge regimes necessary to restore the ecological integrity of the Kissimmee River. The new regulation schedule will provide operational flexibility for fine-tuning the restoration plan and adaptive management of the recovering and restored ecosystem. Following implementation, the schedule's zonation and stage/discharge rules will be continuously reevaluated. Potential modifications will be based upon the future hydrologic performance and results of the project's comprehensive restoration evaluation program. Given the uncertainties of the simulations resulting from incomplete model calibration (i.e., underestimated discharge) and the relatively dry simulation period, it may be possible to modify the schedule to maintain higher lake stages for longer durations and still provide the necessary inflows to achieve restoration of the

river/flood plain ecosystem. It should be emphasized that any future consideration and potential enactment of a different schedule would be strictly evaluated in its ability to deliver necessary flows to the Lower Basin and on its ability to not increase the risk of flooding during the late winter and early spring months.

9. Enlargement of canal C-37 should include restoration of the historic Kissimmee River channel just northeast of the lower end of this canal.

Response: This option will be reexamined during the initiation of plans and specifications. Close coordination with the FGFWFC can be conducted during the development of detailed plans to explore potential options.

10. We recommend that the navigation problems associated with the widening of C-37 be addressed during construction via deepening of the oxbows.

Response: Under current Corps of Engineers policy, there is no Federal interests in recreational navigation project works. As such, the Corps has no authority for deepening the adjacent C-37 oxbows.

11. To maximize the positive environmental impacts associated with the Headwaters Project, lake levels in Lakes Kissimmee, Cypress, and Hatchineha should fluctuate below elevation 48.5 feet msl during dry periods. By lowering the zero discharge elevation from 48.5 feet msl to 47.0 or 47.5 feet, Lakes Cypress and Hatchineha could be lowered sufficiently within the range of the schedule that would not need to be included in future extreme drawdowns of Lake Kissimmee. Periodic low water levels in these lakes would allow implementation of lake bottom restoration activities and further enhance aquatic habitat for the benefit for fish and wildlife.

Response: Recreational navigation has increased substantially since the flood control project was completed and most of the supporting infrastructure such as boat ramps, docks and marinas, and particularly the associated access channels to the lakes, have been constructed based upon the constricted, post-regulation range of water level fluctuations. Consequently, the ability to provide continuous inflows to the river by allowing lake stages to fall to historic low levels is limited by socio-economic concerns associated with the potential for reducing recreational navigational usage. The new regulation schedule will provide operational flexibility for fine-tuning the restoration plan and adaptive management of the recovering and restored ecosystem. Following

implementation, the schedule's zonation and stage/discharge rules will be continuously reevaluated, including ways of increasing the range of lake level fluctuations.

Osceola County

12. How will the increase in the peak regulation schedule stage will affect ground water levels in the areas surrounding Lakes Kissimmee, Cypress and Hatchineha.

Response: A groundwater model, FASTSEEP, will be used to estimate the linear distance from the lake in which the water table is affected by a rise in the lake stage from elevation 52.5 feet to 54.0 feet.

13. How will the loss of storage in Lakes Kissimmee, Cypress and Hatchineha will affect the level of protection from back to back major storm events.

Response: Because of the increased capacity of S-65 from a 3-bay to a 5-bay structure, the level of protection from back-to-back major storm events will actually be improved over the existing conditions.

14. The report states that the maximum discharge rate from Lake Kissimmee is 11,000 cfs but also states that additional bays will be added. Provide the additional peak allowable discharge rate (within rip-rap control criteria) and the ultimate headwater/ tailwater/discharge relationship so that I may compare it with the loss of 100,000 ac-ft feet of storage in Lake Kissimmee. Also, explain the effect this apparent increased discharge rate will have downstream.

Response: The report should state that the maximum discharge rate from S-65 has been increased from 11,000 cfs to a maximum potential rate of 18,000 cfs. However, only under a major storm event when the Lake Kissimmee stage remained 2.5 to 3.0 feet above the resultant S-65 tailwater in Pool A would there be sufficient hydraulic head across S-65 to discharge the design flow of 18,000 cfs. During smaller storms, the discharge from S-65 will be limited by tailwater stages.

15. Confirm that the loss of soil storage and subsequent increased peak runoff rates and discharge volumes due to increased groundwater levels surrounding Lakes Kissimmee, Cypress and Hatchineha have been considered in the hydrologic/hydraulic analysis performed for this project.

Response: An estimate of increased groundwater levels will be determined from the analysis presented in Comment 1. Also, a comparative winter storm UNET analysis will be performed based on a Lake Kissimmee with-project stage of elevation 54.0 feet and an existing conditions stage of 52.5 feet. Thirty-day design rainfall will be determined from a frequency analysis of winter month rain gauge data for the Kissimmee Basin. The winter months analyzed will be November, December and January, corresponding to the three-month period when the lake stage could conceivably be at the top of the regulation schedule.

16. How will the increased winter pool elevation affect the discharge from Lake Tohopekaliga.

Response: The U.S. Army Corps of Engineers has traditionally utilized a wet season or hurricane approach to flood analyses and the design of flood control works in central and southern Florida. However, a comparative winter month flood analysis between existing conditions and the proposed project (see Comment 4.) will be performed to determine the extent of impacts above elevation 54 feet at the S-61 tailwater location. It is anticipated that the impacts above elevation 54 feet will be minimal.

17. The hydrology and hydraulics analysis should have included East and West Tohopekaliga to truly evaluate the effects that the revitalization project will have on Lake Tohopekaliga.

Response: The runoff contributions from East and West Lake Tohopekaliga are reflected in the inflow hydrographs at S-61 and S-63A which represent the upstream boundary conditions for the UNET model. The inflow hydrographs are restricted to a maximum value which corresponds with the design discharge capacity of the structures. UNET analyses for the existing and with-project conditions lead to the design of C-36 and C-37 conveyance improvements so that the flood stage-frequency at the S-61 tailwater location was not impacted at elevations above 54 feet.

18. Did the hydraulic analysis take into account the effects that hydrilla will have on the drainage system? Over the past years, we have seen that hydrilla will impede flow and reduce the efficiency of a storm water system.

Response: Hydrilla effects were not considered since hydrilla infestation is considered an existing problem and would not represent a worsened situation for the with-project condition.

GROUPS

National Audubon Society

19. Request the Corps formally consider setting the low end of the schedule to 47 feet NGVD, 2 feet lower that now proposed. Present plans to allow zero flow below 49 feet NGVD could be altered to allow slow flow down to 47 feet.

Response: See response to Comment 11.

Realists Opposing Alleged Restoration (ROAR), Inc.

20. ROAR objects to the meeting on the Supplement to the Final Environmental Impact Statement on the Headwaters Revitalization Project being held in Lorida instead of Lake Wales, Haines City, or Kissimmee. We believe this was an intentional means to keep from getting proper input from the residents of the effected area and we cry FOUL!

Response: Disagree. The public meeting was held in Lorida in an attempt to obtain both Upper and Lower Basin comment on the subject report. The draft report was circulated extensively within the public comment period to residents within the affected Upper Basin region. Furthermore, the recommendations of the report were presented in a public forum to the Osceola County Commission on March 4, 1996. A public workshop was held for the residents of Lake Hatchineha Estates where about 300 residents attended. A booth was also setup for public input at a workshop which was held in Kissimmee, Florida at the Civic Center on November 16, 1995.

21. Our members want an addition to the final study to include the State of Florida commitment not to remove Lock D or backfill past railroad tracks.

Response: Concur.

22. We want an accurate reporting of the October 1, 1991 meeting held at the Okeechobee Civic Center to appear in all future publications.

Response: A summary of the Okeechobee meeting will be added to the final document.

23. We want to see Highlands County included in the names receiving your correspondence and studies.

Response: The Highlands County Engineering Office was sent a copy of the draft report and is maintained on the project mailing list.

24. We want an assurance that the Federal Law that requires a 3 foot channel maintained in the Kissimmee River is not violated by the restoration.

Response: The authorizing document for the Kissimmee River Restoration Project House Document 102-286, Kissimmee River Restoration Study, 1992, previously addressed the impacts related to the Federally authorized navigation project. Channel depths in the restored river will depend on the availability of flowing water just as was the case during the historic navigation project; thus, wet and dry seasons will have an effect on navigation. During extremely dry periods, the three-foot channel depth for navigation may be reduced due to low flows.

25. We would like to receive an exact accounting of the cost of the project and to see accurate figures appear in all future publications.

Response: The draft and Final Project Modification Report provide an accurate estimate of the project costs.

26. We doubt your assurance that mosquito population will be kept in check by more fish after restoration. We would like more quantifiable scientific documentation to appear in the final study.

Response: We do not anticipate a worsening over existing conditions.

27. We were gratified to learn that all the lots in Hatchineha Estates will be sewered. We believe this statement should appear in the final study.

Response: All of the residents of Hatchineha Estates will be given an opportunity to tie into the proposed sewage treatment facility. The SFWMD is currently pursuing this arrangement.

28. We believe that all definitions used in study by all sources used should be the same. If a wetland is defined as "continuous saturation for at least 5% of the growing season" by one study, this same criteria must be used in all studies. This will make for a much more understandable document and a

wetland will be a wetland, a flood plain will be a flood plain, etc. You have enough engineers and other specialists that revising the acreage figures using like definitions can be accomplished for inclusion in the final document. We do not accept that standard definitions were not used nor evidently required. This lack of standardization shows a rather lackadaisical approach to the scientific studies and does not reflect well on your agency or contributors to the studies.

Response: We have tried to consistently use the same criteria for wetland definition throughout the report.

29. Although monitoring can define the occurrence and scope of changes in mercury mobilization, corrective actions would require broad strategies since mercury would not have a regulatable point source. Avoidance is more effective than mitigation.

Response: We do not anticipate a problem with methylmercury production because the soils around the lakes were historically wetlands, i.e., between the 52.5 to 54 foot elevation. Increased methylmercury production is associated with temperate upland soils which are flooded (reservoir effect). However, due to the lack of information on methylmercury production in soils from this area, we are proposing a monitoring program as described in Section 11.3.2.

30. Impacts to Audobon's crested caracara (see response to Number 1.)

Response: The analysis by ROAR of Table 7-5, pg 7-34, is in error. The outputs of this table are in Habitat Units not individual species. Even if an environmental restoration project were to result in a significant adverse effect (short of the jeopardy threshold) for a listed species, a restoration project would be justified if the selected species alternative optimized benefits to the greatest number of listed species. This rationale is based on ongoing efforts by the USFWS to produce a multi-species recovery plan for south Florida. The USFWS finds that the selected alternative for the Kissimmee Headwaters Revitalization Project will optimize benefits for a variety of wildlife, including threatened and endangered species.

31. Littoral Zone existing 16,000 acres, proposed 20,000 acres. Wetlands/Flood storage existing 16,000 acres, proposed 30,000 acres historical 55,000 acres. (P9-6 Table 9-3) The result of the new lake regulation schedule will be to increase

total littoral wetlands by 45% or 23,236 acres. Acreage figures do not agree.

Response: Table 9-3 was revised to show total littoral wetlands as 23,236 acres from 20,000 acres.

32. Acreage of the levee lands and the number of the levees do not agree in all parts of the study.

Response: There are six local farm levees identified by the Corps within the project area. Five are recommended for breaching. The USFWS's Coordination Act Report and analysis was conducted based on their knowledge of only three of the total six levees. The total acreages for the increase in wetlands through breaching the leveed areas are the same throughout the report, i.e. 7,236 acres. Acreage in Annex C refers to total acres of land between the 52.5 and 54 foot contour, not acres converted to wetlands. Other discrepancies relate to how the wetlands were broken down into high quality and moderate quality wetlands within the USFWS's Coordination Act Report.

INDIVIDUALS

33. It is our contention that the project should include the Lake Kissimmee Extreme Drawdown Project, which is being conducted concurrently and which is in fact discussed in the draft EIS in several places. Without a complete and adequate project description, the EIS is inadequate under NEPA.

Response: The EIS is appropriate as written. These projects have two distinct and separate authorities, proponents, goals and funding. The Florida Game and Fresh Water Fish Commission obtained the required environmental and procedural approvals for the Drawdown Project which is underway now. It is a relatively short term and inexpensive habitat management project undertaken by a state agency under its own authorities. In contrast, the Headwaters Project is a long-term ecosystem restoration project, unprecedented in scope and cost, which is authorized under a federal Water Resources Development Act with the Corps as the lead agency.

34. The SFWMD does not have the legal justification for obtaining easements or fee ownership positions on land surrounding Lake Tiger, or any of the other Kissimmee River lakes until <u>after</u> the EIS is complete. For SFWMD to obtain these lands <u>prior</u> to completion of the EIS is putting "the cart before the horse." It is not legally supportable, and should be enjoined.

Response: As a state agency, the SFWMD is not subject to the requirements of NEPA and it has the right to buy lands for conservation or other purposes without going through the NEPA process.

35. The conclusions on cultural and archeological resources of the area is not fully addressed in the draft EIS. ... It is inappropriate and improper under NEPA to do studies and assessments after the EIS has been drafted and approved. When are these studies to occur? The assessment cannot come later in the process, because it negates the underlying purpose of NEPA: that is, to ensure the public has an active and defined role in environmental decision making prior to such decisions being made. The public's participation in the NEPA process should come as early as in the decision-making process as possible, in order to effectuate the underlying public policy goals of the Act. By putting off archeological and cultural resource investigations until later in the process, the NEPA goals described herein have been thwarted.

Response: A cultural resources investigation was undertaken in the project area. One potentially significant prehistoric archeological site was identified during the survey. In consultation with the State Historic Preservation Officer (SHPO), the Corps will apply the criteria of effect and adverse effect (36 CFR 800.9) for historic properties that meet the criteria of eligibility to the National Register of Historic Places. For those historic properties which will be adversely affected, mitigation plans will be developed by the Corps, in consultation with the SHPO and the Advisory Council on Historic Preservation, to mitigate adverse effects. The Corps will implement the mitigation plans prior to any ground disturbing activities being initiated. Collections from cultural resources investigations will be curated in repositories meeting the standards established by the Corps and the National Park Service.

36. The cumulative impact section is completely conclusorary and unsupported by evidence. .... While there may be positive effects from the Revitalization Project, and we hope there will be, to dismiss all effects, simply because there will be an overall beneficial impact, is not proper under NEPA.

Response: Disagree. No cumulative impacts (based on comparison of past, present and future foreseeable future impacts) are anticipated

KISSIMMEE RIVER
HEADWATERS REVITALIZATION PROJECT

ANNEX B

SECTION 404 (b)(1) EVALUATION

ANNEX B

SECTION 404(b)(1) EVALUATION

KISSIMMEE HEADWATERS REVITALIZATION PROJECT
OSCEOLA AND POLK COUNTIES, FLORIDA

1. Project Description

a. Location. The proposed Kissimmee Headwaters Revitalization Project is located in Osceola County, Florida.

b. General Description. The proposed work consists of Modification of the existing Lake Kissimmee regulation schedule. Modification of the regulation schedule is necessary for the restoration of the Kissimmee River and to expand the upper Kissimmee lake littoral zones; Acquisition of approximately 20,800 acres of land bordering the affected lakes, i.e., Lake Hatchineha, Lake Kissimmee, Lake Cypress and Lake Tiger; Widening of Upper Basin flood control canals, C-36 and C-37. Because of the increased tailwater flood stages at S-65 resulting from the modified regulation schedule, the flood control canals connecting Lake Kissimmee to Lake Hatchineha, C-37, and Lake Hatchineha to Lake Cypress, C-36 will have to be enlarged to flatten the flood profile through the upper lakes and prevent excessive flooding; Increase outlet capacity at water control structure S-65. Modifications to the existing S-65 structure will be needed to reduce higher flood stages in Lake Kissimmee and to provide higher discharge capacity; Degradation of local levees. Breaching of local levees is recommended for obtaining the water storage required for meeting lower basin hydrology and to expand the range of upper basin restoration. Approximately 1 mile of levee sections or about 60,000 cubic yards will be degraded by backfilling nearby borrow ditches. The five levees are located on the east and west sides of Lake Kissimmee, north side of Lake Cypress, and the south and north side of Lake Hatchineha.

c. Authority and Purpose. Section 1135 of Public Law 99-662 (Water Resources Development Act of 1986) authorizes the Chief of Engineers in cooperation with non-Federal interests to consider measures for restoring environmental values at authorized Federal projects. This

study was conceived under that authority. Subsequently, the Water Resources Development Act of 1992 authorized the Assistant Secretary of the Army to construct the Headwaters Revitalization Project in accordance with a report prepared under Section 1135, based on the benefits derived for the environmental restoration of the Kissimmee River (Lower Basin). Consistently with the above-cited authorities, the U.S. Army Corps of Engineers and the State of Florida, with the U.S. Fish and Wildlife Service as a cooperating agency, have studied alternative modifications to the regulation schedule and water control structures of lakes in the Upper Kissimmee River Basin. The present study objective is (a) to formulate a plan to optimize environmental improvements to the Upper Kissimmee Basin (b) while reestablishing discharges to the Lower Basin that are necessary to that basin's restored ecological integrity (defined in the 1992 FEIS, Environmental Restoration Kissimmee River, Florida). Environmental optimization in the upper basin requires reestablishment of lake-level fluctuations with higher levels approximating 54.0 feet NGVD. Restoration in the Lower Basin requires (a) continuous but varied flow in the river channel and (b) flood plain inundation frequencies and recession rates comparable to pre-channelization periods.

d. General Description of Dredged or Fill Material.

(1) General Characteristics of Material. The fill material for this project will come from the canal and adjacent levee which consists of native soils.

(2) Quantity of Material. Unknown - will be determined during detailed design.

(3) Source of Material. West bank of C-37, East bank of C-37, and five local levees. The five levees are located on the east and west sides of Lake Kissimmee, north side of Lake Cypress, and the south and north side of Lake Hatchineha.

e. Description of the proposed Discharge Site.

(1) Location. West bank of C-36 on top of and behind the existing levee, East bank of C-37 on top of and behind the existing levee, and backfilling adjacent borrow ditches associated with the five local levees. The five levees are located on the east and west sides of Lake Kissimmee, north side of Lake Cypress, and the south and north side of Lake Hatchineha.

(2) Size. Approximately 29 acres of freshwater wetlands will be filled by the project.

(3) Type of Site. The project site consists freshwater marsh and grasslands.

(4) Type of Habitat. The habitat consists of freshwater marsh and grass covered levees.

(5) Timing and Duration of Discharge. Eight (8) months.

f. Description of Disposal Method. Fill material will be placed with a dragline.

2. Factual Determination

a. Physical Substrate Determination.

(1) Substrate Elevation and Slope. The area to be filled ranges in elevation from 50-56 foot National Geodetic Vertical Datum of 1929. Fill areas are relative flat.

(2) Sediment Type. Soil in the fill areas is predominately Smyrna-Myakka-Basinger association

(3) Dredge/Fill Material Movement. The fill material will be sloped and stabilized, and should not be subject to erosion.

(4) Physical Effects on Benthos. Benthic organisms within the fill areas would be lost as a result of placement of the fill.

b. Water Circulation, Fluctuation and Salinity Determination.

(1) Water. Standing water or moist soil will be replaced by fill material.

(2) Current Patterns and Circulation. Circulation to adjacent wetlands will be enhanced by breaching of the local levees and reestablihing connection to the lakes.

(3) Normal Water Level Fluctuations and Salinity Gradients. Normal water level fluctuations and salinity gradients will be maintained by proposed project.

c. Suspended Particulate/Turbidity Determinations.

(1) Expected Changes in Suspended Particulates and Turbidity Levels in the Vicinity of the Disposal Site. Temporary impacts may result from the placement of fill during construction. Any increase in turbidity will be confined to the vicinity of the activity and would not be expected to continue after construction.

(2) Effects on the Chemical and Physical Properties of the Water Column. No fill will be placed in open water.

(a) Light Penetration. The project will not change existing conditions.

(b) Dissolved Oxygen. The project will not change existing conditions.

(c) Toxic Metals, Organics, and Pathogens. No toxic metals, organics, or pathogens will be released by the project.

(d) Aesthetics. The project will not change existing conditions.

(3) Effects on Biota.

(a) Primary Productivity and Photosynthesis. Temporary impacts may result from the placement of fill during widening of C-36 and C-37. Breaching of the local levees will provide enhanced wetland function for the areas behind these levees,i.e., approximately 740 acres for Lake Cypress, approximately 2,200 acres for Lake Hatchineha, and approximately 600 acres for Lake Kissimmee, via reconnection with the lakes.

(b) Suspension/Filter Feeders. There will be no long-term adverse impact to suspension/filter feeders.

(c) Sight Feeders. There will be no long-term adverse impact to sight feeders.

d. Contaminant Determinations. Deposited fill material will not introduce, relocate, or increase contaminants.

e. Aquatic Ecosystem and Organism Determinations.

(1) Endangered and Threatened Species. There will be no impacts on any threatened or endangered species or on critical habitat of any threatened or endangered species. The eastern indigo snake may occur in the project area during the time construction takes place. Protective measures as outlined in the USFWS Biological Opinion will be utilized to protect the indigo snake during construction. Management activities associated with the lakes, i.e., extreme drawdowns, will need to be coordinated with the U.S. Fish and Wildlife Service so that these actions do not adversely impact the snail kite.

(2) Hardbottom Habitat. No hardbottom habitat exists in the project area.

f. Proposed Disposal Site Determinations.

(1) Mixing Zone Determination. The fill material will not cause unacceptable changes in the mixing zone specified in the Water Quality Certification in relation to: depth, current velocity, direction and variability, degree of turbulence, stratification, or ambient concentrations of constituents.

(2) Determination of Compliance with Applicable Water Quality Standards. Because of the inert nature of the fill material state water quality standards will not be violated.

(3) Potential Effects on Human Use Characteristics.

(a) Municipal and Private Water Supplies. No municipal or private water supplies will be impacted by the implementation of the project.

(b) Recreational and Commercial Fisheries. Recreational and commercial fisheries will not be impacted by the disposal of dredged material in the project area.

(c) Water Related Recreation. Water related recreation will be preserved and enhanced by the proposed project.

(d) Aesthetics. Approximately 29 acres of wetlands will be converted to levee, i.e., C-36 approximately 10 acres and C-37 approximately 19 acres, by the project.

(e) Parks, National and Historic Monuments, National Seashores, Wilderness Areas, Research Sites, and Similar Preserves. The construction of the Kissimmee Headwaters Revitalization Project will not effect any parks, national or historic monuments, national seashores, wilderness areas, research sites, or similar preserves.

g. Determination of Cumulative Effects on the Aquatic Ecosystem. There will be no cumulative impacts that result in a major impairment of water quality of the existing aquatic ecosystem as a result of the placement of fill at the project site.

3. Findings of Compliance or Non-compliance with the Restrictions on Discharge.

a. No significant adaptations of the guidelines were made relative to this evaluation.

b. No practicable alternative exists which meets the study objectives that does not involve discharge of fill into waters of the United States.

c. The discharge of fill materials will not cause or contribute to, after consideration of disposal site dilution and dispersion, violations of any applicable State water quality standards for Class III waters. The discharge operation will not violate the Toxic Effluent Standards of Section 307 of the Clean Water Act.

d. The disposal of fill material in the project area will not jeopardize the continued existence of any species listed as threatened or endangered or result in the likelihood of destruction or adverse modification of any critical habitat as specified by the Endangered Species Act of 1973, as amended.

e. The placement of fill material will not result in significant adverse effects on human health and welfare, including municipal and private water supplies, recreational and commercial fishing, plankton, fish, shellfish, wildlife, and special aquatic sites. The life stages of aquatic species and other wildlife will not be adversely affected. Significant adverse effects on aquatic ecosystem diversity, productivity and stability, and recreational, aesthetic, and economic values will not occur.

f. On the basis of the guidelines, the proposed disposal site for the discharge of dredged material is specified as complying with the requirements of these guidelines.

KISSIMMEE RIVER
HEADWATERS REVITALIZATION PROJECT

ANNEX C

COASTAL ZONE CONSISTENCY EVALUATION

ANNEX C

FLORIDA COASTAL ZONE CONSISTENCY PROGRAM CONSISTENCY DETERMINATION

KISSIMMEE HEADWATERS REVITALIZATION PROJECT
OSCEOLA AND POLK COUNTIES, FLORIDA

1. Chapter 161, Beach and Shore Preservation.

The intent of the coastal construction permit program established by this chapter is to regulate construction projects located seaward of the line of mean high water and which might have an effect on natural shoreline processes.

Response: No work is proposed seaward of the line of mean high water therefore, this Chapter would not apply.

2. Chapters 186 and 187, State and Regional Planning.

These chapters establish the State Comprehensive Plan which sets goals that articulate a strategic vision of the State's future. Its purpose is to define in a broad sense goals and policies that provide decision-makers directions for the future and provide long-range guidance for an orderly social, economic and physical growth.

Response: The proposed project has been coordinated with the state and no adverse comments were received.

3. Chapter 252, Disaster Preparation, Response and Mitigation.

This chapter creates a state emergency management agency, with the authority to provide for the common defense; to protect the public peace, health and safety; and to preserve the lives and property of the people of Florida.

Response. This statute is not applicable to the project.

4. **Chapter 253, State Lands.**

This chapter governs the management of submerged state lands and resources within state lands. This includes archeological and historical resources; water resources; fish and wildlife resources; beaches and dunes; submerged grass beds and other benthic communities; swamps, marshes and other wetlands; mineral resources; unique natural features; submerged lands; dredged material disposal islands; and artificial reefs.

Response: The proposed Kissimmee Headwaters Revitalization Project will impact approximately 29 acres of wetlands. However, this project will accomplish the following restoration goals: (1) restore approximately 14,000 acres of lake littoral zone bordering the affected lakes, i.e., Lake Cypress, Lake Hatchineha and Lake Kissimmee, (2) hydraulically reconnect approximately 2,650 acres behind local farm levees, which will enhance the wetland functions of these areas, and (3) reestablishing discharges to the lower basin that are necessary to the basin's restored ecological integrity (defined in the 1992 FEIS, Environmental Restoration Kissimmee River, Florida).

5. **Chapters 253, 259, 260, and 375, Land Acquisition.**

These chapters authorize the State to acquire land to protect environmentally sensitive areas.

Response: The South Florida Water Management District, the local sponsor of this project, is acquiring all the lands needed for the project.

6. **Chapter 258, State Parks and Aquatic Preserves.**

This chapter authorizes the State to manage State parks and preserves. Consistency with this statute would include consideration of projects that would directly or indirectly adversely impact park property, natural resources, and park programs management or operations.

Response: The proposed Kissimmee Headwaters Revitalization Project would not directly or indirectly adversely impact any State Parks or Aquatic Preserves. However, the restoration of the upper and lower basins of the Kissimmee River would have a positive impact on State lands within the basins therefore, would be consistent with this chapter.

7. **Chapter 267, Historic Preservation.**

This chapter establishes the procedures for implementing the Florida Historic Resources Act responsibilities.

Response: The study has been coordinated with the Florida State Historic Preservation Officer. Historic preservation compliance will be completed to meet all responsibilities under Chapter 267.

8. **Chapter 288, Economic Development and Tourism.**

This chapter directs the State to provide guidance and promotion of beneficial development through encouraging economic diversification and promoting tourism.

Response: Contribution from the study area to the State's tourism economy will not be compromised by project implementation. The project would be compatible with tourism for this area and could potentially contribute to overall growth and development of the area therefore, would be consistent with the goals of this chapter.

9. **Chapters 334 and 339, Public Transportation.**

This chapter authorizes the planning and development of a safe, balanced and efficient transportation system.

Response: The proposed project would not impact the existing public transportation system of the area and therefore, would be consistent with the goals of this chapter.

10. **Chapter 370, Saltwater Living Resources.**

This chapter directs the State to preserve, manage and protect the marine, crustacean, shell and anadromous fishery resources in State waters; to protect and enhance the marine and estuarine environment; to regulate fishermen and vessels of the State engaged in the taking of such resources within or without State waters; to issue licenses for the taking and processing of products of fisheries; to secure and maintain statistical records of the catch of each such species; and to conduct scientific and economic studies and research.

Response: The proposed Kissimmee Headwaters Revitalization Project does not effect saltwater living resources.

11. Chapter 372, Living Land and Freshwater Resources.

This chapter establishes the Game and Fresh Water Fish Commission and directs it to manage freshwater aquatic life and wild animal life and their habitats to perpetuate a diversity of species with densities and distribution which provide sustained ecological, recreational, scientific, educational, aesthetic, and economic benefits.

Response. The proposed Kissimmee Headwaters Revitalization Project has been coordinated with the US Fish and Wildlife Service for compliance with Section 7 of the Endangered Species Act. The eastern indigo snake listed by the USFWS as endangered may occur in the project area therefore, protective measures will be included in the construction contract. The proposed project will directly impact approximately 29 acres of wetlands. However, this project will accomplish the following restoration goals: (1) restore approximately 14,000 acres of lake littoral zone bordering the affected lakes, i.e., Lake Cypress, Lake Hatchineha and Lake Kissimmee, (2) hydraulically reconnect approximately 2,650 acres behind local farm levees, which will enhance the wetland functions of these areas, and (3) reestablishing discharges to the lower basin that are necessary to the basin's restored ecological integrity (defined in the 1992 FEIS, Environmental Restoration Kissimmee River, Florida).

12. Chapter 373, Water Resources.

This chapter provides the authority to regulate the withdrawal, diversion, storage and consumption of water.

Response. This project does not involve water resources as described by this chapter therefore, this chapter is not applicable.

13. Chapter 376, Pollutant Spill Prevention and Control.

This chapter regulates the transfer, storage, and transportation of pollutants and the cleanup of pollutant discharges.

Response. This project does not involve the transportation or discharging of pollutants, this chapter is not applicable.

14. Chapter 377, Oil and Gas Exploration and Production.

This chapter authorizes the regulation of all phases of exploration, drilling, and production of oil, gas, and other petroleum products.

Response: This project does not involve the exploration, drilling or production of gas, oil or petroleum product and therefore this chapter does not apply.

15. Chapter 380, Environmental Land and Water Management.

This chapter establishes criteria and procedures to assure that local land development decisions include consideration of the regional impacts of proposed large-scale development.

Response: This project does not involve land development as described by this chapter therefore, this chapter is not applicable.

16. Chapter 388, Arthropod Control.

This chapter provides for a comprehensive approach for abatement or suppression of mosquitoes and other pest arthropods within the State.

Response: The project would not further the propagation of mosquitoes or other pest arthropods.

17. Chapter 403, Environmental Control.

This chapter authorizes the regulation of pollution of the air and waters of the State by the Department of Environmental Protection.

Response: An application for Water Quality Certification will be submitted to DEP for the proposed Kissimmee Headwaters Revitalization Project. A Supplemental Environmental Impact Statement of project impacts has also been prepared and will be reviewed by the appropriate resource agencies including DEP, Therefore, the project is complying with the intent of this chapter.

18. Chapter 582, Soil and Water Conservation.

This chapter establishes policy for the conservation of the State's soil and water through the Department of Agriculture. Land use policies will be evaluated in terms of their tendency to cause or contribute to soil erosion or to conserve, develop, and utilize soil and water resources both on site or in adjoining properties affected by the project. Particular attention will be given to projects on or near agricultural lands.

Response: The proposed project would directly impact approximately 202 acres of unique farmland, which is defined by the Farmland Protection Policy Act. The proposed project has been coordinated under the Farmland Protection Policy Act with the U.S. Department of Agriculture, Natural Resources Conservation Service. Project construction will include appropriate erosion control plans and measures to ensure compliance.

KISSIMMEE RIVER
HEADWATERS REVITALIZATION PROJECT

ANNEX D

FISH AND WILDLIFE COORDINATION ACT REPORT

United States Department of the Interior

FISH AND WILDLIFE SERVICE

P.O. BOX 2676

VERO BEACH, FLORIDA 32961-2676

June 30, 1994

Colonel Terrence C. Salt
District Engineer
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019

Attn: Planning Division

Re: Kissimmee Headwater Lakes Revitalization Project

Dear Colonel Salt:

Pursuant to a Scope of Work, the Chief of your Planning Division requested the U.S. Fish and Wildlife Service (Service) provide a Fish and Wildlife Coordination Act (FWCA) Report on the Kissimmee Headwater Lakes Revitalization Project. This project is integral with the plan to restore the Kissimmee River (Canal 38). Both components of this study were authorized by Section 1135 of the Water Resources Development Act of 1986. This FWCA Report is submitted pursuant to our Fiscal Year 1993 Transfer Funding agreement and in accordance with the provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.), and the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.).

The Kissimmee Headwater Lakes Revitalization provides the necessary storage and discharge characteristics to restore flow to the Kissimmee River, while also providing partial restoration of ecosystems in the Headwater Lakes.

To achieve the full potential for restoration of wetlands in the Headwater Lakes Revitalization Project, the Service recommends that the three major levees along the shores of Lakes Kissimmee, Hatchineha and Cypress be breached. The local sponsor, the South Florida Water Management District, will need to acquire all lands behind these three levees that lie below the 54-foot topographic contour in addition to the lands already targeted for acquisition.

Although the selected water regulation schedule is the best we can identify after a series of iterative evaluation of model outputs, it should not be considered as immutable. After several years of operation, the cooperating agencies should re-evaluate the operational rules, particularly to determine if longer periods of inundation between the 52.5 and 54-foot topographic contours can be realized without increasing risk of flood damages. Corps hydrologists have recently suggested lowering the upper controlling elevation of the selected 400C150RR schedule from 52.5 feet to 52 feet. Our analysis indicates that any further reduction of high water levels from the currently selected plan would virtually eliminate all currently projected benefits to wetlands and wetland-dependent wildlife in the upper basin. We strongly urge the Corps not to reduce the duration of water levels above 52.5 feet below those modelled for the 400C150RR alternative.

As a possible future refinement of the project, we also recommend that we study the feasibility of constructing a water control structure/lock at the northern end of Canal 36 (south of Lake Cypress). This structure would allow separate water regulation of Lake Cypress, which presently has water levels severely below historic conditions.

The Service also recommends that the Federal government take action to restore the Kissimmee River by backfilling Canal 38 to the fullest extent possible to achieve restoration of the river's original functions and values. This will mitigate damages caused by the channelization of the river. We also continue to strongly recommend that the Paradise Run reflooding and other flow-through measures in Pool A be incorporated in the Final Feasibility Report as project design features to maximize ecosystem restoration, as described in our 1991 FWCA Report for the Kissimmee River.

The draft FWCA report was circulated for review and comment by the participating agencies. The Florida Game and Fresh Water Fish Commission generally concurred with our draft and provided additional recommendations. The enclosed Final FWCA Report represents the Secretary of Interior's report to Congress as required by Section 2(b) of the FWCA. This report should accompany the Final Feasibility Report and Environmental Impact Statement when it is submitted to Congress.

Thank you for the opportunity to participate in this important ecosystem restoration effort. The Service views the implementation of this project as a step towards fulfilling the restoration goals of the South Florida Ecosystem Task Force.

Sincerely yours,

Robert T. Pace
Acting Field Supervisor

cc:
FG&FWFC, Tallahassee, FL
FG&FWFC, Vero Beach, FL
FG&FWFC, Kissimmee, FL
DEP, Tallahassee, FL
SFWMD, West Palm Beach, FL
FWS, Jacksonville, FL
FWS, Atlanta, GA

United States Department of the Interior

FISH AND WILDLIFE SERVICE

P.O. BOX 2676

VERO BEACH, FLORIDA 32961-2676

February 1, 1994

Mr. A.J. Salem
Chief, Planning Division
U.S. Army Corps of Engineers
Jacksonville District
P.O. Box 4970
Jacksonville, Florida 32232-0019

Dear Mr. Salem:

On January 24, 1994, Mr. Robert Pace of my staff attended an "In-Process Review Conference" for the Kissimmee Headwater Lakes Revitalization 1135 project. He presented the results of the Service's community-level evaluation of the latest two alternatives in the iterative testing of proposed lake regulation schedules. We have been quite pleased to date with the approach of the HEP team members (led by Lou Toth of the SFWMD) in guiding design of this environmental project. We stated on January 24th that in our opinion the agencies had enough data to select a preferred alternative, based on the general behavior of the water routing models. We believe it is now time to move ahead with the species models on the preferred alternative so the Corps will be able to meet its planning deadlines.

On the basis of Mr. Pace's presentation, Richard Bonner proposed that the agencies concur on selection of the 400C150RR as the preferred alternative. There were no objections to this motion, but the agencies agreed to meet in Vero Beach in February to ensure that all parties agreed on the justification for this selection.

Enclosed are draft copies of what will be sections of our Fish and Wildlife Coordination Act report. The first section describes the approach taken to evaluate the water regulation schedules. The second section will be inserted in the "Future with Project" section of our FWCA report, summarizing the results of the general evaluation methodology. An as yet unnumbered table also summarizes these results.

Please forward copies of these materials to Gerald Atmar and Mike Smith, who are expected to meet with us in February on this matter. Your continued cooperation on this important restoration project is greatly appreciated. If you have any questions, please call Mr. Pace at (407) 562-3909.

Sincerely,

David L. Ferrell

David L. Ferrell
Field Supervisor

cc: (w/encl)
Ed Moyers, FGFWGC, Kissimmee
Larry Parent, FGFWFC, Tallahassee
Lou Toth, SFWMD, West Palm Beach
Patricia Sculley, SFWMD, West Palm Beach
Bill Helferich, SFWMD, West Palm Beach

ACKNOWLEDGEMENTS

The authors of this report are Robert T. Pace and Joseph D. Carroll, Senior Field Biologists.

We greatly appreciate the instruction and guidance of Arnold Banner, who introduced Mr. Pace to the concepts and practice of GIS analysis. He also provided assistance directly related to completion of this project.

We appreciate the encouragement of David Ferrell, our Field Supervisor, who has strongly supported development of GIS capabilities in the Ecological Services program of the Fish and Wildlife Service.

Fred Schaeffer, of our Vero Beach Field Office, provided invaluable support in keeping our computer hardware running and technical advice.

The members of an interagency review panel provided guidance and information throughout the analysis: Ed Moyer and Larry Perrin, Florida Game and Fresh Water Fish Commission; Gerald Atmar and Mike Smith, Corps of Engineers; Lou Toth and Patricia Sculley, South Florida Water Management District.

Paul Holt (Corps of Engineers) and Carl Horton (formerly with the South Florida Water Management District) assisted in development of the topographic/bathymetric data. The GIS data provided by personnel at the Florida Game and Fresh Water Fish Commission, Tallahassee, were used extensively in this analysis.

Finally, we must acknowledge the patience and assistance of the species experts we consulted in developing the species models. Those from the Florida Game and Fresh Water Fish Commission include: Ed Moyer, Jim Rodgers, Steve Nesbitt, Paul Gray, and Diane Eggeman. Brian Toland, now an employee of the U.S. Fish and Wildlife Service, also worked for the Game Commission when this evaluation started. Rob Bennetts of the University of Florida's Cooperative Fish and Wildlife Research Unit, James Layne of the Archbold Biological Station, and Herb Kale of the Florida Audubon Society also provided information and advice.

EXECUTIVE SUMMARY

The Kissimmee Lakes Revitalization Project provides the water storage and discharge characteristics to restore the Kissimmee River, while also providing a wider range of water fluctuation in the Kissimmee Chain of Lakes. We strongly recommend that the Corps implement design features as described below to maximize the environmental benefits achievable from this proposal.

The presently recommended revised lake schedule will provide seasonal flooding of greater duration for elevations between about 51 feet and 52.5 feet. Restoration of short hydroperiod wetlands is expected between elevations of 52 feet and 52.5 feet. We have predicted restoration of about 5939 acres of additional marsh relative to the present for the basic project without breaching of levees. If all three levees adjacent to the shorelines of Lakes Kissimmee, Hatchineha, and Cypress are breached (as recommended by the Service), about 7236 acres of marsh would be restored. The selected water regulation schedule would also provide routine low water levels (<47 ft.) of greater duration, which means greater overall fluctuation of water levels. The resulting increased hydrologic dynamics in the lakes is considered beneficial across the entire ecosystem.

Among the 10 evaluation species, 6 species are predicted to benefit significantly from the proposed new schedule. Compared to the future without the project, the predicted increase in availability of suitable habitat ranges from about 10% to 35%, depending on the species and the range of alternative futures considered. The 6 species include the Florida duck, ring-necked duck, snail kite, great egret, snowy egret, and wood stork. For the remaining species; Audubon's crested caracara, bald eagle, sandhill crane, and largemouth bass; we do not predict any major change in habitat availability. If any change occurs, the models point to a possible slight increase for these species.

As indicated in Section XII of this report, the Service has concurred with the Corps' determination that the proposal is not likely to adversely affect any Federally-listed threatened or endangered species. We predict the project is likely to benefit the endangered snail kite and wood stork.

The following summarizes our recommendations:

I. DESIGN AND OPERATION OF THE PRESENTLY PROPOSED PROJECT

- Periodic extreme drawdowns should be superimposed on the normal regulation schedule. This action is an essential habitat management tool for the entire lake ecosystem, particularly with respect to the sport fishery. The frequency and timing of these drawdowns should be fully coordinated to minimize adverse effects on nesting of snail kites.

- Spoil material excavated during widening of C-36 and C-37 should be confined to the existing spoil banks within the right-of-way. If filling of wetlands beyond the toe of the existing spoil mounds is unavoidable, the Corps should develop, during detailed project design, a plan to compensate for these losses.

- The Service continues to support the proposed Level II Backfilling Plan for the Kissimmee River restoration, a project adjacent to, and hydrologically connected with, the Kissimmee Headwater Lakes Revitalization Project.

II. ADDITIONAL PROJECT FEATURES RECOMMENDED TO MAXIMIZE ENVIRONMENTAL BENEFITS

- Lands up to 54 feet in elevation located behind the three levees at Lakes Hatchineha, Kissimmee, and Cypress should be added to the ongoing fee title acquisition of lands around the lakes. The levees should then be breached to hydrologically connect existing wetlands with the lakes and allow additional restoration of wetlands. This will result in the full potential of habitat restoration available in the upper basin and provide additional areas to buffer flood risks during storm events.

- The Service recommends that the Corps evaluate the feasibility and benefits of adding a water control structure/lock at the northern end of C-36 to enable separate water regulation of Lake Cypress at levels closer to the historic condition. Lake Cypress appears to be more adversely affected by water levels held below historic conditions, as exhibited by reduction of the littoral fringe and dense growth of aquatic weeds. Although separate regulation of this lake was not proposed in our Scope of Work, the Service is confident that separate regulation at levels higher than Lakes Hatchineha and Kissimmee would greatly enhance the environmental benefits of the currently proposed plan. We would be willing to prepare a Scope of Work to quantify these additional environmental benefits.

III. PROJECT MONITORING AND CONTINUED EVALUATION

- The Interagency Review Team that convened to prepare this evaluation should continue to meet after implementation of the new water regulation schedule. This will allow evaluation of its effectiveness in reaching restoration goals for the upper basin and the Kissimmee River. Environmental monitoring studies should be planned and funded. Iterative testing of modified water regulation schedules should be conducted if it appears that the project is not fully realizing potential benefits. In particular, the review agencies should revisit the issue of attempting to provide flooding of longer duration between elevations of 52.5 and 54 feet in the upper basin, if this can be achieved without increasing flood risks upstream.

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I. IDENTIFICATION OF PURPOSE, SCOPE AND AUTHORITY

Funding for the proposed Federal action is authorized by Section 1135 of the Water Resources Development Act of 1986. The primary purpose of the proposal is environmental quality, including restoration of fish and wildlife resources of the Kissimmee River Basin, including the Kissimmee Chain of Lakes (upper basin) and the Kissimmee River (lower basin). In response to a request from the South Florida Water Management District (SFWMD), the Congress directed the Corps of Engineers (Corps) to consider a restoration plan for the Kissimmee River, leading to selection of the Level II Backfilling Plan. The authorization calls on the Corps to provide a feasibility report and to implement the backfilling of Canal 38 of the Central and Southern Florida Flood Control Project. The selected plan calls for partial backfilling of the canal, and leaves the northern end (Pool A and part of Pool B) as well as the southern end of Pool E unfilled for flood control purposes.

The Section 1135 Kissimmee Headwater Lakes Revitalization Project is necessary to provide the volume and timing of water discharges to enable restoration of the Kissimmee River. Lakes Kissimmee, Cypress and Hatchineha are the larger lakes that would fall under a revised schedule; water levels in smaller Tiger Lake and Lake Rosalie would also be directly affected. The FGFWFC is currently constructing a project to allow regulation of Lake Jackson apart from the other lakes. Therefore, Lake Jackson was removed from the study area; it would only be affected indirectly by this project in that water levels on Lake Kissimmee could, during higher stages, affect the tailwater conditions at the new Lake Jackson structure.

II. ACKNOWLEDGEMENT OF COORDINATION AND CONCURRENCE OF FLORIDA GAME AND FRESH WATER FISH COMMISSION

Appendix A is a letter, dated June 6, 1994, from the Florida Game and Freshwater Fish Commission (FGFWFC), which concurs in the findings contained in this report. The Service agrees with the FGFWFC's additional recommendations, and we have added to the recommendations in Section XIV. Other letters from the Florida Department of Environmental Protection commenting on the Draft FWCA Report are included as Appendices B and C.

III. DISCUSSION OF RELEVANT PRIOR STUDIES AND REPORTS

The Kissimmee River was dredged as a Federal project in the 1960's resulting in a wide canal from the Kissimmee Chain of Lakes to Lake Okeechobee. In the late 1970's the State of Florida petitioned the Corps to restudy the channelized Kissimmee River, identified as Canal 38 (C-38). After resolutions were passed by Congress in 1978, the

Corps responded with reconnaissance and feasibility reports and an environmental impact statement. These documents established that the original Federal project had severely depleted fish and wildlife resources. These reports reviewed several alternative restoration plans. The report released in September 1985 concluded that there was "no Federal interest" in restoring the Kissimmee River, even though the report indicated that implementing many of the alternatives studied would result in significant benefits to fish and wildlife resources. The conclusion that no Federal action was justified was based on interpretation of the 1983 Principles and Guidelines of the Water Resources Council.

In December 1991 the Corps of Engineers submitted a Final Integrated Feasibility Report and Environmental Impact Statement on Environmental Restoration of the Kissimmee River. This report recommended backfilling of Canal 38 in Pools B, C, D, and E to restore the ecological integrity and fish and wildlife values of the Kissimmee River ecosystem.

A. Prior Fish and Wildlife Service Reports

Because the Kissimmee Chain of Lakes and the Kissimmee River are closely related biologically and administratively, the following listing of Service involvement considers both areas.

1. FWCA Report, December 17, 1958

A major report, entitled "A Detailed report of the Fish and Wildlife Resources in Relation to the Corps of Engineers Plan of Development, Kissimmee River Basin, Florida", was released by the Fish and wildlife Service in 1958. The report comprehensively described the fish and wildlife resources of the entire Kissimmee River basin, both the Chain of Lakes and the Kissimmee River. Particular emphasis was placed on the importance of the recreational use of the river, primarily for largemouth bass fishing, and the significance of the river basin for wintering waterfowl. These findings were based on more than a year of field surveys conducted throughout the basin. The report quantified existing public use of the river for fishing and hunting, and predicted that there would be a reduction in sport fishing and a loss of 40 percent of the waterfowl habitat.

As mitigation, the Service recommended seasonally varying the water levels in the headwater lakes, and substituting a leveed floodway for most of the canal. These recommended modifications were not implemented, and the river was subsequently channelized.

2. Kissimmee River Restudy Planning Aid Report, August 1979

In August 1979, the Service prepared a Planning Aid Report comparing the pre-project conditions with 1979 conditions in the lower basin. That report noted the loss of over 75 percent of the original wetlands and over 50 percent of the original river channel. The report concluded that mitigation efforts in the form of "fish breeding" canals did not offer significant compensation for fish and wildlife resource losses caused by channelization. The Service concluded that overall habitat values declined 90 percent, and offered various restoration and management alternatives for investigation by the Corps.

3. Habitat Evaluation Procedure Report, August 1984

This report described fish and wildlife habitat values evaluated by an interagency Habitat Evaluation Procedures (HEP) team in 1979 and 1980. The report discussed the methods, assumptions, models, and results of the HEP analysis. Baseline conditions were established from surveying the existing system, and results were presented for pre-project conditions and the restoration alternatives.

4. Fish and Wildlife Coordination Act Report on Restudy, March 1986

This report recommended that the Federal government take action to mitigate damages to fish and wildlife resources resulting from the construction of the Kissimmee River Flood Control Project. The Service preferred the alternative of backfilling the C-38 Canal to achieve as complete a restoration of the river's original functions and attributes as is consistent with reasonable flood protection and navigation. The partial backfill alternative, a flow-through marsh proposal in Pools A and B, and the Paradise Run proposals were all supported by the Service.

5. Fish and Wildlife Coordination Act Report, October 24, 1991

The Fish and Wildlife Service endorsed the restoration of the Kissimmee River and provided substantial evidence for improved habitat conditions for fish and wildlife, if restoration was achieved through backfilling C-38.

6. Planning Aid Report, Kissimmee Headwater Lakes Revitalization, February 25, 1994

By letter dated November 16, 1992, the Service provided a Plan of Study (Scope of Work) and cost estimate to evaluate the Kissimmee Headwater Lakes Revitalization Project and provide a Final Fish and Wildlife Coordination Act Report. On February 25, 1993, we provided a Planning Aid Letter for this project; this report provides our official response under the Coordination Act.

IV. LOCATION AND DESCRIPTION OF STUDY AREA

The Kissimmee Chain of Lakes is located in central Florida, south of Orlando, and it forms the upper end of a hydrologic system sometimes referred to as the Kissimmee/Okeechobee/Everglades system (Figure 1). The study area was selected to include the lakes that are regulated together under normal conditions--Lakes Cypress, Hatchineha, Kissimmee, Rosalie, and Tiger. Lake Jackson is currently held at the level of Lake Kissimmee, but the FGFWFC intends to regulate this lake separately from Lake Kissimmee. The water level in all of these above-named lakes remains below the 54-foot contour, except in extreme floods. Lakes Marian, Weohyakapka, Tohopekaliga and East Lake Tohopekaliga are also part of the Kissimmee Chain of Lakes, but because these are regulated at higher water levels, they will not be directly affected by the proposed water regulation schedules.

The Kissimmee Chain of Lakes is located in the Osceola Plain, a geologic feature east of the Lake Wales Ridge. A smaller ridge to the east separates the 1,633 square mile upper basin from the northward flowing St. Johns River basin. The present headwater lakes were probably once the deeper portions of a vast marsh complex. The original flow of water has been highly modified by manmade flood control canals. Lake Marion Creek and Reedy Creek are the remaining natural inflows to Lake Hatchineha. Rosalie Creek and Tiger Creek are also relatively short natural water bodies between Lake Rosalie and Tiger Lake and between Tiger Lake and Lake Kissimmee, respectively. The remainder of the waterways between the lakes in the study area and those connecting outside the study area have been channelized. These include Canoe Creek (C-34), South Port Canal (C-35), Hatchineha Canal (C-36), Short Canal (not part of C&SF system), and two channelized sections of the Kissimmee River: C-37, between Lake Hatchineha and Lake Kissimmee, and C-38, the long, wide canal between Lake Kissimmee and Lake Okeechobee. Several water control structures surround the lakes, but the main structure of significance in this report is S-65, which releases water from Lake Kissimmee, through C-38, to Lake Okeechobee, about 56 miles downstream.

Figure 2 illustrates the boundaries of the study area. State Road 60 forms the southern and southeastern edge, while the Florida Turnpike forms the northeastern boundary. The total area is approximately 213,625 acres (86,453 hectares). Although the effects of the project will be limited to the periphery of the lakes, the Service believes it is important to assess the environmental impacts within the surrounding landscape. For example, the lake shorelines are excellent foraging habitat for wading birds, but the extensive acreage of wetlands outside of the lake shorelines must also be considered to assess the effects of the project on the species within the surrounding landscape.

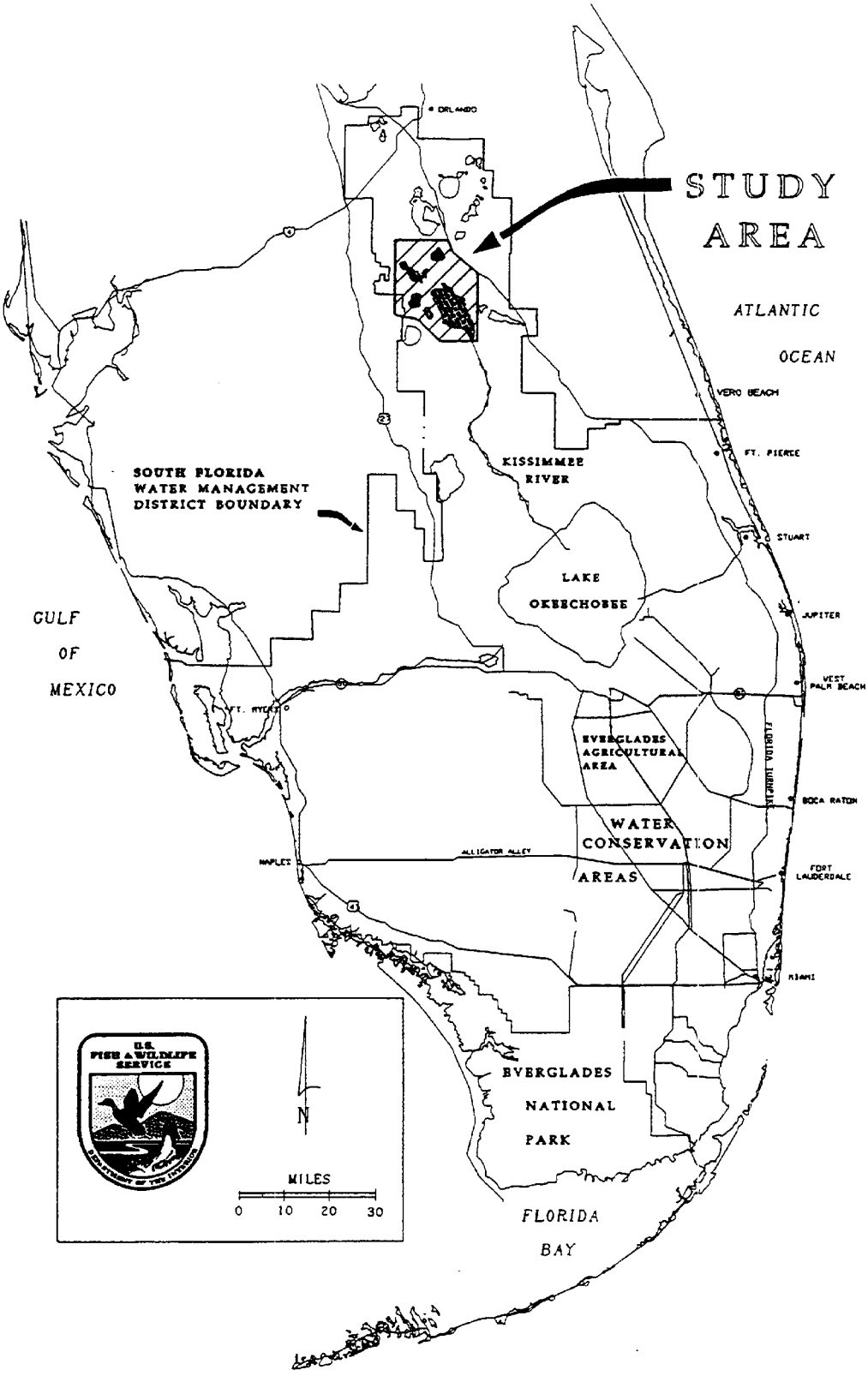


FIGURE 1 - LOCATION OF THE STUDY AREA WITHIN THE KISSIMMEE/OKEECHOBEE/EVERGLADES WATERSHED

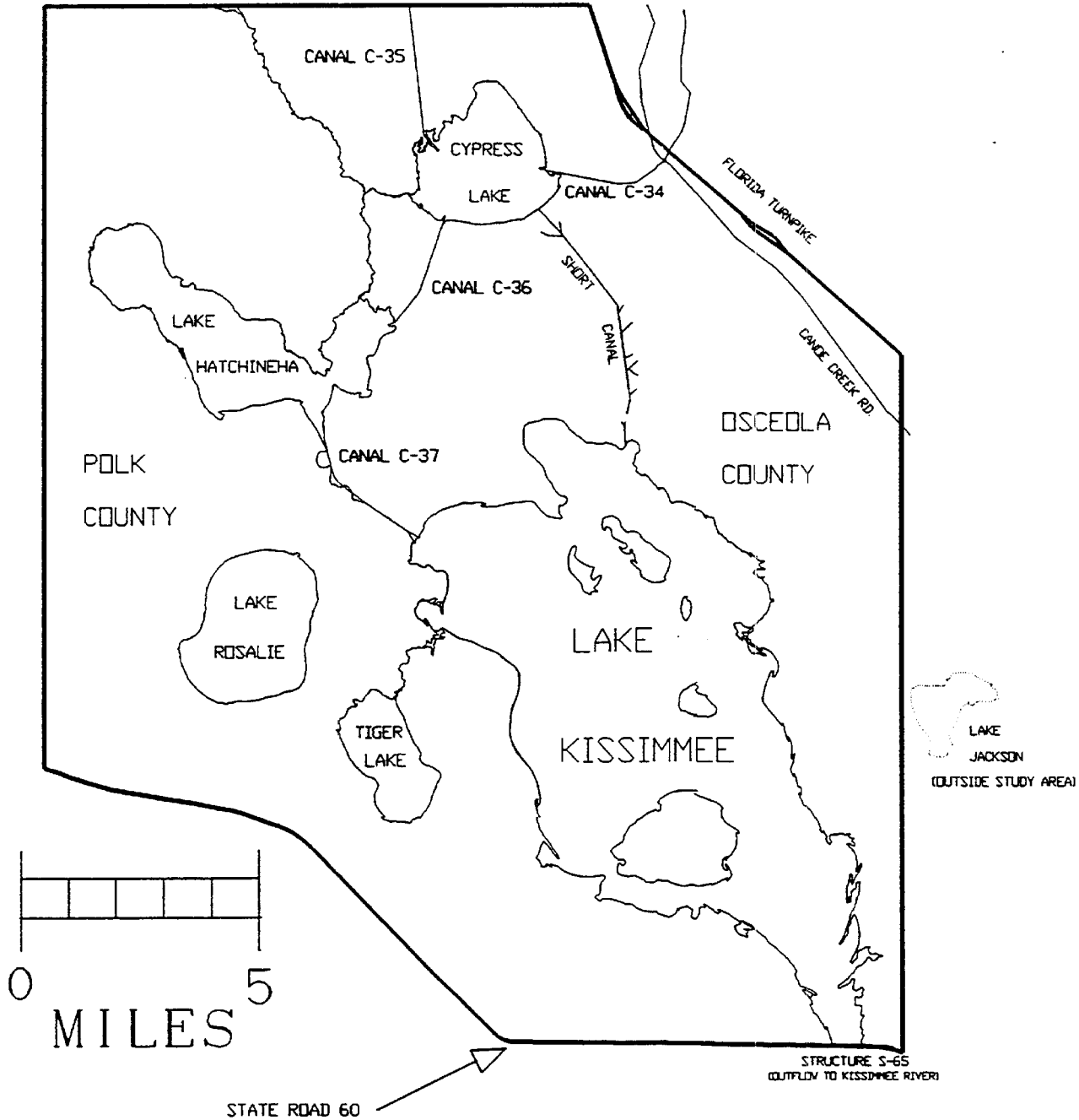


FIGURE 2 - LIMITS OF ENVIRONMENTAL STUDY AREA. KISSIMMEE HEADWATER LAKES

V. SUMMARY OF PLAN SELECTION PROCESS AND IDENTIFICATION OF EVALUATED ALTERNATIVES

The proposed project is largely alteration of the existing water regulation criteria, which is non-structural; however, to achieve the intended water storage in the lakes and discharge characteristics in the Kissimmee River without increasing flood risk, the Corps has determined that structural modifications will be required for canals and water control structures.

Regarding the non-structural aspects, Section VII.B.1. of this report describes the iterative testing process used to select the water regulation schedule. We provide the results of our analysis of the last two modelled alternatives in Section XI.A. of this report; the agencies have concurred on selection of a regulation schedule designated 400C150RR.

Early in plan formulation the Corps considered enlarging the Short Canal between Cypress Lake and Lake Kissimmee (Figure 2) to provide more rapid response to flood conditions. However, based on response from the Service and the Corps' own internal review, this proposal was rejected. The short canal is presently quite small and is surrounded by extensive wetlands. Large volumes of dredge spoil would have to be disposed in adjacent wetlands if traditional canal design were contemplated. Both agencies concurred that excavation of a flood control channel in this area would have unacceptable environmental impact.

Since rejection of the Short Canal design theory, the Corps has investigated widening of Canals C-35, C-36, and C-37 and increasing the capacity of water control structure S-65 to provide additional flood control response capacity. The Service's then recommended widening the canals on one side only, because widening on the existing center line would increase possible impacts on natural areas and increase turbidity effects within the canal and in wetlands outside of the existing spoil banks. Because the canal banks and spoil mounds are vegetated and stabilized, we recommended that one side of the canal remain undisturbed by widening to one side of the center line. After reviewing right-of-way information, the Corps and the SFWMD determined that if they widened to one side, road access requirements led them to select widening of the canals to the east.

The environmental studies in this report identify and evaluate the following five alternative future scenarios:

- Alternative Future 1 -- Adoption of the proposed water control schedule without breaching shoreline levees;

- Alternative Future 2 -- Proposed schedule with breaching of levee south of Lake Hatchineha;

- Alternative Future 3 -- Proposed schedule with breaching of levee north of Cypress Lake;

- Alternative Future 4 -- Proposed schedule with breaching of levee east of Lake Kissimmee;

- Alternative Future 5 -- Proposed schedule with breaching of all three levees (full restoration of all potential areas).

Each recommended breaching of a levee is considered to be an increment on the basic plan; however the Service strongly recommends that the project sponsors take full advantage of all restoration potential in the upper basin. All of these alternative futures were compared to the future without the project, which as stated in Section VIII.B. of this report, is assumed to be substantially the same as the present condition.

VI. EXPLANATION OF FISH AND WILDLIFE CONCERNS AND PLANNING OBJECTIVES

A. Fish and Wildlife Concerns

Fish and wildlife resources of concern and of major Federal interest include migratory birds (especially waterfowl and wading birds), and Federally-listed threatened and endangered species (bald eagle, wood stork, snail kite, Audubon's crested caracara) These wildlife species are, to varying degrees, dependent on wetland habitats in the study area. The Service also advocates public uses of fish and wildlife, including the observation of wildlife, hunting and sport fishing.

The primary planning objective of the Service is recovery and mitigation of habitat supporting these species. Distribution, timing, and volume of water flow to approximate, or at least approach, historic patterns are the principal concerns at the present phase of planning ecosystem restoration. Water quality issues also need to be addressed in the long term to ensure adequate habitat quality in both the upper and lower basins.

Hydrologic conditions were altered by construction of the Kissimmee River Flood Control Project. Water is released from the lakes in sudden pulses when the existing regulation schedule is exceeded. The approved maximum water level is seldom reached because the schedule allows it only late in the year, after the peak of the normal rainy season. Flood control measures instituted since about 1965 have restricted water levels to an extremely narrow range. This lake level stabilization has reduced the size of the littoral zone marshes, reducing the total area for recruitment of forage to the in-lake fishery. Foraging areas for waterfowl and wading birds have also been reduced.

The static condition of the lakes appears to be adversely affecting vegetation in the littoral zone. Short hydroperiod marshes have been displaced by pasture grasses and invaded by shrubs. After decades of restrictive water regulation, even woody vegetation appears affected; although we have no statistics on wetland change during this period, observations indicate a net loss of cypress trees in the upper littoral zone. This is particularly true of Lake Cypress. Lake Cypress was historically upstream of Lakes Hatchineha and Kissimmee, but all three lakes are now held at a flat pool. This exaggerates the effects on the littoral fringe of Lake Cypress. The Service is providing a recommendation that an additional study be conducted to determine the feasibility of constructing a water control structure with a navigational lock at the northern end of C-36, just downstream of Cypress Lake.

Although year-to-year low water levels contribute to the dynamics of the lakes, extreme drawdowns are considered essential on a periodic basis to achieve their beneficial effects on vegetation and organic berms. Deposition of a band of organic material around the lakes' shorelines is exacerbated by narrow restriction of lake levels. At least three factors are involved in this phenomenon. First, if annual low water levels recede to about the same level in most years, deposition of silt is concentrated at that elevation. Secondly, if water levels are not allowed to descend drastically during droughts, as they did under unregulated conditions, vegetation becomes overly dense, impeding the movement of animals, particularly fish that serve as food for other species. Finally, the buildup of dense vegetation has a synergistic effect by accelerating the rate of additional organic material in the same bands of vegetation.

Both the static condition of the lakes and nutrient inputs have contributed to proliferation of nuisance vegetation. Water primrose and cattails are among the emergent nuisance plants that propagate to an unnatural degree in static conditions. Submersed and emersed floating aquatic plants, such as the exotic *Hydrilla* and the native American lotus (*Nelumbo lutea*) also proliferate beyond historic abundance. Lake level stasis is thought to promote formation of floating batteries. Patches of aquatic plants, primarily fragrant water lily and spatterdock, with associated peat and starchy roots, lift up from the bottom and float to another location where they lodge. In addition, *Scirpus cubensis* forms thick mats of vegetation which support colonization by many species of undesirable plants. Battery formation can in turn cause formation of patches of higher islands in the marshes of the littoral zone.

Extreme drawdowns of several months duration allow drying of the built-up sediment load, and even without mechanical removal of the sediment berms, levelling of these berms by extended drying is beneficial to the exchange of water and animals across these berms after re-flooding. Extreme drawdowns help thin out the overly dense bands of vegetation that can develop in static systems. If mechanical removal of vegetation is not practical in a lake as large as Lake Kissimmee, a controlled burn can be an effective

management tool in the shoreline exposed by an extreme drawdown. Natural oxidation and consolidation of sediments is beneficial even without mechanical removal of muck.

The FGFWFC has instituted programs to draw down the lakes on a periodic basis. They attempt to hold water down for at least 90 days, starting in mid-February; results will vary according to rainfall patterns during this period, which normally has low rainfall. Increased rainfall is normally anticipated in June, which is generally the latest lakes can be held down (Ed Moyer, FGFWFC, pers. comm.). For Lake Kissimmee, water levels should remain below 46 feet for a minimum of 90 consecutive days for effective treatment.

Extreme drawdowns were completed for Lake Tohopekaliga in 1971, 1974, and 1987; the last included muck removal. East Lake Tohopekaliga was drawn down in 1990, also with muck removal. (Both of these lakes are in the Kissimmee Chain of Lakes, but north of the limits of the study area for the project considered here.) A drawdown of Lake Kissimmee was completed in 1977; this did not include mechanical removal of muck, but was beneficial through the natural processes described above. A drawdown is planned for Lake Kissimmee in the next two to three years, if funds and permits can be secured.

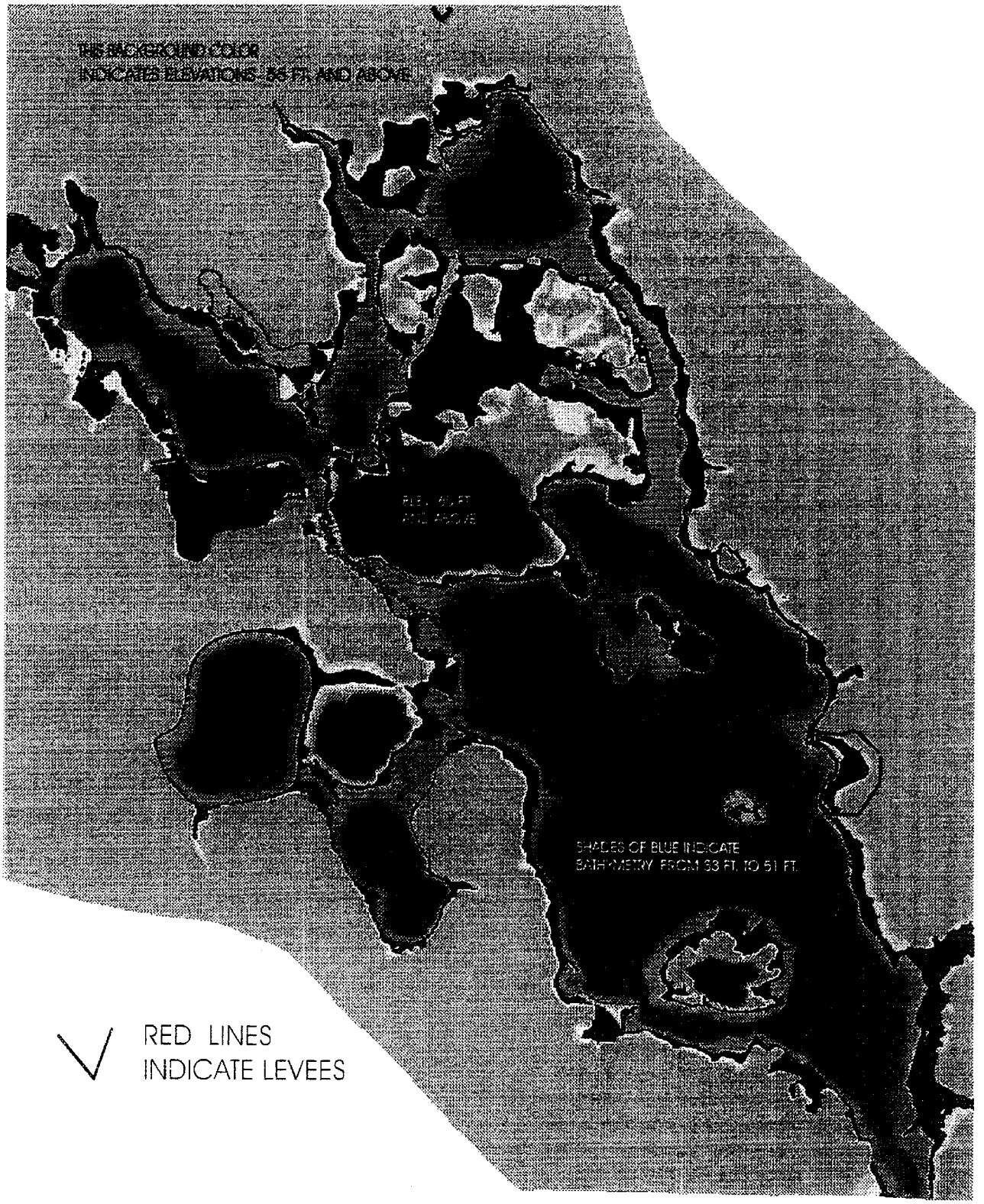
Wegener and Williams (1974) describe the beneficial response of fish populations to the 1971 extreme drawdown of Lake Tohopekaliga. Standing crop of fish in the littoral zone increased from a high of 191 pounds per acre before the drawdown to 455 pounds per acre within two years after reflooding.

Compounding the adverse effects of overly restrictive water management, several levees have been constructed around the lakes, further restricting interchange of water and accelerating conversion of former wetlands to uplands. Figure 3 shows the locations of the three principal levees, north of Lake Cypress, south of Lake Hatchineha, and along the east shore of Lake Kissimmee.

Public access is always a concern for fishermen, froggers and hunters. The higher powering of airboats and other boats has made more and more land (including privately held land) accessible. Conflicts can arise between certain factions among recreational users and landowners. Development of recreational plans by the Corps should consider the balance between the limits on public access sought by landowners along the shoreline and the legitimate needs for public access to the natural resources.

B. Planning Goal

Optimize environmental improvements to the upper Kissimmee basin while reestablishing discharges to the lower basin that are necessary to restore the ecological integrity of the Kissimmee River



IGURE 3 - TOPOGRAPHY/BATHYMETRY AROUND KISSIMMEE CHAIN OF LAKES AND LOCATION OF SIGNIFICANT LEVEES.

(POTENTIAL AREAS FOR WETLAND ENHANCEMENT ARE ISOLATED BY THESE LEVEES)

C. Planning Objectives

1. Provide necessary storage and regulation schedule modifications to approximate historical flow characteristics to achieve or exceed the benefits ascribed to Kissimmee River restoration.

2. Increase the quantity and quality of the wetland habitat in the upper basin lake littoral zones to benefit fish and wildlife.

3. Provide increased potential for recovery of endangered and threatened species, while not jeopardizing any listed species.

VII. DESCRIPTION OF EVALUATION METHODS

A. Data Used in the Evaluation

1. Vegetative Cover

Characterization of habitat suitability in this evaluation relies principally on a classified Landsat Thematic Mapper (TM) image. The study area was cut out from data provided by the FGFWFC. The FGFWFC classified vegetative cover in Florida into 22 categories (including barren areas and open water). Kautz et al. (1993) provide a description of the process of classification, definition of the habitat characteristics of each land cover type, and analysis of the results. Figure 4 shows the original Landsat image used as a basis for our analysis. Sixteen of the 22 land cover types used for Florida are present in the study area. The 5 most abundant cover types in the study area are the following:

TABLE 1 – PREDOMINANT LANDCOVER CLASSES IN STUDY AREA

LANDCOVER CLASS	ACREAGE	PERCENT OF STUDY AREA
Grassland	48,900	22.9%
Open Water	39,373	18.5%
Dry Prairie	30,161	14.1%
Marsh / Wet Prairie	28,673	13.4%
Shrub / Brushland	13,860	6.5%

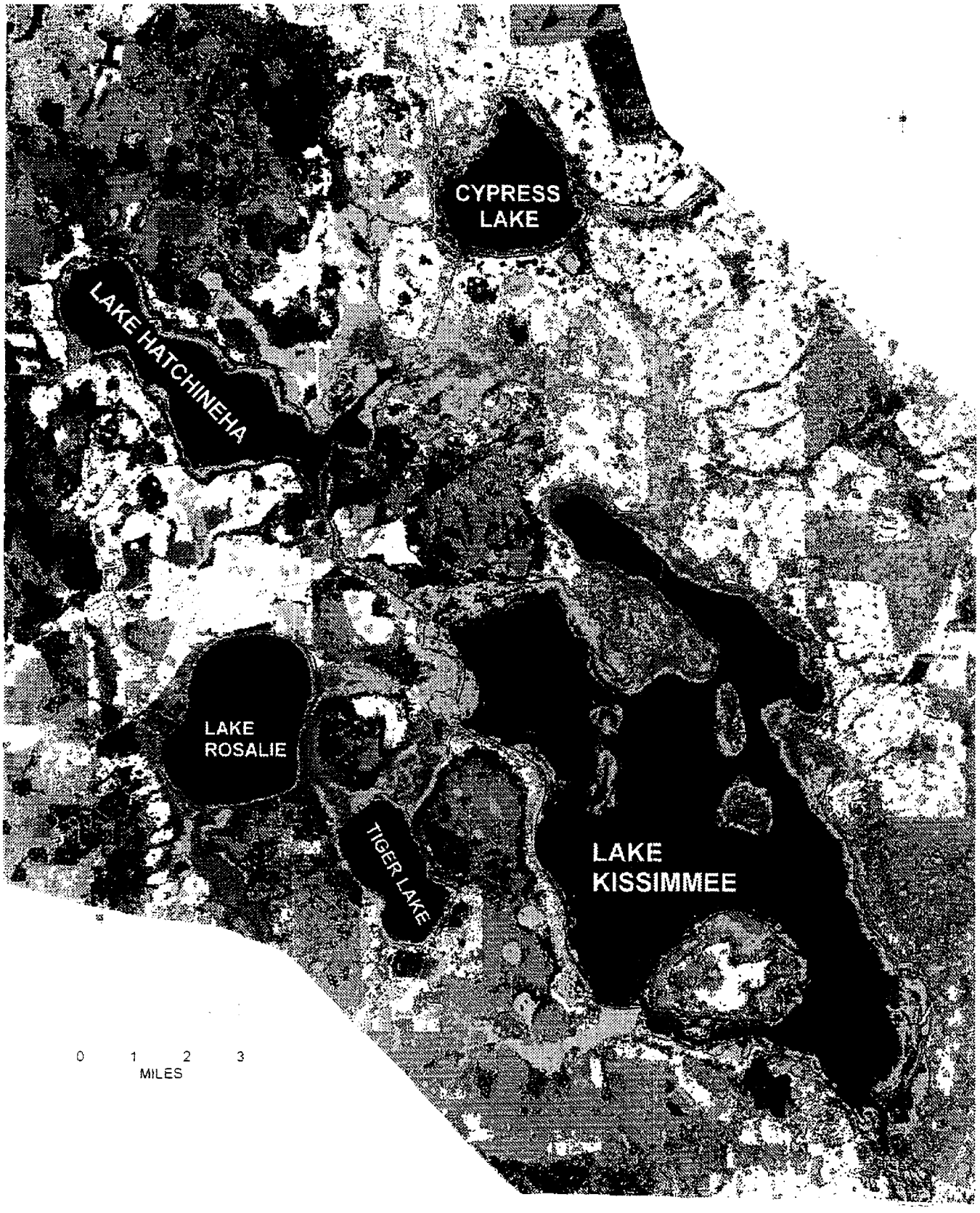


FIGURE 4 - COVER TYPES IN STUDY AREA, KISSIMMEE HEADWATER LAKES
(From FGFWFC classification of 1986 LANDSAT image)

LEGEND FOR VEGETATION CLASSES IN FIGURE 4
FLORIDA GAME & FRESHWATER FISH COMMISSION CLASSIFICATION

- DRY PRAIRIE
- PINELANDS
- SAND PINE SCRUB
- XERIC OAK SCRUB
- MIXED HARDWOOD/PINE FORESTS
- HARDWOOD HAMMOCKS AND FORESTS
- FRESHWATER MARSH & WET PRAIRIE
- CYPRESS SWAMP
- HARDWOOD SWAMP
- BAY SWAMP
- SHRUB SWAMP
- OPEN WATER
- GRASSLAND
- SHRUB AND BRUSHLAND
- BARREN

Additional classes were derived from the 16 classes in the study area, based on National Wetlands Inventory data and projections of future with project conditions, as described below. Although the land cover data distinguishes several categories of woody wetland vegetation, it provides a single category for herbaceous marsh/wet prairie. Duration of flooding and water depth are the main variables used in our analysis of the lake regulation schedules, and the landcover data provide no indication of water regime for the wetlands or open water areas. Therefore, additional data sets, as described below, were used in conjunction with the vegetative cover to assess project effects.

2. Water Routing Model

The Hydrology Section of the Corps' Jacksonville District ran several iterative tests of water regulation schedules. The South Florida Water Management District was the principal designer and initial evaluator of the schedules. The Corps provided historic water level records (1929-42 and 1945-1958), observed conditions (1970-1988), and model outputs from the UKISS water routing model for a series of alternatives.

These data were exported as ASCII files and imported by the Service into a spreadsheet program. The use of these data in the evaluation of general ecological parameters and in species models is summarized in following sections of this report. The two principal variables were water levels in Lake Kissimmee and percent floodplain inundation in the Kissimmee River, which was estimated from discharges from Lake Kissimmee. A major assumption in our analysis is that all the lakes in the study area are treated as a single pool, i.e. water levels are assumed to be at the given level measures or modeled in Lake Kissimmee. In reality, water levels in the peripheral lakes, particularly Cypress, Rosalie, Tiger, and Jackson may be at times perched above the water levels in Lake Kissimmee. However, in the long term, environmental conditions in all the lakes are correlated with regulation of Lake Kissimmee (except for the probable future management of Lake Jackson as a separate entity).

A variety of statistics were extracted from the water records. The general evaluation of alternatives, as described in greater detail in a subsequent section of this report, used daily records, extracted on a seasonal basis, over an 18-year period of record. Where water regulation parameters were used as input in species models, a weekly average over the 18-year period of record was used in most cases, and specific water level variables were extracted from those data. Water elevation in turn had to be referenced to topography to provide a measure of water depth and/or hydroperiod at a given geographic point.

3. Topography and Bathymetry

A reliable topographic data set was not available prior to initiating this analysis. In the Scope of Work for this project, we anticipated that detailed topography (at least to 1-ft

contours, and preferably to 0.5-ft. contours) would be determined by photogrammetry for the entire study area. Certain portions of the study area had already been surveyed in detail, but contracts were not issued to provide detailed surveys of the remainder of the study area. Consequently, significant uncertainty in topography remains, particularly in the area between the three large lakes (Kissimmee, Tohopekaliga, and Cypress) and in the area west and northwest of Cypress Lake.

Despite these data gaps, all available bathymetric and topographic data were assembled from a variety of sources into a single line coverage. The major sources were: bathymetric contours from a 1954 Corps survey, detailed photogrammetric surveys of selected areas, scattered transects by the SFWMD, cross-sections at the major canals from the Corps, and the 55-foot and 60-foot contours from USGS quad sheets. A topographic surface was interpolated from the assembled line coverage using the TIN module in the ARC/INFO program. The resulting 30-meter grid of interpolated values was split into 0.5-ft intervals centered on the contour line. The image was then clipped at the 55-foot contour. Figure 3 shows the resulting map; the map contains some central areas with elevations of 60 feet or above, which are included only for graphic integrity, so as not to show up as "holes". The locations of principal levees in the study area were added. For purposes of the analysis, any elevations above 54 feet are irrelevant, because the effects of the project would not reach above that elevation.

Among the areas lacking topographic accuracy are several significant tracts of low elevation (roughly 52 to 54 feet) located behind levees. The main concern of the Corps and SFWMD has been to minimize the acreage of land acquisition lying below 54 feet. The topographic surveys were generally carried up to the nearest 54-foot elevation around the shore of the lake. Where the surveys encountered a levee at or above 54 feet, the low-lying areas behind the levee were either ignored or not surveyed in adequate detail. However, the Service has attempted to include these areas for possible restoration or enhancement of wetlands if the levees are breached.

4. National Wetlands Inventory

Water regime descriptors from the National Wetlands Inventory were used to supplement the generalized marsh/wet prairie category available from the FGFWFC's Landsat image. Polygons described as temporarily flooded, seasonally flooded, or semi-permanently flooded palustrine emergent wetlands were selected from the 9 quad sheets within the study area. A grid value was assigned as an attribute to each polygon in accordance with the above water regime designations, and the polygons were converted to a 30-meter grid. Any contiguous cells of generalized marsh in the Landsat image were considered to have the same water regime, and any generalized marsh category that did not correspond with a NWI water regime remained as generalized marsh. These marsh categories were used only for wetlands outside the hydrologic influence of the lake shores, i.e. above the 54-foot contour.

B. General Evaluation of Water Regulation Schedules

1. Background of Iterative Testing

Between August 1993 and November 1993, an iterative testing process was conducted using schedules recommended by the South Florida Water Management District (SFWMD). Hydrologists in the Corps' Jacksonville District ran the UKISS hydrologic routing model and provided the results to the SFWMD, the Service, and the FGFWFC for review of the output. Although the SFWMD was the principal designer and reviewer of the schedules, they conferred with all four agencies in a series of meetings to review the model outputs and to fine-tune the schedules. In this iterative process, a total of at least 21 regulation schedules were reviewed. The last two alternatives, T1000HISRR and 400C150RR, were evaluated by the Fish and Wildlife Service, using a series of criteria judged to measure ecologically significant factors. We describe below the theory and assumptions underlying the general ecological evaluation of these schedules and their comparison with the historic (pre-project) condition and the recently regulated conditions (1970-1988).

The primary criterion used by the team members in reviewing the hydrologic outputs was the percent of time that the Kissimmee River floodplain would be expected to exceed a given percentage inundation and the discharge characteristics at structure S-65. This analysis looked at both the percentage of time over the full period of record, and the percentage of time by month, that at least 1%, 15%, 40%, 75%, 95%, or 100% of the floodplain would be inundated. Estimates of the percent floodplain inundation were based on the relationship (in the river's pre-channelization condition) between stages at the Fort Kissimmee station and the extent of floodplain inundation. Stages at Fort Kissimmee were in turn derived from discharges at S-65 modeled for each of the alternative schedules. Evaluation of the effects on the Kissimmee River and comparison of stage exceedence curves for Lake Kissimmee were the basis of the iterative evaluation and re-design of lake regulation criteria.

Because higher water levels in the Kissimmee River floodplain ultimately depend on drainage from the Chain of Lakes, trade-offs must be reconciled. Early in the testing process, it was determined that attempting to provide historic discharges to the Kissimmee River throughout the year would lower the high end of the stage exceedence curves for Lake Kissimmee, relative to the presently regulated condition. As this was considered unacceptable for the Chain of Lakes, the evaluation team continued to seek distribution of discharges for the Kissimmee River in keeping with the typical wet season/dry season pattern characteristic of central and southern Florida, while not lowering the frequency of higher stages in the lakes. To avoid reduction of the higher water levels in the Chain of Lakes, the regulation schedule alternatives were eventually

modified by inserting both a 150 cfs zone and a transitional zone with discharges between 400 cfs and 150 cfs.

2. Assumptions and Description of Community-level Evaluation

Because habitat changes can favor one species and be adverse to another species, species-by-species modeling, as presented in another section of this report, often may identify trade-offs in the effects of a proposal on species of particular concern. This may help wildlife managers set priorities for actions beneficial to a given species or perhaps set limiting factors on the scope of project alternatives if a given alternative is unacceptably detrimental to an important species. However, greater emphasis is now being placed on development of community-level evaluations, especially for measures of ecosystem restoration.

We have used several parameters available from the hydrologic data to assess the overall dynamics and productivity of the last two modelled alternatives, the observed 1970-1987 regulated condition (one using the full record, and another version with the 1977 extreme drawdown excised) and historic conditions prior to regulation. All of the water routing models used inputs from the 18-year period between 1970 through 1987. In evaluating the historic pre-project condition, an 18-year period was selected to keep the evaluation equitable. According to the USGS, regulation of the lakes began in July 1964. The pre-project water records supplied by the Corps were 1929-1958. Because historic records were incomplete in 1943 and 1944, the most recent available full-year periods summing to 18 years were 1939 through 1942 (4 years) and 1945 through 1958 (14 years).

A description of the general evaluation technique and its assumptions follows. The evaluation is divided into two parts -- the first part assesses performance of the observed and proposed hydrologic regimes in the Chain of Lakes, and the second assesses them from the perspective of achieving restoration of the Kissimmee River floodplain.

The present regulation schedule of the lakes has been criticized by wildlife managers as being too restrictive of water levels in a narrow range, without the degree of fluctuation in high and low water levels before regulation. Maintaining water levels within narrow limits has several detrimental effects. Figure 5 shows a graph prepared in 1957 that predicted compression of the elevations at which certain wetland plant species would grow in response to the anticipated more restrictive water regulation following construction of the project. Indeed, water levels are considerably more static today than in the pre-project condition, but we are unaware of any follow-up studies to confirm that such changes have occurred or are in the process of occurring. The most obvious effect is that hydrologic conditions suitable for growth of productive wetland vegetation are concentrated to a narrow band. Areas that used to sustain herbaceous wetlands at higher elevations are now less frequently flooded and/or have been displaced by upland

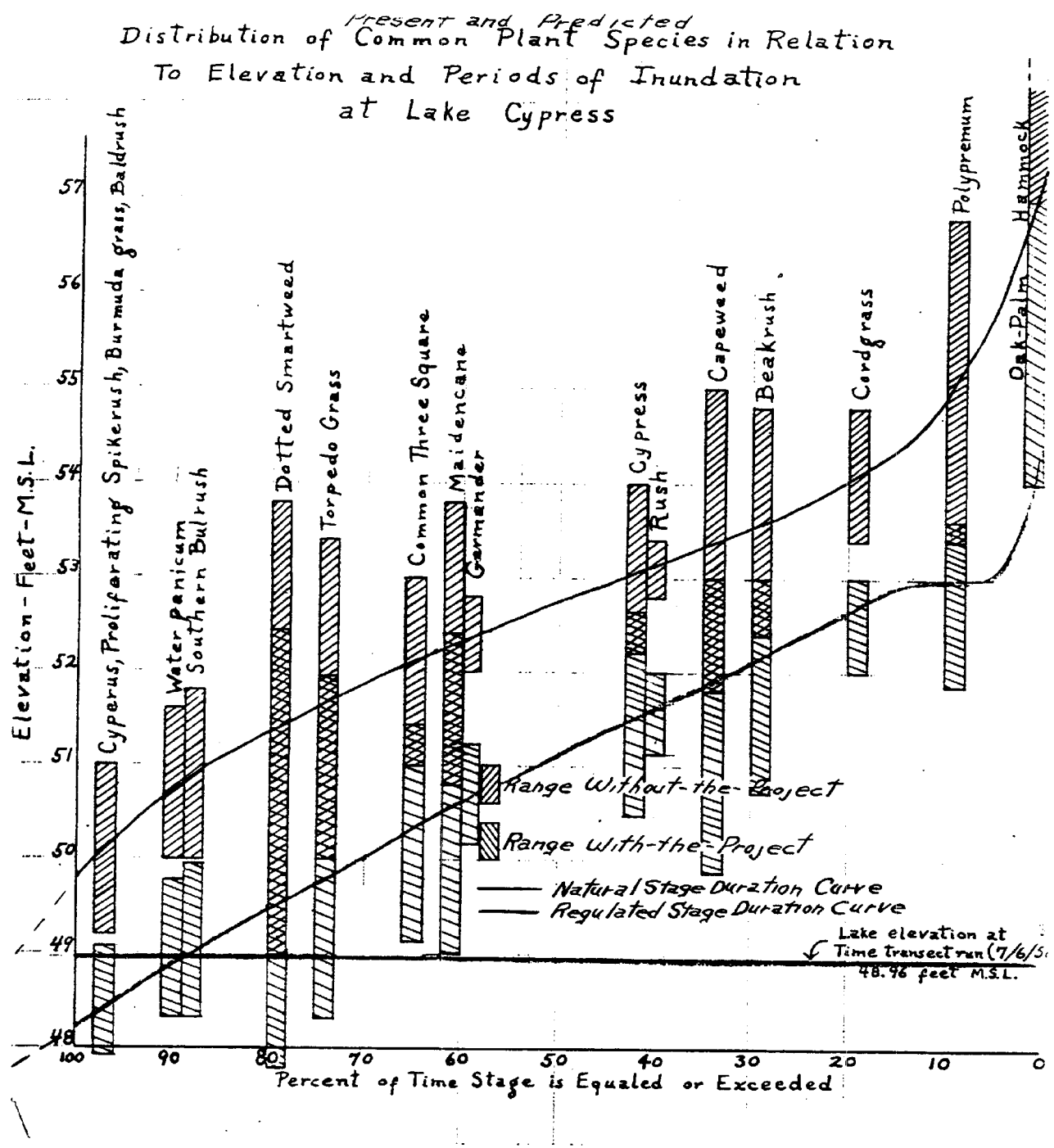


FIGURE 5 - PREDICTION OF CHANGES IN VEGETATION DUE TO REGULATION OF LAKES.
(FROM USFWS' 1957 COORDINATION ACT REPORT)

vegetation. Longer-lived wetland plants such as cypress trees (particularly at Cypress Lake) are now less frequently flooded, and part of the cypress fringe has been lost (Ed Moyer, pers. comm.) Greater fluctuation in water levels expands the distance across which a given species can encounter conditions matching its preferred hydroperiod. Generalist species, including non-native aquatic plants, are expected to dominate in closely regulated conditions, reducing the diversity of the wetland. Therefore, both total area and diversity of wetland vegetation are reduced by the more restrictive water regulation schedules.

Based on the ecological criteria described above, the evaluation assumes that measures of high water periods, routine low water periods, and overall variability in water levels are all indicators of general productivity and health of the lakes.

Screening of the water model outputs for the earlier schedule alternatives was based on inspection of the stage-exceedence graphs. Those alternatives exhibiting higher stages at the upper end of the curve (above the 1970-1988 observed values) were preferred for further consideration. Although this was considered adequate for initial screening of the alternatives, the Service decided to conduct a more detailed analysis of several more refined alternatives in the latter stages of selection. The stage-exceedence curve will only indicate the percent time over the period of record that a certain water level is exceeded; it does not indicate the duration of each occurrence. That is, several one-day or two-day periods of water over 52.5 feet will contribute to the percentage of time exceeding that value in a stage exceedence curve, but these short periods of flooding will have little biological significance. We decided that the average durations of flooding and drying events is more significant, because they will correlate with the suitability of flooded areas as wildlife habitat and with the beneficial effects of routine low water levels.

Three quantitative criteria were examined through use of a spreadsheet program, using the output of the hydrologic models provided by the Corps. The first criterion is the average duration, in days, of water levels greater than 52.5 feet, the presently regulated maximum of the lakes. The second criterion is the average duration of water levels lower than 49 feet, the presently regulated minimum (what we are calling a routine drawdown). The third criterion is the coefficient of variation of the daily records over 18 years, which provides a measure of overall variability of water levels from the mean. All of the above measures were used in the ranking formula as an index of success in achieving restoration in the Chain of Lakes.

Four additional criteria were used to measure performance of the alternatives in achieving restoration of the Kissimmee River. Although the criteria used for the upper basin did not consider seasonality, we considered seasonality important in evaluation of the lower basin. Data for the wet season (June 1 - Oct. 31) and for the dry season (January 1 - May 31) were extracted to separate sections of the spreadsheet throughout the 18-year period of record. Again, the <u>duration</u> of events was considered biologically more

significant than simply the percentage of time over the period of record. (For example, a percentage of time with a certain level of floodplain inundation could consist of many short periods of inundation, but a longer average time period above a certain level of inundation would provide more opportunity for animals to use these areas as habitat.) The spreadsheet accounted for the end of each seasonal period to avoid the possible error of a period that met the criterion erroneously being extended to the next seasonal period. For example, floodplain inundation exceeding 90% until October 31 of one year and picking up again in June 1 of the next year should not be considered a single event of long duration, but rather two separate events meeting the criterion.

We considered it important that the project provide high levels of floodplain inundation during the wet season months (June through October), providing a more natural (i.e. rain-driven) pattern of floodplain inundation. The fourth criterion (first lower basin criterion) measured the average duration, in days, during the June through October wet season when floodplain inundation covered 90% or more of the floodplain. The fifth criterion also started with daily records in the wet season, and measures the duration of periods of very low flow (< 200 cfs). Examination of the model outputs led us to select 200 cfs as indicative of low flow that might lead to adverse conditions in the Kissimmee River; first, 200 cfs is below the level at which water is contained fully within the river banks (0% floodplain inundation) and secondly, periods of less than 200 cfs were found to be relatively infrequent. The wet season months are also the period of high water temperatures, when fish kills due to oxygen depletion are more likely to occur. Oxygen depletion generally occurs during extended periods of no flow or very low flow. High values for this criterion are undesirable and should correlate with a greater risk for harmful situations involving oxygen depletion. The sixth criterion determined the average duration of greater than 25% floodplain inundation in the January - May period. We considered it important that some lower level of floodplain inundation occur in the dryer months, but we felt it would be unrealistic to set a high level of inundation as a goal for this period. The seventh criterion measured the duration of periods with less than 200 cfs flow at S-65 between January 1 and May 31 for the period of record. Although we considered reduction of periods of low flow to be a valid overall goal, we do not consider avoidance of low flow as important in the dry season because water temperatures are lower at that period, and oxygen depletion is less likely.

3. Calculation of Overall Score for Alternatives

A formula was devised to provide an overall ranking of the final two alternatives and to compare these alternatives with the period of record. The preceding section describes the 8 criteria used to calculate the overall ranking. The overall ranking (R) equals the weighting factor (W) for each criterion times the individual ranking value (r) for each criterion, summed across the 7 criteria:

$$R = W_{C1} \times r_{C1} + W_{C2} \times r_{C2} + \ldots W_{C7} \times r_{C7}$$

The individual ranking value (r) for each criterion is a value from 0 to 1, based on the range of values observed for the alternatives and the observed values in the reference periods of record. For criteria 1, 2, 3, 4, and 6, high values are more desirable, and r is calculated as follows:

$$r = \frac{X}{X_{max}}$$

where X_{max} is the highest value for each criterion among the alternatives or the periods of record.

For criteria 5 and 7, lower values are more desirable, and r is calculated as follows:

$$r = 1 - \frac{X}{X_{max}}$$

Evaluation team members assigned weighting factors, based on the following premises that account for institutional priorities::

- The preliminary review of water regulation schedules had already been based on evaluation of the timing and volume of discharges to the Kissimmee River. Although we considered it appropriate to include lower basin criteria in the final selection of a preferred schedule, we decided it was important to give greater weight to the factors originally intended for the Kissimmee Headwater Lakes Revitalization Project -- higher water levels and greater water level fluctuation.

- For the lower basin criteria, we considered that delivery of water to the Kissimmee River during the wet season months was more important than providing floodplain inundation and avoidance of low flow in the dry season.

Therefore, among the 7 criteria, the average number of days with water levels above 52.5 feet (criterion 1) and the overall variability in water levels (criterion 3) were considered most important to the evaluation for the Chain of Lakes, and were assigned a weighting factor of 2. The effects on the lower basin during the dry season (criteria 6 and 7) were considered relatively less important, and were assigned a weighting of 0.5. The other 3 criteria (numbers 2, 4, and 5) were considered to be intermediate in importance, and were assigned a weighting factor of 1.

On February 18, 1994, the four review agencies met in Vero Beach to approve documentation for the evaluation methodology described above. Agency comments were incorporated in the evaluation methodology prior to issuance of the Draft Fish and Wildlife Coordination Act Report.

C. Methods to Estimate Extent and Location of Wetlands to be Restored

1. Introduction

A major benefit of the Kissimmee Headwater Lakes Revitalization Project is the opportunity to restore wetlands that have been degraded or eliminated by too restricted water fluctuations and/or construction of levees holding back water from low-lying areas. An important assumption in our analysis is that the waterward edge of the marsh around the lake shores will not change as a direct result of the proposed change in the water regulation schedule. The rationale for this assumption is that the wetland plants (mainly cattails and bulrushes) at the waterward edge of the marsh are highly tolerant of extended periods of deep flooding. We consider that the outer edge of the marsh would recede in response to higher water levels only if the existing vegetation were drowned out by prolonged periods of extremely high water. However, the higher water levels for the proposed alternative are approximately one half foot higher than at present and are not held high for extended periods of time. In addition to the somewhat higher levels, the proposed schedule would also provide lower average water levels, resulting in greater overall fluctuation. We consider that consistently higher water levels would cause a recession in the waterward edge of the marsh, but since that is not the case, we predict no change for the waterward edge, while the upland edge of the marsh will be extended by the seasonally higher levels, resulting in a net increase in marsh acreage. The following sections describe how we determined the average elevation of the existing marsh/upland edge and how we predicted the extent of additional acreage of wetlands to be restored by the higher water levels.

2. Topographic Range of Wetlands (With and Without the Project)

Two analytical approaches were used to compare the existing extent of wetlands with projected future conditions. The main objective was to determine the elevation at which marshes or wet prairie transition to grasslands or dry prairie. The first analysis (using GIS) centered on delineation of the wetland/upland transition as sensed by the Landsat image used to define vegetative cover in the study area. The second analysis was performed in a spreadsheet program and was based on the regulatory definition for wetland hydrology.

The GIS-based analysis started with the coverages containing the contour lines for the bathymetry and topography of the study area. As previously stated, some areas were surveyed in detail and others were not, requiring extensive interpolation, particularly in low-lying areas distant from lake shorelines. Therefore, we searched for areas where most or all of the 1-foot bathymetric and 0.5-foot topographic contours were present, where these lines ran generally parallel, and where the slope was gradual to better determine at what elevation the wetland/upland transition took place. In this way we intended to select areas with as accurate data as possible and with regularly sloping shorelines (i.e. without islands, peninsulas, embayments or natural berms). We also sought to distribute these areas throughout the study area. However, more complete and accurate contours were available for Lake Kissimmee than for Lake Hatchineha and Cypress Lake, and we avoided selecting areas in Tiger Lake or Lake Rosalie, because these lakes have relatively steep shorelines. Nine areas were selected, drawn in over the contour line coverage, and transferred over the Landsat image. In the Landsat image, we digitized the transition between the marsh/wet prairie vegetation type and the adjacent uplands (usually grassland or dry prairie) in the nine selected sections of shoreline. The resulting lines were rasterized and superimposed on the raster version of the topography/bathymetry. The topographic data used here had been interpolated to 0.1 feet by the SFWMD. We were confident in using this level of interpolation along selected shorelines, but not over the entire study area. (Interpolation to 0.5-foot contours were used for all other GIS analyses, including prediction of future wetland extents and habitat suitability in the species models.) By overlaying the two files, we could determine the elevation of each grid cell along the wetland/upland transition. These data were exported to a spreadsheet and to a statistical program. A total of 395 grid cells were analyzed in the 9 areas distributed geographically as follows: 2 areas in the southern half of Lake Kissimmee; 3 in the northern half of Lake Kissimmee; 2 adjacent to the Short Canal, between Lake Kissimmee and Cypress Lake; 1 at the northern end of Lake Hatchineha; and 1 along the northeastern shore of Cypress Lake. The mean elevation of the upland/wetland transition line on the 1986 Landsat image was 51.96 feet ($\pm$ 0.1, 95% confidence limit).

The current Federal manual for delineation of jurisdictional wetlands uses three diagnostic parameters: vegetation, soils, and hydrology. Our analysis assumes that if suitable hydrology is restored over suitable soils, characteristic wetland vegetation will follow. Consideration of soils enters our analysis later in this section, when we estimate the likely quality of the additional wetlands to be produced by the new water regime. Our spreadsheet-based wetlands analysis, however, considers only the hydrologic criterion, comparing water level readings for the full 18-year period of record for both the selected alternative, 400C150RR, and the observed period of record (1970-1988). By examination of the stage exceedence curve for the preferred alternative, relative to the observed, evaluation team members noted that the two lines crossed at about a 51-foot elevation, and that by "eyeball" it appears that the preferred alternative runs somewhere between a quarter and a half foot higher than the observed (Figure 6). In the section of this report

dealing with the community-level comparison of the schedules, we presented the biological reasoning behind the use of duration of flooding and drying events, rather than the stage exceedence curves, as ecological indicators. The Federal wetlands manual stresses that the duration of continuous periods of inundation and/or saturation is more important in defining wetlands than the total number of days per year with inundation or saturation.

The minimum hydrologic regime for defining wetlands is generally accepted as continuous saturation for at least 5% of the growing season. Assuming that the growing season is year-round in the study area (the most rigorous standard), this equates to 18 days of continuous saturation. In our analysis, we have required 18 consecutive days of water levels at the surface (i.e. saturation) to define suitable hydrology for production of wetlands. We set up a spreadsheet, similar to those used in the general evaluation of the water schedules, that measured the average duration of flooding or drying events. However, rather than measure an average duration above or below a particular elevation, we determined at what elevation (in the 0.01-foot increments provided by the UKISS routing model) the observed and preferred alternative water models produced (on average over the 18-year period of record) saturation of more than 18 continuous days duration. The observed 1970-1988 period had an average duration of 18.2 days saturation at an elevation of 52.19 feet; while the 400C150RR alternative provided an average duration of 19.25 days saturation at 52.87 feet. The 52.19 feet for the observed period is slightly above the elevation where the transition between wetlands and uplands was sensed in the Landsat image, but given the level of precision in the topographic data, they agree quite well, at roughly 52 feet elevation. The difference (52.87 - 52.19 = .68 feet) between the two elevations for the observed and proposed alternative at which wetlands are expected to be produced also generally corresponds with the approximate half-foot difference between the upper ends of the stage exceedence curves for the observed and preferred alternative.

3. Prediction of Future Wetland Conditions

Based on the above figures, we generalized to project the future extent of wetlands under the proposed water regime. Because large portions of the study area lacked detailed topographic contours, extensive interpolation was required, and we were not willing to accept interpolation beyond half-foot intervals. Interpolation to finer increments would be too inaccurate for most of the study area. Therefore, 0.5-foot increments were used for both the projection of future wetland conditions and the species models. We generalized the findings of the previous analysis and assumed that the present upper end of the wetlands is approximately 52 feet and that the future upper end of wetlands would be 52.5 feet. Because the stage exceedence curves cross at about 51 feet elevation, and

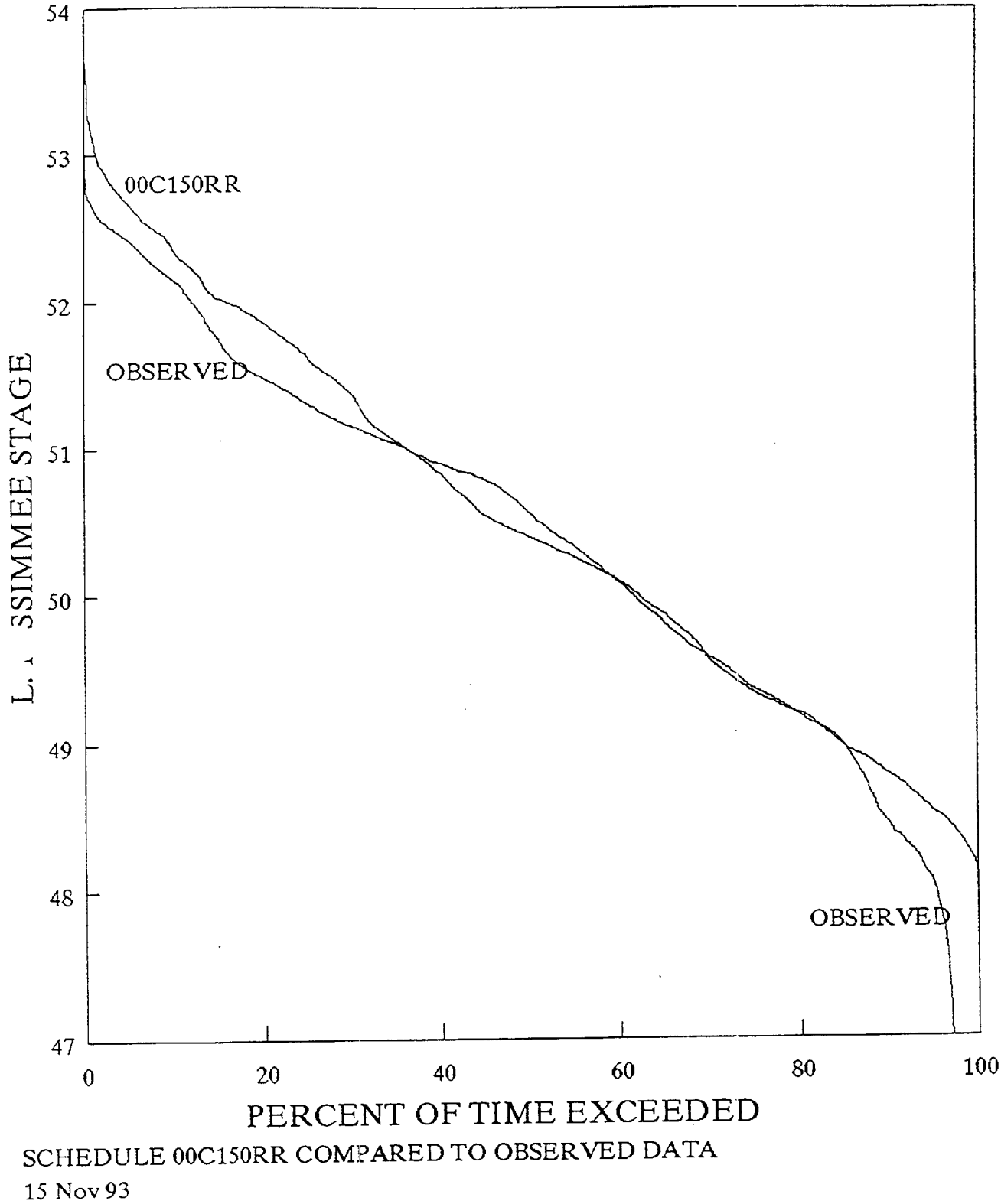


FIGURE 6 - STAGE EXCEEDENCE CURVES FOR OBSERVED PERIOD (1970-1987) AND PROPOSED 400C150 SCHEDULE. NOTE THAT THE PROPOSED SCHEDULE IS ROUGHLY 0.5 FEET HIGHER THAN THE OBSERVED AT WATER LEVELS EXCEEDING 51 FEET.

because the geographic coordinates for the topographic data could be somewhat imprecise, we selected an elevation zone between 51 and 52.5 feet as the zone across which the higher water stages would restore wetlands (hereinafter called the "transitional zone").

Overlaying the present vegetative cover on the half-foot topography, we based our projection of future habitat conditions on several assumptions:

1. All marsh within the transitional zone will remain marsh. (See explanation in subsection a., entitled "Introduction", above.) As would be expected, existing marsh was the dominant vegetative cover in the transitional zone, accounting for 36.9% of the total area in the transitional zone.

2. Open water in this zone most likely indicates deeper water and these areas are expected to remain as open water. However, deep water would not generally be expected to occur along the upper edge of the marsh unless it were excavated and impounded. Indeed, less than 1% of the total transitional zone is open water in the present condition.

3. All shrub or forested wetland classes (cypress swamp, hardwood swamp, bay swamp, shrub swamp) in the transitional zone would not be altered by the change in hydrology. Although the increase in water fluctuation would most likely be beneficial to the productivity of these habitats, we do not anticipate a change in gross habitat structure. These 4 classes combined accounted for 16% of the transitional zone in the present.

4. Xeric communities (oak scrub, sand pine scrub) and hardwood upland covers (hardwood hammocks, mixed hardwood/pine forests) generally should not occur in the transitional zone. Any occurrence of these covers in that zone may be the result of remote sensing errors and/or inaccuracy in the topographic data. These classes remained unchanged in the future scenarios. No sand pine appeared in the zone, and oak scrub was sensed in only 0.37% of the zone.

5. Grasslands and shrub/brushland vegetation types are likely to have invaded areas that were wetlands when water levels were higher prior to operation of the original flood control works in 1958. Field observations confirm that wax myrtle and *Sesbania* are invading former marshes, and wet pasture (which most likely was classified as grasslands, rather than wet prairie) is very common around the lakes in low-lying areas that historically supported marshes. Soils in these areas are most likely amenable to formation of wetlands. We therefore predicted these cover types would be likely to produce wetlands of higher habitat value. Grassland was the second most abundant cover type in the

transitional zone, comprising 22.4% of the total area. Shrub/brush was also quite abundant in the zone, making up 8.3% of the area.

6. Areas sensed as dry prairie, pineland, or barren may be converted to wetlands under the new water regime, but these are considered somewhat less susceptible to conversion than grasslands or shrub/brushland. The distinction between wet prairie and dry prairie is gradual, and pine forests can exhibit understory vegetation grading from upland species, through a mixture of facultative wetland species, to a predominance of facultative or obligate wetland species. Soils in both of these transitional habitats are likely to exhibit patchiness on a finer scale than what is normally portrayed as a map unit by the Soil Conservation Service. Lenses of less permeable layers may be found within an area that was sensed as dry prairie, which normally does not have prolonged saturation within 10 inches of the surface. The distribution of these patches within pinelands or dry prairie is not known on a fine scale; soil distribution, like the remote sensing of vegetative cover, is a probabilistic endeavor. In reality, we will probably end up with patches of upland that will be converted to wetland within areas that will remain essentially unchanged from present conditions. Because our species models multiply area times a relative habitat suitability index (HSI), the results will be equivalent if we ignore this indeterminate patchiness and generalize these areas within the transitional zone as "likely moderate quality wetlands". Dry prairie represented 9.9% of the transitional zone, while pineland and barren classifications amounted to 2.3% and 1.4%, respectively.

Using the above relationships, future habitat conditions were predicted for the base project and the three incremental alternatives involving breaching of levees to allow additional restoration of wetlands.

D. The HEP Team, Evaluation Species, and Features Common to all Species Models

Planning and guidance for the evaluation of the proposed project on selected species of fish and wildlife were provided by the same interagency team (Corps, Service, FGFWFC, SFWMD) that evaluated the water routing outputs to select a recommended water control schedule. The first task of the HEP team was to select the evaluation species. The following species were selected:

1. Great egret
2. Snowy egret
3. Wood stork
4. Florida duck
5. Ring-necked duck

6. Snail kite
7. Bald eagle
8. Florida sandhill crane
9. Audubon's crested caracara
10. Largemouth bass

The above species were selected upon consensus of the HEP team, based on the following factors:

- (Federally-listed species (wood stork, snail kite, bald eagle, caracara);
- Wading birds are considered to be sensitive indicators of ecological integrity (great egret, snowy egret, wood stork);
- Species of economic importance to hunting and fishing (Florida duck, ring-necked duck, largemouth bass);
- A State-listed species that is relatively abundant in the study area as compared to other portions of the State (caracara).

Periodic meetings of the HEP team were held to advise the Service regarding development of the evaluation. The HEP team recommended the appropriate species experts to contact in developing the models. These species experts are cited below in the narratives for each species.

The foundation of the modelling was habitat suitability, similar to the Habitat Evaluation Procedures (HEP), in that we used the convention of assigning a habitat suitability index (HSI) of 0 to 1, multiplying by the acreage at that suitability, and summing these habitat unit (HU) values for each species in each of the future scenarios. However Geographic Information System (GIS) technology was used to develop, test, and run the species models. We used both vector-based GIS (PC ARC/INFO, and Generic CAD) and a raster-based (grid cell) program (EPPL7) to prepare data for use in the models. However, the final model runs were all performed in EPPL7, using a 30-meter grid cell size. By using log files (analogous to a macro file), we could string together a series of GIS commands to automate a routine for each model. Using the search and replace capabilities of Wordperfect on DOS text files, we were able to modify each routine to represent either the present (assumed to be the future without project condition) and a series of alternative future scenarios.

The models were all based on two main themes -- landcover (habitat types) and bathymetry/topography. The bathymetry/topography was, in most cases, mapped in 0.5-foot increments. (Interpolation to 0.1-foot increments was used in one portion of the analysis for the snail kite, as described below.) For marsh/wet prairie above the 54-foot elevation (the prairie wetlands) the National Wetlands Inventory water regime designation was used. However, some marshes of unknown hydroperiod remained as generalized marsh in the prairie. For wetlands in the littoral zone, spreadsheets were used to calculate the hydrologic feature of interest for each species in 0.5-foot increments from the water model outputs. This feature was usually the percent time at a certain water depth of significance to the species for that elevation. (Calculating the percent time when water exceed the substrate elevation, regardless of depth provides the hydroperiod.)

Several of the models used a stepwise approach, assigning an initial habitat suitability to a grid cell, then if a condition in another portion of the model was met at the same geographic coordinate, the model could add, subtract or multiply a value according the model instructions. Because EPPL7 deals only with integers between 0 and 255, we needed to export the grid cell counts as ASCII files to a spreadsheet, standardize the HSI to a 0 to 1 range by dividing the grid cell value by the maximum possible value, and multiply by the corresponding acreage for that class of grid cells.

E. General Information and Model Structure for the Evaluation Species

1. Snowy egret and great egret

Experts consulted: Jim Rodgers, FGFWFC; Brian Toland, USFWS; Herb Kale, Florida Audubon Society

The snowy egret *(Egretta thula)* and great egret *(Casmerodius albus)* are among the wading birds that were severely affected by plume hunters in the early 1900's. More recently, water management practices have reduced the number of breeding birds in the southern Everglades relative to historic records (Ogden, 1994). Closer to the study area, channelization of the Kissimmee River has most likely adversely affected wading birds on a regional level; some reduction of wading bird numbers in the adjacent upper basin is a likely consequence, although we are unaware of any studies documenting this. Neither species is listed by the Federal government; the State lists the snowy egret as a Species of Special Concern. Both species feed and nest in the study area, using colonial wading bird rookeries. Both species use visual hunting methods while stalking their prey in shallow waters.

The models for the snowy egret and great egret are similar in structure. The models have a feeding component and nesting component. The feeding component, in turn, is subdivided into selected littoral zone habitats and all other suitable habitats at higher elevations.

First, we calculated in a spreadsheet the percent time each 0.5-foot elevation zone was flooded with up to 18 inches of water or up to 12 inches of water, using weekly average water levels throughout the period of record for the period between February 1 and July 31, which is considered to encompass the full extent of both species' breeding seasons. These values were calculated for the observed period (excluding the 1977 extreme drawdown) and for the selected alternative. (The depth calculation for a given 0.5-foot elevation band was built into the spreadsheet formulas.) The 12-inch water depth is generalized as the maximum feeding depth for the snowy egret, while the longer-legged great egret can presumably feed in water up to 18 inches deep. (Both species are capable of feeding from floating mats of vegetation, but we think the above generalizations are valid overall.)

Both species are capable of exploiting wetlands of suitable depth across a wide range of hydrologic regimes, and they feed readily in both the littoral zone and the smaller prairie wetlands. Elevation bands in the littoral zone exhibiting suitable water depth for 25% or more of the period of record were assigned highest value, and those with 10%-24.9%, 5%-9.9%, and >0%-4.9% were assigned progressively less suitable values. These frequencies were selected for both ends of the hydroperiod continuum, i.e. those wetlands that are generally too deep except for short periods of time and those that are frequently exposed. Deep water areas that always exceeded the suitable feeding depths are assigned no habitat value.

Habitat classes were overlain on hydrologic suitability to refine and "filter" the values in the littoral zone. Forested and shrub wetlands were assigned low values regardless of where they might occur in the elevation bands. Existing marsh and marsh to be restored in future scenarios that is likely to be of high habitat value was given value in accordance with the graduated scale of hydrologic suitability described in the preceding paragraph. Open water or marsh projected to be likely of moderate value in future scenarios was given reduced value by subtracting a constant from the corresponding elevation band.

Forested and shrub wetlands above the littoral zone were assigned the same low value as for those occurring in the littoral zone. Marshes higher than the selected elevation bands were assigned values in accordance with the water regime attributes from the National Wetlands Inventory data. Temporarily flooded marshes are exploited by these wading birds, but due to their infrequent availability, they were assigned relatively low value, slightly higher than for the forested and shrub wetlands. For seasonally flooded and semi-permanently flooded marshes, size classes were significant in assigning habitat

values. Feeding areas are most accessible around the perimeter of the marsh in the prairies, and wading birds are most often observed feeding near the perimeter. The center of a marsh may not always be accessible to wading birds during periods of high water. Smaller wetlands have a high edge/area ratio. Semi-permanently flooded wetlands were ranked higher than seasonally flooded wetlands, due to the greater time period they are inundated. Within these water regimes, the marshes less than 2 acres in size were rated higher than marshes between 2 and 10 acres, which were rated higher than marshes covering more than 10 acres. In this ranking scheme, semi-permanently flooded wetlands less than 2 acres in size were assigned highest habitat value in areas above the littoral zone, equivalent to the value given the highest rated elevation band in the littoral zone.

The final step in the model introduces the nesting component. The rationale is based on the energetic demands of providing food to nestlings. Bancroft et al. (1994) state:

> When nesting, wading birds are constrained to feed relatively close to the colony site; therefore, successful colonies must be located in areas that provide adequate food for their 10- to 14-week nesting cycle.

The average foraging distance from the rookery varies among species using the same rookery and for a single species among different rookeries (ibid.). We have selected a 7-kilometer radius as an average for both species. Rookery locations, indicating which species occur at each rookery, were available in our GIS data set (originally obtained from the FGFWFC's Non-Game Program). The great egret uses 6 nesting sites in the study area, while the snowy egret uses only one (a colony south of Lake Rosalie supporting nesting of both species). (See Figure 7.) Although the sites of colonial wading bird colonies can shift in response to changing environmental conditions, they are relatively faithful to historic nesting sites (ibid.) We are assuming that the water regulation changes are not so radical as to cause abandonment of a currently used colony or formation of a new colony. In the long term, shifts in colony sites are likely to occur with or without the proposed water regulation schedules. Unfortunately, data are not available on the average number of breeding birds of each species using a rookery. All suitable foraging sites in the study area are used outside the nesting season, and non-breeding birds continue to use all available foraging sites during the nesting season. Therefore, the model retains value for all foraging sites outside the 7-kilometer radius, and doubles the value of all sites within the radius.

In previous versions of wading bird models, we have used slightly different models for wading birds that incorporated an 800-meter radius around nesting colonies where no development should occur to avoid disturbance of the nesting colony. Fortunately, none of the present nesting colonies are within 800 meters of proposed canal widening or the S-65 water control structure, the only structural aspects of the this project. Therefore, the 800-meter disturbance radius has been dropped from the models for this evaluation.

2. Wood stork

Expert consulted: Jim Rodgers, FGFWFC

The wood stork *(Mycteria americana)*, a large long-legged wading bird, is Federally-listed as an endangered species. The species breeds in Georgia and as far north as coastal South Carolina, but the majority of the United States population resides in peninsular Florida. The colonial nesting sites are located in both estuarine coastal areas and in freshwater sites at inland portions of Florida. Wood storks are considerably more conservative than other wading birds, such as herons and egrets, in the persistence of traditional nesting colonies. Two rookeries have persisted in the study area for many years, one at Reedy Creek and one on the south shore of Lake Rosalie. Another large rookery (230 nests) was discovered by Dr. Rodgers from a 1993 aerial survey north of Lake Hatchineha, near the Dead River.

Wood storks use thermal drafts to reach high altitudes before they depart from the vicinity of the rookery in search of food. Their daily feeding range is large, up to 80 miles from the rookery (Ogden et al. 1978). This means that nesting storks can readily reach any suitable nesting areas within the study area from any of the nesting colonies in the study area or from several outside the study area. For this reason, distance of potential foraging sites from nesting colonies was not included in the wood stork model. This differs from the models used for the egrets. The Fish and Wildlife Service has established guidelines for protection of wood stork colonies from disturbance (Ogden, 1989). As with the egret colonies in the preceding models, structural works associated with this project are not expected to occur within the primary or secondary zones. Therefore, the primary and/or secondary zones, which would most likely be used in a generalized species model, were not included in this application.

Aside from the lack of a multiplier accounting for proximity of foraging sites to nesting colonies, the wood stork model is structured the same as the models described above for the two species of egrets. However, the relative habitat values assigned to the wetland classes and the bathymetric zones were altered to reflect the difference in feeding ecology between the stork and the egrets. Unlike the visual hunting techniques of the egrets, the stork uses a tactile or "grope-feeding" strategy. The stork is more dependent on fish as prey, is less able to exploit recently flooded areas, and prefers wetlands that are drying down after a more prolonged period of inundation, where fish are concentrated. Storks feed in the littoral zone of the lakes primarily when receding water levels isolate pools behind berms along the shoreline. Linear rises, which may represent ancient beaches, are readily visible along the lakes, particularly Lake Kissimmee. However, in order to determine precisely at what water levels such isolated pools are formed or rejoined with the main part of the lake by rising water levels, detailed bathymetry/topography on the order of 0.1-foot contours would be needed (Rodgers, pers. comm.). Such detailed contours are not available for the lakes. In general, the

isolated wetlands in the prairie are much more frequently used by storks than the littoral zone.

In view of the above, the preferred bathymetric zones identified for the stork were more narrow than for the egrets and were assigned only a moderate maximum habitat value when compared with the maximum possible value in the prairie. The upper end of the preferred littoral zone occurred where flooding up to 18 inches depth occurred at least 10% of the period of record; any elevations higher than this were considered to be flooded at a frequency that would not allow full exploitation by the prey base, and would be less subject to concentration of prey during receding water levels. Any wetlands situated at elevations above the 10% cut-off zone, up to an elevation of 52.5 feet, were assigned relatively low habitat value. The lower end of the preferred bathymetric zone was also considered more restrictive for the wood stork, and was set at that contour at which the preferred depth occurred at least 3% of the time. Although storks are known to use the littoral zone during extreme drawdown events (Rodgers, pers. comm.), we assumed that such events are infrequent enough so as not to affect the overall habitat suitability for the stork.

As noted above, the preferred wetland types in the prairie were assigned maximum values more than twice the maximum value in the littoral zone to reflect the species' preference to feed in those areas. Because storks prefer a seasonal drying to concentrate prey, seasonally flooded wetlands were rated higher than semi-permanently flooded wetlands, which also distinguishes this model from the models for the herons. While the egret models focused on the higher edge/area ratio of the smaller prairie wetlands, the stork model assumed that prairie wetlands less than 2 acres in size would be less suitable for storks than wetlands 3-10 acres or those over 10 acres. The reasoning is that storks are more able to exploit the lower central areas of the larger wetlands, which have concentrated prey from a larger initial area, and that the prey in these initially larger wetlands is also more likely to be of a size suitable for capture by wood storks.

3. Florida duck

Experts consulted: Paul Gray, FGFWFC; Brian Toland, USFWS

The Florida duck is considered to be a separate subspecies of the mottled duck *(Anas fulvigula)*. It is a year-round permanent resident through most of peninsular Florida and is important as a game species.

The Florida duck breeds primarily between mid-March and mid-May, but will attempt renesting through July. Nesting occurs in a variety of covers, including dense grass or dense shrubs in uplands near the water's edge or even in agricultural fields. (Kale and Maehr, 1990) Tall upland grasses and the borders of agricultural fields are abundant

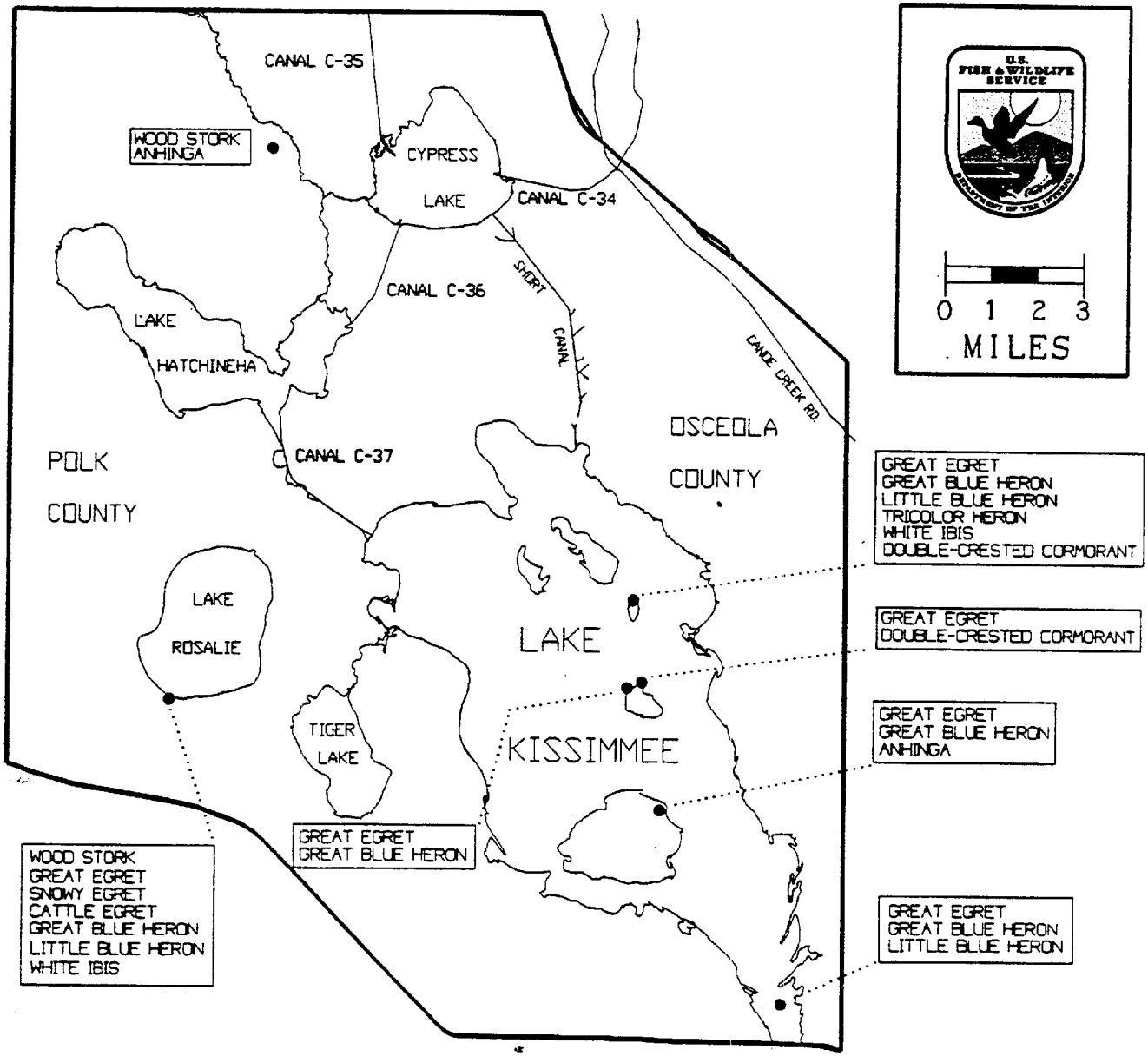


FIGURE 7 - SPECIES OF WADING BIRDS NESTING AT ROOKERIES IN STUDY AREA

around the Kissimmee Chain of Lakes, and because the species can use several different cover types for nesting, we consider nesting habitat not to be a limiting factor. Paul Gray concurs that suitable nesting habitat probably is abundant in the study area,particularly since nesting can occur as much as a mile from water. Also, the cover type data produced by FGFWFC are the principal basis of the models, and these data do not distinguish between tall grasses and grazed or mowed areas.

Based on the likely non-limiting nature of breeding habitat in the study area, we have limited the habitat suitability model to account only for feeding habitat. Florida ducks dabble in shallow waters. Similar to the wading bird models, we used a spreadsheet to determine the percent time the 0.5-foot depth contours were flooded with water up to 18 inches deep. A dabbling duck is considered to have a somewhat narrower preference for wetlands of slightly longer hydroperiod than the snowy egret or great egret, because the latter two species have broader diets and are more able to exploit recently flooded, shorter hydroperiod wetlands. Therefore, we selected those contours with 0-18 inch depths for 25% or more of the period of record as highest initial suitability. Elevations below the previously designated range of elevations and having appropriate water depth for 10-24.9% of the period were assigned moderate initial suitability. Areas within 90 meters of the marsh/open water edge and within the suitable depth zones were given twice the initial value, while the remainder of the suitable depth zones retained their initial values. The resulting values were "filtered" for the appropriate categories in the landcover layer: marsh or open water; any unsuitable landcover types were assigned no value. Finally, for elevations above the littoral zone, any open water, or semi-permanently flooded marsh larger than 2 acres, or undifferentiated marsh was given a relatively low suitability value.

4. Ring-necked duck

Experts consulted: Brian Toland, USFWS

The ring-necked duck *(Aythya collaris)* is the most abundant species of wintering waterfowl in both the upper and lower Kissimmee basins and is an important game species. The ring-necked duck arrives in late October and remains in the Kissimmee lakes region through the end of March (B. Toland, pers. comm.); it does not breed in Florida. During fall migration, ring-necked ducks begin arriving in Central Florida in October and remain in the Kissimmee Lake region into March. This species does not breed in Florida.

Ring-necks are classified as diving ducks and typically feed in waters less than 6 feet deep (Bellrose, 1980.) Traditionally in Florida, ring-necks use deep marsh habitats characterized by floating-leaved and aquatic-bed types of wetland vegetation. Seeds of fragrant water lily and watershield are considered preferred foods. In recent years, the

distribution of ring-necked ducks appears to be determined primarily by the presence and abundance of "topped-out" hydrilla beds. The location of *Hydrilla* mats around the shorelines of the lakes varies considerably from year to year, and the natural fluctuation is compounded by active aquatic weed control efforts. (D. Eggeman, pers. comm.) Therefore, no particular segment of shoreline can be predicted to be of greater value for feeding of ring-necked ducks, except for the physical characteristics of slope. That is, a greater or lesser area of the appropriate depths for feeding of diving ducks will be found along the lake shore, depending on slope, and the alteration of lake levels may also slightly alter the area of suitable water depths.

The model for this species is greatly simplified because of the nature of migratory species to respond to year to year variations in the location of food resources. First, we extracted weekly average water levels for the observed period and the selected alternative during the October through March period the species is expected to be present. The spreadsheet calculates the percent time for each 0.5-foot bathymetric zone that water depth would be between 3 and 7 feet. High initial suitability was assigned to those bathymetric zones having suitable depth more than 50% of the period of record, while those zones with suitable depth between 25% and 49% of the time were ranked slightly lower in suitability. If grid cells in these bathymetric zones coincide with cells within 60 meters of the open water/marsh edge, they were assigned double their initial value. All open water cells retained these values, while all cells in the original landcover that were sensed as marsh were reduced by a fixed value.

5. Florida snail kite

Experts consulted: Jim Rodgers, FGFWFC; Brian Toland, USFWS; Rob Bennetts, Univ. of Florida

The Florida snail kite, or Everglades kite, *(Rostrhamus sociabilis plumbeus)* is listed as endangered by both the Federal and State governments. Once widespread through peninsular Florida, the species' range in the United States has been reduced to an area from just south of Orlando to the southern Everglades. Around 1964, the Florida snail kite population was estimated to be as low as 25 to 60 individuals. Although population estimates have consistently exceeded 400 birds since the 1980's, the 1964 estimate clearly indicates that the species is highly vulnerable.
Natural cycles in rainfall produce fluctuations in both mortality rates and reproductive success. The "boom or bust" fluctuations in the species' population levels are to some extent part of the natural history of a species with specialized habitat needs. However, human modification and manipulation of the natural hydrologic fluctuations could put the snail kite at risk of extinction if adverse actions were to occur coincidentally at several of the essential habitat sites, particularly during a prolonged period of drought.

The study area is located near the north-central limits of the species' range and is one of several essential areas for the survival and recovery of the species. The study area does not include Lake Tohopekaliga or East Lake Tohopekaliga, the two northernmost principal breeding areas for the kite. However, Lake Kissimmee (and to a lesser extent, the other lakes in the study area) is an essential nesting and feeding area for the species.

The kite feeds exclusively on apple snails *(Pomacea)*. The snails must be located at or near the water's surface, which requires the presence of some emergent vegetation. However, dense vegetation is not suitable as a feeding area, because the snail kite feeds by sight. Therefore, the kite requires a delicate balance between open water areas and emergent vegetation to feed effectively.

Snail kites exhibit a high level of nest failure and abandonment, and research on the species has been unable to determine all the causes of this phenomenon. However, water levels appear to account for at least a portion of the relative success or failure of breeding years. Obviously, extreme drought will result in a poor reproductive year. This is not only due to a reduction in food availability, but also to shifting of nest site selection in response to lower water levels. Even moderate year-to-year differences in water levels in Lake Okeechobee have been shown to affect nesting success (Rodgers, 1992). Several researchers have observed that kites will build more nests on herbaceous vegetation closer to the center of water bodies when water levels are low, and they will build more nests on woody vegetation closer to the periphery of the water body when water levels are higher. Dr. Rodgers has demonstrated a significant correlation between higher water levels, nesting in shrubs, and successful fledging of kites at Lake Okeechobee (ibid.). His observations at Lake Kissimmee suggest that the same correlation applies there. Presently, nearly all kite nests in Lake Kissimmee are in herbaceous vegetation. Nests built on herbaceous vegetation (usually cattails) are subject to being toppled over by wave action, by wind storms, or when water supporting the cattails recedes. When kites nest in woody vegetation, shrub swamps, primarily willow or wax myrtle, are the principal nesting sites; however, nests can occasionally be found in sapling cypress or even cabbage palms. Nests built in woody vegetation are much more secure and exhibit higher success. Although we cannot be certain that higher water levels in Lake Kissimmee during the February-March early nesting period would induce a higher percentage of kites to nest in woody vegetation, the evidence is compelling.

We have taken several approaches to determine the possible effect of this project on the snail kite. First, we needed to be assured that the proposed water regime did not increase the likelihood of abrupt declines in water level during the nesting season. Kites select nesting sites over water, and if the water completely dries out beneath the nest site, increased rates of nest collapse and/or predation generally occur. We used a spreadsheet to calculate when extreme drops in water level would occur in the kite nesting season. First, we extracted February through July weekly average water levels from the 17-year period of record (excluding 1977). Assuming initiation of nest construction over water

1.5 feet deep (a typical average), the water level should not drop more than 1.5 feet in the preceding 6-week period. Such an extreme drop is highly detrimental to kite nesting, and the spreadsheet confirmed that it occurs infrequently. Any abrupt human-induced removal of water of this magnitude could be considered an "incidental take" of snail kites as described in Section 7(b)(4) of the Endangered Species Act. In the observed period (excluding 1977) 94% of the weeks in the February-July period were suitable by this criterion. For the selected 400C150RR schedule, 96% of the weeks were suitable. Therefore, the normal operational schedule (excluding periodic extreme drawdowns for fishery habitat development) for the selected alternative should not pose any additional risk of "take", and possibly reduce its likelihood.

The second assessment we performed involved average water levels near the beginning of the nesting season. According to Dr. Rodgers' research, higher initial water levels in the February-March period in Lake Okeechobee lead to more successful nesting. His observations indicate that higher water levels at that time induce kites to nest at interior portions of the littoral zone, rather away from the disturbance of boat traffic and more likely in woody vegetation rather than herbaceous vegetation. We extracted February-March weekly average water levels and averaged them across the 17 years of record for the observed period and the selected alternative. The observed period (again excluding 1977) had an average water level of 50.57 feet, while the selected alternative had an average water level of 50.36 feet in that period. (Although the selected alternative raises water levels roughly 0.5 feet on an annual basis, that rise apparently does not occur during the February-March period when snail kites normally select net sites.) This 0.2-foot difference is quite small, and was found not to be statistically significant ($P=0.261$); the number of weekly average values compared was 138 weeks. Despite the lack of statistical significance, we proceeded to determine what a 0.2-foot difference would mean in the area of marsh and shrub marsh that would be theoretically available to the kites for nesting. We used the 0.1-foot interpolation of bathymetry produced by the SFWMD and the areas of documented kite nesting in the study area. This limited the area of interest to a narrow band, mostly around Lake Kissimmee, where nearly all of the kite nesting has occurred. The area of marsh below the February-March average water level for the present condition is 2850.8 acres, and for the future condition with the selected schedule, it would be 2809.9 acres. The area of shrub swamp is 1040.1 acres, and for the future with the selected alternative, it would be 1009.2 acres. If we assume that shrub swamp is twice as valuable as marsh for successful kite nesting, and compare the relative availability of nesting habitat, we find that the future with the proposed schedule would provide approximately 98% of the nesting habitat of the present condition. Although this change is, as expected, quite small, we reduced the values produced in the snail kite model by 2% to account for this potential change in nesting suitability. Despite this downward adjustment, the results of the overall habitat suitability model still indicate a significant increase for the proposed schedule (See later section of this report.)

The above analyses indicate that nesting suitability is not likely to change substantially. Therefore, the emphasis of the model used in this analysis was on foraging habitat suitability. We first identified bathymetric zones with suitable hydrology for production of apple snails. Apple snails need long hydroperiod wetlands; drying of occupied habitat will force kills the snails to aestivate, and extended drying may kill them. Therefore, we eliminated shorter hydroperiod wetlands as suitable habitat. Using daily water level readings from the 17-year period of record, we determined at what elevation inundation averaged 80% of the time period. The observed hydrology and the selected alternative were essentially equivalent, both rounding off to an elevation of 49 feet. This was designated in the present and all alternative futures as the upper end of suitability for kite foraging. To determine the lower end, we determined the percentage of time for inundation up to 2 feet deep, selecting those where this condition exceeded 25% of the period of record. We determined that for the observed values, the lower end of this zone occurred at 48 feet, while for the selected alternative, this occurred at 47.5 feet.

Similar to the Florida duck model (both these species prefer shallow waters with a mix of marsh and open water), we selected an area within 90 meters of the border of marsh and open water. Considering that the satellite image classifies an area as either open water or marsh, the kite's preferred 30%-40% open water/emergent vegetation mix is likely to occur in this edge zone. The initial suitability value for the bathymetric conditions described in the previous paragraph was doubled if the marsh/open water edge zone coincided at that grid cell, otherwise the initial value was retained. Next, we determined the interspersion marsh/open water in the original satellite image; those having high values indicated a predominance of marsh in a 5-cell window, and those having low values indicated a predominance of open water. By discarding the upper 25% and lower 25% of resulting values, we selected those areas with an interspersion of marsh and open water. Where these cells coincided with the previous suitability values, the values were doubled, otherwise the values were retained. Finally, where the resulting values coincided with known nesting areas the values were again doubled. As with the egret models, foraging habitat within a short distance of the nest is considered more valuable.

6. Bald eagle

Experts consulted: Steve Nesbitt, FGFWFC; Herb Kale, Florida Audubon Society

The bald eagle *(Haliaeetus leucocephalis)* is listed as endangered in Florida by both the Federal government, and as threatened by the State; the Service is currently considering "down-listing" the eagle from endangered to threatened in Florida and other portions of the species' range. Given that the number of nesting eagles has increased in Florida over the last few years, if the eagle is to be reclassified as threatened, Florida is a likely State for that designation. The banning of DDT in 1972 is thought to be a major factor in the partial recovery of the species, but this positive factor is countered by continued

destruction of wetlands and Florida as a whole, and especially the study area, is a stronghold for the species, exhibiting the greatest concentration of breeding pairs in the United States, outside of Alaska. However listing as threatened would still provide protection under the Endangered Species Act, and eagles are also covered under the Bald Eagle Protection Act (16 U.S.C. 668-668d)

As of 1993, Osceola County had 81 active bald eagle nesting territories concentrated in the upper Kissimmee Chain of Lakes, with a cluster of active nests (OS25, OS26, OS27) on Brahma Island in Lake Kissimmee. Polk County had 80 active bald eagle territories in 1993, with most of them close to the Kissimmee Chain of Lakes. Figure 8 shows the location of active eagle nests (as of 1992) in the study area. Future land use patterns around the Kissimmee Chain of Lakes are crucial to the continued recovery of the species on a National scale. The breeding pairs of eagles in the study area may include some year-round resident birds, but the majority are migratory pairs that come to Florida to breed in the winter months.

The species model for the bald eagle selects habitat types within 2 miles of the active (as of 1992) bald eagle nests in the study area. Two miles encompasses the majority of foraging flights from a nest site (Bureau of Land Management, 1973). As with the wading bird rookeries, the eagles show fidelity to certain territories, but over the long term, nesting sites will change. The nests are generally located at some distance from the shorelines of the lakes in prominent pine trees or cypress trees. We do not anticipate that the change in water schedules will have a direct impact on selection of nest trees.

In the vicinity of the Kissimmee Chain of Lakes, fish comprise about 80% of the eagle's diet. Most of these are "rough fish" such as gizzard shad and catfish (Nesbitt, pers.comm.) A variety of other prey items, including small mammals and birds, comprise the remainder of the species' diet. Many of the birds taken by the eagle are "upland" birds, such as crows and cattle egrets. Although aquatic birds, particularly coots and gallinules, are occasionally taken as prey, we estimated that they would contribute no more than 10% of the diet. Therefore, we ranked open water, regardless of depth, as highest habitat value. Semi-permanently inundated marsh over 3 acres in size and undifferentiated marsh were assigned habitat value at one tenth the value of open water, and all other non-forested native cover types were assigned one twentieth the value of open water. Most foraging flights by bald eagles during the nesting season occur within 2 miles of the nest tree (BLM, 1973). We therefore selected the habitat types mentioned above within 2 miles of all active nesting trees in the study area, updated to 1992.

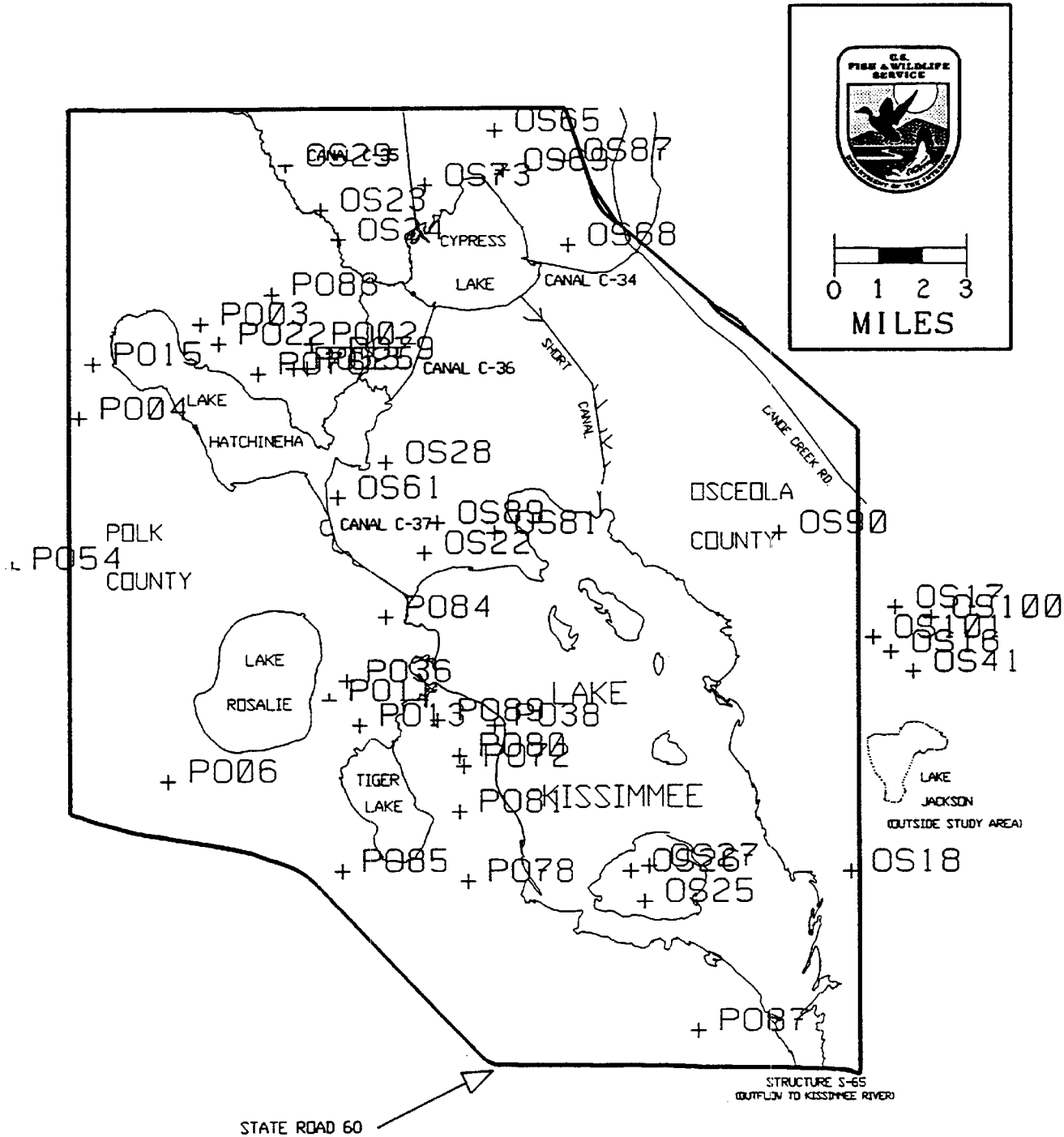


FIGURE 8 - LOCATION OF ACTIVE BALD EAGLE NESTS IN STUDY AREA

7. Sandhill crane

Expert consulted: Steve Nesbitt, FGFWFC

The sandhill crane *(Grus canadensis)* is represented in Florida by two subspecies, the non-migratory Florida sandhill crane *(G. canadensis pratensis)* and the greater sandhill crane *(G. c. tabida)*, which migrates to Florida in late fall through early winter. When both subspecies are present, it is difficult to distinguish between them by casual observation. The Florida subspecies is listed by the State of Florida as threatened; the Service has listed the Mississippi sandhill crane subspecies as endangered, but the Florida subspecies is not Federally-listed.

Sandhill cranes mainly use open grasslands and marshes as feeding areas. The species model assigns highest habitat values to grasslands. Marshes were assigned a range of moderate habitat values, and for those portions of marshes within a 2-cell distance of a border with grasslands, habitat values were increased by adding a constant value.

8. Audubon's crested caracara

Expert consulted: James Layne, Archbold Biological Station

Audubon's crested caracara *(Polyborus plancus audubonii)* is listed by the State and Federal governments as threatened. Layne (1985), based on 1973-1978 surveys, found about 150 active territories (300 adults) and about 100 immature birds, for an estimated total population between 400 and 500 individuals in Florida. Layne (pers. com.) finds that the total population and range of the Florida population has remained stable since the 1980's.

The Florida population is restricted to open grassland and palmetto north and west of Lake Okeechobee. It is geographically isolated from other populations of the subspecies, which are found in northern Baja California, southwestern Arizona, southern Texas south to Panama, and also in Cuba and the Isle of Pines.

The caracara is an opportunistic feeder on both living prey and carrion, combining characteristics of predatory raptors and vultures. The caracara competes with the latter for carrion.

The study area is roughly the northern limit of the Florida population's documented range, as it is rarely observed north of Orlando. Within the study area, the Three Lakes Wildlife Management Area, located near the southeastern corner of Lake Kissimmee, is highly valuable habitat, but all suitable habitat types in the study area are considered in the model.

Native grasslands, the preferred habitat for the caracara, are extremely scarce in Florida. Most of this habitat has been converted to improved pasture, sod farms, citrus groves, or commercial/residential areas. Although caracaras can use improved pasture for feeding, it is suboptimal habitat. Continued operation of large ranches in the Kissimmee prairie, particularly those ranches with large tracts of native rangeland is critical to the continued survival of the caracara. Other land uses, such as housing or groves will not support caracaras in the long term. Fire is used as a management tool on larger tracts of native rangelands. Lack of fire in remnant native prairies on smaller private lands may be adversely affecting caracara habitat. Native grasslands and saw palmetto thickets in dry prairies are fire-maintained communities. Caracaras will use areas with widely separated trees, but if they succeed to denser stands of pine, oak, or cabbage palm, they become less suitable.

The model assigns highest suitability to dry prairie, and slightly less suitability to grasslands. Marshes were assigned values below the grassland, with less permanently flooded areas superior to longer hydroperiod marshes, both in the littoral zone and in the prairie.

Finally, the model uses known caracara territories digitized from maps provided by Dr. Layne. These maps display the estimated extent of caracara territories in the study area for the period 1984-1988. These are the most recent data providing the borders of the territories; surveys in 1989 show only the estimated centers of territories. Because caracaras are known to have restricted ranges, the presence of habitat in recently occupied territories was heavily weighted in the model. Suitable habitat within documented territories was assigned triple the initial value, while the remaining potential habitat in the study area retained its original habitat value.

9. Largemouth bass

Expert consulted: Ed Moyer, FGFWFC

The largemouth bass *(Micropterus salmoides)* is a common species in Florida's natural lakes and in quarry lakes and other borrow areas. Its original distribution was in the southeastern United States, but it has been widely introduced throughout the United States. A Florida subspecies is recognized as *M. salmoides floridanus* (Ramsey, 1975). It is economically very important in Florida's freshwater sport fishery.

The population dynamics of the largemouth bass in the Kissimmee Chain of Lakes most likely depend on a complex combination of physical and biological factors. It is virtually impossible to derive a complete species model for the bass within the timeframe of this study, and water level fluctuations, the main variable in the evaluation of this project, would comprise only one portion of a complete model.

Layher and Maughan (1987) attempted to predict occurrence and standing crop of green sunfish in Kansas streams, based on physical aspects of the habitat and water chemistry, but found their models were not reliable predictors. They were able to better predict occurrence and standing crop of several fish species having more restrictive habitat requirements, and they postulated that the green sunfish models failed because of the difficulty in determining limiting variables for a species with broad tolerance for a variety of habitat conditions. The largemouth bass also has very broad habitat tolerance that makes predictive modeling difficult; complex predator/prey interactions may be more significant, but harder to discern, than physical habitat parameters.

Stuber et al. (1982) published an HSI model for largemouth bass in lakes that included 4 life requisites, described by combinations of 17 variables. The data collection requirements for this model are considerable; and even so, the authors conclude that, "these models will not necessarily represent the population of largemouth bass in the study area." They suggest that the models be used to compare the potential of different water bodies to support largemouth bass. In the present evaluation, the Chain of Lakes is assumed to be a single flat pool, which is close to reality.

Baca et al. (1992) studied 11 Dade County quarry lakes for largemouth bass populations and calculated an array of HSI values. However, they did not provide conclusions as to which of the variables best correlated with the quality of these lakes as bass habitat.

We have decided to use the HSI model by Stuber et al. as a basis for our analysis in terms of the relative contribution of variables to the model as a whole; however specific measures were altered to better fit Florida lakes. Because a wide range of physical attributes (e.g. turbidity, water temperature, dissolved oxygen) are expected to be unaffected by the project, we have used only those variables that would be affected, and have assigned them a relative weight in accordance with their contribution to the outcome of the published model. For example, the percentage of the lake's area less than or equal to 6 meters deep is used as a variable two times out of a total of 14 variables. However, virtually all the area of water in the study area is less than 6 meters deep. Most of the spawning of largemouth bass in these lakes occurs between 3 and 6 feet deep (Moyer, pers. comm.) Therefore, we assigned highest suitability to this depth range, using the present water schedule and the proposed. We selected the 0.5-foot bathymetric zones where water is 3-6 feet deep more than 50% of period of record. Slightly lower suitability was assigned to higher bathymetric contours, up to a maximum where water 0-1 ft deep is present more than 20% of the time. Still lower suitability was assigned to the deeper portions of the lake where water over 6 feet deep is present more than 50% of the time. The model then selected cells of open water within 60 meters of the marsh/open water edge; a constant value was added to the base value for those cells.

Water fluctuation appears in three of 14 variables in the Stuber et al. model. However, it appears that much of the interest in water fluctuation in the model deals with avoiding

abrupt declines in more northerly steep-sided reservoirs. This is not a concern in the study area, where vast areas of shallow water are available, and flood control operations normally do not drop lake levels so quickly as to threaten spawning throughout the lake (Moyer, pers. comm.) As stated in our general analysis of the water schedules, greater fluctuation is considered to be an improvement over the current situation. We used the coefficient of variation of the current and proposed schedules, compared to the historic as an indication of lake dynamics.

The anticipated changes in the depth zone and water variability parameters discussed above were multiplied by a factor reflecting the contribution of these variables to the model as a whole. This was done to account for the fact that most of the physical factors in the model would not be altered directly by the schedule change. For the depth zone, this factor was 2/14, or 0.143; for the overall variability in lake levels, this factor was 3/14, or 0.214.

VIII. DESCRIPTION OF FISH AND WILDLIFE RESOURCES

A. Existing

The littoral zones of the lakes are the focus of this study and are among the significant resources in the Kissimmee River Basin. The distribution of plants is intricate and is a result of history of inundation, fire, grazing, nutrient input and soils. Flooding stage and duration is the dominant influence on composition.

The fluctuating waters portion of the littoral zone is important for overwintering waterfowl, which stop at these lakes during southward migrations. Coot, ring-necked duck, baldpate, pintails and blue-winged teal are the principal species. The native Florida or mottled duck also feeds in the shoreline marshes and breeds in the prairie within the study area. The common snipe is also present in these areas in the fall and winter months.

The littoral zone supports a wide variety of wading birds, including common and snowy egrets, great blue heron, tricolor heron, little blue heron, limpkin, and others. White and glossy ibis also feed here. These species are dependent on forage fishes produced in the littoral zone.

The largest consumptive use is the fishery. Based on creel data collected by the FGFWFC, effort expended fishing Lake Kissimmee over a five-year period (1987-1991) averaged 451,582 hours per year (Moyer et al., 1992).

The only creel survey in Lakes Hatchineha and Cypress was conducted in the spring of 1986. The total fisherman effort was 40,832 hours at Hatchineha and 18,007 hours at Cypress Lake (Moyer et al., 1986). As a comparison, fishermen in Lake Kissimmee fished for 213,921 hours during this same spring quarter (February 21, to May 15, 1986). Lakes Rosalie and Tiger are also popular with fishermen, but no creel census has been conducted on these waters.

The principal species sought by anglers on Lake Kissimmee is the largemouth bass. Bass anglers exerted 59% of the total fishing effort over five years (1987-1991). For the same period, black crappie and bream fishermen comprised 24% and 17% of the recreational effort, respectively. Miscellaneous species, such as channel catfish, brown bullhead, spotted sunfish and chain pickerel were also targeted at times. (Moyer et al., 1992).

Similar to Lake Kissimmee, fishermen in Lakes Hatchineha and Cypress spend most of their time fishing for bass, followed by crappie and various bream species (Moyer et al., 1986). However most fishing on Lake Tiger and Lake Rosalie is open water fishing for black crappie and bream.

Kingfisher Maps, Inc. has published a map of recreational areas and marinas with boating facilities (map entitled "Kissimmee Chain South"); they list 17 facilities within the study area. Hunting, fishing, airboating, and wildlife observation provide a significant proportion of the economy in this area.

The alligator is a dominant reptile in the region. The alligator scavenges for carcasses of birds and hunts for fish in the deep water canals and ponds within the marsh zone.

B. Future Without the Project

In the absence of the proposed project, we do not anticipate major changes in the fish and wildlife values for either the Kissimmee River or the Kissimmee Chain of Lakes. We assume the Corps will continue maintenance and operation of the navigational and flood control works. We also expect that the SFWMD and the Department of Environmental Protection (DEP) will continue programs for aquatic weed control.

The Corps and the SFWMD have confirmed with their model runs that the restoration goals for the Kissimmee River would not be adequately achieved under the present regulation schedule for the Chain of Lakes. The Kissimmee River would provide the limited fish and wildlife productivity as it does today without the restoration project. Compared to historic conditions, a great percentage of habitat values would remain lost.

In the upper basin, we believe the future would be similar to the recent past (1970's - 1990's). With or without the change in water schedules, extreme drawdowns will need to be scheduled to counteract the effects of narrow lake regulation and nutrient inflows.

Although urbanization is rapidly spreading southward from the upper end of the Chain of Lakes, near the towns of Kissimmee, St. Cloud, and the Greater Orlando Metropolitan Area, these activities are generally to the north of the study area. The infrastructure in the study area is not capable of supporting intensive residential or industrial development, and most likely will remain as such for several decades. We anticipate the dominant economic activities in the study area -- cattle ranches, sod farms, other agricultural enterprises, and recreation will continue to predominate in the study area.

IX. DESCRIPTION OF SELECTED PLAN

The selected 400C150RR schedule has been selected as the best available balance of benefits to restoration of the Kissimmee River and increased vitality of the aquatic ecosystem in the Chain of Lakes. The selected schedule differs from the present in that it has a maximum water elevation for flood control purposes of 54 feet, rather than 52.5 feet. It also delivers water to the Kissimmee River more on the basis of availability, rather than a fixed target elevation.

Current estimates by the SFWMD indicate that approximately 18,500 acres need to be purchased around the lakes to allow raising of water levels for this project, and about 4,750 acres had been purchased through 1991. The Service is recommending in this report that additional areas be purchased behind three levees surrounding the lakes. For purposes of this study, the Corps has asked that the Service consider that fee title or easements will be obtained on all lands to be reflooded.

The Corps' original estimation called for widening C-35 from a bottom width of 20 feet to 40 feet; C-36 from 60 feet to 80 feet; and C-37 from 90 feet to 160 feet. Since that time, the Corps has recommended doubling the present discharge capacity of water control structure S-65 (the outlet for Lake Kissimmee). As of this date, the Corps has now revised its canal widening plans to the following:

- Maintenance dredging of C-35; no widening
- Widening of C-36 from a present bottom width of 48 feet to a bottom width of 60 feet
- Widening of C-37 from a present bottom width of 70 feet to a bottom width of 90 feet

X. DESCRIPTION OF IMPACTS

The selected 400C150RR water regulation schedule more closely approximates a rain-driven formula, by varying discharges in accordance with water availability in the Chain of Lakes and seasonal rules more in accordance with the normal wet/season dry season rainfall pattern of Central and South Florida. This provides distribution of flows to the Kissimmee River closer to the seasonal patterns in the historic condition, while also providing greater fluctuation in the Kissimmee Chain of Lakes.

The increased storage capacity of the selected alternative relative to the present regulation will expand littoral zones around the lakes. The methodology to determine the anticipated increase in marshes at the upper end of the littoral zone is described in Section VII.C. of this report. Section XI.B. provides the results of our analysis.

The estimated increase in littoral marshes, in turn, causes changes in habitat suitability for the evaluation species. Section VII.D. of this report provides general information and a narrative of the model structure for each species. The results of our analysis are found in Section XI.C. of this report.

The Corps has stated that all spoil material will be disposed within the existing right-of-way. However, some native habitat, particularly wetlands are present within the right-of-way. We expect the Corps to make every effort to accommodate the spoil not only within the right-of-way, but also on existing spoil piles. If some filling of wetlands is determined to be unavoidable in the detailed design phase of this project, the Service recommends that the Corps identify appropriate compensation for any unavoidable losses of wetlands.

Table 2 indicates the potential impact of widening the canals if spoil material cannot be completely disposed on existing spoil mounds. The analysis assumes that fill would be disposed 30 meters (98 feet) beyond the existing toe of fill along the entire east side of C-36, and that fill would extend 60 meters (197 feet) beyond its present extent along the entire east side of C-37. These figures should be considered as the likely maximum possible impact of this construction; we recommend the Corps make every effort to dispose the spoil on existing spoil mounds.

XI. EVALUATION AND COMPARISON OF THE SELECTED PLAN AND EVALUATED ALTERNATIVES

A. Results of Community-level Evaluation

Table 3 summarizes the results of the community-level analysis described in Section VII.B.2. of this report. After the initial screening of alternatives, the study team narrowed the selection to two final alternatives, and this quantitative comparison was used to select between these. The table is divided into two areas; the top area compares the last two alternatives for which routing models were run by the Corps. The bottom area provides a comparative framework, relative to the historic (pre-project, 1939-1942 & 1945-1958) condition and the recent regulated condition (observed, 1970-1988). In a previous section of this report, we stated that comparison of the modelled alternatives with the observed condition may not be appropriate, because none of the models contained an extreme drawdown, which would deviate from the normal operational rules. Therefore, we have provided both the observed period of record and the period of record without the 1977 drawdown as bases of comparison. The agencies have agreed in principal that a periodic drawdown will be superimposed on the normal operational rules for the selected alternative.

The historic condition exhibits the most desirable values for 5 of the 7 criteria. The average number of days duration with greater than 90% floodplain inundation in the wet season is slightly higher for the 400C150RR alternative than for the historic, but this difference is not statistically significant (P=0.95). The 400C150RR alternative also exhibits shorter durations, on average, of low flow conditions in the wet season than the historic. Both of the modelled alternatives appear to improve on the recent (1970-1988) regulated condition of the lakes. The 400C150RR alternative rated slightly more desirable than the T1000HISRR alternative for 5 of the 7 criteria. Despite the selected 400C150RR alternatives' slightly shorter duration of water levels above 52.5 feet, it still produces a higher overall score than the T100HISRR alternative. The duration of water levels over 52.5 feet was assigned the highest weighting; however the 400C150RR alternative exhibited duration of routine drawdowns (water levels < 49 ft.) approaching those of the historic condition and greater overall variability, which resulted in its overall higher ranking.

TABLE 2 – MAXIMUM POTENTIAL EFFECT ON HABITATS FROM WIDENING C-36 (BETWEEN CYPRESS LAKE AND LAKE HATCHINEHA) AND C-37 (BETWEEN LAKE HATCHINEHA AND LAKE KISSIMMEE) (WORST CASE SCENARIO; ACTUAL IMPACT COULD BE MUCH LESS)

LAND COVER CLASSIFICATION	ACRES AFFECTED BY C-36 WIDENING	ACRES AFFECTED BY C-37 WIDENING
GRASSLAND	8.0	17.5
SHRUB & BRUSH LAND	0.4	7.5
BARREN	0.0	2.2
TOTAL NON-NATIVE	8.4	27.2
MARSH / WET PRAIRIE	13.3	38.8
SHRUB SWAMP	2.0	21.9
CYPRESS SWAMP	0.2	4.9
HARDWOOD SWAMP	0.0	2.0
BAY SWAMP	0.9	0.4
TOTAL WETLANDS	16.4	68.0
MIXED HARDWOOD/PINE	0.0	4.4
HARDWOOD FOREST	0.0	2.0
PINELANDS	0.7	2.4
DRY PRAIRIE	1.6	1.1
OAK SCRUB	0.4	0.7
TOTAL NATIVE UPLANDS	2.7	10.6

Note: For C-36, analysis assumes spoil material would be deposited 30 meters beyond existing toe of spoil mounds along entire canal length.

For C-37, analysis assumes spoil would be deposited 60 meters beyond toe of existing spoil mounds.

TABLE 3 -- RANKING OF THE FINAL TWO WATER SCHEDULE ALTERNATIVES

		CRITERIA						
TOTAL SCORE	ALTERNATIVE	CRIT. 1	CRIT. 2	CRIT. 3	CRIT. 4	CRIT. 5	CRIT. 6	CRIT. 7
4.66	400C150RR	23.3	85.3	2.60	77.3	38.2	102.9	90.4
4.11	T1000HISRR	24.9	63.1	2.57	70.8	52.5	80.7	71.9

COMPARABLE VALUES FOR HISTORIC AND 1970-1988 OBSERVED

		CRITERIA						
TOTAL SCORE	PERIOD OF RECORD	CRIT. 1	CRIT. 2	CRIT. 3	CRIT. 4	CRIT. 5	CRIT. 6	CRIT. 7
7.07	Historic (1939-42; 1945-58)	64.3	87.5	4.35	76.5	50.3	114.9	4.0
2.90	Observed (1970-88)	4.9	38.7	3.08	31.0	56.4	50.3	41.4
2.56	Observed, w/o '77 drawdown	4.9	29.6	2.41	30.9	53.1	49.9	38.0

NOTE: REFER TO TEXT FOR EXPLANATION OF CRITERIA AND THE CALCULATION OF THE TOTAL SCORE

CRITERION 1 = Average duration (days) water levels exceed 52.5 ft. (Positively correlated, with weighting factor = 2)

CRITERION 2 = Average duration (days) water levels below 49 ft. (Positively correlated, with weighting factor = 1)

CRITERION 3 = Coefficient of variation of water levels over 18-year period. (Positively correlated, with weighting factor = 2)

CRITERION 4 = Average duration (days) with greater than 90% floodplain inundation in the wet season (June 1 - Oct. 31). (Positively correlated, with weighting factor = 1)

CRITERION 5 = Average duration (days) with less than 200 cfs flow at S-65, in the wet season. (Inversely correlated, with weighting factor = 1)

CRITERION 6 = Average duration (days) with greater than 25% floodplain inundation, Jan. 1 - May 31. (Positively correlated, with weighting factor = 0.5)

CRITERION 7 = Average duation (days) with less than 200 cfs flow at S-65, Jan. 1 - May 31. (Inversely correlated, with weighting factor = 0.5)

Based on the Service's presentation of these figures to the Corps and SFWMD at an interagency review conference in Jacksonville on January 24, 1994, the agencies concurred that the 400C150RR alternative is preferred and that species models would be run using this alternative.

B. Prediction of Future Wetland Conditions

Table 4 and Figure 9 summarize the results of the analysis to predict the extent and location of additional wetlands to be generated by various alternative futures. In viewing Figure 9, one should be aware that all of the additional wetlands landward of the levees can be realized only if these areas are added to the SFWMD's acquisition plan and the levees are breached.

TABLE 4 -- ESTIMATION OF WETLANDS TO BE RESTORED BY RAISING HIGH WATER LEVELS, KISSIMMEE HEADWATER LAKES

DESCRIPTION OF ALTERNATIVE FUTURES	ADDITIONAL WETLANDS TO BE PRODUCED (ACRES)	
	LIKELY HIGHER QUALITY WETLANDS	LIKELY MODERATE QUALITY WETLANDS
Future with project, but without breaching of levees	3827	2112
Additional increment by breaching Hatchineha levee	1001	27
Additional increment by breaching Cypress levee	146	20
Additional increment by breaching Kissimmee levee	45	58
Basic project and all 3 levees breached (sum of above acreages)	5019	2217

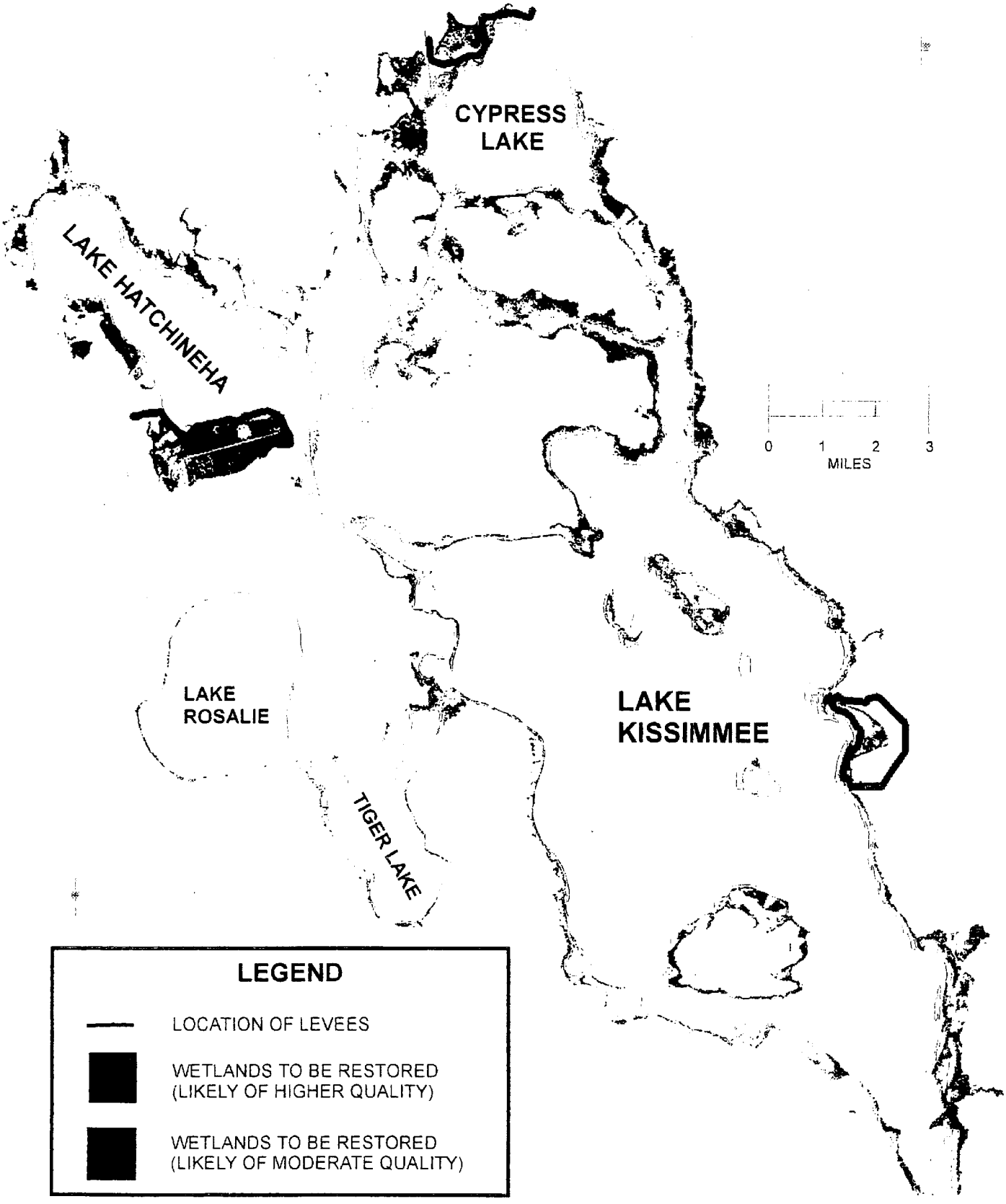


FIGURE 9 - ESTIMATION OF WETLANDS TO BE RESTORED BY HIGHER WATER LEVELS KISSIMMEE HEADWATER LAKES, IF ALL THREE LEVEES ARE BREACHED.

Of the possible total of 2217 acres of moderate quality wetlands that could be produced if all three levees are breached, 1616 acres would be generated in what is now classified as dry prairie, 369 acres in pineland, and 231 acres in barren areas. Of the possible total of 5019 acres of higher quality wetlands to be restored, 3663 acres would be converted from present-day grasslands and 1356 acres from shrub/brushland.

If all three levees are breached, the full potential of 7,236 acres of restored wetlands would be realized.

Breaching the levee south of Lake Hatchineha would produce the greatest benefits of the three additional increments, providing a 17% increase over the basic project in all possibly restorable areas, and more importantly, a 26% increase over the basic project in the acreage of the most readily restorable cover types. Breaching the levee north of Cypress Lake and the levee on the eastern shore of Lake Kissimmee (south of Overstreet Landing) would provide significant additional acres of wetland restoration, but not as great a percentage increase over the basic project as would the Hatchineha levee increment.

C. Results of Species Models

Tables 5 and 6 summarize the results of the species models; the first table expresses the values in terms of habitat units, while the second table expresses the percent change of each future scenario versus the future without the project (assumed to be equivalent to the present).

Six of the 10 species exhibit significant increases in habitat availability; these are the Florida duck, ring-necked duck, great egret, snowy egret, and wood stork. The predicted 2% increase in suitability for the largemouth bass may not be significant, particularly since we assumed that water quality parameters would remain constant with or without the project. Also, a periodic extreme drawdown has such a great beneficial effect for bass (compared to the relatively small differences between the normal operational rules), it would overwhelm any small changes in routine operation. The project is not predicted to have a significant effect on the caracara, bald eagle, and sandhill crane.

Habitat unit values should not be interpreted to reflect abundance of a species, and a given percent increase in habitat units does not imply prediction of a proportional increase in population. Increases in availability of habitat will most likely translate to increases in population, but the degree of effect on relative abundance will vary greatly from species to species. Low habitat unit totals can be the result of a species' narrow selectivity for certain habitat conditions and/or the relative abundance of its preferred habitat type(s) in the study area. For example, the relatively low habitat unit values for

TABLE 5 -- HABITAT UNITS (ACRES X HSI) FOR FUTURE WITHOUT PROJECT AND ALTERNATIVE FUTURES

SPECIES	FUTURE WITHOUT PROJECT	ALT. FUTURE 1 (PROP. SCHEDULE)	ALT. FUTURE 2 (HATCH. LEVEE)	ALT. FUTURE 3 (CYP. LEVEE)	ALT. FUTURE 4 (KISS. LEVEE)	ALT. FUTURE 5 (FULL RESTORATION)
Florida duck	6755	8792	9090	8809	8804	9119
Ring-necked duck	11516	15015	15015	15015	15015	15015
Snail kite	659	839	839	839	839	839
Great egret	17619	20810	21356	20880	20895	21509
Snowy egret	13943	15878	16387	15948	15922	16501
Wood stork	16491	18172	18273	18217	18206	18353
Largemouth bass	38174	38937	38937	38937	38937	38937
Bald eagle	31827	32031	32088	32039	32036	32102
Sandhill crane	63452	63505	63230	63472	63515	63208
Crested caracara	41486	41652	41618	41655	41649	41618
ALL SPECIES	241923	255630	256832	255811	255818	257201

Notes:
Alt. Future 1 = Adoption of proposed water regulation schedule only.
Alt. Future 2 = New water schedule, with breaching of levee south of Lake Hatchineha.
Alt Future 3 = New water schedule, with breaching of levee north of Cypress Lake.
Alt. Future 4. = New water schedule, with breaching of levee east of Lake Kissimmee.
Alt. Future 5. = New water schedule, with breaching of all three levees.

TABLE 6 -- PREDICTED CHANGES IN AVAILABILITY OF SUITABLE HABITAT FOR THE ALTERNATIVE FUTURES

(Expressed as percent increase or decrease, relative to future without project condition, throughout study area.)

SPECIES	ALT. FUTURE 1 (PROP. SCHED.)	ALT. FUTURE 2 (HATCH. LEVEE)	ALT. FUTURE 3 (CYP. LEVEE)	ALT. FUTURE 4 (KISS. LEVEE)	ALT. FUTURE 5 (FULL RESTORATION)
Florida duck	30.2	34.6	30.4	30.3	35.0
Ring-necked duck	30.4	30.4	30.4	30.4	30.4
Snail kite	27.3	27.3	27.3	27.3	27.3
Great egret	18.1	21.2	18.5	18.6	22.1
Snowy egret	13.9	17.5	14.4	14.2	18.3
Wood stork	10.2	10.8	10.5	10.4	11.3
Largemouth bass	2.0	2.0	2.0	2.0	2.0
Bald eagle	0.6	0.8	0.7	0.7	0.9
Sandhill crane	0.1	-0.4	0.0	0.1	-0.4
Crested caracara	0.4	0.3	0.4	0.4	0.3
ALL SPECIES	5.7	6.2	5.7	5.7	6.3

Notes:

Alt. Future 1 = Adoption of proposed water regulation schedule only.

Alt. Future 2 = New water schedule, with breaching of levee south of Lake Hatchineha.

Alt Future 3 = New water schedule, with breaching of levee north of Cypress Lake.

Alt. Future 4. = New water schedule, with breaching of levee east of Lake Kissimmee.

Alt. Future 5. = New water schedule, with breaching of all three levees.

the snail kite and the Florida duck reflect these species' foraging preferences in a narrow band of marsh/open water fringe around the lakes with suitable hydroperiod and water depth. However, because the effects of the project are restricted to the littoral zone, both species show a relatively high percentage increase in habitat availability in the future with project scenarios. The high habitat unit totals for the caracara are the result of large areas of grasslands and moderate amount of dry prairie in the areas above the littoral zone. However, because only the upper end (short hydroperiod) of the littoral zone was scored as moderate habitat suitability for this species, the project has a relatively minor effect on habitat availability in the entire study area. The caracara is a relatively uncommon bird, so this well illustrates that it is incorrect to interpret the habitat unit values as a measure of abundance.

Figures 10 through 14 illustrate examples of the geographic distribution of habitat suitability and predicted change in habitat suitability. We have selected the great egret and the snail kite for these illustrations because other species that exhibit change in habitat suitability as a result of the project show similar patterns.

Figure 10 shows the habitat suitability for the great egret for the basic restoration plan (adoption of the proposed regulation schedule, but without breaching the three levees around the lakes). Note that although the highest habitat values are in the littoral zone, the great egret can use a wide range of wetland habitats both in the littoral zone and in the prairie wetlands that are elevated above the normal water fluctuation in the lakes. As stated previously in the description of the methodology, this provides an estimation of the relative importance of the water regulation changes in the context of the surrounding landscape.

Figure 11 shows the changes in great egret habitat suitability for the basic restoration project, expressed as percent change relative to the future without the project. Notice that although some areas show moderate declines in suitability, larger areas show either moderate or great increases in habitat suitability. The largest percentage increases generally occur along the eastern shoreline of Lake Kissimmee, around Brahma Island, and near Sturm Island. Moderate increases occur over much larger areas in the area between the three major lakes and around Lake Hatchineha. The net gain in habitat units for the great egret with the basic restoration plan is about 18% over the future without the project.

Figure 12 shows the predicted changes in great egret habitat suitability relative to the future without the project, if all three levees around the lakes are breached. The arrows point to the areas behind the levees where additional habitat will be generated, relative to the basic restoration plan (without breaching the levees).

The output for the snowy egret and wood stork vary in their details, but the same general pattern holds for those species as for the great egret.

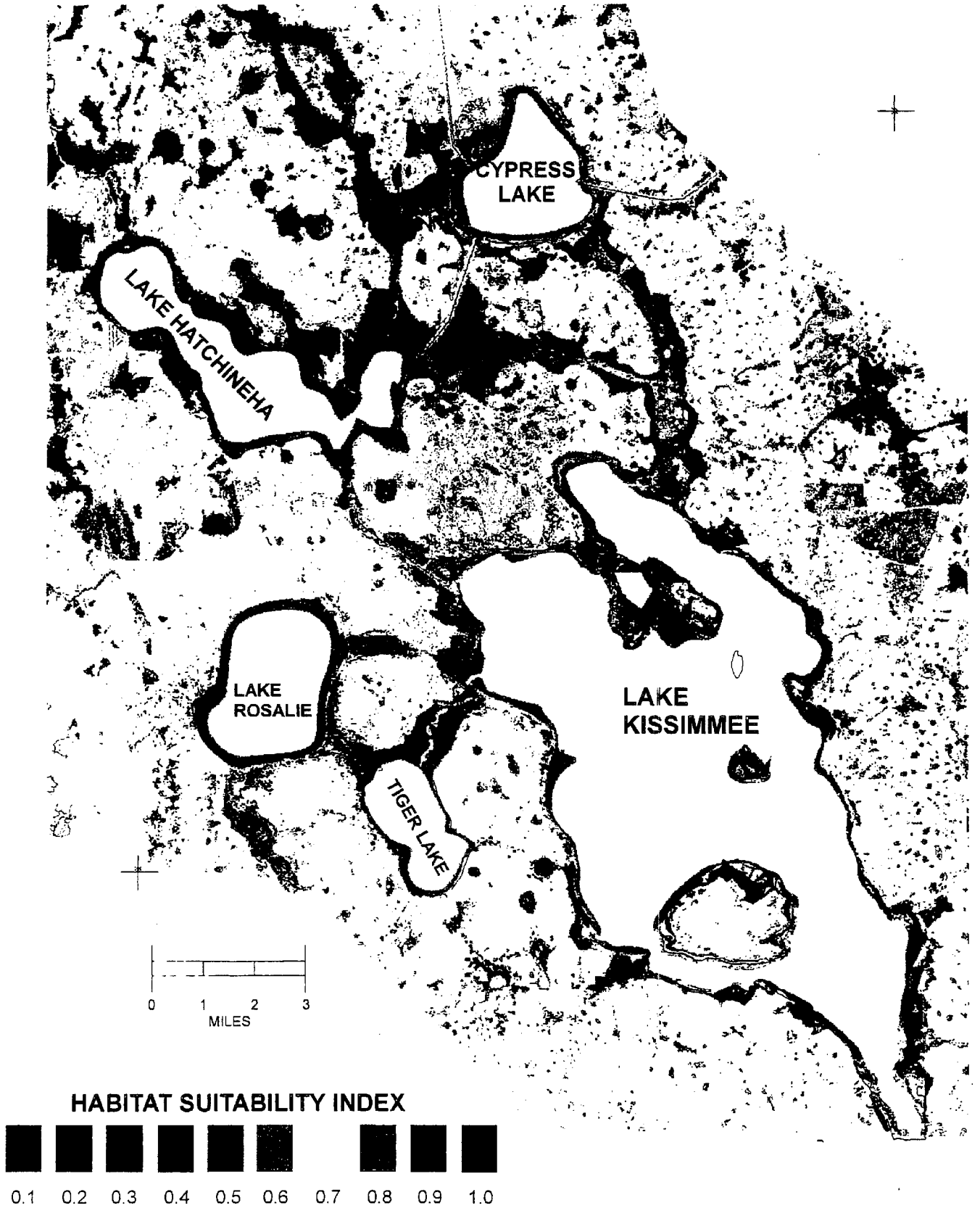


FIGURE 10 - GREAT EGRET HABITAT SUITABILITY, FUTURE WITH BASIC RESTORATION PLAN (No breaching of levees)

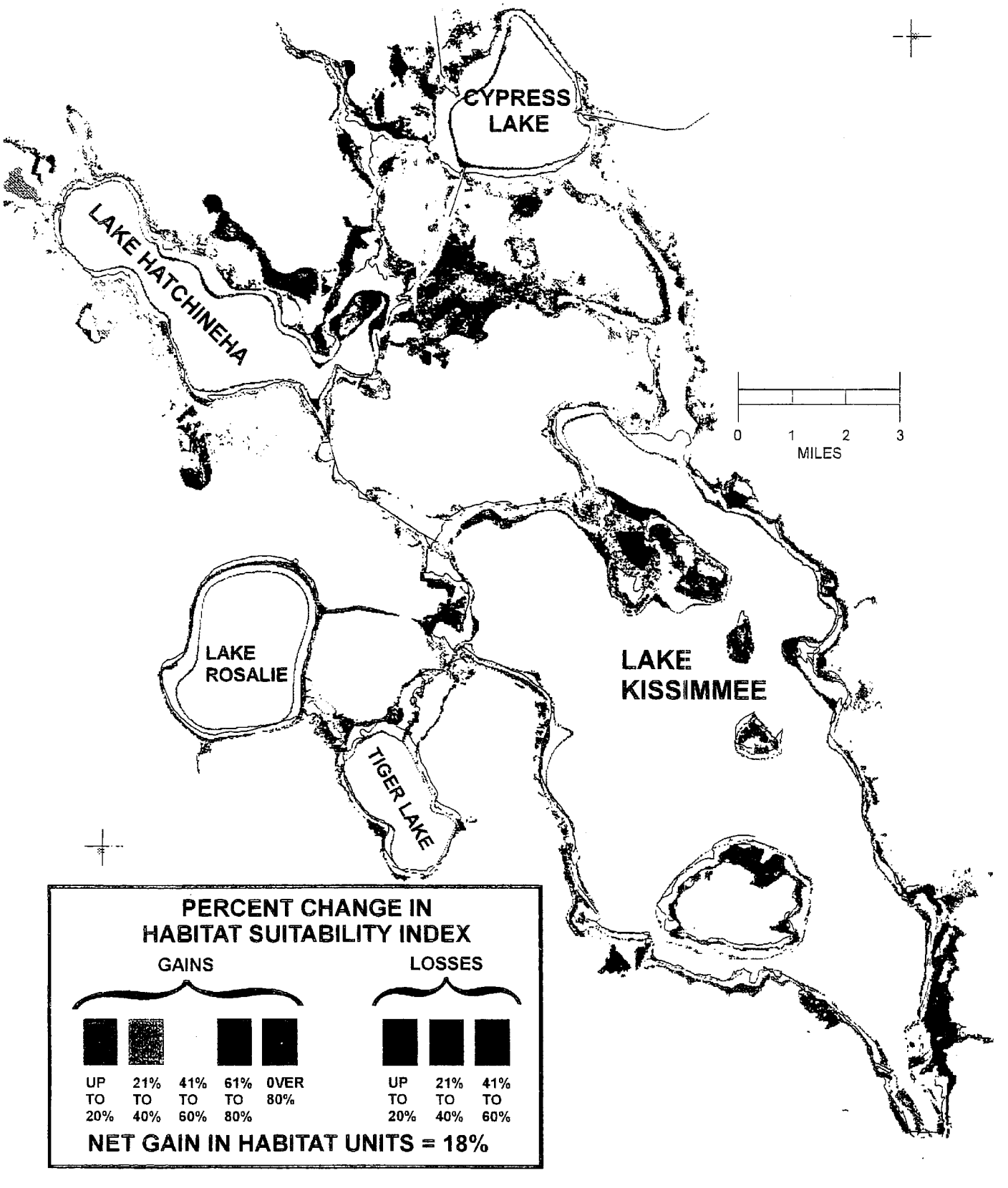


FIGURE 11 - CHANGES IN GREAT EGRET HABITAT SUITABILITY, FUTURE WITH BASIC PROJECT RELATIVE TO FUTURE WITHOUT PROJECT.

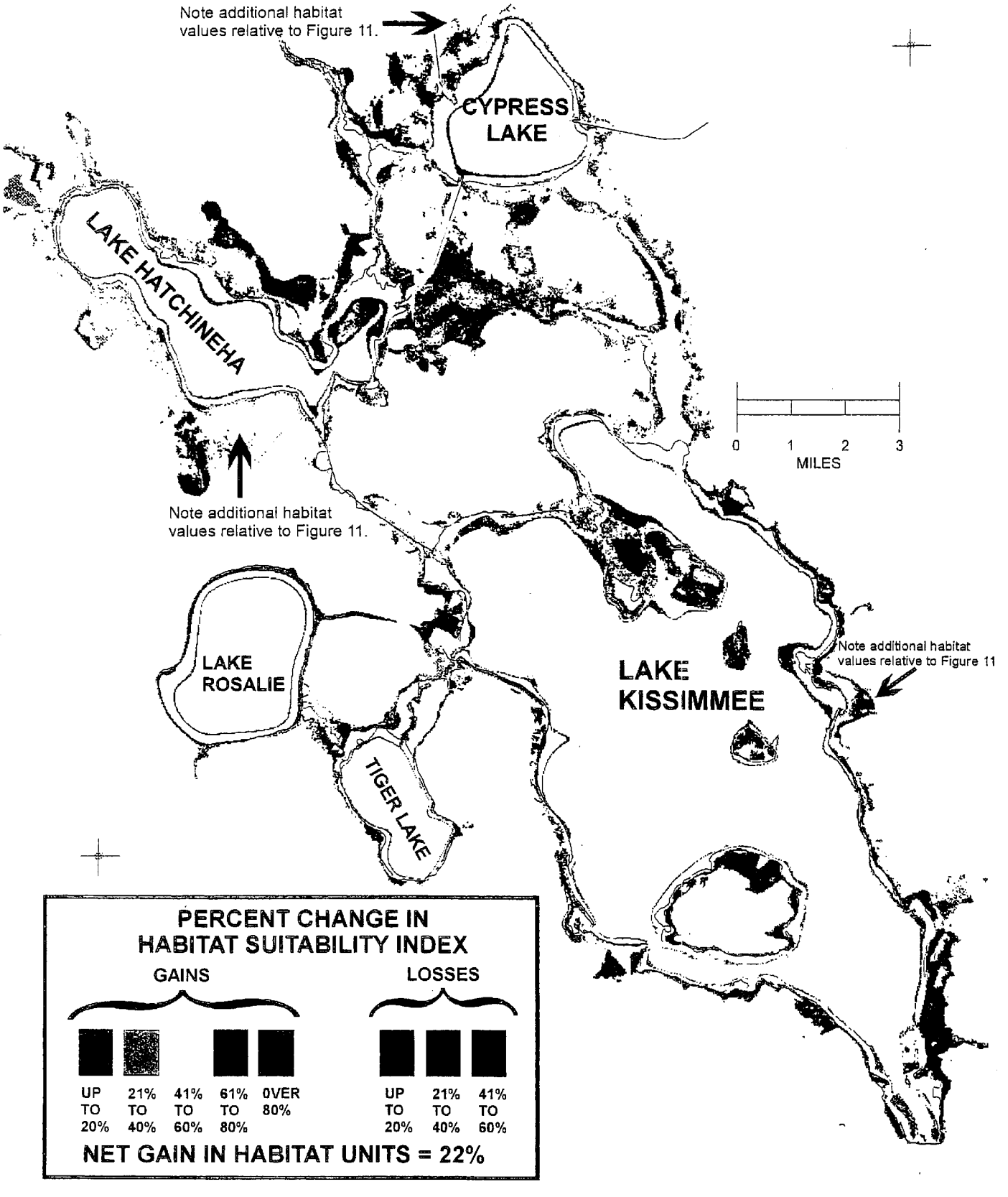


FIGURE 12 - CHANGES IN GREAT EGRET HABITAT SUITABILITY, FUTURE WITH ALL LEVEES BREACHED RELATIVE TO FUTURE WITHOUT PROJECT.

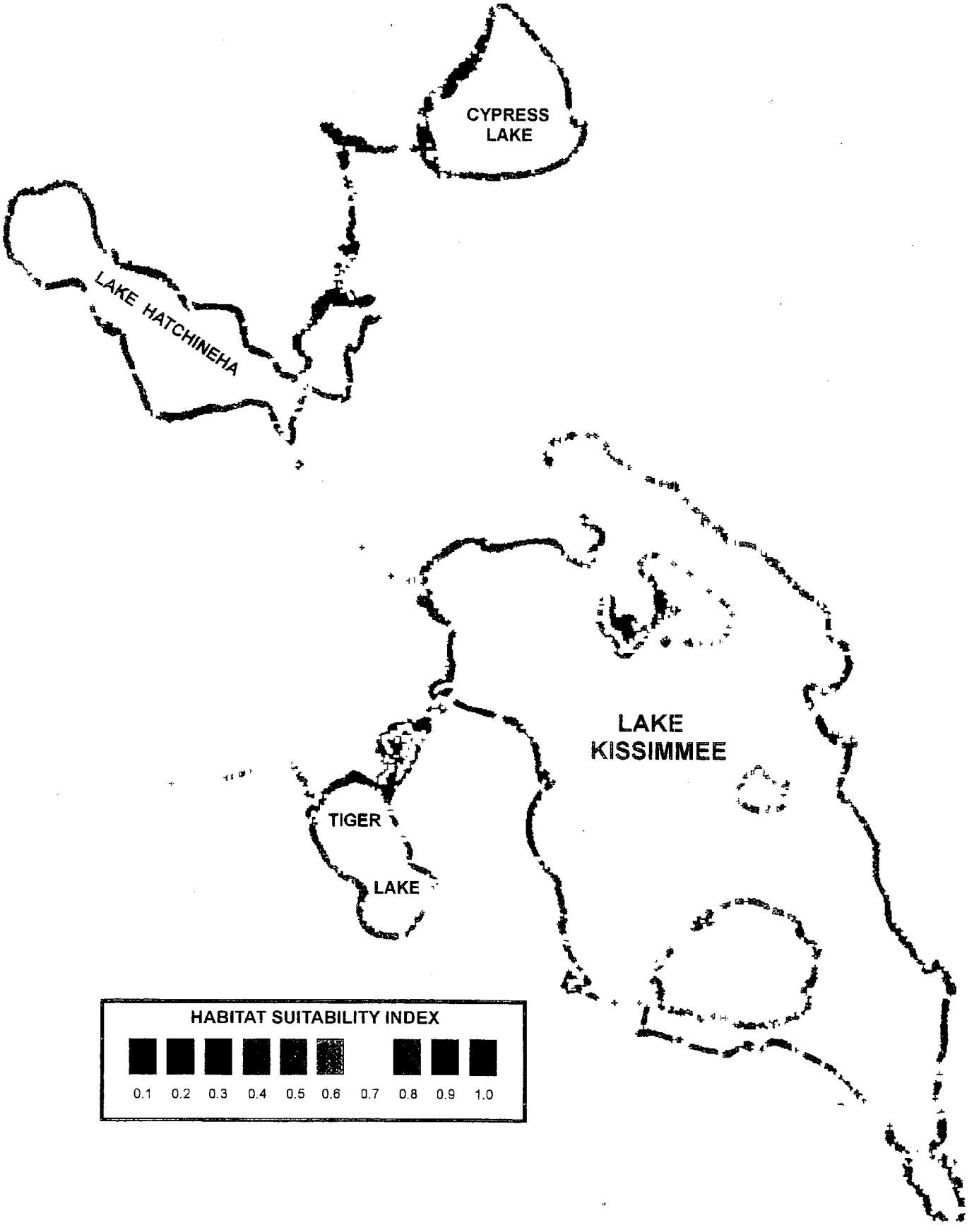


FIGURE 13 - SNAIL KITE HABITAT SUITABILTY, ANY OF THE ALTERNATIVE FUTURES

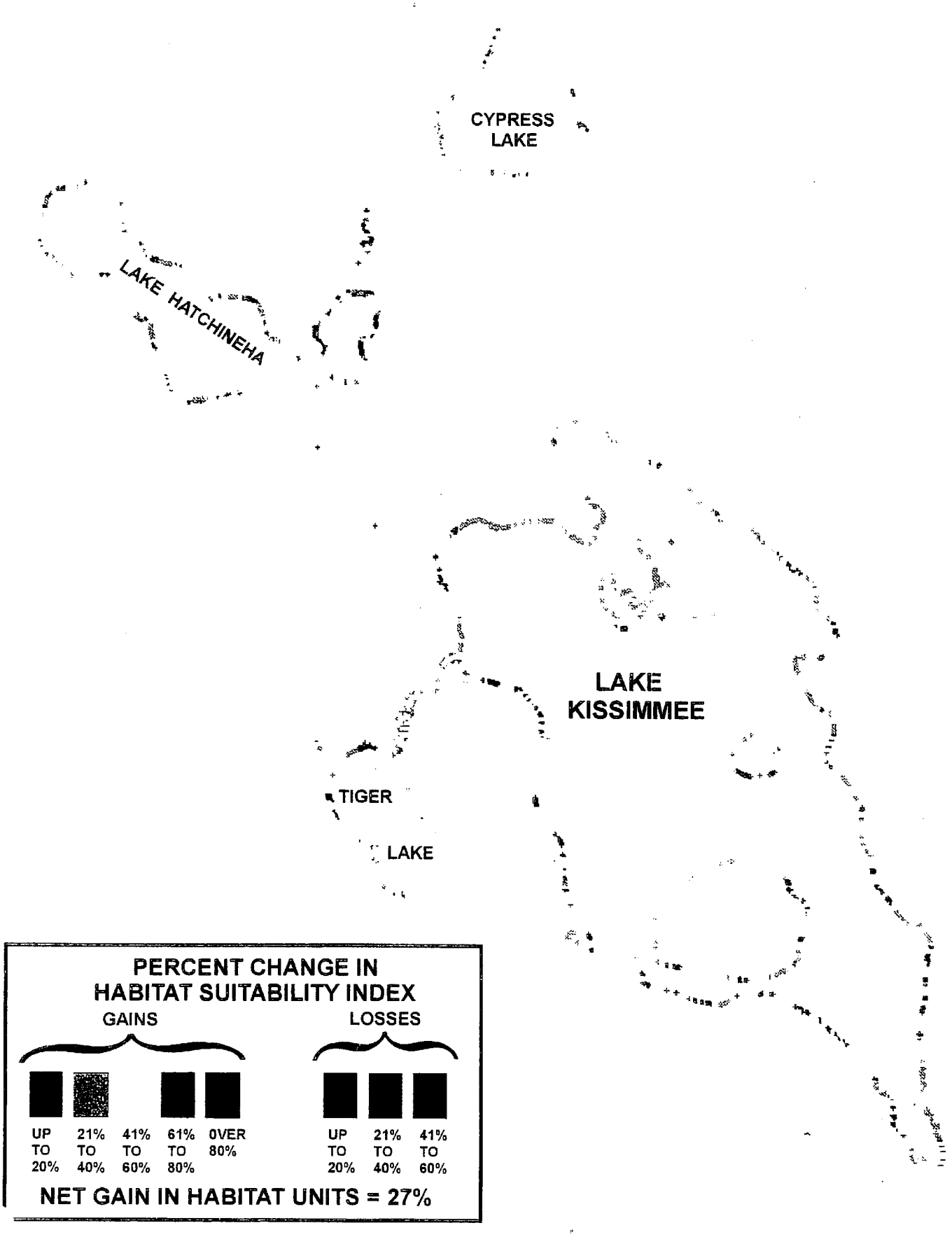


FIGURE 14 - CHANGES IN SNAIL KITE HABITAT SUITABILITY, ANY OF THE ALTERNATIVE FUTURES, RELATIVE TO FUTURE WITHOUT PROJECT.

Figure 13 shows habitat suitability for the snail kite for any of the alternative futures. Notice that the snail kite is not as likely to feed in the prairie wetlands as are the wading birds; the snail kite preferentially selects areas of suitable vegetation and hydrology in narrow portions of the littoral zone. Also notice that the highest habitat values are assigned to portions of the shorelines of Lake Kissimmee and Tiger Lake, where feeding areas are located close to documented nesting areas.

Figure 14 shows the change in habitat suitability for the snail kite for any of the alternative futures, relative to the future without the project. The greatest increase in habitat suitability are predicted to occur along a narrow band around Lake Kissimmee and the northern shore of Tiger Lake. Moderate increases in suitability are predicted for the shorelines of Cypress Lake and Lake Hatchineha. The absolute area of habitat changes for the snail kite is smaller than for the great egret. However, the kite's selectivity of habitat along the shorelines of the lake is precisely in areas to be affected by the project. This translates to a greater percentage change for the species due to the effects of the project, with a predicted net gain in habitat units of about 27%. As stated in Section VII.E.5. of this report, nesting conditions for snail kites are not expect to change significantly; the predicted gains in habitat suitability are strictly the result of improved foraging conditions in response to changes in hydrology.

The relatively high percent increase in habitat units for the Florida duck and the ring-necked duck are also the result of these species using areas to be affected by changes in regulation of the lake. The Florida duck's use of prairie wetlands for feeding was taken into account for the model, but its strongest preference for a mixture of open water and marsh along the shallow edges of the lakes is quite similar to areas preferred for feeding by the snail kite. (Although the species use very different resources and feeding strategies, they can often be seen in the same wetlands.) The ring-necked duck would nearly always be seen in the lakes rather than in the prairie wetlands, but preferring deeper water than the Florida duck. We have predicted a substantial increase of about 35% in habitat units for the Florida duck if all 3 levees are breached, while ring-necked duck habitat is predicted to increase by about 30%, whether or not the levees are breached.

The bottom row of Table 5 sums the habitat units for all 10 evaluation species for each of the alternative futures. The bottom row of Table 6 expresses the percent change anticipate for each alternative future, based on the sum of habitat units for all evaluation species. We have predicted approximately a 5.7% increase in habitat availability for the basic lake re-regulation, and about a 6.3% increase if all 3 levees are breached, taking into account habitat values in the prairie portions of the study area that are not likely to change in response to the project.

Among the evaluation species, the Florida duck, great egret, snowy egret, and wood stork are likely to benefit from the additional wetlands that would be restored by breaching the levees. A variety of other wetland-dependent wildlife would also most likely benefit from breaching the levees.

D. Relative Frequency of Extreme Drawdowns

In a spreadsheet, we calculated the number of extreme drawdown events (natural droughts in the pre-project period) in the 18-year period of record. An extreme drawdown was defined as water levels below 46 ft. for at least 90 consecutive days. In the same period we used to compare the evaluated alternatives with historic conditions (1939-1942 and 1945-1958), we discovered only one extreme drawdown of this magnitude. Water levels remained below 46 feet for 187 consecutive days, from mid-April to mid-October 1956. Under regulated conditions (1970-1988) the single extreme drawdown of 1977 also met this criterion, lasting 175 consecutive days, from mid-March to the end of August.

We also examined the 15-year period between 1929 and 1943. Although no droughts in this period met the criterion we set, extended low water periods occurred in 1932 and 1933. Water levels below 46 feet occurred a total of 70 days in the 15-year period, without consideration of consecutiveness. In April-August 1932, water levels stayed below 46.5 feet for more than 90 consecutive days, with 13 consecutive days below 46 feet. The longest consecutive period with water below 46 feet lasted 32 days, from early June to early July 1933.

It appears that extreme drawdowns of the magnitude we have defined did not occur more frequently than roughly every 10-20 years. However, the unregulated system fluctuated much more each year than is feasible under today's system of gates and canals. After long periods without fluctuation, a more pronounced and/or more frequent extreme drawdown is necessary to partially compensate for the lack of year-to-year variability in the location of the low water line.

The frequency and timing of extreme drawdowns need to be negotiated among the concerned agencies. The fisheries program of the FGFWFC currently recommends a frequency of once every 7 to 10 years. Due to the degree of coordination and expense of performing an extreme drawdown, once the process has been started, all attempts should be made to complete the drawdown satisfactorily. Barring any unseasonable heavy rains, the 46-foot/90-day duration guideline should be met to provide the desired benefits for the funds expended.

XII. FEDERALLY-LISTED THREATENED AND ENDANGERED SPECIES

A. Determination of Effect and General Findings

By letter, dated December 3, 1993, the Corps' Planning Division provided the Service with a determination of effect in accordance with Section 7(a)(1) of the Endangered Species Act (ESA). They determined that the proposed project is not likely to adversely affect any Federally-listed threatened or endangered species. On March 28, 1994, the Service concurred with this determination.

Section VII.E. of this report provides general biological information and the basis of our models for the bald eagle, snail kite, wood stork, and Audubon's crested caracara, which in addition to being Federally-listed as endangered, are also evaluation species for this report. On the basis of our familiarity with the species' biology in the area and the results of our species models, the Service predicts that the project will likely be beneficial to the snail kite and wood stork, while it is not likely to have a significant effect on the bald eagle or the caracara.

The Corps' evaluation included the Eastern indigo snake (*Drymarchon corais couperi*), which is listed as threatened. The indigo snake is likely to occur in higher elevations unaffected by the changes in water regulation schedules. We concur with the Corps' determination, and provide Conservation Recommendations to assist them to protect any indigo snakes that may be found during earth work in widening the flood control canals.

The Corps also mentioned the whooping crane (*Grus americana*) in its determination. The FGFWFC and the Service are cooperating in an attempt to re-introduce the whooping crane in and adjacent to the study area. Most of the introduced flock presently uses habitat west of the study area, near Lake Marian and Lake Jackson. Although the whooping crane is listed as endangered in the remainder of its range in the United States, this flock is considered an experimental population, and is not currently covered under Section 7 of the Endangered Species Act. However, we encourage the agencies to consider effects on this population in project planning. The whooping crane has a greater affinity for wetlands than the sandhill crane (Nesbitt, pers. comm.), and we expect that establishment of a breeding population in Central Florida will be enhanced by the greater water fluctuation and expanded littoral zone as a result of the Kissimmee Headwater Lakes Revitalization Project.

B. Conservation Recommendations

1. Snail kite

The Service has recommended that each of the principal nesting areas and drought refugia be managed to benefit reproduction of the species during most years, while recognizing

that droughts and management of other fish and wildlife species will require periodic deviations from what is considered an ideal management plan for snail kite reproduction. Coordination of management actions throughout the species' range would be required to ensure that the majority of the essential kite habitats were managed for kite nesting in any given year. For example, an extreme drawdown of a waterbody for water supply, construction activity, aquatic weed control or fishery habitat management could be permitted if other essential habitats in the species' range were managed for kites in that same year. Ongoing telemetry studies indicate that kites will migrate long distances within their overall range to find favorable conditions and that they exhibit a high level of resilience to environmental conditions (Bennetts et al., 1994 and Bennetts, pers. comm.). However, if a number of activities adverse to the kite coincide during a prolonged drought, the impact could overwhelm the species' inherent capacity to respond with opportunistic behavior.

The responsible agencies must insure that potentially conflicting goals (such as habitat enhancement for fisheries and water management for snail kite nesting) are reconciled. This may be more a matter of timing and coordination than an inherent conflict. The long-term management of the lakes should include extreme drawdowns which could be beneficial for all species, including the snail kite. However the frequency of these events and the compatibility of lake management with kite nesting in the intervening years can be worked out through cooperation. Bennetts et al. (1994) stated the following with regard to the Everglades, but it could apply throughout the range of the snail kite:

> Undoubtedly, compromise solutions will need to be identified in order to accommodate increasing demands for water, habitat for snail kites, and flow systems that will maintain the unique Everglades environment. Almost any proposed solution to the problems of the Everglades and the kite will meet with opposition from individuals or groups with differing objectives or viewpoints.

2. Eastern indigo snake

The indigo snake (*Drymarchon corais couperi*) is a large black to glossy blue-black snake. Indigo snakes prefer sandy upland habitats, but can be found in many kinds of habitats, including canal banks and spoil mounds. In much of Florida it uses gopher tortoise burrows for shelter. In addition to habitat destruction, illegal collection of indigo snakes for the pet trade is a significant threat.

All construction personnel involved in this project should be informed of the possible presence of the indigo snake in the area, its recognition, and the possible civil and criminal penalties resulting from the unauthorized take (harming, harassing, killing, collection) of a listed species. The Service can furnish, under separate correspondence, an outline for an education/protection program for the indigo snake.

C. Conclusion

The Service concurs with the Corps' determination that the project is not likely to adversely affect the Audubon's crested caracara, bald eagle, wood stork, and Eastern indigo snake.

Although this does not constitute a Biological Opinion described under Section 7 of the Endangered Species Act, it does fulfill the requirements of the Act, and no further action is required. If modifications are made in the project or if additional information involving potential impacts on listed species becomes available, please notify our office (407-562-3909).

XIII. STATE-LISTED SPECIES AND SPECIES OF SPECIAL CONCERN

The sandhill crane is one of our evaluation species, and is listed by the State of Florida as Threatened. The snowy egret, another evaluation species, is listed as a Species of Special Concern. We have predicted a likely benefit for the snowy egret, and no significant effect on the sandhill crane.

Among the more prominent Species of Special Concern that occur in the study area are: gopher tortoise, osprey, burrowing owl, limpkin, little blue heron, and tricolored heron. Based on our modelling of effects on wading birds, the Service anticipates that the last three species are likely to benefit from the proposed project, because they are wetland- also wetland-dependent wading birds.

XIV. CONCLUSIONS AND RECOMMENDATIONS

Restoration of the Kissimmee River and the associated proposal to improve water regulation in the Kissimmee Chain of Lakes are environmental restoration projects on an unprecedented scale; they serve as nationally significant cornerstones in efforts to restore ecosystems.

The Service recommends the following:

1. Lands up to 54 feet in elevation located behind the three levees at Lakes Hatchineha, Kissimmee, and Cypress should be added to the ongoing fee title acquisition of lands around the lakes. The levees should then be breached to hydrologically connect existing wetlands with the lakes and allow additional restoration of wetlands. These actions will realize the full potential of habitat restoration available in the upper basin and provide additional areas to buffer flood risks during storm events. Among the evaluation species, the Florida duck, great egret, snowy egret. and wood stork are likely to benefit from the additional wetlands that would be restored by breaching the levees. A variety of other wetland-dependent wildlife would also most likely benefit from this action. Direct hydrological connection of the wetlands with the lakes would increase the flow of nutrients and promote movement of aquatic animals; the wetlands behind the levees are now generally isolated from the lakes. Acquisition of the area behind the levees would also ensure that existing wetlands behind the levees are not pumped dry by more intensive agricultural practices on private lands.

2. Periodic extreme drawdowns should be superimposed on the normal regulation schedule and should be referenced in the operational notes for the schedule. This action is an essential habitat management tool for the entire lake ecosystem, particularly with respect to the sport fishery. Field research has demonstrated substantial increases in the yield of the sport fishery for several years after an extreme drawdown. The periodic reduction in density of vegetation in the littoral zone is also beneficial to the ecosystem as a whole. The frequency and timing of these drawdowns should be fully coordinated to minimize adverse effects on nesting of snail kites.

3. Spoil material excavated during widening of C-36 and C-37 should be confined to the existing spoil banks within the right-of-way. If filling of wetlands beyond the toe of the existing spoil mounds is unavoidable, the Corps should develop, during detailed project design, a plan to compensate for losses of wetlands. The Corps should investigate redirecting flow to the remnant river run adjacent to C-37. After widening the canals, the banks should be replanted

with cypress trees, and a littoral shelf should constructed and planted with desirable aquatic plants such as bulrush.

4. The Corps should develop an aquatic plant management plan, including funding projections, to address control of *Hydrilla*, floating plants, and tussocks in the lakes.

5. The Interagency Review Team used to prepare this evaluation should continue to meet after implementation of the new water regulation schedule. This will allow evaluation of its effectiveness in reaching restoration goals for the upper basin and the Kissimmee River. Environmental monitoring studies should be planned and funded. Iterative testing of modified water regulation schedules should be conducted if it appears that the project is not fully realizing potential benefits. In particular, the review agencies should revisit the issue of attempting to provide flooding of longer duration between elevations of 52.5 and 54 feet in the upper basin, if this can be achieved without increasing flood risks upstream.

6. The Service recommends that the Corps evaluate the feasibility and benefits of adding a water control structure/lock at the northern end of C-36 to enable separate water regulation of Lake Cypress at levels closer to the historic condition. Lake Cypress appears to be more adversely affected by water levels held below historic conditions, as exhibited by reduction of the littoral fringe and dense growth of aquatic weeds. Although separate regulation of this lake was not proposed in our Scope of Work, the Service is confident that separate regulation at levels higher than Lakes Hatchineha and Kissimmee would greatly enhance the environmental benefits of the currently proposed plan. We would be willing to prepare a Scope of Work to quantify these additional environmental benefits.

7. The Service continues to support the proposed Level II Backfilling Plan for the Kissimmee River restoration, a restoration project adjacent to, and hydrologically connected with, the Kissimmee Headwater Lakes Revitalization Project.

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FLORIDA GAME AND FRESH WATER FISH COMMISSION

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June 6, 1994

Mr. David L. Ferrell
Field Supervisor
U.S. Fish and Wildlife Service
P.O. Box 2676
Vero Beach, FL 32961-2676

Re: Kissimmee Headwater Lakes Revitalization Project, Draft Fish and Wildlife Coordination Act Report

Dear Mr. Ferrell:

The Division of Fisheries, Division of Wildlife, and Office of Environmental Services of the Florida Game and Fresh Water Fish Commission have reviewed the referenced document, and offer the following comments.

The Kissimmee Headwater Lakes Revitalization Project is an important component of the Kissimmee River restoration, which we believe is the premier natural resource oriented public works project in the history of Florida. For the restoration to work, river flow from the headwater lakes must be reestablished in a regime similar to the historic condition. This will require new lake regulation schedules, the centerpiece of the revitalization project, and for these to maximize potential natural resource benefits within the Kissimmee basin, the historic condition should also be the goal.

We concur with the six conclusions and recommendations, as stated on pp. 68 and 69 of the Draft Coordination Act Report. However, we believe that the fish and wildlife habitat benefits of this project could be greatly enhanced if the water level schedule for lakes Cypress, Hatchineha, and Kissimmee provided high water levels closer to the historic condition. The modest wetland habitat benefits of the Corps of Engineers' proposed schedule (400C150RR) could be dramatically improved with longer durations of water level between the 52.5- and 54-foot contours. Table 3 of your report illustrates that the proposed schedule closely approximates historic low water stages, but provides only 36% of the historic high water levels. Your specific recommendation for the Interagency Review Team to "revisit" this

issue in the future acknowledges the environmental desirability of higher lake stages, but our experience has been that any modification in lake regulation schedules is an arduous, protracted process. The current Kissimmee Headwater Lakes Revitalization Project is our window of opportunity to establish an optimum schedule; should we not "go for it"? If additional flood plain acquisition is required to restore historic water levels, that requirement should be defined now. The Kissimmee River restoration is a visionary project, and we believe the headwater lakes (as well as Lake Okeechobee and the Everglades) require and deserve a similar vision. Thus our principal recommendation to the Corps of Engineers is to modify their proposed schedule to allow longer duration of water levels between the 52.5- and 54-foot contours.

Specific comments pertaining to your recommendations are as follows:

Recommendation 1. Analysis of the benefits derived by breaching the levees on lakes Cypress, Hatchineha, and Kissimmee should include the enhancement and protection of the wetlands presently existing behind these levees, which were excluded from your wetland restoration estimates. An addition to Table 4 could include this acreage, which we calculate to be 721 acres for Lake Cypress, 1,500 acres for Lake Hatchineha, and 429 acres for Lake Kissimmee. Potential project benefits would include: protection of wetlands currently in private ownership which are jeopardized by existing drainage systems; enhancement of wetland function, especially fisheries, via reconnection with the lakes; and additional flood storage acreage.

Recommendation 2. Extreme drawdowns should be referenced in the operational notes for the lake regulation schedules.

Recommendation 3. As part of the Corps of Engineers' plan to widen canals C-35, C-36, and C-37, they should investigate adding flowways through the levees adjacent to these canals. A remnant river run parallels C-37, and should be restored. After dredging, the canal banks should be replanted with cypress trees, and a littoral shelf should be constructed and planted with desirable aquatic plants such as bulrush.

We would also add a recommendation that the Corps of Engineers develop an aquatic plant management plan, including funding projections, to address hydrilla control in flowing lake water, and control of floating plants and tussocks.

We have given additional minor recommendations and corrections for this Draft Coordination Act Report to Robert Pace of your staff via telephone. Attached to this letter are two memoranda from waterfowl biologists in our

Division of Wildlife, offering specific language changes for sections of the report dealing with ring-necked ducks and mottled ducks.

Sincerely,

Bradley J. Hartman

Bradley J. Hartman, Director
Office of Environmental Services

BJH/BSB/tgw
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kissimmee.bsb
Attachments
cc: Col. Terrence C. Salt, USACOE
Mr. Dennis Holcomb, GFC
Mr. Ed Moyer, GFC
Mr. Dennis Hammond, GFC
Ms. Diane Eggeman, GFC
Mr. Paul Gray, GFC

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M E M O R A N D U M

May 24, 1994

TO: Duke Hammond
SWIM Coordinator

FROM: Paul N. Gray, Ph.D.
Bio. Sci. III

SUBJECT: Comments on USFWS Kissimmee Headwater Lakes Revitalization Project

---

Thank you for sending parts of the Kissimmee Project report to me. I applaud the USFWS for working on plans of this sort--they will help. Here are suggestions/comments:

-He misspelled my name--Gray.

-The Fish and Wildlife Concerns (p. 8) has a good discussion about the pejorative effects of stabilized water levels in the lakes. The one point I would emphasize more is that high water levels impede decomposition--which helps create the excess muck--and serves to bind up nutrients. In continuously flooded sites, the vegetation gets thick (forms batteries or tussocks) and chokes that area out--but actually has low primary productivity, which makes the system less productive overall. During drawdowns, decomposition frees the nutrients, which allows increased productivity (such as improved fish growth).

-The Florida subspecies of mottled duck (p. 33) is denoted *Anas fulvigula fulvigula*, if he wants to include that.

-I would rewrite the first sentence of the second paragraph of the mottled duck account (p. 33) to say, "Florida's mottled duck nests primarily between mid-March and mid-May, but will attempt renesting through July."

-I would add that mottled ducks can nest as much as a mile from water, which helps reduce the chance that nesting habitat is limiting.

-Change to, "Paul Gray concurs that suitable **nesting** habitat **probably** is abundant in the study area." (changes in bold)

-Paragraph 3 mentions "non-limiting nature of the breeding habitat" and while that might be true, it may not--and we don't know for sure. A fudge word could be added, "**presumed** non-limiting..."

Further, BROOD REARING areas have not been discussed and are a critical part of the breeding habitat. However, I think brood rearing habitat will take care of itself if the "feeding habitat" part of the model is done correctly. I think the author could explicitly state that good brood habitat resembles good feeding areas, but with a mandatory component of nearby cover (which should be no problem on lakes with cattails, bullrush, maidencane, or a similar robust cover). Adult birds do not need cover to have suitable feeding habitat.

-I am not sure I understand how the model will work, so I hope the following comments make sense.

-Mottled ducks "prefer" feeding in water less than 6 inches deep. They can use water as much as 12 inches deep, but water more than 12 inches deep should be considered unsuitable (unless it is a bed of hydrilla or some plant that grows close to the surface). Mottled ducks LOVE recently flooded, short hydroperiod wetlands because these wetlands frequently are dominated by seed-bearing plants (good food), and when newly flooded, the seeds and bugs float, making them easy to feed on. Hence, I think the authors should give very high suitability scores to shallow water areas and temporarily flooded wetland areas. Of course, short hydroperiod wetlands are suitable only when flooded.

-I'm not sure areas within 90 m of marsh/open water edges are better for mottled ducks than other areas; I think it could be deleted.

-The last sentence confuses me a little. Mottled ducks appear to "prefer" small wetlands that are found out on the prairies--and have no clear preference for large lakes. Hence, semipermanent wetlands (and some open water areas) above the littoral zone should be assigned high habitat values. Ducks do "prefer" littoral zones of large lakes when natural marsh cycles make temporally suitable habitat (such as the productive period following a drawdown or fire). However, when there is a drought, the ducks have nowhere else to go--and the lakes can become important (preferred?) habitat, even when the lakes have low quality habitat.

-I think the conclusions/recommendations (p. 68) are good, especially #2.

If you have any questions, please call.

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FN: C:\P\DUKE2
WLD 8-7
cc: Lt. Col. Daniel Dunford
Mr. David Brakhage

FLORIDA GAME AND FRESH WATER FISH COMMISSION

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May 25, 1994

M E M O R A N D U M

TO: Brian Barnett, Biological Administrator
Office of Environmental Services

FROM: Diane Roth Eggeman, Waterfowl Biologist
Division of Wildlife

SUBJECT: Comment on Draft Report on Kissimmee Lakes Revitalization Project

Duke Hammond provided me with pages from the draft Fish and Wildlife Coordination Act Report for the Kissimmee Headwater Lakes Revitalization Project and asked that I review them and provide comments to you. My comments concern the section on ring-necked ducks on pages 35-36. I am listed as one of the "experts consulted". I did not, to my knowledge, provide any written input for this report, but I vaguely remember discussing this issue over the telephone in the distant past. I am not comfortable with the section as it is written. The first paragraph is a fairly accurate description of the ring-necked duck and its habitat. However, the application of that information to the model appears to be based almost solely on water depth. As I indicated below, the distribution of ring-necked ducks in the upper Kissimmee Lakes and elsewhere in central and southern Florida in recent years has been most strongly influenced by the presence and abundance of "topped-out" hydrilla (hydrilla growing up to the water surface). In the absence of hydrilla, ring-necked duck habitat is characterized by deep-marsh type of vegetation, typically white water lily (Nymphaea odorata) and watershield (Brasenia schreberi). Although these communitites and their value to ring-necks are more directly determined by water depth, I would not expect the extent of these communities to be dramatically influenced by the types of water regulation changes being considered. The most important point is this: I would not expect use of the upper Kissimmee lakes by ring-necks to change appreciably as a direct result of changes in the water regulation schedule. I definitely do not want my name associated with the model for ring-necked ducks as it currently described on page 36 because the model is based solely on water depth, which is relatively unimportant given the current availability of hydrilla as habitat in the region. I suggest the following re-write of the first paragraph of this section:

"The ring-necked duck (Aythya collaris) is the most abundant species of wintering waterfowl in both the upper and lower Kissimmee basins and is an important game species. During fall migration, ring-necked ducks begin arriving in central Florida in October and remain in the Kissimmee lakes region into March. This species does not breed in Florida. Ring-necks are classified as diving ducks and typically feed in waters less than 6 feet deep (Bellrose 1980). Traditionally in Florida, ring-necks use deep-marsh habitats characterized by floating-leaved and aquatic-bed type of wetland vegetation.

Seeds of white water lily (Nymphaea odorata) and watershield (Brasenia schreberi) are considered preferred foods. In recent years, the distribution of ring-necked ducks appears to be determined primarily by the presence and abundance of "topped-out" hydrilla beds. This conclusion is based on aerial surveys and other field observations of wintering waterfowl in central and southern Florida. Johnson and Montalbano (1984) studied the selection of plant communities by wintering waterfowl in the littoral zone of Lake Okeechobee. Ring-necked ducks were the most abundant species observed. Of all vegetative communities available, hydrilla received the highest preference ranking, and wildcelery (Vallisineria americana) the second highest. This study examined preference based on habitat use and abundance but did not examine food habits. However, hydrilla is a predominant duck food in areas where it occurs (Montalbano et al. 1978, 1979). Johnson and Montalbano's research suggested that water depth was of relatively minor importance in habitat selection. Ring-necked ducks feed on all parts of hydrilla, including vegetation, tubers and turions. Water depth is relatively unimportant to ring-necks using hydrilla beds, because hydrilla leaves, stems, and turions are available at or near the surface even in water deeper than the birds would dive if they were feeding on foods on the bottom. Therefore, given the current availability of hydrilla in the region, changes in the hydrology of the Kissimmee lakes likely will substantially influence habitat for ring-necked ducks only to the extent that the changes directly or indirectly determine the availability of "topped-out" hydrilla."

I would also suggest the author(s) consider deleting the ring-necked duck from the report because the species is not a sensitive barometer of changes in habitat caused by changes in water regulation schedules.

Thank you for this opportunity to comment. If you have questions, please give me a call.

CITATIONS:

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WLD 2-9-V

cc: Mr. Duke Hammond

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May 10, 1994

Robert T. Pace, Senior Biologist
Joseph D. Carroll, Senior Biologist
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Dear Gentleman:

I was provided a copy of your draft report entitled "Kissimmee Headwater Lakes Revitalization Project, Fish and Wildlife Coordination Act Report" for review. The following are comments as they relate to aquatic plant management in the upper Kissimmee Chain of Lakes.

The Department of Environmental Protection recognizes the significance of the Kissimmee River restoration project, and supports this effort. However, we have concerns regarding the effect the Revitalization Project may have on aquatic plant management in the upper basin lakes. Hydrilla is extremely difficult to manage in flowing water conditions. Because the Project greatly restricts periods of zero discharge, costs to manage the invasive hydrilla could escalate far above recent annual expenditures which have averaged one million dollars.

Hydrilla is expanding in the upper Kissimmee Chain of Lakes, and has the potential to adversely affect implementation of the Revitalization Project. A concerted interagency effort is now underway to develop a hydrilla management plan for the South Florida Water Management District. District staff has assured us that this management plan will be incorporated into the draft plan, and final plan, of the Revitalization Project. We, therefore, request that the USFWS Coordination Act Report also acknowledge the importance of hydrilla management in the upper basin lakes.

Please contact me at 904-488-5631 if you have any questions or comments pertaining to this issue.

Sincerely,

Judy Ludlow

Judy Ludlow, Biologist
Bureau of Aquatic Plant Management

/jl

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Florida Department of
Environmental Protection

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June 1, 1994

Mr. Robert Pace
U. S. Fish and Wildlife Service
P.O. Box 2676
Vero Beach, FL 32961-2676

Dear Mr. Pace:

After review of the supporting documentation and consultation with Tony Morrell, park manager at Lake Wales Ridge GEOpark, I have the following comments with respect to the Fish and Wildlife Coordination Act Report on the Kissimmee Headwater Lakes Revitalization Project. The proposed project will result in more frequent seasonal flooding and higher water levels within the hydric communities of Lake Kissimmee State Park; this action will contribute to the hydrological restoration of these communities within the park and is consistent with the Department of Environmental Protection's emphasis on ecosystem management. The increased water levels and periodic extreme drydown events associated with the project will assist in the eradication of exotic plants such as *Sesbania vesicaria*, and the control of pest plants, such as *Ludwigia* spp. In addition, numerous vertebrate species will benefit as a result of the restoration of these communities.

If you have any questions regarding my comments, please contact me at 407-884-2102.

Sincerely,

Alice M. Bard

Alice M. Bard, District Biologist
Bureau of Parks, District 3 Administration

AMB/amb
cc: Mark Glisson, Natural and Cultural Resources
Rosi Mulholland, District 3 Administration
Tony Morrell, Lake Wales Ridge GEOpark
Judy Ludlow, Aquatic Plant Management
Patricia Sculley, South Florida Water Management District

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CENTRAL AND SOUTHERN FLORIDA PROJECT
FOR FLOOD CONTROL AND OTHER PURPOSES

APRIL 1996

KISSIMMEE RIVER, FLORIDA HEADWATERS REVITALIZATION PROJECT

APPENDICES to the

INTEGRATED PROJECT MODIFICATION REPORT AND SUPPLEMENT TO THE FINAL ENVIRONMENTAL IMPACT STATEMENT

US Army Corps
of Engineers
Jacksonville District
South Atlantic Division

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B . . . . . Water Control Plan Discussion

C . . . . . Geotechnical Engineering Data

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E . . . . . Early Establishment of Headwaters Component

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E . . . . . Evaluation Process

G . . . . . Social Impact Assessment

H . . . . . Real Estate Agreement

I . . . . . Project Cooperation Agreement

J . . . . . Navigation Impact Study

KISSIMMEE RIVER
HEADWATERS REVITALIZATION PROJECT

APPENDIX A

HYDROLOGY AND HYDRAULICS ANALYSES

Appendix A
Hydrology and Hydraulic Analyses

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Appendix A
Hydrologic and Hydraulic Analyses

1. Forward. This analysis updates and expands on the hydrologic models, operating criteria, and engineering requirements for the hydrologic and hydraulic analyses presented in the U.S. Army Corps of Engineers' (Corps) 1991 Feasibility Report on the Kissimmee River Restoration. The current study offers the initial opportunity in which the entire Middle and Lower Kissimmee basins could be analyzed as a fully-integrated hydraulic system with the Corp's one-dimensional unsteady flow routing model, UNET. UNET provides the analytical tool for designing the structural modifications (i.e., enlarged canals, increasing structural capacity) necessary to maintain existing flood control criteria upstream of S-65 for the recommended Section 1135 project. The analysis also utilizes a modified version of the South Florida Water Management District (SFWMD) period of record routing model, UKISS, to analyze and evaluate a multitude of proposed regulation schedules for Lake Kissimmee. The intent of the schedule optimization is to develop an operational scheme which primarily reestablishes historical flow characteristics to the Kissimmee River for restoration purposes, while at the same time providing increased environmental benefits to the Kissimmee chain of lakes because of a wider and more natural fluctuation of water stages. Because of the capabilities of the UKISS and UNET models, the current study also allowed flood control features to be designed through a coincident frequency approach whereby flood stages are considered to result from the joint probabilities of starting water surface elevation and rainfall frequency. The joint probability approach provided a more statistical basis for the flood control project and resulted in the design optimization and cost reduction of certain project features.

Previously, SFWMD and the Corps prepared Kissimmee River Restoration feasibility reports in 1990 and 1991 which used the hydrologic analyses produced by the Corps' 1985 Survey Report on the Kissimmee River. Both reports used the Corps' runoff hydrograph model (HEC-1) and routing model (CHANOP) for the upper basin down to the outlet of Lake Kissimmee. Below the outlet, a dynamic wave routing model (DWOPER) was used to simulate the restoration plan for the Kissimmee River. The CHANOP model is better suited for simulating the closely regulated existing Kissimmee River project and was used for the lower basin existing conditions.

In the 1990 and 1991 flood analyses of the recommended restoration plan, the assumed starting water surface elevation of Lake Kissimmee was raised to

52.5 feet, National Geodetic Vertical Datum of 1929 (NGVD)[1], rather than the 51.0 feet used in the 1985 report. These elevations represent the top of the Lake Kissimmee regulation schedule for the assumed 1 September flood date. This is an integral part of the new plan to re-regulate lakes in the upper basin and to extend the hydroperiod of the Kissimmee River. To offset the increase in flood stages on Lake Kissimmee, the plan also calls for an increase in the maximum early regulatory release from Lake Kissimmee from 3,000 cubic-feet-per-second (cfs) to 6,000 cfs.

Although this analysis is also predicated on raising the Lake Kissimmee regulation schedule by 1.5 feet, the starting water surface elevations (SWSEL) for flood events are not necessarily assumed be at the top of the seasonal lake regulation schedule but instead vary according to the stage-duration relationship generated by the UKISS period of record routing model. Since the UKISS routings indicate that lake levels only reach the top of schedule a relatively small percentage of the time, resultant flood stages for a given rainfall frequency based on the joint probability approach will be correspondingly lower than the top of regulation case. Although the growing acceptance of statistical and risk-based hydrology within the Corps provide credibility to the joint-probability approach, the results of the analyses are intrinsically linked to the specific regulation schedule. Conversely, a top of regulation approach provides the flexibility of making future adjustments within the schedule without further analyses since the most extreme condition (i.e., SWSEL of 51.0 or 52.5 feet) has already been verified.

Storm frequency in this appendix is shown as return period. Actual statistical analyses and flood risks are defined by exceedence probabilities of 0.2, 0.1, 0.04, 0.02, and 0.01 which represent return periods of 5-, 10-, 25-, 50-, and 100-year. The Standard Project Storm (SPS) and resultant Standard Project Flood (SPF) is defined as the most severe combination of meteorological and hydrological conditions that is considered reasonably characteristic of the geographical area.

2. Hydrologic History.

a. First Survey. Historical information on the Kissimmee River basin dates back to the Seminole Indian Wars which ended in 1858. Forts Kissimmee and Bassinger were constructed along the Kissimmee River, Fort Gardner between Lake Kissimmee and Lake Hatchineha, and Fort Davenport near the Polk-Osceola County line where it crosses Reedy Creek. The first Survey of the

[1]All elevations in this appendix are referenced to NGVD.

Kissimmee River was made by Lt. H. Benson of the Second Artillery, by direction of Col. H. Brown, commander of troops on the Caloosahatchee River; it was dated June 7, 1885. The survey gave the depths at different points along the river as well as tree growth. Lt. Benson wrote, "in my opinion a boat more than 60 to 70 feet in length drawing more than three feet of water could not go up the river, on account of the short bends, strong current and narrow channel".

b. Hamilton Disston. The area began to populate after the Civil War when settlers began moving into the Kissimmee basin. On July 20, 1881, Hamilton Disston and associates incorporated as the Atlantic and Gulf Coast Canal and Okeechobee Land Company. Four dredges were built by the company. One worked entirely on connecting Lake Okeechobee to the Gulf of Mexico through the Caloosahatchee River. The others worked from Lake Tohopekaliga to Lake Okeechobee. By August 1884, Disston's company had established a navigable waterway linking Lake Tohopekaliga with the Gulf of Mexico. East Lake Tohopekaliga was connected to Lake Tohopekaliga in 1884. However, the channel was little more than a ditch; navigable only by small boats. That year, the report of the State Engineer, H.S. Duval, stated that over two million acres had been permanently drained. Lake Tohopekaliga is reported to have dropped three feet in the first 30 days after Southport Canal was completed to Lake Cypress.

c. Navigation Study. Navigation began to flourish and dredging continued to tap into new headwater lakes. In 1888, dredging began from Lake Tohopekaliga up the east chain of lakes. Although the Kissimmee River had been dredged, the discharge capacity was still very small. The additional runoff from the new drainage area is likely to have held the river abnormally high for many years. Drainage works ceased in the early 1890's and the water table in the upper lakes basin began to stabilize at a lower level. The groundwater levels in the upper basin also stabilized and runoff to the Kissimmee River slowed. As discharge in the river slowed during the dry season, stages in the river began to fall to pre-dredging depths, and navigation was impacted. The navigation problem was probably not so much a lack of depth; but a lack of additional runoff created by upland drainage. These low water problems provided the impetus for the federal navigation survey study of the Kissimmee River in March 1901. This Survey provides us with the earliest record of water level elevation in the Kissimmee basin.

d. Higher Water Levels. The 1901 Survey shows the Kissimmee River and its headwater lakes at much higher stages than those recorded in recent history. Lakes Tohopekaliga, Cypress, Hatchineha, and Kissimmee were measured at stages of 63.82, 62.01, 60.86, and 58.84 feet NGVD, respectively, which are appreciably higher than the current wet season regulation schedule

stages of 53.5, 51.0, 51.0 and 51.0 feet, respectively. However, the depths and sizes of the lakes found during the 1901 Survey were only slightly greater when compared to those found today.

3. Basin Description.

a. Location. The area under consideration is located in central Florida; it includes most of Osceola and Okeechobee Counties and parts of Orange, Polk, and Highlands Counties. It is bounded on the north by the lakes of the Orlando area, on the west by the Peace River watershed, on the south by Lake Okeechobee and the Indian Prairie-Harney Pond Canals area, and on the east by the upper St. Johns River Basin. The Kissimmee River is crossed from east to west by United States Highway 98, CSX Transportation Railroad (CSXT), State Road 70, and by State Road 60 near the outlet of Lake Kissimmee.

b. Kissimmee Basin. The entire Kissimmee River Basin comprises 3,013 square miles. The Lake Istokpoga area (622 sq. miles), lower Kissimmee River Basin (758 sq. miles), and the Upper Kissimmee Basin (1633 sq. miles) make up the principle divisions in the watershed. For description, the Upper Basin is subdivided into the East and West chains of lakes (732 sq. miles) and the Middle Lakes Basin (901 sq. miles). Lakes Kissimmee, Hatchineha, and Cypress were originally the principal source of the Kissimmee River but channel and drainage development work connecting the headwater lakes in the upper basin now place the source just south of Orlando. The watershed is about 105 miles long and has a maximum width of 35 miles. Elevations range from about 100 feet in the headwaters, and in excess of 200 feet in the high sandy ridge along the westerly boundary, to about 15 feet near Lake Okeechobee. Characteristics of the major subdivisions of the watershed are discussed in the following paragraphs.

c. East and West Chains of Lakes. The major lakes in the east and west chains are Gentry, Alligator, Preston, Mary Jane, Hart, East Tohopekaliga, and Tohopekaliga. Together with several minor lakes, they have a total surface area at normal stages of 70 square miles, or about 10 percent of the drainage area of the east and west chains. The flow divides generally in Alligator Lake. Northward flow is to Lake Mary Jane, thence south through Lakes Hart, East Tohopekaliga, and Tohopekaliga, thence to Cypress Lake; southward flow is through Lake Gentry and thence to Cypress Lake by way of Canoe Creek (C-34). A low, flat divide just east of Lake Mary Jane separates the Kissimmee River and upper St. Johns River watersheds. Overflow from the Kissimmee River Basin to the upper St. Johns River watershed once occurred during extreme high water. Boggy Creek, draining an area of about 77 square miles,

discharges into East Lake Tohopekaliga. Shingle Creek, with a drainage area of 199 square miles, discharges directly into Lake Tohopekaliga.

d. Middle Lakes Basin. The principal lakes of the Middle Lakes Basin are Cypress, Hatchineha, Kissimmee, Tiger, Rosalie, Weohyakapka, and Marian. The combined surface area of those lakes plus that of several minor lakes is about 132 square miles, or about 15 percent of the total middle Kissimmee River drainage area. Lake Kissimmee is the most important and largest of the lakes in the Kissimmee River Basin, with a surface area of 55.5 square miles at the normal stage of about 51 feet. It is the southernmost storage area of the upper Kissimmee River watershed, collecting the inflow from 1,633 square miles of area before discharging into Kissimmee River. Cypress Lake, the collector lake for inflow from the east and west chains of lakes, discharges to Lake Kissimmee by way of Cypress-Hatchineha Canal (C-36), Lake Hatchineha, and Hatchineha-Kissimmee Canal (C-37). The average daily discharge from Lake Kissimmee for the period of gage record prior to the C-38 project was 1,180 cfs. The maximum daily outflow during the period of known record (c. 1928) was 8,820 cfs, which occurred during the 1948 flood. Elevations in the Middle Lakes Basin range from as high as 200 feet on the sandy ridge west of Lake Pierce (near the city of Lake Wales) to about 58 feet around Lake Kissimmee. Several important lakes in the Middle Lakes Basin are not in the main chain of lakes, but are tributary to it.

Lakes Marion and Pierce are both tributary to Lake Hatchineha from the west. Lake Marion has an outlet on its north side by way of Lake Marion Creek, which flows southeasterly about 8 miles to the northwest corner of Lake Hatchineha. Flow from Lake Pierce enters the southwest side of Lake Hatchineha by way of Catfish Creek, which flows about seven miles east and northeast from Lake Pierce. In the area west of Lake Kissimmee, Lakes Weohyakapka, Rosalie, and Tiger form a secondary chain of lakes which discharge generally north and east to Lake Kissimmee. Lake Marian (not to be confused with the Lake Marion that is tributary to Lake Hatchineha, mentioned above) and Lake Jackson discharge into the east side of Lake Kissimmee through Jackson Canal. Reedy Creek, which discharges into both Lakes Cypress and Hatchineha, is the largest tributary, with a drainage area of 207 square miles.

e. Lower Kissimmee River Basin. Excluding the Lake Istokpoga area, the Kissimmee River between the outlet of Lake Kissimmee and Lake Okeechobee has a drainage area of 758 square miles. The easterly divide separating that basin from the upper St. Johns River Basin is low and poorly defined, with elevations up to 75 feet. For the most part, the westerly divide is a well-defined ridge with elevations ranging up to 130 feet. The old river channel meandered extremely. The straight-line distance between Lakes Kissimmee

and Okeechobee is 52 miles but the old river channel distance was about 100 miles, with a total fall of about 36 feet. The maximum observed discharge at the lower mouth of the Kissimmee River occurred in October 1953 when the discharge reached a peak of 17,800 cfs resulting in a stage of 27.0 feet at the State Road 70 Bridge. A peak flow of 17,400 cfs was observed during the 1948 flood with about 2,000 cfs of the total coming from the Lake Istokpoga area. The flood of August 1928 (prior to gage records), which resulted from a hurricane, caused the river to discharge an estimated 20,000 cfs and rise to elevation 29.0 feet at State Road 70 bridge near Okeechobee.

4. Historical Flooding.

a. General. Rainfall records, dating back to 1871 for the Kissimmee River basin and the adjoining St. Johns River Basin, document the repeated incidents of major storms and the extended periods of inundation associated with these storms. Since construction of C-38 began in the mid-1960's, only the 1969 storm has produced flooding. A discussion of the more severe floods follows:

b. Flood of 1945. Flooding of lengthy durations resulted from a hurricane that struck South Florida on September 15, 1945. The Kissimmee River Basin received average rainfalls of eight inches when the hurricane traveled northward through the center of the State. Because the area was already saturated from prior rains, areas of the Kissimmee basin experienced flooding for as long as eight months. The Reedy Creek tributary area was inundated for about three months, as well as tracts of fringe lands adjacent to the basin. The lower Kissimmee River Basin was flooded for most of the year. The peak outflow from Lake Kissimmee was 6,130 cfs and the peak stage of the lake reached 56.0 feet.

c. Flood of 1947. Flooding that occurred during 1947 was the most damaging of all recorded floods within the Kissimmee River Basin. About 250,000 acres were subjected to flooding of lengthy durations. An unusually wet summer followed by two hurricanes occurring on September 17, 1947 and October 12, 1947, caused the areas of the upper chains of lakes to flood for three months. The central valley, located between Lakes Cypress and Kissimmee, was inundated for about eight months. The peak outlet discharge from Lake Kissimmee reached 6,870 cfs at a peak stage in the lake of 56.9 feet.

d. Flood of 1953. Rainfall that was recorded during this time was one of the heaviest of any flood on record. An average rainfall of 46.8 inches occurred from June to October 1953. On October 9, 1953, a tropical disturbance traveled through the basin, bringing three to five inches of rainfall. The peak outflow

from Lake Kissimmee was 7,170 cfs and the peak stage of the lake reached 56.8 feet.

5. Existing Flood Control Project.

a. Kissimmee River Project (Canal 38). Canal 38 (C-38) was authorized for flood control in 1954; designed between 1954 and 1960 and constructed between 1962 and 1971. The total length of C-38 is about 56 miles. There are six water control structures, S-65, S-65A, S-65B, S-65C, S-65D, and S-65E, each with tieback levees, that divide the river into five pools. S-65 is the outlet structure from Lake Kissimmee and uses the S.R. 60 road embankment as a tieback levee. Pool A is between S-65 and S-65A; Pool B is between S-65A and S-65B; Pool C is between S-65B and S-65C; Pool D is between S-65C and S-65D, and Pool E is between S-65D and S-65E. Structure 65E is located eight miles north of Lake Okeechobee.

b. Design. The Kissimmee structures are designed to step down the 36-foot drop of the river in six-foot increments. The canal is designed to pass the outflow from Lake Kissimmee plus local inflow for a storm equal to 30 percent of the SPF. The 30 percent SPF discharge capacity at Lake Kissimmee represents a 25 percent increase over historical capacity, thus, providing flood protection to the upper chain of lakes. In the lower C-38 basin, the design channel is capable of passing the twin-peaked hydrograph produced by the local inflow and the delayed peak from the upper basin. Even with higher inflow discharges, the C-38 project significantly reduced flood stages in the lower valley because of the reduction in surface friction and hydraulic conveyance provided by the canal. An example of this improved performance is the September 1969 flood when a peak discharge of +23,000 cfs occurred at the S.R. 70 Bridge resulting in a stage of 23.3 feet, compared to the pre-project peak of 17,800 cfs at a stage of 27 feet.

c. Lake Kissimmee Regulation. Lakes Kissimmee, Hatchineha, and Cypress are regulated by a single structure, S-65 located at the outlet of Lake Kissimmee, at the head of C-38. The lakes are currently regulated between elevations 48.5 and 52.5 feet according to the seasonally varying schedule, as shown in Appendix B, Figure B-7. The present regulation schedule for flood protection of the Kissimmee River valley uses the storage capacity in Lakes Kissimmee, Hatchineha, and Cypress above elevation 51.0 feet to temporarily store floodwaters from the upper lakes. The design discharge of 11,000 cfs from Lake Kissimmee is restricted to a firm capacity of 3,000 cfs until flooding recedes along the lower river; usually less than two weeks. When the river recedes to a point where the Kissimmee River structures can discharge their design flow at design stages, the discharge from Lake Kissimmee is increased

to 11,000 cfs. For floods less than about 10-year recurrence frequency, the inflow hydrograph into Lakes Kissimmee, Hatchineha, and Cypress has already passed the peak and has dropped to below 11,000 cfs before S-65 is opened up to the 11,000 cfs maximum discharge. Therefore, the peak stage in Lake Kissimmee would occur at the time discharge at S-65 is increased to 11,000 cfs. Before C-38 was built, the outlet capacity of Lake Kissimmee was impacted by backwater effects from the reach of Kissimmee River immediately downstream of the lake. The maximum discharge recorded from Lake Kissimmee prior to the project was 8,800 cfs and occurred during the 1948 flood at a peak stage of about 57.0 feet. Today, the 11,000 cfs outlet capacity is available any time there is a 2.5-foot head differential across S-65. During floods, the full capacity usually becomes available on a rising stage in Lake Kissimmee at about 51 feet.

d. Regulation of Lakes Kissimmee, Hatchineha, and Cypress with Level II Backfilling Plan. The proposed regulation schedule is shown in Appendix B, Figure B-9. Primarily, this schedule raised the maximum stage of Lakes Kissimmee, Hatchineha, and Cypress from 52.5 feet to 54.0 feet; however, there are other differences. The new schedule proposed that, during March, the level of these lakes should not be allowed to rise or fall at a rate greater than 0.1 feet per week. This was based on a recommendation by the Florida Game and Fresh Water Fish Commission to facilitate fish spawning. There was also a minimum discharge requirement of 250 cfs at all times, except during March or when the Lakes were below 48.5 feet.

The new schedule shows a maximum 1 September stage of Lakes Kissimmee, Hatchineha, and Cypress of 52.5 feet. These are the date and starting water surface elevation used in the SFWMD hydrologic analyses. Accordingly, some discussion on the relationship of the regulation schedule to flood stages on the lakes is warranted. Theoretically, floods can occur almost any time. Therefore, the probability of a specific flood stage in Lake Kissimmee is a joint probability of antecedent lake stage and rainfall. Specifically, the total probability is the integral summation of the product of all the possible combinations that would produce that stage. The more traditional approach has been to start the storm at an average lake level which is usually represented by the 1 September stage on the regulation schedule. This was the approach followed in the 1990 and 1991 feasibility reports and all prior studies of the Kissimmee River Basin. However, the capabilities of the UKISS and UNET models enabled a joint probability approach to be used for the first time during the current study for the Middle Basin flood routings.

6. Hydrology/Rainfall

Current Rainfall Procedure. The rainfall frequency analysis performed for this study included a review of the following:

Central and Southern Florida Project, Partial Definite Project Report, Part VI, Section 6. U.S. Army Corps of Engineers (September 1953)

Central and Southern Florida Project, General Design Memorandum - Kissimmee River Basin, Part II, Supplement 5. U.S. Army Corps of Engineers (1956)

Technical Paper No. 40 - Rainfall Frequency Atlas of the United States for Durations from 30 Minutes to 24 Hours and Return Periods from 1 to 100 Years. U.S. Department of Commerce, Weather Bureau (1961)

Technical Paper No. 49 - Two to Ten Day Precipitation for Return Periods of 2 to 100 Years in the Contiguous United States. U.S. Department of Commerce, Weather Bureau (1964)

ESSA Technical Report WB-7 , Frequency and Areal Distributions of Tropical Storm Rainfall in the United States Coastal Region on the Gulf of Mexico. U.S. Department of Commerce, Weather Bureau (1968)

Rainfall Analysis of Orange and Seminole Counties, based on eight long term daily rainfall gages. U.S. Army Corps of Engineers (1977)

NOAA Technical Report NWS 24, A Methodology for Point to Area Rainfall Frequency Rations. (1980)

Technical Publication 81-3, Frequency Analysis of Rainfall Maximums for Central and Southern Florida. South Florida Water Management District (1981)

Central and Southern Florida Project, Kissimmee River, Florida Feasibility Report. U.S. Army Corps of Engineers (1985)

The current study utilizes a combination of new analyses performed strictly for this report as well as previous data which was the product of detailed and comprehensive studies performed for the 1985 feasibility report. Any new rainfall values (i.e., 24-, 48-, 72-, 96-, and 120-hr amounts) generated were based on accepted methodologies outlined in the above listed standard technical publications. Previous information, such as the 30-day basin wide rainfall amounts published in the 1985 and 1991 reports, have again been used because

of the thoroughness and expertise obvious in the original data development. However, the current study does embrace a different assumption as to the distribution of a "balanced storm" which results in greater run-off values when applied to HEC-1. The procedure for computing the rainfall for this study is outlined below:

Before the rainfall values taken from isopluvial maps from different sources could be compared, the rainfall amounts may have needed adjustments for several statistical factors. The point rainfall amounts given in isopluvial maps in TP 40 and 49 are for n-hour precipitation rather than observational-day precipitation. Accordingly, no adjustment is needed to convert from daily to hourly rainfall. However, the TP 40 and 49 statistical analyses use all high rainfall values (partial duration series) rather than yearly peaks (annual series). Therefore, the values taken from isopluvial maps in TP 40 and 49 require the following adjustments as shown below in Table A-1.

TABLE A-1

Partial to Annual Series Conversion Factors

	CONVERSION FACTOR FROM PARTIAL TO ANNUAL SERIES
2-YEAR	0.88
5-YEAR	0.96
10-YEAR	0.99
25-YEAR	1.00
50-YEAR	1.00
100-YEAR	1.00

The rainfall values contained in SFWMD Technical Publication 81-3 are based on annual series which do not require the above adjustment. However, the rainfall data analyzed were based on observational-day precipitation. Therefore, adjustments shown below in Table A-2 were made to convert the results to n-hour precipitation.

TABLE A-2

Daily to Hourly Precipitation Conversion Factors

FACTORS TO CONVERT DAILY TO HOURLY PRECIPITATION	
1 DAY TIMES 1.13 =	24 HOUR
2 DAY TIMES 1.04 =	48 HOUR
3 DAY TIMES 1.03 =	72 HOUR
4 DAY TIMES 1.03 =	96 HOUR
5 DAY TIMES 1.02 =	120 HOUR
6 DAY TIMES 1.02 =	144 HOUR
7 DAY TIMES 1.02 =	168 HOUR
8 DAY TIMES 1.02 =	192 HOUR
9 DAY TIMES 1.01 =	216 HOUR
10 DAY TIMES 1.01 =	240 HOUR

1. The isopluvial maps from NOAA Technical Publication 40 (1961) were used to develop 3-, 6-, 12-, and 24-hour point rainfall for annual recurrence frequencies of 2, 5, 10, 25, 50, and 100 years.

2. Using isopluvial maps in NOAA Technical Publication 49 (1961), the duration for the above frequencies was extended to 96, 168, and 240-hour point rainfalls.

3. SFWMD Technical Publication 81-3 was used to develop the 24, 48, 72, and 120-hour point rainfalls for frequency intervals ranging from 3-year to 100-year. Published in 1981, SFWMD TP 81-3 contains an additional 20 years of rainfall record over the NOAA reports and was used to develop a more consistent and current set of data.

A comparison of the TP 40 and 49 values with the SFWMD TP 81-3 numbers is shown in Table A-3 below.

TABLE A-3

Comparison of TP-40 and TP-49 with SFWMD TP 81-3
(Rainfall Depth in Inches)

	2-YR	3-YR	5-YR	10-YR	25-YR	50-YR	100-YR
NOAA TP-40							
6-HR	3.5		4.5	5.5	6.0	7.0	8.0
12-HR	4.3		5.3	6.3	7.5	8.3	9.0
24-HR	4.8		6.5	7.5	8.5	9.5	11.0
NOAA TP-49							
72-HR							
96-HR	6.7		8.2	9.8	11.8	13.4	15.4
120-HR							
168-HR	7.7		9.7	11.2	13.8	15.3	17.9
240-HR	8.6		11.1	13.6	15.2	17.7	19.2
SFWMD TP 81-3							
24-HR		5.0	5.6	7.6	9.6	10.7	11.9
48-HR		6.0	7.0	8.8	10.4	12.0	13.5
72-HR		6.4	7.7	9.8	11.8	12.6	14.4
120-HR		7.1	8.2	10.2	12.2	13.3	15.3

4. 30-Day Rainfall

The Corps' 1985 Kissimmee River study included a statistical analysis of monthly rainfall in the Kissimmee Basin. Analyses were carried out to determine the 30-day rainfall frequency at selected rain gages in the basin. The Thiessen polygon method of averaging the point rainfall frequency determined at these gages was used as the average point rainfall for the basin. Analyses were also carried out to determine the 30-day areal reduced basin rainfall frequency. This was obtained by analysis of Thiessen average daily rainfall data for the basin. The procedure for these analyses are contained in NOAA Technical Report NWS 24, A Methodology for Point-to-Area Rainfall

Frequency Ratios, Washington D.C., February 1989. Average point 30-day rainfall and average 2300 square mile basin rainfall are displayed in Figure A-2 of the 1985 report. The latter was also used for the current study and is shown Table A-4 below.

TABLE A-4

Kissimmee Basin (2300 Sq. Mile) Rainfall from 1985 Report

RAIN (in.)	DURATION (DAYS)					
FREQUENCY	1	2	5	10	20	30
5-YEAR	5.78	7.16	8.30	9.67	11.85	**13.42**
10-YEAR	6.40	7.92	9.18	10.69	13.11	**14.84**
50-YEAR	7.64	9.46	10.96	12.76	15.64	**17.71**
100-YEAR	8.14	10.08	11.68	13.60	16.67	**18.88**
SPF	9.28	11.48	13.31	15.50	19.00	**21.51**

Used in
This Study

5. After applying the correction factors to adjust to hourly rainfall and annual series, the point rainfall values from 3-hour to 10-day obtained from the NOAA and SFWMD TP's, as well as the 30-day point rainfall from the 1985 report, were graphed for each frequency (5-yr, 10-yr, 25-yr, 50-yr, 100-yr, and SPF). A set of parallel curves were then fit through all the available data to obtain a smooth curve for each of the six frequencies. It should be mentioned that the SFWMD TP 81-3 24-hour values were used exclusively since the TP 40 24-hour values appeared low when plotted on the graph.

6. From the above plotted rainfall versus duration frequency curves, the 1-, 2-, 3-, 4-, and 5-day (in hour) values were extracted from the graph to be used in the 5-day storm portion of the 30-day rainfall. See Table A-5 below.

TABLE A-5

Point Rainfall Values Extracted From Plotted Curves

Rainfall (in)	RETURN PERIOD IN YEARS						
DURATION	2	5	10	25	50	100	SPF
24-HR	5.20	6.40	7.53	9.15	10.60	11.90	14.88
48-HR	5.70	7.20	8.55	10.40	12.05	13.50	16.88
72-HR	6.10	7.70	9.10	11.05	12.80	14.35	17.94
96-HR	6.50	8.20	9.60	11.70	13.40	15.20	19.00
120-HR	6.85	8.65	10.10	12.40	14.00	16.10	20.13

7. Using NOAA Bulletin 52-8, the point rainfall values shown in Table A-5 were multiplied by the following factors to account for areal reduction of the 1600 square mile Kissimmee River basin. See Table A-6 below.

TABLE A-6

Areal Reduction Factors

DURATION	REDUCTION FACTOR TO 1600 SQUARE MILE KISSIMMEE BASIN
24-HR	0.77
48-HR	0.78
72-HR	0.79
96-HR	0.80
120-HR	0.81

8. After applying the reduction factors to the point rainfall values in Table A-5 and utilizing the 30-day areally reduced rainfall from the 1985 report, the following basin (1600 square mile) rainfall values were adopted for the current study. See Table A-7 below.

TABLE A-7

Kissimmee Basin (1600 Sq. Mile) Rainfall

Rain (in.)	RETURN PERIOD IN YEARS						
DURATION	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR	SPF
24-HR	4.004	4.928	5.798	7.046	8.162	9.163	11.454
48-HR	4.446	5.616	6.669	8.112	9.399	10.530	13.163
72-HR	4.819	6.083	7.189	8.730	10.112	11.337	14.171
96-HR	5.200	6.560	7.680	9.360	10.720	12.160	15.200
120-HR	5.549	7.007	8.181	10.044	11.340	13.041	16.301
30-DAY	N/A	13.42	14.84	16.70	17.71	18.88	21.510

9. From Table A-7 the rainfall values for the peak five days of a 30-day storm for a given frequency were determined as follows:

No. 1 peak day = (24HR value)
No. 2 peak day = (48HR value - 24HR value)
No. 3 peak day = (72HR value - 48HR value)
No. 4 peak day = (96HR value - 72HR value)
No. 5 peak day = (120HR value - 96HR value)

For the variation of the daily basin rainfall values from 6 days to 30 days, the same procedure used in the 1985 report was again followed for the current study. For each frequency the difference between the 30-day rainfall and 5-day (120-HR) rainfall totals, both shown in Table A-7, will be varied according to the 1953 pilot storm used in the 1985 report. The rainfall between the fifth and thirtieth day will also be adjusted in magnitude proportionally so that the total rainfall adds up to the 30-day totals shown in the above table. A comparison of the peak 5-day rainfall (before evaporation) between the 1985 report and the 1995 (current) study is shown below in Table A-8:

TABLE A-8

Peak 5-Day Rainfall(Inches) for Two Corps Reports

Rain (in.)	5-YR		10-YR		25-YR	
DAY	1985	1995	1985	1995	1985	1995
1	0.3476	0.447	0.3844	0.491	N/A	0.618
2	0.3650	0.477	0.4036	0.520	N/A	0.684
3	0.4241	4.928	0.4689	5.7988	N/A	7.045
4	1.3769	0.688	1.5226	0.871	N/A	1.067
5	5.788	0.467	6.4005	0.501	N/A	0.631

Rain (in.)	50-YR		100-YR		SPF	
DAY	1985	1995	1985	1995	1985	1995
1	0.4587	0.608	0.489	0.807	0.5571	1.008
2	0.4817	0.713	0.5135	0.881	0.5851	1.101
3	0.5596	8.162	0.5966	9.163	0.6797	11.454
4	1.817	1.237	1.9371	1.367	2.2069	1.709
5	7.6383	0.620	8.1429	0.824	9.2773	1.029

10. Losses in this study due to initial abstraction and ground storage were accounted for by the SCS curve number technique. However, the SCS procedure is based upon rainfall occurring in a 24-hour period. Accordingly, the curve method would likely overestimate the losses for a 30-day storm. Thus, for a given amount of rainfall less runoff will occur if that rain occurs over a 30-day period than it would over a 24-hour period. One of the additional losses over a 30-day period is evaporation. In Florida, a general estimate of evaporative losses is about 1 inch per week. The 1985 report, and likewise the current study, adopted 3.8 inches of evaporative losses for the 30-day flood event. With the exception of the peak day, the 3.8 inches of evaporation were subtracted from each day's rainfall proportionally to the rainfall magnitude. Evaporation on the peak rainfall day is usually assumed to be very low and is therefore not included.

11. The 1985 report had the peak five days of rainfall distributed in the first five days of the storm. The rain was assembled in ascending order with the peak rain occurring on the fifth day. However, analyses showed that if this arrangement was used in conjunction with the SCS curve number technique, the result would be to extract too many losses out of the first five days of the storm. Accordingly, to approximate a balanced storm, the peak five days were moved to the center of the 30-day storm and arranged in a 5, 3, 1, 2, 4 distribution. Table A-9 below shows the rainfall amounts (after losses) used to generate the HEC-1 flood hydrographs for this study.

TABLE A-9

1995 Daily Rainfall and Distribution
(include evaporation losses)

1995 Study (Day)	1985 Report (Day)	5-YR	10-YR	25-YR	50-YR	100-YR	SPF
1	6	0.053	0.058	0.0603	0.057	0.053	0.048
2	7	0.222	0.242	0.2529	0.240	0.223	0.203
3	8	0.106	0.115	0.1206	0.115	0.106	0.097
4	9	0.192	0.210	0.2190	0.208	0.193	0.176
5	10	0.373	0.406	0.4243	0.403	0.374	0.341
6	11	0.030	0.032	0.0338	0.032	0.030	0.027
7	12	0.090	0.098	0.1026	0.098	0.090	0.082
8	13	0.339	0.370	0.3862	0.367	0.340	0.310
9	14	0.241	0.262	0.2740	0.260	0.241	0.220
10	15	0.101	0.110	0.1153	0.110	0.102	0.093
11	16	0.215	0.234	0.2444	0.232	0.215	0.196
12	17	0.030	0.032	0.0338	0.032	0.030	0.027
13	2	0.264	0.285	0.3823	0.366	0.501	0.640
14	4	0.380	0.505	0.6467	0.745	0.832	1.063
15	5	4.928	5.798	7.0455	8.162	9.163	11.454
16	3	0.258	0.301	0.3744	0.429	0.491	0.627
17	1	0.247	0.290	0.4147	0.373	0.537	0.685
18	18	0.101	0.110	0.1153	0.110	0.102	0.093
19	19	0.117	0.128	0.1333	0.127	0.117	0.107
20	20	0.249	0.271	0.2836	0.270	0.250	0.228
21	21	0.189	0.206	0.2148	0.204	0.189	0.172
22	22	0.124	0.136	0.1418	0.135	0.125	0.114
23	23	0.143	0.156	0.1629	0.155	0.144	0.131
24	24	0.026	0.028	0.0296	0.028	0.026	0.024
25	25	0.011	0.012	0.0126	0.012	0.011	0.010

TABLE A-9 (Continued)

1995 Daily Rainfall and Distribution
(includes evaporation losses)

1995 Study (Day)	1985 Report (Day)	5-YR	10-YR	25-YR	50-YR	100-YR	SPF
26	26	0.000	0.000	0.0000	0.000	0.000	0.000
27	27	0.121	0.132	0.1375	0.131	0.121	0.110
28	28	0.072	0.078	0.0814	0.077	0.072	0.065
29	29	0.286	0.312	0.3259	0.310	0.287	0.262
30	30	0.113	0.124	0.1291	0.123	0.114	0.104
Totals(inches)		9.620	11.041	12.9000	13.911	15.081	17.710

7. Hydrologic Models.

a. HEC-1 Flood Hydrograph Model.

(1) General. The Corps' flood hydrograph model (HEC-1) was used to compute flood discharges for the 5-year, 10-year, 25-year, 50-year, 100-year, and SPF storm frequencies. The Kissimmee Basin was divided into seventy-four sub-basins with twenty-four of the sub-basins draining into the upper/middle chain of lakes and the remaining fifty draining into the four pools along C-38 from S-65 to S-65D. The model simulates the rainfall runoff response to the watershed by representing the basin as a system of hydraulically connected sub-basins. Each sub-basin is simulated as a group of hydrologic and hydraulic parameters which describe aspects of the rainfall runoff process within each sub-basin. Principal parameters used in the hydrologic simulation are average basin rainfall, infiltration, losses, land slope, soils, stream length, soil cover, and land use. Another parameter used was the SCS's formula of small watershed lag. This is a mathematical composite of several hydrologic parameters.

Dimension-less unit hydrographs generated by HEC-1 were used to model the rainfall runoff process in the Kissimmee River basin. However, the standard unit hydrograph shape, developed by the Soil Conservation Service (SCS) based on the ratio between the rising and falling limbs of a triangular unit graph, were inappropriate for the area. The shape of the unit hydrographs were instead patterned after those presented in the Kissimmee River GDM, Part II, Supplement 5 (1956). The standard peak rate factor was changed from

484 to 312 which produced unit hydrographs with lower peak flows and longer recession limbs.

Principal hydraulic parameters used in the HEC-1 model are channel conveyance, channel roughness, and channel storage. These parameters are primarily used to route storm runoff hydrographs through channel storage to downstream junctions. However, the existing Kissimmee River (C-38) is highly regulated and outflows are predominately tailwater driven. Therefore, a new routing model was required. HEC-1 was used to develop the inflow hydrograph for input into the new routing model, UNET.

(2) Middle Basin HEC-1 Model.

(a) General. The Upper Basin is divided into a Middle Basin Chain of Lakes and an East and West Upper Chain of Lakes. Due to a limited scope of new topographic surveys, a revised HEC-1 model was developed strictly for the Middle Basin Chain of Lakes. Hydrology and routings for the East and West Upper Chain of Lakes were obtained from a previous study and input as upstream inflow hydrographs into the current HEC-1 model at the S-63A and S-61 boundary locations. A subsequent report will address the hydrology and hydraulic performance of the Upper Chain of Lake's flood control system to determine if the canals and water control structures in the system should be modified.

The Middle Basin drainage area was divided into 22 sub-basins extending from the northern boundary of the watershed near Orlando to the southern outlet of the basin at S-65. The basin divides were developed from a compilation of previous Corps and SFWMD studies and new analysis of existing USGS quadrangles. Basin divides were digitized and drainage areas computed with a measuring feature in the CADD software MicroStation. Sub-basins were delineated for each of the 10 major lakes (Kissimmee, Hatchineha, Cypress, Rosalie, Tiger, Jackson, Marian, Weohyakapka, Marion, and Pierce) in the chain as well as for certain tributaries and natural storage basins which tend to attenuate peak flows. In particular, Lake Marion Creek, Catfish Creek, Horse Creek, Tiger Creek, and Reedy Creek tributaries were modeled for this purpose. Non-contributory drainage areas based on USGS quadrangle topography were also identified within certain sub-basins and deleted from the runoff contribution to the overall basin.

Previous HEC-1 modeling of the Middle Basin upstream of S-40 along Reedy Creek had separated the approximately 184 square mile area into 6 sub-basins divided along topographic divides. This most upstream region of the Middle Basin is characterized by a myriad of small and medium-sized lakes which normally represent some storage potential in a storm event. Historical gaging

records along Reedy Creek near Loughmann indicate a peak discharge of less than 1,000 cfs for the contributory drainage area of 110 square miles during the 1940-1988 period of record. Based strictly on drainage area, this discharge value appears low and indicates that there are likely attenuating factors within the basin which warrant further study. Apparently, some of the flow attenuation can be attributed to the restriction of Reedy Creek at the U.S. 17 railroad and highway bridge crossings just upstream of Loughmann which results in the diversion of some flow to Lake Tohopekaliga.

To better estimate the storage potential of Reedy Creek upstream of S-40, the Reedy Creek Improvement District (RCID) was contacted and information on their UNET modeling results for 10-year and 100-year/3-day storm events centered over the upper Reedy Creek Basin was obtained. Results from their detailed UNET modeling indicate that the peak discharges at S-40 for the 10-year and 100-year events are 2984 cfs and 3791 cfs, respectively. Utilizing this flow information, a storage-discharge relationship was developed in HEC-1 for the 184 square mile sub-basin calibrated against the RCID UNET values. This storage-discharge relationship more accurately reflects the storage and routing potential of the basin than the previous multiple sub-basin approach.

(b) Basin Data. Summation of the areas for the 22 sub-basins resulted in a total drainage area for the Middle Basin of 945 square miles. In conjunction with the combined drainage area of 631 square miles for the East and West Chain of Lakes at S-63A and S-61, the total drainage area for the Upper Kissimmee Basin at S-65 is approximately 1576 square miles.

Except for the Upper Reedy Creek Basin, curve numbers for each of the sub-basins are essentially the same as those used in the larger basins delineated in the Corps' previous studies in 1985 and 1991. However, due to the physical reconfiguration of sub-basins the hydrologic parameter of lag was recomputed for the current study effort. Various lag formulas and methodologies were used to compute an average lag value for each sub-basin, although the SCS and Manning's approaches were predominantly utilized in the final selection. Table A-10 lists some of the hydrologic parameters for the Middle Basin sub-basins. The drainage areas and divides for the Middle Basin are shown on Plate A-1.

(c) Routing Data. Stage/volume relationships for lakes and lake outlet rating curves were obtained from the original 1956 Kissimmee GDM as well as other sources including USGS quadrangle measurements, SFWMD records, and more recent topographic surveys around the lakes.

(d) Base Flow Factors. Base flow factors, in cfs per square mile, were developed for each of the storm frequencies by calibrating HEC-1 stages on Lake Kissimmee with observed historical stages for a known storm. These

factors are useful in establishing a base flow condition within the basin often the result of significant antecedent moisture conditions or persistent groundwater contributions to the basin runoff. The historical floods selected for model calibration were the 1953, 1960, and 1969 storms. According to frequency analyses performed by the Corps and SFWMD, the 1969 storm represents approximately a 20-year event and is the most severe storm to date with the flood control project in-place. The 1953 and 1960 storms occurred prior to the C-38 channelization and represent between a 40 to 50 year event. The final base flow factors selected were 1.375, 1.375, 1.875, 1.875, 2.20, and 2.75 for the 5-year, 10-year, 25-year, 50-year, 100-year, and SPF frequencies, respectively.

(e) Existing and With-Project Conditions. The first attempt in computing existing and with-project flood stages for Lake Kissimmee under a series of storm events was made with the HEC-1 Middle Basin model. The major difference in the modeling for the two conditions is the method in which outflows from Lake Kissimmee through S-65 are addressed. The existing conditions operation of S-65 is governed by local inflows into Pool A which require that S-65 discharges be reduced to 3,000 cfs when tailwater reaches a predetermined stage. Since HEC-1 is incapable of assessing tailwater impacts, discharges out of S-65 were obtained from a previous CHANOP analysis which is specifically adapted to complex structure operations. These CHANOP discharges were applied to the HEC-1 model in the form of an inflow hydrograph coupled with an outlet rating curve which produced the same net outflows from the system as the CHANOP values. For the with-project or backfill condition, outflows from the HEC-1 model through S-65 were modeled as a stage-discharge rating curve based on the original concept of a 6,000 cfs firm and 11,000 cfs full discharging structure. The rating curve still assumes that the stated discharges will be available at the given headwater stage and is not capable of determining if downstream tailwaters in the Lower Basin will restrict discharges. The obvious limitations in HEC-1 to assess the S-65 tailwater impacts lead to the selection of a comprehensive routing model (UNET) integrating the Middle and Lower Basins in a dynamic mode. Although superseded by subsequent UNET results, Table A-11 shows the original HEC-1 stages computed for Lake Kissimmee under existing and with-project conditions.

(3) Lower Basin HEC-1 Model.

(a) General. The HEC-1 model for the Kissimmee Lower Basin extends from S-65 to S-65D and develops runoff for the basins and tributaries which drain into C-38. The lower basin was not modeled downstream of S-65D because the current backfill reach terminates upstream of S-65D and tailwater effects impacting the discharge of S-65D are not expected because of the large

discharge capacities of S-65D and S-65E and the downstream proximity of Lake Okeechobee. In contrast to previous HEC-1 studies by the Corps in 1985 and SFWMD in 1990, the current modeling effort delineates various sub-basins within each of the four main pools. The majority of the sub-basins are associated with a tributary stream or slough which drains into C-38. Due to the upland nature and ample slope of most of the tributaries, all runoff from the sub-basins is unrouted and reaches C-38 with a negligible backwater effect. The lower basin HEC-1 model was developed strictly to provide hydrograph input for the integrated flood routing model, UNET, and is not capable of computing flood stages for the lower basin.

(b) Basin Data. The majority of the 50 sub-basins in Pools A through D were delineated in the Corps' 1991 Feasibility Report. The current effort involved digitizing and measuring the drainage areas, recomputing lags for the more critical basins in Pools A and B, and utilizing the same curve numbers which were used in the 1985 and 1991 Corps studies. Some minor redefinition of sub-basin boundaries occurred in Pools A and B where inflow and potential tailwater effects on S-65 could affect the performance of the Middle Basin project. However, an effort was made to maintain the overall drainage area of 626.6 square miles between S-65 and S-65D. Table A-12 lists some of the hydrologic parameters for the lower basin sub-basins. Also, Table A-13 provides a comparison by Pool of lower basin drainage areas between this report and previous studies. Drainage areas and divides are shown for the Lower Basin on Plate A-2.

b. UNET.

(1) General. UNET, a one-dimensional unsteady flow program, was the dynamic-routing model used to simulate flood flows and stages in a fully developed network of open channels and storage areas. UNET was originally developed by Dr. Robert Barkau and is available for U.S. Army Corps of Engineer's use through the distribution and support of the Hydrologic Engineering Center (HEC), Davis, California.

UNET is particularly effective in solving split flow in two or more channels, especially when the flow is subcritical and the division of flow depends on the stages in the receiving channels. These stages are a function of channel geometry and downstream backwater effects. Another feature of UNET is the storage area which can provide or divert water from a channel based on the water surface elevation in the storage area. In addition to solving the continuity and momentum equations for the network system, UNET provides the user with the ability to apply several external and internal boundary conditions, including: flow and stage hydrographs, gated and uncontrolled spillways, bridges, culverts, and levee systems.

UNET input generally consists of a CSECT or geometry file which defines the physical configuration of the hydraulic network including reach connections, channel cross-sections, storage area sizes, and structures (i.e., culverts, bridges, spillways). To facilitate model application, UNET cross-sections are input in a modified forewater HEC-2 format. Secondly, the UNET or .BC input file contains all the internal and external boundary conditions (i.e., hydrographs, gate opening sequences, rating curves) which are applied to the CSECT file.

Both the Corps' 1991 Feasibility Report and the 1990 SFWMD Report utilized CHANOP as the Middle Basin hydraulic routing model and DWOPER as the Lower Basin model. The current study utilizes UNET exclusively in both the Middle and Lower Basins. UNET is particularly superior to CHANOP in simulating the dynamic interplay between flow and stage for the various interconnecting lakes in the Middle Basin. Unlike CHANOP, UNET allowed the three main stem lakes (Kissimmee, Hatchineha, and Cypress) to be modeled as separate entities thereby identifying the respective headlosses between the lakes and ultimately leading to an optimization of design channel enlargements for Canals 35, 36, and 37. Due to modeling constraints and a lack of topographic information in the canals, previous studies in 1990 and 1991 had computed a common peak flood stage for the three lakes.

(2) Middle Basin UNET Model.

(a) General. As with the HEC-1 model, a UNET model was developed initially only for the Middle Basin above S-65. However, consideration of potential tailwater effects restricting the discharge from S-65 eventually lead to the development of a Lower Basin UNET model as well.

Figure A-1 shows a schematic of the UNET models for the Middle Basin under existing and with-project conditions. The CSECT or cross-section files for these two models are identical. It is only the UNET or boundary condition input files which vary. However, it is with the boundary condition files by which the increased lake regulation schedule and the different S-65 operating criteria between existing and with-project conditions are reflected in the model. The existing conditions flood routing model accounts for the fluctuation of starting water surface elevations on Lakes Kissimmee, Hatchineha, Cypress, and Tiger between elevations 49.0 to 51.0 feet, the with-project condition model accounts for possible stages between elevations 48.5 to 52.5 feet.

Although there are additional lakes in the Middle Basin, only the lakes which would potentially be impacted by a change in the Lake Kissimmee regulation schedule are included in the UNET model. However, hydrology and HEC-1 flood routings were also developed for the other major lakes (i.e., Lakes Weohyakapka, Marion, and Pierce) and input as upstream boundary

hydrographs into the UNET model shown. The previous hydrologic modeling for the Upper Basin chain of lakes was included in the current UNET model as upstream boundary hydrographs at the S-61 and S-63A locations.

(b) Topographic Input Data. Survey cross-sections for the majority of the canals and tributaries connecting the major lakes of the Middle Basin were obtained in 1991 to assist in constructing the UNET model. New cross-sections taken at 500 foot intervals were obtained along Canals 34, 35, 36, and 37. Cross-sections surveyed at wider-spaced intervals were obtained for the canals and tributaries connecting the branch lakes (i.e., Jackson, Marian, Rosalie, Tiger) with the main stem of lakes. These sections were used to evaluate the effects of the increased Lake Kissimmee regulation schedule on the branch lakes.

Existing cross-sections taken in 1979 were used to model the Short Canal reach. Also, in an attempt to account for the storage potential of the Reedy Creek basin downstream of S-40 to Lake Cypress, cross-sections were developed for this and the Dead River from USGS quadrangle map contours.

(c) Structural Input Data. Survey data for bridges crossing the Canals 34, 35, and 37 were obtained along with the channel cross-sections in 1991. Hydraulic data and dimensions for the Lake Rosalie Control Structure (G-103) and Lake Marion Control Structure (G-113) were obtained from the SFWMD Structures Description Manuals. The Lake Jackson Structure Feasibility Study published by SFWMD provided design data for the proposed culvert structure and Jackson Canal channel improvements.

(3) Lower Basin UNET Model.

(a) General. The UNET Lower Basin model was developed subsequent to the Middle Basin model and was joined with the latter to form an integrated model for the purpose of: 1) evaluating potential tailwater effects of high stages in Pools A and B on the discharge capacity of S-65 and thus the hydraulic performance of the Middle Basin project; 2) modeling the Lower Basin under the backfill condition to compare lower basin flood stages with values published in the 1991 Feasibility Report. The establishment and comparison of the UNET lower basin flood values is critical in determining the need for additional land acquisitions in the lower basin, particularly since SFWMD's land acquisition program is already underway.

Refer to Figures A-2 and A-3 for schematics of the lower basin UNET model. The model essentially consists of one reach, C-38, which extends from S-65 to S-65D. The fifty hydrographs generated from the HEC-1 lower basin model are input at lateral inflow locations to represent inflows into C-38 from

contributory sub-basins, tributaries, and canals. The lateral inflows were not modeled as separate UNET reaches because of a lack of accurate topographic data; however, review of the USGS quadrangle map contours indicated that because of their upland nature and ample slope, particularly the critical tributaries in Pools A and B, the majority of tributary flood hydrographs would reach the Kissimmee River floodplain with little attenuation due to storage. Because of this assumption, it was crucial that the C-38 cross-sections in the lower basin model extend sufficiently to high ground to account for all available storage within the floodplain.

Unlike the Middle Basin model, both the CSECT and boundary condition input files for the lower basin vary between existing and with-project conditions. This is because physical reconfiguration of the C-38 reach occurs in the with-project (with backfill) condition. Some of the physical changes include the backfilling of C-38 from reach mile 39.30 in Pool B to reach mile 17.10 in Pool D, the complete removal of S-65B, S-65C and their associated tieback levees, and the partial degrading of the S-65A tieback levees. The backfilling of C-38 also involves the selection of an increased Mannings "n" roughness value for the revegetated section of the floodplain adjacent to the restored river.

S-65 is modeled as a submerged-controlled rating curve which computes a given discharge based on a corresponding set of headwater and tailwater conditions at the structure. The discharge (Q)used in the rating was computed from the standard flow equation:

$$Q=cA\sqrt{(2gH)}$$

c (structure discharge coefficient) = 0.75
A (flow area) = total width of structure gates x gate opening
H (hydraulic head) = headwater-tailwater stage

Under both existing and with-project conditions, the assumption is that full available discharges are made from the structure when the headwater reaches 0.2 feet above schedule. However, under existing conditions, S-65 discharge is then reduced to 3,000 cfs, regardless of headwater, when the tailwater reaches 49 feet. This constraint is designed to not exceed the design inflow capacity at

S-65A and thus avoid flooding in Pool A. S-65A and S-65B, under existing conditions, are also modeled as submerged rating curves allowing full available discharges with no additional restrictions applied.

Because of the elevation of the tieback levees at each structure, floodplain flows moving downstream under the existing system will be forced to discharge through each of the S-65(A-D) structures before entering the next downstream Pool. However, under the with-project (backfill) conditions, there is potential for concentrated flow through the structure and overland flow around the structure because of the significantly lowered tieback levees at S-65A. UNET modeling for this situation was handled with the CSECT spillway option in conjunction with modifying the tieback levee cross-section. The spillway option calculated flow through the S-65A structure based on given data of crest elevation, gate width, discharge coefficient, and a time series of gate openings. Overland flow across the levee was computed by the standard UNET equations solving flow, conveyance, and stage between cross-sections.

(b) S-65 Operation. The existing flood control project is designed to convey a 30 percent SPF (approximately a 7-year event) flood event within the C-38 canal, which translates to approximately an 11,000 cfs peak flowing in Pool A. The local sponsor currently owns the lands necessary to withstand the 11,000 cfs flow in Pool A at a design headwater of elevation 46.3 feet at S-65A (translates to about elevation 49.5 feet at S-65 tailwater). S-65 is operated such that the total discharge at S-65A (S-65 releases plus local inflow into Pool A) does not exceed 11,000 cfs and therefore maintains flood stages within available sponsor-owned lands. Under the with-project condition, backwater effects from the restored river section in Pool B under a 30 percent SPF flow already translate to a peak stage at the S-65 tailwater of about elevation 51.5 feet. Any attempt to maintain a tailwater comparable to existing conditions would require the reduction of S-65 releases to less than 5,000 cfs, which in turn would lead to an unacceptable rise in the Lake Kissimmee and Upper Basin lake stages. Therefore, in order to maintain the flood protection upstream of S-65, S-65 must be operated to make full available discharges to the Lower Basin.

(c) Topographic Input Data. The detailed topographic information needed to define the floodplain geometry in the UNET Lower Basin model was developed primarily from cross-section surveys obtained by the Corps in 1993-1994. Cross-sections at approximately 1000-foot stations were obtained along a baseline that followed the C-38 alignment from S-65 downstream to S-65D. Since UNET is a one-dimensional flow model, cross-sections were taken generally perpendicular to the flow path and extending outward to encompass the SPF flood stage. The cross-sections, particularly on the east side of the basin, extend across a large portion of the contributory sloughs and thus

account for the majority of the available storage in the floodplain. During subsequent design memorandums for the Kissimmee River Restoration, two-dimensional flow modeling, utilizing a detailed topographic grid for the entire floodplain and major sloughs, will be used to better define lower basin flood stages as well as evaluate the hydrologic performance of the "restored" system.

(d) Structural Input Data. The UNET submerged rating curves for S-65, S-65A, S-65B, and S-65C and the downstream rating curve for S-65D were developed from design and as-built data compiled on each spillway structure. This data is published in the U.S. Army Corps of Engineer's (Jacksonville District) document, "Water Control Manual for Kissimmee River - Lake Istokpoga" dated November 1994. Included in the manual are a brief description, operating criteria, hydraulic design data, discharge rating curves, and maximum allowable gate openings for each S-65(A-E) structures.

(4) UNET Model Evolution.

(a) General. The development of the UNET model into a fully-integrated hydrologic routing tool for the Kissimmee River basin followed a logical, deliberate progression intended to provide increasingly accurate and comprehensive results. To this end, new topographic information for Pools A, B, C, and D continues to be incorporated into the model as it becomes available. Flexibility of the model also allows for relatively simple incorporation of alternative proposals including new water control structures or physical reconfiguration of existing channels, levees, and roadways.

(b) Middle Basin Model.

(i) Existing Conditions. Initially the existing conditions Middle Basin UNET model was a mixture of a UNET network combined with previous CHANOP results. Because the operation of S-65 was so closely linked to downstream tailwater, it was virtually impossible to model S-65 with a UNET rating curve based solely on headwater, as was assumed for the with-project condition. Therefore, the previous S-65 discharges developed by CHANOP were applied to the UNET model in a manner similar to the HEC-1 existing conditions model. However, this combination of modeling results was unsuccessful and deemed unacceptable. The necessity of constructing a UNET model to assess tailwater effects on S-65 discharges ultimately lead to the development of the Lower Basin and fully-integrated UNET models which resulted not only in improved results for existing conditions, but eventually for the with-project conditions as well.

(ii) With-Project Conditions. The first model consisted of the network shown on Figure A-1. S-65 was modeled as a downstream rating curve

with discharges restricted to 6,000 cfs or less until Lake Kissimmee reached a stage of elevation 53.8 feet. Maximum discharge for S-65 was set at the design discharge of 11,000 cfs and was available at a minimum stage of 53.85 feet. The with-project condition assumes backfill in C-38, however, tailwater effects restricting the S-65 discharge are neglected because no lower basin model exists to evaluate them. Canals 35, 36, and 37 are modeled at their existing bottom widths of 20, 48, and 70 feet, respectively, and the SWSEL on Lake Kissimmee is 52.5 feet. Result of the Middle Basin UNET model under with-project conditions are shown in Table A-14.

(iii) Full-Design Canals. Under this condition, Canals 35, 36, and 37 in the with-project model are improved to bottom widths of 40, 80, and 160 feet, respectively. The canal improvements were implemented to reduce the tailwater at S-61 to design stages listed in the original Kissimmee GDM with the intent of not impacting flood control for Lake Tohopekaliga and the entire upstream west chain of upper lakes. These canal sizes represent the initial design iteration and were computed using HEC-2 and 10-year discharges under a steady-state condition with a starting backwater stage of 54.05 feet on Lake Kissimmee. Subsequent design iterations made with the UNET unsteady flow model ultimately resulted in smaller (optimized) canal sizes. Results of the Middle Basin UNET model with the 40, 80, and 160 foot design canals incorporated are shown in Table A-14.

(c) Integrated Model (Lower Basin Added).

(i) General. The development of comparable UNET models for existing and with-project conditions established a reasonable method of designing and evaluating improvements. The relative success of a design proposal could be determined to the extent it satisfied the governing flood control criteria for the Middle Basin, which was to not worsen existing peak stages for any flood frequency at any location in the basin. However, this criteria was modified for Lakes Kissimmee, Hatchineha, and Cypress to include only stages above elevation 54 feet, since the project sponsor, SFWMD, has already committed to purchase lands to this elevation. An additional impetus for not increasing existing flood stages was to ensure that stage impacts from the Middle Basin project did not extend upstream of the S-61 and S-63A locations, thus maintaining the existing level of flood protection in the Upper Chain of Lakes.

The modeling progressed in the following order: 1) development of existing and with-project (backfill) models and stage comparison; 2) iterative process to design channel improvements to Canals 35, 36, and 37; 3) design of additional

outlet capacity at S-65; and 4) comparison of Lower Basin stages with previous modeling to determine additional land requirements.

(ii) Existing Conditions. The fully-integrated model includes the Middle and Lower Basin UNET models joined together at S-65. S-65 is modeled as a submerged rating curve (maximum capacity of 11,000 cfs at head of 2.5 feet) which computes discharge based on headwater and tailwater; however, discharge is restricted to 3,000 cfs when tailwater exceeds elevation 49.0 feet. S-65A, S-65B, and S-65C are also modeled as submerged rating curves with their full-height tieback levees represented with cross-sections. A downstream rating curve is used to simulate outflow from the model at S-65D. Canals 35, 36, and 37 are represented with existing bottom widths and side slopes and the Lake Kissimmee SWSEL for the flood event fluctuates between elevation 49.0 to 51.0 feet. C-38 is left intact (no backfill) and Mannings "n" values of 0.03 and 0.15 used for the channel and overbanks, respectively. Peak stage results for the integrated UNET existing conditions model is shown in Table A-15.

(iii) With-Project Conditions. The fully-integrated model is identical to the existing conditions model except for the following changes: 1) S-65 discharges are based strictly on what the headwater and tailwater will allow; 2) S-65A is modeled as a spillway with a time series of gate openings; 3) S-65B and S-65C are removed; 4) Lake Kissimmee SWSEL varies between elevation 48.5 to 52.5 feet; and 5) C-38 is backfilled from river mile 39.30 to river mile 16.43 with a Mannings "n" value of 0.30 for the backfill and overbank sections. Peak stages for the integrated UNET with-project model are shown in Table A-15.

(iv) Design Canals. Although the intent of the full-design canals was to reduce the upstream with-project stages to acceptable levels, comparison of the resultant UNET stages with existing conditions indicated that the canals were over designed (too large). Since the original sizes of the canals were determined with HEC-2, it was decided to optimize the canal sizes using UNET as the design tool. Various alternatives with different canal sizes were run with UNET and the resultant peak lake stages compared to existing conditions to evaluate which canal arrangement was the most efficient. The combination of Canal 35 (20' bottom width), Canal 36 (60' bottom width) and Canal 37 (90' bottom width) was the best alternative and, with the exception of the 25-year stage on Lake Kissimmee, resulted in acceptable stages at all locations for each storm frequency. A significant reduction in canal sizes and construction costs, Canal 35 (40' to 20'), Canal 36 (80' to 60'), and Canal 37 (160' to 90') were achieved through the design optimization process.

(v) Additional S-65 Outlet Capacity. Although the improvements to C-36 and C-37 resulted in acceptable stages upstream of Lake Kissimmee, the increased conveyance in the canals caused the downstream stages in Lake Kissimmee to increase. Since the design sizes of Canals 35, 36, and 37 were already minimized, the only means of further reducing the stage on Lake Kissimmee was to design additional outlet capacity at S-65. Additional capacities of 33 percent and 67 percent of the original 11,000 cfs (3-bay) structure were run with UNET, these options are commonly referred to as Plan 2 (4-bay total outlet capacity at S-65) and Plan 1 (5-bay total outlet capacity at S-65). Results for Plan 1 and Plan 2 can also be found in Table A-15. Plan 2 is an unacceptable alternative because the 25-year peak stages for Lakes Kissimmee and Tiger exceed both the existing stages and the 54-foot elevation.

(d) Sensitivity Runs.

(i) Removing Backfill. The impact of the backfill on Lower Basin conveyance and the tailwater effect on the discharge from S-65 have long been concerns for the hydrologist involved in Kissimmee River studies. To determine the backwater effect resulting strictly from the backfill required that a comparative analysis be performed between conditions in which the only modified parameter was the backfill. This could be accomplished with two approaches: 1) run the with-project condition (Lake Kissimmee SWSEL at 52.5 feet) and remove the backfill from the C-38 reach, or 2) run the existing conditions (Lake Kissimmee SWSEL at 51.0 feet) and insert the backfill in the C-38 reach. Interestingly, the impact attributable to backfill is different for the two methods, indicating that the S-65 operating criteria, which varies for existing and with-project conditions, and the lake SWSEL (available storage) are the more important parameters affecting peak flood stages on Lake Kissimmee. The results for the backfill and SWSEL sensitivities are indicated in Table A-16. This sensitivity analysis was performed prior to final plan selection and is provided strictly for the reader to ascertain the relative impact of the above mentioned variables on peak flood stages in the Upper Basin lakes.

(ii) Manning's "n" Values for Backfill. The hydraulic resistance of the future reestablished marsh-filled floodplain is perhaps the most important parameter in the UNET analysis. Manning's Roughness Coefficient ("n") is a major determinant of flow velocity and conveyance which directly affect flood stages. Sensitivity analyses on a range of "n" values from 0.1 to 0.5 showed that even minor variations in the value can have a significant impact on flood stages as shown on Table A-17. The value of 0.3 used in this study was selected for the same reasons discussed in the Appendices (page A-15) of the Corps' 1991 Feasibility Report. Further verification of the 0.3 value was obtained by calibrating the current Lower Basin UNET model to the historical rating curve

at the Fort Kissimmee gage, located about 16.1 miles downstream of S-65, as shown on Figures A-8 and A-9.

(iii) Lag for Lake Kissimmee. Because of the large area and flatness of the Lake Kissimmee sub-basin a wide variation in calculated lags was observed depending on the computation methodology selected. The previous 1985 Corps study had used a value of 16 hours for the basin lag. However, the SCS and Mannings approaches for the current study resulted in much larger values between 50 and 100 hours. To assess the sensitivity of lag time on computed peak stage for Lake Kissimmee, three UNET runs were made for the 25-year frequency with lag values of 16.8, 33.6, and 50.4 hours. The resultant peak stage on Lake Kissimmee for all three runs was 54.47 feet, thus illustrating the relative insensitivity of runoff lag in determining flood stages. Lake Kissimmee is such a large lake that overall rainfall volume, rather than timing of the inflow, is a much more critical factor in determining ultimate flood stages.

(iv) Rainfall Distribution. The difference in rainfall distribution between the previous 1985 and 1991 Corps reports and the current study was discussed in the Hydrology/Rainfall section of this report and depicted in Table A-9. The tendency of the early-month storm to overestimate losses in comparison with the mid-month balanced storm was also noted. Therefore, the effects of the distribution on HEC-1 generated runoff and hydrographs and ultimately on UNET peak water stages is an extremely important factor in explaining the higher flood stages for the current study and is illustrated in Table A-18.

(v) Variation of Lower Basin Flood. It is sometimes the practice of the Corps of Engineers to define a flood event for the overall project as the combination of different magnitude events each occurring within a defined sub-area of the overall project. For example, a 100-year flood for a reservoir may be defined as the 100-year rainfall event applied to the reservoir in conjunction with a 10-year tailwater stage occurring in the outlet channel downstream of the reservoir. Although this approach was not used in the Kissimmee 1135 study, the sensitivity of applying a 10-year rainfall to the Lower Basin in combination with the 5-, 25-, 50-, 100-year, and SPF Middle Basin floods and comparing the resultant stages with the standard flood frequency combinations (i.e., 5-year Middle Basin flood with 5-year Lower Basin flood, etc...) was investigated. Results for the sensitivity are shown in Tables A-19 and A-20.

(vi) Lake Jackson Water Control Structure. The Florida Game and Fresh Water Fish Commission (GFC) in 1992 proposed the Lake Jackson Restoration Plan with the intent of improving the aquatic habitat and

developing a quality sport fishery in the lake. Working with the GFC, SFWMD was tasked to design the outlet water control and conveyance improvements necessary to regulate stages on Lake Jackson from a dry season high of 53.5 feet mean sea level (msl) to a wet season pool level of 51.0 msl. According to SFWMD's Lake Jackson Project Feasibility Report dated February 12, 1993, it is "understood that such improvements are in their conceptual stage and the final Kissimmee River Restoration Project design may require eventual modification to the water works constructed under this project."

From SFWMD's analysis, the improvements required to insure existing flood levels are not exceeded include enlargement of Jackson Canal (50-foot bottom width at design invert of 45.0 msl with 2.5H:1V side slopes) from the lake outlet to a location 4000 feet downstream. For water control, five (5) 84-inch diameter CMP culverts at invert elevation 45.0 msl with standard 108-inch wide risers, (riser top elevation 53.5 msl), and a 50-foot long reinforced concrete auxiliary spillway (trapezoidal section at a crest elevation of 53.5 msl), are recommended.

In May 1993, SFWMD requested that the Corps review the design and advise if the proposed 1.5 foot increase in the Lake Kissimmee regulation schedule would affect the discharge of the proposed Lake Jackson structure. After incorporating the proposed works into the UNET model it was concluded that the peak stages and discharges for Lake Jackson were not affected by the 1.5-foot increase in the Lake Kissimmee schedule. According to SFWMD, the structure was constructed and in-place by August 1994.

(5) Model Calibration.

(a) HEC-1. After the initial development of the Middle Basin HEC-1 model down to S-65, calibration of the model with observed floods was necessary. Since computed stages are the critical parameter in assessing the flood control performance of the project, it was decided to calibrate the model on the observed Lake Kissimmee stage under a set of historical floods. The selected floods of 1953, 1960, and 1969 were the largest of the Kissimmee Basin over the last 40 years. The 1947 storm was also extremely large but stage and rainfall records for the period were inadequate.

The basic approach was to obtain daily rainfall data from all available gages in the basin area during the flood event and generate a composite basin daily rainfall by Thiessen weighting the gages. Observed daily lake stages and S-65 discharge values from Lake Kissimmee were also obtained. After applying the composite rainfall values to the HEC-1 model and accounting for the daily lake outflows in the form of a downstream rating curve at S-65, the model was run. The HEC-1 computed Lake Kissimmee stages were then plotted in the form of

a stage-graph and compared with the shape of the observed stage curve to assess the validity of the model. A plot of the Lake Kissimmee HEC-1 versus historical stages for the three calibrated floods are shown in Figures A-4 through A-6.

(b) UNET.

(i) Middle Basin. The September 1969 flood was the only flood event in the Middle Basin since the completion of the Kissimmee Project which could be used to calibrate the UNET model. Since the S-65 daily releases were available from gaging records it was possible to use the Middle Basin UNET model with a downstream rating curve modified to account for the actual outflows from the system. The flow hydrographs generated from the HEC-1 1969 calibration were inserted into the UNET model at the appropriate physical locations. Stage records were used to assign the actual starting water surface elevations for Lakes Kissimmee and Cypress. After running the UNET model, the computed stage hydrographs for Lake Kissimmee were compared with the observed 1969 lake stages to assess the accuracy of the UNET model. Figure A-7 shows a graphical comparison between the computed and historical stages demonstrating a relatively high level of correlation for the UNET and historical results.

(ii) Lower Basin. Calibration of the Kissimmee Lower Basin UNET model for the backfill conditions was accomplished by comparing the stage-discharge curve generated by UNET with the historical rating curve for a known location along the original Kissimmee River. Fort Kissimmee, located about 16.1 miles downstream of S-65 in Pool B and approximately adjacent to the proposed upstream terminus of the C-38 backfill reach, presented the best available location for the comparison. Figure A-8 reflects that the UNET stages, with a Manning's "n" value of 0.3 for the backfill, are slightly higher than the historical Fort Kissimmee stage for a given discharge.

(6) Tributary Lake Analyses.

(a) General. The following three lakes are connected directly to Lake Kissimmee either through natural tributaries or man-made canals. Hydraulic analyses were conducted with UNET to determine if and to what extent an increase in the Lake Kissimmee regulation schedule would impact the flood stages in the three lakes and tributaries.

(b) Lake Tiger. Lake Tiger and Lake Kissimmee are at approximately the same natural ground elevation (the 50-foot contour closely parallels the waters edge for both lakes on the USGS quadrangles) and are hydraulically connected by Tiger Creek. Tiger Creek is a small, mildly

meandering natural stream which flows from Lake Tiger to Lake Kissimmee through a flat, swampy expanse of marshes over a distance of about 9,000 feet. Under normal stage and flow conditions, the head loss through Tiger Creek generally results in Lake Tiger exhibiting a 0.1 to 0.5 feet higher water stage than Lake Kissimmee. The head loss may increase to over 1 foot in the early phases of a flood when discharges through Tiger Creek are high and the Lake Kissimmee stage is still relatively low (i.e., less than elevation 51 feet). However, as the stage in Lake Kissimmee rises due to a larger flood event and approaches or exceeds 54 feet, the head difference between the two lakes is reduced to 0.1 feet or less. Improvements to Tiger Creek will result in a reduction in the head difference, however, Lake Tiger will invariably show a slightly higher stage than Lake Kissimmee.

Since the Lake Tiger flood stage is intrinsically linked to the Lake Kissimmee flood stage, outside of isolating Lake Tiger and installing a substantial pump station, there is no structural measure to insure that the Lake Tiger with-project stages can be reduced below those of Lake Kissimmee. Therefore, the flood control solution for Lake Tiger must be similar to that already recommended for Lake Kissimmee, which is a combination of implementing Plan 1 (C-36 and C-37 improvements, S-65 enlargement) and acquiring interest in lands to elevation 54 feet around Lake Tiger.

The prospect of a pumping station for Lake Tiger flood control was further pursued and cost were compared to the non-structural measure of purchasing real estate interests between elevation 52.5 and 54.0 feet around the lake. Sizing of the pump station based on the critical 25-year flood frequency indicated that a 1650 cfs capacity pump station would be required at the Tiger Creek outlet of Lake Tiger. Preliminary cost estimates, based on a similar sized pumping station, indicate that the machinery costs (pumps and drivers) and superstructure alone for a 1650 cfs pumping station would exceed $10,000,000. Additional costs would be incurred for inlet and outlet channels, culverts, and tieback levees extending to high ground. Annual operating and maintenance costs as well as environmental mitigation are additional considerations making the pumping option even less attractive.

(c) Lake Rosalie. Lake Rosalie is connected to Lake Kissimmee through Zipperer Canal, a man-made canal about 2.0 miles in length. G-103, a SFWMD weir structure is installed in the canal about 1.6 miles downstream from Lake Rosalie and helps, in part, to control the level in Lake Rosalie. The natural outlet of Lake Rosalie, however, is Rosalie Creek, a meandering stream at the south end of the lake, which discharges at a natural sill elevation of 50 feet downstream to Lake Tiger. According to SFWMD, Lake Rosalie is currently regulated between elevation 54.0 to 54.5 feet. If the G-103 weir crest is maintained at an elevation higher than the proposed Lake Kissimmee

regulation schedule, which appears to be the current practice for Lake Rosalie, flood impacts from Lake Kissimmee will not extend upstream of the weir. Refer to "Lake Rosalie Analysis", Table A-21 for results.

Hydraulic analyses for the reach of Zipperer Canal downstream of G-103 were also made and according to Table A-22, "Zipperer Canal Analysis" show that the adverse stage impacts (note 25-year values) will be limited to an elevation of 54 feet or less.

(d) Lake Jackson. Lake Jackson is connected to Lake Kissimmee through Jackson Canal, a man-made canal approximately 2.75 miles in length. The Lake Jackson Water Control Structure (LJWCS), installed in 1994, was designed to maintain Lake Jackson at a higher stage (elevation 53.5 feet) in order to improve the aquatic habitat of the lake. Although the peak stages in Lake Jackson increased after the LJWCS was installed these impacts are attributable to the structure itself and to the higher regulation schedule for Lake Jackson. Table A-23, "LJWCS, Lake Jackson and Lake Marian Analysis" show that these locations are sufficiently elevated to remain unaffected by the changes in the Lake Kissimmee regulation schedule and S-65 capacity. Stage impacts resulting specifically from the increased Lake Kissimmee regulation schedule were limited to Jackson Canal downstream of the LJWCS. However, Table A-24 reveals that backwater effects due to implementation of Plan 1 would be restricted to river mile 6.0 to 6.5 along Jackson Canal and would be on the magnitude of 0.1 feet. Lake Kissimmee is considered to be at river mile 5.25 and LJWCS at river mile 7.5.

8. Joint Probability Analysis.

a. Hydrologic Criteria. In the process of performing rainfall runoff modeling, there are several hydrologic parameters that are unknown and which must be assumed before the analyses can begin. One of these relates to the antecedent hydrologic condition that will be present at the beginning of design storms. Whether the lakes, reservoirs, and/or canals in the basin are at a low, mean or high stage when the storm occurs, will have a significant effect on resulting peak flood stages. In past design studies, the criteria for the Central and Southern Florida Project has assumed that design storms will occur on hydrologic conditions expected during the wet season. Rainfall records show that most rainfall and large storms occur during the months of June, July, August, and September, commonly referred to as the hurricane season. For lakes that are regulated for flood control, the water level is prevented from exceeding a specified stage during the wet period to provide storage for storm water runoff. Therefore, the design storm for regulated lake basins was assumed to occur when the lake was at the maximum stage permitted by the

regulation schedule during the wet season. For plotting purposes the storm has been shown to occur on 1 September. However, this was somewhat arbitrarily chosen and the 1 September date has no special significance.

The top of the wet season regulation schedule on Lake Kissimmee is currently 51.0 feet. Accordingly, the design criteria used for construction of upstream levees, canals, and structures 61 and 63A were based on rainfall runoff models that assumed that Lake Kissimmee would be at elevation 51.0 feet at the beginning of the design flood. That assumption is reasonable because the current regulation schedule and operating criteria for Lake Kissimmee tends to keep the lake at elevation 51.0 feet. If the lake exceeds 51.0 feet from June to September, S-65 is opened to a maximum discharge of 11,000 cfs to bring the lake back to the schedule. When the lake is below 51.0 feet, no releases are made. Of course, during extremely dry years the lake will be below elevation 51.0 feet during much of the, if not the entire, wet season; and, this deviation is not considered in determining flood stage probabilities. However, the criteria is appropriate for design because upstream levees, canals, and structures had to be designed to function on conditions that are likely to occur. For the period of record 1970 to 1988 under the current regulation schedule and operating criteria, Lake Kissimmee was on schedule during the wet season about 40 percent of the time.

The primary purpose of the rainfall runoff modeling in this study was not to design; but, to analyze and compare the hydrologic effects of the existing and proposed new regulation schedules, to insure that the Kissimmee project continues to function, and to maintain the same level of flood protection in the middle and upper Kissimmee basins as it was originally designed for all lands above 54.0 feet elevation. Below elevation 54.0 feet some increase in the flood risks could not be avoided because of the physical limit to gravity discharge from Lake Kissimmee with restoration of the Kissimmee River. Evaluation of the flood actuarial impacts of the new zoned regulation schedules requires a determination of the real flood risks for each schedule. The past criteria of beginning the analyses with the lakes at the top of the wet season schedule is not valid for zoned schedules.

The new alternative schedules are zone schedules, and while they may appear to be similar to the existing schedule, they differ greatly in performance. The alternative schedules permit Lake Kissimmee to rise an additional 1.5 feet to elevation of 52.5 feet during the wet season, However, discharge from the lake is not terminated when the lake falls below 52.5 feet. The new schedules have discharge zones and significant discharges will continue from Lake Kissimmee even when the lake level is below 52.5 feet. Period of record routings with the new schedule show that Lake Kissimmee will be at elevation 52.5 less than 10 percent of the time during the wet season. Accordingly, the

past policy of assuming Lake Kissimmee at the wet season schedule elevation at the start of the design storms, is probably too conservative even for design. A new method of analyses had to be developed so that the flood stage frequency of the two different types of schedules could be compared. However, profiles showing the UNET results for the 51.0 existing and 52.5 proposed starting water levels are shown in the report. They are shown in part because they represent a worst case scenario for each storm frequency; but, mostly because the new method of analysis does not produce a flood profiles.

Flood stage frequency on Lake Kissimmee is a combination of the probabilities of both rainfall and antecedent lake stage. The probability that the lake will reach a given stage in any year is the sum of the probabilities of all the possible combinations of rainfall and beginning lake stages that could produce that stage. This relationship can be determined stochastically, or by numerical integration. In this study Lakes Kissimmee, Hatchineha, and Cypress were analyzed by both methods and the results compared. Both methods produced essentially the same results. The results obtained by integration were selected because the computations produce repeatable results. The results of the Stochastic method varied $\pm$ 0.1 feet depending on the initial seed value.

b. Stochastic Method. Daily period of record routings were made for Lake Kissimmee using the existing schedule and each of the alternative regulation schedules. Each routing produced a tabulation of daily stages from 1 January 1970 to 1 January 1988. From this output the percent of time the lake level exceeded a specific stage could be determined. Multiple HEC-1 runoff and UNET routing model runs were made for the 5-, 10-, 25-, 50-, 100-year, and SPF floods from all possible starting water surface elevations on Lake Kissimmee at one-half (1/2) foot increments. This produces a set of parallel frequency curves depicting stage rise in feet versus storm frequencies for various starting water surface elevations. From this data, the height the lake would rise for a storm of any frequency at any SWSEL within the modeled range can be obtained by interpolation.

The stochastic approach is to compute an annual maximum stage for a theoretical year by selecting a random lake stage and a random storm frequency for each year. The annual maximum stage for each year is derived by adding the corresponding stage rise obtained from the UNET data to the randomly selected stage. Annual maximum stages are derived for a large number of years and total stage frequency is determined by statistical analysis of the data.

For this study a day during the wet season, June through September, was selected randomly between 1970 and 1988. The stage of Lake Kissimmee

corresponding to that day was obtained from the period of record UKISS routings. The random flood frequency was selected by randomly selecting a number between zero and one. For this random frequency and this random initial water surface elevation, a stage rise was obtained from the UNET flood routing model results. The annual maximum stage for each year was recorded as the algebraic sum of the beginning stage and the stage rise. This was repeated 10,000 times for each of the alternative regulation schedules and frequency analysis performed on the results.

c. Integration by Segmenting the Stage-Duration Curve. In the past, this has been the most common solution to joint probability of hydrologic data. A direct solution is obtained by segmenting the variables into a finite number of intervals. Daily Wet season stages obtained from the period of record routings from 1970 to 1988 were ordered and then segmented into 1/2 foot increment groups. The percentage of time that the lake level was within each segment was determined by dividing the number of days in that segment by 2196, the total wet season days from 1970 to 1988. Each segment of the stage duration curve represented a possible starting water surface level.

UNET model results showing stage rise for various flood frequencies were used to obtain the probability of experiencing a storm that would raise the lake a specific height above each of the segmented levels. The total probability of reaching any given flood stage is the sum of the products of the probability of reaching that stage from each segment, multiplied by the percent of time the lake level is within those segments. Perhaps it is easier visualized in terms of a hypothetical stage-duration curve and a given flood stage to compute the total probability. Figure A-22 is a sample calculation of the annual probability of the Lake Kissimmee stage exceeding 55.3 feet by joint probability.

d. Stage-Frequency. Stage-frequency curves generated from the joint probability approach comprise the analytical basis for evaluating different design alternatives and their relative performance to the existing condition. The four design alternatives analyzed in an attempt to satisfy the governing flood control criteria for the Middle Basin, that is, limiting flood stage impacts to less than elevation 54 feet, are discussed below:

Alternative 1 (With backfill and new regulation schedule) is the condition of restoration of the Kissimmee River and installation of the new schedule without any other structural modifications.

Alternative 2 (With backfill, new schedule, and enlarged canals) is the same as Alternative 1 but with enlargement to the canals C-36 and C-37 connecting Lakes Kissimmee, Hatchineha, and Cypress.

Alternative 3 (Plan 2) is the same as Alternative 2 but with an increase of 33 percent in the Lake Kissimmee outlet capacity by enlarging S-65 from a 3-bay to a 4-bay structure.

Alternative 4 (Plan 1) is the same as Alternative 2 but with an increase of 67 percent in the Lake Kissimmee outlet capacity by enlarging S-65 from a 3-bay to a 5-bay structure.

For each of the six middle basin locations (Kissimmee, Tiger, Hatchineha, Cypress, S-61 tailwater, S-63A tailwater) shown to be affected by the regulation change, stage frequency curves are presented based on:

a) a coincident frequency analysis approach

b) a UNET computation with the top of the wet season schedule as the initial condition

Although the S-65 enlargement and canal improvements were designed based on the coincident frequency approach, the latter values are plotted for comparison purposes only. Figures A-10 through A-21 show plots of the stage-frequency curves for existing conditions and the four alternatives using the proposed regulation schedule.

Review of the stage-frequency curves leads to several conclusions:

1. Alternative 1 satisfied the stage-frequency criteria for Lake Kissimmee, however, the increased stages at the upstream locations made it necessary to improve downstream conveyance by enlarging canals C-36 and C-37.

2. Alternative 2 satisfied the stage-frequency criteria for Lakes Cypress and Hatchineha,but the improved downstream conveyance increased stages in Lake Kissimmee above acceptable levels.

3. Alternative 3 (S-65: 4-bay) is unacceptable when compared to Alternative 4 (S-65: 5-bay) because the former does not restrict stage impacts on Lake Kissimmee to below elevation 54 feet.

4. Alternative 4 (S-65: 5-bay) is the recommended plan because it limits stage impacts at all six locations to elevation 54 feet or below (see 5. below).

5. Although the S-61 and S-63A tailwater locations show minor stage impacts (0.1 feet) above elevation 54 for the recommended plan, maintenance dredging of Canals 35 and 34 to their as-built templates will remedy the situation.

9. Stage-Duration. Although stage and flow-duration curves under a variety of conditions and alternative schedules are presented in Appendix F, two of the more general and informative graphs are presented in this appendix. Figure A-23 compares the Lake Kissimmee stage-duration for the pre-flood control project period of 1929-1960 with the existing project period of 1970-1988. The curves, based on actual daily gage values over the period, reflect a wider fluctuation in lake stage for the pre-project or unregulated period. The larger variation in the natural system was due primarily to a less efficient outlet from Lake Kissimmee in the form of the meandering Kissimmee River and the absence of the S-65 control structure operating in conjunction with an established regulation schedule. Flood and wet season stages are now reduced because of the improved outlet capacity at S-65 and the downstream conveyance of C-38 while dry season stages tend to be higher because releases from S-65 are curtailed when the lake is below schedule. It should be noted that the extreme drawdown of Lake Kissimmee in 1977 inappropriately skews the post-project data on the low end of the curve. A graphical comparison of the Lake Kissimmee stage-duration when routed by the UKISS model under the existing and proposed regulation schedules is shown in Figure A-24. Although the proposed schedule results in a wider variation in stage, the increase in stage at the upper end of the curve (above elevation 52 feet) is appreciably less than the proposed 1.5 foot increase in the schedule. At stages below elevation 51.85 feet the proposed schedule results in stages on the average about 0.5 feet lower than the existing schedule. These reductions can be attributed to the near continual release nature of the proposed operating criteria which specifies a stage-discharge relationship be maintained even when the lake falls below schedule.

10. Hydraulic Design Criteria.

a. General. The hydraulic designs of recommended improvements for the Kissimmee River Restoration are based on approved design practices and applicable criteria set forth in EM 1110-2-1601, Hydraulic Design of Flood Control Channels and EM 1110-2-1603, Hydraulic Design of Spillways. Hydraulic analyses and designs were accomplished with HEC-2, a one-dimensional steady flow modeling computer program supported by the Hydrologic Engineering Center (HEC), Davis, California. The primary objective of these improvements was to maintain existing flood control while increasing environmental benefits to the Kissimmee chain of lakes via a wider and more natural fluctuation of water stages. Erosion protection measures were included to ensure stability in areas where high flow velocities are expected (e.g., bridges, alignment curves, etc.).

b. Existing Hydraulic Conditions.

(1) Topographic Data. Due to the vast size of the project area, numerous surveys were conducted to obtain adequate topographical coverage. Topographic data used in construction of the hydologic and hydraulic models for analyses of existing hydraulic conditions and development of hydraulic designs were obtained from surveys in 1979, 1991, and 1993-1994 and USGS quadrangle maps. These data included cross-sections for the project area canals and principal tributaries connecting the major lakes of the Middle Basin. Additional topographic data were obtained in cross-sectional format at 500-foot intervals for Canals 34, 35, 36, and 37. Designs for modifications to S-65 were based on spot elevations on a 50- to 80-foot grid.

(2) Canal Characteristics. Existing canals in the project area are shown on Plates A-1 and A-2 and are described as follows:

C-34(Canoe Creek) begins at the south side of Lake Gentry and ends at the east side of Lake Cypress. Two spillway structures, S-63 and S-63A, drop the water surface elevation from a design headwater peak stage of 62.8 feet at S-63 to a design tailwater peak stage of 53.8 feet at S-63A. Canal side slopes are 1 vertical to 2 horizontal (1V:2H). Bottom widths range from 20 feet at S-63 to 70 feet at its southern terminus. Total length of the canal is about 5.7 miles. Photo A-4 shows C-34 looking downstream from S-63A.

C-35(South Port Canal) begins at Structure 61 on the south side of Lake Tohopekaliga and ends at the northwest side of Lake Cypress. The water surface elevation for the design tailwater peak stage is 54.3 feet at S-61. The canal has side slopes of 1V:2H, a constant invert elevation of 30.6 feet, and a bottom width of 20 feet. Total length of the canal is about 4.1 miles. Photo A-2 shows C-35 looking downstream from S-61.

C-36 connects Lake Cypress with Lake Hatchineha. C-36 has side slopes of 1V:2H, a constant invert elevation of 31.3 feet, and a bottom width of 48 feet. Total length of the canal is about 2.8 miles. Photo A-5 shows C-36 looking downstream along the east disposal bank.

C-37 connects Lake Hatchineha with Lake Kissimmee. The canal has side slopes of 1V:2H and a bottom width of 70 feet. Invert elevations range from 27.6 feet at Lake Hatchineha to 26.6 feet at Lake Kissimmee. Total length of the canal is about 3.9 miles. Photo A-6 shows C-37 looking downstream along the east disposal bank.

C-38 is the outlet for Lake Kissimmee flows to Lake Okeechobee. Stages are regulated along the canal by six water control structures, S-65, S-65A, S-65B, S-65C, S-65D, and S-65E. These structures are designed to step down the 36-foot fall of the canal in six-foot increments. Bottom widths range from 90 feet at S-65 to 425 feet at S-65E. Side slopes are 1V:2H. Invert elevations range from 19.0 feet to -14.0 feet over the canal length of about 56 miles.

(3) Tributaries. Middle Basin tributaries typically have well defined channels with sinuous flow paths. Bed slopes are mild, ranging from about 2.0 to 2.5 feet per mile. Tributaries are generally in a natural condition with no evidence of man-made channelization. Overbank areas are low-lying and heavily vegetated with dense brush. Major Middle Basin tributaries are shown on Plate A-1. Photos A-12 and A-13 are views of Reedy Creek looking upstream from C.R. 531 and looking upstream from the CSX Railroad Bridge at U.S. 92, respectively.

c. Design Canal Characteristics.

(1) Design Water Surface in Canals. The design water surface elevation would be based on the flood level at which flood damages and other adverse effects are considered relatively minor. The initial design constraint limited canal widening to one side of the canals to minimize impacts to existing cypress trees adjacent to the canals.

(2) Maximum Permissible Velocities. Based on canal bed material found in the project areas the maximum non-erosive velocities for Canals 34, 35, 36, 37, and 38 would be 2.0 feet per second.

(3) Side Slopes. Based on geotechnical investigations of slope stability, a maximum side slope of 1 vertical to 2.5 horizontal would be used for modifications to project canals.

(4) Cross-Sections. Canal cross-sections are based on the most economical section that would carry the design discharge at the design water surface and slope.

(5) Roughness Coefficients. Roughness coefficients for Manning's equation were based on several site visits between 1992 and 1994 and reference to Chow's Open Channel Hydraulics (1959) and Barnes' Roughness Characteristics of Natural Channels (1967).

(6) Transitions. Smooth transitions would be provided at all changes in canal geometry or slope. Transitions of about 100 feet in length are recommended wherever dimensions of the canal are changed.

(7) Freeboard. No freeboard was considered in the canal designs.

d. Existing Bridges. There are numerous bridges that cross the study area's canals. C-34 is crossed by two privately owned farm road bridges, S.R. 523, and the Florida's Parkway. C-35 is crossed by a farm road immediately downstream of S-61. There are no bridges over C-36. C-37 is crossed by the privately owned Zipperer Bridge. S.R. 60 crosses the outlet of Lake Kissimmee about 380 feet upstream of S-65. Locations of major roads are shown on Plate A-1.

e. Existing Water Control Structures. Existing structures in the project area are shown on Plate A-1 and are described as follows:

S-61 is a one-bay spillway located on C-35 at the outlet of Lake Tohopekaliga. The structure is constructed of reinforced concrete and discharge is controlled by a cable operated vertical lift slide gate. The structure also consist of a reinforced concrete lock structure with two pairs of sector gates. Photo A-1 shows the downstream side of S-61.

S-63A is a two-bay spillway located on C-34 about 500 feet upstream from S.R. 523 and about 2.5 miles upstream from Lake Cypress. The structure is constructed of reinforced concrete and discharge is controlled by cable operated vertical lift slide gates. The structure also consist of a reinforced concrete lock structure with two pairs of sector gates. Photo A-3 shows the downstream side of S-63A.

S-65 is a three-bay spillway located at the outlet of Lake Kissimmee about 380 feet downstream from S.R. 60 on the Kissimmee River. The structure is constructed of reinforced concrete and discharge is controlled by cable operated vertical lift slide gates. The structure also consist of a reinforced concrete lock structure with two pairs of sector gates. Plate A-3 shows a detailed plan view of S-65. Photo A-7 is an aerial view from the southwest of the S-65 spillway, lock, and lock operator's residence with the S.R. 60 bridge in the foreground.

f. Disposal Areas. All disposal material would be placed in areas that would not adversely impact the current flow path.

g. Sediment Potential. Existing and project canals within the project area are typically very flat and were designed with very little hydraulic slope. Velocities under design discharges and low frequency flood events are generally less than 2.5 feet per second. Therefore, it is not anticipated that appreciable shoaling and scouring will occur during design discharges.

11. Hydraulic Analyses of Existing Conditions.

a. Model Development. HEC-2 models were developed to analyze flows immediately upstream and downstream of S-65. The models were developed from spot elevations spaced about 50 feet to 80 feet on center and surveyed in 1991. Cross-sections were spaced at 20-foot intervals near the structure and increased to 100-foot intervals at the farthest cross-sections from the structure. The downstream model(getaway channel) extends from about 840 feet downstream of the structure to the structure's end sill. The upstream model(approach channel) extends from the upstream apron of the structure to about 100 feet upstream of the S.R. 60 bridge, a distance of about 480 feet. S.R. 60 bridge piers and abutments were included in the model.

The starting water surface elevations corresponded to various flow conditions. The following starting water surface elevations at the upstream side of S-65 are shown for respective flow conditions. The same starting water surface elevations were used for both existing and with-project conditions with the exception of the optimum range of water surface elevations.

FLOW CONDITION	STARTING WATER SURFACE ELEV.
Design	51.5 feet, NGVD
SPF	58.0
Critical	58.0
Optimum(Existing)	48.5 to 52.5
Optimum(With-Project)	48.5 to 54.0
Minimum	46.7

The following starting water surface elevations at the downstream side of S-65 are shown for respective flow conditions. The same starting water surface elevations were used for both existing and with-project conditions.

FLOW CONDITION	STARTING WATER SURFACE ELEV.
Design	49.0 feet, NGVD
SPF	53.1
Critical	48.2
Optimum	46.3
Minimum	44.0

Roughness coefficients for Manning's equation were based on several site visits in summer, 1994 and reference to Chow's Open Channel Hydraulics (1959) and Barnes' Roughness Characteristics of Natural Channels (1967).

In attempting to calibrate the HEC-2 models, data correlating stages with known discharges at specific locations were not available. Cross-section geometry, hydraulic input data, and resulting HEC-2 water surface profiles were compared as a relative check.

b. Tributaries. Major tributaries in the Middle Basin were modeled with the UNET models. These tributaries included Reedy Creek, Dead Creek, Rosalie Creek, and Tiger Creek. Cross-sections for the UNET models were based on topographic surveys obtained in 1991, USGS quadrangle interpolations, and field observations.

c. Conclusions. The HEC-2 models were used to compute water surface profiles and channel velocities at the immediate location of S-65 for an array of flow conditions under existing conditions. These data were used for determining the effects of increased discharges and/or stages for the with-project conditions. Comparison of the model results revealed negligible changes in water surface profile elevations and channel velocities.

Comparison of the existing and with-project conditions for the UNET models showed that the with-project's starting water surface elevations were higher at the mouth of Dead and Reedy Creeks. However, the peak stages for the existing condition were higher at those same locations. This is because of the widening of C-36 and C-37 and the increased outlet capacity at S-65. Therefore, no adverse impacts beyond those that currently exist are anticipated for the with-project condition.

12. Hydraulic Designs.

a. General. Hydraulic designs for the plan of improvement to the Middle Basin canals were performed with use of the UNET models. Hydraulic designs of the approach and getaway channels as part of the S-65 modification were performed with use of the HEC-2 models.

b. Recommended Plan.

Several alternative plans were evaluated. Alternatives consisted of: "no action", which would leave the existing Middle Basin works in place and operating with existing schedules; modification of the regulation schedules for various combinations of the Middle Basin Lakes; and various combinations of

land acquisition and structural modifications, such as canal dredging, to control effects of changed water levels. These alternatives were formulated and evaluated in detail, including hydrologic modeling and environmental analyses.

Based on the performance of the alternatives, the recommended plan for the Headwaters Revitalization Project includes the following features:

Modification of Existing Lake Kissimmee Regulation Schedule. Modification of the regulation schedule is necessary for the restoration of the Kissimmee River and to expand the upper Kissimmee lake littoral zones. The proposed regulation schedule is shown in Appendix B, Figure B-9.

Land Acquisition. Acquisition of approximately 20,800 acres of land bordering the affected lakes, Lake Hatchineha, Lake Kissimmee, Lake Cypress and Lake Tiger. See Plate 8-1 in the main report.

Widening of Flood Control Canals. Because of the increased tailwater flood stages at S-65 resulting from the modified regulation schedule, the flood control canals connecting Lake Kissimmee to Lake Hatchineha, C-37, and Lake Hatchineha to Lake Cypress, C-36 will have to be enlarged to flatten the flood profile through the upper lakes and prevent increasing flood stages.

Degradation of Local Levees. Breaching of five local levees is recommended for obtaining additional water storage in the Middle Basin and to expand the range of Middle Basin restoration. See Plate 8-1 in the main report for locations of local levees.

Increase Outlet Capacity of S-65. Modifications to the existing S-65 will be needed to provide a greater discharge capacity. If a low-frequency storm event coincides with the top of the regulation schedule water will need to be discharged from S-65 at a greater rate to prevent adverse impacts. As part of the increased outlet capacity of S-65, modification to C-38 at the immediate location of the structure is required. The canal would be widened to accommodate the additional two-bay structure and to provide an even flow distribution to the five bays.

Level of Protection. The level of protection for the recommended plan will be equal to or greater than the flood protection of the existing project at elevations of 54 feet and higher. The existing project design specifies protection for the 30% SPF event.

c. Canals. The recommended plan of improvement does not require modifications to Canals 34 and 35.

C-36 would be widened from its original bottom width of 48 feet to 60 feet. Widening would be performed on the canal's west side only. Maintenance dredging of C-36 would restore the invert elevation to 31.3 feet. Canal widening would increase the canal's discharge capacity by about 15 percent for a 10-year event.

C-37 would be widened from its original bottom width of 70 feet to 90 feet. Canal widening would be performed on the canal's east side only. Maintenance dredging would restore the invert elevation to 27.6 feet at Lake Hatchineha and transition to 26.6 feet at Lake Kissimmee. Canal widening and maintenance dredging would not be performed at the location of the Zipperer Bridge. Transition reaches of about 100 feet in length would be provided upstream and downstream of the bridge. Canal widening would increase the canal's discharge capacity by about 20 percent for a 10-year event.

Modifications for C-38 would be limited to excavations required for construction of the new two-bay structure and approach and getaway channels. Canal modifications would extend about 700 feet downstream and about 350 feet upstream of the structure.

d. Tributaries. Because of the limited backwater effects in the tributaries due to the recommended plan, no modifications are recommended.

e. Levees. The recommended plan does not require construction of any levees. Breaching of local levees is recommended for obtaining additional water storage in the Middle Basin and to expand the basin's range of restoration. Approximately one mile of levee sections or about 60,000 cubic yards will be degraded by backfilling nearby borrow ditches. The five local levees are Bronson Levee located along Lake Cypress, Overstreet and Oasis Levees located along Lake Kissimmee, and Rolling Meadows and Sparks Candler Levees located along Lake Hatchineha.

Levees will be degraded by pushing the mounded fill back into the adjacent borrow source ditches. The earth will be graded to the extent necessary to restore the area to its natural ground elevation. No offsite disposal areas will be required for the operation. The levees will be breached in a series of 100-foot gaps and will substantially impede the flow of flood waters landward of the levees. Gaps will be spaced at about 1,000-foot intervals. Gap spacing will be optimized to correspond with degrading low lying areas first and to avoid areas presently overgrown with substantial trees. Tree lined areas will remain intact to provide a source of alternative upland habitat.

f. Bridges. The recommended plan does not require modifications to any bridges in the project area.

The recommended canal design for C-37 would not require canal widening and maintenance dredging at the location of the Zipperer Bridge. Canal improvements would be done to within about 100 feet upstream and downstream of the bridge.

Canal modifications as part of the new structure at S-65 would have a northern limit just downstream of the S.R. 60 bridge and would have no adverse impacts on the bridge.

g. Structures.

(1) General. The S-65 Expansion is a two-bay spillway structure located at the outlet of Lake Kissimmee along the Kissimmee River. Each bay would consist of a reinforced concrete ogee weir with vertical lift slide gate controls. The structure would lie 24 feet to the east of the existing three-bay spillway structure. The 24-foot offset is required such that the foundation of the existing structure does not interfere with construction of the new structure. Plates A-3 and A-4 show plan views of the existing S-65 and recommended S-65 Expansion, respectively. Typical section views of the additional structure are shown on Plate S-3. A summary of hydraulic design data for the structures are given on Tables A-26 through A-28.

(2) Crest. The crest is a ogee weir and was designed in accordance with guidelines and equations set forth in EM 1110-2-1603. The design head (H_d) is the maximum head differential on the weir that would occur during the standard project flood.

(3) Gates. The vertical lift slide gates of S-65 and S-65 Expansion would be operated symmetrically.

(4) Tieback Levee. The S-65 Expansion would be constructed along the existing tieback levee/access road to S-65. Therefore, construction of an additional tieback levee would not be required.

(5) Energy Dissipation. Adequate energy dissipation to prevent downstream erosion would be accomplished with two rows of baffle blocks and an end-sill. Baffle blocks designs are based on physical modeling conducted for S-65B, S-65D, and S-65E in 1979 by the Waterways Experiment Station, Vicksburg, Mississippi. Results of physical modeling for S-65B were considered applicable for S-65 because of their similar structural configuration and range of hydraulic parameters. Baffle block and end-sill designs were verified with guidelines and equations set forth in EM 1110-2-1603. Plate S-2 shows baffle block layout and details and end-sill.

(6) Riprap. Riprap protection for high discharge events would be required for the approach and getaway channels. Limits of riprap placement are shown on Plate S-1.

(7) Discharge Rating Curves. Discharge rating curves were developed for the expected headwater and tailwater extremes. Headwater and tailwater elevations at the structures are expected to range from elevation 45.0 feet to 58.0 feet and 44.0 feet to 55.0 feet, respectively. Discharge rating curves and applicable derivations, formulas, and coefficients for controlled and uncontrolled discharges of the structures are shown on Figures A-25 through A-33.

(8) Water Level Recorders. Automatic water level recorders and staff gages would not be required for the additional S-65 since these items are currently located at the existing S-65. An automatic gate position recorder would be installed for the additional structure.

h. Disposal Areas. The recommended plan of improvement calls for the excavated material to be placed on existing spoil mounds adjacent to the canals. Placement of the material on the spoil mounds would not adversely impact the current flow path.

i. Project Performance/Water Surface Profiles. The level of protection for the recommended plan will be equal to or greater than the flood protection of the existing project at elevations of 54 feet and higher. The existing project design specifies protection for the 30% SPF event. Examination of the stage-frequency curves, Figures A-10 through A-21, for the recommended plan (Plan 1) reflect that depending on the location, a stage of 54 feet will be reached with varying frequency events. This occurs because unlike previous analyses when a level pool was assumed for Lakes Kissimmee, Hatchineha, and Cypress, headloss between the lakes results in the requirement of a less severe flood to reach a given stage as one progresses upstream. For example, a stage of 54 feet would represent approximately a 4, 4.5, 7.5, 10, and 20 percent chance of exceedence event for Lakes Kissimmee, Tiger, Hatchineha, Cypress, and S-61 tailwater locations, respectively. It should be noted that with C-35 restored to its original as-built template the chance of exceeding a stage of 54 feet would be reduced to about 14 percent for the S-61 tailwater location. Although guidance requires that flood events now be measured in percent chance of exceedence, an approximation to return frequency in years can be estimated as 100 percent divided by percent chance of exceedence, thus 14 percent chance of exceedence is about a 7.4-year event. This minimum level of protection agrees with the common assertion that a 30 percent SPF flood represents between a 5- and 10-year event for the Middle Kissimmee Basin. The above percent chance of exceedences are based on a coincident frequency analysis; the

chance of exceeding elevation 54 feet would increase if a top of wet season schedule was selected as the initial condition to begin the analyses.

13. Sediment Assessment. A limited sediment assessment showed that a small amount of shoaling has occurred over the project life to date. The project canals were built in the early to mid 1960's. Since their construction, about 3.0 to 3.5 feet (approximately 14-[illegible] of total depth) of shoaling has occurred in C-36 and about 3.5 to 4.0 feet (approximately 14-16% of total depth) in C-37. Plate A-5 shows typical cross-sections for the canals with existing cross-sections based on the 1991 surveys overlaying the original design templates.

Comparison of 10-year existing and with-project conditions showed similar velocities for C-36 and C-37. Velocities for the 10-year event under these conditions were about 2.3 feet per second for both canals. Bottom material found in C-36 and C-37 consisted mostly of fine to medium sands with a d_{50} ranging from 0.177 to 0.354 mm. Using Figure A-34, bed material movement would not occur for velocities less than about 4.0 feet per second. Therefore, an increased rate of shoaling is not anticipated for the with-project condition.

CENTRAL AND SOUTHERN FLORIDA PROJECT
KISSIMMEE RIVER
HEADWATERS REVITALIZATION PROJECT
Appendix A
Hydrology and Hydraulic Analyses

TABLES

TABLE A–10

MIDDLE BASIN HYDROLOGIC PARAMETERS

SUB–BASIN NO.	SUB–BASIN NAME	DRAINAGE AREA (SQ. MI.)	CURVE NUMBER	HEC–1 LAG (HOURS)
168, 167	REEDY CREEK	184.25	44	16
166, 165	IMPROVEMENT			
164, 163	DISTRICT @ S–40			
162	REEDY CREEK	36.91	74	40
162A	REEDY SWAMP	14.59	74	25
162B	LOWER LOUGHMAN	6.87	40	12
161A	LAKE RUSSELL	4.17	74	7.8
	(lake)	1.15	100	
161B	LOWER REEDY	19.26	74	20
152	HORSE CREEK	27.33	52	34.6
151A	LAKE PIERCE	44.88	52	38
	(lake)	5.96	100	
151B	CATFISH CREEK	15.56	63	13.7
142	MARIAN	49.12	74	33.6
	(lake)	10	100	
141	JACKSON	33.53	74	36.6
	(lake)	2.4	100	
133	WEOHYAKAPKA	35.09	74	13.7
	(lake)	11.8	100	
133A	TIGER CREEK	37.14	52	33.6
132	TIGER	9.03	74	8
	(lake)	5.3	100	
131	ROSALIE	28.55	74	8
	(lake)	10.4	100	
121	CANOE CREEK	6.7	73	16
113	CYPRESS	16.8	73	11.1
	(lake)	8.59	100	
112A	LAKE MARION	28.1	52	10.8
	(lake)	4.74	100	
112B	LAKE MARION CREEK	35.19	63	34.6
112C	LONDON CREEK	10.41	63	10
112D	HATCHINEHA	32.27	74	12.8
	(lake)	13.59	100	
111	KISSIMMEE	131.71	73.5	16.8
	(lake)	63.67	100	
	TOTALS	945.06 SQ. MILES		

TABLE A-11

COMPARISON OF 1994 HEC-1 RESULTS WITH 1991 FEASIBILITY REPORT

	LAKE KISSIMMEE PEAK STAGE, EL. FT.					
	5-YEAR	10-YEAR	25-YEAR	50-YEAR	100-YEAR	SPF
1994 HEC-1 EXISTING CONDITIONS	53.13	53.53	54.57	55.10	55.61	57.06
1991 CHANOP EXISTING CONDITIONS	52.81	53.46	N/A	54.93	55.49	56.56
1994 HEC-1 WITH-PROJECT CONDITIONS	53.78	53.86	54.56	54.96	55.37	56.53
1991 CHANOP WITH-PROJECT CONDITIONS	53.81	54.05	N/A	55.03	55.42	56.40

NOTE:

1. 1994 ANALYSES USE A HEC-1 UPPER/MIDDLE BASIN MODEL CONSTRUCTED DOWNSTREAM TO S-65.

2. 1991 ANALYSES USE A CHANOP UPPER/MIDDLE BASIN MODEL CONSTRUCTED TO S-65 IN CONJUNCTION WITH A DWOPER LOWER BASIN MODEL CONSTRUCTED FROM S-65 TO S-65E.

3. EXISTING CONDITIONS ASSUMES A LAKE KISSIMMEE SWSEL OF 51.0 FT, EXISTING CANALS AND S-65 CAPACITY OF 11,000 CFS. S-65 DISCHARGE IS REDUCED TO 3,000 CFS WHEN S-65A HEADWATER EXCEEDS ELEVATION 46.6 FEET.

4. WITH-PROJECT CONDITIONS ASSUMES A LAKE KISSIMMEE SWSEL 0F 52.5 FT, EXISTING CANALS, BACKFILL PLACED IN C-38 AND S-65 CAPACITY OF 11,000 CFS. S-65 DISCHARGE IS RESTRICTED TO 6,000 CFS UNTIL LAKE KISSIMMEE REACHES ELEVATION 53.8 FEET.

TABLE A-12

LOWER BASIN HYDROLOGIC PARAMETERS

POOL	HEC-1 SUB-BASIN NO.	SUB-BASIN NAME	DRAINAGE AREA (SQ. MILES)	CURVE NUMBER	HEC-1 LAG (HOURS)
A	1	UNNAMED	1.52	71	14.8
A	2	BUTTERMILK SLOUGH	33.31	71	22.8
A	3	BLANKET BAY SLOUGH	30.51	71	64.7
A	4	ICE CREAM SLOUGH	13.89	71	30.2
A	5	UNNAMED	2.68	71	24.2
A	6	TICK ISLAND SLOUGH	37.56	71	35.5
A	7	UNNAMED	4.16	71	17.6
A	8	UNNAMED	8.26	71	33.7
A	9	S-65A EAST	17.48	71	37.4
A	18	S-65 EAST	1.00	71	7.4
A	19	UNNAMED	1.34	71	6.1
A	20	LONG HAMMOCK SLOUGH	3.04	71	5.8
A	21	UNNAMED	2.58	71	8.7
A	22	UNNAMED	2.40	71	10.2
A	23	UNNAMED	3.23	71	16.3
A	AREM	A-REMAINDER	12.32	72	20.0
		POOL "A" TOTAL	175.28 SQ. MILES		
B	10A	PINE ISLAND SLOUGH	41.16	72	60.1
B	10B	SEVEN MILE SLOUGH	73.10	72	39.3
B	11	DUCK SLOUGH	14.60	72	68.1
B	24	ORANGE HAMMOCK	3.54	72	17.0
B	25	UNNAMED	1.13	72	9.0
B	26	FORT KISSIMMEE	2.27	72	10.5
B	27	UNNAMED	3.28	72	14.7
B	28	AVON PARK	2.56	72	17.0
B	29	BILL BAY	14.53	72	17.0
B	30	MOSQUITO HAMMOCK	12.09	72	11.7
B	36	UNNAMED	1.92	72	8.1
B	37	SADDLE HAMMOCK	1.85	72	10.0
B	38	McGUIRE HAMMOCK	0.75	72	14.5
B	39	RODGERS HAMMOCK	1.95	72	9.2
B	BREM	B-REMAINDER	17.25	72	24.0
		POOL "B" TOTAL	191.98 SQ. MILES		

TABLE A-12 (continued)

LOWER BASIN HYDROLOGIC PARAMETERS

POOL	HEC-1 SUB-BASIN NO.	SUB-BASIN NAME	DRAINAGE AREA (SQ. MILES)	CURVE NUMBER	HEC-1 LAG (HOURS)
C	12	STARVATION SLOUGH	11.31	74	24.3
C	13	HICKORY HAMMOCK	11.59	74	27.9
C	14	OAK CREEK	29.39	74	52.7
C	31	BLUFF HAMMOCK	2.46	74	4.5
C	32	DINNER BAY	1.30	74	4.8
C	33	HOLE IN THE WALL	1.09	74	4.6
C	34	UNNAMED	2.59	74	14.8
C	35	UNNAMED	1.88	74	8.1
C	40	UNNAMED	0.85	74	5.7
C	41	S-65C EAST	1.26	74	8.5
C	50	ISTOKPOGA	31.55	74	42.8
		POOL "C" TOTAL	95.27 SQ. MILES		
D	15	CHANDLER SLOUGH	101.98	74	64.3
D	42	S-65C EAST	3.54	74	12.2
D	43	UNNAMED	2.38	74	7.9
D	44	UNNAMED	5.05	74	18.2
D	45	UNNAMED	2.13	74	10.3
D	46	CORNWELL	4.65	74	14.8
D	48	FORT BASINGER	2.24	74	8.0
D	DREM	D-REMAINDER	45.34	74	32.0
		POOL "D" TOTAL	167.31 SQ. MILES		
		POOL "A", "B", "C", "D" TOTALS	629.84 SQ. MILES		

TABLE A-13

COMPARISON OF KISSIMMEE LOWER BASIN HYDROLOGIC PARAMETERS BY POOL

	1990 SFWMD / 1985 CORPS REPORTS			1995 CORPS 1135 REPORT		
	DRAINAGE AREA (SQ. MILES)	SCS CURVE NUMBER	LAG (HOURS)	DRAINAGE AREA (SQ. MILES)	SCS CURVE NUMBER	LAG (HOURS)
POOL A	161.32	71	20	175.28	71	N/A
POOL B	202.43	72	24	191.98	72	N/A
POOL C	78.29	74	16	95.27	74	N/A
POOL D	184.55	74	32	167.31	74	N/A
TOTALS	626.6			629.8		

NOTE:

1. THE 1994 CORPS ANALYSES SUBDIVIDE EACH POOL INTO INDIVIDUAL DRAINAGE SUB-BASINS. THE LAG TIMES FOR EACH OF THE SUB-BASINS IS SHOWN IN TABLE A-.

2. POOL E DATA IS NOT SHOWN SINCE THE 1994 CORPS HEC-1 AND UNET MODELS EXTEND ONLY TO THE DOWNSTREAM END OF POOL D AT S-65D.

TABLE A-14

UNET PEAK STAGES (UPPER/MIDDLE BASIN MODEL ONLY)

PEAK STAGES EL., FT.	LAKE KISSIMMEE SWSEL @ EL. 52.5 FT. WITH-PROJECT S-65 6,000 CFS FIRM 11,000 CFS @ EL. 53.8 FT. C-35 20' B.W., C-36 48' B.W. C-37 70' B.W.	LAKE KISSIMMEE SWSEL @ EL. 52.5 FT. FULL CANALS S-65 6,000 CFS FIRM 11,000 CFS @ EL. 53.8 FT. C-35 40' B.W., C-36 80' B.W. C-37 160' B.W.
5-YEAR		
S-61 T.W.	55.22	54.37
CYPRESS	54.96	54.27
HATCHINEHA	54.75	54.08
KISSIMMEE	53.84	53.86
TIGER	53.90	53.93
10-YEAR		
S-61 T.W.	55.64	54.55
CYPRESS	55.38	54.46
HATCHINEHA	55.11	54.24
KISSIMMEE	53.86	53.93
TIGER	54.01	54.04
25-YEAR		
S-61 T.W.	56.33	55.50
CYPRESS	56.08	55.38
HATCHINEHA	55.78	55.28
KISSIMMEE	54.14	54.98
TIGER	54.33	55.00
50-YEAR		
S-61 T.W.	56.86	56.06
CYPRESS	56.64	55.96
HATCHINEHA	56.42	55.89
KISSIMMEE	54.78	55.63
TIGER	54.79	55.64
100-YEAR		
S-61 T.W.	57.24	56.54
CYPRESS	57.04	56.46
HATCHINEHA	56.90	56.42
KISSIMMEE	55.60	56.19
TIGER	55.61	56.20
SPF		
S-61 T.W.	58.44	58.11
CYPRESS	58.27	58.05
HATCHINEHA	58.27	58.04
KISSIMMEE	58.00	57.95
TIGER	58.00	57.95

TABLE A-15

UNET PEAK STAGES

(BASED ON COINCIDENT FREQUENCY ANALYSIS)

PEAK STAGE (EL., FT.)	L. KISS SWSEL 49.0 TO 51.0 FT.	L. KISSIMMEE SWSEL VARIES BETWEEN EL. 48.5 TO 52.5 FEET BASED ON PERIOD OF RECORD ROUTINGS									
	EXISTING CONDITIONS S-65 11,000 CFS C-35,20' C-36, 48' C-37, 70'	WITH BACKFILL S-65 11,000 CFS C-35,20' C-36, 48' C-37, 70'	VS. EX.	DESIGN CANALS S-65 11,000 CFS C-35,20' C-36, 60' C-37, 90'	VS. EX.	PLAN 2 (B/F "n" = 0.3) S-65: 4-BAY CAP. C-35,20' C-36, 60' C-37, 90'		PLAN 1 ("n"=0.15/0.30/0.15) S-65: 5-BAY CAP. C-35,20' C-36, 60' C-37, 90'	VS. EX.	PLAN 1 (B/F "n" = 0.3) S-65: 5-BAY CAP. C-35,20' C-36, 60' C-37, 90'	VS. EX.
5-YEAR											
S-61 T.W.	53.91	54.53	0.6	54.11	0.2	54.05	0.1	53.96	0.0	54.01	0.1
S-63A T.W.	53.85	54.49	0.6	54.03	0.2	54.01	0.2	53.94	0.1	53.98	0.1
CYPRESS	53.47	54.15	0.7	53.67	0.2	53.63	0.2	53.52	0.0	53.58	0.1
HATCHINEHA	52.87	53.82	1.0	53.39	0.5	53.35	0.5	53.23	0.4	53.3	0.4
KISSIMMEE	51.77	52.73	1.0	52.83	1.1	52.83	1.1	52.69	0.9	52.77	1.0
TIGER	52.39	52.99	0.6	53.03	0.6	52.99	0.6	52.96	0.6	52.99	0.6
JACKSON	56.8	56.8	0.0	56.8	0.0	56.8	0.0	56.8	0.0	56.8	0.0
ROSALIE	56.1	56.1	0.0	56.1	0.0	56.1	0.0	56.1	0.0	56.1	0.0
MARIAN	61.4	61.4	0.0	61.4	0.0	61.4	0.0	61.4	0.0	61.4	0.0
S-65 T.W.	49.66							51.15	1.5	51.9	2.2
S-65A H.W.	48.04							50.31	2.3	51.27	3.2
S-65A T.W.	44.18							49.96	5.8	50.99	6.8
@ BACKFILL	43.93							49.65	5.7	50.71	6.8
S-65B H.W.	42.86							44.27	1.4	44.75	1.9
S-65B T.W.	35.4										
S-65C H.W.	34.35							38.52	4.2	39.39	5.0

TABLE A-15 (continued)

UNET PEAK STAGES

(BASED ON COINCIDENT FREQUENCY ANALYSIS)

PEAK STAGE (EL., FT.)	L. KISS SWSEL 49.0 TO 51.0 FT.	L. KISSIMMEE SWSEL VARIES BETWEEN EL. 48.5 TO 52.5 FEET BASED ON UKISS PERIOD OF RECORD ROUTINGS									
	EXISTING CONDITIONS S-65 11,000 CFS C-35,20' C-36, 48' C-37, 70'	WITH BACKFILL S-65 11,000 CFS C-35,20' C-36, 48' C-37, 70'	VS. EX.	DESIGN CANALS S-65 11,000 CFS C-35,20' C-36, 60' C-37, 90'	VS. EX.	PLAN 2 (B/F "n" = 0.3) S-65: 4-BAY CAP. C-35,20' C-36, 60' C-37, 90'		PLAN 1 ("n"=0.15/0.30/0.15) S-65: 5-BAY CAP. C-35,20' C-36, 60' C-37, 90'	VS. EX.	PLAN 1 (B/F "n" = 0.3) S-65: 5-BAY CAP. C-35,20' C-36, 60' C-37, 90'	VS. EX.
10-YEAR											
S-61 T.W.	54.53	54.96	0.4	54.47	-0.1	54.47	-0.1	54.26	-0.3	54.38	-0.1
S-63A T.W.	54.53	54.94	0.4	54.5	-0.0	54.49	-0.0	54.33	-0.2	54.43	-0.1
CYPRESS	54.16	54.62	0.5	54.09	-0.1	54.09	-0.1	53.86	-0.3	53.99	-0.2
HATCHINEHA	53.69	54.29	0.6	53.85	0.2	53.85	0.2	53.57	-0.1	53.74	0.1
KISSIMMEE	52.41	53.09	0.7	53.29	0.9	53.29	0.9	52.97	0.6	53.17	0.8
TIGER	52.93	53.35	0.4	53.46	0.5	53.44	0.5	53.26	0.3	53.37	0.4
JACKSON	57.4	57.4	0.0	57.4	0.0	57.4	0.0	57.4	0.0	57.4	0.0
ROSALIE	56.3	56.3	0.0	56.3	0.0	56.3	0.0	56.3	0.0	56.3	0.0
MARIAN	61.7	61.7	0.0	61.7	0.0	61.7	0.0	61.7	0.0	61.7	0.0
S-65 T.W.	49.51							52.03	2.5	52.41	2.9
S-65A H.W.	48.14							51.22	3.1	51.82	3.7
S-65A T.W.	44.55							50.83	6.3	51.54	7.0
@ BACKFILL	44.27							50.45	6.2	51.37	7.1
S-65B H.W.	43.16							45.06	1.9	45.27	2.1
S-65B T.W.	35.92										
S-65C H.W.	34.85							39.37	4.5	40.01	5.2

TABLE A-15 (continued)

UNET PEAK STAGES

(BASED ON COINCIDENT FREQUENCY ANALYSIS)

PEAK STAGE (EL., FT.)	L. KISS SWSEL 49.0 TO 51.0 FT.	L. KISSIMMEE SWSEL VARIES BETWEEN EL. 48.5 TO 52.5 FEET BASED ON UKISS PERIOD OF RECORD ROUTINGS									
	EXISTING CONDITIONS S-65 11,000 CFS C-35,20' C-36, 48' C-37, 70'	WITH BACKFILL S-65 11,000 CFS C-35,20' C-36, 48' C-37, 70'	VS. EX.	DESIGN CANALS S-65 11,000 CFS C-35,20' C-36, 60' C-37, 90'	VS. EX.	PLAN 2 (B/F "n" = 0.3) S-65: 4-BAY CAP. C-35,20' C-36, 60' C-37, 90'		PLAN 1 ("n"=0.15/0.30/0.15) S-65: 5-BAY CAP. C-35,20' C-36, 60' C-37, 90'	VS. EX.	PLAN 1 (B/F "n" = 0.3) S-65: 5-BAY CAP. C-35,20' C-36, 60' C-37, 90'	VS. EX.
25-YEAR											
S-61 T.W.	55.96	55.91	-0.0	55.35	-0.6	55.33	-0.6	55.02	-0.9	55.22	-0.7
S-63A T.W.	56.01	55.92	-0.1	55.37	-0.6	55.36	-0.6	55.09	-0.9	55.27	-0.7
CYPRESS	55.71	55.59	-0.1	55	-0.7	54.98	-0.7	54.65	-1.1	54.88	-0.8
HATCHINEHA	55.42	55.3	-0.1	54.85	-0.6	54.82	-0.6	54.39	-1.0	54.68	-0.7
KISSIMMEE	53.96	53.79	-0.2	54.21	0.3	54.14	0.2	53.6	-0.4	53.95	-0.0
TIGER	54.08	53.96	-0.1	54.25	0.2	54.2	0.1	53.8	-0.3	54.05	-0.0
JACKSON	58.1	58.1	0.0	58.1	0.0	58.1	0.0	58.1	0.0	58.1	0.0
ROSALIE	56.6	56.6	0.0	56.6	0.0	56.6	0.0	56.6	0.0	56.6	0.0
MARIAN	62.1	62.1	0.0	62.1	0.0	62.1	0.0	61.7	-0.4	62.1	0.0
S-65 T.W.	49.83							52.62	2.8	53.04	3.2
S-65A H.W.	48.59							51.85	3.3	52.43	3.8
S-65A T.W.	45.47							51.45	6.0	52.13	6.7
@ BACKFILL	45.3							51.01	5.7	51.86	6.6
S-65B H.W.	44.51							45.64	1.1	45.8	1.3
S-65B T.W.	36.06										
S-65C H.W.	35.12							40.02	4.9	40.64	5.5

TABLE A-15 (continued)

UNET PEAK STAGES

(BASED ON COINCIDENT FREQUENCY ANALYSIS)

PEAK STAGE (EL., FT.)	L. KISS SWSEL 49.0 TO 51.0 FT.	L. KISSIMMEE SWSEL VARIES BETWEEN EL. 48.5 TO 52.5 FEET BASED ON UKISS PERIOD OF RECORD ROUTINGS									
	EXISTING CONDITIONS S-65 11,000 CFS C-35,20' C-36, 48' C-37, 70'	WITH BACKFILL S-65 11,000 CFS C-35,20' C-36, 48' C-37, 70'	VS. EX.	DESIGN CANALS S-65 11,000 CFS C-35,20' C-36, 60' C-37, 90'	VS. EX.	PLAN 2 (B/F "n" = 0.3) S-65: 4-BAY CAP. C-35,20' C-36, 60' C-37, 90'		PLAN 1 ("n"=0.15/0.30/0.15) S-65: 5-BAY CAP. C-35,20' C-36, 60' C-37, 90'	VS. EX.	PLAN 1 (B/F "n" = 0.3) S-65: 5-BAY CAP. C-35,20' C-36, 60' C-37, 90'	VS. EX.
50-YEAR											
S-61 T.W.	56.77	56.45	-0.3	55.88	-0.9	55.79	-1.0	55.44	-1.3	55.68	-1.1
S-63A T.W.	56.84	56.45	-0.4	55.89	-1.0	55.82	-1.0	55.5	-1.3	55.71	-1.1
CYPRESS	56.56	56.19	-0.4	55.58	-1.0	55.5	-1.1	55.12	-1.4	55.37	-1.2
HATCHINEHA	56.41	55.94	-0.5	55.49	-0.9	55.39	-1.0	54.93	-1.5	55.23	-1.2
KISSIMMEE	55.13	54.34	-0.8	54.88	-0.3	54.68	-0.5	54.08	-1.0	54.46	-0.7
TIGER	55.15	54.44	-0.7	54.88	-0.3	54.71	-0.4	54.23	-0.9	54.53	-0.6
JACKSON	58.4	58.4	0.0	58.4	0.0	58.4	0.0	58.4	0.0	58.4	0.0
ROSALIE	56.8	56.8	0.0	56.8	0.0	56.8	0.0	56.8	0.0	56.8	0.0
MARIAN	62.4	62.4	0.0	62.4	0.0	62.4	0.0	62.4	0.0	62.4	0.0
S-65 T.W.	49.99							53.02	3.0	53.45	3.5
S-65A H.W.	49.02							52.28	3.3	52.87	3.8
S-65A T.W.	46.22							51.87	5.6	52.57	6.3
@ BACKFILL	46.08							51.4	5.3	52.27	6.2
S-65B H.W.	45.43							46.01	0.6	46.2	0.8
S-65B T.W.	36.47										
S-65C H.W.	35.61							40.45	4.8	41.1	5.5

TABLE A–15 (continued)

UNET PEAK STAGES

(BASED ON COINCIDENT FREQUENCY ANALYSIS)

PEAK STAGE (EL., FT.)	L. KISS SWSEL 49.0 TO 51.0 FT.	L. KISSIMMEE SWSEL VARIES BETWEEN EL. 48.5 TO 52.5 FEET BASED ON UKISS PERIOD OF RECORD ROUTINGS									
	EXISTING CONDITIONS S–65 11,000 CFS C–35,20' C–36, 48' C–37, 70'	WITH BACKFILL S–65 11,000 CFS C–35,20' C–36, 48' C–37, 70'	VS. EX.	DESIGN CANALS S–65 11,000 CFS C–35,20' C–36, 60' C–37, 90'	VS. EX.	PLAN 2 (B/F "n" = 0.3) S–65: 4–BAY CAP. C–35,20' C–36, 60' C–37, 90'		PLAN 1 ("n"=0.15/0.30/0.15) S–65: 5–BAY CAP. C–35,20' C–36, 60' C–37, 90'	VS. EX.	PLAN 1 (B/F "n" = 0.3) S–65: 5–BAY CAP. C–35,20' C–36, 60' C–37, 90'	VS. EX.
100–YEAR											
S–61 T.W.	57.22	56.9	–0.3	56.37	–0.9	56.22	–1.0	55.86	–1.4	56.09	–1.1
S–63A T.W.	57.46	56.88	–0.6	56.36	–1.1	56.24	–1.2	55.89	–1.6	56.12	–1.3
CYPRESS	57.04	56.67	–0.4	56.11	–0.9	55.96	–1.1	55.57	–1.5	55.82	–1.2
HATCHINEHA	56.99	56.48	–0.5	56.05	–0.9	55.87	–1.1	55.44	–1.6	55.71	–1.3
KISSIMMEE	56.18	55.02	–1.2	55.53	–0.7	55.19	–1.0	54.58	–1.6	54.96	–1.2
TIGER	56.18	55.05	–1.1	55.54	–0.6	55.22	–1.0	54.69	–1.5	55.01	–1.2
JACKSON	58.7	58.7	0.0	58.7	0.0	58.7	0.0	58.7	0.0	58.7	0.0
ROSALIE	57	57	0.0	57	0.0	57	0.0	57	0.0	57	0.0
MARIAN	62.7	62.7	0.0	62.7	0.0	62.7	0.0	62.7	0.0	62.7	0.0
S–65 T.W.	49.92							53.28	3.4	53.72	3.8
S–65A H.W.	48.87							52.49	3.6	53.07	4.2
S–65A T.W.	46.16							52.05	5.9	52.75	6.6
@ BACKFILL	46.03							51.56	5.5	52.44	6.4
S–65B H.W.	45.36							46.16	0.8	46.37	1.0
S–65B T.W.	36.47										
S–65C H.W.	35.61							40.61	5.0	41.27	5.7

TABLE A–16

C–38 BACKFILL AND LAKE KISSIMMEE SWSEL SENSITIVITY

(SENSITIVITY RUNS)

PEAK STAGE (EL., FT.)	VARIATION OF BACKFILL AND LAKE KISSIMMEE SWSEL FOR WITH–PROJECT CONDITION			VARIATION OF BACKFILL AND LAKE KISSIMMEE SWSEL FOR EXISTING CONDITION		
	WITH–PROJECT SWSEL = 52.5' (B/F @ RM 39.30) S–65 11,000 CFS S65A 11,000 CFS C–35,20' C–36, 48' C–37, 70'	WITH–PROJECT SWSEL = 52.5' (B/F REMOVED) S–65 11,000 CFS S65A 11,000 CFS C–35,20' C–36, 48' C–37, 70'	WITH–PROJECT SWSEL = 51.0' (B/F @ RM 39.30) S–65 11,000 CFS S65A 11,000 CFS C–35,20' C–36, 48' C–37, 70'	EXISTING SWSEL = 51.0' (NO BACKFILL) S–65 11,000 CFS S65A 11,000 CFS C–35,20' C–36, 48' C–37, 70'	EXISTING SWSEL = 51.0' (B/F @ RM 39.30) S–65 11,000 CFS S65A 11,000 CFS C–35,20' C–36, 48' C–37, 70'	EXISTING SWSEL = 52.5' (NO BACKFILL) S–65 11,000 CFS S65A 11,000 CFS C–35,20' C–36, 48' C–37, 70'
5–YEAR						
S–61 T.W.	54.75	54.63	54.11	53.97	55.4	54.84
CYPRESS	54.45	54.31	53.73	53.54	55.13	54.53
HATCHINEHA	54.11	53.97	53.21	52.91	55.01	54.17
KISSIMMEE	53.17	52.95	52.02	51.88	54.64	53.31
TIGER	53.35	53.15	52.52	52.42	54.64	53.46
S–65 T.W.	52.01	50.03	51.12	49.22	50.41	49.18
S–65A H.W.	51.34	48.07	50.63	47.63	50.18	47.55
S–65A T.W.	50.45	42.55	49.97	43.94	49.19	43.94
@ BACKFILL	50.04	39.31	49.59	42.96	48.85	42.96
S–65B H.W.	44.66	35.48	44.18	41.94	44.6	41.94
S–65B T.W.				35.38	43.21	35.38
S–65C H.W.	38.8	33.62	38.35	34.21	37.93	34.21
S–65C T.W.				30.48	36.93	30.48
100–YEAR					50–YEAR	
S–61 T.W.	57.34	57.21	56.78	57.31	58.47	57.94
CYPRESS	57.15	57.01	56.55	57.15	58.33	57.8
HATCHINEHA	57.02	56.84	56.28	57.07	58.33	57.8
KISSIMMEE	55.81	55.51	54.6	56.16	58.29	57.52
TIGER	55.82	55.51	54.62	56.17	58.29	57.52
S–65 T.W.	53.56	51.12	52.85	49.28	52.34	49.27
S–65A H.W.	52.89	48.62	52.28	48.62	52.14	48.6
S–65A T.W.	51.65	45.06	51.23	45.96	50.38	45.96
@ BACKFILL	51.19	42.37	50.83	45.4	50.05	45.4
S–65B H.W.	46.04	37.96	45.67	44.8	46.92	44.79
S–65B T.W.				36.47	44.41	36.47
S–65C H.W.	40.31	35.96	39.96	35.54	40.19	35.54
S–65C T.W.				32.26	38.18	32.27

TABLE A-17

SENSITIVITY RUNS FOR C-38 BACKFILL MANNINGS "N" AND LAKE KISSIMMEE HEC-1 LAG

PEAK STAGE (EL., FT.)	VARIATION OF MANNINGS "N" VALUE FOR C-38 BACKFILL SECTION		
	PLAN 1 "N" VALUE = 0.1 SWSEL = 52.5 FT. S-65 (5-BAY CAP.) C-35,20' C-36, 60' C-37, 90'	PLAN 1 "N" VALUE = 0.3 SWSEL = 52.5 FT. S-65 (5-BAY CAP.) C-35,20' C-36, 60' C-37, 90'	PLAN 1 "N" VALUE = 0.5 SWSEL = 52.5 FT. S-65 (5-BAY CAP.) C-35,20' C-36, 60' C-37, 90'
25-YEAR			
S-63A T.W.	55.28	55.64	56.11
S-61 T.W.	55.07	55.56	56.1
CYPRESS	54.72	55.25	55.83
HATCHINEHA	54.48	55.11	55.76
KISSIMMEE	53.62	54.41	55.26
TIGER	53.9	54.49	55.27
S-65 T.W.	52.39	53.42	54.44
S-65A H.W.	50.93	52.89	54.03
S-65A T.W.	50.28	52.58	53.65
@ BACKFILL	49.24	52.28	53.5
S-65B	43.35	46.22	47.52
S-65C	38.15	41.13	42.51

PEAK STAGE (EL., FT.)	VARIATION OF HEC-1 LAG FOR LAKE KISSIMMEE DRAINAGE BASIN		
	PLAN 1 LAG = 16.8 HOURS SWSEL = 52.5 FT. S-65 (5-BAY CAP.) C-35,20' C-36, 60' C-37, 90'	PLAN 1 LAG = 33.6 HOURS SWSEL = 52.5 FT. S-65 (5-BAY CAP.) C-35,20' C-36, 60' C-37, 90'	PLAN 1 LAG = 50.8 HOURS SWSEL = 52.5 FT. S-65 (5-BAY CAP.) C-35,20' C-36, 60' C-37, 90'
25-YEAR			
S-63A T.W.			
S-61 T.W.	55.69	55.69	55.67
CYPRESS	55.39	55.39	55.36
HATCHINEHA	55.25	55.25	55.23
KISSIMMEE	54.47	54.47	54.46
TIGER	54.55	54.55	54.53
S-65 T.W.	53.41	53.41	53.25
S-65A H.W.	52.7	52.7	52.53
S-65A T.W.	51.47	51.47	51.36
@ BACKFILL	51.02	51.02	50.92
S-65B	45.85	45.85	45.75
S-65C	40.08	40.08	39.99

TABLE A–18

SENSITIVITY RUNS FOR EARLY – MONTH AND MID – MONTH RAINFALL DISTRIBUTION

UNET PEAK STAGE (EL., FT.)	EARLY – MONTH DISTRIBUTION (used in 1985 and 1991 reports) PLAN 1 SWSEL = 52.5 FT. S–65 (5–BAY CAP.) C–35,20' C–36, 60' C–37, 90'	MID – MONTH DISTRIBUTION (used in 1995 report) PLAN 1 SWSEL = 52.5 FT. S–65 (5–BAY CAP.) C–35,20' C–36, 60' C–37, 90'
25–YEAR		
S–61 T.W.	54.92	55.33
S–63A T.W.	55.05	55.43
CYPRESS	54.50	55.00
HATCHINEHA	54.22	54.83
KISSIMMEE	53.47	54.04
TIGER	53.70	54.19
JACKSON	57.95	58.39
ROSALIE	56.32	56.56
MARIAN	61.71	62.05
S–65 T.W.	52.54	53.01
S–65A H.W.	51.72	52.23
S–65A T.W.	51.31	51.80
@ BACKFILL	50.88	51.33
S–65B	45.53	45.96
S–65C	39.88	40.40

TABLE A–19

IMPACT OF VARYING LOWER BASIN FLOOD FOR GIVEN MIDDLE BASIN FLOOD

(EXISTING CONDITION SENSITIVITY RUNS)

PEAK STAGE (EL., FT.)	EXISTING CONDITION: LAKE KISSIMMEE SWSEL 51.0 FT.; S–65 11,000 CFS, S–65A 11,000 CFS NO BACKFILL IN C–38; EXISTING CANALS WITH C–35, 20' B.W.; C–36, 48' B.W.; C–37, 70' B.W.					
	5–YEAR		10–YEAR		25–YEAR	
	WITH 5–YEAR LOWER BASIN FLOOD	WITH 10–YEAR LOWER BASIN FLOOD	WITH 10–YEAR LOWER BASIN FLOOD	WITH 100–YEAR LOWER BASIN FLOOD	WITH 25–YEAR LOWER BASIN FLOOD	WITH 10–YEAR LOWER BASIN FLOOD
S–61 T.W.	53.97	54.02	54.52	54.86	55.93	55.74
CYPRESS	53.54	53.6	54.2	54.56	55.67	55.44
HATCHINEHA	52.91	52.96	53.7	54.14	55.37	55.13
KISSIMMEE	51.88	52.03	52.46	53.08	53.81	53.43
TIGER	52.42	52.48	52.94	53.3	53.96	53.63
S–65 T.W.	49.22	49.1	49.19	49.23	48.78	48.95
S–65A H.W.	47.63	47.67	47.69	48.57	47.97	47.67
S–65A T.W.	43.94	44.58	44.58	45.93	45.28	44.59
@ BACKFILL	42.96	43.73	43.74	45.37	44.61	43.75
S–65B H.W.	41.94	42.87	42.89	44.76	43.89	42.89
S–65B T.W.	35.38	35.42	35.42	36.47	35.91	35.42
S–65C H.W.	34.21	34.21	34.21	35.54	34.88	34.21
S–65C T.W.	30.48	30.87	30.88	32.26	31.61	30

PEAK STAGE (EL., FT.)	EXISTING CONDITION: LAKE KISSIMMEE SWSEL 51.0 FT.; S–65 11,000 CFS, S–65A 11,000 CFS NO BACKFILL IN C–38; EXISTING CANALS WITH C–35, 20' B.W.; C–36, 48' B.W.; C–37, 70' B.W.					
	50–YEAR		100–YEAR		SPF	
	WITH 50–YEAR LOWER BASIN FLOOD	WITH 10–YEAR LOWER BASIN FLOOD	WITH 100–YEAR LOWER BASIN FLOOD	WITH 10–YEAR LOWER BASIN FLOOD	WITH SPF LOWER BASIN FLOOD	WITH 10–YEAR LOWER BASIN FLOOD
S–61 T.W.	56.79	56.52	57.31	57.07	59.18	58.35
CYPRESS	56.6	56.32	57.15	56.89	59.07	58.2
HATCHINEHA	56.42	56.07	57.07	56.74	59.07	58.2
KISSIMMEE	55.08	54.48	56.16	55.45	58.91	57.94
TIGER	55.09	54.5	56.17	55.46	58.91	57.95
S–65 T.W.	49.27	48.93	49.28	49.16	51.85	49.08
S–65A H.W.	48.61	47.67	48.62	47.67	51.49	47.67
S–65A T.W.	45.95	44.59	45.96	44.59	48.83	44.59
@ BACKFILL	45.39	43.75	45.4	43.75	48.51	43.76
S–65B H.W.	44.79	42.9	44.8	42.9	48.17	42.9
S–65B T.W.	36.47	35.42	36.47	35.42	38.32	35.42
S–65C H.W.	35.54	34.21	35.54	34.21	37.67	34
S–65C T.W.	32.26	30.88	32.26	30.88	34.54	30.88

TABLE A–20

IMPACT OF VARYING LOWER BASIN FLOOD FOR GIVEN MIDDLE BASIN FLOOD

(SENSITIVITY RUNS FOR WITH–PROJECT CONDITION)

PEAK STAGE (EL., FT.)	WITH–DESIGN CANAL CONDITION: LAKE KISSIMMEE SWSEL 52.5 FT.; S–65 11,000 CFS, S–65A 11,000 CFS BACKFILL IN C–38; IMPROVED CANALS WITH C–35, 20' B.W.; C–36, 60' B.W.; C–37, 90' B.W.					
	5–YEAR		10–YEAR		25–YEAR	
	WITH 5–YEAR LOWER BASIN FLOOD	WITH 10–YEAR LOWER BASIN FLOOD	WITH 10–YEAR LOWER BASIN FLOOD	WITH 100–YEAR LOWER BASIN FLOOD	WITH 25–YEAR LOWER BASIN FLOOD	WITH 10–YEAR LOWER BASIN FLOOD
S–61 T.W.	54.36	54.4	54.92	55	55.99	55.87
CYPRESS	54.03	54.07	54.63	54.72	55.71	55.58
HATCHINEHA	53.77	53.82	54.42	54.53	55.61	55.48
KISSIMMEE	53.29	53.35	53.82	53.95	54.97	54.81
TIGER	53.44	53.49	53.91	54.03	54.98	54.83
S–65 T.W.	52.02	52.21	52.39	52.8	53.03	52.67
S–65A H.W.	51.34	51.58	51.73	52.27	52.39	51.93
S–65A T.W.	50.46	50.67	50.76	51.26	51.28	50.89
@ BACKFILL	50.04	50.25	50.34	50.84	50.85	50.46
S–65B	44.67	44.96	45.07	45.68	45.68	45.22
S–65C	38.81	39.13	39.23	39.95	39.91	39.41

PEAK STAGE (EL., FT.)	WITH DESIGN CANAL CONDITION: LAKE KISSIMMEE SWSEL 52.5 FT.; S–65 11,000 CFS, S–65A 11,000 CFS BACKFILL IN C–38; IMPROVED CANALS WITH C–35, 20' B.W.; C–36, 60' B.W.; C–37, 90' B.W.					
	50–YEAR		100–YEAR		SPF	
	WITH 50–YEAR LOWER BASIN FLOOD	WITH 10–YEAR LOWER BASIN FLOOD	WITH 100–YEAR LOWER BASIN FLOOD	WITH 10–YEAR LOWER BASIN FLOOD	WITH SPF LOWER BASIN FLOOD	WITH 10–YEAR LOWER BASIN FLOOD
S–61 T.W.	56.45	56.33	56.86	56.76	58.32	58.12
CYPRESS	56.21	56.08	56.64	56.53	58.15	57.94
HATCHINEHA	56.15	56.03	56.6	56.49	58.15	57.94
KISSIMMEE	55.59	55.44	56.14	55.99	58.01	57.78
TIGER	55.6	55.45	56.14	56	58.01	57.78
S–65 T.W.	53.31	52.82	53.49	52.99	54.59	53.34
S–65A H.W.	52.69	52.05	52.84	52.18	54.05	52.47
S–65A T.W.	51.52	50.95	51.62	51.03	52.62	51.2
@ BACKFILL	51.08	50.52	51.17	50.58	52.14	50.74
S–65B	45.93	45.29	46.02	45.37	47.05	45.54
S–65C	40.2	39.48	40.29	39.55	41.54	39.72

TABLE A-21

LAKE ROSALIE ANALYSIS

PEAK LAKE STAGE (EL., FT.)	TOP OF REGULATION SCHEDULE		JOINT PROBABILITY APPROACH	
	EXISTING CONDITIONS (KISS SWSEL @ 51.0') S-65 11,000 CFS C-35,20' C-36, 48' C-37, 70'	PLAN 1 (B/F @ RM 39.30) (KISS SWSEL @ 52.5') S-65 (5-BAY CAP.) C-35,20' C-36, 60' C-37, 90'	EXISTING CONDITIONS (KISS SWSEL 50.0' - 50.3') S-65 11,000 CFS C-35,20' C-36, 48' C-37, 70'	PLAN 1 (B/F @ RM 39.30) (KISS SWSEL 51.1' - 51.3') S-65 (5-BAY CAP.) C-35,20' C-36, 60' C-37, 90'
5-YEAR	56.06	56.07	56.06	56.07
10-YEAR	56.26	56.27	56.26	56.27
25-YEAR	56.54	56.56	56.54	56.56
50-YEAR	56.77	56.78	56.77	56.78
100-YEAR	56.94	56.95	56.94	56.95
SPF	58.93	57.37	N/A	N/A

TABLE A-22

ZIPPERER CANAL ANALYSIS

PEAK STAGE ON ZIPPERER CANAL D/S OF G-113 (EL., FT.)	TOP OF REGULATION SCHEDULE		JOINT PROBABILITY APPROACH	
	EXISTING CONDITIONS (KISS SWSEL @ 51.0') S-65 11,000 CFS C-35,20' C-36, 48' C-37, 70'	PLAN 1 (B/F @ RM 39.30) (KISS SWSEL @ 52.5') S-65 (5-BAY CAP.) C-35,20' C-36, 60' C-37, 90'	EXISTING CONDITIONS (KISS SWSEL @ 50.3') S-65 11,000 CFS C-35,20' C-36, 48' C-37, 70'	PLAN 1 (B/F @ RM 39.30) (KISS SWSEL @ 51.2') S-65 (5-BAY CAP.) C-35,20' C-36, 60' C-37, 90'
5-YEAR	52.2	53	52.05	52.55
10-YEAR	52.7	53.4	52.7	52.6
25-YEAR	54.1	54.1	54.1	53.8
50-YEAR	55.25	54.6	55.1	54.25
100-YEAR	56.34	54.9	56.22	54.6
SPF	58.93	56.2	N/A	N/A

NOTE:

1. G-113 IS THE WEIR STRUCTURE INSTALLED ON ZIPPERER CANAL BETWEEN LAKE ROSALIE AND LAKE KISSIMMEE. UNET ANALYSES SHOW THERE WILL BE NO ADVERSE STAGE IMPACTS TO LAKE ROSALIE DUE TO THE PROJECT IF THE WEIR IS SET AT A MINIMUM ELEVATION EQUAL TO OR GREATER THAN THE LAKE KISSIMMEE REGULATORY STAGE. FURTHER ANALYSES INDICATE THAT THE PEAK STAGES ON LAKE ROSALIE WOULD BE REDUCED BY 0.2 TO 0.3 FEET IF THE WEIR WERE REMOVED. THE PRIMARY OUTLET FROM LAKE ROSALIE IS ROSALIE CREEK FLOWING TO LAKE TIGER AT A NATURAL SILL ELEVATION OF APPROXIMATELY 50 FEET.

TABLE A-23

LAKE JACKSON WATER CONTROL STRUCTURE (LJWCS), LAKE JACKSON AND LAKE MARIAN ANALYSIS

PEAK STAGE (EL., FEET)	WITH LAKE JACKSON WATER CONTROL STRUCTURE IN-PLACE		
	EXISTING CONDITIONS (KISS SWSEL @ 51.0') S-65 11,000 CFS	PLAN 1 (KISS SWSEL @ 51.0') S-65 (5-BAY CAP.)	PLAN 1 (KISS SWSEL @ 52.5') S-65 (5-BAY CAP.)
5-YEAR			
L. KISSIMMEE	51.9	52.7	52.9
LJWCS (TW/HW)	55.7/56.75	55.75/56.8	55.7/56.8
L. JACKSON	56.8	56.8	56.8
G-103 (TW/HW)	58.5/61.35	58.5/61.35	58.5/61.35
L. MARIAN	61.4	61.4	61.4
10-YEAR			
L. KISSIMMEE	52.5	52.8	53.3
LJWCS (TW/HW)	56.1/57.3	56.2/57.35	56.25/57.3
L. JACKSON	57.4	57.4	57.4
G-103 (TW/HW)	58.8/61.6	58.8/61.6	58.8/61.6
L. MARIAN	61.7	61.7	61.7
25-YEAR			
L. KISSIMMEE	54.1	53.6	54.0
LJWCS (TW/HW)	56.6/58	56.6/58	56.6/58
L. JACKSON	58.1	58.1	58.1
G-103 (TW/HW)	59.2/62.0	59.2/62.0	59.2/62.0
L. MARIAN	62.1	62.1	62.1
50-YEAR			
L. KISSIMMEE	55.2	54.1	54.5
LJWCS (TW/HW)	56.75/58.3	56.7/58.3	56.75/58.3
L. JACKSON	58.4	58.4	58.4
G-103 (TW/HW)	59.25/62.4	59.25/62.4	59.25/62.4
L. MARIAN	62.4	62.4	62.4
100-YEAR			
L. KISSIMMEE	56.3	54.5	54.9
LJWCS (TW/HW)	56.85/58.65	56.8/58.6	56.8/58.6
L. JACKSON	58.7	58.7	58.7
G-103 (TW/HW)	59.35/62.6	59.35/62.6	59.35/62.6
L. MARIAN	62.7	62.6	62.6
SPF			
L. KISSIMMEE	58.9	55.8	56.2
LJWCS (TW/HW)	58.93/59.32	57.0/59.3	57.1/59.25
L. JACKSON	59.4	59.3	59.3
G-103 (TW/HW)	59.4/63.15	59.4/63.15	59.4/63.15
L. MARIAN	63.15	63.1	63.1

TABLE A–24

JACKSON CANAL DOWNSTREAM OF LJWCS ANALYSIS

PEAK STAGE ON JACKSON CANAL AT RIVER MILE ___ (EL., FT.)	TOP OF REGULATION SCHEDULE		JOINT PROBABILITY APPROACH	
	EXISTING CONDITIONS (KISS SWSEL @ 51.0') S–65 11,000 CFS C–35,20' C–36, 48' C–37, 70'	PLAN 1 (KISS SWSEL @ 52.5') S–65 (5–BAY CAP.) C–35,20' C–36, 60' C–37, 90'	EXISTING CONDITIONS (KISS SWSEL @ 50.3') S–65 11,000 CFS C–35,20' C–36, 48' C–37, 70'	PLAN 1 (KISS SWSEL @ 51.2') S–65 (5–BAY CAP.) C–35,20' C–36, 60' C–37, 90'
5–YEAR				
5.25 (KISSIMMEE)	51.88	52.9	51.77	52.68
5.5	52.1	53.05	52	52.8
6.0	54	54.2	53.9	54.1
6.5	55	55.1	55	55.1
7.0	55.55	55.6	55.6	55.6
7.5 (D/S OF LJWCS)	55.7	55.75	55.7	55.75
10–YEAR				
5.25 (KISSIMMEE)	52.48	53.3	52.41	52.98
5.5	52.6	53.4	52.6	53
6.0	54.4	54.6	54.4	54.5
6.5	55.4	55.45	55.4	55.4
7.0	55.9	56	55.9	55.9
7.5 (D/S OF LJWCS)	56.15	56.15	56.1	56.15
25–YEAR				
5.25 (KISSIMMEE)	54.07	54.04	53.96	53.6
5.5	54.1	54.05	54	53.7
6.0	55.1	55.1	55	55
6.5	55.8	55.8	55.8	55.8
7.0	56.3	56.35	56.35	56.4
7.5 (D/S OF LJWCS)	56.6	56.6	56.6	56.6
50–YEAR				
5.25 (KISSIMMEE)	55.24	54.53	55.12	54.08
5.5	55.25	54.55	55.15	54.2
6.0	55.4	55.35	55.35	55.2
6.5	56	56	56	55.95
7.0	56.5	56.5	56.5	56.5
7.5 (D/S OF LJWCS)	56.75	56.75	56.75	56.7
100–YEAR				
5.25 (KISSIMMEE)	56.34	54.89	56.18	54.58
5.5	56.34	54.9	56.2	54.6
6.0	56.34	55.5	56.2	55.4
6.5	56.35	56.15	56.25	56.1
7.0	56.65	56.6	56.6	56.6
7.5 (D/S OF LJWCS)	56.85	56.85	56.85	56.85

Structure 65

Hydraulic Design Data

Type of Structure	Spillway
Location	
Canal	C-38
Station	N/A
Discharge (cfs)	
Design	3,000
SPF	11,000
Critical	11,000
Headwater Elevation	
Design	51.5
SPF	58.0
Critical	58.0
Optimum	48.5 to 52.5
Minimum	46.7
Tailwater Elevation	
Design	49.0
SPF	53.1
Critical	48.2
Optimum	46.3
Minimum	44.0
Crest	
Shape	Ogee
Design Head (ft.)	18.7
Elevation	39.3
Net Length (ft.)	81.0
Gates	
Number	3
Width X Height (ft.)	27.0 X 14.2
Clearance Elevation	53.1
Stilling Basin	
Apron Elevation	34.0
Apron Length	48.0
End Sill Elevation	36.5
Training Wall Elevation	49.0
Channel Section	
Side Slopes (vert. on horiz.)	1 on 2
Upstream Bottom Width & Elev.	210 @ 34.0
Downstream Bottom Width & Elev.	90 @ 19.0
Riprap	
Upstream Channel	
Length (ft.)	80.0
Protection Elev.	54.5
Downstream Channel	
Length (ft.)	180.0
Protection Elev.	52.0
Approximate Ground Elevation at Structure	
Protection Elevation	60.0

Notes: All elevations refer to feet, NGVD.

Structure 65 Expansion

Hydraulic Design Data

Type of Structure	Spillway
Location	
Canal	C-38
Station	N/A
Discharge (cfs)	
Design	2,000
SPF	7,350
Critical	7,350
Headwater Elevation	
Design	51.5
SPF	58.0
Critical	58.0
Optimum	48.5 to 52.5
Minimum	46.7
Tailwater Elevation	
Design	49.0
SPF	53.1
Critical	48.2
Optimum	46.3
Minimum	44.0
Crest	
Shape	Ogee
Design Head (ft.)	18.7
Elevation	39.3
Net Length (ft.)	54.0
Gates	
Number	2
Width X Height (ft.)	27.0 X 14.2
Clearance Elevation	53.1
Stilling Basin	
Apron Elevation	34.0
Apron Length	48.0
End Sill Elevation	36.5
Training Wall Elevation	49.0
Channel Section	
Side Slopes (vert. on horiz.)	1 on 2 to 2.5
Upstream Bottom Width & Elev.	54 @ 34.0
Downstream Bottom Width & Elev.	54 @ 19.0
Riprap	
Upstream Channel	
Length (ft.)	80.0
Protection Elev.	54.5
Downstream Channel	
Length (ft.)	180.0
Protection Elev.	52.0
Approximate Ground Elevation at Structure	
Protection Elevation	60.0

Notes: All elevations refer to feet, NGVD.

Structure 65 Combined

Hydraulic Design Data

Type of Structure	Spillway
Location	
Canal	C-38
Station	N/A
Discharge (cfs)	
Design	5,000
SPF	18,350
Critical	18,350
Headwater Elevation	
Design	51.5
SPF	58.0
Critical	58.0
Optimum	48.5 to 52.5
Minimum	46.7
Tailwater Elevation	
Design	49.0
SPF	53.1
Critical	48.2
Optimum	46.3
Minimum	44.0
Crest	
Shape	Ogee
Design Head (ft.)	18.7
Elevation	39.3
Net Length (ft.)	135
Gates	
Number	5
Width X Height (ft.)	27.0 X 14.2
Clearance Elevation	53.1
Stilling Basin	
Apron Elevation	34.0
Apron Length	48.0
End Sill Elevation	36.5
Training Wall Elevation	49.0
Channel Section	
Side Slopes (vert. on horiz.)	1 on 2 to 2.5
Upstream Bottom Width & Elev.	288 @ 34.0
Downstream Bottom Width & Elev.	168 @ 19.0
Riprap	
Upstream Channel	
Length (ft.)	80.0
Protection Elev.	54.5
Downstream Channel	
Length (ft.)	180.0
Protection Elev.	52.0
Approximate Ground Elevation at Structure	
Protection Elevation	60.0

Notes: All elevations refer to feet, NGVD.

CENTRAL AND SOUTHERN FLORIDA PROJECT
KISSIMMEE RIVER
HEADWATERS REVITALIZATION PROJECT
Appendix A
Hydrology and Hydraulic Analyses

PHOTOGRAPHS

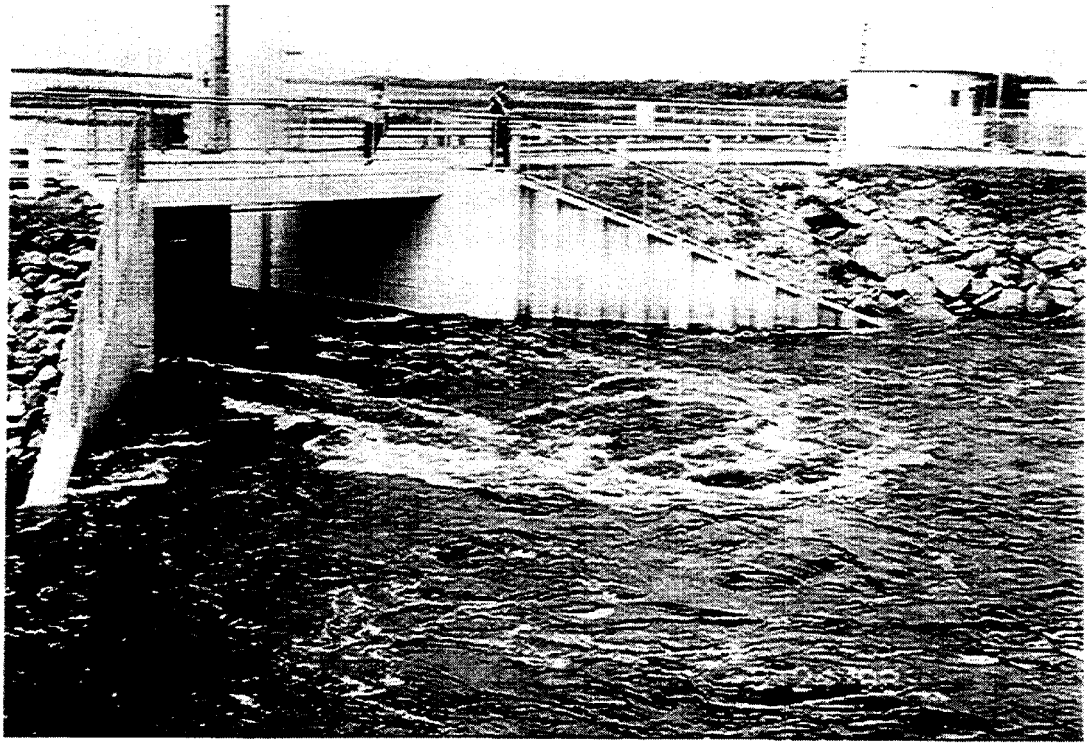


PHOTO A-1
S-61
(Downstream Side)

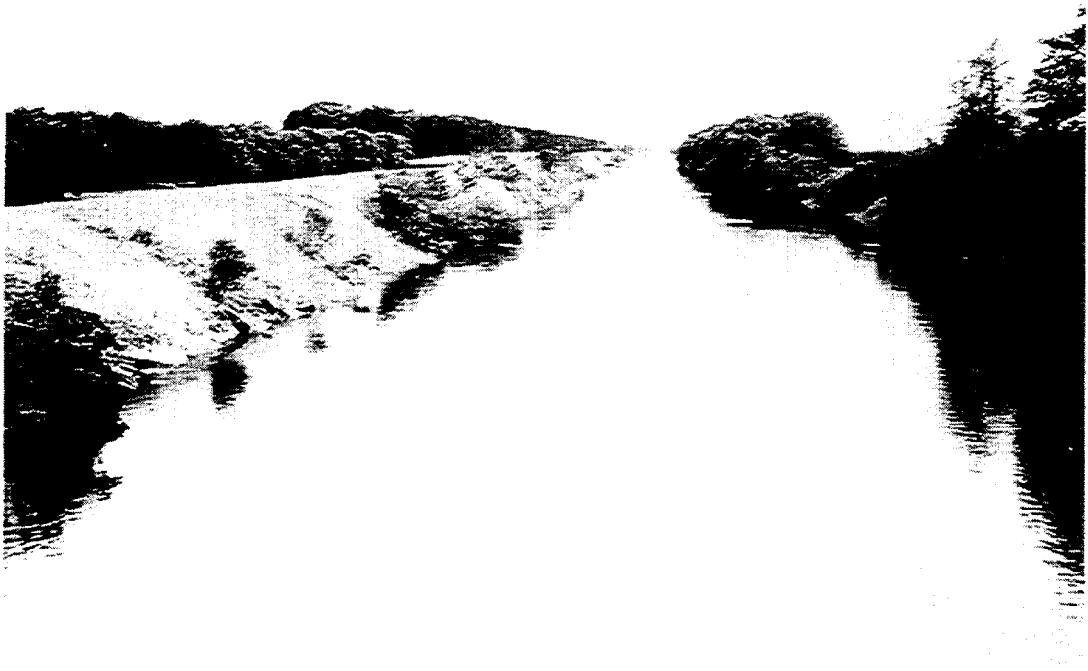


PHOTO A-2
C-35
(Looking Downstream from S-61)

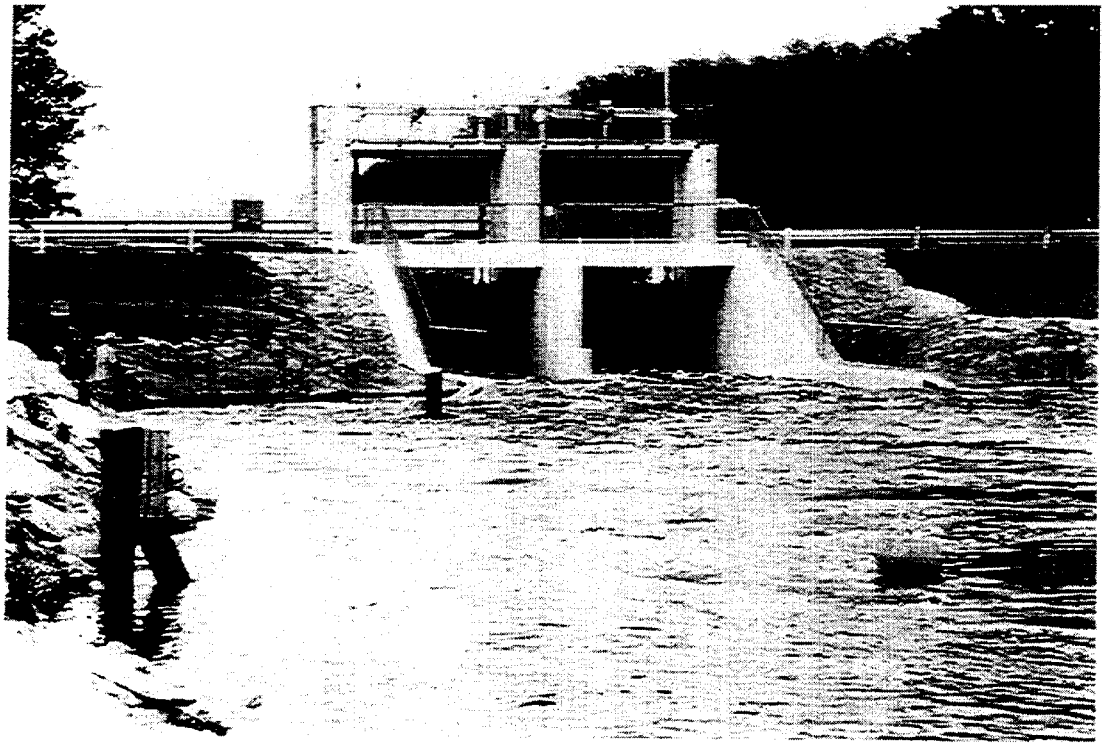


PHOTO A-3
S-63A
(Downstream Side)

PHOTO A-4
C-34
(Looking Downstream from S-63A)

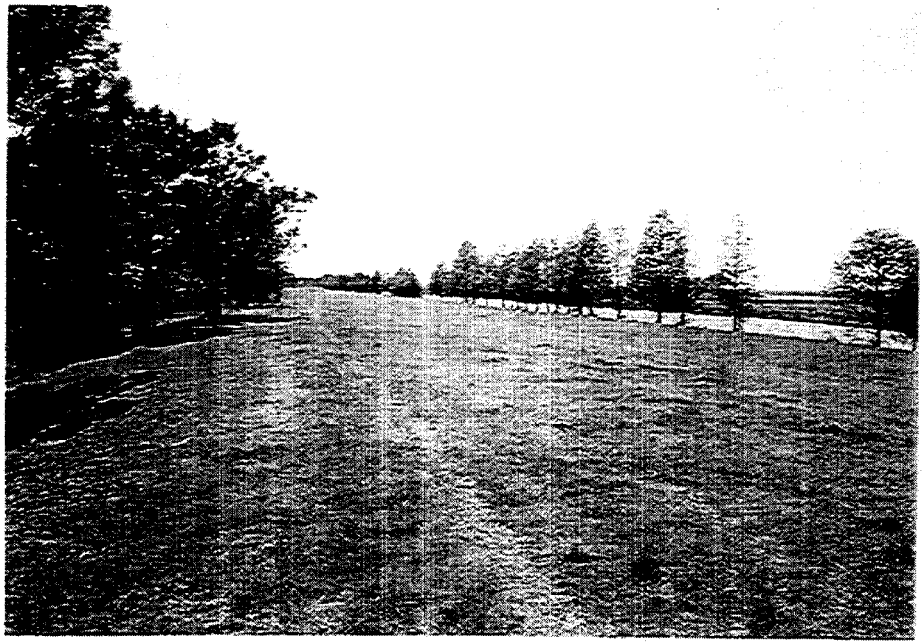


PHOTO A-5
C-36
(Looking Downstream along East Disposal Bank)

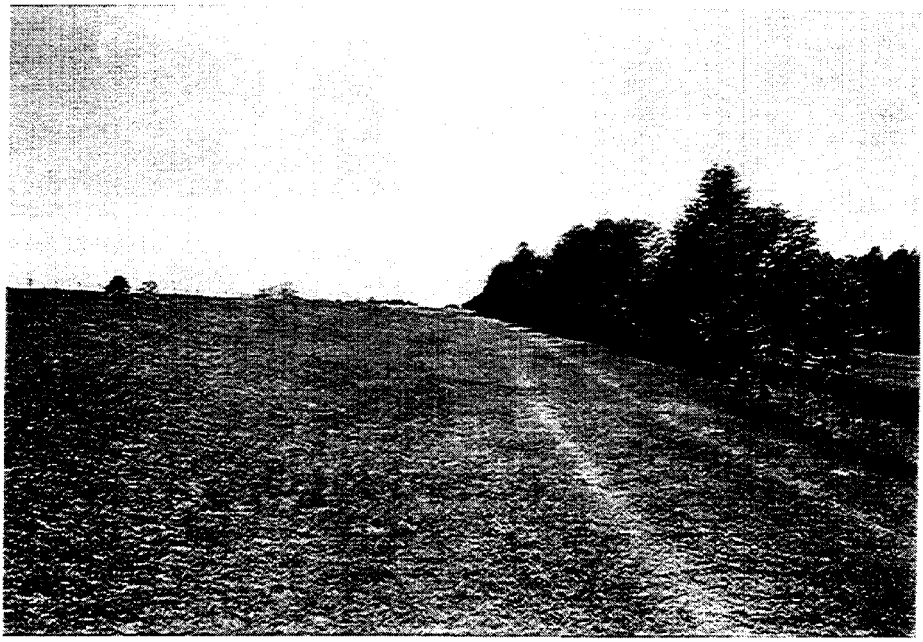


PHOTO A-6
C-37
(Looking Downstream along East Disposal Bank)

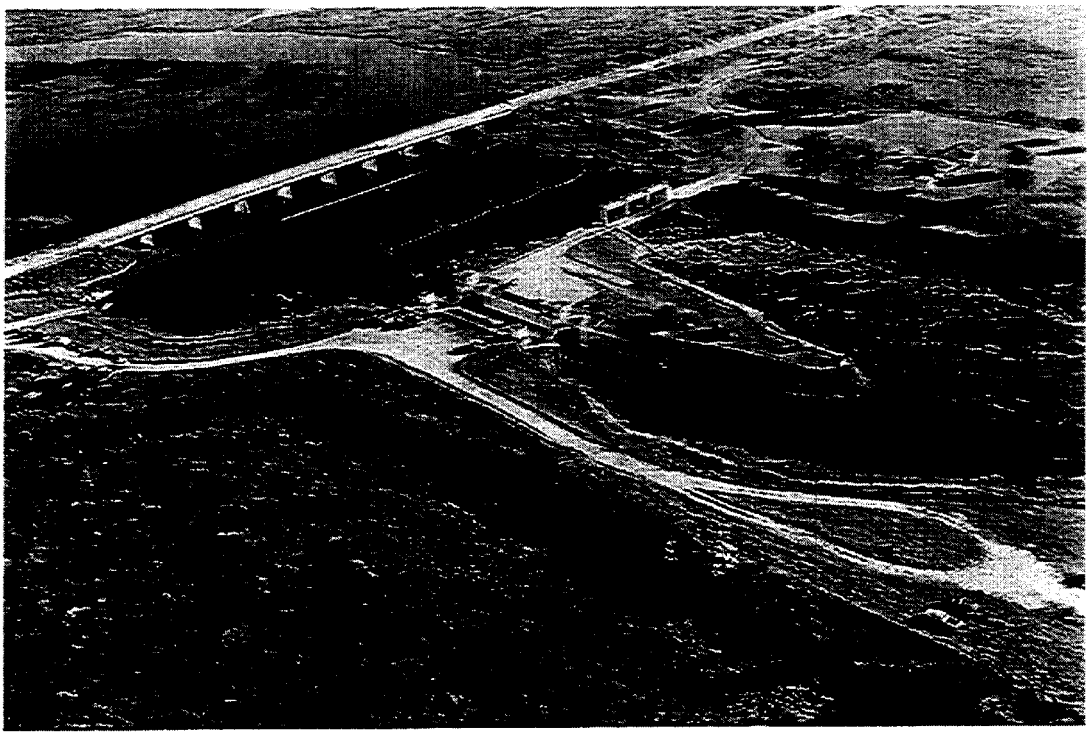


PHOTO A-7
S-65, Lock Structure and Operator's Residence
(Looking from southwest towards S.R. 60 Bridge)

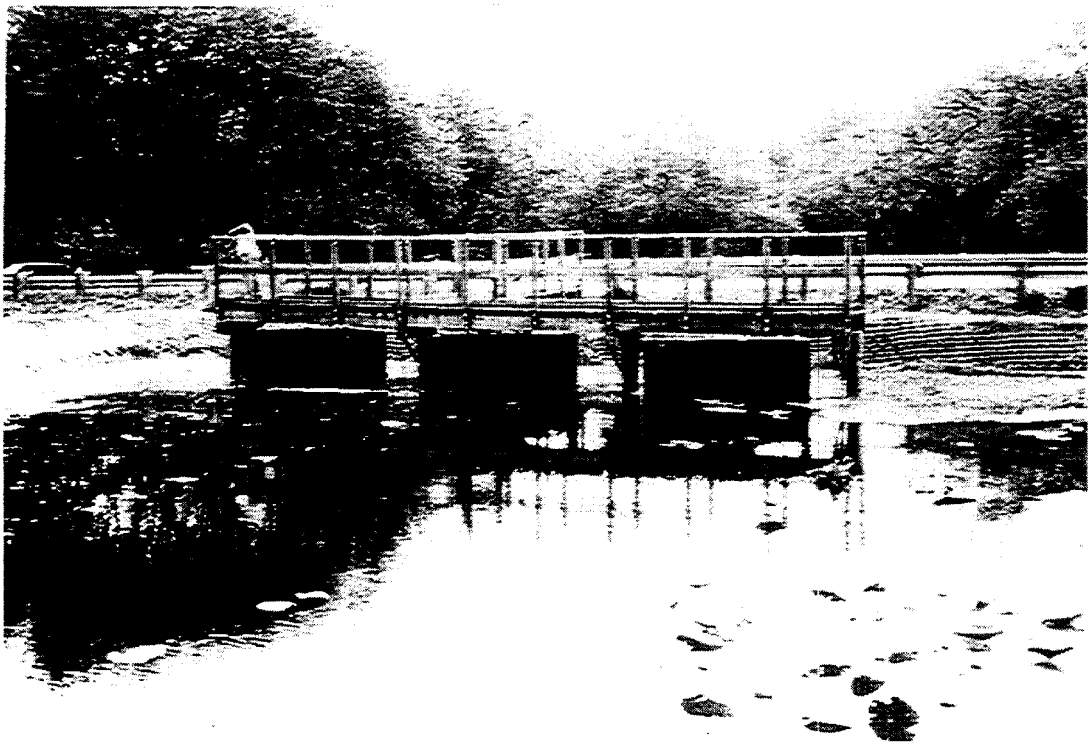


PHOTO A-8
Lake Marian Control Structure, G-113
(Upstream Side)

PHOTO A-9
Lake Jackson Water Control Structure
(Upstream Side)

PHOTO A-10
Lake Rosalie Control Structure, G-103
(Downstream Side)

PHOTO A-11
Zipperer Canal
(Looking Downstream from G-103)

PHOTO A-12
Reedy Creek at S.R. 531 near Lake Russell
(Looking Downstream)

PHOTO A-13
Reedy Creek at U.S. 92 near S-40
(Looking Upstream at CSX Railroad Bridge)

CENTRAL AND SOUTHERN FLORIDA PROJECT
KISSIMMEE RIVER
HEADWATERS REVITALIZATION PROJECT
Appendix A
Hydrology and Hydraulic Analyses

FIGURES

UNET MODEL - MIDDLE BASIN

(EXISTING AND WITH-PROJECT CONDITIONS)

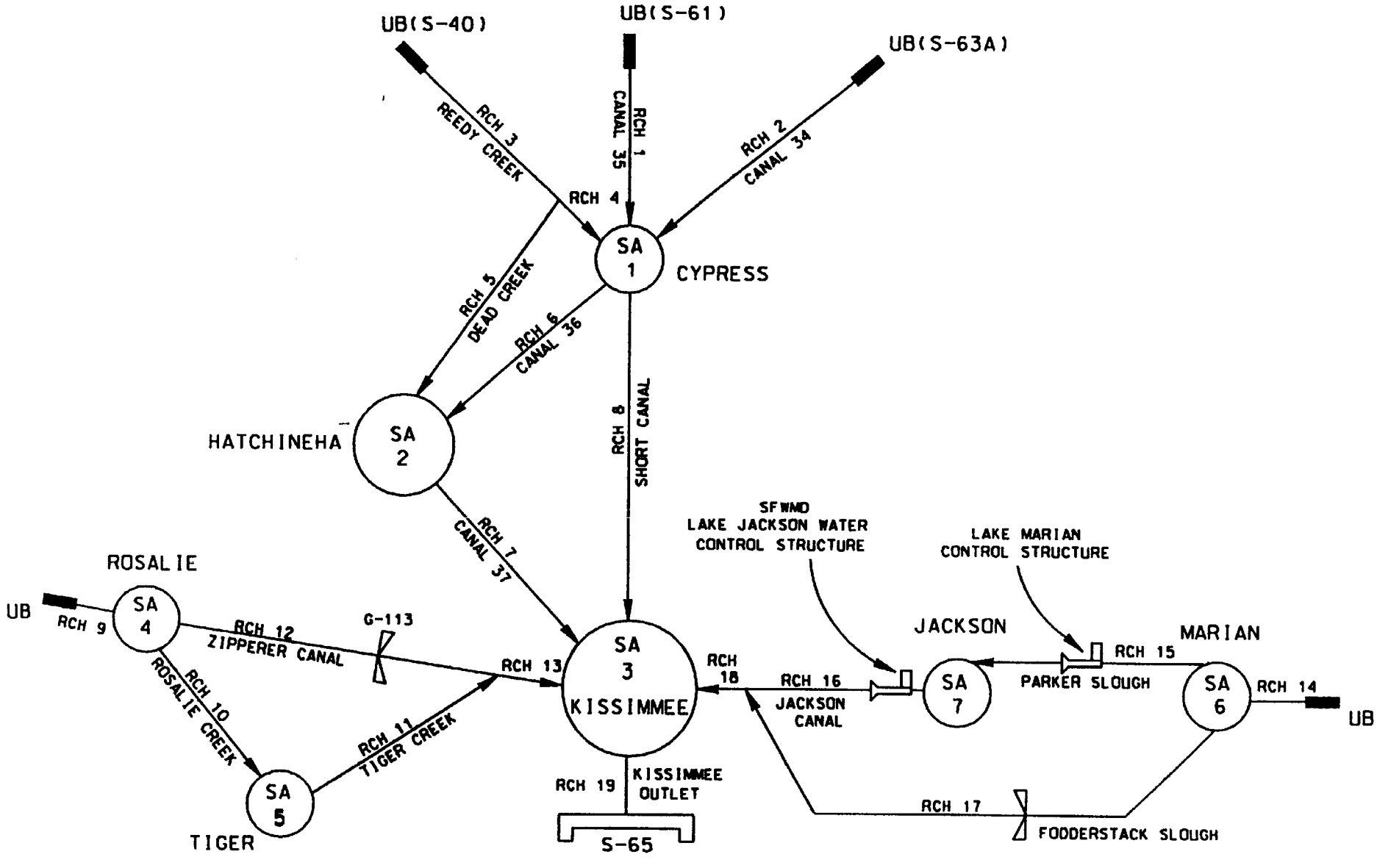


FIGURE A-1

UNET LOWER BASIN MODEL

(EXISTING CONDITIONS)

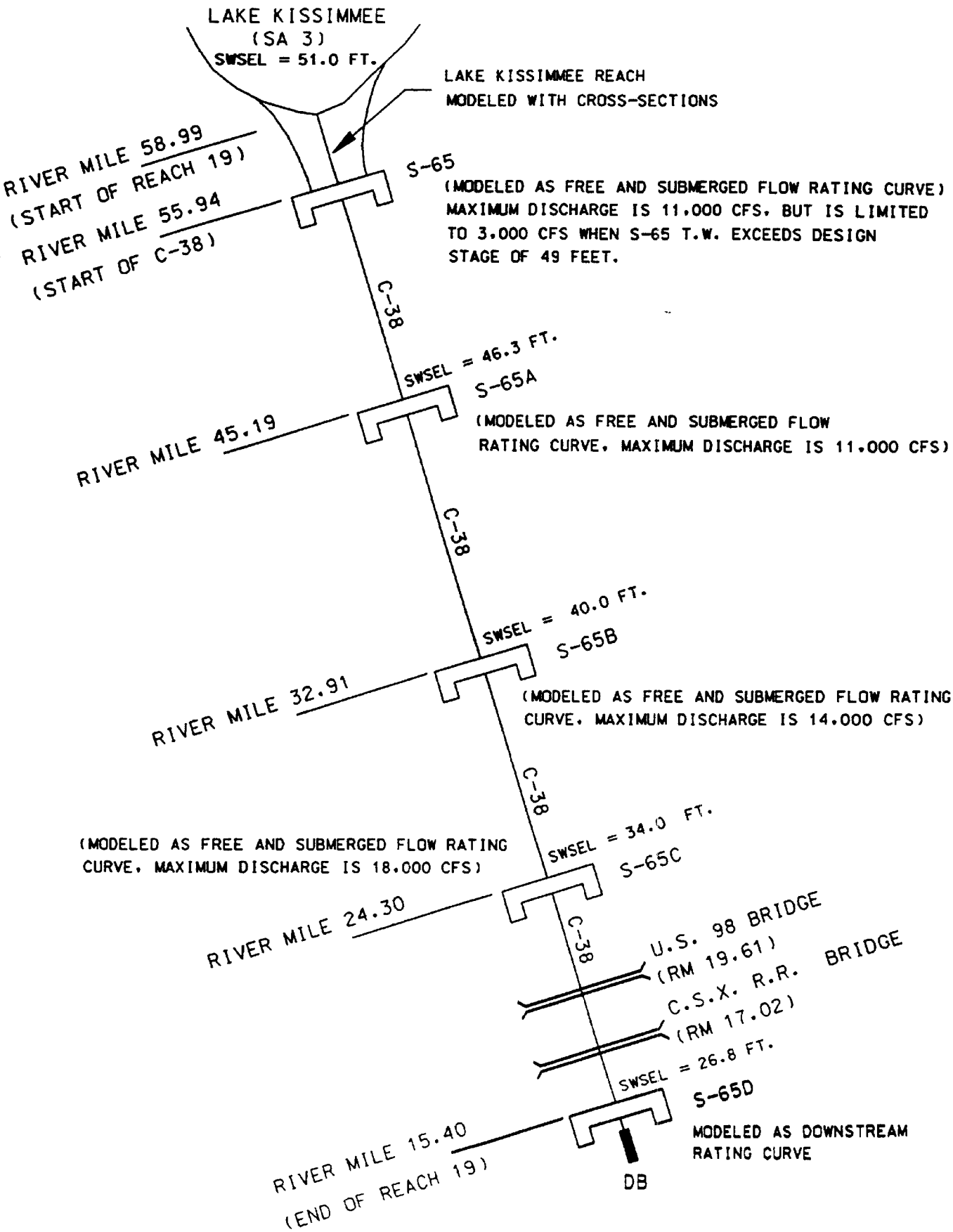


FIGURE A-2

UNET LOWER BASIN MODEL

(WITH PROJECT CONDITIONS)

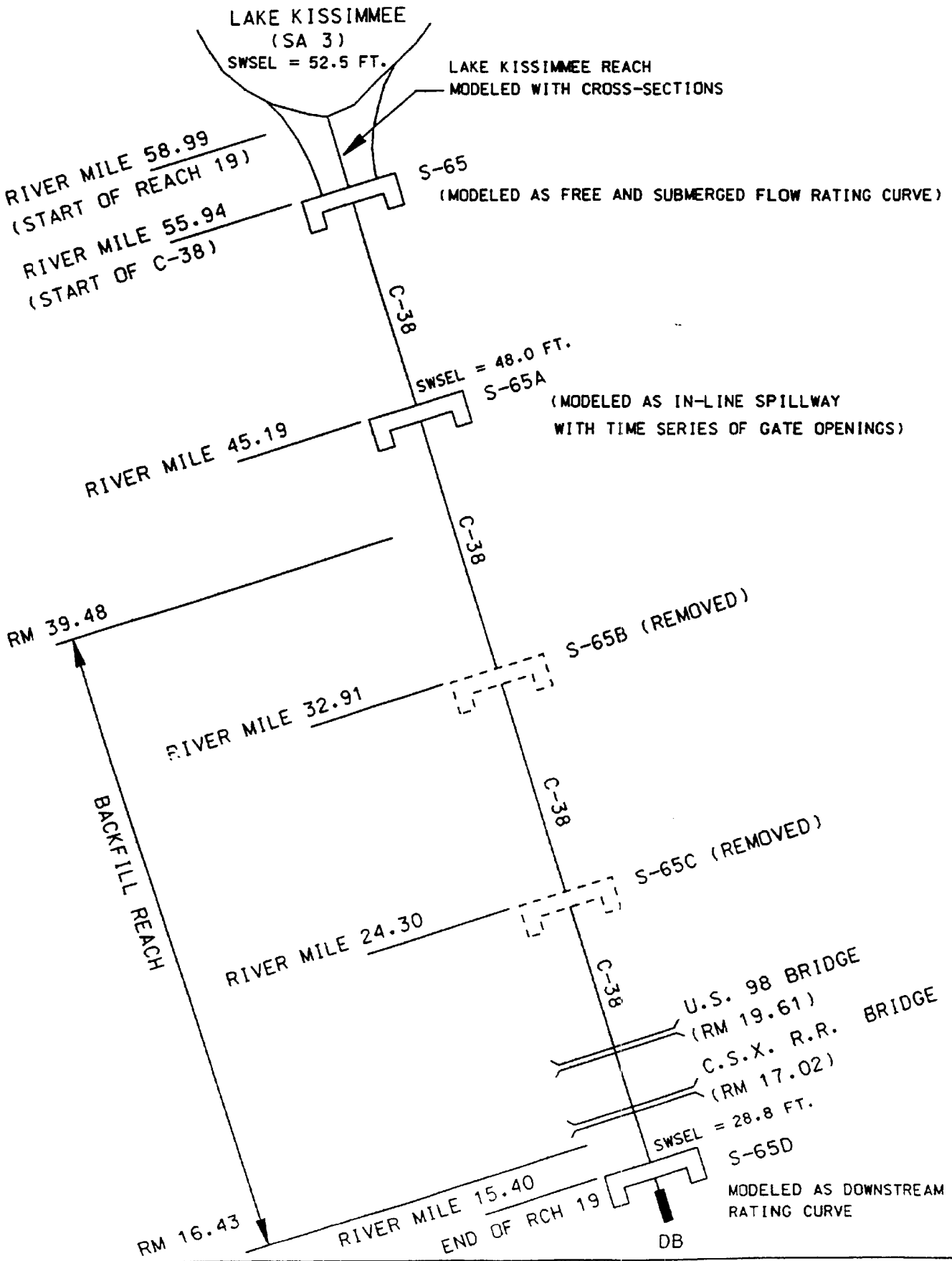


FIGURE A-3

LAKE KISSIMMEE STAGE

(HEC-1 CALIBRATION FOR 1953 FLOOD)

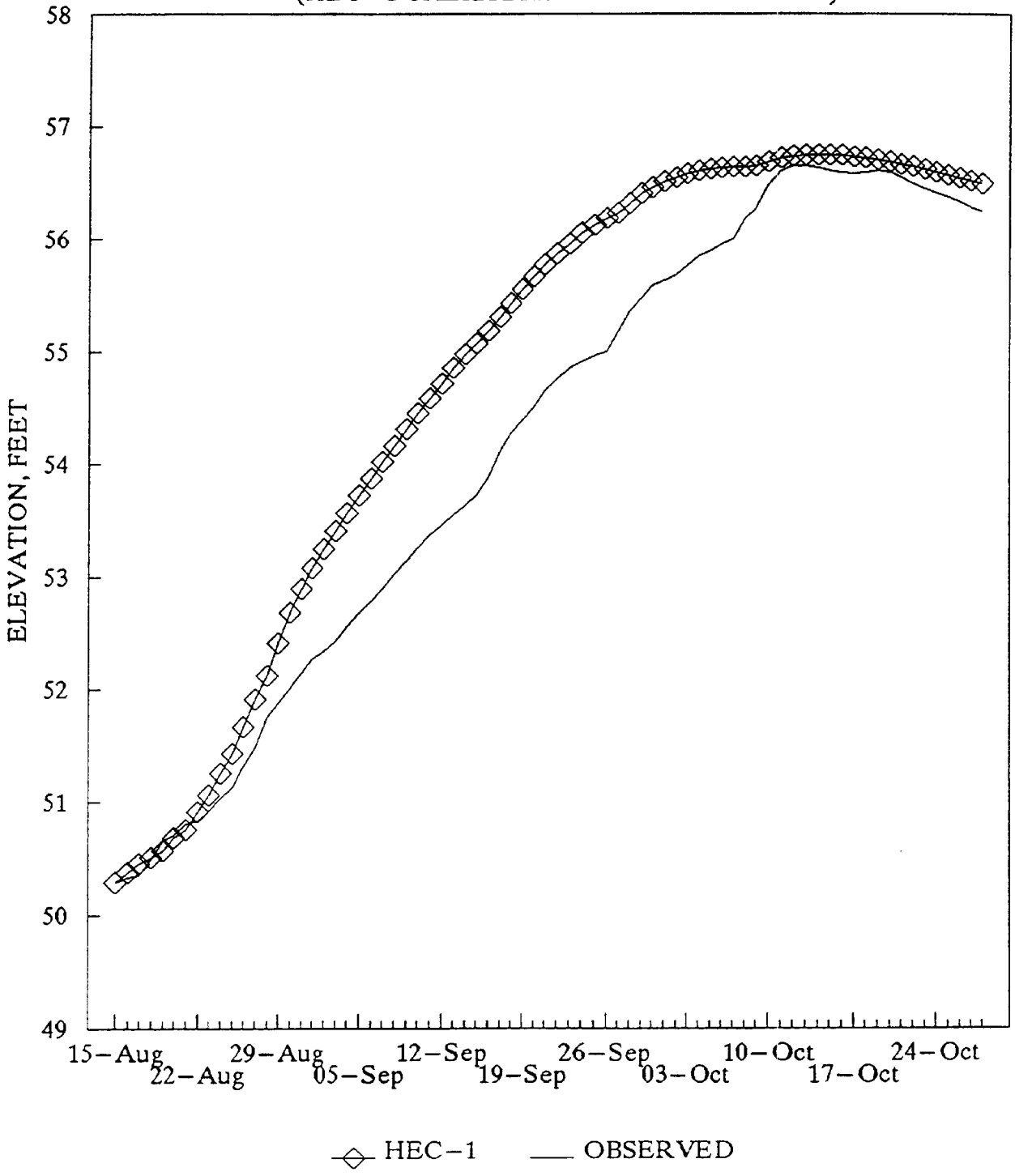


FIGURE A-4

LAKE KISSIMMEE STAGE

(HEC-1 CALIBRATION FOR 1960 FLOOD)

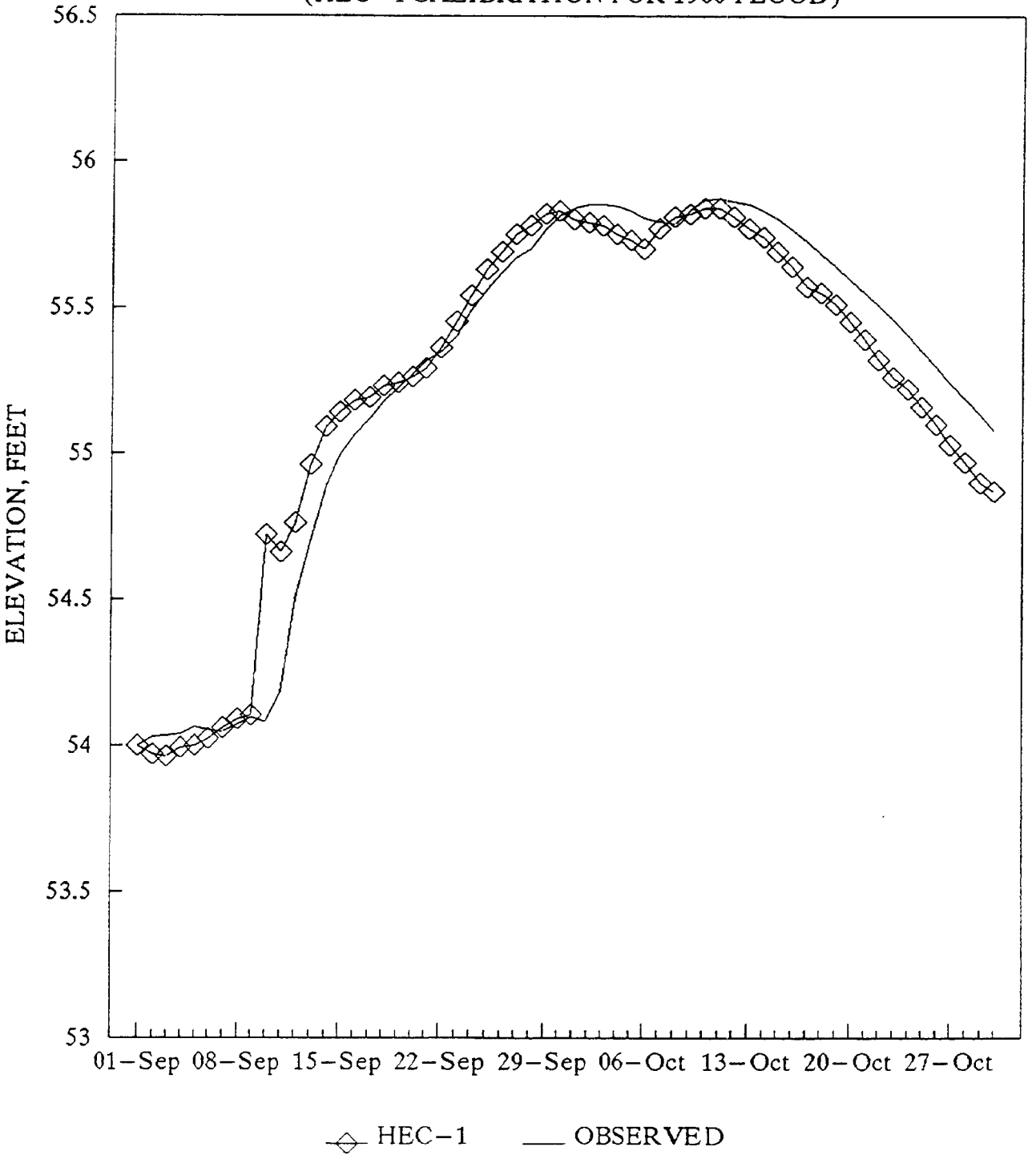


FIGURE A-5

LAKE KISSIMMEE STAGE

(HEC-1 CALIBRATION FOR 1969 FLOOD)

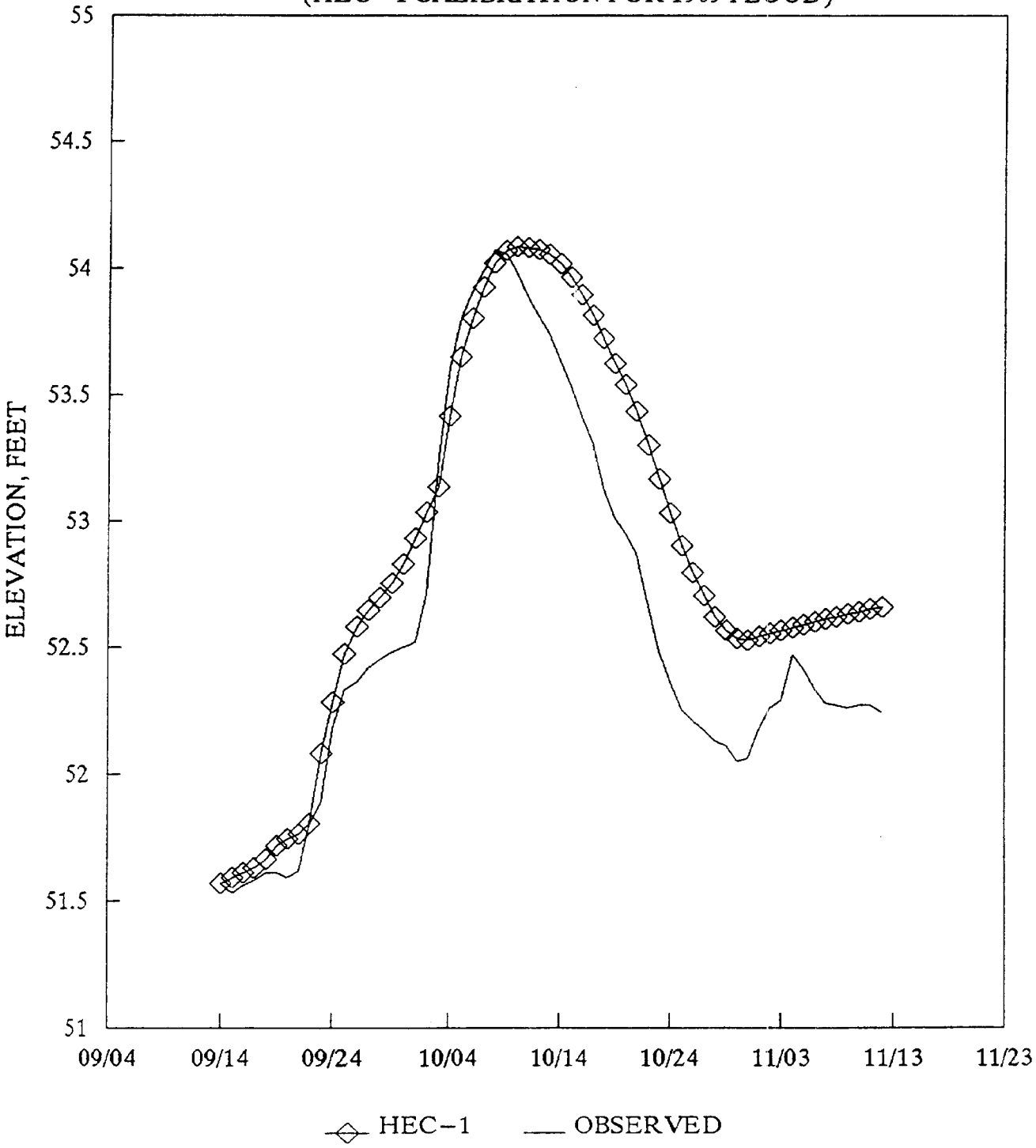


FIGURE A-6

LAKE KISSIMMEE STAGE

(UNET CALIBRATION FOR 1969 FLOOD)

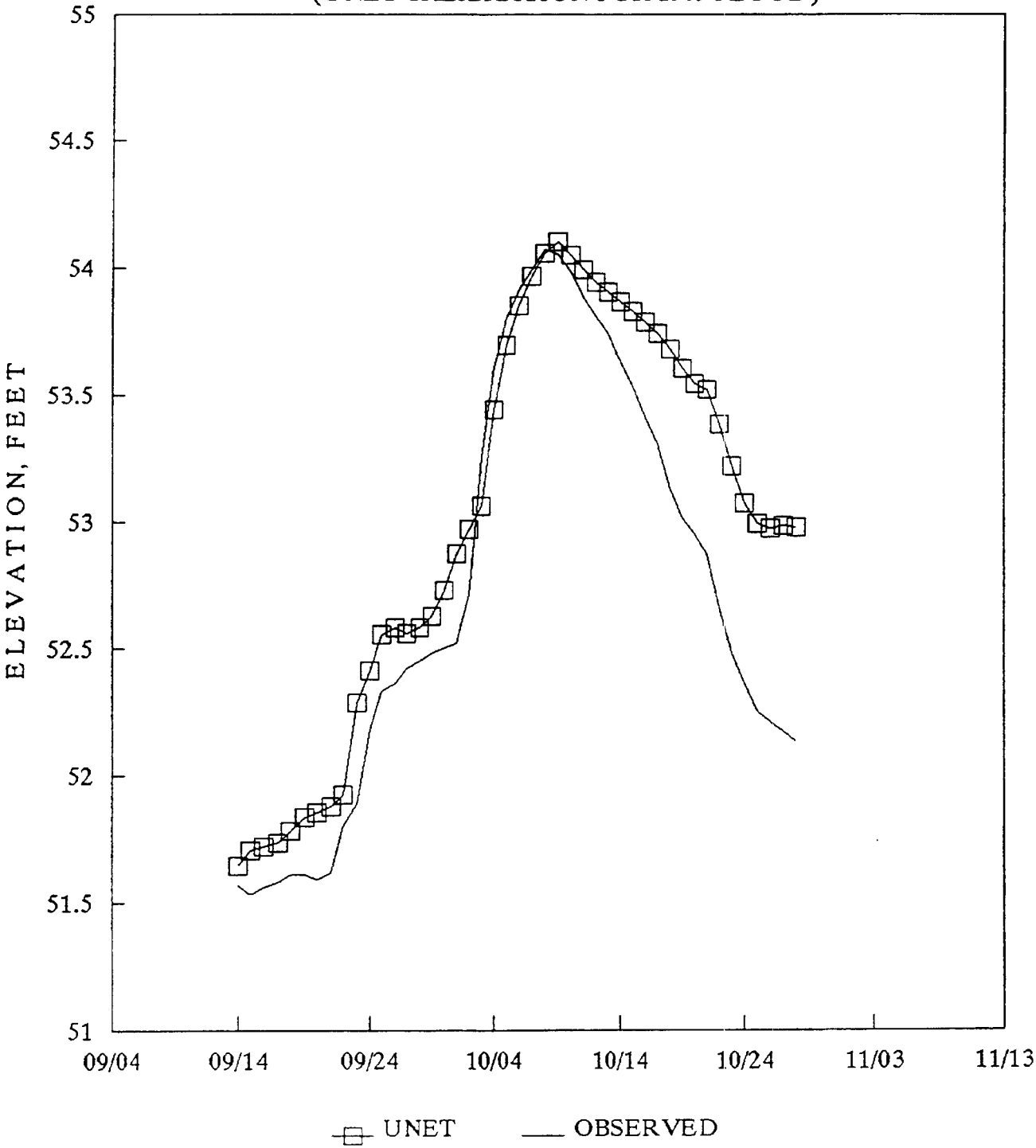
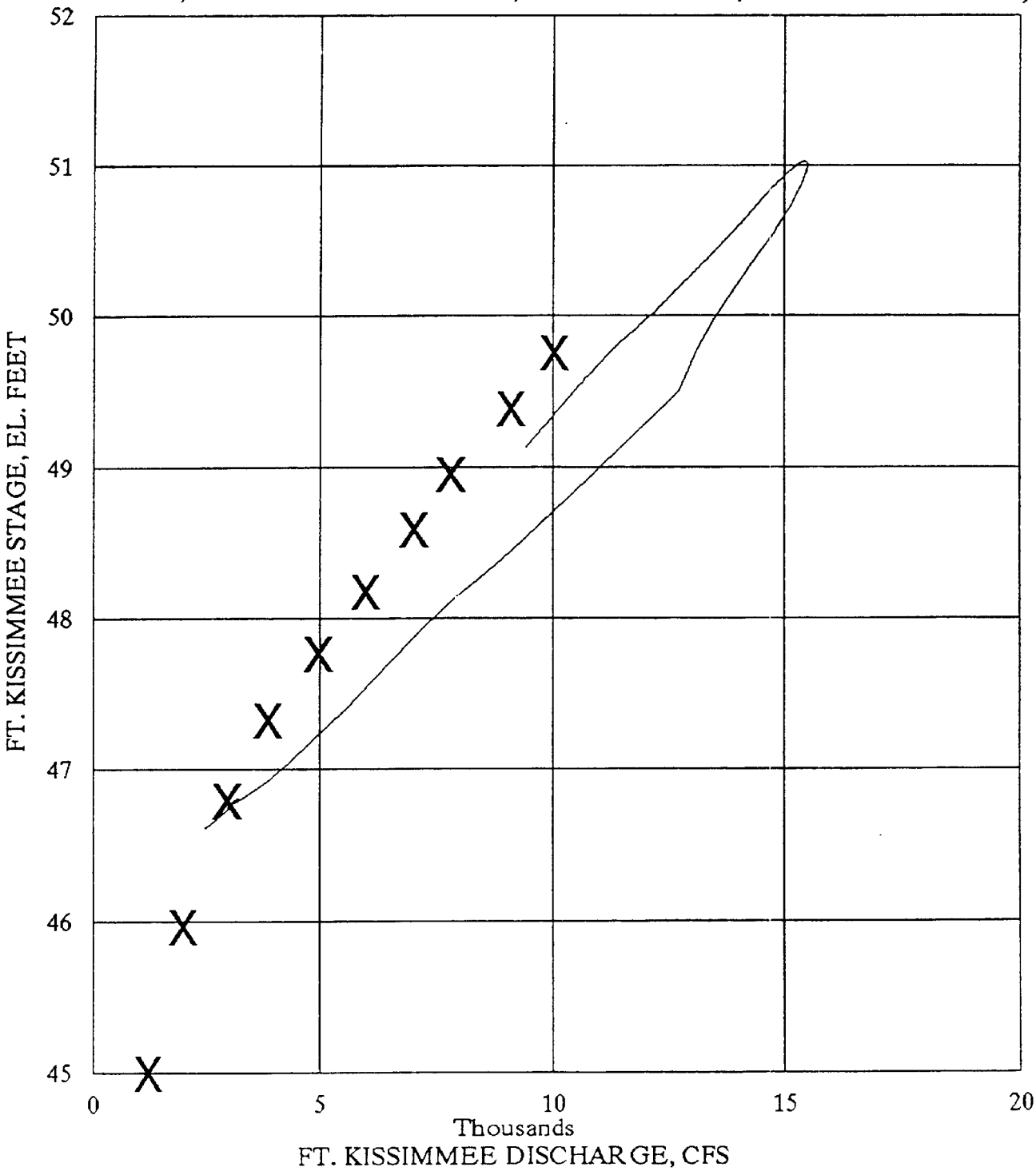


FIGURE A-7

FT. KISSIMMEE RATING CURVE

(10-YR PLAN 1; S-65: 5-BAY CAPACITY; KISS SWSEL 52.5', B/F "N" = 0.15/0.30/0.15)



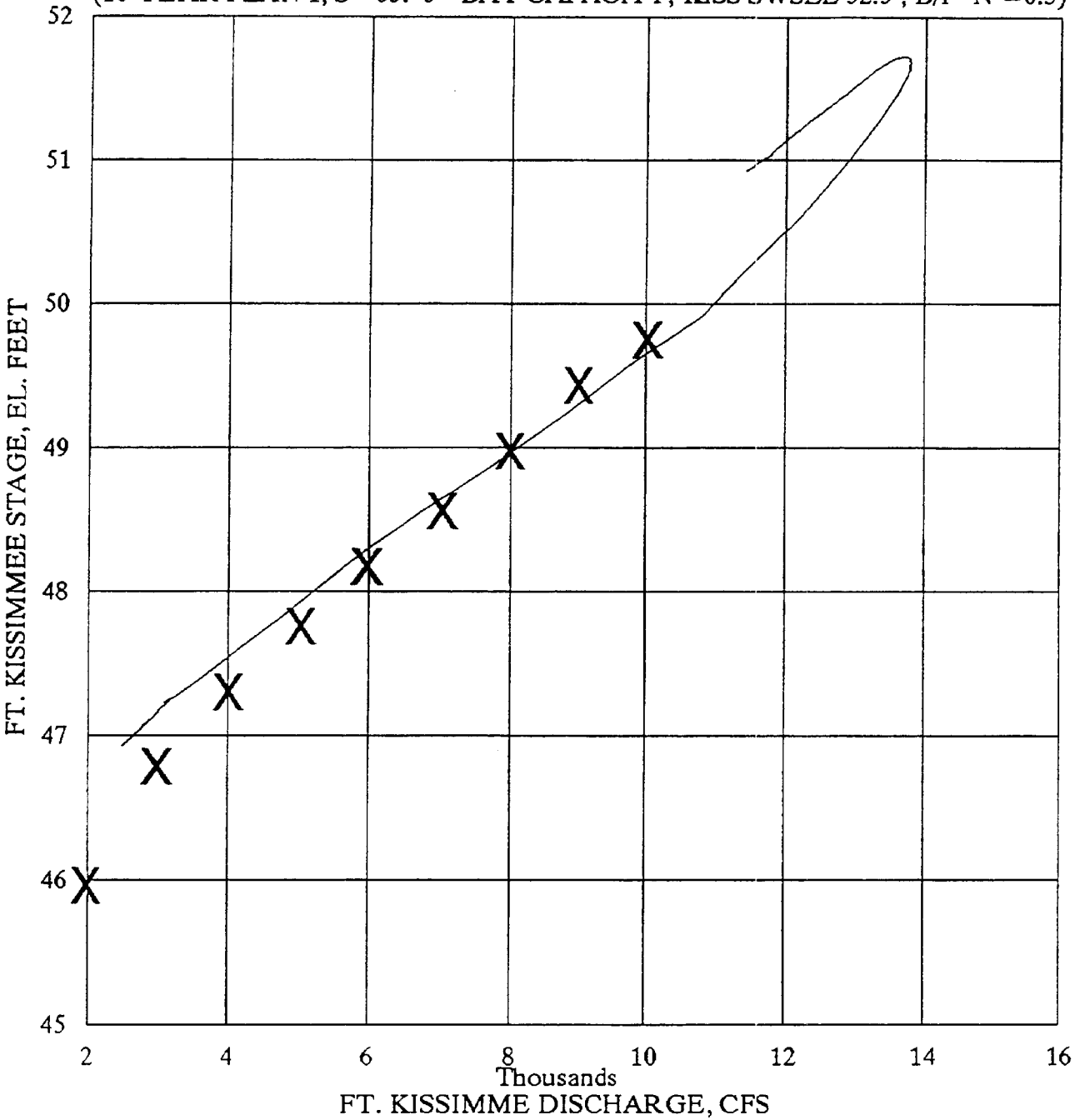
X – HISTORICAL RATING CURVE

___ UNET

FIGURE A-8

FT. KISSIMMEE RATING CURVE

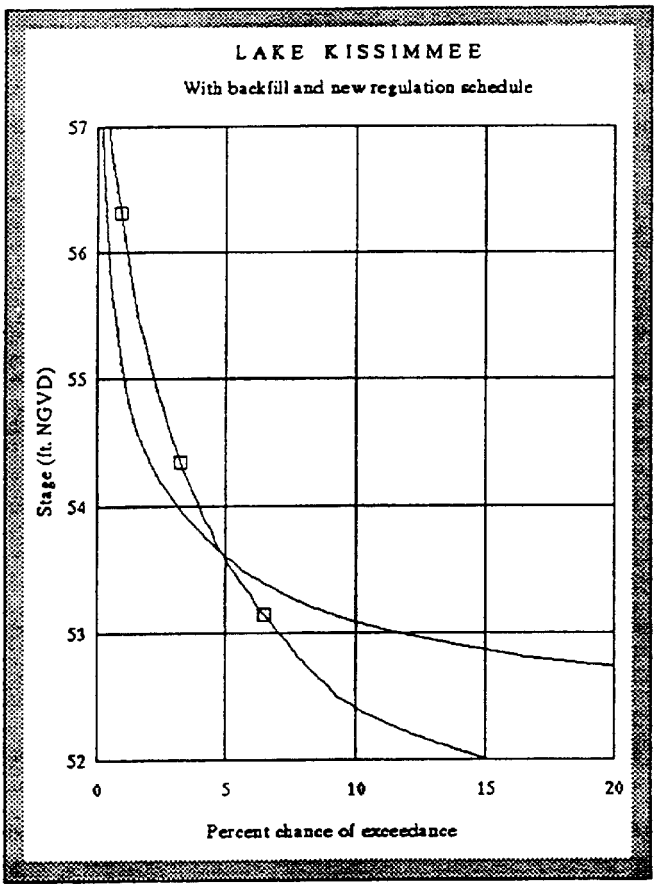
(10 YEAR PLAN 1; S–65: 5–BAY CAPACITY, KISS SWSEL 52.5', B/F "N"=0.3)

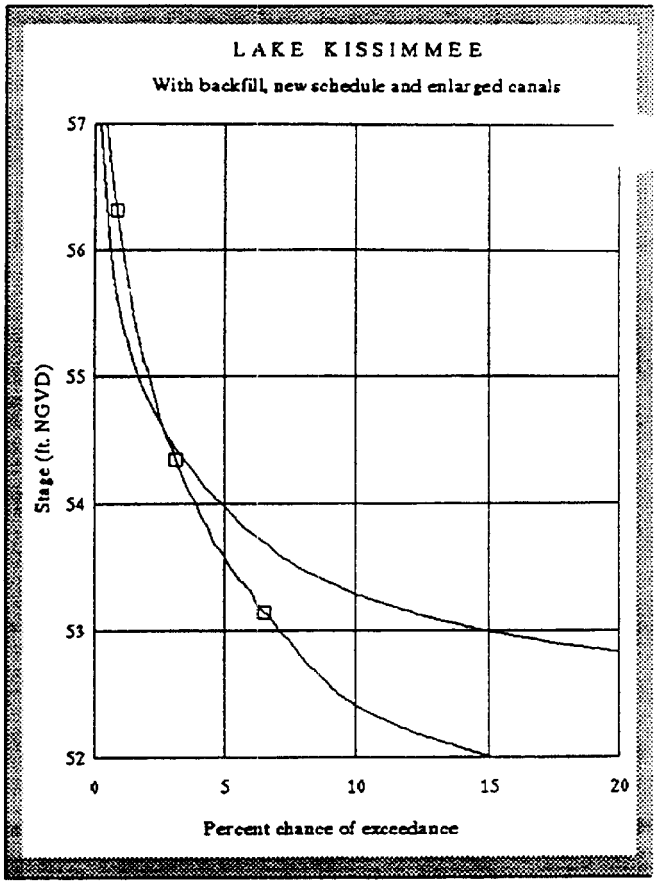


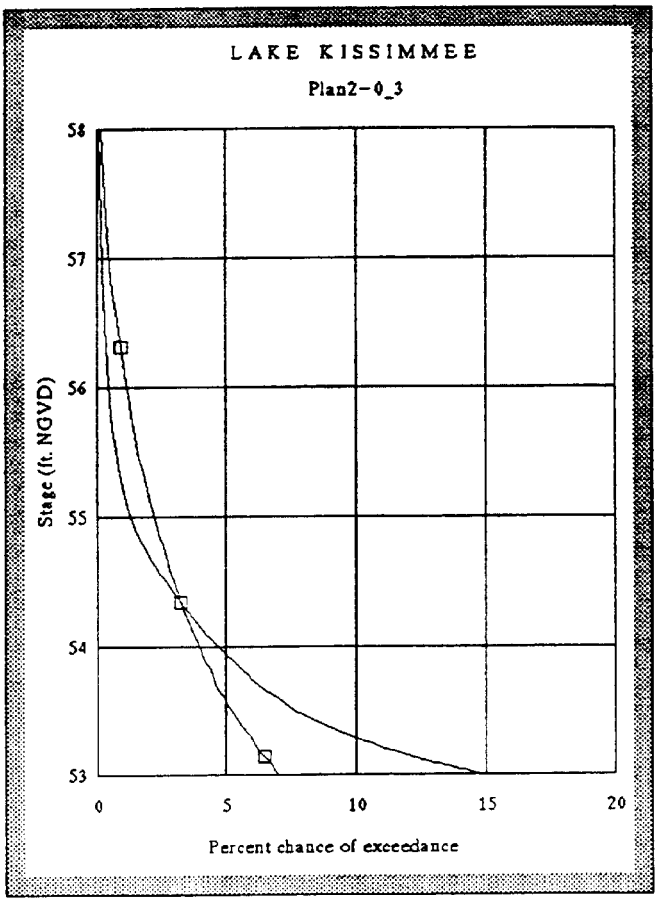
X – HISTORICAL RATING CURVE

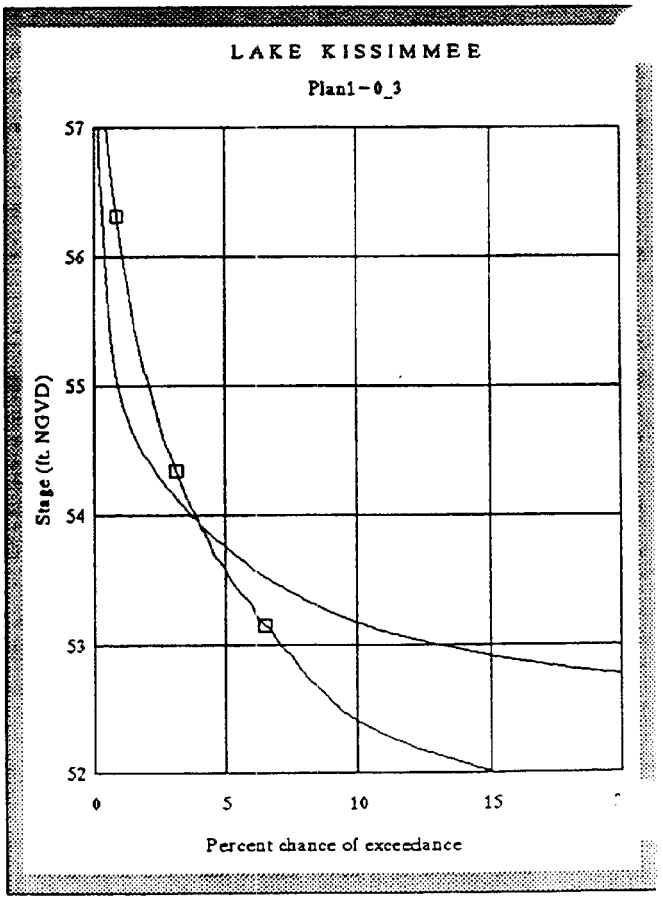
___ UNET

FIGURE A-9



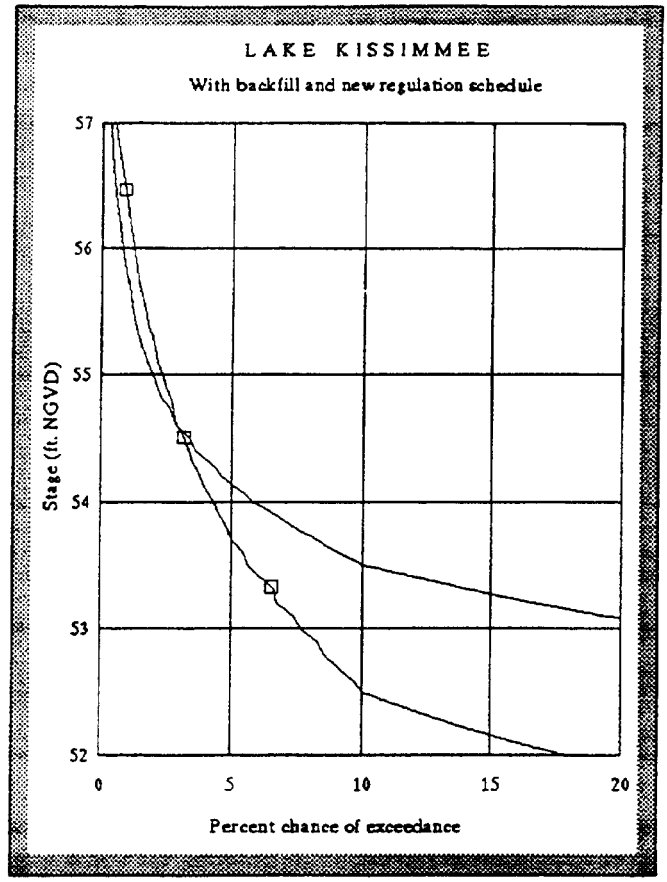


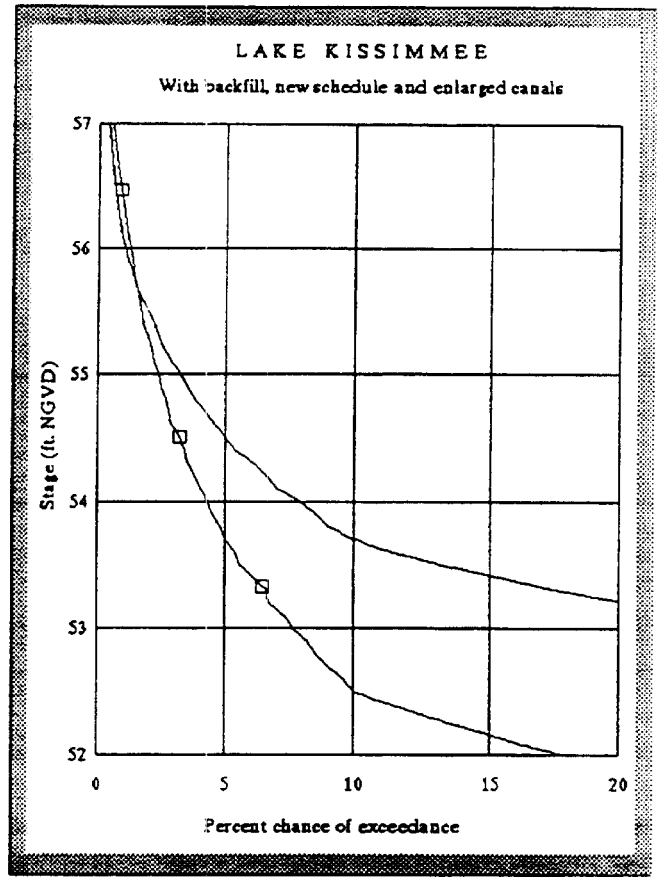


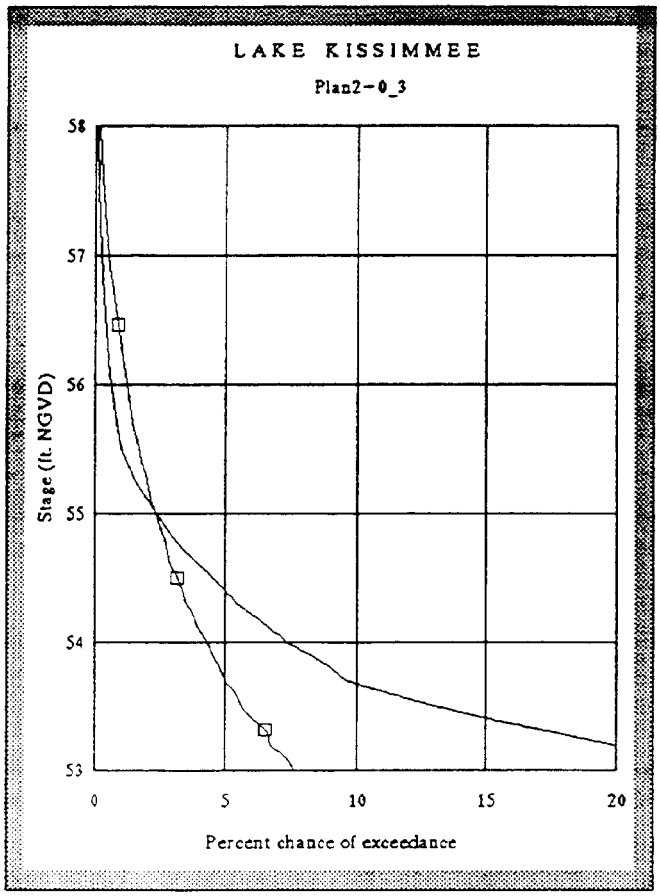


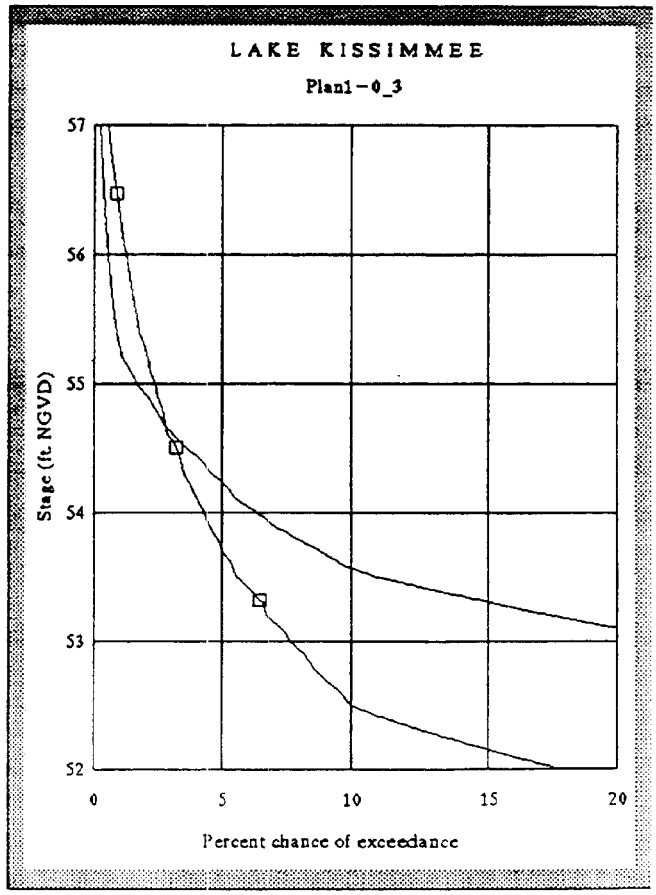
☐ Existing stage frequency
Computed by coincident frequency

FIGURE A-10





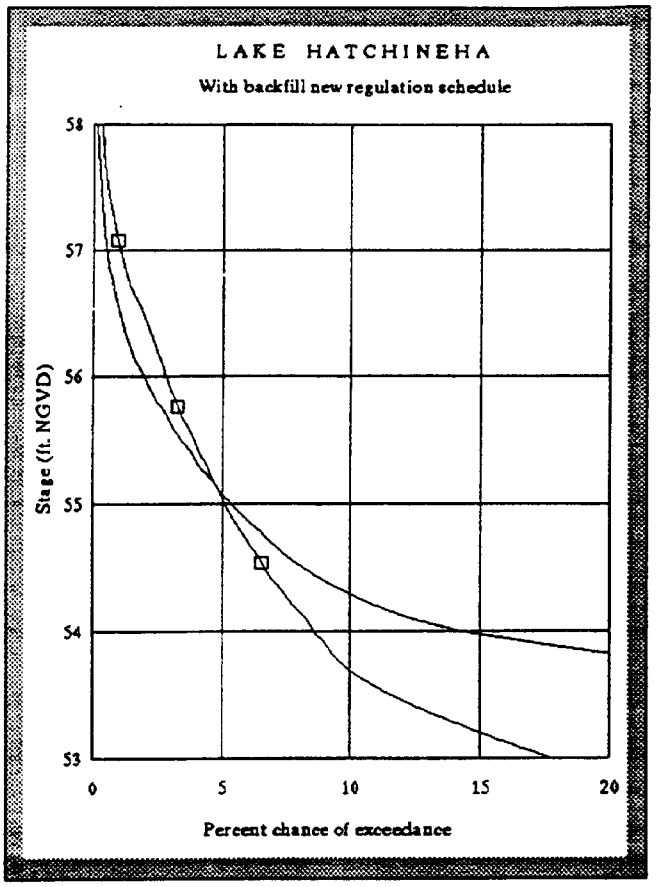


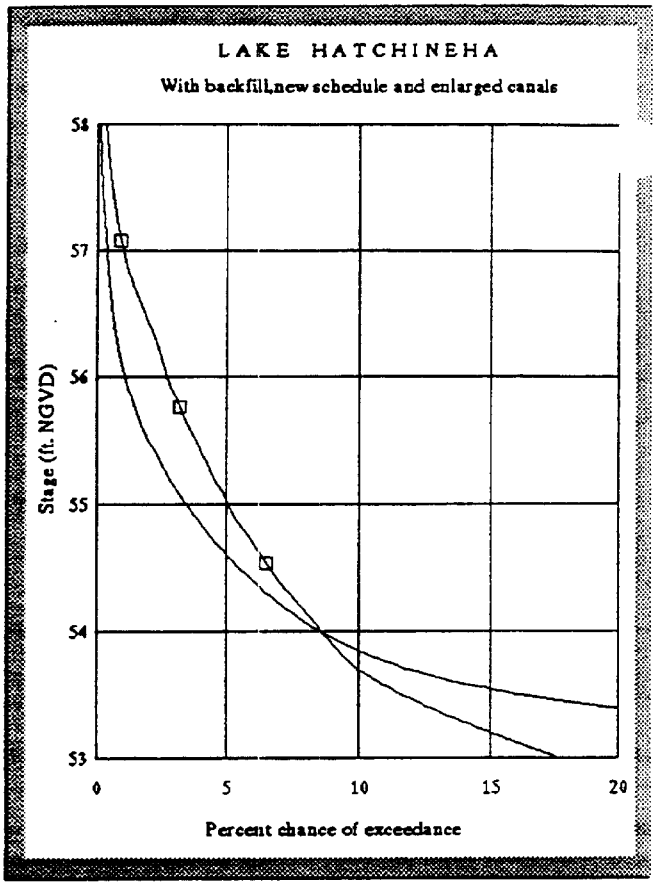


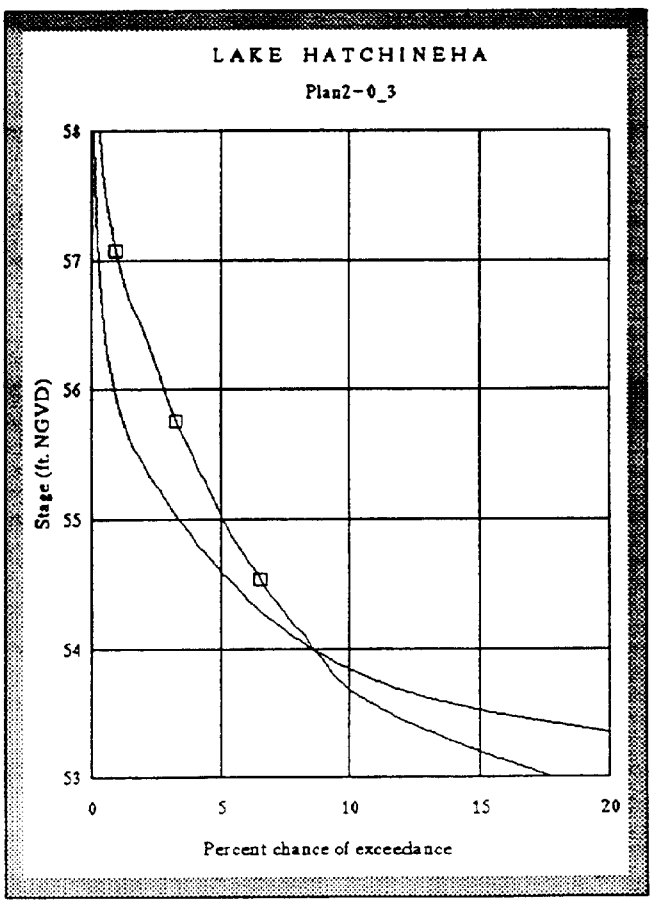
☐ Existing stage frequency

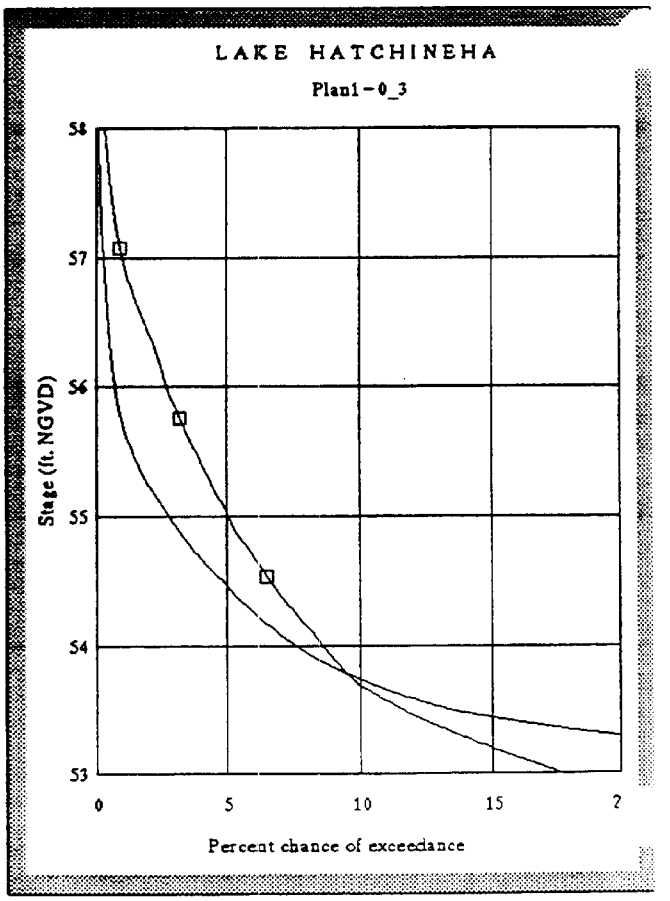
Computed by UNET with top of wet season schedule as the initial condition

FIGURE A-11



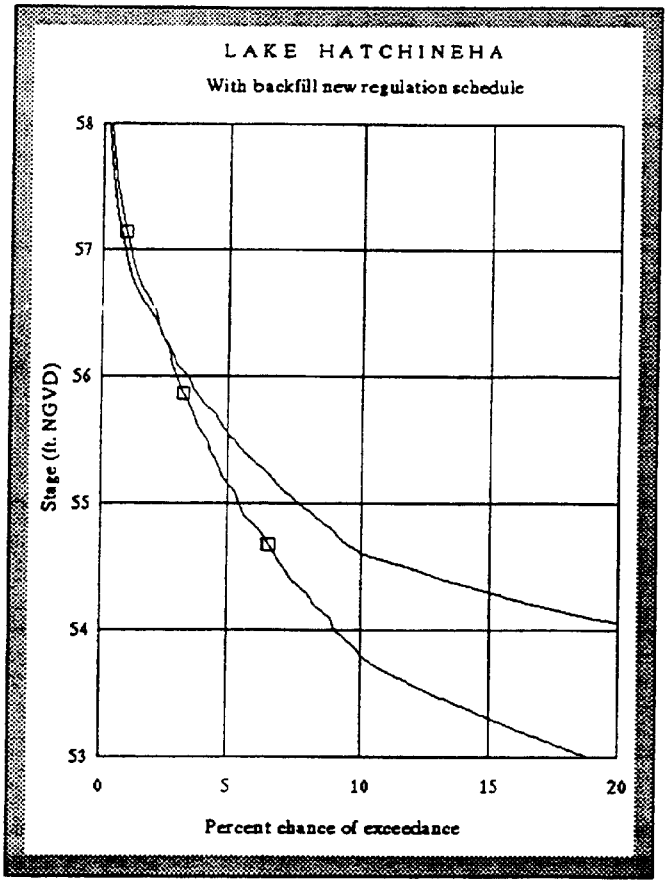


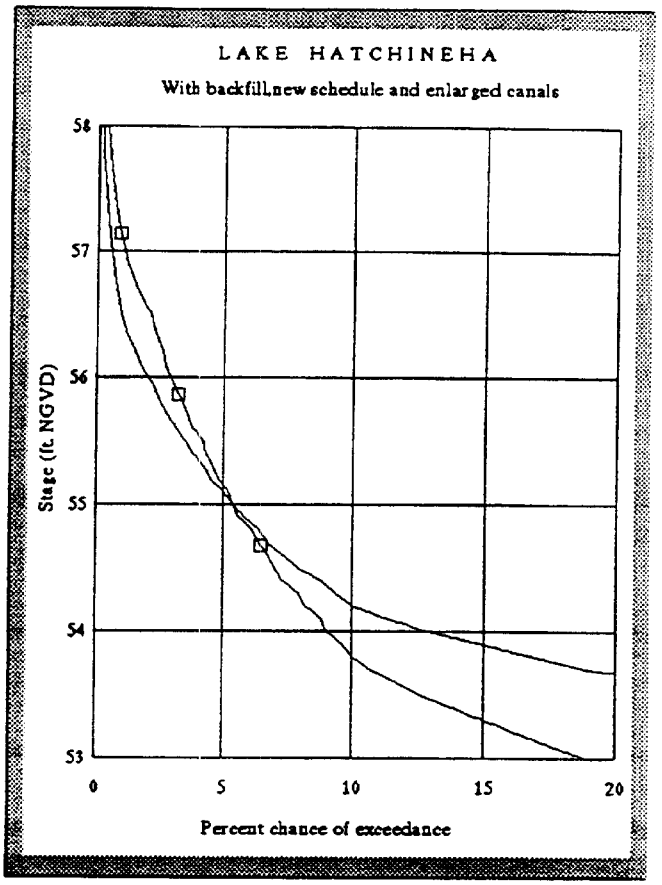


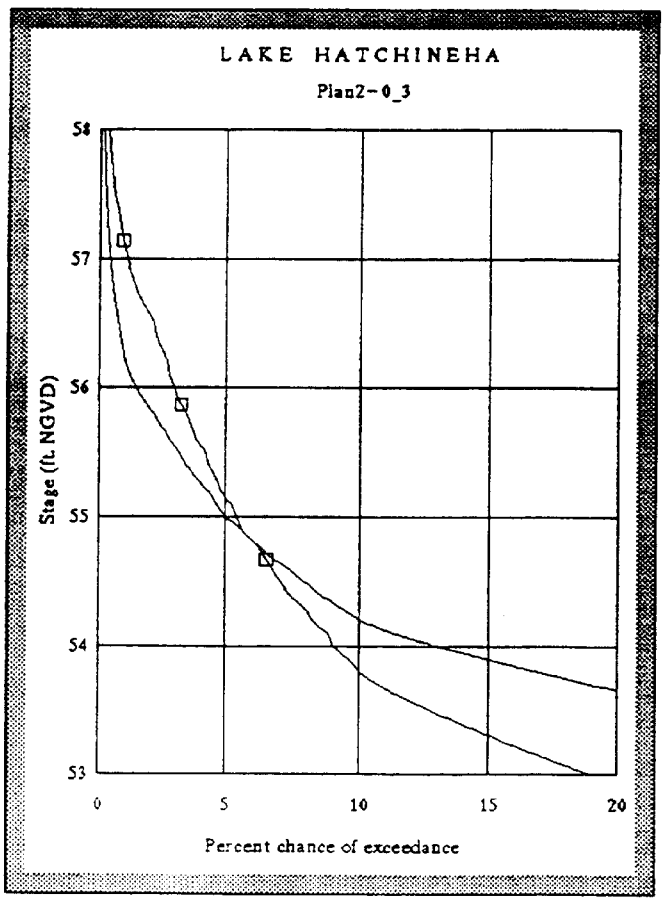


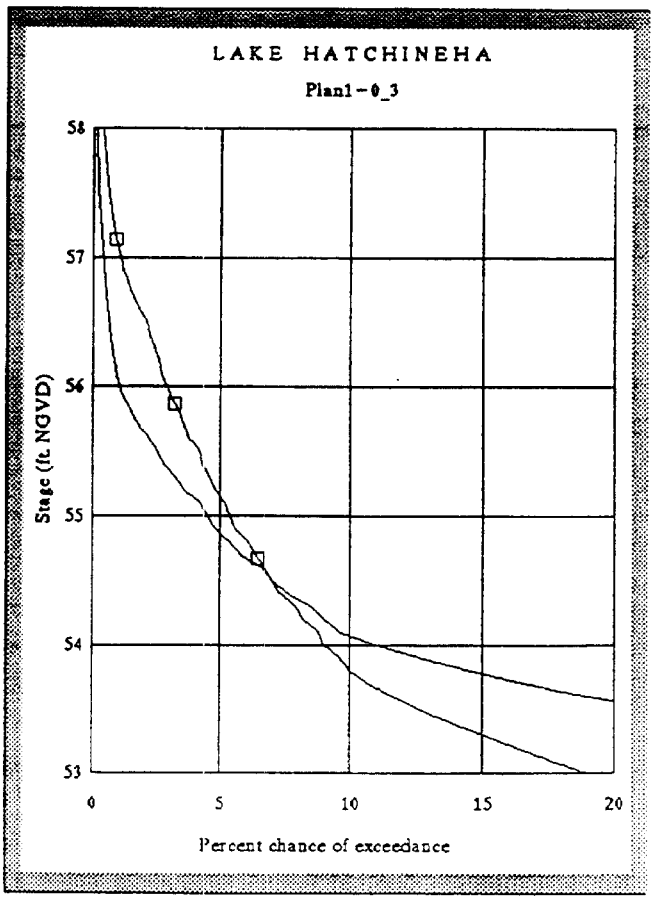
☐ Existing stage frequency
Computed by coincident frequency

FIGURE A-12





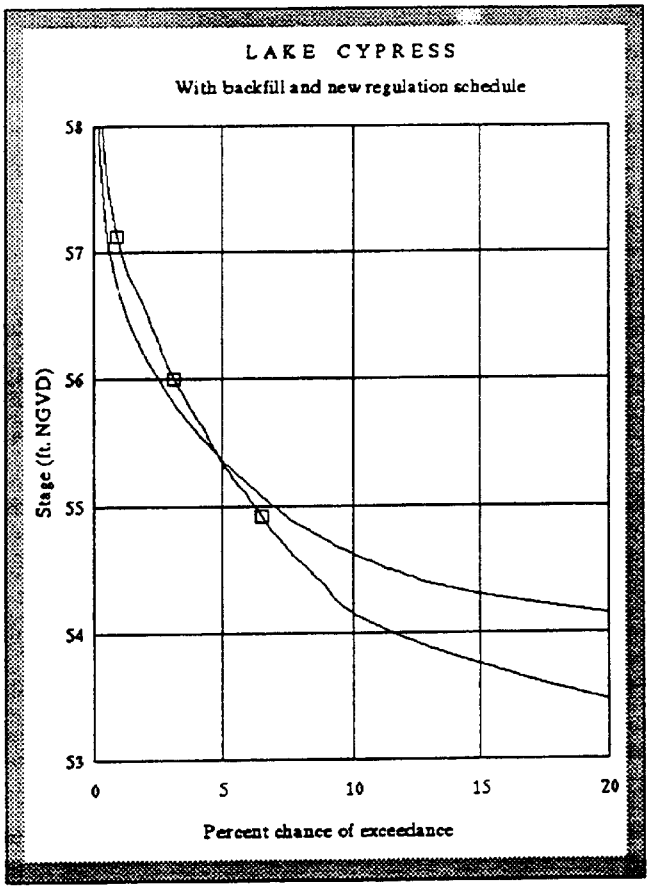


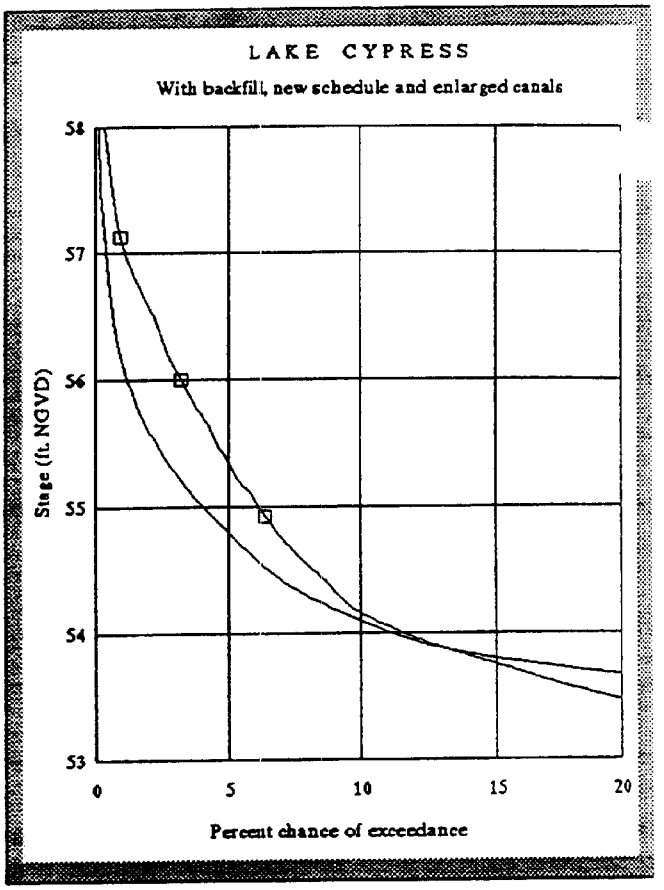


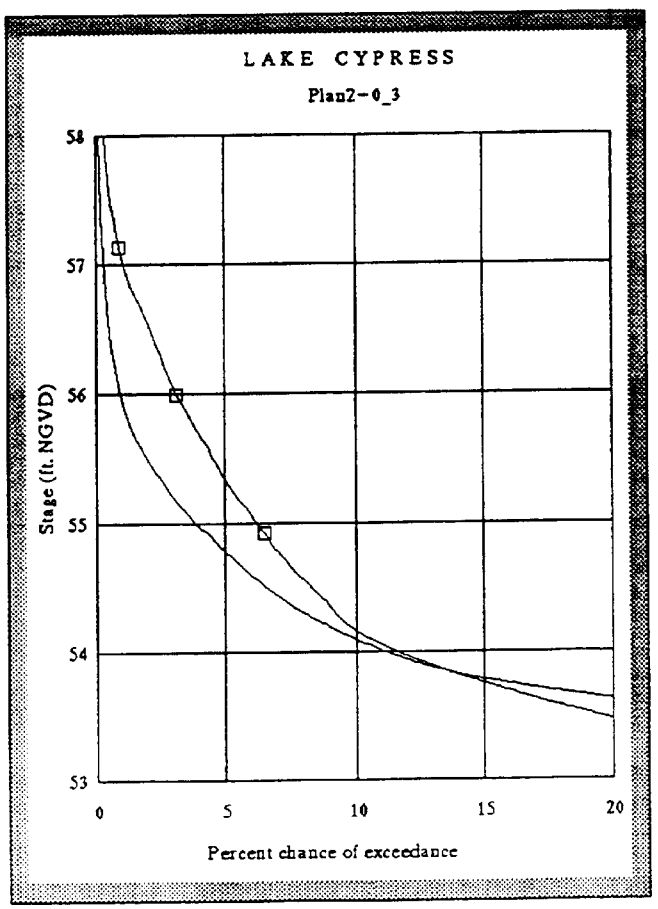
☐ Existing stage frequency

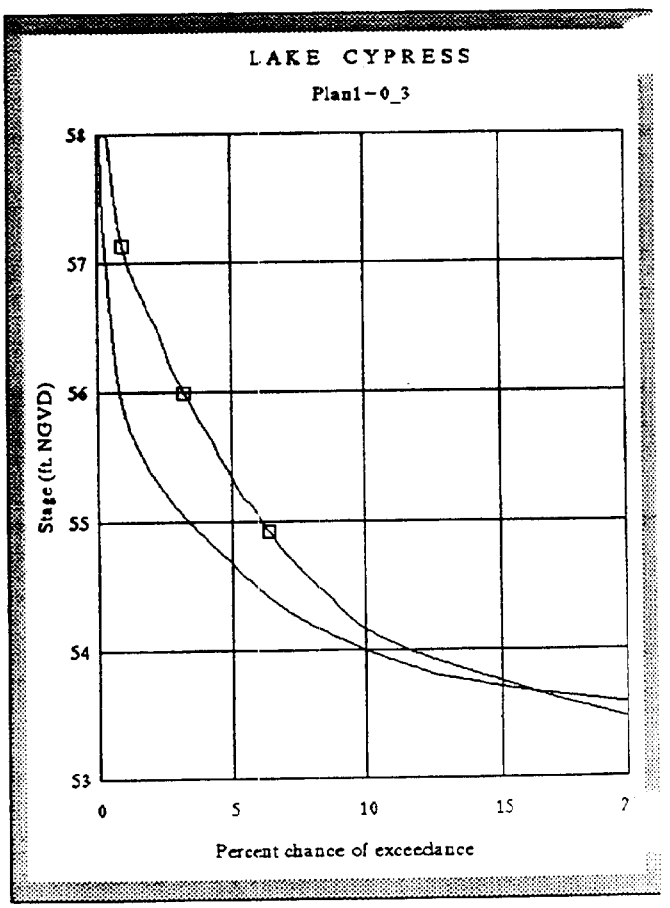
Computed by UNET with top of wet season schedule as the initial condition

FIGURE A–13



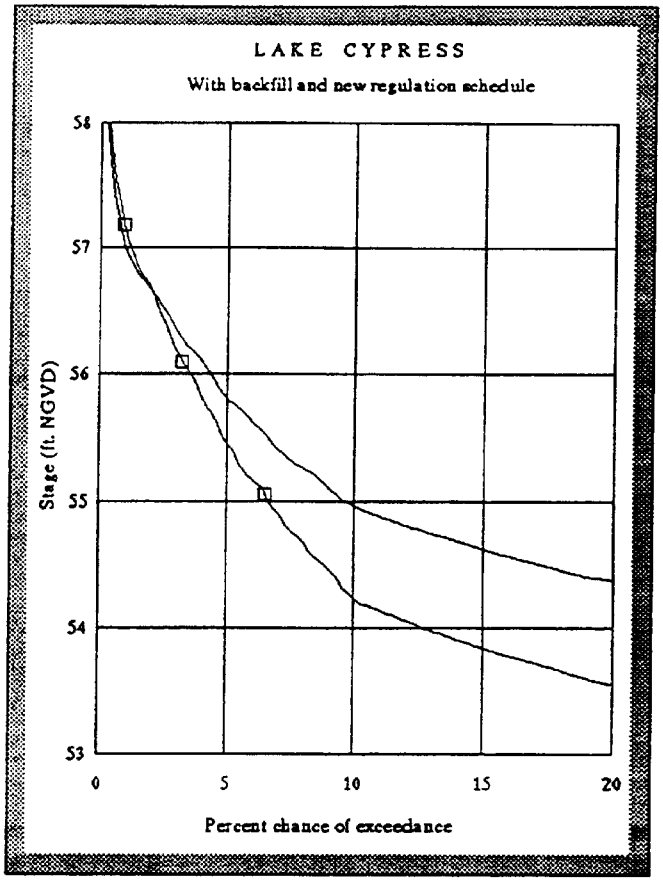


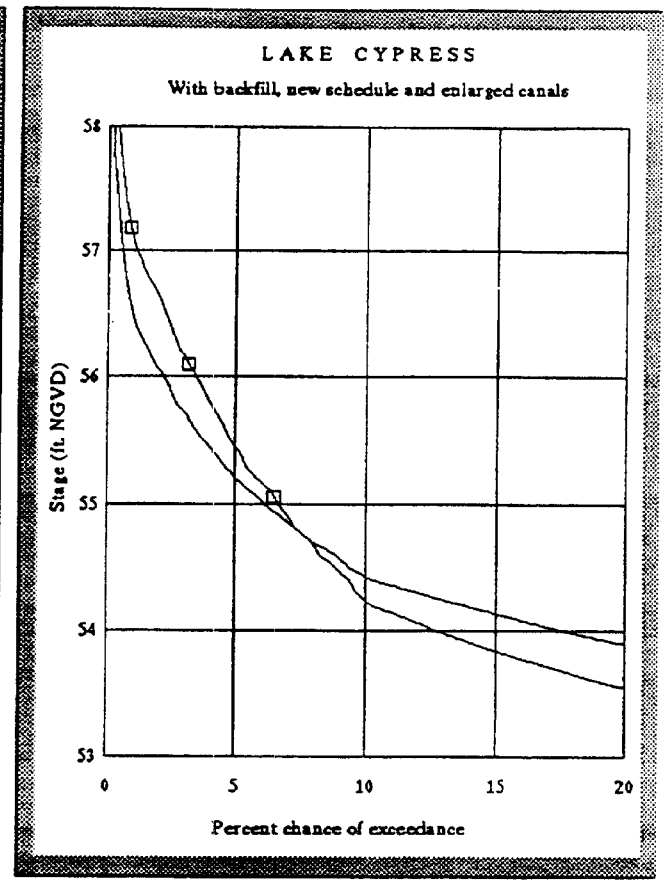


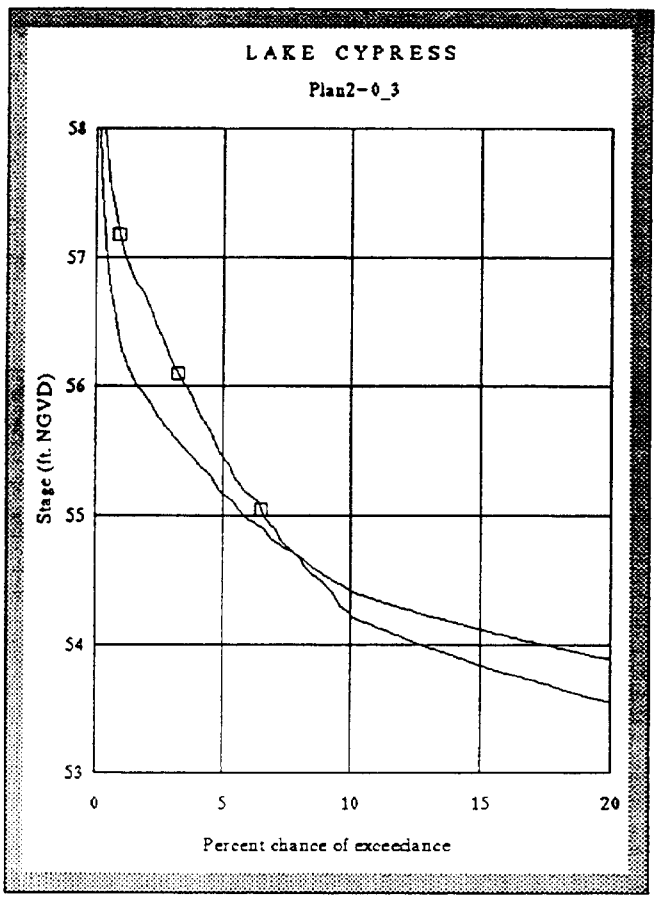


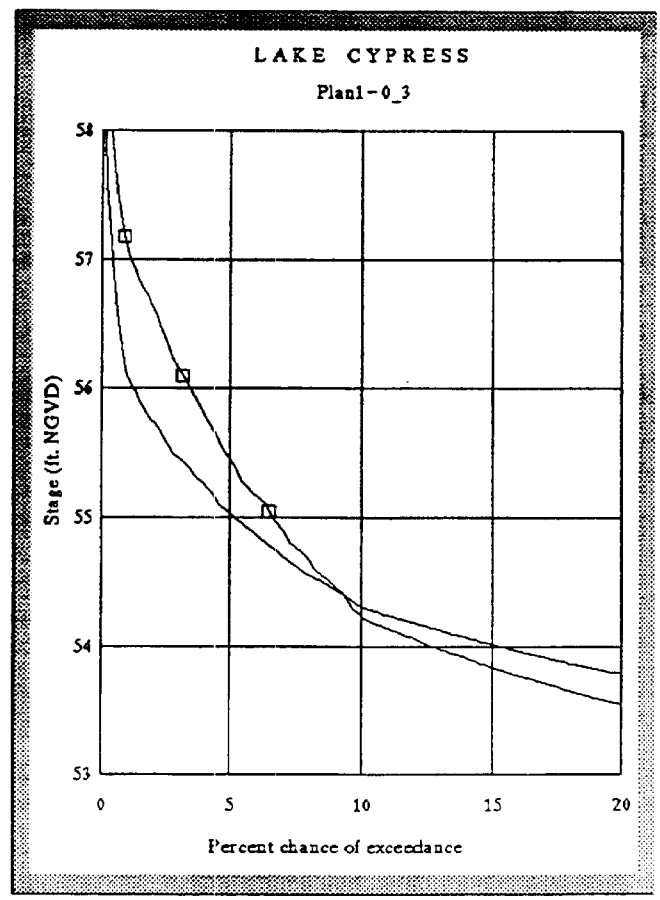
☐ Existing stage frequency
Computed by coincident frequency

FIGURE A-14





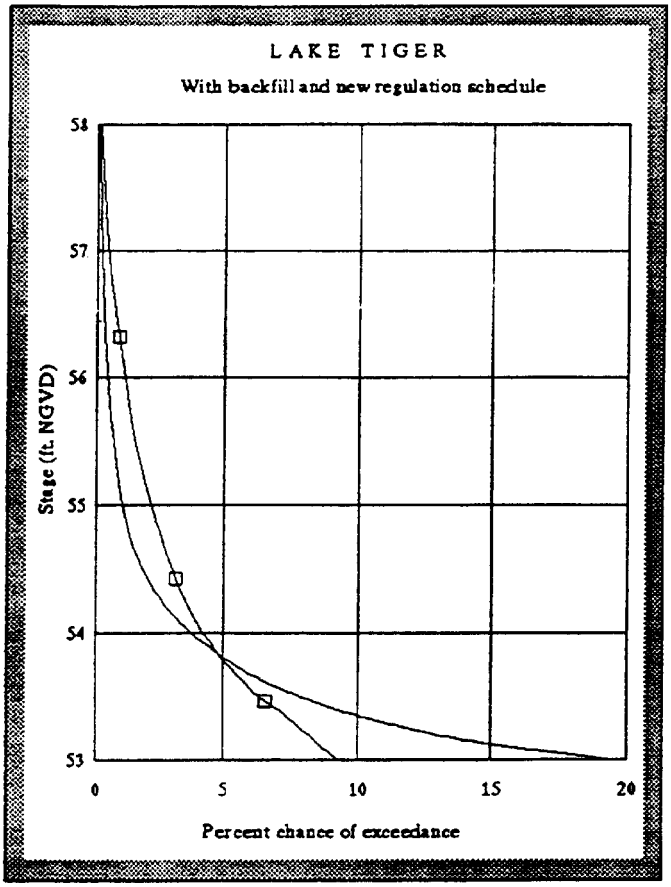


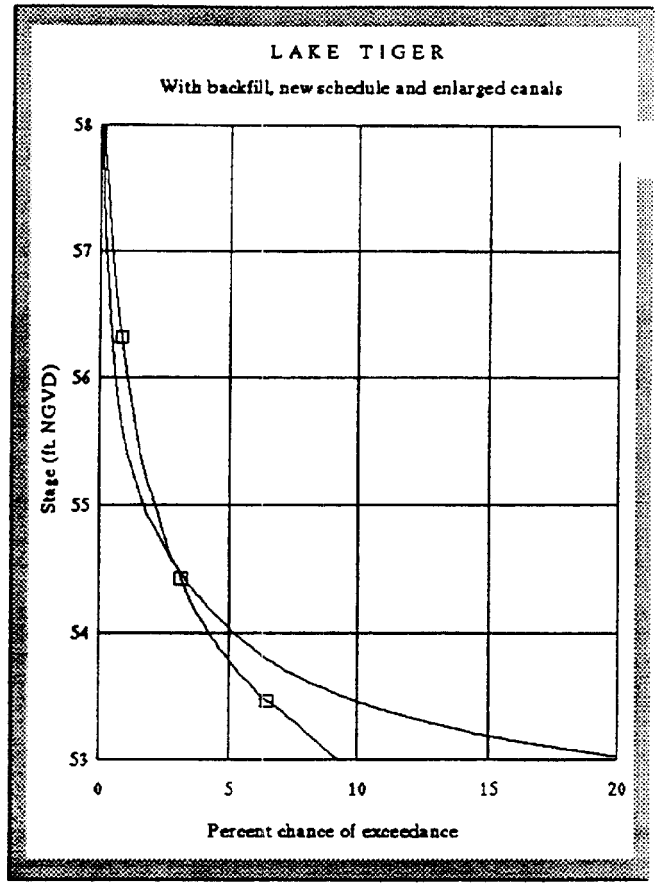


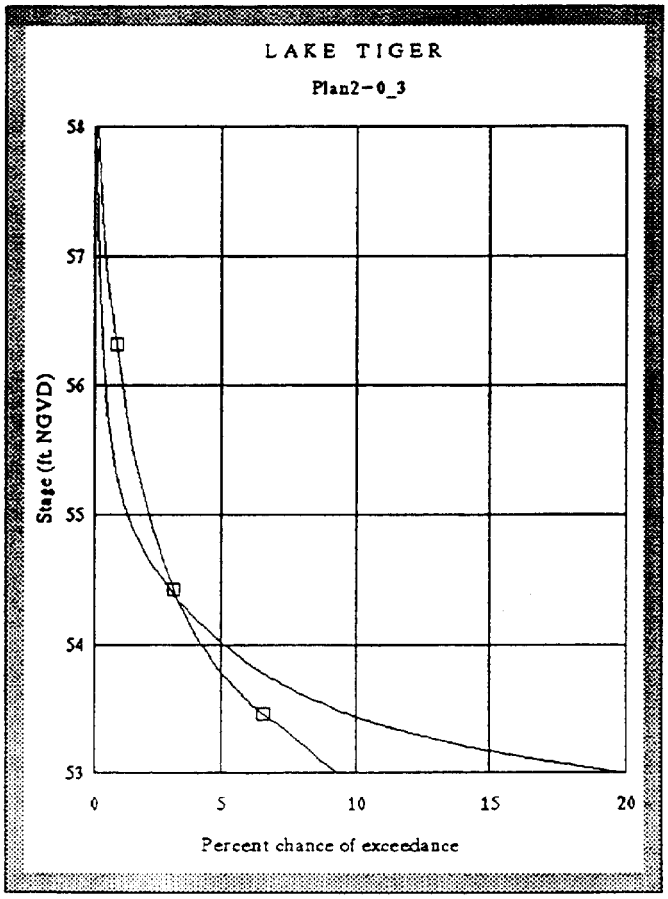
☐ Existing stage frequency

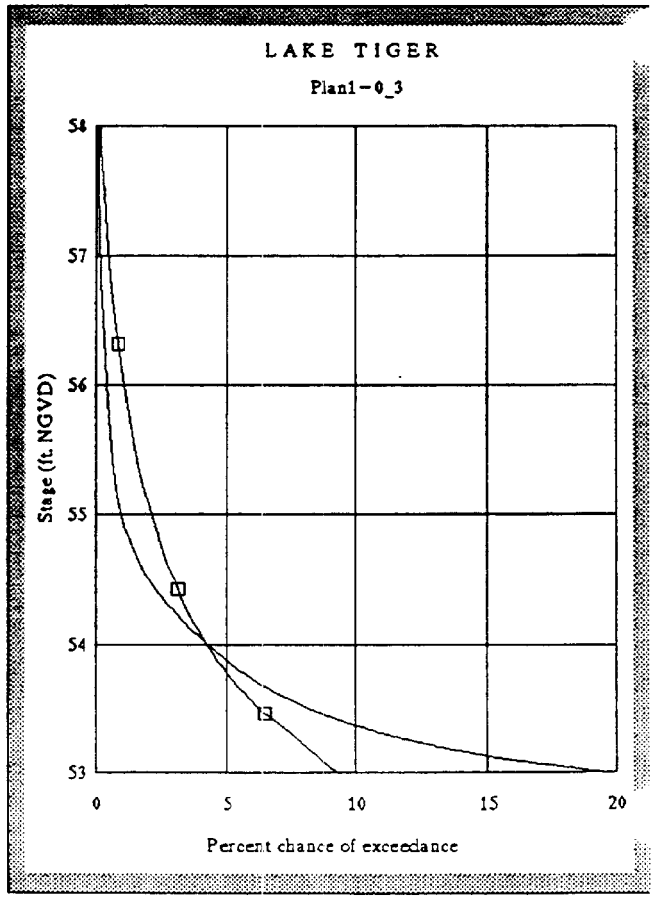
Computed by UNET with top of wet season schedule as the initial condition

FIGURE A–15



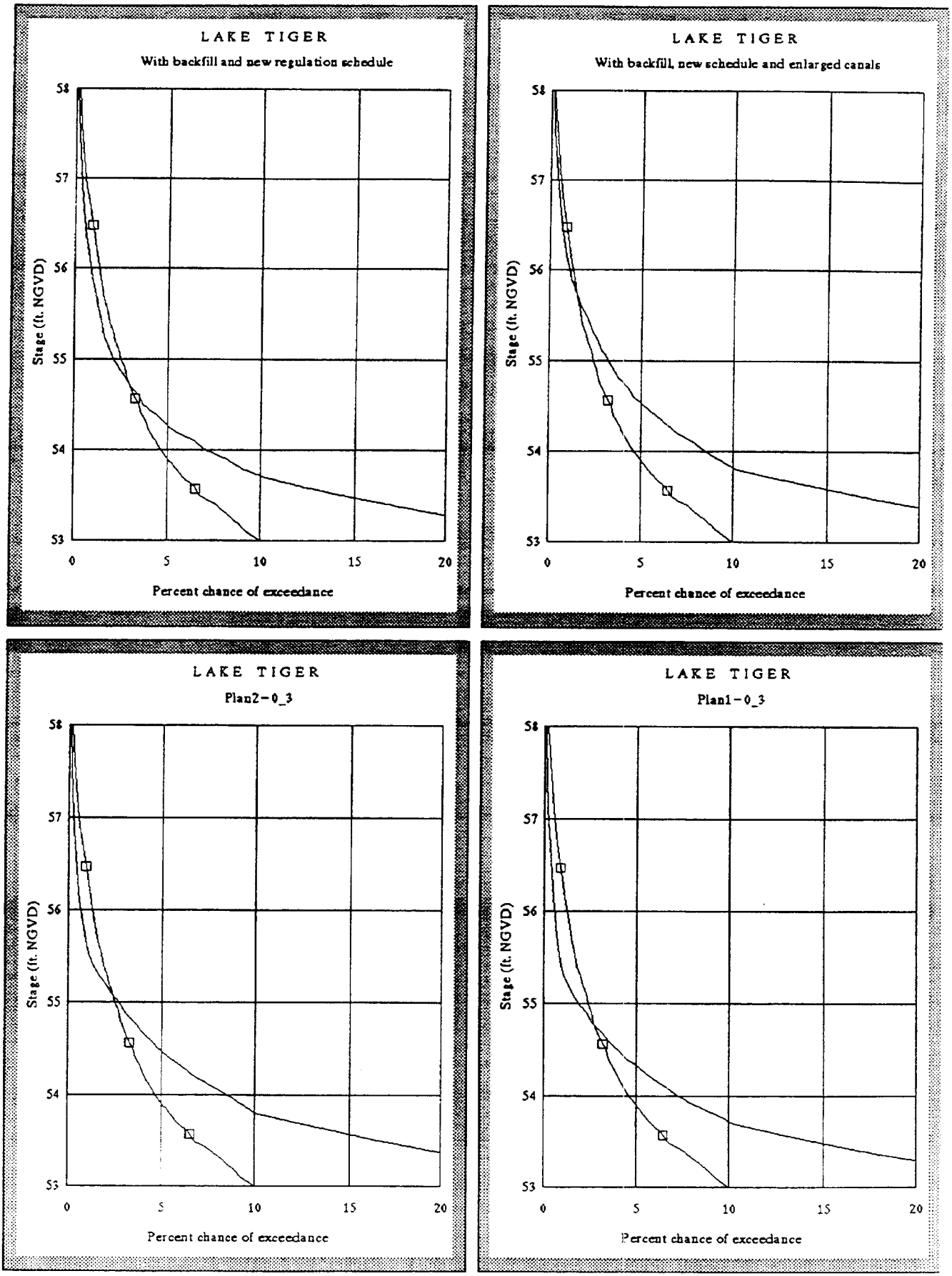






☐ Existing stage frequency
Computed by coincident frequency

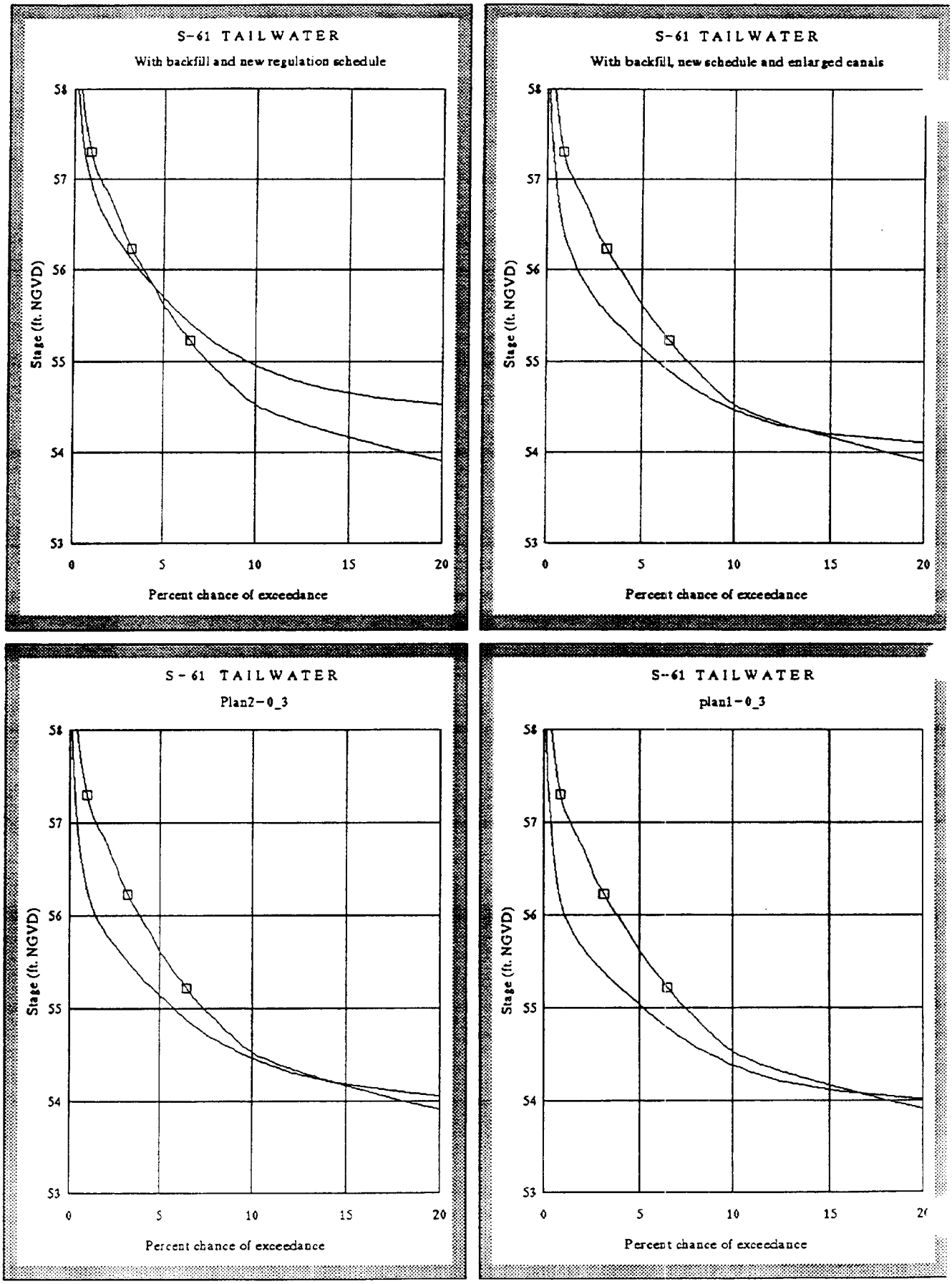
FIGURE A-16



☐ Existing stage frequency

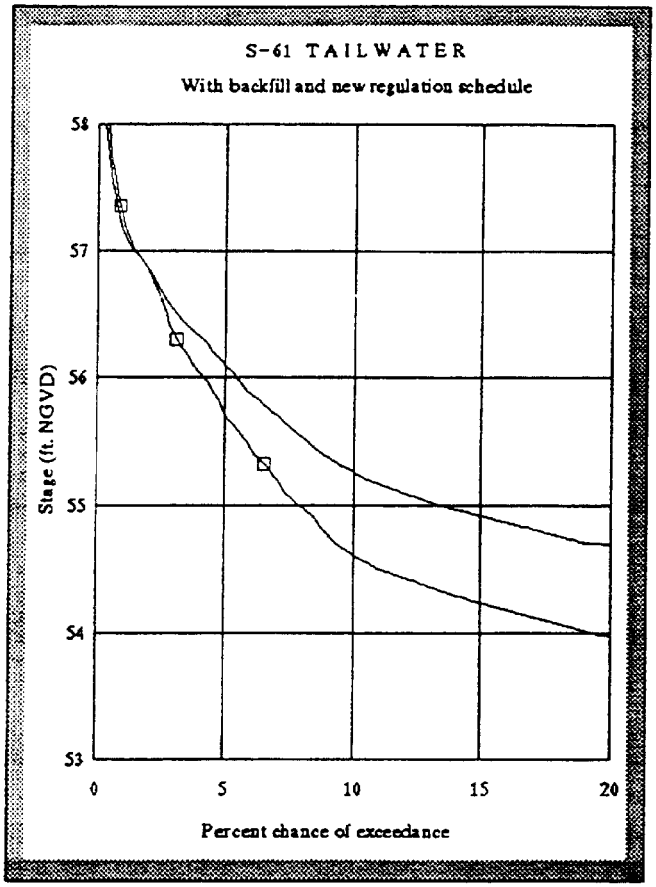
Computed by UNET with top of wet season schedule as the initial condition

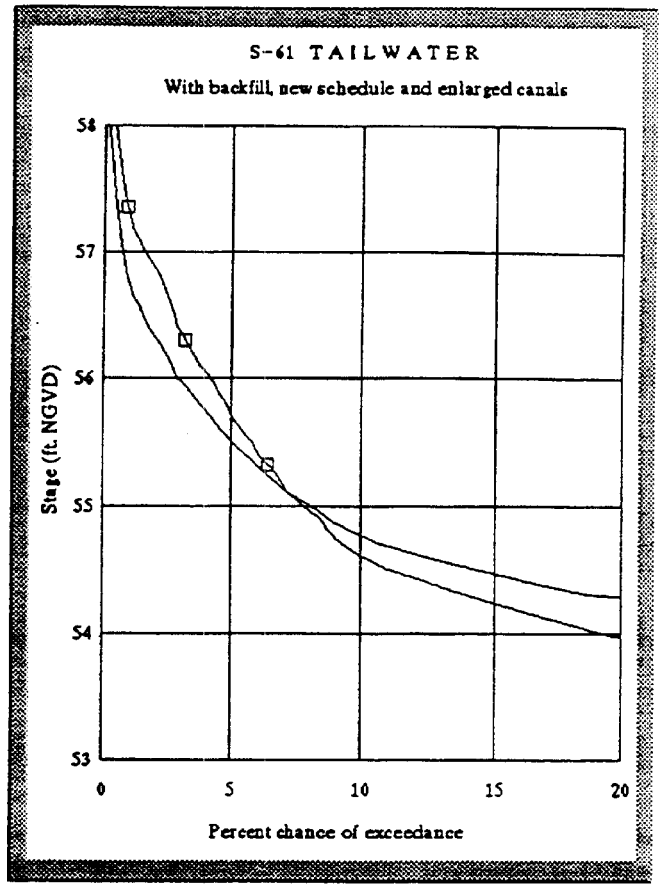
FIGURE A-17

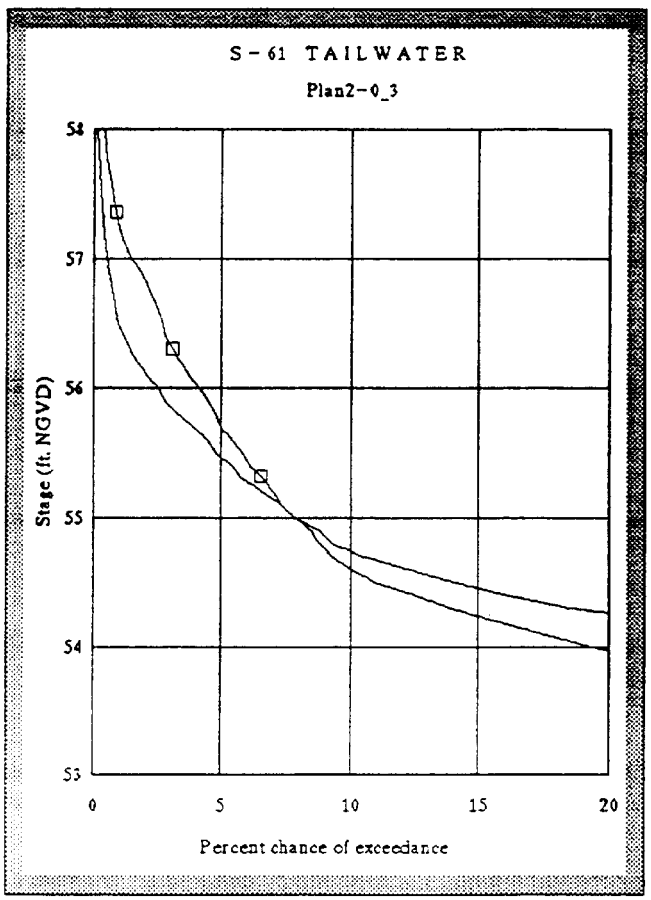


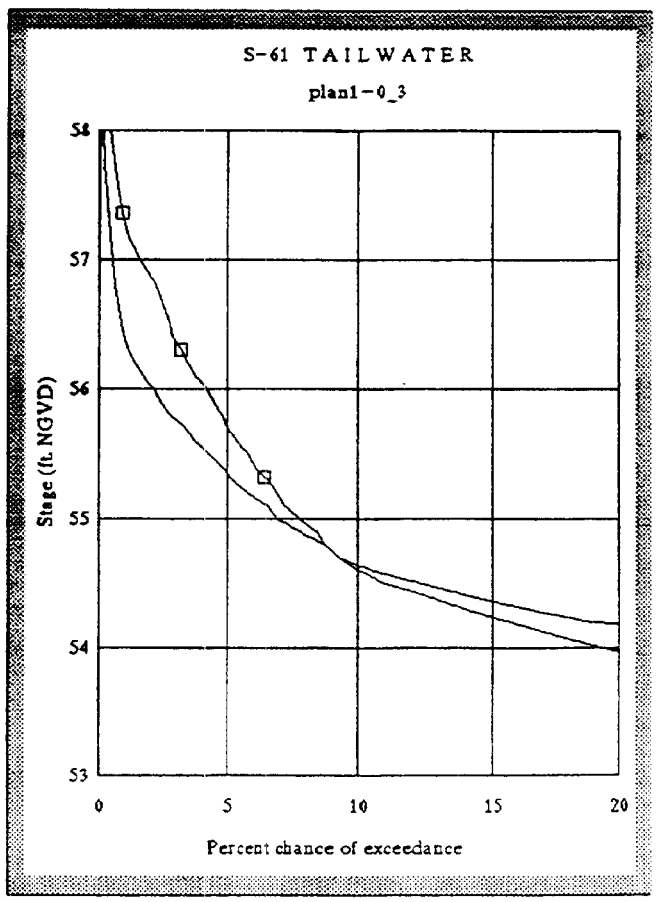
☐ Existing stage frequency
Computed by coincident frequency

FIGURE A-18





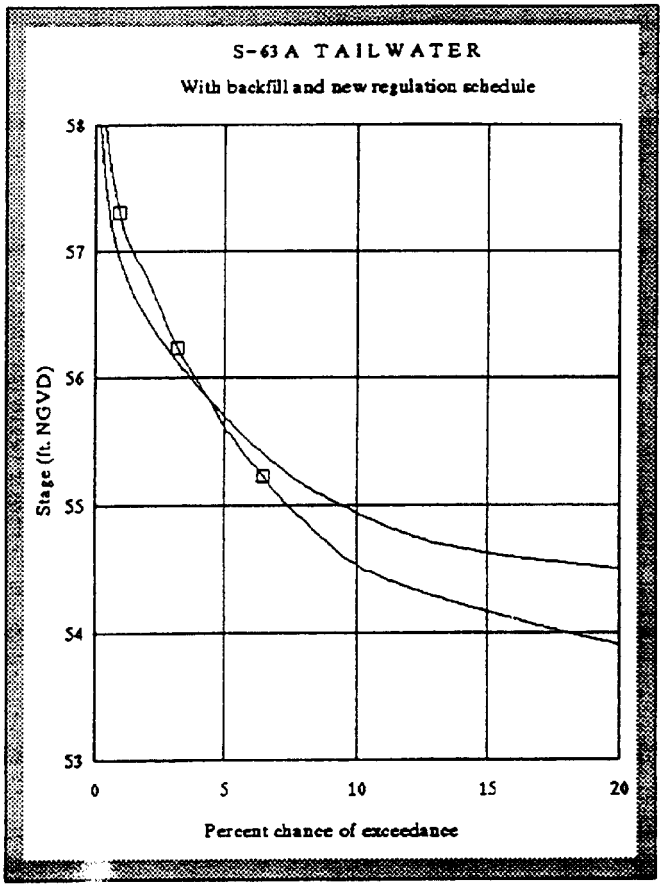


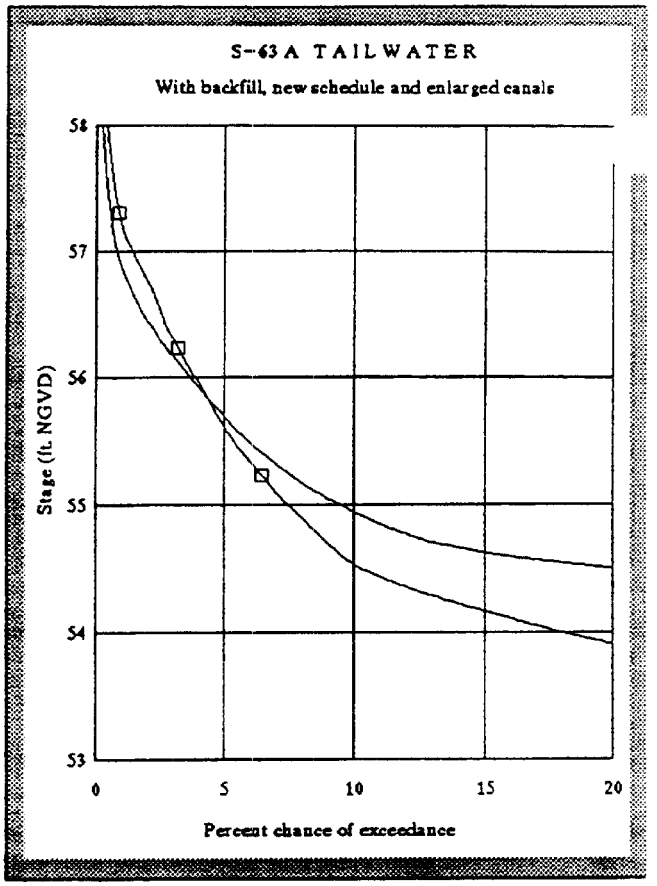


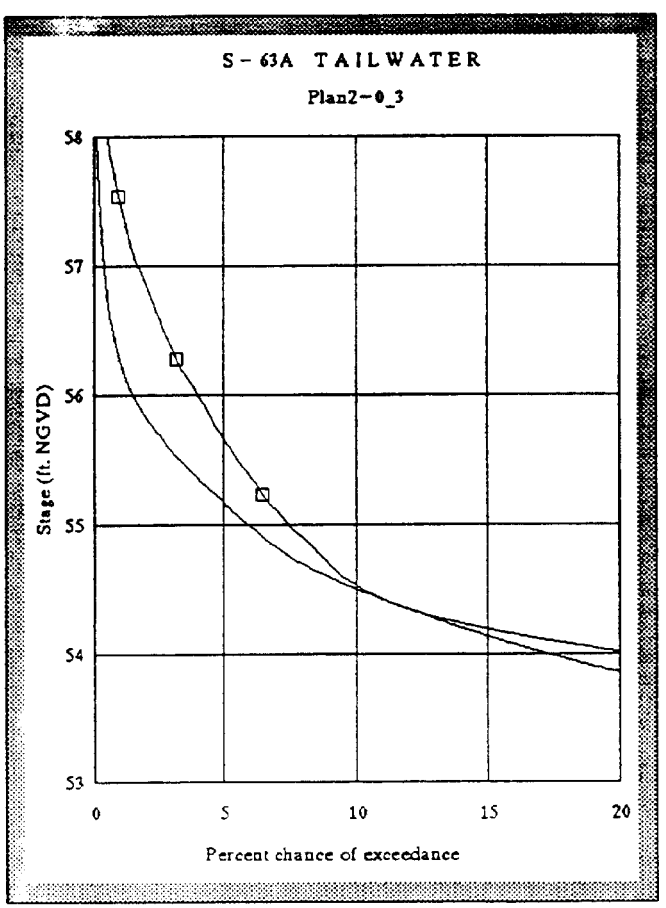
☐ Existing stage frequency

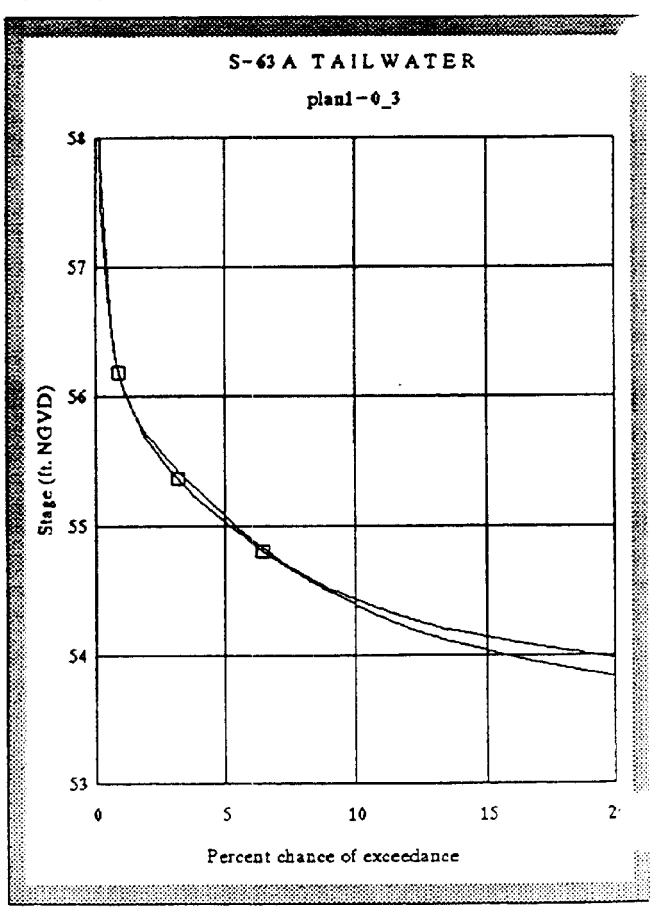
Computed by UNET with top of wet season schedule as the initial condition

FIGURE A-19



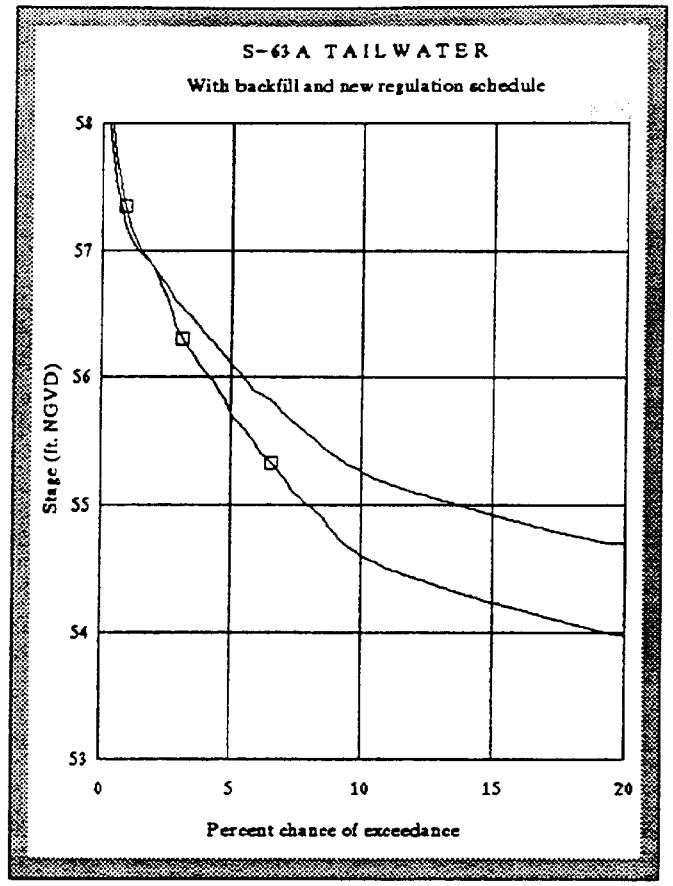


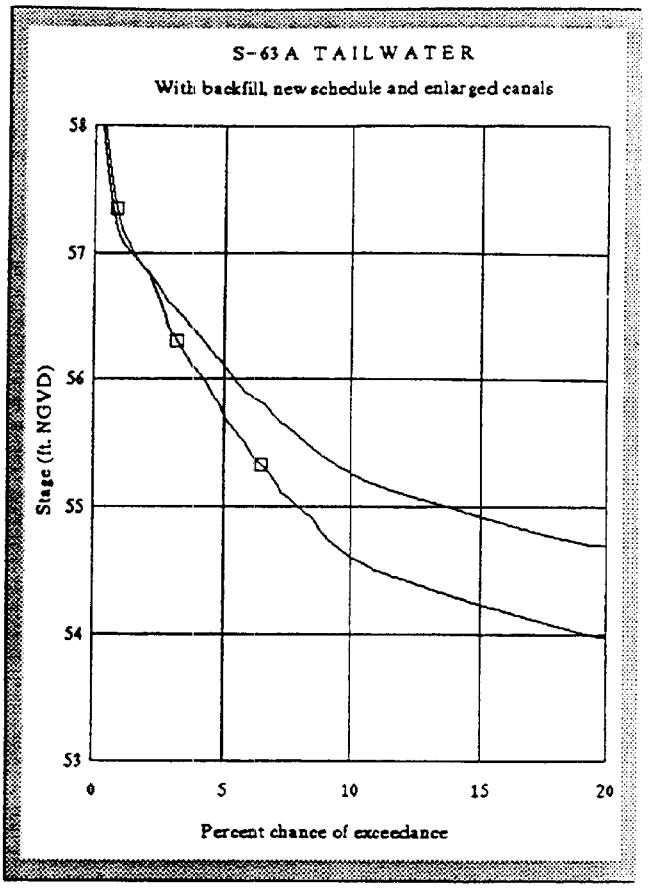


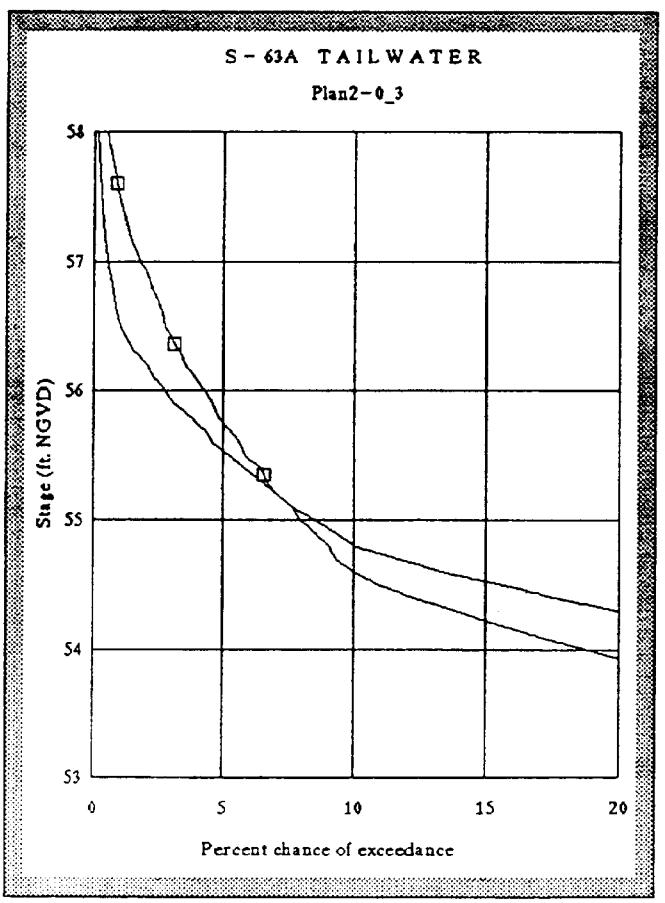


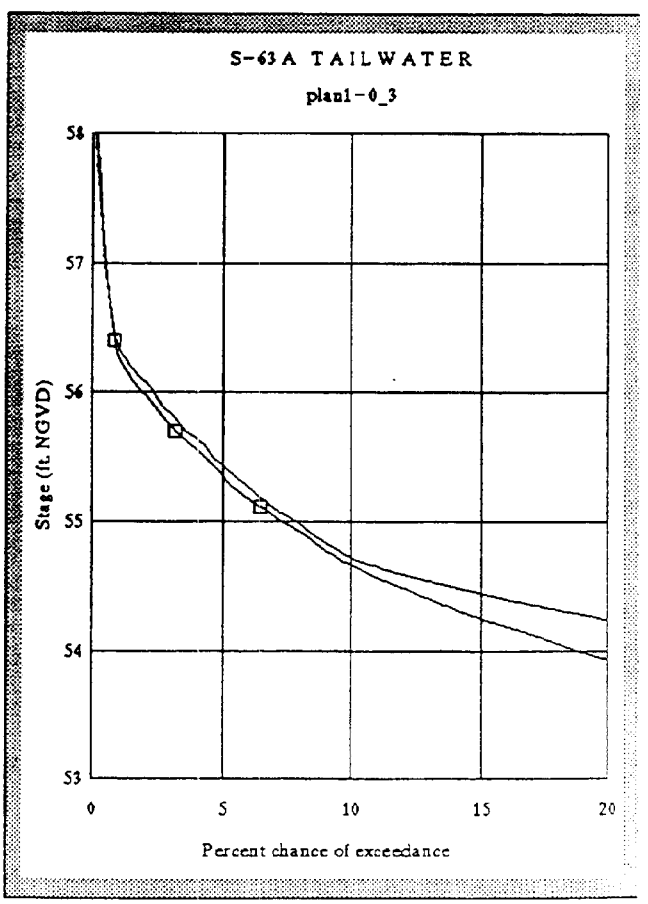
☐ Existing stage frequency
Computed by coincident frequency

FIGURE A-20









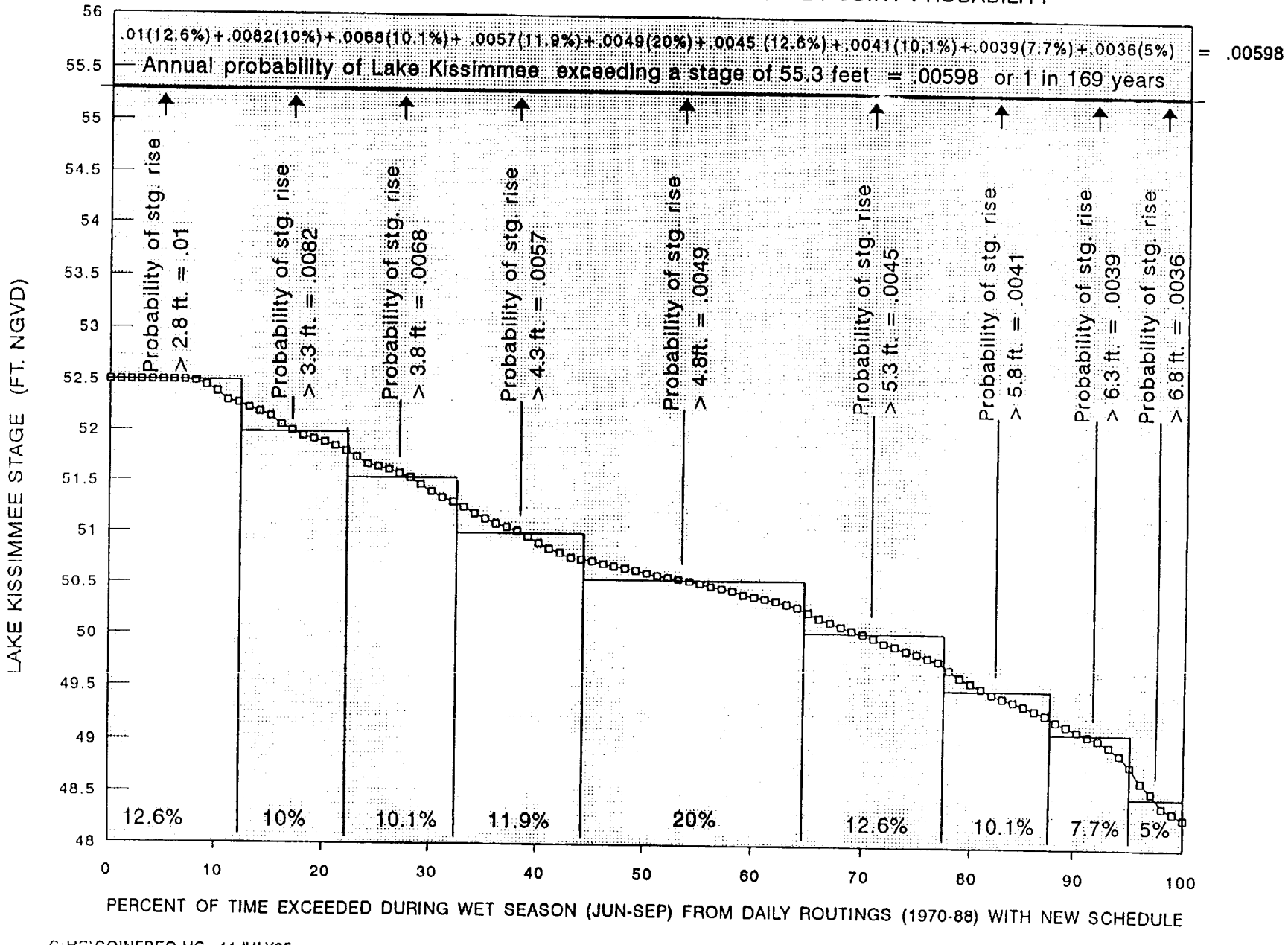
☐ Existing stage frequency

Computed by UNET with top of wet season schedule as the initial condition

FIGURE A-21

LAKE KISSIMMEE (SAMPLE CALCULATION)

COMPUTATION OF THE PROBABILITY OF EXCEEDING 55.3 Ft. BY JOINT PROBABILITY



C:P\COINFREQ.HG 11JULY95

Figure A-22

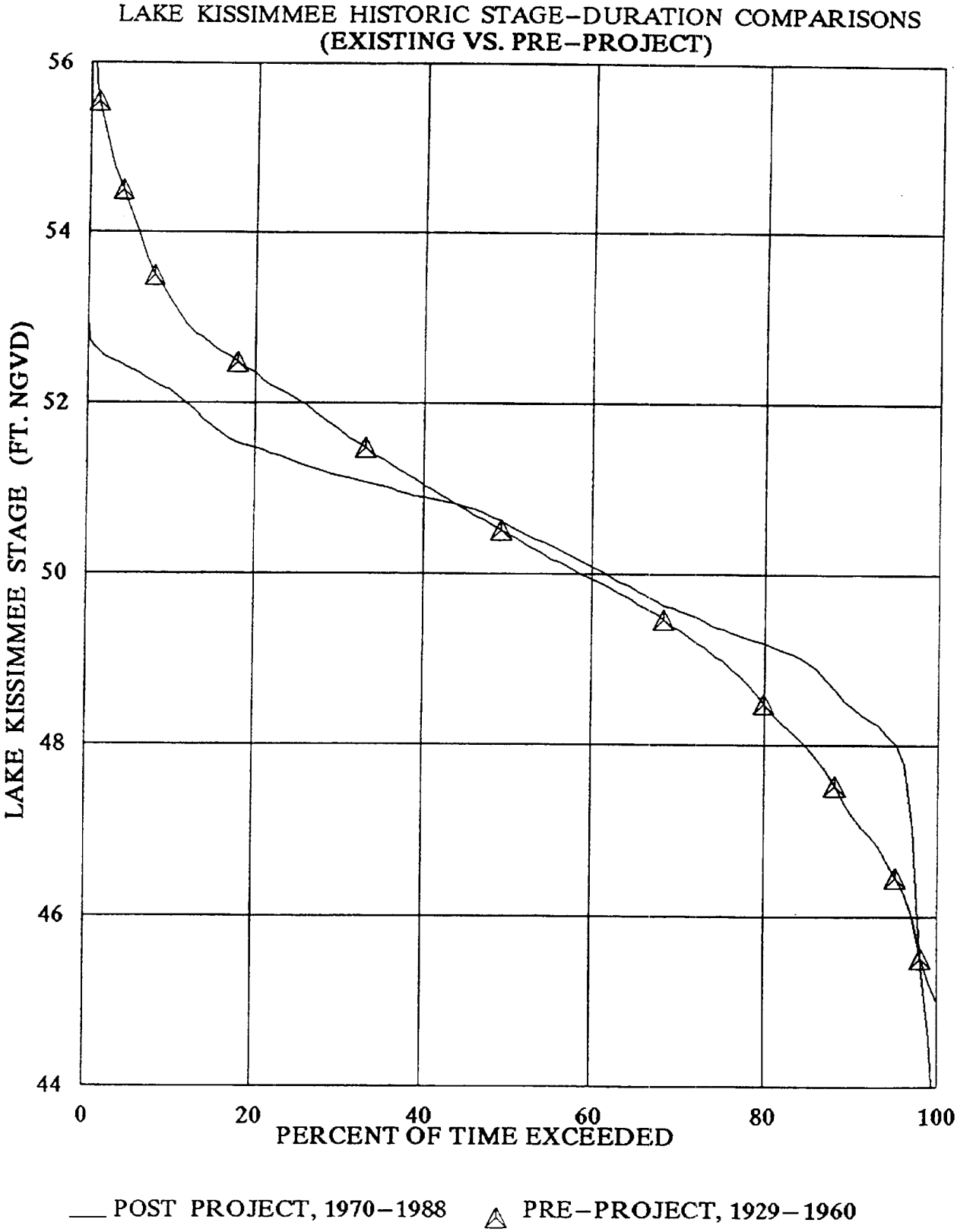
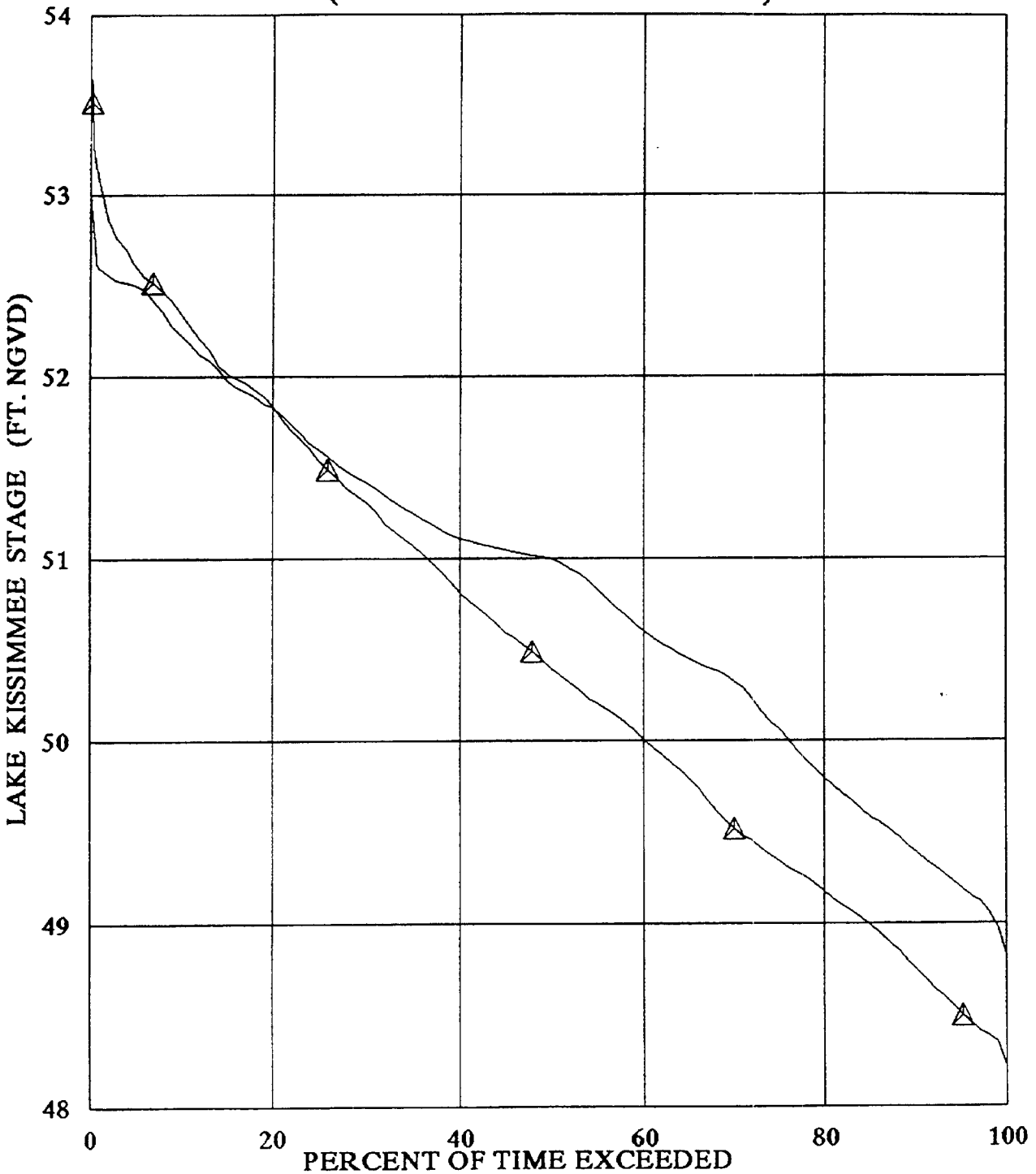

LAKE KISSIMMEE HISTORIC STAGE-DURATION COMPARISONS
(EXISTING VS. PRE-PROJECT)
LAKE KISSIMMEE STAGE (FT. NGVD)
56
54
52
50
48
46
44
0
20
40
60
80
100
PERCENT OF TIME EXCEEDED
POST PROJECT, 1970-1988
PRE-PROJECT, 1929-1960

FIGURE A-23

LAKE KISSIMMEE UKISS STAGE–DURATION COMPARISONS
(EXISTING VS. WITH–PROJECT)



___ EXISTING SCHEDULE △ PROPOSED SCHEDULE

FIGURE A–24

S-65

RATING CURVE FOR SUBMERGED CONTROLLED FLOW

1-27.0' x 13.7' GATE (CREST ELEV. 39.3')

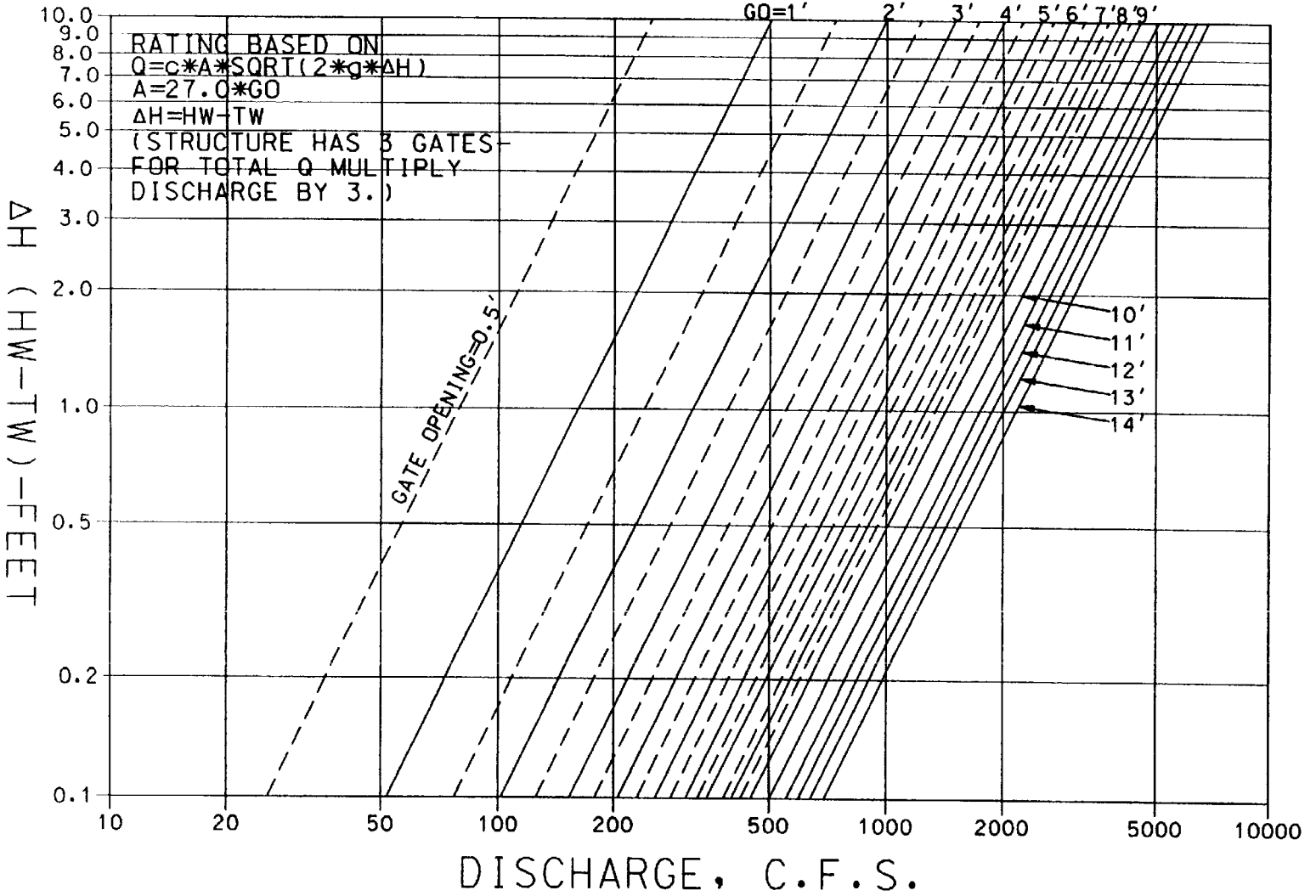


FIGURE A-25

S-65

DISCHARGE RATING CURVE FOR FREE CONTROLLED FLOW

3-27.0' x 13.7' GATE (CREST ELEV. 39.3')

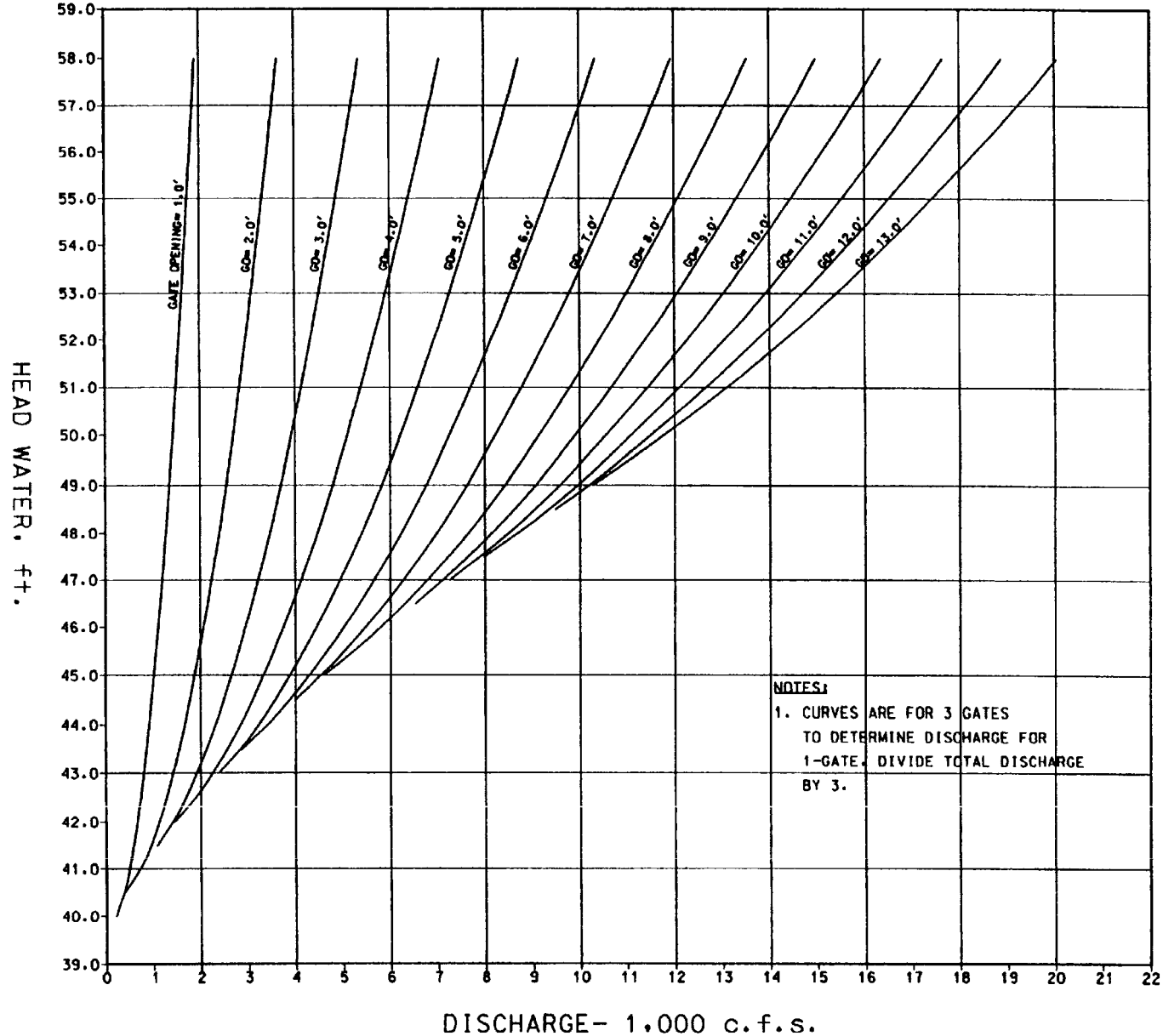


FIGURE A-26

S-65

DISCHARGE RATING CURVE FOR SUBMERGED UNCONTROLLED FLOW

3-27.0' x 13.7' GATE (CREST ELEV. 39.3')

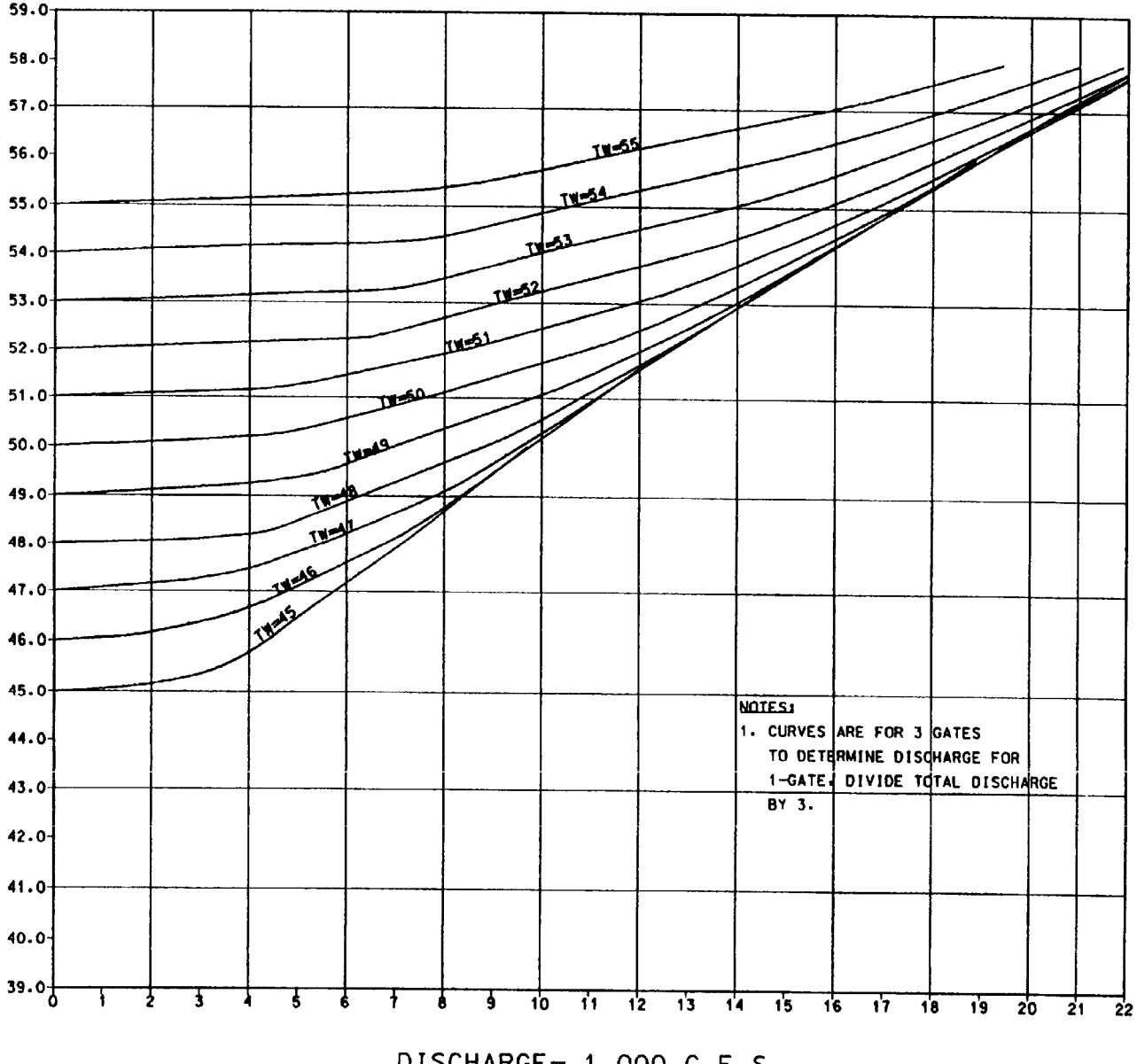


FIGURE A-27

S-65 EXPANSION

RATING CURVE FOR SUBMERGED CONTROLLED FLOW

1-27.0' x 13.7' GATE (CREST ELEV. 39.3')

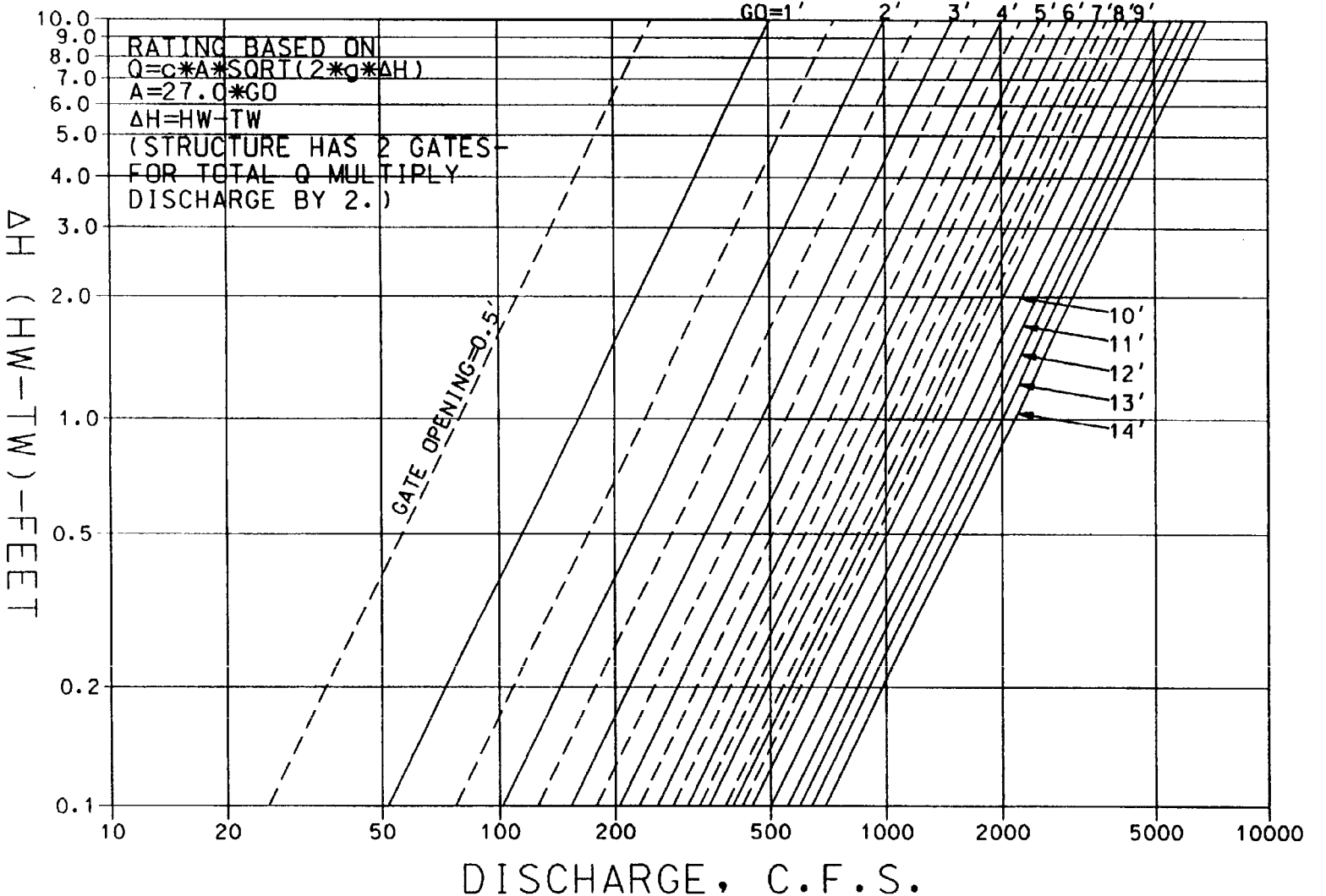


FIGURE A-28

S-65 EXPANSION

DISCHARGE RATING CURVE FOR FREE CONTROLLED FLOW

2-27.0' x 13.7' GATE (CREST ELEV. 39.3')

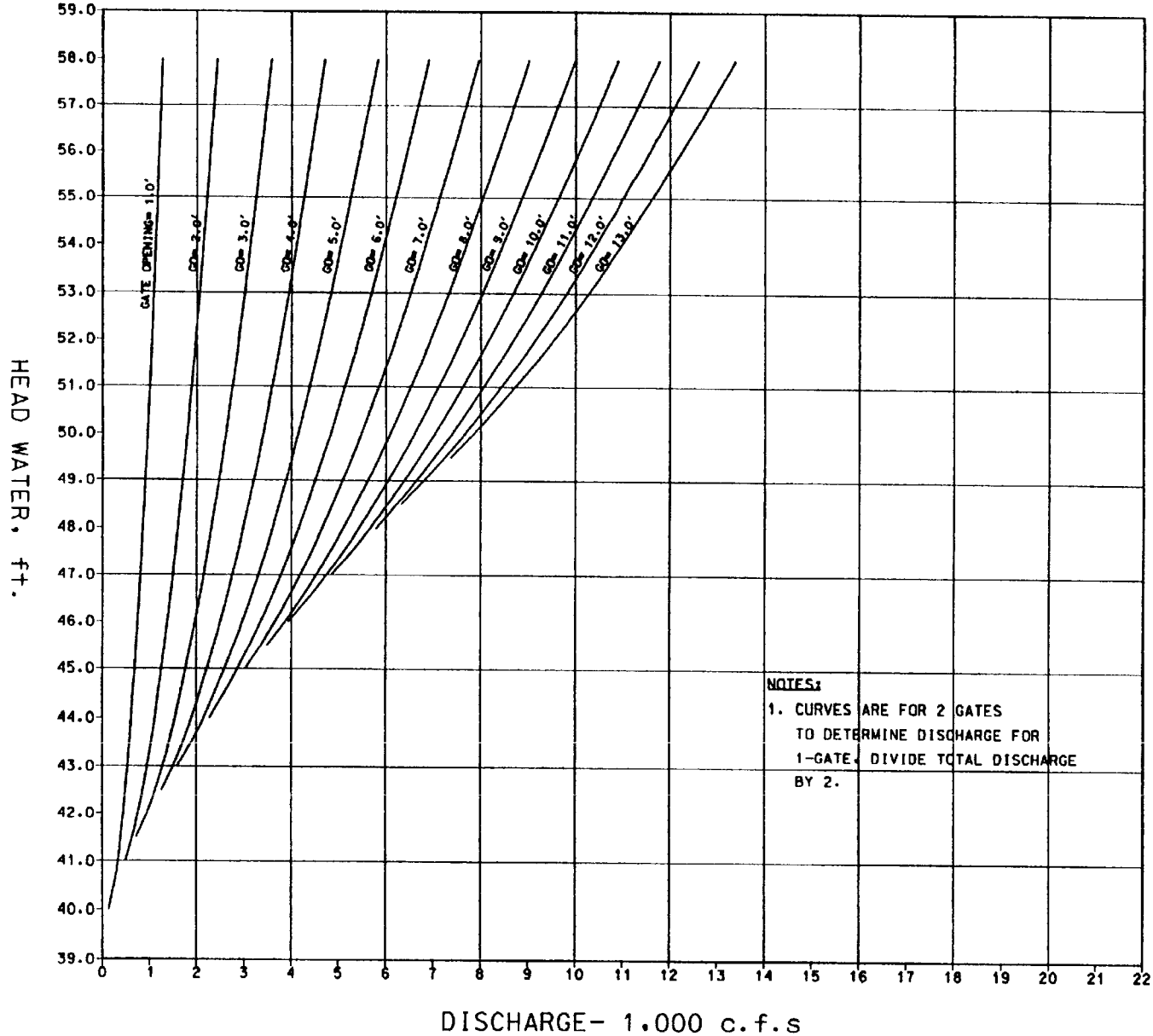


FIGURE A-29

S-65 EXPANSION

DISCHARGE RATING CURVE FOR SUBMERGED UNCONTROLLED FLOW

2-27.0' x 13.7' GATE (CREST ELEV. 39.3')

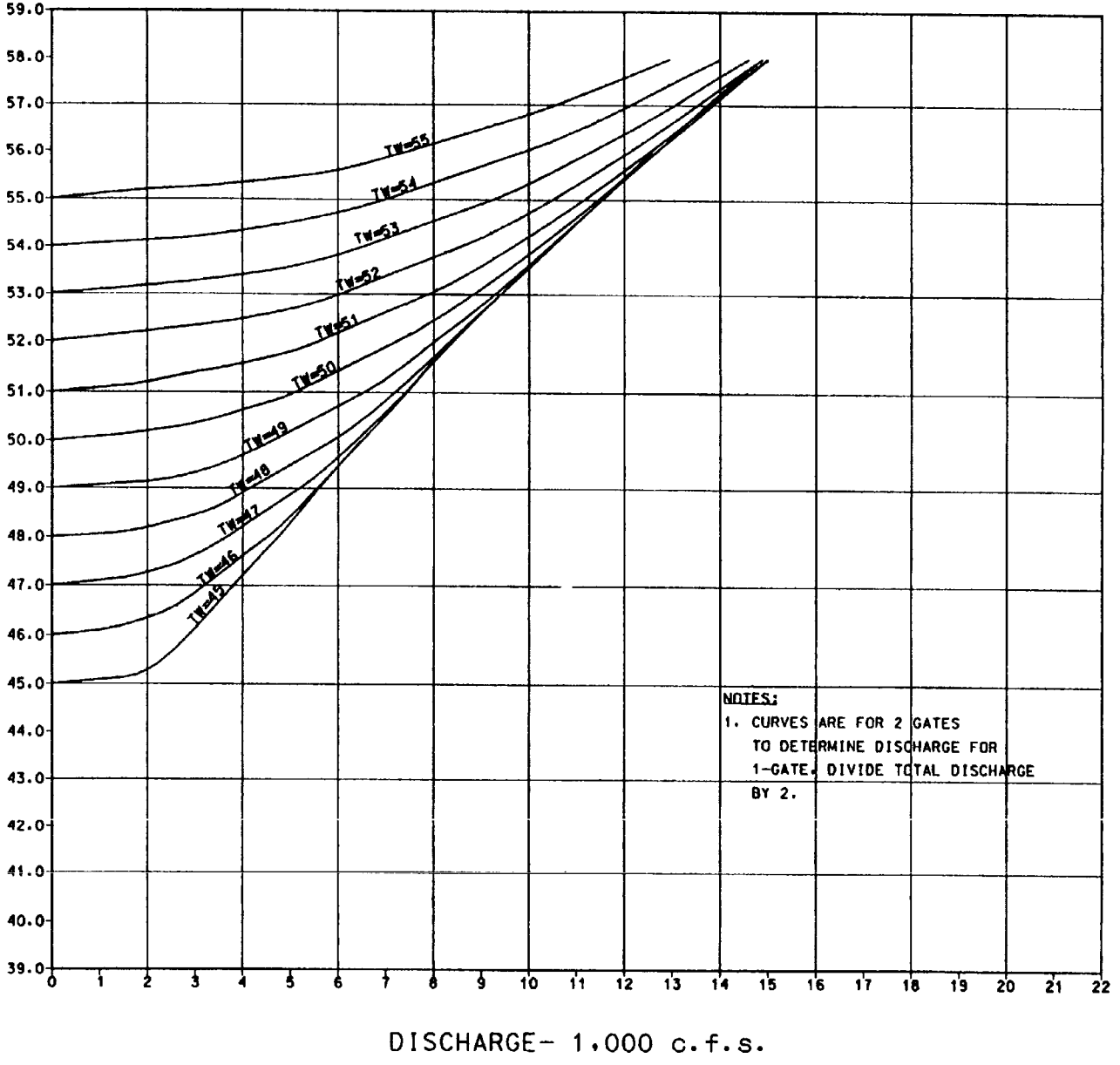


FIGURE A-30

COMBINED DISCHARGE FOR S-65 AND S-65 EXPANSION

RATING CURVE FOR SUBMERGED CONTROLLED FLOW

1-27.0' x 13.7' GATE (CREST ELEV. 39.3')

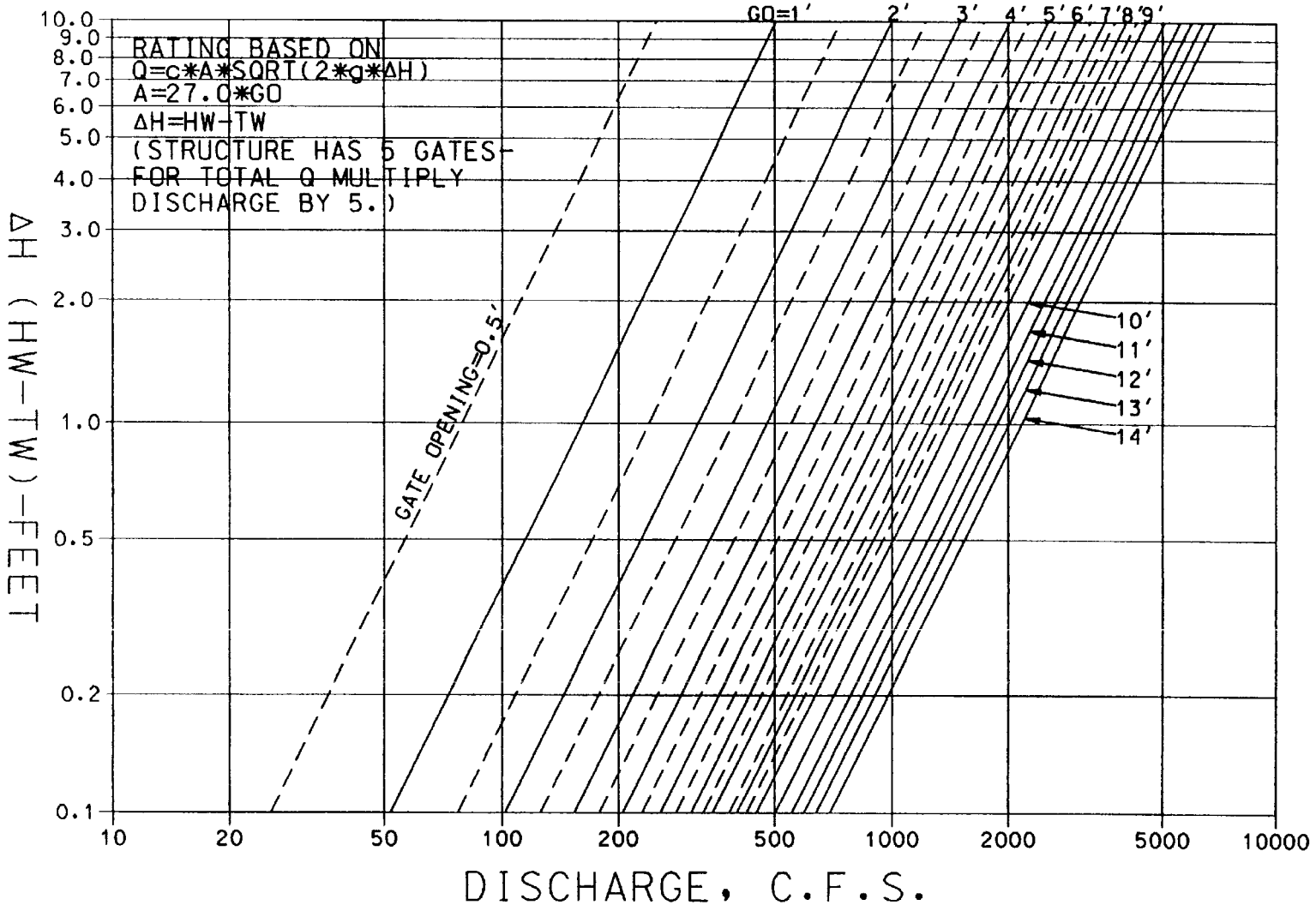


FIGURE A-31

COMBINED DISCHARGE FOR S-65 AND S-65 EXPANSION

DISCHARGE RATING CURVE FOR FREE CONTROLLED FLOW

5-27.0' x 13.7' GATE (CREST ELEV. 39.5')

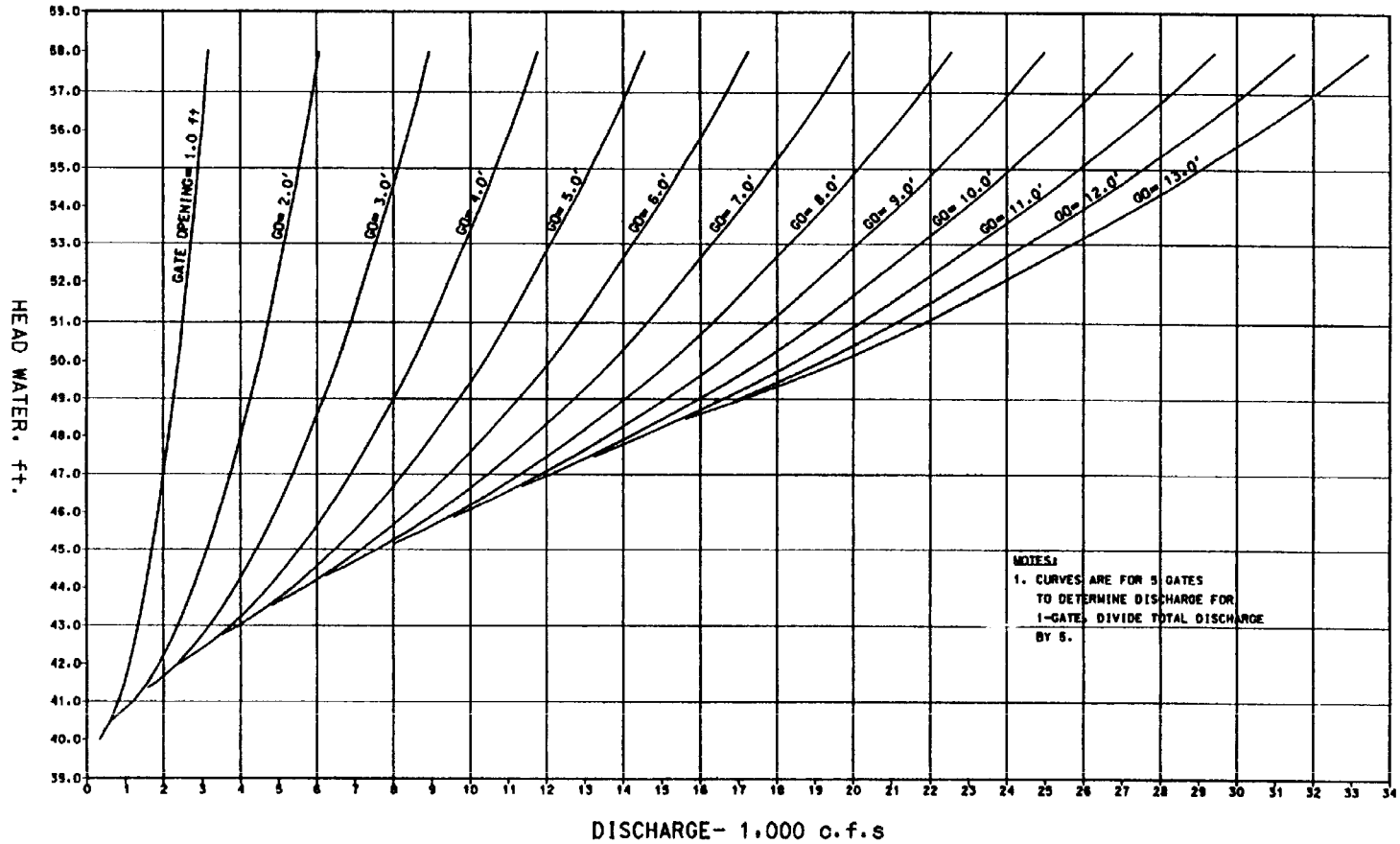


FIGURE A-32

COMBINED DISCHARGE FOR S-65 AND S-65 EXPANSION

DISCHARGE RATING CURVE FOR SUBMERGED UNCONTROLLED FLOW

S-27.0' x 13.7' GATE (CREST ELEV. 39.3')

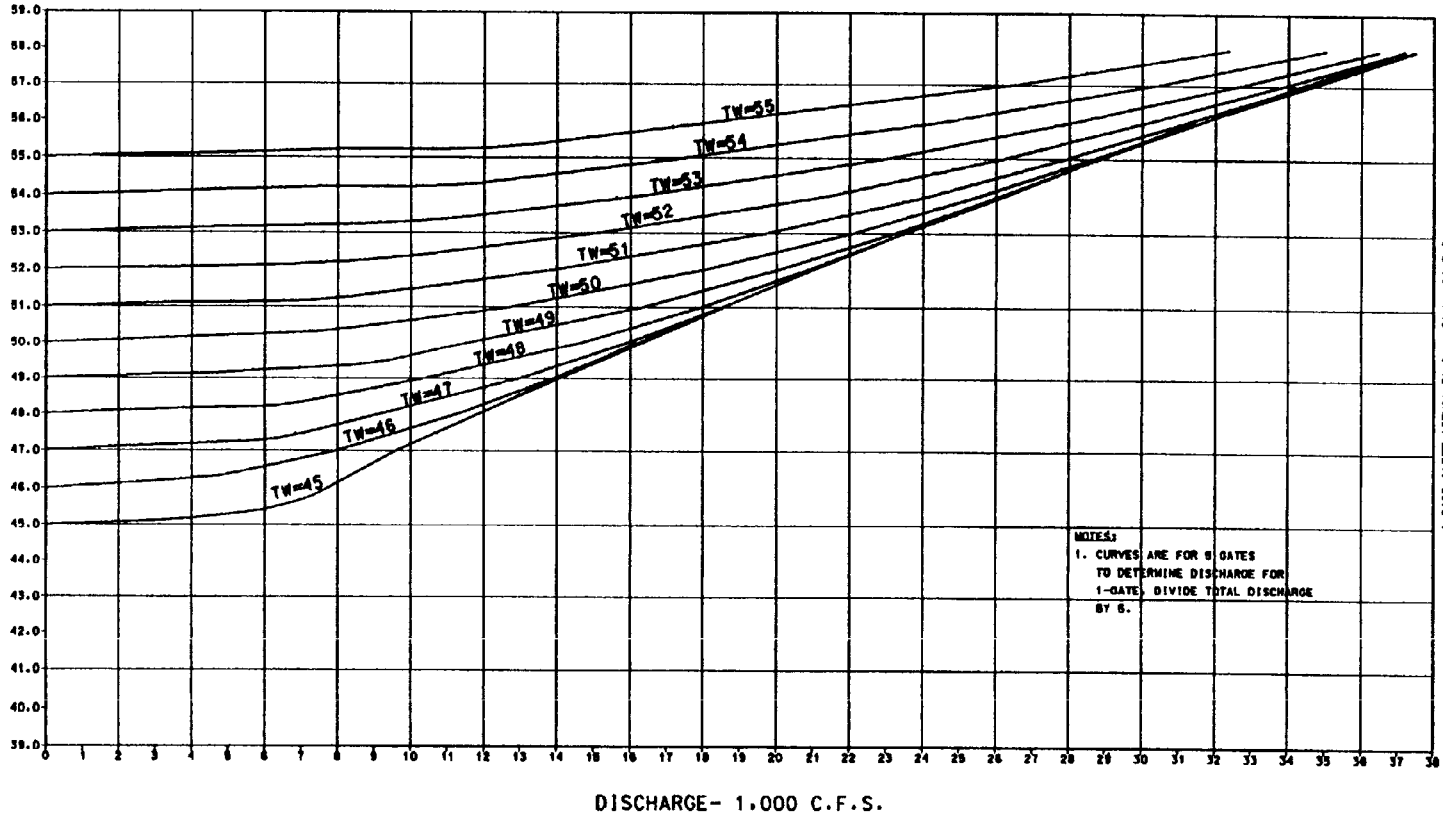


FIGURE A-33

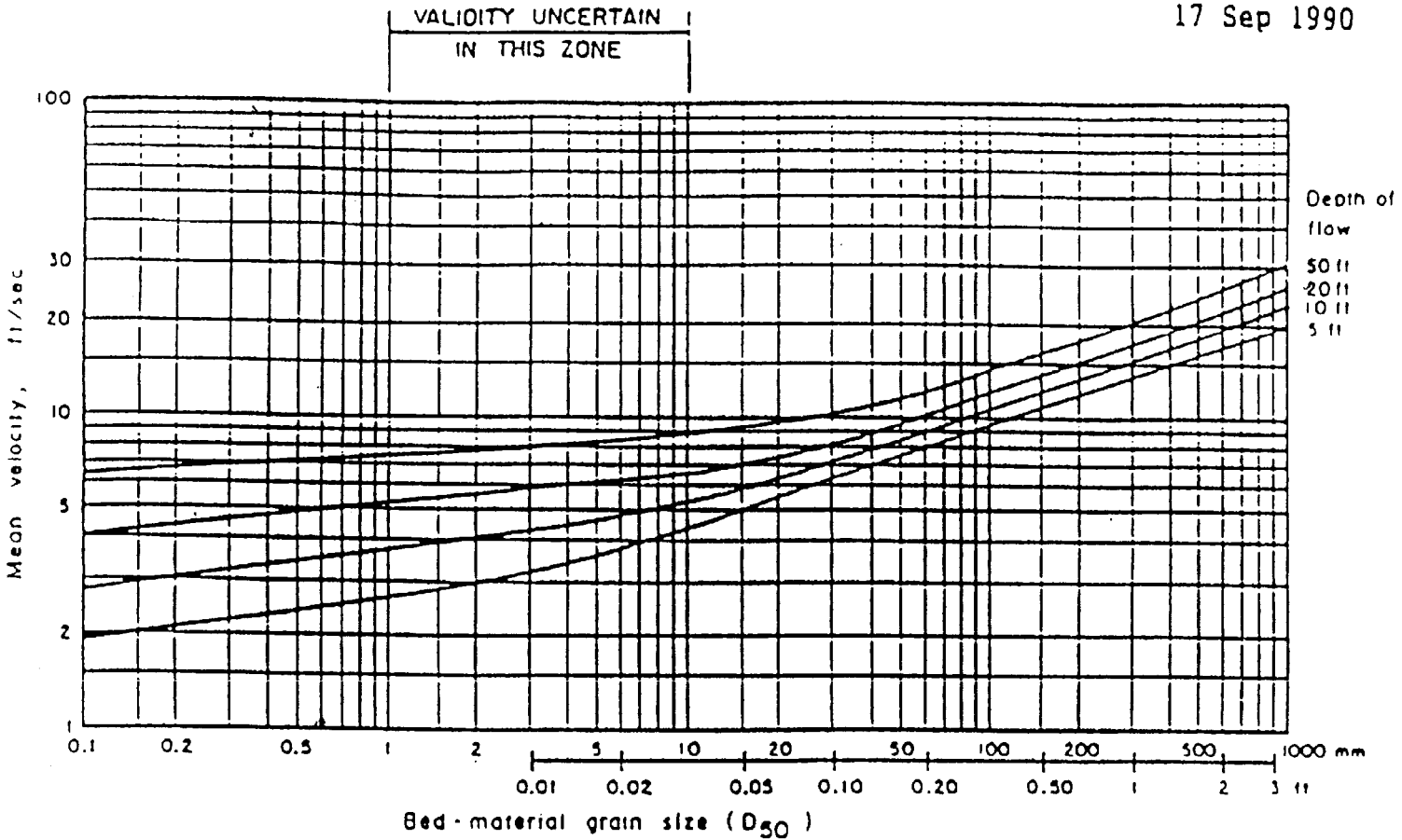
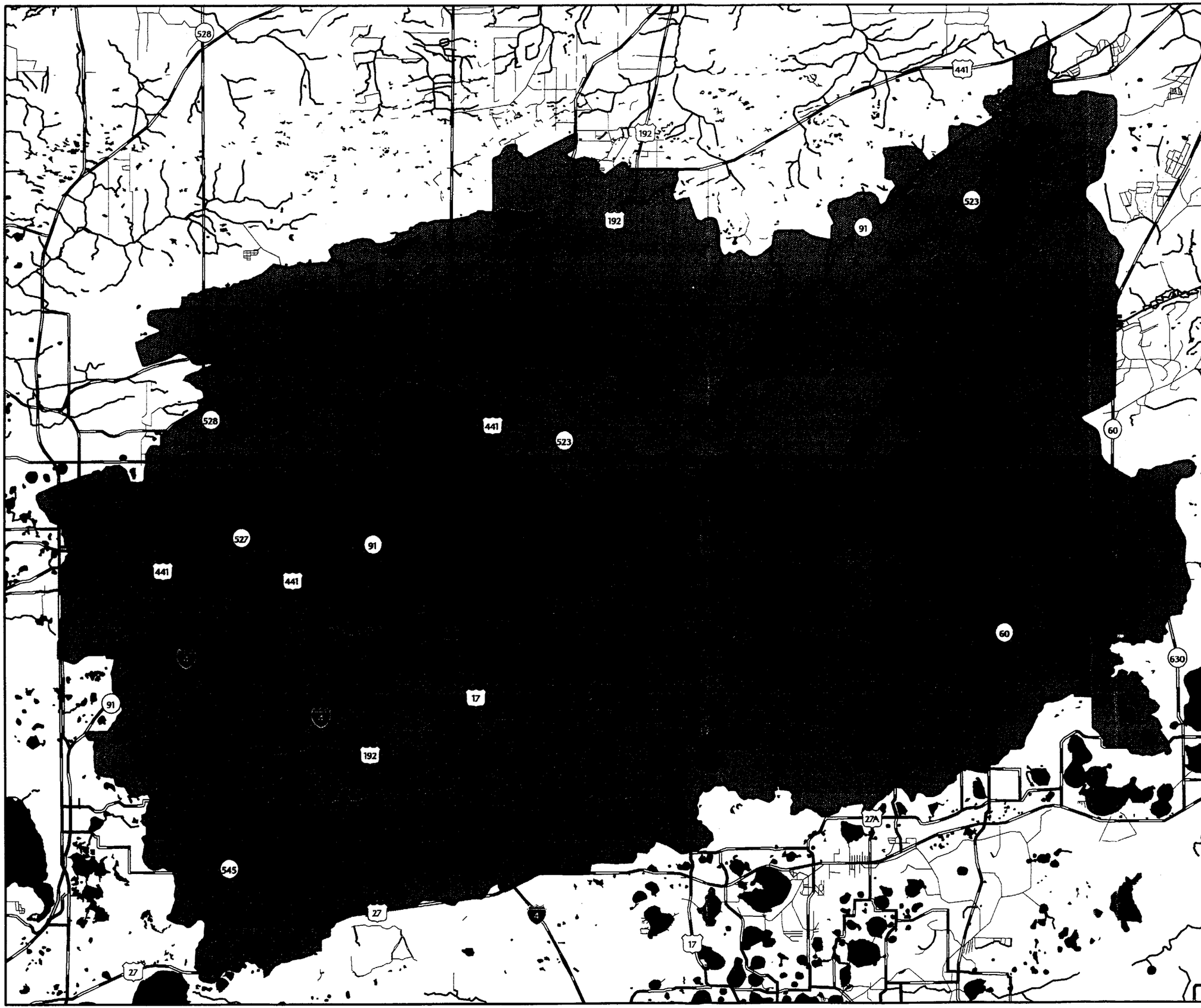


Figure 5.3.3 Approximate threshold velocities for bed movement of granular materials.

CENTRAL AND SOUTHERN FLORIDA PROJECT
KISSIMMEE RIVER
HEADWATERS REVITALIZATION PROJECT
Appendix A
Hydrology and Hydraulic Analyses

PLATES



REFER TO TABLE A-10 FOR PERTINENT DATA ON LABELED DRAINAGE AREAS

LEGEND

Upper/middle basin

Drainage divide

111 Drainage area number

Gated spillway

Non-Federal Contral Structure

North

Miles

3 0 3 6 9

CENTRAL AND SOUTHERN FLORIDA PROJECT
KISSIMMEE RIVER
HEADWATERS REVITALIZATION
SECTION 1135

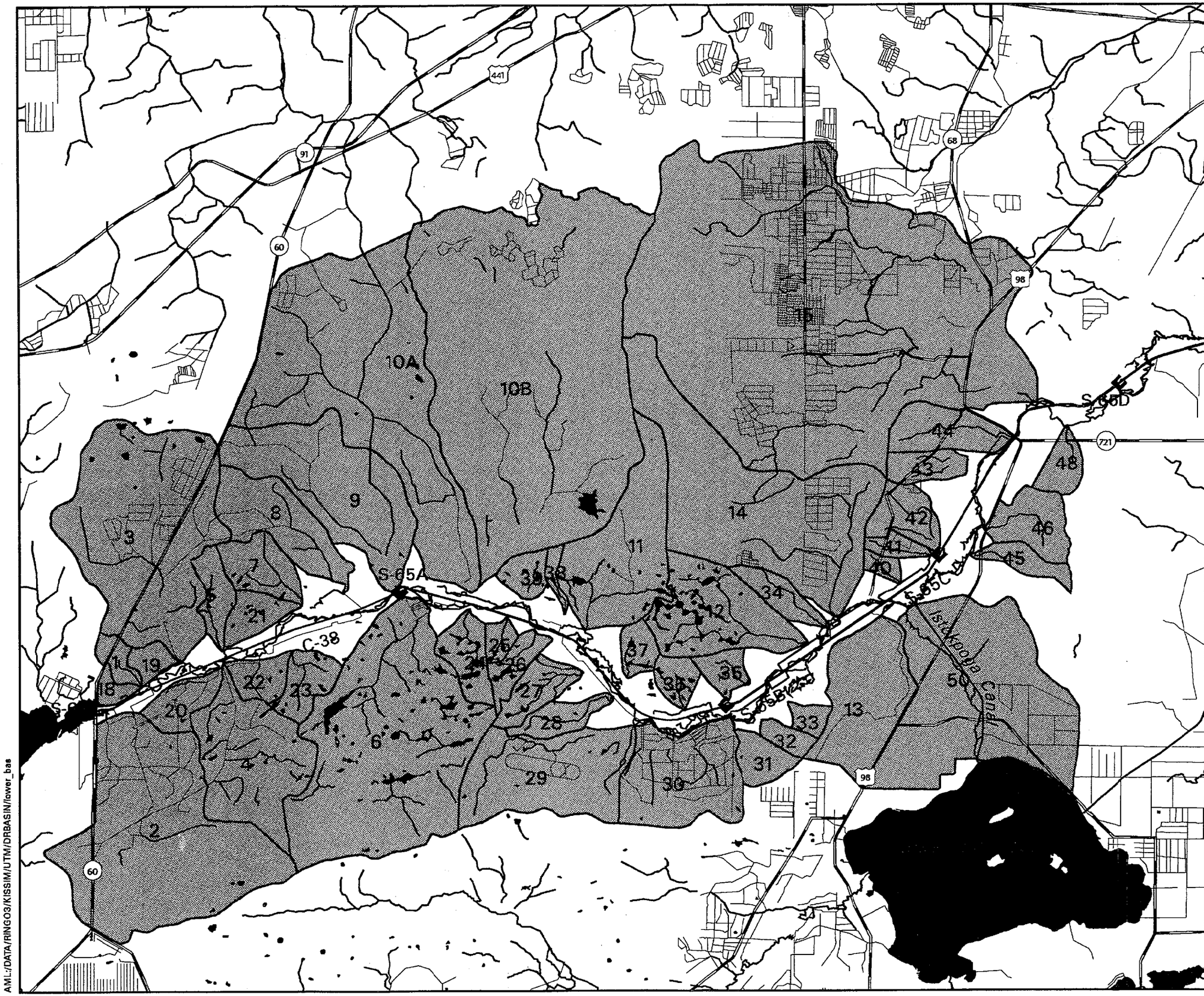
UPPER / MIDDLE BASIN

DRAINAGE AREAS

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

DATED, JULY 1995

AML:/DATA/RINGO3/KISSIM/UTM//DRBASIN/upper_bas



REFER TO TABLE A-12 FOR PERTINENT DATA ON LABELED DRAINAGE AREAS

CENTRAL AND SOUTHERN FLORIDA PROJECT
KISSIMMEE RIVER
HEADWATERS REVITALIZATION
SECTION 1135

LOWER BASIN

DRAINAGE AREAS

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

DATED, JULY 1995

AML:/DATA/RINGO3/KISSIM/UTM/DRBASIN//lower_bas

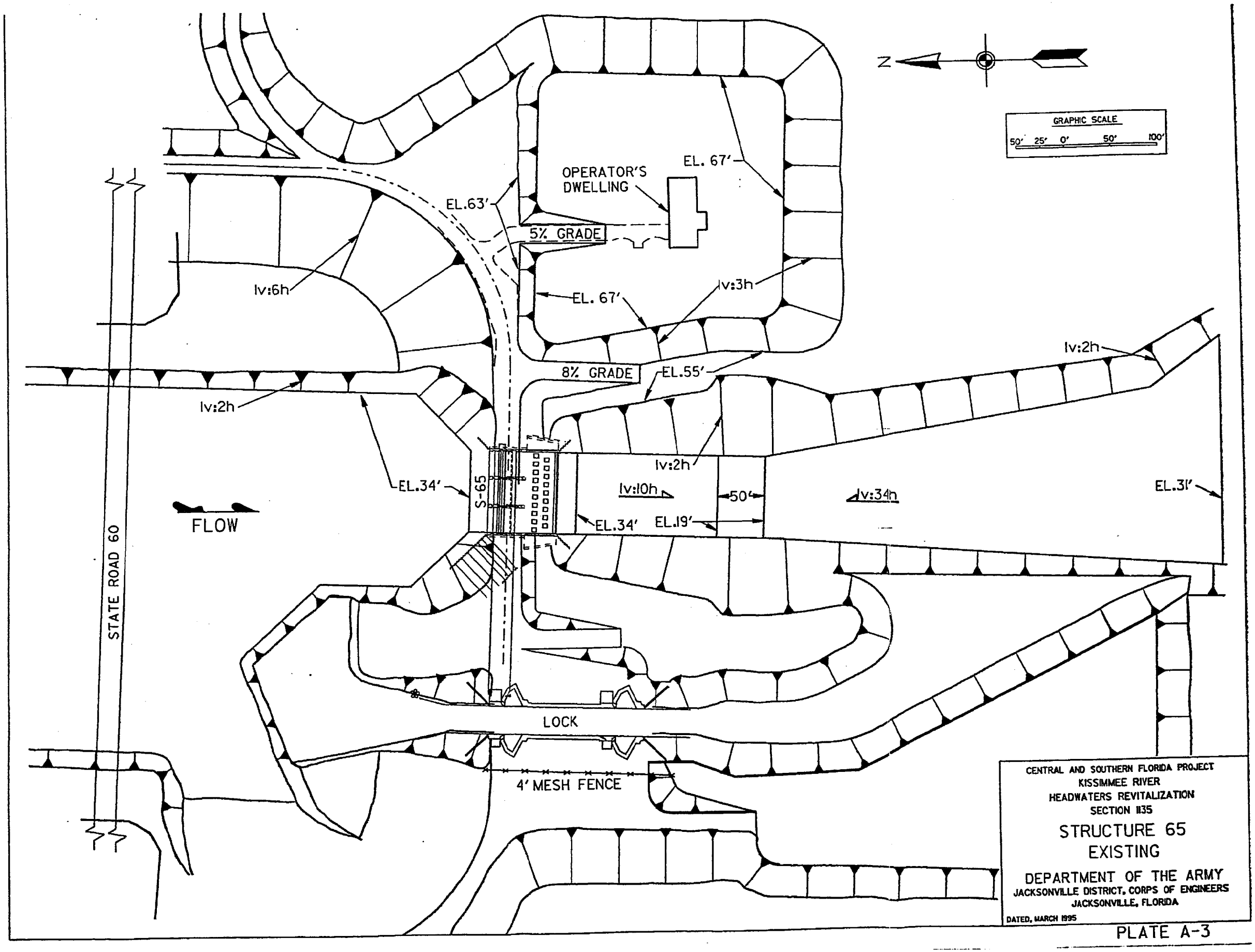
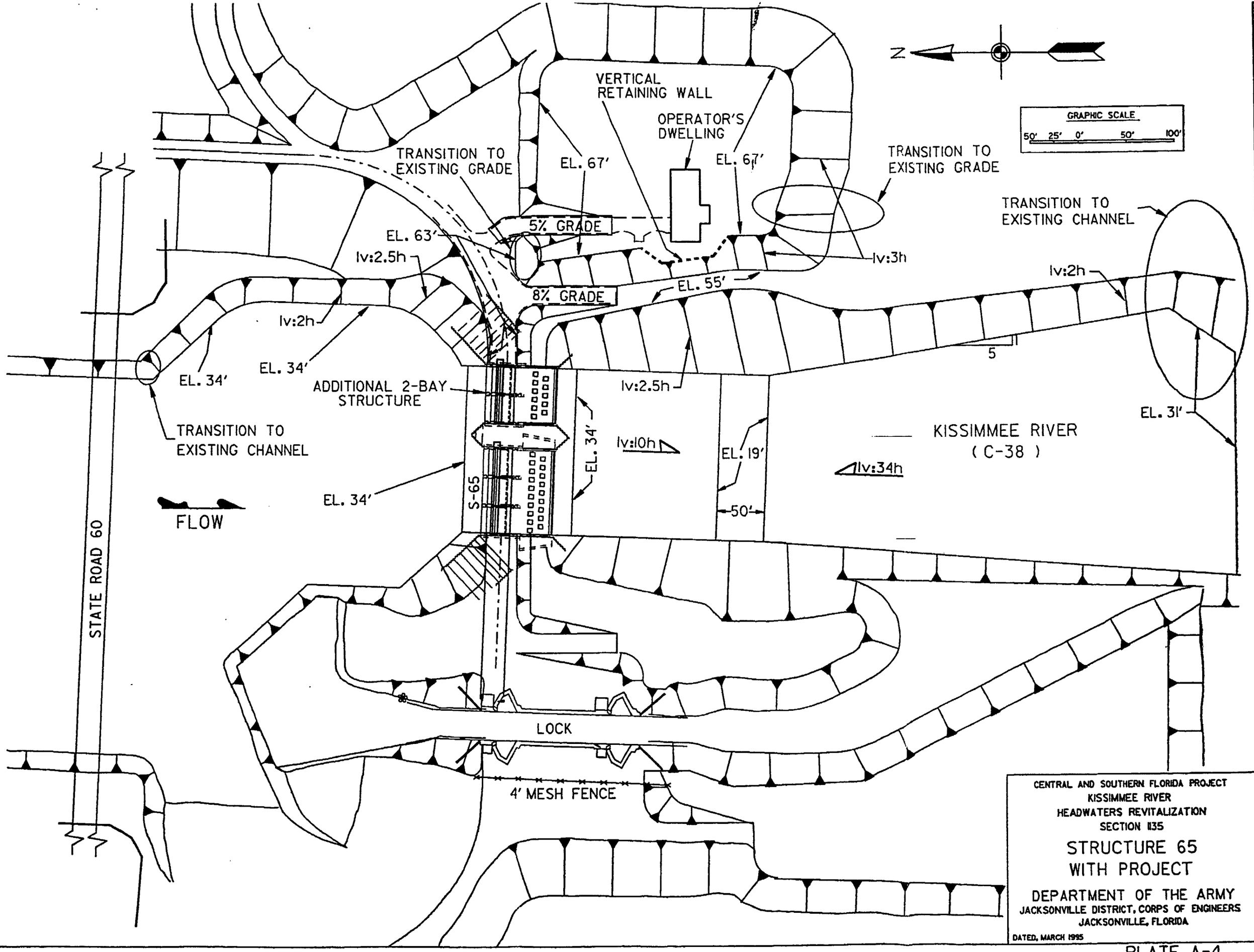

N
GRAPHIC SCALE
50' 25' 0' 50' 100'
OPERATOR'S DWELLING
EL. 67'
EL.63'
5% GRADE
1v:6h
1v:3h
EL. 67'
1v:2h
8% GRADE
EL.55'
1v:2h
1v:2h
EL.34'
S-65
1v:10h
50'
1v:34h
EL.31'
FLOW
EL.34'
EL.19'
STATE ROAD 60
LOCK
4' MESH FENCE
CENTRAL AND SOUTHERN FLORIDA PROJECT
KISSIMMEE RIVER
HEADWATERS REVITALIZATION
SECTION 1135
STRUCTURE 65
EXISTING
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA
DATED, MARCH 1995

PLATE A-3



CENTRAL AND SOUTHERN FLORIDA PROJECT
KISSIMMEE RIVER
HEADWATERS REVITALIZATION
SECTION 1135

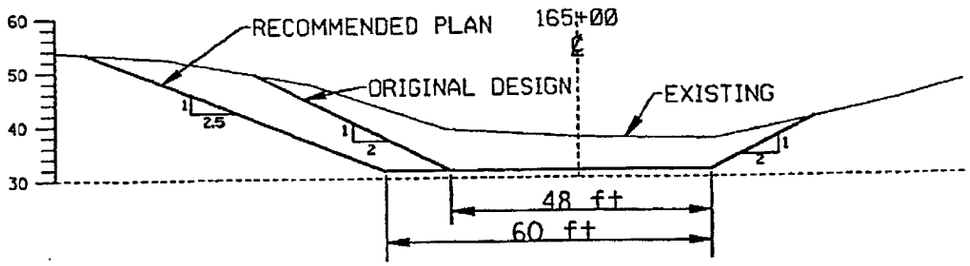
STRUCTURE 65
WITH PROJECT

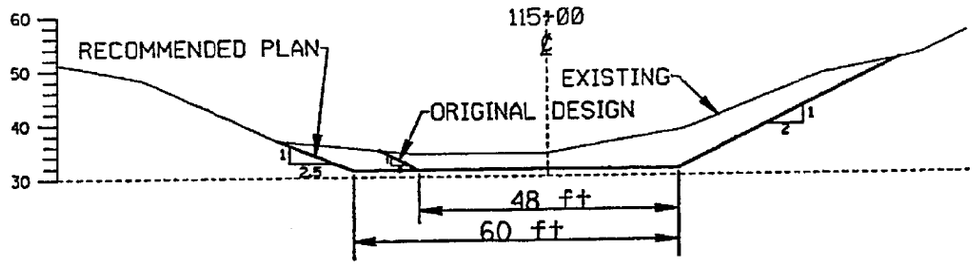
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

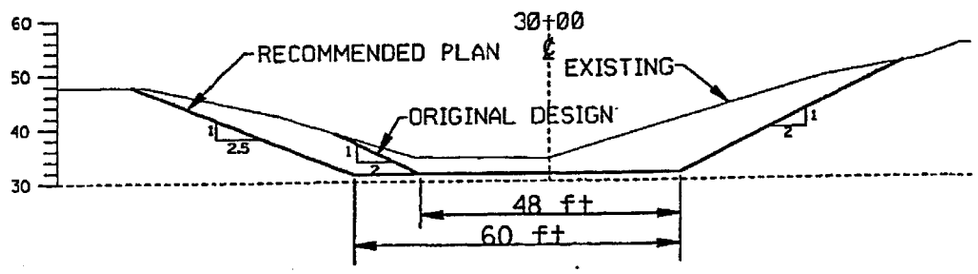
DATED, MARCH 1995

PLATE A-4

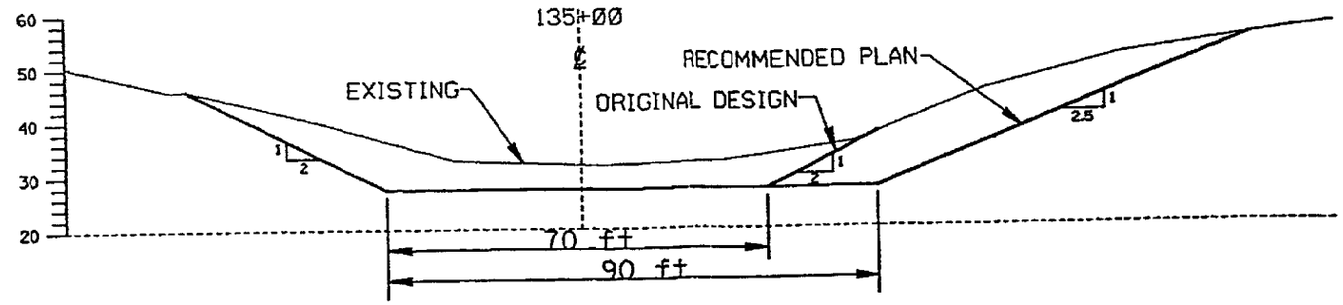
C-36

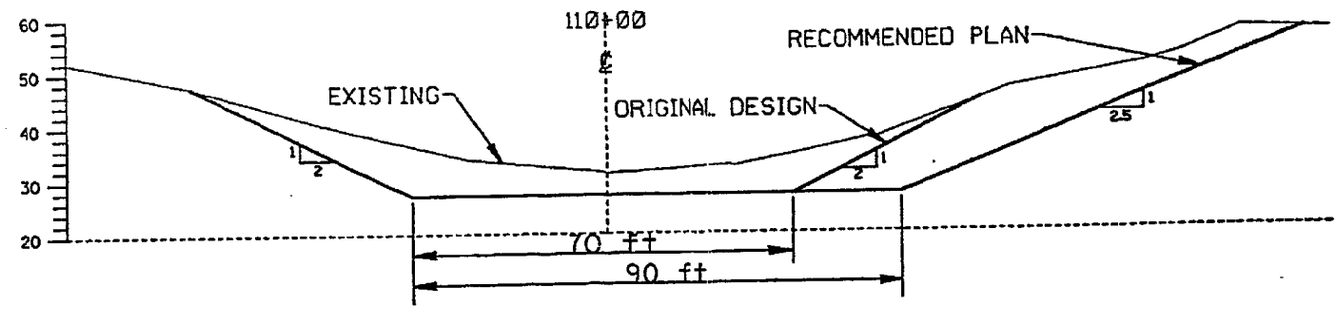


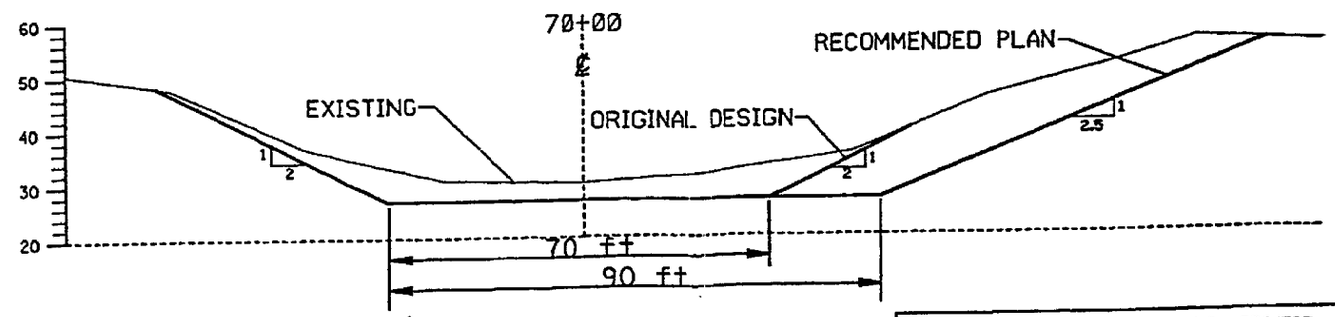




C-37







CENTRAL AND SOUTHERN FLORIDA PROJECT
KISSIMMEE RIVER
HEADWATERS REVITALIZATION
SECTION 1135

CANAL 36 & 37 MODIFICATIONS
TYPICAL CROSS SECTIONS

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

DATED, MARCH 1995

KISSIMMEE RIVER
HEADWATERS REVITALIZATION PROJECT

APPENDIX B

WATER CONTROL PLAN DISCUSSION

Appendix B
Water Control Plan Discussion

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Appendix B
Water Control Plan Discussion

B-1. Kissimmee Basin. The Kissimmee Basin is an integrated system of lake storage capabilities and structure outlet capacities. The Upper Kissimmee Basin structures are operated according to the regulation schedules. The regulation schedule essentially represents the seasonal and monthly limits of storage which guides the regulation of the project for the planned purposes. The regulation schedules vary from high stages in the late fall and winter to low stages at the beginning of the wet season. The lakes are drawndown in the spring to provide flood control storage and fish and wildlife enhancement. The minimum levels are set to provide for sufficient flood control storage and navigation depths. The amount of seasonal fluctuation was derived by determining the effect of various water levels on the flood control, low water regulation, groundwater, fish and wildlife, and recreation. The maximum levels were governed by damage prevention for up to 30-percent of the Standard Project Flood (SPF) and reduced damages for larger floods and maximum level desirable for fish and wildlife. Runoff during the wet season is stored for use in the dry season. The regulation schedules take into account these varying, and often, conflicting purposes.

B-2. Kissimmee Basin - Pre-Regulation. Under natural conditions, the lakes in the Kissimmee River Basin fluctuated seasonally through a range in stage varying from about 2 to 10 feet. The existing outlet capacities were limited and the lakes functioned as natural detention reservoirs which stored large quantities of water during the wet season and was released during dry periods. Prior to regulation, the river received continuous inflows from the Upper Basin, with the lowest discharge occurring during the winter-spring dry season and steadily increasing to an end of the wet season (November) peak. Overflows of the lakes during the wet season inundated the large adjacent marsh areas from three to five months on average, and as long as ten months during wet years. Historical seasonal flows out of Lake Kissimmee provided opportunities for fluctuating water levels within the meandering river channel, oxbows, and natural river floodplains within the Lower Kissimmee Basin. Under historic hydrologic conditions, wet prairies were typically dry from spring through early summer, allowing annual plants such as wild millet to germinate and produce seed. Fall and early winter flooding made these wet prairies attractive feeding sites for resident and wintering waterfowl.

B-3. Current Regulation Schedule for Lakes Kissimmee, Hatchineha, and Cypress. These lakes are regulated by a single structure, S-65 located at the outlet of Lake Kissimmee at the head of C-38. Lake Kissimmee is normally regulated between elevations 49.0 and 52.5 ft., NGVD according to a seasonally varying schedule. One year in three the lake is regulated between 48.5 ft. and 52.5 ft., NGVD for fish and wildlife enhancement. The current regulation schedule is shown on Figure B-1. When the stage in the lakes is in Zone A on the regulation schedule (Figure B-1), releases of 3,000 cfs minimum can be made at anytime. During design flood conditions, discharge from S-65 will vary between 3,000 and 11,000 cfs according to downstream conditions. When local inflow to C-38 is equal to or greater

than design flood runoff, S-65 will limit discharge to 3,000 cfs. After local inflow subsides, discharge from S-65 could increase to 11,000 cfs depending on downstream capacity. When the lake stage is in Zone B, releases may be made to maintain downstream flows for water supply, navigation, and environmental purposes.

B-4. Effect of Lake Regulation. With the increased outlet capacities provided by the project, the lakes are regulated to prevent much of the fluctuation that occurred under natural conditions. When regulation was implemented, the fluctuation of Lakes Cypress, Hatchineha, and Kissimmee was set within a four foot range. The current regulation schedule requires that water levels be drawn down in advance of the wet season and that water levels be allowed to rise to maximum safe storage prior to the dry season. Consequently, discharges to the lower basin are generally limited during the wet season and extended periods of no flow are common as water is being stored in the lakes. Discharges increase in the dry season as water levels are once again being drawn down in advance of the next wet season. In addition, the range of water level fluctuations and maximum annual lake stages have been reduced and the outer fringe of littoral wetlands surrounding the lakes have been drained diminishing associated fish and wildlife values. These operation rules have resulted in discharge regimes that have been greatly altered compared to historical conditions. Since regulation, the natural seasonality of high and low periods have been reversed and there are extended periods during each year when there is no discharge from the upper lakes to the lower basin.

B-5. Goals and Objectives of the Proposed Regulation Schedule. Changes to the water management of the upper Kissimmee chain of lakes will provide the necessary storage and modifications to approximate historical flow characteristics required to achieve or exceed the benefits ascribed to Kissimmee River Restoration. In addition, the modification of the regulation schedule will increase the quantity and quality of the wetland habitat in the lake littoral zones in the upper chain of lakes to benefit fish and wildlife.

The primary criterion for achieving environmental improvements in the upper basin is to increase the maximum extent and frequency of high lake stages. The basic strategy is to modify the regulation schedule and operation rules to allow lake stages to fluctuate more naturally with rainfall and associated inflows from the watershed, and to reestablish outflow regimes that reflect historic (pre-regulation) stage-discharge relationship for the lakes. Hydrologic restoration for the lower basin requires reestablishment of continuous inflows from the lakes, particularly during July through October.

The following constraints were placed on the development of the proposed regulation schedule for Lakes Cypress, Hatchineha, and Kissimmee:

a. maintain the existing level of flood protection in the upper basin;

b. avoid adverse impacts to existing flood protection upstream of Lakes Gentry and Lake Tohopekaliga;

c. insure continuous flow in the Kissimmee River downstream of S-65 with duration and variability comparable to pre-project records; and

d. reestablish water schedules that result in flood plain inundation frequencies and recession rates comparable to pre-channelization hydroperiods.

B-6. Proposed Regulation Schedule for Lakes Kissimmee, Hatchineha, and Cypress. To achieve restoration, the proposed regulation schedule for Lakes Kissimmee, Cypress and Hatchineha has three new features: (1) eliminate the pulsating effect (on/off) effect of the current regulation schedule; (2) provide a seasonal shift in water releases from the lakes; and (3) increase the range of high to low water fluctuations in the lakes. In order to provide a more natural flow condition, the seasonal water storage had to be increased at the upper end of lake levels. The upper limit of water levels or increased storage capability was also controlled by flood protection constraints. The proposed regulation schedule is a seasonally varying schedule with a high stage of 54.0 ft. and a low of 52.5 ft., NGVD. This change will increase the quantity of littoral zone around the lakes. In addition, S-65 discharge capacity will be increased to 18,000 cfs eliminate impacts due to raising the top of the regulation schedule 1.5 ft. Widening Canals 35 and 36 (C-35 and C-36) will also be done to eliminate impacts to flood protection upstream of these lakes. The proposed regulation schedule is designed to provide the necessary discharges for downstream hydrology essential for restoration while permitting the inundation of approximately additional 7,236 acres in the upper basin.

a. Flood Control. The proposed regulation schedule for Lakes Kissimmee, Hatchineha, and Cypress has a flood control pool (Zone A) which varies seasonally between elevation 52.5 ft. and 54.0 ft., NGVD. When the stage in the lakes is in Zone A on the regulation schedule (Figure B-2), releases of 2,500 cfs minimum can be made at anytime. During design flood conditions, discharge from S-65 can vary between 2,500 and 18,000 cfs according to conditions upstream of S-65.

Hydrologic modeling done for this study assumed that during floods, S-65 will discharge upto its maximum capacity in Zone A. However, operators discretion in making large flood control releases when in Zone A is required to prevent large surges occuring downstream.

b. Normal Operation. The proposed regulation schedule is devised to replicate historic flows in the lower basin to achieve restoration of the remnant flood plain marshes. The regulation schedule has several zones which dictate discharges downstream through S-65 based on the stage at the S-65 headwater. There are several gages located in Lake Kissimmee. Operating experience has shown that during high flow conditions, there is a drawdown of water levels at S-65. During these conditions, it is appropriate to monitor these other gages to obtain a more suitable indication of the lake stage for operating purposes. The zones are as follows with elevations referring to the S-65 headwater stage:

Period of record routings done for this study assumed S-65 discharges are incrementally increased as the stage in Lake Kissimmee increased. Accordingly, releases in Zone B2 should be increased or decreased as stages in Lake Kissimmee change. However, operator discretion is required in making these discharges to optimize environmental benefits both in the lakes and downstream river.

(1) Zone B1 - Stage between elevations 50.0 ft. and 52.0 ft., NGVD during January 1 through June 30. During the period from January 1 through April 30 when the stage is between 50.0 ft. and 52.0 ft. the discharge from S-65 will be 400 cfs. From May 1 through May 31 the 400 cfs zone varies between 51.0 ft. and 52.0 ft., NGVD. From June 1 through June 30, the 400 cfs discharge zone varies between 50.0 ft. and 51.0 ft, NGVD.

(2) Zone B2 - Stage between elevations 50.0 ft. and 54.0 ft., NGVD. When the S-65 stage is in this zone, the discharge will vary between 400 cfs at elevation 50.0 ft., 800 cfs at elevation 51.0 ft., 1,000 cfs at 52.0 ft., 1,600 cfs at elevation 53.0 ft., and 2,500 cfs at elevation 54.0 ft., NGVD.

(3) Zone C - Stage between elevations 49.0 ft. and 50.0 ft., NGVD. When the stage is in this range the discharge through S-65 will range between 150 and 400 cfs.

(4) Zone D - Stage between elevations 48.5 ft. and 49.0 ft., NGVD. When the stage is between these elevations, a constant flow of 150 cfs will be discharged through S-65.

(5) Zone E - Stage below elevation 48.5 ft., NGVD. Below 48.5 ft., NGVD no discharges would be made through S-65.

B-7. Water Control Plan Flexibility to Achieve Restoration. The goal of the proposed regulation schedule for Lakes Kissimmee, Hatchineha, and Cypress is to permit the lakes to fluctuate in a more natural manner and to support restoration of the Kissimmee River. However, because of the variability in hydro-meteorological conditions, it may be necessary to deviate from the discharges prescribed by the regulation schedule. These deviations will be done to maximize restoration opportunities in both the upper and lower basins and will be done in a manner consistent with maintaining the existing level of flood protection.

In addition a number of additional management activities will be periodically required to maintain and/or enhance the natural resources of the lakes. One such activity is the on-going aquatic plant management program. This program is designed to maintain exotic species at a maintenance control level, contingent upon available interagency funding sources, to protect flood control and navigation capabilities.

Another management practice used in the Kissimmee Basin are extreme drawdowns of the lakes. Extreme drawdowns and lake restoration projects are effective management tools for fisheries and aquatic plant management. Extreme drawdowns on Lake Kissimmee,

Lake Tohopekaliga, and East Lake Tohopekaliga have been performed successfully, with fisheries responding in subsequent years.

The major problem exotic plant (as of this writing) in Lake Kissimmee, Hatchineha, and Cypress is the submersed plant hydrilla. Efforts to control this species in these lakes have been ongoing since the mid-1980's. Management activities for hydrilla in these lakes utilizes an integrated approach and includes biological, chemical, mechanical, and environmental manipulation practices.

While it is anticipated that the proposed water control plan will provide enhanced treatment opportunities, it is also recognized that under some conditions, additional water control activities and temporary regulation schedule modifications will be required. These modifications (i.e. extreme drawdowns and lake restoration projects) will be reviewed on a case-by-case basis and used as appropriate.

B-8. Effect of the Proposed Water Control Plan. The proposed project (proposed regulation schedule, land acquisition, and structural modifications) will result in hydrologic alterations that will provide environmental benefits in both the upper and lower basins. The proposed regulation schedule will enable a wider range of water levels, with higher peak discharges and lower minimum stages. As a result, there will be an increase in the size and quality of the peripheral marshes for the benefit of the fish and wildlife. Environmental benefits will result in the lower basin as a result of establishment of more natural timing of discharges from the upper basin.

B-9. Current Water Control Plan for Kissimmee River Basin.

a. General Objectives. A general plan for flood damage prevention in the Kissimmee Basin was incorporated in the comprehensive plan that was presented to Congress in 1948. The purpose of the general plan was to relieve flooding and minimize flood damages, largely in the upper Kissimmee basin. This was to be accomplished partially by flood storage in the lakes of the upper basin and partially by providing the capability to more rapidly remove the flood water from the basin when necessary. The report to Congress clearly stated that complete flood protection could not be provided, but that reasonable flood protection would result from such a plan.

The Kissimmee River Basin and Related Areas General Design Memorandum, Part II - Supplement 5 stated the following objectives for the Kissimmee River Comprehensive Plan:

a. Protection of lands adjacent to the lakes and along Kissimmee River from frequent and prolonged flooding.

b. Provision of water supply for agricultural uses in the area around the lakes and along the Kissimmee River.

c. Maintenance of lake stages at a desirable level for fish and wildlife and for recreational purposes.

d. Consideration of the relation and any adverse effects that improvements planned for Kissimmee River Basin might have on Lake Okeechobee, and finding means of preventing or reducing such adverse effects.

The project (C-38) also provides the Congressionally-authorized 3-foot navigation project (PL 56-154) and now permits year-round navigation from Lake Kissimmee to Lake Okeechobee. The regulation schedules have been developed for flood control, navigation, agricultural water supply, and environmental enhancement.

b. Water Control Plan for Remaining Lakes. With the exception of the single regulation schedule used for Lakes Kissimmee, Hatchineha, and Cypress, regulation schedules for the remainder of the upper chain of lakes in the Kissimmee Basin will not change with implementation of this project. However, several project canals will be widened to eliminate impacts due to the change in water management in Lakes Kissimmee, Hatchineha, and Cypress.

(1) Lake Gentry. Lake Gentry is regulated by S-63 located in C-34 at the south end of the lake. Water levels in C-34, downstream of S-63, are further stepped down by S-63A before it discharges into Lake Cypress. The lake is regulated between elevations 59.0 and 61.5 ft., NGVD according to a seasonally varying schedule. The current regulation schedule is found on Figure B-3. S-63 has a design capacity of 715 cfs. S-63 is designed to pass 30 percent of the SPF (approximately a 1-in-10 year flood) and will considerably reduce damages for storms greater than the 30 percent Standard Project Flood. S-63A also located in C-34 has a design discharge of 870 cfs and will restrict discharges during larger-than-design floods to 2,000 cfs. S-63A is designed to pass 30 percent of the SPF (approximately a 1-in-10 year flood) and will considerably reduce damages for storms greater than 30 percent of the Standard Project Flood.

(a) Flood Control. When the stage in Lake Gentry is in Zone A on the regulation schedule (Figure B-3), releases shall be made at the design capacity of 715 cfs except when the lake is within 0.5 ft. of the desired stage. Forecasts will then be made and releases made to bring the lake back down to schedule within 15 days.

(b) Normal Operation. The lake is normally regulated between elevations 59.5 and 61.5 ft., NGVD according to a seasonally varying schedule. One year in three the lake is regulated between 59.0 and 61.5 ft., NGVD for fish and wildlife enhancement. The current regulation schedule is found on Figure B-3. When the lake stage is in Zone B, releases may be made to maintain minimum flows downstream for water supply, navigation, and environmental purposes.

(2) Lakes Alligator, Center, Coon, Trout, Lizzie, and Brick. These lakes are controlled by two structures, S-58 located in C-32 which connects Lakes Trout and Joel, and S-60 located in C-33 between Lakes Alligator and Gentry. The lakes are regulated between elevations 61.5 and 64.0 ft., NGVD on a seasonally varying schedule. The current regulation schedule is shown on Figure B-4. S-58 has a design discharge capacity of 160 cfs. S-58 maintains stages in Lake Alligator upstream from the structure; passes up to 30 percent of the SPF (approximately a 1-in-10 year flood); and passes sufficient discharge during low-flow periods to meet irrigation demands downstream. S-60 is operated to maintain the optimum stage on Lake Alligator. The structure has a design capacity of 450 cfs. The structure is designed to pass up to 30 percent of the SPF (approximately a 1-in-10 year flood) without exceeding desirable stages; restricts discharge during floods to that which will not cause damaging velocities or stages downstream; and passes sufficient discharge during low-flow periods to maintain stages and satisfy irrigation demands downstream.

(a) Flood Control. When the stage in the lakes is in Zone A on the regulation schedule (Figure B-4) releases shall be made at design capacity (610 cfs) except when the lake is within 0.5 ft. of the desired stage. Forecasts will then be made and releases started to bring the lake back to schedule within 15 days.

(b) Normal Operation. The lakes are normally regulated between elevations 62.0 and 64.0 ft., NGVD on a seasonally varying schedule. One year in three the lakes are regulated between 61.5 ft. and 64.0 ft., NGVD for fish and wildlife enhancement. The current regulation schedule is shown on Figure B-4. When the lake stage is in Zone B, releases may be made to maintain downstream flows for water supply, navigation, and environmental purposes.

(3) Lakes Joel, Myrtle, and Preston. These lakes are regulated by a single structure, S-57 located in C-30 connecting Lakes Myrtle and Mary Jane. The lakes are regulated between elevations 59.5 and 62.0 ft., NGVD on a seasonally varying schedule. The current regulation schedule is shown on Figure B-5. S-57 is operated to maintain the optimum stage in Lake Myrtle. The design capacity of S-57 is 170 cfs. S-57 is designed to pass up to 30 percent of the SPF (approximately a 1-in-10 year flood) and passes sufficient discharge during low-flow periods to satisfy irrigation demands downstream.

(a) Flood Control. When the stage in the lakes is in Zone A on the regulation schedule (Figure B-5) releases shall be made at design capacity (170 cfs) except when the lake is within 0.5 ft. of the desired stage. Forecasts will then be made and releases started to bring the lake back to schedule within 15 days.

(b) Normal Operation. The lakes normally are regulated between elevations 60.0 and 62.0 ft., NGVD according to a seasonally varying regulation schedule. When the 1 November stage is below 62.0 ft., the an alternate regulation schedule varying between 59.5 and 61.5 ft., NGVD is used. Regulation is to be such that drawdown to 59.5 ft. occurs at least twice but not more than three times in any six-year period for fish and wildlife enhancement. The current regulation schedule is shown on Figure B-5. When the lake stage is in Zone B, releases may be made to maintain downstream flows for water supply, navigation, and environmental purposes.

(4) Lakes Hart and Mary Jane. Lakes Hart and Mary Jane are regulated by a single structure, S-62 located in C-29 which discharges into Lake Ajay. The lakes are regulated between elevations 59.5 and 61.0 ft., NGVD according to a seasonally varying schedule. The current regulation schedule is shown on Figure B-6. S-62 has a design capacity of 640 cfs. S-62 is designed to pass 30 percent of the SPF (approximately a 1-in-10 year flood) and will considerably reduce damages for storms greater than the 30 percent of the Standard Project Flood.

(a) Flood Control. When the stage in the lakes is in Zone A on the regulation schedule (Figure B-6) releases shall be made at design capacity (640 cfs) except when the lake is within 0.5 ft. of the desired stage. Forecasts will then be made and releases started to bring the lake back to schedule within 15 days.

(b) Normal Operation. The lakes are regulated between elevations 59.5 and 61.0 ft., NGVD on a seasonally varying schedule. The current regulation schedule is shown on Figure B-6. When the lake stage is in Zone B, releases may be made to maintain downstream flows for water supply, navigation, and environmental purposes.

(5) East Lake Tohopekaliga. East Lake Tohopekaliga and a small tributary lake named Ajay are regulated by S-59, located in the St. Cloud Canal (C-31) between East Lake Tohopekaliga and Lake Tohopekaliga. The lakes are regulated between elevations 54.5 and 58.0 ft., NGVD on a seasonally varying schedule. The current regulation schedule is found on Figure B-7. S-59 is used to maintain the optimum stage in East Lake Tohopekaliga. The design capacity of S-59 is 820 cfs. The structure is designed to pass up to 30 percent of the SPF (approximately a 1-in-10 year flood) without exceeding desirable stages; restricts discharges during floods to that which will not cause damaging velocities or stages downstream; and passes sufficient discharge during low-flow periods to maintain stages and satisfy irrigation demands downstream. A weir structure was built downstream of S-59 by the local sponsor to influence the tailwater of S-59. The crest of the weir is at

elevation 51.0 ft., NGVD. The weir is submerged; therefore, the tailwater influences the headwater of S-59.

(a) Flood Control. When the stage in the lakes is in Zone A on the regulation schedule (Figure B-7) releases shall be made at design capacity (820 cfs) except when the lake is within 0.5 ft. of the desired stage. Forecasts will then be made and releases started to bring the lake back to schedule within 15 days.

(b) Normal Operation. The lake is normally regulated between elevations 55.0 and 58.0 ft., NGVD according to a seasonally varying schedule. One year in three the lake is regulated between 54.5 ft and 58.0 ft., NGVD for fish and wildlife enhancement. The current regulation schedule is shown on Figure B-7. When the lake stage is in Zone B, releases may be made to maintain downstream flows for water supply, navigation, and environmental purposes.

(6) Lake Tohopekaliga. Lake Tohopekaliga is regulated by S-61, located in the Southport Canal (C-35) at the south shore of the lake. The lakes are regulated between elevations 51.5 and 55.0 ft., NGVD on a seasonally varying schedule. The current regulation schedule is shown on Figure B-8. S-61 is used to maintain the optimum stage in Lake Tohopekaliga. S-61 has a design capacity of 2,300 cfs. The structure passes up to 30 percent of the SPF (approximately a 1-in-10 year flood) without exceeding desirable stages; restricts discharges during floods to that which will not cause damaging velocities or stages downstream; and passes sufficient discharge during low-flow periods to maintain stages and satisfy irrigation demands downstream.

(a) Flood Control. When the stage in the lakes is in Zone A on the regulation schedule (Figure B-8) releases shall be made at design capacity (2,300 cfs) except when the lake is within 0.5 ft. of the desired stage. Forecasts will then be made and releases started to bring the lake back to schedule within 15 days.

(b) Normal Operation. The lake is normally regulated between elevations 52.0 and 55.0 ft., NGVD according to a seasonally varying schedule. One year in three the lake is regulated between 51.5 ft. and 55.0 ft., NGVD for fish and wildlife enhancement. The current regulation schedule is shown on Figure B-8. When the lake stage is in Zone B, releases may be made to maintain downstream flows for water supply, navigation, and environmental purposes.

(7) Lakes Kissimmee, Hatchineha, and Cypress. These lakes are regulated by a single structure, S-65 located at the outlet of Lake Kissimmee at the head of C-38. The lakes are regulated between elevations 48.5 and 52.5 ft., NGVD on a seasonally varying schedule. The current regulation schedule is shown on Figure B-1 and will remain in effect until the required structural modifications and land acquisition for implementation of the proposed regulation schedule is complete. S-65 consists of a spillway for regulating stages and a navigation lock. Discharge from S-65 will vary between 3,000 and 11,000 cfs

according to downstream conditions. When local inflow into C-38 is equal to or greater than design runoff, S-65 will be limited to a firm discharge capacity of 3,000 cfs and a secondary capacity of 8,000 cfs. (Firm capacity is that capacity available at any time). After local inflow subsides, discharge from S-65 could increase to 11,000 cfs depending on downstream capacity. In addition to the spillway and lock structures, there is a culvert structure located through the tieback levee at the natural channel of the Kissimmee River and serves as a water supply for the existing river.

(a) Flood Control. When the stage in the lakes is in Zone A on the regulation schedule (Figure B-1), releases of 3,000 cfs minimum can be made at anytime. During design flood conditions, discharge from S-65 will vary between 3,000 and 11,000 cfs according to downstream conditions. When local inflow to C-38 is equal to or greater than design flood runoff, S-65 will limit discharge to 3,000 cfs. After local inflow subsides, discharge from S-65 could increase to 11,000 cfs depending on downstream capacity. When the lake stage is higher than 0.5 ft. above the scheduled stage, forecasts will be made and releases started to return the lake to schedule within 15 days.

(b) Normal Operation. Lake Kissimmee is normally regulated between elevations 49.0 and 52.5 ft., NGVD according to a seasonally varying schedule. One year in three the lake is regulated between 48.5 ft. and 52.5 ft., NGVD for fish and wildlife enhancement. The current regulation schedule is shown on Figure B-1. When the lake stage is in Zone B, releases may be made to maintain downstream flows for water supply, navigation, and environmental purposes.

(8) Canal 38 (Kissimmee River). Except when pool levels drop below canal regulation levels, the pools shall be regulated automatically or manually, as designed, insofar as possible, in accordance with optimum levels shown in Table 1. An interim regulation schedule (Figure B-9) for the pools in C-38 was adopted in July 1982, however it has only been used in Pool B thus far. This regulation schedule may be implemented when the local sponsor (SFWMD) has acquired sufficient lands along the canal to implement the fluctuating schedule.

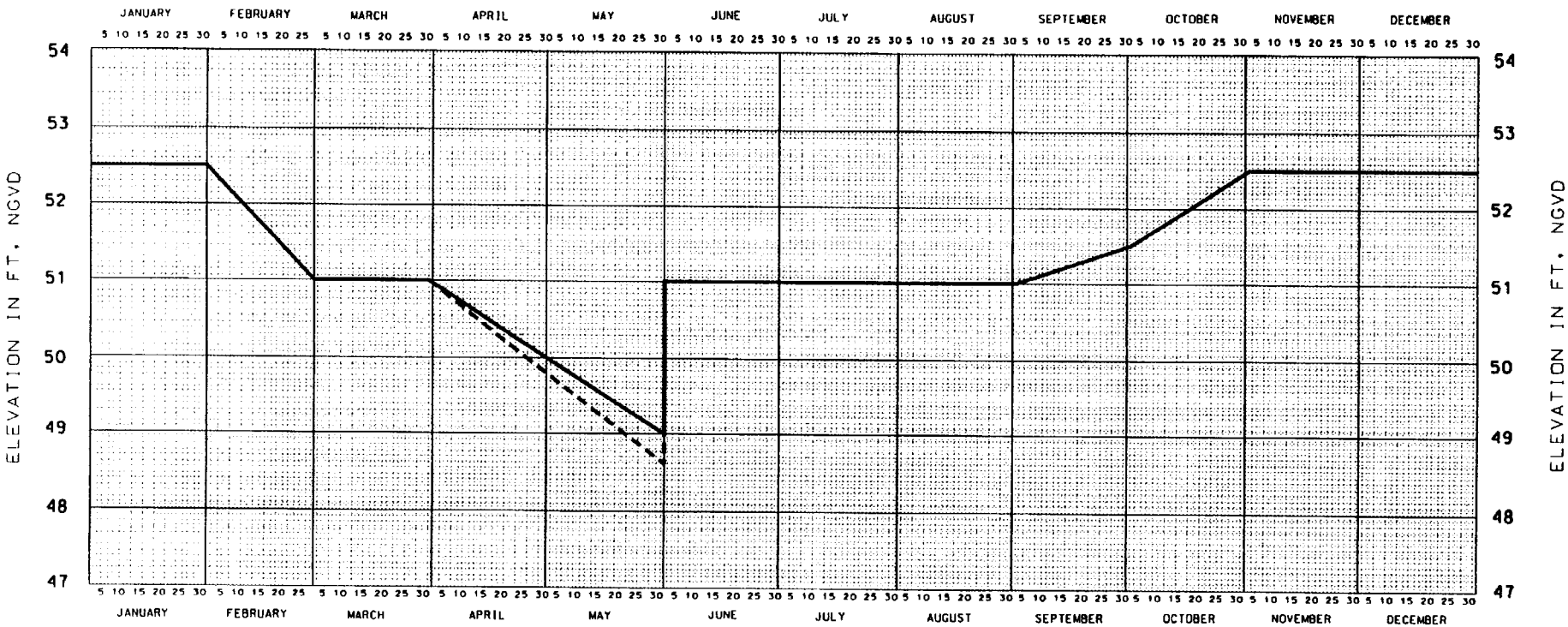
The water control plan for Canal 38 will be revised as appropriate to facilitate construction of the Kissimmee River Restoration Project.

Table B-1

Water Control Stages For C-38 Structures (ft.,NGVD)

Pool	Control Structure	Discharge	Optimum Stage	Design Stage
A	S-65A	11,000	46.3	46.3
B*	S-65B	14,000	40.0	40.0
C	S-65C	18,000	34.0	34.0
D	S-65D	21,300	26.8	28.0
E	S-65E	24,000	21.0	22.0

* During high flow periods, the S-65B headwater stage is raised to 41.0 to 41.5 ft., NGVD to reduce erosive velocities across the test fill for the river restoration project.



ZONE	RELEASES S-65
A	3.000 CFS. UP TO DESIGN CAPICITY (11.000 CFS) W/O EXCEEDING DESIGN CONDITIONS DOWNSTREAM. WHEN THE LAKE IS WITHIN 0.5 FT. OF DESIRED STAGE. FORECASTS WILL THEN BE MADE AND RELEASES STARTED TO BRING THE LAKE BACK TO SCHEDULE WITHIN 15 DAYS.
B	TO MAINTAIN MINIMUM FLOWS.

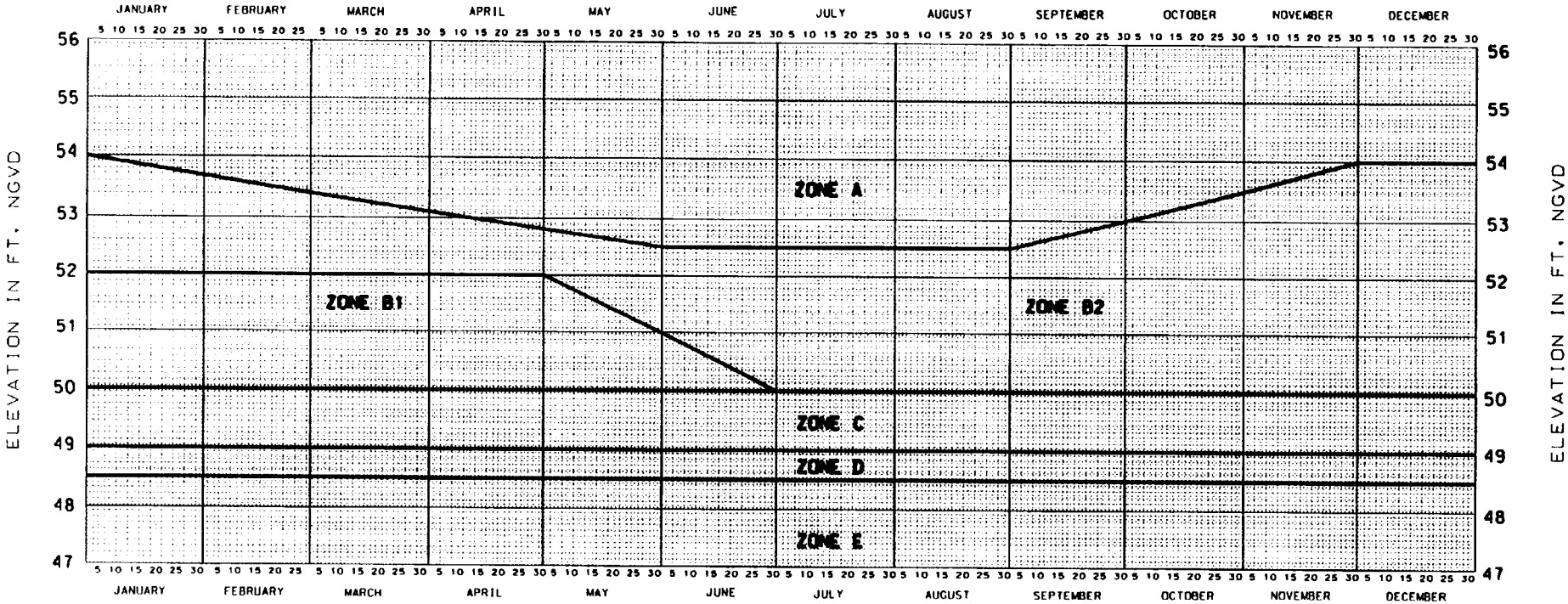
NOTE: (- - - - - - - - -) USE THIS SCHEDULE ONE YEAR IN THREE.

CENTRAL AND SOUTHERN FLORIDA
INTERIM REGULATION SCHEDULE
KISSIMMEE RIVER BASIN

LAKES KISSIMMEE, HATCHINEHA
AND CYPRESS

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA
DATED: 01 DECEMBER 1981

FIGURE B-1



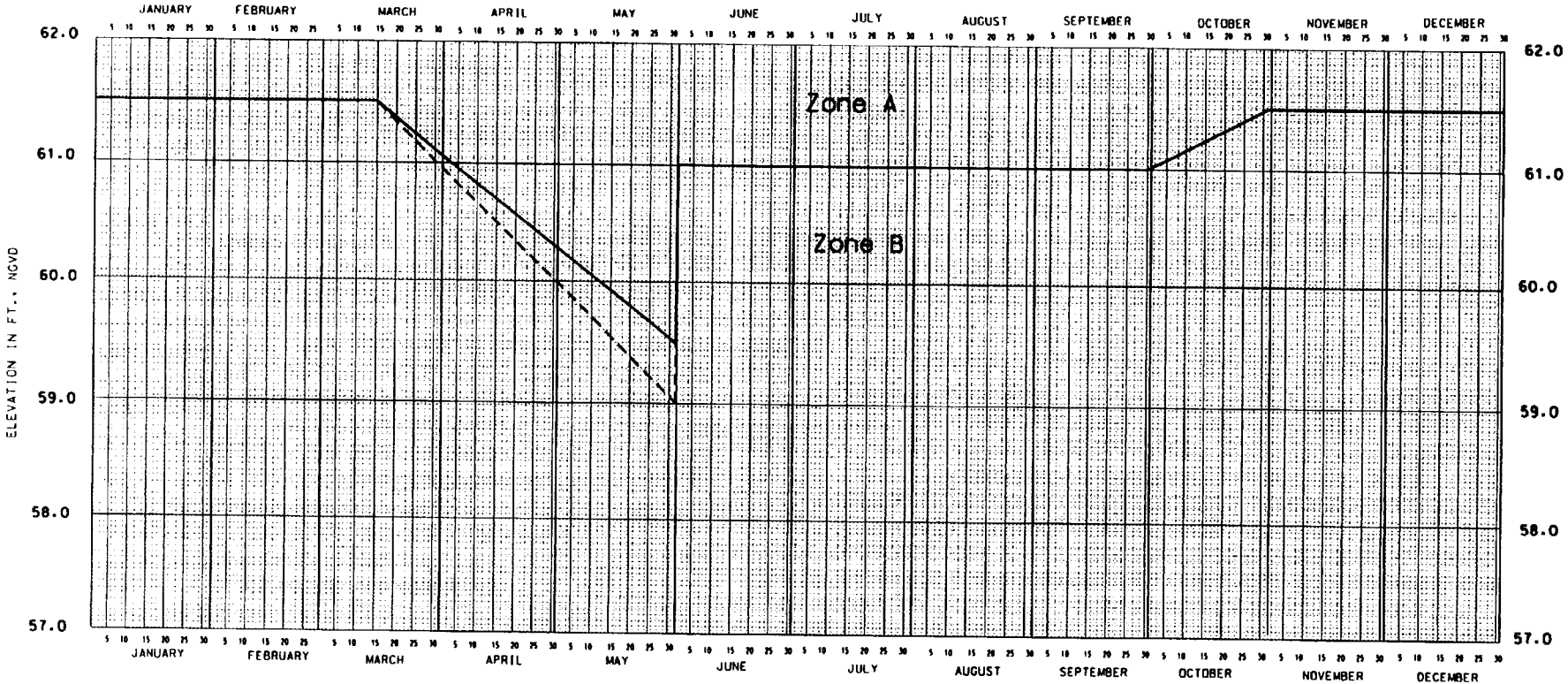
ZONE	RELEASES S-65
A	UP TO MAXIMUM RELEASES AT S-65.
B1	CONSTANT DISCHARGE OF 400 CFS.
B2	DISCHARGE WILL VARY BETWEEN 400 CFS AND 2500 CFS.
C	DISCHARGE WILL VARY BETWEEN 150 CFS AND 400 CFS.
D	CONSTANT DISCHARGE OF 150 CFS.
E	NO RELEASES.

CENTRAL AND SOUTHERN FLORIDA
INTERIM REGULATION SCHEDULE
KISSIMMEE RIVER BASIN

LAKES KISSIMMEE, HATCHINEHA
AND CYPRESS

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA
PROPOSED: AUGUST 1995

FIGURE B-2



ZONE	RELEASES
A	AT DESIGN CAPACITY (715 CFS) EXCEPT WHEN THE LAKE IS WITHIN 0.5 FT. OF DESIRED STAGE. FORECASTS WILL THEN BE MADE AND RELEASES STARTED TO BRING THE LAKE BACK TO SCHEDULE WITHIN 15 DAYS.
B	TO MAINTAIN MINIMUM FLOWS

NOTE: (- - - - - - - - -) USE THIS SCHEDULE ONE YEAR IN THREE

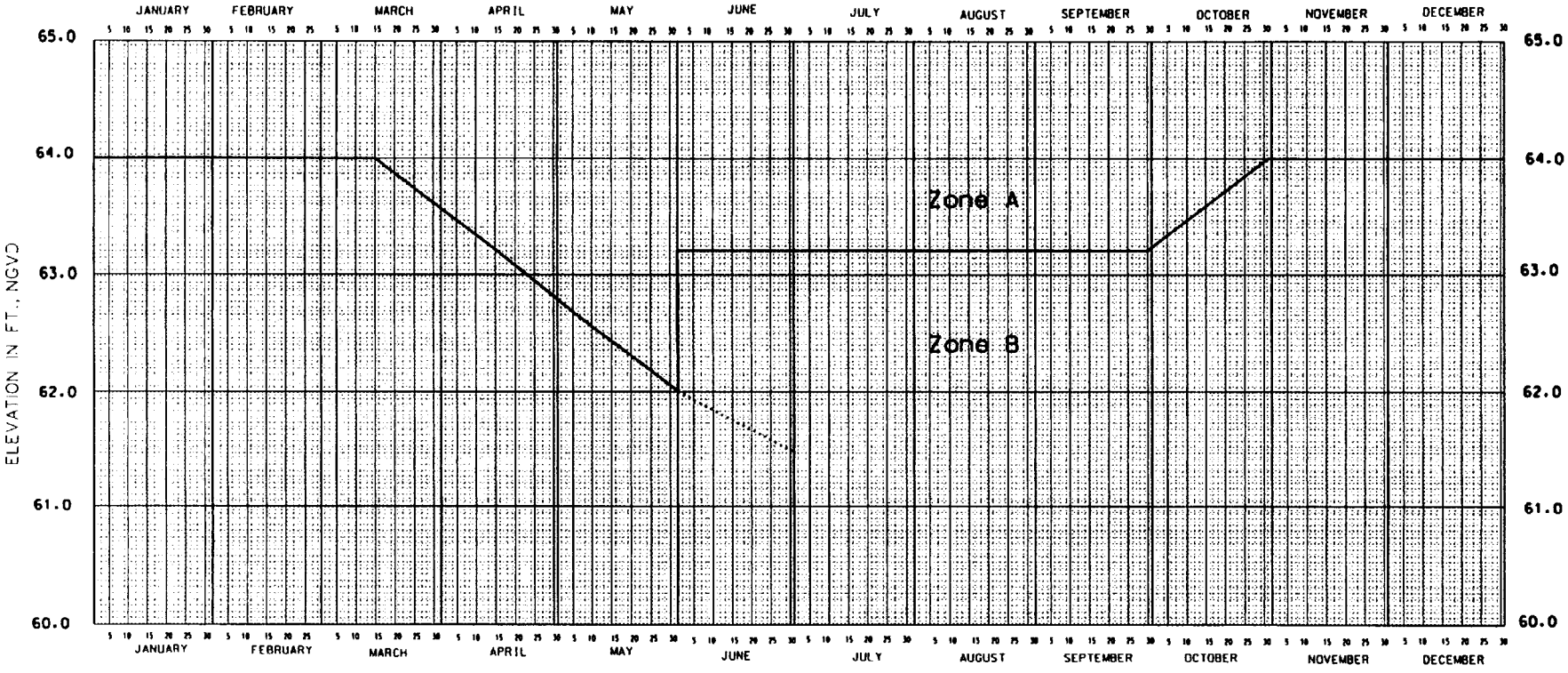
CENTRAL AND SOUTHERN FLORIDA
INTERIM REGULATION SCHEDULE
KISSIMMEE RIVER BASIN

LAKE GENTRY

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

DATED: 1 DECEMBER 1981

Figure B-3



ZONE	RELEASES
A	AT DESIGN CAPACITY (610 CFS) EXCEPT WHEN THE LAKE IS WITHIN 0.5 FT. OF DESIRED STAGE. FORECASTS WILL THEN BE MADE AND RELEASES STARTED TO BRING THE LAKE BACK TO SCHEDULE WITHIN 15 DAYS.
B	TO MAINTAIN MINIMUM FLOWS

NOTE: (- - - - - - - - - -) USE THIS SCHEDULE ONE YEAR IN THREE

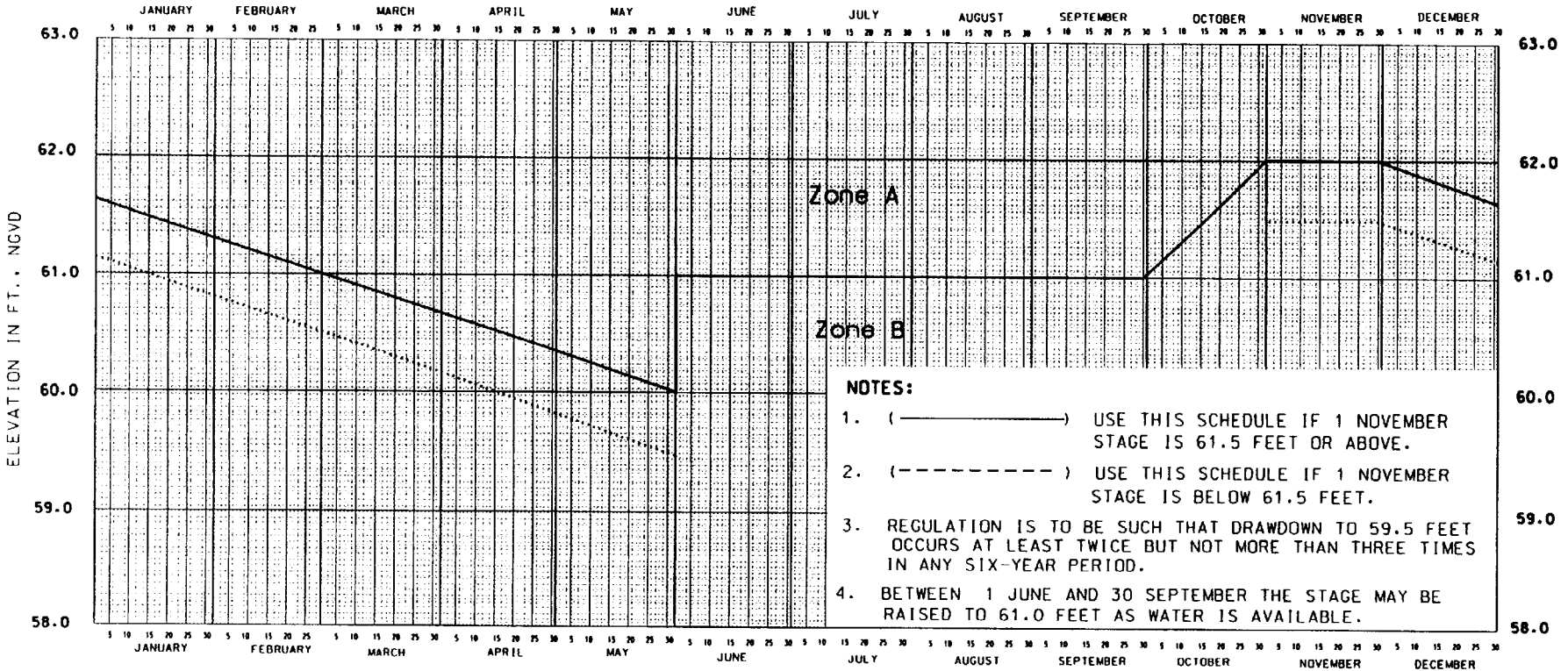
CENTRAL AND SOUTHERN FLORIDA
INTERIM REGULATION SCHEDULE
KISSIMMEE RIVER BASIN

LAKES ALLIGATOR, BRICK,
LIZZIE, COON, CENTER,
& TROUT

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

DATED: 1 DECEMBER 1981

Figure B-4



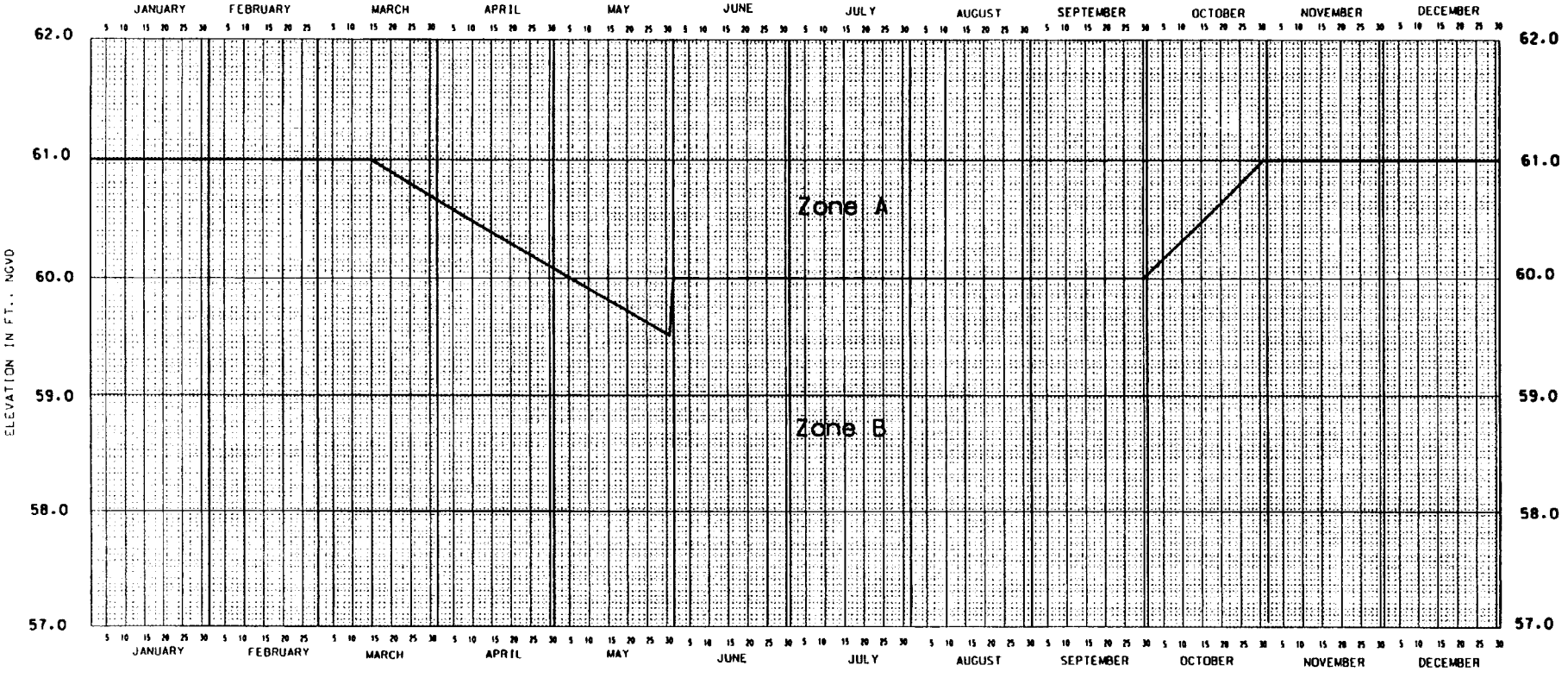
ZONE	RELEASES S-57
A	AT DESIGN CAPACITY (170 CFS) EXCEPT WHEN THE LAKE IS WITHIN 0.5 FT. OF DESIRED STAGE. FORECASTS WILL THEN BE MADE AND RELEASES STARTED TO BRING THE LAKE BACK TO SCHEDULE WITHIN 15 DAYS.
B	TO MAINTAIN MINIMUM FLOWS

CENTRAL AND SOUTHERN FLORIDA
INTERIM REGULATION SCHEDULE
KISSIMMEE RIVER BASIN

LAKES JOEL, MYRTLE
& PRESTON

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

DATED: 1 DECEMBER 1981



ZONE	RELEASES
A	AT DESIGN CAPACITY (640 CFS) EXCEPT WHEN THE LAKE IS WITHIN 0.5 FT. OF DESIRED STAGE. FORECASTS WILL THEN BE MADE AND RELEASES STARTED TO BRING THE LAKE BACK TO SCHEDULE WITHIN 15 DAYS.
B	TO MAINTATIN MINIMUM FLOWS

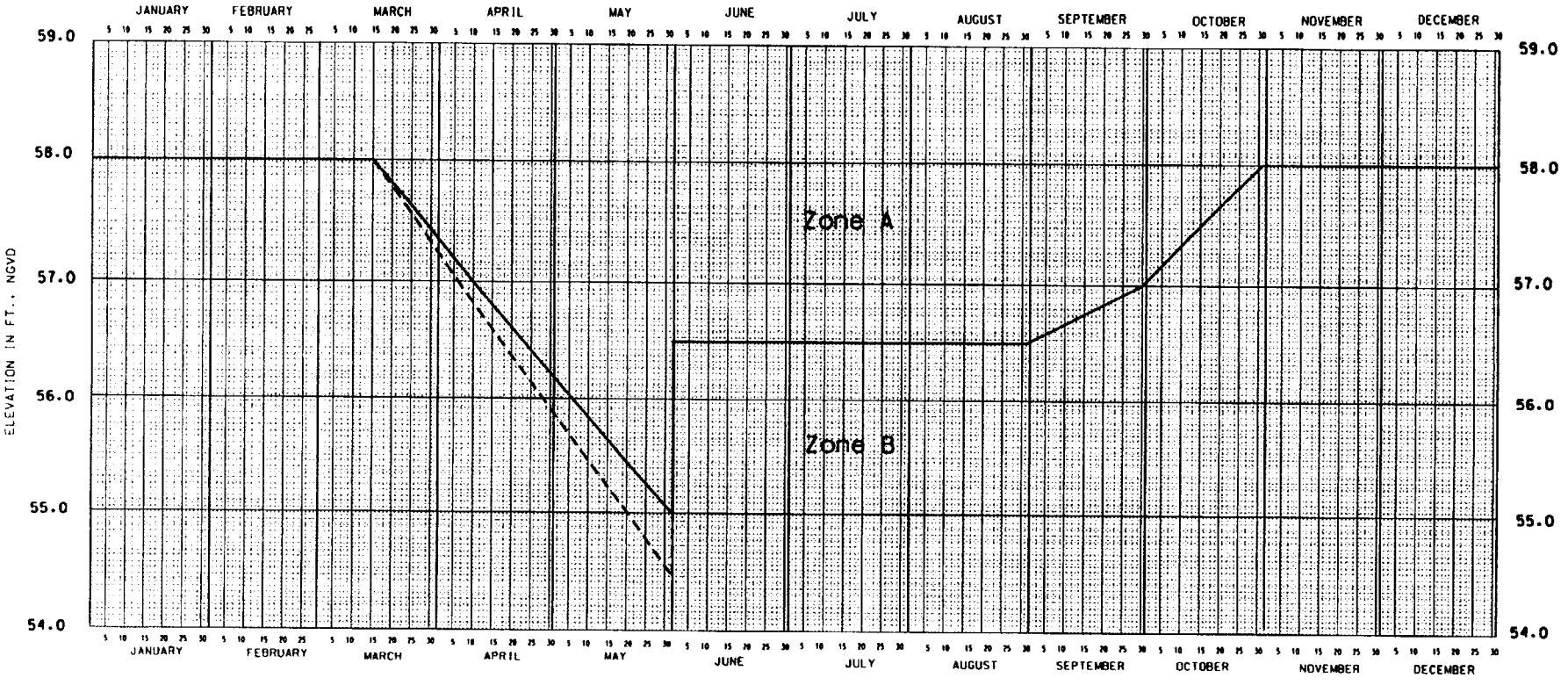
CENTRAL AND SOUTHERN FLORIDA
INTERIM REGULATION SCHEDULE
KISSIMMEE RIVER BASIN

LAKES HART &
MARY JANE

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

DATED: 12 APRIL 1982

Figure B-6



ZONE	RELEASES
A	AT DESIGN CAPACITY (820 CFS) EXCEPT WHEN THE LAKE IS WITHIN 0.5 FT. OF DESIRED STAGE. FORECASTS WILL THEN BE MADE AND RELEASES STARTED TO BRING THE LAKE BACK TO SCHEDULE WITHIN 15 DAYS.
B	TO MAINTAIN MINIMUM FLOWS

NOTE: (- - - - - - - - - -) USE THIS SCHEDULE ONE YEAR IN THREE

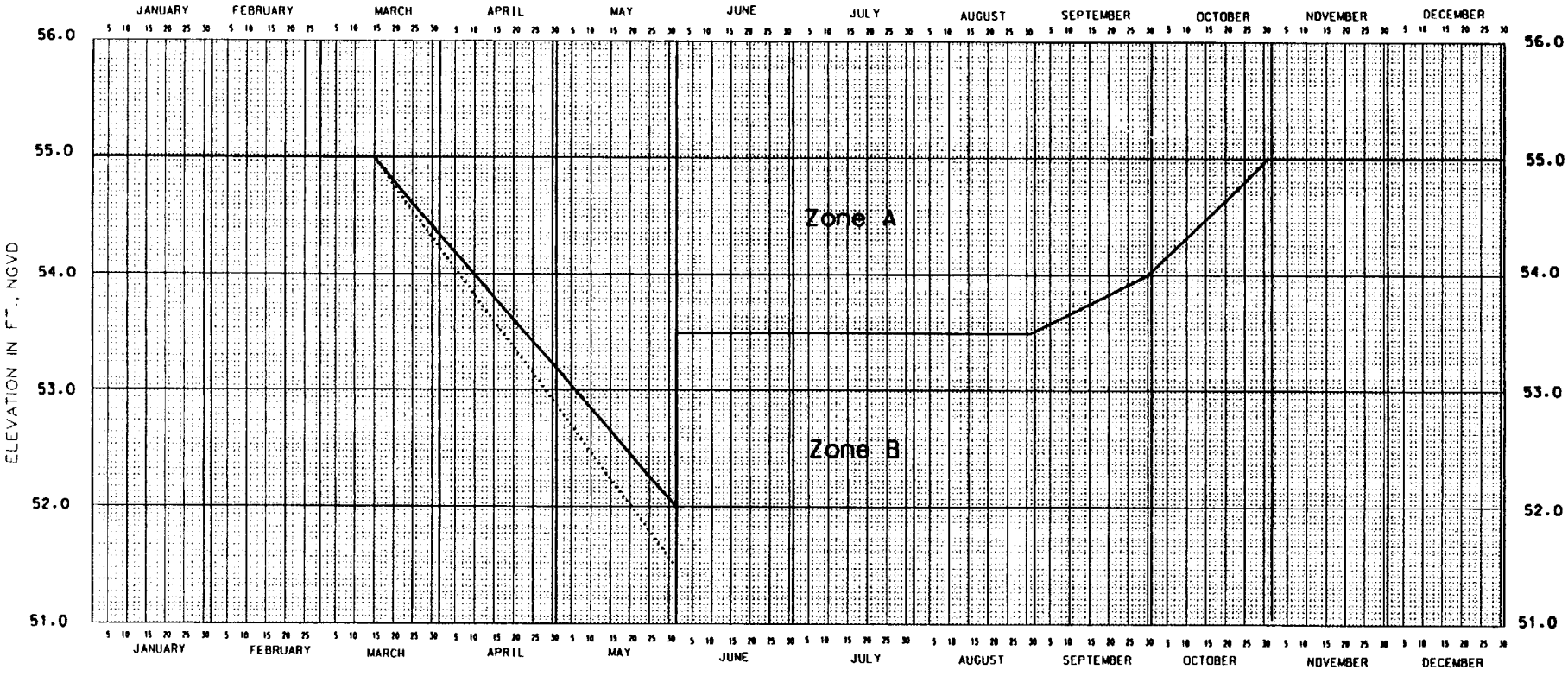
CENTRAL AND SOUTHERN FLORIDA
INTERIM REGULATION SCHEDULE
KISSIMMEE RIVER BASIN

EAST LAKE TOHOPEKALIGA

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

DATED: 1 DECEMBER 1981

Figure B-7



ZONE	RELEASES
A	AT DESIGN CAPACITY (2300 CFS) EXCEPT WHEN THE LAKE IS WITHIN 0.5 FT. OF DESIRED STAGE. FORECASTS WILL THEN BE MADE AND RELEASES STARTED TO BRING THE LAKE BACK TO SCHEDULE WITHIN 15 DAYS.
B	TO MAINTAIN MINIMUM FLOWS

NOTE: (- - - - - - - - - -) USE THIS SCHEDULE ONE YEAR IN THREE

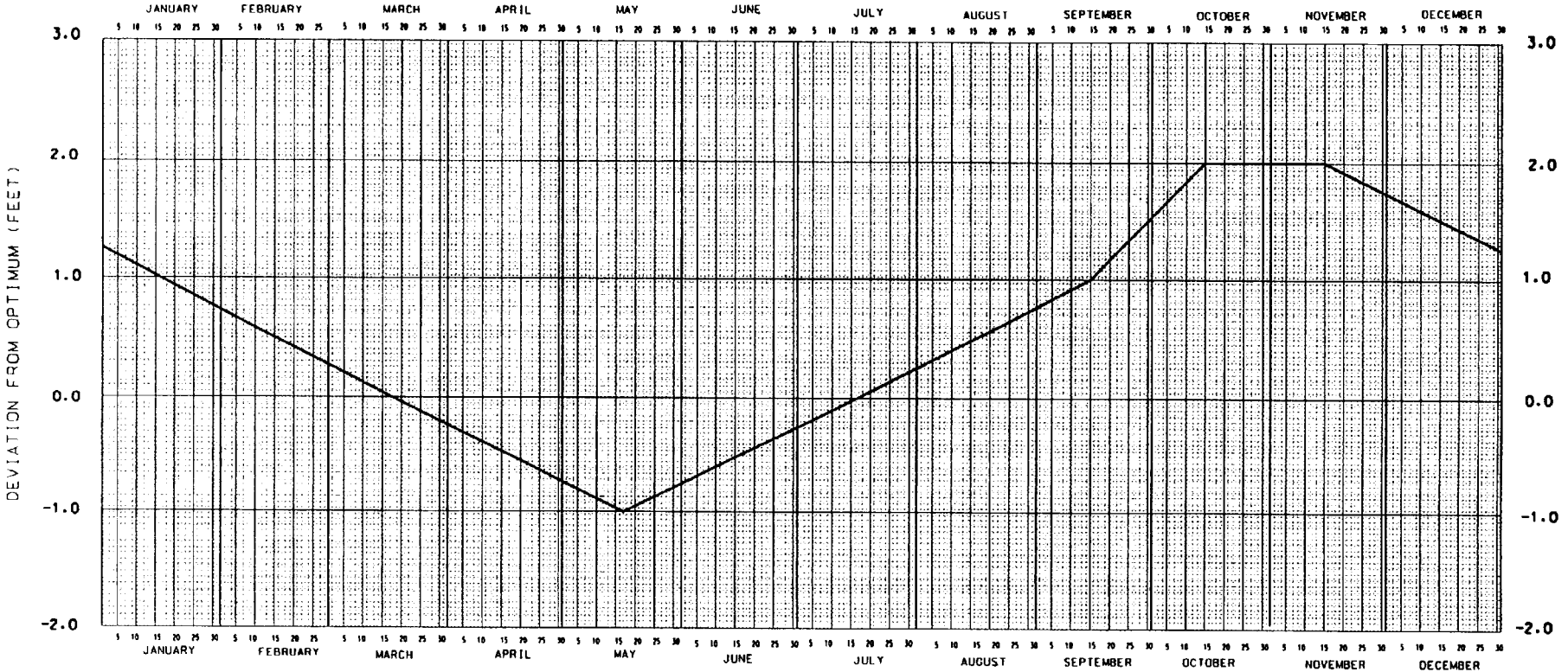
CENTRAL AND SOUTHERN FLORIDA
INTERIM REGULATION SCHEDULE
KISSIMMEE RIVER BASIN

LAKE TOHOPEKALIGA

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

DATED: 1 DECEMBER 1981

Figure B-8



NOTES:

1. THE OPTIMUM & DESIGN WATER SURFACE ELEV. FOR THE POOLS ARE (FT. NGVD):

		OPTIMUM	DESIGN
a.	S-65A	46.3	46.3
b.	S-65B	40.0	40.0
c.	S-65C	34.0	34.0
d.	S-65D	26.8	28.0
e.	S-65E	21.0	22.0

2. LIMIT RISE IN POOL A TO 1.9 FEET.
3. RESTORE C-38 POOLS TO DESIGN OR OPTIMUM WATER SURFACE ELEVATION AS APPROPRIATE IN ADVANCE OF HURRICANES OR TROPICAL STORMS.
4. THE POOLS SHOULD BE BALANCED THE SAME AMOUNT ABOVE OR BELOW SCHEDULE WHEN SCHEDULE CAN NOT BE ATTAINED BECAUSE OF HIGH OR LOW WATER.

CENTRAL AND SOUTHERN FLORIDA
INTERIM REGULATION SCHEDULE
KISSIMMEE RIVER BASIN

KISSIMMEE RIVER POOLS
(S-65 A, B, C, D, & E)

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

DATED: JULY 1982

KISSIMMEE RIVER
HEADWATERS REVITALIZATION PROJECT

APPENDIX C

GEOTECHNICAL ENGINEERING DATA

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APPENDICES

APPENDIX C-1 - Core Boring Logs

APPENDIX C-2 - Laboratory Test Results

GEOTECHNICAL ENGINEERING DATA

1. **SCOPE AND PURPOSE.** This appendix presents the results of geotechnical subsurface investigations performed at the proposed structure location and along the proposed improved channel alignments. The purpose of the investigations is to define the geologic features and engineering characteristics of the foundation materials and to define canal excavation requirements.

2. **STRUCTURE S-65 EXPANSION.**

2.1. Investigations Performed. Two core borings (CB-S65K-9 and CB-S65K-10) were drilled in July 1994 at the proposed structure location in order to determine the engineering characteristics of the materials encountered. The materials were sampled continuously utilizing the Standard Penetration Test according to ASTM D-1586.

All samples were field classified in accordance with the Unified Soil Classification System (USCS). Grain size analysis, moisture content, and Atterberg limits were performed on select samples. The locations of the core borings are shown on Plate C-1.

2.2. Materials Encountered. The materials encountered at the proposed structure S-65 expansion location are characteristic of the general geology of the area. The materials are documented in the core boring logs (Appendix C-1) and laboratory test results (Appendix C-2). Where differences in classifications occur, laboratory classifications take precedence over field visual classifications shown on the core boring logs.

The materials are both fill and natural soils. The fill was placed during the construction of the tieback levee for the original structure S-65. The fill material is primarily a medium to very dense fine quartz sand (SP) with pockets of clay and silt. The natural soils, which underlie the fill, are highly variable and primarily composed of sands (SP, SM, SC,), silts (MH) and clays (CL, CH). Plate C-3 shows the geologic cross section for the proposed structure location.

2.3. Foundation Conditions. The proposed structure will have a bottom elevation of 29.5 feet, NGVD. A tremie concrete seal, for dewatering purposes, extends 10.0 feet below the structure to elevation 19.5 feet, NGVD. In conjunction with the tremie concrete seal, helical soil anchors will be used to resist uplift forces during dewatering.

The placement of the tremie concrete seal involves overexcavation by 10 feet, which also serves to remove unsuitable foundation materials (CH and MH) encountered at foundation grade. In addition, the tremie concrete seal will provide lateral support for the cofferdam by acting as a bottom strut resulting in a more economical cofferdam section.

An analysis was made to evaluate the bearing capacity of the foundation material which consists of a layer of SM material. The critical loading case is the SPF loading condition. The factor of safety against a bearing failure is adequate. The thickness of the tremie seal and the capacity of the helical anchors are such that hydrostatic uplift will not be a problem. Settlement was calculated and is considered negligible for the structure.

2.4. Excavation. Excavation for the structure S-65 expansion will be required to elevation 19.5 feet, NGVD to accommodate the tremie concrete seal. Excavation will take place inside the cofferdam and will be accomplished in the wet using conventional excavation methods.

2.5. Disposal of Excavated Material. Excavated materials which are unsuitable for construction and in excess of what is needed for backfill during construction will be disposed of in the designated borrow area.

2.6. Structural Backfill. Backfill material will be obtained from required structure and channel widening excavations. Select backfill, consisting of material with no more than 10 percent passing a No. 200 sieve, will be placed adjacent to the structure. The maximum particle size will be three inches. Materials classified as GW, GP, SW, SP, GW-GM, GW-GC, GP-GM, GP-GC, SW-SM, SW-SC, SP-SM, and SP-SC will be suitable for structural backfill. If the contractor can not satisfy the above gradation requirements with on-site material, he will be required to obtain the backfill from a commercial source. Structural backfill will be compacted to 95 percent of the standard proctor density.

2.7. Dewatering. Dewatering will be accomplished using a sheetpile cofferdam, a tremie concrete seal, and sump pumps. The tremie thickness and helical anchors were designed using the maximum headwater at elevation 58 feet, NGVD, which corresponds to the SPF event. If the headwater should exceed the design water surface elevation, the excavation will be flooded until the headwater recedes. Flooding the structure will alleviate excess pressures that could cause a foundation failure. Also, the excess water can be pumped off more economically than increasing the tremie thickness.

2.8. Stone Protection. The existing S-65 is protected on either side by a section of grouted riprap. Replacement of grouted riprap is not desirable due to the potential for undetectable voids to form beneath the grouted riprap. Loose riprap will be placed adjacent to the new structure. It will have the same requirements as the channel protection riprap, which is discussed below.

3. S-65 EXPANSION APPROACH AND GETAWAY CHANNELS.

3.1. Investigations Performed. Three core borings (CB-S65K-11 to CB-S65K-13) were obtained along the alignment of the getaway channel in July 1994. The borings were drilled in the same manner as those previously discussed. Refer to Plate C-1 for the core boring locations.

3.2. Materials Encountered. The materials encountered during the field investigation are characteristic of the materials found in other areas of the project. The materials are documented in the core boring logs (Appendix C-1) and laboratory test results (Appendix C-2). Where differences in classifications occur, laboratory classifications take precedence over field visual classifications shown on the core boring logs.

The materials are both fill and natural soils. The fill was placed during the construction of the original structure S-65. The fill material is primarily a medium density to very dense fine quartz sand (SP). The natural soils, which underlay the fill, are highly variable and primarily composed of sands (SP, SM, SC,), silts (ML) and clays (CL, CH). Plate C-4 shows the geologic cross section for the proposed getaway channel location.

3.3. Excavation. Excavation for the S-65 expansion approach channel will be required to elevation 34.0 feet, NGVD. The getaway channel will require excavation ranging from elevation 34.0 to 19.0 feet, NGVD. Prior to the excavation for channel widening, the existing riprap will be removed and stockpiled for potential reuse. The materials can be removed using conventional land based excavation methods.

3.4. Slope Stability. Slopes were analyzed for stability using the UTEXAS3 computer program. The End of Construction (EOC) and Steady State Seepage (SSS) conditions were considered in accordance with EM 1110-2-1913. Strength properties were assumed based on field classification, SPT blow count correlations, and visual inspection by the project engineer and geologist.

Slope stability analysis was not performed for the widening of the approach channel since the excavation is minimal and the existing slopes of 1V on 2H are stable.

Slope stability analyses were performed for the widening of the getaway channel due to the extreme depth of excavation and the adjacent spoil mound on which the operators dwelling is located. The top part of the embankment consists of fill material (SP) underlain by what once was natural ground consisting of layers of sand (SP), silty sand (SM), clayey sand (SC), silt (ML), and clay (CL, CH). The natural water table in the upper slope was determined to be near elevation 57 feet, NGVD during subsurface investigations and water levels in the getaway channel vary with the regulation schedule. Various canal water levels were used in the analysis.

Based on the results of the slope stability analysis, the channel side slope will be 1V to 2.5H. An intermediate berm with a minimum width of 20 feet is incorporated to allow for future maintenance of the riprap protected channel slopes. The upper slope will be 1V on 3H to allow for safe maintenance of the grassed slope. The upper portion of the slope will encroach upon the existing lock operators dwelling and an adjacent antenna tower. A retaining wall will be constructed in this area to eliminate impacts to these structures.

The factors of safety of the critical failure surfaces for the EOC and SSS cases are 1.75 and 1.32, respectively. The EOC factor of safety is in accordance with EM 1110-2-1913, but the SSS case does not meet the minimum factor of safety of 1.4. However, LMVD DIVR 1110-1-400 addresses channel side slopes specifically and it indicates that a minimum factor of safety of 1.25 is required for the long term loading case using S shear strengths. In addition, the existing channel slope has remained stable at 1V on 2H since the original construction of S-65. Flattening of the slope beyond 1V on 2.5H would have adverse impacts as the slope would encroach upon the existing operators dwelling and an adjacent antenna tower. The cross section used in the analysis is shown on Plate C-7, as well as the location of the critical failure surfaces and the strength parameters.

3.5. Slope/Erosion Protection. The maximum exit velocity anticipated at the structure is approximately 7.4 feet per second, which is less than that of existing conditions (11 feet per second). This velocity will decrease further upon reaching the discharge channel. The maximum entrance velocity reaches 8.0 feet per second but this flow is considered laminar and does not control the riprap design. The existing protection consists of 18 inches of riprap underline by 9 inches of bedding material.

Riprap was chosen as the form of protection for the approach and discharge channels. Key factors considered in selecting riprap include constructability for underwater placement, long term stability, and existing project conditions. The riprap design is based on the application of EM 1110-2-1601 and the computer program RIPRAP 15. The riprap stone should have a minimum unit weight of 165 pcf (saturated surface dry).

The design for the upstream riprap requires a minimum section consisting of 9 inches of riprap with a 6 inch bedding layer. In order to provide for uncertainties associated with under water placement and to account for the subject to attack by large floating debris or by waves from wind, the upstream riprap thickness will be increased to 18 inches with a 9 inch bedding layer. This is consistent with the existing riprap. The riprap will tie into existing riprap on the bottom and will extend up to elevation 60 feet, NGVD adjacent to the structure and elevation 54.5 feet, NGVD along the channel slope. The protection will extend 80 feet upstream of the structure.

The design for the downstream riprap required the use of the Isbach equation to account for turbulent flow. The calculated required thickness has been increased by 50% in order to account for underwater placement in a turbulent zone. The downstream thickness will be 22 inches with a 9 inch bedding layer. The riprap will tie into existing riprap on the bottom and will extend up to elevation 60 feet, NGVD adjacent to the structure and elevation 52 feet, NGVD along the channel slope. The protection will extend 180 feet downstream of the apron.

The reuse of existing riprap removed for channel excavation will be permitted providing it meets the specification and gradation requirements. For cost estimating purposes it is assumed that 50% of removed riprap will be salvageable. It is doubtful that the bedding material will be salvageable.

The riprap should be well graded within the following limits:

Limits of Stone Weight (pounds)		**Percent Lighter (by Weight)**
Max	Min	
292	116	100
86	58	50
43	18	15

The bedding stone should be well graded within the following limits:

Stone Size (inches) or Sieve Number	Percent Finer (by Weight)
3	85-100
1½	70-85
¾	58-72
No. 4	30-45
No. 20	10-25
No. 50	0-12

3.6. Retaining Wall. As mentioned above, a retaining wall will be required to minimize impacts to existing structures resulting from the widening of S-65 getaway channel. A steel sheet pile wall was the most economical. The material in this area is spoil material placed during construction of C-38. The fill material is primarily a medium to very dense fine quartz sand (SP) with pockets and layers of clayey and silty materials. Based on an analysis using the CWALSHT computer program, the sheet pile wall will be cantilever and will have a maximum tip elevation of 48 feet, NGVD.

4. CANAL MAINTENANCE SHOAL REMOVAL.

4.1. Investigations Performed. Twelve core borings (CB-C35-S1 thru CB-C35-S5, CB-C36-S1 thru CB-C36-S3, and CB-C37-S1 thru CB-C37-S4) were drilled in February 1994 along the centerline of canals C-35, C-36, and C-37 in order to evaluate the shoal material present in the canals. The materials were sampled continuously utilizing 5 foot split spoon driven with a 140-pound hammer falling 30-inches. Blow counts were recorded for each foot of penetration.

All samples were field classified in accordance with the Unified Soil Classification System (USCS). The locations of the core borings are shown on Plate C-2.

4.2. Materials Encountered. The shoal materials encountered in all three canals consist of fine quartz sand (SP). The materials are documented in the core boring logs (Appendix C-1)

4.3. Excavation. Shoal removal from canals C-35, C-36, and C-37 will be considered maintenance which will restore them to their original as-built cross sections. Excavation will be performed by side cast dredging utilizing conventional land based excavation methods.

4.4. Disposal of Excavated Material. Excavated material from maintenance operations will be placed in the adjacent upland disposal areas.

5. C-36 and C-37 CANAL IMPROVEMENTS.

5.1. Investigations Performed. Seventeen core borings (CB-C36-K1 thru CB-C36-K9 and CB-C37-K1 thru CB-C37-K8) were drilled in August and September 1992 along the alignments for proposed canal improvements in order to determine the engineering characteristics of the materials encountered. The materials were sampled continuously using methods described in ASTM D-1586.

All samples were field classified in accordance with the Unified Soil Classification System (USCS). The locations of the core borings are shown on Plate C-2.

5.2. Materials Encountered. The materials encountered at the proposed C-36 and C-37 canal improvements are characteristic of the general geology of the area. The materials are documented in the core boring logs (Appendix C-1).

The upper 5 to 10 feet of material consists of sand (SP) and clayey sand (SC) deposited during original canal excavation. They are underlain by natural ground made up of a layer of peat (PT) ranging in thickness from 0 to 6 feet. The natural soils, which underlie the peat, are highly variable and are primarily composed of sands (SP, SC), and clays (CL, CH). Plates C-5 and C-6 show the geologic cross sections for the proposed C-36 and C-37 canal improvements respectively.

5.3. Excavation. Canals C-36 and C-37 will be widened by side cast dredging utilizing conventional land based excavation methods. Canal C-36 will be widened from 48 feet to 60 feet along the west side and C-37 will be widened from 70 feet to 90 feet along the east side.

5.4. Disposal of Excavated Material. Excavated material from the widening operations will be placed in the same disposal areas as the excavated materials from the maintenance operations.

5.5. Slope Stability. Slopes were analyzed for stability using the UTEXAS3 computer program. The End of Construction (EOC) and Steady State Seepage (SSS) conditions were considered in accordance with EM 1110-2-1913. Strength properties were assumed based on field classification, SPT blow count correlations, and visual inspection by the

project engineer and geologist. All factors of safety are in accordance with EM 1110-2-1913.

Because the area geology is relatively uniform, the cross section generated for the analysis is assumed to be the worst case and will apply to both C-36 and C-37 canal improvements.

The canals were originally designed with side slopes of 1V on 2H for the canals and the adjacent disposal mound. Recent surveys indicate that existing canal side slopes vary from 1V to 2H to 1V to 3H. Slope stability analysis indicates that a section consisting of canal and disposal mound side slopes of 1V to 2.5H will be stable. A berm with a minimum width of 25 feet will be required between the top of the canal slope and the toe of the disposal mound. The height of the disposal mound will be limited to approximately 10 feet. The factors of safety of the critical failure surfaces for the EOC and SSS cases are 1.3 and 2.6, respectively. The cross section used in the analysis is shown on Plate C-8, as well as the critical failure surfaces and the strength parameters.

5.6. Slope/Erosion Protection. The improved canal side slopes will be require grassing to prevent surface erosion.

6. **LOCAL LEVEE MODIFICATIONS**. In order to meet project requirements, 5 local levees will be degraded to allow for storage and environmental restoration. The levees will be breached by creating approximately 100 foot wide openings at various spacings. Material from the levees will be pushed back into the original adjacent borrow canal using conventional earth moving equipment.

A sixth levee, known as the "Exposition" levee, will remain intact. A minimal subsurface investigation consisting of hand auger borings, along with a thorough inspection of the levee, was performed in April 1995. A typical cross section consists of a 7 to 10 foot high levee with a 12 to 15 foot top width and approximately 1 on 3 side slopes. A small berm separates the toe of the levee from both land and lake side borrow canals. The levee section is fairly uniform throughout the entire length of the levee and little to no surface erosion was evident. The materials encountered in the levee fill section consist primarily of medium density quartz sands with pockets of clay. The foundation materials are primarily composed of sands and clays. The levee was evaluated for a loading condition equivalent to the 10 year event with project features. Based on the results of the field investigation and experience, the levee will be adequate to protect against a 10 year storm which will result in a relatively low head of approximately 2 feet for a limited duration.

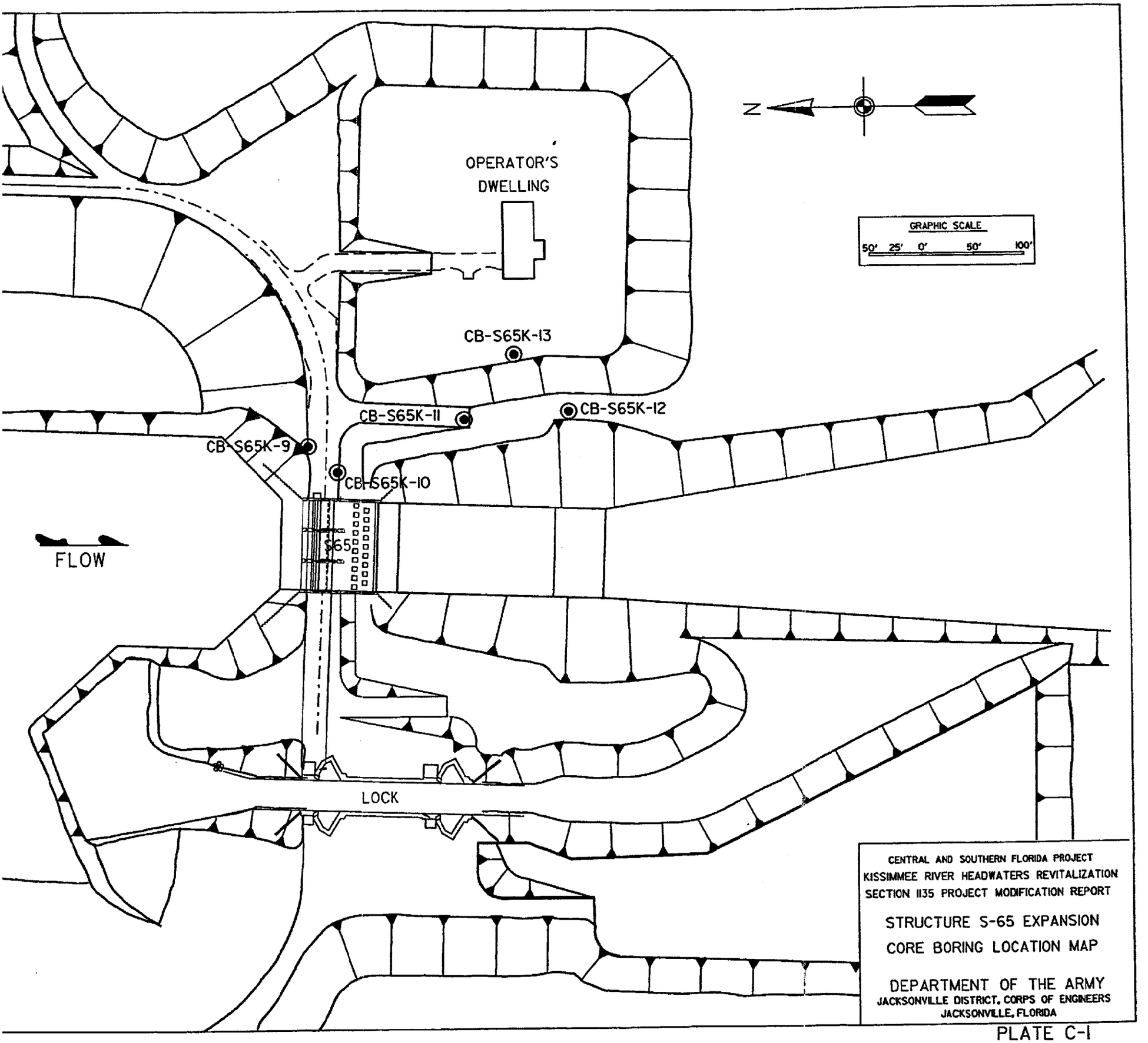
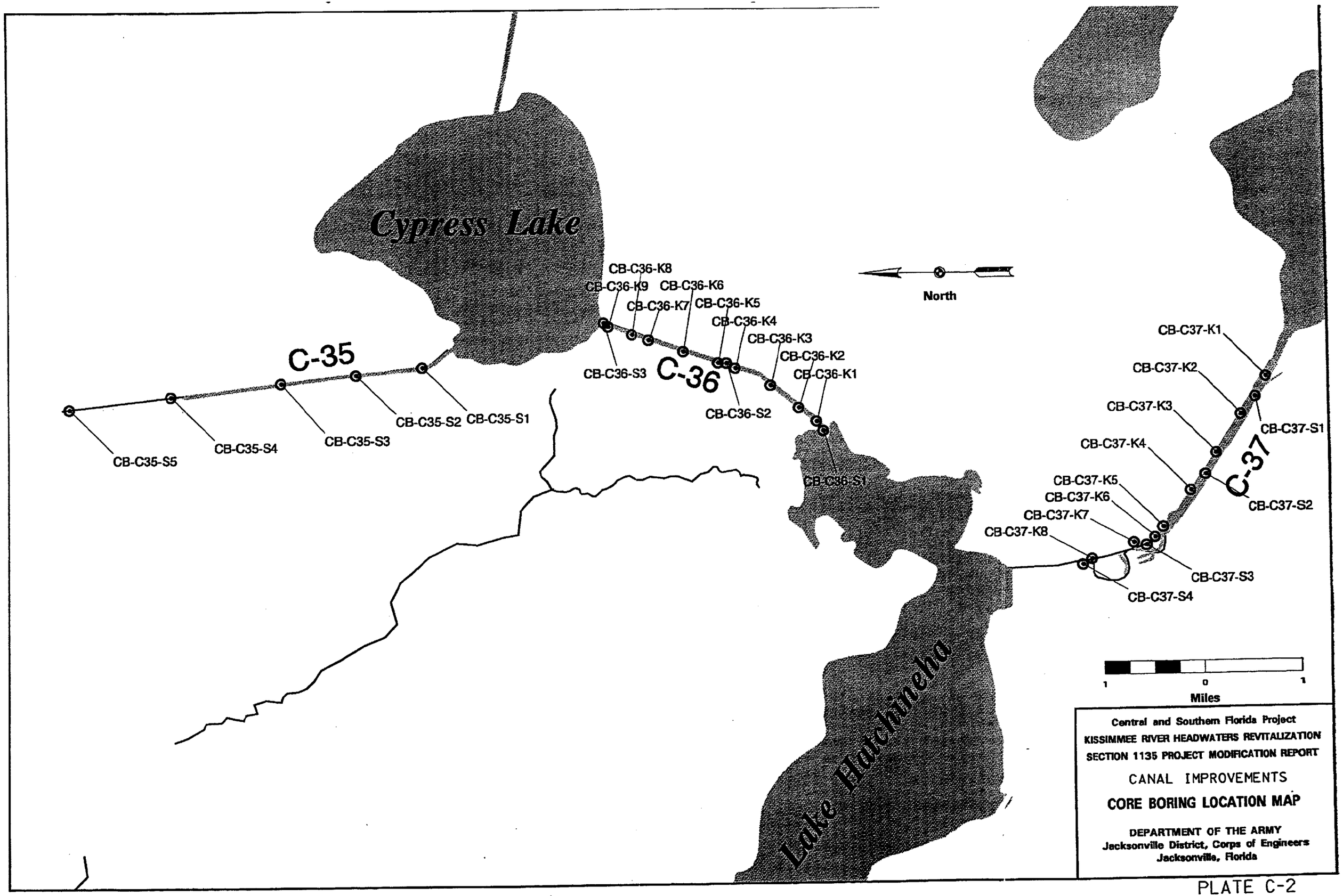

OPERATOR'S
DWELLING
N
GRAPHIC SCALE
50' 25' 0' 50' 100'
CB-S65K-13
CB-S65K-11
CB-S65K-12
CB-S65K-9
CB-S65K-10
S65
FLOW
LOCK
CENTRAL AND SOUTHERN FLORIDA PROJECT
KISSIMMEE RIVER HEADWATERS REVITALIZATION
SECTION 1135 PROJECT MODIFICATION REPORT
STRUCTURE S-65 EXPANSION
CORE BORING LOCATION MAP
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

PLATE C-1


Cypress Lake
C-35
CB-C35-S5
CB-C35-S4
CB-C35-S3
CB-C35-S2
CB-C35-S1
C-36
CB-C36-K8
CB-C36-K9
CB-C36-K6
CB-C36-K7
CB-C36-K5
CB-C36-K4
CB-C36-K3
CB-C36-K2
CB-C36-K1
CB-C36-S3
CB-C36-S2
CB-C36-S1
North
C-37
CB-C37-K1
CB-C37-K2
CB-C37-K3
CB-C37-K4
CB-C37-K5
CB-C37-K6
CB-C37-K7
CB-C37-K8
CB-C37-S1
CB-C37-S2
CB-C37-S3
CB-C37-S4
Lake Hutchineha
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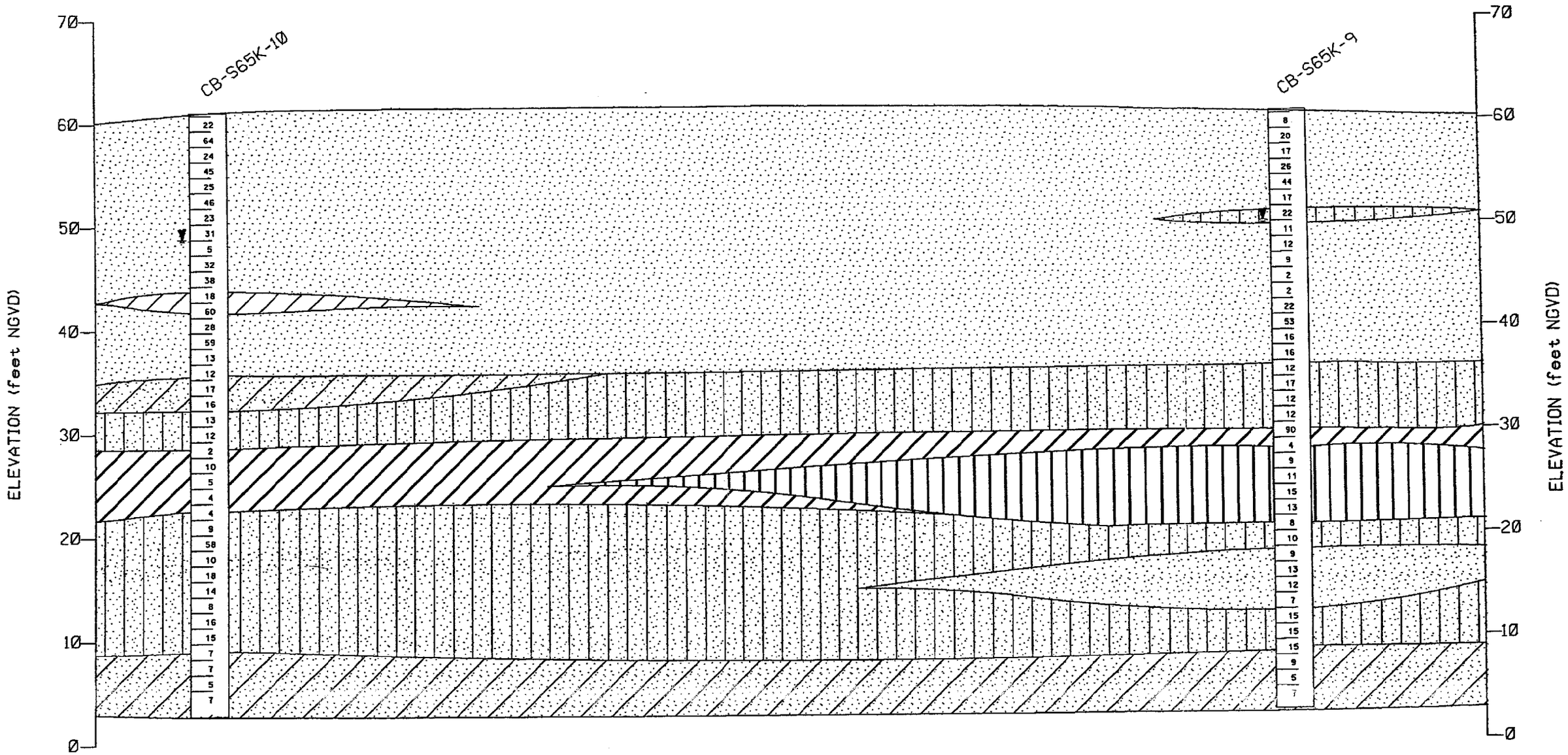
Central and Southern Florida Project
KISSIMMEE RIVER HEADWATERS REVITALIZATION
SECTION 1135 PROJECT MODIFICATION REPORT
CANAL IMPROVEMENTS
CORE BORING LOCATION MAP
DEPARTMENT OF THE ARMY
Jacksonville District, Corps of Engineers
Jacksonville, Florida

PLATE C-2



NOTE: NUMBERS ON BORINGS ARE STANDARD PENETRATION TEST RESULTS IN BLOWS/FT

SOIL LEGEND:

- (SP) POORLY GRADED SANDS OR GRAVELLY SANDS. LITTLE OR NO FINES.
- (SC) CLAYEY SANDS. SAND-CLAY
- (CL) INORGANIC CLAYES OF LOW TO MEDIUM PLASTICITY. GRAVELLY CLAYS. SANDY CLAYS. SILTY CLAYS. LEAN CLAYS.
- (SM) SILTY SANDS. SAND-SILT
- (MH) INORGANIC SILTS. MICACEOUS OR DIATOMACEOUS. FINE SANDY OR SILTY SOILS. ELASTIC SILTS.
- (CH) INORGANIC CLAYS OF HIGH PLASTICITY. FAT CLAYS.

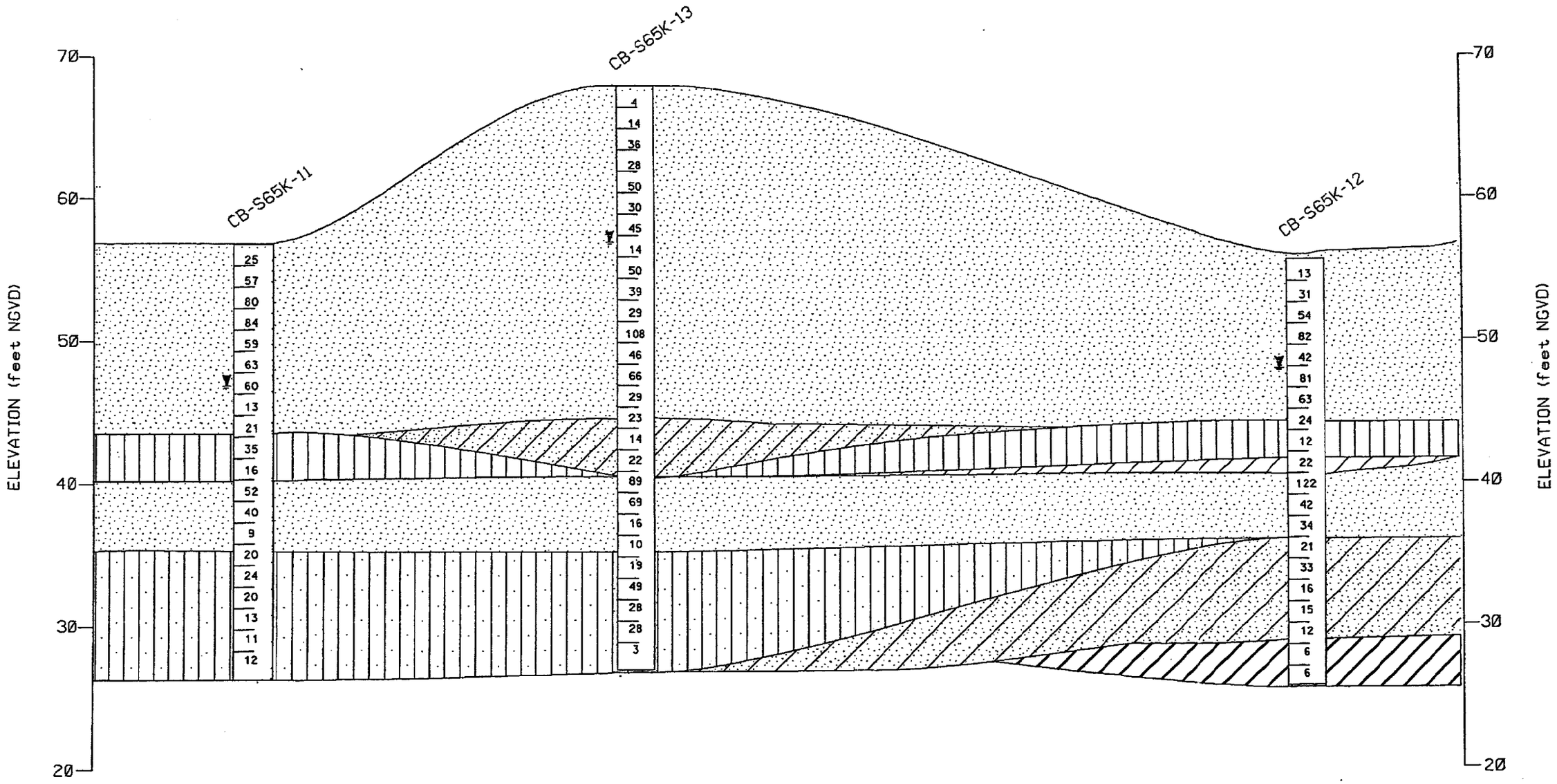
CENTRAL AND SOUTHERN FLORIDA
KISSIMMEE RIVER HEADWATERS REVITALIZATION
SECTION 1135 PROJECT MODIFICATION REPORT

STRUCTURE S-65 EXPANSION

GEOLOGIC SECTION

(SCALES AS SHOWN)

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA



NOTE: NUMBERS ON BORINGS ARE STANDARD PENETRATION TEST RESULTS IN BLOWS/FT

SOIL LEGEND:

(SP) POORLY GRADED SANDS OR GRAVELLY SANDS. LITTLE OR NO FINES.

(SC) CLAYEY SANDS. SAND-CLAY

(CL) INORGANIC CLAYES OF LOW TO MEDIUM PLASTICITY. GRAVELLY CLAYS. SANDY CLAYS. SILTY CLAYS. LEAN CLAYS.

(SM) SILTY SANDS. SAND-SILT

(ML) INORGANIC SILTS AND VERY FINE SANDS. ROCK FLOUR. SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY

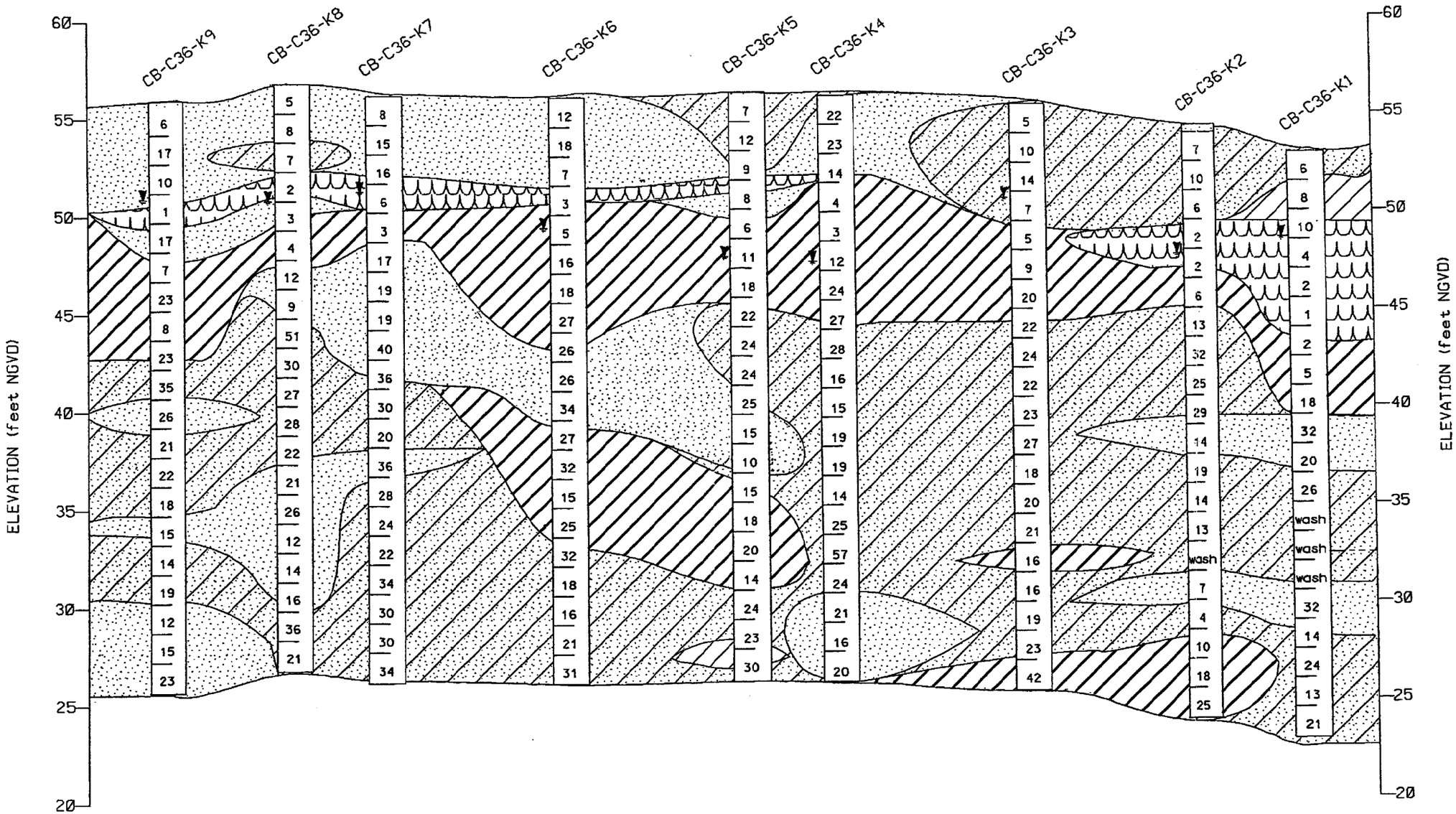
(CH) INORGANIC CLAYS OF HIGH PLASTICITY. FAT CLAYS.

CENTRAL AND SOUTHERN FLORIDA
KISSIMMEE RIVER HEADWATERS REVITALIZATION
SECTION 1135 PROJECT MODIFICATION REPORT

S-65 GETAWAY CHANNEL
GEOLOGIC SECTION

(SCALES AS SHOWN)

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA



NOTE: NUMBERS ON BORINGS ARE STANDARD PENETRATION TEST RESULTS IN BLOWS/FT

SOIL LEGEND:

(SP) POORLY GRADED SANDS OR GRAVELLY SANDS, LITTLE OR NO FINES.

(SC) CLAYEY SANDS, SAND-CLAY

(CL) INORGANIC CLAYES OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS.

(CH) INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS.

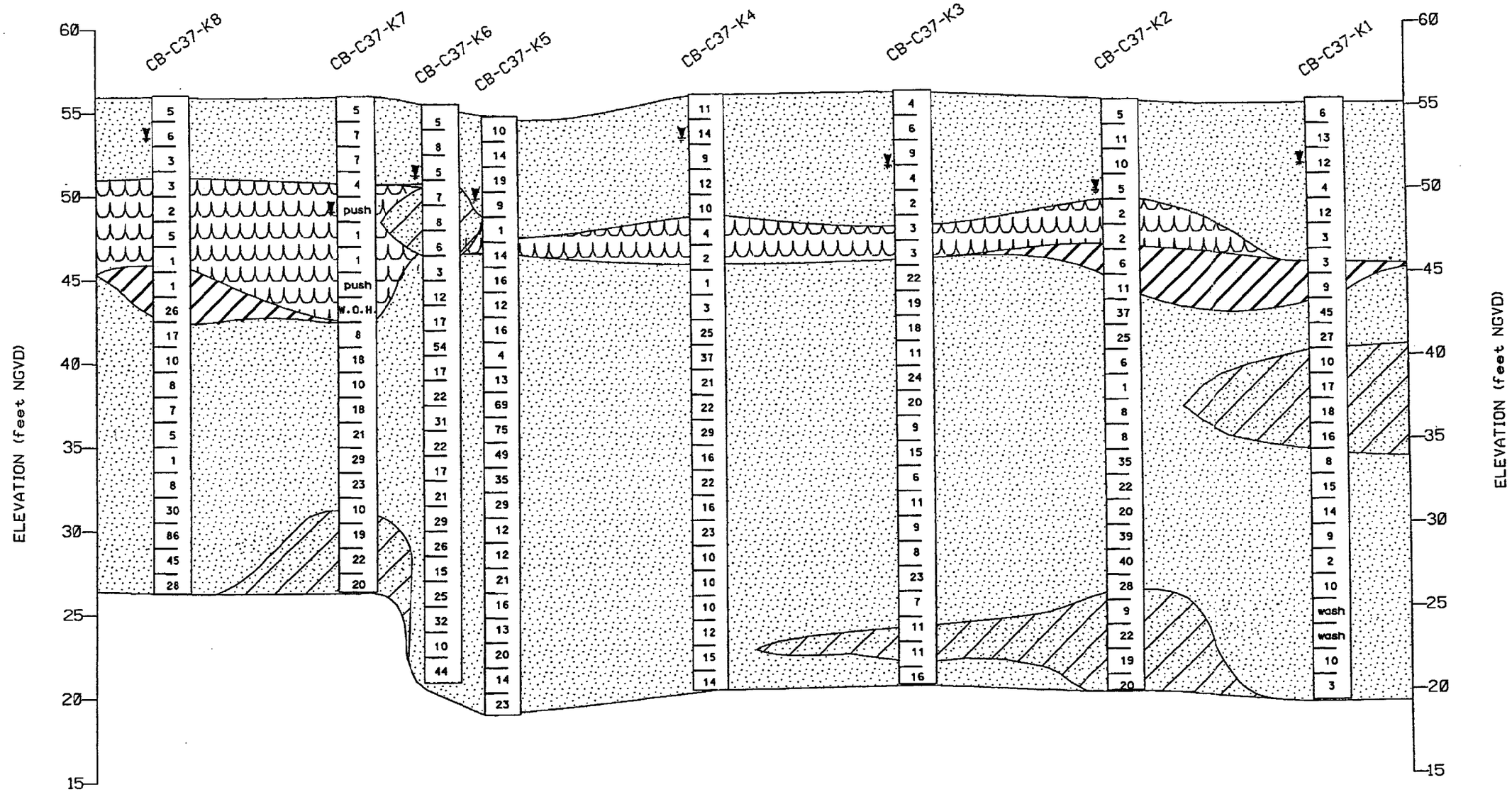
(PT) PEAT AND OTHER HIGHLY ORGANIC SOILS.

CENTRAL AND SOUTHERN FLORIDA
KISSIMMEE RIVER HEADWATERS REVITALIZATION
SECTION 1135 PROJECT MODIFICATION REPORT

C-36 CANAL IMPROVEMENTS
GEOLOGIC SECTION

(SCALES AS SHOWN)

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA



NOTE: NUMBERS ON BORINGS ARE STANDARD PENETRATION TEST RESULTS IN BLOWS/FT

SOIL LEGEND:

(SP) POORLY GRADED SANDS OR GRAVELLY SANDS, LITTLE OR NO FINES.

(SC) CLAYEY SANDS, SAND-CLAY

(CH) INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS.

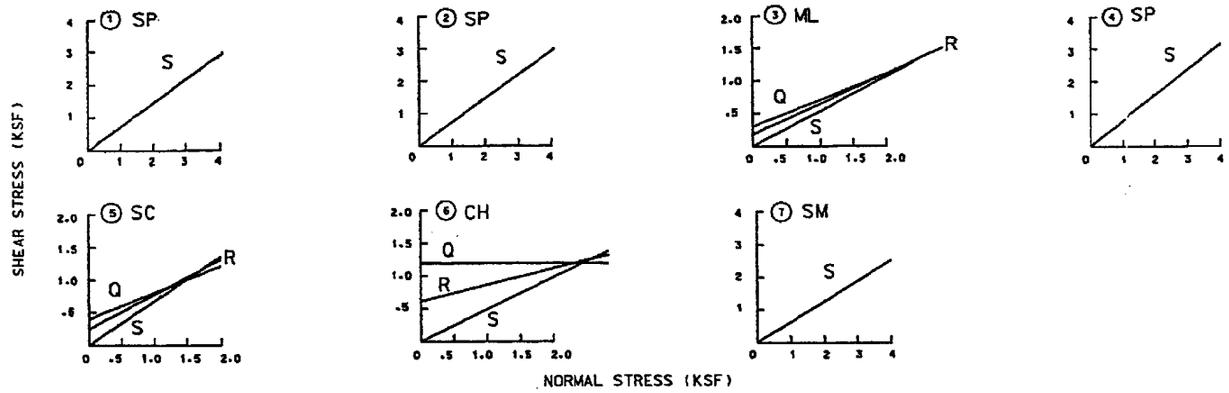
(PT) PEAT AND OTHER HIGHLY ORGANIC SOILS.

CENTRAL AND SOUTHERN FLORIDA
KISSIMMEE RIVER HEADWATERS REVITALIZATION
SECTION 1135 PROJECT MODIFICATION REPORT

C-37 CANAL IMPROVEMENTS
GEOLOGIC SECTION

(SCALES AS SHOWN)

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA



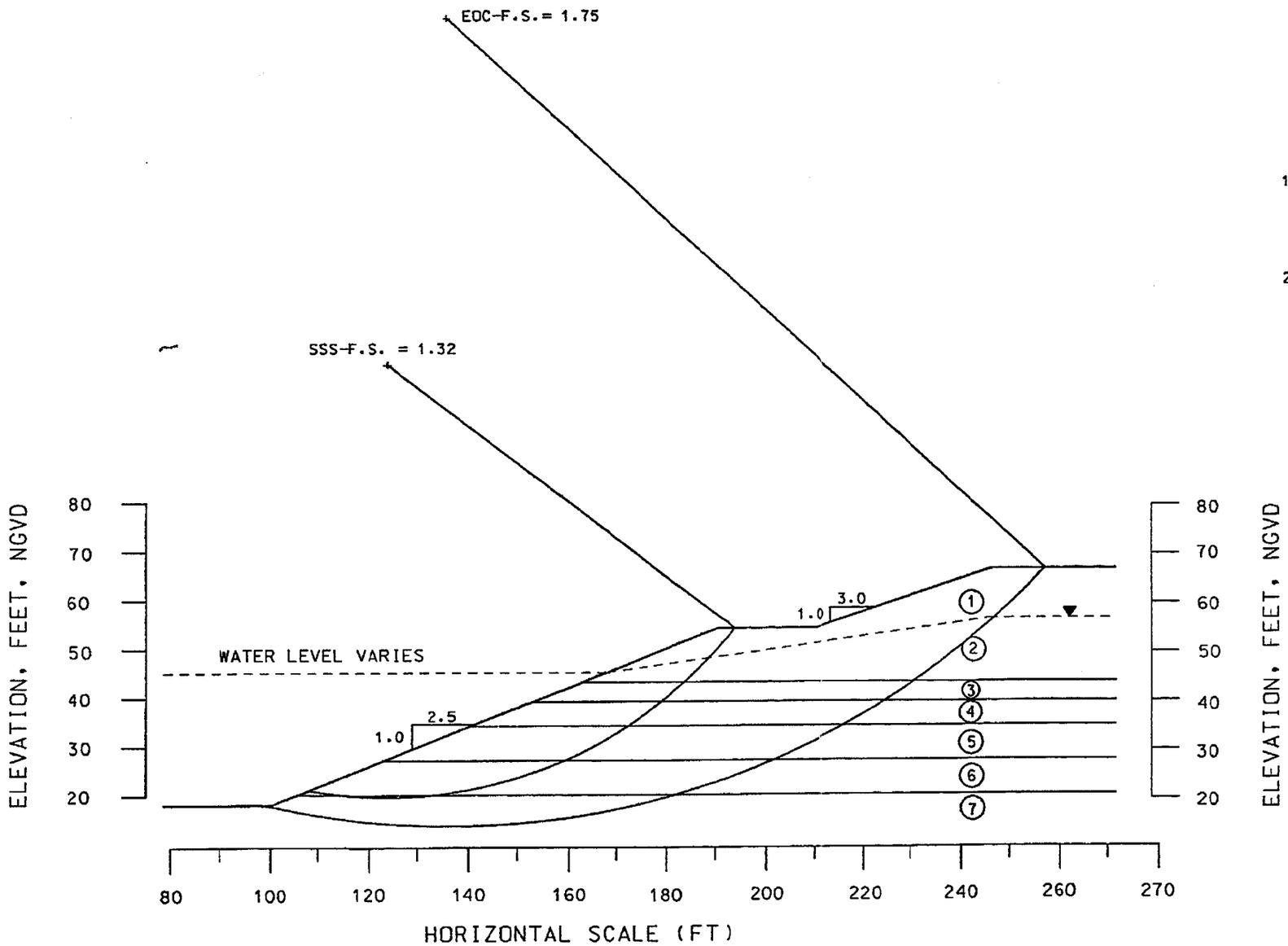
COMPOSITE STRENGTH ENVELOPES

ASSUMED DESIGN DATA				Q		R		S	
MATERIAL LAYER	MATERIAL TYPE	UNIT WT. (PCF)		Q STRENGTH		R STRENGTH		S STRENGTH	
		γ_m	γ_s	Φ	C	Φ	C	Φ	C
1	SP	120	130	---	---	---	---	36	0
2	SP	120	130	---	---	---	---	36	0
3	ML	110	120	22	0.3	25	0.2	28	0
4	SP	120	130	---	---	---	---	38	0
5	SC	120	125	22	0.4	28	0.25	34	0
6	CH	100	110	0	1.2	14	0.65	26	0
7	SM	120	125	---	---	---	---	32	0

NOTES:

1. CIRCULAR ANALYSIS WAS PERFORMED USING THE UTEXAS-3 COMPUTER PROGRAM

2. COREBORINGS CB-S65-13 WAS USED TO DEVELOP THE SECTION FOR ANALYSIS



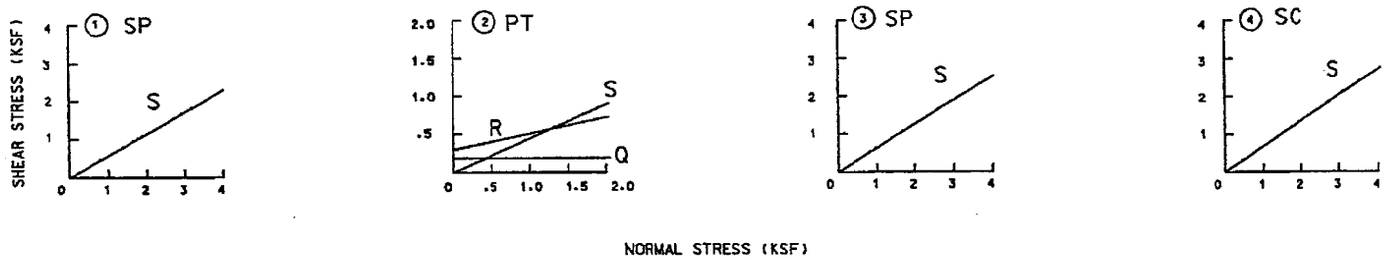
CENTRAL AND SOUTHERN FLORIDA
KISSIMMEE RIVER HEADWATERS REVITALIZATION
SECTION 1135 PROJECT MODIFICATION REPORT

STRUCTURE S-65 GETAWAY CHANNEL

SLOPE STABILITY ANALYSIS

(SCALES AS SHOWN)

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA



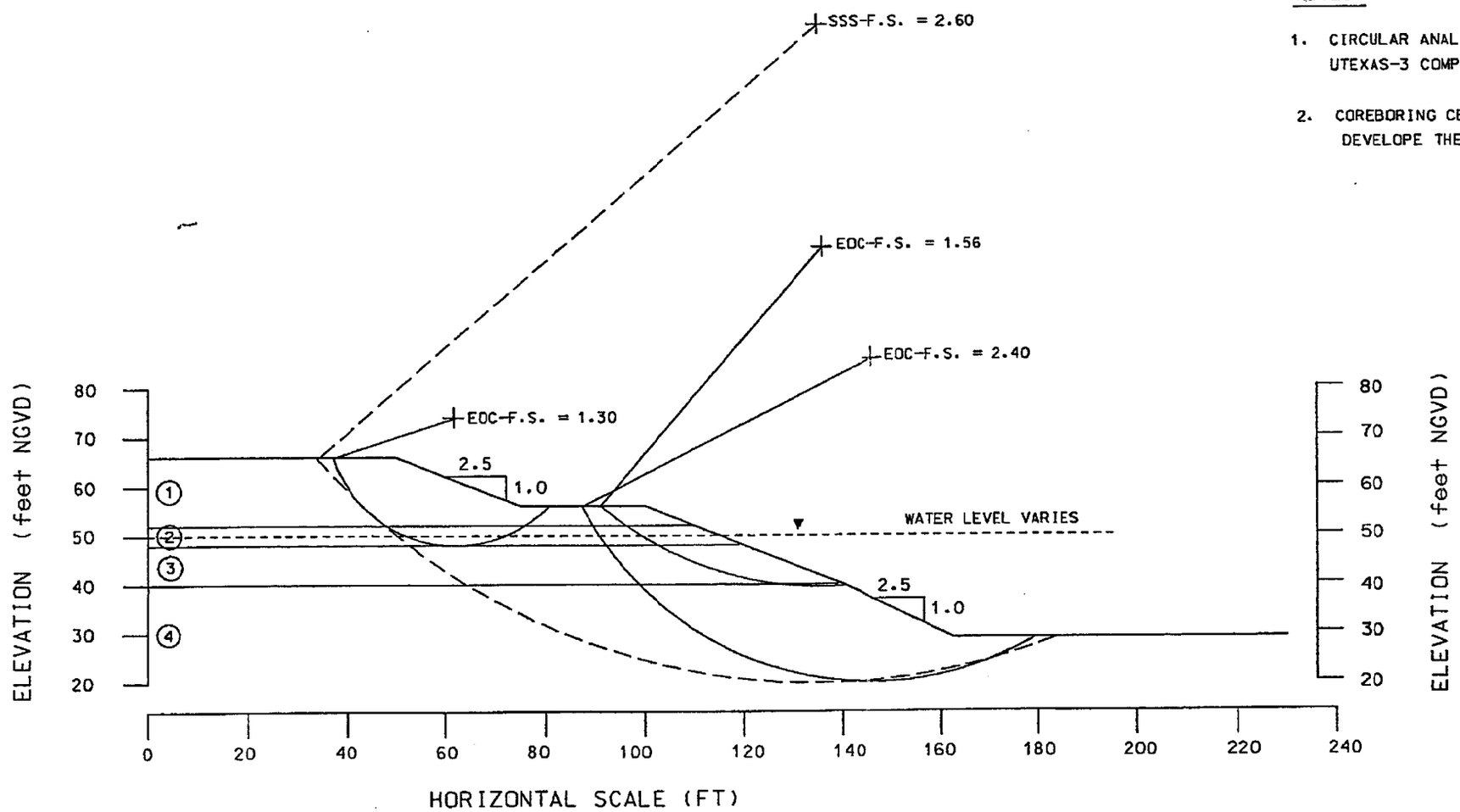
COMPOSITE STRENGTH ENVELOPES

ASSUMED DESIGN DATA				Q		R		S	
MATERIAL LAYER	MATERIAL TYPE	UNIT WT. (PCF)		Q STRENGTH		R STRENGTH		S STRENGTH	
		γ_m	γ_s	Φ (DEG)	C (KSF)	Φ (DEG)	C (KSF)	Φ (DEG)	C (KSF)
1	SP	110	120	---	---	---	---	30	0
2	PT	70	75	0	0.2	12	0.3	24	0
3	SP	115	125	---	---	---	---	32	0
4	SC	115	125	---	---	---	---	34	0

NOTES:

1. CIRCULAR ANALYSIS WAS PERFORMED USING THE UTEXAS-3 COMPUTER PROGRAM

2. COREBORING CB-C36-K7 WAS USED TO DEVELOPE THE SECTION FOR ANALYSIS



CENTRAL AND SOUTHERN FLORIDA
KISSIMMEE RIVER HEADWATERS REVITALIZATION
SECTION 1135 PROJECT MODIFICATION REPORT

C-36 AND C-37 CANAL IMPROVEMENTS

SLOPE STABILITY ANALYSIS

(SCALES AS SHOWN)

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

APPENDIX C-1

CORE BORING LOGS

DRILLING LOG

DIVISION: SOUTH ATLANTIC

INSTALLATION: JACKSONVILLE DISTRICT

1. PROJECT: STRUCTURE 65/KISSIMMEE RIVER
2. LOCATION (Coordinates or Station): X=592,352 Y=1261,336
3. DRILLING AGENCY: CORPS OF ENGINEERS
4. HOLE NO. (As shown on drawing title and file number): CB-S65K-9
5. NAME OF DRILLER: L.C. GREGORY
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED
7. THICKNESS OF BURDEN: Ft.
8. DEPTH DRILLED INTO ROCK: Ft.
9. TOTAL DEPTH OF HOLE: 60 Ft.
10. SIZE AND TYPE OF BIT: SEE REMARKS
11. DATUM FOR ELEVATION SHOWN (TBM or MSL): NGVD
12. MANUFACTURER'S DESIGNATION OF DRILL: FAILING 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: disturbed: 0 undisturbed: 0
14. TOTAL NUMBER OF CORE BOXES: 2
15. ELEVATION GROUND WATER: 50.2
16. DATE HOLE STARTED: 7/20/94 COMPLETED: 7/21/94
17. ELEVATION TOP OF HOLE: 63.0 Ft.
18. TOTAL CORE RECOVERY FOR BORING: 78.4 %
19. SIGNATURE OF: M. MARTY GOFF

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/.5'
63.0	.0					63.0	
						61.5	Rock Bit
60.0	3.0					60.0	
			SAND, fine to medium, quartz, brown, damp, trace shell fragments (SP)	60	1	SPLIT SPOON 58.5	5 3 5
				87	2	SPLIT SPOON 57.0	7 8 12
			(CH layer at depth 6.3')	73	3	SPLIT SPOON 55.5	6 7 10
			8.5' to 8.9' - black silty layer with thin red to brown sandy layers. Color change at 10.1' to light brown. From depth 9.6' to 10.1' brown sand with black silty sand laminae throughout.	100	4	SPLIT SPOON 54.0	6 9 17
				93	5	SPLIT SPOON 52.5	23 20 24
				73	6	SPLIT SPOON 51.0	7 9 8
50.7	12.3				7		
50.3	12.7		SAND, fine to medium, quartz, green (SM)	100	8	SPLIT SPOON 49.5	6 10 12
			SAND, brown, fine to medium, quartz, damp (SP)	93	9	SPLIT SPOON 48.0	6 5 6
			wet. (SP)	100	10	SPLIT SPOON 46.5	6 5 7
			depth 15.7' to 15.8' black (CH) layer	47	11	SPLIT SPOON 45.0	11 5 4
			trace wood fragments (SP)	53	12	SPLIT SPOON 43.5	0 1 1
				33	13	SPLIT SPOON 42.0	0 1 1
			21.3' black silty sand layer	47	14	SPLIT SPOON 40.5	1 1 21
						(continued)	

DRILLING LOG (Cont. Sheet)

ELEVATION TOP OF HOLE 63.0 Ft.

PROJECT: STRUCTURE 65/KISSIMMEE RIVER

INSTALLATION: JACKSONVILLE DISTRICT

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/.5'
40.5	22.5					40.5	
				87	15	SPLIT SPOON	11, 24, 29
						39.0	
				87	16	CSG TO 25.5'	3, 7, 9
						37.5	
				73	17	NO CSG ADVANCE	3, 9, 7
36.0	27.0					36.0	
			Silty SAND, fine medium, quartz, wet, soft, green (SM)	73	18	NO CSG ADVANCE	5, 6, 6
						34.5	
				80	19	CSG TO 30.0'	6, 6, 11
						33.0	
				67	20	NO CSG ADVANCE	7, 5, 7
31.2	31.8					31.5	
			SAND, slight silt, green, fine to medium, quartz, (SP-SM)	73	21	NO CSG ADVANCE	4, 5, 7
30.0	33.0					30.0	
			Silty SAND, green, fine to medium, quartz, soft (SM)	80	22	CSG TO 34.5'	6, 82, 8
28.5	34.5					28.5	
28.0	35.0		Clay, green, Fat, Firm, trace silt (CH)	100	23, 24	NO CSG ADVANCE	2, 2, 2
			SILT, light green, slightly clayey, trace shell, soft (MH) calcareous. Below 36.6' very shelly (shell fragments sand to gravel size)			27.0	
				60	25	SPLIT SPOON	1, 3, 6
						25.5	
				60	26	SPLIT SPOON	6, 5, 6
						24.0	
			Some sand (shell and quartz) trace gravel size shell fragments, soft. Trace sandy limestone fragments (gravel size)	67	27	SPLIT SPOON	8, 8, 7
						22.5	
				73	28	SPLIT SPOON	6, 7, 6
21.0	42.0					21.0	
			Silty SAND, trace shell fragments (some with weathering), green fine to medium, quartz (SM) (Shell fragments are sand to gravel size)	100	29	SPLIT SPOON	5, 3, 5
19.3	43.7					19.5	
18.9	44.1		SC layer from 43.7' to 44.1'	80	30	SPLIT SPOON	5, 5, 5
18.0	45.0					18.0	
			SAND, fine to medium, quartz, green, wet, trace shell fragments, loose (SP)	80	31	SPLIT SPOON	4, 4, 5
						16.5	
				47	32	SPLIT SPOON	4, 6, 7
15.0	48.0					15.0	
			Silty SAND, light green, fine to medium, quartz, trace shell fragments (SM)	60	33	SPLIT SPOON	9, 7, 5
						13.5	
				87	34	SPLIT SPOON	5

(continued)

DRILLING LOG (Cont. Sheet)

ELEVATION TOP OF HOLE 63.0 Ft.

PROJECT: STRUCTURE 65/KISSIMMEE RIVER

INSTALLATION: JACKSONVILLE DISTRICT

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/.5'
13.0	50.0						
			Trace to little shell fragments (Sand to gravel size)	87	34	SPLIT SPOON 12.0	4 3
			little shell with sandy limestone fragments	100	35	SPLIT SPOON 10.5	52 7 8
			Little shell fragments, little silt (SM)	100	36	SPLIT SPOON 9.0	11 4 11
9.0	54.0		Clayey, SAND, olive green, trace shell fragments (weathered), fine to medium, quartz (SC).	100	37	CSG TO 55.5' 7.5	8 4 11
				100	38	SPLIT SPOON 6.0	5 4 5
				100	39	SPLIT SPOON 4.5	3 3 2
				87	40	SPLIT SPOON 3.0	2 3 4
3.0	60.0						

NOTES:

Soils are field visually classified in accordance with the Unified Soils Classification System.

After the visual classification was performed, Atterberg limits and water contents were obtained from some of the samples: the results and final Unified Soil Classification take precedence over the visual classification.

The following laboratory tests were performed as indicated below:

Sample #18: Sieve Analysis (SC) Visual

Sample #26: Sieve Analysis W=25.9% LL=32 PL=15 PJ=17 (SC)

Sample #34: Sieve Analysis (SC) Visual

Sample #37: Sieve Analysis W=33.5 LL=28 PL=17 PI=11 (SC)

140# Hammer with 30" Drop used on 2.0' Split Spoon. (1 3/8" I.D. X 2" O.D.)

50 52.5 55 57.5 60 62.5 65 67.5 70 72.5 75 77.5

DRILLING LOG

DIVISION: SOUTH ATLANTIC

INSTALLATION: JACKSONVILLE DISTRICT

1. PROJECT: STRUCTURE 65/KISSIMMEE RIVER
2. LOCATION (Coordinates or Station): X=592,326 Y=1261,322
3. DRILLING AGENCY: CORPS OF ENGINEERS
4. HOLE NO. (As shown on drawing title and file number): CB-S65K-10
5. NAME OF DRILLER: R.A. GORDON/L.C. GREGORY
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED
7. THICKNESS OF BURDEN: Ft.
8. DEPTH DRILLED INTO ROCK: Ft.
9. TOTAL DEPTH OF HOLE: 60 Ft.
10. SIZE AND TYPE OF BIT: SEE REMARKS
11. DATUM FOR ELEVATION SHOWN (TBM or MSL): NGVD
12. MANUFACTURER'S DESIGNATION OF DRILL: FAILING 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: disturbed: 0 undisturbed: 0
14. TOTAL NUMBER OF CORE BOXES: 2
15. ELEVATION GROUND WATER: 48.8
16. DATE HOLE STARTED: 7/19/94 COMPLETED: 7/20/94
17. ELEVATION TOP OF HOLE: 63.03 Ft.
18. TOTAL CORE RECOVERY FOR BORING: 73.3 %
19. SIGNATURE OF: M. MARTY GOFF

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/.5'
63.0	.0					63.0	
62.2	.8		Pavement				Rock Bit
						61.5	
60.0	3.0					60.0	
			SAND, fine to medium, quartz, brown, trace shell fragments, trace fines (SP)	80	1	SPLIT SPOON	4, 8, 14
						58.5	
				100	2, 2D	SPLIT SPOON	16, 26, 38
						57.0	
				67	3	SPLIT SPOON	4, 10, 14
						55.5	
				100	4	SPLIT SPOON	17, 21, 24
						54.0	
				100	5	SPLIT SPOON	11, 12, 13
						52.5	
				100	6	SPLIT SPOON	19, 21, 25
						51.0	
				67	7	SPLIT SPOON	11, 13, 10
						49.5	
				100	8	SPLIT SPOON	12, 15, 16
						48.0	
				33	9	SPLIT SPOON	2, 2, 3
						46.5	
				53	10	SPLIT SPOON	8, 12, 20
						45.0	
				87	11, 12	SPLIT SPOON	4, 14, 24
43.5	19.5					43.5	
			CLAY, dark brown to black, firm to stiff, trace sand, medium plasticity (CL). Little clay silt in thin layers throughout	100	13	SPLIT SPOON	4, 7, 11
42.0	21.0					42.0	
			SAND, fine to medium, quartz, tan, wet, trace fines (thin layer of silty sand at 21.7') (SP)	73		SPLIT SPOON	18, 29, 31
						40.5	
						(continued)	

Depth scale: 0, 2.5, 5, 7.5, 10, 12.5, 15, 17.5, 20, 22.5

DRILLING LOG (Cont. Sheet)

ELEVATION TOP OF HOLE 63.03 Ft.

PROJECT: STRUCTURE 65/KISSIMMEE RIVER

INSTALLATION: JACKSONVILLE DISTRICT

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/.5'
40.5	22.5					40.5	
				73	14	SPLIT SPOON	6 8 20
						39.0	
				60	15	NO CSG ADVANCE	25 33 26
						37.5	
				60	16	NO CSG ADVANCE	3 5 8
35.7	27.3					36.0	
			Clayey SAND, fine to medium, quartz, brown to greenish, soft, low to medium plasticity (SC)		17		
			Silt content increasing with depth	87	18	NO CSG ADVANCE	6 6 6
						34.5	
				73	19	CSG TO 30.0'	3 6 11
33.0	30.0					33.0	
			Silty SAND, fine to medium, quartz, green, soft, moist (SM)	73	20	NO CSG ADVANCE	4 6 10
						31.5	
			Trace very weathered shell fragments	73	21	NO CSG ADVANCE	4 5 8
						30.0	
				87	22	NO CSG ADVANCE	3 6 6
28.5	34.5					28.5	
			CLAY, green, soft, Fat, plastic, trace sand, trace shell fragments (CH)	100	23	CSG TO 36.0'	1 1 1
			Silt content increasing with depth			27.0	
				60	24	SPLIT SPOON	0 4 6
						25.5	
				67	25	SPLIT SPOON	7 2 3
						24.0	
				0		SPLIT SPOON	0 3 1
22.5	40.5					22.5	
22.2	40.8		SAND, little shell fragments (sand size to gravel), wet, soft, calcareous, (SM) with SC layer from 40.5' to 40.8'. Trace rock fragments to gravel size from 42.0' to 42.3'. From 43.8' to 44.2' SC layer.	67	26	SPLIT SPOON	0 2 2
21.0	42.0					21.0	
20.7	42.3			53	27	SPLIT SPOON	6 5 4
						19.5	
19.2	43.8						
18.8	44.2			100	28	SPLIT SPOON	4 8 52 6
						18.0	
				100	29	SPLIT SPOON	5 5 5
16.5	46.5					16.5	
			SAND, fine medium, quartz, trace shell fragments, trace silt, wet, green (SP)	67	30	SPLIT SPOON	4 7 11
15.0	48.0					15.0	
			Silty SAND, trace to little shell fragments, wet, slightly calcareous, green (SM)	31	31	SPLIT SPOON	8 7 7
						13.5	
				73	32	SPLIT SPOON	4

22.5 25 27.5 30 32.5 35 37.5 40 42.5 45 47.5 50

(continued)

DRILLING LOG (Cont. Sheet)

ELEVATION TOP OF HOLE 63.03 Ft.

PROJECT: STRUCTURE 65/KISSIMMEE RIVER

INSTALLATION: JACKSONVILLE DISTRICT

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/.5
13.0	50.0						
				73	32	SPLIT SPOON 12.0	4 4
				87	33	SPLIT SPOON 10.5	6 9 7
				100	34	SPLIT SPOON 9.0	7 8 7
9.0	54.0		Clayey SAND, trace silt green, trace shell fragments (weathered), soft, fine to medium, quartz, (SC).	100	35	CSG TO 55.5' 7.5	7 3 4
				87	36	SPLIT SPOON 6.0	6 3 4
				73	37	SPLIT SPOON 4.5	3 2 3
				87	38	SPLIT SPOON 3.0	3 3 4
3.0	60.0						

NOTES:

Soils are field visually classified in accordance with the Unified Soils Classification System.

After the visual classification was performed, Atterberg limits and water contents were obtained from some of the samples: the results and final Unified Soil Classification take precedence over the visual classification.

The following laboratory tests were performed as indicated below:

Sample #18: Sieve Analysis
(SC) Visual

Sample #23: Sieve Analysis
W=67.5
LL=101
PL=22
PI=79 (CH)

Sample #28: Sieve Analysis
(SC) Visual

Sample #34: Sieve Analysis
W=25.1
LL=31
PL=17
PI=14 (SC)

140# Hammer with 30" Drop Used on 2.0" Split Spoon. (1 3/8" I.D. X 2" O.D.)

50 52.5 55 57.5 60 62.5 65 67.5 70 72.5 75 77.5

DRILLING LOG

DIVISION: SOUTH ATLANTIC

INSTALLATION: JACKSONVILLE DISTRICT

SHEET 1 OF 2

1. PROJECT: STRUCTURE 65/KISSIMMEE RIVER
2. LOCATION (Coordinates or Station): X=592,380 Y=1261,192
3. DRILLING AGENCY: CORPS OF ENGINEERS
4. HOLE NO. (As shown on drawing title and file number): CB-S65K-11
5. NAME OF DRILLER: R.A. GORDON
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED
7. THICKNESS OF BURDEN: Ft.
8. DEPTH DRILLED INTO ROCK: Ft.
9. TOTAL DEPTH OF HOLE: 30 Ft.
10. SIZE AND TYPE OF BIT: SEE REMARKS
11. DATUM FOR ELEVATION SHOWN (TBM or MSL): NGVD
12. MANUFACTURER'S DESIGNATION OF DRILL: FAILING 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: disturbed: 0 undisturbed: 0
14. TOTAL NUMBER OF CORE BOXES: 2
15. ELEVATION GROUND WATER: 46.9
16. DATE HOLE STARTED: 7/14/94 COMPLETED: 7/14/94
17. ELEVATION TOP OF HOLE: 56.47 Ft.
18. TOTAL CORE RECOVERY FOR BORING: 87.7 %
19. SIGNATURE OF: M. MARTY GOFF

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/.5'	
56.5	.0					56.5		
55.0	1.5		SAND, fine to medium, quartz, trace silt, trace shell fragments, slightly calcareous, trace organics, brown, with white, calcareous layer from 0.2' to 0.6' (SP)	53	1	SPLIT SPOON 55.0	7 12 13	0
			SAND, fine to medium, clean (SP)	60	2	SPLIT SPOON 53.5	19 27 30	2.5
			Trace Fines below depth 4.0	93	3	SPLIT SPOON 52.0	33 37 43	
				45	4	SPLIT SPOON 50.5	33 36 48	5
				100	5	SPLIT SPOON 49.0	24 27 32	7.5
				100	6	SPLIT SPOON 47.5	14 27 36	
			Trace silt (in thin layers) (SP)	100	7	SPLIT SPOON 46.0	26 36 24	10
				100	8	SPLIT SPOON 44.5	18 9 4	
43.8	12.7			100	9	CSG TO 13.5'	2 4	12.5
43.5	13.0		SILT, dark gray to black, organic stain, trace sand, stiff, low plasticity, damp, clayey layer from 12.7' to 13.0' (ML)		10	43.0	17	
				93	11	CSG TO 15.0' 41.5	12 19 16	
41.1	15.4		From depth 15.4' to 15.6' clayey layer.					15
40.9	15.6			100	12	NO CSG ADVANCE	7 7	
40.5	16.0				13	40.0	9	
			SAND, with little silt, fine to medium, quartz, dark brown, wet (SP-SM)	73	14	NO CSG ADVANCE 38.5	7 24 28	17.5
38.5	18.0		Silt decreasing with depth.					
			SAND, fine to medium, quartz, tan, clean, wet (SP)	67	15	CSG TO 19.5' W/300LBS HAMMER 37.0	5 18 22	
			SC layer depth 19.9' to depth 20.0	80	16	NO CSG ADVANCE 35.5	2 3 6	20
35.5	21.0		SC layer depth 20.5 to 20.6 Trace Fines, tan to brown					
			Silty SAND, fine to medium, quartz, soft, moist, green (SM)	87	17	NO CSG ADVANCE 34.0	5 7 13	22.5
						(continued)		

DRILLING LOG (Cont. Sheet)

ELEVATION TOP OF HOLE 56.47 Ft.

PROJECT: STRUCTURE 65/KISSIMMEE RIVER

INSTALLATION: JACKSONVILLE DISTRICT

ELEV.	DEPTH	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/.5'
34.0	22.5				34.0	
			67	18	CSG TO 24.0' W/300LBS HAMMER	8 11 13
					32.5	
			93	19	SPLIT SPOON	7 9 11
					31.0	
			100	20	SPLIT SPOON	7 5 8
					29.5	
		Occasional gravel size (sandy) rock fragments.	100	21	SPLIT SPOON	3 6 5
					28.0	
		Trace weathered limestone fragments. Trace clay.	100	22	SPLIT SPOON	5 6 6
26.5	30.0				26.5	

NOTES:

Soils are field visually classified in accordance with the Unified Soils Classification System.

After the visual classification was performed. Atterberg limits and water contents were obtained from some of the samples: the results and final Unified Soil Classification take precedence over the visual classification.

The following laboratory tests were performed as indicated below:

Sample #3: Sieve Analysis (SP-SM) Visual

Sample #17: Sieve Analysis
W=32.4
LL=34
PL=20
PI=14 (SC)

140# Hammer with 30" Drop Used on 2.0' Split Spoon. (1 3/8" I.D. X 2" O.D)

DRILLING LOG

DIVISION SOUTH ATLANTIC	INSTALLATION JACKSONVILLE DISTRICT
	SHEET 1 OF 2
1. PROJECT STRUCTURE 65/KISSIMMEE RIVER	10. SIZE AND TYPE OF BIT SEE REMARKS
2. LOCATION (Coordinates or Station) X=592,387 Y=1261,095	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) NGVD
3. DRILLING AGENCY CORPS OF ENGINEERS	12. MANUFACTURER'S DESIGNATION OF DRILL FAILING 1500
4. HOLE NO. (As shown on drawing title and file number) CB-S65K-12	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 0 undisturbed: 0
5. NAME OF DRILLER R.A. GORDON	14. TOTAL NUMBER OF CORE BOXES 2
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED	15. ELEVATION GROUND WATER 48.1
	16. DATE HOLE STARTED 7/13/94 COMPLETED 7/14/94
7. THICKNESS OF BURDEN Ft.	17. ELEVATION TOP OF HOLE 55.73 Ft.
8. DEPTH DRILLED INTO ROCK Ft.	18. TOTAL CORE RECOVERY FOR BORING 93 %
9. TOTAL DEPTH OF HOLE 30 Ft.	19. SIGNATURE OF M. MARTY GOFF

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/.5'
55.7	.0					55.7	
			SAND, fine to medium, quartz, brown, clayey, trace organics (SP-SC)	87	1	HOLE CLEANED W/6.0" AUGER	4, 6, 7
						54.2	
				93	2	SPLIT SPOON	7, 12, 19
			Silt content increasing with depth. Occasional sand layer.			52.7	
				100	3	SPLIT SPOON	20, 26, 26
						51.2	
				100	4	GROUNDWATER MEASURED AT 6.0"	25, 35, 47
49.7	6.0					49.7	
			SAND, fine to medium, quartz, tan, clean, wet (SP)	100	5	CON'T CLEANING HOLE W/AUGER	18, 20, 22
						48.2	
				100	6	"	33, 37, 44
			Color change to gray to brown, with dark gray layering throughout.			46.7	
				100	7	"	20, 30, 33
						45.2	
44.6	11.1			100	8	"	11, 11, 13
43.9	11.8		SAND, silty, dark gray to brown (SP-SM)		9	43.7	
			SILT, dark gray, little to some sand, soft, low plasticity (ML)	100	11	CSG TO 13.5'	7, 5, 7
						42.2	
41.8	13.9			93	12	SPLIT SPOON	3, 10, 12
			Clay, Firm, little sand, low to medium plasticity, greenish, gray (CL)		13	40.7	
40.7	15.0						
			SAND, fine to medium, quartz, trace Fines, tan to gray, wet (SP)	87	14	NO CSG ADVANCE	21, 43, 79
						39.2	
				60	15	NO CSG ADVANCE	6, 20, 22
						37.7	
				73	16	CSG TO 19.5' NO CSG ADVANCE	19, 15, 19
36.2	19.5					36.2	
			SAND, fine to medium, quartz, clayey, light green, low plasticity (SC)	87	17	CSG TO 22.5'	3, 8, 13
						34.7	
				87	18		15, 16, 27
						33.2	
						(continued)	

0 2.5 5 7.5 10 12.5 15 17.5 20 22.5

DRILLING LOG (Cont. Sheet)

ELEVATION TOP OF HOLE 55.73 Ft.

PROJECT: STRUCTURE 65/KISSIMMEE RIVER

INSTALLATION: JACKSONVILLE DISTRICT

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/ 5'
33.2	22.5					33.2	
				100	19	NO CSG ADVANCE	3 7 9
						31.7	
				93	20	NO CSG ADVANCE	3 6 9
						30.2	
29.5	26.2			100	21	CSG TO 27.0'	7 6 6
			Clay, Fat, trace, sand, silt, green (CH)		22	28.7	
				100	23	NO CSG ADVANCE	2 2 4
					24	27.2	
				93	25	SPLIT SPOON	2 2 4
25.7	30.0					25.7	

NOTES:

Soils are field visually classified in accordance with the Unified Soils Classification System.

After the visual classification was performed. Atterberg limits and water contents were obtained from some of the samples; the results and final Unified Soil Classification take precedence over the visual classification.

The following laboratory tests were performed as indicated below:

Sample #2: Sieve Analysis (SC) Visual

Sample #11: Sieve Analysis (CH) Visual

Sample #23: Sieve Analysis
W=48.3
LL=70
PL=19
PI=51 (CH)
SG=2.63

140# Hammer with 30" Drop Used on 2.0' Split Spoon. (1 3/8" I.D. X 2" O.D)

22.5 25 27.5 30 32.5 35 37.5 40 42.5 45 47.5 50

Hole No.CB-S65K-13

DRILLING LOG	DIVISION SOUTH ATLANTIC	INSTALLATION JACKSONVILLE DISTRICT	SHEET 1 OF 2

1. PROJECT: STRUCTURE 65/KISSIMMEE RIVER
2. LOCATION (Coordinates or Station): X=592,428 Y=1261,159
3. DRILLING AGENCY: CORPS OF ENGINEERS
4. HOLE NO. (As shown on drawing title and file number): CB-S65K-13
5. NAME OF DRILLER: R.A. GORDON
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED
7. THICKNESS OF BURDEN: Ft.
8. DEPTH DRILLED INTO ROCK: Ft.
9. TOTAL DEPTH OF HOLE: 40.5 Ft.
10. SIZE AND TYPE OF BIT: SEE REMARKS
11. DATUM FOR ELEVATION SHOWN (TBM or MSL): NGVD
12. MANUFACTURER'S DESIGNATION OF DRILL: FAILING 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: disturbed: 0 undisturbed: 0
14. TOTAL NUMBER OF CORE BOXES: 2
15. ELEVATION GROUND WATER: 56.97
16. DATE HOLE: STARTED 7/14/94 COMPLETED 7/18/94
17. ELEVATION TOP OF HOLE: 67.57 Ft.
18. TOTAL CORE RECOVERY FOR BORING: 77.5 %
19. SIGNATURE OF: M. MARTY GOFF

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/.5'
67.6	.0					67.6	
			SAND, fine to medium, quartz, trace Fines, trace organic brown (SP)	87	1	HOLE CLEANED W/6.0" AUGER	1, 2, 2
						66.1	
				87	2	SPLIT SPOON	5, 6, 8
						64.6	
				67	3	SPLIT SPOON	11, 16, 20
						63.1	
				87	4	SPIT SPOON	8, 14, 14
61.6	6.0					61.6	
			SAND, fine to medium, quartz, silty (occurs in layer), gray-brown, trace shell fragments and trace red-brown staining (SP-SM)	93	5	SPLIT SPOON	18, 24, 26
						60.1	
				100	6	SPLIT SPOON	16, 16, 14
						58.6	
57.6	10.0			100	7	SPLIT SPOON	12, 19, 26
			SAND, fine to medium, quartz, white to tan, clean (SP)			57.1	
56.6	11.0						
			SAND, fine to medium, quartz, little clay, gray and brown with red brown mottling, throughout (SP-SC)	100	8	SPLIT SPOON	6, 7, 7
						55.6	
			SAND, slightly clayey, green to gray (mottled) (SP-SC)	100	9	CSG TO 13.5'	18, 26, 24
						54.1	
			(SP) and (SC) layers	80	10	CST TO 15.0'	11, 15, 24
						52.6	
				60	11	CSG TO 16.5'	12, 13, 16
51.1	16.5					51.1	
			SAND, fine to medium, quartz, moist, trace Fines (SP)	80	12	NO CSG ADVANCE	39, 47, 61
						49.6	
				67	13	CSG TO 19.5'	10, 23, 23
						48.1	
				60	14	NO CSG ADVANCE	16, 31, 35
						46.6	
			From 21.5' to 21.8' - SC layer 22.3' to 22.5 - SC layer wet.	67	15	NO CSG ADVANCE	8, 16, 13
						45.1	
						(continued)	

0 2.5 5 7.5 10 12.5 15 17.5 20 22.5

DRILLING LOG (Cont. Sheet)

ELEVATION TOP OF HOLE 67.57 Ft.

PROJECT: STRUCTURE 65/KISSIMMEE RIVER

INSTALLATION: JACKSONVILLE DISTRICT

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/.5'
45.1	22.5					45.1	
44.5	23.1				16		8
44.1	23.5		Clayey SAND, slightly plasticity, dark brown (SC)	87		NO CSG ADVANCE	9
43.6	24.0		Clay, dark brown, trace to little sand, soft, medium plasticity (CL)		17	43.6	14
			Clayey SAND, medium plasticity, soft, wet, dark brown (SC)	87	18	NO CSG ADVANCE	3
			Occasional (CH) layer throughout.		19	42.1	5
							9
				100	20	NO CSG ADVANCE	6
40.6	27.0					40.6	8
			SAND, fine to medium, quartz, brown, wet, trace Fines (SP)				14
				80	21	NO CSG ADVANCE	16
						39.1	34
							55
				73	22	NO CSG ADVANCE	19
						37.6	34
							35
				40	23	CSG TO 30.5'	7
						36.1	8
35.6	32.0						8
			Silty SAND, fine to medium, quartz, green, soft (SM)	87	24	NO CSG ADVANCE	1
					25	34.6	2
							8
				67	26	SPLIT SPOON	7
						33.1	8
							11
				73	27	SPLIT SPOON	11
31.6	36.0					31.6	21
							28
			Trace very weathered shell fragments. (SM)	87	28	CSG TO 37.5'	8
						30.1	10
							18
			Below 38.5', loose, little silt, very wet.	73	29	NO CSG ADVANCE	11
						28.6	12
							16
				7	30	NO CSG ADVANCE	7
27.1	40.5					27.1	2
							1

NOTES:

Soils are field visually classified in accordance with the Unified Soils Classification System.

After the visual classification was performed, Atterberg limits and water contents were obtained from some of the samples; the results and final Unified Soil Classification take precedence over the visual classification.

The following laboratory tests were performed as indicated below:

Sample #6: Sieve Analysis (SC) Visual

Sample #13: Sieve Analysis (SP-SM) Visual

Sample #28: Sieve Analysis W=30.2 LL=34 PL=27 PI=7 (ML)

140# Hammer with 30" Drop Used on 2.0' Split Spoon. (1 3/8" I.D. X 2" O.D)

22.5 25 27.5 30 32.5 35 37.5 40 42.5 45 47.5 50

Hole No.CB-C35-S1

DRILLING LOG	DIVISION South Atlantic	INSTALLATION Jacksonville District	SHEET 1 OF 1

1. PROJECT: Kissimmee River Restoration-Section 1135
2. LOCATION (Coordinates or Station): X=388,714 Y=1364,274
3. DRILLING AGENCY: Corps of Engineers
4. HOLE NO. (As shown on drawing title and file number): CB-C35-S1
5. NAME OF DRILLER: R Gordon
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED
7. THICKNESS OF BURDEN: 0 Ft.
8. DEPTH DRILLED INTO ROCK: 0 Ft.
9. TOTAL DEPTH OF HOLE: 5 Ft.
10. SIZE AND TYPE OF BIT: See Remarks
11. DATUM FOR ELEVATION SHOWN (TBM or MSL): NGVD
12. MANUFACTURER'S DESIGNATION OF DRILL: CD-33
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: disturbed: 1 undisturbed: 0
14. TOTAL NUMBER OF CORE BOXES: 1
15. ELEVATION GROUND WATER:
16. DATE HOLE: STARTED 02/09/94 COMPLETED 02/09/94
17. ELEVATION TOP OF HOLE: 41.05 Ft.
18. TOTAL CORE RECOVERY FOR BORING: 60.0 %
19. SIGNATURE OF GEOLOGIST: M. Marty Goff

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS	BLOWS/ 1.0'
41.0	.0					41.0	
			SAND, Predominately fine grains, quartz, light brown, trace silt, trace organics, trace shell fragments (to gravel size). SP	60	1	Used 5 Foot Split Spoon.	SETTLE SETTLE 2 3 6
36.0	5.0					36.0	
			Soils are field visually classified in accordance with the Unified Soils Classification System. NOTE: Core boring samples were logged on 2/24/94 by M. Marty Goff in Jacksonville, Florida.			140# HAMMER WITH 30" DROP USED ON 5.0' SPLIT SPOON. Water level is 9.2'	

Depth scale: 0, 2.5, 5, 7.5, 10, 12.5, 15, 17.5, 20, 22.5

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PROJECT	HOLE NUMBER
Kissimmee River Restoration-Section 1135	CB-C35-S1

Hole No.CB-C35-S2

DRILLING LOG

DIVISION South Atlantic	INSTALLATION Jacksonville District
	SHEET 1 OF 1
1. PROJECT Kissimmee River Restoration-Section 1135	10. SIZE AND TYPE OF BIT See Remarks
2. LOCATION (Coordinates or Station) X=388,316 Y=1367,752	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) NGVD
3. DRILLING AGENCY Corps of Engineers	12. MANUFACTURER'S DESIGNATION OF DRILL CD-33
4. HOLE NO. (As shown on drawing title and file number) CB-C35-S2	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 1 undisturbed: 0
5. NAME OF DRILLER R Gordon	14. TOTAL NUMBER OF CORE BOXES 1
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED	15. ELEVATION GROUND WATER
	16. DATE HOLE STARTED 02/09/94 COMPLETED 02/09/94
7. THICKNESS OF BURDEN 0 Ft.	17. ELEVATION TOP OF HOLE 41.25 Ft.
8. DEPTH DRILLED INTO ROCK 0 Ft.	18. TOTAL CORE RECOVERY FOR BORING 80.0 %
9. TOTAL DEPTH OF HOLE 5 Ft.	19. SIGNATURE OF GEOLOGIST M. Marty Goff

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS	BLOWS/ 1.0'
41.2	.0					41.2	
			SAND, Predominately fine grains, quartz, light brown, trace silt, trace organics, trace shell fragments (to gravel size). SP				SETTLE
							SETTLE
				80	1	Used 5 Foot Split Spoon.	2
							3
							5
36.2	5.0					36.2	
			Soils are field visually classified in accordance with the Unified Soils Classification System.			140# HAMMER WITH 30" DROP USED ON 5.0' SPLIT SPOON.	
			NOTE: Core boring samples were logged on 2/24/94 by M. Marty Goff in Jacksonville, Florida.			Water level is 9.0'	

0, 2.5, 5, 7.5, 10, 12.5, 15, 17.5, 20, 22.5

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PROJECT	HOLE NUMBER
Kissimmee River Restoration-Section 1135	CB-C35-S2

Hole No.CB-C35-S3

DRILLING LOG

DIVISION South Atlantic	INSTALLATION Jacksonville District
SHEET 1 OF 1	
1. PROJECT Kissimmee River Restoration-Section 1135	10. SIZE AND TYPE OF BIT See Remarks
2. LOCATION (Coordinates or Station) X=387,895 Y=1371,729	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) NGVD
3. DRILLING AGENCY Corps of Engineers	12. MANUFACTURER'S DESIGNATION OF DRILL CD-33
4. HOLE NO. (As shown on drawing title and file number) CB-C35-S3	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 1 undisturbed: 0
5. NAME OF DRILLER R Gordon	14. TOTAL NUMBER OF CORE BOXES 1
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED	15. ELEVATION GROUND WATER
	16. DATE HOLE STARTED 02/09/94 COMPLETED 02/09/94
7. THICKNESS OF BURDEN 0 Ft.	17. ELEVATION TOP OF HOLE 38.05 Ft.
8. DEPTH DRILLED INTO ROCK 0 Ft.	18. TOTAL CORE RECOVERY FOR BORING 85.0 %
9. TOTAL DEPTH OF HOLE 5 Ft.	19. SIGNATURE OF GEOLOGIST M. Marty Goff

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS	BLOWS/ 1.0'
38.0	.0					38.0	
			SAND, Predominately fine grains, quartz, light brown, trace silt, trace organics, trace shell fragments (to gravel size). SP	85	1	Used 5 Foot Split Spoon.	SETTLE 2 3 5 9
33.0	5.0					33.0	
			Soils are field visually classified in accordance with the Unified Soils Classification System. NOTE: Core boring samples were logged on 2/24/94 by M. Marty Goff in Jacksonville, Florida.			140# HAMMER WITH 30" DROP USED ON 5.0' SPLIT SPOON. Water level is 12.2'	

0 2.5 5 7.5 10 12.5 15 17.5 20 22.5

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PROJECT	HOLE NUMBER
Kissimmee River Restoration-Section 1135	CB-C35-S3

Hole No.CB-C35-S4

DRILLING LOG

DIVISION South Atlantic	INSTALLATION Jacksonville District
	SHEET 1 OF 1
1. PROJECT Kissimmee River Restoration-Section 1135	10. SIZE AND TYPE OF BIT See Remarks
2. LOCATION (Coordinates or Station) X=387,212 Y=1377,690	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) NGVD
3. DRILLING AGENCY Corps of Engineers	12. MANUFACTURER'S DESIGNATION OF DRILL CD-33
4. HOLE NO. (As shown on drawing title and file number) CB-C35-S4	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 1 undisturbed: 0
5. NAME OF DRILLER R Gordon	14. TOTAL NUMBER OF CORE BOXES 1
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED	15. ELEVATION GROUND WATER
	16. DATE HOLE STARTED 02/09/94 COMPLETED 02/09/94
7. THICKNESS OF BURDEN 0 Ft.	17. ELEVATION TOP OF HOLE 39.25 Ft.
8. DEPTH DRILLED INTO ROCK 0 Ft.	18. TOTAL CORE RECOVERY FOR BORING 50.0 %
9. TOTAL DEPTH OF HOLE 5 Ft.	19. SIGNATURE OF GEOLOGIST M. Marty Goff

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS	BLOWS/ 1.0'
39.2	.0					39.2	
			SAND, Predominately fine grains, quartz, light brown, trace silt, trace organics, trace shell fragments (to gravel size). SP	50	1	Used 5 Foot Split Spoon.	SETTLE SETTLE 2 3 5
34.2	5.0					34.2	
			Soils are field visually classified in accordance with the Unified Soils Classification System. NOTE: Core boring samples were logged on 2/24/94 by M. Marty Goff in Jacksonville, Florida.			140# HAMMER WITH 30" DROP USED ON 5.0' SPLIT SPOON. Water level is 11.0'	

0 2.5 5 7.5 10 12.5 15 17.5 20 22.5

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.

PROJECT	HOLE NUMBER
Kissimmee River Restoration-Section 1135	CB-C35-S4

Hole No.CB-C35-S5

DRILLING LOG

DIVISION South Atlantic	INSTALLATION Jacksonville District
	SHEET 1 OF 1
1. PROJECT Kissimmee River Restoration-Section 1135	10. SIZE AND TYPE OF BIT See Remarks
2. LOCATION (Coordinates or Station) X=386,557 Y=1383,150	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) NGVD
3. DRILLING AGENCY Corps of Engineers	12. MANUFACTURER'S DESIGNATION OF DRILL CD-33
4. HOLE NO. (As shown on drawing title and file number) CB-C35-S5	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 1 undisturbed: 0
5. NAME OF DRILLER R Gordon	14. TOTAL NUMBER OF CORE BOXES 1
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED	15. ELEVATION GROUND WATER
	16. DATE HOLE STARTED 02/09/94 COMPLETED 02/09/94
7. THICKNESS OF BURDEN 0 Ft.	17. ELEVATION TOP OF HOLE 40.25 Ft.
8. DEPTH DRILLED INTO ROCK 0 Ft.	18. TOTAL CORE RECOVERY FOR BORING 20.0 %
9. TOTAL DEPTH OF HOLE 5 Ft.	19. SIGNATURE OF GEOLOGIST M. Marty Goff

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS	BLOWS/ 1.0'
40.2	.0					40.2	
			SAND, Predominately fine grains, quartz, light brown, trace silt, trace organics, trace shell fragments (to gravel size). SP	20	1	Used 5 Foot Split Spoon.	2, 5, 7, 8, 10
35.2	5.0					35.2	
			Soils are field visually classified in accordance with the Unified Soils Classification System. NOTE: Core boring samples were logged on 2/24/94 by M. Marty Goff in Jacksonville, Florida.			140# HAMMER WITH 30" DROP USED ON 5.0' SPLIT SPOON. Water level is 10.0'	

0, 2.5, 5, 7.5, 10, 12.5, 15, 17.5, 20, 22.5

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PROJECT	HOLE NUMBER
Kissimmee River Restoration-Section 1135	CB-C35-S5

Hole No.CB-C36-S1

DRILLING LOG

DIVISION South Atlantic	INSTALLATION Jacksonville District
	SHEET 1 OF 1
1. PROJECT Kissimmee River Restoration-Section 1135	10. SIZE AND TYPE OF BIT See Remarks
2. LOCATION (Coordinates or Station) X=385,116 Y=1342,801	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) NGVD
3. DRILLING AGENCY Corps of Engineers	12. MANUFACTURER'S DESIGNATION OF DRILL CD-33
4. HOLE NO. (As shown on drawing title and file number) CB-C36-S1	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 1 undisturbed: 0
5. NAME OF DRILLER R Gordon	14. TOTAL NUMBER OF CORE BOXES 1
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED	15. ELEVATION GROUND WATER
	16. DATE HOLE STARTED 02/10/94 COMPLETED 02/10/94
7. THICKNESS OF BURDEN 0 Ft.	17. ELEVATION TOP OF HOLE 35.75 Ft.
8. DEPTH DRILLED INTO ROCK 0 Ft.	18. TOTAL CORE RECOVERY FOR BORING 40.0 %
9. TOTAL DEPTH OF HOLE 5 Ft.	19. SIGNATURE OF GEOLOGIST M. Marty Goff

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS	BLOWS/ 1.0'
35.7	.0					35.7	
			SAND, Predominately fine grains, quartz, light brown, trace silt, trace organics, trace shell fragments. SP	40	1	Usec 5 Foot Split Spoon.	SETTLE 3 6 9 11
30.7	5.0					30.7	
			Soils are field visually classified in accordance with the Unified Soils Classification System. NOTE: Core boring samples were logged on 2/24/94 by M. Marty Goff in Jacksonville, Florida.			140# HAMMER WITH 30" DROP USED ON 5.0' SPLIT SPOON. Water level is 14.5'	

0 2.5 5 7.5 10 12.5 15 17.5 20 22.5

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.

PROJECT	HOLE NUMBER
Kissimmee River Restoration-Section 1135	CB-C36-S1

Hole No.CB-C36-S2

DRILLING LOG

DIVISION South Atlantic	INSTALLATION Jacksonville District
	SHEET 1 OF 1
1. PROJECT Kissimmee River Restoration-Section 1135	10. SIZE AND TYPE OF BIT See Remarks
2. LOCATION (Coordinates or Station) X=388,811 Y=1347,911	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) NGVD
3. DRILLING AGENCY Corps of Engineers	12. MANUFACTURER'S DESIGNATION OF DRILL CD-33
4. HOLE NO. (As shown on drawing title and file number) CB-C36-S2	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 1 undisturbed: 0
5. NAME OF DRILLER R Gordon	14. TOTAL NUMBER OF CORE BOXES 1
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED	15. ELEVATION GROUND WATER
	16. DATE HOLE STARTED 02/10/94 COMPLETED 02/10/94
7. THICKNESS OF BURDEN 0 Ft.	17. ELEVATION TOP OF HOLE 35.55 Ft.
8. DEPTH DRILLED INTO ROCK 0 Ft.	18. TOTAL CORE RECOVERY FOR BORING 80.0 %
9. TOTAL DEPTH OF HOLE 5 Ft.	19. SIGNATURE OF GEOLOGIST M. Marty Goff

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS	BLOWS/ 1.0'
35.5	.0					35.5	
			SAND, Predominately fine grains, quartz, light brown, trace silt, trace organics, trace shell fragments. SP	80	1	Used 5 Foot Split Spoon.	3, 5, 7, 11, 12
30.5	5.0					30.5	
			Soils are field visually classified in accordance with the Unified Soils Classification System.			140# HAMMER WITH 30" DROP USED ON 5.0' SPLIT SPOON.	
			NOTE: Core boring samples were logged on 2/24/94 by M. Marty Goff in Jacksonville, Florida.			Water level is 14.7'	

0, 2.5, 5, 7.5, 10, 12.5, 15, 17.5, 20, 22.5

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PROJECT	HOLE NUMBER
Kissimmee River Restoration-Section 1135	CB-C36-S2

DRILLING LOG

DIVISION South Atlantic	INSTALLATION Jacksonville District
	SHEET 1 OF 1
1. PROJECT Kissimmee River Restoration-Section 1135	10. SIZE AND TYPE OF BIT See Remarks
2. LOCATION (Coordinates or Station) X=391,056 Y=1354,541	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) NGVD
3. DRILLING AGENCY Corps of Engineers	12. MANUFACTURER'S DESIGNATION OF DRILL CD-33
4. HOLE NO. (As shown on drawing title and file number) CB-C36-S3	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 1 undisturbed: 0
5. NAME OF DRILLER R Gordon	14. TOTAL NUMBER OF CORE BOXES 1
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED	15. ELEVATION GROUND WATER
	16. DATE HOLE STARTED 02/10/94 COMPLETED 02/10/94
7. THICKNESS OF BURDEN 0 Ft.	17. ELEVATION TOP OF HOLE 37.75 Ft.
8. DEPTH DRILLED INTO ROCK 0 Ft.	18. TOTAL CORE RECOVERY FOR BORING 50.0 %
9. TOTAL DEPTH OF HOLE 5 Ft.	19. SIGNATURE OF GEOLOGIST M. Marty Goff

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS	BLOWS/ 1.0'
37.7	.0					37.7	
			SAND, Predominately fine grains, quartz, light brown, trace silt, trace organics, trace shell fragments. SP				SETTLE
							SETTLE
				50	1	Used 5 Foot Split Spoon.	3
							5
							9
32.7	5.0					32.7	
			Soils are field visually classified in accordance with the Unified Soils Classification System.			140# HAMMER WITH 30" DROP USED ON 5.0' SPLIT SPOON.	
			NOTE: Core boring samples were logged on 2/24/94 by M. Marty Goff in Jacksonville, Florida.			Water level is 12.5'	

0 2.5 5 7.5 10 12.5 15 17.5 20 22.5

Hole No.CB-C37-S1

DRILLING LOG

DIVISION South Atlantic	INSTALLATION Jacksonville District
	SHEET 1 OF 1
1. PROJECT Kissimmee River Restoration-Section 1135	10. SIZE AND TYPE OF BIT See Remarks
2. LOCATION (Coordinates or Station) X=386,658 Y=1319,647	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) NGVD
3. DRILLING AGENCY Corps of Engineers	12. MANUFACTURER'S DESIGNATION OF DRILL CD-33
4. HOLE NO. (As shown on drawing title and file number) CB-C37-S1	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 1 undisturbed: 0
5. NAME OF DRILLER R Gordon	14. TOTAL NUMBER OF CORE BOXES 1
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED	15. ELEVATION GROUND WATER
	16. DATE HOLE STARTED 02/10/94 COMPLETED 02/10/94
7. THICKNESS OF BURDEN 0 Ft.	17. ELEVATION TOP OF HOLE 31.25 Ft.
8. DEPTH DRILLED INTO ROCK 0 Ft.	18. TOTAL CORE RECOVERY FOR BORING 60.0 %
9. TOTAL DEPTH OF HOLE 5 Ft.	19. SIGNATURE OF GEOLOGIST M. Marty Goff

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS	BLOWS/ 1.0'
31.2	.0					31.2	
			SAND, Fine to medium grains, quartz, light brown, trace silt, trace organics, trace shell fragments (to gravel size). SP	60	1	Used 5 Foot Split Spoon.	SETTLE 3 7 12 16
26.2	5.0					26.2	
			Soils are field visually classified in accordance with the Unified Soils Classification System. NOTE: Core boring samples were logged on 2/24/94 by M. Marty Goff in Jacksonville, Florida.			140# HAMMER WITH 30" DROP USED ON 5.0' SPLIT SPOON. Water level is 19.0'	

0 2.5 5 7.5 10 12.5 15 17.5 20 22.5

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE. MAR 71

PROJECT	HOLE NUMBER
Kissimmee River Restoration-Section 1135	CB-C37-S1

DRILLING LOG

DIVISION South Atlantic	INSTALLATION Jacksonville District
SHEET 1 OF 1	
1. PROJECT Kissimmee River Restoration-Section 1135	10. SIZE AND TYPE OF BIT See Remarks
2. LOCATION (Coordinates or Station) X=382,520 Y=1322,452	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) NGVD
3. DRILLING AGENCY Corps of Engineers	12. MANUFACTURER'S DESIGNATION OF DRILL CD-33
4. HOLE NO. (As shown on drawing title and file number) CB-C37-S2	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 1 undisturbed: 0
5. NAME OF DRILLER R Gordon	14. TOTAL NUMBER OF CORE BOXES 1
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED	15. ELEVATION GROUND WATER
	16. DATE HOLE STARTED 02/10/94 COMPLETED 02/10/94
7. THICKNESS OF BURDEN 0 Ft.	17. ELEVATION TOP OF HOLE 30.25 Ft.
8. DEPTH DRILLED INTO ROCK 0 Ft.	18. TOTAL CORE RECOVERY FOR BORING 85.0 %
9. TOTAL DEPTH OF HOLE 5 Ft.	19. SIGNATURE OF GEOLOGIST M. Marty Goff

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS	BLOWS/1.0'
30.2	.0					30.2	
			SAND, Fine to medium grains, quartz, light brown, trace silt, trace organics, trace shell fragments (to gravel size). SP	85	1	Used 5 Foot Split Spoon.	SETTLE SETTLE 2 2 4
25.2	5.0					25.2	
			Soils are field visually classified in accordance with the Unified Soils Classification System. NOTE: Core boring samples were logged on 2/24/94 by M. Marty Goff in Jacksonville, Florida.			140# HAMMER WITH 30" DROP USED ON 5.0' SPLIT SPOON. Water level is 20.0'	

0, 2.5, 5, 7.5, 10, 12.5, 15, 17.5, 20, 22.5

DRILLING LOG

DIVISION South Atlantic	INSTALLATION Jacksonville District
	SHEET 1 OF 1
1. PROJECT Kissimmee River Restoration-Section 1135	10. SIZE AND TYPE OF BIT See Remarks
2. LOCATION (Coordinates or Station) X=378,735 Y=1325,657	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) NGVD
3. DRILLING AGENCY Corps of Engineers	12. MANUFACTURER'S DESIGNATION OF DRILL CD-33
4. HOLE NO. (As shown on drawing title and file number) CB-C37-S3	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 1 undisturbed: 0
5. NAME OF DRILLER R Gordon	14. TOTAL NUMBER OF CORE BOXES 1
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED	15. ELEVATION GROUND WATER
	16. DATE HOLE STARTED 02/10/94 COMPLETED 02/10/94
7. THICKNESS OF BURDEN 0 Ft.	17. ELEVATION TOP OF HOLE 30.85 Ft.
8. DEPTH DRILLED INTO ROCK 0 Ft.	18. TOTAL CORE RECOVERY FOR BORING 60.0 %
9. TOTAL DEPTH OF HOLE 5 Ft.	19. SIGNATURE OF GEOLOGIST M. Marty Goff

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS	BLOWS/ 1.0'
30.8	.0					30.8	
			SAND, Fine to medium grains, quartz, light reddish tan brown, trace silt, trace organics, trace shell fragments (to gravel size). SP	60	1	Used 5 Foot Split Spoon.	SETTLE SETTLE 4 5 9
25.8	5.0					25.8	
			Soils are field visually classified in accordance with the Unified Soils Classification System. NOTE: Core boring samples were logged on 2/24/94 by M. Marty Goff in Jacksonville, Florida.			140# HAMMER WITH 30" DROP USED ON 5.0' SPLIT SPOON. Water level is 19.4'	

0 2.5 5 7.5 10 12.5 15 17.5 20 22.5

DRILLING LOG

DIVISION: South Atlantic

INSTALLATION: Jacksonville District

SHEET 1 OF 1

1. PROJECT: Kissimmee River Restoration-Section 1135
2. LOCATION (Coordinates or Station): X=377,727 Y=1328,994
3. DRILLING AGENCY: Corps of Engineers
4. HOLE NO. (As shown on drawing title and file number): CB-C37-S4
5. NAME OF DRILLER: R Gordon
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED
7. THICKNESS OF BURDEN: 0 Ft.
8. DEPTH DRILLED INTO ROCK: 0 Ft.
9. TOTAL DEPTH OF HOLE: 5 Ft.
10. SIZE AND TYPE OF BIT: See Remarks
11. DATUM FOR ELEVATION SHOWN (TBM or MSL): NGVD
12. MANUFACTURER'S DESIGNATION OF DRILL: CD-33
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: disturbed: 1 undisturbed: 0
14. TOTAL NUMBER OF CORE BOXES: 1
15. ELEVATION GROUND WATER:
16. DATE HOLE: STARTED 02/10/94 COMPLETED 02/10/94
17. ELEVATION TOP OF HOLE: 32.95 Ft.
18. TOTAL CORE RECOVERY FOR BORING: 80.0 %
19. SIGNATURE OF GEOLOGIST: M. Marty Goff

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS	BLOWS/ 1.0'
33.0	.0					33.0	
			SAND, Fine to medium grains, quartz, light reddish tan brown, trace silt, trace organics, trace shell fragments (to gravel size). SP	80	1	Used 5 Foot Split Spocn.	SETTLE SETTLE 3 5 7
28.0	5.0					28.0	
			Soils are field visually classified in accordance with the Unified Soils Classification System. NOTE: Core boring samples were logged on 2/24/94 by M. Marty Goff in Jacksonville, Florida.			140# HAMMER WITH 30" DROP USED ON 5.0' SPLIT SPOON. Water level is 17.3'	

0 2.5 5 7.5 10 12.5 15 17.5 20 22.5

DRILLING LOG

DIVISION: South Atlantic

INSTALLATION: Jacksonville District

SHEET 1 OF 2

1. PROJECT: KISSIMMEE UPPER BASIN
2. LOCATION (Coordinates or Station): X=385,629 Y=1343,156
3. DRILLING AGENCY: Corps of Engineers
4. HOLE NO. (As shown on drawing title and file number): CB-C36-K1
5. NAME OF DRILLER: R. Gordon
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED
7. THICKNESS OF BURDEN: 0 Ft.
8. DEPTH DRILLED INTO ROCK: 0 Ft.
9. TOTAL DEPTH OF HOLE: 30 Ft.
10. SIZE AND TYPE OF BIT: Vibracore
11. DATUM FOR ELEVATION SHOWN (TBM or MSL): NGVD
12. MANUFACTURER'S DESIGNATION OF DRILL: Failing 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: disturbed: 0 undisturbed: 0
14. TOTAL NUMBER OF CORE BOXES: 1
15. ELEVATION GROUND WATER: 48.6
16. DATE HOLE STARTED: 8/04/92 COMPLETED: 8/04/92
17. ELEVATION TOP OF HOLE: 52.96 Ft.
18. TOTAL CORE RECOVERY FOR BORING: 74 %
19. SIGNATURE OF GEOLOGIST: M. Goff

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/.5'
53.0	.0					53.0	
51.3	1.7		SAND, fine-medium grain, quartz, tan, with black organic stain, little clay, trace roolets. (SC)	73	1	SPLIT SPOON 51.5	2, 3, 3
49.3	3.7		CLAY, black, slightly damp, medium plasticity, little sand to occasionally in lens. (CL)	100	2	SPLIT SPOON 50.0	3, 4, 4
				100	3	SPLIT SPOON 48.5	4, 5, 5
			PEAT, black, slightly damp, trace roots, trace sand, low plasticity (PT). (Natural Ground)	100	4	SPLIT SPOON 47.0	1, 2, 2
			Sand lens (SP) with piece of bone.	67	5	SPLIT SPOON 45.5	1, 1, 1
			Area of some roots damp to moist below 8.0'.	100	6	SPLIT SPOON 44.0	W.O.H., W.O.H., 1
43.3	9.7			100	7	SPLIT SPOON 42.5	W.O.H., W.O.H., 2
41.0	12.0		CLAY, dark gray, damp, soft, trace sand (quartz). (CH)	100	8	SPLIT SPOON 41.0	1, 3, 2
39.5	13.5		below depth 12.0, gray, trace-little sand, trace decomposing shell fragments, soft. (CH)	100	9	SPLIT SPOON 39.5	3, 5, 13
36.5	16.5		SAND, fine-medium grain, quartz, wet, gray. Trace clay. (SP)	60	10	SPLIT SPOON 38.0	WASH, 7, 25
				33	11	SPLIT SPOON 36.5	4, 7, 13
35.0	18.0		SAND, fine-medium grain, quartz, gray, little to some clay, wet. (SC)	80	12	SPLIT SPOON 35.0	13, 12, 14
				0	13	33.5	WASHED, WASHED, WASHED
				0	14	32.0	WASHED, WASHED, WASHED
30.5	22.5			0	15	30.5	WASHED, WASHED, WASHED
						(continued)	

0 2.5 5 7.5 10 12.5 15 17.5 20 22.5

DRILLING LOG (Cont. Sheet)

ELEVATION TOP OF HOLE 52.96 Ft.

PROJECT: KISSIMMEE UPPER BASIN

INSTALLATION: Jacksonville District

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/.5'
30.5	22.5					30.5	
29.0	24.0		SAND, fine-medium grain, quartz, gray trace clay in lens/nodules. (SP)	100	16	SPLIT SPOON 29.0	12, 15, 17
28.1	24.9		SAND, fine-medium grain, quartz. (SP)	100	17	SPLIT SPOON 27.5	2, 5, 9
			SAND, fine-medium grain, quartz, gray, little-some clay. (SC)	80	18	SPLIT SPOON 26.0	7, 11, 13
				100	19	SPLIT SPOON 24.5	5, 4, 9
23.0	30.0			80	20	SPLIT SPOON 23.0	4, 6, 15

Note: Soils are field visually classified in accordance with the Unified Soils Classification System.

22.5 25 27.5 30 32.5 35 37.5 40 42.5 45 47.5 50

DRILLING LOG

DIVISION South Atlantic

INSTALLATION Jacksonville District

SHEET 1 OF 2

1. PROJECT KISSIMMEE UPPER BASIN
2. LOCATION (Coordinates or Station) X=386,367 Y=1344,099
3. DRILLING AGENCY Corps of Engineers
4. HOLE NO. (As shown on drawing title and file number) CB-C36-K2
5. NAME OF DRILLER R. Gordon
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED
7. THICKNESS OF BURDEN 0 Ft.
8. DEPTH DRILLED INTO ROCK 0 Ft.
9. TOTAL DEPTH OF HOLE 30 Ft.
10. SIZE AND TYPE OF BIT Vibracore
11. DATUM FOR ELEVATION SHOWN (TBM or MSL) NGVD
12. MANUFACTURER'S DESIGNATION OF DRILL Failing 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 0 undisturbed: 0
14. TOTAL NUMBER OF CORE BOXES 2
15. ELEVATION GROUND WATER 47.79
16. DATE HOLE STARTED 8/05/92 COMPLETED 8/05/92
17. ELEVATION TOP OF HOLE 53.99 Ft.
18. TOTAL CORE RECOVERY FOR BORING 73 %
19. SIGNATURE OF GEOLOGIST M. Goff

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/.5'
54.0	.0					54.0	
			SAND, fine-medium grain, quartz, tan-light brown, trace rootlets, slightly damp, little clay. (SC)	73	1	SPLIT SPOON	2, 3, 4
						52.5	
				100	2	SPLIT SPOON	3, 4, 6
						51.0	
				100	3	SPLIT SPOON	3, 3, 3
49.6	4.4		Color change to light green.			49.5	
			PEAT, black, trace roots, trace sand, damp to moist, very soft. (PT). (Natural Ground)	100	4	SPLIT SPOON	1, 1, 1
						48.0	
				67	5	SPLIT SPOON	W.O.H., 1, 1
46.6	7.4					46.5	
			CLAY, gray, soft, damp, little sand, Fat, trace rootlets. (CH)	100	6	SPLIT SPOON	W.O.H., 3, 3
45.0	9.0					45.0	
			SAND, fine-medium grain, quartz, gray, wet, little clay (clay occasionally in lens). (SC)	100	7	SPLIT SPOON	8, 6, 7
						43.5	
				100	8	SPLIT SPOON	8, 15, 17
			Below depth 12.0, gray with yellow brown mottling			42.0	
				100	9	SPLIT SPOON	13, 12, 13
						40.5	
				60	10	SPLIT SPOON	11, 11, 18
39.0	15.0					39.0	
			SAND, fine-medium grain, quartz, wet, gray, trace clay. (SP)	33	11	SPLIT SPOON	4, 7, 7
37.5	16.5					37.5	
			SAND, fine-medium grain, quartz, wet, gray, little to some clay. (SC)	80	12	SPLIT SPOON	8, 9, 10
						36.0	
				67	13		5, 5, 9
						34.5	
				60	14		8, 9, 4
33.0	21.0					33.0	
				0	15		WASH
31.5	22.5					31.5	
						(continued)	

0 2.5 5 7.5 10 12.5 15 17.5 20 22.5

DRILLING LOG (Cont. Sheet)

ELEVATION TOP OF HOLE 53.99 Ft.

PROJECT: KISSIMMEE UPPER BASIN

INSTALLATION: Jacksonville District

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/ 5'
31.5	22.5					31.5	
			SAND, fine-medium grain, quartz, gray, wet. (SP)	100	16	SPLIT SPOON	1, 2, 5
29.4	24.6					30.0	
			SAND, fine-medium grain, quartz, gray, wet little clay. (SC)	100	17	SPLIT SPOON	4, 1, 3
28.5	25.5					28.5	
			CLAY, brown, firm to stiff, wet, little sand. (CH)	80	18	SPLIT SPOON	3, 4, 6
						27.0	
				100	19	SPLIT SPOON	4, 8, 10
			Sand lenses (SP)			25.5	
				80	20	SPLIT SPOON	6, 10, 15
24.0	30.0					24.0	

Note: Soils are field visually classified in accordance with the Unified Soils Classification System.

22.5 25 27.5 30 32.5 35 37.5 40 42.5 45 47.5 50

DRILLING LOG

DIVISION South Atlantic

INSTALLATION Jacksonville District

1. PROJECT: KISSIMMEE UPPER BASIN
2. LOCATION (Coordinates or Station): X=387,579 Y=1345,597
3. DRILLING AGENCY: Corps of Engineers
4. HOLE NO. (As shown on drawing title and file number): CB-C36-K3
5. NAME OF DRILLER: R. Gordon
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED
7. THICKNESS OF BURDEN: 0 Ft.
8. DEPTH DRILLED INTO ROCK: 0 Ft.
9. TOTAL DEPTH OF HOLE: 30 Ft.
10. SIZE AND TYPE OF BIT: Vibracore
11. DATUM FOR ELEVATION SHOWN (TBM or MSL): NGVD
12. MANUFACTURER'S DESIGNATION OF DRILL: Failing 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: disturbed: 0 undisturbed: 0
14. TOTAL NUMBER OF CORE BOXES: 1
15. ELEVATION GROUND WATER: 50.7
16. DATE HOLE STARTED: 8/05/92 COMPLETED: 8/06/92
17. ELEVATION TOP OF HOLE: 55.50 Ft.
18. TOTAL CORE RECOVERY FOR BORING: %
19. SIGNATURE OF GEOLOGIST: M. Goff

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/.6'
55.5	.0					55.5	
			SAND, fine-medium grain, quartz, slightly damp, tan to light brown, little clay, little roots. (SC)	93	1	SPLIT SPOON	2, 3, 2
						54.0	
			occasional yellow-brown mottling	80	2	SPLIT SPOON	2, 4, 6
						52.5	
				100	3	SPLIT SPOON	3, 6, 8
						51.0	
				80	4	SPLIT SPOON	6, 5, 2
						49.5	
49.1	6.4						
			CLAY, gray, firm, little sand, fat. (CH)	87	5	SPLIT SPOON	1, 2, 3
						48.0	
				100	6	SPLIT SPOON	2, 4, 5
						46.5	
				100	7	SPLIT SPOON	7, 7, 13
						45.0	
44.2	11.3						
			SAND, fine-medium grain, grey, quartz, wet, little to some clay (SC)	100	8	SPLIT SPOON	12, 11, 11
						43.5	
				100	9	SPLIT SPOON	7, 10, 14
						42.0	
				87	10	SPLIT SPOON	11, 11, 11
						40.5	
				80	11	SPLIT SPOON	12, 11, 12
						39.0	
				60	12	SPLIT SPOON	13, 13, 14
						37.5	
				100	13	SPLIT SPOON	6, 8, 10
						36.0	
				100	14	SPLIT SPOON	11, 10, 10
						34.5	
				87	15	SPLIT SPOON	6, 13, 18
33.0	22.5					33.0	
						(continued)	

Depth scale: 0, 2.5, 5, 7.5, 10, 12.5, 15, 17.5, 20, 22.5

Hole No.CB-C36-K3

DRILLING LOG (Cont. Sheet)

ELEVATION TOP OF HOLE 55.50 Ft.

SHEET 2 OF 2

PROJECT: KISSIMMEE UPPER BASIN

INSTALLATION: Jacksonville District

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/.5'
33.0	22.5					33.0	
31.5	24.0		CLAY, dark gray, soft to firm, little sand. (CH)	47	16	SPLIT SPOON 31.5	5 6 10
27.4	28.1		SAND, fine-medium grain, quartz, wet, little clay. (SC)	80	17	SPLIT SPOON 30.0	6 8 8
				100	18	SPLIT SPOON 28.5	6 9 10
				100	19	SPLIT SPOON 27.0	4 8 15
25.5	30.0		CLAY, dark gray, fat, soft to firm, little sand. (CH)	100	20	SPLIT SPOON 25.5	8 15 27

Note: Soils are field visually classified in accordance with the Unified Soils Classification System.

22.5 25 27.5 30 32.5 35 37.5 40 42.5 45 47.5 50

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PROJECT: KISSIMMEE UPPER BASIN

HOLE NUMBER: CB-C36-K3

DRILLING LOG

DIVISION: South Atlantic

INSTALLATION: Jacksonville District

SHEET 1 OF 2

1. PROJECT: KISSIMMEE UPPER BASIN
2. LOCATION (Coordinates or Station): X=388,525 Y=1347,456
3. DRILLING AGENCY: Corps of Engineers
4. HOLE NO. (As shown on drawing title and file number): CB-C36-K4
5. NAME OF DRILLER: R. Gordon
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED
7. THICKNESS OF BURDEN: 0 Ft.
8. DEPTH DRILLED INTO ROCK: 0 Ft.
9. TOTAL DEPTH OF HOLE: 30 Ft.
10. SIZE AND TYPE OF BIT: Vibracore
11. DATUM FOR ELEVATION SHOWN (TBM or MSL): NGVD
12. MANUFACTURER'S DESIGNATION OF DRILL: Failing 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: disturbed: 0 undisturbed: 0
14. TOTAL NUMBER OF CORE BOXES: 1
15. ELEVATION GROUND WATER: 47.53
16. DATE HOLE STARTED: 8/06/92 COMPLETED: 8/07/92
17. ELEVATION TOP OF HOLE: 56.03 Ft.
18. TOTAL CORE RECOVERY FOR BORING: 79 %
19. SIGNATURE OF GEOLOGIST: M. Goff

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/6"
56.0	.0					56.0	
			SAND, fine-medium grain, quartz, tan, trace clay. (SP)	67	1	SPLIT SPOON	5, 10, 12
						54.5	
				87	2	SPLIT SPOON	5, 10, 13
						53.0	
52.0	4.0			60	3	SPLIT SPOON	4, 6, 8
51.5	4.5		Peat, black, slightly damp, some sand. (PT)			51.5	
			CLAY, gray, damp, fat, soft, with little sand. (CH)	60	4	SPLIT SPOON	1, 2, 2
						50.0	
				67	5	SPLIT SPOON	1, 1, 2
						48.5	
				80	6	SPLIT SPOON	4, 6, 6
						47.0	
				100	7	SPLIT SPOON	5, 12, 12
						45.5	
44.5	11.5			100	8	SPLIT SPOON	9, 12, 15
			SAND, fine to medium grain, quartz, wet, gray to green, little clay (occasionally in lenses) (SC)			44.0	
				73	9	SPLIT SPOON	9, 12, 16
						42.5	
				80	10	SPLIT SPOON	8, 8, 8
						41.0	
				80	11	SPLIT SPOON	5, 6, 9
						39.5	
				67	12	SPLIT SPOON	5, 9, 10
						38.0	
				67	13	SPLIT SPOON	7, 8, 11
						36.5	
				80	14	SPLIT SPOON	5, 5, 9
35.0	21.0					35.0	
34.5	21.5		Clay layer (CH) from 21.0' - 21.5'.	93	15	SPLIT SPOON	9, 10, 15
33.5	22.5					33.5	
						(continued)	

Depth scale: 0, 2.5, 5, 7.5, 10, 12.5, 15, 17.5, 20, 22.5

DRILLING LOG (Cont. Sheet)

ELEVATION TOP OF HOLE 56.03 Ft.

PROJECT: KISSIMMEE UPPER BASIN

INSTALLATION: Jacksonville District

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/.5'
33.5	22.5					33.5	
33.1	22.9		Sand layer (SP) from 22.5' - 22.9'.	100	16	SPLIT SPOON	9, 22, 35
			Below Depth 24.0, dark gray to grey			32.0	
				87	17	SPLIT SPOON	6, 13, 11
30.5	25.5					30.5	
			SAND, fine-medium grain, quartz, gray, trace clay. (SP)	73	18	SPLIT SPOON	5, 10, 11
						29.0	
				73	19	SPLIT SPOON	4, 7, 9
						27.5	
			Fragments of sandy limestone up to 1/4 inch.	80	20	SPLIT SPOON	5, 10, 10
26.0	30.0					26.0	

Note: Soils are field visually classified in accordance with the Unified Soils Classification System.

22.5 25 27.5 30 32.5 35 37.5 40 42.5 45 47.5 50

DRILLING LOG

DIVISION South Atlantic	INSTALLATION Jacksonville District
	SHEET 1 OF 2
1. PROJECT KISSIMMEE UPPER BASIN	10. SIZE AND TYPE OF BIT Vibracore
2. LOCATION (Coordinates or Station) X=388,826 Y=1348,349	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) NGVD
3. DRILLING AGENCY Corps of Engineers	12. MANUFACTURER'S DESIGNATION OF DRILL Failing 1500
4. HOLE NO. (As shown on drawing title and file number) CB-C36-K5	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 0 undisturbed: 0
5. NAME OF DRILLER R. Gordon	14. TOTAL NUMBER OF CORE BOXES 2
	15. ELEVATION GROUND WATER 47.81
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED	16. DATE HOLE STARTED 8/10/92 COMPLETED 8/10/92
7. THICKNESS OF BURDEN 0 Ft.	17. ELEVATION TOP OF HOLE 56.11 Ft.
8. DEPTH DRILLED INTO ROCK 0 Ft.	18. TOTAL CORE RECOVERY FOR BORING 87.3 %
9. TOTAL DEPTH OF HOLE 30 Ft.	19. SIGNATURE OF GEOLOGIST M. Goff

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/.5'
56.1	0					56.1	
			SAND, fine-medium grain, quartz, white-tan with dark gray clayey layers, slightly damp, with little clay. (SC)	87	1	SPLIT SPOON 54.6	2 3 4
				87	2	SPLIT SPOON 53.1	4 5 7
				80	3	SPLIT SPOON 51.6	6 5 4
51.4	4.7						
50.8	5.3		PEAT, black, damp, little sand. (PT) Natural Ground	93	4	SPLIT SPOON 50.1	3 4 4
49.8	6.3		SAND, fine-medium grain, quartz, gray damp-wet. (SP)				
			CLAY, gray, wet, soft, little sand, fat. (CH)	73	5	SPLIT SPOON 48.6	1 2 4
				93	6	SPLIT SPOON 47.1	6 5 6
				93	7	SPLIT SPOON 45.6	5 7 11
45.6	10.5						
			SAND, fine-medium grain, quartz, gray, yellow brown mottling, trace shell fragments, little clay. (SC)	100	8	SPLIT SPOON 44.1	8 8 14
				87	9	SPLIT SPOON 42.6	11 12 12
				87	10	SPLIT SPOON 41.1	10 10 14
				67	11	SPLIT SPOON 39.6	7 11 14
39.6	16.5						
			SAND, fine-medium grain, quartz, gray with yellow-brown mottling, wet, trace clay. (SP)	67	12	SPLIT SPOON 38.1	5 7 8
				53	13	SPLIT SPOON 36.6	3 3 7
36.6	19.5						
			SAND, fine-medium grain, quartz, gray, little clay. (SC)	93	14	SPLIT SPOON 35.1	8 7 8
35.1	21.0						
			CLAY, green, firm-stiff, dry, little sand, medium plasticity. (CH)	100	15	SPLIT SPOON 33.6	4 7 11
						(continued)	

0 2.5 5 7.5 10 12.5 15 17.5 20 22.5

Hole No.CB-C36-K5

DRILLING LOG (Cont. Sheet)

ELEVATION TOP OF HOLE 56.11 Ft.

SHEET 2 OF 2

PROJECT: KISSIMMEE UPPER BASIN

INSTALLATION: Jacksonville District

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/.5'
33.6	22.5					33.6	
32.4	23.7			100	16	SPLIT SPOON	6, 10, 10
32.1	24.0		SILT, black. (OH)			32.1	
31.5	24.6		CLAY, gray, dry, medium plasticity, little sand. (CH)	100	17	SPLIT SPOON	4, 6, 8
31.2	24.9						
31.0	25.1		SILT, black, (OH) little sand.			30.6	
			Clay (CH)				
29.1	27.0		SILT, black, little sand, dry. (OH)	93	18	SPLIT SPOON	2, 15, 9
27.8	28.3		SAND, fine-medium grain, quartz, trace silt, little clay, gray. (SC)	100	19	SPLIT SPOON	20, 18, 5
27.0	29.1		CLAY, green, dry, stiff. (CH)			27.6	
26.1	30.0		SAND, fine-medium grain, quartz, gray-green, little clay. (SC)	93	20	SPLIT SPOON	7, 13, 17

Note: Soils are field visually classified in accordance with the Unified Soils Classification System.

22.5 25 27.5 30 32.5 35 37.5 40 42.5 45 47.5 50

DRILLING LOG

DIVISION: South Atlantic

INSTALLATION: Jacksonville District

SHEET 1 OF 2

1. PROJECT: KISSIMMEE UPPER BASIN
2. LOCATION (Coordinates or Station): X=389,458 Y=1350,219
3. DRILLING AGENCY: Corps of Engineers
4. HOLE NO. (As shown on drawing title and file number): CB-C36-K6
5. NAME OF DRILLER: R. Gordon
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED
7. THICKNESS OF BURDEN: 0 Ft.
8. DEPTH DRILLED INTO ROCK: 0 Ft.
9. TOTAL DEPTH OF HOLE: 30 Ft.
10. SIZE AND TYPE OF BIT: Vibracore
11. DATUM FOR ELEVATION SHOWN (TBM or MSL): NGVD
12. MANUFACTURER'S DESIGNATION OF DRILL: Failing 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: disturbed: 0 undisturbed: 0
14. TOTAL NUMBER OF CORE BOXES: 1
15. ELEVATION GROUND WATER: 49.31
16. DATE HOLE: STARTED 8/11/92 COMPLETED 8/11/92
17. ELEVATION TOP OF HOLE: 56.01 Ft.
18. TOTAL CORE RECOVERY FOR BORING: 78 %
19. SIGNATURE OF GEOLOGIST: M. Goff

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/.5'
56.0	.0					56.0	
			SAND, fine-medium grain, quartz, tan, trace clay and roots upper foot (SP)	100	1	SPLIT SPOON	3, 5, 7
						54.5	
				93	2	SPLIT SPOON	5, 7, 11
						53.0	
				100	3	SPLIT SPOON	4, 4, 3
51.5	4.5					51.5	
50.6	5.4		PEAT, black, dry, little sand, trace clay. (PT) Natural Ground	73	4	SPLIT SPOON	1, 2, 1
			CLAY, gray, soft to stiff, wet, little sand, (CH)			50.0	
				67	5	SPLIT SPOON	1, 2, 3
						48.5	
				100	6	SPLIT SPOON	4, 6, 10
						47.0	
				100	7	SPLIT SPOON	9, 7, 11
						45.5	
				100	8	SPLIT SPOON	10, 10, 17
			Some sand below 12.0			44.0	
43.0	13.0			0	9	SPLIT SPOON	10, 13, 13
			SAND, fine-medium grain, quartz, gray with yellow-brown mottling, trace clay. (SP)			42.5	
				73	10	SPLIT SPOON	10, 10, 16
						41.0	
				80	11	SPLIT SPOON	8, 13, 21
						39.5	
38.8	17.2			73	12	SPLIT SPOON	5, 10, 17
			CLAY, green, firm to stiff, trace-little sand, fat, trace peat. (CH)			38.0	
				87	13	SPLIT SPOON	10, 14, 18
						36.5	
				73	14	SPLIT SPOON	8, 4, 11
						35.0	
				100	15	SPLIT SPOON	6, 9, 16
						33.5	
						(continued)	

0 2.5 5 7.5 10 12.5 15 17.5 20 22.5

DRILLING LOG (Cont. Sheet)

ELEVATION TOP OF HOLE 56.01 Ft.

PROJECT: KISSIMMEE UPPER BASIN

INSTALLATION: Jacksonville District

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/.5'
33.5	22.5					33.5	
33.0	23.0						
			SAND, fine-medium grain, quartz, green with little clay. (SC)	73	16	SPLIT SPOON 32.0	8, 12, 20
				100	17	SPLIT SPOON 30.5	6, 9, 9
				87	18	SPLIT SPOON 29.0	3, 6, 10
				87	19	SPLIT SPOON 27.5	5, 9, 12
				97	20	SPLIT SPOON 26.0	7, 15, 16
26.0	30.0						

Note: Soils are field visually classified in accordance with the Unified Soils Classification System.

22.5 25 27.5 30 32.5 35 37.5 40 42.5 45 47.5 50

DRILLING LOG

DIVISION: South Atlantic

INSTALLATION: Jacksonville District

1. PROJECT: KISSIMMEE UPPER BASIN
2. LOCATION (Coordinates or Station): X=390,105 Y=1352,090
3. DRILLING AGENCY: Corps of Engineers
4. HOLE NO. (As shown on drawing title and file number): CB-C36-K7
5. NAME OF DRILLER: R. Gordon
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED
7. THICKNESS OF BURDEN: 0 Ft.
8. DEPTH DRILLED INTO ROCK: 0 Ft.
9. TOTAL DEPTH OF HOLE: 30 Ft.
10. SIZE AND TYPE OF BIT: Vibracore
11. DATUM FOR ELEVATION SHOWN (TBM or MSL): NGVD
12. MANUFACTURER'S DESIGNATION OF DRILL: Failing 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: disturbed: 0 undisturbed: 0
14. TOTAL NUMBER OF CORE BOXES: 1
15. ELEVATION GROUND WATER: 51.23
16. DATE HOLE: STARTED 8/12/92 COMPLETED 8/12/92
17. ELEVATION TOP OF HOLE: 56.13 Ft.
18. TOTAL CORE RECOVERY FOR BORING: 82 %
19. SIGNATURE OF GEOLOGIST: M. Goff

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/.5'
56.1	.0					56.1	
			SAND, fine-medium grain, quartz, tan to white, trace clay rootlets upper foot. (SP)	93	1	SPLIT SPOON	1 3 5
			Damp to moist.	100	2	SPLIT SPOON	5 7 8
				80	3	SPLIT SPOON	6 7 9
51.6	4.5		Little peat last .8'.			51.6	
			PEAT, black, little sand, wet. (PT) Natural Ground	100	4	SPLIT SPOON	1 1 5
49.8	6.3					50.1	
			SAND, fine-medium grain, quartz, tan (occasionally layers of CH or SC material). (SP)	80	5	SPLIT SPOON	1 1 2
			(CH) clay layer 6.6 - 6.9 with little sand			48.6	
			(CH) clay layer 8.2 - 8.8 with little sand	100	6	SPLIT SPOON	3 7 10
			(CH) clay layer 9.6 - 9.9 with little sand			47.1	
				100	7	SPLIT SPOON	7 7 12
						45.6	
				47	8	SPLIT SPOON	11 6 13
44.1	12.0					44.1	
			SAND, fine-medium grain, quartz, gray to brown, wet, little clay. (SC)	80	9	SPLIT SPOON	17 19 21
			(SP) sand layer 13.7 - 13.9			42.6	
			(SP) sand layer 14.2 - 14.4	67	10	SPLIT SPOON	17 19 17
			(CH) clay layer 15.0 - 15.4 with little sand			41.1	
				93	11	SPLIT SPOON	12 13 17
						39.6	
				73	12	SPLIT SPOON	7 9 11
37.7	18.4					38.1	
			SAND, fine-medium grain, quartz, brown, wet, trace clay. (SP)	80	13	SPLIT SPOON	17 17 19
36.6	19.5					36.6	
			SAND, fine-medium grain, quartz, gray-brown, little clay. (SC)	80	14	SPLIT SPOON	9 13 15
						35.1	
				80	15	SPLIT SPOON	7 11 13
						33.6	

(continued)

DRILLING LOG (Cont. Sheet)

ELEVATION TOP OF HOLE 56.13 Ft.

PROJECT: KISSIMMEE UPPER BASIN

INSTALLATION: Jacksonville District

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/.5'
33.6	22.5					33.6	
				73	16	SPLIT SPOON	8, 11, 11
						32.1	
				80	17	SPLIT SPOON	12, 16, 18
						30.6	
				80	18	SPLIT SPOON	11, 14, 16
						29.1	
				73	19	SPLIT SPOON	6, 12, 18
						27.6	
				87	20	SPLIT SPOON	10, 14, 20
26.1	30.0					26.1	

Note: Soils are field visually classified in accordance with the Unified Soils Classification System.

22.5 25 27.5 30 32.5 35 37.5 40 42.5 45 47.5 50

DRILLING LOG

DIVISION: South Atlantic

INSTALLATION: Jacksonville District

1. PROJECT: KISSIMMEE UPPER BASIN
2. LOCATION (Coordinates or Station): X=390,406 Y=1353,019
3. DRILLING AGENCY: Corps of Engineers
4. HOLE NO. (As shown on drawing title and file number): CB-C36-K8
5. NAME OF DRILLER: R. Gordon
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED
7. THICKNESS OF BURDEN: 0 Ft.
8. DEPTH DRILLED INTO ROCK: 0 Ft.
9. TOTAL DEPTH OF HOLE: 30 Ft.
10. SIZE AND TYPE OF BIT: Vibracore
11. DATUM FOR ELEVATION SHOWN (TBM or MSL): NGVD
12. MANUFACTURER'S DESIGNATION OF DRILL: Failing 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: disturbed: 0 undisturbed: 0
14. TOTAL NUMBER OF CORE BOXES: 2
15. ELEVATION GROUND WATER: 50.76
16. DATE HOLE: STARTED 8/12/92 COMPLETED 8/13/92
17. ELEVATION TOP OF HOLE: 56.76 Ft.
18. TOTAL CORE RECOVERY FOR BORING: 79 %
19. SIGNATURE OF GEOLOGIST: M. Goff

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/.5'
56.8	.0					56.8	
			SAND, fine-medium grain, quartz, tan to white, trace clay, trace roots. (SP)	80	1	SPLIT SPOON 55.3	2 2 3
~~54.9~~	~~1.9~~		(CH) Clay layer 1.9' - 2.1'.	80	2	SPLIT SPOON 53.8	2 3 5
~~54.7~~	~~2.1~~						
~~54.4~~	~~2.4~~		(CH) Clay layer 2.4' - 2.5'.				
53.8	3.0						
			SAND, fine-medium grain, quartz, tan with black-brown and orange mottling, little clay. (SC)	100	3	SPLIT SPOON 52.3	2 3 4
51.9	4.9						
			PEAT, black, wet, trace roots. (PT) Natural Ground	100	4	SPLIT SPOON 50.8	2 1 1
50.5	6.3						
50.0	6.8		Sand, fine-medium grain, quartz, wet. (SP)	100	5	SPLIT SPOON 49.3	2 2 1
			CLAY, gray, soft, trace to little sand. (CH)	73	6	SPLIT SPOON 47.8	1 2 2
47.3	9.5						
			SAND, fine-medium grain, quartz, wet, tan. (SP)	100	7	SPLIT SPOON 46.3	5 5 7
				100	8	SPLIT SPOON 44.8	6 3 6
44.8	12.0						
			SAND, fine-medium grain, quartz, gray, wet, little clay. (SC)	67	9	SPLIT SPOON 43.3	2 21 30
				67	10	SPLIT SPOON 41.8	14 15 15
				100	11	SPLIT SPOON 40.3	14 14 13
				73	12	SPLIT SPOON 38.8	8 14 14
				87	13	SPLIT SPOON 37.3	10 9 13
37.5	19.3						
			SAND, fine-medium grain, quartz, wet, gray, trace clay. (SP)	73	14	SPLIT SPOON 35.8	2 6 15
				27	15	SPLIT SPOON 34.3	7 13 13
						(continued)	

0 2.5 5 7.5 10 12.5 15 17.5 20 22.5

Hole No.CB-C36-K8

DRILLING LOG (Cont. Sheet)

ELEVATION TOP OF HOLE 56.76 Ft.

SHEET 2 OF 2

PROJECT: KISSIMMEE UPPER BASIN

INSTALLATION: Jacksonville District

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/.5'
34.3	22.5					34.3	
32.8	24.0			27	16	SPLIT SPOON	3, 4, 8
30.2	26.6		SAND, fine-medium grain, quartz, gray, wet, trace clay. (SP) Color change from gray-brown to gray-green.	60	17	SPLIT SPOON	3, 6, 8
				73	18	SPLIT SPOON	5, 6, 10
26.8	30.0		SAND, fine-medium grain, quartz, gray-brown, little-some clay. (SC) (Bottom is green.)	100	19	SPLIT SPOON	13, 17, 19
				87	20	SPLIT SPOON	7, 9, 12

31.3

29.8

28.3

26.8

Note: Soils are field visually classified in accordance with the Unified Soils Classification System.

22.5 25 27.5 30 32.5 35 37.5 40 42.5 45 47.5 50

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.

PROJECT: KISSIMMEE UPPER BASIN

HOLE NUMBER: CB-C36-K8

DRILLING LOG

DIVISION South Atlantic	INSTALLATION Jacksonville District
	SHEET 1 OF 2
1. PROJECT KISSIMMEE UPPER BASIN	10. SIZE AND TYPE OF BIT Vibracore
2. LOCATION (Coordinates or Station) X=390,846 Y=1354,307	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) NGVD
3. DRILLING AGENCY Corps of Engineers	12. MANUFACTURER'S DESIGNATION OF DRILL Failing 1500
4. HOLE NO. (As shown on drawing title and file number) CB-C36-K9	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 0 undisturbed: 0
5. NAME OF DRILLER R. Gordon	14. TOTAL NUMBER OF CORE BOXES 1
	15. ELEVATION GROUND WATER 50.85
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED	16. DATE HOLE STARTED 8/13/92 COMPLETED 8/13/92
7. THICKNESS OF BURDEN 0 Ft.	17. ELEVATION TOP OF HOLE 55.65 Ft.
8. DEPTH DRILLED INTO ROCK 0 Ft.	18. TOTAL CORE RECOVERY FOR BORING 73 %
9. TOTAL DEPTH OF HOLE 30 Ft.	19. SIGNATURE OF GEOLOGIST M. Goff

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/.5'
55.7	.0					55.7	
			SAND, fine-medium grain, quartz, with trace clay, also trace rootlets. (SP)	100	1	SPLIT SPOON	1 3 3
			(CH) Clay layer 1.9' - 2.1'.	80	2	SPLIT SPOON	2 3 14
			(CH) Clay layer 3.1' - 3.2'. Peat layer 3.7' - 3.8'.	100	3	SPLIT SPOON	6 5 5
50.3	5.3			80	4	SPLIT SPOON	3 1
49.5	6.2		PEAT, black, wet, trace rootlets, trace to little sand. (PT)				
			SAND, fine-medium grain, quartz, gray with brown, wet, trace peat. (SP)	93	5	SPLIT SPOON	W.O.H. 10 7
47.5	8.1			87	6	SPLIT SPOON	1 1 6
			CLAY, gray, soft-firm, little-some sand. (CH)	93	7	SPLIT SPOON	4 10 13
				0	8	SPLIT SPOON	2 2 6
42.7	12.9			73	9	SPLIT SPOON	6 8 15
			SAND, fine-medium grain, quartz, gray, with little clay. (SC)	100	10	SPLIT SPOON	18 18 17
40.7	15.0						
			SAND, fine-medium grain, quartz, tan. (SP) with trace clay.	67	11	SPLIT SPOON	7 9 17
38.8	16.8						
			SAND, fine-medium grain, quartz, brown with little clay firm. (SC)	60	12	SPLIT SPOON	4 10 11
				47	13	SPLIT SPOON	WASH 8 14
				60	14	SPLIT SPOON	6 6 12
34.7	21.0						
			SAND, fine-medium grain, quartz, gray, trace clay, wet. (SP)	60	15	SPLIT SPOON	3 8 7
33.2	22.5					33.2	
						(continued)	

0 2.5 5 7.5 10 12.5 15 17.5 20 22.5

DRILLING LOG (Cont. Sheet)

ELEVATION TOP OF HOLE 55.65 Ft.

PROJECT: KISSIMMEE UPPER BASIN

INSTALLATION: Jacksonville District

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIAL (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/.5'
33.2	22.5					33.2	
			SAND, fine-medium, grain, quartz, gray-green, little clay (soft-firm). (SC)	87	16	SPLIT SPOON	7, 6, 8
						31.6	
				47	17	SPLIT SPOON	2, 7, 12
30.1	25.5					30.1	
			SAND, fine-medium grain, quartz, wet, gray, trace clay. (SP)	80	18	SPLIT SPOON	3, 5, 7
						28.6	
				73	19	SPLIT SPOON	3, 4, 11
						27.1	
				80	20	SPLIT SPOON	5, 7, 16
25.6	30.0					25.6	

Note: Soils are field visually classified in accordance with the Unified Soils Classification System.

22.5 25 27.5 30 32.5 35 37.5 40 42.5 45 47.5 50

Hole No.CB-C37-K1

DRILLING LOG

DIVISION South Atlantic	INSTALLATION Jacksonville District
SHEET 1 OF 2	
1. PROJECT KISSIMMEE UPPER BASIN	10. SIZE AND TYPE OF BIT Vibracore
2. LOCATION (Coordinates or Station) X=387,750 Y=1319,059	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) NGVD
3. DRILLING AGENCY Corps of Engineers	12. MANUFACTURER'S DESIGNATION OF DRILL Failing 1500
4. HOLE NO. (As shown on drawing title and file number) CB-C37-K1	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 0 undisturbed: 0
5. NAME OF DRILLER R. Gordon	14. TOTAL NUMBER OF CORE BOXES 1
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED	15. ELEVATION GROUND WATER 51.53
	16. DATE HOLE STARTED 9/01/92 COMPLETED 9/01/92
7. THICKNESS OF BURDEN 0 Ft.	17. ELEVATION TOP OF HOLE 55.43 Ft.
8. DEPTH DRILLED INTO ROCK 0 Ft.	18. TOTAL CORE RECOVERY FOR BORING 73 %
9. TOTAL DEPTH OF HOLE 36 Ft.	19. SIGNATURE OF GEOLOGIST M. Goff

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/.5'
55.4	.0					55.4	
			SAND, fine-medium grain, quartz, tan, damp, trace clay, trace roots. (SP)	73	1	SPLIT SPOON 53.9	1 2 4
				87	2	SPLIT SPOON 52.4	4 5 8
52.4	3.0		Color change to brown. Wet.	73	3	SPLIT SPOON 50.9	4 4 8
				67	4	SPLIT SPOON 49.4	4 3 1
			Sand with peat from 6.3' to 6.5'.	93	5	SPLIT SPOON 47.9	3 5 7
				53	6	SPLIT SPOON 46.4	2 1 2
45.9	9.5		CLAY, gray, damp, soft, fat, trace to little sand. (CH)	100	7	SPLIT SPOON 44.9	1 1 2
43.4	12.0			87	8	SPLIT SPOON 43.4	2 3 6
			SAND, fine-medium grain, quartz, moist-slightly-wet, gray, trace clay. (SP)	80	9	SPLIT SPOON 41.9	10 17 28
40.4	15.0			73	10	SPLIT SPOON 40.4	9 14 13
			SAND, fine-medium grain, quartz, wet, little clay, gray. (SC)	87	11	SPLIT SPOON 38.9	5 4 6
				73	12	SPLIT SPOON 37.4	4 7 10
				73	13	SPLIT SPOON 35.9	3 7 11
				73	14	SPLIT SPOON 34.4	3 8 8
34.2	21.2		SAND, fine-medium grain, quartz, wet, tan, slightly-calcareous. (SP)	73	15	SPLIT SPOON 32.9	1 1 7
						(continued)	

0 2.5 5 7.5 10 12.5 15 17.5 20 22.5

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PROJECT KISSIMMEE UPPER BASIN | HOLE NUMBER CB-C37-K1

DRILLING LOG (Cont. Sheet)

ELEVATION TOP OF HOLE 55.43 Ft.

PROJECT: KISSIMMEE UPPER BASIN

INSTALLATION: Jacksonville District

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/.5'
32.9	22.5					32.9	
				47	16	SPLIT SPOON	3 7 8
						31.4	
				80	17	SPLIT SPOON	2 6 8
						29.9	
				67	18	SPLIT SPOON	2 4 5
						28.4	
				53	19	SPLIT SPOON	1 1 1
						26.9	
				40	20	SPLIT SPOON	2 4 6
						25.4	
				67	21	SPLIT SPOON	WASHED WASHED WASHED
						23.9	
				47	22	SPLIT SPOON	WASHED WASHED WASHED
						22.4	
				80	23	SPLIT SPOON	4 4 6
						20.9	
				93	24	SPLIT SPOON	4 3
19.4	36.0					19.4	

Note: Soils are field visually classified in accordance with the Unified Soils Classification System.

22.5 25 27.5 30 32.5 35 37.5 40 42.5 45 47.5 50

DRILLING LOG

DIVISION South Atlantic	INSTALLATION Jacksonville District
	SHEET 1 OF 2
1. PROJECT KISSIMMEE UPPER BASIN	10. SIZE AND TYPE OF BIT Vibracore
2. LOCATION (Coordinates or Station) X=385,725 Y=1320,456	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) NGVD
3. DRILLING AGENCY Corps of Engineers	12. MANUFACTURER'S DESIGNATION OF DRILL Failing 1500
4. HOLE NO. (As shown on drawing title and file number) CB-C37-K2	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 0 undisturbed: 0
5. NAME OF DRILLER R. Gordon	14. TOTAL NUMBER OF CORE BOXES 1
	15. ELEVATION GROUND WATER 50.01
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED	16. DATE HOLE STARTED 8/31/92 COMPLETED 8/31/92
7. THICKNESS OF BURDEN 0 Ft.	17. ELEVATION TOP OF HOLE 56.01 Ft.
8. DEPTH DRILLED INTO ROCK 0 Ft.	18. TOTAL CORE RECOVERY FOR BORING 80 %
9. TOTAL DEPTH OF HOLE 36 Ft.	19. SIGNATURE OF GEOLOGIST M. Goff

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/.6'
56.0	.0					56.0	
			SAND, fine-medium grain, quartz, tan, damp, trace clay, tan, trace roots. (SP)	87	1	SPLIT SPOON	2 3 2
				87	2	SPLIT SPOON	3 5 6
53.0	3.0		Color change to brown. Moist to slightly wet.			53.0	
				100	3	SPLIT SPOON	4 5 5
				80	4	SPLIT SPOON	3 3 2
49.8	6.2					50.0	
			PEAT, black, damp, trace to little clay, (PT)	87	5	SPLIT SPOON	1 1 1
				100	6	SPLIT SPOON	1 1 1
47.0	9.0					47.0	
			CLAY, gray, wet, soft, little sand. (CH)	80	7	SPLIT SPOON	1 2 4
				100	8	SPLIT SPOON	4 6 5
44.0	12.0					44.0	
			SAND, fine-medium grain, quartz, brown, wet (SP), trace clay.	60	9	SPLIT SPOON	13 14 23
				73	10	SPLIT SPOON	8 14 11
41.0	15.0					41.0	
			Slightly calcareous, trace coarse grain sand (quartz).	87	11	SPLIT SPOON	4 4 2
				67	12	SPLIT SPOON	1
						38.0	
				73	13	SPLIT SPOON	2 3 5
				73	14	SPLIT SPOON	3 3 5
						35.0	
				47	15	SPLIT SPOON	4 9 26
						33.5	
						(continued)	

0 2.5 5 7.5 10 12.5 15 17.5 20 22.5

DRILLING LOG (Cont. Sheet)

ELEVATION TOP OF HOLE 56.01 Ft.

PROJECT: KISSIMMEE UPPER BASIN

INSTALLATION: Jacksonville District

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/.5'
33.5	22.5					33.5	
32.0	24.0			47	16	SPLIT SPOON	5, 10, 12
			SAND, fine-medium grain, quartz, wet, brown, trace coarse grain sand (quartz), trace clay. (SP)	67	17	SPLIT SPOON	3, 8, 12
				67	18	SPLIT SPOON	5, 11, 28
				100	19	SPLIT SPOON	WASH, 20, 20
26.0	30.0			100	20	SPLIT SPOON	3, 8, 20
			SAND, fine-medium grain, quartz, wet, brown with little to some clay (SC)	80	21	SPLIT SPOON	2, 5, 4
23.0	33.0			87	22	SPLIT SPOON	1, 9, 13
			Trace weathered sandstone fragments below 33.0', little clay.	73	23	SPLIT SPOON	5, 6, 13
21.5	34.5		Trace-little clay below 34.5.				
20.0	36.0			100	24	SPLIT SPOON	9, 7, 13
			Note: Soils are field visually classified in accordance with the Unified Soils Classification System.				

22.5 25 27.5 30 32.5 35 37.5 40 42.5 45 47.5 50

DRILLING LOG

DIVISION South Atlantic	INSTALLATION Jacksonville District
	SHEET 1 OF 2
1. PROJECT KISSIMMEE UPPER BASIN	10. SIZE AND TYPE OF BIT Vibracore
2. LOCATION (Coordinates or Station) X=383,665 Y=1321,846	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) NGVD
3. DRILLING AGENCY Corps of Engineers	12. MANUFACTURER'S DESIGNATION OF DRILL Failing 1500
4. HOLE NO. (As shown on drawing title and file number) CB-C37-K3	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 0 undisturbed: 0
5. NAME OF DRILLER R. Gordon	14. TOTAL NUMBER OF CORE BOXES 2
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED	15. ELEVATION GROUND WATER 51.58
	16. DATE HOLE STARTED 8/28/92 COMPLETED 8/28/92
7. THICKNESS OF BURDEN 0 Ft.	17. ELEVATION TOP OF HOLE 56.58 Ft.
8. DEPTH DRILLED INTO ROCK 0 Ft.	18. TOTAL CORE RECOVERY FOR BORING 65 %
9. TOTAL DEPTH OF HOLE 36 Ft.	19. SIGNATURE OF GEOLOGIST M. Goff

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/.5'
56.6	.0					56.6	
			SAND, fine-medium grain, quartz, tan, trace roots, (SP)	80	1	SPLIT SPOON 55.1	1 1 3
				80	2	SPLIT SPOON 53.6	1 2 4
				87	3	SPLIT SPOON 52.1	3 4 5
				87	4	SPLIT SPOON 50.6	3 2 2
50.1	6.5		Color change to brown.	67	5	SPLIT SPOON 49.1	1 1 1
48.3	8.3			100	6	SPLIT SPOON 47.6	1 2 1
			PEAT, black, damp, trace sand, little clay. (PT) NATURAL GROUND	73	7	SPLIT SPOON 46.1	W.O.H. W.O.H. 3
46.1	10.5		SAND, fine-medium grain, quartz, wet, brown, (SP)	67	8	SPLIT SPOON 44.6	5 8 14
				60	9	SPLIT SPOON 43.1	6 12 7
				60	10	SPLIT SPOON 41.6	5 8 10
				67	11	SPLIT SPOON 40.1	3 5 6
40.1	16.5		Trace clay below 16.5'	40	12	SPLIT SPOON 38.6	7 10 14
				73	13	SPLIT SPOON 37.1	5 7 13
				13	14	SPLIT SPOON 35.6	2 4 5
				87	15	SPLIT SPOON 34.1	3 6 9
						(continued)	

0 2.5 5 7.5 10 12.5 15 17.5 20 22.5

DRILLING LOG (Cont. Sheet)

ELEVATION TOP OF HOLE 56.58 Ft.

PROJECT: KISSIMMEE UPPER BASIN

INSTALLATION: Jacksonville District

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/.5'
34.1	22.5					34.1	
				80	16	SPLIT SPOON	1, 1, 5
						32.6	
				13	17	SPLIT SPOON	3, 5, 6
						31.1	
				93	18	SPLIT SPOON	4, 4, 5
						29.6	
				67	19	SPLIT SPOON	2, 3, 5
						28.1	
				7	20	SPLIT SPOON	4, 9, 14
						26.6	
				33	21	SPLIT SPOON	2, 4, 3
						25.1	
				87	22	SPLIT SPOON	7, 7, 4
23.9	32.7					23.6	
			SAND, fine-medium grain, quartz, tan, wet, with little clay occasionally in layers up to 2" thick. (SC)	80	23	SPLIT SPOON	3, 5, 6
22.1	34.5					22.1	
			SAND, predominantly fine grain, quartz, tan, damp (SP).	67	24	SPLIT SPOON	3, 4, 12
20.6	36.0					20.6	

Note: Soils are field visually classified in accordance with the Unified Soils Classification System.

22.5 25 27.5 30 32.5 35 37.5 40 42.5 45 47.5 50

DRILLING LOG

DIVISION South Atlantic	INSTALLATION Jacksonville District
	SHEET 1 OF 2
1. PROJECT KISSIMMEE UPPER BASIN	10. SIZE AND TYPE OF BIT Vibracore
2. LOCATION (Coordinates or Station) X=381,662 Y=1323,258	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) NGVD
3. DRILLING AGENCY Corps of Engineers	12. MANUFACTURER'S DESIGNATION OF DRILL Failing 1500
4. HOLE NO. (As shown on drawing title and file number) CB-C37-K4	13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN disturbed: 0 undisturbed: 0
5. NAME OF DRILLER R. Gordon	14. TOTAL NUMBER OF CORE BOXES 2
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED	15. ELEVATION GROUND WATER 53.31
	16. DATE HOLE STARTED 8/26/92 COMPLETED 8/27/92
7. THICKNESS OF BURDEN 0 Ft.	17. ELEVATION TOP OF HOLE 56.31 Ft.
8. DEPTH DRILLED INTO ROCK 0 Ft.	18. TOTAL CORE RECOVERY FOR BORING 73 %
9. TOTAL DEPTH OF HOLE 36 Ft.	19. SIGNATURE OF GEOLOGIST M. Goff

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/.5'
56.3	.0					56.3	
			SAND, fine-medium grain, quartz, tan, slightly damp, trace roots upper .5'. (SP)	80	1	SPLIT SPOON	3, 5, 6
						54.8	
				87	2	SPLIT SPOON	3, 5, 9
						53.3	
				67	3	SPLIT SPOON	3, 3, 6
						51.8	
				87	4	SPLIT SPOON	3, 5, 7
						50.3	
				87	5	SPLIT SPOON	3, 7, 3
48.8	7.5					48.8	
			PEAT, black, damp, soft, trace to little sand. (PT)	73	6	SPLIT SPOON	1, 1, 3
			NATURAL GROUND			47.3	
				100	7	SPLIT SPOON	1, 1, 1
						45.8	
45.2	11.1			80	8	SPLIT SPOON	W.O.H., W.O.H., 1
			SAND, fine-medium grain, quartz, wet, tan, trace coarse grain, trace of peat, (SP)			44.3	
				33	9	SPLIT SPOON	1, 2, 1
						42.8	
				80	10	SPLIT SPOON	1, 2, 23
						41.3	
				47	11	SPLIT SPOON	3, 13, 24
39.8	16.5		No PEAT below 16.5'.			39.8	
				93	12	SPLIT SPOON	4, 7, 14
						38.3	
				100	13	SPLIT SPOON	4, 8, 14
						36.8	
				33	14	SPLIT SPOON	4, 15, 14
						35.3	
34.4	21.9		Slightly calcareous below 21.9	100	15	SPLIT SPOON	4, 6, 10
						33.8	
						(continued)	

Depth scale: 0, 2.5, 5, 7.5, 10, 12.5, 15, 17.5, 20, 22.5

Hole No.CB-C37-K4

DRILLING LOG (Cont. Sheet)

ELEVATION TOP OF HOLE 56.31 Ft.

SHEET 2 OF 2

PROJECT: KISSIMMEE UPPER BASIN

INSTALLATION: Jacksonville District

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/.5'
33.8	22.5					33.8	
				20	16	SPLIT SPOON	4 8 14
						32.3	
				67	17	SPLIT SPOON	5 7 9
						30.8	
			No Recovery		18	SPLIT SPOON	9 10 13
						29.3	
				100	19	SPLIT SPOON	4 5 5
						27.8	
				100	20	SPLIT SPOON	4 5 5
						26.3	
				100	21	SPLIT SPOON	6 5 5
						24.8	
				60	22	SPLIT SPOON	3 5 7
						23.3	
				80	23	SPLIT SPOON	6 6 9
						21.8	
				87	24	SPLIT SPOON	5 6 8
20.3	36.0					20.3	

Note: Soils are field visually classified in accordance with the Unified Soils Classification System.

22.5 25 27.5 30 32.5 35 37.5 40 42.5 45 47.5 50

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.

PROJECT: KISSIMMEE UPPER BASIN

HOLE NUMBER: CB-C37-K4

DRILLING LOG

DIVISION: South Atlantic

INSTALLATION: Jacksonville District

1. PROJECT: KISSIMMEE UPPER BASIN
2. LOCATION (Coordinates or Station): X=379,708 Y=1324,767
3. DRILLING AGENCY: Corps of Engineers
4. HOLE NO. (As shown on drawing title and file number): CB-C37-K5
5. NAME OF DRILLER: R. Gordon
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED
7. THICKNESS OF BURDEN: 0 Ft.
8. DEPTH DRILLED INTO ROCK: 0 Ft.
9. TOTAL DEPTH OF HOLE: 36 Ft.
10. SIZE AND TYPE OF BIT: Vibracore
11. DATUM FOR ELEVATION SHOWN (TBM or MSL): NGVD
12. MANUFACTURER'S DESIGNATION OF DRILL: Failing 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: disturbed: 0 undisturbed: 0
14. TOTAL NUMBER OF CORE BOXES: 1
15. ELEVATION GROUND WATER: 49.78
16. DATE HOLE: STARTED 8/23/92 COMPLETED 8/23/92
17. ELEVATION TOP OF HOLE: 54.98 Ft.
18. TOTAL CORE RECOVERY FOR BORING: 76 %
19. SIGNATURE OF GEOLOGIST: M. Goff

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/.5'
55.0	.0					55.0	
			SAND, fine-medium grain, quartz, brown, slightly damp, trace clay, trace to little roots. (SP)	67	1	SPLIT SPOON 53.5	3, 4, 6
				93	2	SPLIT SPOON 52.0	7, 7, 7
				80	3	SPLIT SPOON 50.5	9, 8, 11
				80	4	SPLIT SPOON 49.0	3, 4, 5
48.0	7.0		Sand (SP) with little trace peat in layers, 6.5' - 7.0'.	80	5	SPLIT SPOON 47.5	
			PEAT, black, moist, with trace clay. (PT) NATURAL GROUND				1
46.5	8.5			100	6	SPLIT SPOON 46.0	1, 2, 12
			SAND, fine-medium grain, quartz, wet, brown, trace silt, trace coarse to gravel size sand (quartz). (SP) (Peat layer at 8.9')	100	7	SPLIT SPOON 44.5	3, 7, 9
				100	8	SPLIT SPOON 43.0	5, 5, 7
				100	9	SPLIT SPOON 41.5	8, 8, 8
				100	10	SPLIT SPOON 40.0	2, 2, 2
				87	11	SPLIT SPOON 38.5	3, 4, 9
37.0	18.0			80	12	SPLIT SPOON 37.0	4, 19, 50
			Color change to reddish-brown	73	13	SPLIT SPOON 35.5	19, 30, 45
				80	14	SPLIT SPOON 34.0	7, 22, 27
33.3	21.7		Color change to dark brown	100	15	SPLIT SPOON 32.5	7, 16, 19

(continued)

DRILLING LOG (Cont. Sheet)

ELEVATION TOP OF HOLE 54.98 Ft.

PROJECT: KISSIMMEE UPPER BASIN

INSTALLATION: Jacksonville District

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/.5'
32.5	22.5					32.5	
				47	16	SPLIT SPOON	3, 12, 17
31.0	24.0		Slightly calcareous, tan-light brown			31.0	
				60	17	SPLIT SPOON	3, 4, 8
						29.5	
			Slightly calcareous	No Recovery	18	SPLIT SPOON	3, 4, 8
28.0	27.0		Tan below depth 27.0			28.0	
				93	19	SPLIT SPOON	3, 9, 12
26.5	28.5		Samples no longer calcareous below 28.5'			26.5	
				47	20	SPLIT SPOON	7, 6, 10
						25.0	
				73	21	SPLIT SPOON	W.O.H., 7, 6
23.5	31.5		predominantly fine grain below 31.5'			23.5	
				47	22	SPLIT SPOON	4, 8, 12
						22.0	
				40	23	SPLIT SPOON	7, 7, 7
						20.5	
				100	24	SPLIT SPOON	13, 10, 13
19.0	36.0					19.0	

Note: Soils are field visually classified in accordance with the Unified Soils Classification System.

22.5 25 27.5 30 32.5 35 37.5 40 42.5 45 47.5 50

DRILLING LOG

DIVISION: South Atlantic

INSTALLATION: Jacksonville District

1. PROJECT: KISSIMMEE UPPER BASIN
2. LOCATION (Coordinates or Station): X=379,166 Y=1325,211
3. DRILLING AGENCY: Corps of Engineers
4. HOLE NO. (As shown on drawing title and file number): CB-C37-K6
5. NAME OF DRILLER: R. Gordon
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED
7. THICKNESS OF BURDEN: 0 Ft.
8. DEPTH DRILLED INTO ROCK: 0 Ft.
9. TOTAL DEPTH OF HOLE: 36 Ft.
10. SIZE AND TYPE OF BIT: Vibracore
11. DATUM FOR ELEVATION SHOWN (TBM or MSL): NGVD
12. MANUFACTURER'S DESIGNATION OF DRILL: Failing 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: disturbed: 0 undisturbed: 0
14. TOTAL NUMBER OF CORE BOXES: 1
15. ELEVATION GROUND WATER: 51.17
16. DATE HOLE: STARTED 8/20/92 COMPLETED 8/21/92
17. ELEVATION TOP OF HOLE: 55.47 Ft.
18. TOTAL CORE RECOVERY FOR BORING: 75 %
19. SIGNATURE OF GEOLOGIST: M. Goff

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/.5'
55.5	.0					55.5	
			SAND, fine-medium grain, quartz, lt. brown, trace clay and roots. (SP)	73	1	SPLIT SPOON 54.0	3 2 3
			Damp, color changing from dark brown to white.	80	2	SPLIT SPOON 52.5	2 3 5
			Color change to brown. Wet last .5'.	100	3	SPLIT SPOON 51.0	3 3 2
50.6	4.9						
			SAND, fine to medium grain, quartz, wet, little-some clay, soft-firm (SC).	67	4	SPLIT SPOON 49.5	3 3 4
49.0	6.5						
48.5	7.0		Color change grey to brown below 6.5'	87	5	SPLIT SPOON 48.0	1 1 7
			SAND, fine-medium grain, quartz, brown, wet, trace clay. (SP)	80	6	SPLIT SPOON 46.5	3 3 3
47.4	8.1						
46.5	9.0		SAND, fine to medium grain, quartz, wet little-some clay, gray. (SC)				
			SAND, fine to medium grain, quartz, brown, wet, trace clay. (SP)	100	7	SPLIT SPOON 45.0	1 1 2
			Trace coarse grain size sand (quartz) last 1.0'.	100	8	SPLIT SPOON 43.5	4 5 7
				73	9	SPLIT SPOON 42.0	3 7 10
41.5	14.0						
			Color change to orange brown at 14.0'.	60	10	SPLIT SPOON 40.5	10 20 34
				60	11	SPLIT SPOON 39.0	4 7 10
				60	12	SPLIT SPOON 37.5	3 10 12
37.5	18.0						
			Color change to tan.	73	13	SPLIT SPOON 36.0	13 17 14
				53	14	SPLIT SPOON 34.5	6 9 13
				87	15	SPLIT SPOON 33.0	5 7 10

(continued)

DRILLING LOG (Cont. Sheet)

ELEVATION TOP OF HOLE 55.47 Ft.

PROJECT: KISSIMMEE UPPER BASIN

INSTALLATION: Jacksonville District

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/.5'
33.0	22.5					33.0	
				87	16	SPLIT SPOON	4, 7, 14
						31.5	
				47	17	SPLIT SPOON	8, 10, 19
						30.0	
				100	18	SPLIT SPOON	5, 12, 14
						28.5	
				27	19	SPLIT SPOON	4, 6, 9
						27.0	
				73	20	SPLIT SPOON	5, 10, 15
						25.5	
				100	21	SPLIT SPOON	5, 17, 15
						24.0	
				67	22	SPLIT SPOON	4, 10, WASH
						22.5	
				75	23	SPLIT SPOON	9, 15, 21, 23
19.5	36.0					19.5	

Note: Soils are field visually classified in accordance with the Unified Soils Classification System.

22.5 25 27.5 30 32.5 35 37.5 40 42.5 45 47.5 50

DRILLING LOG

DIVISION South Atlantic

INSTALLATION Jacksonville District

SHEET 1 OF 2

1. PROJECT
KISSIMMEE UPPER BASIN

2. LOCATION (Coordinates or Station)
X=378,885 Y=1326,319

3. DRILLING AGENCY
Corps of Engineers

4. HOLE NO. (As shown on drawing title and file number) CB-C37-K7

5. NAME OF DRILLER
R. Gordon

6. DIRECTION OF HOLE
☒ VERTICAL ☐ INCLINED

7. THICKNESS OF BURDEN 0 Ft.

8. DEPTH DRILLED INTO ROCK 0 Ft.

9. TOTAL DEPTH OF HOLE 30 Ft.

10. SIZE AND TYPE OF BIT Vibracore

11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
NGVD

12. MANUFACTURER'S DESIGNATION OF DRILL
Failing 1500

13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN
disturbed: 0 undisturbed: 0

14. TOTAL NUMBER OF CORE BOXES 2

15. ELEVATION GROUND WATER 49.01

16. DATE HOLE STARTED 8/19/92 COMPLETED 8/20/92

17. ELEVATION TOP OF HOLE 56.31 Ft.

18. TOTAL CORE RECOVERY FOR BORING 75 %

19. SIGNATURE OF GEOLOGIST
M. Goff

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/.5'
56.3	.0					56.3	
			SAND, fine-medium grain, quartz, brown, trace clay, trace roots. (SP)	80	1	SPLIT SPOON	2 3 2
			Damp.	87	2	SPLIT SPOON	3 3 4
53.1	3.2		Color change to tan.	100	3	SPLIT SPOON	4 4 3
50.8	5.5			87	4	SPLIT SPOON	3 2 2
			PEAT, black, wet, soft, trace to little clay, (PT) trace roots. (Natural Ground)	100	5	SPLIT SPOON	PUSH
				100	6	SPLIT SPOON	1 1
				100	7	SPLIT SPOON	PUSH 1
				100	8	SPLIT SPOON	PUSH
44.3	12.0		Little sand below depth 12.0'	67	9	SPLIT SPOON	W.O.H. W.O.H. W.O.H.
42.8	13.5						
			SAND, fine-medium grain, dark gray, quartz, wet. (SP)	53	10	SPLIT SPOON	5 4 4
			Occasional thin PEAT layers from 16.8' - 19.0'.	47	11	SPLIT SPOON	4 7 11
				67	12	SPLIT SPOON	1 1 9
			Trace coarse-gravel size sand (quartz) below 18.0'.	87	13	SPLIT SPOON	4 7 11
				33	14	SPLIT SPOON	14 12 9
				100	15	SPLIT SPOON	4 10 19
						33.8	
						(continued)	

0 2.5 5 7.5 10 12.5 15 17.5 20 22.5

DRILLING LO (Cont. Sheet)

ELEVATION TOP OF HOLE 56.31 Ft.

PROJECT: KISSIMMEE UPPER BASIN

INSTALLATION: Jacksonville District

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/.5'
33.8	22.5					33.8	
32.3	24.0		Tan below depth 24.0'	33	16	SPLIT SPOON 32.3	3 8 15
31.3	25.0			73	17	SPLIT SPOON 30.8	4 4 6
			SAND, tan, fine-medium grain, trace coarse grain, wet, quartz, little clay, trace to little shell. (SC)	80	18	SPLIT SPOON 29.3	6 5 14
				73	19	SPLIT SPOON 27.8	10 10 12
26.3	30.0			33	20	SPLIT SPOON 26.3	5 10 10
			Note: Soils are field visually classified in accordance with the Unified Soils Classification System.				

22.5 25 27.5 30 32.5 35 37.5 40 42.5 45 47.5 50

DRILLING LOG

DIVISION: South Atlantic

INSTALLATION: Jacksonville District

1. PROJECT: KISSIMMEE UPPER BASIN
2. LOCATION (Coordinates or Station): X=378,024 Y=1328,515
3. DRILLING AGENCY: Corps of Engineers
4. HOLE NO. (As shown on drawing title and file number): CB-C37-K8
5. NAME OF DRILLER: R. Gordon
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED
7. THICKNESS OF BURDEN: 0 Ft.
8. DEPTH DRILLED INTO ROCK: 0 Ft.
9. TOTAL DEPTH OF HOLE: 30 Ft.
10. SIZE AND TYPE OF BIT: Vibracore
11. DATUM FOR ELEVATION SHOWN (TBM or MSL): NGVD
12. MANUFACTURER'S DESIGNATION OF DRILL: Failing 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: disturbed: 0 undisturbed: 0
14. TOTAL NUMBER OF CORE BOXES: 1
15. ELEVATION GROUND WATER: 53.50
16. DATE HOLE: STARTED 8/18/92 COMPLETED 8/19/92
17. ELEVATION TOP OF HOLE: 56.30 Ft.
18. TOTAL CORE RECOVERY FOR BORING: 82 %
19. SIGNATURE OF GEOLOGIST: M. Goff

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/.5'
56.3	.0					56.3	
			SAND, fine-medium grain, quartz, tan, with trace clay and trace roots. (SP)	100	1	SPLIT SPOON	1, 2, 3
						54.8	
				87	2	SPLIT SPOON	2, 3, 3
			SAND, predominantly medium grain, moist to wet. (SP)			53.3	
				73	3	SPLIT SPOON	8, 1, 2
51.5	4.8					51.8	
			PEAT, black, trace-little clay, soft. (PT) Natural Ground.	100	4	SPLIT SPOON	1, 1, 2
						50.3	
				87	5	SPLIT SPOON	1, 2
			7.7' - 8.0' - Some sand. (SP)			48.8	
				80	6	SPLIT SPOON	3, 3, 2
			Some clay, very soft.			47.3	
				80	7	SPLIT SPOON	1, 1
45.8	10.5					45.8	
			CLAY, grey, wet, some silt. (CH)	100	8	SPLIT SPOON	W.O.H, 1
						44.3	
43.4	12.9			100	9	SPLIT SPOON	W.O.H, 11, 15
			SAND, fine-medium grain, wet, quartz, tan-hard brown, trace clay. (SP)			42.8	
				73	10	SPLIT SPOON	5, 8, 9
						41.3	
				87	11	SPLIT SPOON	5, 5, 5
						39.8	
				80	12	SPLIT SPOON	2, 3, 5
38.3	18.0					38.3	
			At 18.0' grain size changes from fine-medium to medium-course grain.	80	13	SPLIT SPOON	2, 2, 5
36.8	19.5					36.8	
			Color change to brown.	93	14	SPLIT SPOON	3, 4, 1
						35.3	
			Trace gravel size quartz (sand).	73	15	SPLIT SPOON	1
						33.8	
						(continued)	

Depth scale: 0, 2.5, 5, 7.5, 10, 12.5, 15, 17.5, 20, 22.5

DRILLING LOG (Cont. Sheet)

ELEVATION TOP OF HOLE 56.30 Ft.

PROJECT: KISSIMMEE UPPER BASIN

INSTALLATION: Jacksonville District

ELEV.	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	CORE REC %	SAMPLE NUMBER	REMARKS Bit or Barrel	BLOWS/.5'
33.8	22.5					33.8	
32.3	24.0		Below depth 24.0', fine to medium grain, trace coarse grain, quartz, brown, trace clay with silt. (SP)	87	16	SPLIT SPOON 32.3	2 3 5
				87	17	SPLIT SPOON 30.8	2 10 20
				60	18	SPLIT SPOON 29.3	11 36 50
				67	19	SPLIT SPOON 27.8	30 22 23
26.3	30.0			47	20	SPLIT SPOON 26.3	10 11 17

Note: Soils are field visually classified in accordance with the Unified Soils Classification System.

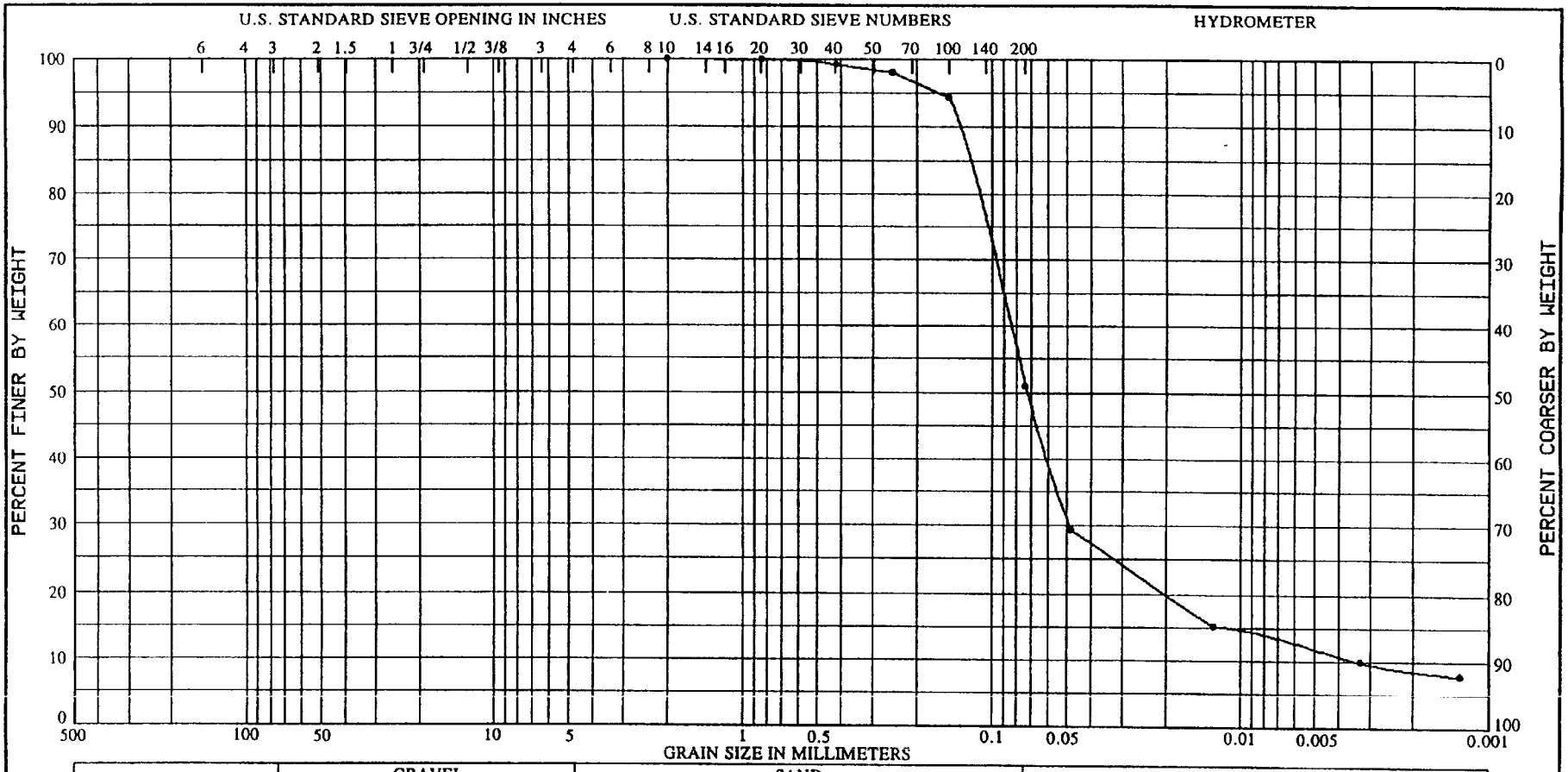
22.5 25 27.5 30 32.5 35 37.5 40 42.5 45 47.5 50

APPENDIX C-2

LABORATORY TEST DATA

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE , MARIETTA, GA. 30060

WORK ORDER: 7378
REQUISITION: RM-CW-94-0148



Sample No.	Depth	Classification	Nat w%	LL	PL	PI
18	27.0-28.5'	(VISUAL) GRAY, CLAYEY SAND (SC).				

Project KISSIMMEE RIVER
RESTORATION SECTION 1135 PROJECT

Lab No. 73/6547

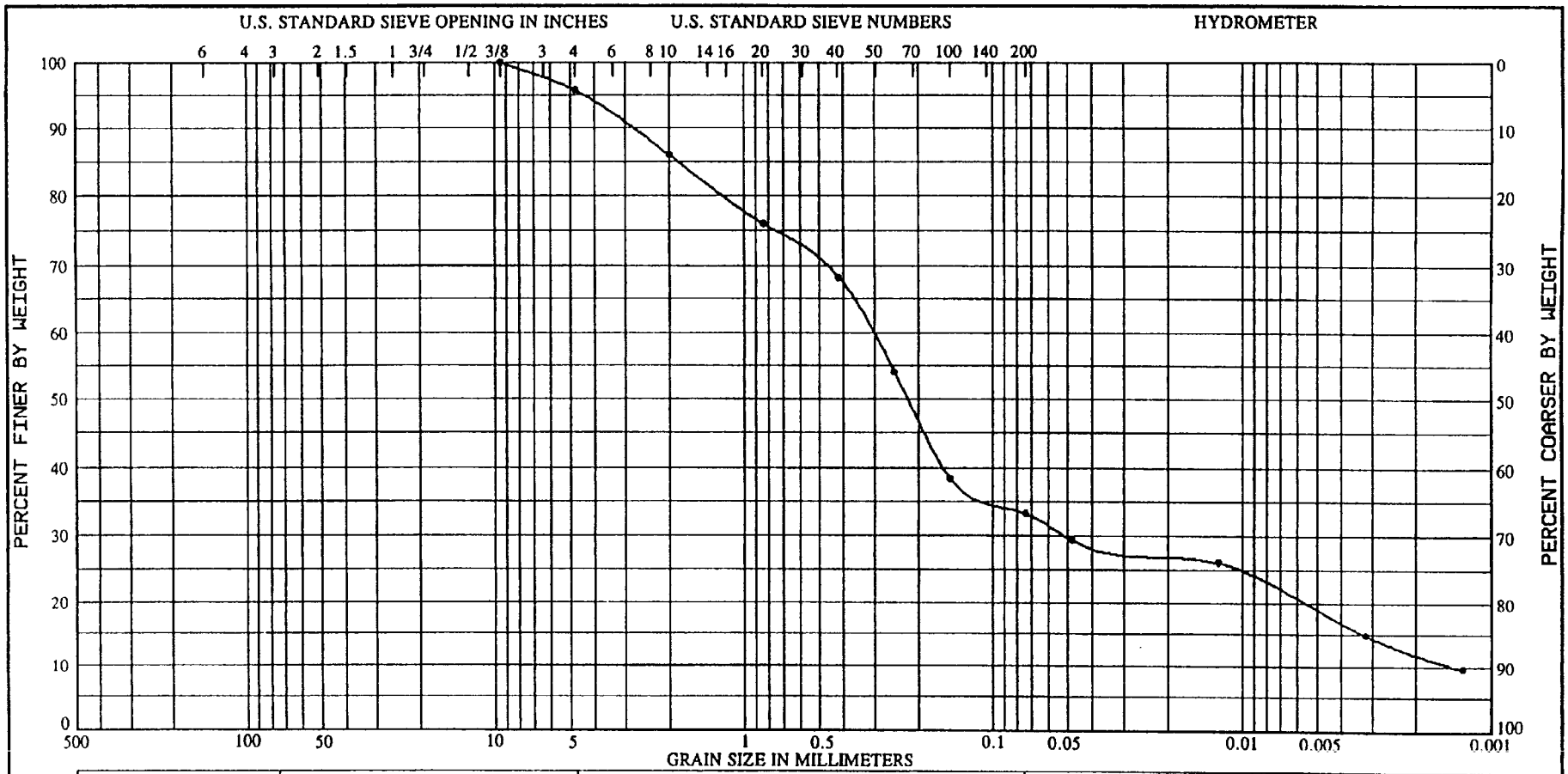
Boring No. CB-S65K-9

Date 09/20/94

GRADATION CURVES

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE , MARIETTA, GA. 30060

WORK ORDER: 7378
REQUISITION: RM-CW-94-0148



Sample No.	Depth	Classification	Nat w%	LL	PL	PI
26	37.5-39.0'	LT. GRAY, CLAYEY SAND (SC), WITH A TRACE OF GRAVEL SIZES.	25.9	32	15	17
		SP. GRAVITY = 2.70				

Project KISSIMMEE RIVER RESTORATION SECTION 1135 PROJECT

Lab No. 73/6548

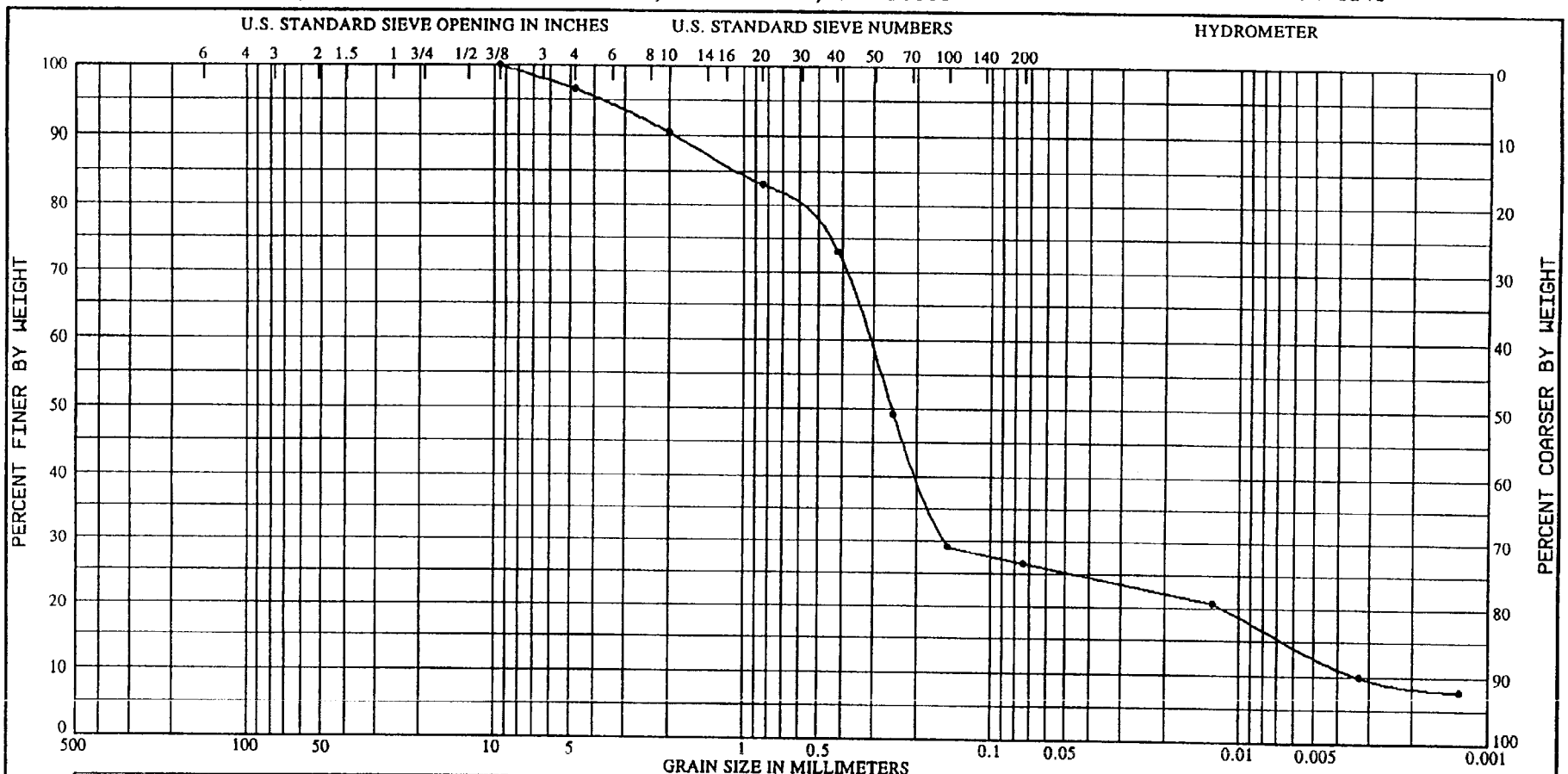
Boring No. CB-S65K-9

Date 08/19/94

GRADATION CURVES

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE , MARIETTA, GA. 30060

WORK ORDER: 7378
REQUISITION: RM-CW-94-0148



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Sample No.	Depth	Classification	Nat w%	LL	PL	PI
34	49.5-51.0'	(VISUAL) LT. GRAY, CLAYEY SAND (SC), WITH				
		A TRACE OF GRAVEL SIZES.				

Project KISSIMMEE RIVER
RESTORATION SECTION 1135 PROJECT

Lab No. 73/6549

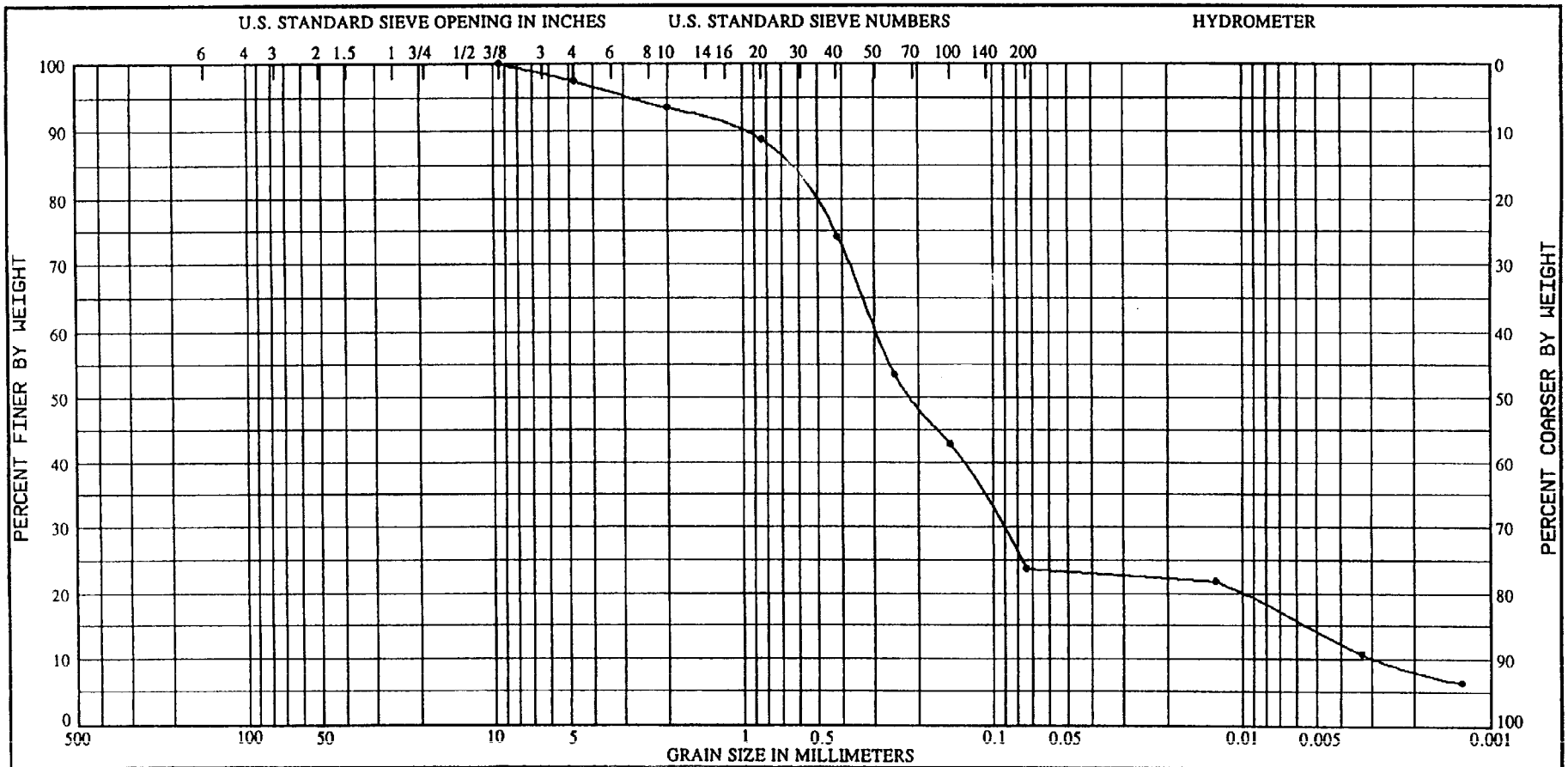
Boring No. CB-S65K-9

Date 09/20/94

GRADATION CURVES

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE , MARIETTA, GA. 30060

WORK ORDER: 7378
REQUISITION: RM-CW-94-0148



Sample No.	Depth	Classification	Nat w%	LL	PL	PI
37	54.0-55.5'	GRAY, CLAYEY SAND (SC), WITH A TRACE OF GRAVEL SIZES.	33.5	28	17	11
		SPECIFIC GRAVITY = 2.63.				

Project KISSIMMEE RIVER RESTORATION SECTION 1135 PROJECT

Lab No. 73/6550

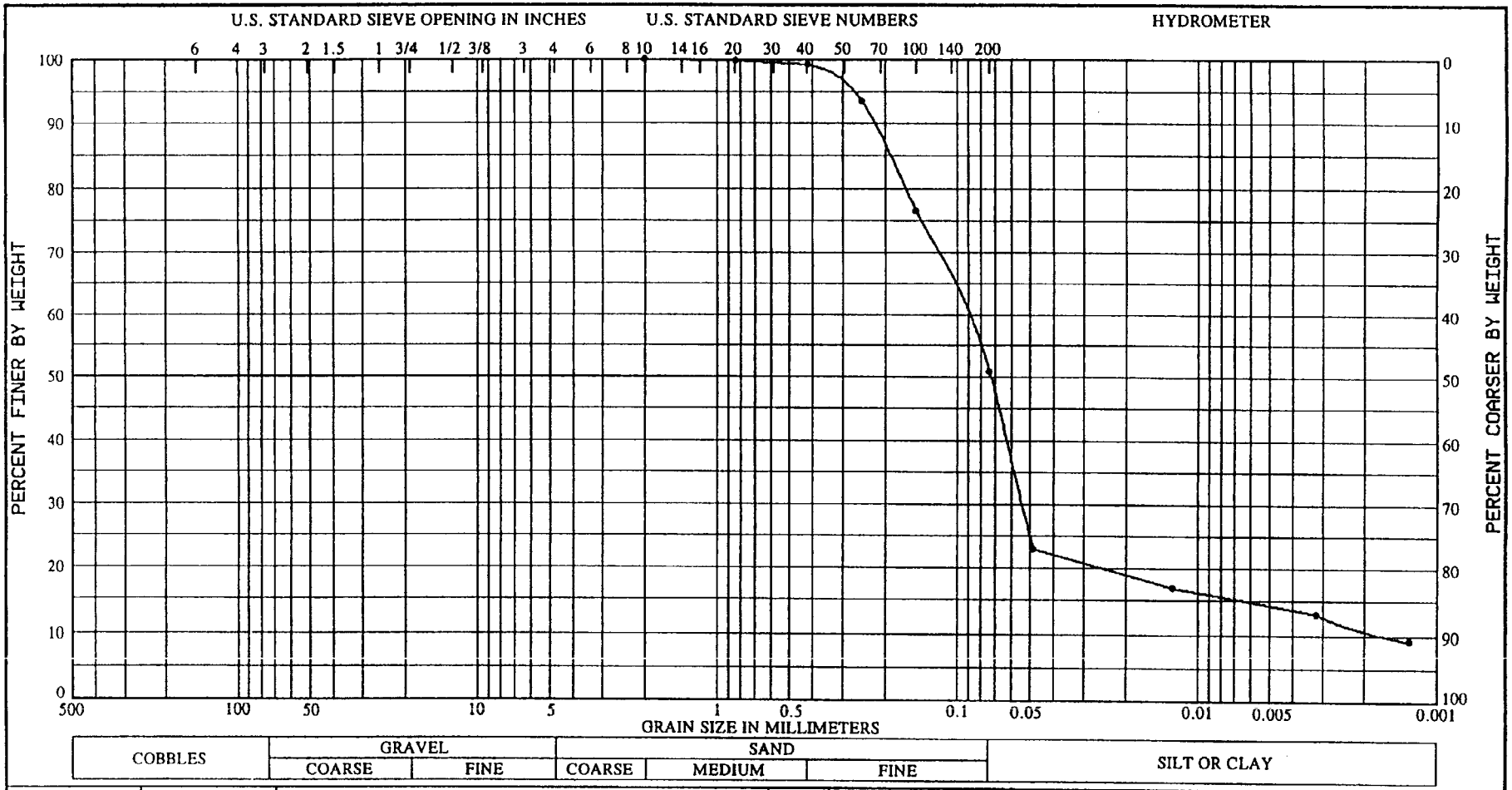
Boring No. CB-S65K-9

Date 08/20/94

GRADATION CURVES

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE , MARIETTA, GA. 30060

WORK ORDER: 7378
REQUISITION: RM-CW-94-0148



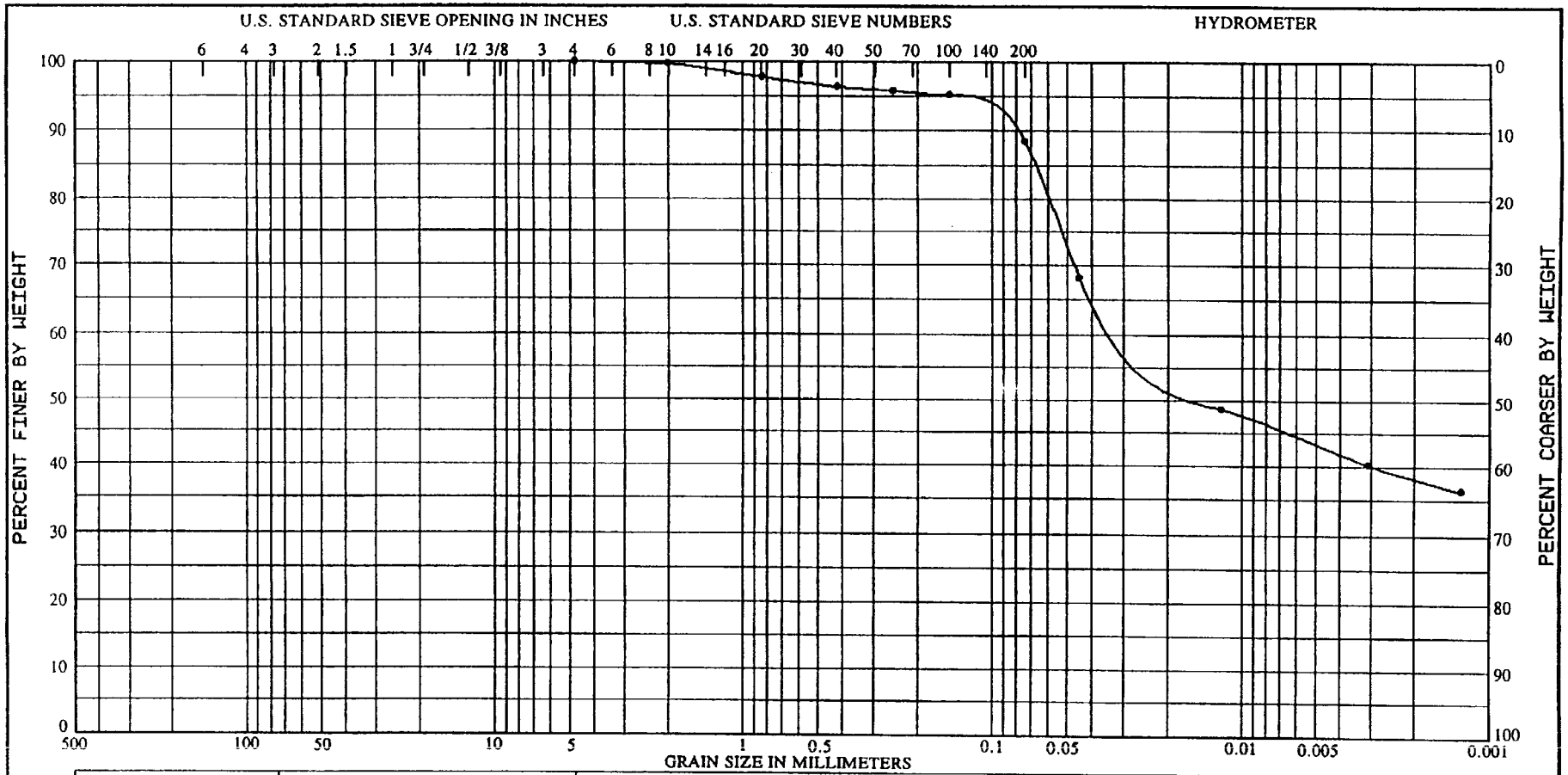
Sample No.	Depth	Classification	Nat w%	LL	PL	PI
18	27.3-28.5'	(VISUAL) DK. GRAY, CLAYEY SAND (SC).				

Project KISSIMMEE RIVER
RESTORATION SECTION 1135 PROJECT
Lab No. 73/6551
Boring No. CB-S65K-10
Date 09/20/94

GRADATION CURVES

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE , MARIETTA, GA. 30060

WORK ORDER: 7378
REQUISITION: RM-CW-94-0148



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

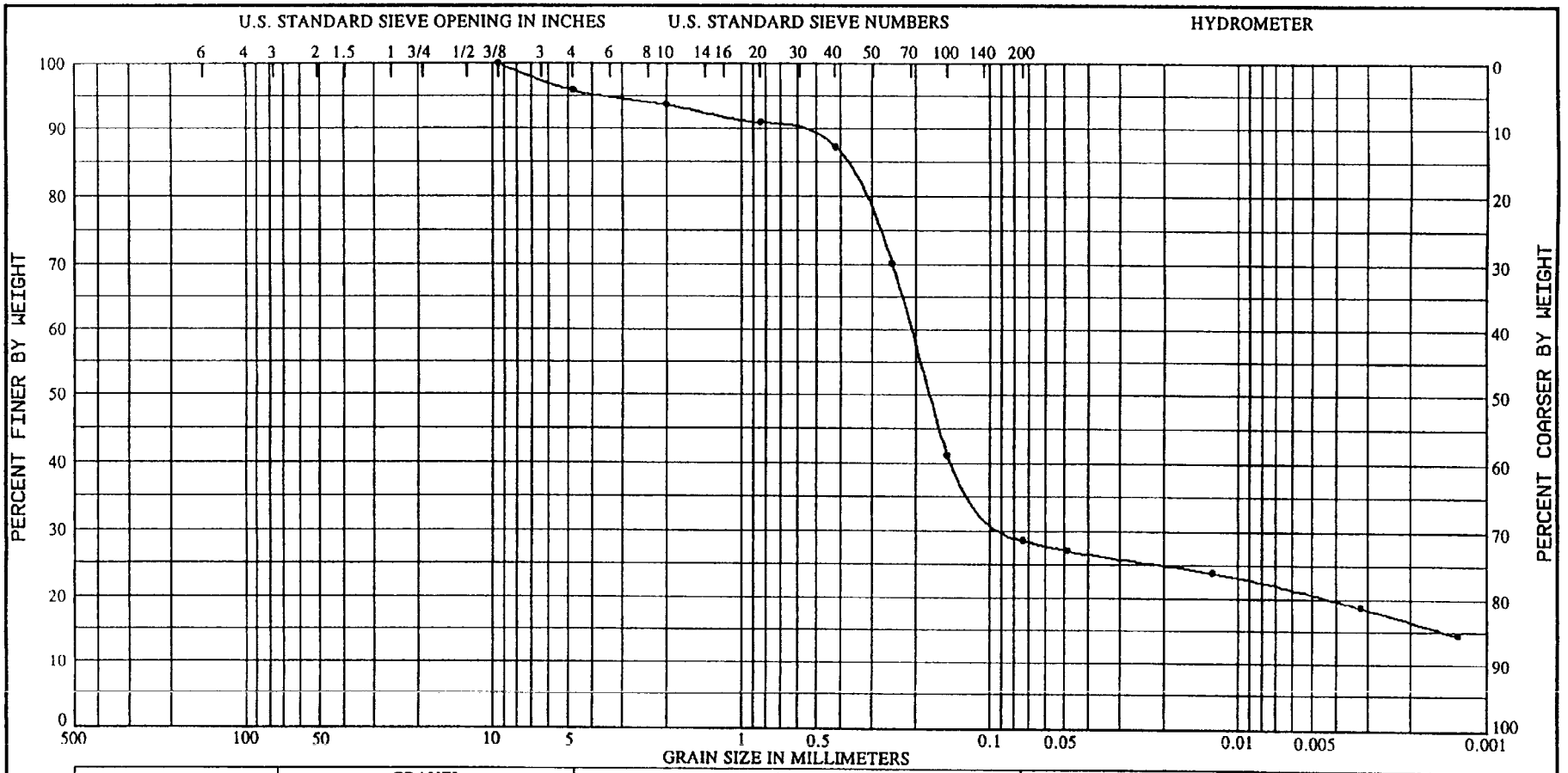
Sample No.	Depth	Classification	Nat w%	LL	PL	PI
23	34.5-36.0'	LT GRAY, FAT CLAY (CH), WITH A LITTLE	67.5	101	22	79
		SAND SIZES.				
		SP GRAVITY = 2.65				

Project KISSIMMEE RIVER
RESTORATION SECTION 1135 PROJECT
Lab No. 73/6552
Boring No. CB-S65K-10
Date 08/19/94

GRADATION CURVES

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE , MARIETTA, GA. 30060

WORK ORDER: 7378
REQUISITION: RM-CW-94-0148



Sample No.	Depth	Classification	Nat w%	LL	PL	PI
28	43.5-45.0'	(VISUAL) LT. GRAY, CLAYEY SAND (SC), WITH				
		A TRACE OF GRAVEL SIZES.				

Project KISSIMMEE RIVER
RESTORATION SECTION 1135 PROJECT

Lab No. 73/6553

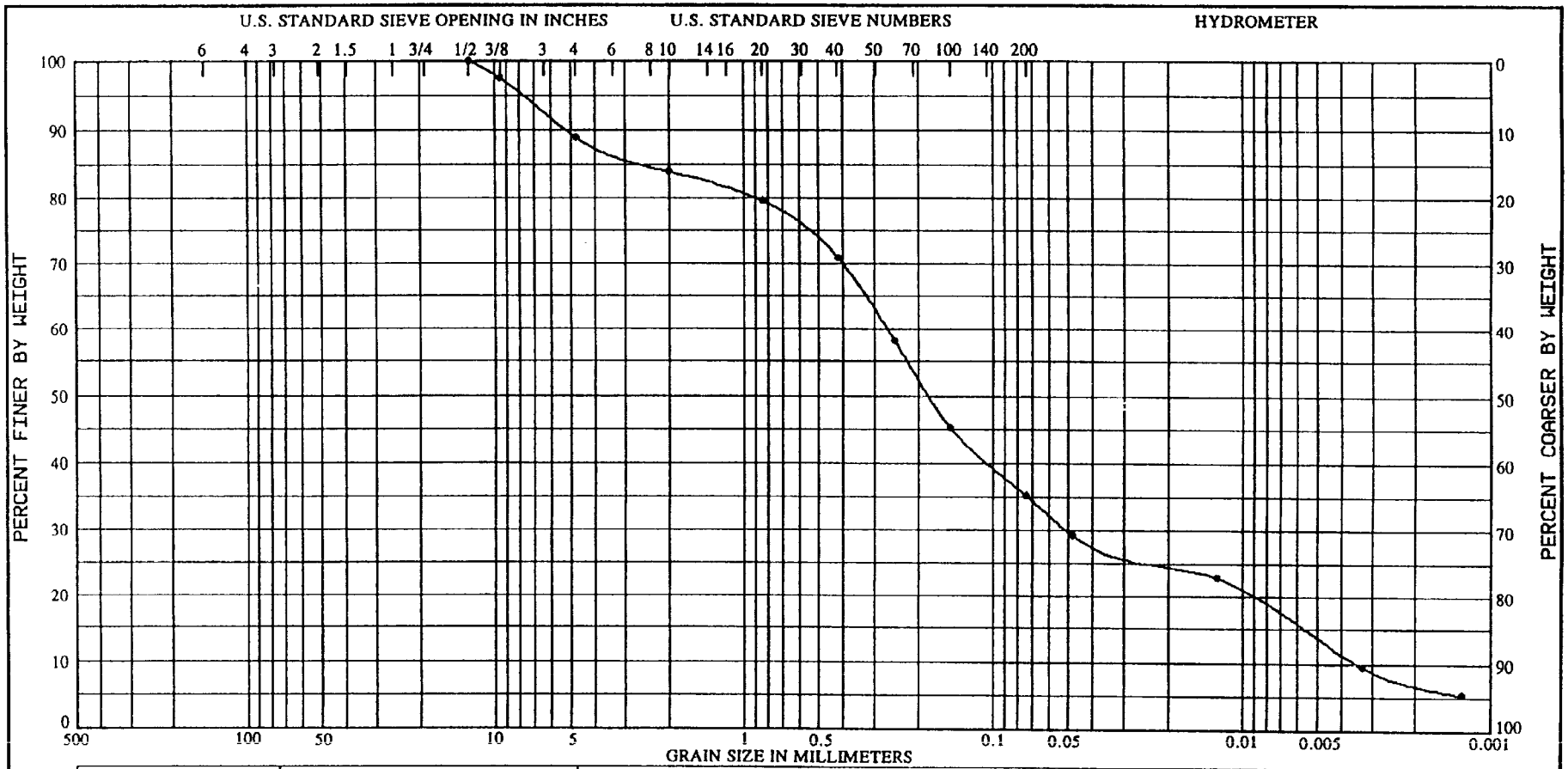
Boring No. CB-S65K-10

Date 09/20/94

GRADATION CURVES

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE , MARIETTA, GA. 30060

WORK ORDER: 7378
REQUISITION: RM-CW-94-0148



Sample No.	Depth	Classification	Nat w%	LL	PL	PI
34	52.5-54.0'	LT. GRAY, CLAYEY SAND (SC), WITH A	25.1	31	17	14
		LITTLE GRAVEL SIZES.				
		SP GRAVITY = 2.70				

Project KISSIMMEE RIVER
RESTORATION SECTION 1135 PROJECT

Lab No. 73/6554

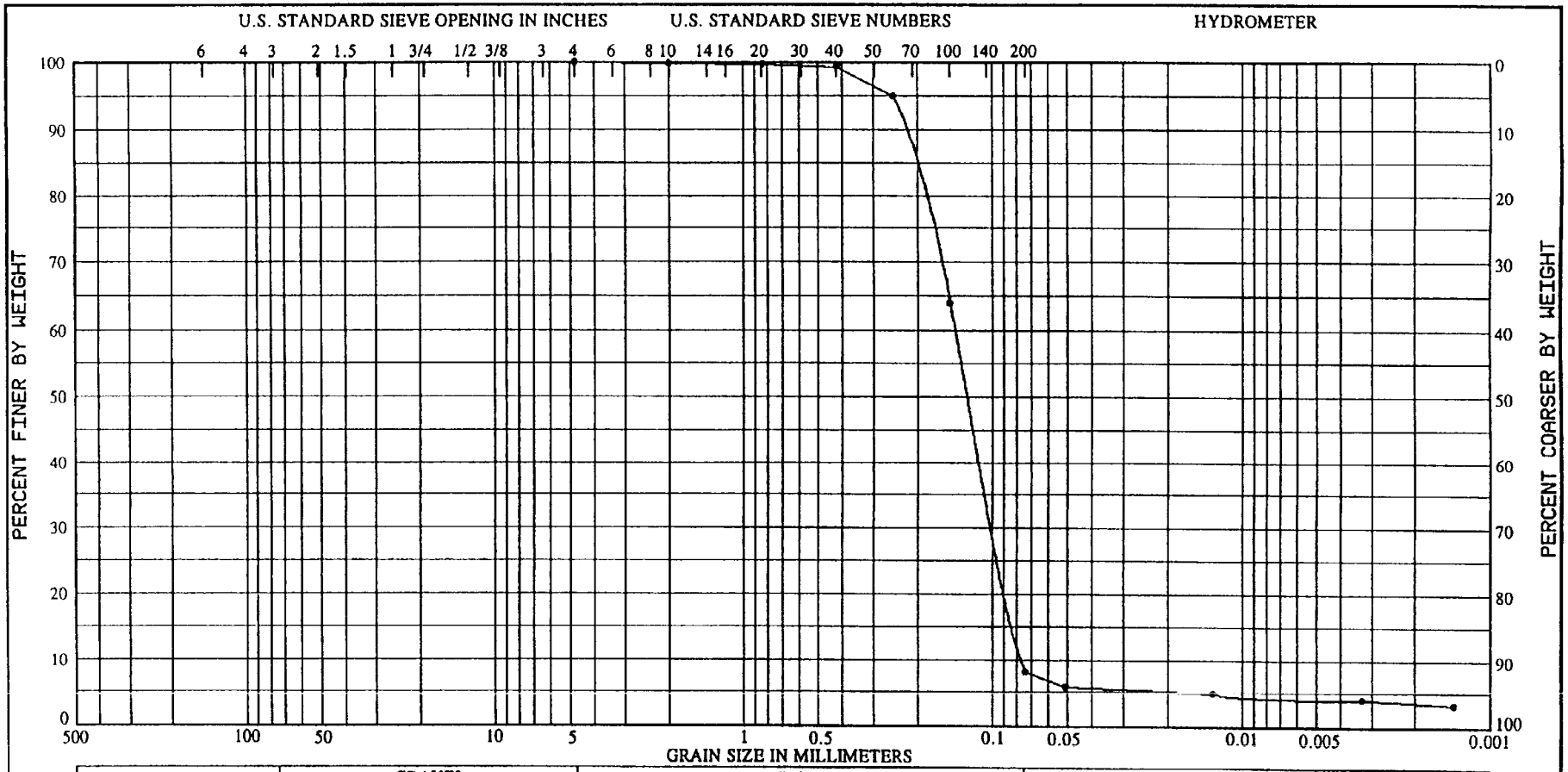
Boring No. CB-S65K-10

Date 08/19/94

GRADATION CURVES

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE , MARIETTA, GA. 30060

WORK ORDER: 7378
REQUISITION: RM-CW-94-0148



Sample No.	Depth	Classification	Nat w%	LL	PL	PI
3	3.0-4.5'	(VISUAL) LT. BROWN, POORLY GRADED SILTY SAND (SP-SM).				

Project KISSIMMEE RIVER RESTORATION SECTION 1135 PROJECT

Lab No. 73/6555

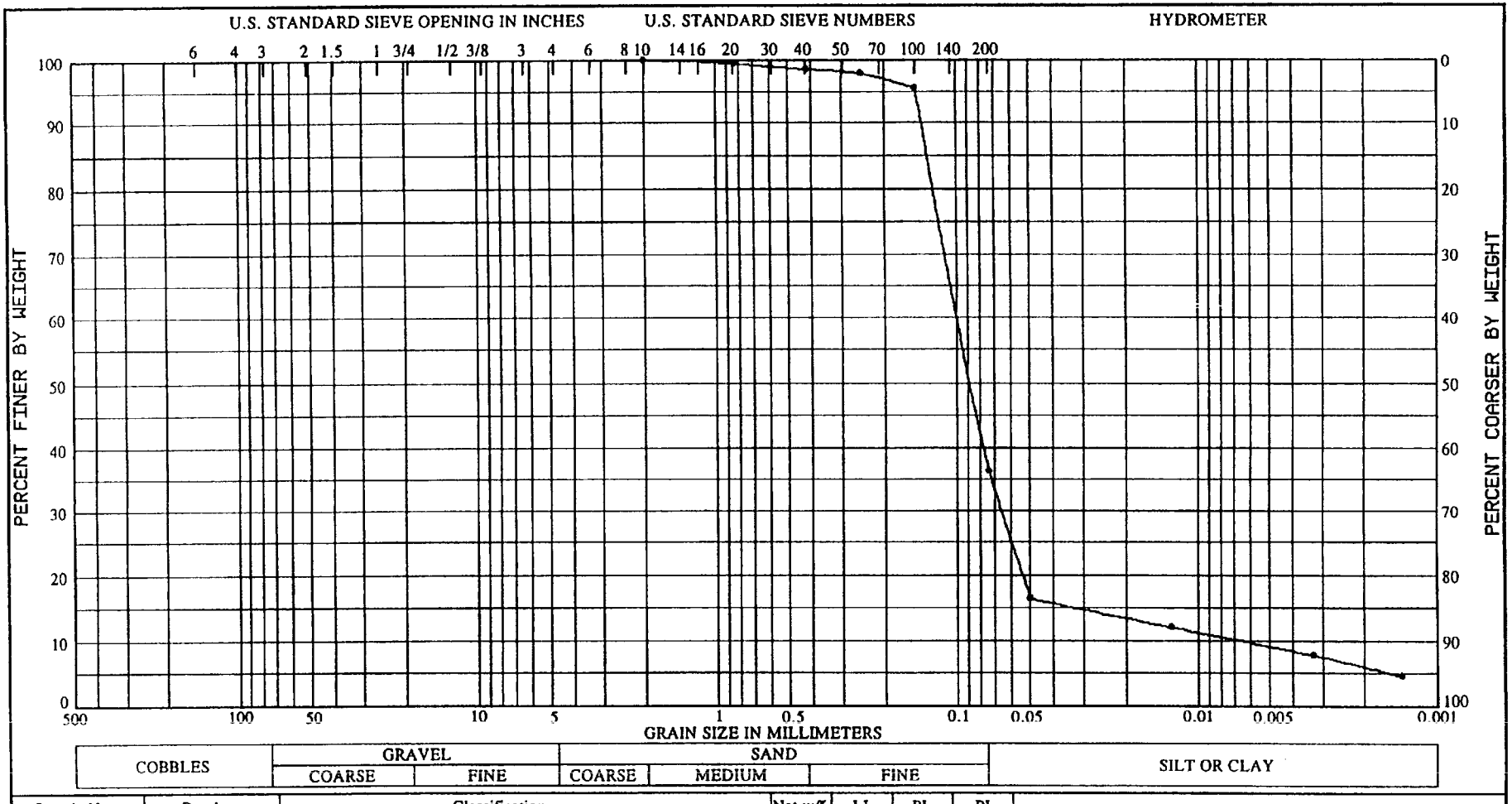
Boring No. CB-S65K-11

Date 09/20/94

GRADATION CURVES

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE , MARIETTA, GA. 30060

WORK ORDER: 7378
REQUISITION: RM-CW-94-0148



Sample No.	Depth	Classification	Nat w%	LL	PL	PI
17	21.0-22.5'	TANNISH GRAY, CLAYEY SAND (SC).	32.4	34	20	14

Project KISSIMMEE RIVER
RESTORATION SECTION 1135 PROJECT

Lab No. 73/6556

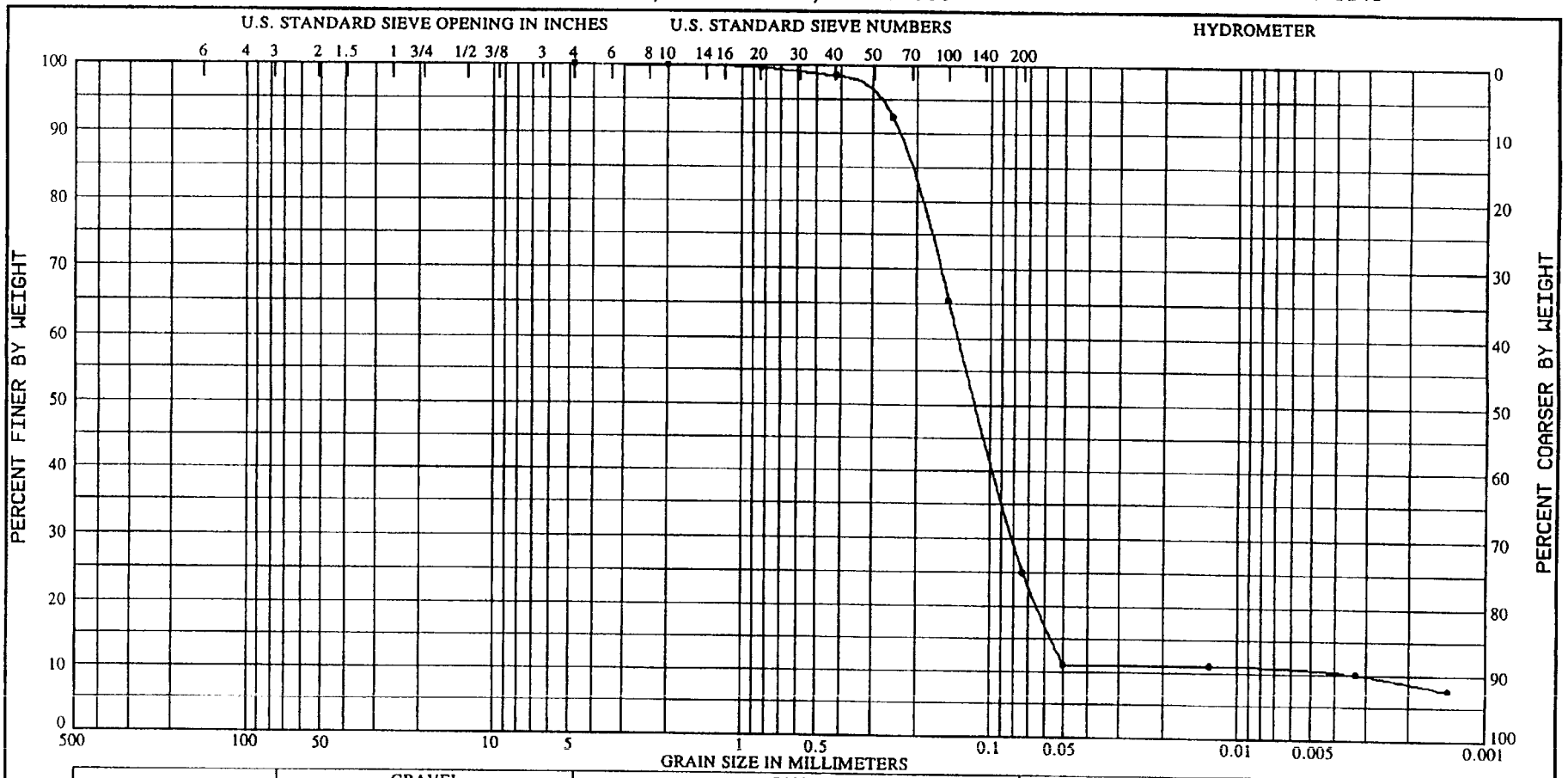
Boring No. CB-S65K-11

Date 08/19/94

GRADATION CURVES

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE , MARIETTA, GA. 30060

WORK ORDER: 7378
REQUISITION: RM-CW-94-0148



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

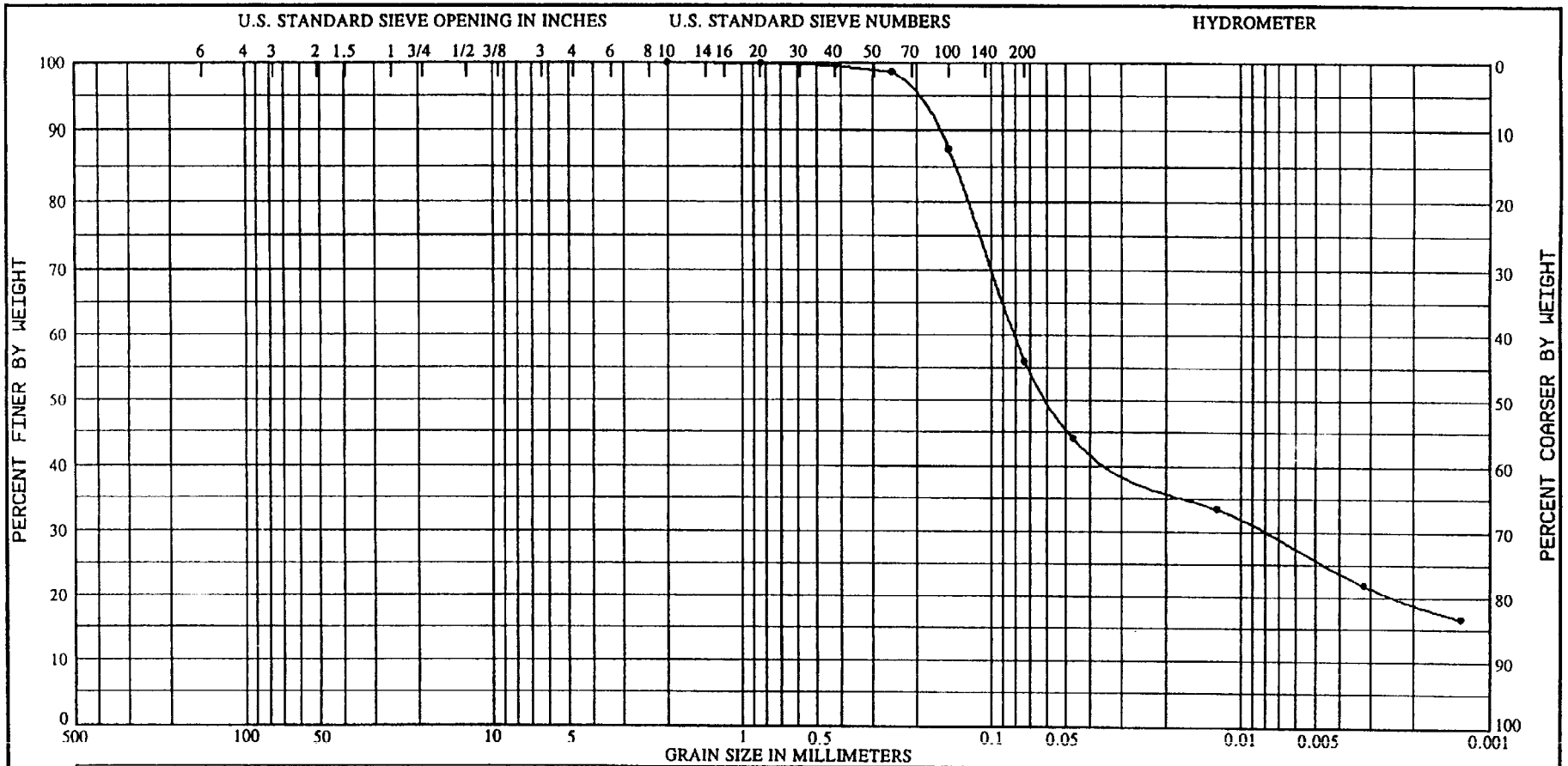
Sample No.	Depth	Classification	Nat w%	LL	PL	PI
2	1.5-3.0'	(VISUAL) LT. BROWN, CLAYEY SAND (SC).				

Project KISSIMMEE RIVER
RESTORATION SECTION 1135 PROJECT
Lab No. 73/6557
Boring No. CB-S65K-12
Date 09/20/94

GRADATION CURVES

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE , MARIETTA, GA. 30060

WORK ORDER: 7378
REQUISITION: RM-CW-94-0148



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Sample No.	Depth	Classification	Nat w%	LL	PL	PI
11	12.0-13.5'	(VISUAL) DK. BROWN SANDY FAT CLAY (CH).				

Project KISSIMMEE RIVER
RESTORATION SECTION 1135 PROJECT

Lab No. 73/6558

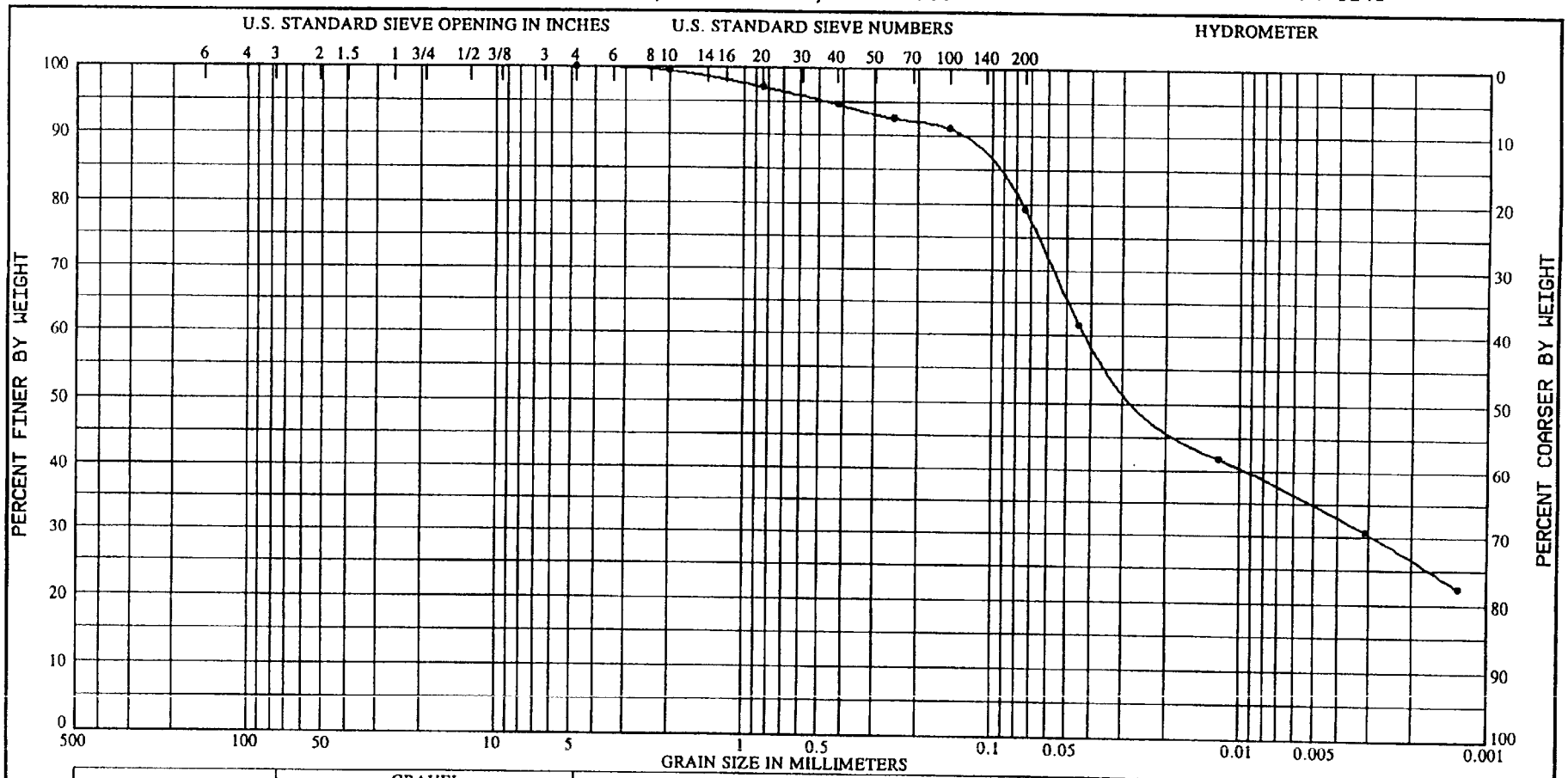
Boring No. CB-S65K-12

Date 09/20/94

GRADATION CURVES

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE , MARIETTA, GA. 30060

WORK ORDER: 7378
REQUISITION: RM-CW-94-0148



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Sample No.	Depth	Classification	Nat w%	LL	PL	PI
23	27.0-27.9'	LT. GRAY, FAT CLAY (CH), WITH SOME	48.3	70	19	51
		SAND SIZES.				
		SP. GRAVITY = 2.63				

Project KISSIMMEE RIVER
RESTORATION SECTION 1135 PROJECT

Lab No. 73/6559

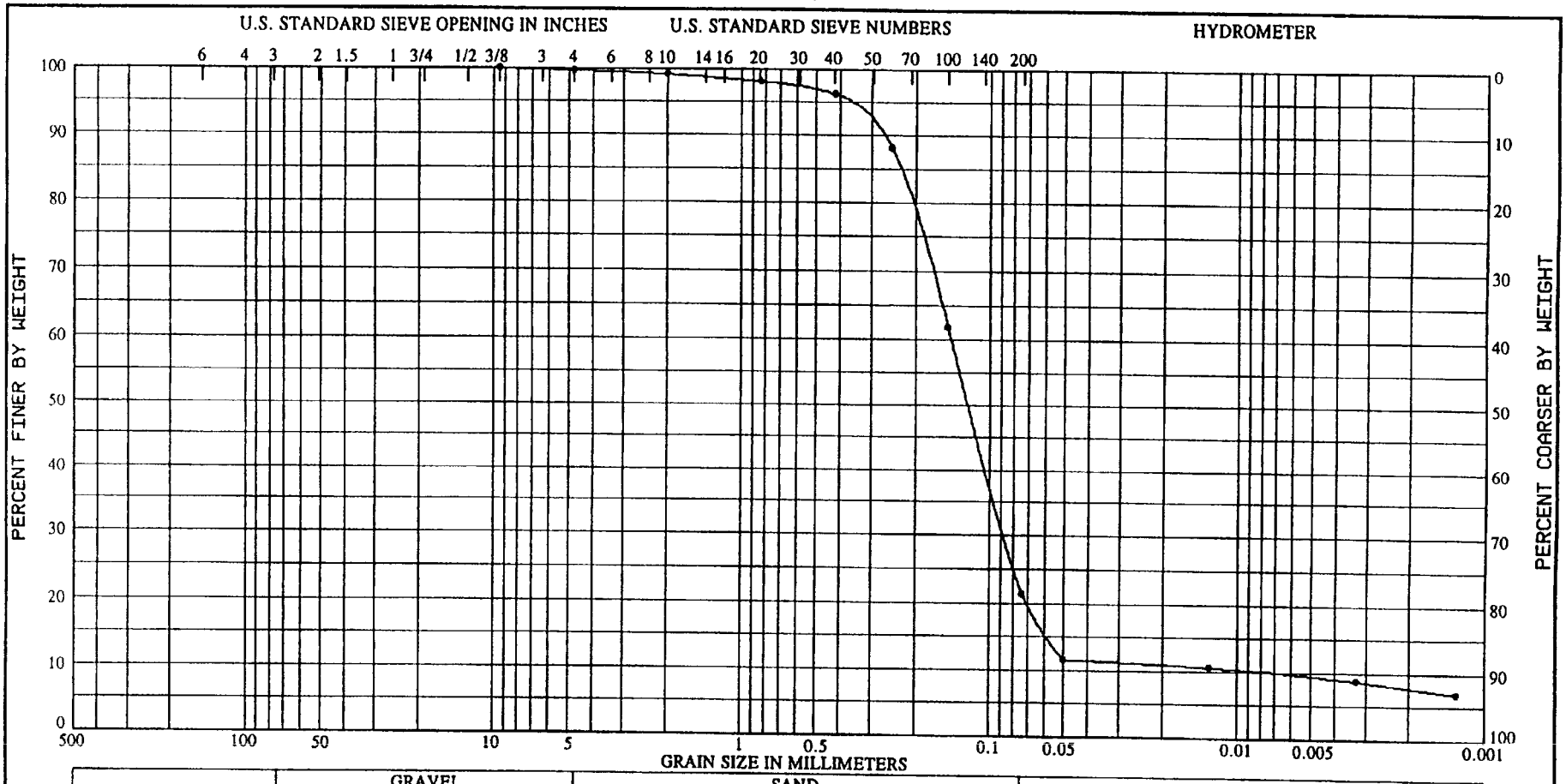
Boring No. CB-S65K-12

Date 08/19/94

GRADATION CURVES

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE , MARIETTA, GA. 30060

WORK ORDER: 7378
REQUISITION: RM-CW-94-0148



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

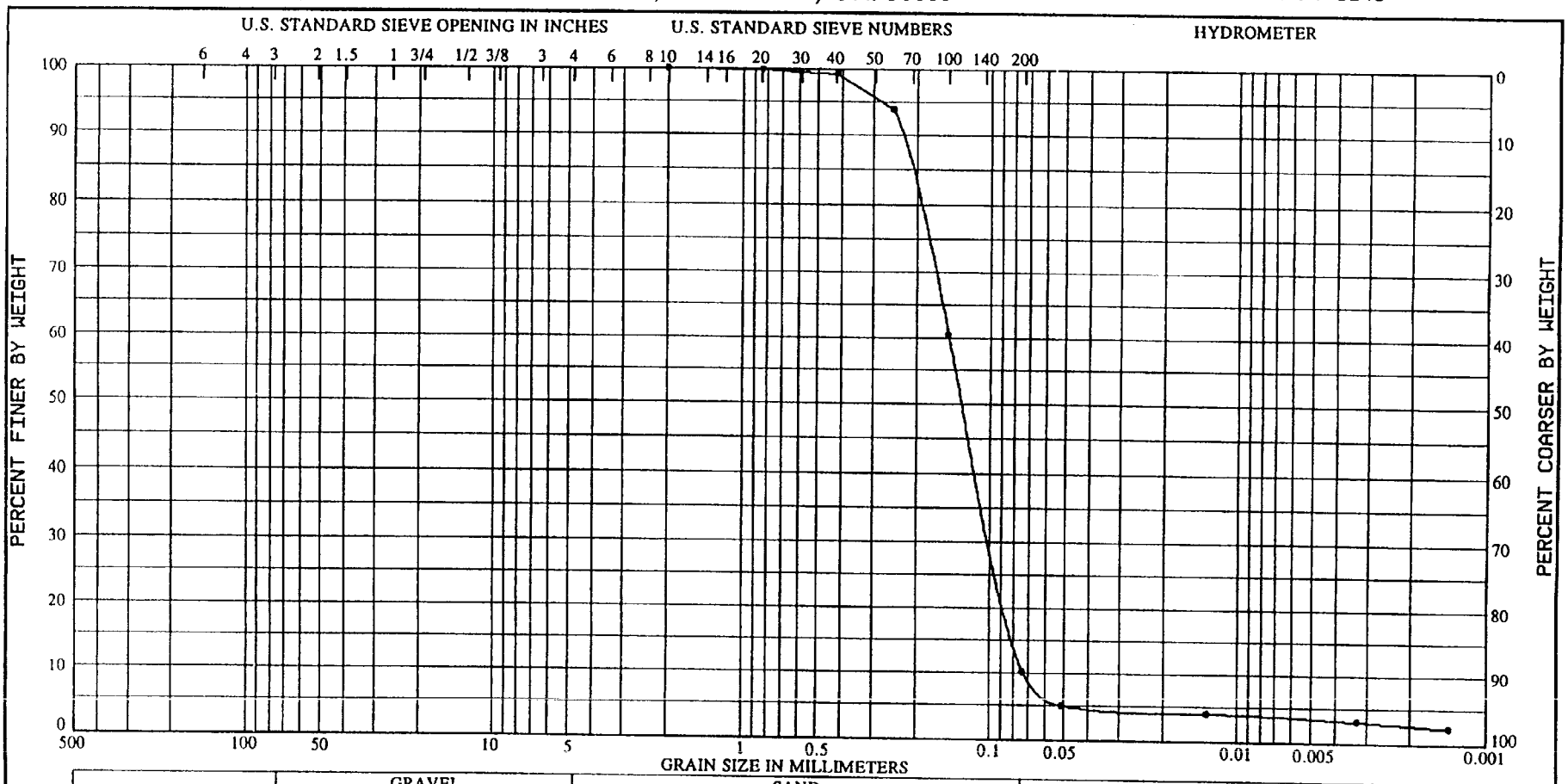
Sample No.	Depth	Classification	Nat w%	LL	PL	PI
6	7.5-9.0'	(VISUAL) LT. BROWN CLAYEY SAND (SC).				

Project KISSIMMEE RIVER
RESTORATION SECTION 1135 PROJECT
Lab No. 73/6560
Boring No. CB-S65K-13
Date 09/20/94

GRADATION CURVES

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE , MARIETTA, GA. 30060

WORK ORDER: 7378
REQUISITION: RM-CW-94-0148



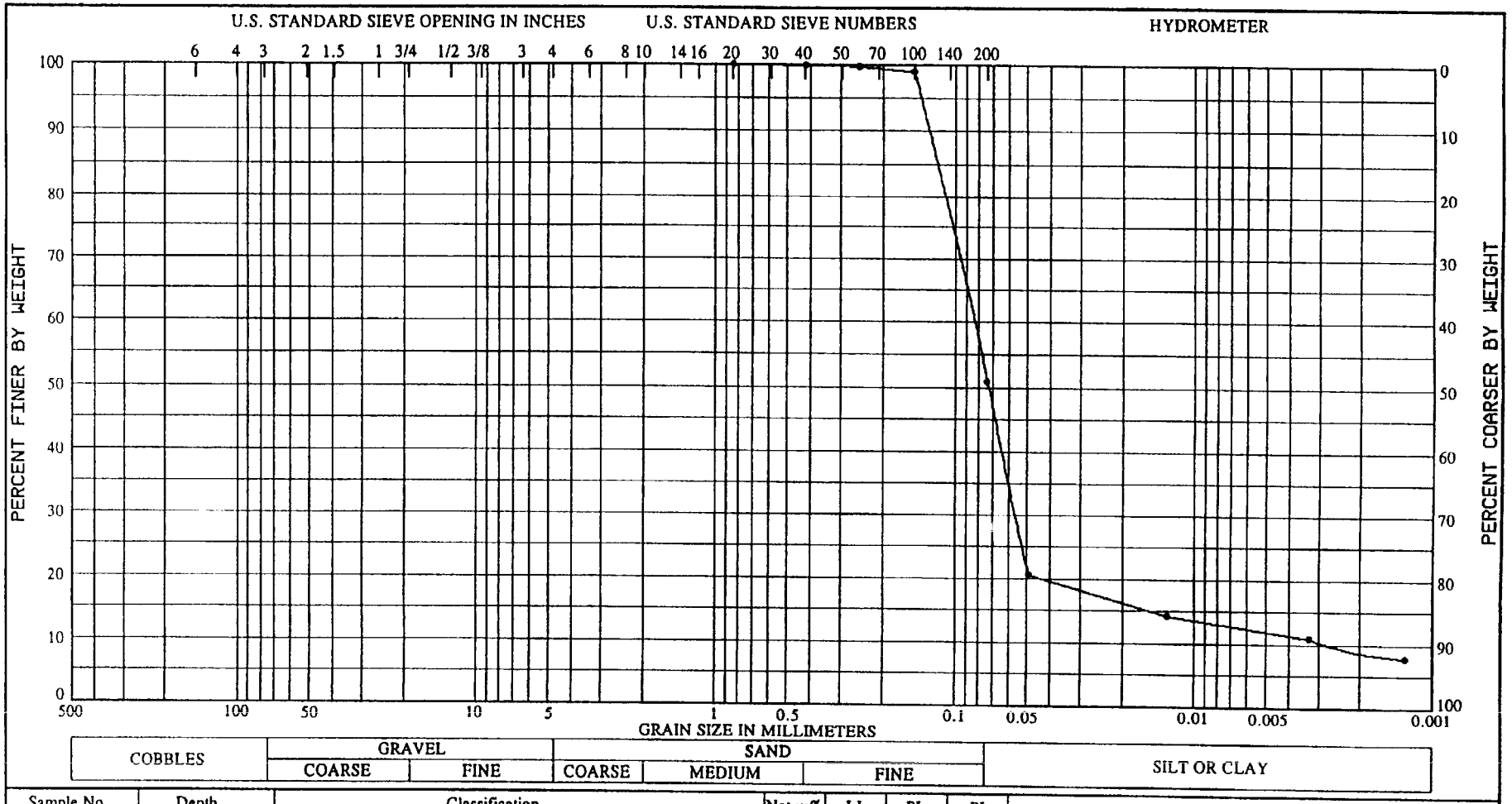
Sample No.	Depth	Classification	Nat w%	LL	PL	PI
13	18.0-19.5'	(VISUAL) LT. BROWN, POORLY GRADED SILTY SAND (SP-SM).				

Project KISSIMMEE RIVER
RESTORATION SECTION 1135 PROJECT
Lab No. 73/6561
Boring No. CB-S65K-13
Date 09/20/94

GRADATION CURVES

DEPARTMENT OF THE ARMY, SOUTH ATLANTIC DIVISION LABORATORY
CORPS OF ENGINEERS, 611 SOUTH COBB DRIVE , MARIETTA, GA. 30060

WORK ORDER: 7378
REQUISITION: RM-CW-94-0148



Sample No.	Depth	Classification	Nat w%	LL	PL	PI
28	36.0-37.5'	TANNISH GRAY, SANDY INORGANIC SILT LOW LL (ML).	30.2	34	27	7

Project KISSIMMEE RIVER RESTORATION SECTION 1135 PROJECT

Lab No. 73/6562

Boring No. CB-S65K-13

Date 08/19/94

GRADATION CURVES

KISSIMMEE RIVER
HEADWATERS REVITALIZATION PROJECT

APPENDIX D

DESIGN AND COST ESTIMATES

Appendix D
Design and Cost Estimates

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Appendix D
Design and Cost Estimates

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Appendix D
Design and Cost Estimates

A. INTRODUCTION

1. General. The Kissimmee River Headwaters Revitalization Plan calls for increased lake storage capacity of the Upper Basin chain of lakes (those north of spillway structure S-65). Because of the higher water levels in the lakes, in particular Lake Kissimmee, a major modification to the existing S-65 control structure is required. The spillway modification takes the form of an additional, smaller spillway of the same design adjacent to the original. Analysis of the effects of the higher water indicate that the combined spillways will be able to adequately handle the necessary flow increases expected through the structure. Other design interests incorporated in this appendix include stability analysis for S-61 and S-63A, mechanical and electrical considerations of the new spillway, some minor levee construction, and canal maintenance work. This appendix discusses all of the pertinent design considerations utilized to establish a basis for the construction cost estimate. General design parameters, specifications, and basic construction methods are also included.

B. DESIGN AND CONSTRUCTION

2. Canals.

a. General. Under the Kissimmee River Headwaters project proposed in this report, there are three canals C-35, C-36, C-37 that require excavation work. The canal excavations are necessary in order to increase the flow capacities to acceptable levels, thus preventing excessive flooding in times of high water. The excavation within the original construction design template is considered maintenance work and all excavation material outside of the original canal limits is considered new work. The canal requirements are different for each canal. Within canal C-35 only maintenance dredging is to occur, within C-36 and C-37 both maintenance and new work is planned. The disposal mounds for the excavation material will be roughly in the same location as the original spoil mounds, except that the berm width leading from the canal edge to the spoil mound will be approximately 25 feet for all of the canals (see Plate D-1 for details), and all deposits will be within existing right-of-ways.

b. C-37 Construction. C-37 will be dredged to the original design depth which varies in elevation from +26.6' to +27.6' on the canal bottom. The canal

will also be widened from the original design width of 70 feet to a project width of 90 feet as shown on Plate D-1. The side slope on the additional cut (or new work excavation) will be 1v:2.5h. The bottom elevation varies from +26.6' to +27.6' between stations 18+23 and 179+60. Between Sta. 0+00 to 18+23 and Sta. 79+60 to 210+07 the canal is sloped upwards to about elevation +45' due to the higher bottom elevations of Lake Hatchineha to the north and Lake Kissimmee to the south. It is estimated that 703,000 cubic yards of material (373,000 maintenance & 330,000 new work) is required to be removed from the canal and placed into a spoil location on the east bank of the canal. The spoil mound begins 25 feet from the crest of the canal and maintains 1v:2.5h side slopes and a top width of about 85 feet. The top of the mound will rise no higher than elevation +65'. The spoil mound dimensions may vary slightly depending on the condition of the existing mound.

c. C- 36 Construction. C-36 will also require both maintenance dredging and new work excavation. The project bottom elevation is a constant +31.3' elevation between Sta. 23+85 and 164+83. Outside of these stations, the bottom elevation increases to about +45' due to the higher lake bottom elevations of Lake Hatchineha to the south and Lake Cypress to the north. The bottom width of the canal is 60 feet, which includes 48 feet from the original design template and an additional 12 feet as new work (see Plate D-1). The side slope on the east side of the canal will be 1v:2.5h and 1v:2h on the west side. The estimated total volume of material for removal is 285,000 cubic yards (160,000 maintenance & 125,000 new work). The spoil mound begins 25 feet from the crest of the canal and maintains 1v:2.5h side slopes and a top width of about 15 feet. The top of the mound will rise no higher than elevation +65'. Again the spoil mound may vary depending on the condition of the existing mound.

d. C-35 Construction. C-35 is to be maintenance dredged only. The design from Sta. 35+00 to Sta. 221+00 calls for a bottom width of 20 feet at elevation +30.6' with 1v:2h side slopes. Between Sta. 0+00 and 35+00 and Sta. 221+00 and 223+00 the canal bottom is sloped upwards to compensate for the higher lake bottom elevations of Lake Tohopekaliga to the north and Lake Cypress to the south. The spoil material is to be placed on the west side of the canal and the mound shall have a top width of 40 feet with 1v:2h side slopes. The approximate volume of material to be removed from the canal is 170,000 cubic yards. Existing conditions may alter spoil disposal specifications.

3. Local Levee Degradation.

a. General. As a significant aspect of the Headwaters Revitalization Project, five locally constructed levees will be partially degraded and restored

to natural ground elevations. The levees will have a series of gaps cut into them at regular intervals over their entire length (see Plate D-3). The intent behind the gap construction is to allow unimpeded water flow up to the +54' elevation, thereby achieving full project storage capacity within the Upper Basin chain of lakes. When the lake elevations rise and fall according to the regulation schedule, the gaps should permit flood waters to flow around the remaining levees without unnatural obstruction.

b. Design. The five levees within the upper chain of lakes to be degraded are Lake Kissimmee Levee, Cypress Lake Levee, Sparks Chandler Levee, Rolling Meadows Levee, and Oasis Levee. The respective estimated volumes of material and number of cuts to be removed from each levee are 12,500 cy - 10 cuts; 15,000 cy - 10 cuts; 15,000 cy - 14 cuts; 30,000 cy - 19 cuts; and 2,000 cy - 2 cuts. Exposition Levee, to the east of Lake Hatchineha, will not require degradation as originally planned as it was determined to be unjustifiable due to the limited benefits expected from its construction. The levees were constructed from material taken from adjacent borrow canals, and thus the degraded material will be used to backfill the borrow canals, and therefore no offsite disposal is required. The gaps will be one hundred feet wide at the natural ground elevation and will be spaced approximately 1000 feet apart. Variations in the gap spacing may occur due to the presence of heavily vegetated areas found periodically atop the levees as shown by aerial photography. The vegetation growth may serve as upland habitat to local wildlife and thus these areas should remain intact. The gap specifications also call for cuts with 1v:3h side slopes. See plate D-3 for local levee construction details.

4. Structural Modifications and Analysis of S-65, S-63A, & S-61.

a. General. The proposed plan requires the construction of a new two bay spillway structure, S-65X, adjacent to the existing S-65 structure. A retaining wall near the Lock Operator's dwelling at the same location will be constructed to stabilize embankment fill near that facility. Construction of a new generator house will be required. Structure S-61 and S-63A will not require modifications as a result of this project but will instead have a stability analysis done. The results of the stability analysis on these structures discussed below.

b. Excavation/Fill. The soil behind the northeast wingwall of the existing S-65 structure will be excavated to an elevation sufficient to reduce the lateral load on the wingwall prior to the construction of the cofferdam. After construction is completed on the new structure, the space between the new and old structures, upstream and downstream, will be closed by adding new sheet

pile. The area will between the two structures will be backfilled to the required elevation.

c. Removal/Relocation.

(1) General. There is a generator house 60 feet west of the Operator's dwellings at the S-65 site. The generator house will be relocated as a result of the embankment modifications for the new spillway. The location of the new generator house will be determined during plans and specifications (P&S) phase. The location of the antenna tower, at the southwest corner of the Operator's dwelling, will be reviewed during P&S to determine if the guy wires can be relocated or if the antenna must be relocated.

(2) Existing S-65 Spillway. A portion of the northeast (upstream) wingwall, the entire adjoining tieback wall and tierods will be removed prior to construction of the cofferdam. A new sheet pile wall will be constructed with the new spillway structure and will be connected to the existing sheet pile wall. The southeast (downstream) sheet pile wingwall of the existing spillway structure will be connected to the downstream sheet pile wingwall of the new structure.

(3) Safety Barrier. The eastern anchor pile dolphins of the existing S-65 safety barriers, upstream and downstream of the structure, will be removed and the barriers extended eastward as needed to accommodate both structures. Intermediate dolphins may be required.

d. Software. The sheet pile cofferdam for S-65X was designed using the "CWALSHT" and "CWALSSI" programs for design of sheet pile walls. Corps program X0031 - "CWALSHT" uses the classical method to design or analyze cantilevered or anchored sheet pile walls. Corps program X0070 - "CWALSSI" incorporates the soil-structure interaction method to the design of sheet pile walls. The steel grid support system inside the cofferdam, including the steel columns, was designed using the "STAAD-III" computer program. STAAD-III is a structural analysis program that allows three dimensional frame modeling. The structural steel grid system was modeled in this manner to more accurately determine moments and shears in the system. S-65X will be designed in accordance with EM 1110-2-2400, "Structural Design of Spillways and Outlet Works" and EM 1110-2-1603, "Hydraulic Design of Spillways". Existing structures S-61 and S-63A were analyzed using the Corps program X0075 - "C-Slide". This program assesses the sliding stability of concrete structures using the criteria set forth in ETL 1110-2-256, "Sliding Stability for Concrete Structures".

e. Dewatering. Dewatering for Structure S-65X will be accomplished using a cofferdam as shown in plate nos. S-4 & S-5. The cofferdam will enclose an area of approximately 7,100 square feet. A ten foot deep tremie concrete seal, placed inside the cofferdam, will serve as the foundation for the structure. The top of the tremie seal will be at elevation 29.5 ft. and will be secured against uplift using 31.5 ft. helical soil anchors. The interior walls of the cofferdam will be supported by a two layer structural steel grid system supported by steel piles. The upper layer of the grid system will be located at elevation 55.0 ft. The lower layer will be located at elevation 45.0 ft. The ground surface adjacent to the existing structure is at elevation 63.0 feet. The sheet pile of the cofferdam however, was modeled at 58.0 feet, reducing the lateral loads on the sheet pile walls. The supporting piles will be removed when construction is complete.

f. Design Criteria. The structural design is based on standard practice as set forth by the engineering technical letters and design manuals of the U. S. Army Corps of Engineers, subject to modifications indicated by engineering judgement and experience.

Unit Weights and Measures at Structure S-65X

Weight of saturated soil	= 100 - 125 pcf
Weight of moist backfill	= 95 - 120 pcf
Weight of concrete	= 140 pcf

(1) Reinforced Concrete. Design of S-65X was based on the requirements of ETL 1110-2-312, "Strength Design Criteria for Reinforced Concrete Hydraulic Structures", and EM 1110-2-2104, "Strength Design for Reinforced-Concrete Hydraulic Structures".

Cast-in-Place Concrete.....fc' = 3,500 psi
Reinforcing Steel (Grade 60).....fy = 60,000 psi

(2) Steel Sheet Pile at S-65X. The steel sheet pile wingwalls of the spillway structure will be size PZ-27 on the upstream side and PZ-40 on the downstream side. The sheet pile for the cofferdam, plate no. S-5, will be 60 feet long and of size PZ-40. After construction, the cofferdam sheet pile will be cut off at the top of the tremie seal. The lower section will remain in place to allow for seepage protection.

(3) Stability Analysis. The critical stability loading cases for the S-65X spillway structure were analyzed as described in paragraph 4.f.(3).a. "Stability Loading Conditions". The structure was analyzed for overturning in

accordance with EM 1110-2-3104, "Structural and Architectural Design of Pumping Stations". The structure was designed with the uplift forces assumed to act over 100 percent of the base of the structure, varying from 100 percent of headwater to 100 percent of tailwater with consideration for hydraulic jump. Construction of the spillway structure will be in monolithic sections. The concrete stilling basin slab was designed for flotation stability in accordance with ETL-1110-2-307, "Flotation Stability Criteria for Concrete Hydraulic Structures". Structures S-61 and S-63A. were analyzed for overturning, sliding and overstressing of the foundation. Monolithic analyses were used for the structures as shown on plates nos. S-10, S-11 and S-12. The existing S-65 structure is founded on piles and should not be affected by the partial excavation required for the new structure.

a. Stability Loading Conditions. The reinforced concrete spillway structure, S-65X, was analyzed for four loading conditions. 1) Normal Operating Condition (Case I) - Structure operating to discharge routine floods over a range of exterior flood levels (Usual). 2) Maintenance Condition (Case II) - Maximum design water level in one bay with the other bay dewatered (Unusual). Upstream WSEL at 52.5 ft. and downstream at 49.07 ft. 3) Standard Project Flood Condition (Case III) - Maximum flood levels upstream and downstream of structure (Extreme). This condition incorporates hydraulic jump. Upstream WSEL at 58.0 ft. and downstream at 48.2 ft. 4) Hurricane Condition (Case IV) - Hurricane loading including wind tide (Extreme). Upstream WSEL at 64.7 ft. and downstream at 56.35 ft.. Structures S-61 and 5-63A were analyzed for the following load conditions 1) Normal Operating Condition - Same as above (Usual); 2) Dewatered - Same as Maintenance Condition above (Unusual.); and 3) Optimum - Similar to Normal Operating Condition with different headwater and tailwater elevations.

b. Stability Results. All structures were determined to be stable for all loading conditions, with all resultants falling within the base. Table I provides the stability criteria as stated in EM 1110-2-3104. Table II shows the calculated results of the design data for S-65X. Table III shows the calculated results for S-61 and S-63A.

Table I

	STABILITY	CRITERIA	
Aspect	Usual	Unusual	Extreme
% Base in Compression	100	75	0
Sliding Safety Factor	2	2	1.33
Flotation S.F.	1.5	1.3	1.1

Table II

COMPUTED	FACTORS	OF SAFETY	FOR S-65X	
	Case I	Case II	Case III	Case IV
SLIDING	5.25	3.29	1.47	1.72
FLOTATION	1.86	1.57	1.30	1.50

Table III

SLIDING	FACTOR OF	SAFETY	
	Case I	Case II	Case III
S-61	5.16	4.86	2.62
S-63a	4.92	4.29	3.02

c. Structural Analysis.

(1) Reinforced Concrete Stilling Basin. The stilling basin slab will be located on the downstream side of the structure measuring 57'-3" wide. The 34 foot length of the basin. will be redesigned during plans and specifications to 48 feet. The slab will be 4-1/2 feet thick and will have 11 baffle blocks arranged in two rows to reduce the maximum velocities of water leaving the structure. The baffle blocks will be standard shape baffle measuring 3'-6" high x 4'-5" wide x 4'-11" deep (Plate no. S-2). Anchors will be used to preclude downstream movement by water forces due to spillway discharge. The size of

the baffle blocks will also be reevaluated during plans and specifications due to the change in basin length. The end sill for the stilling basin will have a top elevation of 36.5 feet and the training wall elevation will be 49.0 feet.

(2) Gates. The new spillway gates for S-65X are of the same type, size and construction as the existing gates on structure S-65. The gates will be vertical lift gates constructed of structural steel channels and faced with a 3/8" skin plate. The exterior frame will be continuous steel members with intermediate members welded at uniform spacings. The skin plate will be welded to the upstream side of the gates. The gates will measure 27 ft. wide by 14.2 ft. high. Gate seals will be provided to protect against leakage.

(3) Retaining Wall. The steel sheet pile wall adjacent to the west wall of the Operator's dwelling will be approximately 113 feet long, 19 feet deep and of size PZ-22. The wall, constructed in three sections, will serve as a retaining wall to ensure the integrity of the embankment near the Operator's dwelling. The wall was designed for three loading conditions; usual, unusual, and extreme, using Corps program X0031 - CWALSHT.

5. Mechanical Design for the S-65 Addition.

a. Existing Spillway Structure. The existing S-65 three-bay spillway structure was built in the early 1960's and continues to operate satisfactorily. Hoisting equipment is used to raise and lower the 27-foot by 14.2-foot, 30,000-pound gate. The existing hoisting system includes a 1-inch, 6 x 37 IWRC stainless steel wire rope, with a hydraulic system comprised of a cylinder with a 12-inch bore and a 5 1/2-inch rod that has a stroke of 83 inches. The operating pressure of the existing system is 1300 psi. The total hoist load (weight of gate and friction due to hydraulic loading) is 45,000 pounds. Although the equipment is operating satisfactorily, the wire rope and sheaves are sized smaller than they would be by today's standards. While wire ropes used for lifting spillway gates are normally sized today with a minimum safety factor of 5.0, the existing 1-inch wire rope offers a safety factor of 3.44. There are no plans to change the operating equipment for this structure.

b. Additional Spillway Structure. The new spillway structure at S-65 will have two bays and gate operating machinery and related equipment as shown on plates ME-1 and ME-2. Each vertical lift gate will be raised and lowered by means of a horizontal hydraulic cylinder connected to a two-part sheave block assembly over which each of two 1-1/4-inch cables run. One end of each cable will be fastened to the gate, and the other will be connected to the base of the hoist unit. Hydraulic fluid from a new motor-driven hydraulic-

power unit, which is located in the control room on the side of the new S-65 spillway structure addition, shall be used to operate each hydraulic cylinder. Each hydraulic cylinder will be located on the operating platform as a part of the hoist unit. Gate hoist capacity, operating load, and hydraulic pressure will be as shown on plate ME-1. Each hydraulic cylinder will have a 12-inch bore and a 5-1/2-inch rod with a stroke of one-half of the gate travel. A flow control valve will be used to set the speed at which the gate may be raised to 6 inches per minute. Each gate opening will be manually operated to maintain optimum headwater elevations and to provide the regulation discharge when required. Existing commercial power will be used to operate the hoist equipment. During commercial power failure, the existing stand-by 30-kilowatt LP gas-fired generator (located in the existing generator building) will be used for operating the hoist equipment. A gate position indicator will be located at each of the gates. Upstream and downstream water levels will be recorded via the existing stilling wells located in the control room on the side of the existing S-65 spillway structure. No new water level monitoring system will be required for the new spillway.

c. Relocations. The construction of the new channel and spillway structure at S-65 will require the relocation of a number of existing items at the site. The generator building, which contains the generator, pumps, tank, step-up transformer, other, will be moved to in front of the lock master's house in a location as indicated in the site plan on plate ME-4. The underground LP gas storage tank and the water treatment tank (part of the potable water system) will also be relocated adjacent to the relocated generator building. The lawn sprinkler system (piping and pump) will need to be redesigned and relocated to avoid the new channel. The aboveground fuel storage tank located adjacent to the existing storage building will be removed from the site.

6. Electrical Design for the S-65 Addition.

a. General. Electrical installation for the S-65 addition will be provided as shown on plate ME-3.

b. Power Supplies. The local power company, Peace Electric Utility, has an overhead 14 KV, single phase power line along the Levee. A service pole, with step down transformer located adjacent to the generator building, provides a 120/240 volt, single phase, 200 Amp. 60 hertz, three wire underground electrical service to the existing generator building. The power is distributed to the lock master's residence, and to the existing spillway and adjacent lock. The residence requires 120/240 volt, single phase service. The lock and spillway service is stepped up to 480 volts at the generator building to reduce voltage drop. The underground feeder from the generator building feeds power

to the spillway and lock structures and is stepped down to 120/240 volts at these structures. The existing service will be upgraded to 300 amps. to feed the existing and new structures. The manual transfer switch, step up transformer, and associated equipment and feeder will be modified to take the additional electrical load. Approximate location of the service is shown on plate ME-4. An existing 30 KW engine-generator set will be upgraded by SFWMD to 60 KW and would provide emergency power to existing and new structures in case of failure of the commercial service. A transfer switch would be provided to start the engine-generator unit upon failure of the commercial service, thus providing continuous service for the structures.

c. Power Distribution. A control center would be connected to the distribution panel in the generator building. The distribution panel is connected to the load side of the Transfer Switch. The control center will house a main breaker, combination starter for 3 Hp motor, lighting panel, relay compartment and a circuit for exterior lighting.

d. Gate and Motor Controls. Duplicate open-close push button stations in the control house and at the spillway structure would be provided for manual gate control. Necessary open, close, control relays, and limit switches would be incorporated in the gate control circuit. A time delay relay would provide a 5-second energization delay to a dumping solenoid valve to permit unloaded start of the hydraulic power unit motor. Existing water level recorders at existing spillway will be used. Therefore, new water level recorders will not be required. Gate position recorders will be of the mechanical type and will not require electrical power or controls.

e. Lighting. Industrial fluorescent fixtures would be provided for control house lighting. Exterior lighting for security purposes would be automatically controlled by a photo-electric relay. Exterior lighting would consist of lighting the spillway operating platform, safety barriers, warning signs and pole mounted HPS area lighting.

f. Wiring. Insulated copper conductors would generally be installed in either rigid galvanized steel conduit or schedule 40 rigid plastic conduit. Conductors would be rated for 600 volt insulation Types RHW, THW, THWN, OR XHHW. Conductors would be of copper except that aluminum conductors could be used as an equivalent for copper conductors of No. 6 AWG and larger. Aluminum conductors would have ampacity not less than the copper conductors.

g. Grounding. Ground rods and large embedded metallic masses would be utilized for a project main ground installation and would be tied together

with "AWG No.1" ground wire. Frames or enclosures of electrical equipment would be bonded to the grounding system. Ground conductors would be bare, soft annealed copper cables and ground rods would be of copperclad type 3/4 inch in diameter by 8 feet long. Ground inserts with ground straps would be used for equipment ground connection.

f. Electrical Relocations.

(1) Electrical Lines. The power line relocation work will be done by Peace River Electric Coop. (PRE) at Government cost. To the south side of Highway 60, PRE Coop. has a 14 KV, 3-phase, 4-wire power line. The 3-phase, 14 KV power line will be extended to east side of the proposed levee as depicted on plate ME-4. To the east side of Structure-65, The Peace River Electric Coop. has a 14 KV, 1-phase, 2-wire aerial power line, tapped from the 3-phase power line, extending to the S-65 spillway and residence. The 1-phase, 14 KV power line, transformer, and associated hardware will be relocated to the east side of the proposed levee while considering appropriate sizing of the proposed load as depicted on plates ME-4 and ME-3 respectively. The power line will extend to the west side of residential driveway where it will terminate. Mr. James Swails at PRE has indicated the power line relocation and commercial transformer cost to be approximately $3,500.00. The 1-phase line terminates at a 25 KVA, 14 KV - 120/240 volt transformer. The 25 KVA, 14 KV - 120/240 volt transformer will be replaced with a 50 KVA, 14 KV - 120/240 volt transformer.

The 120/240 volt service feeds underground from the service pole to the generator building, to a meter socket and 200 amp disconnect. Downstream of the 200 amp disconnect is a 200 amp manual transfer switch which is connected to a 30 KW generator for emergency power. SFWMD proposes to upgrade the emergency generator to a 60 KW unit in 1-2 years. The residence has a 150 amp, 120/240 volt underground service fed from a sub-panel within the generator building. The relocation of the generator building will require relocation of the 120/240 volt underground residential service. The spillway and lock are fed from a 37.5 KVA, 240/600 volt transformer within the generator building. The 600 volt circuit is fed underground to the spillway and lock location. The spillway and lock have separate taps into the 600 volt feeder at a common junction box. The spillway is fed from a 10 KVA, 600/240 volt transformer. The lock is fed from a 25 KVA, 600/240 volt transformer. See plate ME-3 for one line diagram. The 600 volt underground circuit feeding the spillway and lock will require relocation with the proposed generator building. This new underground circuit will be sized to feed the existing lock and spillway and the proposed spillway.

(2) Telephone Lines. The telephone line relocation work will be done by General Telephone (GTE) Company at no cost to the Government. GTE has a 50-pair, copper cable sharing Peace River Electric Cooperative's utility poles as depicted on plate ME-4. The telephone cable will require relocation with Peace River Electric Cooperative's power line. The relocation work will require close coordination between GTE and Peace River Electric Coop. The underground telephone circuit to the residence will also require relocation. According to Mr. Joe Emery with GTE, this work will be done by GTE at their costs.

C. CONSTRUCTION PROCEDURE

7. General. The construction details are generally outlined in the Design and Cost Appendix, and they will be refined during plans & specifications.

D. COST ESTIMATES

8. General. The summary of the estimates for the first cost of construction for the recommended plan, including quantities, unit costs, contingencies, and reasons for contingencies is presented in Table T-1. The complete estimate will be incorporated into final draft.

9. Quantities. The quantities for canal excavation were developed from survey data taken in August 1991. No significant changes in estimated volumes are anticipated, and no future surveys of the canals are scheduled. Quantities for the grading of the local levees were basically rough estimates taken from average berm widths and side slopes, as determined from visual inspections of the levees. The earthwork volumes associated with the structural additions were provided by design engineers, and were best guess calculations. Detailed site surveys, cross-sections, and geotechnical information would be required prior to preparation of contract plans and specifications.

10. Cost Estimates. The estimate for the Headwaters Project was done using MCACES GOLD estimating software. The estimate details all costs to the government and to the local sponsor. The dollar values were calculated to include contingencies, current interest rates, and estimated inflation. Because this project study serves as a supplement to the 1991 Kissimmee River Feasibility Study, the cost factors (shown as percentages) for contingencies, planning, engineering and design, and construction management will be the same.

E. OPERATIONS AND MAINTENANCE

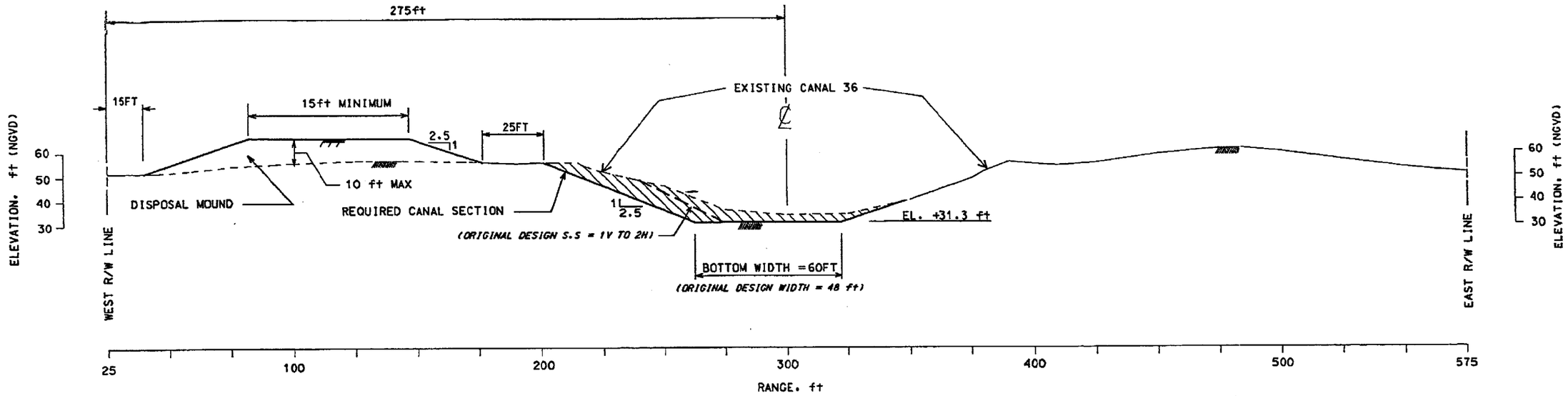
11. General. Maintenance and operation of the new spillway structure will be performed by the project sponsor. All applicable criteria for the existing spillway will apply to the new spillway. The contractor will be responsible for all maintenance required during the contract. Operation and Maintenance of the project facilities will be performed in accordance with the instructions prepared and incorporated into the "Operation and Maintenance Manual" which will be furnished to the project sponsor prior to turning the project over to the sponsor.

KISSIMMEE RIVER
HEADWATERS REVITALIZATION REPORT

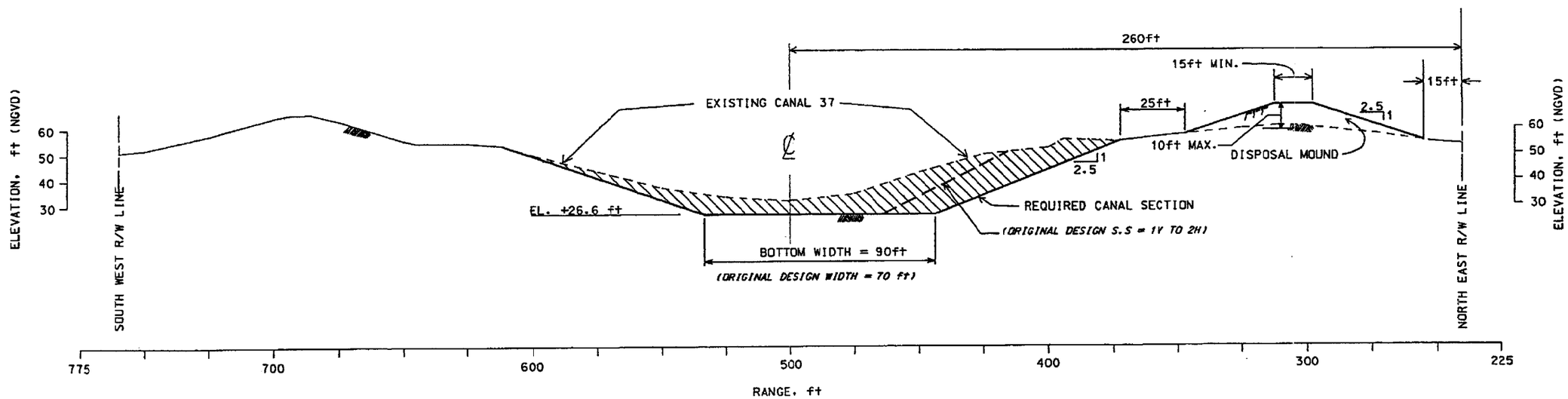
APPENDIX D

Design and Cost Estimates

PLATES



C-36 SECTION AT STA. 100+00



C-37 SECTION AT STA. 130+00

NOTES:

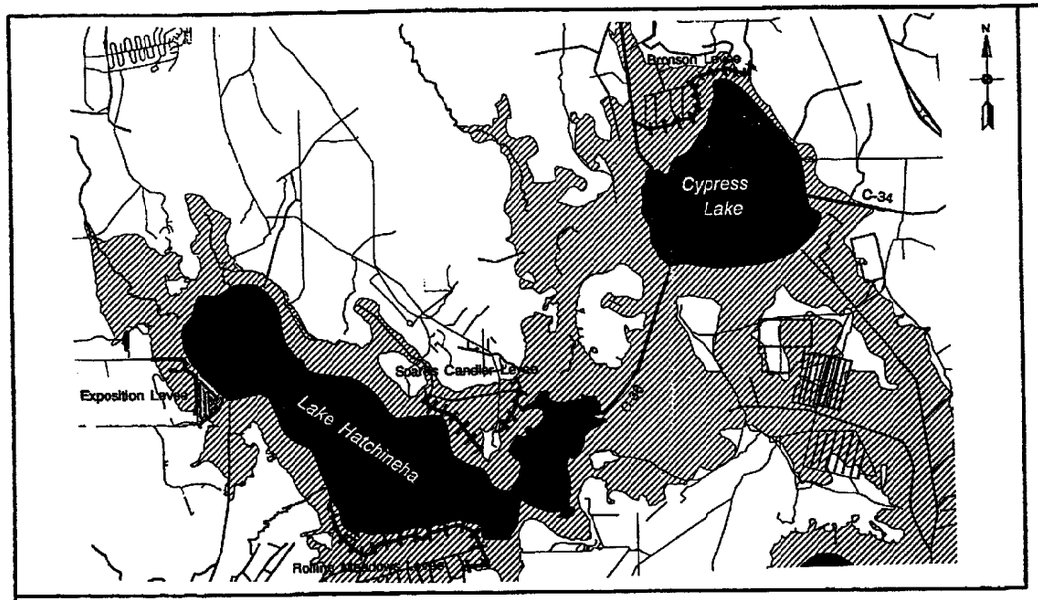
1. The area shown within the required canal section represents the material to be removed during both maintenance and widening operations.

CENTRAL AND SOUTHERN FLORIDA
KISSIMMEE RIVER HEADWATERS REVITALIZATION

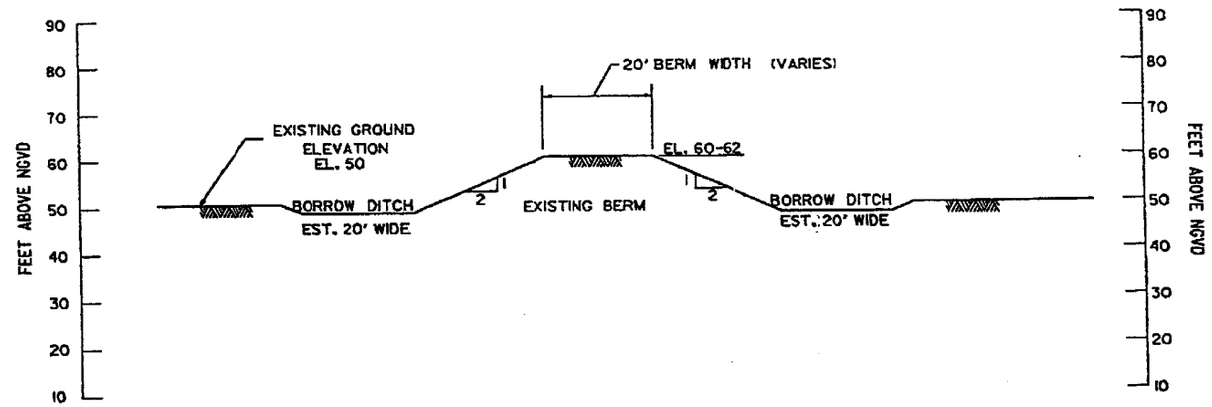
CONSTRUCTION FOR C-36 AND C-37

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA
SECTION 135 PROJECT MODIFICATION REPORT

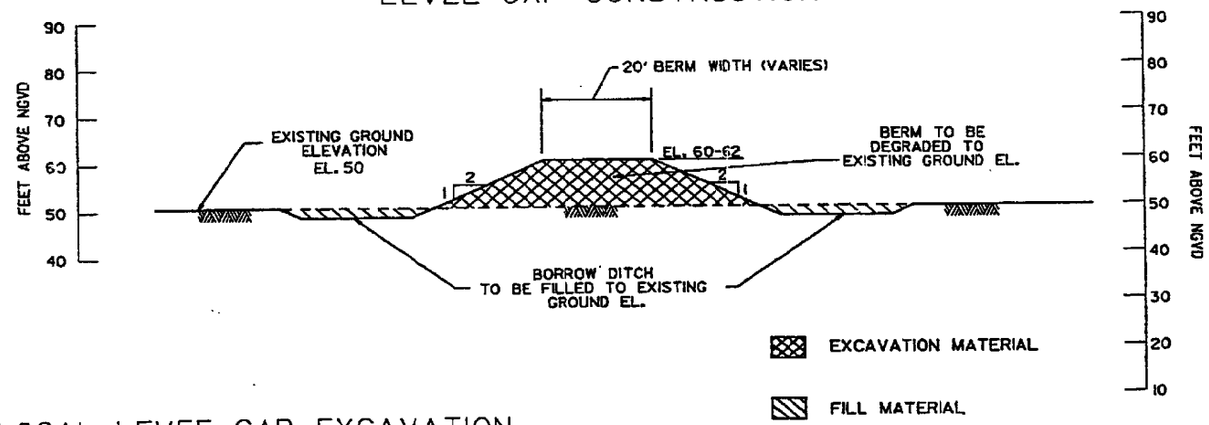
D.O. FILE NO. 400-36.826 DATE: JULY 1995

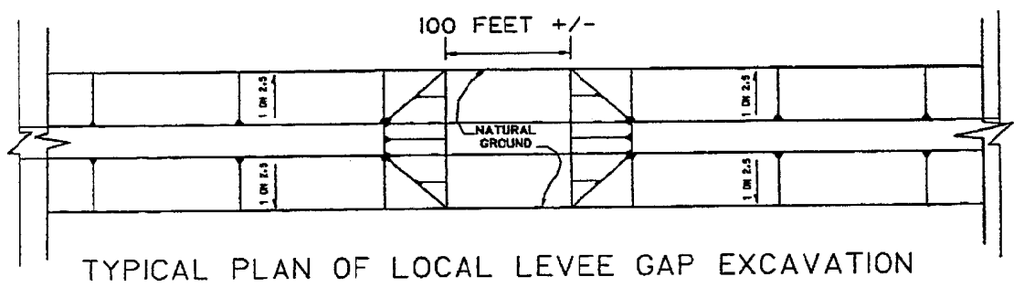


TYPICAL CROSS-SECTION OF LOCAL LEVEES



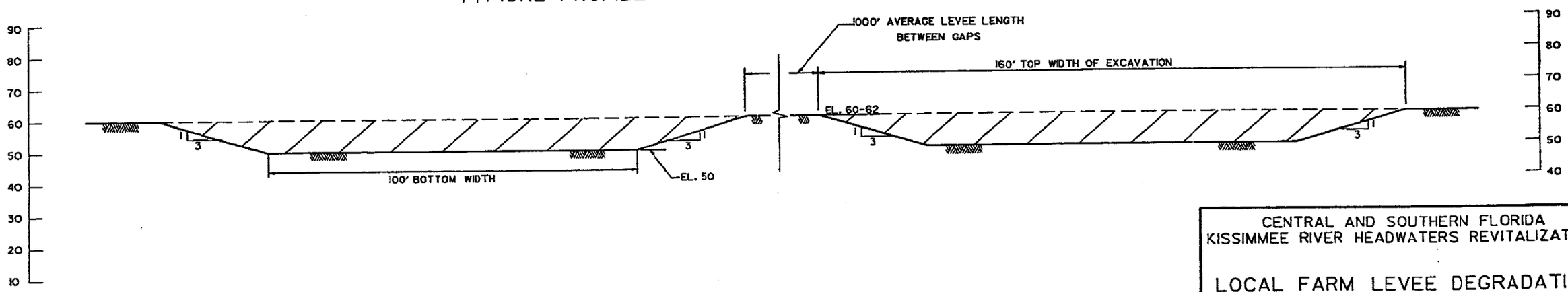
TYPICAL CROSS-SECTION OF LEVEE GAP CONSTRUCTION





TYPICAL PLAN OF LOCAL LEVEE GAP EXCAVATION

TYPICAL PROFILE OF LOCAL LEVEE GAP EXCAVATION



SHADED REGION INDICATES MATERIAL TO BE EXCAVATED

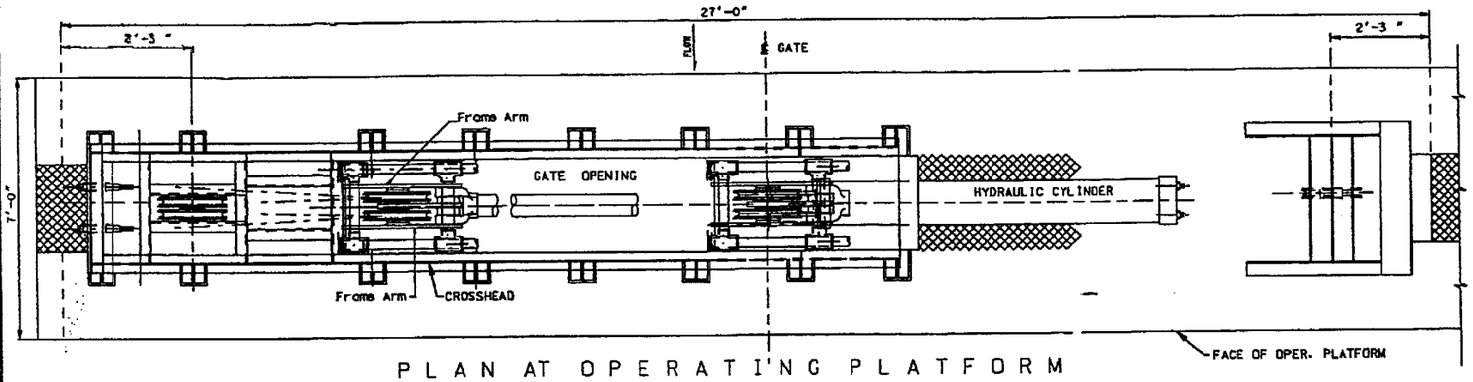
CENTRAL AND SOUTHERN FLORIDA
KISSIMMEE RIVER HEADWATERS REVITALIZATION

LOCAL FARM LEVEE DEGRADATION

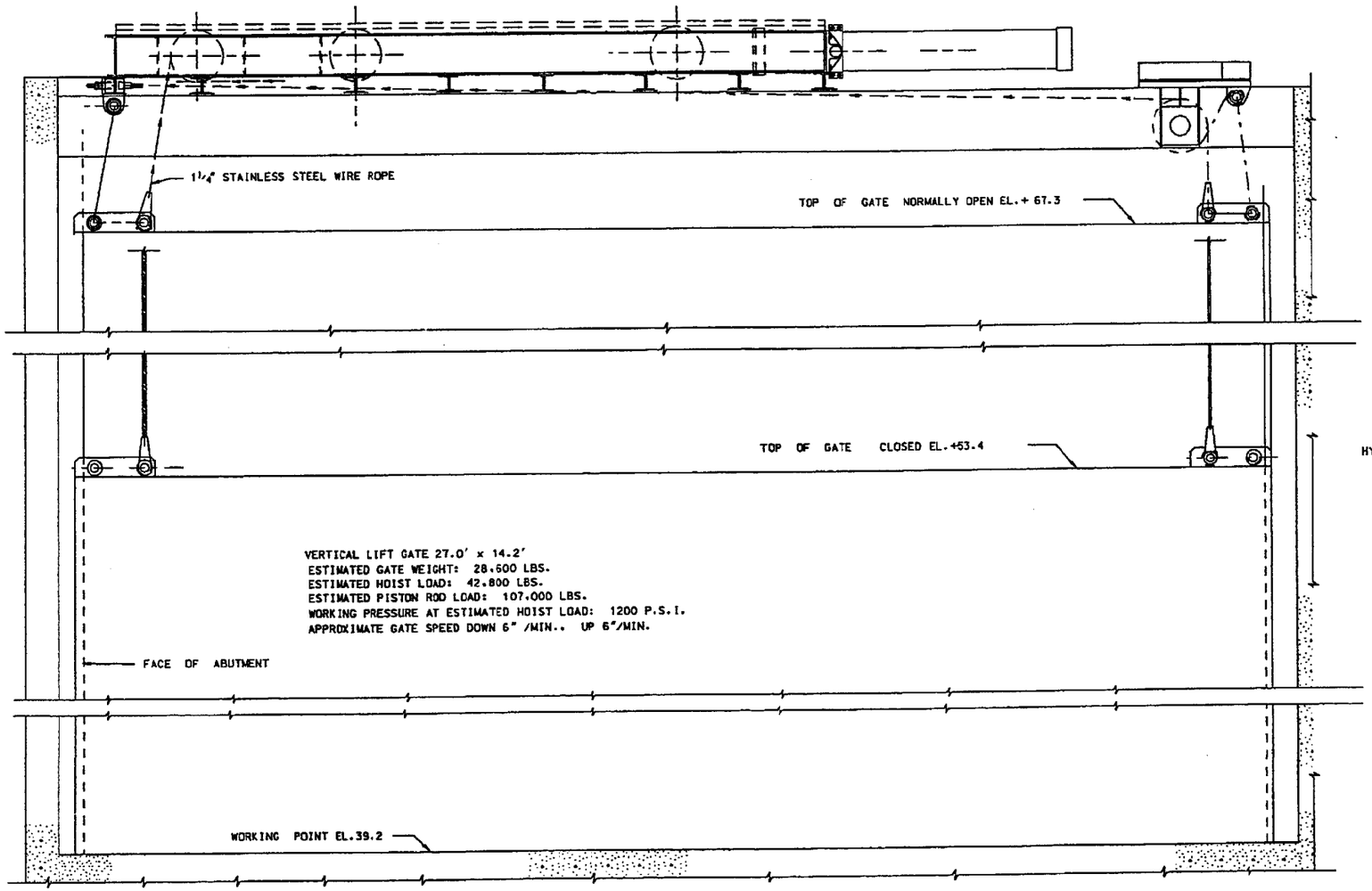
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

SECTION 1135 PROJECT MODIFICATION REPORT

D.O. FILE NO. 400-36,826 DATE: JULY 1995



PLAN AT OPERATING PLATFORM



SECTION ELEVATION

NOT TO SCALE

HOIST HYDRAULIC SYSTEM

NOTES:

1. WITH THIS SYSTEM, OIL IS PUMPED TO THE CYLINDER WHEN GATE IS OPENED.
2. DRAIN LINES TO COMPONENTS REQUIRING SAME SHALL BE PROVIDED ALTHOUGH NOT SHOWN.
3. AIR BLEEDING VALVES SHALL BE PROVIDED AT HIGH POINTS OF SYSTEM.

LEGEND

1. HYDRAULIC HOIST CYL. 12" BORE, 5½" Ø ROD, 84" STROKE.
2. ALL PIPES SHALL BE STAINLESS STEEL TUBING WITH 0.065" WALL.

M ELECT. MOTOR 3HP, 230V, 1Ø

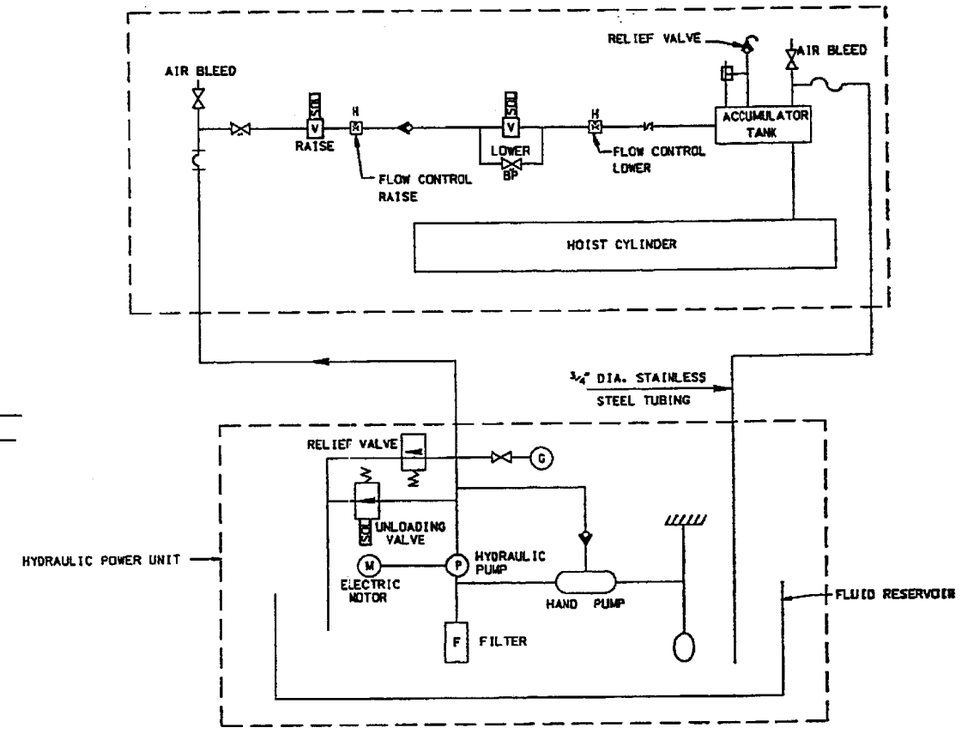
P PUMP RATED AT 1.4 GPM AT 2000 P.S.I., 1800 R.P.M.

G PRESSURE GAGE, 0-3000 P.S.I.

BP BYPASS

V SOLENOID VALVE NORMALLY CLOSED.

H VARIABLE FLOW CONTROL VALVES PRESSURE COMPENSATED.



NOTE: THE UNLOADING VALVE IS SOLENOID OPERATED, TIME DELAYED, AND SPRING OFFSET

CENTRAL AND SOUTHERN FLORIDA
CANAL 38
KISSIMMEE RIVER HEADWATERS REVITILIZATION

STRUCTURE S-65 ADDITION

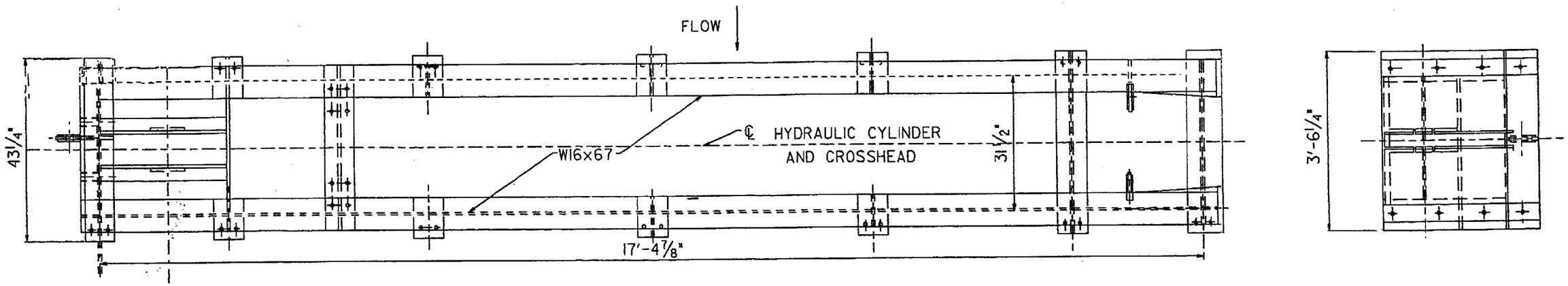
GATE HOIST

(SCALES AS SHOWN)

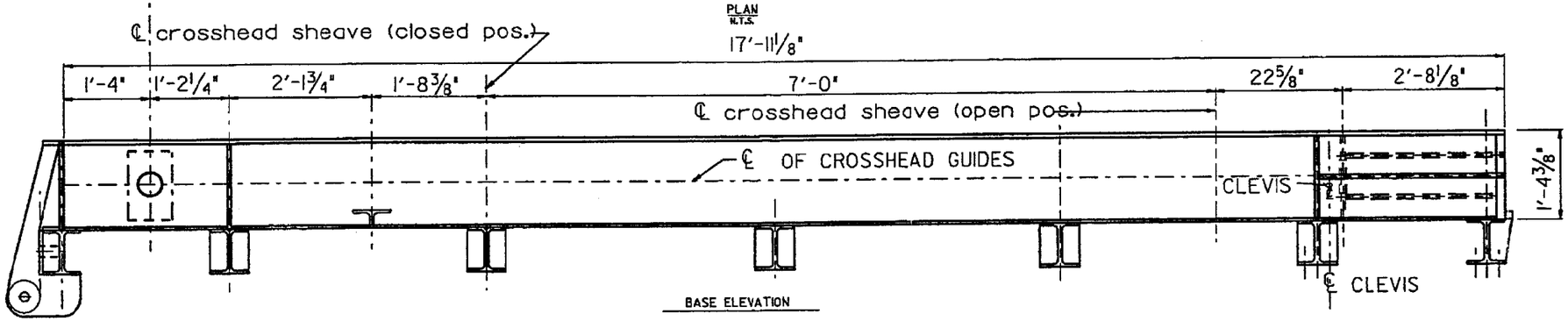
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

SECTION 1135 PROJECT MODIFICATION REPORT

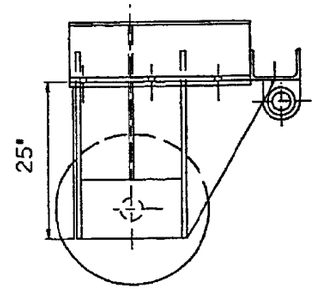
D.O. FILE NO. 400-36,826



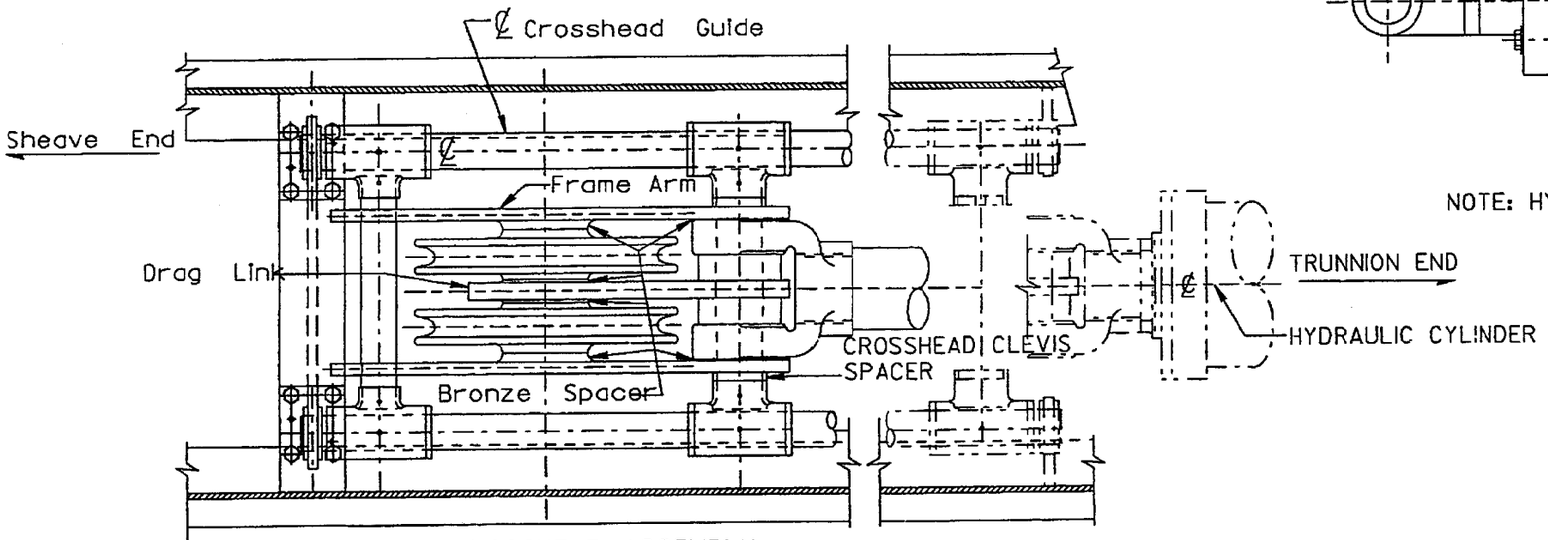
PLAN
N.T.S.



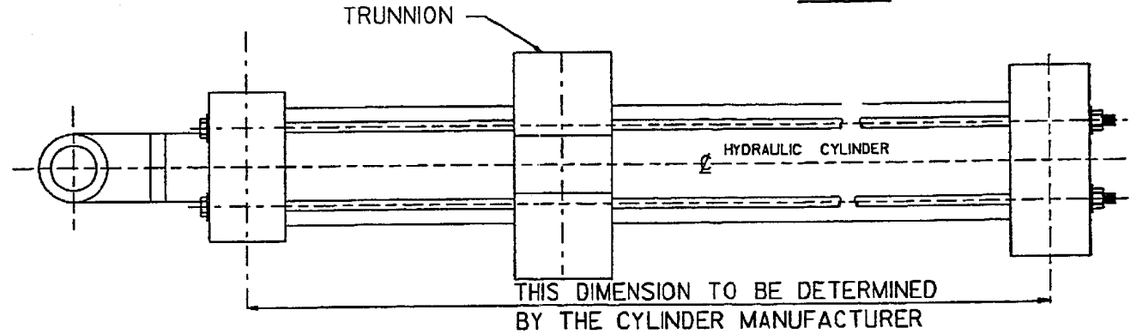
BASE ELEVATION



ELEVATION



CROSSHEAD ASSEMBLY



NOTE: HYDRAULIC CYLINDER - 12" BORE, 5 1/2" DIA. ROD & 84" WORKING STROKE

HYDRAULIC CYLINDER

CENTRAL AND SOUTHERN FLORIDA
CANAL 38
KISSIMMEE RIVER HEADWATERS REVITILIZATION

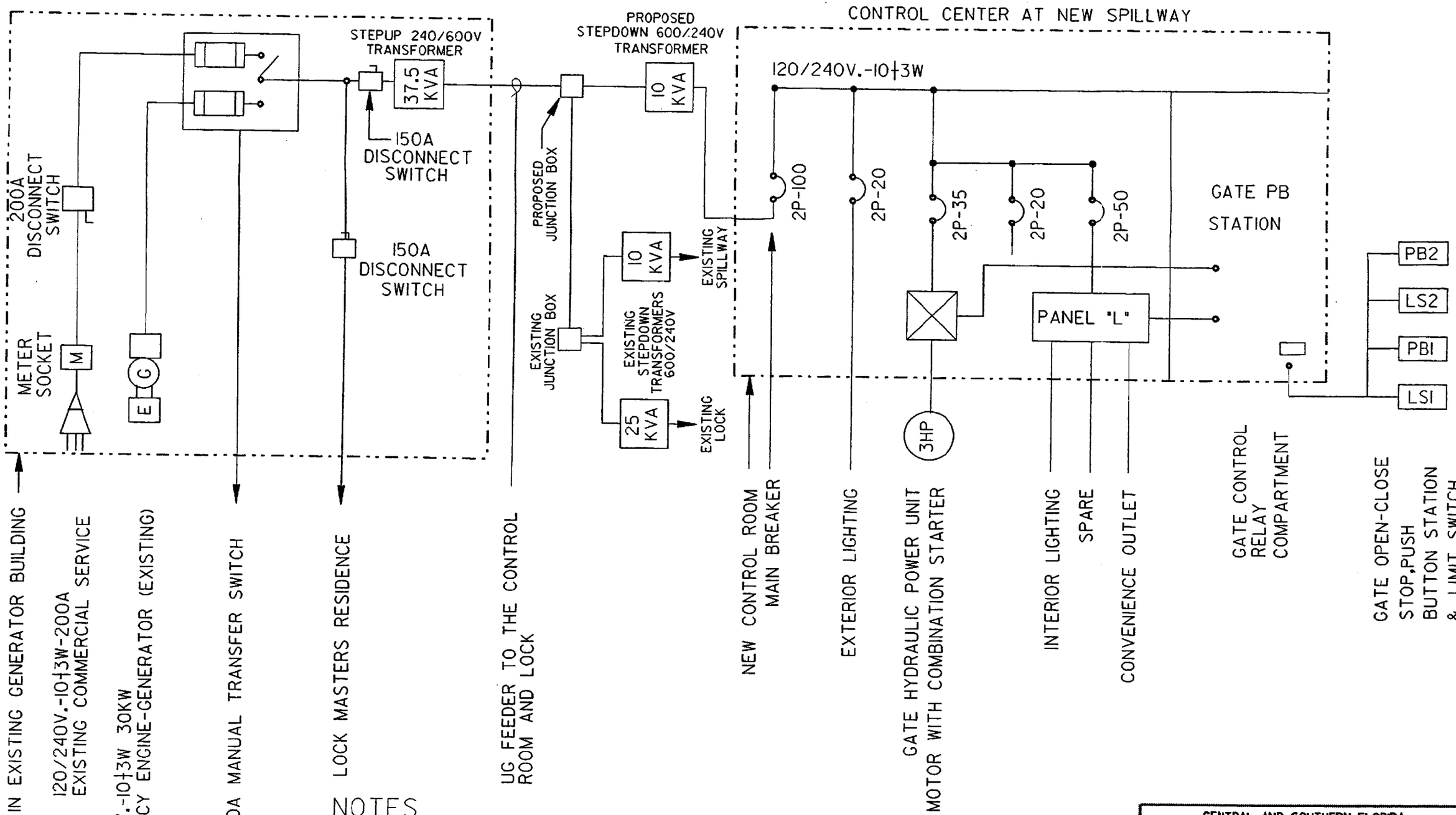
STRUCTURE S-65 ADDITION
GATE HOIST
MECHANICAL DETAILS

(SCALES AS SHOWN)

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

SECTION 1135 PROJECT MODIFICATION REPORT

D.O. FILE NO. 400-36,826



NOTES

1. FOR NEW POWERLINE AND SERVICE POLE LOCATION SEE PLATE ME-4.
2. SFWMD PROPOSES TO UPGRADE THE EMERGENCY GENERATOR TO A 60KW UNIT IN 1-2 YEARS.
3. THE EXISTING ELECTRICAL SERVICE, FEEDERS, AND ASSOCIATED EQUIPMENT SHALL BE UPGRADED TO 300A CAPACITY.

DESIGN ENG.: S.M.	
DWN. BY: W.F.	CKD. BY: D.L.N.

CENTRAL AND SOUTHERN FLORIDA
CANAL 38
KISSIMMEE RIVER HEADWATERS REVITILIZATION

STRUCTURE S-65 ADDITION

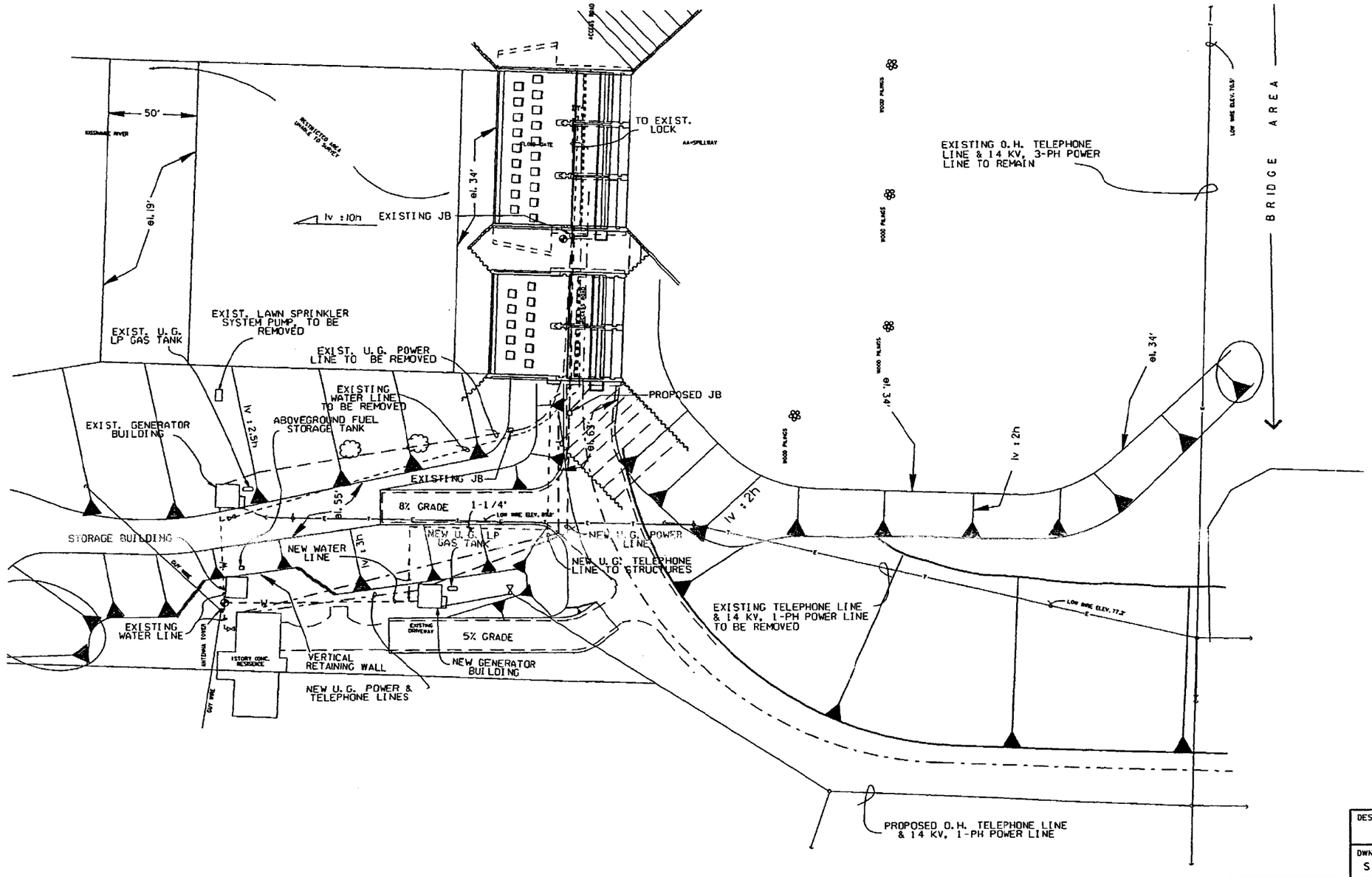
ELECTRICAL SYS.-ONE LINE DIAGRAM

(NO SCALE)

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

SECTION 1135 PROJECT MODIFICATION REPORT

D.O. FILE NO. 400-36,826 DATE: OCTOBER 1994



LEGEND

O. H. OVERHEAD

U. G. UNDERGROUND

LP LIQUEFIED PETROLEUM

POINT OF CONNECTION BETWEEN NEW & EXISTING

N

50 25 0 50 100FT

SCALE: 1" = 50'

CENTRAL AND SOUTHERN FLORIDA
CANAL 38
KISSIMMEE RIVER HEADWATERS REVITILIZATION

STRUCTURE S-65 ADDITION

MECH. & ELEC. RELOCATIONS

(SCALES AS SHOWN)

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

SECTION 1135 PROJECT MODIFICATION REPORT

D.O. FILE NO. 400-36,826 DATE: JANUARY 1995

DESIGN ENG.: S.J.P.	
DWN. BY: S.J.P.	CKD. BY: S.M.

PLATE ME-

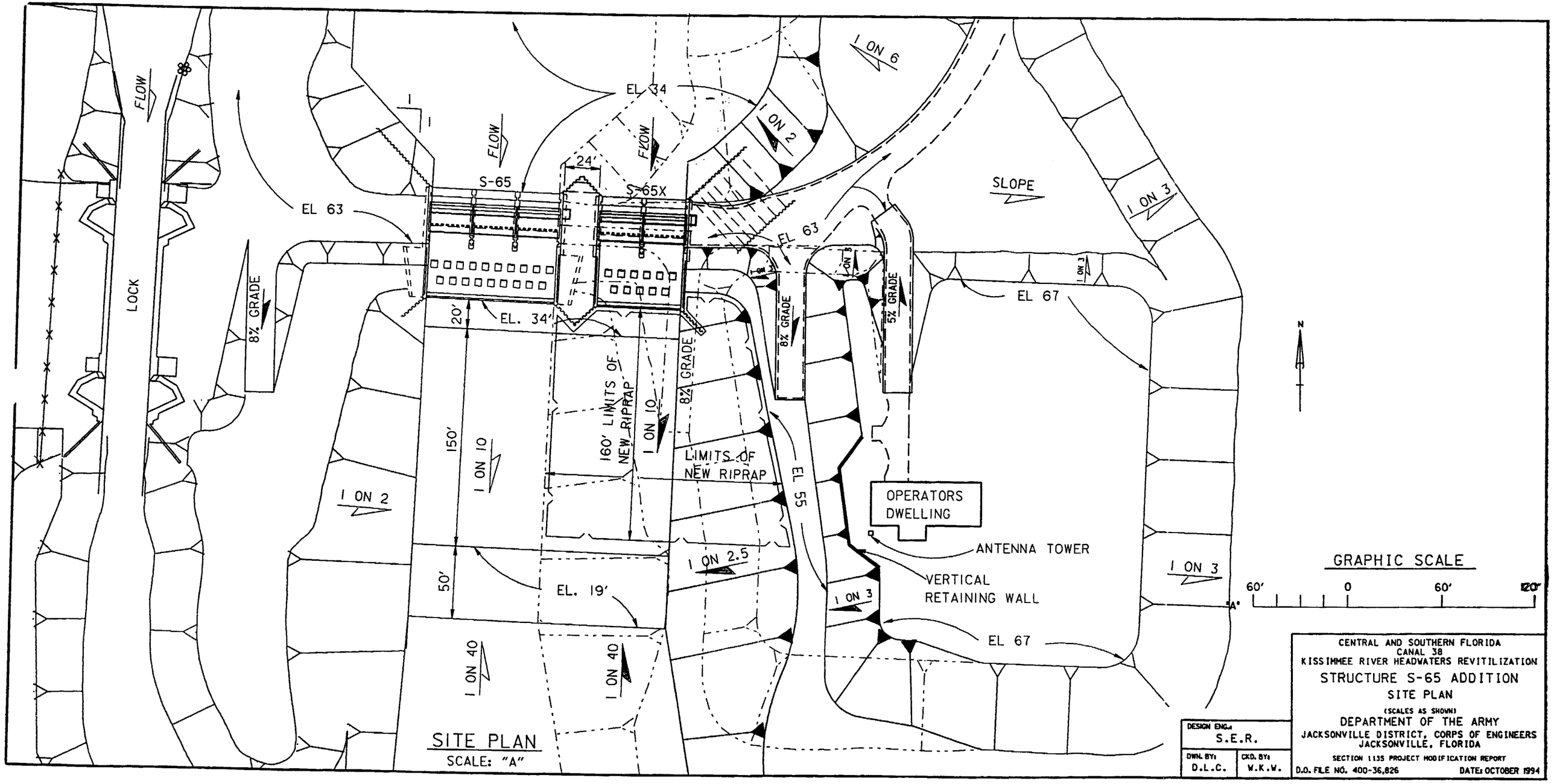

FLOW
LOCK
8% GRADE
EL 63
S-65
S-65X
24'
EL 34
FLOW
FLOW
1 ON 6
1 ON 2
SLOPE
1 ON 3
EL 63
EL 67
5% GRADE
8% GRADE
8% GRADE
EL. 34'
20'
150'
1 ON 10
160' LIMITS OF NEW RIPRAP
1 ON 10
LIMITS OF NEW RIPRAP
EL 55
1 ON 2
1 ON 2.5
50'
EL. 19'
1 ON 40
1 ON 40
OPERATORS DWELLING
ANTENNA TOWER
VERTICAL RETAINING WALL
1 ON 3
EL 67
1 ON 3
N
GRAPHIC SCALE
60' 0 60' 120'
SITE PLAN
SCALE: "A"
DESIGN ENG.: S.E.R.
DWN. BY: D.L.C.
CKD. BY: W.K.W.
CENTRAL AND SOUTHERN FLORIDA
CANAL 38
KISSIMMEE RIVER HEADWATERS REVITILIZATION
STRUCTURE S-65 ADDITION
SITE PLAN
(SCALES AS SHOWN)
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA
SECTION 1135 PROJECT MODIFICATION REPORT
D.O. FILE NO. 400-36,826
DATE: OCTOBER 1994

PLATE S-1

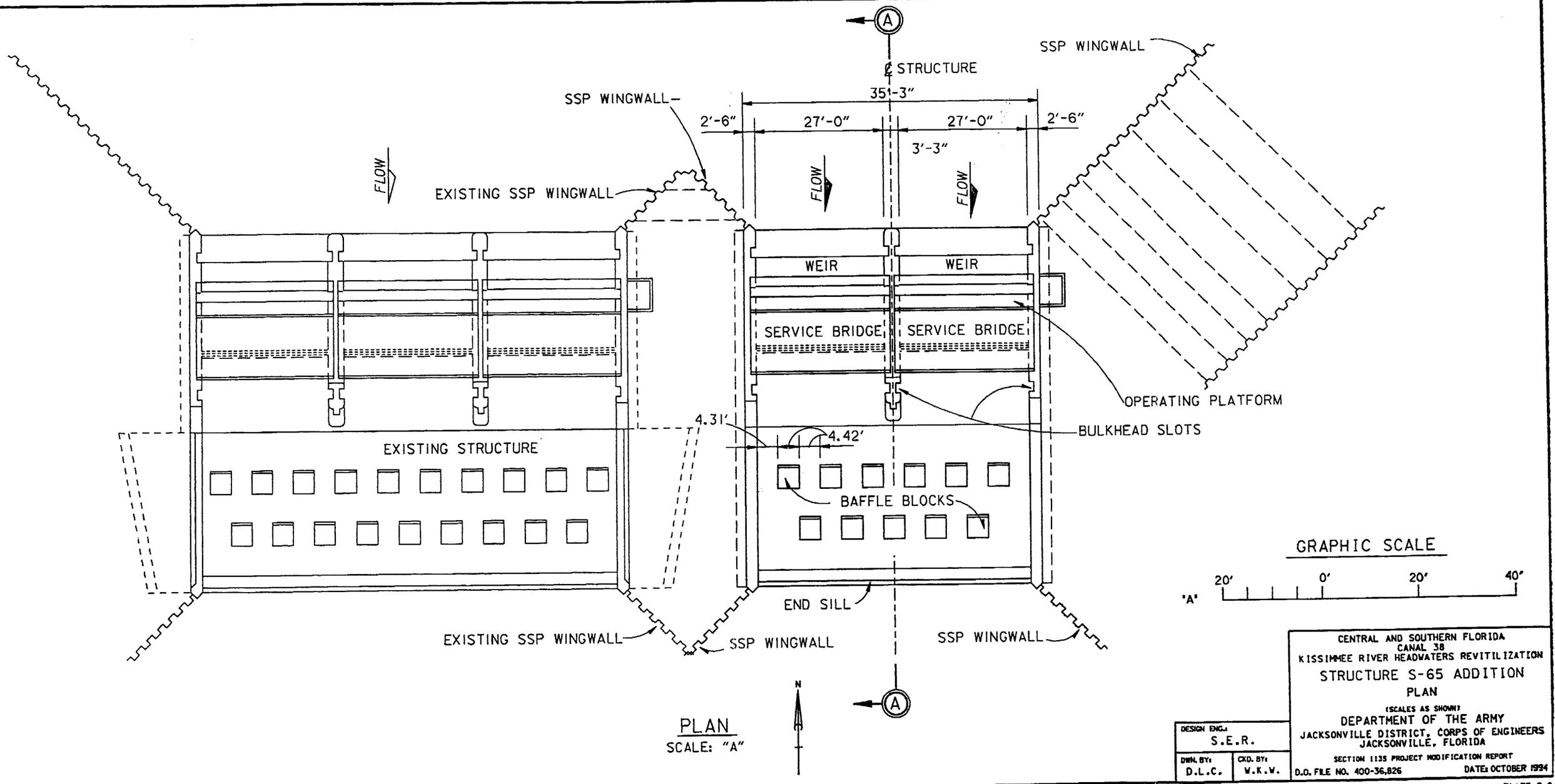
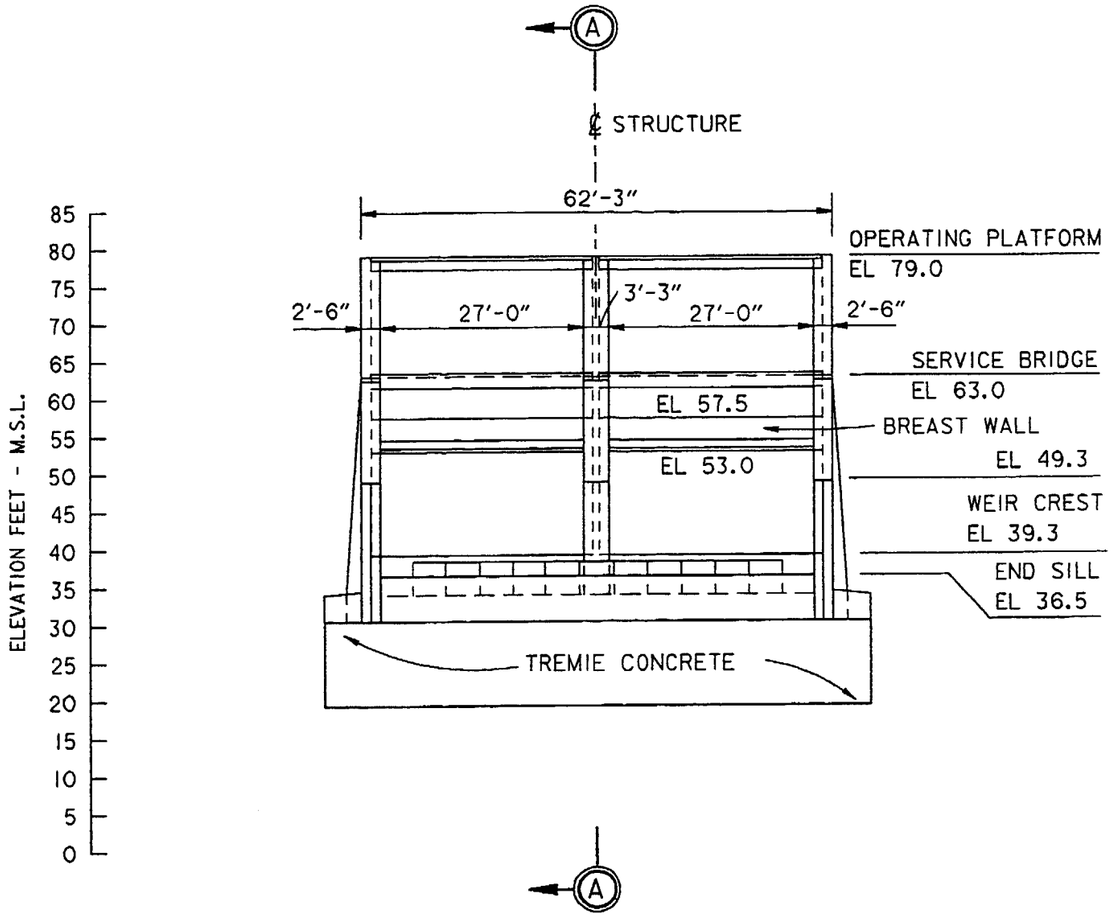
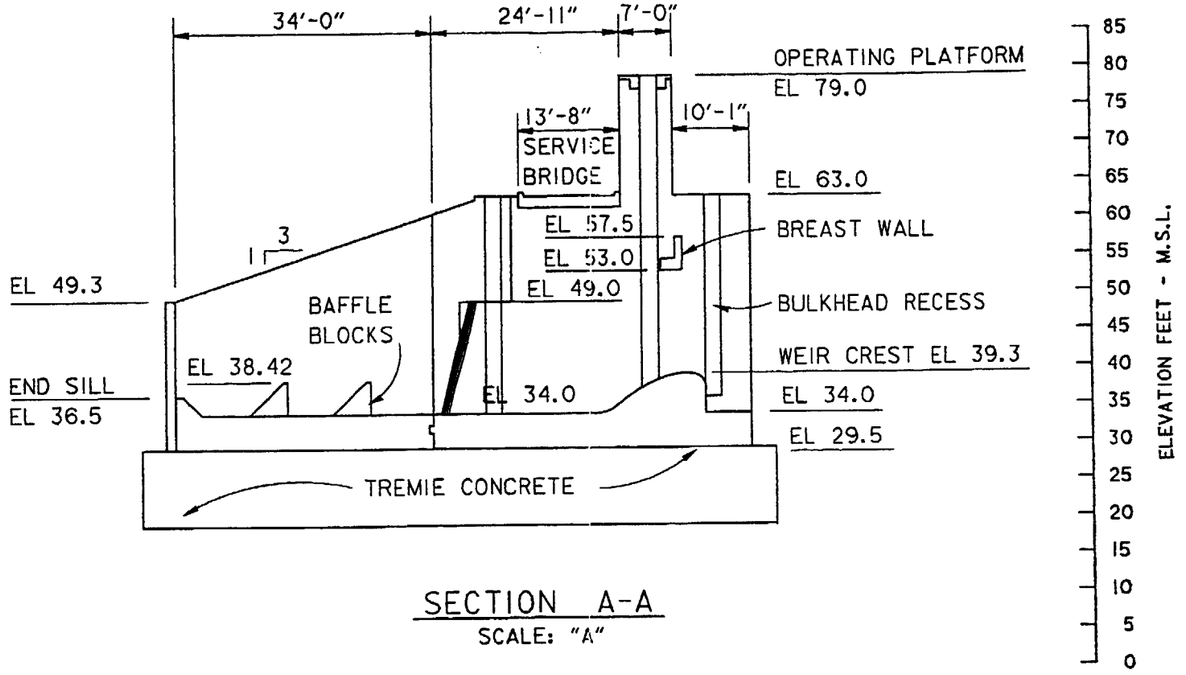

A
SSP WINGWALL
℄ STRUCTURE
351'-3"
SSP WINGWALL
2'-6"
27'-0"
27'-0"
2'-6"
3'-3"
FLOW
FLOW
FLOW
EXISTING SSP WINGWALL
WEIR
WEIR
SERVICE BRIDGE
SERVICE BRIDGE
OPERATING PLATFORM
BULKHEAD SLOTS
4.31'
4.42'
EXISTING STRUCTURE
BAFFLE BLOCKS
END SILL
EXISTING SSP WINGWALL
SSP WINGWALL
SSP WINGWALL
A
N
PLAN
SCALE: "A"
GRAPHIC SCALE
20'
0'
20'
40'
"A"
CENTRAL AND SOUTHERN FLORIDA
CANAL 38
KISSIMMEE RIVER HEADWATERS REVITILIZATION
STRUCTURE S-65 ADDITION
PLAN
(SCALES AS SHOWN)
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA
SECTION 1135 PROJECT MODIFICATION REPORT
D.O. FILE NO. 400-36,826
DATE: OCTOBER 1994
DESIGN ENG.: S.E.R.
DWN. BY: D.L.C.
CKD. BY: W.K.W.

PLATE S-2



DOWNSTREAM ELEVATION

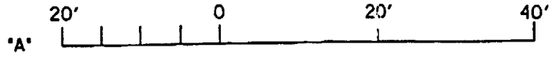
SCALE: "A"



SECTION A-A

SCALE: "A"

GRAPHIC SCALE



CENTRAL AND SOUTHERN FLORIDA
CANAL 38
KISSIMMEE RIVER HEADWATERS REVITILIZATION

STRUCTURE S-65 ADDITION

ELEVATION AND SECTION

(SCALES AS SHOWN)

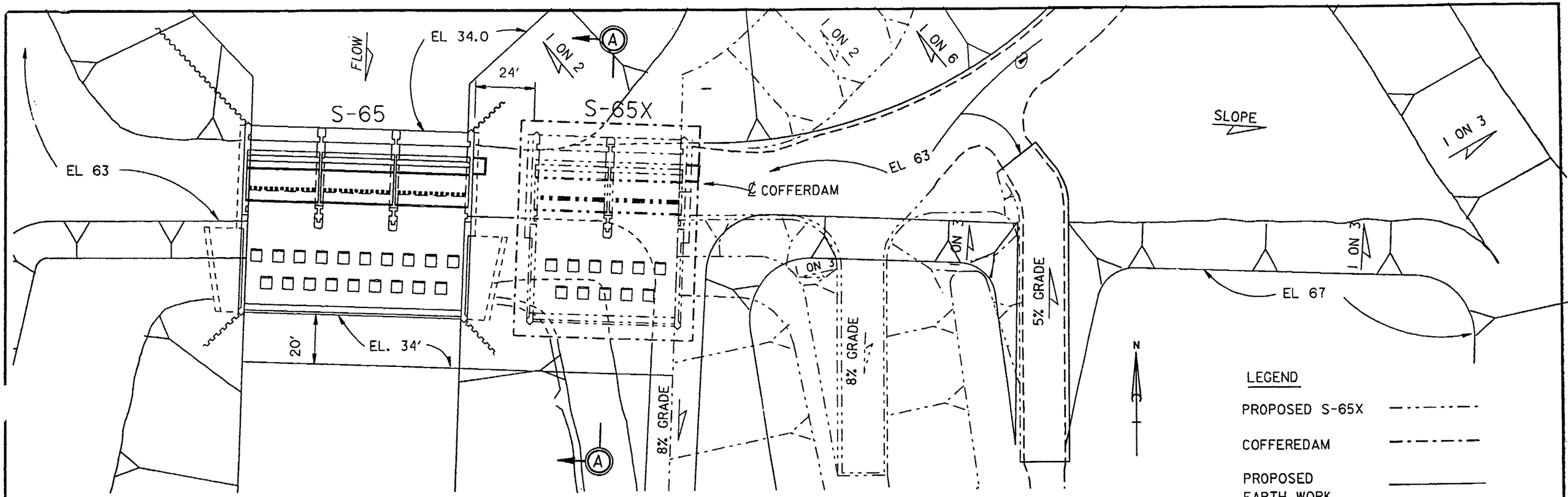
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

SECTION 1135 PROJECT MODIFICATION REPORT

DESIGN ENG.: S.E.R.	
DWN. BY: D.L.C.	CKD. BY: W.K.W.

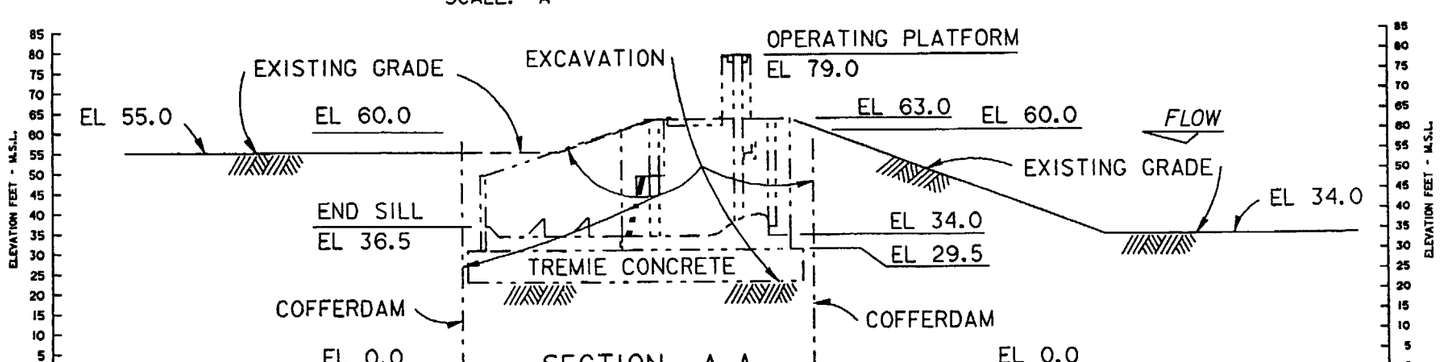
D.O. FILE NO. 400-36,826 DATE: OCTOBER 1994

PLATE S-3



CONSTRUCTION SITE PLAN

SCALE: "A"



SECTION A-A

SCALE: "A"

GRAPHIC SCALE

"A" 40' 0 40' 80'

CENTRAL AND SOUTHERN FLORIDA
CANAL 38
KISSIMMEE RIVER HEADWATERS REVITILIZATION

STRUCTURE S-65 ADDITION
CONSTRUCTION SITE PLAN AND SECTION

(SCALES AS SHOWN)

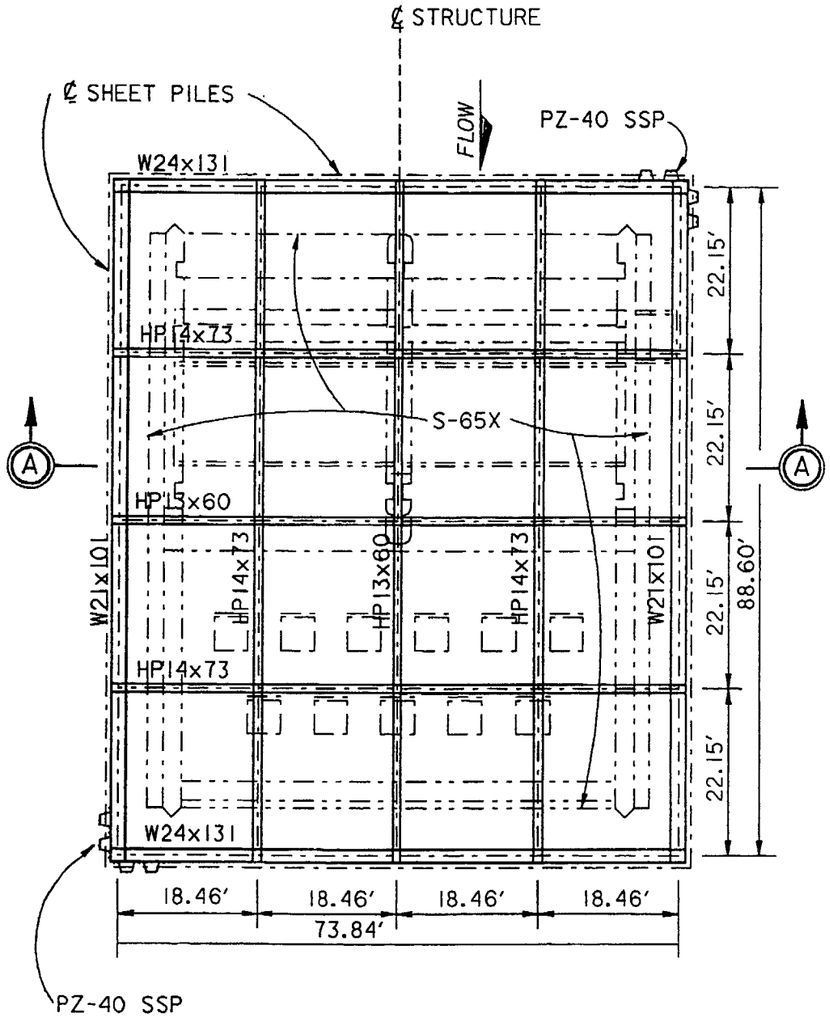
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

SECTION 1135 PROJECT MODIFICATION REPORT

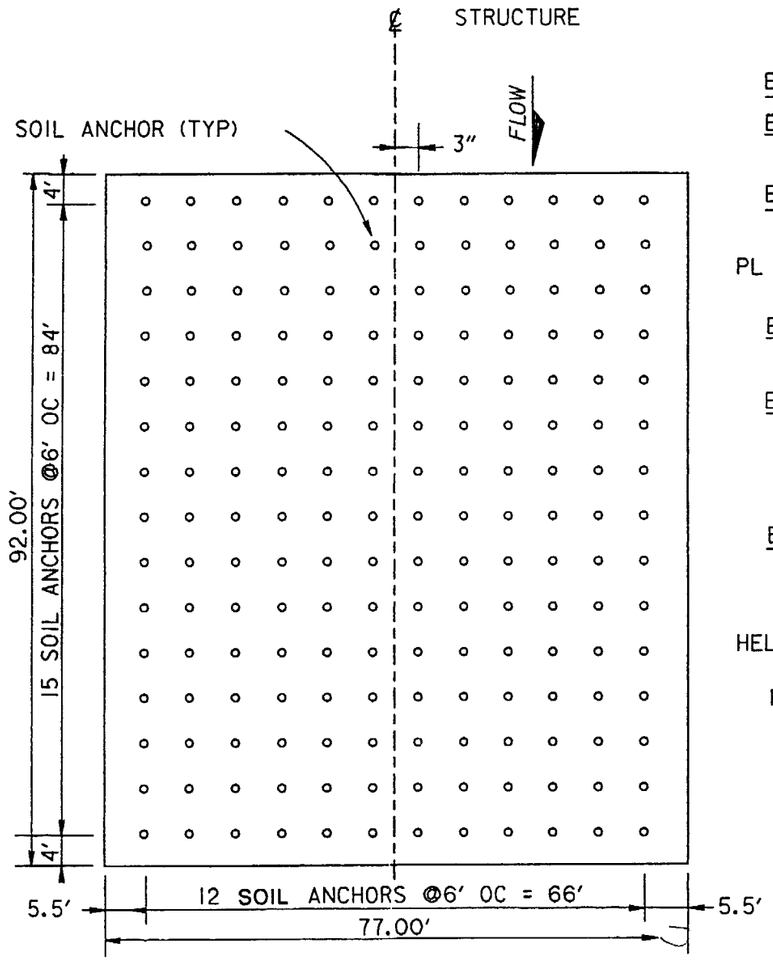
DESIGN ENG.: S.E.R.	
DWN. BY: D.L.C.	CKD. BY: W.K.W.

D.O. FILE NO. 400-36,826 DATE: OCTOBER 1994

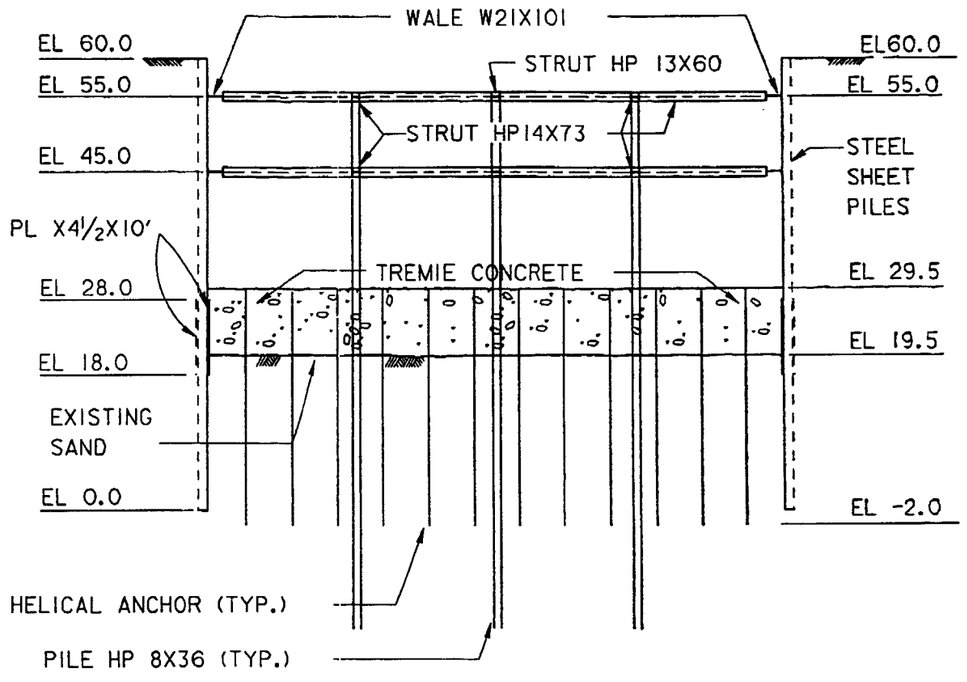
PLATE S-4



COFFERDAM PLAN
SCALE: "A"



SOIL ANCHOR PLAN
SCALE: "A"



SECTION A-A
SCALE: "A"

GRAPHIC SCALE

20' 0 20' 40'
"A"

DESIGN ENG.: S.E.R.	
DWN. BY: D.L.C.	CKD. BY: W.K.W.

CENTRAL AND SOUTHERN FLORIDA
CANAL 38
KISSIMMEE RIVER HEADWATERS REVITILIZATION

STRUCTURE S-65 ADDITION
DEWATERING COFFERDAM PLAN/SECTION

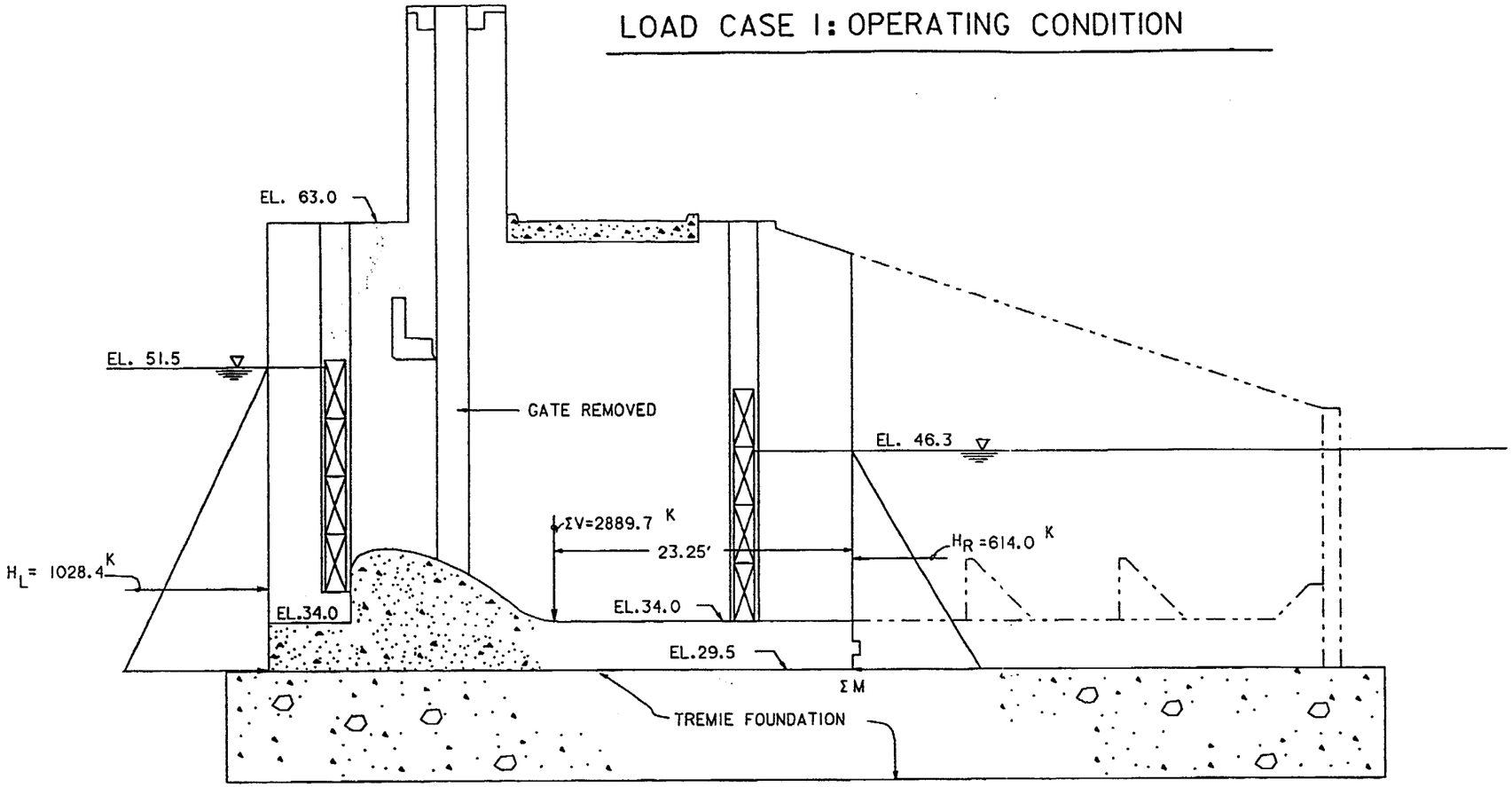
(SCALES AS SHOWN)

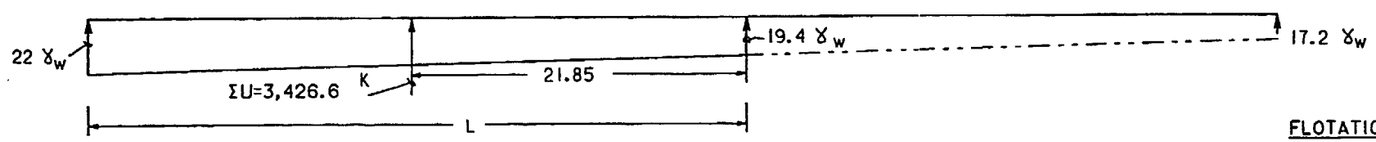
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

SECTION 1135 PROJECT MODIFICATION REPORT

D.O. FILE NO. 400-36,826 DATE: OCTOBER 1994

LOAD CASE I: OPERATING CONDITION





OVERTURNING STABILITY

BASE AREA IN COMPRESSION: 100%; e=0.67'
MINIMUM ALLOWADLE BASE AREA IN COMPRESSION: 75%

FLOTATION STABILITY

LOAD CASE I: S.F.=1.84 ≥ 1.5

NOTES:

1. ONE BAY DEWATERED AND THE OTHER BAY IN OPERATION.
2. STABILITY RESULTS ARE FOR CNTROL STRUCTURE ONLY. SEE PLATES FOR STABILITY RESULTS OF STILLING BASIN.

SLIDING STABILITY

HORIZONTAL FAILURE PLANE DATA	
STRUCTURAL WEDGE	
TAN O; O=45 °	1.0
∝	0°
L (FT)	42.0
W (KIPS)	6,316.3
U (KIPS)	3,426.6
H_L (KIPS)	1,028.4
H_R (KIPS)	614.0
SLIDING S.F. = 6.97 > 2.0	

SYMBOL	SYMBOL DESCRIPTION
Ø	ANGLE OF OBLIQUITY
∝	INCLINATION ANGLE OF POTENTIAL FAILURE SURFACE
γ_w	UNIT WEIGHT OF WATER (0.0625 KCF)
W	TOTAL WEIGHT OF WATER, SOIL AND STRUCTURE
U	UPLIFT FORCE ON THE FAILURE SURFACE
H_L	HORIZONTAL LOAD APPLIED TO THE STRUCTURE
H_R	HORIZONTAL LOAD APPLIED TO THE STRUCTURE - OPPOSITE DIRECTION
L	LENGTH OF WEDGE ALONG THE FAILURE SURFACE

GRAPHIC SCALE

10' 5' 0 10' 20'

DESIGN ENG.: S.E.R.

DWN. BY: D.L.C. CKD. BY: W.K.W.

CENTRAL AND SOUTHERN FLORIDA
CANAL 38
KISSIMMEE RIVER HEADWATERS REVITILIZATION

STRUCTURE S-65 ADDITION

SLIDING, OVERTURNING AND FLOTATION STABILITY ANALYSIS-LOAD CASE I

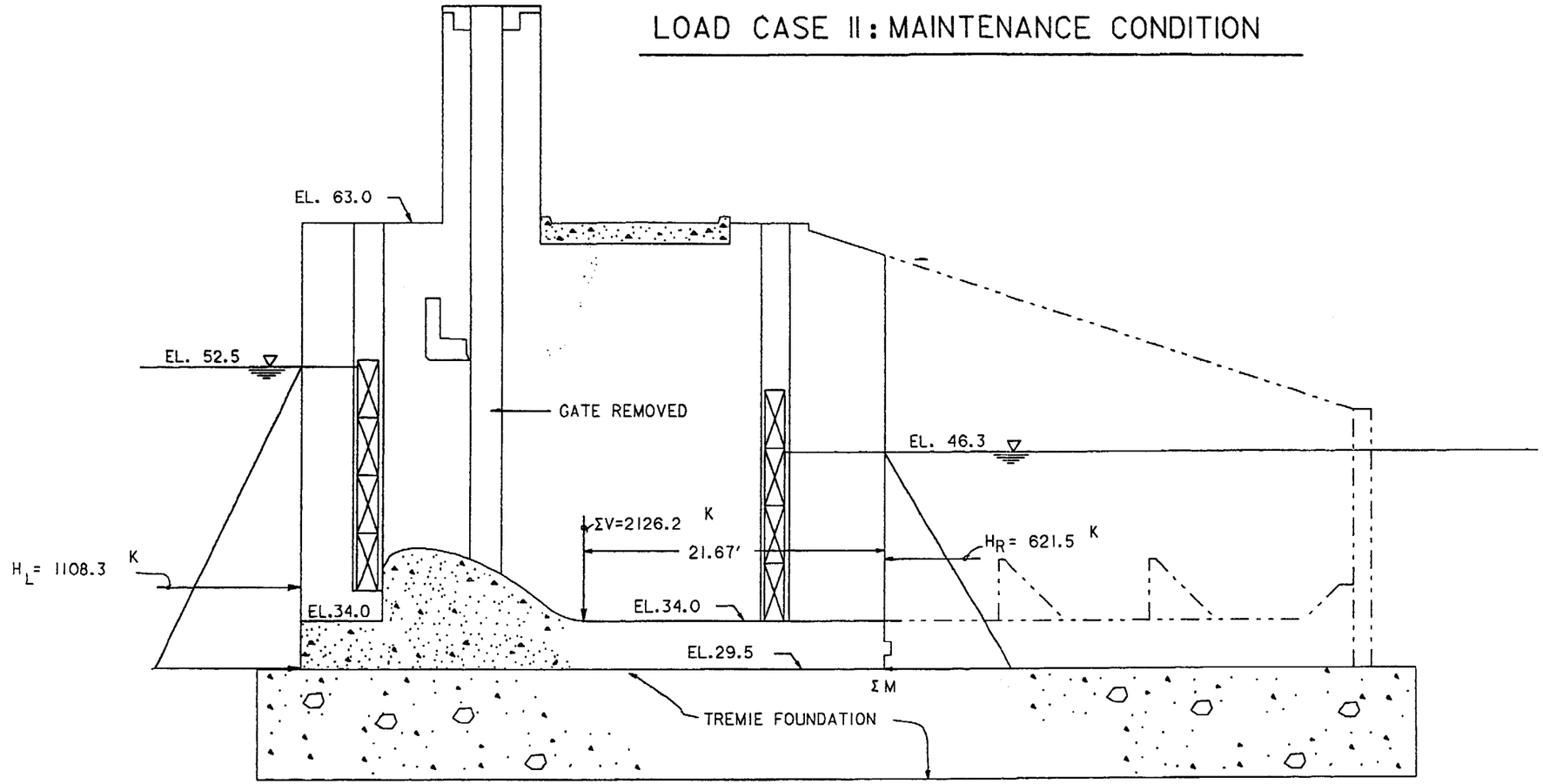
(SCALES AS SHOWN)

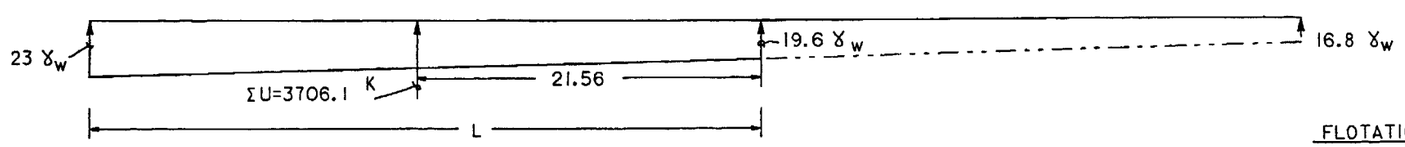
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

SECTION 1135 PROJECT MODIFICATION REPORT

D.O. FILE NO. 400-36,826 DATE: OCTOBER 1994

LOAD CASE II: MAINTENANCE CONDITION





NOTES:

1. ONE BAY DEWATERED AND THE OTHER BAY IN OPERATION.
2. STABILITY RESULTS ARE FOR CNTROL STRUCTURE ONLY. SEE PLATES FOR STABILITY RESULTS OF STILLING BASIN.

OVERTURNING STABILITY

BASE AREA IN COMPRESSION: 100%; e=0.67'
MINIMUM ALLOWADLE BASE AREA IN COMPRESSION: 75%

FLOTATION STABILITY

LOAD CASE II: S.F.=1.57 1.3

SLIDING STABILITY

HORIZONTAL FAILURE PLANE DATA	
STRUCTURAL WEDGE	
TAN 0; 0=45 °	1.0
∝	0°
L (FT)	42.0
W (KIPS)	5,832.3
U (KIPS)	3,706.1
H_L (KIPS)	1,108.3
H_R (KIPS)	621.5
SLIDING S.F. = 4.37 2≥0	

SYMBOL	SYMBOL DESCRIPTION
ø	ANGLE OF OBLIQUITY
∝	INCLINATION ANGLE OF POTENTIAL FAILURE SURFACE
γ_w	UNIT WEIGHT OF WATER (0.0625 KCF)
W	TOTAL WEIGHT OF WATER, SOIL AND STRUCTURE
U	UPLIFT FORCE ON THE FAILURE SURFACE
H_L	HORIZONTAL LOAD APPLIED TO THE STRUCTURE
H_R	HORIZONTAL LOAD APPLIED TO THE STRUCTURE - OPPOSITE DIRECTION
L	LENGTH OF WEDGE ALONG THE FAILURE SURFACE

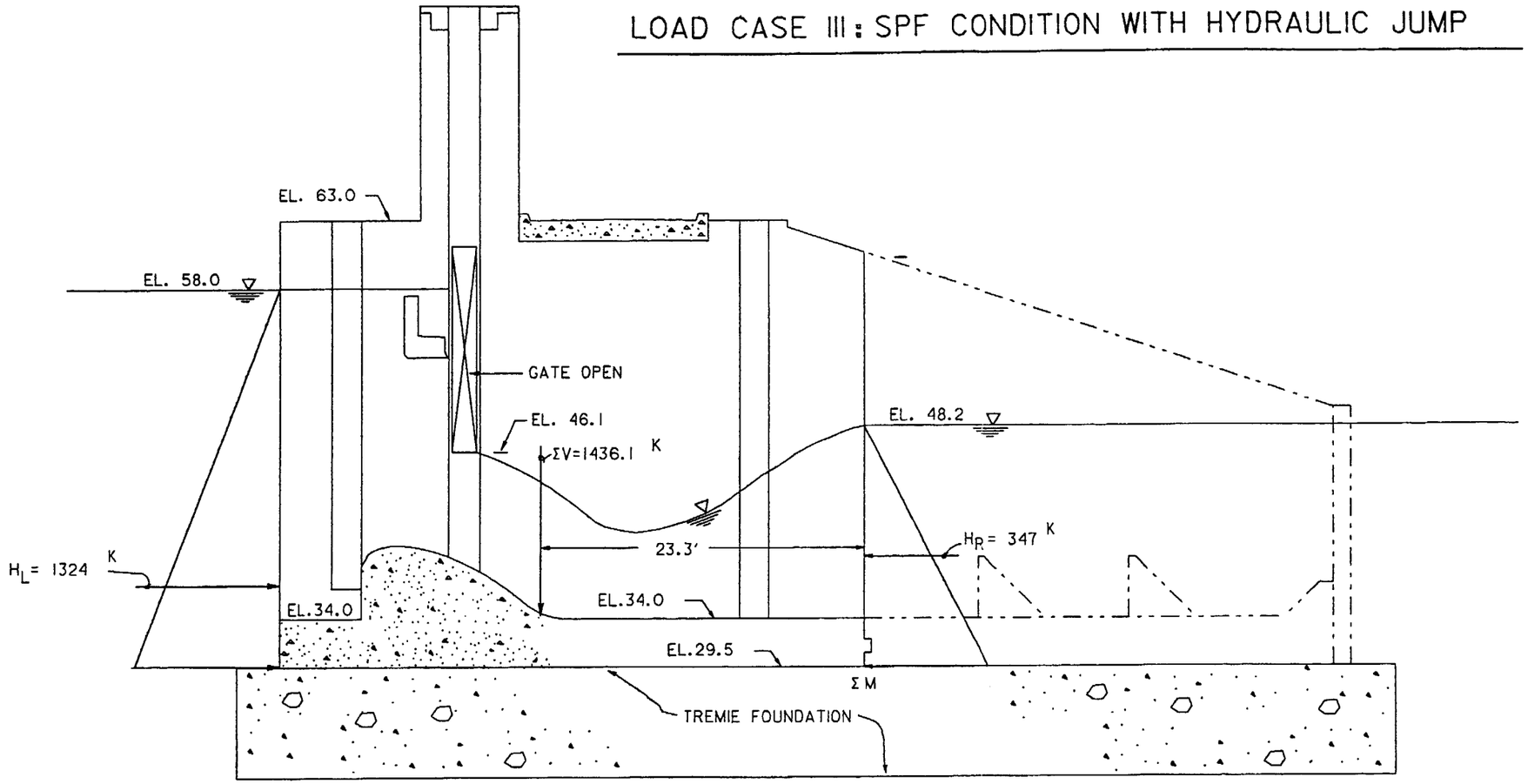
GRAPHIC SCALE

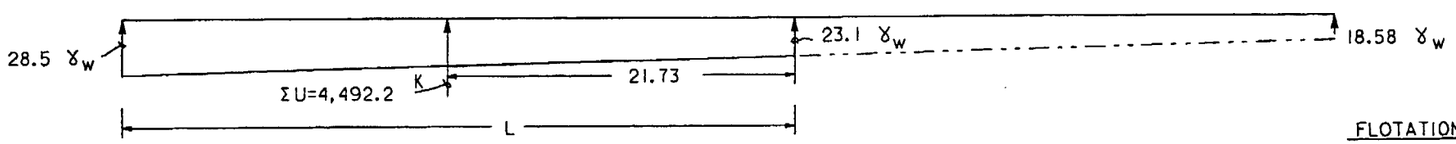
10' 5' 0 10' 20'

DESIGN ENG.: P.E.S.
DWN. BY: D.L.C.
CKD. BY: W.K.W.

CENTRAL AND SOUTHERN FLORIDA
CANAL 38
KISSIMMEE RIVER HEADWATERS REVITILIZATION
STRUCTURE S-65 ADDITION
SLIDING, OVERTURNING AND FLOTATION STABILITY ANALYSIS-LOAD CASE II
(SCALES AS SHOWN)
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA
SECTION 1135 PROJECT MODIFICATION REPORT
D.O. FILE NO. 400-36,826 DATE: OCTOBER 1994

LOAD CASE III: SPF CONDITION WITH HYDRAULIC JUMP





OVERTURNING STABILITY

BASE AREA IN COMPRESSION: 100%; e=2.3'

MINIMUM ALLOWABLE BASE AREA IN COMPRESSION: 75%

NOTE:

1. STABILITY RESULTS ARE FOR CNTROL STRUCTURE ONLY. SEE PLATES FOR STABILITY RESULTS OF STILLING BASIN.

FLOTATION STABILITY

LOAD CASE III: S.F.=1.32 1.1≥

SLIDING STABILITY

HORIZONTAL FAILURE PLANE DATA	
STRUCTURAL WEDGE	
TAN 0; 0=45 °	1.0
∝	0°
L (FT)	42.0
W (KIPS)	5,928.3
U (KIPS)	4,492.2
H_L (KIPS)	1,324.0
H_R (KIPS)	347
SLIDING S.F. = 1.47	1.3

SYMBOL	SYMBOL DESCRIPTION
ø	ANGLE OF OBLIQUITY
∝	INCLINATION ANGLE OF POTENTIAL FAILURE SURFACE
γ_w	UNIT WEIGHT OF WATER (0.0625 KCF)
W	TOTAL WEIGHT OF WATER, SOIL AND STRUCTURE
U	UPLIFT FORCE ON THE FAILURE SURFACE
H_L	HORIZONTAL LOAD APPLIED TO THE STRUCTURE
H_R	HORIZONTAL LOAD APPLIED TO THE STRUCTURE - OPPOSITE DIRECTION
L	LENGTH OF WEDGE ALONG THE FAILURE SURFACE

GRAPHIC SCALE

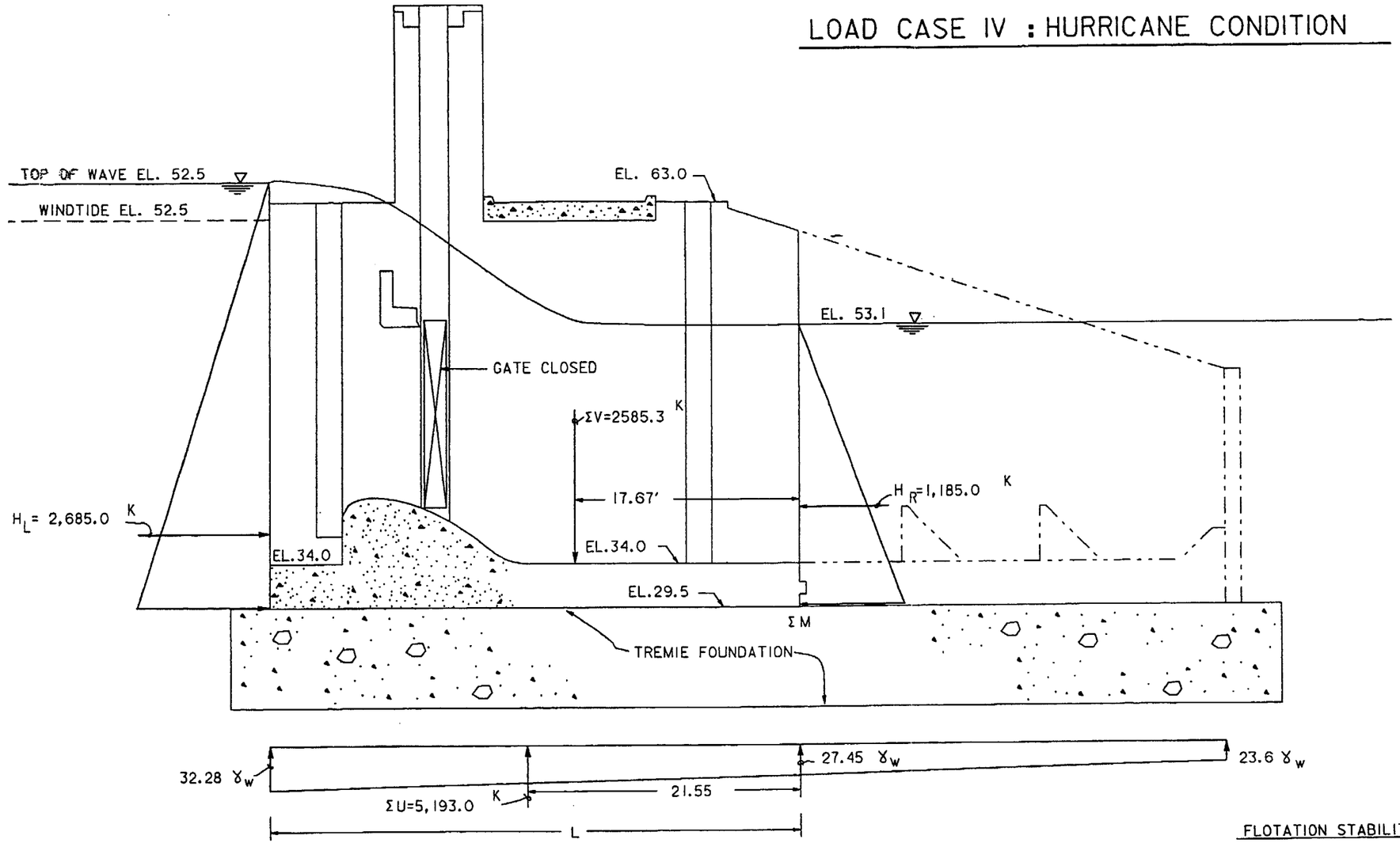
10' 5' 0 10' 20'

DESIGN ENG.: P.E.S.

DWN. BY: D.L.C. CKD. BY: W.K.W.

CENTRAL AND SOUTHERN FLORIDA
CANAL 38
KISSIMMEE RIVER HEADWATERS REVITILIZATION
STRUCTURE S-65 ADDITION
SLIDING, OVERTURNING AND FLOTATION STABILITY ANALYSIS-LOAD CASE III
(SCALES AS SHOWN)
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA
SECTION 1135 PROJECT MODIFICATION REPORT
D.O. FILE NO. 400-36,826 DATE: OCTOBER 1994

LOAD CASE IV : HURRICANE CONDITION



NOTE:

1. STABILITY RESULTS ARE FOR CNTROL STRUCTURE ONLY. SEE PLATES FOR STABILITY RESULTS OF STILLING BASIN.

OVERTURNING STABILITY

BASE AREA IN COMPRESSION: 100%; e=3.33'
MINIMUM ALLOWABLE BASE AREA IN COMPRESSION: 75%

FLOTATION STABILITY

LOAD CASE IV: S.F.=1.50 ≥ 1.1

SLIDING STABILITY

HORIZONTAL FAILURE PLANE DATA	
STRUCTURAL WEDGE	
TAN Ø; Ø=45 °	1.0
∝	0°
L (FT)	42.0
W (KIPS)	7,778.3
U (KIPS)	5,193.0
H_L (KIPS)	2,685.0
H_R (KIPS)	1,185.0
SLIDING S.F. = 1.72 > 1.3	

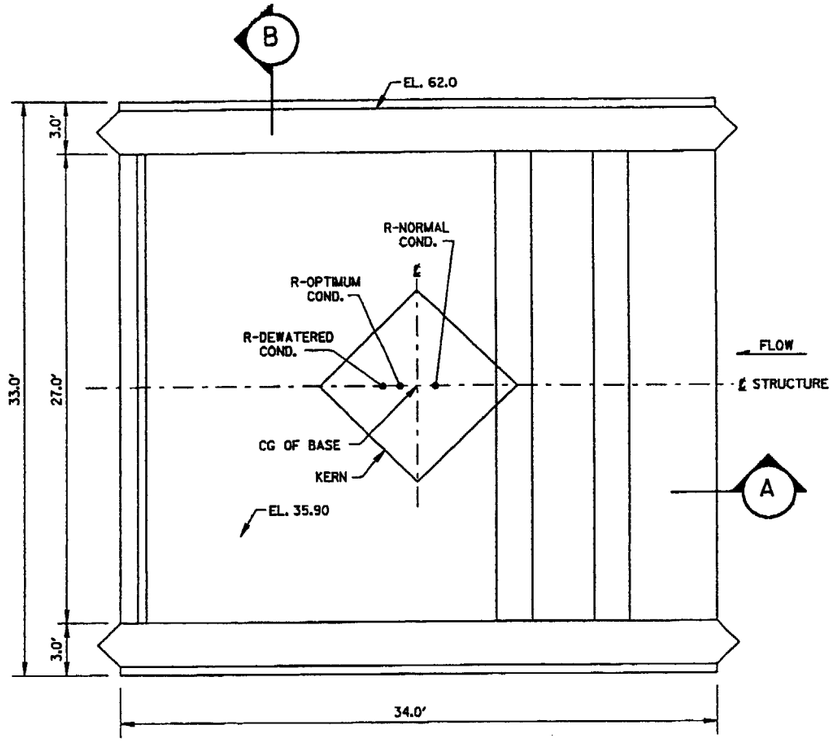
SYMBOL	SYMBOL DESCRIPTION
Ø	ANGLE OF OBLIQUITY
∝	INCLINATION ANGLE OF POTENTIAL FAILURE SURFACE
γ_w	UNIT WEIGHT OF WATER (0.0625 KCF)
W	TOTAL WEIGHT OF WATER, SOIL AND STRUCTURE
U	UPLIFT FORCE ON THE FAILURE SURFACE
H_L	HORIZONTAL LOAD APPLIED TO THE STRUCTURE
H_R	HORIZONTAL LOAD APPLIED TO THE STRUCTURE - OPPOSITE DIRECTION
L	LENGTH OF WEDGE ALONG THE FAILURE SURFACE

GRAPHIC SCALE

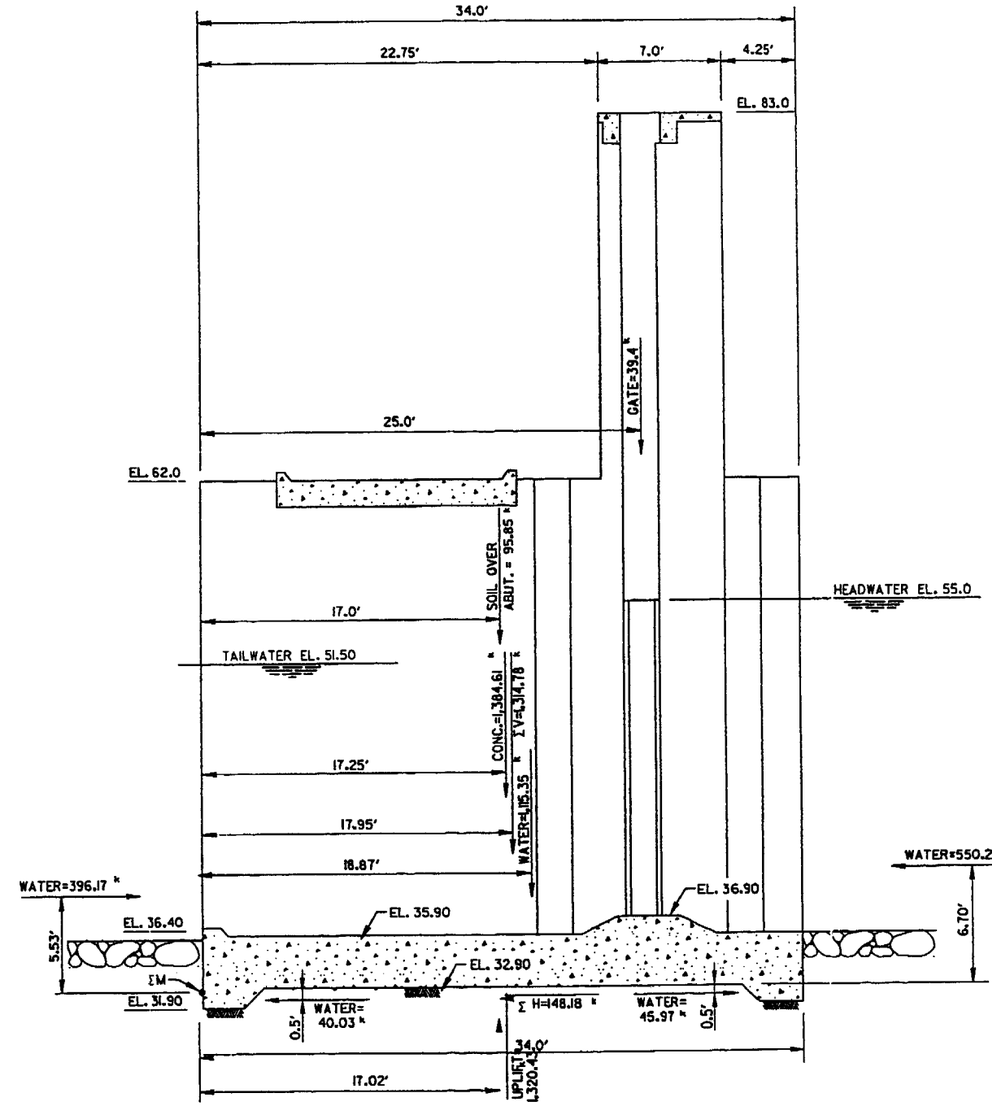
10' 5' 0 10' 20'

DESIGN ENG.: P.E.S.
DWN. BY: D.L.C.
CKD. BY: W.K.W.

CENTRAL AND SOUTHERN FLORIDA
CANAL 38
KISSIMMEE RIVER HEADWATERS REVITILIZATION
STRUCTURE S-65 ADDITION
SLIDING, OVERTURNING AND FLOTATION STABILITY ANALYSIS-LOAD CASE IV
(SCALES AS SHOWN)
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA
SECTION 1135 PROJECT MODIFICATION REPORT
D.O. FILE NO. 400-36,826 DATE: OCTOBER 1994

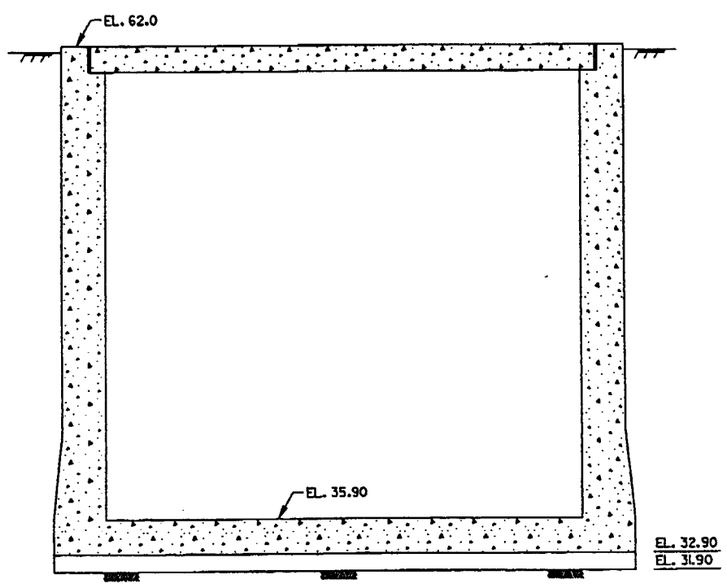


PLAN



SECTION A

NORMAL CONDITION



SECTION B

CONDITION	ΣV kips	ΣH kips	ΣM FT-kips	SLIDING FS	FOUNDATION PRESSURE TONS/FT²	
NORMAL	1,314.78	148.18	23,600	5.16	U/S=0.69	D/S=0.49
DEWATERED	883.40	108.42	13,002	4.86	U/S=0.24	D/S=0.56
OPTIMUM	1,146.84	255.08	18,975	2.62	U/S=0.47	D/S=0.55

DESIGN ENG.: J.A.M.

DWN. BY: T.D.B. CKD. BY: J.A.M.

CENTRAL AND SOUTHERN FLORIDA
CANAL 38
KISSIMMEE RIVER HEADWATERS REVITILIZATION

STRUCTURE 61

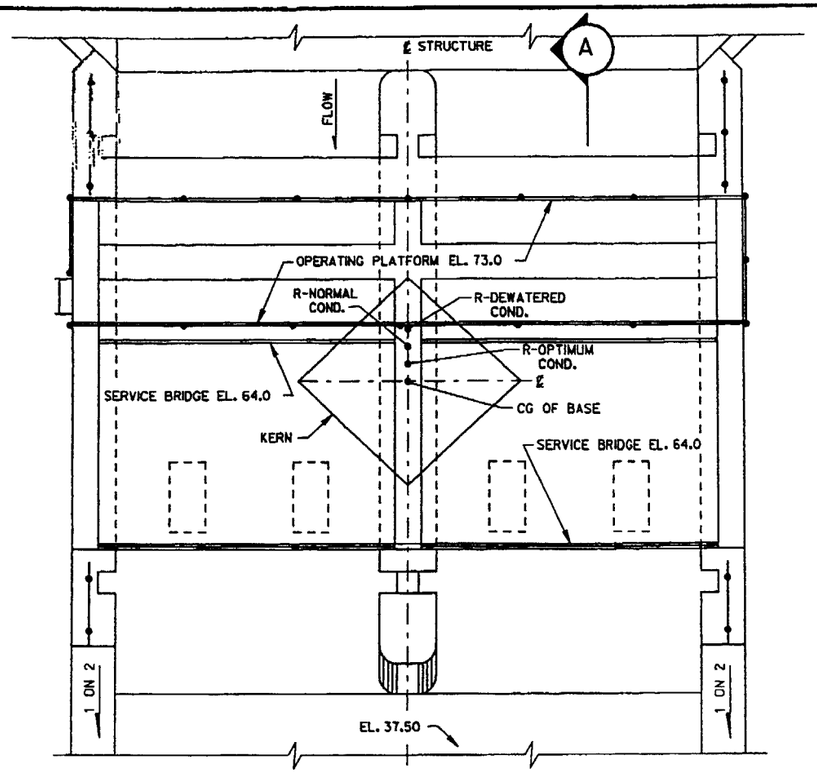
STABILITY ANALYSIS

(SCALES AS SHOWN)

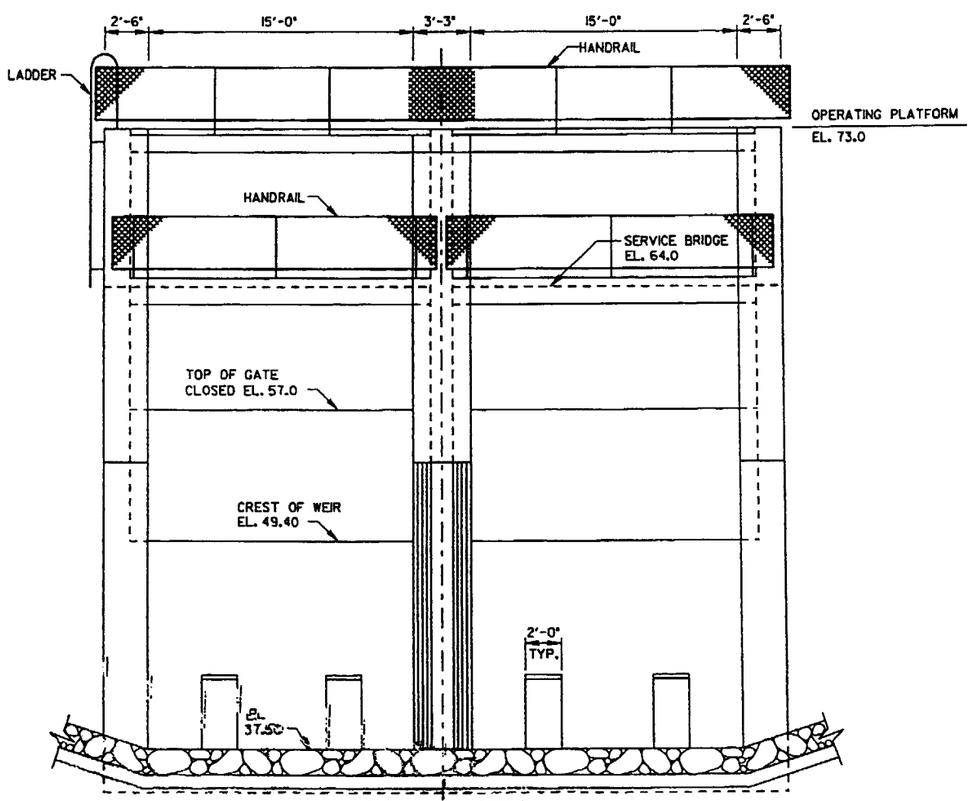
DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

SECTION 1135 PROJECT MODIFICATION REPORT

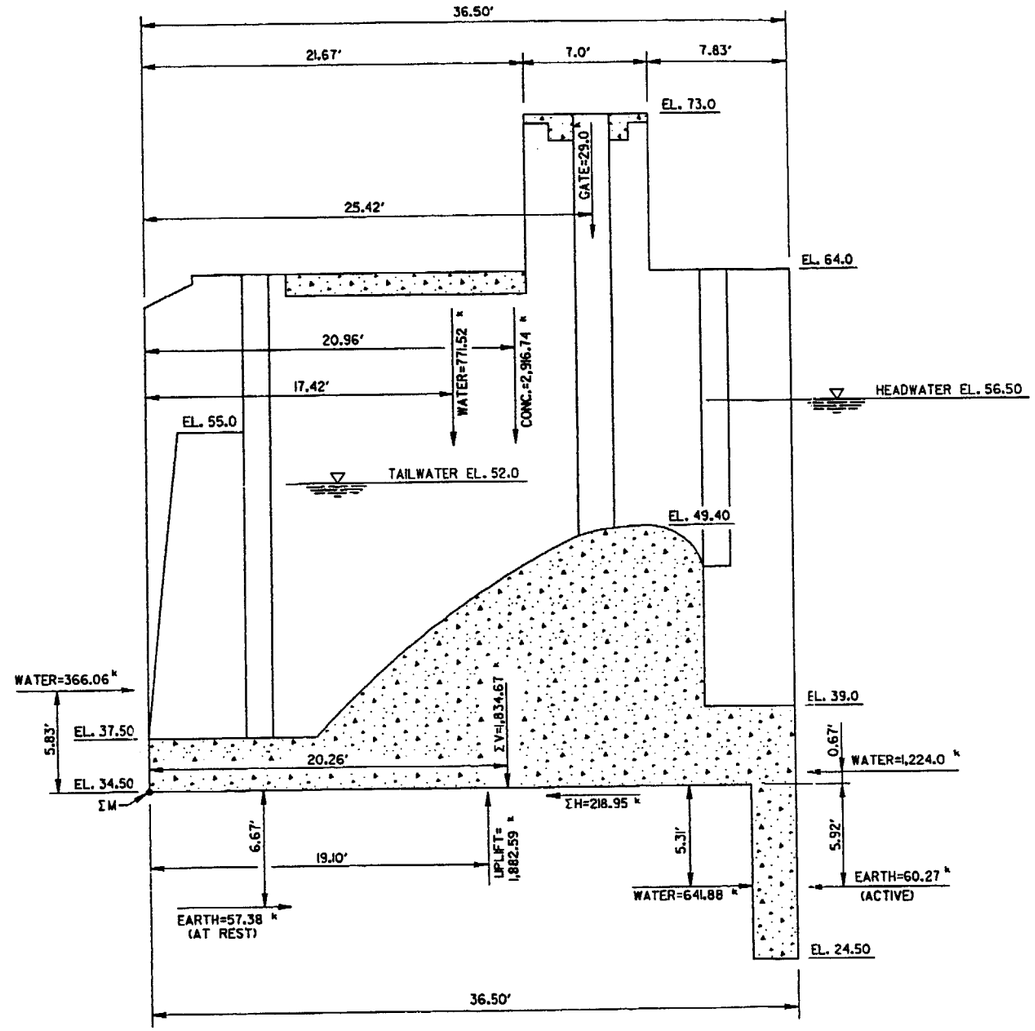
D.O. FILE NO. 400-36,826 DATE: APRIL 1995



PLAN



ELEVATION



SECTION A

NORMAL CONDITION

CONDITION	ΣV kips	ΣH kips	ΣM FT-kips	SLIDING FS	FOUNDATION PRESSURE TONS/FT²	
NORMAL	1,834.67	218.95	37,163	4.92	U/S=0.87	D/S=0.44
DEWATERED	1,426.52	218.95	30,181	4.29	U/S=0.76	D/S=0.27
OPTIMUM	1,718.34	353.60	32,428	3.02	U/S=0.80	D/S=0.44

CENTRAL AND SOUTHERN FLORIDA
CANAL 38
KISSIMMEE RIVER HEADWATERS REVITILIZATION

STRUCTURE 63A

UPPER MONOLITH-STABILITY ANALYSIS

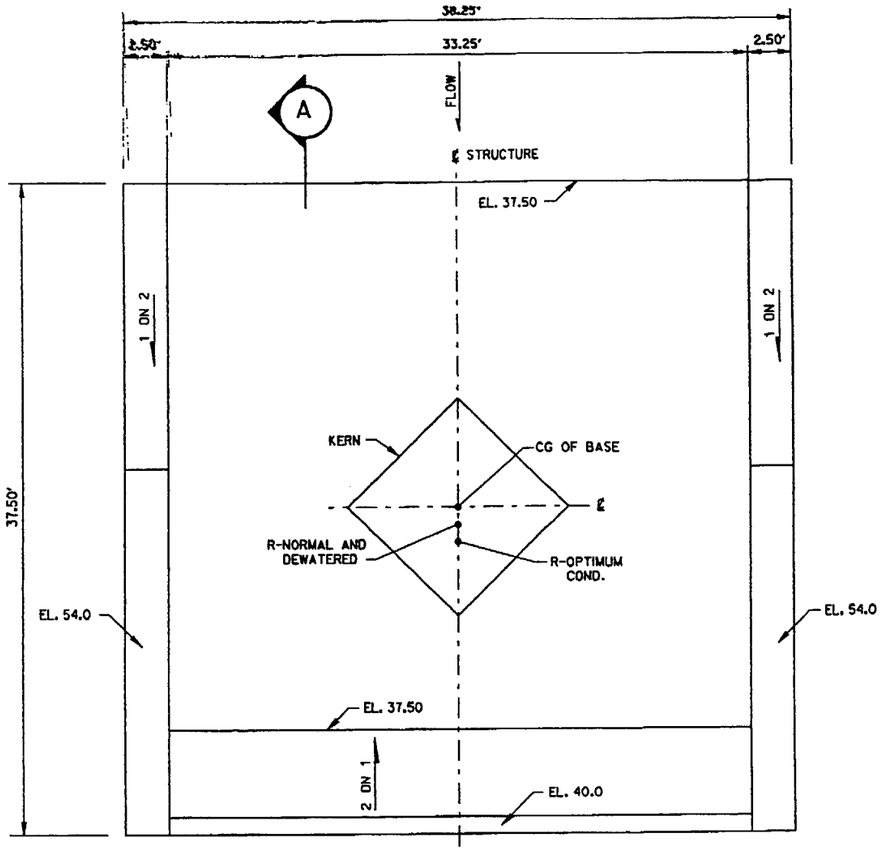
(SCALES AS SHOWN)

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

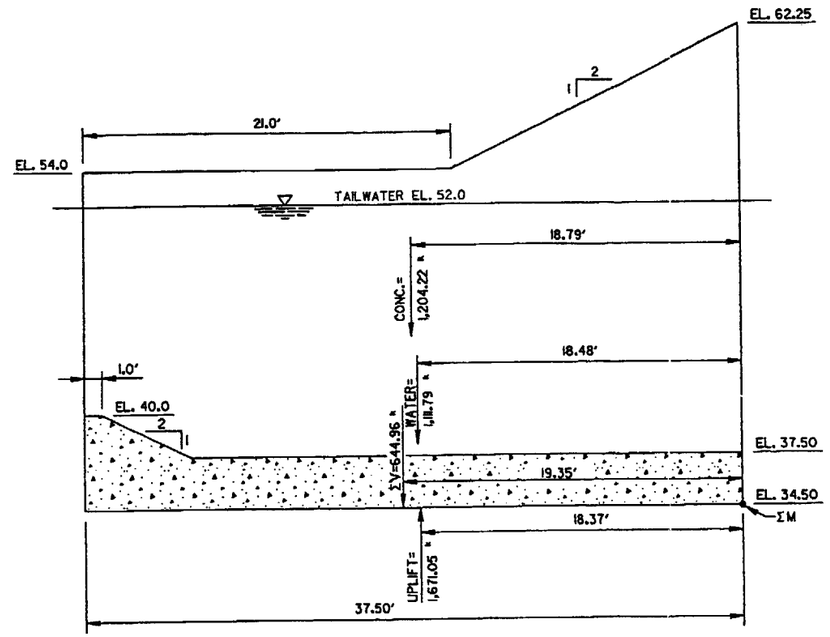
SECTION 1135 PROJECT MODIFICATION REPORT

DESIGN ENG.: J.A.M.	
DWN. BY: T.D.B.	CKD. BY: J.A.M.

D.O. FILE NO. 400-36,826 DATE: APRIL 1995

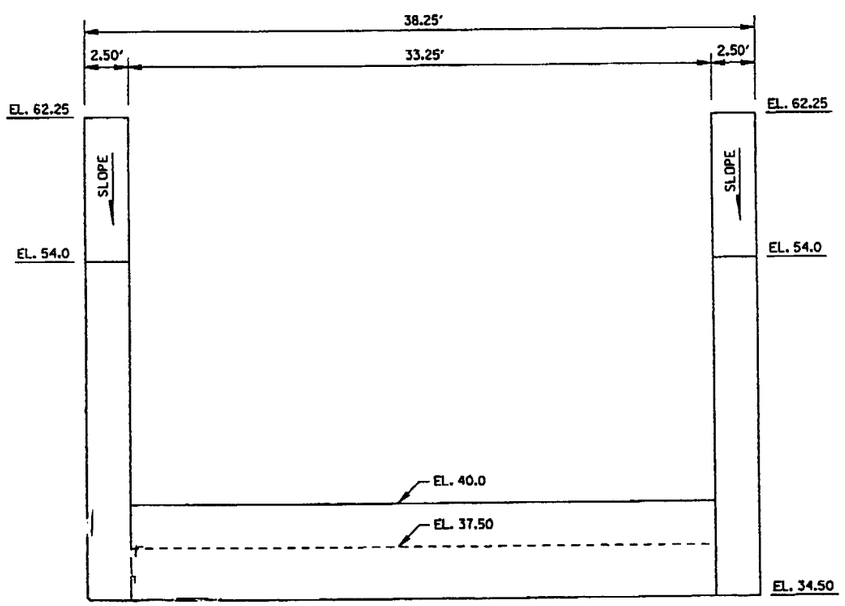


PLAN



SECTION A

NORMAL CONDITION



ELEVATION

CONDITION	ΣV kips	ΣH kips	ΣM FT-kips	SLIDING FS	FOUNDATION PRESSURE TONS/FT²
NORMAL	644.96	0	12,482	-	U/S=0.21 D/S=0.25
DEWATERED	644.96	0	12,482	-	U/S=0.21 D/S=0.25
OPTIMUM	606.64	0	12,259	-	U/S=0.16 D/S=0.26

CENTRAL AND SOUTHERN FLORIDA
CANAL 38
KISSIMMEE RIVER HEADWATERS REVITILIZATION

STRUCTURE 63A

LOWER MONOLITH-STABILITY ANALYSIS

(SCALES AS SHOWN)

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

SECTION 1135 PROJECT MODIFICATION REPORT

D.O. FILE NO. 400-36,826 DATE: APRIL 1995

DESIGN ENG.: J.A.M.

DWN. BY: T.D.B. CKD. BY: J.A.M.

KISSIMMEE RIVER
HEADWATERS REVITALIZATION REPORT

APPENDIX D

Design and Cost Estimates

COST ESTIMATE
(Table T-1)

Kissimmee River Headwaters Rest
Project Modification Report

Designed By: Jacksonville District
Estimated By: G. Torres

Prepared By: G. Torres

Preparation Date: 01/11/96
Effective Date of Pricing: 01/11/96

Sales Tax: 6.00%

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The Project Modification Report for the Kissimmee River Headwaters Restoration Project involves the modification of the existing Lake Kissimmee regulation schedule; acquisition of approximately 16,000 acres of land bordering the affected lakes, Lake Hatchineha, Lake Kissimmee, Lake Cypress and Lake Tiger; the widening of upper basin flood control canals, C-36 and C-37; modification of the S-65 structure to reduce higher flood stage in Lake Kissimmee and to provide higher discharge capacity; and finally the degradation of local levees to expand the range of upper basin restoration.

Engineering and Design cost and Construction Management cost were provided by the project manager and are a percentage of the construction cost; 10% for E&D and 8% for S&A.

Contingencies are based on discussions with Planning Division and Design Branch. Real Estate Division determined their own contingencies.

SUMMARY REPORTS SUMMARY PAGE

PROJECT OWNER SUMMARY - Contract.....1
PROJECT OWNER SUMMARY - Level 2.....2
PROJECT OWNER SUMMARY - Feature.....3
PROJECT OWNER SUMMARY - Element.....5

No Detailed Estimate...

No Backup Reports...

* * * END TABLE OF CONTENTS * * *

** PROJECT OWNER SUMMARY - Contract **

	QUANTITY UOM	CONTRACT	CONTING	TOTAL COST	UNIT COST
A Construction Cost		4,957,662	810,748	5,768,410	
B Non-Construction Cost		52,011,400	20,576,500	72,587,900	
TOTAL Kissimmee River Headwaters Rest		56,969,062	21,387,248	78,356,310	

** PROJECT OWNER SUMMARY - Level 2 **

	QUANTITY UOM	CONTRACT	CONTING	TOTAL COST	UNIT COST
A Construction Cost					
A-02 Relocations		72,368	10,855	83,224	
A-06 Fish and Wildlife Facilities		670,990	167,748	838,738	
A-09 Channels and Canals		1,496,660	224,499	1,721,159	
A-11 Levees and Floodwalls		89,172	13,376	102,548	
A-15 Floodway Control-Diversion Struc		2,628,471	394,271	3,022,742	
TOTAL Construction Cost		4,957,662	810,748	5,768,410	
B Non-Construction Cost					
B-01 Lands and Damages		51,119,000	20,447,600	71,566,600	
B-30 Planning, Engineering and Design		495,800	49,580	545,380	
B-31 Construction Management (S&I)		396,600	79,320	475,920	
TOTAL Non-Construction Cost		52,011,400	20,576,500	72,587,900	
TOTAL Kissimmee River Headwaters Rest		56,969,062	21,387,248	78,356,310	

** PROJECT OWNER SUMMARY - Feature **

	QUANTITY UOM	CONTRACT	CONTING	TOTAL COST	UNIT COST
A Construction Cost					
A-02 Relocations					
A-02/03 Cemetery, Utilities, & Structure		72,368	10,855	83,224	
TOTAL Relocations		72,368	10,855	83,224	
A-06 Fish and Wildlife Facilities					
A-06/03 Wildlife Facilities & Sanctuary		670,990	167,748	838,738	
TOTAL Fish and Wildlife Facilities		670,990	167,748	838,738	
A-09 Channels and Canals					
A-09/02 Canals		1,496,660	224,499	1,721,159	
TOTAL Channels and Canals		1,496,660	224,499	1,721,159	
A-11 Levees and Floodwalls					
A-11/01 Levees		89,172	13,376	102,548	
TOTAL Levees and Floodwalls		89,172	13,376	102,548	
A-15 Floodway Control-Diversion Struc					
A-15/00 Floodway Control-Diversion Struc		2,628,471	394,271	3,022,742	
TOTAL Floodway Control-Diversion Struc		2,628,471	394,271	3,022,742	
TOTAL Construction Cost		4,957,662	810,748	5,768,410	
B Non-Construction Cost					
B-01 Lands and Damages					
B-01/01 Project Planning		100,000	40,000	140,000	
B-01/02 Acquisitions		3,082,000	1,232,800	4,314,800	
B-01/03 Condemnation		2,190,000	876,000	3,066,000	
B-01/05 Appraisals		1,471,000	588,400	2,059,400	
B-01/06 PL 91-646 Assistance		459,000	183,600	642,600	
B-01/07 Temporary Permits		144,000	57,600	201,600	
B-01/08 Project Related Admin		403,000	161,200	564,200	

** PROJECT OWNER SUMMARY - Feature **

	QUANTITY UOM	CONTRACT	CONTING	TOTAL COST	UNIT COST
B-01/18 Real Estate Payments		43,270,000	17,308,000	60,578,000	
TOTAL Lands and Damages		51,119,000	20,447,600	71,566,600	
B-30 Planning, Engineering and Design		495,800	49,580	545,380	
B-31 Construction Management (S&I)		396,600	79,320	475,920	
TOTAL Non-Construction Cost		52,011,400	20,576,500	72,587,900	
TOTAL Kissimmee River Headwaters Rest		56,969,062	21,387,248	78,356,310	

** PROJECT OWNER SUMMARY - Element **

	QUANTITY	UOM	CONTRACT	CONTING	TOTAL COST	UNIT COST
A Construction Cost						
A-02 Relocations						
A-02/03 Cemetery, Utilities, & Structure						
A-02/03.01 Mob, Demob & Preparatory Work						
A-02/03.01.01 Mob, Demob & Preparatory Work			2,599	390	2,989	
TOTAL Mob, Demob & Preparatory Work			2,599	390	2,989	
A-02/03.18 Utilities						
A-02/03.18.01 Pole Relocation			3,502	525	4,027	
TOTAL Utilities			3,502	525	4,027	
A-02/03.47 Structures						
A-02/03.47.01 CMU Buildings w/Mechanical Equip	2.00	EA	35,083	5,262	40,345	20172.72
A-02/03.47.02 Antenna Tower Guy Wires	2.00	EA	31,185	4,678	35,863	17931.31
TOTAL Structures			66,268	9,940	76,208	
TOTAL Cemetery, Utilities, & Structure			72,368	10,855	83,224	
TOTAL Relocations			72,368	10,855	83,224	
A-06 Fish and Wildlife Facilities						
A-06/03 Wildlife Facilities & Sanctuary						
A-06/03.73 Habitat and Feeding Facilities						
A-06/03.73.01 Mercury Study			161,398	40,350	201,748	
A-06/03.73.02 Vegetation Monitoring			509,592	127,398	636,990	
TOTAL Habitat and Feeding Facilities			670,990	167,748	838,738	
TOTAL Wildlife Facilities & Sanctuary			670,990	167,748	838,738	
TOTAL Fish and Wildlife Facilities			670,990	167,748	838,738	
A-09 Channels and Canals						

** PROJECT OWNER SUMMARY - Element **

	QUANTITY UOM	CONTRACT	CONTING	TOTAL COST	UNIT COST
A-09/02 Canals					
A-09/02.01 Mob, Demob & Preparatory Work					
A-09/02.01.01 Mob, Demob & Preparatory Work		57,562	8,634	66,196	
TOTAL Mob, Demob & Preparatory Work		57,562	8,634	66,196	
A-09/02.31 Earthwork					
A-09/02.31.01 Excavation, Canal 36	125000.00 CY	185,038	27,756	212,794	1.70
A-09/02.31.02 Excavation, Canal 37	330000.00 CY	537,385	80,608	617,993	1.87
A-09/02.31.03 Excavation, U/S S-65	25000.00 CY	87,839	13,176	101,015	4.04
A-09/02.31.04 Excavation, D/S S-65	90000.00 CY	315,155	47,273	362,428	4.03
TOTAL Earthwork		1,125,417	168,813	1,294,230	
A-09/02.99 Associated General Items					
A-09/02.99.01 Grassing	85.00 AC	97,693	14,654	112,347	1321.73
A-09/02.99.02 Remove Riprap	1130.00 CY	22,024	3,304	25,328	22.41
A-09/02.99.03 U/S and D/S Riprap	2965.00 CY	134,842	20,226	155,068	52.30
A-09/02.99.05 U/S and D/S Bedding	1300.00 CY	59,121	8,868	67,990	52.30
TOTAL Associated General Items		313,681	47,052	360,733	
TOTAL Canals		1,496,660	224,499	1,721,159	
TOTAL Channels and Canals		1,496,660	224,499	1,721,159	
A-11 Levees and Floodwalls					
A-11/01 Levees					
A-11/01.01 Mob, Demob & Preparatory Work					
A-11/01.01.01 Mob, Demob & Preparatory Work		3,378	507	3,885	
TOTAL Mob, Demob & Preparatory Work		3,378	507	3,885	
A-11/01.31 Earthwork					
A-11/01.31.01 Excavate Gaps @ Lake Kissimmee	12500.00 CY	13,790	2,068	15,858	1.27
A-11/01.31.02 Excavate Gaps @ Cypress Lakee	15000.00 CY	16,616	2,492	19,108	1.27
A-11/01.31.03 Excavate Gaps @ Sparks Chandler	15000.00 CY	16,616	2,492	19,108	1.27
A-11/01.31.04 Excavate Gaps @ Rolling Meadows	30000.00 CY	33,205	4,981	38,185	1.27

** PROJECT OWNER SUMMARY - Element **

	QUANTITY UOM	CONTRACT	CONTING	TOTAL COST	UNIT COST
A-11/01.31.06 Excavate Gaps @ Oasis Levee	2000.00 CY	2,119	318	2,437	1.22
TOTAL Earthwork		82,345	12,352	94,697	
A-11/01.99 Associated General Items					
A-11/01.99.01 Grassing	3.00 AC	3,448	517	3,965	1321.73
TOTAL Associated General Items		3,448	517	3,965	
TOTAL Levees		89,172	13,376	102,548	
TOTAL Levees and Floodwalls		89,172	13,376	102,548	
A-15 Floodway Control-Diversion Struc					
A-15/00 Floodway Control-Diversion Struc					
A-15/00.01 Mob, Demob & Preparatory Work					
A-15/00.01.01 Mob, Demob & Preparatory Work		95,478	14,322	109,799	
TOTAL Mob, Demob & Preparatory Work		95,478	14,322	109,799	
A-15/00.03 Care and Diversion of Water					
A-15/00.03.02 Steel Sheet Pile-Place & Remove		951,670	142,750	1,094,420	
A-15/00.03.05 Soil Anchors	180.00 EA	136,898	20,535	157,432	874.62
A-15/00.03.06 Tremie Concrete in Place	2624.00 CY	240,727	36,109	276,836	105.50
A-15/00.03.07 Dewatering	1.00 EA	37,484	5,623	43,106	43106.25
TOTAL Care and Diversion of Water		1,366,778	205,017	1,571,795	
A-15/00.10 Earthwork for Structures					
A-15/00.10.02 Excavation for Tremie Concrete	8000.00 CY	49,779	7,467	57,246	7.16
A-15/00.10.04 Structural Backfill	640.00 CY	4,670	700	5,370	8.39
TOTAL Earthwork for Structures		54,449	8,167	62,616	
A-15/00.11 Foundation Work					
A-15/00.11.02 Steel Sheet Pile Wingwalls	7268.00 SF	251,151	37,673	288,823	
TOTAL Foundation Work		251,151	37,673	288,823	

** PROJECT OWNER SUMMARY - Element **

	QUANTITY	UOM	CONTRACT	CONTING	TOTAL COST	UNIT COST
A-15/00.25 Embedded Metal Work						
A-15/00.25.01 Handrail	160.00	LF	4,231	635	4,866	30.41
A-15/00.25.03 Ladder and Basket Guard	2.00	EA	8,576	1,286	9,862	4931.11
TOTAL Embedded Metal Work			12,807	1,921	14,728	
A-15/00.41 Gates, Stop Logs-Associated Eqpt						
A-15/00.41.01 Inst. and Test Vert. Lift Gate			169,615	25,442	195,057	
A-15/00.41.02 Gate Operating Machinery	2.00	EA	99,201	14,880	114,081	57040.49
TOTAL Gates, Stop Logs-Associated Eqpt			268,816	40,322	309,138	
A-15/00.53 Overflow Structure						
A-15/00.53.01 Concrete, in Place	1680.00	CY	362,936	54,440	417,377	248.44
A-15/00.53.04 Staff Gage Instruments	2.00	EA	3,274	491	3,766	1882.79
TOTAL Overflow Structure			366,211	54,932	421,142	
A-15/00.99 Associated General Items						
A-15/00.99.01 Pavement	110.00	SY	2,913	437	3,350	30.45
A-15/00.99.02 Safety Barriers Floats	1.00	JOB	20,548	3,082	23,630	23630.17
A-15/00.99.03 Grassing	0.90	AC	1,034	155	1,190	1321.73
A-15/00.99.04 Misc. St, Cntrl Hse, Stllg Wells	1.00	JOB	80,721	12,108	92,829	92828.71
A-15/00.99.06 Guardrail	120.00	LF	1,256	188	1,444	12.04
A-15/00.99.07 Electrical Work			47,839	7,176	55,015	
A-15/00.99.08 Sheet Pile Retaining Wall PZ-22	1800.00	SF	58,472	8,771	67,242	37.36
TOTAL Associated General Items			212,782	31,917	244,700	
TOTAL Floodway Control-Diversion Struc			2,628,471	394,271	3,022,742	
TOTAL Floodway Control-Diversion Struc			2,628,471	394,271	3,022,742	
TOTAL Construction Cost			4,957,662	810,748	5,768,410	
B Non-Construction Cost						
B-01 Lands and Damages						
B-01/01 Project Planning			100,000	40,000	140,000	
TOTAL Project Planning			100,000	40,000	140,000	

** PROJECT OWNER SUMMARY - Element **

	QUANTITY UOM	CONTRACT	CONTING	TOTAL COST	UNIT COST
B-01/02 Acquisitions					
B-01/02.02 By Local Sponsor		2,910,000	1,164,000	4,074,000	
B-01/02.04 Review of Local Sponsor		172,000	68,800	240,800	
TOTAL Acquisitions		3,082,000	1,232,800	4,314,800	
B-01/03 Condemnation					
B-01/03.02 By Local Sponsor		150,000	60,000	210,000	
B-01/03.03 By Govt On Behalf Local Sponsor		2,040,000	816,000	2,856,000	
TOTAL Condemnation		2,190,000	876,000	3,066,000	
B-01/05 Appraisals					
B-01/05.03 By Local Sponsor		1,369,000	547,600	1,916,600	
B-01/05.05 Review of Local Sponsor		102,000	40,800	142,800	
TOTAL Appraisals		1,471,000	588,400	2,059,400	
B-01/06 PL 91-646 Assistance					
B-01/06.02 By Local Sponsor		393,000	157,200	550,200	
B-01/06.04 Review of Local Sponsor		66,000	26,400	92,400	
TOTAL PL 91-646 Assistance		459,000	183,600	642,600	
B-01/07 Temporary Permits					
B-01/07.02 By Local Sponsor		100,000	40,000	140,000	
B-01/07.04 Review of Local Sponsor		34,000	13,600	47,600	
B-01/07.06 Damage Claims		10,000	4,000	14,000	
TOTAL Temporary Permits		144,000	57,600	201,600	
B-01/08 Project Related Admin					
B-01/08.02 Env Audit By Local Sponsor		403,000	161,200	564,200	
TOTAL Project Related Admin		403,000	161,200	564,200	
B-01/18 Real Estate Payments					

** PROJECT OWNER SUMMARY - Element **

	QUANTITY	UOM	CONTRACT	CONTING	TOTAL COST	UNIT COST
B-01/18.01 Land Payments			40,300,000	16,120,000	56,420,000	
TOTAL Land Payments			40,300,000	16,120,000	56,420,000	
B-01/18.02 PL 91-646 Assistance Payments						
B-01/18.02.02 By Local Sponsor			2,970,000	1,188,000	4,158,000	
TOTAL PL 91-646 Assistance Payments			2,970,000	1,188,000	4,158,000	
TOTAL Real Estate Payments			43,270,000	17,308,000	60,578,000	
TOTAL Lands and Damages			51,119,000	20,447,600	71,566,600	
B-30 Planning, Engineering and Design			495,800	49,580	545,380	
B-31 Construction Management (S&I)			396,600	79,320	475,920	
TOTAL Non-Construction Cost			52,011,400	20,576,500	72,587,900	
TOTAL Kissimmee River Headwaters Rest			56,969,062	21,387,248	78,356,310	

No errors detected...

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KISSIMMEE RIVER
HEADWATERS REVITALIZATION PROJECT

APPENDIX E

EARLY ESTABLISHMENT OF HEADWATERS COMPONENT

Appendix E
Early Establishment of Headwaters Component

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* Excerpt from the Proceedings of, Kissimmee River Restoration Symposium, Orlando, Florida, SFWMD, October 1988

** Excerpt from the Kissimmee River Restoration, Alternative Plan Evaluation & Preliminary Design Report, SFWMD, June 1990

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HYDROLOGY OF THE KISSIMMEE RIVER BASIN - INFLUENCE OF MAN-MADE AND NATURAL CHANGES

*Jayantha Obeysekera and Kent Loftin**

ABSTRACT

Hydrology of the Kissimmee River basin plays a major role in current efforts for its restoration. The man-made influence in the form of basin regulation and the land use changes have significantly altered the characteristics of the flow inputs and the stages in the lower basin. A seasonal shift in the flow release from the upper basin as well as a completely altered hydrograph are key changes that the regulation has introduced to flow inputs to the lower basin. The lower basin hydrology has changed from an upland/floodplain retention with slow runoff to one characterized by upland/floodplain drainage with rapid runoff. Recently, the Kissimmee River basin has also experienced reduced rainfall which in turn have impacted the runoff availability in the entire basin. The runoff in the lower basin appears to have been influenced both by reduced rainfall as well as the changes in the land use. The changes in the hydrology both due to man-made and/or natural causes have altered the natural pre-project regime to the extent that even the feasibility its reversal is questionable. The deficiency of a simplistic approach such as restoring the physical form without any regard to current changes in functional characteristics is emphasized.

PART I

INTRODUCTION

The Kissimmee river basin located in Central Florida is the largest tributary to Lake Okeechobee and provides approximately one third of the surface water inflows to the lake. The river's original watershed area was about 3000 square miles. At present, the basin drains approximately 2400 square miles at S-65E, the last structure in the channelized Kissimmee river before it enters Lake Okeechobee. The upper Kissimmee basin defined as the drainage area above the outlet of lake Kissimmee is approximately 1600 square miles of which approximately ten percent is comprised of water bodies. The northern portion of this watershed consists of flat, marshy sandlands with high-grade development consisting of small residential communities and citrus groves concentrated on the shores of the lakes. Unimproved native pasture and citrus in highlands are common in other areas. The lower Kissimmee basin (drainage area below Lake Kissimmee) through which the Kissimmee River runs has a drainage area of about 750 square miles. This basin consists generally of grassy prairies with scattered pinewood and palmetto growths.

Hydrology of the Kissimmee river basin plays a key role in ongoing efforts for environmental restoration of the Kissimmee River. It will be shown in this paper how the regulation of the upper basin has drastically altered the hydrology of the pre-canal

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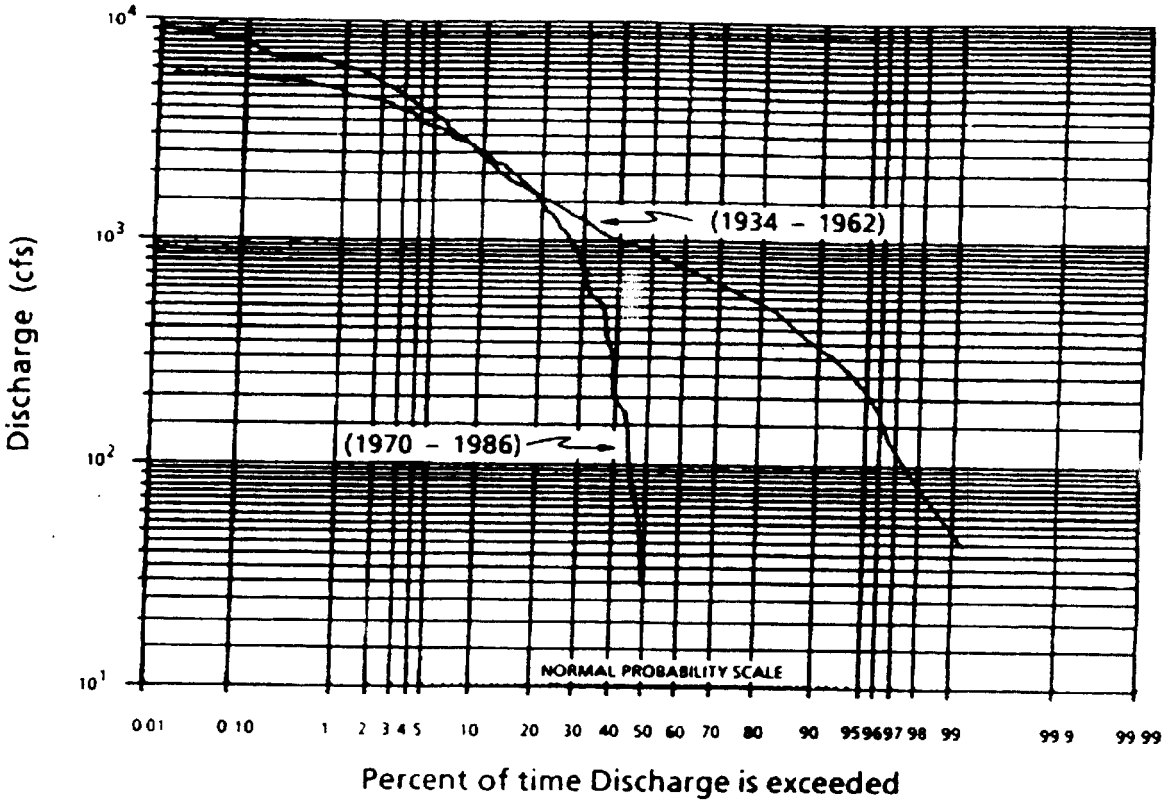


Figure 1. Flow duration curves at S-65 structure near Lake Kissimmee for pre-project(1934-1986) and post-project(1970- 1986) periods.

A close look at the pre- and post-project hydrographs reveals the frequency of near zero flow conditions. The discharges from lake Kissimmee now resembles "plug flow" (or pulse flow) with frequent periods of zero or near zero flows. This flow pattern represents a drastic change from the typical daily hydrograph with sustained flow during most of the year as seen in figure 3(a). A daily frequency of near zero flow is shown in figure 4. During months of June through January, the upper basin contribution to lower basin is frequently near zero in spite of the period covered by these months include the wet season. In comparison, prior to upper basin regulation except for few days during the entire period of record of about 20 years, there was always a substantial amount of base flow during this period. During the spring months when it is usually dry, the frequency of near zero flow from lake Kissimmee is much smaller and this can be attributed to regulatory releases.

The persistence of flows of different magnitudes is also important. The plug type flow introduced by regulation decreases the consecutive days any flow rate is sustained. The magnitude of this reduction can be estimated from the mean duration of a given flow condition or higher, computed for both pre- and post project periods. It is noted that the mean duration can be influenced by the number of consecutive periods (called "runs") used for its computation. On the average post project mean duration of flows are approximately eight to ten times smaller than those for the same flow conditions prior to regulation. This is a significant change in the pattern of flow delivery to lower basin river and the flood plain.

A consequence of the plug flow pattern under uncontrolled conditions is a potentially larger variability in the stages in the lower basin river and the flood plain. A sudden reduction of water levels in an inundated floodplain can result in a drastic increase in biochemical oxygen demand in the receding water which in turn plummet

Kissimmee River basin. The accelerated land-use practices primarily resulting from improved drainage following the completion of flood control project has significantly modified the flow characteristics of the tributaries of the lower basin. The current interest lies also in investigating the influence of natural changes that are unrelated to channelization. Unfortunately, such natural changes, say in climate, are difficult to detect until a long period of data become available. The post-canal observed data are corrupted by both man-made and natural changes and the separation of the effect of individual change is often difficult.

BASIN REGULATION

Upper basin

Regulation of flows in the upper chain of flows introduces a drastic change in the characteristics of flow inputs to C-38 at S65. Under pre-project conditions, Lake Kissimmee stages fluctuated in a range of about 10 feet at any time. In general all lake stages in the upper basin fluctuated from 2 to 10 feet (Florida Department of Administration, 1976). The flood control project in the upper basin specified the regulation of the lakes in range of about 2 to 4 feet. From an analysis of Lake Kissimmee stages, it was found that the highest post-project lake levels coincides roughly with the pre-project levels corresponding to 25 percent exceedence for the period of January through July. The reduction of high levels during the remaining period of the year is even greater with maximum post-project levels now only about a foot above mean pre-project lake levels. The water which was temporarily stored during previous high flow events is now released with a much reduced lag time. The water which maintained the recession flow prior to regulation is now stored in the lakes for maintaining increased minimum lake stages.

Figure 1 presents the flow duration curve at S65 (outflow from Lake Kissimmee) for the pre- (1942-1962) and post- (1970-1986) project periods. The mean discharges for the two periods are shown in figure 2. Figure 3 presents mean daily flows from Lake Kissimmee for pre- and post- project ten year periods. Except for a minor influence, the regulation of upper chain of lakes should not significantly alter the average annual water input to C-38 at S65. The distribution of flow within the year however, has drastically changed. Figure 1 shows that, approximately 50 percent of the time, flow input to C-38 is below 30 cfs. In comparison, prior to regulation, Lake Kissimmee delivered discharges at or above 600 cfs 70 percent of the time. In general, the discharges at or below about 1100 cfs have been influenced substantially by regulation. This is a direct result of the absence of long recession periods that existed prior to regulation. The absence of long recessions and the presence of frequent near zero flow conditions are deemed detrimental to the health of both habitat and vegetation in the lower valley.

The impact of regulation on the seasonal distribution flows is a key consideration in the overall restoration effort. Roughly, a 3-month lag in stage recession following the wet period has introduced a seasonal shift in the flow releases to lower basin. The maintenance of higher than normal stages in the months of November through January followed by a steeper recession has resulted in substantially low flows immediately following the wet period and somewhat increased flows during spring months when it is usually dry, and the river carries mostly base flow. Unless the upper basin regulation is altered to minimize the extent of this seasonal shift, the wetlands and marshes in the restored floodplain would receive less water during wet period when they should receive more for maintaining high water levels. During the dry spring period floodplain would receive more flow than what they did prior to regulation and consequently the water levels may recede at a lesser rate.

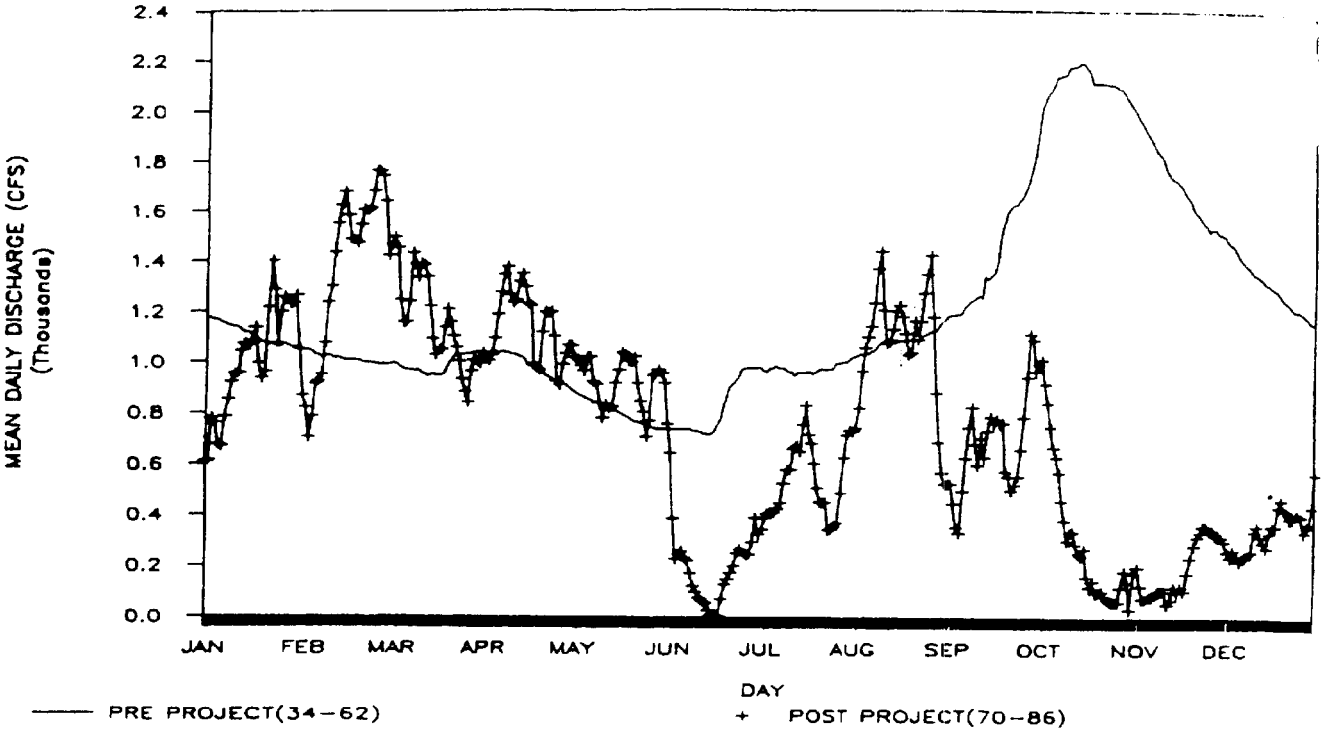


Figure 2. Mean discharge at S65 for pre-(1942-1960) and post-(1970-1986) project periods.

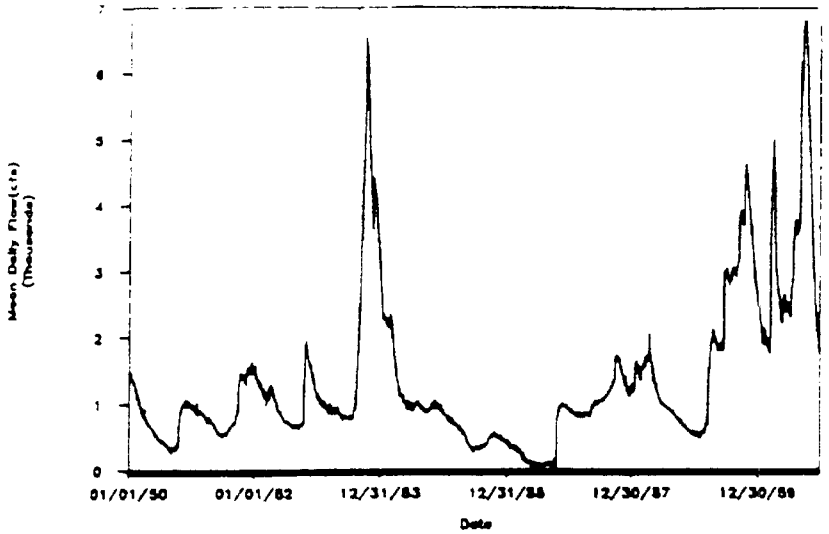
the dissolved oxygen levels in the river to a very low level. The final result is a potential fish kill as it has already happened twice in Pool B of the lower Kissimmee river in September of 1985, and more recently in September of 1988.

The step increase in the current regulation schedule at the beginning of the month of June is also detrimental. During the months of June and sometimes in July, the upper basin flow input is near zero. In the absence of substantial base flow in lower basin this low flow condition during summer when temperatures are high, can result in very low dissolved oxygen in the river creating choked conditions for aquatic habitat.

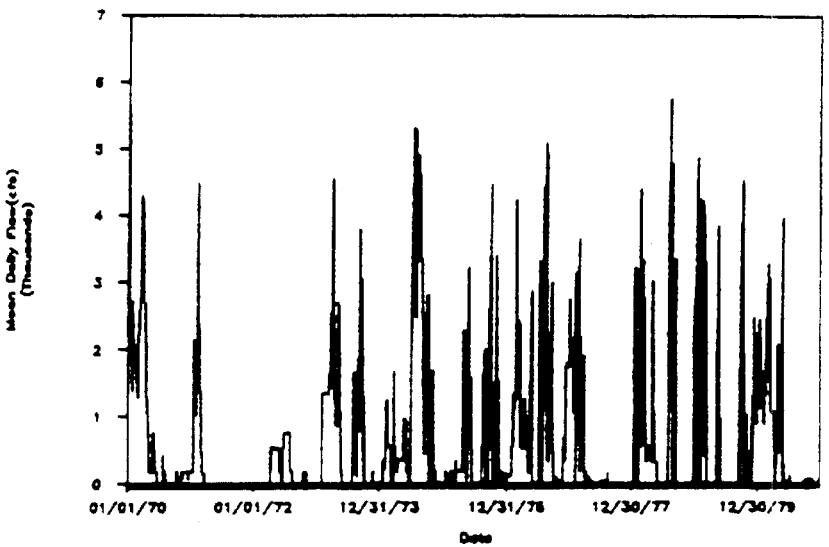
Lower basin

Stage regulation in the lower basin floodplain via control structures S-65A through S-65E in the C38 canal, has significantly reduced the mean and the variability of floodplain stage in comparison to the pre-project period of record. Five control structures (S-65A, S- 65B, S-65C, S-65D, and S-65E) now control water levels in five impoundments along the river. The effect of this regulation is to remove the natural slope of the Kissimmee river in such a manner that in each impoundment the water levels in the northern reach is lowered significantly, whereas water levels in the southern reach is increased, creating permanent impoundments. It is estimated that approximately 7600 acres were flooded in southern portions of all pools (Corps of Engineers, 1985). However, this form of regulation has significantly impacted the marshes in the northern portion of each pool. The historic stage fluctuation of about 10-12 feet has now been reduced to a much smaller range of about 3-4 feet at each location along the river. This again illustrates the impact of regulation on the water levels in the northern reaches of each pool.

At the Fort Kissimmee station (in Pool B above S-65B) it appears that



(a)



(b)

Figure 3. Mean daily flow from lake Kissimmee at S65 structure for the period (a) 1950-1960(before regulation); and (b) 1970-1980(after regulation).

approximately 70 percent of the time the floodplain was inundated. For the period 1970-1980 (prior to the alteration of the regulation of water levels in Pool B as a part of a demonstration project) at no time the water levels exceeded the average floodplain elevation of about 43 feet NGVD. In case of Basinger(Pool D), the flood plain stages exceeded the average ground elevation of about 28.5 feet about 70 percent of the time whereas for a location near Okeechobee exceedence is about 40 percent for the corresponding average floodplain elevation of 21 feet. The depth of water in the floodplain in the vicinity of Fort Kissimmee varied in a range of about 7 feet whereas the same for Basinger and Kissimmee River near Okeechobee are 7.5 feet and 7 feet

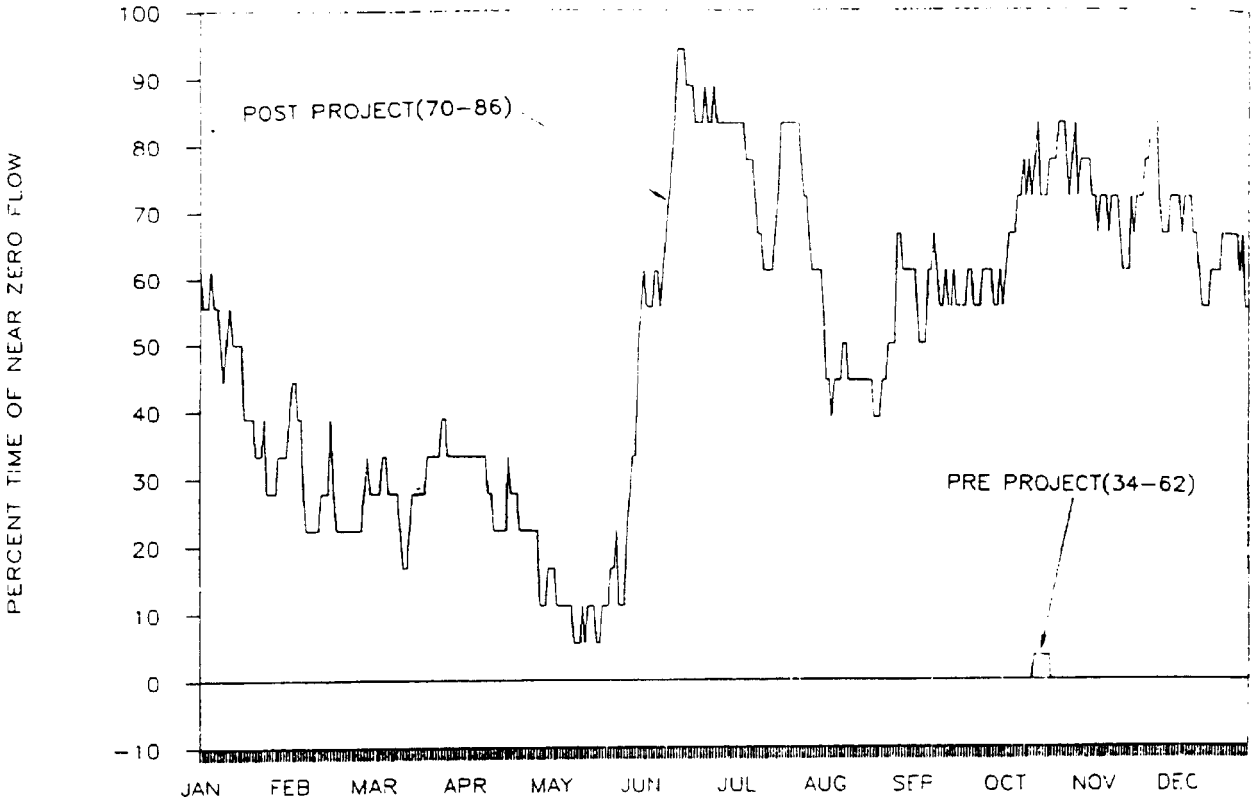


Figure 4. Daily percent frequency of near zero flow input to C-38 at S-65 for the pre-project period of 1942-1962 and the post-project period of 1970-1986.

respectively. With the current regulation of upper basin input whether there is sufficient water at the appropriate time of the year to recreate this stage variability in any restoration alternative is a concern that perhaps will have a major bearing on overall restoration project.

LAND USE CHANGES

Land use

Land use in the lower basin has undergone substantial changes over the last 30 years. Table 1 presents a limited comparison of land uses for years 1958, 1972 and 1980. Most notable in this comparison is the development of unimproved pasture lands to improved pasture at an accelerated pace during the period 1958 to 1972. This development has a significant bearing on the hydrology the lower basin primarily because of the accompanying changes in the drainage characteristics of the basin. The increased agricultural land use in the basin has resulted in the channelization of both primary and secondary tributaries and the construction of extensive tertiary ditch systems. Using the areal photographs taken in 1972-1973 and the U.S. Geological Survey quadrangle maps Gatewood and Bedient (1975) estimated that the drainage density for lower basin increased from an estimated value of 1.59 mi./ sq. mi. under natural conditions to an overall value of 4.43 mi. /sq. mi. which reflects both modified natural drainage and man-made drainage. The man-made drainage density was estimated to be as high as 23.3 mi./sq. mi.

Intensive ditching in agricultural lands alone does not provide the necessary control of the water table for agriculture practices. Control is generally accompanied by improvements to the primary and secondary drainage systems in the form of straightening, channelization, and connecting wetland areas. Previously isolated wetlands and

marshy areas in the uplands and the floodplain are now connected for rapid movement of surface runoff resulting in a vastly improved drainage to the entire system. A majority of these improvements is concentrated in the lower half of the basin.

Table 1. Comparison of 1958, 1972 and 1980 land uses in the Lower Kissimmee River Basin

Area in 100 acres (%increase from previous estimate)			
Land Use	1958†	1972†	1980††
Urban	0	13	31(138%)
Crops	3	16(433%)	54(238%)
Improved Pasture	329	2232(578%)	1871(-16%)
Unimproved Pasture	2806	1332(-53%)	1415(6%)*
Citrus	13	10(-23%)	17(70%)
Forest	32	75(134%)	358(377%)
Marsh	1337	842(-37%)	549(-35%)
Total	4520	4520	4385**

† From Huber et al(1976).
†† Estimated from South Florida Water Management District Data.
* Includes rangeland for 1980 estimate. It is assumed that previous estimates of Huber et al.(1976) also included rangeland in this category.
** Area for 1980 does not include subbasin below S-65E structure

Hydrologic impact

The reduced storage effect and the acceleration of water movement in the primary, and secondary tributaries and in the tertiary ditching systems have substantially increased the hydrologic response of the lower basin. In addition, the construction of C-38 with its increased outlet capacity has increased the efficiency of the upland drainage systems. The combined effects of upland drainage and flood control project has changed the basin hydrology from one of "upland/floodplain retention and slow runoff to one characterized by upland/floodplain drainage and rapid runoff" (Florida Department of Administration, 1976). The flow regime has experienced a major shift from predominantly baseflow runoff to one of surface (direct) runoff with increased volume discharged at a much faster rate. Huber et al(1976) estimated that from 1958 to 1972 the proportion of surface runoff for the lower basin has increased from about 14 percent to 48 percent. The increase in surface runoff is attributed to the "transfer to it of an interflow component that is derived from a soil region that no longer contributes to baseflow" (Huber and Heaney, 1976).

Closely related to reduced baseflow and increased surface runoff is the influence on flow detention times. The altered drainage practices significantly influences the detention time. Huber et al(1976) estimated, from 1958 to 1972 the lower basin surface runoff detention time has reduced from 6 days to about 4 days. Intensively drained areas has values below 2 days (Florida Department of Administration, 1976). The baseflow detention time has reduced from approximately 48 days to about 34 days during the period 1958 to 1972. Earlier, Langbein(1955) estimated that prior to 1946, the average lag of baseflow from time of recharge to mass outflow from the entire Kissimmee basin is about 3.5 months. The average lag for direct runoff was estimated to be only 10 days. For the lower basin alone Huber et. al(1976) suggested an appropriate value for baseflow travel time should be about 50 days.

.A new analysis of flow data to determine the changes in the flow recession coefficient was made using flow records at S-65E and S-65. Two periods(1942-1962 and 1970-1984) were selected to make the comparison of recession flow characteristics. The recession coefficient was computed as Qt/Qt-1 where Qt > Qt-1 is the daily flow at a given location. The values which produced a small sample are discarded. The coefficients computed for S-65 should reflect the influence of the upper basin on flow regimes for pre- and post- project periods. The coefficients for S-65E should reflect influence of both upper basin and lower basin. The recession coefficients computed for the difference S65E-S65 approximately reflects the changes in the lower basin storage recession.

A significant reduction in recession coefficient was seen for all cases as expected. As discussed earlier, the upper basin regulation has changed the recession limb of the hydrograph from a slow recession to a pulse or plug flow reflecting much smaller values of recession coefficient. The improved drainage in the lower basin introduces similar effect on reducing baseflow recession coefficients for local inflow. On the average, for the flow regime in the range of 0-1000 cfs, the flow on any given day reduces to about 65 percent on the following day whereas during pre-project period this percentage is above 90 percent. The impact on the hydrograph recession characteristics is larger in the lower (baseflow) range of flow and diminishes as the magnitude of the flow increases towards values reflecting predominantly direct runoff. This reduction in lag time of inflows to the lower basin floodplain is a factor to be considered in floodplain stage fluctuation for any particular restoration alternative. The combined effects of the changes in flow characteristics due to land use changes and the upper basin regulation are steeper rising and recession limbs in the stage hydrographs in the lower basin.

RECENT CLIMATE AND ITS IMPACT

Rainfall

Since 1970, the entire south Florida region has experienced an apparent change in rainfall characteristics. Sculley(1986) analyzed the average rainfall over 12 basins within the SFWMD boundaries and found that during the period 1970-1985, most basins received below-normal annual rainfall. The Upper and Lower Kissimmee River basins were among the basins where the reduction was most evident. Moreover, the rainfall reduction appears to be concentrated in the wet season (June through September). Sculley(1986) reported that the lower Kissimmee basin received below- normal wet season amounts in eleven consecutive years beginning in 1975. Wet season deficiencies were reported for other basins as well. Shih(1983) analyzed 38 rainfall stations distributed within the SFWMD and concluded that the most probable break year for change in mean annual rainfall is 1970 and that the annual rainfall in the period following this year is about 5 inches less per year. The reduction was attributed to drier and shorter wet seasons, less heavy storms, and less rainfall associated with tropical storms. The Kissimmee River basin has not experienced a major tropical storm since 1969. There is evidence of reduced rainfall also in the dry season. Shih(1988) analyzed five rainfall stations in south Florida and concluded that the chance of rainfall occurring during the second half of the dry season (February, March, and April) showed a significant decrease since 1960. The month of April showed the most significant decrease.

Any natural change in climate reflecting reduced rainfall, will have a serious impact on water management in south Florida. It should also be a major concern for Kissimmee restoration efforts for potential reduction that it may have on water availability for maintaining water levels in restored floodplain and the areas in uplands.

Moreover, if the range of extremes are lesser now than before perhaps the fluctuation that the floodplain water levels experienced in the past may not return in the future. Any attempt to fully restore the hydrology that existed prior to channelization (assuming this is the restoration approach selected) will be unsuccessful if it is proven that the nature itself has changed or is changing significantly.

Rainfall-Runoff Relationship

Any potential change in rainfall characteristics will also induce a similar change in the rainfall-runoff relationship of a particular basin. Unfortunately, the data available for upper and lower Kissimmee basins reflect not only the change of rainfall amounts received but also potential changes in runoff generation due to man-made changes. It is difficult to isolate the changes due to natural causes from those due to man-made changes. However, an attempt will be made to investigate impact of both. Table 2 presents a comparison of relevant statistics for two periods reflecting pre- and post-project conditions.

A careful review of the statistics computed in Table 2 led to the following conclusions. The pre-project runoff contribution by the upper basin agrees well with the proportion of the area drained by the upper basin. However, this is not the case for post-project period. The post- project average of percent runoff from upper basin is only about 58 percent whereas the percent area in the upper basin for post-project condition is 70 percent. However, a careful look at individual years revealed that in 9 out of 16 years, percent runoff from upper basin is over 80 percent. Under average rainfall conditions, percent runoff contribution from the upper basin is expected to approach the percent area drained by the upper basin.

The mean annual rainfall input to both upper and lower basins have decreased by about 10 percent from the pre- project period to the post-project period. The decrease in rainfall has caused the amount of runoff contributed by the upper basin to decrease as much as 40 percent. The rainfall decrease however, has caused only about 18 percent decrease in runoff in the lower basin. The upper basin evapotranspiration estimates (computed as rainfall-runoff) do not indicate a significant change whereas the lower basin evapotranspiration estimates in fact show a decrease from pre-project period to post-project period. A possible explanation for such a decrease is that the post-project drainage improvements have decreased the evaporation opportunity of the natural impoundments, and surface soil layers which were previously exposed for evapotranspiration for long periods following storm events. Whether this seemingly reduction has any influence on the local climate is a separate issue that has not been proven conclusively.

Hypotheses on Climatic Changes

Recently, many hypotheses have been advanced regarding possible influences of land use changes on climate in south Florida. Art Marshall (reported by Boyle and Meachem, 1982) has suggested that the recent drought(1981) is not a "meterological aberration but a predictable consequence of the land development and the drainage of wetlands in the Everglades and the Kissimmee River basin that have disrupted the normal rain cycle." His theory suggested that the recent development has reduced the amount of sheet-flow water and consequently the reduced evapotranspiration is insufficient to initiate what is called the "rain machine."

Pielke et al.(1988) presented following other arguments for potential effect of land use changes on local precipitation patterns.

Table 2. Rainfall-runoff statistics for upper and lower Kissimmee River basins for pre- and post-project periods. For all entries under rainfall the periods 1915-1961 and 1970-1986 were used for pre- and post project conditions respectively. For all others except as noted the analysis periods were 1934-1961 for pre-project condition and 1970- 1986 for the post project condition.

Rainfall-Runoff Statistics		
Statistic	Pre-project	Post-project
Rainfall(inches)		
Upper basin mean	49.80	44.99*
Lower basin mean	51.47	45.82*
Runoff(cfs)		
Upper basin mean	1241	722*
Total basin mean	2200	1151*
(period used)	(1929-1961)	(1970-1986)
Percent runoff from upper basin		
Mean	0.558	0.583**
(95% confidence interval)	(0.529,0.586)	(0.475,0.690)
Median	0.566	0.627
Minimum	0.400	0.100
Maximum	0.700	0.836
Runoff coefficient		
Upper basin mean	0.199	0.134*
(95% confidence interval)	(0.164,0.234)	(0.097,0.170)
Lower basin mean		
using area ratio	0.192	0.184**
(95% confidence interval)	(0.161,0.222)	(0.123,0.244)
using Istok. canal data	0.184	
(95% confidence interval)	(0.148,0.221)	
Evapotranspiration		
(estimated as Rainfall-Runoff)		
Upper basin mean	40.18	38.90*
(95% confidence interval)	(37.58,42.79)	(36.52,41.28)
Lower basin mean	41.10	36.85*
(95% confidence interval)	(38.56,43.64)	(34.87,38.83)

* Difference statistically significant at 5 percent level
** Difference is not statistically significant at 5 percent level

(a). Blanchard(1983) found that the water conservation areas (as well as Lake Okeechobee and the coastal configuration) played a major role in the generation, maintenance and decay of thunderstorms.

(b). In the southwest region, the large evapotranspiration and evaporation from the wet peat surface provides an enriched lower atmosphere which is conducive to earlier thunderstorm activity.

Further, Peilke et al(1988) hinted that the land use changes can have a major impact on summer convective rainfall over south Florida. The elimination of standing water and wet peat soils can have a "deleterious effect precipitation, as well as result in higher surface temperatures."

Occurrence of droughts are not a recent phenomenon in south Florida. Langbein(1955) reported occurrence of droughts at Miami in 1944-45, 1906,07, 1927-28, 1897-98, and 1913-14 (listed in approximate order of magnitude). At Kissimmee, the five droughts occurred in 1897-98, 1942-43, 1906-07, 1931-32, and 1938-39. Hypotheses on the influence of land use changes on climate appear intuitively appealing but more evidence is needed for their proof. However, these theories if proven to be valid can have a major bearing on restoration of wetlands and marshes not only in Kissimmee but also in other areas of south Florida as well.

Other potential causes of climatic changes must be considered in future planning. For instance one such cause is the "green house effect." Using a Pielke(1988) concluded that based on the General Circulation Model (GCM) results of Schlesing and Mitchell(1987), the loss of precipitation due to a global doubling of CO_2 can be as much as 7 inches per year. The results of any GCM however must be considered in the light of their poor resolution in representing a local area.

CONCLUSIONS

Following is a list of findings based on the results of the previous sections:

1. The upper basin regulation has significantly altered the characteristics of flow inputs to the lower basin from the upper basin. The restoration of the Kissimmee river may not claim full success unless upper basin regulation is modified to mimic as closely as possible, the flow characteristics required for environmental enhancement objectives.

2. The land use changes in the lower basin have further influenced its hydrology. The lower basin hydrology has changed form upland/floodplain retention with slow runoff to one characterized by upland/floodplain drainage with rapid runoff. Consequently, the physical re-creation of floodplain/upland marsh system alone will not re-create the hydrology of pre-project Kissimmee River and a careful design is needed to establish to variability of water levels necessary for environmental restoration.

3. Since 1970 the Kissimmee River basins have received about 10 percent less rainfall than the mean annual rainfall for the prior period beginning 1915. As a consequence a reduction in water availability as indicated by the runoff estimates is evident. However, the lower basin runoff appears to be less impacted by the reduced rainfall and this appears to be the result of lesser evapotranspiration that has occurred during the post-project period.

4. There is not enough data to determine whether the recent decrease rainfall is a random behavior or else if south Florida is experiencing a change in climate due to land use changes. The water availability with or without a climatic change which may be natural or man-made must play a key role in the restoration of possibly thousands of acres of wetlands in the floodplain and uplands.

The above evidence clearly demonstrates the deficiencies of a restoration approach which advocates re-creation of the river physically (say by backfilling) expecting restoration of environmental values to follow automatically. Since the system itself has

changed and evolved over the years an approach which seeks the desirable features of environmental restoration under the current changed conditions may be the only feasible one unless a total basin solution is sought.

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PART II

4.2 HEADWATERS REVITALIZATION

The Upper Kissimmee Chain of Lakes has been regulated since 1970. Regulation has altered surface water flow patterns within and out of the basin. For restoration of

the Kissimmee River to be successful, some alteration of the current Upper Lakes regulation scheme must be implemented. Of particular importance to river restoration is the magnitude and distribution of flow from S-65.

Figure 4-2 and 4-3 compare flows at the present location of S-65 for a pre-project (1934 to 1962) and post-project period (1970 to 1987). Figure 4-2 shows a comparison of flow duration curves; Figure 4-3 shows a comparison of the monthly distribution of flows. Pre-project flows at S-65 serve as a quantification of "natural" flow patterns. The main goal of re-regulation of the Upper Basin Chain of Lakes is to restore a more natural pattern of S-65 discharges (i.e., like that of the pre-project period).

It is not possible to restore flow patterns completely because some changes in the basin, such as secondary drainage and regulation for flood control, are considered not reversable. Additionally, there is substantial impact to flow resulting from decreased basin rainfall over the past twenty years. This reduction is attributable mostly to a lack of tropical storm rainfall in the basin during this period. Within these bounds, flows will be restored to more natural conditions to the maximum extent possible.

Any regulation plan for the Upper Chain of Lakes is subject to several constraints:

- The current level of flood protection in the Upper Kissimmee Basin should be maintained.
- Some acceptable level of surface water availability in the Upper Kissimmee Basin should be maintained.
- Some level of navigability should be maintained.
- The biological resources of the Upper Kissimmee Chain of Lakes should not be impacted.

Methods of Regulation Schedule Analysis

A preliminary schedule modification was evaluated for Lakes Kissimmee, Hatchineha, and Cypress. Other lakes may be involved in a final regulation plan. Several schedules were developed and evaluated using a modified version of Fan's (1986) Upper Kissimmee Chain of Lakes (UKISS) Model.

The model has three modes of operation:

Calibration mode: In calibration mode, the model performs a simulation for the available record of rainfall data, including all local runoff values rather than historic runoff values.

Simulation mode: In simulation mode, historic runoff values are used whenever possible. If historic values are missing, values are estimated with methods utilized in calibration mode.

Forecast mode: In forecast mode, a small set of forecasted rainfall values are used as input, and the model simulates for a six month period. This mode was not used for this evaluation.

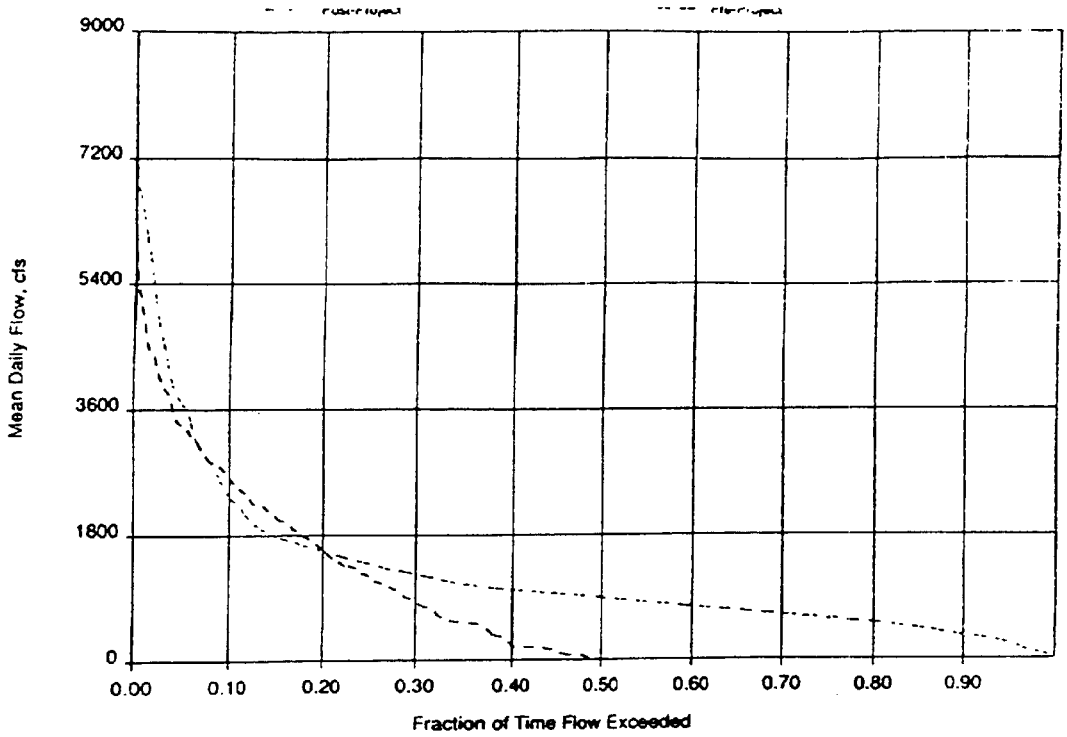

FIGURE 4-2 Pre-project (1934-1962) and post-project (1970-1987) flow duration curves for the outlet of Lake Kissimmee.

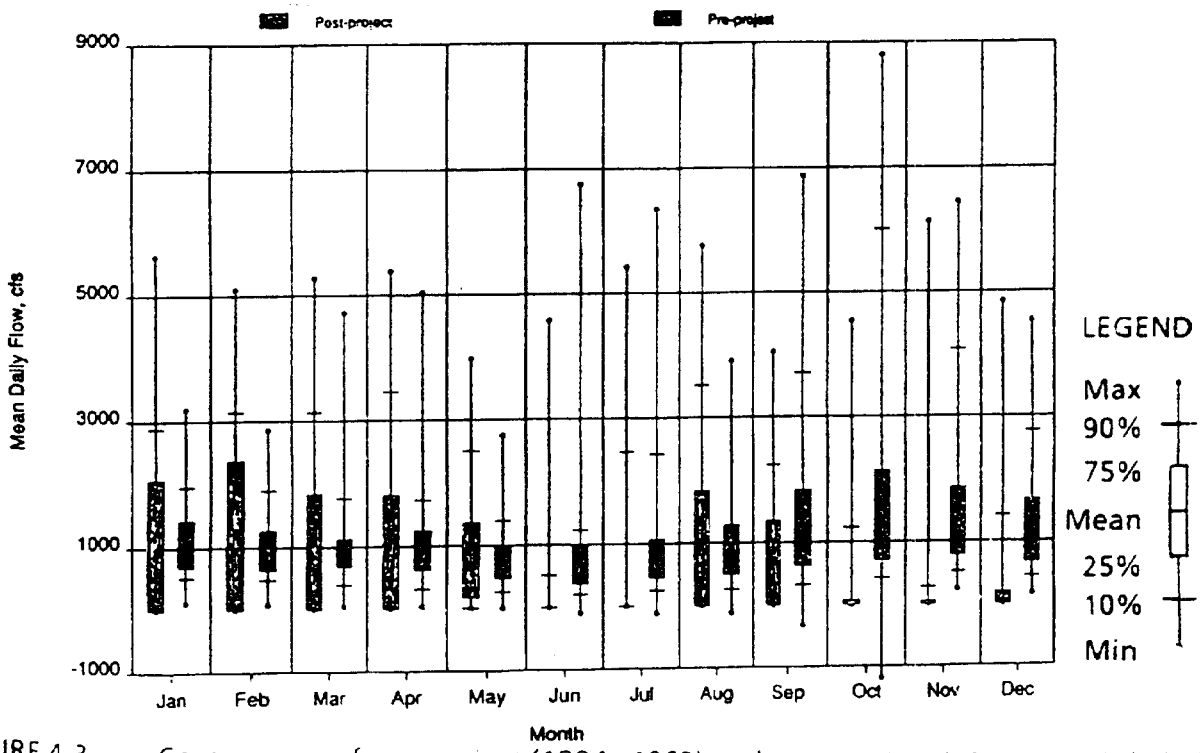

FIGURE 4-3 Comparison of pre project (1934 - 1962) and post-project (1970 - 1987) daily flow frequencies, by month, for the outlet of Lake Kissimmee.

Several changes were made to the model so that it could be used for this analysis. Major changes included:

Allowance for zoned schedules: The original model allowed only single line schedules, that is, schedules that only allow two modes of operation: full allowable discharge or zero discharge. The model was changed to allow an arbitrary number of modes (i.e., zones), which depend on stage and time of year. Table 4-2 shows types of zones that were used in evaluated schedules.

Table 4-2. Descriptions of operational rules used for preliminary schedule evaluation.

Zone Code Name	Description of Discharge Rule
FULL	Full discharge: Releases from the lake are made as rapidly as possible. This zone is always above the top line of the schedule.
STGQ	Historic stage-discharge relation: Releases from the lake are made according to the historic stage-discharge relationship at S-65.
M250	Minimum 250 cfs: Discharges are maintained at a minimum of 250 cfs.
MRCH	The March Rule: During March, changes in Lake Kissimmee stages are limited to 0.1 ft per week. Discharges are made accordingly.
ZERO	Zero discharge: Discharge from the lake is not allowed.

Estimation of evapotranspiration: The original model estimated evapotranspiration (ET) using a linear regression with rainfall. The model was changed to estimate ET based on a method used in the CREAMS model (Knisel, 1980). The approach is based on a method proposed by Ritchie (1972). Daily ET is estimated using leaf area index, and monthly means of temperature and solar radiation. This leads to a slightly better simulation of monthly and annual runoff volumes.

Routing of local runoff: In the UKISS model, local runoff into the various lakes is computed using the SCS runoff equation. For a given day, rainfall and simulated soil moisture deficit were used and any computed runoff was assumed to reach a lake on that day. Because this is not indicative of runoff in the headwaters basin, the model was modified to attenuate computed daily runoff using an imaginary linear reservoir.

The original model was calibrated using data from 1970 to 1980. After the above changes were incorporated, the model was calibrated using data from 1970 to 1987. Comparison of historic and simulated stages for Lake Kissimmee (Figure 4-4) shows historic stages are reproduced relatively well. The historic record for 1977 shows an extreme draw-down event that was artificially induced as part of current lake management practices. For the Kissimmee River Restoration project, it is more important that the model produces realistic flows, especially from S-65. Figure 4-5 shows a comparison of historic and simulated annual volumes from S-65. Figure 4-6 compares historic and simulated flow duration curves at S-65. Figure 4-7 shows observed and simulated flows by month. The UKISS model tends to produce flows

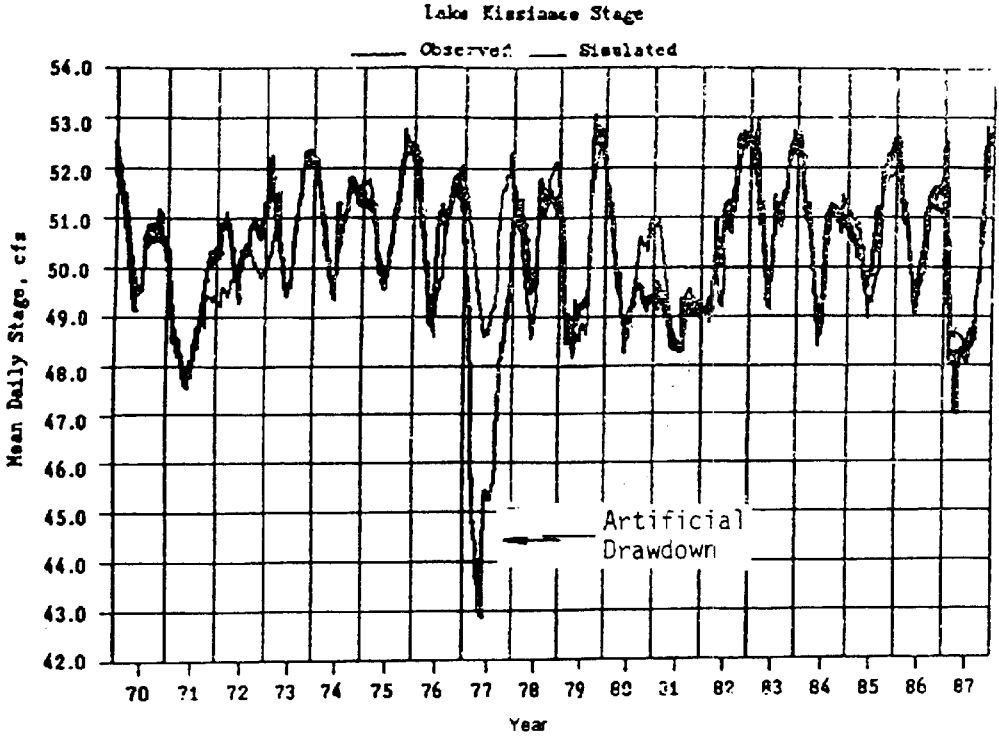

FIGURE 4-4 Comparison of observed stages in Lake Kissimmee, and stages simulated by the Upper Kissimmee Chain of Lakes Model.

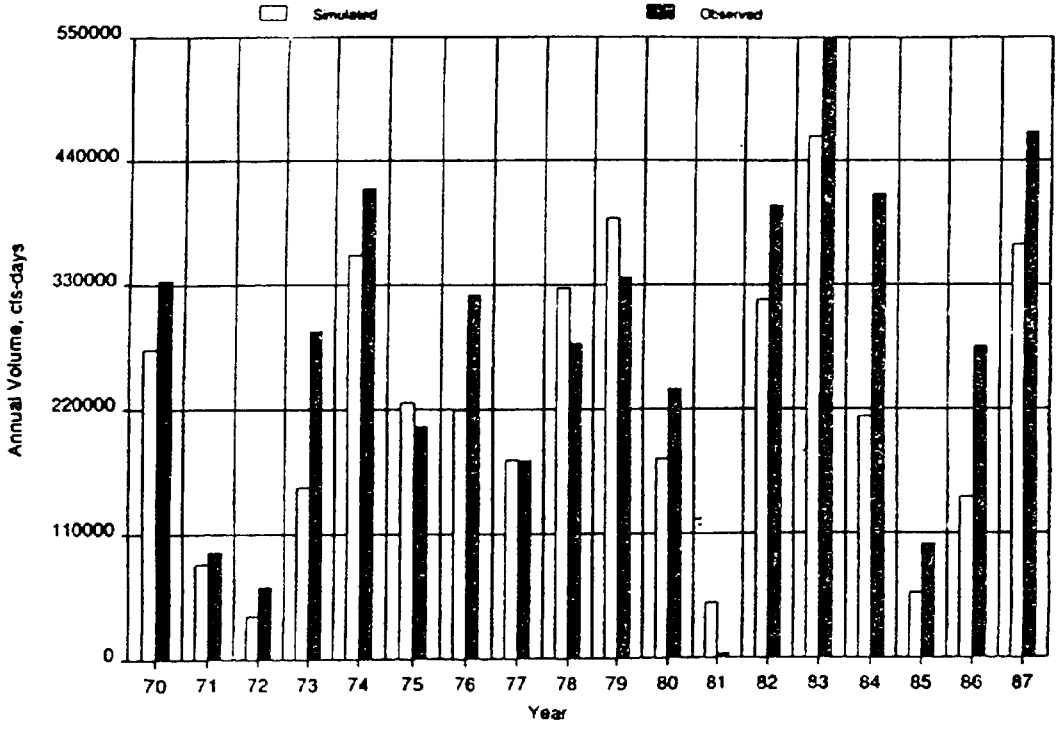

FIGURE 4-5 Calibration results: comparison of observed annual runoff volumes at the outlet of Lake Kissimmee and volumes simulated by the Upper Kissimmee Chain of Lakes Model.

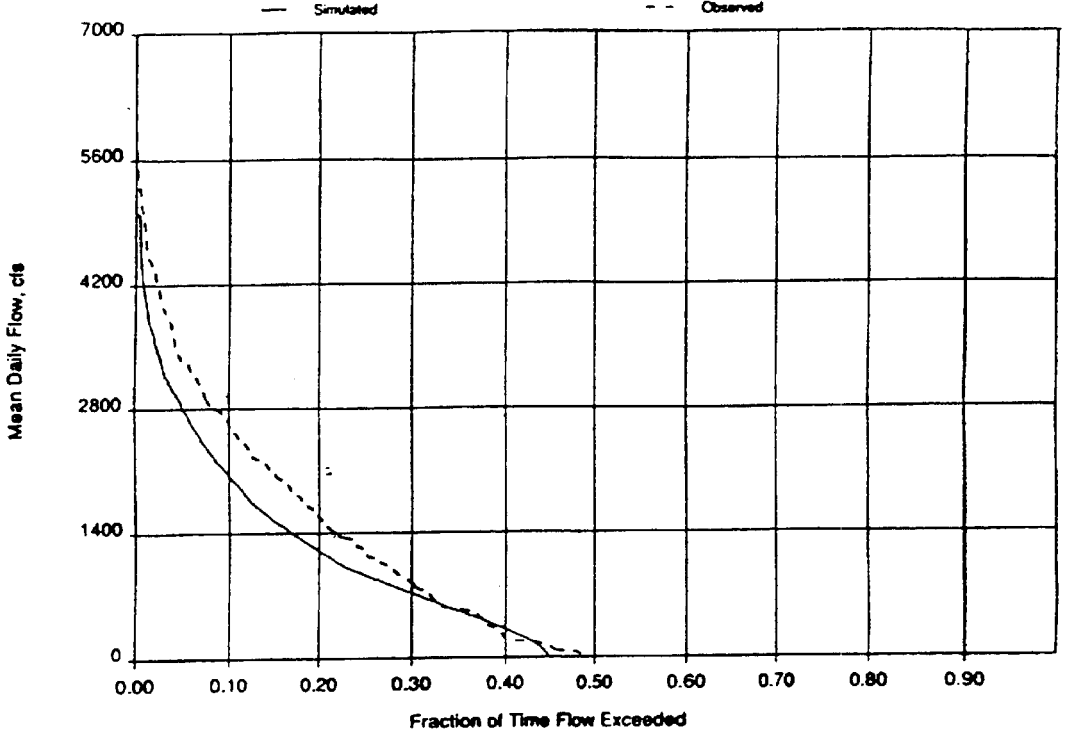

FIGURE 4-6 Observed and simulated flow duration curves at the outlet of Lake Kissimmee.

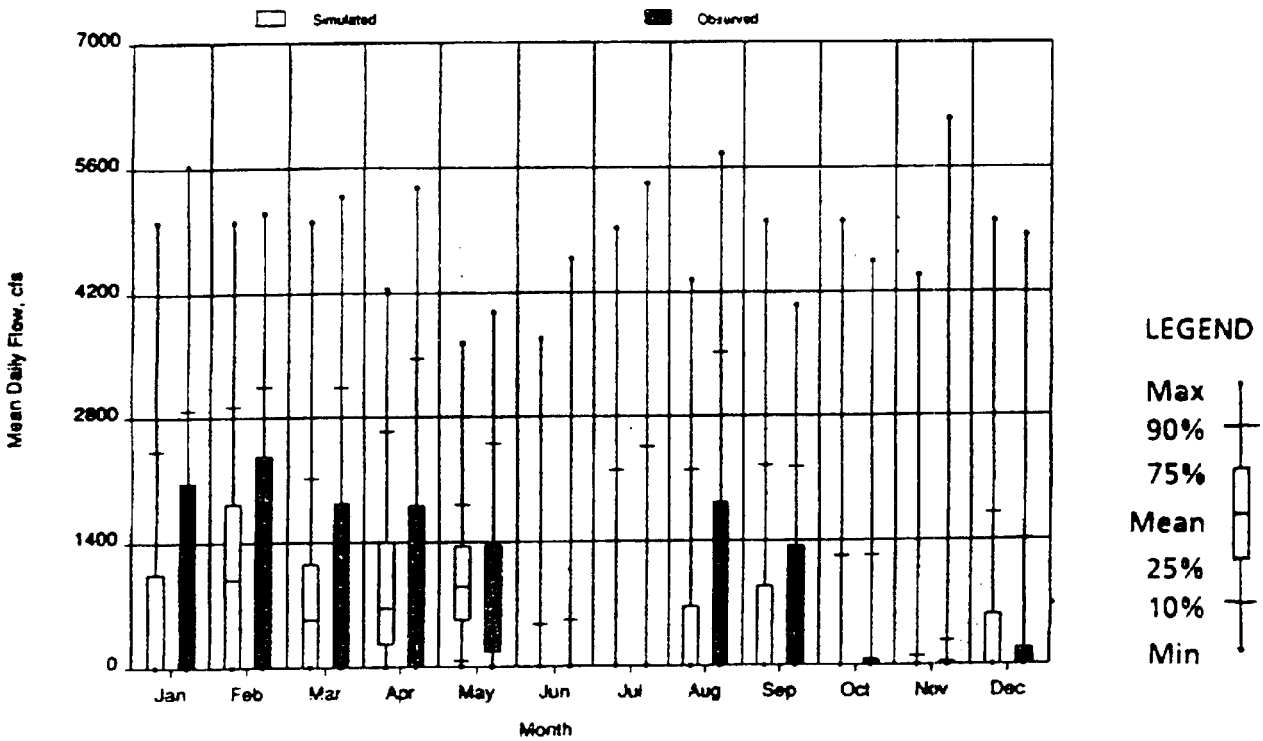

FIGURE 4-7 Box and whisker plots of observed and simulated daily flows, by month, at the outlet of Lake Kissimmee.

which are less variable than occurred historically, but is a useful tool for comparison of schedule alternatives.

Several schedules were developed and examined using post-project (1970 through 1987) conditions. A single schedule was selected for presentation in this report. Additional schedules, with appropriate structural modifications, should be evaluated in the detailed design phase of this restoration component.

Schedule Evaluation

Of the schedules examined, the one shown in Figure 4-8 produced the most desirable effects. Comparison of simulated, post-project, and pre-project flow duration curves (Figure 4-9) shows that this schedule maintains low flows, and decreases the time when zero flow occurs at S-65. The simulated flow duration curves clearly show the impact of reduced rainfall during the past twenty years. If rainfall patterns return to the wetter pre-project conditions, there would be substantial increases in flow performance (i.e., flow characteristics would be more similar to pre-project data). When the performance of this schedule is examined over the entire simulation period (Figures 4-10 and 4-11), it is clear that the preliminary schedule not only maintains a minimum flow for a longer portion of the period, but also tends to smooth the historically sharp discharge peaks. Figure 4-12 compares simulated daily flows that were produced using the schedule in Figure 4-8, to pre-project and post-project flow distributions. Values for simulated and post-project flows are presented in Table 4-3 and Table 4-4, respectively. The preliminary

Table 4-3 Distribution of simulated (1970-1987) post-project daily flows, by month, at the outlet of Lake Kissimmee.

Month	Percent Time Mean Daily Flow (cfs) is Exceeded During Month						
	0%	10%	25%	50%	75%	90%	100%
January	2041	1196	968	250	250	0	0
February	1815	1204	808	250	250	0	0
March	2500	299	256	236	0	0	0
April	4000	1947	999	250	250	0	0
May	2500	1302	1021	473	250	0	0
June	1790	1058	804	599	250	0	0
July	2500	1556	746	462	261	236	0
August	2500	1870	1220	495	250	175	0
September	2500	1731	1265	904	386	250	0
October	7739	1790	1152	722	250	250	235
November	1766	1089	250	250	250	250	250
December	1755	1052	250	250	250	250	0

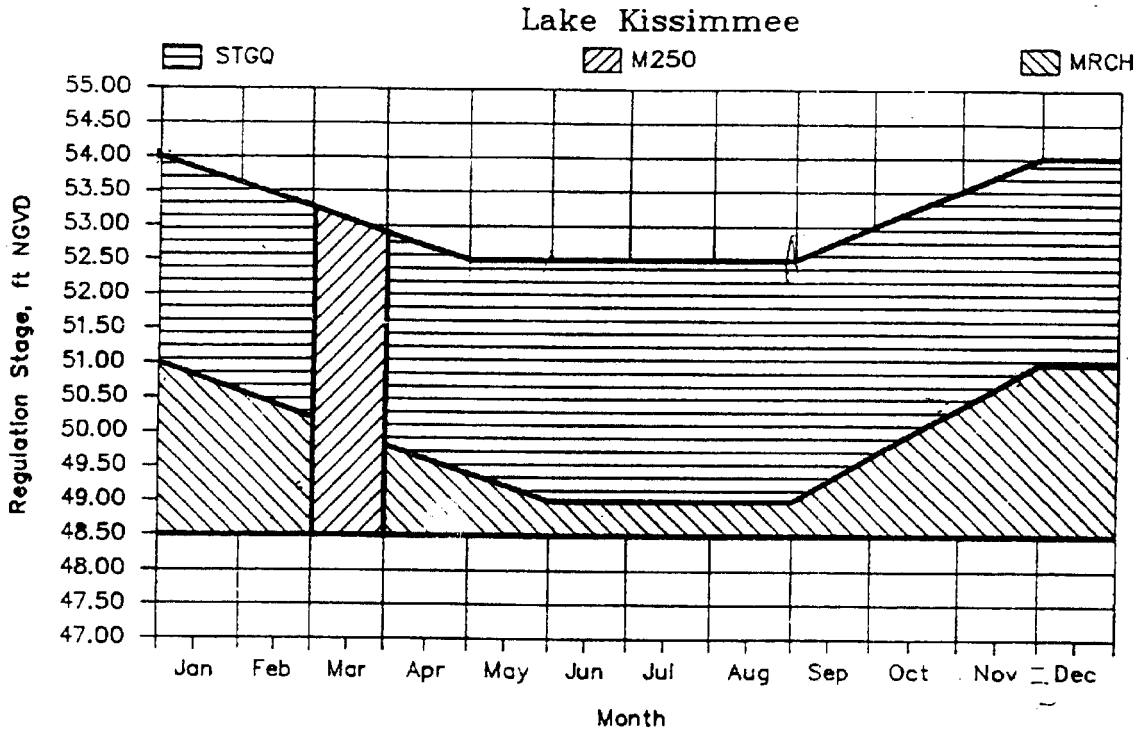

FIGURE 4-8 Proposed preliminary schedule for Lakes Kissimmee, Hatchineha and Cypress.

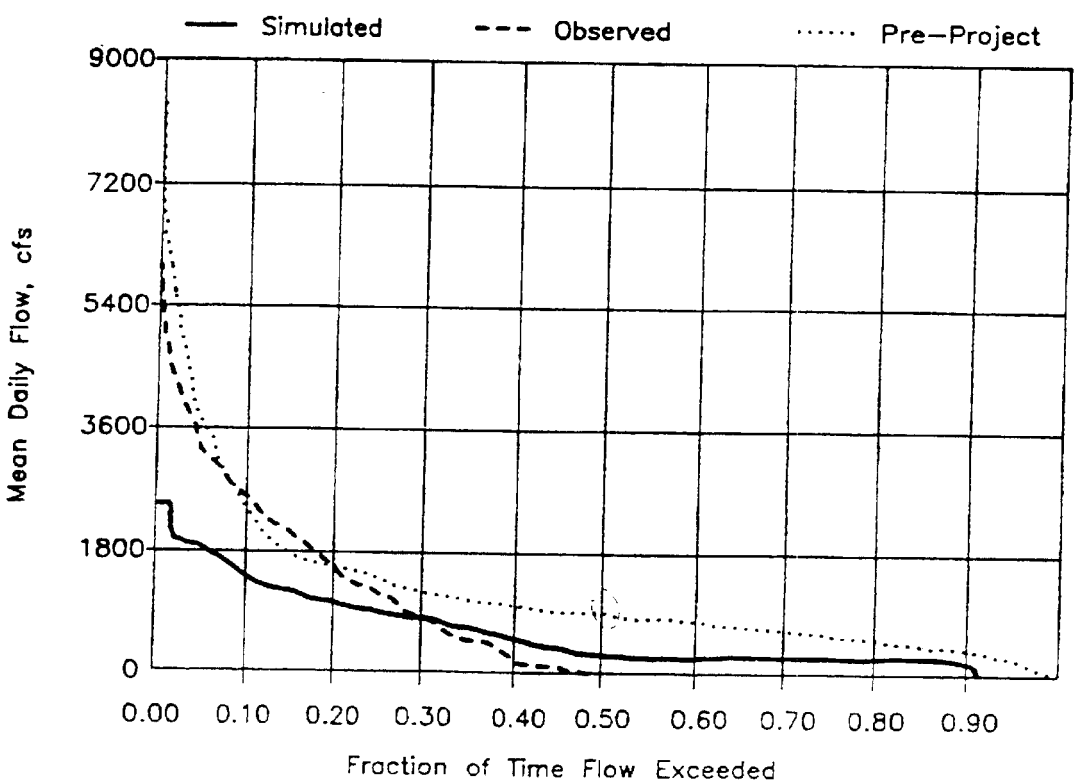

FIGURE 4-9 Comparison of pre-project observed and post project observed and simulated daily flow duration curves at the outlet of Lake Kissimmee. Simulated values are based on the schedule shown in Figure 4-8.

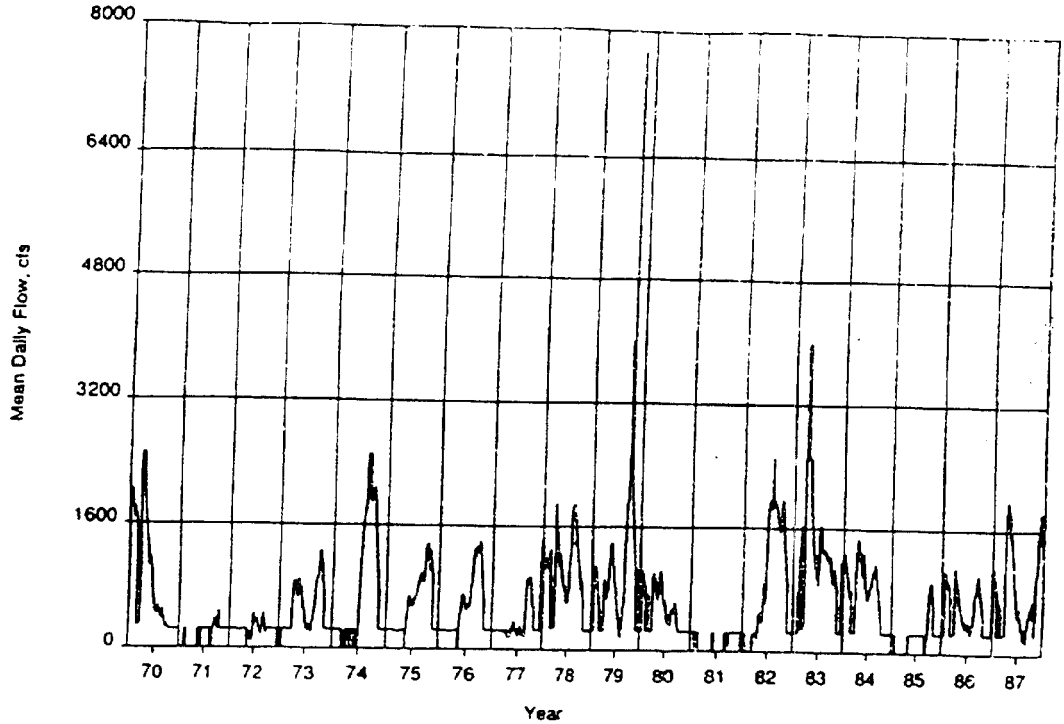

FIGURE 4-10 Simulated flows from the outlet of Lake Kissimmee for the post-project period (1970-1987). Simulated values are based on the schedule shown in Figure 4-8.

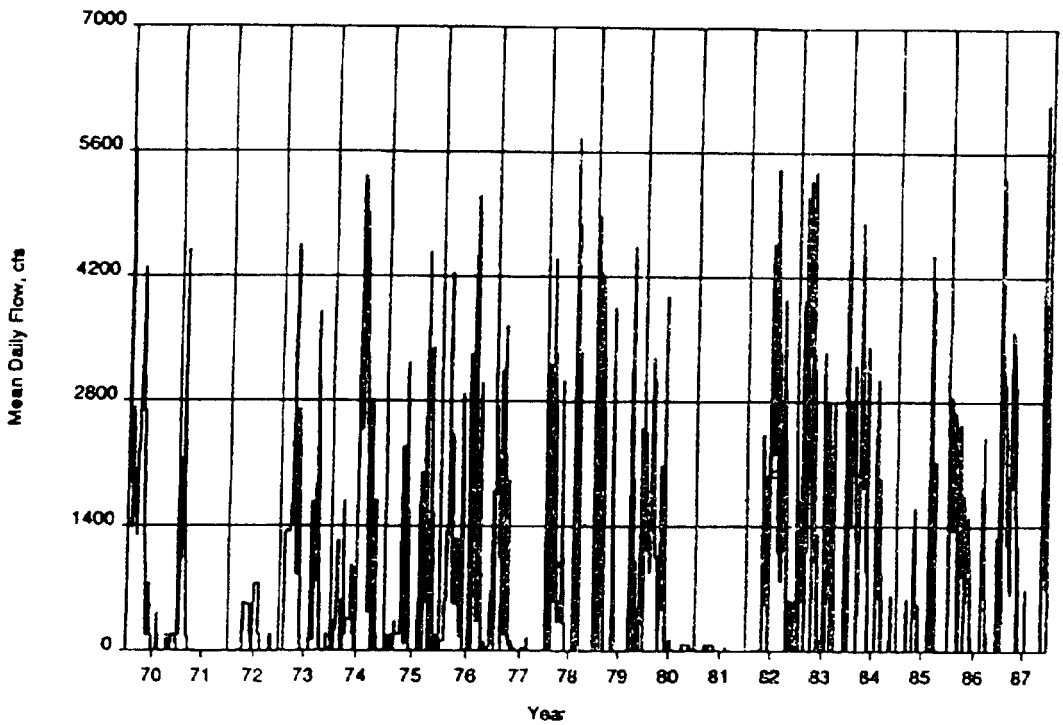

FIGURE 4-11 Observed flows from the outlet of Lake Kissimmee for the post-project period (1970-1987)

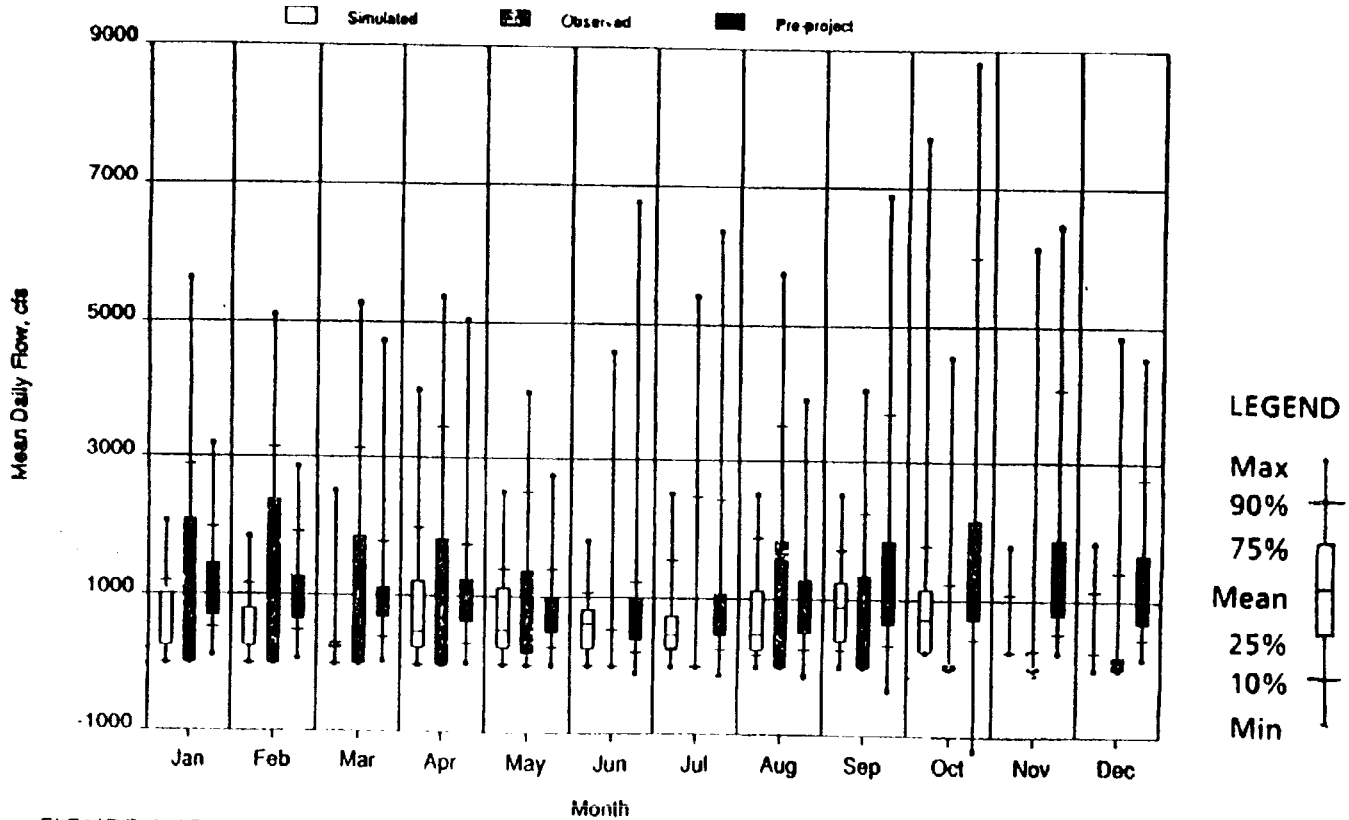

FIGURE 4-12 Comparison of pre-project observed and post-project observed and simulated daily flows by month. Simulated values are based on the schedule shown in Figure 4-8.

Table 4-4. Distribution of observed (1970-1987) post-project daily flows, by month, at the outlet of Lake Kissimmee.

Month	Percent Time Mean Daily Flow (cfs) is Exceeded During Month						
	0%	10%	25%	50%	75%	90%	100%
January	5630	2860	1970	113	1	0	0
February	5100	3121	2250	1350	3	1	0
March	5280	3051	1795	739	2	0	0
April	5380	3450	1837	546	4	0	0
May	3980	2580	1362	538	167	1	0
June	4580	521	3	0	0	0	0
July	5420	2461	5	1	0	0	0
August	5760	3523	1822	167	0	0	0
September	4050	2230	1340	2	0	0	0
October	4540	1231	69	1	0	0	0
November	6140	274	37	1	0	0	0
December	3970	1410	183	2	0	0	0

schedule reversed the change in seasonal flow patterns caused by regulation of the Upper Kissimmee Chain of Lakes (Figure 4-12, Tables 4-3 and 4-4). However, during some months, particularly March, November, and December, simulated flows do not show as much variability as desired. Lack of variability in March flows is due to imposition of the "March Rule". This constraint was recommended by the GFC to facilitate fish spawning.

The schedule shown in Figure 4-8 should be considered a pattern for future schedules to be incorporated in the Kissimmee Restoration project. It is not a final recommended schedule. It produces some of the desired changes in S-65 flows, but there is still some latitude with which some "fine tuning" can be investigated. For example, schedule adjustments involving tradeoffs between high- and low-flow regimes can be made. The "March Rule"also could be re-evaluated with consideration given to accomplishing goals of this rule while reestablishing hydrologic variability in the ecosystem.

This schedule is the basis for evaluation of alternative plans considered in this report. The preliminary schedule shows the potential improvement in the hydrologic performance possible in future restoration scenarios.

KISSIMMEE RIVER
HEADWATERS REVITALIZATION PROJECT

APPENDIX F

LAKE KISSIMMEE REGULATION SCHEDULE
EVALUATION PROCESS

Appendix F
Lake Kissimmee Regulation Schedule Evaluation Process

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Tables

Table B1 - Regulation Schedule Alternatives Lake Kissimmee Regulation Schedule Evaluation . . F-6

Table C1 - A Comparison of Lake Discharges to River Elevation . F-9

Description of Figures

Figure A1 - Existing flood control regulation schedule for Lake Kissimmee. It is my understanding that this will be shown in a previous section. Change the A1 reference in the text to whatever the figure number should be.

Figure A2a - Bar graphs showing monthly discharge exceedence data for the pre-regulation period of record (1934-60).

Figure A2b - Bar graphs showing monthly discharge exceedence data for the post-regulation period of record (1970-88).

Figure A3 - Bar graphs showing mean monthly Lake Kissimmee stages during the pre- and post-regulation periods of record.

Figure A4 - Alternative regulation schedule RS1.

Figure B1-B6 - Alternative regulation schedules RS1-A, 1-B, 2, 3, 4, 5, 6, 7, 8, 9, 9-A, 9-B, 9-C, 9-D, 10, 10-A, 10-B, 10-C, 11, and 11-A.

Figure C1 - Simulated versus observed stages in Lake Kissimmee from the historical period of record, 1970-1988.

Figure C2 - Simulated versus observed discharges at S-65 from the historical period of record, 1970-1988.

Figure C3 - Rating curves of S-65 discharges versus Lake Kissimmee stages for historical, RC-A, and RC-B outlet ratings.

Figure C4 - Lake Kissimmee stage duration curves for the pre- and post-regulation periods of record.

Figure D1 - Comparison of observed and simulated Lake Kissimmee stage duration curves for alternative RS1 & RS1-A.

Figure D2 - Comparison of observed and simulated Lake Kissimmee stage duration curves for alternative RS1-B.

Figure D3 - Comparison of observed and simulated Lake Kissimmee stage duration curves for alternative RS3.

Figure D4 - Comparison of observed and simulated Lake Kissimmee stage duration curves for alternative RS4.

Figure D5 - Bar graphs showing monthly Lake Kissimmee discharges that were exceeded 50% of the time during the simulation period by alternatives RS2, RS5, RS6 and RS8 compared to discharges that were exceeded 50% of the time during the pre-regulation period of record.

Figure D6 - Historical (pre-regulation) relationship between Lake Kissimmee discharges and stages at Fort Kissimmee.

Figure D7 - Comparison of observed and simulated Lake Kissimmee stage duration curves for alternative RS10.

Figure D8 - Comparison of observed and simulated Lake Kissimmee stage duration curves for alternative RS10-A.

Figure D9 - Comparison of observed and simulated Lake Kissimmee stage duration curves for alternative RS10-B.

Figure D10 - Comparison of observed and simulated Lake Kissimmee stage duration curves for alternative RS10-C.

Figure D11 - Comparison of observed and simulated Lake Kissimmee stage duration curves for alternative RS7.

Figure D12 - Comparison of observed and simulated Lake Kissimmee stage duration curves for alternative RS11.

Figure D13 - Comparison of observed and simulated Lake Kissimmee stage duration curves for alternative RS11-A..

Figure D14 - Comparison of observed and simulated Lake Kissimmee stage duration curves for alternative RS9.

Figure D15 - Comparison of observed and simulated Lake Kissimmee stage duration curves for alternative RS9-A.

Figure D16 - Comparison of observed and simulated Lake Kissimmee stage duration curves for alternative RS9-B.

Figure D17 - Comparison of observed and simulated Lake Kissimmee stage duration curves for alternative RS9-C.

Figure D18 - Comparison of observed and simulated Lake Kissimmee stage duration curves for alternative RS9-D.

Figure D19 - Bar graphs showing monthly Lake Kissimmee discharges that were exceeded 25% of the time during the simulation period by alternatives RS9, RS9-A, RS9-B, RS9-C and RS9-D compared to discharges that were exceeded 25% of the time during the pre-regulation period of record.

Appendix F
Lake Kissimmee Regulation Schedule
Evaluation Process

SECTION A

One of the key findings of the planning studies that have been conducted for the Kissimmee River Restoration Project is that dechannelization alone, that is backfilling of C-38, is not sufficient to accomplish ecological restoration of the river/floodplain ecosystem. Due to the flood control schedules and operation rules that are used to regulate stages in Lakes Kissimmee, Cypress, and Hatchineha (Figure A1), discharge regimes from the Upper Basin have been greatly altered compared to historical conditions. Prior to regulation, the river received continuous inflows from the Upper Basin, with lowest discharge typically occurring during the winter-spring dry season and steadily increasing to the November peak (Figure A2a). Since regulation began, the natural seasonality of high and low flow periods has been reversed and there are extended periods during each year when there is no discharge from the upper lakes to the Lower Basin. Low or no discharge is common during the period June through November, while highest annual flows often occur during the dry season months (particularly February-May), as stages in the upper lakes are lowered to provide storage for flood control (Figure A2b). the changes to historical flow regimes have impact the potential for restoring fish and wildlife habitat in the river and its flanking floodplain.

Flood control regulation also has impacted environmental resources in the Upper Basin. Because the range of water level fluctuations and maximum annual lake stages have been reduced (Figure A3), the outer fringe of littoral wetlands surrounding the lakes has been drained and associated fish and wildlife values have diminished.

The 1991 feasibility study demonstrated that discharges required to accomplish ecological restoration of the Lower Basin could be provided by modifying the flood control regulation schedule and operation rules for the lower group of headwater lakes (i.e., Kissimmee, Hatchineha, and Cypress). The proposed modifications (Figure A4) provided required inflow regimes for the Lower Basin restoration, including relatively continuous discharges, with rates that varied with lake stages. These modifications to the operation rules, along with proposed provisions to raise the upper level of the regulation schedule to 52.5 during May-September and between 52.5-54 ft during the remaining months of the year, also have the potential for increasing the range and temporal dynamics of water level fluctuations in the lakes. An associated expansion of littoral wetlands and increased quality and productivity of littoral habitat surrounding the lakes was suggested, but not rigorously evaluated.

SECTION B

Use of regulation schedule and operation rule modifications, such as those proposed in the 1991 feasibility study for achieving the integrated environmental objectives for the Upper and Lower Kissimmee Basins, is based upon the established premise that the basin's environmental restoration objectives will be met by reestablishing key hydrologic characteristics. Hydrologic restoration criteria for the Lower Basin requires reestablishment of continuous inflows from the Upper Basin, particularly during July-October, natural seasonality of high and low inflow regimes and a wide-range of stochastic discharge variability. The primary measure for achieving environmental improvements in the Upper Basin is to increase the extent and frequency of high lake stages. The basic strategy is to modify the regulation schedule and operation rules to allow lake stages to fluctuate more naturally with rainfall and associated inflows from the Upper Basin watershed, and to reestablish outflow regimes that reflect historic (pre-regulation) stage-discharge relationships for the headwater lakes. More natural, rainfall-driven fluctuations would lead to higher lake stages which would provide increased water storage and thereby accommodate maintenance of continuous inflows from the Upper to Lower Basins.

However, the potential for modifying the Upper Basin regulation schedule and operation rules is limited by flood control and navigation constraints, which establish an upper and lower envelop for lake stages and discharge manipulations. The flood control envelop limits maximum lake stages to 54 ft, and to 52.5 ft from June 1-September 1. Navigation constraints restrict minimum lake stages to 48.5 ft. Within this envelop, alternative operation rules can be devised for manipulating discharge regimes to the lower basin.

Key components of the regulation schedule and operation rule modifications in the 1991 feasibility study were used as a template for developing alternative Upper Basin water management schemes for meeting the restoration criteria and environmental objectives of the river and headwater lakes. Through an iterative process, 21 alternative schemes (Table B1 and Figures B1-B6) were developed and evaluated by Corps and SFWMD staff, with input from the FGFWFC and USFWS.

Table B1
Regulation Schedule Alternatives
Lake Kissimmee Regulation Schedule Evaluation

Regulation schedule alternatives. See Figures A4 and B1-6 for more details on operation rules for each alternative.	
ALTERNATIVE	**OPERATION RULES**
RS1	Three discharge zones bounded by an upper flood control regulation zone when lake stages exceed 52.5-54 ft and a lower no discharge zone when lake stages are < 48.5 ft. Within this envelop no discharges are made during March; during other months discharges either vary according to the historic (pre-regulation) stage-discharge relationship or are maintained at 250 cfs, depending upon lake stages.
RS1-A	Same as RS1 with slight modifications to historic stage-discharge rating curve.
RS1-B	Same as RS1 without March no discharge zone.
RS2	Same discharge zones as RS1-B except upper flood control regulation zone is bounded by existing regulation schedule elevations.
RS3	Same as RS1-B with slightly higher flood control envelop during May.
RS4	Same as RS4 except 250 cfs zone changed to 400 cfs zone.
RS5	Two discharge zones bounded by the same flood control and lower no discharge zones as RS4. Within this envelop discharges are maintained at 250 cfs when lake stages are < 41.68 ft or vary as lake stages overtop a weir with a fixed crest of 41.68 ft.
RS6	Two discharge zones bounded by the same flood control and lower no discharge zones as RS4. Within this envelop discharges are maintained at 150 cfs when lake stages are < 49 ft or vary according to a this alternative's stage-discharge rating curve.
RS7	Same as RS6 with the addition of a 400 cfs discharge zone when lake stages fall within designated ranges during November-May.
RS8	Same as RS6 with a different stage-discharge rating curve.
RS9	Same as RS6 with the addition of a 400 cfs discharge zone that occurs at different lake stages than the RS7 400 cfs discharge zone
RS9-A	Same as RS9 with a modification to the 400 cfs discharge zone

Regulation schedule alternatives. See Figures A4 and B1-6 for more details on operation rules for each alternative.	
ALTERNATIVE	**OPERATION RULES**
RS9-B	Same as RS9 with a modification to the 400 cfs discharge zone different from that of RS9-A
RS9-C	Same as RS9 with a modification to the 400 cfs discharge zone different from that of RS9-A and RS9-B
RS9-D	Same as RS9-C with elimination of 400 cfs discharge zone during November-December
RS10	Same as RS9-A with historical stage-discharge rating curve.
RS10-A	Same as RS9-B with historical stage-discharge rating curve.
RS10-B	Same as RS9-C with historical stage-discharge rating curve.
RS10-C	Same as RS9-D with historical stage-discharge rating curve.
RS11	Same as RS9-C and RS10-B with RS8 stage-discharge rating curve during January-June and historical stage-discharge rating curve during July-December.
RS11-A	Same as RS11 with elimination of 400 cfs discharge zone during November-December.

SECTION C

The hydrologic performances of the alternative schemes were modeled over an 18-year, post-channelization (1970-87) simulation period, using a modified version of a continuous simulation model (Fan, 1986) for the upper chain of lakes (UKISS). Period of record of rainfall, average monthly temperature, and average solar radiation data provided required inputs for the model to generate daily lake stages and flow for the simulation period. The model has been calibrated for stage, but appeared to underestimate discharge during the simulation period by approximately 20 percent. During the 18-year period used for model simulations, the Upper Basin received approximately 10 percent less rainfall, and as a result, contributed 40 percent less average annual runoff to the Lower Basin than during the pre-regulation period of record (Obeysekera and Loftin, 1990).

The long term hydrologic effects of the alternative regulation schedules on Lakes Kissimmee, Hatchineha and Cypress were analyzed using UKISS, a computer model developed by the SFWMD. The model was first developed in 1981 to address the problems created by the prolonged Kissimmee Basin drought of 1980-81.

Later, the model was used to evaluate new schedules proposed in 1982 for the Middle and Upper Kissimmee Lakes. It has subsequently been modified extensively and used to evaluate impacts associated with the Kissimmee River Demonstration Project and extreme drawdowns. It was again used to by SFWMD to evaluate the alternative plans presented in their 1990, Alternative Plan Evaluation & Preliminary Design Report on Kissimmee River Restoration. A detailed description of the UKISS model is contained in SFWMD Technical Publication 86-5 entitled, A ROUTING MODEL FOR THE UPPER KISSIMMEE CHAIN OF LAKES, dated September, 1986. In summary, UKISS is a continuous simulation model designed to simulate the daily operation of the nine lakes in the Middle and Upper Kissimmee Basins. The model estimates the average daily stage of nine Kissimmee lakes, including Lakes Kissimmee, Hatchineha, and Cypress. It also estimates the average daily discharge from Lake Kissimmee. Input to the model are regulation schedules for each year of simulation, daily rainfall, and average monthly temperature and solar radiation. It uses linear reservoir routing techniques and the SCS methods for estimating overland flow travel times and soil moisture storage. The model simulates the complex hydrologics of structures gate operations by simplified equations. The period of record for which records are available is from 1970 to 1988. In order to verify the accuracy of the model the period of record, 1970 to 1988, was simulated for Lake Kissimmee using historical schedules; the results were compared with the historical stage and discharge data (Figures C1 and C2).

In previous studies of the restoration of the Kissimmee River most of the effort was directed to the lower River. It was generally assumed that the new regulation schedule for Lake Kissimmee would be a zoned schedule where the regulated outflow in that zone would closely resembled the outflow prior to the project, (pre 1970). It was also assumed with this outflow that Lake Kissimmee would be higher at the end of the wet season and this additional storage would extend the hydroperiod of the lower river. Perhaps because the rainfall has been less since the project was completed in 1970, Ukiss routings showed that with historical outlet capacity Lake Kissimmee would not have sufficient water to adequately extend the hydroperiod of the Kissimmee River. The historical rating curve used in the model was then modified to limit flow to 400 cfs at a lake stage of 50.0 feet and no outflow below 48.5 feet. Later, two other outlet ratings (RC-A and RC-B) were developed by Lou Toth of the SFWMD. These new outlet capacities were modeled for each general schedule plan to produce two new alternatives. The RC-A and RC-B rating curves are displayed along with historical capacity (Figure C3). The historical outlet capacity for Lake Kissimmee is derived from a rating curve developed by the U.S. Geological Survey based on records from 1934 to 1955 for a gage that was located 3 miles south of Structure 65 at State Road 60. The original rating curve is presented on plate 57 of the basic report, Part II Supplement 5 General Design Memorandum Kissimmee River Basin 1956. To correct for the stage difference over that 3 miles, 0.3 feet was added to the stage at S-65.

In order to evaluate the effect of the alternative regulation schedules on the Kissimmee River below Lake Kissimmee, it was necessary to devise a relationship between the discharges from Lake Kissimmee and the percent of floodplain inundated along the Kissimmee River. In the SFWMD 1990 Restoration Study, a relationship was developed by linear regression between historical stages at the Fort Kissimmee gage and the discharges from Lake Kissimmee. In Table 2-1 of the 1990 study, a relationship is given between the river stages at Fort Kissimmee and the percentage of local floodplain inundation for a representative 0.66 square mile floodplain adjacent to Fort Kissimmee. These relationships were used to evaluate the effects of the alternative regulation schedules on the Kissimmee River floodplain and are shown in Table C1. The table shows 100 percent of the representative floodplain inundated at elevation 45 feet. Stages of 45 feet were equalled or exceeded approximately 30 percent of the time during the period of record. Although flood stages greater than 45 feet inundated areas beyond the representative floodplain during the period of record, these areas were not inundated frequently enough to increase the area representing the "natural floodplain" boundary.

Table C1
A Comparison of Lake Discharges to River Elevations

Lake Kissimmee Discharge (cfs)	Fort Kissimmee Stage (feet msl)	% of Flood- Plain Inundated
0	38.0	0
190	39.9	0
250	40.5	7.5
350	41.0	15.85
400	41.6	30.00
500	42.2	45.85
600	43.0	48.73
700	43.5	88.70
800	44.0	93.65
900	44.3	96.50
1000	44.5	97.80
1200	45.0	100.0
1500	45.5	100.0
2000	46.0	100.0
3000	46.8	100.0
4000	47.1	100.0
5000	47.8	100.0
6000	48.2	100.0

Environmental analyses of the alternatives focussed on comparisons of their simulated hydrologic performance with the established restoration criteria. Upper Basin environmental analyses were based upon comparisons of observed and simulated stage duration curves for the post-channelization period. Although maximum hydrologic restoration would be achieved by reestablishing lake stage frequencies similar to the pre-regulation period, the flood control and navigation constraints limit the range of fluctuation to 48.5-54 ft. During the 1934-60 period of record, Lake Kissimmee stages exceeded 54 ft approximately 7 percent of the time and were less than 48.5 ft approximately 19 percent of the time. Because frequencies of lake stages between 49.6 ft and 50.8 ft were similar for the observed post-regulation period and historical period (Figure C4), and the primary environmental objective for the Upper Basin is to reestablish littoral wetlands that were drained by lowered lake stages, Upper Basin analyses focussed on the degree to which the alternatives increased frequencies of lake stages between 50.8 ft and 54.0 ft.

Lower Basin environmental analyses were based upon the simulated discharge regimes of the alternatives. Simulated Lake Kissimmee outflows for each alternative were compared to discharge characteristics of the RS1 schedule, because the 1991 feasibility study demonstrated that the hydrologic performance of this schedule met the criteria for restoration of the Lower Basin ecosystem and was used as a basis for the restoration project's authorization. New alternatives were considered acceptable if their simulated discharge characteristics equalled or exceeded the hydrologic performance of the RS1 schedule. Comparisons were based upon monthly discharge exceedence data (i.e., discharges that were exceeded during various percentages of the simulation period). The continuous flow criteria was evaluated by determining monthly discharges that were exceeded during 90 percent of the simulation period. The degree to which the alternatives reestablished discharge variability and natural seasonal distributions of high and low flow periods was evaluated by monthly discharges that were exceeded during 10, 25, 50, and 75 percent of the simulation period. These percentages were chosen to represent magnitudes of discharges that could be expected during low (discharge exceeded during 75% of simulation period), average (discharge exceeded during 50% of simulation period), high (discharge exceeded during 25% of simulation period), and peak (discharges exceeded during 10% of simulation period) flow periods.

SECTION D

Initial screening of the hydrologic performance of each alternative indicated that nine schedules failed to meet the minimum requirements of the upper or lower basin restoration criteria. Five alternatives, the RS1, RS1-A, RS1-B, RS3, and RS4 schedules, were eliminated because simulations indicated

schedules, were eliminated because simulations indicated these alternatives would result in Upper Basin water levels that would be consistently lower than stages produced by the existing regulation schedule (Figure D1-4). The RS2, RS5, RS6 and RS8 alternatives were eliminated because their discharge characteristics during average flow periods (Figure D5) were inadequate for Lower Basin restoration. Simulations indicate that 50 percent of the time the RS2 and RS5 schedules would produce inflows of only 250 cfs. The RS6 and RS8 alternatives produced higher discharges, but were less than 600 cfs during most months, including much of the wet season. Based upon Lower Basin stage and Upper Basin discharge relationships (Figure D6), inflows produced by these schedules would consistently inundate only 50 percent or less of the river's floodplain.

All other alternatives produced discharge regimes that met the Lower Basin restoration criteria and improved upon the hydrologic performance of the RS1 schedule. Compared to the RS1 schedule, these remaining alternatives had lower frequencies of no flow periods, increased the magnitude of low flows during wet season months, and average flows during dry season months, and redistributed average and high flow volumes in a more natural seasonal pattern.

When the simulated effects of these 12 schedules on lake stages were compared to observed lake stage frequencies between 1970-88, the remaining alternatives grouped into three categories. Alternatives RS10, RS10-A, RS10-B, and RS10-C resulted in frequencies of lake stages > 51.5 feet that were similar to that produced by the current regulation schedule, but significantly lower frequencies of stages between 49.5-51.5 feet (Figure D7-10). Alternatives RS7, RS11, and RS11-A resulted in slightly higher frequencies of stages > 51.0 feet and lower frequencies of stages between 50-51 feet than the current schedule (Figure D11-13). Alternatives RS9, RS9-A, RS9-B, RS9-C, and RS9-D produced the greatest increase in frequencies of lake stages >51 feet, and had frequencies of stages between 49-51 feet similar to observed frequencies of these stages during the 1970-88 simulation period (Figures D14-18).

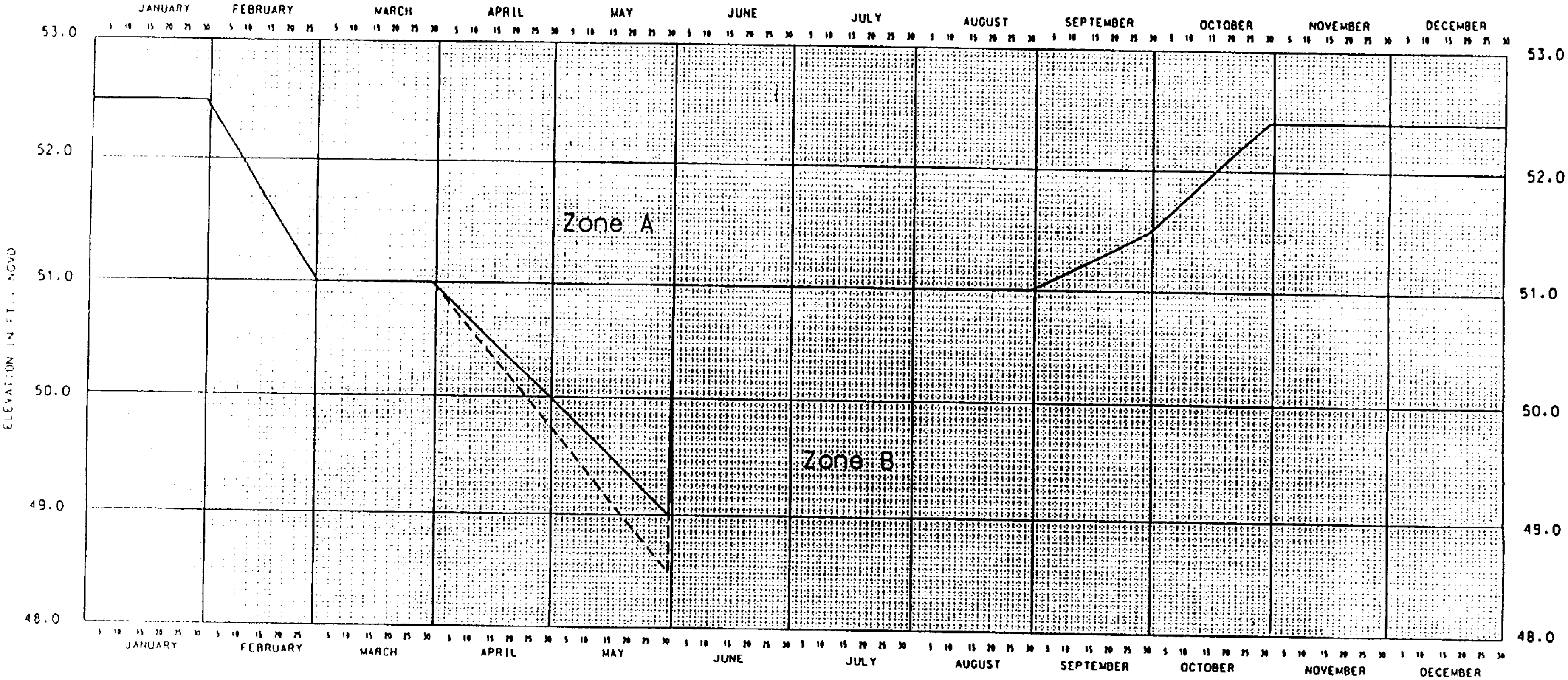
Based upon the simulated effects of the alternatives on lake stage frequencies, alternatives RS9, RS9-A, RS9-B, RS9-C, and RS9-D had the greatest potential for leading to expanded littoral wetlands and associated environmental improvements to the Upper Basin. Although all five of these alternatives also would provide inflow regimes that meet the Lower Basin restoration criteria, the simulations suggest that alternatives RS9-C and RS9-D would provide a more natural seasonal distribution of high and low flow periods (Figure D19). While the hydrologic performance of these two alternatives would be similar for both the Upper and Lower basins, RS9-D has less operation constraints. Because this alternative does not have a zone that limits discharges to 400 cfs when lake stages are between 50-52 feet during November-December, it would produce more natural inflows to Lower Basin during these months than alternative RS9-C.

KISSIMMEE RIVER
HEADWATERS REVITALIZATION PROJECT

APPENDIX F

Lake Kissimmee Regulation Schedule Evaluation Process

FIGURES



ZONE	RELEASES
A	3,000 CFS UP TO DESIGN CAPACITY(11000) WITHOUT EXCEEDING DESIGN CONDITIONS DOWNSTREAM. WHEN THE LAKE IS WITHIN 0.5 FEET OF SCHEDULED STAGE FORECASTS WILL BE MADE AND RELEASES STARTED TO RETURN THE LAKE TO SCHEDULE WITHIN 15 DAYS
B	TO MAINTAIN MINIMUM FLOWS

NOTE: (- - - - - - - - - -) USE THIS SCHEDULE ONE YEAR IN THREE

CENTRAL AND SOUTHERN FLORIDA
INTERIM REGULATION SCHEDULE
KISSIMMEE RIVER BASIN
LAKES KISSIMMEE, HATCHINEHA, AND CYPRESS

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
JACKSONVILLE, FLORIDA

DATED: 1 DECEMBER 1981

FIGURE A1

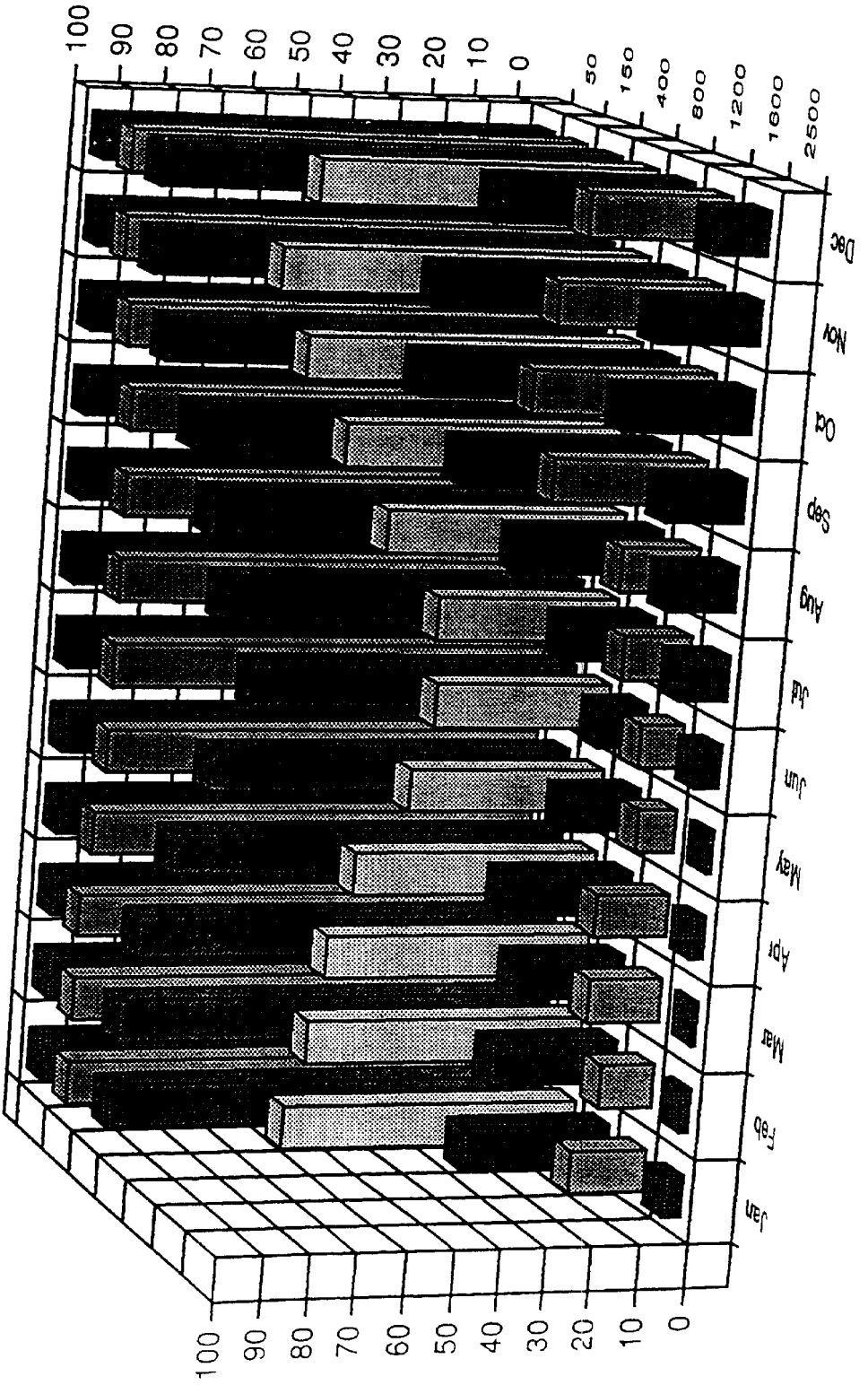

% of Historical Period of Record (1929-60)
100
90
80
70
60
50
40
30
20
10
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
50
150
400
800
1200
1600
2500
Discharge (cfs)

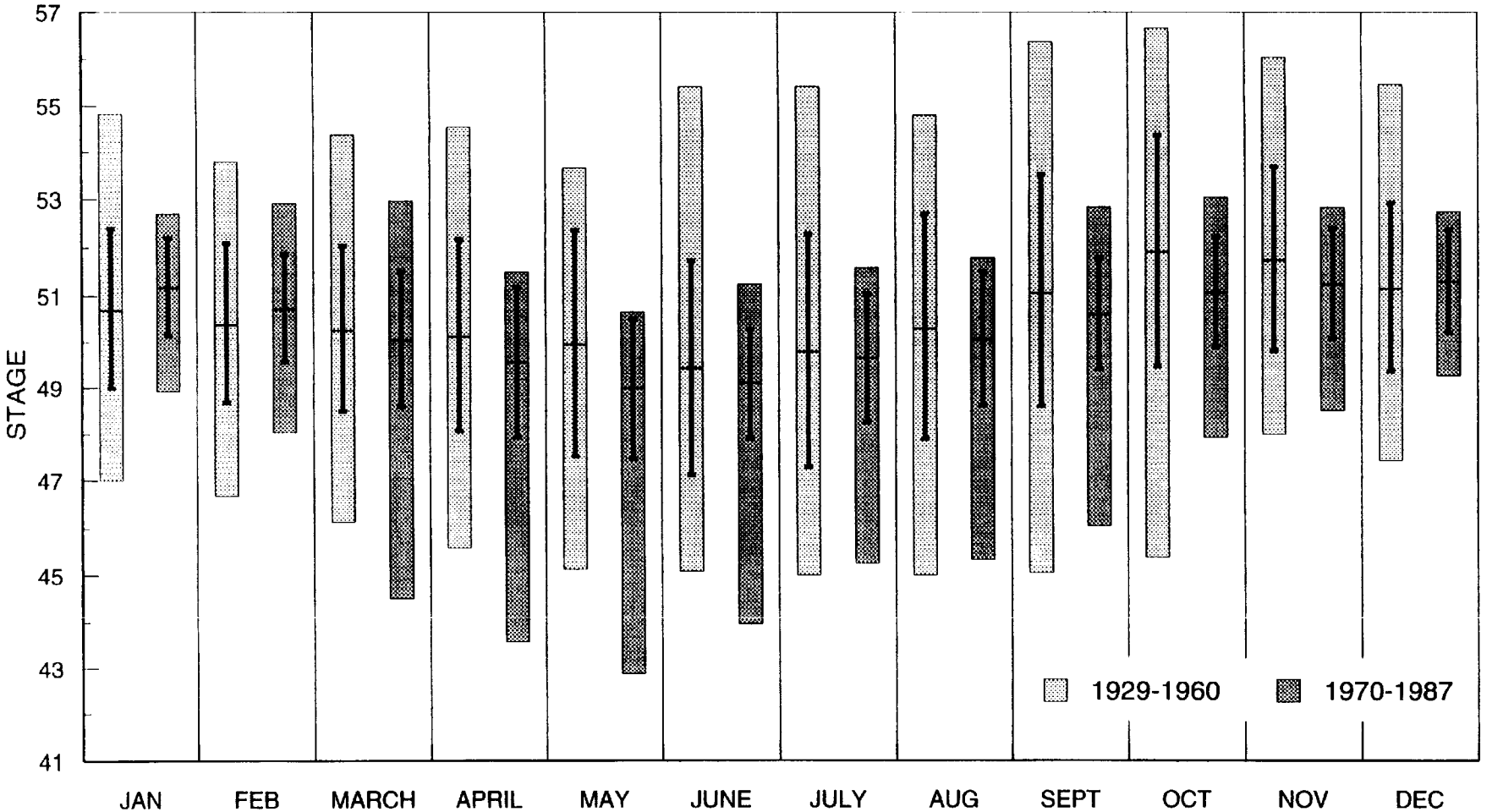
FIGURE A2a

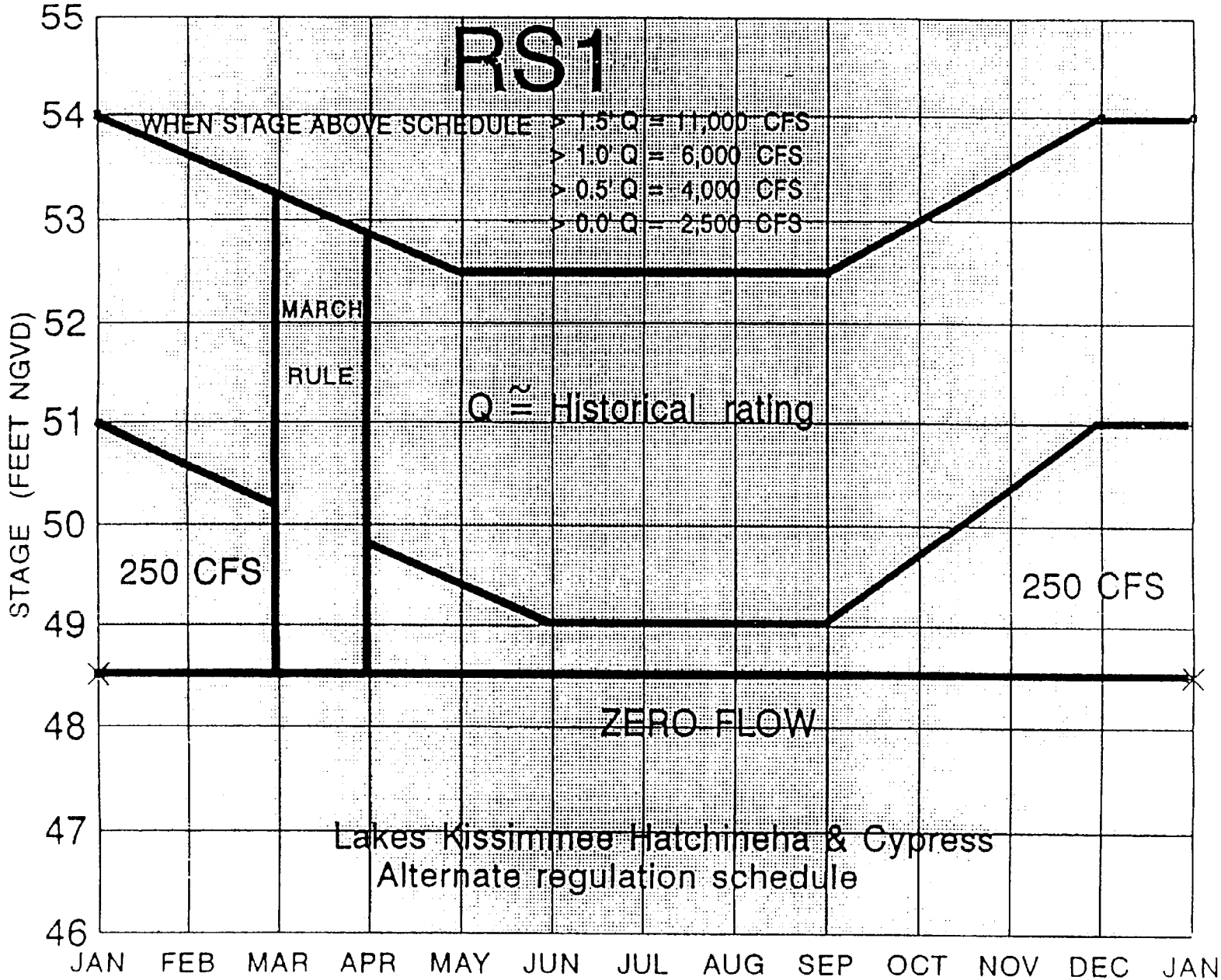
% of Post-Regulation Period of Record (1970-88)
100
90
80
70
60
50
40
30
20
10
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Discharge (cfs)
50
150
400
800
1200
1600
2500

FIGURE A2b

Lake Kissimmee Mean Monthly Stage

1929-1960 vs 1970-1987




RS1
WHEN STAGE ABOVE SCHEDULE > 1.5' Q = 11,000 CFS
> 1.0' Q = 6,000 CFS
> 0.5' Q = 4,000 CFS
> 0.0 Q = 2,500 CFS
MARCH
RULE
Q ≅ Historical rating
250 CFS
250 CFS
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
STAGE (FEET NGVD)
55
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53
52
51
50
49
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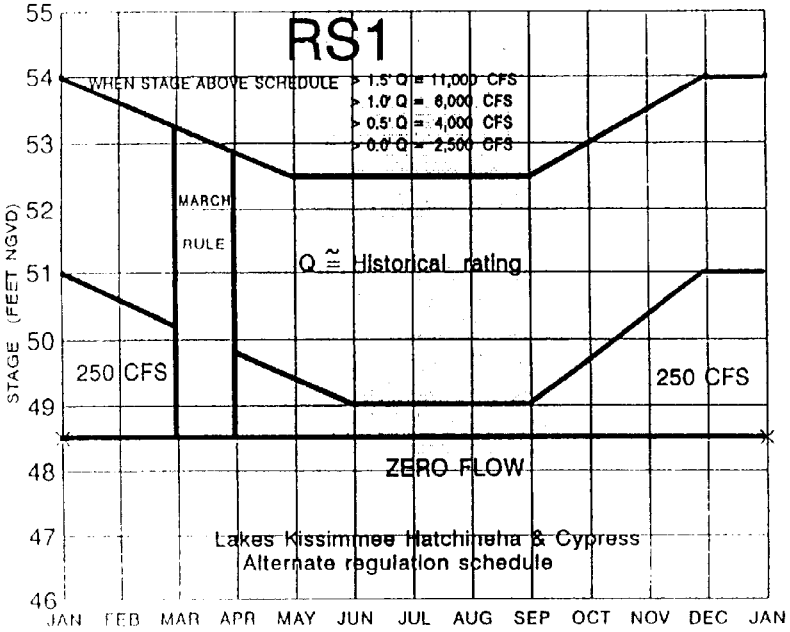
47
46
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
JAN

FIGURE A4


RS1
WHEN STAGE ABOVE SCHEDULE > 1.5' Q = 11,000 CFS
> 1.0' Q = 6,000 CFS
> 0.5' Q = 4,000 CFS
> 0.0' Q = 2,500 CFS
MARCH
RULE
Q ≅ Historical rating
250 CFS
250 CFS
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
STAGE (FEET NGVD)
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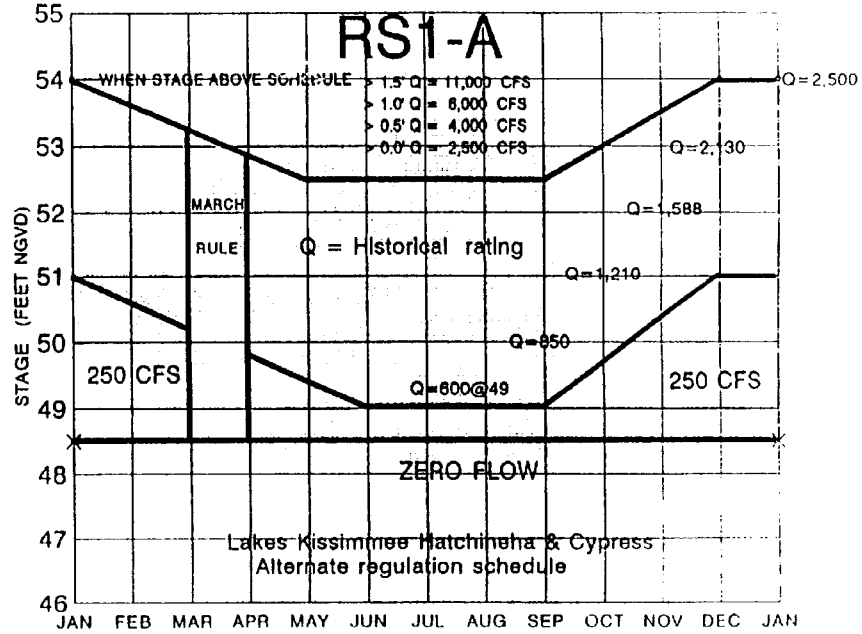
48
47
46
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN


RS1-A
WHEN STAGE ABOVE SCHEDULE > 1.5' Q = 11,000 CFS
> 1.0' Q = 6,000 CFS
> 0.5' Q = 4,000 CFS
> 0.0' Q = 2,500 CFS
Q=2,500
Q=2,130
Q=1,588
Q=1,210
Q=850
Q=600@49
MARCH
RULE
Q = Historical rating
250 CFS
250 CFS
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
STAGE (FEET NGVD)
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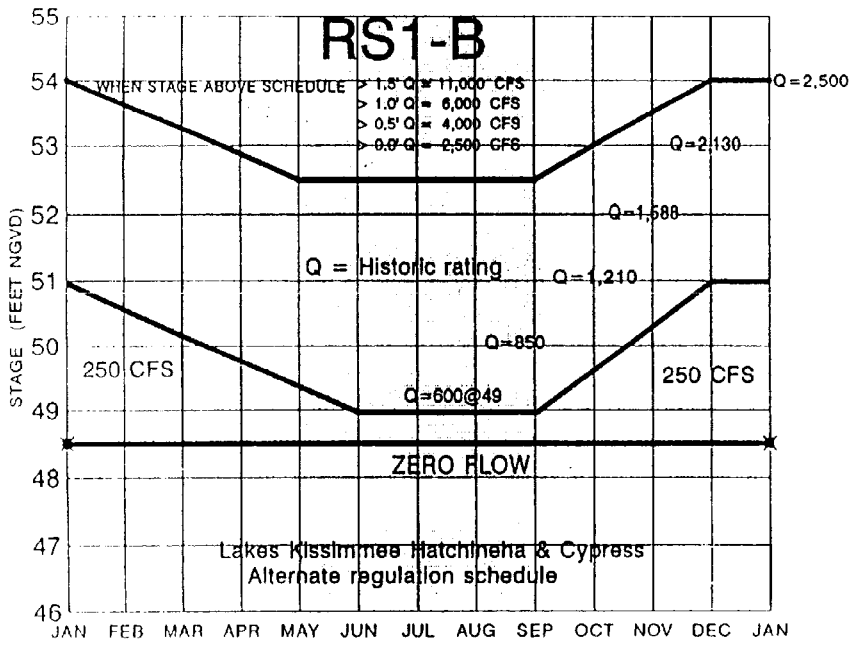
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN


RS1-B
WHEN STAGE ABOVE SCHEDULE > 1.5' Q = 11,000 CFS
> 1.0' Q = 6,000 CFS
> 0.5' Q = 4,000 CFS
> 0.0' Q = 2,500 CFS
Q=2,500
Q=2,130
Q=1,588
Q=1,210
Q=850
Q=600@49
Q = Historic rating
250 CFS
250 CFS
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
STAGE (FEET NGVD)
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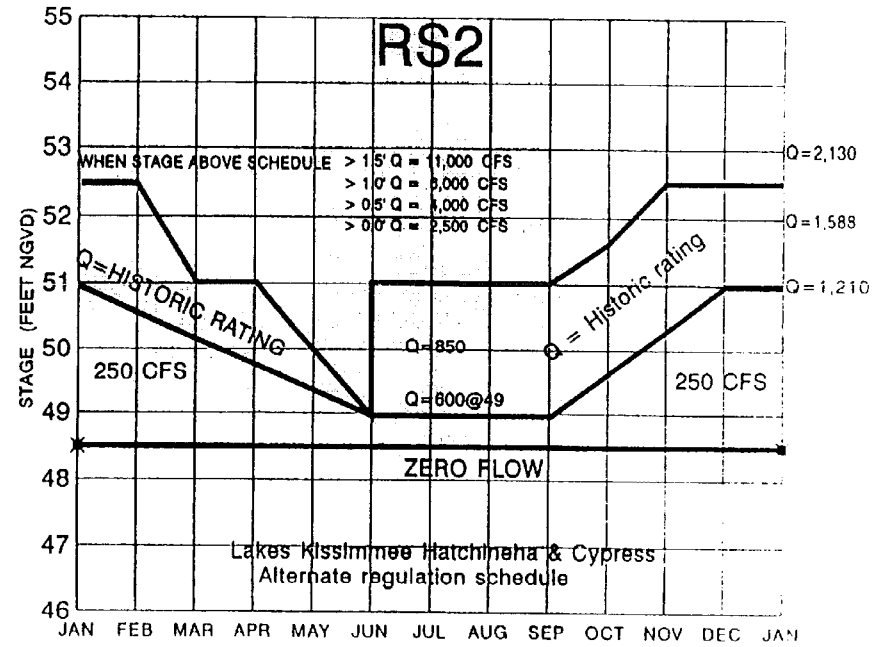
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN


RS2
WHEN STAGE ABOVE SCHEDULE > 1.5' Q = 11,000 CFS
> 1.0' Q = 6,000 CFS
> 0.5' Q = 4,000 CFS
> 0.0' Q = 2,500 CFS
Q=2,130
Q=1,588
Q=1,210
Q=HISTORIC RATING
Q = Historic rating
Q=850
Q=600@49
250 CFS
250 CFS
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
STAGE (FEET NGVD)
55
54
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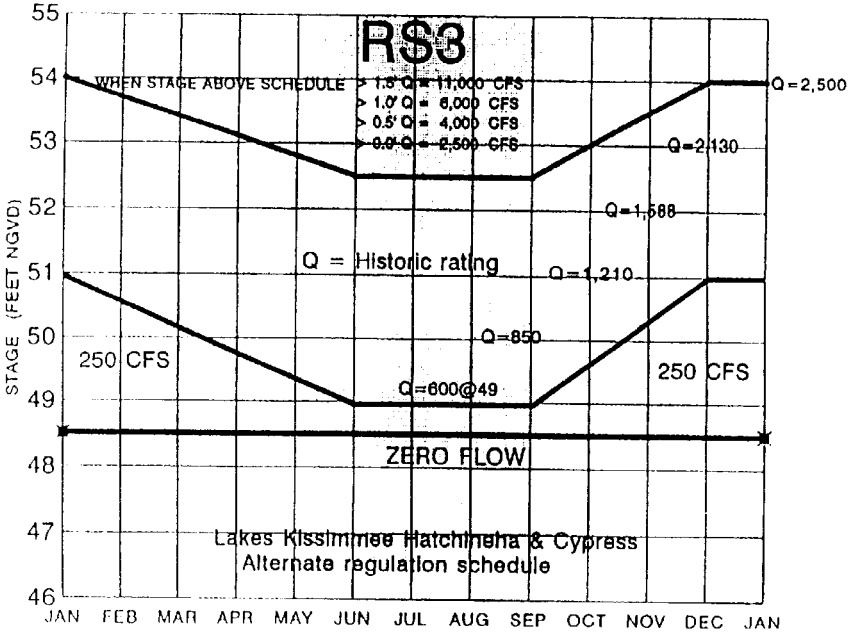
48
47
46
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN

FIGURE B1


RS3
WHEN STAGE ABOVE SCHEDULE > 1.5' Q = 11,000 CFS
> 1.0' Q = 6,000 CFS
> 0.5' Q = 4,000 CFS
> 0.0' Q = 2,500 CFS
Q = 2,500
Q=2,130
Q=1,588
Q = Historic rating
Q=1,210
Q=850
250 CFS
250 CFS
Q=600@49
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
STAGE (FEET NGVD)
55
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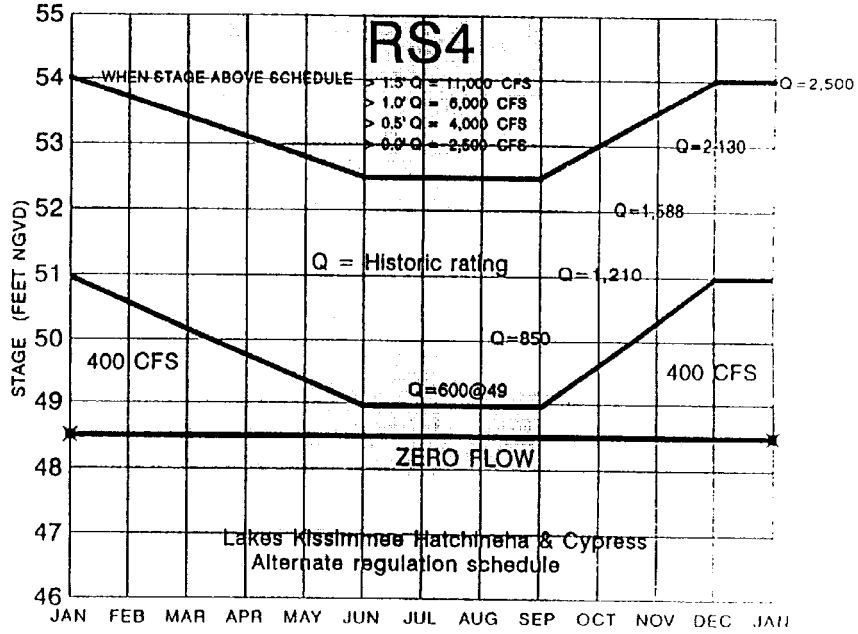
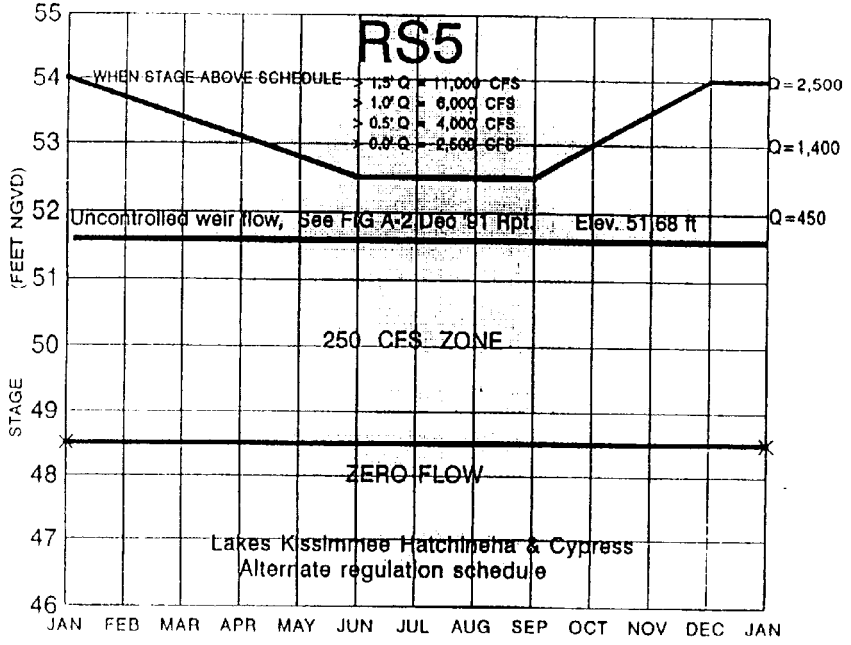
49
48
47
46
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN


RS4
WHEN STAGE ABOVE SCHEDULE > 1.5' Q = 11,000 CFS
> 1.0' Q = 6,000 CFS
> 0.5' Q = 4,000 CFS
> 0.0' Q = 2,500 CFS
Q = 2,500
Q=2,130
Q=1,588
Q = Historic rating
Q=1,210
Q=850
400 CFS
400 CFS
Q=600@49
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
STAGE (FEET NGVD)
55
54
53
52
51
50
49
48
47
46
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN


RS5
WHEN STAGE ABOVE SCHEDULE > 1.5' Q = 11,000 CFS
> 1.0' Q = 6,000 CFS
> 0.5' Q = 4,000 CFS
> 0.0' Q = 2,500 CFS
Q = 2,500
Q=1,400
Q=450
Uncontrolled weir flow, See FIG A-2 Dec '91 Rpt.
Elev. 51.68 ft
250 CFS ZONE
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
STAGE (FEET NGVD)
55
54
53
52
51
50
49
48
47
46
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN

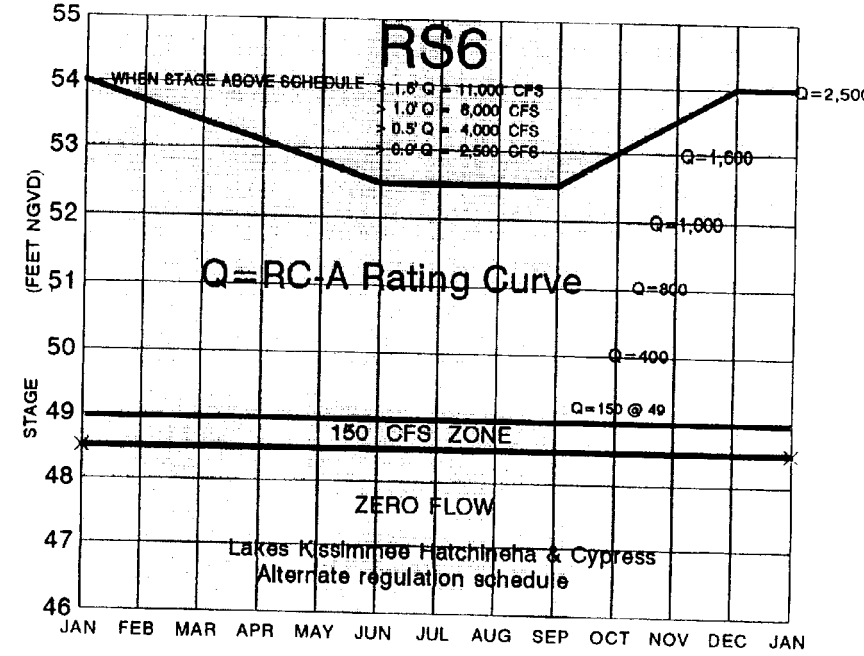
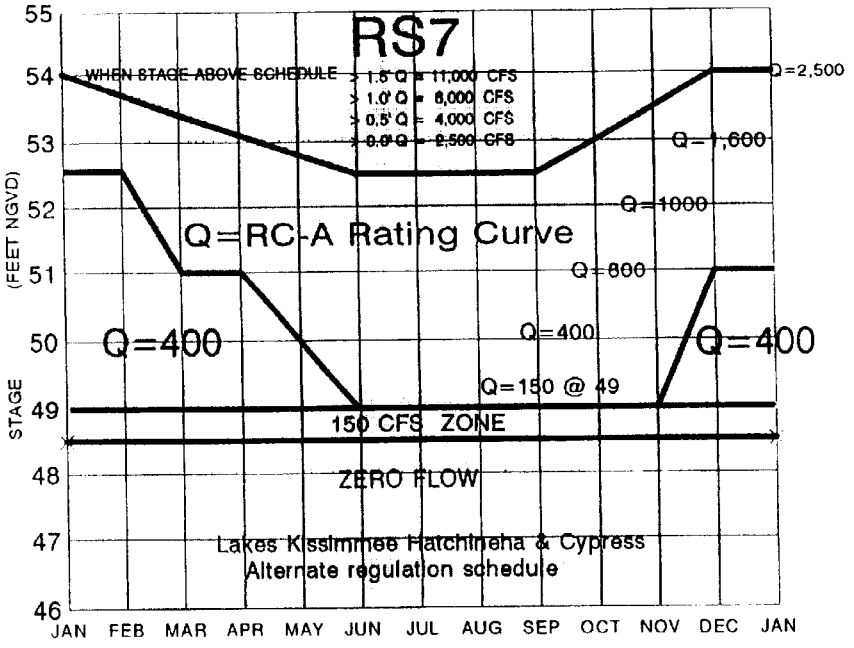
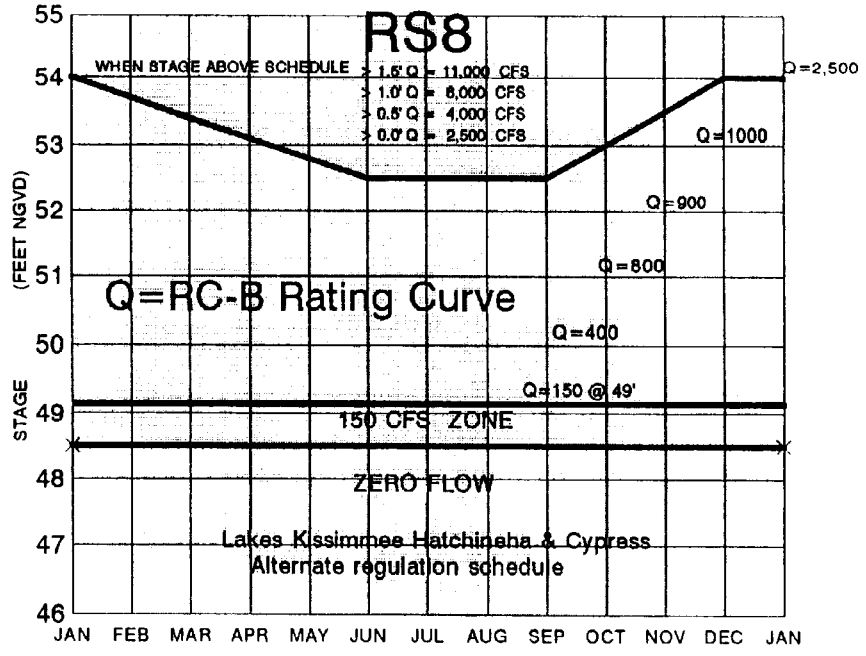
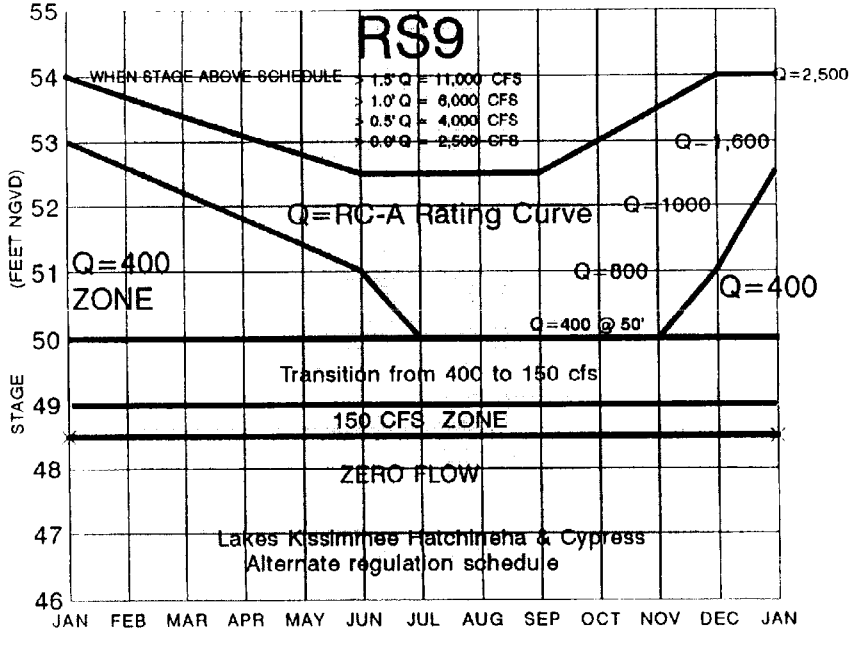

RS6
WHEN STAGE ABOVE SCHEDULE > 1.5' Q = 11,000 CFS
> 1.0' Q = 6,000 CFS
> 0.5' Q = 4,000 CFS
> 0.0' Q = 2,500 CFS
Q=2,500
Q=1,600
Q=1,000
Q=800
Q=400
Q=150 @ 49
Q=RC-A Rating Curve
150 CFS ZONE
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
STAGE (FEET NGVD)
55
54
53
52
51
50
49
48
47
46
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN

FIGURE B2


RS7
WHEN STAGE ABOVE SCHEDULE
> 1.5' Q = 11,000 CFS
> 1.0' Q = 6,000 CFS
> 0.5' Q = 4,000 CFS
> 0.0' Q = 2,500 CFS
Q=2,500
Q=1,600
Q=1000
Q=800
Q=400
Q=150 @ 49
Q=RC-A Rating Curve
Q=400
Q=400
150 CFS ZONE
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
STAGE (FEET NGVD)
55
54
53
52
51
50
49
48
47
46
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN


RS8
WHEN STAGE ABOVE SCHEDULE
> 1.5' Q = 11,000 CFS
> 1.0' Q = 6,000 CFS
> 0.5' Q = 4,000 CFS
> 0.0' Q = 2,500 CFS
Q=2,500
Q=1000
Q=900
Q=800
Q=400
Q=150 @ 49'
Q=RC-B Rating Curve
150 CFS ZONE
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
STAGE (FEET NGVD)
55
54
53
52
51
50
49
48
47
46
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN


RS9
WHEN STAGE ABOVE SCHEDULE
> 1.5' Q = 11,000 CFS
> 1.0' Q = 6,000 CFS
> 0.5' Q = 4,000 CFS
> 0.0' Q = 2,500 CFS
Q=2,500
Q=1,600
Q=1000
Q=800
Q=400 @ 50'
Q=RC-A Rating Curve
Q=400
ZONE
Q=400
Transition from 400 to 150 cfs
150 CFS ZONE
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
STAGE (FEET NGVD)
55
54
53
52
51
50
49
48
47
46
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN

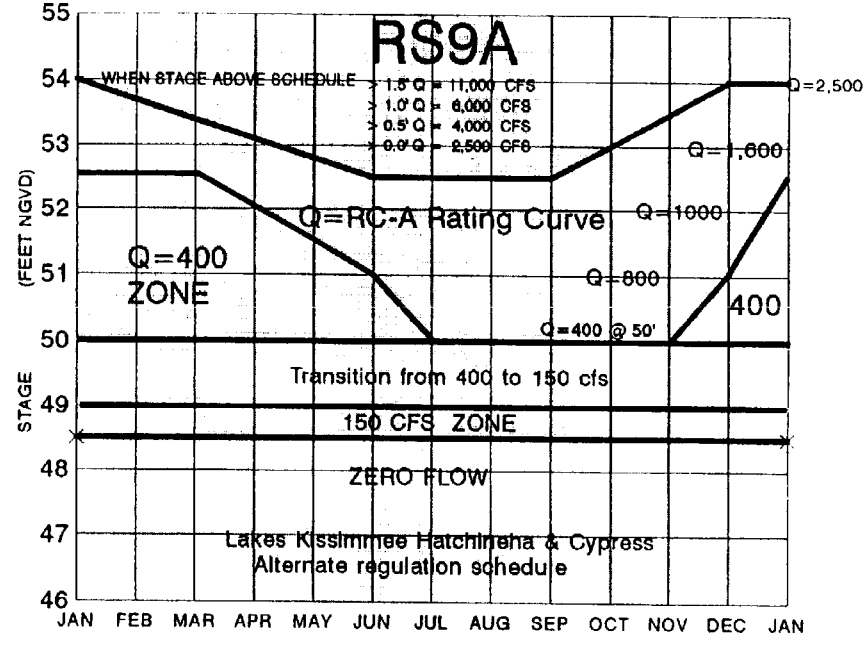
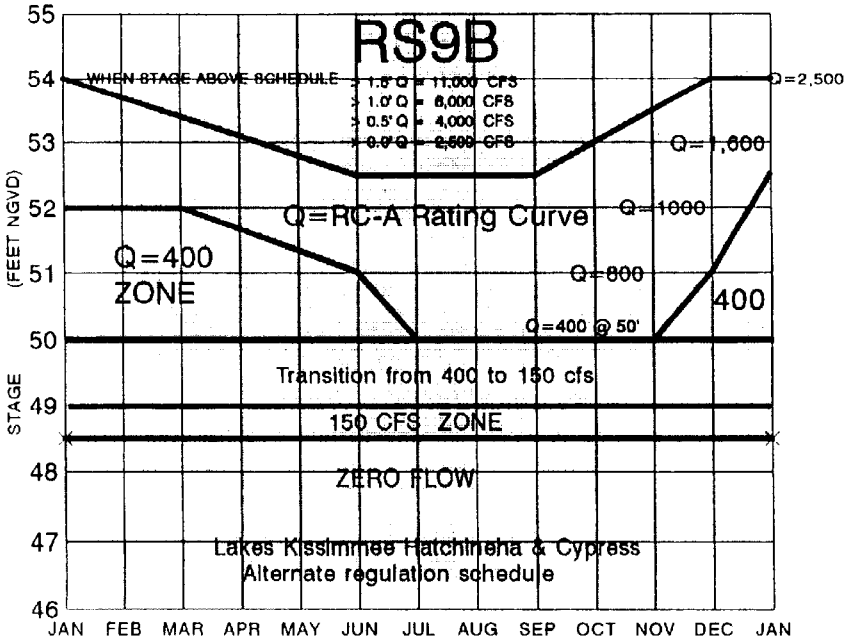
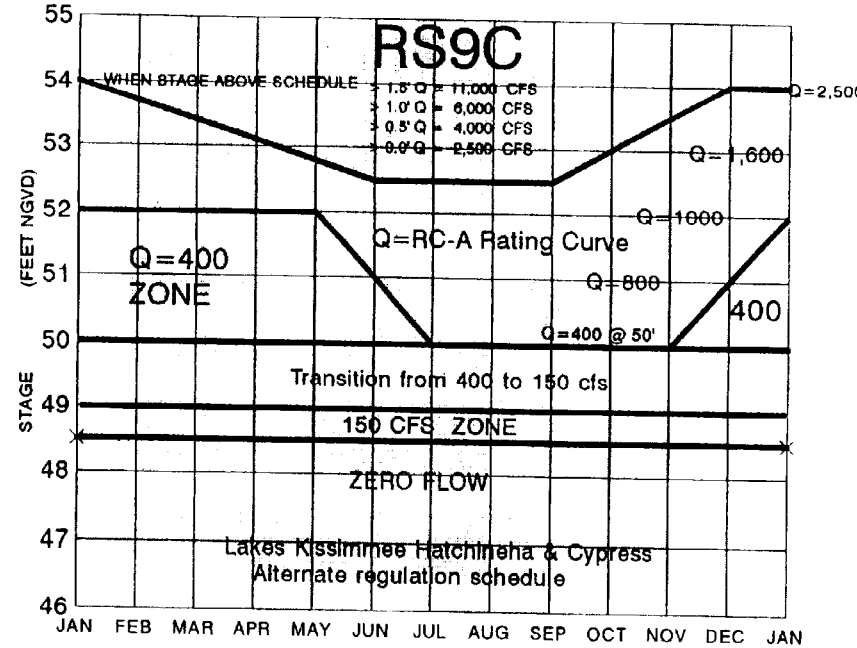

RS9A
WHEN STAGE ABOVE SCHEDULE
> 1.5' Q = 11,000 CFS
> 1.0' Q = 6,000 CFS
> 0.5' Q = 4,000 CFS
> 0.0' Q = 2,500 CFS
Q=2,500
Q=1,600
Q=1000
Q=800
Q=400 @ 50'
Q=RC-A Rating Curve
Q=400
ZONE
400
Transition from 400 to 150 cfs
150 CFS ZONE
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
STAGE (FEET NGVD)
55
54
53
52
51
50
49
48
47
46
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN

FIGURE B3


RS9B
WHEN STAGE ABOVE SCHEDULE
> 1.5' Q = 11,000 CFS
> 1.0' Q = 6,000 CFS
> 0.5' Q = 4,000 CFS
> 0.0' Q = 2,500 CFS
Q=2,500
Q=1,600
Q=1000
Q=800
Q=400 @ 50'
Q=RC-A Rating Curve
Q=400
ZONE
400
Transition from 400 to 150 cfs
150 CFS ZONE
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
STAGE
(FEET NGVD)
55
54
53
52
51
50
49
48
47
46
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN


RS9C
WHEN STAGE ABOVE SCHEDULE
> 1.5' Q = 11,000 CFS
> 1.0' Q = 6,000 CFS
> 0.5' Q = 4,000 CFS
> 0.0' Q = 2,500 CFS
Q=2,500
Q=1,600
Q=1000
Q=800
Q=400 @ 50'
Q=RC-A Rating Curve
Q=400
ZONE
400
Transition from 400 to 150 cfs
150 CFS ZONE
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
STAGE
(FEET NGVD)
55
54
53
52
51
50
49
48
47
46
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN

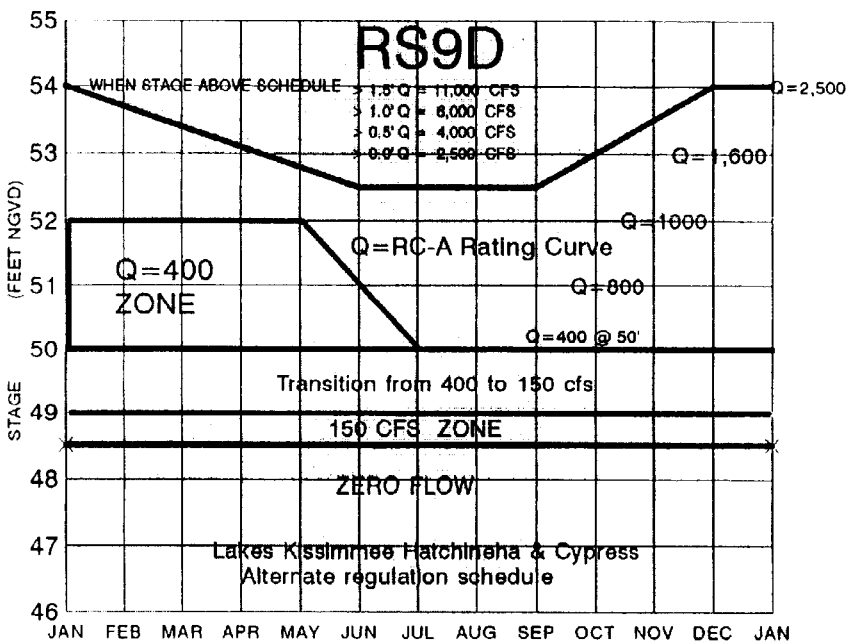
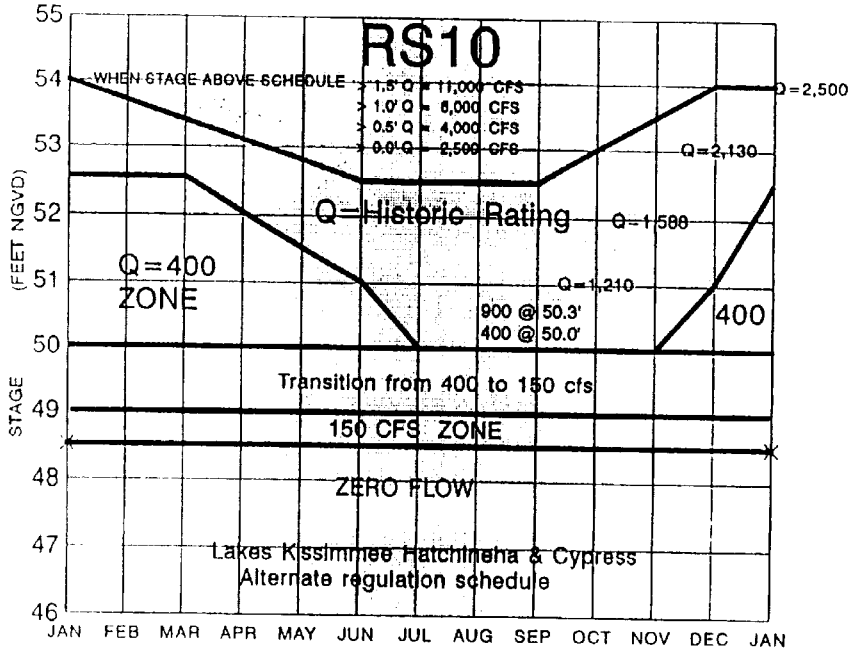
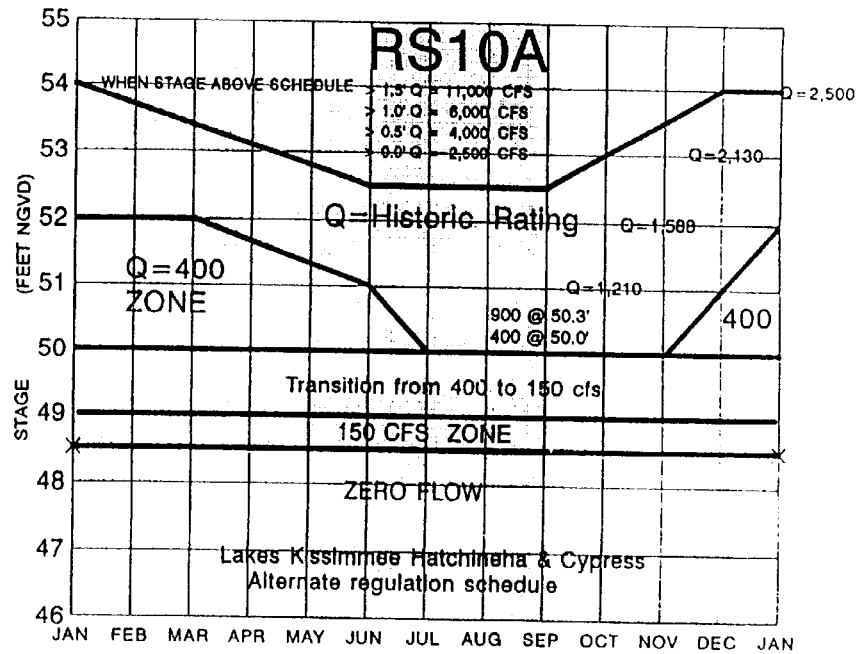
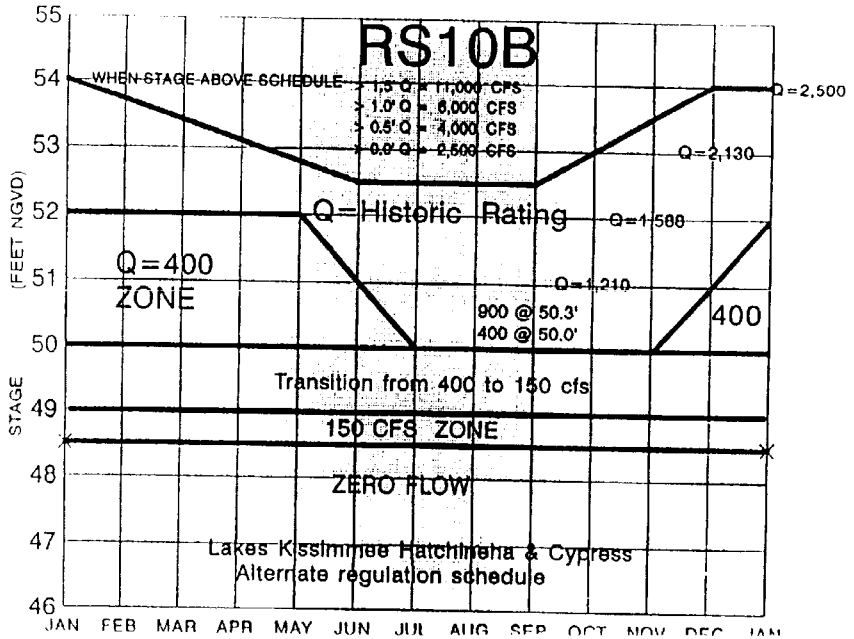

RS9D
WHEN STAGE ABOVE SCHEDULE
> 1.5' Q = 11,000 CFS
> 1.0' Q = 6,000 CFS
> 0.5' Q = 4,000 CFS
> 0.0' Q = 2,500 CFS
Q=2,500
Q=1,600
Q=1000
Q=800
Q=400 @ 50'
Q=RC-A Rating Curve
Q=400
ZONE
Transition from 400 to 150 cfs
150 CFS ZONE
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
STAGE
(FEET NGVD)
55
54
53
52
51
50
49
48
47
46
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN

FIGURE B4


RS10
WHEN STAGE ABOVE SCHEDULE
> 1.5' Q = 11,000 CFS
> 1.0' Q = 6,000 CFS
> 0.5' Q = 4,000 CFS
> 0.0' Q = 2,500 CFS
Q=2,500
Q=2,130
Q=Historic Rating
Q=1,580
Q=1,210
Q=400
ZONE
900 @ 50.3'
400 @ 50.0'
400
Transition from 400 to 150 cfs
150 CFS ZONE
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
STAGE (FEET NGVD)
55
54
53
52
51
50
49
48
47
46
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN


RS10A
WHEN STAGE ABOVE SCHEDULE
> 1.5' Q = 11,000 CFS
> 1.0' Q = 6,000 CFS
> 0.5' Q = 4,000 CFS
> 0.0' Q = 2,500 CFS
Q=2,500
Q=2,130
Q=Historic Rating
Q=1,580
Q=1,210
Q=400
ZONE
900 @ 50.3'
400 @ 50.0'
400
Transition from 400 to 150 cfs
150 CFS ZONE
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
STAGE (FEET NGVD)
55
54
53
52
51
50
49
48
47
46
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN


RS10B
WHEN STAGE ABOVE SCHEDULE
> 1.5' Q = 11,000 CFS
> 1.0' Q = 6,000 CFS
> 0.5' Q = 4,000 CFS
> 0.0' Q = 2,500 CFS
Q=2,500
Q=2,130
Q=Historic Rating
Q=1,580
Q=1,210
Q=400
ZONE
900 @ 50.3'
400 @ 50.0'
400
Transition from 400 to 150 cfs
150 CFS ZONE
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
STAGE (FEET NGVD)
55
54
53
52
51
50
49
48
47
46
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN

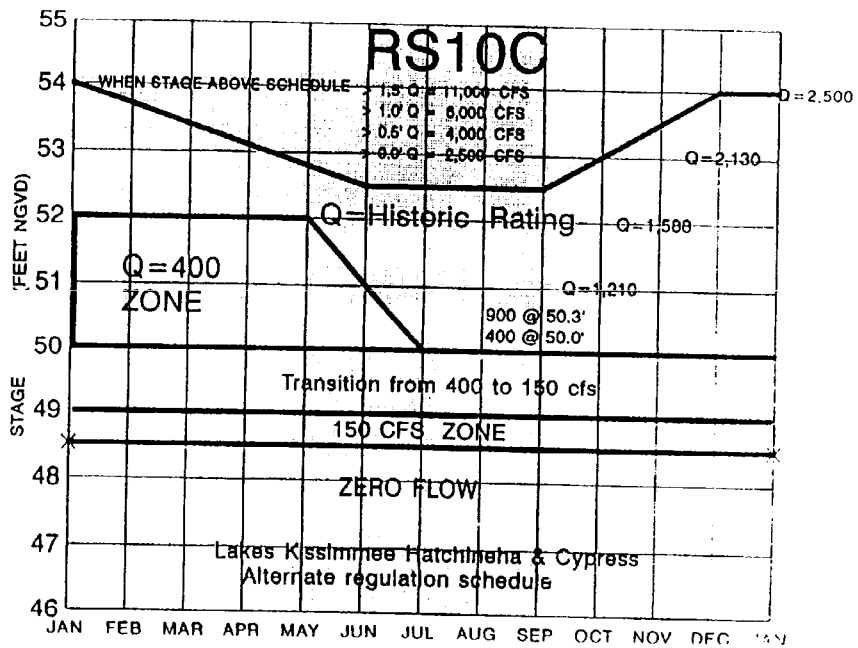
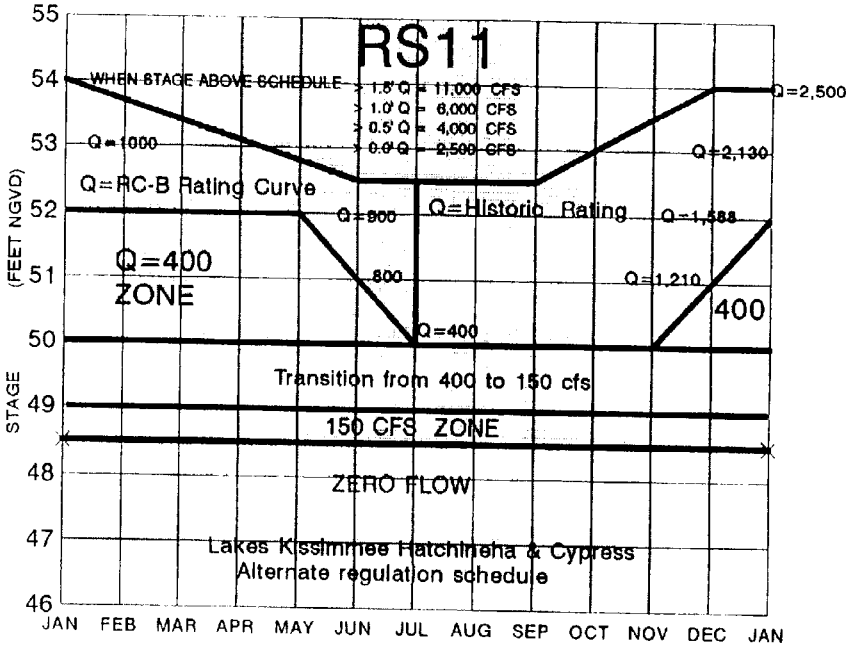

RS10C
WHEN STAGE ABOVE SCHEDULE
> 1.5' Q = 11,000 CFS
> 1.0' Q = 6,000 CFS
> 0.5' Q = 4,000 CFS
> 0.0' Q = 2,500 CFS
Q=2,500
Q=2,130
Q=Historic Rating
Q=1,580
Q=1,210
Q=400
ZONE
900 @ 50.3'
400 @ 50.0'
Transition from 400 to 150 cfs
150 CFS ZONE
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
STAGE (FEET NGVD)
55
54
53
52
51
50
49
48
47
46
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN

FIGURE B5


RS11
WHEN STAGE ABOVE SCHEDULE
> 1.5' Q = 11,000 CFS
> 1.0' Q = 6,000 CFS
> 0.5' Q = 4,000 CFS
> 0.0' Q = 2,500 CFS
Q=1000
Q=RC-B Rating Curve
Q=900
Q=Historic Rating
Q=1,588
Q=2,130
Q=2,500
Q=400
ZONE
800
Q=1,210
400
Q=400
Transition from 400 to 150 cfs
150 CFS ZONE
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
STAGE
(FEET NGVD)
55
54
53
52
51
50
49
48
47
46
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN

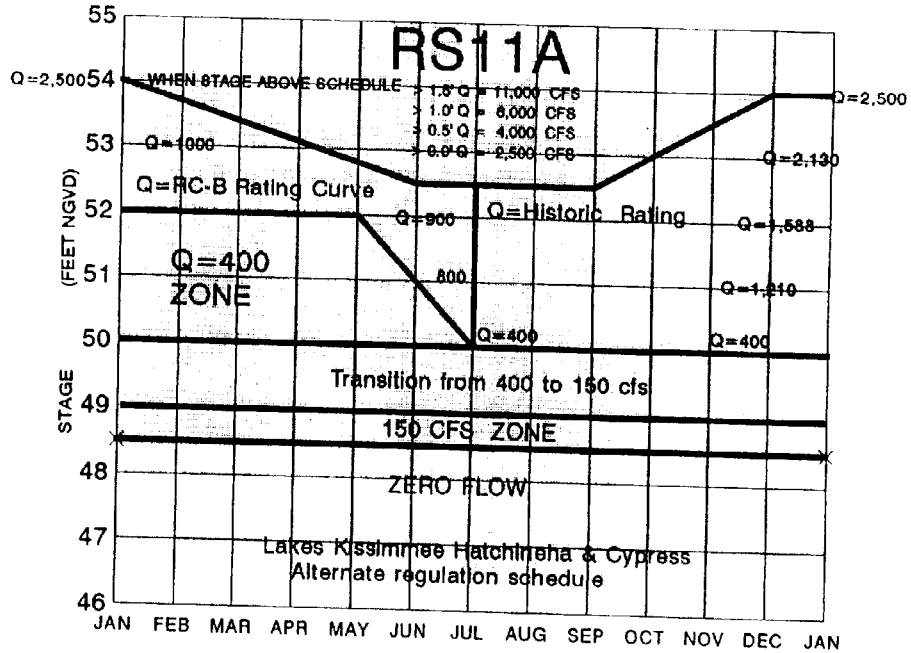

RS11A
Q=2,500
WHEN STAGE ABOVE SCHEDULE
> 1.5' Q = 11,000 CFS
> 1.0' Q = 6,000 CFS
> 0.5' Q = 4,000 CFS
> 0.0' Q = 2,500 CFS
Q=2,500
Q=1000
Q=RC-B Rating Curve
Q=900
Q=Historic Rating
Q=1,588
Q=2,130
Q=400
ZONE
800
Q=1,210
Q=400
Transition from 400 to 150 cfs
150 CFS ZONE
ZERO FLOW
Lakes Kissimmee Hatchineha & Cypress
Alternate regulation schedule
STAGE
(FEET NGVD)
55
54
53
52
51
50
49
48
47
46
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN

FIGURE B6

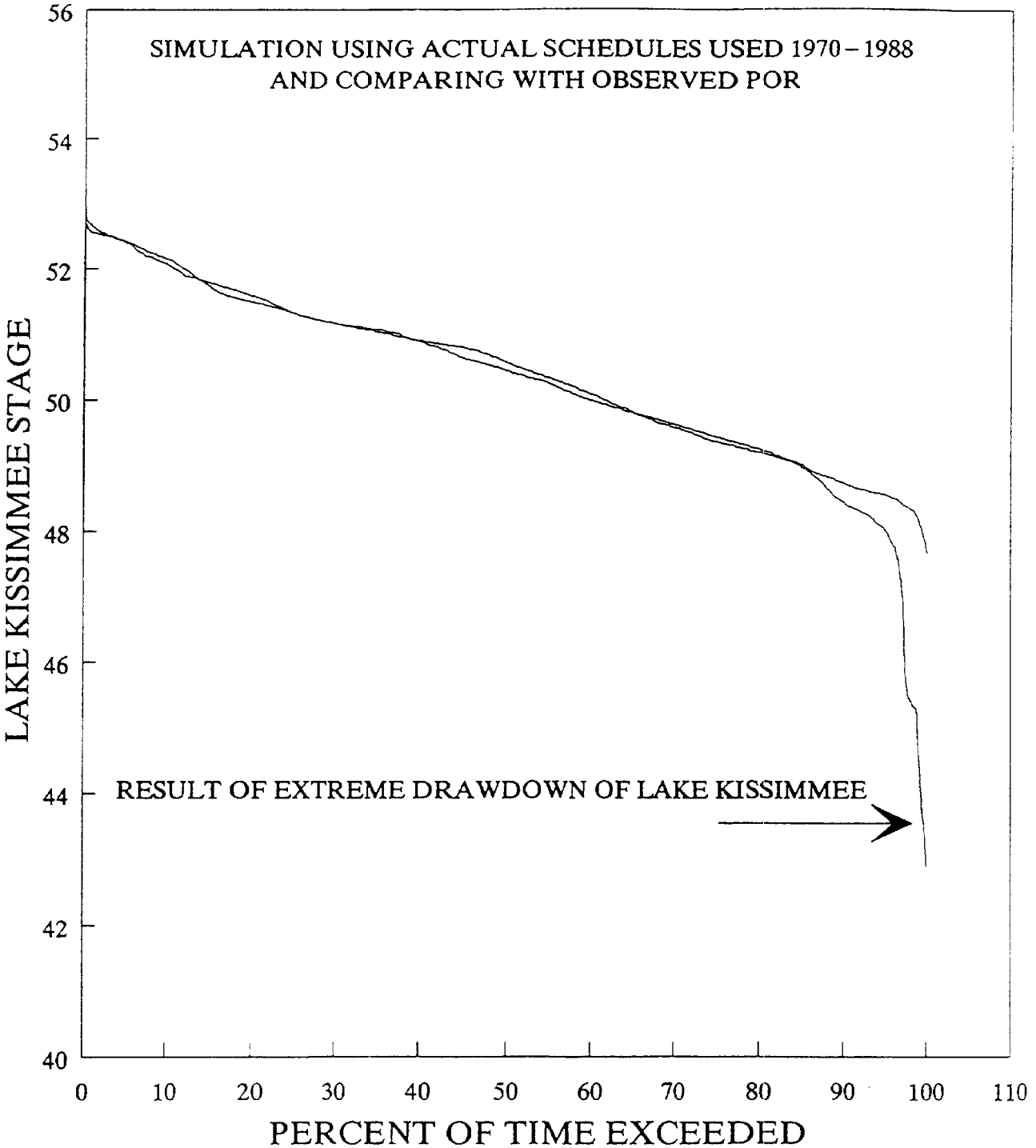

SIMULATION USING ACTUAL SCHEDULES USED 1970 – 1988
AND COMPARING WITH OBSERVED POR
RESULT OF EXTREME DRAWDOWN OF LAKE KISSIMMEE
LAKE KISSIMMEE STAGE
PERCENT OF TIME EXCEEDED
56
54
52
50
48
46
44
42
40
0
10
20
30
40
50
60
70
80
90
100
110

FIGURE C1

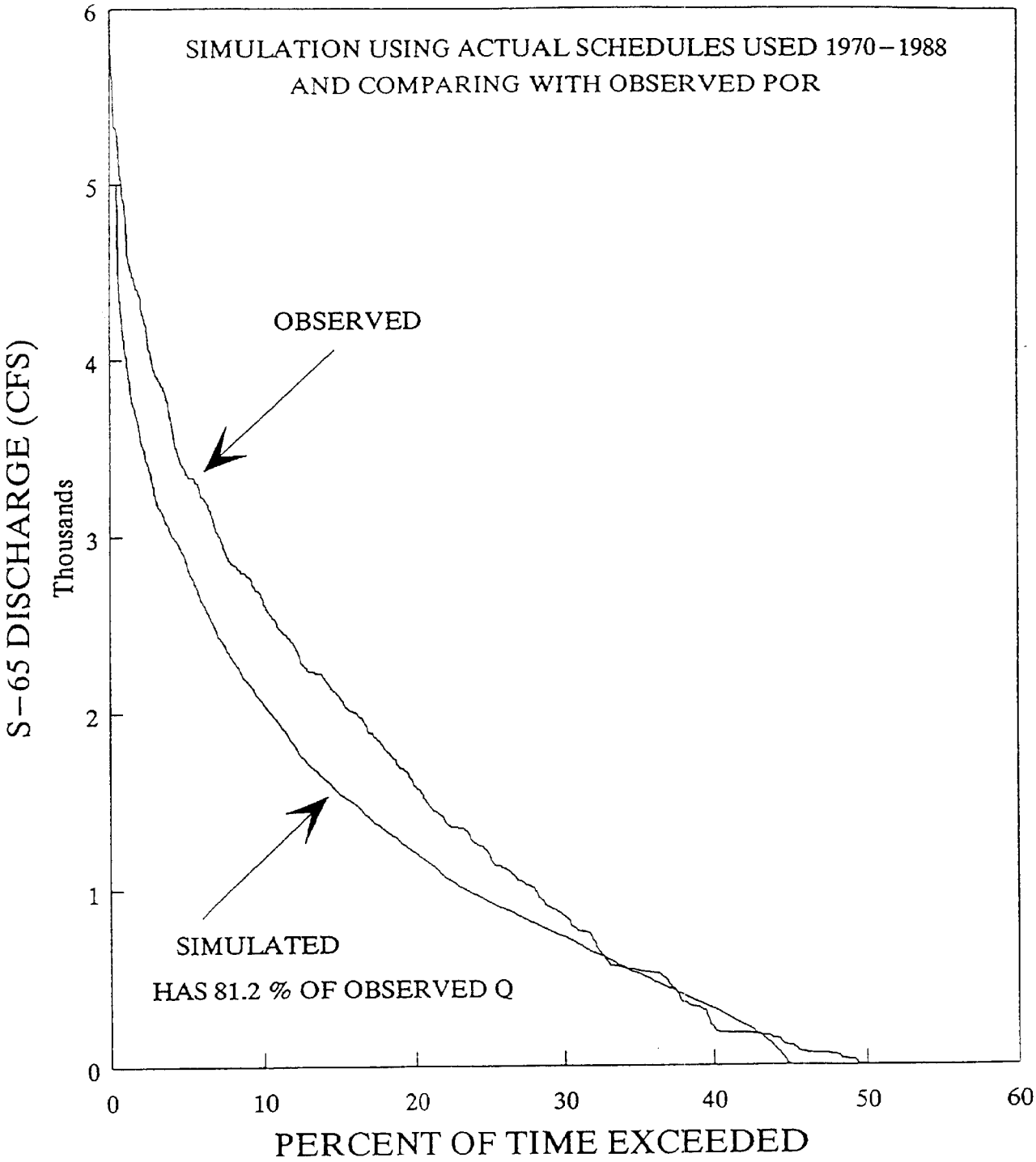

SIMULATION USING ACTUAL SCHEDULES USED 1970–1988
AND COMPARING WITH OBSERVED POR
OBSERVED
SIMULATED
HAS 81.2 % OF OBSERVED Q
S–65 DISCHARGE (CFS)
Thousands
PERCENT OF TIME EXCEEDED
0
1
2
3
4
5
6
0
10
20
30
40
50
60

FIGURE C2

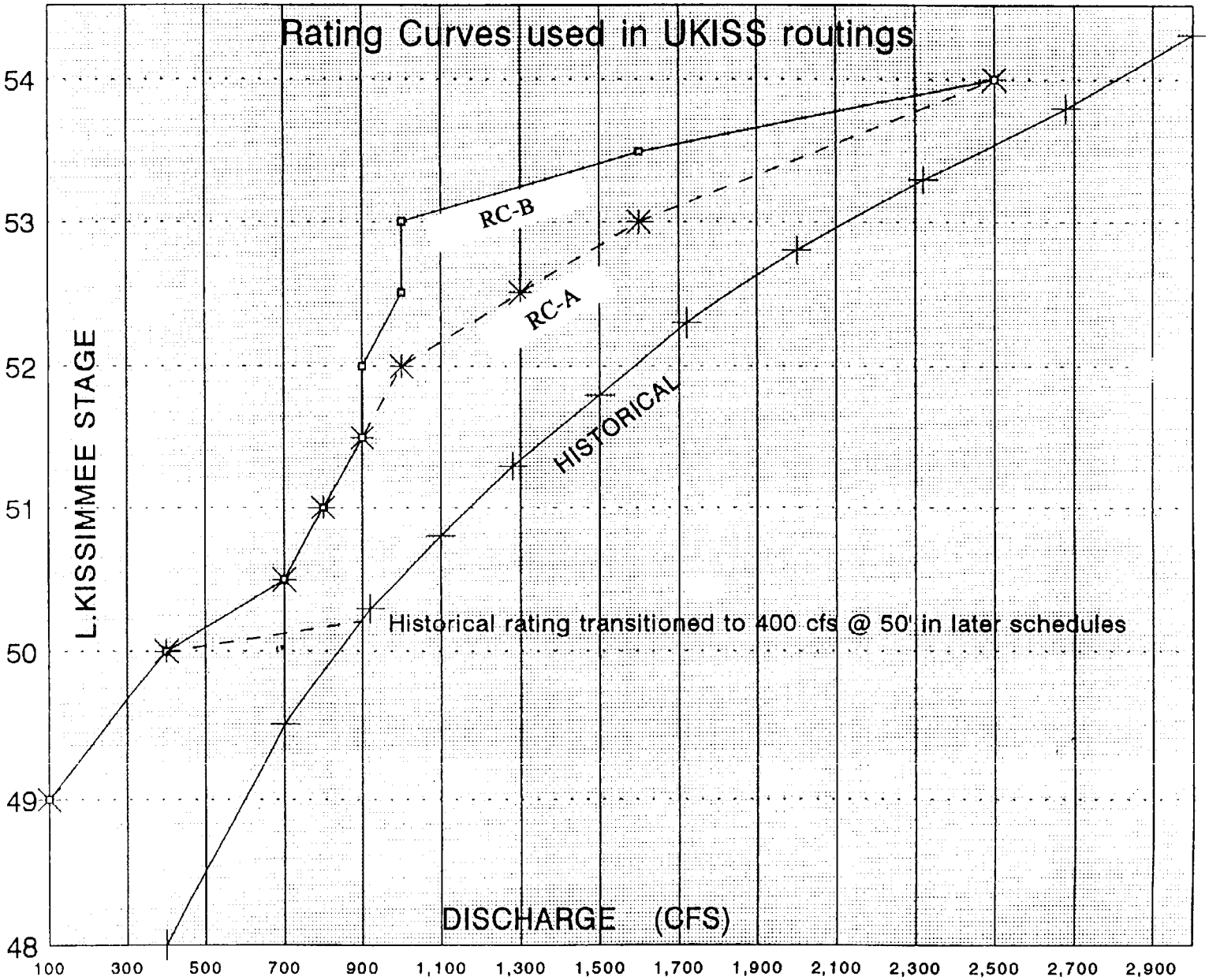

Rating Curves used in UKISS routings
L.KISSIMMEE STAGE
54
53
52
51
50
49
48
RC-B
RC-A
HISTORICAL
Historical rating transitioned to 400 cfs @ 50' in later schedules
DISCHARGE (CFS)
100
300
500
700
900
1,100
1,300
1,500
1,700
1,900
2,100
2,300
2,500
2,700
2,900

FIGURE C3

Comparison of Pre and Post-channelization Stage

Duration Curves for Lake Kissimmee

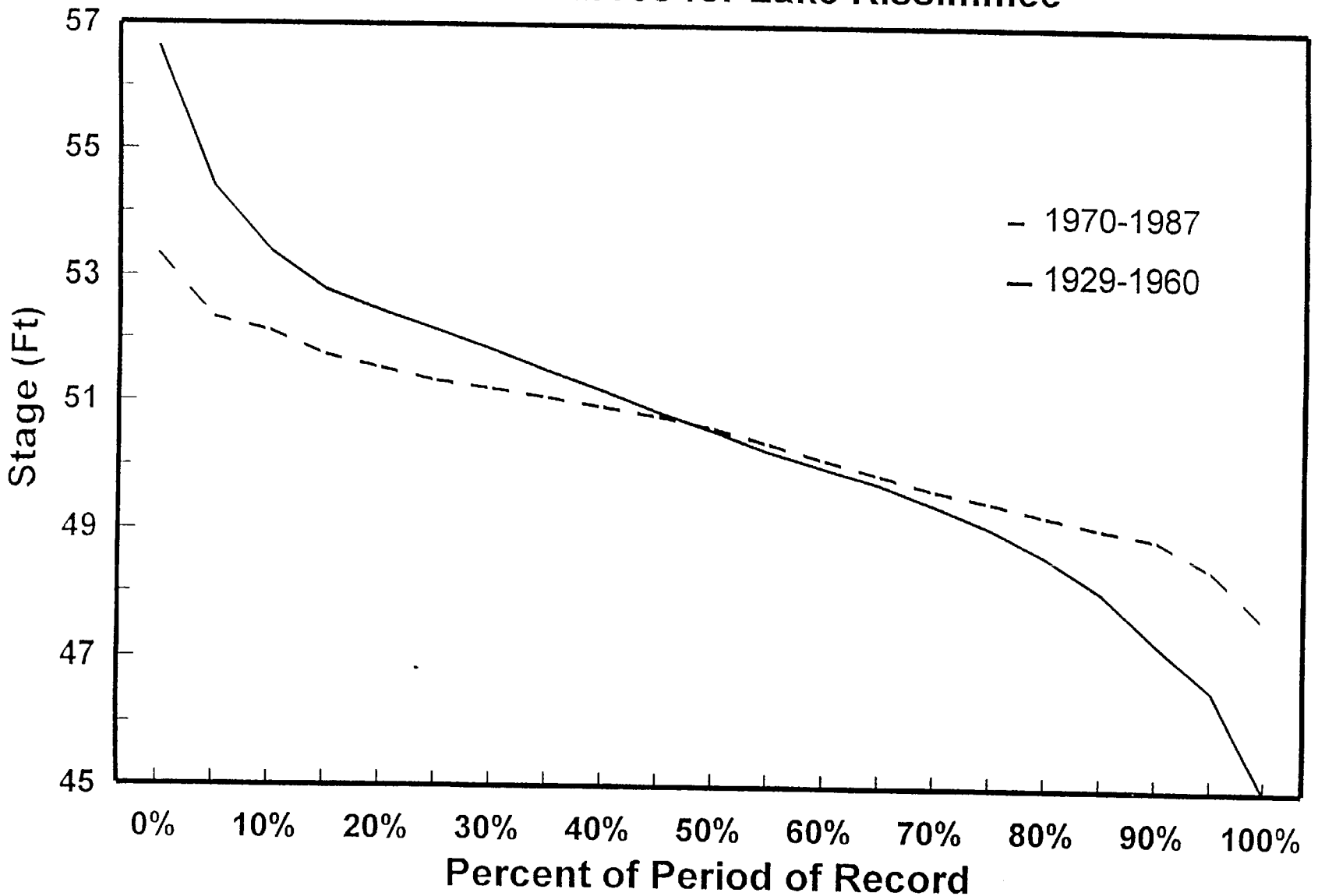


FIGURE C4

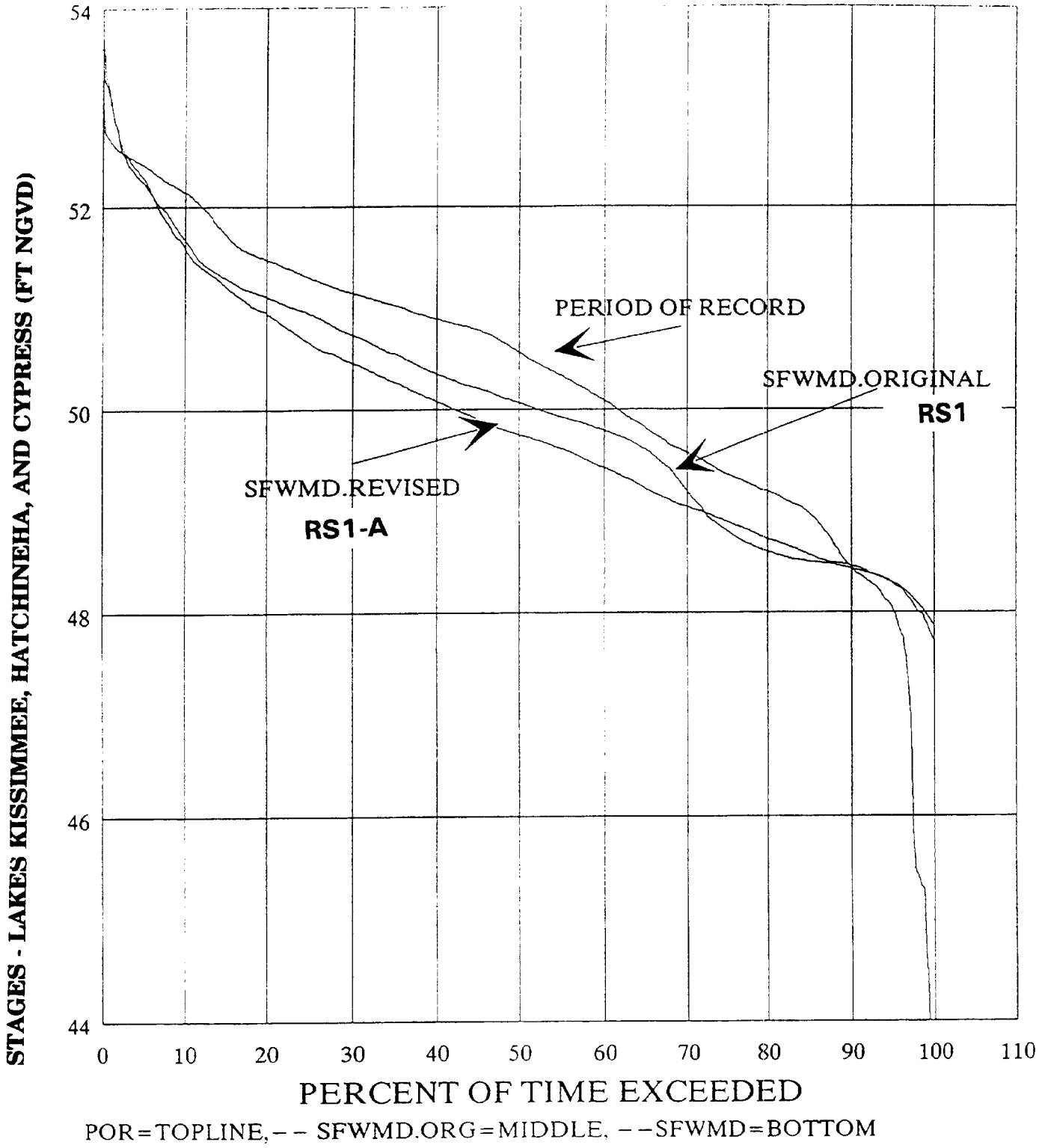
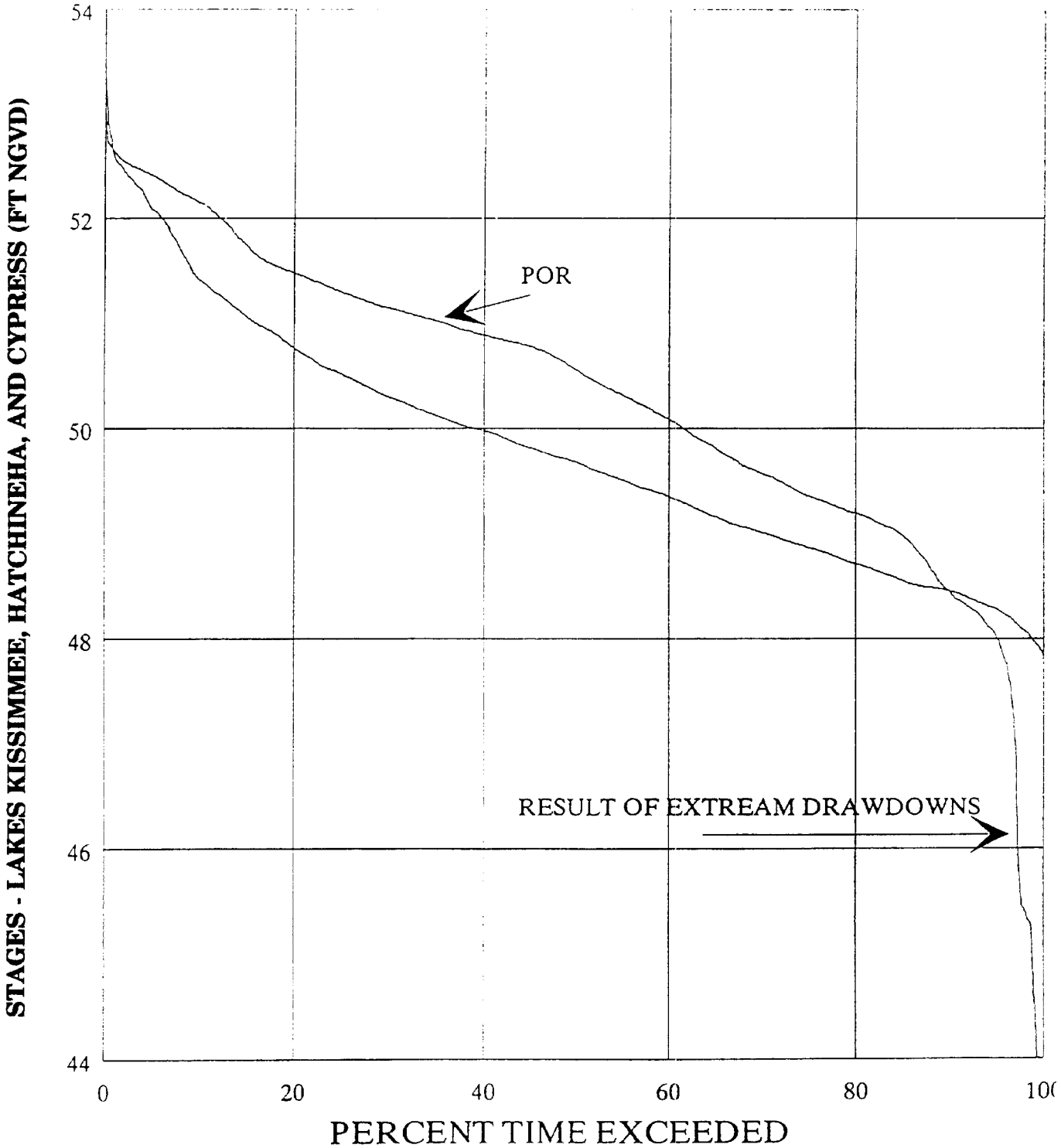
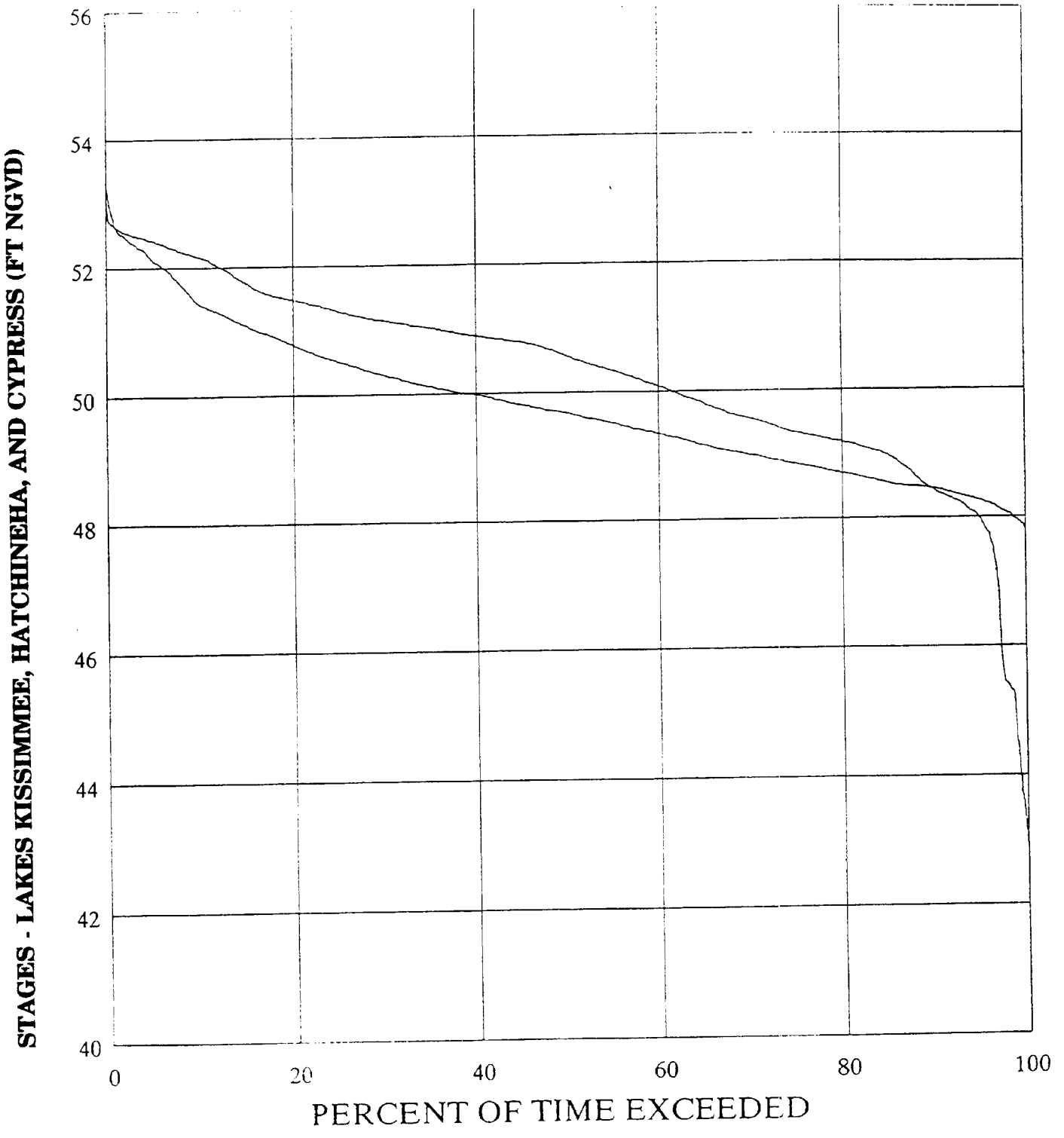

STAGES - LAKES KISSIMMEE, HATCHINEHA, AND CYPRESS (FT NGVD)
54
52
50
48
46
44
0
10
20
30
40
50
60
70
80
90
100
110
PERCENT OF TIME EXCEEDED
PERIOD OF RECORD
SFWMD.ORIGINAL
RS1
SFWMD.REVISED
RS1-A
POR=TOPLINE,-- SFWMD.ORG=MIDDLE, --SFWMD=BOTTOM

FIGURE D1



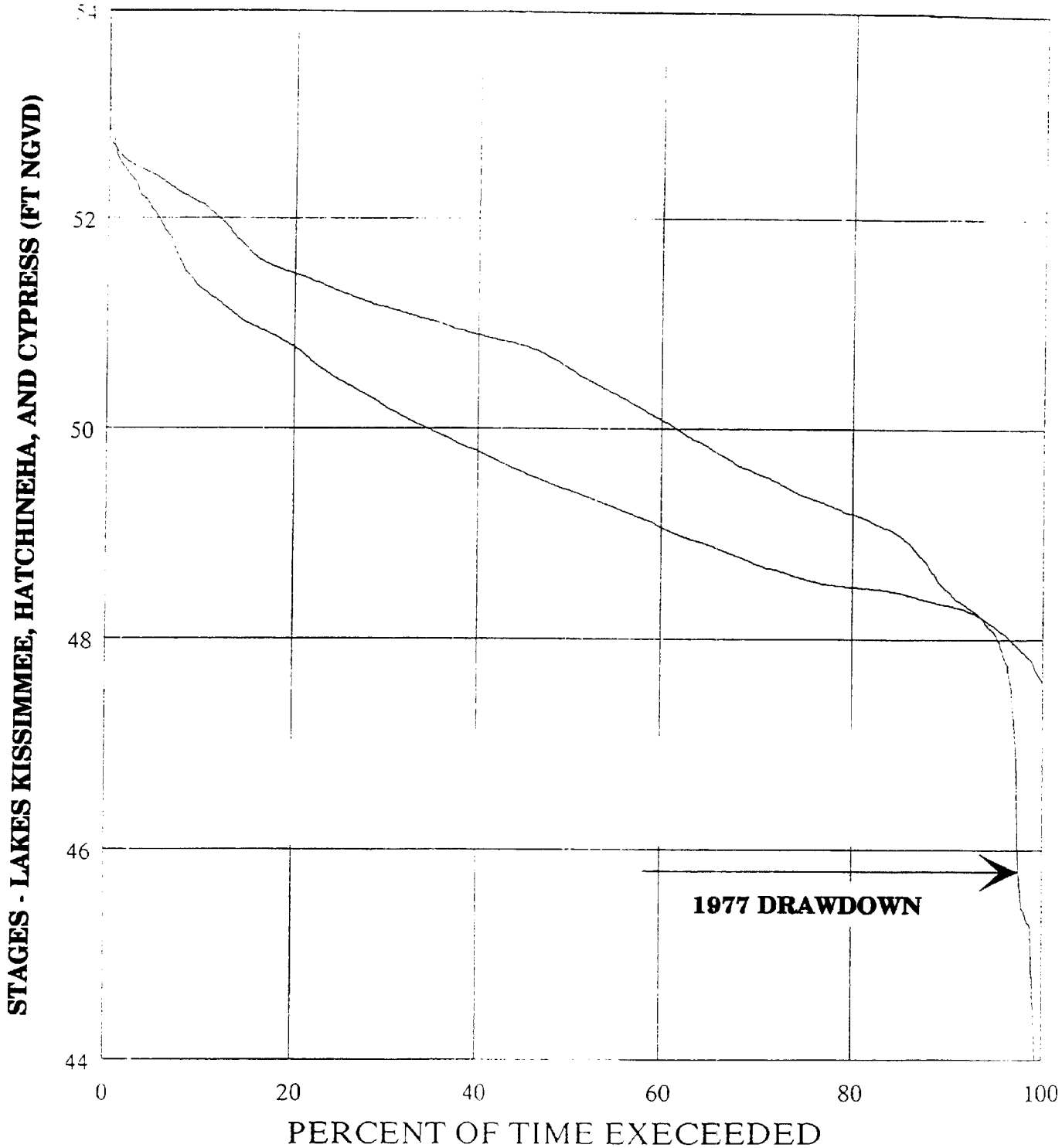
Schedule **RS1-B**

FIGURE D2



Schedule **RS3**

FIGURE D3



Schedule **RS4**

FIGURE D4

Discharge Exceeded 50% of the Time

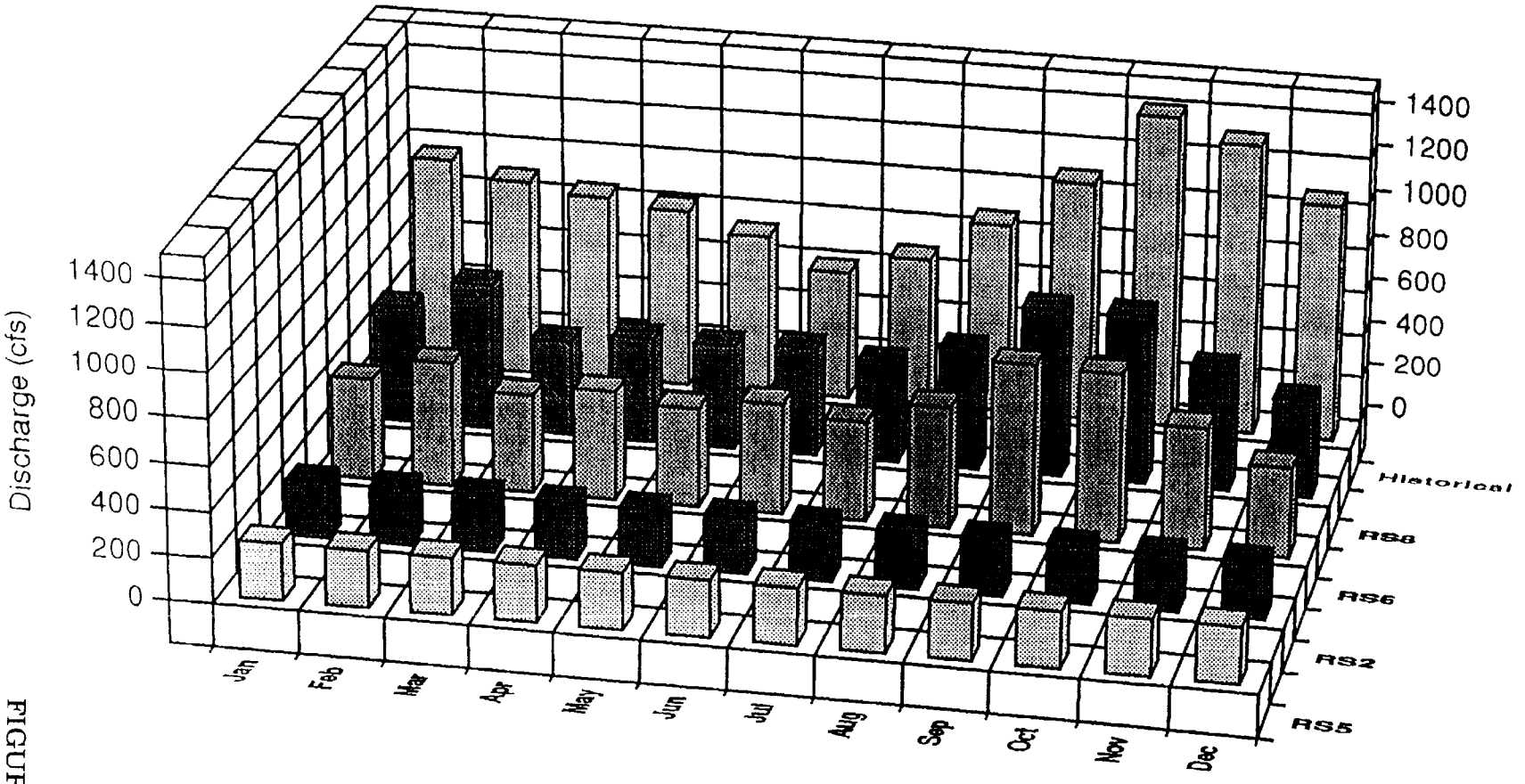


FIGURE D5

Historical Relationship between Lake Kissimmee Discharges and Fort Kissimmee Stages (1940 - 1961)

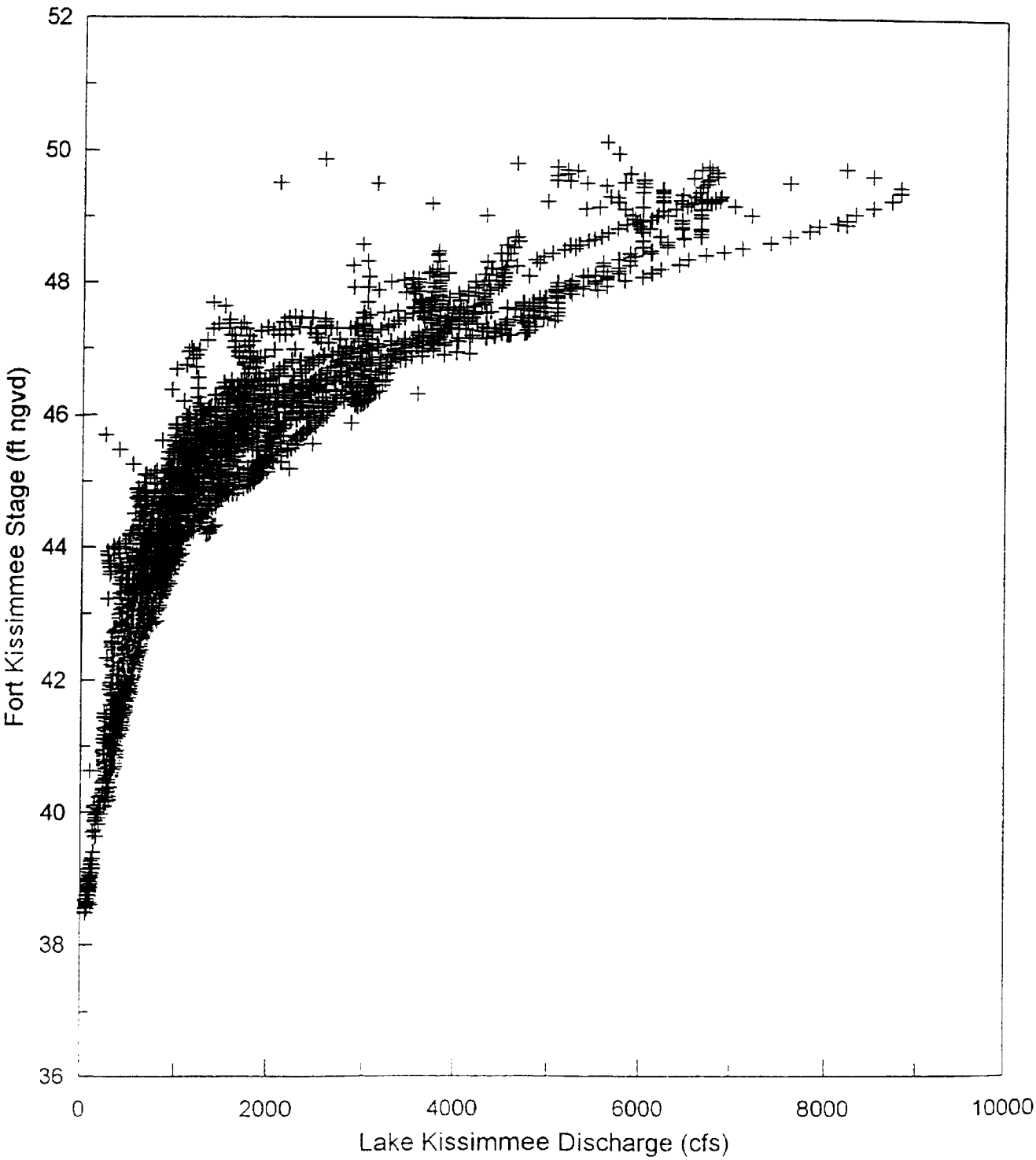
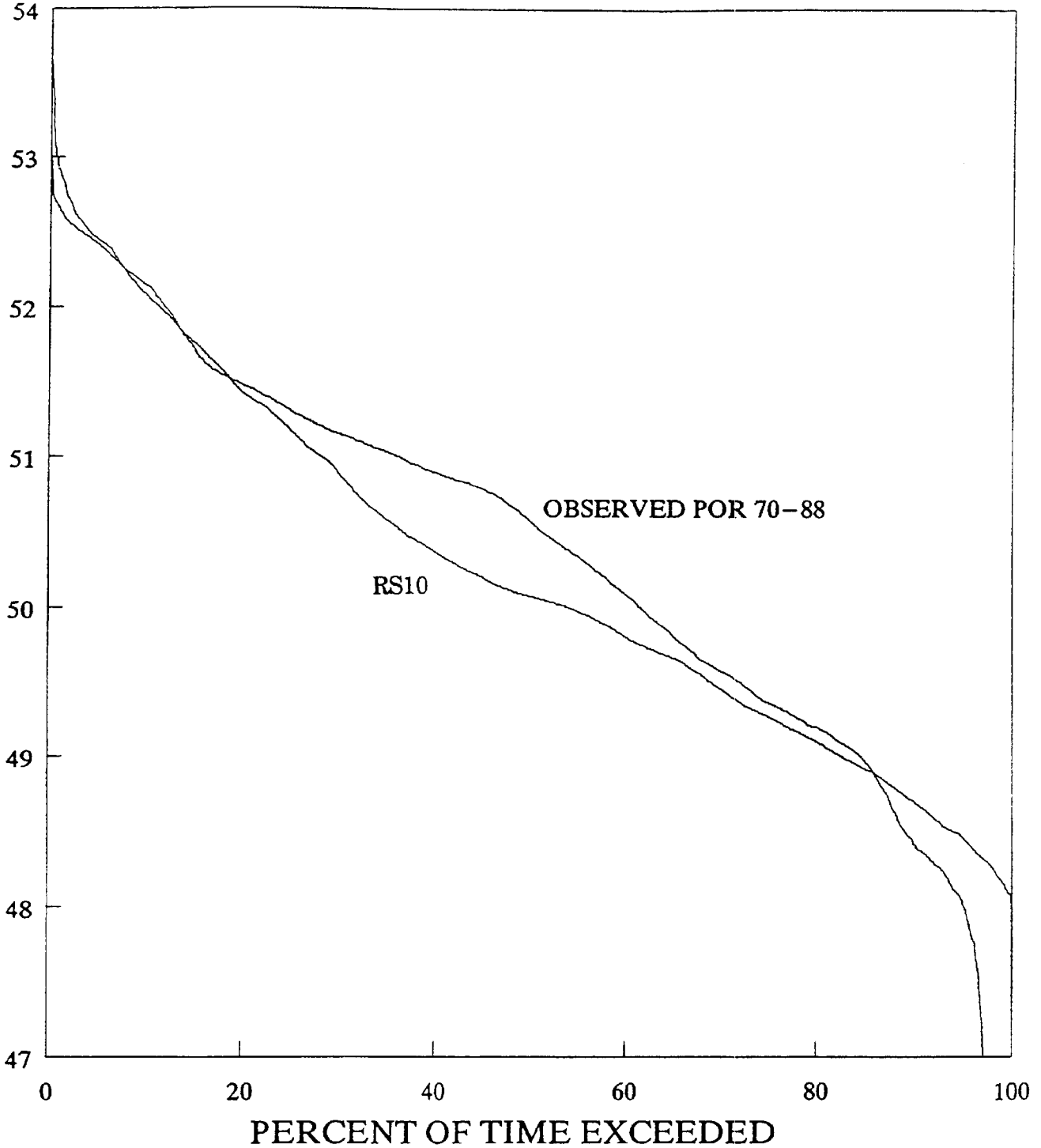
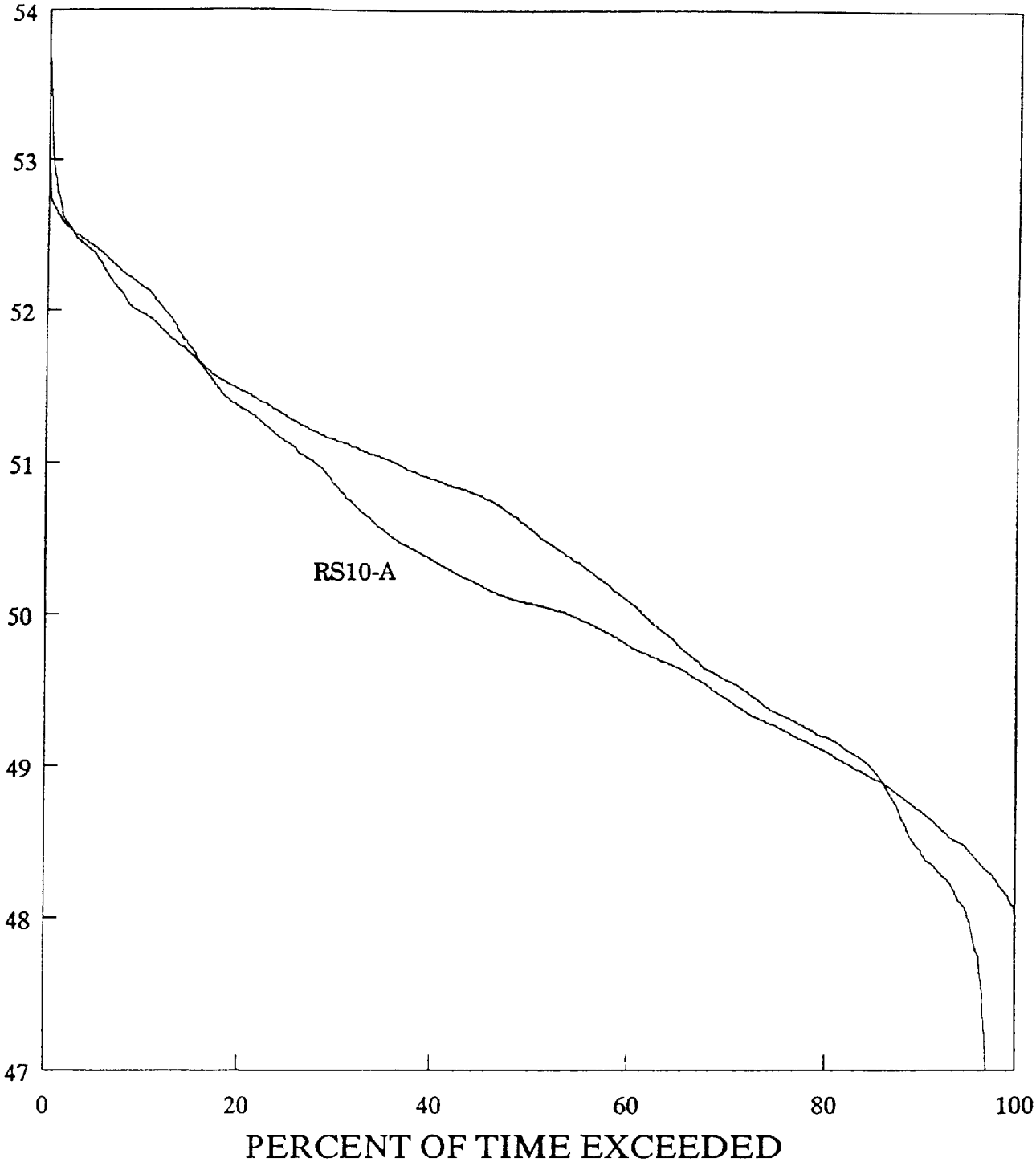


FIGURE D6



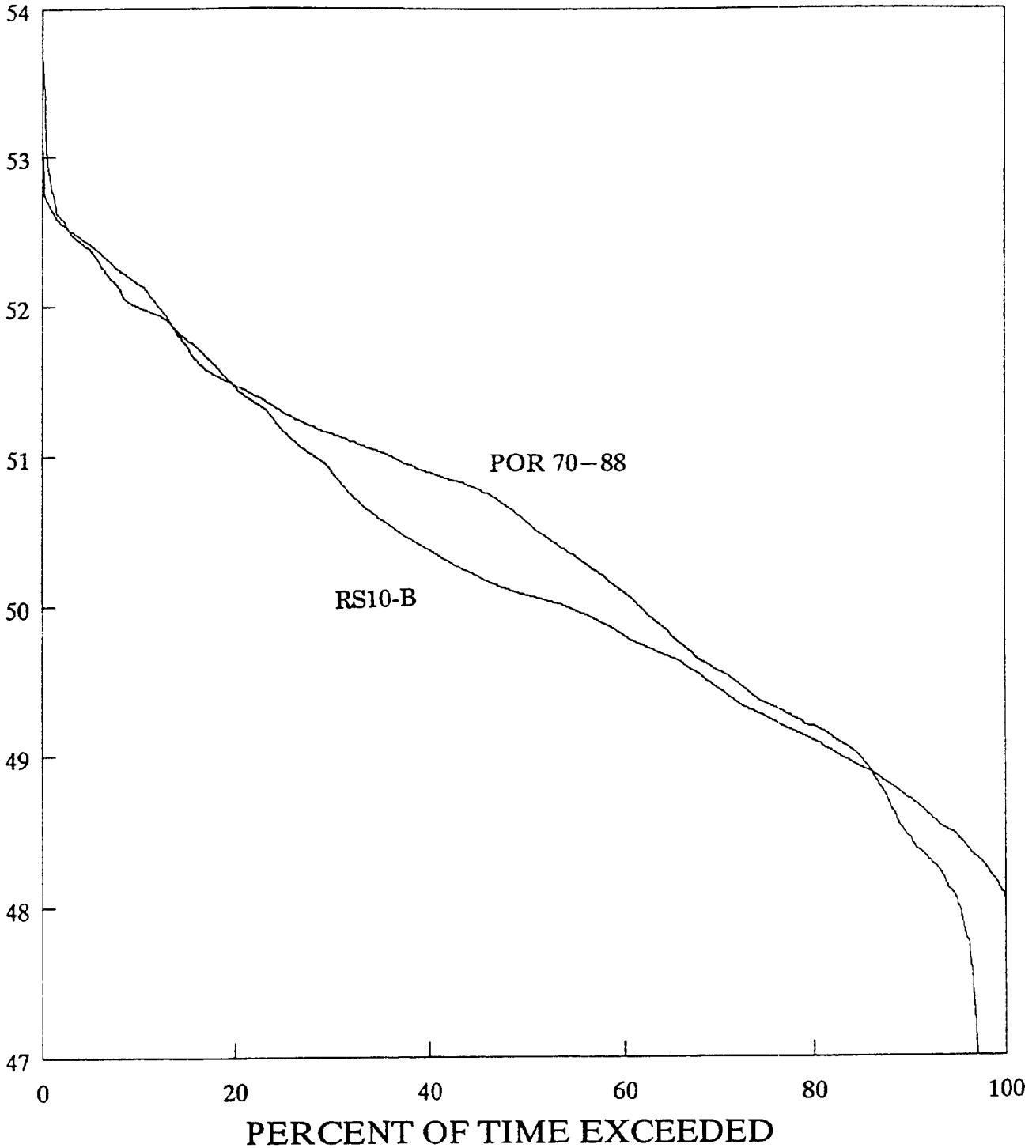
RS10
10 SEP 93

FIGURE D7



RS10-A
10 SEP 93

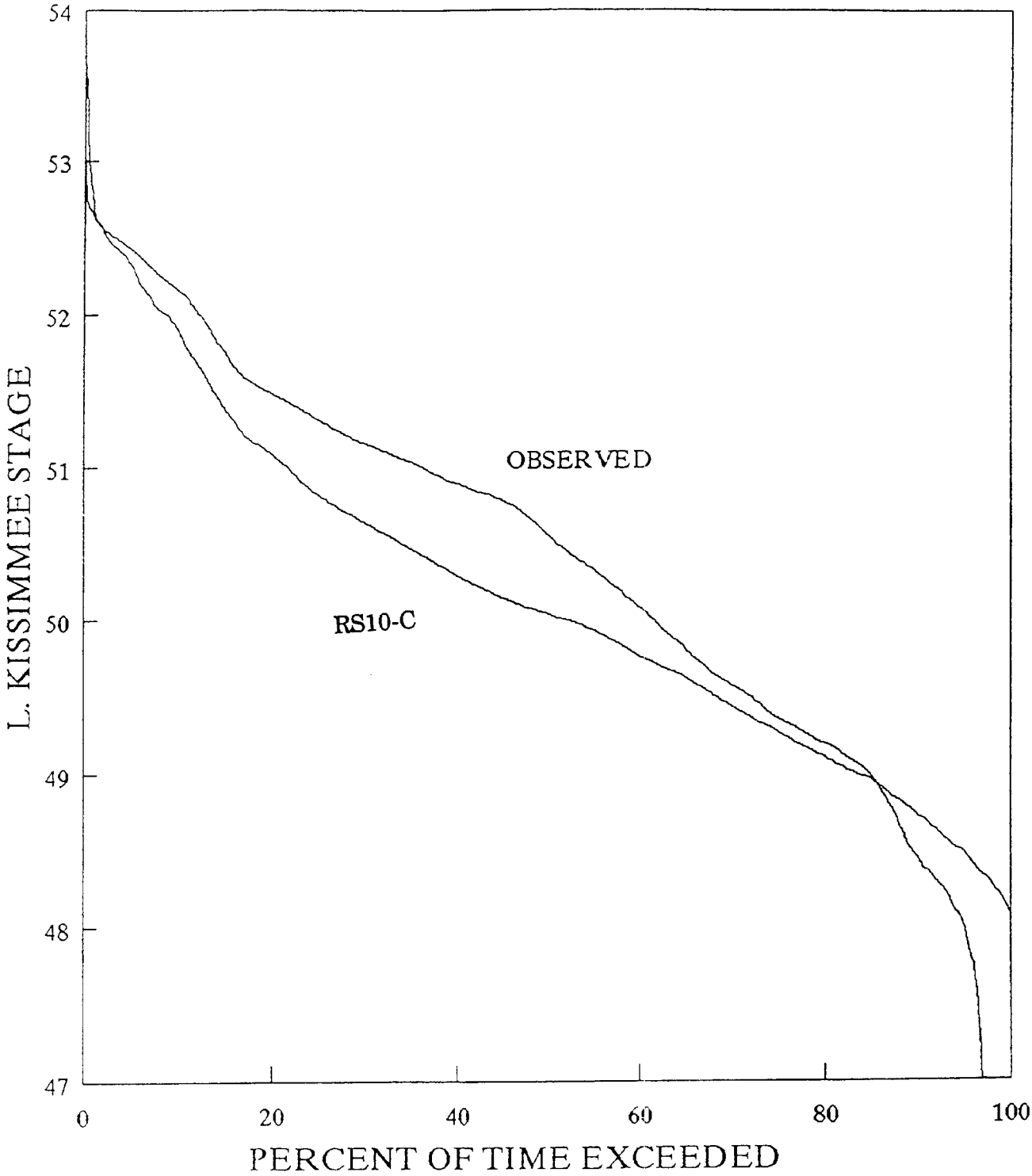
FIGURE D8



RS10-B

1 OCT 93

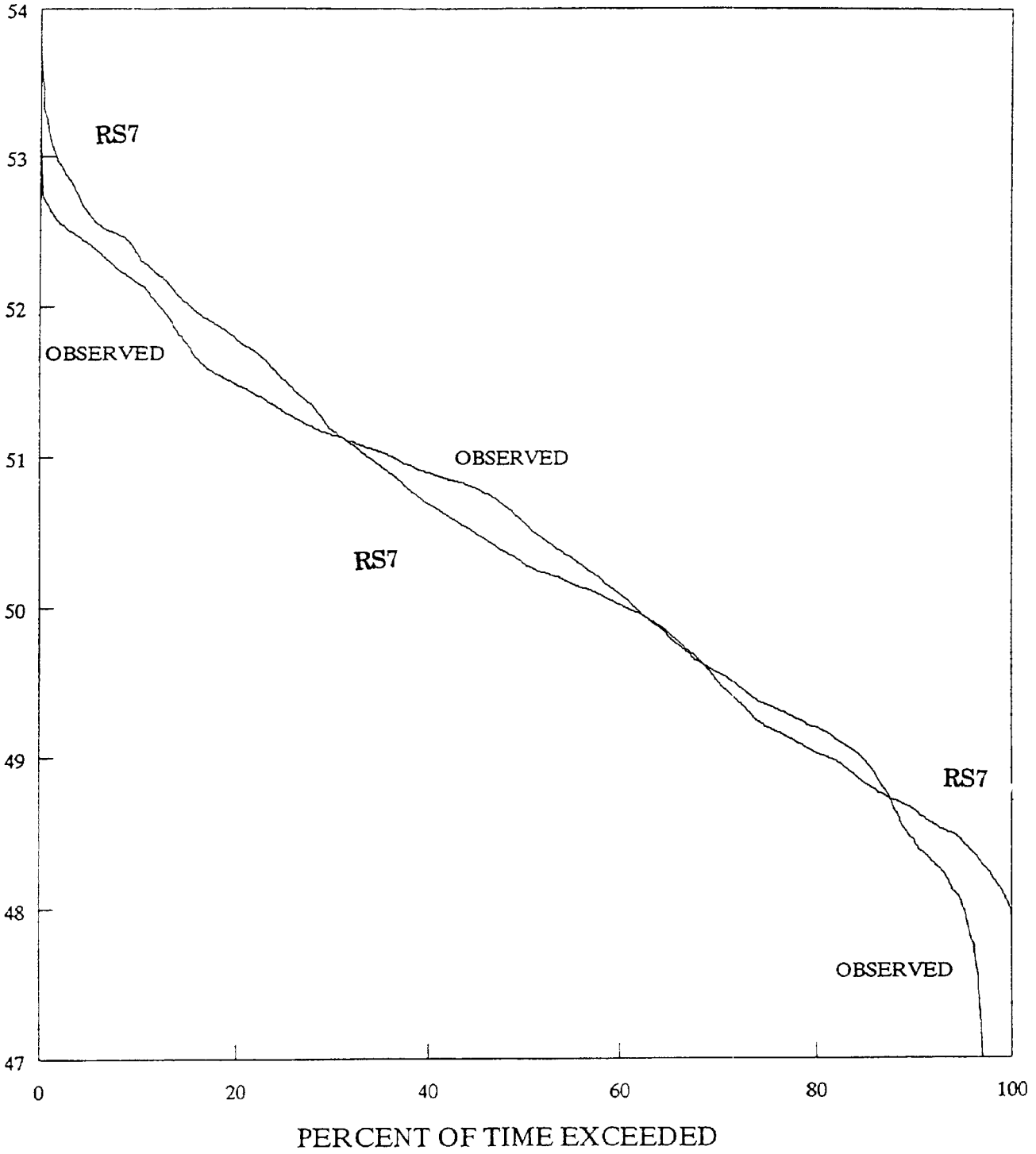
FIGURE D9



RS10-C

15 Nov 93

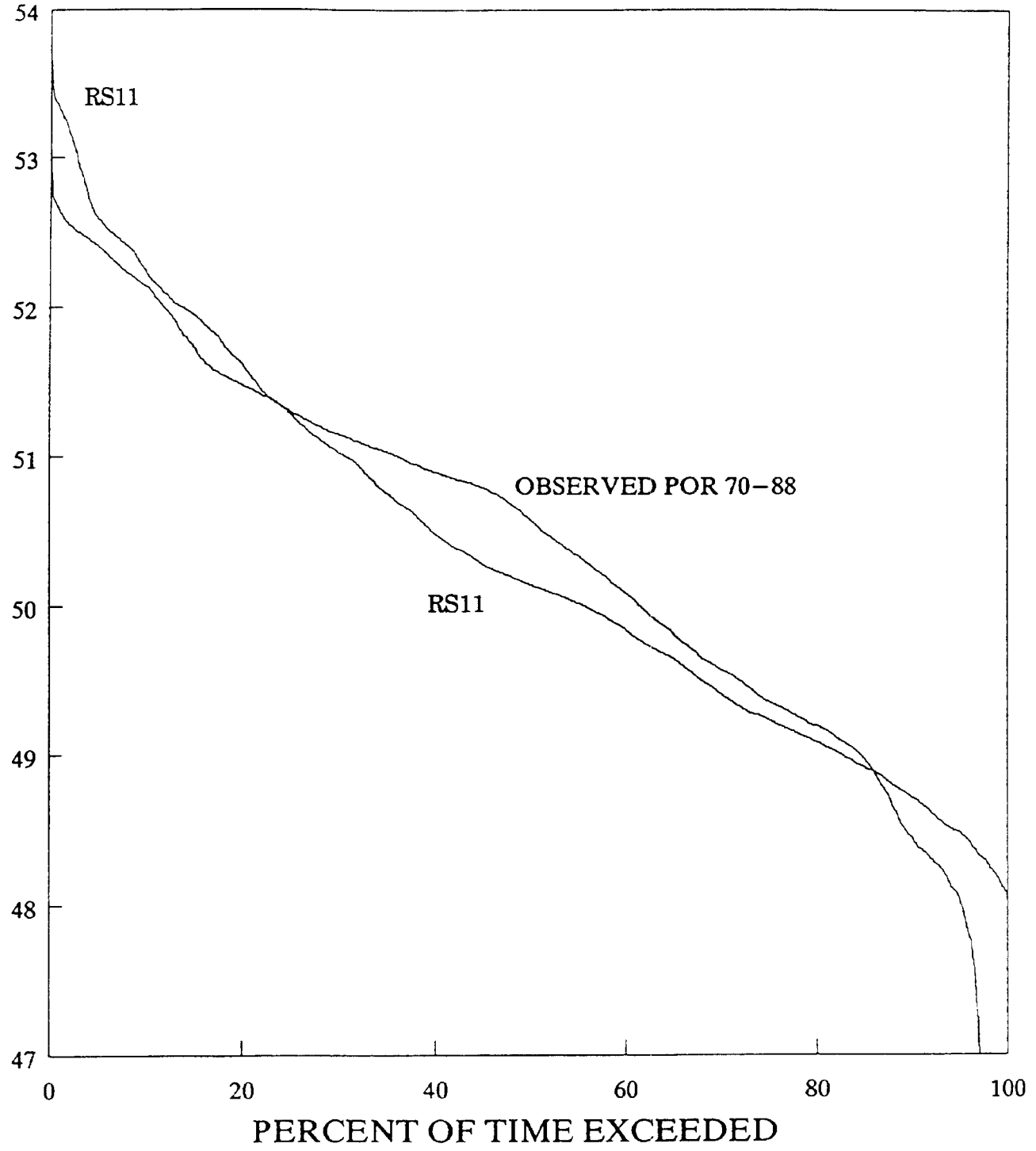
FIGURE D10



RS7

24 August 93

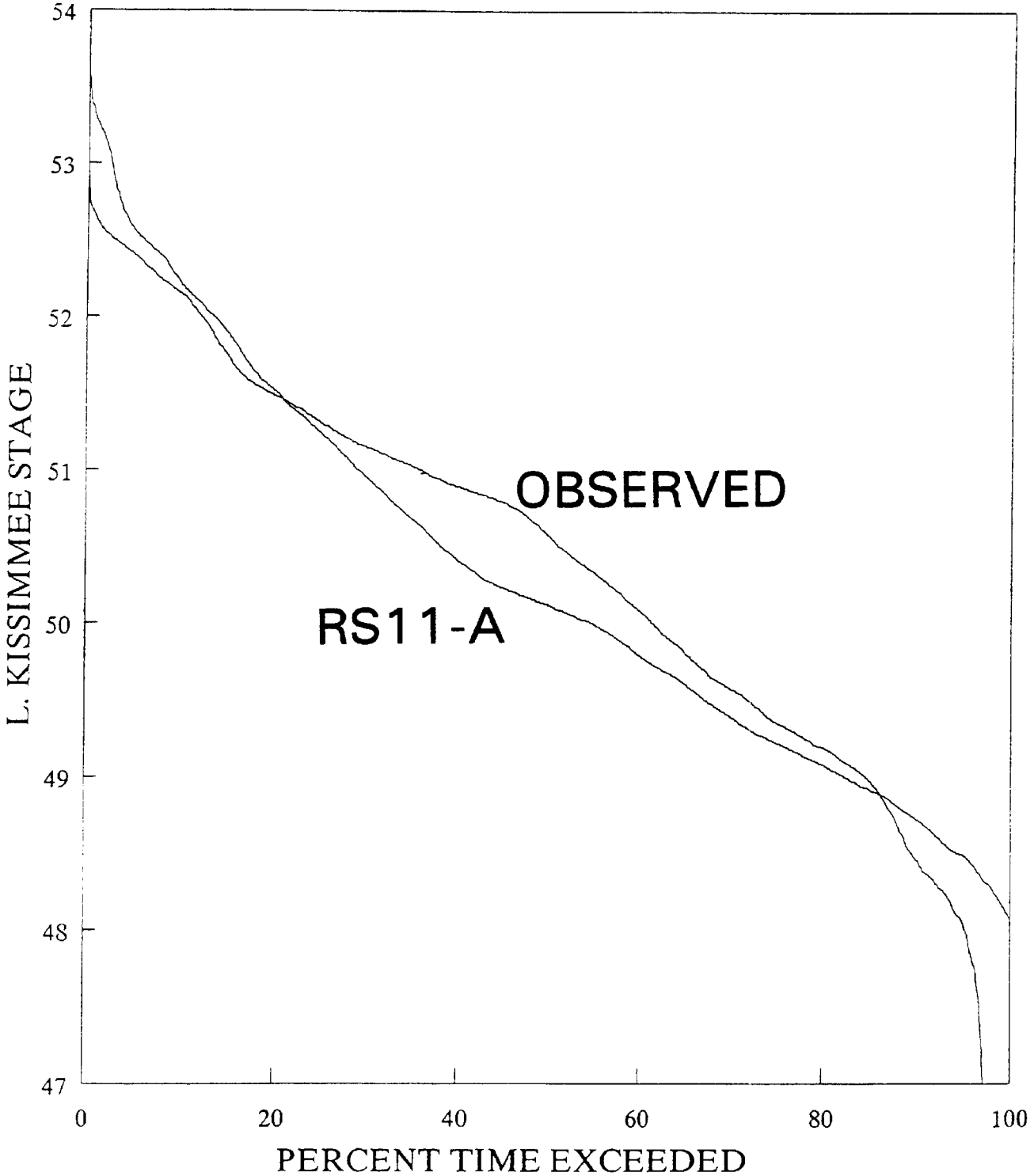
FIGURE D11



RS11

4 Oct 93

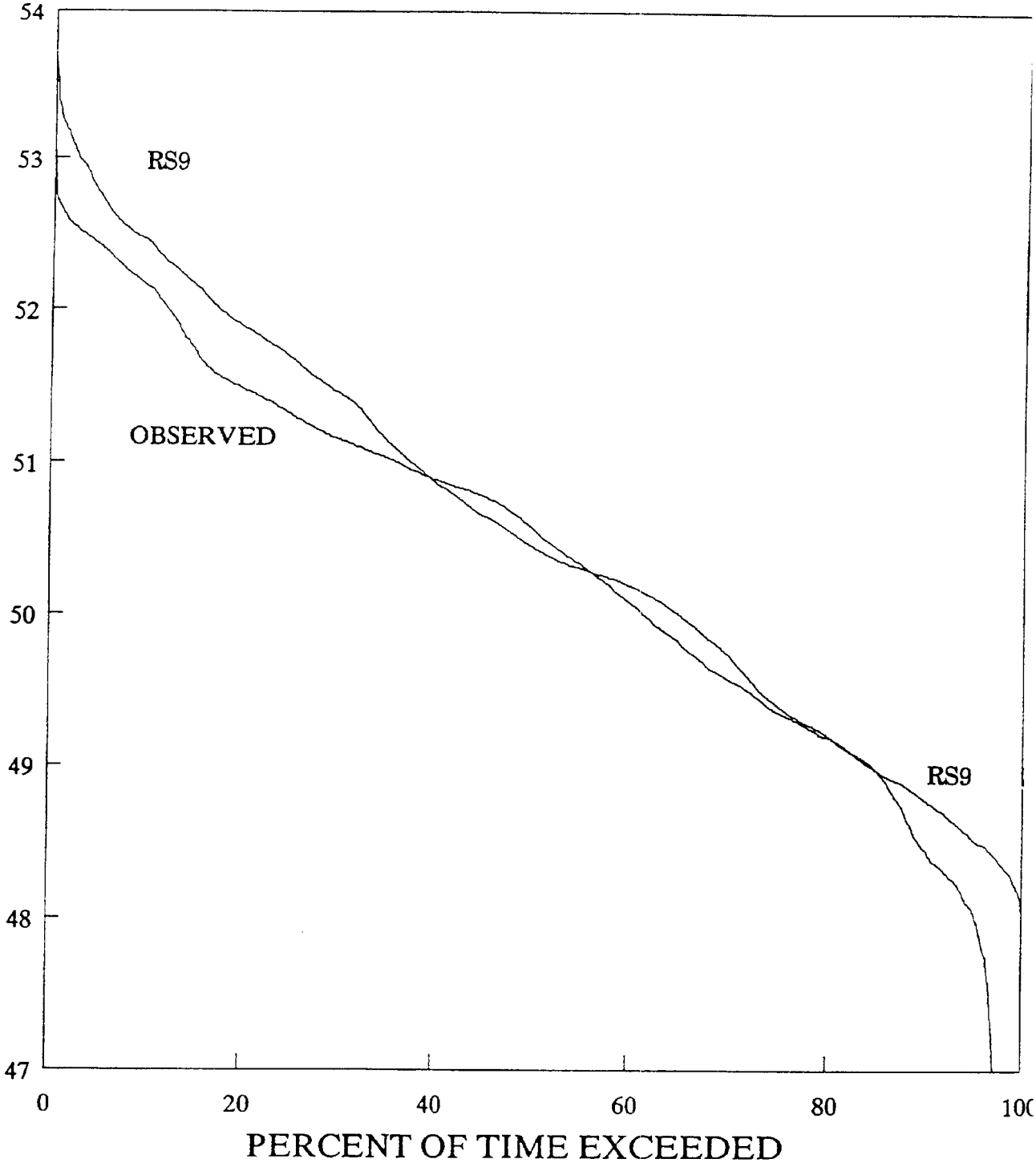
FIGURE D12



RS11-A

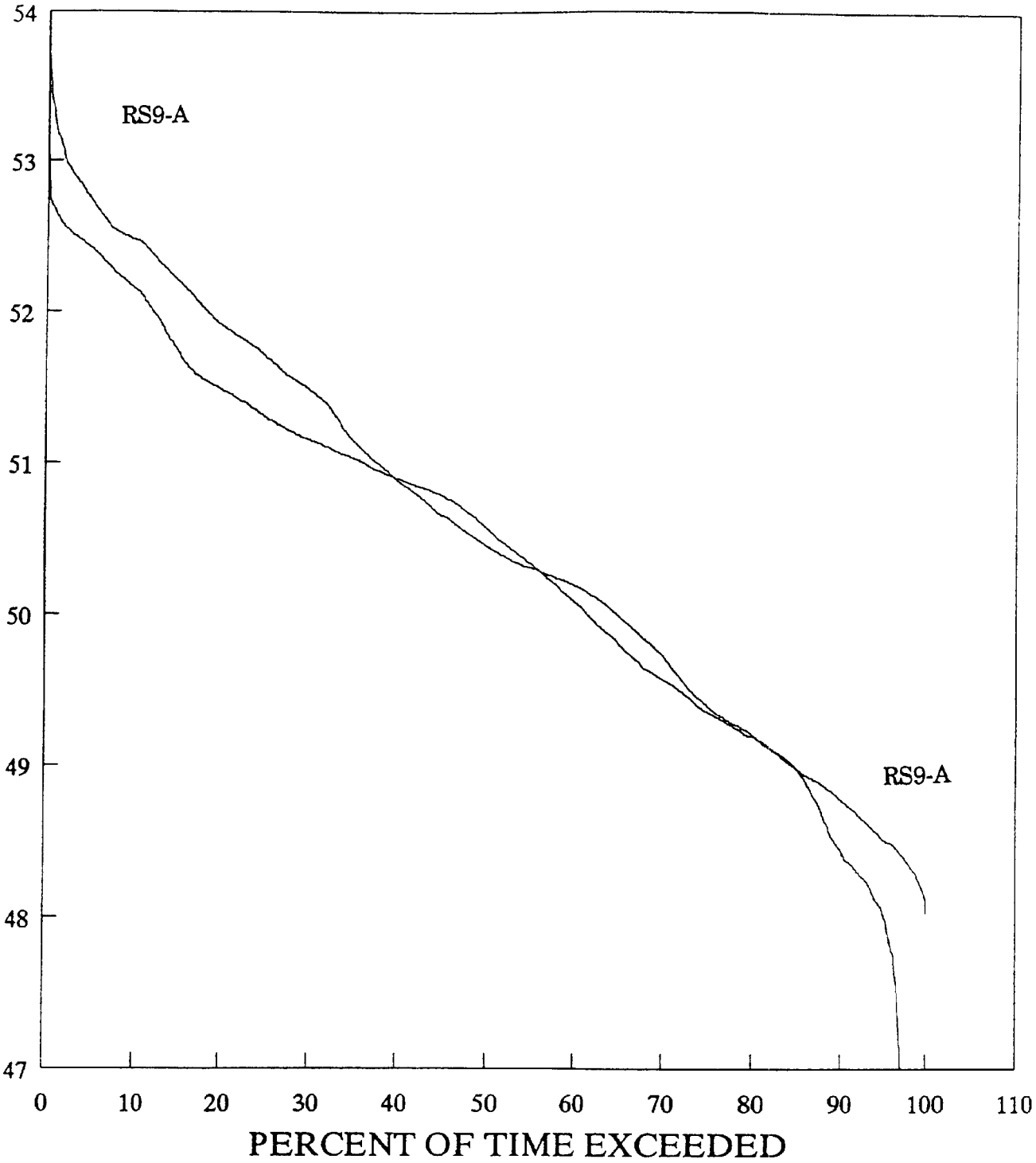
16 Nov 93

FIGURE D13



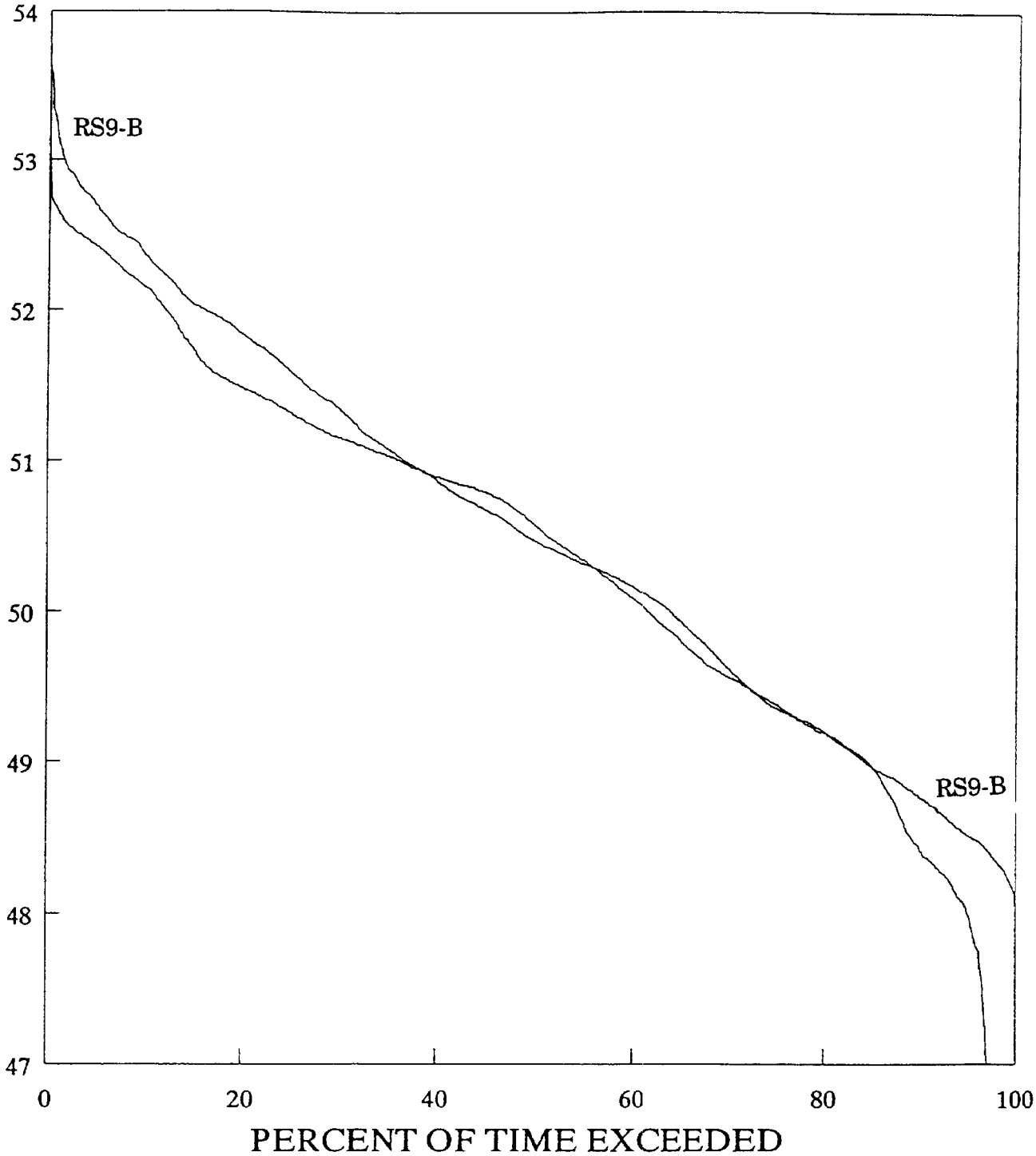
RS9
7 Sep 93

FIGURE D14



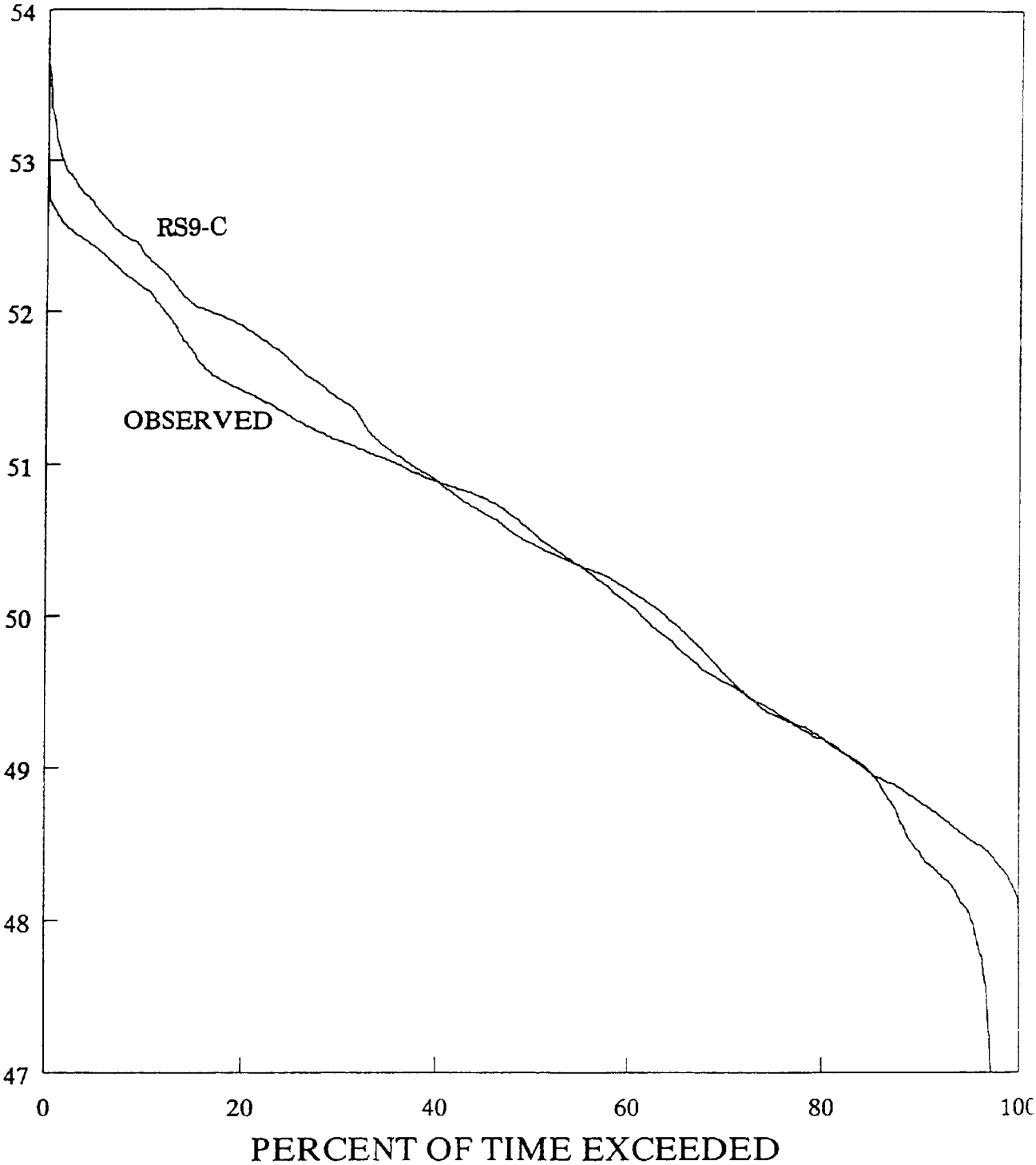
RS9-A
10 SEP 93

FIGURE D15



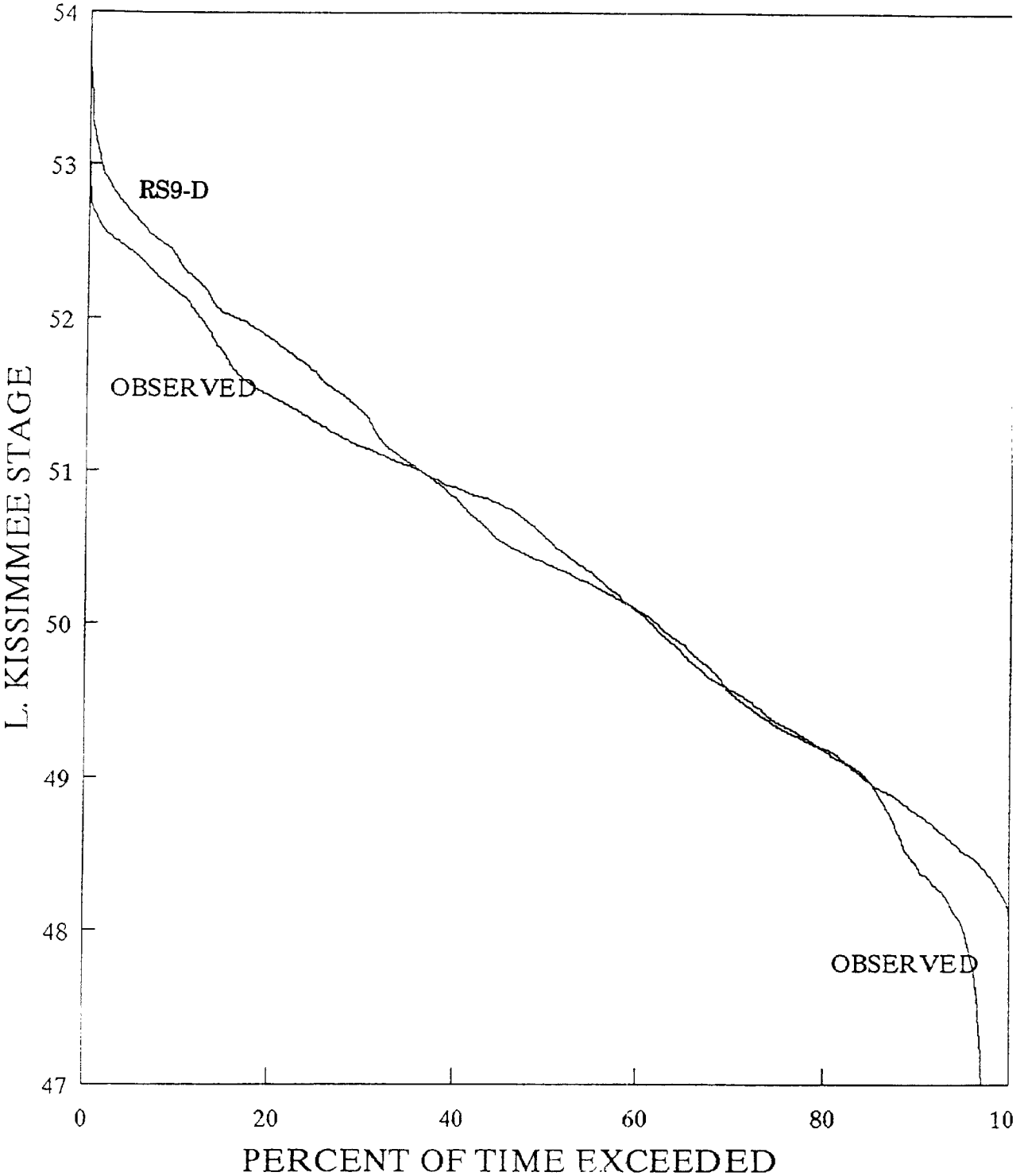
RS9-B
10 SEP 93

FIGURE D16



RS9-C
29 Sep 93

FIGURE D17



RS9-D

15 Nov 93

FIGURE D18

Discharge Exceeded 25% of the Time

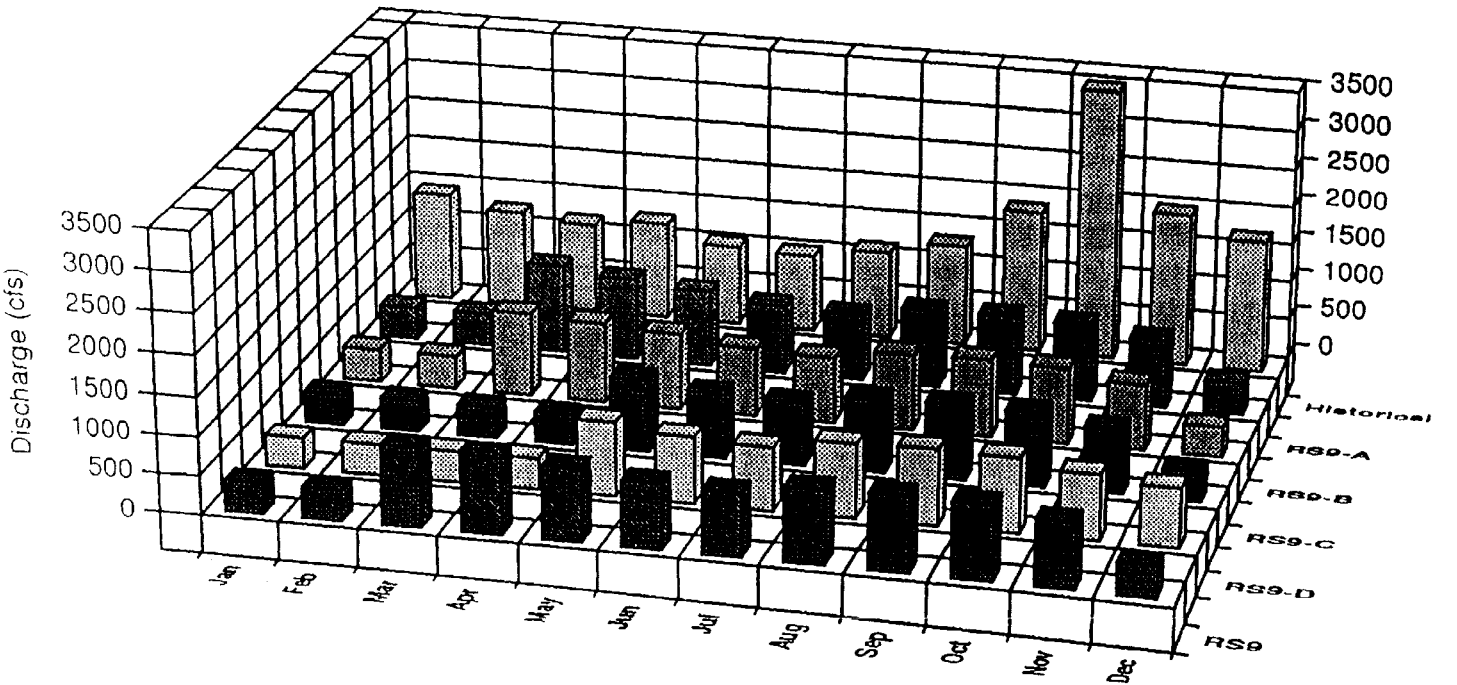


FIGURE D19

KISSIMMEE RIVER
HEADWATERS REVITALIZATION PROJECT

APPENDIX G

SOCIAL IMPACT ASSESSMENT

SOCIAL IMPACT ASSESSMENT FOR THE KISSIMMEE RIVER BASIN HEADWATERS REVITALIZATION PROJECT

SCOPE OF THE STUDY

The scope of this study is that upper portion of the Kissimmee River Basin included in Polk and Osceola counties. The social assessment for the Kissimmee River Headwaters Revitalization project will be conducted for both Osceola and Polk counties and the areas adjacent to the affected lakes.

PURPOSE OF THE STUDY

The purpose of this study is to identify and assess the social impacts of the work/changes in the upper basin carried out in support of the Kissimmee River Headwater Revitalization project and to assess the effects on the people living in the area adjacent to Cypress, Hatchineha, and Kissimmee lakes. The primary objective of this study is to optimize environmental improvements to the upper Kissimmee River Basin while reestablishing the discharges to the lower basin which are necessary to restore the ecological integrity of the Kissimmee River. Modifying the upper level of the existing Lake Kissimmee regulation schedule will provide higher fluctuations of water levels in the upper lakes. Although the upper level of the proposed lake regulation schedule would be increased by 1.5 feet, the schedule will be zoned to provide varying discharge capabilities based on season and water levels. Continuous discharges will reduce the likelihood that the lake will maintain or reach the top of the proposed lake regulation schedule. The project and subsequent increase in lake level elevations will impact local communities within the two counties and particularly areas surrounding the lakes. The present effort is an attempt to categorize and quantify changes in social and economic conditions that the Kissimmee River Basin Restoration Project will cause in the Upper Basin project area. This social assessment will focus on the displacement of houses, people, businesses, and farms. Some of the social factors that will be considered include impacts on population distribution, employment, income, housing stock, fiscal condition, and community cohesion.

EXISTING CONDITIONS

Osceola County, one of four counties that comprise the Orlando Metropolitan Statistical Area (MSA), is in the southeastern quadrant of the Orlando MSA. Osceola County's 1,350 square miles comprise approximately 35 percent of the 3,872 square miles of Metro Orlando. Most of the urban development in Osceola County is around the cities of Kissimmee and St. Cloud in the northwest corner near Orlando and Disney World. Service and tourist industries predominate in this area. The remainder of the county is rural/agricultural and is dominated by citrus, cattle, and timber industries.

Polk County is a single-county metropolitan area; the Lakeland-Winter Haven MSA. These two cities and a number of smaller towns contain most of the population. At 2,048 square miles, it is the fourth largest county in Florida. Polk County is at the center of Florida's industrial belt and

contains notable phosphate mining, manufacturing, agricultural, tourist, and service sectors. Polk County produces almost 25 percent of the state's citrus crop.

Major highways servicing these counties are the Florida Turnpike, Interstate 4, Interstate 75, Highway 60, Highway 92, Highway 98, and U.S. Highway 441. U.S. 192 runs east-west and connects with Interstate 4 near Disney World. A number of major airlines service Orlando International Airport.

Many of the now permanent residents of Polk and Osceola counties moved to the area from the northern states to enjoy the benefits of climate and growth. Also, a large number of seasonal residents ("snowbirds") spend four to six months in the area to avoid cold weather in the North. These two counties enjoy a subtropical climate with warm summers and mild winters. The average annual temperature of this area is 72.7^0 Fahrenheit (F), with an average January minimum of 49^{0}F and an average August high of 93.9^{0}F. The average precipitation is 48 to 55 inches.

DEMOGRAPHIC CHARACTERISTICS

The 1990 Census indicated that the population of Polk County was 405,382, Osceola County's was 107,728, and the population of the State of Florida was 12,937,926. The population projections shown in Table 1 indicate that the rate of population growth in Osceola County is expected to greatly exceed that experienced by Polk County and Florida as a whole. The major factor in Osceola County's population increase of over 100 percent between 1980 and 1992 was the development of the Kissimmee-St. Cloud area as a result of Orlando's (Orange County) Disney World and other area tourist attractions. Also, the absolute increase of 70,473 persons was applied to a relatively small 1980 base population for the county. Polk County's population ranked eighth in the state according to the 1990 Census. Polk County showed an absolute increase in the same period of almost 100,000 persons, which was about 30 percent higher than its 1980 population figure.

Table 1. Population Projections
Osceola and Polk Counties and Florida

County/ State	1980	1990	1992	1995	2000	2005	Percent Change 1980-1990	Percent Change 1990-1992
Osceola	49,287	107,728	119,760	137,595	165,098	191,603	118.60	11.20
Polk	321,652	405,382	420,885	443,802	478,002	510,202	26.00	3.80
Orlando Metro[1]	804,774	1,224,852	1,300,848	1,426,888	1,618,994	1,802,504	52.20	6.20
Florida	9,746,961	12,937,926	13,424,416	14,275,000	15,573,000	16,805,000	32.70	3.80

[1]Orlando Metro area includes Lake, Orange, Osceola, and Seminole counties.

Source: *Florida Statistical Abstract, 1993*, 27th Edition. Bureau of Economic and Business Research, College of Business Administration, University of Florida and University of Florida Press.

As shown in Table 2, Polk and Osceola counties on the whole are ethnically diverse. Polk County population characteristics do not differ substantially from those of the State of Florida. Osceola County has proportionately fewer black citizens and more other citizens than either Polk County or the state. However, the population of the direct impact lakeshore area is almost all white in both counties.

Table 2. Racial Composition - 1992
Osceola and Polk Counties and Florida
(Percentage)

Race	Osceola (Percent)	Osceola (Study Area) (Percent)	Polk (Percent)	Polk (Study Area) (Percent)	Florida (Percent)
White	89.33	96.5	84.35	99.6	83.08
Black	5.48	0	13.42	0	13.60
American Indian Eskimo or Aleut	0.33	0	0.29	0.28	0.28
Asian or Pacific Islander	1.52	0.58	0.61	0.09	1.19
Other	3.34	2.91	1.33	0.18	1.85
Total	100.00	100.00	100.00	100.00	100.00

Source: *Florida Statistical Abstract, 1993*, 27th Edition. Bureau of Economic and Business Research, College of Business Administration, University of Florida and University of Florida Press.

Table 3 shows that the age structures of Polk and Osceola counties and the State of Florida are fairly similar. Osceola County has a smaller percentage of inhabitants over 65 than either the State of Florida or Polk County.

Table 3. Population Age Groups (Years)
Osceola and Polk Counties and Florida
(Percentage)

County/ State	0-14 years (Percent)	15-24 years (Percent)	25-44 years (Percent)	45-64 years (Percent)	65 + years (Percent)	Total (Percent)
Osceola	21.48	13.32	30.41	20.23	14.55	100.00
Polk	20.56	12.78	27.96	20.30	18.40	100.00
Florida	19.08	12.43	29.83	20.24	18.41	100.00

Source: *Florida Statistical Abstract, 1993*, 27th Edition. Bureau of Economic and Business Research, College of Business Administration, University of Florida and University of Florida Press.

The 1990 demographic characteristics of the study area are shown in Table 4. The total population for the census blocks in the portion of Osceola County within the direct impact area was 23 persons. These people are located in the area around Cypress Lake. Within Polk County, the population for the census blocks within the direct impact area was 1,068 persons. These people are located on the west side of Hatchineha and Kissimmee lakes.

Table 4. Selected Demographic Characteristics of the Lakeshore Study Areas and Polk and Osceola Counties

Characteristics	Osceola[1] (Study Area)	Osceola County Total	Polk[1] (Study Area)	Polk County Total
Population	23	107,728	1,068	405,382
Race (White)	22	96,231	1,064	341,952
Race (Black)	0	5,902	0	54,385
American Indian	0	360	3	1,158
Asian\Pacific	1	1,637	1	2,486
Other	0	3,598	0	5,401
Hispanic Origin[2]	0	(12,866)	(2)	(16,600)
School Age and Presumed Retired Persons				
Age (under 18)	4	89,503	93	318,601
Age (65 or older)	2	17,428	376	77,425

[1]Osceola Study Area = Lake Cypress
Polk County Study Area = Lakes Hatchineha and Kissimmee
[2]Persons of Hispanic origin may be of any race.

Sources: U.S. Department of Commerce, Economics & Statistics Administration Bureau of the Census; and 1990 Census of Population & Housing.

As can be seen from the tables, over 35 percent of the residents enumerated by the census are over 65 and are likely to be retired. The actual percentage is probably higher since many of their spouses are under 65 and not counted in this category. Also, many people retire before age 65.

Housing Stock

The 1990 Census reported a total of 186,225 year-round housing units in Polk County. Of this number, 109,885 were owner occupied, 46,084 were renter occupied, 30,256 were vacant. Of these, 13,130 were classified as being for seasonal or recreational use. The mean cash rent for rental dwellings was $273.00 per month. Osceola County, on the other hand, had a reported 47,959 year-round units. Of this number, 25,730 were owner occupied, 13,420 were renter occupied and 8,809 were vacant including 3,982 seasonal recreational units. The mean cash rent for rental dwellings was $292.00 per month for Osceola County.

The 1990 census housing characteristics of the lakeside study area are shown in Table 5. The areas adjacent to the lakes in Osceola County contained 17 housing units in 1990. Nine of these

(53 percent) were reported as vacant in census block statistics. According to informants, they were used only on weekends or seasonally. Of the 879 housing units in the lakeside areas along the west side of Hatchineha and Kissimmee lakes, 374 (43 percent) were reported by the census to be vacant and/or for seasonal use.

Table 5. Selected Housing Characteristics of the Lakeshore Study Areas and Polk and Osceola Counties

Characteristics	Osceola[1] (Study Area)	Osceola County Total	Polk[1] (Study Area)	Polk County Total
Housing Units	17	47,959	879	186,225
Owner (Occupied)	57	25,730	460	109,885
Renter (Occupied)	3	13,420	45	46,084
Total Vacant	9	8,809	374	30,256
Seasonal/Recreational Use (Vacant)[2]	NA	3,982	NA	13,130
Mean Value	$30,417	$75,700	$60,728	$61,000
Mean Rent	$362	$438	$273	$300

[1]Osceola County Study Area = Lake Cypress
Polk County Study Area = Hatchineha and Kissimmee lakes
[2]Vacant units intended for use only in certain seasons, for recreational or other occasional use throughout the year.

NA = Not Available.

Source: U.S. Department of Commerce, Economics & Statistics Administration, Bureau of the Census. 1990 Census of Population & Housing.

Labor Force/Employment

Table 6 shows the percentages of total population in various wage and salaried employment categories in Osceola and Polk counties and in Florida. The total and each category are presented as a percentage of the total population to facilitate comparison. Wage and salary workers comprise nearly half (47 percent) of Polk's employment, compared to approximately 38 percent for Osceola County and slightly over half (51 percent) for Florida as a whole. Trade and service employment sectors total 66 percent of wage and salary workers in Osceola County and 49 percent in Polk County. These figures indicate the place of trade and service sector employment to the economies of Osceola and Polk counties. The construction labor force is estimated at approximately 2,395 in Osceola County and 12,626 in Polk County.

As seen in Table 6, Polk County had an unemployment rate of 12.4 percent in 1992, compared to Osceola's 6.6 percent and Florida's 8.1 percent (Florida Department of Labor & Employment Security).

Polk County has been designated by the United States Department of Labor as a labor surplus area, which means that companies located in Polk County are eligible for preference in obtaining Federal contracts.

Table 6. Employment and Labor Force--1992
(As a Percent of Total Population)

Category	Osceola	Polk	Florida
Total Wage and Salary Employment	38.0	47.0	51.0
Agriculture Services	1.0	2.0	2.0
Manufacturing	2.0	5.0	4.[illegible]
Mining	0	1.0	0
Construction	2.0	3.0	3.0
Transportation/Public Utilities	1.0	2.0	2.0
Wholesale Trade	1.0	2.0	2.0
Retail Trade	11.0	9.0	10.0
Finance/Insurance/Real Estate	3.0	3.0	4.0
Services	13.0	12.0	17.0
Government	5.0	6.0	7.0
Unemployment Rate August (1993)	6.6	12.4	8.1

NOTE: Categories do not total due to rounding.

Source: Florida Department of Commerce--1992, Division of Economic Development. Regional Economic Information System, Bureau of Economic Analysis, In Cooperation with Florida Department of Labor and Employment Security.

Income

As shown in Table 7, Osceola County experienced a reduction in per capita income from 1989 to 1991. Polk County and Florida recorded a net increase in per capita income during the same period.

Table 7. Per Capita Income for Selected Years:
Osceola and Polk Counties and Florida

County/State	1989	1990	1991	Percent Change 1989-1991
Osceola County	$ 16,746	$ 16,893	$ 16,666	$ -0.48%
Polk County	$ 14,457	$ 14,906	$ 15,176	$ 4.97%
Florida	$ 17,904	$ 18,759	$ 19,087	$ 6.10%

Note: These data were derived by dividing each type of income by the total population of the area, not just the segment of the population receiving that particular type of income. Per capita is computed using Bureau of Economic and Business Research Florida Estimates of Population for intercensal years and Bureau of the Census data for 1990.

Source: Florida Department of Commerce--1992, Division of Economic Development. Regional Economic Information System, Bureau of Economic Analysis and Florida Department of Labor and Employment Security.

Lakeside Study Area Land Use

The proposed action will require acquisition of lands lying between the contours of 52.5 and 54 feet. Except in a few areas, lands necessary for the project will be acquired in fee to insure that project environmental and flood storage requirements are obtained. These lands consist of approximately 16,000 acres of rangeland, pasture, forests, and wetlands. Also, about 300 acres of urban or built-up lands will be required. Descriptions of some of the built-up areas given below are taken from material provided by the real estate section of the Jacksonville District Corps of Engineers (COE).

Lake Cypress RV and Fish Camp: This facility on Lake Cypress consists of a fish camp with a store, snack bar, manager's residence, and approximately 45 RV/trailer pads. It is located on the south side of a public boat launch and provides services to boat ramp users. On the north side of the launch area is a cluster of about a dozen privately owned cabins on three to four foot piers. Some are in a dilapidated condition. Each of the cabins has its own septic system.

Hatchineha Estates, Hatchineha Marina Lots, and L&M Estates: This area consists of approximately 306 lots, 48 of which are vacant. The lots are arranged along a system of dug canals so that each has water frontage. Almost all have docks or boat shelters. A few of the structures have over-water quarters in a second story over the boat shelter. Most of the homes in the area are built-in-place structures. Some are rather large, and two-story and brick veneer structures are not uncommon. Hatchineha Marina, located in this area, provides a boat ramp, gas, bait, and other boating/fishing services, as well as a small store and restaurant. The marina also has RV sites for rent. Each of the housing units in this area has its own septic system.

Grape Hammock Acres and Chandley Point: There are 57 housing units and 11 vacant lots in this area. Most of the houses are frame or cinder block construction. Two are mobile homes.

Grape Hammock Fish Camp: Grape Hammock Fish Camp contains approximately 22 acres and consists of 40 mobile home (MH) pads, 74 recreational vehicle (RV) pads, 11 cabins, 7 camp sites, 100 boat slips, and a manager's residence. Amenities include a store, recreation hall, two restroom/shower/laundromat facilities, outside storage area, and above-ground swimming pool. The MH sites are served by their own sewer system, whereas eight septic tank systems service the RV sites. The whole camp is provided water by an on-site well.

Shady Oaks Fish Camp: Shady Oaks Fish Camp is a portion of a 3,000-acre ranch containing an undetermined number of acres. The camp provides eight RV lots, 270 mobile home lots, boat slips, a convenience store/bait store, and a covered picnic shelter. The mobile homes all have septic tanks, which were installed and paid for by the tenants. The whole camp is provided water by an on-site well.

Rocks Fish Camp: Rocks Fish Camp is a portion of the same 3,000-acre ranch as Shady Oaks. Its approximately 67 acres of land contain 116 mobile home sites and some boat slips. The mobile homes all have septic tanks, which were installed and paid for by the tenants. The whole camp is provided water by an on-site well.

Oasis Marina: Oasis Marina is located on the south end of Lake Kissimmee on the west side. The marina provides lodging, fuel docking facilities for boat operators, and an access ramp into the lake. Along with a marina office and store, there are two residences, two cottages, a quadruplex cottage, two mobile homes, and additional hook-up facilities for eight trailer homes. All of the six existing septic tanks have top-of-tank elevations less than 56 feet MSL.

Tiger Lake: In the Tiger Lake Sub-division, only back lots of the property situated near the lake would be impacted with the exception of one structure. This particular structure is being built between the 52.5 and 54 feet flood level with a raised ground elevation of approximately 3 to 4 feet. However, flooding would occur around the raised structure making it unaccessible at the time of flooding. The developed areas along Bud's Fish Camp and the Lion's Fish camp consist of campers/trailer homes/RVs. Except for a about 11 trailers, 103.42 acres); 2 structures (1 frame and 1 brick), 5.22 acres, and sheds/barns, 8.12 acres. The rest of the land area is woodland, pasture (95.5 acres) and rangeland (191.7 acres). On 35.93 acres there is an improved unpaved airstrip. The structures between 52.5 feet - 54 feet elevation are shown in Table 8

TABLE 8
Lands Around Lake Tiger
Improvement Impacted Between 52.5 - 54.0 Feet Contour

LAND USE/ IMPROVEMENT	EST. ACREAGE
A-frame and pole barn	3.72
Double wide	2.73
Mobile Home/Barn	3.88
Mobile Home	3.00
Mobile Home	0.31
Imp. Pasture/Storage Shed	20.50
Double /wide >54.0 (entire acreage is not impaceted, approx. 50-75 %)	
No improvement, undeveloped	14.10
R/v, storage shed & single wide <54.0	1.72
Shed & Barn <54.0	5.03
Double wide <54.0 pasture	83.37
Two trailers & Barn <54.0	5.40
Two trailers <54.0	3.01
Barn <54.0	1.49
House <54.0	2.22
Fish camp w/R/V lots	5.13
Possible 1,000 ft. grass airstrip	36.93

Institutions and Services

Police protection is provided to the lakeside communities by the Osceola and Polk counties sheriffs' offices. Fire protection and emergency response services are furnished by nearby volunteer fire departments within each county. There are no schools in the lakeside areas, and school children are bussed to schools within the nearest towns. Churches range from small local chapels/churches observed along the roads leading to the lakeside study area to churches and temples within the towns nearby.

Other Factors

The proposed project has resulted in the formation of at least one activist interest group that opposes the Kissimmee River Restoration Plan. The group, which has about 500 members, is named *Realists Opposed to the Alleged Restoration,* but is best known by the acronym ROAR. However, most of its membership apparently have interests in areas below Lake Kissimmee. ROAR was formed to review the proposed project in its entirety. It has made contact with and received support from national private property interest organizations such as The National Taxpayers Union, Citizens for Constitutional Property Rights, the Institute for Justice, and the James Madison Institute.

Another factor to be noted is that both Osceola and Polk counties are in the National Flood Insurance Program. Under this program, any new construction or new residences built in flood plain areas must be built with the first floor at least one foot above the elevation of the 100-year flood in order to obtain flood insurance. Banks or mortgage institutions require flood insurance in designated flood plain areas before they will make a loan. Older structures can be "grandfathered" into the flood insurance program if they were built before the flood plain regulations became effective.

PROJECT IMPACTS

Acquisition and Displacement

Implementing the project will require the scheduled retention of water in Cypress, Hatchineha, Kissimmee and Tiger lakes to an elevation of 54 feet MSL during the course of each year. This is 1.5 feet higher than the currently authorized maximum programmed elevation of 52.5 feet MSL. The right to flood the area between the 52.5-foot contour and the 54-foot contour will be secured by buying the property in this zone. Most of this property is used for cattle grazing, wetlands, non-commercial forest and a small amount in crops.

Agricultural Displacement: Land use maps provided by the Jacksonville District COE were used to ascertain the areas of different land uses below the 54-foot contour. Around the three lakes, an estimated 6,069 acres of pasture and 1,707 acres of rangeland would be acquired. An additional 95.5 acres of pasture and 192 acres of rangeland could be affected around Lake Tiger in Polk County. Approximately 1700 acres of sod farm exist at the Rolling Meadows property adjacent to the south side of Lake Hatchineha. This area will more than likely be acquired as part of the project.

The impact on cattle production of flooding lakeside lands depends on whether the lands remain available for grazing on a lease basis. The current practice is for pasture fences to be

to the lakeshore and extend into the water to a depth that keeps the cattle from wandering around the end of the fence into the next pasture. If this practice is maintained and the lands are leased back to the ranchers, the impact on production will be minimized. Cattle would simply adjust to the moving shoreline as water levels fluctuated. There would be some deterioration of pasture quality for part of the year. If the acquired area is fenced off from the lakeshore, the cattle production potential will be removed.

In previous studies on the Kissimmee River Basin, Jacksonville District COE agricultural economists calculated the relationships between factors contributing to economic loss to cattle producers and the duration of pasture flooding. These values were used in the present study to calculate a weighted average cost per acre per day of inundation. Two assumptions insured that the average cost per acre calculated for the present study resulted in a conservative estimate (i.e., maximized) of damages. The first, that there was as much improved as semi-improved pasture in the zone between 52.5 feet and 54.0 feet elevation was based on conversations with area agricultural agency personnel.

The second assumption was that improved and semi-improved pasture and rangeland are equally subject to innundation. A normal expectation is that improved pasture would be on higher ground and thus not as likely to sustain damages as semi-improved pasture or rangeland. On the land-use maps for the study both improved and semi-improved pasture lands were simply identified as pasture. Differential innundation was not calculated for pasture and rangeland categories as no detailed topography was shown between the 52.5 foot and 54.0 foot contours. Inspection of the land use maps seemed to show that lands identified as pasture were as likely to be proximal to the lakeside as those identified as rangeland. The Jacksonville District COE costs were in 1990 dollars. These costs were indexed to 1994 values by using the index of Prices Paid by Farmers for Production from the Survey of Current Business. The computations are shown in Table 9 and 10.

Table 9. Calculated Average Cost Per Day Per Acre Flooded For Cypress, Hatchineha, and Kissimmee Lakes

Land Use Type	Cost Per Day Per Acre Flooded	Total Number of Acres	Total Cost
Improved Pasture (1 cow per 3 acres)	$ 6.62	3,035	$ 20,088
Semi-Improved (1 cow per 5 acres)	$ 3.97	3,035	$ 12,047
Rangeland (1 cow per 15 acres)	$ 1.32	1,899	$ 2,507
Totals		7,968	$ 34,642

$ 34,642 / 7968 Acres = $ 4.35 acre per day (average)
$ 4.35 (1990 value) * 1.04 (index) = $ 4.52 (1994 value)

Table 10. Calculated Average Cost Per Day Per Acre Flooded For Tiger Lake

Land Use Type	Cost Per Day Per Acre Flooded	Total Number of Acres	Total Cost
Improved Pasture (1 cow per 3 acres)	$ 6.62	47.75	$ 316.11
Semi-Improved (1 cow per 5 acres)	$ 3.97	47.75	$ 189.57
Rangeland (1 cow per 15 acres)	$ 1.32	192.00	$ 253.44
Totals		287.50	$ 759.11

$759/288 Acres = 2.64 = acre per day (average)
$2.64 (1990 value) * 1.04 (index) = 2.75 (1994)value

Sources: Jacksonville District Corps of Engineers; and Gulf Engineers & Consultants, Inc.

The Jacksonville District provided a graph showing the exceedance curves for the pre-existing and proposed schedules under which the project lake levels would be managed. These graphs plotted lake levels between 52.0 and 54.0 feet on one axis against the percent of time the levels would be exceeded on the other. Lake stages were converted into acres flooded by assuming a constant slope to the land between 52.5 and 54.0 feet. The number of days of flooding for different numbers of acres was calculated by assuming an average expected annual cycle and converting percent of time to days (365 days/year base). These calculated stage/acres flooded by percent of time/days relationships under the existing and proposed regulation schedules were used to estimate the number of acres flooded for each duration period (in days). The acre/days were then multiplied by the weighted average value ($4.52 for Lake Cypress, Hatchineha, and Kissimmee) and ($2.75 for Lake Tiger) described above. Calculations of the damage estimates for the four lakes under existing (tables 11 and 12) and proposed regulation schedules (tables 13 and 14).

The recommended plan includes fee acquisition of the affected pasture land to mitigate induced damages. The 6,086 acres shown in table 13 and the 288 acres shown in table 14 are included within the 20,000 acres to be acquired. Because the affected pasture will be acquired and converted to wetlands, no induced damages will be realized.

Table 11. Damage Estimates for Pasture Flooding
Existing Regulation Schedule For Cypress, Hatchineha, and Kissimmee Lakes

Days Flooded	Acres Flooded	Cost per Acre per Day Flooded	Cost
1	2188	4.52	$ 9,890.07
2	625	4.52	$5,651.47
3	573	4.52	$7,775.03
4	522	4.52	$9,430.47
5	469	4.52	$10,596.51
6	417	4.52	$11,311.45
7	365	4.52	$11,558.28
8	313	4.52	$11,302.94
9	261	4.52	$10,609.27
10	209	4.52	$9,447.49
11	156	4.52	$7,770.77
12	137	4.52	$7,404.79
13	17	4.52	$6,860.07
14	97	4.52	$6,136.61
15	77	4.52	$5,234.42
16	57	4.52	$4,153.49
17	38	4.52	$2,893.83
18	18	4.52	$1,455.42
Total Cost			$139,482.39

Table 12. Damage Estimates for Pasture Flooding
Existing Regulation Schedule Tiger Lake

Days Flooded	Acres Flooded	Cost per Acre per Day Flooded	Cost
1	103	2.75	$283.81
2	82	2.75	$451.79
3	75	2.75	$621.55
4	69	2.75	$753.88
5	62	2.75	$847.10
6	55	2.75	$904.25
7	48	2.75	$923.98
8	41	2.75	$903.57
9	34	2.75	$848.12
10	28	2.75	$755.24
11	21	2.75	$621.21
12	18	2.75	$591.95
13	15	2.75	$548.40
14	13	2.75	$490.57
15	10	2.75	$418.45
16	8	2.75	$332.04
17	5	2.75	$231.34
18	2	2.75	$116.35
Total Cost			$10,643.59

Sources: U.S. Army Corps of Engineers, Jacksonville District; and Gulf Engineers & Consultants, Inc.

Table 13. Damage Estimates for Pasture Flooding
Proposed Regulation Schedule For Lakes Cypress, Hatchinha, and Kissimmee

Days Flooded	Acres Flooded	Cost per Acre per Day Flooded	Cost
1	6086	4.52	$27,506.73
2	3628	4.52	$32,800.74
3	3277	4.52	$44,433.95
4	2926	4.52	$52,906.06
5	2575	4.52	$58,187.32
6	2224	4.52	$60,315.96
7	1872	4.52	$59,245.27
8	1763	4.52	$63,765.99
9	1654	4.52	$67,300.99
10	1544	4.52	$69,807.78
11	1435	4.52	$71,367.09
12	1326	4.52	$71,940.68
13	1217	4.52	$71,528.55
14	1108	4.52	$70,130.69
15	998	4.52	$67,683.38
16	889	4.52	$64,309.84
17	780	4.52	$59,950.57
18	671	4.52	$54,605.58
19	562	4.52	$48,274.87
20	452	4.52	$40,873.46
21	343	4.52	$32,567.05
22	234	4.52	$23,274.93
23	176	4.52	$18,274.09
24	118	4.52	$12,848.37
25	58	4.52	$ 6,585.64
Total Cost			$1,250,485.57

Table 14. Damage Estimates for Pasture Flooding Proposed Regulation Schedule For Lake Tiger

Days Flooded	Acres Flooded	Cost per Acre per Day Flooded	Cost
1	288	2.75	$792.00
2	172	2.75	$944.43
3	155	2.75	$1,279.38
4	138	2.75	$1,523.32
5	122	2.75	$1,675.38
6	105	2.75	$1,736.67
7	89	2.75	$1,705.85
8	83	2.75	$ 1,836.01
9	78	2.75	$1,937.79
10	73	2.75	$2,009.97
11	68	2.75	$2,054.87
12	63	2.75	$2,071.38
13	58	2.75	$2,059.52
14	52	2.75	$2,019.27
15	47	2.75	$1,948.80
16	42	2.75	$1,851.67
17	37	2.75	$1,726.15
18	32	2.75	$1,572.26
19	27	2.75	$1,389.98
20	21	2.75	$1,176.87
21	16	2.75	$937.70
22	11	2.75	$670.15
23	8	2.75	$526.16
24	6	2.75	$369.94
25	3	2.75	$189.62
Total Cost			$36,005.17

Sources: U.S. Army Corps of Engineers, Jacksonville District; and Gulf Engineers & Consultants, Inc.

As noted earlier, these calculations presume a constant slope of the land between elevations 52.5 feet and 54.0 feet and a relatively random mix of types of grazing lands. As also noted, inspection of the land use maps indicate that the latter assumption is not unreasonable for pasture and rangeland in the zone between 52.5 feet elevation and 54.0 feet elevation. The annual damages expected due to pasture flooding under the existing regulation schedule for Lake Cypress, Hatchineha, and Kissimmee are $139,482 and for Lake Tiger $10,644. Under the proposed regulation schedule these damages are estimated to be $1,250,486 and $36.005 annually. The net

annual damages due to increased pasture flooding are estimated to be $1,111,003 and $25,362 respectfuly. It should be noted again that this is in the high end of the range of expected damages.

Effects on the local economy are problematic for losses in agricultural production due to pasture damage. The effect of diminished production will be offset for the land owner by the purchase price of the land acquired for flowage rights. Subsequent lease-back arrangements (if any) will undoubtedly take the reduced carrying capacity of the pasturage into account; therefore, the individual cattle producer will suffer little or no loss due to the project.

Commercial Displacement: All of the marina/fish camps around the three lakes will be impacted to a greater or lesser degree. The nature and extent of impacts and the consequences are both particular and problematic for each business. A comparison of the existing and proposed regulation schedule shows that the current regulated elevation of 52.5 feet will likely be exceeded approximately five percent of the time. On an annualized basis this is 18 days. Under the proposed regulation schedule the 52.5 foot elevation would likely be exceeded approximately seven percent of the time, or 25 days on an annualized basis. The actual effects of this change on business are likely to be limited. However, if the docks are raised they may then be too high to provide convenient access to boats when the water levels are reduced throughout the rest of the year. Owners have no compensable rights for impacts to their docks/boat sheds because the COE has preemptive navigability servitude/rights. Owners could actually be required to remove their docks if deemed necessary, although no such action is planned at this time. Some outbuildings as well as other dockside improvements such as fish cleaning houses, bait storage facilities, or gas pumps may be impacted by water at a 54-foot elevation. However, no primary structures have first-floor elevations less than 54 feet MSL and therefore would not be displaced due to flooding of the structure. The extent to which business owners might choose to relocate facilities or modify existing ones is unknown. Also unknown is whether businesses would remain viable if changes were made and debt was incurred, or if changes were not made and customers chose not to accommodate to the short-lived inconvenience and went elsewhere.

Field personnel talked with several marina operators. They were reluctant to discuss their businesses or future plans, since all maintained they were either in the process of negotiating with the South Florida Water Management District (SFWMD) or the COE or soon would be. Some complained that they had been contacted initially, asked to provide extensive information, and then had not been contacted again. Several mentioned that attempts to obtain clarification of their cases had been unsuccessful. No information as to the value business owners placed on their operations or what actions they expected to take was acquired.

Real estate appraisers for the SFWMD and COE have prepared estimates of the costs of relocation and flood proofing as well as the value of the properties potentially impacted by increasing lake levels. These estimates of acquisition costs for the fish camps and marinas around the lakes were combined with general acquisition costs for improvements made by tenants and the relocation costs associated with moving tenants as well as businesses. These were then compared with the projected costs of flood proofing the properties. The estimated cost for acquiring the businesses, homes, and mobile homes subject to impact was approximately $49 million. The estimated cost to floodproof the same properties was approximately $23 million (a difference of approximately $26 million). Floodproofing would also avoid the wholesale dislocation that would be produced by

acquisition. Some facilities at particular marinas or fish camps will probably have to be relocated or otherwise modified, but the businesses will not have to be acquired for the needs of the project.

The extent to which a particular business is impacted and whether the business can remain viable under the changed conditions is problematic for each situation. If individual businesses close, they will likely be replaced at some time by a similar business if the demand for the service is great enough. The Kissimmee River Restoration project is unlikely to have long-term negative impacts on the economy of the Upper Basin region by causing marinas to go out of business.

Residential Dislocation: There are no primary residential structures with first-floor elevations at or below 54 feet MSL. Therefore, no housing units will need to be acquired and/or occupants displaced because the dwelling would be flooded. Some outbuildings, garages, patios, etc., will need to be elevated to 54 feet MSL or above.

Septic System Impacts: The impact of water level increases on septic systems of both homes and businesses is the most difficult to predict and deal with. All of the homes and businesses in the lakeside study area use septic tanks with drain fields to dispose of their sewage. Most are individual on-site below-ground installations with both the tank and the drain field below the general ground level. There are a few cluster systems in place where the effluent from several sources is disposed of in a common drain field. There are also a few mounded drain fields in the area.

To function properly, typical septic systems should have the discharge pipe invert at least two feet lower than the top of the septic tank and resting on at least six inches of gravel. The gravel layer should be at least one foot above the "seasonal high water table." If the lake elevation is increased to 54 feet MSL for part of the year, it would likely cause septic systems whose tanks/drain fields are too low to malfunction. This would create an intolerable health hazard as untreated sewage would be discharged to the Kissimmee.

Based on the criteria developed by the COE and the SFWMD, septic systems with a top of tank elevation of 56 feet or lower would be considered impacted under the operation of the modified lake regulation schedule. This is based on application of the vertical clearance requirement of 3.5 feet from the seasonal high water level. The seasonal high water level was taken to be the maximum scheduled lake elevation during the wet season, or 52.5 feet. Systems with higher elevations may experience some difficulty. However, these existing systems will be allowed to remain. A new system, meeting more stringent criteria, will be required only when the owner seeks a permit to repair an older system that has failed.

A survey was carried out by Bromwell & Carrier, Inc. (BCI) under contract to the SFWMD to identify septic systems and other facilities likely to be impacted by raising the water level in the lakes. A number of building lots with systems at or below 56 feet MSL were identified. These lots are located in Grape Hammock, Shady Oaks, and Oasis fish camps and in Hatchineha Estates.

Mounded systems are proposed as replacements in those areas where basic criteria for their use can be met. The criteria are: sufficient land to site a mounded system; mound could be sited with at least five-foot setbacks from property lines; and mound could be sited at least 150 feet from delineated bodies of water.

The proposed repair methods are as follows:

1. On-site mounded system: The repair for an impacted lot will require installation of a four-foot diameter manhole, a dosing pump station, and a raised mound. This repair is feasible if the raised 34'x44' mound can be sited on the lot and maintain 150-foot setbacks from water courses.

2. Off-site mounded system: In situations where the site did not meet setback requirements from bodies of water or the lot was too small, the raised mound could be sited on a vacant lot. The system would use the same 34'x44' raised mound and dosing pump station, but a two inch PVC force main would be used to deliver the effluent to a mound. The dosing pump would be selected to meet any additional head constraints imposed by a remote mound.

3. Cluster Systems: When several adjacent lots are too close to a water body or lot sizes are too small, a remote cluster system can be used. In this design, a mounded system is located off-site with a dosing pump station. Sewage effluent from two to six residences would be pumped to this central dosing pump station.

The following paragraphs describe the number of likely impacted systems and the possibility for using mounded systems in different locations.

Shady Oaks: Shady Oaks Fish Camp has 107 identifiable lots. The COE has determined that 85 lots would be impacted by annual operation of lake levels over 52.5 feet. The COE analysis determined that 59 of the impacted lots could be corrected by construction of on-site mounded systems. The remaining 27 lots could be corrected by construction of eight off-site mounded systems and seven off-site cluster systems.

Rocks Fish Camp: Rocks Fish Camp has 116 identifiable lots. The COE has determined that 77 lots would likely be impacted by annual operation over 52.5 feet. The COE analysis determined that 49 of the impacted lots could be corrected by construction of on-site mounded systems. The remaining 28 lots could be corrected by construction of two off-site mounded systems and nine off-site cluster systems.

Grape Hammock Fish Camp: The Grape Hammock Subdivision has 127 identifiable lots. The COE analysis has determined that 20 lots are likely to be impacted by annual operation over 52.5 feet. The COE analysis determined that 12 lots could be corrected by construction of an on-site mounded system. The remaining eight lots could be corrected by construction of two off-site cluster systems.

Hatchineha Estates: Hatchineha Estates has 306 identifiable lots. Hatchineha Estates mainly consists of single-family homes on water-front lots. A COE survey determined that 61 lots would be impacted by annual operation over 52.5 feet. Since the subdivision consists of waterfront lots situated on dug canals, 150-foot setbacks cannot be achieved. In addition, there are no vacant lots where off-site mounded systems could be placed to handle the sewage from several houses. Sewer lines with a package system or connection to an existing system several miles away are the only viable options for Hatchineha Estates. Table 11 details the septic tank repair options for the various impacted areas.

Table 11. Septic Tank Impacts

Fish Camps	Total Lots	Estimated Total Lots Impacted by Lake Operation Over 52.5 feet	Can Be Corrected by On-Site Mounded System	Can Be Corrected by Off-Site Mounded Systems	Off-site Cluster System (Number of lots)	Sewered Lots
Shady Oaks	107	85	58	8	7(19)	0
Rocks Fish	116	77	49	2	9(26)	0
Grape Hammock	127	12	4	0	2(8)	0
Hatchineha Estates[1]	306	61	0	0		61
The Oasis	6	6	0	0	1(6)	0

[1]Note the only method of correction is to connect the impacted lots to a sewer system.

Source: U.S. Army Corps of Engineers, Jacksonville District.

Package sewer treatment plants have also been suggested as an option for Grape Hammock, Shady Oaks, and Rocks Fish camps. If centralized treatment plants are installed, no housing units would need to be displaced. If sewage systems are not installed at the fish camps and mounded systems are used where possible, the housing units on 35 lots would still be subject to displacement. These are likely to all be mobile home sites. Whether the occupants are permanent or part-time residents is unknown.

Foregone Taxes: A number of acres of undeveloped land will flood with the increase in authorized water levels. These lands will be acquired and become publicly owned, thus removing them from the tax rolls of the two counties. Tables 12 and 13 detail the lost taxes for each county.

Table 12. Agricultural Land Use Tax Rates and Tax Values Osceola County

Land Use	Total Acres	Assessed Value Per Acre	Tax Millage	Total Taxes
Pasture: 50% Improved Pasture Land	571	$ 217.00	0.0173085	$ 2,147
50% Semi-Improved Pasture	571	$ 138.00	0.0173085	$ 1,365
Forest	92	$ 252.50	0.0173085	$ 402
Rangeland	488	$ 75.00	0.0173085	$ 633
Wetland	614	$ 30.00	0.0173085	$ 318
TOTAL ACRES	2,337		OSCEOLA TOTAL	$ 4,865

Sources: U.S. Army Corps of Engineers, Land Use Maps for the Kissimmee River Basin; Osceola County Assessor's Office; and Gulf Engineers & Consultants, Inc.

Table 13. Agricultural Land Use Tax Rates and Tax Values
Polk County

Land Use	Total Acres	Assessed Value Per Acre	Tax Millage	Total Taxes
Pasture: 50% Improved Pasture Land	2,494.5	$ 225.00	0.01744	$ 9,788.42
50% Semi-Improved Pasture	2,494.5	$ 100.00	0.01744	$ 4,350.41
Forest	262	$ 300.00	0.01744	$ 1,370.78
Rangeland	1,843	$ 75.00	0.01744	$ 2,410.64
Wetland	1,965	$ 20.00	0.01744	$ 688.88
TOTAL ACRES	9,069		POLK TOTAL	$18,609.13

Sources: U.S. Army Corps of Engineers, Land Use Maps for the Kissimmee River Basin; Polk County Assessor's Office; and Gulf Engineers & Consultants, Inc.

Economic Impacts of Construction: Project implementation in the Upper Basin requires widening the connecting canals between Lakes Cypress, Hatchineha and Kissimmee, respectively, and increasing the size of the water control structure at the lower end of Lake Kissimmee. Dredging is expected to take about a year and cost $3.5 million. Construction of the water control structure will also take about a year and will cost about $4.5 million. These values, job types, and location were input into the *Economic Impact Forecast System* (EIFS) maintained by the Construction Engineering Research Laboratory (CERL) at Champagne, Illinois. EIFS estimated that the canal work would provide 17 man-years of direct employment and 77 man-years of induced employment in the region. The water control structure portion would provide 22 man-years of direct employment and 99 man-years of induced employment. The total impacts would be 39 man-years of direct employment and 176 man-years of induced employment.

These jobs represent a net plus for the local overall economy since the money comes from outside the region. The same is true for expenditures for sewer systems or for mounded septic systems since these are project expenses. The same ratios as for the canal and water control structure expenditures ($205,000 in project expenditures per direct job, $45,500 per induced job) can be used to estimate the economic effect of building package systems or installing mounded systems. Installing a sewer system for Hatchineha Estates, at an estimated cost of $2,158,293, would result in approximately 11 man-years of direct employment and 47 man-years of indirect employment. Sewer plants for Grape Hammock, Shady Oaks, and Rocks Fish Camps, at a cost of $3,630,288, would generate 18 man-years of direct employment in the local economy and 80 man-years of induced employment. If mounded systems are used at the three fish camps instead of a sewer plant, the project expenditures total approximately $1,251,600. This translates into six man-years of direct employment and about twenty-five man-years of induced employment.

The total estimated cost for floodproofing all properties in lieu of acquisition would be approximately $23 million. This cost would be for mainly construction type actions and would be borne by the project thereby constituting an infusion of money into the local area. Leaving out the $5.7 million for sewer systems leaves about $17.5 million in floodproofing expenditures. This would

support approximately 85 man-years of direct employment and would generate almost 385 man-years of induced employment.

Given the large number of construction workers in the local labor force and the high unemployment rate in Polk County, it is unlikely that there would be a large influx of construction workers who would make demands on housing, schools, and other infrastructure.

Institutional/Service Impacts: Conversations with sheriff's office and fire department personnel, and emergency service providers indicated that the project would have no influence on the delivery of services to residents of the study area. No barriers to access or increased response times were anticipated.

School officials in both counties were contacted. Many children in the study area attend schools in the nearby towns. Officials said that any changes in the school population as a result of the project would be quite small and would be well within the capacity of the school system.

Potential Impact on Property Values: In general, the potential impacts fall into two categories. First, project implementation could bring about changes in general economic activity, which could in turn affect property values as increased (or decreased) business activity may bring with it increased (or decreased) demand for land in certain areas. Second, changes to properties directly brought about by a project could change values by changing amenities, access, or other factors which could make the property either more or less attractive. The extent and magnitude of these potential impacts is not necessarily expected to be large, widespread, or significant. We can only say that these are potential impacts, without detailed knowledge of the many variables that contribute to affect the market value of a particular piece of property, with or without a project.

For properties to be purchased by the Government as a part of project implementation, if a land owner were to be left with an "uneconomic remnant," its value would be negatively impacted. Land acquisition necessary to implement a project is conducted in a way to avoid such situations. Therefore, while this type of land value impact is potential, it is highly unlikely.

The potential exists for land value to be impacted for those properties whose septic systems will have to be modified or replaced with sewer systems because of the project. For those septic systems which will require replacement with a mounded system, there could be a negative aesthetic appeal impact, in that a smoothly landscaped area will have been replaced with a less attractive look. This effect could be offset to some extent by the fact that a fairly new septic system is better than an older one, in combination with the fact that the property owner may not have had to pay for the change, if it will have been paid for by the Government. For those properties whose septic systems would be replaced with sewer systems, property values could potentially be enhanced.

There is likely to be a reduction in the amount of property subject to local taxes, in that private property will be purchased for project use. In order to fund the same level of local government services with a reduced tax base, the potential exists for property taxes to be raised on the remaining taxable property in the area. This could in turn have a negative impact on property values.

If transportation access to a property is affected by the project, or if there is a change in transportation patterns, there is a potential for some property values to be impacted. Such effects are neither expected nor known, but could be a source of impact.

If recreation activity in the area changes significantly because of the project, there could be a resulting impact on some property values. More activity means more spending, which means more income, more business activity, and more demand in some areas for land. Similarly, the depressing effect of less activity has the potential for a negative impact.

There are a number of fish camps operating in the project area with water access and recreational facilities. Existing regulations make it unlikely that new additional activities of this type would be able to obtain the necessary permits to operate in the future, while permits for existing operations to a large extent have been grandfathered in. Given this situation, if property acquisition for the project were to restrict access points to the lake, or to restrict recreational activity access at existing fish camp operations, the remaining access points to the lake could become more intensely used and more valuable following project implementation.

With the project, the establishment of a conservation easement for a particular property would have the potential to negatively impact property value because of possible lake view amenity reduction. Without the conservation easement, a lakeside property owner can mow the grass right up to the water's edge. Establishing a lakeside conservation easement is likely to eventually result in a wooded area where there previously will have been a mowed area. The decreased lake view amenity could have a depressing effect on such properties' values. Those properties which still would have lake views would be fewer in number, potentially having the effect of increased value.

The values of those lakeside properties with bulkheads, boathouses, docks and piers which will be permitted to be modified (at the owner's expense), have the potential to be impacted. If a boat house or dock, for example, will require modification to be usable under the new lake level regime, a potential buyer would possibly be willing to pay more for a property with such a modification than without."

General Impacts--Short and Long Term: In the short term, the economies of local communities and the counties in the region will be stimulated by an infusion of monies from outside the region through project expenditures. This will particularly benefit the retail sector. Most of the economic benefit will be in the form of wages for construction labor. The Polk-Osceola-Orange county region has a large construction work force. Most of the work would not be very specialized, so there would be little reason to import labor. The benefits may be dispersed over much of the multi-county region, since construction workers often commute considerable distances for work and would spend most of their wages where they live.

The study area will have a considerable improvement in its infrastructure (sewage, water, roads, etc.) that will increase property values and make for a more satisfying place to live for most people. Both permanent and temporary residents in the study area may suffer temporary inconvenience while floodproofing and other construction is being carried out. These impacts can be reduced if the work is scheduled during periods when the "snowbirds" are not in residence.

Some people with interests in the area have joined the citizen's organization "ROAR." The activity associated with the project may well engender more localized, homeowner, or neighborhood associations. This could work to foster community cohesion within the different localities of the study area. Once started because of a common purpose, many such organizations continue because of the social aspects among like people with similar interests and circumstances.

The SFWMD and the COE have both said that no new regulations are envisioned. Concern has been expressed that raising the lake level will put the area more at risk for major flooding. However, because of the increased carrying capacity of the canals and increased discharge capacity of the water control structure at the lower end of Lake Kissimmee, the stage for a 100-year flood is projected to be somewhat lower than under present conditions. No changes are called for in flood insurance requirements, and exposure to flooding damage would be reduced.

Public health should be positively impacted over both the short and longer term by the actions taken as a result of the lake level increase. Local septic systems will be required to be brought up to standard. Central sewer systems may even be the preferred route. The potential for sewage contamination of water bodies, even though very slight with upgraded septic systems, would be far less likely with centralized package systems. Docks, boat houses, and other facilities will be upgraded, lessening physical dangers. Ground shaping to promote surface drainage should reduce mosquito breeding sites within residential areas.

Central sewage systems have a number of advantages over mounded systems. Mounded systems continue to be impacted by water level fluctuations. If water levels stay high enough for long enough, the effluent cannot percolate downward and can seep out at the edges of the mound. This can be unsightly, odorous, and even somewhat unhealthy. For the most part, however, septic systems are adequate from a health standpoint if built to standard. Central systems are healthier in that waste processing is removed from residential areas. Central systems could be especially beneficial around waterfront areas because they are largely unaffected by water level/ground water level fluctuations. Mounded systems are unsightly and are a constant reminder of their function when most people would prefer to put such things out of mind. Also, mounds take up space and remove an area from use for any other purpose. Mounds constrain passage since paths go around septic mounds. Property values are reduced because of the yard area taken up by a mound and because of its negative aesthetics. Central systems, on the other hand, are aesthetically benign since they are hidden and the land can be used for other more desirable purposes. Property values are increased, and the area is more attractive overall.

There are no obvious economic benefits from simply increasing the lake levels. Some people have commented that with higher water they have less difficulty getting their boats into the canals and to their docks.

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The Oasis Marina, Inc. 25601 HWY. 60 East, Lake Wales, Florida 33853.

Osceola County Deputy Appraiser, C.F.E. P.O. Box 422366 Office Complex Room 130, Kissimmee, Florida 34742-2366.

Osceola County Development Department. Special Assessments. 17 South Vernon Avenue, Room 219 Kissimmee, Florida 34741.

Osceola County District Schools Environmental Center. P.O. Box 1948, Kissimmee, Florida 32742-1948.

Osceola County Planning Department. 17 South Vernon Avenue, Room 246, Kissimmee, Florida 34741.

Osceola County Social Services Department. Board of County Commissioners. 1895 Boggy Creek Road, Kissimmee, Florida 34744.

Osceola County Soil and Water Conservation District. 1895 E. Irlo Bronson Hwy, Kissimmee, Florida 34744.

Polk County Agricultural Stabilization and Conservation Service. P.O. Box 688, Bartow, Florida 33830.

Polk County Housing & Development. Polk County Board of County Commissioners. 1290 S. Golfview Avenue, Bartow, Florida 33830.

Polk County School Board, Facilities Planning Specialist. P.O. Box 391, Bartow, Florida 33830.

Polk County Planning Division. Board of County Commissioners, Imperial Polk County. 330 W. Church Street, Bartow, Florida 33830.

South Florida Water Management District, Kissimmee River Restoration, Upper Basin Works, Camp Mack and Camp Lester Area Residential Impact Evaluation, Final Report by Bromwell & Carrier, Inc., June 1994.

South Florida Water Management District, Kissimmee River Restoration, Upper Basin Works, Residential Impact Evaluation, Final Report - Kissimmee River Park by Bromwell & Carrier, Inc., November 1993.

South Florida Water Management District, Kissimmee River Restoration, Upper Basin Works. Residential Impact Evaluation, Final Report by Bromwell & Carrier, Inc., September 1993.

South Florida Water Management District, Kissimmee River Restoration, Upper Basin Works, Camp Mack & Camp Lester Area Residential Impact Evaluation: Evaluation of Impacts: Database Listings and Summaries for Hatchineha Estates, Rocks Fish Camp, Shady Oaks Fish Camp, and Grape Hammock. Bromwell & Carrier, Inc., June 1993.

APPENDIX H

REAL ESTATE SUPPLEMENT

APPENDIX H

REAL ESTATE SUPPLEMENT

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APPENDIX H

REAL ESTATE SUPPLEMENT

CHART OF ACCOUNTS

O1	LANDS AND DAMAGES			
O1A	PROJECT PLANNING	$	$	100,000
O1B--	ACQUISITIONS			
O1B20	BY LS OBTAINED	$		2,910,000
01B40	REVIEW OF LS			172,000
O1C--	CONDEMNATIONS			
O1C20	PREPARATION BY LS	$		150,000
O1C30	BY GOVT ON BEHALF OF LS			2,040,000
O1E--	APPRAISALS			
O1E30	BY LS	$		1,369,000
O1E50	REVIEW OF LS			102,000
O1F--	PL 91-646 ASSISTANCE			
O1F20	BY LS	$		393,000
O1F30	REVIEW OF LS			66,000
O1G--	TEMPORARY PERMITS/LICENSES/RIGHTS-OF-ENTRY			
O1G20	BY LS	$		100,000
O1G40	REVIEW OF LS			34,000
O1G60	DAMAGE CLAIMS			10,000
01M00	PROJECT RELATED ADMINISTRATION			
	ENVIRONMENTAL AUDITS BY LS			403,000
O1R--	REAL ESTATE PAYMENTS			
O1R10	LAND PAYMENTS			
O1R1B	BY LS	$		40,300,000
O1R20	PL 91-646 ASSISTANCE PAYMENTS			
O1R2B	BY LS	$		2,970,000

TOTAL REAL ESTATE COSTS (EXCLUDING CONTINGENCIES)		$	51,119,000
TOTAL REAL ESTATE CONTINGENCIES (RD)	$20,448,000		
TOTAL REAL ESTATE COSTS (RD)		$	71,567,000

STATEMENT OF PURPOSE

This Real Estate Supplement is tentative in nature for planning purposes only and both the final real property acquisition lines and the estimate of value are subject to change even after approval of this Project Modification Report.

PROJECT AUTHORIZATION

A general comprehensive plan for flood damage prevention for central and southern Florida was brought about by the drought of 1944-45, and the hurricane of 1947 which caused wide-spread flooding. The inclusion of the Kissimmee basin in the comprehensive plan was directed, pursuant to Public Law 534, dated 1947.

The comprehensive plan for the existing flood control system was presented in the report to the Chief of Engineers on Central and Southern Florida, published as House Document Numbered 643, Eightieth Congress, Second Session, 1948. It was authorized by the Flood Control Act approved 3 September 1954 (Public Law 780, 83d Congress, 2d Session). The existing flood control project works in the Kissimmee basin conform closely with the general plan outlined in the 1948 report to Congress. The major lakes of the upper basin, which are used as water conservation reservoirs, are connected by channels, in most cases channels excavated in the 1880's, but enlarged to varying degrees under the Congressionally authorized plan. Nine control structures regulate water levels and flows into the lake channel system. A 56-mile canal now connects Lake Kissimmee with Lake Okeechobee. Canal 38 (C-38), some 48 miles in length from Lake Kissimmee to Structure 65 (S-65E), and the previously constructed borrow canal below S-65E of some 8 miles to Lake Okeechobee, comprise this watercourse. Five structures control water elevation in the canal and regulate flows originating in both the upper and lower basins. These structures also have locks which provide year-round navigability within and through the Kissimmee basin.

Work in the upper basin was started in the early 1960's. Regulation of the levels in some of the major lakes started in 1964. Work in the lower basin started shortly thereafter with the lower control structure, S-65E, being completed in mid-1964. In 1965, control of flows and water levels in the Kissimmee basin started under this project. Channel excavation of C-38 was completed in late 1970.

The Kissimmee River Headwaters Revitalization Project was authorized under Section 1135 of the Water Resources Development Act of 1986 (P.L. 99-662), as amended, based on benefits derived for the environmental restoration of the Kissimmee River Basin, and Section 101 of the Water Resources Development Act of 1992 (P.L. 102-580, October 31, 1992). The Environmental Restoration of the Kissimmee River, Florida, Feasibility Report was prepared by the Jacksonville District in December 1991 as authorized under Section 116(h) of the Water Resources

Development Act of 1990 (P.L. 101-640). The Feasibility Report is the foundation of this Project Modification Report.

Construction of the Kissimmee River Restoration Project and the Kissimmee River Headwaters Revitalization Project were merged into the single project called the Kissimmee River, Florida Project authorized by Section 101(8) of the Water Resources Development Act of 1992. On March 25, 1994, a Project Cooperation Agreement was executed between the Department of the Army and the South Florida Water Management District (SFWMD). The unique cost-sharing requirements applicable to this Project were authorized by Section 101 of the Water Resources Development Act of 1992, Public Law 102-580.

Costs will be shared 50/50 by the Corps of Engineers and South Florida Water Management District, as the non-federal sponsor. The sponsor will be reimbursed for any LERRD's costs above 50 percent of the total project costs. Should the sponsor's contributions of LERRD's not equal the 50 percent cost share, the sponsor will be required to pay 50 percent of other designated costs not to exceed 50 percent of the total project costs.

The project modification report for the upper basin segment of the Kissimmee River Florida Project was prepared in accordance with authority provided under Section 1135.

PROJECT LOCATION AND DESCRIPTION

The Kissimmee River basin study area contains approximately 3,000 square miles and is located in south central Florida extending from Orlando southward to Lake Okeechobee. Lake Kissimmee was originally the principle source of the Kissimmee River, but the construction of connecting canals between the upper chain of lakes now places the source just south of Orlando. The northern portion of the basin, the upper basin, is comprised of approximately 1,595 square miles and is sometimes referred to as the "Headwaters". The upper basin contains a series of lakes some of which are interconnected by canals and managed by water control structures.

The upper basin occupies parts of Osceola, Orange, and Polk Counties. This area is bounded on the north by the lakes of the Orlando area, on the west by the Peace River basin, on the south by Kissimmee River and on the east by the upper St. Johns River basin.

The lower basin contributes lateral inflow to the Kissimmee River. The lower basin consists of a 48 mile channel called Canal 38 (C-38) and six water control structures; between Lake Kissimmee and Lake Okeechobee. Five of the water control structures form pools with constant water surface elevations. The lower basin

receives flow from the upper basin through Lake Kissimmee at S-65. The Lake Istokpoga basin is a 422 square mile tributary to the lower basin, though only a portion of these historical flows now reach the Kissimmee River.

This supplement addresses the modification to the Kissimmee River Restoration Study (House Document 102-286 dated April 7, 1993) approved for the lower basin, subject to further studies of the Headwaters Revitalization portion of the project. This report addresses Lakes Kissimmee, Tiger, Cypress, and Hatchineha in the upper basin above State Road 60 where the basin's largest lake, Lake Kissimmee, discharges into the Kissimmee River, as shown on Plate 8- 1.

RECOMMENDED PLAN

In accordance with Section 1135 guidance and the 1992 authorizations, the improvements to the upper basin must be in place and operational in order to obtain restoration benefits in the Kissimmee River. The Headwaters project is an authorized component of the larger Kissimmee River Florida Project. Specific project outputs of the Headwaters component were tied directly to the outputs of the Kissimmee River Restoration Plan as detailed in the 1991 Feasibility Report. Thus, the primary objective of the headwaters revitalization is to provide necessary discharges to obtain the environmental benefits for the lower basin, thereby improving the quality of the environment by restoration or improvement of degraded habitats to their natural integrity, productivity, stability, and biological diversity. Plan development for this study was centered around the development of a modified Lake Kissimmee regulation schedule and operational criteria which would first achieve the environmental benefits associated with the restoration of the lower Kissimmee River which could then be modified to improve environmental conditions within the upper basin. If the Headwaters project is not implemented, the hydrologic conditions required for successful restoration of the Lower Basin ecosystem could not be achieved.

Construction of the C-38 and regulation of the upper basin lakes has reduced the flood threat in the upper and lower basins enabling more extensive land uses to occur. However, it also led to a number of environmental impacts such as loss of fish and wildlife habitat. Because of the environmental nature of this project, an analysis in support of an NED Plan was not conducted for this study. The opportunity to achieve additional environmental benefits in the headwaters while maintaining the flood damage prevention for the study area was a secondary objective of this study and report.

The Corps of Engineers and the State of Florida, with the U. S. Fish and Wildlife Service as a cooperating agency, have studied alternative modifications to the regulation schedule and water control structures of the lakes in the upper basin. This study has been conducted in accordance with current Federal water resources

planning procedures and guidelines, with assistance and support from numerous State and Federal agencies.

Modifications to the existing Lake Kissimmee regulation schedule are necessary to meet two of the five hydrologic conditions that must be established to restore the lower basin ecosystem. The recommended plan for the Headwaters provides for re-establishment of continuous flow with duration and variability characteristics comparable to that of prechannelization conditions by reestablishing the base regulation schedule at 54 feet. Increasing the upper level of lake regulation will expand the littoral zone of the upper basin lakes. Modification of the schedule will provide greater and more natural fluctuations of water levels in the lakes enhancing the peripheral marsh habitats.

The establishment of the 54-foot base regulation schedule was the result of the following. Under natural conditions, the lake surfaces had a range of fluctuation of approximately 6 feet, 75 percent or more of the time. The current schedule is regulated over a 4-foot range. In order to provide more natural flowage conditions, the seasonal water storage had to be increased at the upper end of the lake levels. Based on a sensitivity study by the South Florida Water Management team, it was determined that approximately 100,000 acre-feet of additional water storage was required to provide for longer durations and seasonal variability of flow to the lower river basin. The storage available at 54 feet is 545,000 acre -feet, or approximately 100,000 acre-feet above the existing schedule range.

The Fish and Wildlife Coordination Act Report dated April 1994 and cover letter dated June 30, 1994, from the U. S. Department of the Interior, recommended operational flexibility to increase periods of inundation between the 52.5 and 54-foot contours to increase environmental benefits. Coordination with Fish and Wildlife and the South Florida Water Management District environmental experts resulted in a determination by the Corps of Engineers that it will be beneficial to extend duration of water storage at the 54 foot regulation schedule when this can be accomplished without detrimental impacts to flood control. This will increase wetlands and provide even greater environmental benefits in the upper basin. The simulated period (1970 to 1988) on which the projected benefits were based was drier than historic wet seasons (1929-1960). By increasing the depth to 54 feet N.G.V.D. for a longer period of time, wetlands will be restored to higher elevations than the simulations indicate.

The project in the upper basin consists of necessary structural and operational modifications to the upper chain of lakes. Environmental benefits will be realized in the upper basin as a result of enlarged littoral zones in Lake Kissimmee, Lake Cypress and Lake Hatchineha and in the lower basin as a result of re-establishing the historic seasonal timing of inflows.

The overall objective of this plan is to optimize environmental improvements to the upper basin of the project, while reestablishing discharges to the Lower Basin that are necessary to restore the ecological integrity of the Kissimmee River. This consists of upper basin works which include modification to regulation schedules, channel enlargement and modification of structure S-65. Flood control regulation has impacted environmental resources in the upper and lower basins. Because of the range of water level fluctuations and maximum annual lake stages, which have been reduced, the outer fringe of littoral wetlands surrounding the lakes has been drained and associated fish and wildlife values have diminished.

An additional objective is to provide increased potential for recovery of several endangered and threatened species, while not jeopardizing any remaining listed species. The U.S. Fish and Wildlife Service has determined that the modification of the regulation schedule will benefit the endangered bald eagle, crested caracara, Florida snail kite, Florida grasshopper sparrow, wood stork, and eastern indigo snake. State listed species of special concern are the sandhill crane, the American alligator, least tern, limpkin, snowy egret, little blue heron, and the tricolored heron. This increased storage capacity and expanded littoral zone would result in expanded riparian and wetland feeding habitat and increased food supply.

The upper basin includes the area tributary to the upper chain of lakes (Tohopekaliga and East Tohopekaliga, Hart, Mary Jane, Myrtle, Preston, Alligator, Gentry, and Lake Cypress). Upper basin lakes also include Lakes Marion, Hatchineha, Pierce, Rosalie, Weohyakapka, Tiger, Marian, Jackson and Kissimmee.

The upper basin is characterized by numerous lakes ranging in size from a few acres to 54 square miles. The total surface area of these lakes at normal water surface elevations is more than 10 percent of the total area in the upper basin. Lake levels are controlled by a system of canals and control structures.

Modification of the regulation schedule for the upper chain of lakes will provide the necessary storage and regulation schedule modifications to approximate the historical flow characteristics to achieve or exceed the benefits ascribed to the Kissimmee River Restoration. This will provide higher fluctuations of water levels in four lakes (Kissimmee, Hatchineha, Cypress and Tiger) since no structures control the flow of water between these lakes. The water levels are controlled with a single outflow structure at the south end of Lake Kissimmee, S-65 and inflow control by S-61, 63 and 63A. Lake Jackson was removed from the study area since the Florida Game and Fish Water Fish Commission has constructed a structure to allow regulation of Lake Jackson apart from the other lakes. Lake Rosalie was also not included in the study area as a steel sheet pile weir, G-103, partially separates the lake from the canal connecting it with Lake Kissimmee. The natural outlet of Lake Rosalie is Rosalie Creek, a meandering stream at the south end of the lake which discharges into Lake Tiger.

The recommended plan will increase the quantity and quality of the wetland habitat in the upper basin lake littoral zones to benefit fish and wildlife. More natural fluctuations of water levels will enhance the peripheral marshes of the lakes through reducing buildup of organic sediments and will maintain the same level of flood protection as is provided by the existing flood control project.

The recommended plan authorized in 1992 is being reviewed to reduce impacts to residential areas in the lower limits of the backfill. When the H&H modeling is complete, results will be included in future design memorandum and real estate requirements will be reanalyzed.

COMPONENTS OF RECOMMENDED PLAN AND REAL ESTATE INTERESTS REQUIRED

a. Modify the existing lake regulation schedule from 52.5 feet NGVD to 54.0 NGVD to restore the lower basin, Kissimmee River and to expand the upper basin, Lake Kissimmee littoral zone. The operational flexibility to store water to the revised regulation schedule of 54.0 on an "as needed" basis requires acquisition of land in fee or perpetual easements to insure the minimum project requirements are obtained. As a result of the recommended regulation schedule, lands between the existing 52.5 foot regulation schedule and the proposed 54.0 foot regulation schedule will be flooded when necessary to obtain water storage required to meet lower basin and upper basin requirements. Fee is required in agricultural areas where land uses would be detrimental to the environmental benefits being achieved for this project. Fertilization, mowing, chopping, cultivating, and other agricultural practices are not consistent with environmental practices. Fee acquisition or perpetual easements will assure that environmental goals are achieved and that flexibility is available to manage the regulation schedule as necessary to achieve the greatest environmental benefits without impacting flood control. An incremental analysis cannot be prepared for the operational flexibility requirements due to unknown factors and an incremental analysis was not prepared by the Jacksonville District for the environmental benefits. Acquisition of a lesser estate could result in a reduction of real estate costs. However, this lesser estate would not provide real estate requirements for project purposes as determined by the Attorney's Opinion, January 1996.

The following estates are required: fee title; fee title with reservations of riparian rights as well as grazing (beef cattle only); fee title with reservations of riparian rights as well as road access in several parcels; a perpetual flowage easement over the Celebration lands; perpetual conservation/flowage easements in dense residential areas and on State park lands (Three Lakes Management Area and Lake Kissimmee State Park);perpetual conservation/flowage easements with the right to prohibit, remove or fill septic systems in Hatchineha Estates; Water Inundation Easements; and

perpetual flowage easements surrounding Lake Tiger where environmental benefits will not be realized in the areas between 52.5 and 54.0 feet impacted by the recommended regulation schedule. Land acquisition of approximately 20,800 acres bordering the four lakes impacted by the increased storage and restoration will be required.

a.1. Fee is recommended in accordance with Draft Chapter 12, ER 405-1-12, and Draft Interim EC 1105-2-206, which states "the use of a real property interest less than fee for any permanent project modification purpose must be approved . . ." Traditional acquisition policy based on hydrologic stage frequencies, will not provide adequate levels of interests in project lands. This is based on an inability of operational flexibility for obtaining and/or increasing the performance of the project environmental outputs. Extending the duration of water storage at the 54-foot regulation schedule will increase wetlands and provide greater environmental benefits in the upper basin as well as providing the necessary flow to achieve environmental restoration of the lower basin. It is hydrologically feasible, and desirable, during future wet years to store water at or near the 54-foot elevation for sustainable periods to achieve greater environmental benefits. The benefits of the environmental outputs cannot be measured quantitatively nor has an incremental analysis been performed. The purpose of this project modification is to attain environmental restoration in the Kissimmee River (lower basin) while providing the same flood protection in the headwaters and attaining environmental benefits in the chain of lakes. The restrictions required to achieve the environmental goals would prohibit fertilizing, chopping, mowing, weeding, and cultivating practices which would render the lands unusable for highest and best use which is agricultural. It is estimated that the appraised value of a Perpetual Conservation/Flowage or Perpetual Flowage Easements on impacted lands would approach fair market value or be tantamount to fee value. Therefore, fee title is recommended to assure operational flexibility and protection of the environmental benefits as outlined in Table 9-1 and 9-2, with lesser estates in some areas where the environmental benefits will be minimal or non-existent. A standard flowage easement does not provide for the restrictions of land use detrimental to the environmental aspects of the upper and lower basins.

a.2. Where reservation of grazing (beef cattle only), riparian and/or road access will not interfere with project purposes, these reservations have been incorporated into the fee estate and coordinated with Fish and Wildlife Service as well as the project sponsor.

b. Canal widening for C-36 and C-37 that connect the affected lakes to flatten the flood profile and prevent increased flood stages. By enlarging these canals the tailwaters of Lake Tohopekaliga and Gentry could be reduced to prevent the need for structural modifications or land interests upstream of Lake Cypress. Dredged material will be placed on the existing canal spoil areas within the adjacent rights-of-way owned in fee and permanent easements by South Florida Water Management

District for operation and maintenance, dredging, fill, and spoil disposal for the existing project. It is anticipated that access to construction areas will be by existing maintenance roads available for the current project. However, should additional access become necessary Temporary Road Access easements will be required during the construction period.

c. Increase outlet capacity at water control structure S-65. Modifications to the existing structure will be needed to reduce higher flood stages in Lake Kissimmee and to provide higher discharge capacity. The increase in outlet capacity will be provided by the addition of two concrete bays on the east side of the existing three bay structure as well as enlarging the exit and entrance channels. Modifications will be within the existing right-of-way owned in fee by South Florida Water Management District and a temporary disposal area will be required. Possible relocation of an existing utility pole may be required; however, relocation will occur within the existing right-of-way, which is owned in fee by the local sponsor and certified for the existing project.

d. It was determined that there are parcels that have septic tanks which will be impacted by the project. Parcels in areas where an onsite cure is permittable and feasible (mounded septic tanks) were appraised using the Water Inundation Easement. Parcels which cannot be cured would be acquired in fee. There are 61 parcels where no onsite cure is permittable or possible in Hatchineha Estates. These parcels were appraised in fee acquisition. A Perpetual Flowage Easement may need to be acquired over approximately 120 of the lots impacted below 54.0 N.G.V.D. If the sewer system alternative is implemented, the 61 lots impacted will also require the Perpetual Flowage Easement. This estate will be less restrictive in residential areas to allow property owners to mow and maintain their lawns.

d.1. The COE has studied has studies and proposed an engineering solution in lieu of land acquisition. The construction of a sewer treatment plant was recommended for Hatchineha Estates as a result of the engineering study and if constructed will be a non-Federal responsibility. A perpetual conservation/flowage easement with the right to prohibit existing and future septic tanks, and the right to fill and remove exiting septic tanks, as well as a release will be acquired from landowners required to participate in the hookup to the recommended sewer treatment plant. Should the sewer treatment plant alternative be implemented credit to the sponsor for LERRD's will be set at a fixed ceiling of the COE estimate for construction as the "cost to cure" in lieu of fee acquisition of the impacted tracts. See Compensation for Impacted Residential Septic Systems, page H-16.

e. Breaching of existing local levees. Lands up to the 54-foot contour will be periodically reflooded with the implementation of the recommended regulation schedule. Throughout Lakes Kissimmee, Hatchineha and Cypress, several farm levees were constructed by private landowners. Plate 8-1, Project Plan Plate, shows the

location of these levees. Three were identified by the USFWS in their Coordination Act Report and two more were identified later in the study. These levees have encroached upon the historic lake littoral zone, separating the large, historic, lake bottom marshes from the lakes. In each case, either drainage canals or pump stations are in place to drain surface water run-off into the adjacent lake.

e.1. It has been determined in an engineering analysis that the levees would not provide adequate protection for lands behind the levees which will be inundated as part of the project requirements for water storage. These lands are not considered a separable project area; therefore, an incremental analysis was not prepared. While a quantitative environmental incremental analysis was not performed, a modified qualitative analysis was prepared which describes the potential for increases in environmental performance for the recommended lake regulation schedules.

e.2. Lands behind the five levees are required for water storage to meet the restoration requirements for the Lower Kissimmee River Basin and, as an incidental benefit will provide additional areas for environmental enhancement in the Upper Basin. The removal of these levees will provide full storage capacity required for maintenance of the existing flood control project and for environmental restoration and benefits. The removal or partial removal of the levees will enhance the hydroperiod on the interior portions of the property presently being protected by the levees, allowing for expansion of the lake littoral zone of the upper basin. The levees will be breached at a minimum of 100 foot gaps every one thousand feet along the levee alinement. This alternative would be less expensive than degrading the entire levee, and would provide areas for upland habitat to remain.

e.3. An analysis was performed to demonstrate the cost effectiveness of breaching the levees. Table 7-6 describes the levees and analysis based on the value of wetlands and the habitat value outputs as detailed by the USFWS in their Coordination Act Report. Breaching of the levees would restore an additional 1,350 acres of marsh for a total additional littoral marsh of 7,236 acres. Fee acquisition is recommended behind these levees to assure availability for operational flexibility and protection of the environmental outputs. No interest is required in lands below 52.5 feet which are subject to navigation servitude. These lands were protected from inundation only by the privately constructed levees.

f. The lands north of Lake Hatchineha known as Celebration lands (Walker Ranch) are owned by the Celebration Company a subsidiary of the Disney Corporation as mitigation lands for other lands of the Celebration Company and other subsidiaries of the Disney Corporation. The conditions of a Department of the Army permit and Department of Environmental Protection Permit issued December 1992, required the Celebration Company to purchase these lands in fee for mitigation purposes. The lands are to be managed by the Nature Conservatory, a non-profit corporation with fee title being conveyed to the Nature Conservatory in stages. The permit also

required the Celebration Company to convey a Perpetual Conservation Easement to the State, South Florida Water Management District, Florida Game and Freshwater Fish Commission, and the Nature Conservation. The Celebration Company conveyed a perpetual conservation easement dated December 22, 1992 to the Nature Conservatory, the South Florida Water Management District, the Florida Game and Fresh Water Fish Commission and the State of Florida Department of Environmental Regulation. This easement restricts the use of the property for environmental purposes. The additional right to flood, flow and store water on the property for flood control purposes is required for the Kissimmee Headwater Revitalization Project; therefore, a Perpetual Flowage Easement is recommended for the Celebration lands.

g. Approximately 5,986 acres of land below 52.5 feet NGVD, located between Lakes Cypress and Kissimmee were previously made available for the existing Flood Control Project by Perpetual Flowage Easements. These lands are now required in fee to support the operational flexibility of the schedule and environmental restoration purposes of the project. The lands are upland and surrounded by elevations exceeding 52.5 feet NGVD. These lands have been determined not to be subject to navigation servitude as they are not hydrologically connected to the lakes. With the increase in regulation schedule and inundation of these as well as surrounding lands to 54.0 feet, it is now necessary to include these lands in acquisition of fee for the water storage requirements and to comply with environmental restoration of the project. The valuation will be for the difference between the value of interest previously provided and the value of the required fee estate.

GOVERNMENT-OWNED LAND IN PROJECT AREA

Three Lakes Management Area and Lake Kissimmee State Park:

The portion of Three Lakes Management Area that is within the project consists of 1,261.51 acres and is owned in fee by the State of Florida. Lake Kissimmee State Park is also owned in fee by the State of Florida and contains approximately 472.20 acres within the project area. It has been determined based on conclusions in the Attorney's Opinion dated January 1996, that Perpetual Conservation and Flowage Easement are recommended for acquisition in these areas. Existing uses of the lands and management practices by the Trustees of the Internal Improvement Fund (State of Florida) are not available for flood control nor environmental benefits between the 52.5 and 54.0 foot contours.

APPRAISAL INFORMATION

A Gross Appraisal Report was prepared by the South Florida Water Management District in cooperation with the Jacksonville District, Real Estate Division. This gross

appraisal covered the areas discussed in this report has been approved. The following information was extracted from this report.

The Kissimmee River Headwaters Revitalization Project, (now referred to as the Kissimmee River Project), consisting of the necessary structural and operational modifications, will increase the highest regulation pool in four headwater lakes (Kissimmee, Hatchineha, Cypress, and Tiger) from elevation 52.5 to elevation 54 feet. The project area extends from approximately 12 miles south of the City of Kissimmee to structure S-65 at the south shore of Lake Kissimmee.

Environmental benefits will be realized in the upper basin as a result of enlarged littoral zones in Lakes Kissimmee, Cypress, and Hatchineha. Modification of the regulation schedule for the upper chain of lakes will restore the ability to simulate the historic seasonal flow from Lake Kissimmee to the lower basin (along the Kissimmee River southward to Lake Okeechobee) and provide higher fluctuations of water levels.

Property types in the area are generally restricted to agricultural use (mostly cattle grazing, some row crop, sod and citrus), ranchette subdivision, mobile home parks, single family residential and limited commercial use. See land use maps located at Plate 4-2.

Population in the area is small with most residential development being situated around the lakes. The predominate land use is and will be for some time, agricultural -- including cattle ranching, citrus production and sod farming. Land values have remained stable over the past few years. There are no incorporated areas within the neighborhood.

Much of the area's development is related to fishing and boating. All of the lakes in this area are connected by canals or creeks. Lake Kissimmee and upper chain of lakes form the first link in South Florida's massive watershed, which also includes Lake Okeechobee and the Everglades. This hydrologic system is the source of fresh water for the underground Biscayne Aquifer which serves South Florida.

In conclusion, the neighborhood consists of the rural areas of eastern Polk County and west Osceola County located in close proximity to the Kissimmee Chain of Lakes. This area is east of the developed portions of Polk County and south of the municipalities of Kissimmee and St. Cloud. The area is agricultural in nature and is sparsely populated.

Highest and Best Use: The highest and best use for most of the subject properties was considered to be for continued agricultural and recreational uses.

Agricultural/Commercial: Most of the properties are utilized for agricultural purposes, primarily for grazing, and have been for years. These are owner/operated

ranches specializing in cow/calf operations with sod production and hunting leases as side operations. The wetlands and uplands have been valued similarly as equally productive. Current uses require use of both wetland for access to the water and the uplands for cattle grazing, sod farming, hunting, etc. The dual land uses are equally productive and therefore valued similarly. If another use was in transition, the wetlands may be less valuable.

Residential: The highest and best use for those subject properties containing at least five acres or located within platted subdivisions was considered by the individual appraisers to be for continued single family residential development. For those properties containing less than five acres and not being a "lot of record" by Polk County prior to May 1, 1991, the highest and best use was considered for assemblage to an adjacent, larger parcel having single family development potential.

RELOCATION ASSISTANCE (PUBLIC LAW 91-646, AS AMENDED BY PUBLIC LAW 100-17)

Under this project there is an estimated total of 123 residences and eight (8) commercial businesses affected under Public Law 91-646. This total includes the 61 parcels impacted at Hatchineha Estates which will be require relocation if the septic system alternatives are not implemented. Of the 123 residences, approximately 50 are permanent residence trailers to be relocated which would qualify for full relocation benefits as real property.

Estimates of costs to comply with Public Law 91-646 total $2,970,000.00. This figure represents an average payment of $23,500 for each of the 123 residential acquisitions homes for a total of $2,890,000.00 and $10,000 for each of the 8 commercial acquisitions for a total of $80,000. These payments allow for expenses incurred for recording fees, transfer taxes and costs for prepayment of pre-existing mortgages incident to conveying real property to the Sponsor. Also included in this figure, for residences, are the costs associated with providing displaced persons with comparable decent, safe and sanitary housing.

AVAILABILITY OF REPLACEMENT HOUSING

An Availability of Housing Survey was performed by South Florida Water Management District and indicates that there is sufficient decent, safe and sanitary replacement housing for persons affected under the project. The Local Sponsor will document with a written report on specifics of available housing.

ACQUISITION/ADMINISTRATIVE COST ESTIMATES

Estimates of project acquisition/administrative costs for both the Local Sponsor and the Federal Government are explained below. South Florida Water Management District provided cost estimates for the non-Federal costs.

Based on South Florida Water Management District's experience, it is estimated that 20% of the total parcels to be acquired will result in condemnation, refer to Exhibit C. The ownership data used in calculating the acquisition/administrative costs includes a total of 344 ownership tracts.

Based on the above data, the estimated Federal acquisition/administrative costs (rounded) are as follows:

Project Planning	$ 100,000
Review of Acquisitions (344 x $500)	172,000
Condemnations by Govt on behalf of L.S. (68 x $30,000)	2,040,000
Review of Appraisals (344 x $300)	102,000
Review of PL 91-646 Assistance (123 x $540)	66,000
Review of Temporary Permits (344 x $100)	34,000
Total Federal Acquisition/Administrative Cost	$2,514,000

Applying the unit costs provided by the Local Sponsor for this project, the estimated non Federal acquisition/administrative costs (rounded) are as follows:

Acquisitions: 287 x $ 6,000 =	$1,722,000	
12 x 8,000 =	96,000	
45 x 24,275 =	1,092,000	
Total Acquisition Cost		$2,910,000
Condemnations (administrative preparations	150,000	
Appraisals:		
Administrative Costs (Review, etc.):		
287 x 1,000 =	$287,000	
12 x 5,000 =	60,000	
45 x 7,460,000 =	336,000	
	683,000	
Appraisal (contract costs)		484,000
Title (policies)		202,000
Total Appraisal Cost		$1,369,000
PL 91-646 Assistance (131 x $3,200)		393,000
Temporary Permits		100,000
Damage Claims		10,000
Environmental Audits (contract)		403,000
Total Non-Federal Acquisition/Administrative Cost		$5,335,000

RELOCATIONS, STRUCTURES, AND FACILITIES

There are no known relocations of public facilities to be affected by the upper basin portion of the Kissimmee River Project although there is a possibility of a utility pole relocation required at S-65. It is presumed at this time that the existing rights-of-way are sufficient to support any relocations that may arise, together with the fee lands to be acquired adjacent to the current project right-of-way. If the utility pole relocation is required outside the existing right-of-way, a relocations plan will be prepared and real estate addressed at that time.

NON-FEDERAL OPERATION/MAINTENANCE RESPONSIBILITIES

The South Florida Water Management District, as the Local Sponsor of the projects, will operate and maintain during life of the project at 100% local cost, pursuant to the directions and guidelines of the United States Government.

NON-FEDERAL AUTHORITY TO PARTICIPATE IN THE PROJECT

The South Florida Water Management District was created by virtue of Florida Statutes, Chapter 373, Section .069. The South Florida Water Management District was created to further the State policy of flood damage prevention, preservation natural resources of the State, including fish and wildlife, and to assist in maintaining the navigability of rivers and harbors. (There are other enumerated purposes, but they are not directly applicable to this project.) The South Florida Water Management District is specifically empowered to "Cooperate with the United States in the manner provided by Congress for flood control, reclamation, conservation, and allied purposes in protecting the inhabitants, the land, and other property within the district from the effects of a surplus or a deficiency of water when the same may be beneficial to the public health, welfare, safety, and utility". (Section 373.103)

To carry out the above purposes, the South Florida Water Management District is empowered to "...hold, control, and acquire by donation, lease, or purchase, or to condemn any land, public or private, needed for rights-of-way or other purposes, and may remove any building or other obstruction necessary for the construction, maintenance, and operation of the works; and to hold and have full control over the works and rights-of-way of the district". The term "works of the district" is defined by Section 373.019 to be "those projects and works, including, but not limited to, structures, impoundments, wells, and other water courses, together with the appurtenant facilities and accompanying lands, which have been officially adopted by the governing board of the district as works of the district". Section 373.139 specifically empowers the South Florida Water Management District "...to acquire fee title to real property and easements therein by purchase, gift, devise, lease, eminent

domain, or otherwise for flood control, water storage, water management, and preservation of wetlands, streams and lakes, except that eminent domain powers which may be used only for acquiring real property for flood control and water storage".

The eminent domain power is potentially limited to the above cited purposes and a resort to Federal acquisition might be required if it is construed that South Florida Water Management District's power is limited to the above cited purposes (flood control, water storage or district works). The question essentially becomes whether the governing board's adoption of the project as a district works allows use of its eminent domain powers under Section 373.086 or whether the project is for flood control and/or water storage purposes. The restoration project provides for water storage in the historic flood plain and continues the flood control capabilities of the project with non-structural features having been substituted for structural.

The Corps of Engineers was requested by letters from South Florida Water Management District dated September 1, 1994, and Governor Lawton Chiles dated November 23, 1994, to acquire interests in land needed for the project as agent for the South Florida Water Management District where it has been determined that such interests must be acquired through the filing of eminent domain actions. By letter dated January 6, 1995, Deputy General Counsel (Civil Works and Environment) Earl Stockdale advised that the Corps will perform the requested land acquisitions on the sponsor's behalf only for those lands and real estate interests needed for the Federally authorized project. Upon approval of this report, the Corps of Engineers, Jacksonville District and the South Florida Water Management District will enter into a condemnation agreement delineating the parties' responsibilities in this area.

South Florida Water Management District's Real Estate Division has extensive acquisition experience and has acquired 80 percent of the lands needed for the project and is currently acquiring the remaining lands. South Florida Water Management District is budgeting to acquire the balance of the lands.

ENGINEERING ALTERNATIVES FOR IMPACTED RESIDENTIAL SEPTIC SYSTEMS

Hatchineha Estates and Grape Hammocks subdivisions are residential areas where on-site septic tanks will be impacted by the increase in groundwater levels as a result of the increase in regulation schedule to 54.0 NGVD. All septic tanks located with top of tank below the 56-foot elevation must be replaced with mounded septic tanks or if onsite cure is not possible, be acquired in fee. An engineering analysis was completed by the Jacksonville District of several alternatives.

The results of this analysis indicated the most viable, cost effective alternative for Hatchineha estates construction of a sewer treatment plant. There are approximately 306 lots in Hatchineha Estates with an estimate of 61 impacted with no means of an onsite cure. This subdivision consists of waterfront lots situated on man-made canals, and 150-foot setbacks cannot be achieved. In addition, there are no vacant lots where off-site mounded systems could be placed. These septic systems do not meet current permitting criteria, but were "grandfathered" in for zoning purposes because they were built long before the zoning laws were developed.

Construction of a sewer system has been determined to be the feasible alternative to land acquisition as a least cost alternative for Hatchineha Estates. The non-Federal sponsor has indicated a preference to construct a sewer system in lieu of acquisition and further analysis of the alternative will be performed and a decision made prior to submission of a feature design memorandum for this area. In the event that a sewer system is constructed, the Perpetual Conservation/Flowage Easement would be acquired for lands between the 52.5 and 54.0 foot contours to support project purposes and would prohibit existing and future septic tanks as well as a release will be acquired from owners required to participate in the hookup to the system.

The estimated construction cost including construction, supervision and inspection and contingencies is $2,834,000 for the residences impacted versus estimated real estate costs of acquisition, 91-646 relocation, administration and contingencies totalling $9,260,000. The construction cost estimate is based on a Jacksonville District Corps of Engineers analysis. The sponsor will receive credit for fee acquisition if the sewer treatment system is not implemented. The project sponsor may receive LERRD's credit as a "cost to cure" if the sewer treatment system is implemented, with a maximum set at the COE estimate for construction of the sewer treatment plant .

Parcels with septic tanks in Grape Hammock which can be cured by relocating on existing property with mounded septic tanks required a Water Inundation Easement. These ownerships include four impacts lots which can be cured by onsite mounded systems. These lots were also considered damaged due to relatively large land area required for the mounded systems and associated loss of use.

The remaining impacted lots in Grape Hammocks, Shady Oaks, and Rocks Fish Camp will require either fee acquisition (if they cannot be cured onsite), Perpetual Conservation/Flowage Easements or Water Inundation Easements (for the onsite mounded systems).

HAZARDOUS AND TOXIC WASTES (HTW)

A Civil Work Audit of Property Impacted by the upper basin portion of the Kissimmee River Project was performed by the Jacksonville District and a report dated February 24, 1995 indicated that there is no contamination evident in the lands being acquired for the project in the upper basin. A report from the South Florida Water Management District received in the interim indicates that two cattle dipping vats are located on lands being acquired. These lands will be cleaned prior to certification of lands under the State of Florida "amnesty" program at the expense of the landowner or the sponsor. This effort will be closely coordinated with the Jacksonville District to assure compliance with the CERCLA regulations. The sponsor is preparing a Remediation Plan for completion in mid-January which will be closely coordinated with the Jacksonville District and the Florida Department of Environmental Protection. Cleanup costs will be borne by the landowner or the sponsor and will not be project costs.

The relocation of electrical structures will be accomplished on existing project lands. PCB's have been phased out from the Corps of Engineers projects. In recent years, Corps of Engineers scopes of work have included in the project specifications requirements for contractors to remove all hazardous wastes generated during construction. Cleanup costs, if PCB's were discovered, would be at the sponsor or electrical companies expense and will not be project costs.

RECREATION LANDS

There are no known separable recreation lands included within project lands. Recreational development on project lands will be within the fee taking boundary which will preclude requirements for additional estates.

OUTSTANDING RIGHTS

Known outstanding rights include easements for roads, power lines and communications cables.

MINERAL RIGHTS

Based on South Florida Water Management District's experience to date, there is a minimal amount of outstanding mineral rights in the project area. These mineral rights will be acquired by the Local Sponsor to the greatest extent possible.

TIMBER/VEGETATIVE COVER

Proposed acquisition of lands for project implementation will not consist of any area which will include standing timber or other vegetative cover that has significant recreation or scenic value, therefore, there will be no reservation of standing timber for the proposed acquisition. Standing timber has been determined to have no merchantable value.

TOWNS AND CEMETERIES

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

CULTURAL RESOURCES

A Cultural Resource Study for the project area has been completed. The results of this study will be used to develop a plan should any areas be found in the lands required for the project. (See also paragraph 4.13 CULTURAL RESOURCES.)

ESTIMATED COST OF LANDS, EASEMENTS, RIGHTS-OF-WAY AND RELOCATIONS (LERR) FOR THE PROJECT

The following is a summary of estimated real estate costs for subject project.

1. Lands and Damages
Lands (20,807.54 acres total)

<u>Agricultural Lands</u>

Fee Simple:	
18,375.01 acres	$ 22,827,000
Temporary Disposal Easement:	
10.00 acres	28,000
Perpetual Conservation/Flowage Easement:	
1,922.88 acres	1,303,000
Improvements:	0
Severance Damages:	3,633,000
Total Lands and Damages (Rounded)	$ 27,800,000

Commercial Lands

Fee Simple:	
247.29 acres	$ 1,462,000
Perpetual Conservation/Flowage Easement:	
9.04 acres	44,000
Improvements:	2,437,000
Severance Damages:	857,000
Total Lands and Damages (Rounded)	$ 4,800,000

Residential Lands

Fee Simple:	
51.66 acres	$ 1,648,000
Perpetual Flowage/Inundation Easement:	
191.66 acres	2,045,000
Water Inundation Easement:	
4 ownerships	28,000
Perpetual Conservation/Flowage Easement:	
120 ownerships	82,000
Improvements:	3,876,000
Severance Damages:	4,000
Total Lands and Damages (Rounded)	$ 7,700,000
TOTAL LANDS AND DAMAGES	$40,300,000
2. Acquisition-Administrative costs	
Federal	2,514,000
NonFederal	5,335,000
3. Public Law 91-646	2,096,000
4. Contingencies: 40% (Rounded)	20,098,000
Total Estimated Real Estate Costs	$ 70,343,000

* CONTINGENCIES: A 40% contingency is recommended to be used in connection with this project. Typically, a real estate contingency factor of 25% is added to the total real estate project cost, to cover uncertainties associated with elements such as valuation variance, negotiation latitude, condemnation awards and interest, and refinement of boundary lines during ownership verification. For this report, a contingency factor of 40% has been applied. The contingency is higher due to the magnitude of the project area, limited information available in some areas, the lack of boundary lines in some dense residential areas, unknown costs to be determined during refinement of boundary surveys, final decision on septic tank alternative, the potential for condemnation awards exceeding the number anticipated, and resulting legal issues including sovereign lands and other potential requirements to be determined during refinement of the project in preparation of contracts. Real estate requirements will be reanalyzed during preparation of the Feature Design Memoranda for each segment of the project.

REAL ESTATE ACQUISITION SCHEDULE

The majority of project lands for the upper basin portion of the Kissimmee River Project are scheduled to be acquired by August 31, 1996, with any exceptions being condemnations which may be required for the upper basin. This schedule and Real Estate Supplement has been coordinated with South Florida Water Management District.

Certificates of title, individual tract appraisals, and land surveys will be accomplished by the Local Sponsor and monitored by the Corps of Engineers. Condemnations will be performed by the Corps of Engineers on behalf of the local sponsor.

ATTITUDE OF LANDOWNERS

The Project Modification Report was coordinated with the South Florida Water Management District who has held public meetings with landowners potentially being impacted by the implementation of the project. It has also been coordinated with other agencies, including the Fish and Wildlife Service. The attitudes of the landowners in the upper basin have been varied. The residents are generally receptive, with several expressing concerns for the detrimental impacts to their land use. In areas where less restrictive easements could be utilized without detrimental impact to the environmental benefits, the non-standard estates were developed to meet the needs of the public as well as the landowners.

ESTATES TO BE ACQUIRED

STANDARD ESTATES:

1. Fee Title:

The fee simple title to (the land described in Schedule A) (Tracts Nos. _____, and ____), subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines.

2. Flowage Easement (Permanent Flooding): (To be used on the Disney Celebration Lands)

The perpetual right, power, privilege and easement permanently to overflow, flood and submerge (the land described in Schedule A) (Tract No. ____ and ____) in connection with the operation and maintenance of the Kissimmee River, Florida Project as authorized by the Act of Congress (Public Law 103-126) and the Water Resources Development Acts of 1988 and 1992, and the continuing right to clear and remove any brush, debris and natural obstructions which in the opinion of the Grantee, may be detrimental to the Project, together with all right, title and interest in and to the structures, improvements situate on the land; provided that no structures for human habitation shall be constructed or maintained on the land, that no other structures shall be constructed or maintained on the land except as may be approved in writing by the Grantee, and that no excavation shall be conducted and no landfill placed on the land without such approval as to the location and method of excavation and/or placement of landfill; the above estate is taken subject to existing easements for public roads and highways, public utilities, railroads and pipelines; reserving, however, to the landowners, their heirs and assigns, all such rights and privileges as may be used and enjoyed without interfering with the use of the project for the purposes authorized by Congress or abridging the rights and easement hereby acquired, provided further that any use of the land shall be subject to Federal and State laws with respect to pollution.

3. Temporary Disposal/Borrow Area Easement

A temporary assignable easement and right-of-way in, on, over and across (the land described in Schedule A) (Tracts Nos. ____, ____, and ____), for a period not to exceed _____, beginning with date possession of the land is granted to the Grantee, for use by the Grantee, its representatives, agents, and contractors as a (borrow area) (work area), including the right to (borrow and/or deposit fill, spoil and waste material thereon) (move, store and remove equipment and supplies, and erect and remove temporary structures on the land and to perform any other work necessary and incident to the construction of the Kissimmee River, Florida Project, together with the right to trim, cut, fell and remove therefrom all trees, underbrush,

obstructions, and any other vegetation, structures, or obstacles within the limits of the right-of-way; reserving, however, to the landowners, their heirs and assigns, all such rights and privileges as may be used without interfering with or abridging the rights and easement hereby acquired; subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines.

4. Temporary Access Road Easement

A temporary assignable easement and right-of-way in, on, over and across (the land described in Schedule A) (Tracts Nos. ___, ___ and ___), for a period not to exceed _____, beginning on the date possession of the land is granted to the Grantee, for the location, construction, operation, maintenance, alteration and replacement of (a) road(s) and appurtenances thereto by the Grantee, its representatives, agents and contractors; together with the right to trim, cut, fell and remove therefrom all trees, underbrush, obstruction and other vegetation, structures, or obstacles within the limits of the right-of-way; (reserving, however, to the owners, their heirs and assigns, the right to cross over or under the right-of-way as access to their adjoining land at the locations indicated in Schedule B); 5/ subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines.

NON-STANDARD ESTATES:

5. Fee Reserving Riparian Rights and Reserving Perpetual Road Easement
(To be used only where acquisition of property cuts off access to remaining property of grantor)

The fee simple title to (the land described in Schedule A) (Tracts Nos. _, _ and _), subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines; reserving unto Grantor, his heirs, successors and assigns, a perpetual easement for ingress and egress, over and through the property, to the waters of Lake(s) (Kissimmee, Cypress, Hatchineha, Tiger) abutting the property for the benefit of remaining contiguous property presently owned by Grantor for the purpose of exercising only the following rights to said waters: access to the water, the right to navigate, and fish. The reserved rights enumerated herein are restricted to non-commercial uses, and are subject to any and all federal, state, or local laws and rules relating to the use of the property including obtaining any permits which may be required thereby and are subordinate to the right of the Grantee, its successors and assigns to flood and submerge the land, at any time, in connection with the construction, operation and maintenance of the Kissimmee River, Florida Project. Use or access to said waters by Grantors, its agents, guests, or invitees of the Grantor, its successors and assigns, for the benefit of remaining contiguous property is permitted provided Grantor does not charge a fee therefor and the Grantor shall not exclude the public from use of the property.

Also reserving to the Grantor, his heirs, successors and assigns, a perpetual access road easement along the existing roadway as depicted on Exhibit " " attached hereto and made a part hereof, for ingress and egress over and across the property described herein to the remaining contiguous property presently owned by the Grantor, provided however that the right of access for ingress and egress is subordinated to the right of the Grantee, its successors and assigns to flood and submerge the land in connection with the construction, operation and maintenance of the Kissimmee River, Florida Project. The Grantee shall not be obligated to maintain said access road easement. Grantor may raise the existing road, at its sole cost and expense, only upon the written permission of the Grantee and provided that such raising does not interfere with the authorized purposes of the Kissimmee River, Florida Project. Provided, further, however, that the Grantee reserves the right to reasonably approve the size and placement of culverts in and elevations of the elevated road and that any elevation of the surface of the road will not impede the surface flow of water in any direction.

6. Fee Reserving Riparian and/or Grazing Rights

The fee simple title to (the land described in Schedule A) (Tracts Nos. _, _ and _), subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines; reserving unto Grantor, their heirs and assigns, a perpetual easement for ingress and egress, over and through the property, to the waters of Lake (Kissimmee, Cypress or Hatchineha) abutting the property for the benefit of remaining contiguous property presently owned by Grantor for the purpose of exercising only the following rights to said waters: access to the water, the right to navigate, fish, and bathe. The reserved rights enumerated herein are restricted to non-commercial uses, and are subject to any and all federal, state, or local laws and rules relating to the use of the property including obtaining any permits which may be required thereby and are subordinate to the right of the Grantee, its successors and assigns to flood and submerge the land, at any time, in connection with the construction, operation and maintenance of the Kissimmee River, Florida Project. Use or access to said waters by Grantors, its agents, guests, or invitees of the Grantor, its successors and assigns, for the benefit of remaining contiguous property is permitted provided Grantor does not charge a fee
therefor and the Grantor shall not exclude the public from use of the property.

Also subject to a reservation in favor of the Grantor reserving the right to possess and occupy the property for the purpose of grazing cattle (beef cattle only), however, such right is subordinated to the right of the Grantee, its successors and assigns to flood and submerge the land, at any time, in connection with the construction, operation and maintenance of the Kissimmee River, Florida Project.

7. Perpetual Flowage: (To be used on Lake Tiger)

The perpetual right, power, privilege and easement to regularly or at any time and for any length of time to overflow, flood and submerge the land described on Schedule A, Tract Nos. ____ ____ and _____ in connection with the operation and maintenance of the Kissimmee River, Florida Project, as authorized by Public Law 103-126 and the Water Resources Development Acts of 1988 and 1992, together with all right, title and interest in and to the timber, structures and improvements situate on the lands, except (here identify those structures not designed for human habitation) and providing that no structures shall be constructed or maintained on the land except as may be approved in writing by the representative of the Grantee in charge of the Project, and further that the above estate is taken subject to existing easements for public roads and highways, public utilities, railroads and pipelines; reserving, however, to the landowners, their heirs and assigns, all such rights and privileges as may be used and enjoyed without interfering with the use of the Project for the purposes authorized by Congress or abridging the rights and easement hereby acquired.

8. Perpetual Conservation and Flowage Easement (Permanent Flooding): (To be used on Lake Kissimmee State Park and Three Lakes Management Area [State Lands] and in Residential Areas) (the language in bold will be inserted in those deeds in areas (Hatchineha Estates) where the existing septic systems can not be raised and a sewer system is being installed to provide an alternative to septic systems and the landowner is not willing to voluntarily attach to the sewer facilities and will be used in Hatchineha Estates -the other 120 lots where septic tanks are not impacted by the project but which hook-up to the sewer system will require estate number 7, as described above)

The perpetual right, power, privilege and easement permanently to overflow, flood and submerge the land described on Schedule A, Tract Nos. _____ ____ _____ in connection with the operation and maintenance of the Kissimmee River, Florida Project, as authorized by Public Law 103-126 and the Water Resources Development Acts of 1988 and 1992, and the continuing right to clear and remove any brush, debris and natural obstructions which, in the opinion of the representative of the Grantee in charge of the Project, may be detrimental to the Project, together with all right, title and interest in and to the timber, structures and improvements situated on the lands, and provided that no structures and improvements shall be constructed or maintained on the land; and provided that the Grantor is prohibited from constructing, operating or maintaining any existing or future septic system on the remaining contiguous land of the Grantor described on Schedule B, and that the grantee may enter onto the remaining contiguous land of the Grantor described on Schedule B to fill in or remove any existing septic system or to take other action to render the septic system inoperable; and further that the above estate is taken subject to existing easements for public roads and highways, public utilities, railroads and

to existing easements for public roads and highways, public utilities, railroads and pipelines; reserving, however, to the landowners, their heirs and assigns, all such rights and privileges as may be used and enjoyed without interfering with the use of the Project for the purposes authorized by Congress or abridging the rights and easement hereby acquired; the Grantor is expressly authorized to use said real property as a native pasture for grazing purposes (beef cattle only) in accordance with sound, generally accepted agricultural practices; provided further that any use of the land shall be subject to federal, state and local laws with respect to pollution and provided further that no fertilizers or chemicals of any kind or description are used, spread or distributed on the aforesaid property.

In addition to the restrictions set forth above, the following shall be prohibited except with the express written permission of the Grantee:

(a) The placement or construction of docks, dikes, pilings, boathouses, piers or any water control activities.

(b) Dumping or place of soil or other substance or material as landfill or dumping or placing of trash, waste, unsightly or offensive materials, or excavation, dredging, removal of loam, soil, peat, gravel, rock or other substance or material of any type.

(c) Removal or destruction of trees, shrubs or other vegetation. This includes mowing or aerating land or earth moving activities of any kind.

(d) Dairy operation of any type will not be permitted.

The Grantor reserves the right to construct fences at any location on the above described property of any nature whatsoever, so long as they do not impede the flow of water or affect the quantity of water that may be stored on the property and provided that no fences are constructed parallel to the shore of the lakes below elevation 52.5 feet N.G.V.D. The Grantee shall not have any responsibility to monitor, maintain or replace all or any portions of the fence.

9. **Water Inundation Easement (Structures Remain):** (to be used in areas where the existing septic system can be raised)

The perpetual right, power, privilege and easement permanently to flood and inundate with water to ground elevation _____ NGVD the land described in Schedule A (Tracts _____) in connection with the operation and maintenance of the Kissimmee River, Florida Project as authorized by Public Law 103-126 and the Water Resources Development Acts of 1988 and 1992; provided that no structures for human habitation shall be constructed or maintained on the land and provided further that no existing or future septic system or other structures shall be constructed, operated or maintained on the land which requires ground water elevation below 56 feet NGVD;

landowners, their heirs and assigns, all such rights and privileges as may be used and enjoyed without interfering with the use of the project for the purposes authorized by Congress or abridging the rights and easement hereby acquired.

10. Utility and/or Pipeline Easement: (To be used for installation of sewer pipelines-Easement from County)

A perpetual and assignable easement and right-of-way in, on, over, across and under (the land described in Schedule A) (Tract Nos. ____ and ____) for the purpose of locating, constructing, excavating, operating, maintaining, altering, repairing, and replacing of underground wastewater sewer facilities and pipelines; together with the right to trim, cut, fell and remove therefrom all trees, underbrush, obstructions and other vegetation, structures, or obstacles within the limits of the right-of-way; reserving, however, to the landowner, their heirs and assigns, all such rights and privileges as may be used without interfering with or abridging the rights and easement hereby acquired; subject , however, to existing easements for public roads and highways, public utilities, railroads and pipelines.

11. Perpetual Flowage/Inundation Easement: Alternative Estate to Perpetual Conservation and Flowage Easement: (to be used in areas where the existing septic system can not be raised and sewer system is being installed to provide alternative to septic tanks and landowner will not willingly attach to sewer facilities) Easement should encompass entire property of Grantor-Full legal description of all Grantor's property including lands above 54.0 feet.

The perpetual right, power, privilege and easement permanently to flood and inundate with water to ground elevation 54 feet NGVD; the land described in Schedule A (Tracts _____) in connection with the operation and maintenance of the Kissimmee River, Florida Project as authorized by Public Law 103-126 and the Water Resources Development Acts of 1988 and 1992; provided that no structures for human habitation shall be constructed or maintained on the land below ground elevation 54 feet NGVD; **and provided, further, that the Grantor is prohibited from constructing, operating or maintaining any existing or future septic system on the land; and provided further that the Grantee may enter onto the land to fill in or remove any existing septic system or to take other action to render the septic system inoperable**; the above estate is taken subject to existing public easements for public roads and highways, public utilities, railroads and pipelines; reserving, however, to the landowners, their heirs and assigns, all such rights and privileges as may be used and enjoyed without interfering with the use of the project for the purposes authorized by Congress or abridging the rights and easement hereby acquired.

12. Release (for use where landowner agrees to connect to wastewater sewer utility)

The South Florida Water Management District is the local sponsor for the operation and maintenance of the Kissimmee River, Florida Project (the "Project"), as authorized by Acts of the United States Congress as authorized by Public Law 103-126 and the Water Resources Development Acts of 1988 and 1992. The Project includes raising water levels in the Kissimmee River and the Kissimmee Chain of Lakes, including lake _____ to elevation 54.0 feet NGVD.

The use of a septic system for wastewater disposal service to Owner's property, as legally described in the attached Exhibit "A", incorporated herein by reference (hereinafter "Owner's Property"), will adversely impacted by the Project.

The South Florida Water Management District has provided the Owner access to a wastewater sewer utility system to service Owner's Property in lieu of Owner's use or operation of any existing or future septic system.

In consideration thereof, Owner hereby releases the South Florida Water Management District, the State of Florida, and the United States of America and their successors and assigns, from any claim, loss, damage, demand, cost, including attorney's fees, expense, cause of action, or judgment (hereinafter collectively "claim") which Owner now has or may hereinafter have in perpetuity with regard to impacts of the Project on Owner's use or operation of any existing or future septic system on Owner's Property.

Owner further shall not install a septic system or use any existing septic system on Owner's Property. The district may enter onto Owner's Property to fill in or remove any existing septic system or to take other action to render the septic system inoperable.

JUSTIFICATION FOR REAL ESTATE INTERESTS RECOMMENDED

In accordance with ER 405-1-12, a permanent flowage easement would normally be required for flooding lands between the 52.5 and 54.0 foot contours for flood control purposes. However, in the Draft Chapter 12, ER 405-1-12 as well as EC 1105-2-206, fee title is required for environmental, fish and wildlife mitigation, projects. Acquisition of approximately 20,800 acres of land bordering the three lakes and Lake Tiger is recommended to provide the necessary storage requirements for the Lower Kissimmee River Basin and expansion of the Upper Kissimmee Basin wetlands. The recommended plan is expected to at least achieve and probably exceed the environmental benefits to the Kissimmee River Restoration Project. Approximately 7,236 acres of littoral wetlands will be realized by implementation of the proposed regulation schedule. Operational flexibility in the regulation schedules is required to

incorporate flexible management strategies to meet or exceed the varying and unforeseen needs of both the Kissimmee River Upper and Lower Basins. The Government needs to right to adjust the schedule for frequency, depth (not to exceed the 54.0 foot regulation schedule) and duration at any time for any length of time. In addition, the fee title acquisition will allow greater environmental outputs for the restoration project in both the lower and upper basins. These benefits will be achieved by providing a wider range between high and low water levels in the upper basin. The tables provided at 9-1 and 9-2 indicate the environmental outputs to be realized. An incremental analysis was not prepared to indicate qualitative environmental outputs. An real estate incremental analysis was also not prepared. The acquisition of less than the recommended estates could result in reduction in land costs. However, a lesser estate would not provide the real estate requirements of the project for, not only the environmental benefits, but the operational flexibility. The reduction in real estate costs now could result in higher costs in the future to re-evaluate the schedule and discharges for adjustments and resulting acquisition of additional interests to provide for operation of the regulation schedule. A lesser estate would also not be consistent with the environmental restoration purposes of this overall project.

The fee acquisition is required to meet the project requirements. The real estate analysis has been prepared consistent with level of detail of remainder of the elements of this study. The Attorney's Opinion dated January 1996, concludes that the fee acquisition is necessary in cited areas to achieve the operational flexibility and environmental enhancements of the recommended plan. Referenced opinion also supports the following recommendations of estates to be acquired.

The Perpetual Conservation/Flowage easements are recommended in densely populated areas where environmental benefits will be realized by permitting landowners to retain ownership of their property with restrictions to prohibit activities on easement lands that would be detrimental to or interfere with the Federal project. This will include Hatchineha Estates located on Lake Hatchineha and the State Park lands which are not protected nor managed to provide protection for environmental restoration or benefits to be obtained by the new regulation schedule.

The Perpetual Flowage Easement is recommended for lands surrounding Lake Tiger and for the Celebration mitigation lands. A Takings analysis was prepared for the Lake Tiger area. Impacts of flooding of these lands will be significant and the estate was drafted based on the standard flowage easement with additional restrictions to prohibit activities not consistent with project purposes. The environmental benefits for Lake Tiger are very minimal. The primary economic impact is to lands used for grazing. Therefore, a lesser estate is recommended for project purposes. Lake Tiger is connected to Lake Kissimmee through Tiger Creek, a small meandering natural stream. Since Lake Tiger and Lake Kissimmee are at essentially the same natural ground elevation and since no water control structure is

currently installed on Tiger Creek, the peak flood stages for the two lakes are intrinsically linked and are nearly identical for floods above elevation 54 feet. Outside of isolating Lake Tiger and installing a substantial pump station, there is no structural alternative to insure that Lake Tiger with-project stages can be reduced below those of Lake Kissimmee. Therefore, acquiring the Perpetual Flowage Easement to assure the operational flexibility of the schedule and to protect the lesser degree of environmental benefits achieved in this area are required. The Perpetual Flowage Easement is also required for flood control and water storage on the Disney Celebration Lands.

(3) The remaining lands required are in areas where ground water elevation will impact septic tanks in isolated areas requiring Water Inundation Easements (Structures Remain), Fee Simple for parcels where there is or will be no cure; and a Perpetual Conservation/Flowage Easement and a release for those parcels to hookup to an alternative sewer treatment system for the Hatchineha Estates.

RECOMMENDATION REGARDING ESTATES BEING ACQUIRED BY LOCAL SPONSOR

Perpetual Conservation and Flowage easements or Perpetual Flowage easements are recommended only where fee acquisition is not required to provide the maximum environmental benefits. These areas include residential areas, State of Florida Trustee of the Internal Improvement Funds (T.I.I.F.) lands, and mitigation lands owned by the Celebration for Disney, Inc. The Perpetual Conservation Easement which has been acquired in several agricultural areas by the Local Sponsor is sufficient to support the needs of the restoration project. The sponsor has not acquired interests in the Lakes Hatchineha and Tiger areas since they are awaiting approval of the non-standard estates to initiate acquisition. A Perpetual Flowage easement will be required for the Celebration for Disney, Inc. mitigation lands.

The Perpetual Flowage easements the sponsor has obtained will have to be revised to eliminate zones for flooding which may be adjusted for operational flexibility after analyzing the revised regulation schedule.

Fee estates with reservations to the grantor have been acquired by the sponsor in some agricultural areas . The areas which have been acquired in fee by the sponsor have been recommended in fee to assure that fertilization, chemical treatments, aerating, burning, mowing, chopping, clearing, diking, fill or water control activities which are not consistent with environmental restoration purposes of the projects are prohibited.

The Jacksonville District has coordinated with the sponsor during the planning process. The sponsor has been advised of the risks of proceeding with acquisition prior to approval of real estate requirements in this report. The sponsor is aware of the risks during the crediting process and the risk of additional real estate interests being required.

SOVEREIGN LANDS AND NAVIGATION SERVITUDE

While is it clear that the State of Florida, pursuant to Florida case and statutory law, owns fee title to the ordinary high-water line as it existed at the time of the establishment of statehood, the exact location of the ordinary high-water line on the Upper Basin lakes has not been determined.

There have been several studies, reports and articles written that have attempted to determine the location of the ordinary high water line on the upper chain of lakes. However, none of the conclusions reached by these articles have been accepted by the State of Florida as proof of the location of the ordinary high water line.

An Attorney's Opinion prepared January 1996, concluded that the only lake where the ordinary high water line has been decided for state sovereign land purposes is Lake Hatchineha.

In MacNamara v. Kissimmee River Valley Sportsman's Association and Board of Trustees of the Internal Improvement Trust Fund, 1994 W.L. 558430 (Fla. App. 2nd Dist 1994), the court was requested to determine where the location of the ordinary high water line on Lake Hatchineha. A property owner constructed a fence on a spoil island below what was claimed to be the high water line and was prohibiting hunters from entering the spoil island. The Trustees' intervened in the action and agreed to be bound by the results. The court held that the ordinary high water line for Lake Hatchineha was at 52.5 feet mean sea level and that all lands below 52.5 feet were state sovereign lands. The establishment of the ordinary high-water line at 52.5 feet was based on the current regulation schedule for Lake Hatchineha.

The State of Florida has determined that without extensive surveys of the lands surrounding the upper basin lakes and probably without extensive, lengthy, and expensive litigation, the ordinary high water line cannot be determined and that, therefore, it will not assert its claim of ownership to any individual parcel in the Kissimmee River and its headwaters provided that the South Florida Water Management District acquired the parcels by means of voluntary acquisition and complied with other terms of a resolution signed by the Trustees of the Internal Improvement Trust Fund.

The same studies, reports and articles were reviewed to determine the location of the ordinary high-water line on the upper basin lakes for purposes of the federal navigation servitude.

The above referenced Attorney's Opinion also addressed navigation servitude and the following reflects discussion and conclusion in this opinion.

In March 1975, the U. S. Army, Corps of Engineers, Jacksonville District prepared a Navigability Study of the Kissimmee River and its Tributaries. While this study is unapproved, it concluded that for navigability purposes the ordinary high water line on Lakes Cypress, Hatchineha and Kissimmee was located at 52.5 feet mean sea level. Based on this study; the lack of data on the location of the historic ordinary high water line for the lakes; the fact that for the current project, the South Florida Water Management District was required to acquire lands below the 52.5 foot contour; and to establish the location of the ordinary high water line would require extensive surveys of all the lands surrounding the upper basin lakes, the recommendation of the Jacksonville District is that acquisition of interests in lands between the 52.5 and 54.0 foot contour is justified for the proposed project modification.

The recommendation of the Jacksonville District is that the ordinary high water mark for the purposes of the state sovereign lands and the Federal Navigation servitude extends to at least the 52.5 foot elevation and that establishing the requirement for acquisition of interests in lands between 52.5 and 54.0 feet is justified based on: (1) the lack of data on the location of the historic ordinary high water line for the three lakes at the time of statehood; (2) the fact that for the existing Kissimmee River project, the South Florida Water Management District was required to acquire lands below the 52.5 foot contour in the upper basin lakes; and (3) to establish the location of the ordinary high water line would require extensive surveys of all the lands surrounding the upper basin lakes.

Navigation Servitude is being applied to lands located below 52.5 feet NGVD in navigable waters of Lake Kissimmee, Lake Cypress, Lake Hatchineha and Lake Tiger. However, upland areas not hydrologically connected to the lakes, i.e. lands between Lake Cypress and Lake Kissimmee, are excluded from the navigation servitude.

PRE-PROJECT CONDITIONS

The following discussions and conclusions were taken from the Attorney's Opinion dated January 1996.

Based on the modeling of the recommended plan, water level stages will not exceed historic conditions. For the period 1929 to 1960 (pre-existing project), water level stages exceeded 48.5 feet, 79% of the time; 52.0 feet, 40% of the time; 52.5 feet, 16% of the time and 54.0 feet 6% of the time. Current modeling of the recommended

plan indicates the water level stages will exceed 48.5 feet, 93% of the time, 51.0 feet 36% of the time; 52.5 feet 8% of the time; and 54.0 feet 0.1% of the time.

The regulation schedule for the existing flood control project underwent a series of modifications (1956, 1976, and 1982) prior to a final regulation schedule being established. Current modeling is based on the period from 1970 to 1988, which was a much drier period than the period from 1929 to 1960. The anticipated benefits of the recommended plan are that in addition to hydrologic regimes that will effectively accomplish the integrated environmental restoration objectives for both the upper and lower basins, the new regulation schedule will provide operational flexibility for fine-tuning the restoration plan and adaptive management of the recovering and restored ecosystem. Following implementation, the regulation schedule may be re-evaluated. Potential modification of the regulation schedule would be based upon future hydrologic performance and results of the project's comprehensive restoration evaluation program in both the upper and lower basin. It may be probable to modify the schedule to maintain higher lake stages in the lakes for longer durations and still provide the necessary inflows to achieve the lower basin restoration. Alternatively, adjustments may be required to facilitate restoration of the lower basin. Without an interest in the lands surrounding the lakes, operational flexibility will depend on a continuing analysis of proposed modifications to the regulation schedules to determine that a "taking" will not occur. Future water storage capabilities would also be lost if an interest in these lands is not acquired.

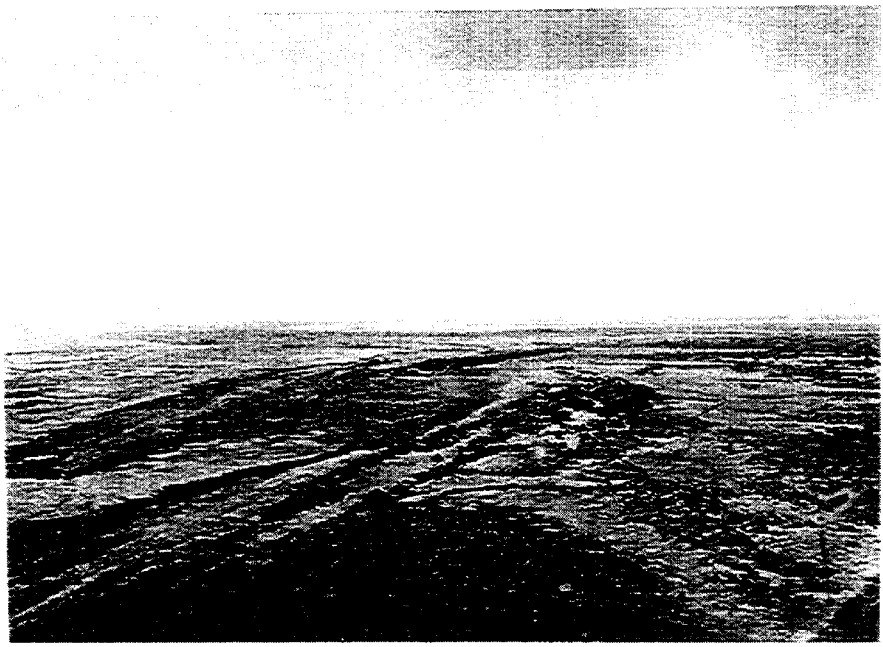
MAPS

For the purpose of this report, the Jacksonville District and the Local Sponsor established the perimeter boundaries of the project. In the upper basin the limits are between the contours at elevation 52.5 and 54 feet, NGVD with the addition of the approximately 5,986 acres of uplands below 52.5 feet located between Lakes Cypress and Kissimmee. These lands are surrounded by elevations of greater than 52.5 NGVD and are required for water storage, operational flexibility and environmental benefits.

The maps shown as Plates H-1 thru H-10 were computer generated from maps furnished by the Local Sponsor. Final segment/acquisition maps and tract descriptions will be prepared in coordination with the project sponsor.

EXHIBIT B

SOUTHEAST CORNER OF LAKE KISSIMMEE LOOKING NORTHEAST
HYATT AND MACK PROPERTIES ON RIGHT SIDE OF PICTURE



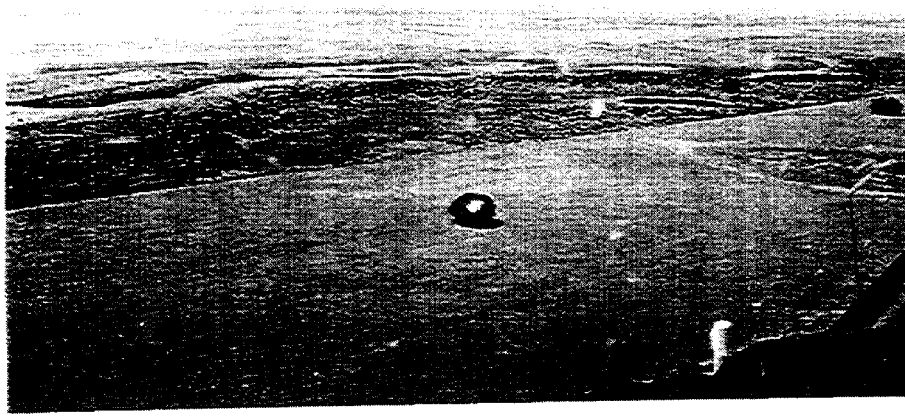
SOUTHEAST SIDE OF LAKE KISSIMMEE LOOKING NORTH
THREE LAKES WILDLIFE MANAGEMENT AREA IN FOREGROUND

EXHIBIT B

EAST SIDE OF LAKE KISSIMMEE LOOKING NORTH
RAWLIN OVERSTREET PROPERTY IN FOREGROUND

NORTHEAST SIDE OF LAKE KISSIMMEE LOOKING NORTH
SOUTHPORT RANCH PROPERTY IN FOREGROUND

EXHIBIT B



NORTHEAST CORNER OF LAKE KISSIMMEE LOOKING NORTH
BILL JOHNSTON PROPERTY IN FOREGROUND
BRONSON PROPERTY AT TOP OF PICTURE

SOUTHEAST SIDE OF LAKE CYPRESS LOOKING NORTH AT BRONSON PROPERTY

EXHIBIT B

EAST SIDE OF LAKE CYPRESS LOOKING NORTH
RAWN FISH CAMP IN FOREGROUND

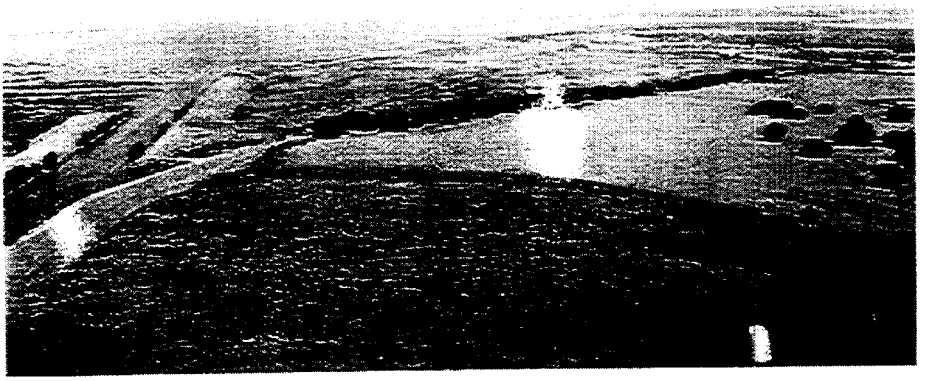
WEST SIDE OF LAKE HATCHINEHA LOOKING SOUTHEAST
AT IMAGINATION FARMS PROPERTY

EXHIBIT B

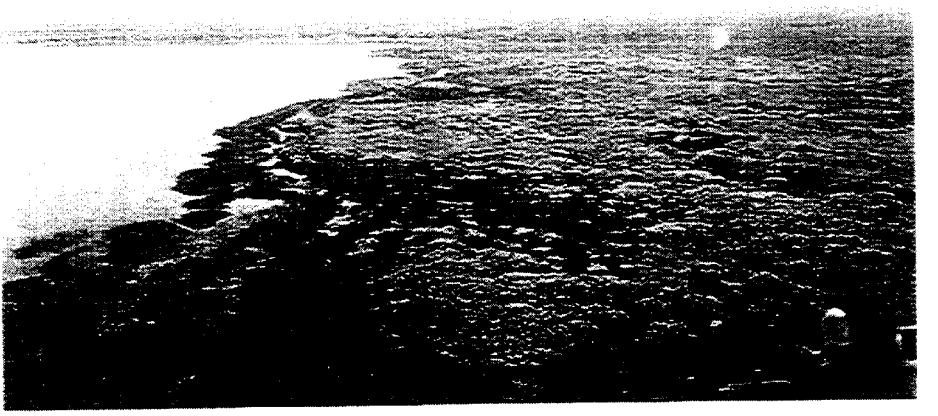
SOUTHWEST CORNER OF LAKE HATCHINEHA LOOKING SOUTHEAST
ROLLING MEADOW SOD FARM IN FOREGROUND

WEST SIDE OF C-37 LOOKING SOUTHEAST
RAY LEIS PROPERTY (KISSIMMEE RIVER PARK) IN FOREGROUND

EXHIBIT B



NORTHWEST CORNER OF LAKE KISSIMMEE LOOKING SOUTHEAST



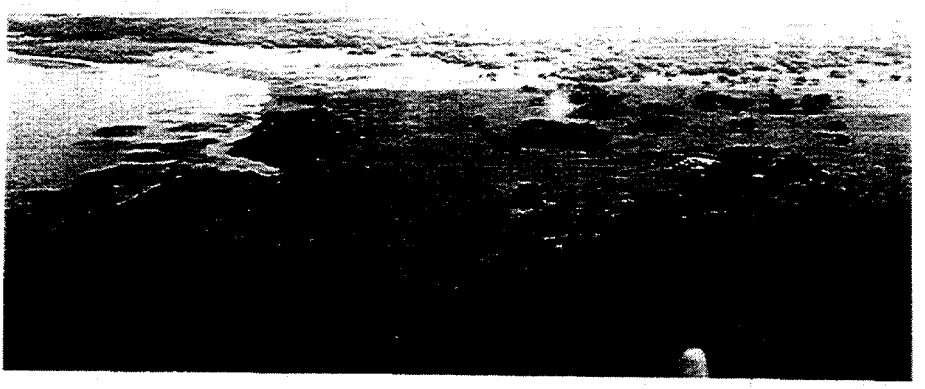
NORTH SIDE OF LAKE TIGER LOOKING SOUTHWEST

EXHIBIT B

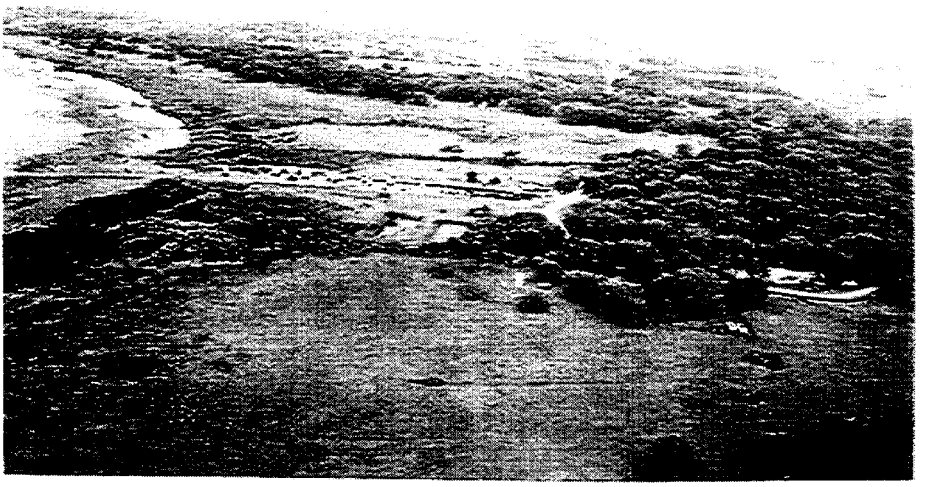
NORTHWEST SIDE OF LAKE TIGER LOOKING SOUTHWEST
LIONS CAMP IN CENTER OF PICTURE

WEST SIDE OF LAKE TIGER LOOKING SOUTH
BUD'S FISH CAMP IN FOREGROUND

EXHIBIT B



SOUTHWEST CORNER OF LAKE TIGER LOOKING SOUTHEAST



SOUTH SIDE OF LAKE TIGER LOOKING EAST
CAMP TIGER IN CENTER OF PICTURE

EXHIBIT B

SOUTHEAST SIDE OF LAKE TIGER LOOKING NORTHEAST

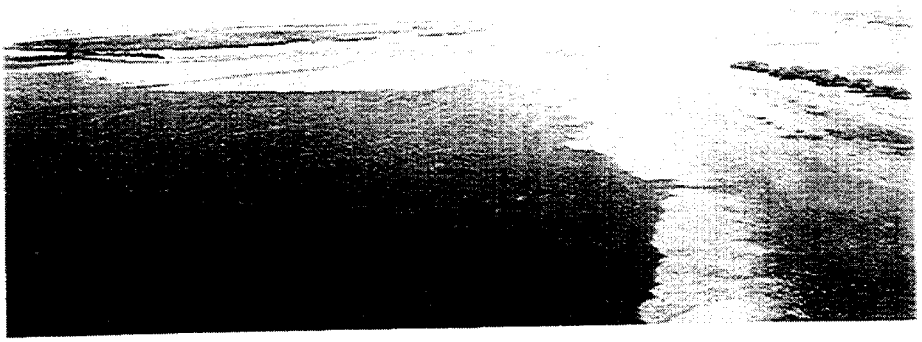
NORTHEAST CORNER OF LAKE TIGER LOOKING NORTH

EXHIBIT B

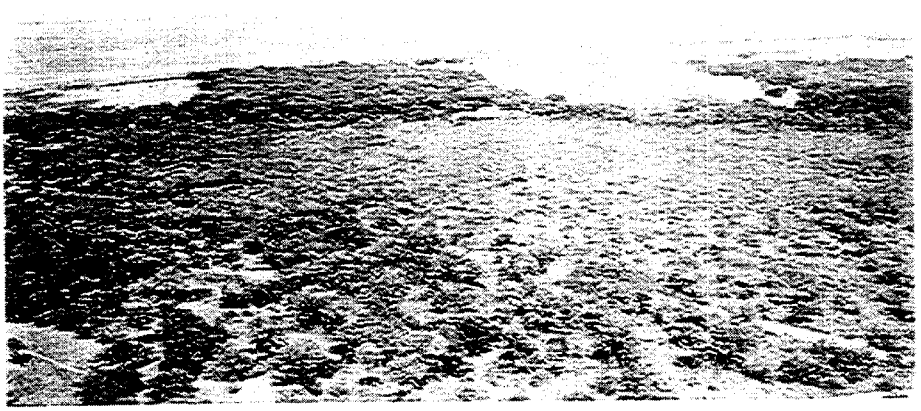
NORTHWEST SIDE OF LAKE KISSIMMEE LOOKING SOUTHEAST
MILES PROPERTY IN FOREGROUND

WEST SIDE OF LAKE KISSIMMEE LOOKING SOUTH

EXHIBIT B



SOUTHWEST SIDE OF LAKE KISSIMMEE LOOKING SOUTHEAST
BRAHMA ISLAND ON LEFT SIDE OF PICTURE



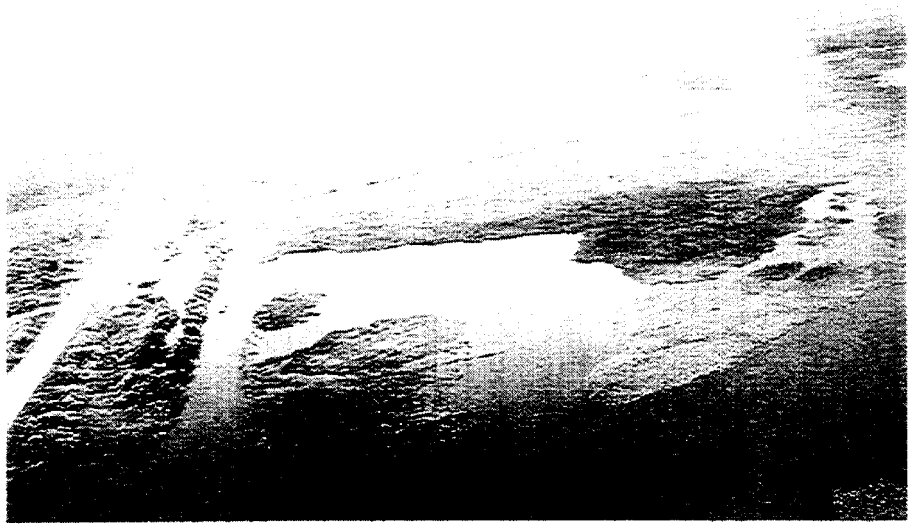
SOUTHWEST SIDE OF LAKE KISSIMMEE LOOKING SOUTHEAST
ROCKS FISH CAMP IN CENTER OF PICTURE

EXHIBIT B

SOUTHWEST SIDE OF LAKE KISSIMMEE LOOKING SOUTHEAST
SHADY OAKS FISH CAMP IN CENTER OF PICTURE

SOUTHWEST CORNER OF LAKE KISSIMMEE LOOKING SOUTH
GRAPE HAMMOCK FISH CAMP IN CENTER OF PICTURE

EXHIBIT B



SOUTHWEST CORNER OF LAKE KISSIMMEE LOOKING WEST
OASIS MARINA ON LEFT SIDE OF PICTURE

SOUTHWESTERLY VIEW OF HATCHINEHA ESTATES

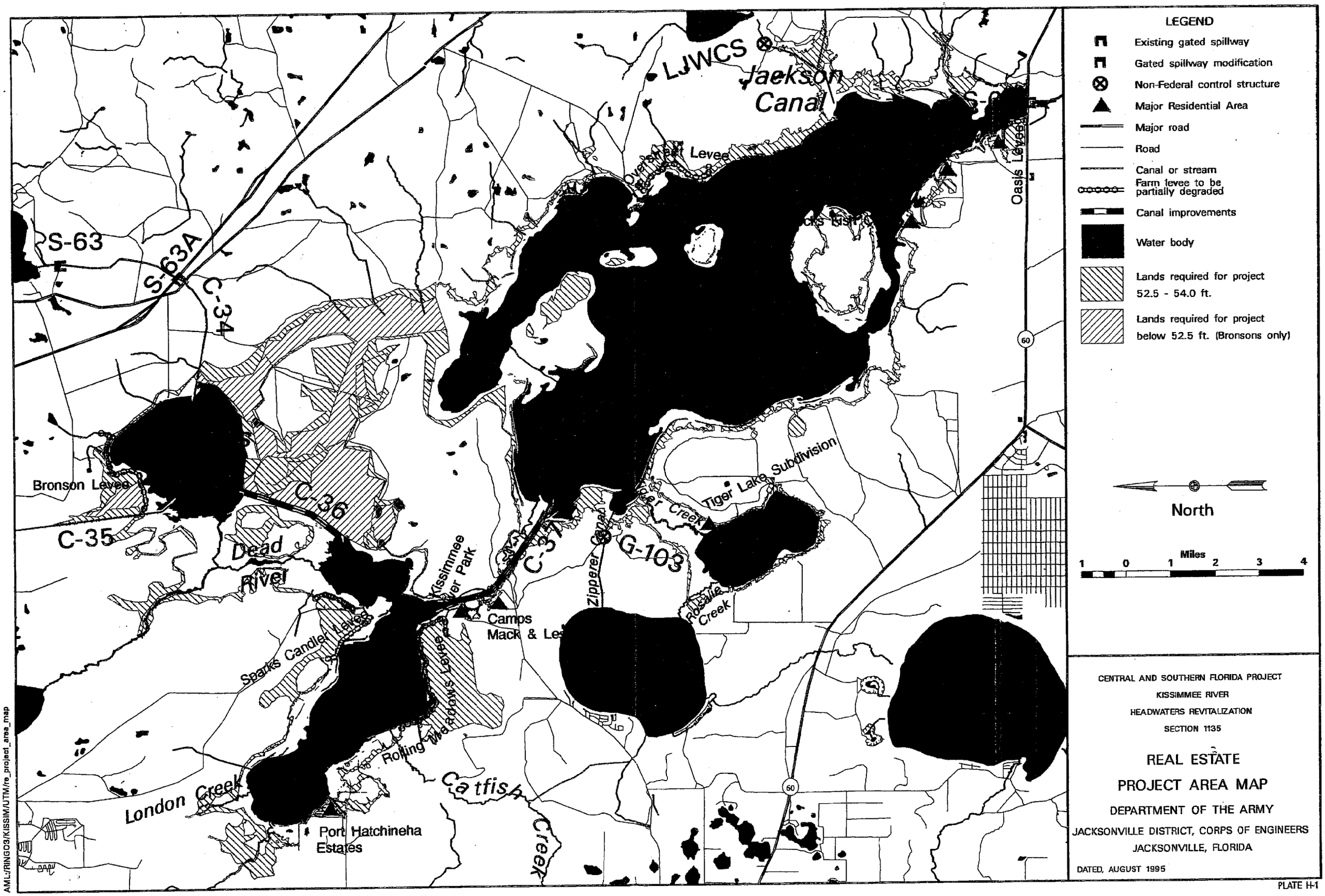


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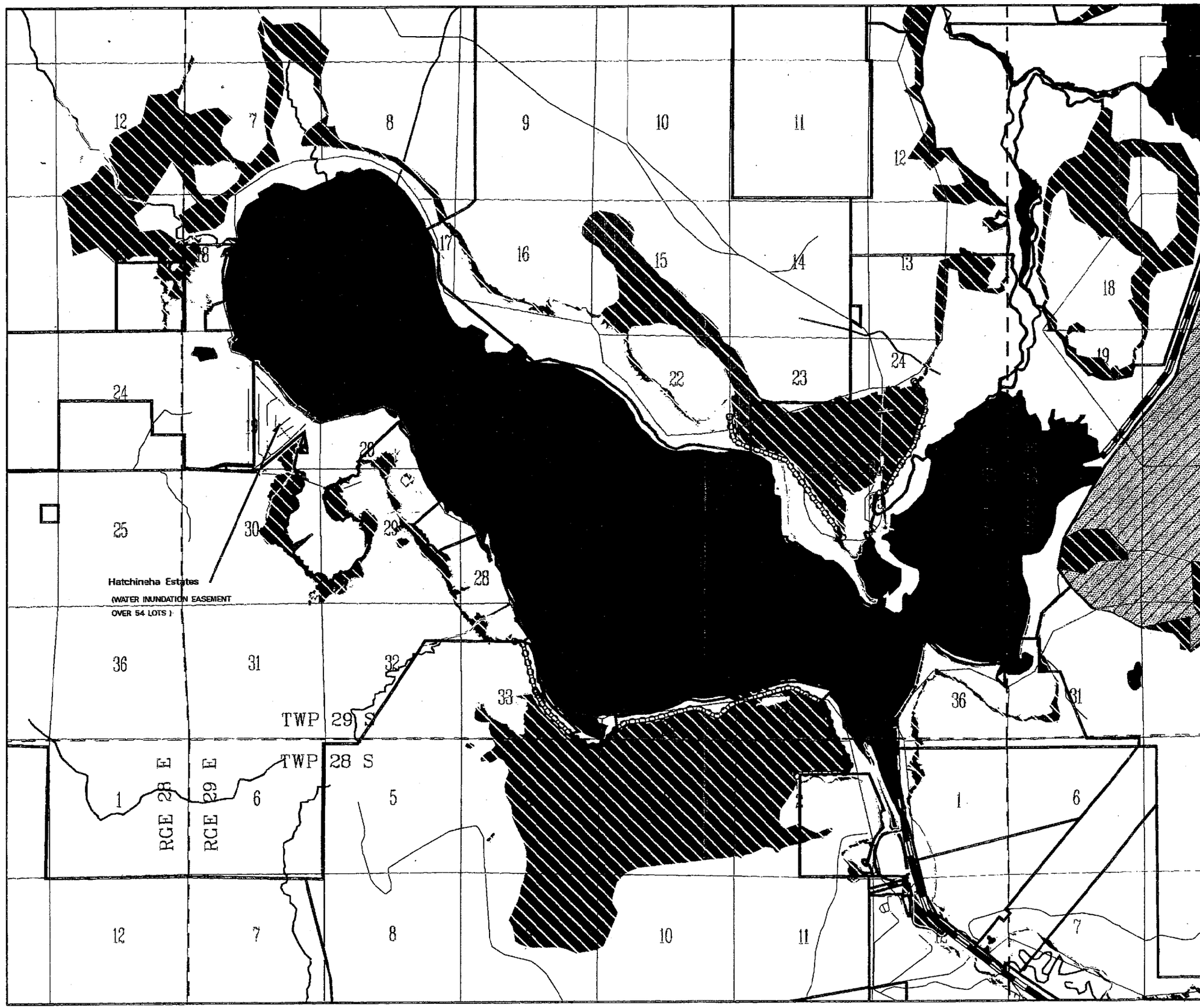
PLATE H-1



LEGEND

- Tract boundary
- Major road
- Road
- Canal or stream
- Farm levee to be partially degraded
- Canal improvements
- Water body
- Lands required for project 52.5 - 54.0 ft.
- Lands required for project below 52.5 ft. (Bronsons only)

ESTATES

- Fee simple
- Fee reserving riparian rights and perpetual road easment
- Temporary disposal area easment
- Perpetual conservation and flowage easement
- Perpetual flowage/ inundation easement

Miles 0.5 0 0.5 1

CENTRAL AND SOUTHERN FLORIDA PROJECT

KISSIMMEE RIVER

HEADWATERS REVITALIZATION

SECTION 1135

REAL ESTATE PROJECT AREA MAP

DEPARTMENT OF THE ARMY

JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

JACKSONVILLE, FLORIDA

DATED, AUGUST 1995 SHEET 1 OF 8

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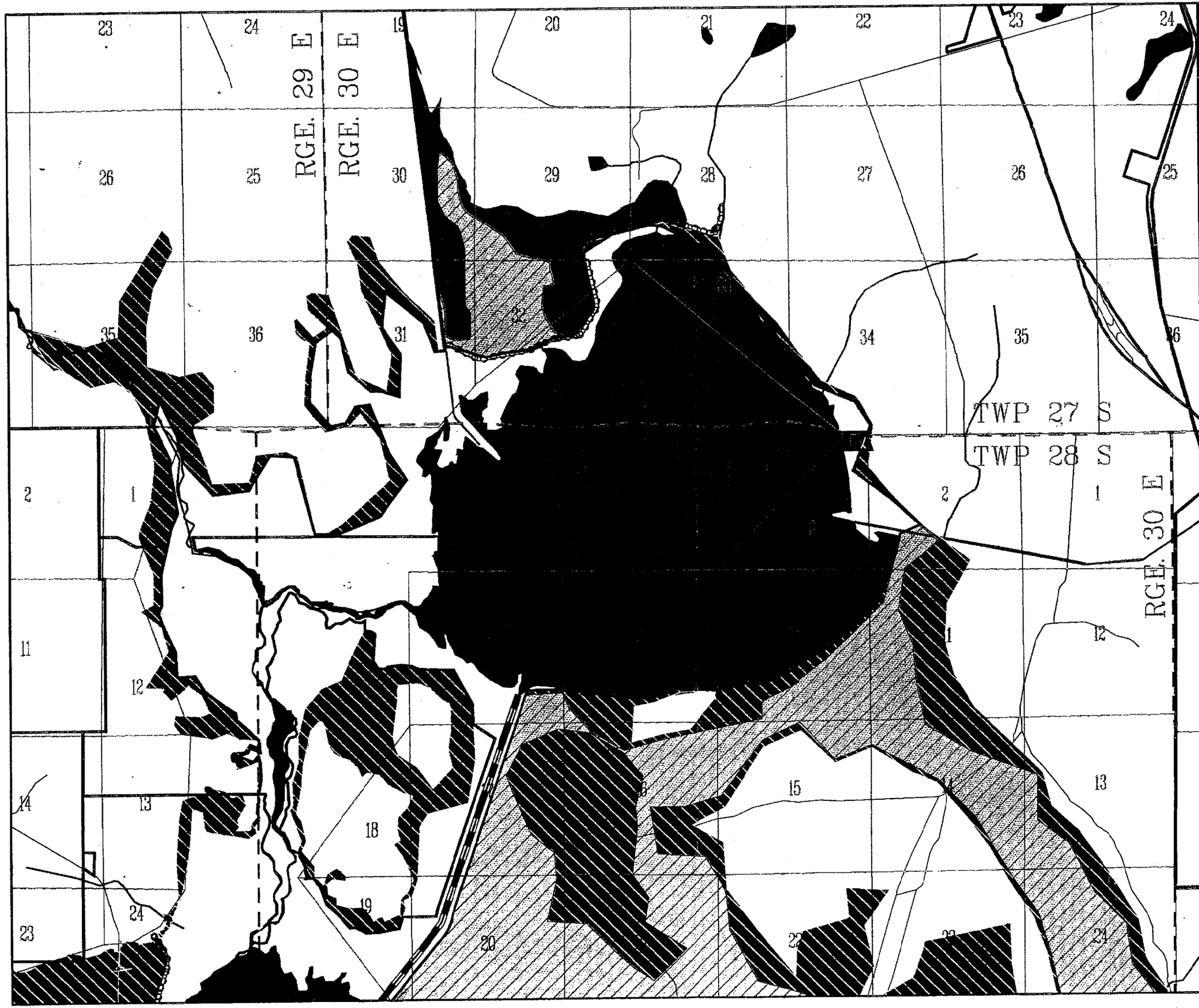

LEGEND

- Tract boundary
- Major road
- Road
- Canal or stream
- Farm levee to be partially degraded
- Canal improvements
- Water body
- Lands required for project 52.5 - 54.0 ft.
- Lands required for project below 52.5 ft. (Bronsons only)

ESTATES

- Fee simple
- Fee reserving riparian rights and perpetual road easment
- Temporary disposal area easment
- Perpetual conservation and flowage easement
- Perpetual flowage/ inundation easement

Miles 0.5 0 0.5 1

CENTRAL AND SOUTHERN FLORIDA PROJECT

KISSIMMEE RIVER

HEADWATERS REVITALIZATION

SECTION 1135

REAL ESTATE PROJECT AREA MAP

DEPARTMENT OF THE ARMY

JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

JACKSONVILLE, FLORIDA

DATED, AUGUST 1995

SHEET 2 OF 8

AML:/HOME/MATZ/KISSIMMEE/klasim_upper_basin_plots

LEGEND

- Tract boundary
- Major road
- Road
- Canal or stream
- Farm levee to be partially degraded
- Canal improvements
- Water body
- Lands required for project 52.5 - 54.0 ft.
- Lands required for project below 52.5 ft. (Bronsons only)

ESTATES

- Fee simple
- Fee reserving riparian rights and perpetual road easment
- Temporary disposal area easment
- Perpetual conservation and flowage easement
- Perpetual flowage/ inundation easement

Miles 0 0.5

CENTRAL AND SOUTHERN FLORIDA PROJECT

KISSIMMEE RIVER

HEADWATERS REVITALIZATION

SECTION 1135

REAL ESTATE

PROJECT AREA MAP

DEPARTMENT OF THE ARMY

JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

JACKSONVILLE, FLORIDA

DATED, AUGUST 1995

SHEET 3 OF 8

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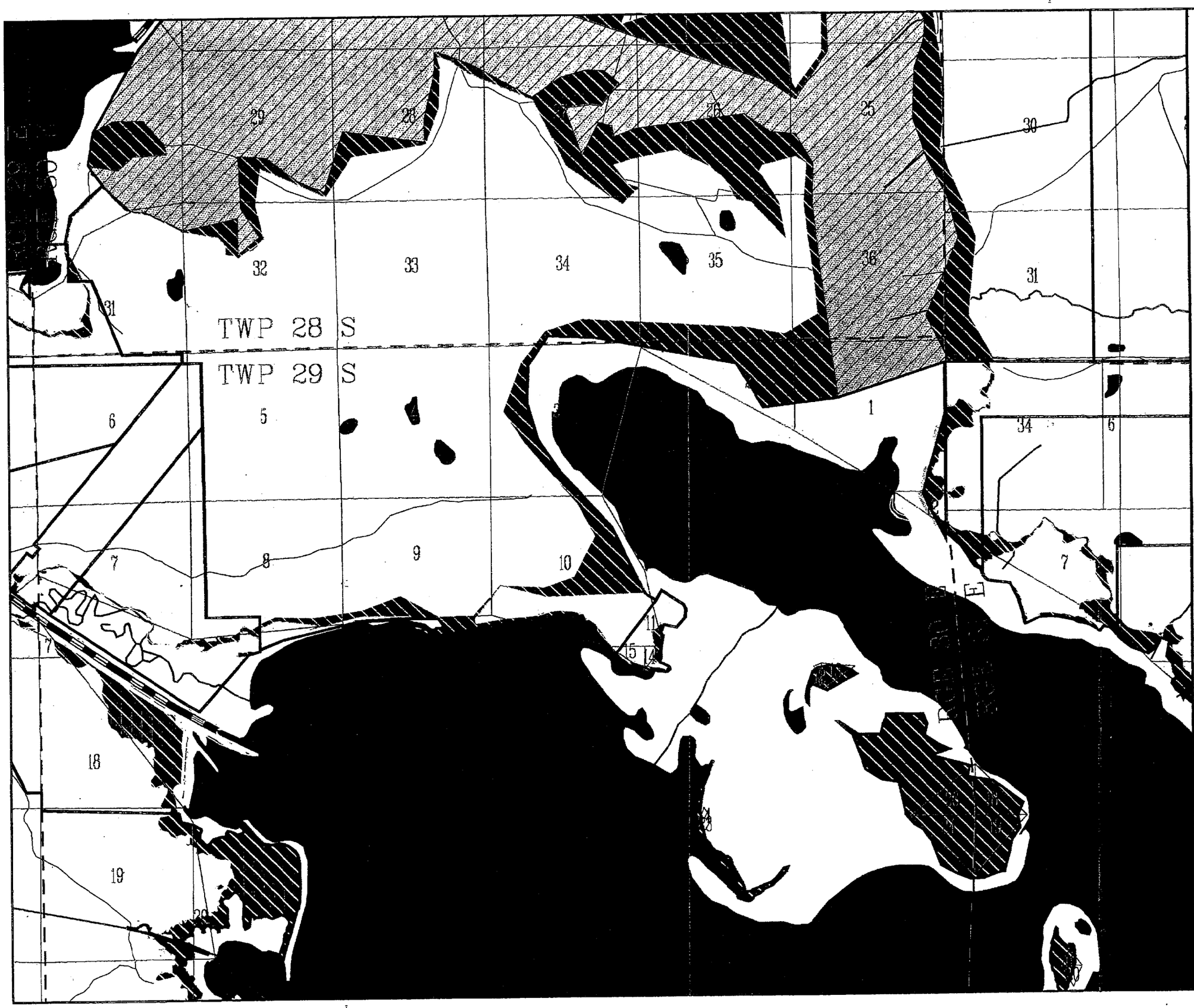

LEGEND

- Tract boundary
- Major road
- Road
- Canal or stream
- Farm levee to be partially degraded
- Canal improvements
- Water body
- Lands required for project 52.5 - 54.0 ft.
- Lands required for project below 52.5 ft. (Bronsons only)

ESTATES

- Fee simple
- Fee reserving riparian rights and perpetual road easment
- Temporary disposal area easment
- Perpetual conservation and flowage easement
- Perpetual flowage/ inundation easement

Miles

0.5 0 0.5 1

CENTRAL AND SOUTHERN FLORIDA PROJECT

KISSIMMEE RIVER

HEADWATERS REVITALIZATION

SECTION 1135

REAL ESTATE PROJECT AREA MAP

DEPARTMENT OF THE ARMY

JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

JACKSONVILLE, FLORIDA

DATED, AUGUST 1995

SHEET 4 OF 8

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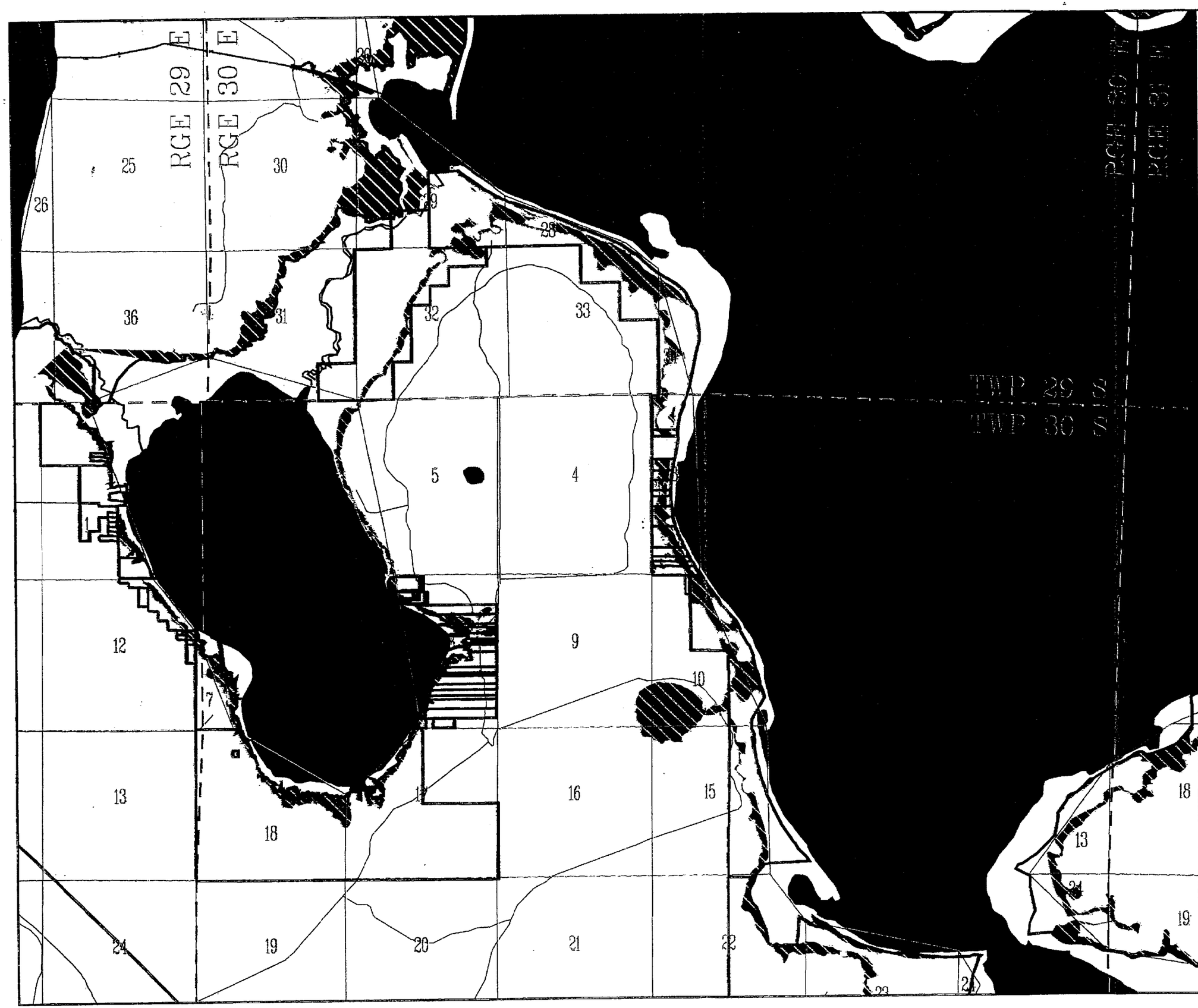

LEGEND

- Tract boundary
- Major road
- Road
- Canal or stream
- Farm levee to be partially degraded
- Canal improvements
- Water body
- Lands required for project 52.5 - 54.0 ft.
- Lands required for project below 52.5 ft. (Bronsons only)

ESTATES

- Fee simple
- Fee reserving riparian rights and perpetual road easment
- Temporary disposal area easment
- Perpetual conservation and flowage easement
- Perpetual flowage/ inundation easement

Miles

0.5 0 0.5 1

CENTRAL AND SOUTHERN FLORIDA PROJECT

KISSIMMEE RIVER

HEADWATERS REVITALIZATION

SECTION 1135

REAL ESTATE

PROJECT AREA MAP

DEPARTMENT OF THE ARMY

JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

JACKSONVILLE, FLORIDA

DATED, AUGUST 1995

SHEET 5 OF 8

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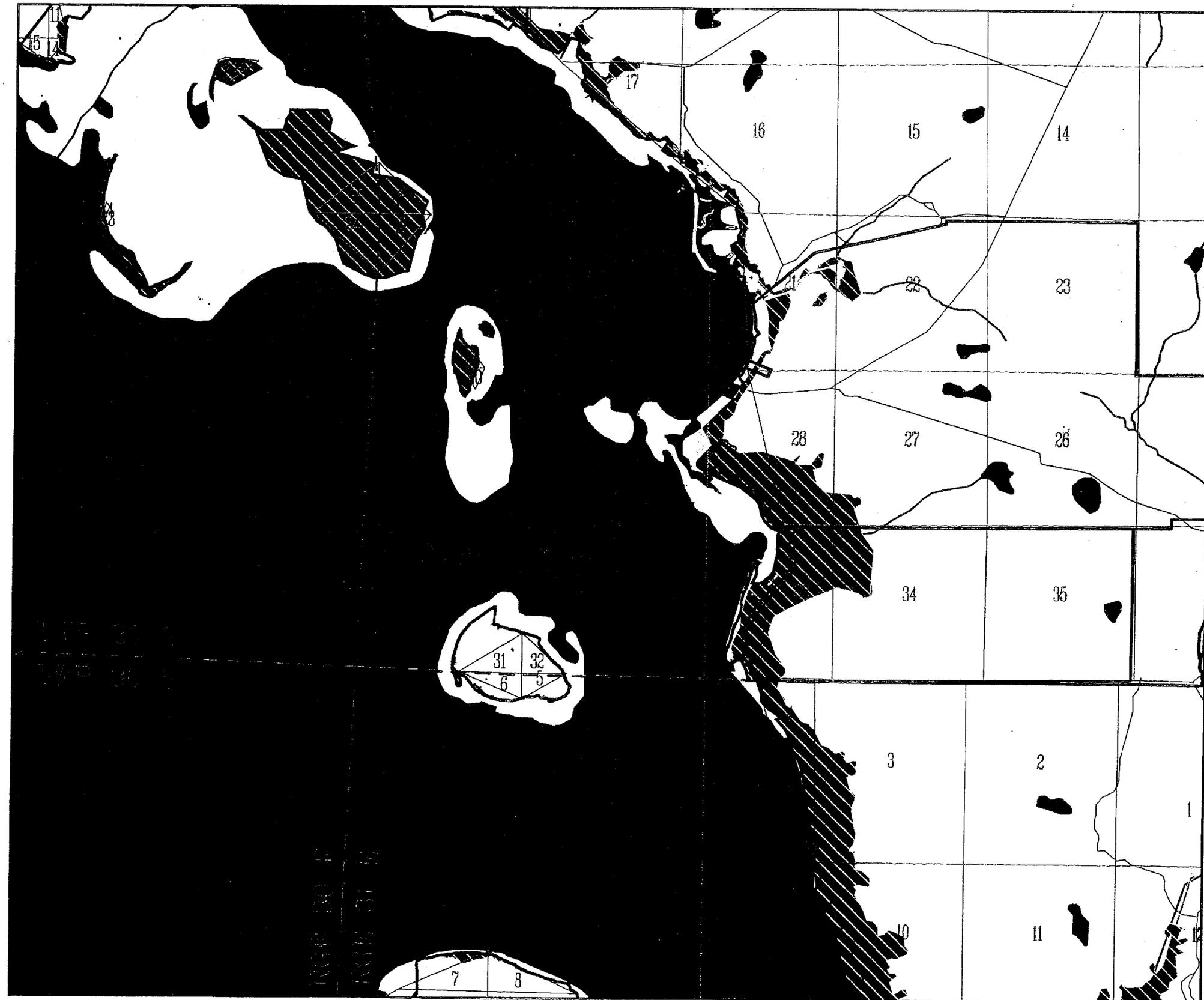

LEGEND

- Tract boundary
- Major road
- Road
- Canal or stream
- Farm levee to be partially degraded
- Canal improvements
- Water body
- Lands required for project 52.5 - 54.0 ft.
- Lands required for project below 52.5 ft. (Bronsons only)

ESTATES

- Fee simple
- Fee reserving riparian rights and perpetual road easment
- Temporary disposal area easment
- Perpetual conservation and flowage easement
- Perpetual flowage/ inundation easement

Miles

0.5 0 0.5 1

CENTRAL AND SOUTHERN FLORIDA PROJECT

KISSIMMEE RIVER

HEADWATERS REVITALIZATION

SECTION 1135

REAL ESTATE PROJECT AREA MAP

DEPARTMENT OF THE ARMY

JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

JACKSONVILLE, FLORIDA

DATED, AUGUST 1995

SHEET 6 OF 8

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LEGEND

- Tract boundary
- Major road
- Road
- Canal or stream
- Farm levee to be partially degraded
- Canal improvements
- Water body
- Lands required for project 52.5 - 54.0 ft.
- Lands required for project below 52.5 ft. (Bronsons only)

ESTATES

- Fee simple
- Fee reserving riparian rights and perpetual road easment
- Temporary disposal area easment
- Perpetual conservation and flowage easement
- Perpetual flowage/ inundation easement

Miles 0 0.5

CENTRAL AND SOUTHERN FLORIDA PROJECT

KISSIMMEE RIVER

HEADWATERS REVITALIZATION

SECTION 1135

REAL ESTATE PROJECT AREA MAP

DEPARTMENT OF THE ARMY

JACKSONVILLE DISTRICT, CORPS OF ENGINEERS

JACKSONVILLE, FLORIDA

DATED, AUGUST 1995

SHEET 7 OF 8

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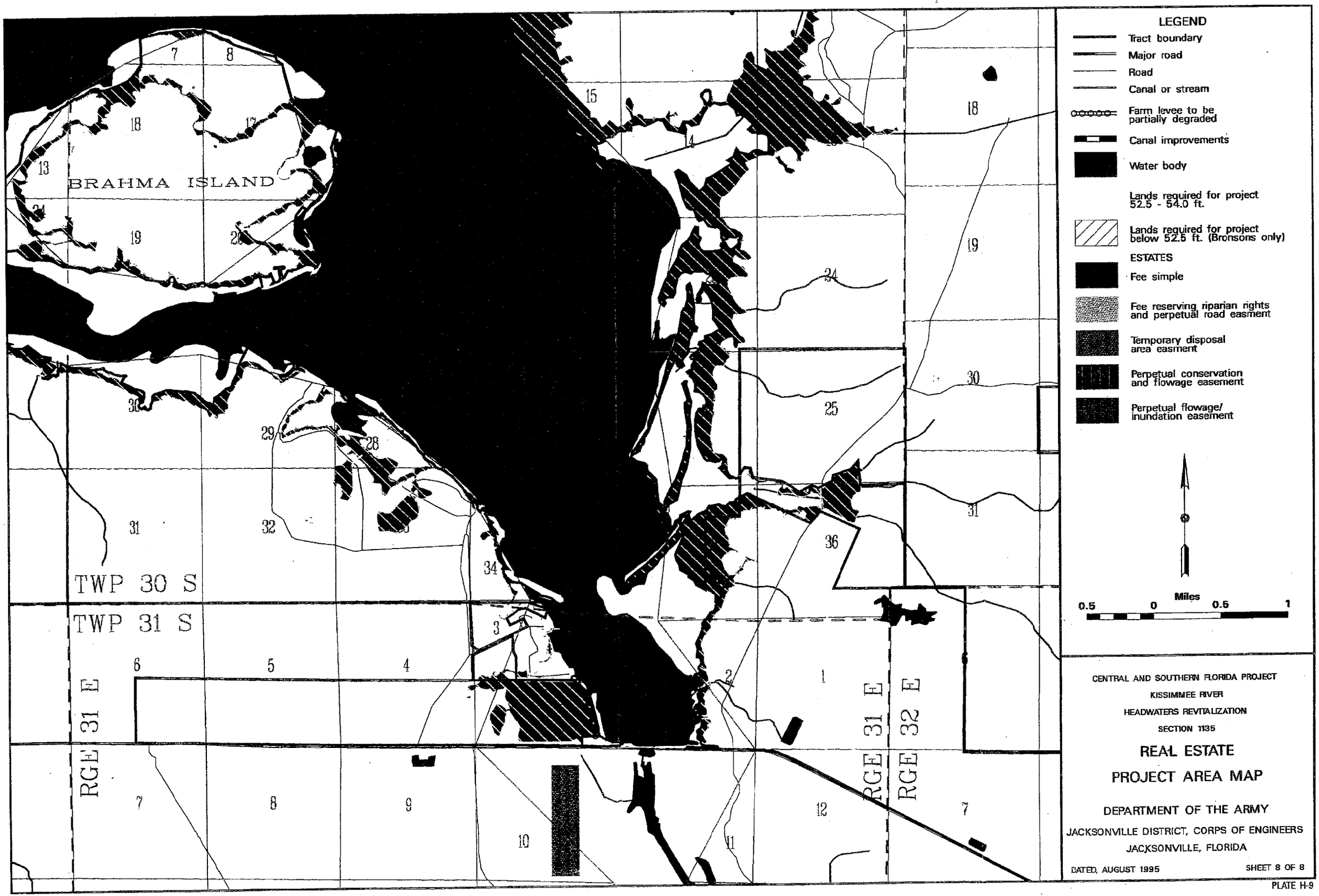

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KISSIMMEE RIVER
HEADWATERS REVITALIZATION PROJECT

APPENDIX I

KISSIMMEE RIVER, FLORIDA
PROJECT COOPERATION AGREEMENT

PROJECT COOPERATION AGREEMENT

BETWEEN

THE DEPARTMENT OF THE ARMY

AND

SOUTH FLORIDA WATER MANAGEMENT DISTRICT

FOR CONSTRUCTION OF THE

KISSIMMEE RIVER, FLORIDA, PROJECT

THIS AGREEMENT is entered into this 22 day of March, 1994, by and between the DEPARTMENT OF THE ARMY (hereinafter the "Government"), acting by and through the Assistant Secretary of the Army (Civil Works), and the SOUTH FLORIDA WATER MANAGEMENT DISTRICT (hereinafter the "Local Sponsor"), acting by and through its Governing Board.

WITNESSETH, THAT:

WHEREAS, construction of the Kissimmee River Restoration Project and the Kissimmee River Headwaters Revitalization Project were authorized by Section 101(8) of the Water Resources Development Act of 1992 and by Section 46 of the Water Resources Development Act of 1988, respectively, and have been subsequently combined into the single project called the Kissimmee River, Florida, Project, located in south-central Florida and bordered by Lake Okeechobee to the South and approaching the City of Orlando to the North;

WHEREAS, the Government and the Local Sponsor desire to enter into a Project Cooperation Agreement for construction of the Kissimmee River, Florida Project (hereinafter the "Project" and defined in Article I.a. of this Agreement);

WHEREAS, the Conference Report, House Report 103-305, which accompanied the Fiscal Year 1994 Appropriations Act (Public Law 103-126) provided guidance to execute a single Project Cooperation Agreement for this Project in advance of a Report being completed and approved for the Kissimmee Headwaters Revitalization Project;

WHEREAS, Section 101 of the Water Resources Development Act of 1992, Public Law 102-580, specifies the cost-sharing requirements applicable to the Project;

WHEREAS, Section 221 of the Flood Control Act of 1970, Public Law 91-611, as amended, provides that the construction of any water resources project by the Secretary of the Army shall not be commenced until each non-Federal interest has entered into a written agreement to furnish its required cooperation for the project;

WHEREAS, the Government and the Local Sponsor have the legal authority and capability to perform as hereinafter set forth and intend to cooperate in the cost-sharing and financing of the construction of the Project in accordance with the terms of this Agreement.

NOW, THEREFORE, the Government and the Local Sponsor agree as follows:

ARTICLE I - DEFINITIONS AND GENERAL PROVISIONS

For purposes of this Agreement:

a. The term "Project" shall mean the construction of the Kissimmee River Restoration which includes approximately 22 miles of contiguous backfilling of the middle portion of the channelized Kissimmee River as generally described in the Report of the Chief of Engineers, dated March 17, 1992 and approved by Secretary of the Army, on April 3, 1992 and construction of the Headwaters Revitalization Project as generally described in a report to be prepared and approved by the Chief of Engineers. Not included within this definition are the partial filling of Pools A & B, the weir modifications in Pool B and the backfilling in Pool E.

b. The term "total project costs" shall mean all costs incurred by the Local Sponsor and the Government directly related to construction of the Project. Such costs shall include, but not necessarily be limited to: all continuing planning and engineering costs incurred after October 1, 1985; all advanced engineering and design costs; all preconstruction engineering and design costs; engineering and design costs during construction; actual construction costs, including the costs of constructing, relocating or modifying existing railroad bridges and approaches thereto; supervision and administration costs; costs of contract dispute settlements or awards; the value of lands, easements, and rights-of-way, including suitable borrow and dredged or excavated material disposal areas, and the value of relocations, as may be required for the construction, operation, and maintenance of the Project; and the cost of investigations to identify the existence of hazardous substances as identified in Article XVIII.a.; but shall not include any costs for operation, maintenance, repair, replacement, or rehabilitation or increased costs for betterments.

c. The term "period of construction" shall mean the time from the advertisement of the first construction contract to the time the Government certifies in writing to the Local Sponsor that construction of the Project is complete. The Government shall furnish to the Local Sponsor copies of the Government's Written Notice of Acceptance of Completed Work furnished to the contractor(s) for all contracts for the Project.

d. The term "highway" shall mean any highway, thoroughfare, roadway, street, or other public road or way.

e. The term "relocations" shall mean the preparation of plans and specifications for, and the accomplishment of all, alterations, modifications, lowering or raising in place, and/or new construction related to, but not limited to, existing: railroads (excluding existing railroad bridges and approaches thereto), highways, and other bridges, pipelines, public utilities (such as municipal water and sanitary sewer lines, telephone lines, and storm drains), aerial utilities, cemeteries, and other facilities, structures, and improvements determined by the Government to be necessary for the construction, operation and maintenance of the Project.

f. The term "fiscal year" shall mean one fiscal year of the Government. The Government fiscal year begins on October 1 and ends on September 30.

g. The term "functional portion of the Project" shall mean a completed portion of the Project as determined by the Government in writing to be suitable for tender to the Local Sponsor to operate and maintain in advance of completion of the entire Project. To be suitable for tender, the Government, in consultation with the Local Sponsor, must determine that the completed portion of the Project can function independently and for a useful purpose, although the balance of the Project is not complete.

h. The term "betterment" shall mean the design and construction of a Project feature accomplished on behalf of, or at the request of, the Local Sponsor in accordance with standards which exceed the standards which the Government would otherwise apply for accomplishing the design and construction of the Project.

i. The term "in-kind services" shall mean Project engineering and design services that the Local Sponsor has performed or may perform at the request of the Government.

ARTICLE II - OBLIGATIONS OF THE GOVERNMENT AND LOCAL SPONSOR

a. The Government, subject to receiving funds appropriated by the Congress of the United States and using funds provided by the Local Sponsor, shall expeditiously construct the Project (including construction, modification, or relocation of existing railroad bridges and approaches thereto), applying those procedures usually followed or applied in Federal projects, pursuant to Federal laws, regulations, and policies. The Local Sponsor shall be afforded the opportunity to review and comment on all contracts, including relevant plans and specifications, prior to the issuance of invitations for bids. The Government shall not issue the solicitation for the first construction

contract until the Local Sponsor has confirmed in writing its willingness to proceed with the Project. To the extent possible, the Local Sponsor thereafter also will be afforded the opportunity to review and comment on all modifications and change orders prior to the issuance to the contractor of a Notice to Proceed. In those cases where providing notice to the Local Sponsor of the required contract modifications or change orders is not possible prior to issuance of Notice to Proceed, such notification will be provided after the fact at the earliest date possible. The Government will, in good faith, consider the comments of the Local Sponsor, but award of contracts, modifications or change orders, and performance of all work on the Project (whether the work is performed under contract or by Government personnel), shall be exclusively within the control of the Government.

b. After the Government determines, in consultation with the Local Sponsor, that the Project or a functional portion of the Project is complete, and notifies the Local Sponsor in writing of such determination, the Government shall turn the Project or functional portion of the Project over to the Local Sponsor, which shall accept the Project or functional portion of the Project and be solely responsible for operating, maintaining, repairing, replacing, and rehabilitating the Project or functional portion of the Project in accordance with Article VIII hereof.

c. The Local Sponsor shall contribute 50 percent of total project costs in accordance with the provisions of this paragraph.

1. As further specified in Article III hereof, the Local Sponsor shall provide all lands, easements, and rights-of-way, including suitable borrow and dredged or excavated disposal areas, and perform all relocations determined by the Government to be necessary for construction, operation, and maintenance of the Project.

2. The Government has determined that the Local Sponsor shall receive credit for the following in-kind services completed or initiated prior to the execution of this Agreement:

(a) 2-D model development
(b) Chandler Slough Backwater Study
(c) Dissolved oxygen model development
(d) Rights-of-entry for PED field work
(e) The test fill permit
(f) Residential impact evaluation

Furthermore, the Government may request the Local Sponsor to provide some or all of the following in-kind services and grant credit therefor:

(a) Seven Mile and Pine Island Sloughs Backwater Study
(b) Remaining Tributary Backwater Studies
(c) SFWMD staff modeling support for UKISS and 2-D model utilization
(d) SFWMD staff support for Upper Basin Study
(e) SFWMD staff support for the restoration evaluation component in accordance with the feasibility report

The affording of such credit shall be subject to an inspection as appropriate by the Government to verify that the work was accomplished in a satisfactory manner and is suitable for inclusion in the Project. The actual amount of credit shall be subject to an audit to determine reasonableness, allocability, and allowability of costs in accordance with Article XI.

3. If the value of the contributions provided under paragraphs c.1. and c.2. of this Article is less than 50 percent of total projects costs, the Local Sponsor shall provide, during the period of construction, additional cash contributions in the amount necessary to make the Local Sponsor's contribution equal to 50 percent of total project costs.

4. If the value of the contributions provided under paragraphs c.1. and c.2. of this Article exceed 50 percent of the total project costs, the Government shall, subject to the availability of funds, reimburse the Local Sponsor for that portion of the value of lands, easements, rights-of-way, and dredged or excavated material disposal areas, and relocations and in-kind services provided by the Local Sponsor in accordance with paragraph c.2., which exceed 50 percent of the total project cost. Alternately, and at the sole discretion of the Government, the Government may at no cost to the Local Sponsor provide any remaining lands, easements, rights-of-way, relocations, and dredged or excavated material disposal areas required for the construction operation, and maintenance of the Project in excess of 50 percent of the total project costs.

d. The Local Sponsor may request the Government to acquire lands, easements, or rights-of-way, or perform relocations on behalf of the Local Sponsor. Such services as the Government may elect to provide, shall be performed in accordance with terms or conditions of separate agreements and all such work shall be paid for by the Local Sponsor in advance of the Government incurring any financial obligation therefor, in accordance with Article VI.

e. The Local Sponsor may request the Government to accomplish betterments. The Local Sponsor will be solely responsible for any increase in costs resulting from the betterments and all such increased costs will be paid by the Local Sponsor in advance of the Government incurring any financial obligation therefor, in accordance with Article VI.

f. No Federal funds may be used to meet the Local Sponsor's share of total project costs under this Agreement unless the expenditure of such funds is expressly authorized by statute as verified in writing by the Federal granting agency.

g. The Local Sponsor agrees to participate in and comply with applicable Federal flood plain management and flood insurance programs.

h. The Local Sponsor shall publicize flood plain information in the area concerned and shall provide this information to zoning and other regulatory agencies for their use in preventing unwise future development in the flood plain and in adopting such regulations as may be necessary to prevent unwise future development and to ensure compatibility with protection levels provided by the Project.

ARTICLE III - LANDS, RELOCATIONS, AND PUBLIC LAW 91-646

a. The Government shall provide, in coordination with the Local Sponsor, a written description of the anticipated real estate requirements for the Project. Thereafter, the Local Sponsor shall furnish all lands, easements, and rights-of-way, including suitable borrow and dredged or excavated material disposal areas, as may be determined by the Government in that description, or in any subsequent description coordinated with the Local Sponsor, to be necessary for the construction, operation and maintenance of the Project, and shall furnish to the Government evidence supporting the Local Sponsor's legal authority to grant rights-of-entry to such lands. The necessary lands, easements, and rights-of-way for the Project may be provided incrementally for each construction contract. All lands, easements, and rights-of-way determined by the Government to be necessary for work to be performed under a construction contract must be furnished prior to the advertisement of that construction contract.

b. The Local Sponsor shall provide or pay to the Government the cost of providing all retaining dikes, wasteweirs, bulkheads, and embankments, including all monitoring features and stilling basins, that may be required at any dredged or excavated material disposal areas required for the construction, operation, and maintenance of the Project.

c. The Government shall provide, in coordination with the Local Sponsor, a written description of the anticipated relocation requirements for the Project. Thereafter, the Local Sponsor shall accomplish or arrange for the accomplishment of all relocations, as may be determined by the Government in that description, or in any subsequent description coordinated with the Local Sponsor, to be necessary for the construction, operation and maintenance of the Project. The necessary relocations for the Project may be provided incrementally for

each construction contract. All relocations determined by the Government to be necessary for work to be performed under a construction contract must be furnished prior to the advertisement of that construction contract.

d. The Local Sponsor shall comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended by Title IV of the Surface Transportation and Uniform Relocation Assistance Act of 1987 (Public Law 100-17), and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way, and performing relocations for construction, operation, and maintenance of the Project, and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act.

ARTICLE IV - VALUE OF LANDS AND RELOCATIONS

a. The Local Sponsor shall not receive any credit for lands, easements, and rights-of-way, including suitable borrow and dredged or excavated material disposal areas, previously provided as an item of cooperation for another Federal project nor shall the value thereof be included in total project costs. The value of the lands, easements, and rights-of-way, including suitable borrow and dredged or excavated material disposal areas, to be included in total project costs and credited towards the Local Sponsor's share of total project costs shall be determined in accordance with the following procedures:

1. If the lands, easements, or rights-of-way are owned by the Local Sponsor as of the date this Agreement is signed by both parties, the credit shall be the fair market value of the interest at the time this Agreement is signed by both parties or, in exceptional circumstances, upon request of the Local Sponsor and in the sole discretion of the Assistant Secretary of the Army for Civil Works, the actual purchase price paid by the Local Sponsor. The fair market value, if used, shall be determined by an appraisal, to be obtained by the Local Sponsor, which has been prepared by a qualified appraiser who is acceptable to both the Local Sponsor and the Government. The appraisal shall be reviewed and approved by the Local Sponsor and the Government.

2. If the lands, easements, or rights-of-way are acquired by the Local Sponsor after the date this Agreement is signed by both parties, the credit shall be the fair market value of the interest at the time such interest is acquired. The fair market value shall be determined as specified in Article IV.a.1. of this Agreement. If the Local Sponsor pays an amount in excess of the approved appraised fair market value, the Local Sponsor may be entitled to a credit for the actual purchase price paid provided that the purchase price is approved by the Government in writing.

3. If the Local Sponsor acquires more lands, easements, or rights-of-way than the Government determines are necessary for construction, operation, and maintenance of the Project, then only the value of such portions of those acquisitions as have been determined by the Government to be necessary for the construction, operation, and maintenance of the Project shall be included in total project costs and credited towards the Local Sponsor's share.

4. Credit for lands, easements, and rights-of-way acquired through eminent domain proceedings occurring after the date of this Agreement will be based on court awards for the real property interests taken, or on stipulated settlements or portions of stipulated settlements that have received written Government approval. The fair market value for the purposes of filing an eminent domain proceeding in court shall be based on an appraisal prepared and approved as specified in Article IV a.1. of this Agreement.

5. Credit for lands, easements, or rights-of-way acquired by the Local Sponsor within a five-year period preceding the date this Agreement is signed by both parties, or at any time after this Agreement is signed by both parties, will also include the reasonable documented incidental costs of acquiring the interest, e.g., closing and title costs, appraisal costs, survey costs, attorney's fees, plat maps, and mapping costs, as well as the actual amounts expended for payment of any Public Law 91-646 relocation assistance benefits provided in accordance with the obligations under this Agreement.

b. The value of relocations which will be included in total project costs and credited towards the Local Sponsor's share of total project costs shall be determined by the Government as set forth below:

1. Highways and Highway Bridges: Only that portion of the cost as would be necessary to construct substitute bridges and highways to the design standard that the State of Florida would use in constructing a new bridge or highway under similar conditions of geography and traffic loads.

2. Utilities and Facilities, Structures and Improvements (including railroads): Actual relocation costs, less depreciation, less salvage value, plus the cost of removal, less the increased cost of betterments. New materials shall not be used in any alteration or relocation if materials of value and usability equal to those in the existing facility are available or can be obtained as salvage from the existing facility or otherwise, unless the provision of new material is more economical. If, despite the availability of used material, new material is used, where the use of such new material represents an additional cost, such cost will not be included in total project costs, nor credited toward the Local Sponsor's share.

ARTICLE V - CONSTRUCTION PHASING AND MANAGEMENT

a. To provide for consistent and effective communication, the Local Sponsor and the Government shall, prior to the advertisement of the first construction contract, appoint representatives to coordinate on all facets of Project development, including Project design, scheduling, plans, specifications, real estate requirements, award of contracts, contract modifications and change orders, contract costs, claims, and other related matters.

b. These representatives shall generally oversee the Project construction and shall be identified as the Project Coordination Team. They shall meet regularly during the period of construction and will be informed of all changes in total project costs. The Project Coordination Team shall make recommendations concerning construction as it deems are warranted to the Government, including suggestions to avoid potential sources of dispute.

c. The Government shall, in good faith, consider the recommendations of the Project Coordination Team on all matters relating to construction and anticipated requirements for operation, maintenance, repair, replacement and rehabilitation of the Project. The Government, having the legal authority and responsibility for construction of the Project, has discretion to accept, reject, or modify the recommendations of such representatives.

ARTICLE VI - METHOD OF PAYMENT

a. The Local Sponsor shall provide, during the period of construction, the cash payments required under Article II of this Agreement. Total project costs are currently estimated to be $511,098,000 and the Local Sponsor's share of total project costs is currently estimated to be $255,496,000. In order to meet the Local Sponsor's share, the Local Sponsor must provide a cash contribution currently estimated to be $65,895,000. The dollar amounts set forth in this Article are based upon the Government's best estimates which reflect projections of costs, price level changes, and anticipated inflation. Such costs estimates are subject to adjustments based upon cost actually incurred and are not to be construed as the total financial responsibilities of the Government and the Local Sponsor.

b. The Local Sponsor shall provide the Local Sponsor's required cash contribution during the period of construction in accordance with the following provisions:

1. For purposes of budget planning, the Government shall notify the Local Sponsor by March 15 of each year of the estimated funds that will be required from the Local Sponsor to

meet the Local Sponsor's share of total project costs for the upcoming fiscal year.

2. No later than 120 calendar days prior to the award of the first construction contract, the Government shall notify the Local Sponsor of the Local Sponsor's share of the total project costs required for the first fiscal year of construction, including the Local Sponsor's share of costs attributable to the Project incurred prior to the initiation of construction. No later than 60 calendar days thereafter, the Local Sponsor shall verify to the satisfaction of the Government that the Local Sponsor has deposited the requisite amount in an escrow or other account acceptable to the Government, with interest accruing to the Local Sponsor.

3. For the second and subsequent fiscal years of Project construction, the Government shall, no later than 60 calendar days prior to the beginning of the fiscal year, notify the Local Sponsor of the Local Sponsor's share of total project costs for that fiscal year. No later than October 1, or the first business day of the fiscal year, the Local Sponsor shall make the necessary funds available to the Government through the funding mechanism specified in Article VI.b.2. of this Agreement.

4. As construction of the Project proceeds, the Government shall on a regular basis each year, adjust the amounts required to be provided under this paragraph to reflect actual costs to date. If at any time during the period of construction the Government determines that additional funds will be needed from the Local Sponsor, the Government shall so notify the Local Sponsor, and the Local Sponsor, no later than 60 calendar days from receipt of such notice, shall make the necessary funds available through the funding mechanism specified in Article VI.b.2. of this Agreement.

c. The Government will draw on the escrow or other account provided by the Local Sponsor such sums as the Government deems necessary to cover contractual and in-house fiscal obligations attributable to the Project as they are incurred, as well as Project costs incurred by the Government prior to the initiation of construction.

d. During the period of construction, the Government shall provide quarterly financial reports on the status of total project cost and the status of contributions made by the Local Sponsor. Upon completion of the Project and resolution of all relevant contract claims and appeals, the Government shall compute the total project costs and tender to the Local Sponsor a final accounting of the Local Sponsor's share of total project costs.

1. In the event the total contribution by the Local Sponsor is less than the Local Sponsor's required share of total project costs, the Local Sponsor shall, no later than 90 calendar

days after receipt of written notice, make a cash payment to the Government of whatever sum is required to meet the Local Sponsor's required share of the total project costs.

2. In the event the total contribution by the Local Sponsor is more than the Local Sponsor's required share of total project costs, the Government shall, no later than 90 calendar days after the final accounting is complete, subject to the availability of funds, return the excess to the Local Sponsor. In the event existing funds are not available to repay the Local Sponsor for excess contributions provided, the Government shall seek such appropriations as are necessary to repay the Local Sponsor for excess contributions provided.

ARTICLE VII - DISPUTES

Before any party to this Agreement may bring suit in any court concerning an issue relating to this Agreement, such party must first seek in good faith to resolve the issue through negotiation or other forms of nonbinding alternative dispute resolution mutually acceptable to the parties.

ARTICLE VIII - OPERATION, MAINTENANCE, REPAIR, REPLACEMENT, AND REHABILITATION (OMRR&R)

a. After the Government has determined that construction of the Project or functional portion of the Project is complete and provided the Local Sponsor with written notice of such determination, the Local Sponsor shall operate, maintain, repair, replace, and rehabilitate the completed Project, or functional portion of the Project, at no cost to the Government, in accordance with applicable Federal and State laws as provided in Article XII and specific directions prescribed by the Government in an OMRR&R Manual and any subsequent amendments thereto.

b. The Local Sponsor hereby gives the Government a right to enter, at reasonable times and in a reasonable manner, upon land which the Local Sponsor owns or controls for access to the Project for the purpose of inspection, and, if necessary, for the purpose of completing, operating, maintaining, repairing, replacing, or rehabilitating the Project. If an inspection shows that the Local Sponsor for any reason is failing to fulfill the Local Sponsor's obligations under this Agreement without receiving prior written approval from the Government, the Government will send a written notice to the Local Sponsor. If, after 30 calendar days from receipt of notice, the Local Sponsor continues to fail to perform, then the Government shall have the right to enter, at reasonable times and in a reasonable manner, upon lands the Local Sponsor owns or controls for access to the Project for the purpose of completing, operating, maintaining, repairing, replacing, or rehabilitating the Project. No completion, operation, maintenance, repair, replacement, or

rehabilitation by the Government shall operate to relieve the Local Sponsor of responsibility to meet the Local Sponsor obligations as set forth in this Agreement, or to preclude the Government from pursuing any other remedy at law or equity to assure faithful performance pursuant to this Agreement.

ARTICLE IX - RELEASE OF CLAIMS

The Local Sponsor shall hold and save the Government free from all damages arising from the construction, operation, maintenance, repair, replacement, and rehabilitation of the Project and any Project-related betterments, except for damages due to the fault or negligence of the Government or the Government's contractors.

ARTICLE X - MAINTENANCE OF RECORDS

Within 60 days of the date of this Agreement, the Government and the Local Sponsor shall develop procedures for keeping books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to this Agreement to the extent and in such detail as will properly reflect total project-costs. The Government and the Local Sponsor shall maintain such books, records, documents, and other evidence in accordance with these procedures and for a minimum of three years after completion of construction of the Project and resolution of all relevant claims arising therefrom, and shall make available at their offices at reasonable times, such books, records, documents, and other evidence for inspection and audit by authorized representatives of the parties to this Agreement.

ARTICLE XI - GOVERNMENT AUDIT

The Government may conduct audits of the Local Sponsor's records for the Project to ascertain the allowability, reasonableness, and allocability of the Local Sponsor's costs for inclusion as credit against the Local Sponsor's share of total project costs. Any such Government audits shall be conducted in accordance with Government Auditing Standards and the cost principles in OMB Circular No. A-87 and other applicable cost principles and regulations.

ARTICLE XII - FEDERAL AND STATE LAWS

In the exercise of the Local Sponsor's rights and obligations hereunder, the Local Sponsor agrees to comply with all applicable Federal and State laws and regulations, including Section 601 of the Civil Rights Act of 1964, Public Law 88-352, and Department of Defense Directive 5500.11 issued pursuant thereto, as well as Army Regulations 600-7, entitled "Nondiscrimination on the Basis

of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army".

ARTICLE XIII - RELATIONSHIP OF PARTIES

The Government and the Local Sponsor act in an independent capacity in the performance of their respective functions under this Agreement, and neither is to be considered the officer, agent, or employee of the other.

ARTICLE XIV - OFFICIALS NOT TO BENEFIT

No member of, or delegate to, the Congress, or resident commissioner, shall be admitted to any share or part of this Agreement, or to any benefit that may arise therefrom.

ARTICLE XV - COVENANT AGAINST CONTINGENT FEES

The Local Sponsor warrants that no person or selling agency has been employed or retained to solicit or secure this Agreement upon agreement or understanding for a commission, percentage, brokerage, or contingent fee, excepting bona fide employees or bona fide established commercial or selling agencies maintained by the Local Sponsor for the purpose of securing business. For breach or violation of this warranty, the Government shall have the right to annul this Agreement without liability, or, in the Government's discretion, to add to the Agreement or consideration, or otherwise recover, the full amount of such commission, percentage, brokerage, or contingent fee.

ARTICLE XVI - TERMINATION OR SUSPENSION

a. If at any time the Local Sponsor fails to fulfill its obligations under this Agreement, the Assistant Secretary of the Army (Civil Works) shall terminate this Agreement or suspend future work under this Agreement, unless the Assistant Secretary of the Army (Civil Works) determines that continuation of work on the Project is in the interest of the United States or is necessary in order to satisfy agreements with any other non-Federal interests in connection with the Project. Any delinquent payment shall be charged interest at a rate, to be determined by the Secretary of the Treasury, equal to 150 per centum of the average bond equivalent rate of the 13-week Treasury bills auctioned immediately prior to the date on which such payment became delinquent, or auctioned immediately prior to the beginning of each additional 3-month period if the period of delinquency exceeds 3 months.

b. If the Government fails to receive annual appropriations in amounts sufficient to meet Project expenditures for the

then-current or upcoming fiscal year, the Government shall so notify the Local Sponsor. After 60 calendar days either party may elect without penalty to terminate this Agreement pursuant to this Article or to defer future performance hereunder; however, deferral of future performance under this Agreement shall not affect existing obligations or relieve the parties of liability for any obligation previously incurred. In the event that either party elects to terminate this Agreement pursuant to this Article or Article XVIII.c. of this Agreement, both parties shall conclude their activities relating to the Project and proceed to a final accounting in accordance with Article VI. of this Agreement. In the event that either party elects to defer future performance under this Agreement pursuant to this Article, such deferral shall remain in effect until such time as the Government receives sufficient appropriations or until either the Government or the Local Sponsor elects to terminate this Agreement.

ARTICLE XVII - OBLIGATIONS OF FUTURE APPROPRIATIONS

This Agreement does not obligate future appropriations by the South Florida Water Management District. The Local Sponsor will use its best efforts to obtain adequate funding and seek sufficient appropriations in subsequent fiscal years.

ARTICLE XVIII - HAZARDOUS SUBSTANCES

a. After execution of this Agreement and upon direction by the Government, the Local Sponsor shall perform, or cause to be performed, such investigations for hazardous substances as are determined necessary by the Government or the Local Sponsor to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 USC 9601-9675, on lands necessary for Project construction, operation, and maintenance. All actual costs incurred by the Local Sponsor which are properly allowable and allocable to performance of any such investigations for hazardous substances shall be included in total project costs and cost shared as a construction cost.

b. In the event it is discovered through an investigation for hazardous substances or other means that any lands, easements, rights-of-way, or disposal areas to be acquired or provided for the Project contain any hazardous substances regulated under CERCLA, the Local Sponsor and the Government shall provide prompt notice to each other, and the Local Sponsor shall not proceed with the acquisition of lands, easements, rights-of-way, or disposal areas until mutually agreed.

c. The Government and the Local Sponsor shall determine whether to initiate construction of the Project, or if already in construction, to continue with construction of the Project, or to terminate construction of the Project for the convenience of the

Government in any case where hazardous substances regulated under CERCLA are found to exist on any lands necessary for the Project. Should the Government and the Local Sponsor determine to proceed or continue with construction after considering any liability that may arise under CERCLA, the Local Sponsor shall be responsible, as between the Government and the Local Sponsor, for any and all necessary clean up and response costs, to include the costs of any studies and investigations necessary to determine an appropriate response to the contamination. Such costs shall not be considered a part of total project costs as defined in this Agreement. In the event the Local Sponsor fails to provide any funds necessary to pay for clean up and response costs or to otherwise discharge the Local Sponsor's responsibilities under this paragraph upon direction by the Government, the Government may either terminate or suspend work on the Project or proceed with further work as provided in Article XVI of this Agreement.

d. The Local Sponsor and the Government shall consult with each other under Article V of this Agreement to assure that responsible parties bear any necessary clean up and response costs as defined in CERCLA. Any decision made pursuant to Article XVIII.c. of this Agreement shall not relieve any party from any liability that may arise under CERCLA.

e. As between the Government and the Local Sponsor, the Local Sponsor shall be considered the operator of the Project for purposes of CERCLA liability. To the maximum extent practicable, the Local Sponsor shall operate, maintain, repair, replace and rehabilitate the Project in a manner that will not cause liability to arise under CERCLA.

ARTICLE XIX - NOTICES

a. All notices, requests, demands, and other communications required or permitted to be given under this Agreement shall be deemed to have been duly given if in writing and delivered personally, given by prepaid telegram, or mailed by first-class (postage pre-paid), registered, or certified mail, as follows:

If to the Local Sponsor:

Executive Director
South Florida Water Management
District
Post Office Box 24680
West Palm Beach, Florida 33416-4680

If to the Government:

District Engineer
U.S. Army Engineer District
Jacksonville District
P.O. Box 4970
Jacksonville, Florida 32232-0019

b. A party may change the address to which such communications are to be directed by giving written notice to the other party in the manner provided in this Article.

c. Any notice, request, demand, or other communication made pursuant to this Article shall be deemed to have been received by the addressee at such time as it is either personally delivered or seven calendar days after it is mailed, as the case may be.

ARTICLE XX - CONFIDENTIALITY

To the extent permitted by the laws governing each party, the parties agree to maintain the confidentiality of exchanged information when requested to do so by the providing party.

ARTICLE XXI - SECTION 902 PROJECT COST LIMITS

The Local Sponsor has reviewed the provisions set forth in Section 902 of P.L. 99-662, as amended, and understands that Section 902 establishes the maximum total project cost. For purposes of this Agreement, the Section 902 cost limit is $572,565,000 as calculated on December 15, 1993. This amount is calculated using procedures set forth in Appendix P of ER 1105-2-100. It shall be adjusted to allow for appropriate increases for inflation and changes in total project costs as provided in Section 902. Should this cost maximum be reached, no additional funds may be expended on the Project until additional authority is obtained from Congress.

ARTICLE XXII - CONTINGENCY OF PERFORMANCE

Performance by either party under this Agreement and any entitlement owing to either party under this Agreement is contingent upon completion of a report by the Chief of Engineers on the Headwaters Revitalization Project that is approved by the Assistant Secretary of the Army (Civil Works).

IN WITNESS WHEREOF, the parties hereto have executed this Agreement.

THE DEPARTMENT OF THE ARMY

BY: JOHN H. ZIRSCHKY
Acting Assistant Secretary
of the Army (Civil Works)

DATE: March 22, 1994

SOUTH FLORIDA WATER
MANAGEMENT DISTRICT

BY: TILFORD C. CREEL
Executive Director

DATE: March 22, 1994

Legal Form Approved
SFWMD Office of Counsel
By Abner Cooper Date 3/18/94

CERTIFICATE OF AUTHORITY

I, Barbara Markham, do hereby certify that I am the principal legal officer of the South Florida Water Management District, that the South Florida Water Management District is a legally constituted public body with full authority and legal capability to perform the terms of the Agreement between the Department of the Army and the South Florida Water Management District in connection with the Project, and to pay damages, if necessary, in the event of the failure to perform, in accordance with Section 221 of Public Law 91-611, that Thomas MacVicar, in executing this Agreement on behalf of the Executive Director of the South Florida Water Management District, has acted within his statutory authority and is fully empowered to execute this Agreement and bind the South Florida Water Management District to the terms thereof.

IN WITNESS WHEREOF, I have made and executed this certification this 22nd day of March, 1994.

Barbara Markham
General Counsel for the South
Florida Water Management District

CERTIFICATION REGARDING LOBBYING

The undersigned certifies, to the best of his or her knowledge and belief that:

(1) No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.

(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

DATE: March 22, 1994

Thomas K. MacVicar

Tilford C. Creel
Executive Director
South Florida Water
Management District

CERTIFICATION OF LEGAL REVIEW

The draft Project Cooperation Agreement for the Kissimmée River, Florida Project has been fully reviewed by the Office of Counsel, USAED Jacksonville and is legally sufficient.

Assistant District Counsel

KISSIMMEE RIVER
HEADWATERS REVITALIZATION PROJECT

APPENDIX J

NAVIGATION IMPACT STUDY

UPPER KISSIMMEE REVITALIZATION BOATING IMPACTS NAVIGATION STUDY

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UPPER KISSIMMEE REVITALIZATION BOATING IMPACTS

HISTORY

Early problems on the Kissimmee River were a result of natural droughts in the area that would halt waterborne transportation from 4 to 8 months of the year. Growing steamer traffic on that river in the late 1800s provided cargo and passengers to the region. Reported commerce at that time had a total value of about $151,000. The river port of Kissimmee secured the service of two passenger lines with the potential of a third one in 1902. The growing traffic on the river provided the support necessary to justify a Federal navigation project. The Rivers and Harbors of 13 June 1902 authorized the Federal navigation project in the upper Kissimmee basin. That project provided for a channel 3 feet deep over a bottom width of 30 feet at ordinary low stage.

Waterborne movement of goods and passengers has since declined in this region. Better rail and highway service have replaced cargo movements by water. The navigation features of the project are now part of a more extensive flood control project that came later and provided a broader and deeper waterway. Current usage of those waters is in the form of recreational boating. A 1994 Florida Game and Freshwater Fish Commission Creel Report indicates that recreational boaters contribute over $ 8,510,000 a year (excluding boat/trailer expenditures) to the economy of the upper Kissimmee basin.

PROBLEM AREA IDENTIFICATION

Potential problems areas are most likely to occur at extreme high water above 53.0 feet national geodetic vertical datum (NGVD) and extreme low water below 48.5 feet NGVD. The extreme high water condition is the top elevation of the lowest boat ramps in the impacted area. The extreme low water condition comes from interview information obtained during field work. Those two conditions are most likely in the summer and winter months, respectively. The analysis focuses on boat usage in those months to assess the most likely impact to boating on the lakes.

COUNTY BOAT REGISTRATION DATA

Osceola and Polk Counties are in the study area. Vessel registration for 1995 shows 6,370 and 24,905 recreational vessels in Osceola and Polk Counties, respectively. Those two counties have over 660 commercial vessel registrations. Recreational boat registrations from those counties are by class of boat. The class, length, and number of boats most prevalent in those counties are in table 1.

TABLE 1
Boat Registration

	Recreational Boat	
Class	Length	Number
A-1	under 12 feet	4,041
A-2	12-15 feet 11 inches	13,792
1	16-25 feet 11 inches	11,914
2	26-39 feet 11 inches	374
3	40-64 feet 11 inches	55
4-5	65 and more	2

CURRENT BOAT RAMP USAGE AND CONDITIONS

A field investigation of boating in the area occurred in December 1995 to survey boating facilities as well as boat use. Site visits covered about 40 known public and private boat ramps and marinas in the affected area to determine conditions and usage. The investigation included a weekend to more accurately determine boat use. A count of trailers provided an estimate of usage at each boat ramp. Roughly, that count indicated ramp usage at about 380 boats a day during the weekend in the upper Kissimmee. An estimate of weekday usage is about 40 percent of the usage on the weekend or about 150 boats a day. That estimate is from visual observation and knowledgeable area sources.

Discussions with boaters at the ramp sites provided other information. An estimate of vessel size at the ramps from the field data is in table 2 according to registration class. Boater origin from license plate information on the trailers and discussions with boat owners indicated about 95 boats from the approximate 380 boats a day during the weekend were from out of state. Time spent in using boats from interview data indicated an averaged about 6.1 hours a day on the lakes. Based on the estimated average people per boat from field data, the combined usage is about 18 user hours per boat day. The season of

preferred usage is the winter. Boaters also provided information as to their anticipated usage with higher and lower lake regulation stages during the year for comparison with existing usage. Boaters indicated no significant change in their boat usage as other alternatives are abundant in the area.

TABLE 2
Ramp Boats by Class

Class	Boat length	Percentage at ramp boats
A-1	under 12 feet	3
A-2	12-15 feet 11 inches	20
1	16-25 feet 11 inches	74
2	26-39 feet 11 inches	3
3-5	40-64 feet 11 inches	0

Access ramp conditions were visually noted as to water levels in relation to the ends of the ramps. Two ramps appeared to be a potential problem with high water. Discussions with county engineers confirmed the estimated conditions from visual observations.

NAVIGABLE CONDITIONS AND PROBLEMS

The Florida Game and Fresh Water Fish Commission (FG&FWFC) officials provided assistance during field work in determining existing conditions. A visit to each public ramp by water enabled an assessment of channel depths. Rough depth checks of other channels, canals, and navigational routes indicated available water based on the lake stage at that time. The results of those rough measurements compared favorably with more accurate survey data obtained in 1986.

Four waterway areas, identified during recent field work as public access routes, had sufficient shoaling to constrict navigation at a lake stage of 49.8 feet. Two of those shoaled areas are on a main waterway route in Lake Cypress. Lake Hatchineha has one shoaled area on a main waterway route. The fourth area is Tiger Creek which drains Tiger Lake into Lake Kissimmee. Water depth in the creek at an elevation of 48.5 NGVD is an estimated 1.0 feet.

Based on a preliminary assessment of overall water depths in the lakes, the main waterways in the lakes have about 1.5 feet or more of usable depth at a stage of 48 feet NGVD. An elevation of

48.5 feet NGVD enables a depth of about 2.0 feet which is about the minimum for most small outboard traffic to operate. Depths less than that begin to cause boating problems.

Hydrilla is a major navigational problem on two lakes and a minor problem on Lake Kissimmee. Lakes Cypress and Hatchineha have hydrilla that affects boating on about 70 to 80 percent of the lakes' surfaces. The only vessels that have no problems are airboats in those lakes. Boats with propellers in the water have difficulty with navigation through the hydrilla which can foul props and block water intakes. That water plant can be found in nearly all depths of water in the lakes.

Inspection of navigation markers provided data on their height above water and their surrounding water depths. That information enables an assessment on the susceptibility to extreme low or high waters. Depths at low waters can cause vessel grounding if not sufficient for navigation in the marked channel. Extreme high waters could put a marker or a portion of one under water. A preliminary inspection of navigational markers indicated no significant impact would occur to existing markers considering current conditions. Figure 1 shows the condition of a marker on the waterway and is typical of other markers.

AREA DATA COORDINATION

Meetings with county, water management district, and state officials concerning initial findings. The Osceola County officials helped confirm initial findings. The South Florida Water Management District Kissimmee Field Office corroborated data retrieved concerning navigational markers. None seem to pose a potential problem with respect to the proposed lake levels on the upper Kissimmee River.

State officials from the FG&FWFC confirmed a wealth of anecdotal knowledge concerning the location of impediments to navigation with high water at boat ramps. Their annual survey information on fishing effort is current on Lake Kissimmee and indicates the approximate numbers of people fishing on that lake. Current information on Lakes Cypress and Hatchineha was not available. However, a survey in 1985 indicated those lakes had a smaller amount of fishing effort than Lake Kissimmee. That survey indicated the effort in Lake Cypress was about 25 percent of that in Lake Kissimmee. Lake Hatchineha had about 59 percent of the Lake Kissimmee effort. The hydrilla weed in those lakes at that time was not as great a problem as the current situation making those lakes almost unusable except to airboats.

Table 3 provides a preliminary estimate of boating use in the lakes. FG&FWFC observations in the area and their surveys on fishing efforts were primary considerations in obtaining those estimates. Observations during data collection indicated most boats had an estimated two people fishing. The count excludes non-fishing boat usage for other recreational purposes. Their records do not distinguish between commercial and recreational fishing effort. Using the estimated value of two people per boat, current survey numbers were adjusted to show boating use on Lake Kissimmee. Table 3 values for Lakes Cypress and Hatchineha are an estimated percentage of Lake Kissimmee taking into account recent observations with the severe hydrilla problem.

TABLE 3
Boats Used for Fishing

	Estimated Average Boats a Day for Fishing 1/					
	Lake Kissimmee		Lake Cypress		Lake Hatchineha	
Year	Winter	Summer	Winter	Summer	Winter	Summer
1993	944	532	47	27	142	80
1994	974	615	49	31	146	92
1995	-	664	-	33	-	100
Average	959	603	48	30	144	90

1/ Estimates for Lakes Cypress and Hatchineha are a percentage of Lake Kissimmee based on 1985 survey data and recent field observations.

The three lakes have an estimated average total for each season of about 1151 boats a day during the winter and 723 boats a day during the summer. As fishing is a primary activity on the lakes, most of the estimated boat use is already in table 3. Other recreational usage does occur to increase these totals.

Considering the hydrilla problem in Lakes Cypress and Hatchineha, other recreational boating activities in them is probably very small to none. Excluding those lakes from consideration leaves Lake Kissimmee as the primary area for those activities. An increase in boating related to other recreational activities can possibly increase the boats a day another 10 to 20 percent. However, that usage probably involves a shorter day of about 3 hours verses 6 hours for fishing. Increasing the average boats a day in use on Lake Kissimmee by about 15 percent and accounting for the shorter usage period, the equivalent boats for

other recreational activities are about 72 and 45 boats a day during the winter and summer, respectively. Estimated total average usage is about 1220 and 650 boats a day for the winter and summer seasons, respectively

LOW WATER IMPACTS

Figures 2, 3, and 4 show stage duration curves for the proposed and observed lake level schedules for each lake from 0 to 100 percent of the time. The ordinary high and low water (OHW and OLW) reference datums are on these figures. The low water end of figures 2, 3, and 4 from 80 to 100 percent of the time are on figures 5, 6, and 7 for an enlarged view of that portion Field interview information indicates the problems at low water start at about elevation 48.5 feet NGVD under current conditions.

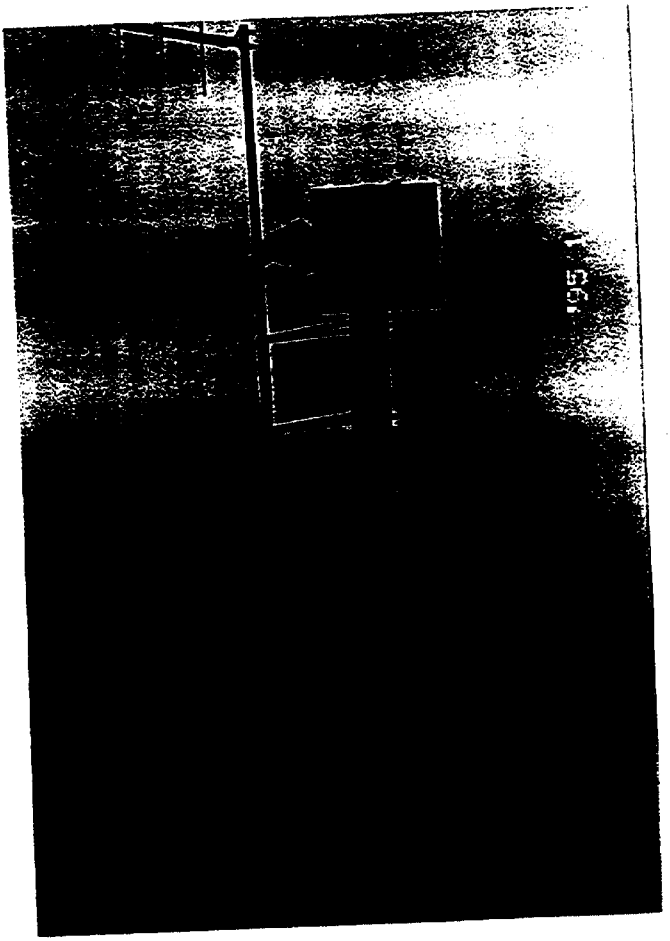
The proposed schedules drop no lower than the 48 feet NGVD stage level which is higher than the observed schedules as shown for each lake on figures 5, 6, and 7. The observed schedule at a lake stage of 48.5 feet NGVD is below the proposed schedule on all three lakes. The proposed schedule offers less of a duration restriction at that low water stage and below than the observed schedule. The proposed schedule, therefore, results in less of an impact on boating use than the observed schedule at low water conditions of 48.5 feet NGVD and lower. This is especially true on Lake Kissimmee which has a more severe drawdown with the observed schedule than the proposed one. Since Lake Kissimmee has the most usage, the obvious conclusion is the proposed schedule has a significant beneficial impact to boating in the area at low water.

Two boat ramps were susceptible to low water impacts. The two ramps are both on Lake Kissimmee. Both ramps face the likelihood of descending into mud flats at water levels of 48 feet NGVD or below. The Osceola County Environmental Services Director confirmed that the county has plans to perform the required maintenance to keep those boat ramps operational during periods of low water. Since low water conditions are better with the proposed schedule than the observed, only a beneficial impact is likely.

HIGH WATER IMPACTS

High water impacts take the form of overtopping the high end of boat ramps and raising boats to higher levels in covered slips. Navigational markers as stated previously will not be adversely affected by proposed high or low waters conditions.

Figure 1



LAKE CYPRESS STAGE DURATION COMPARISON

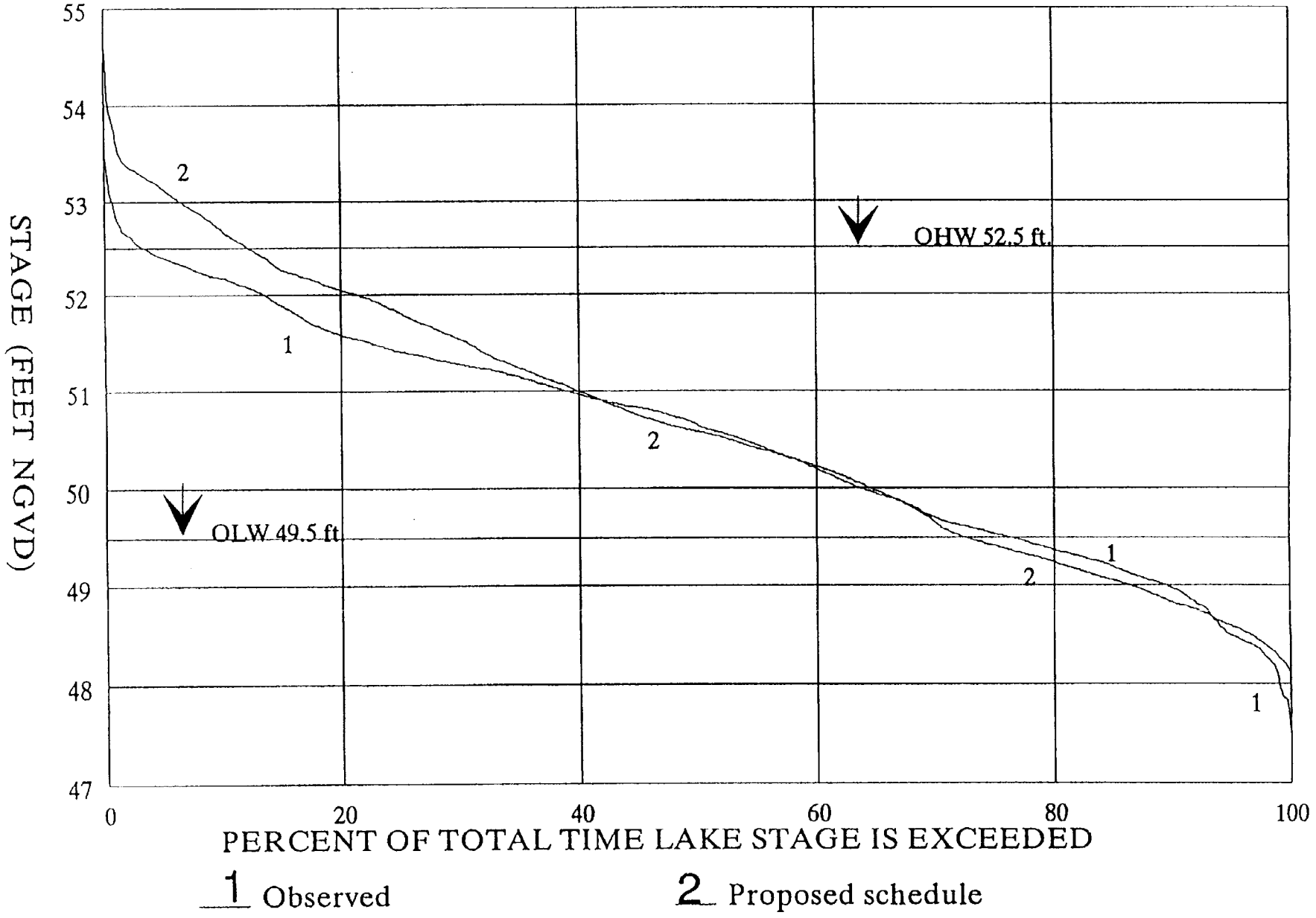


Figure 2

LAKE HATCHINEHA STAGE DURATION COMPARISON

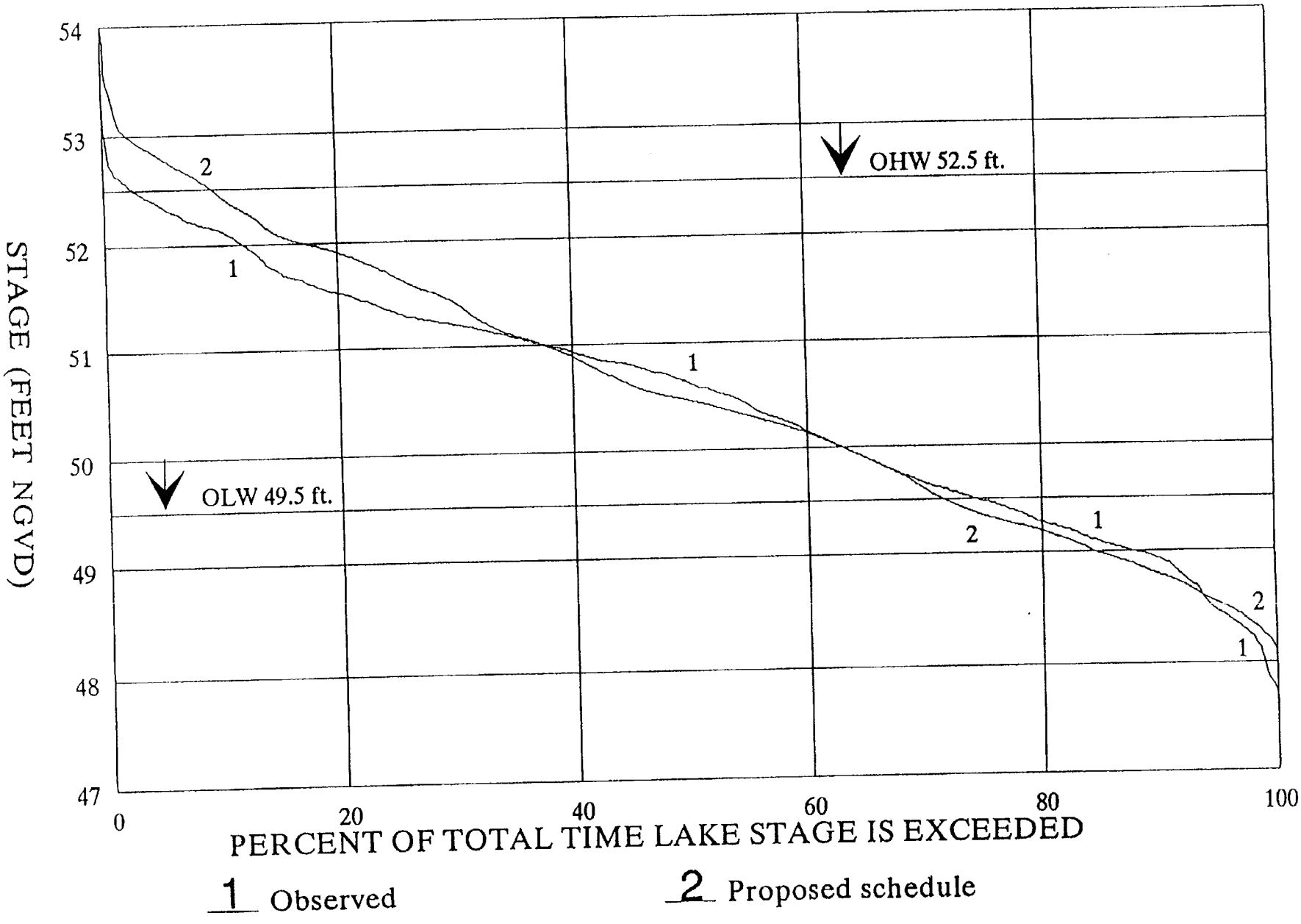


Figure 3

LAKE KISSIMMEE STAGE DURATION COMPARISON

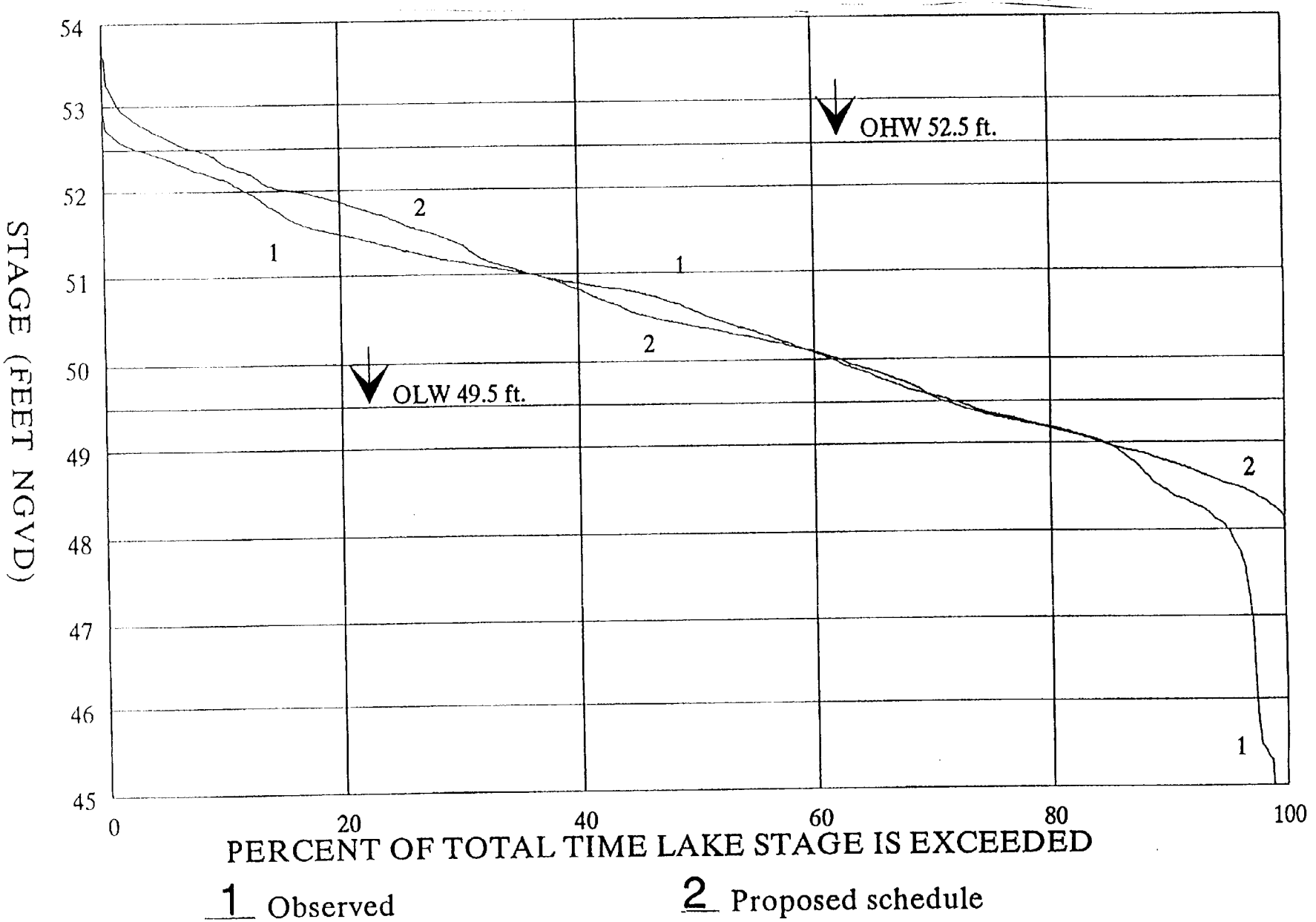


Figure 4

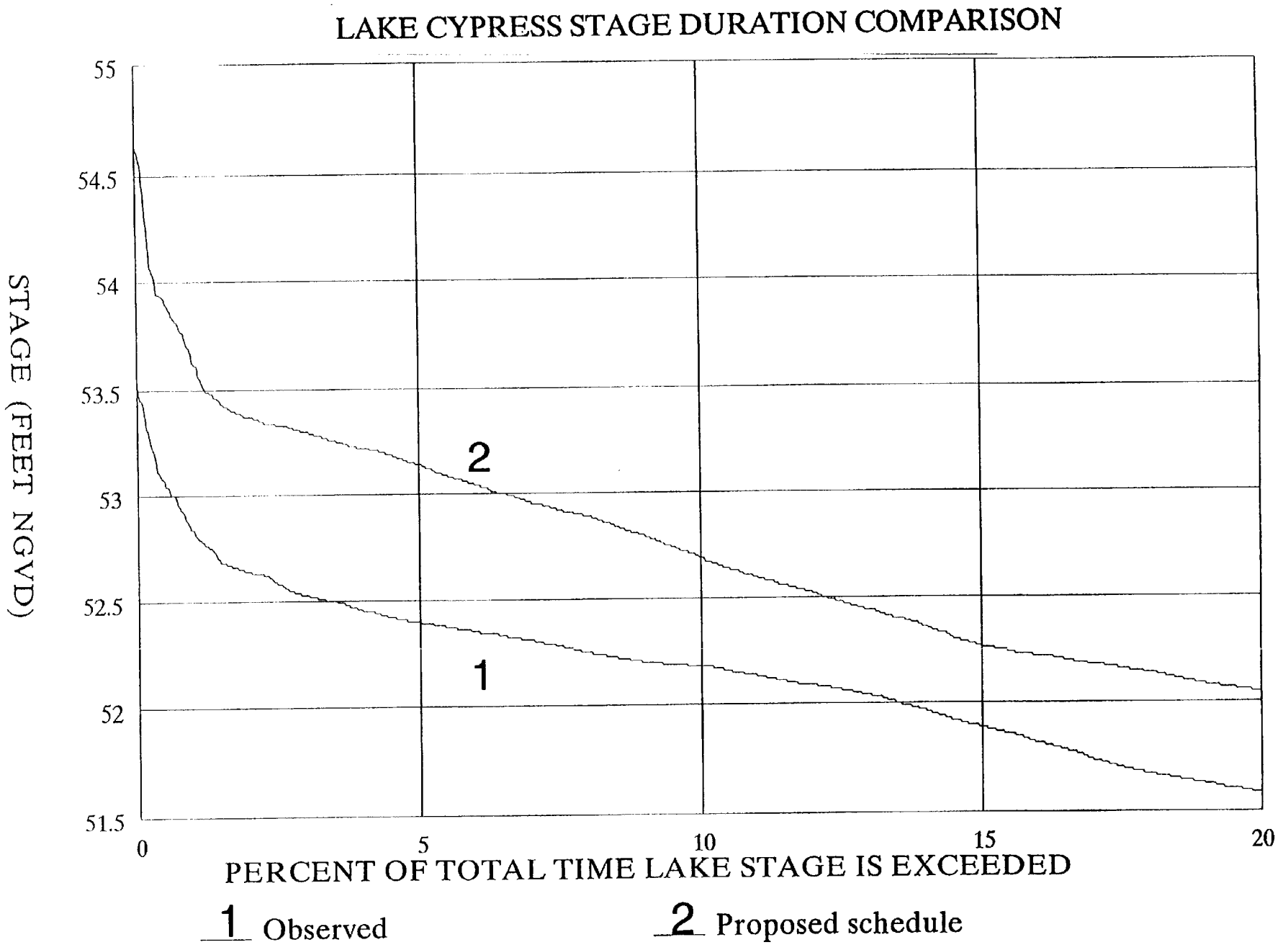

LAKE CYPRESS STAGE DURATION COMPARISON
STAGE (FEET NGVD)
55
54.5
54
53.5
53
52.5
52
51.5
0
5
10
15
20
PERCENT OF TOTAL TIME LAKE STAGE IS EXCEEDED
2
1
1 Observed
2 Proposed schedule

Figure 5

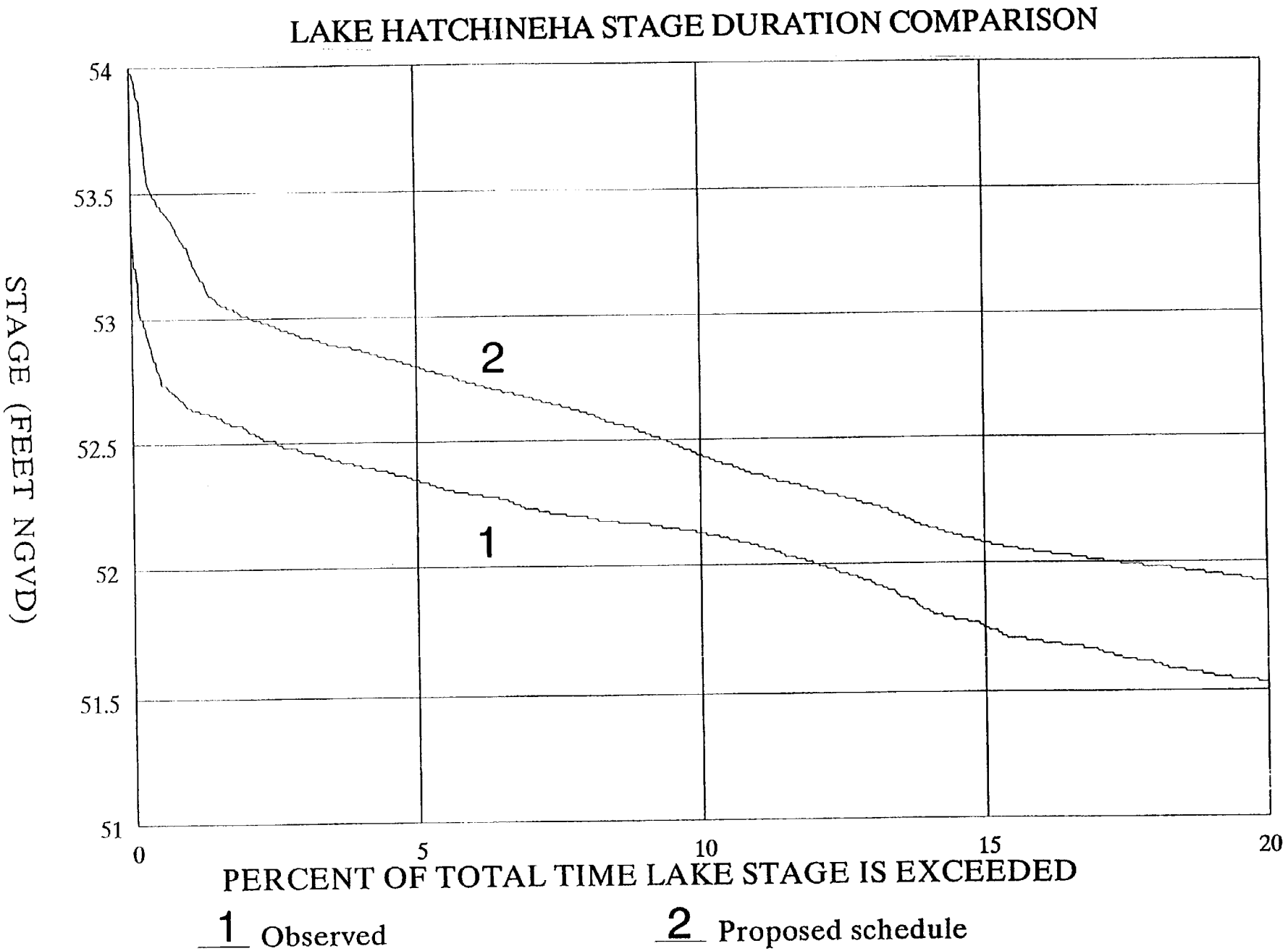

LAKE HATCHINEHA STAGE DURATION COMPARISON
STAGE (FEET NGVD)
54
53.5
53
52.5
52
51.5
51
0
5
10
15
20
2
1
PERCENT OF TOTAL TIME LAKE STAGE IS EXCEEDED
1 Observed
2 Proposed schedule

Figure 6

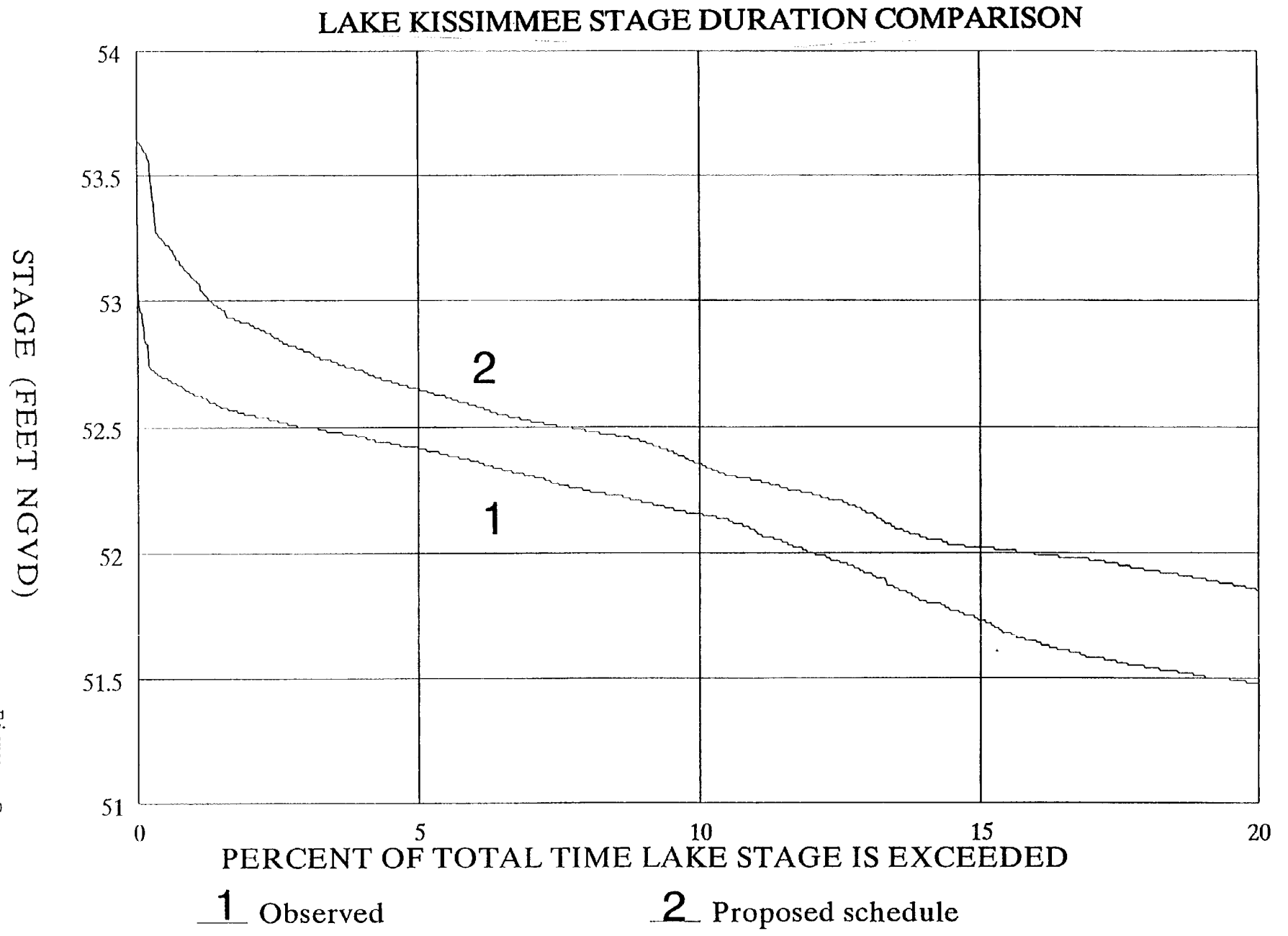

LAKE KISSIMMEE STAGE DURATION COMPARISON
STAGE (FEET NGVD)
54
53.5
53
52.5
52
51.5
51
0
5
10
15
20
PERCENT OF TOTAL TIME LAKE STAGE IS EXCEEDED
2
1
1 Observed
2 Proposed schedule

Figure 7

Boat Ramp Access. Two boat ramps are subject to overtopping with water levels above 53 feet NGVD. One is on Lake Kissimmee and the other is on Lake Cypress. Figure 8 is an aerial photograph of the public ramp on Lake Kissimmee and the other ramp is a commercial ramp at a marina. Figure 12 shows the general location of the sites with "P" and "N" (Overstreet's Landing) being the location of the public ramps on Lakes Cypress and Kissimmee, respectively. The triangle on figure 12 with the number "14" in it is the location of a commercial ramp (Grape Hammock) that is subject to isolation. Isolation takes place when the public paved access road leading to the commercial ramp becomes inundated.

The high water level with the observed schedules range from about 53 to 53.5 feet NGVD as shown on figures 9, 10, and 11. The proposed schedule ranges from about 53 to 54.5 feet NGVD. The high water from the proposed schedule can cover the landward ends of the concrete ramps with water which will impact their use for boat access to the lakes. The impacted public ramps on both lakes have dirt roads for access. The private commercial ramp has a paved access road. A portion of those roads nearest the lakes would also be covered with water at a lake level of 53 feet NGVD or above. The total impact with the proposed schedule and the net impact between the proposed and observed schedules is as follows for Lake Cypress and Kissimmee:

Lakes	Total Impact Days a year	Net Impact Days a year
Cypress	24	21
Kissimmee	5	5

Boat Slips. Boat slips in the water numbered about 630 around the lakes and include both private residences and marinas. Approximately 225 have a cover over them and about two-thirds of those are in marinas. Figures 13 and 14 show the types of covered boat slips in the area. About 25 covered slips on Lakes Hatchineha and Kissimmee would be affected with a proposed schedule exceeding 53.9 feet. The net duration of that impact with the proposed schedule over the observed schedule is about 2 days a year in Lake Hatchineha and 1 day a year in Lake Kissimmee between July and September. Interviews with marina operators indicate that dockage is not in high demand at that time of year. Finding other mooring alternatives for 1 or 2 days a year is a minor inconvenience which does not appear to be a significant problem.

Figure 8

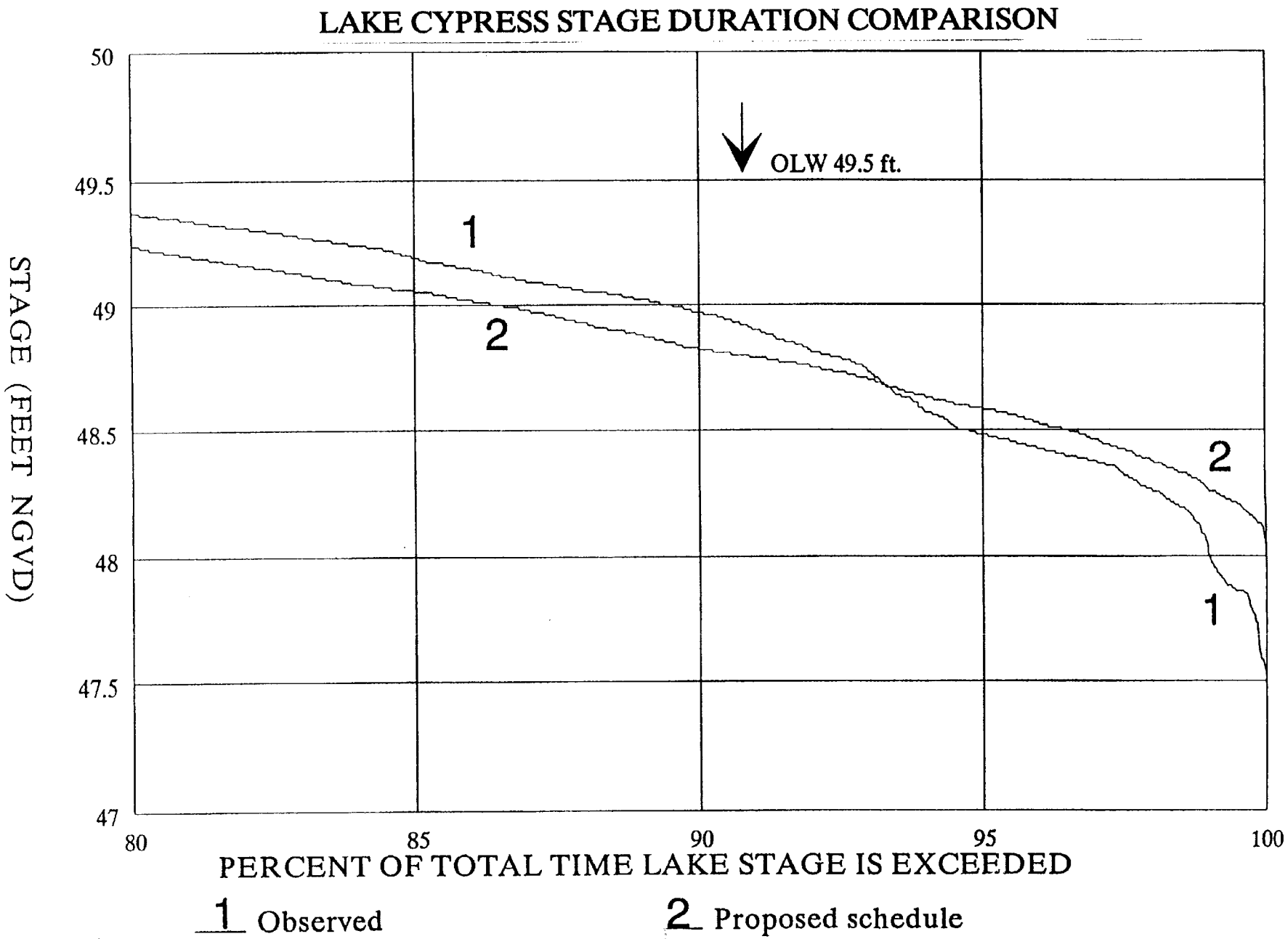

LAKE CYPRESS STAGE DURATION COMPARISON
OLW 49.5 ft.
STAGE (FEET NGVD)
50
49.5
49
48.5
48
47.5
47
80
85
90
95
100
PERCENT OF TOTAL TIME LAKE STAGE IS EXCEEDED
1
2
1 Observed
2 Proposed schedule

Figure 9

LAKE HATCHINEHA STAGE DURATION COMPARISON

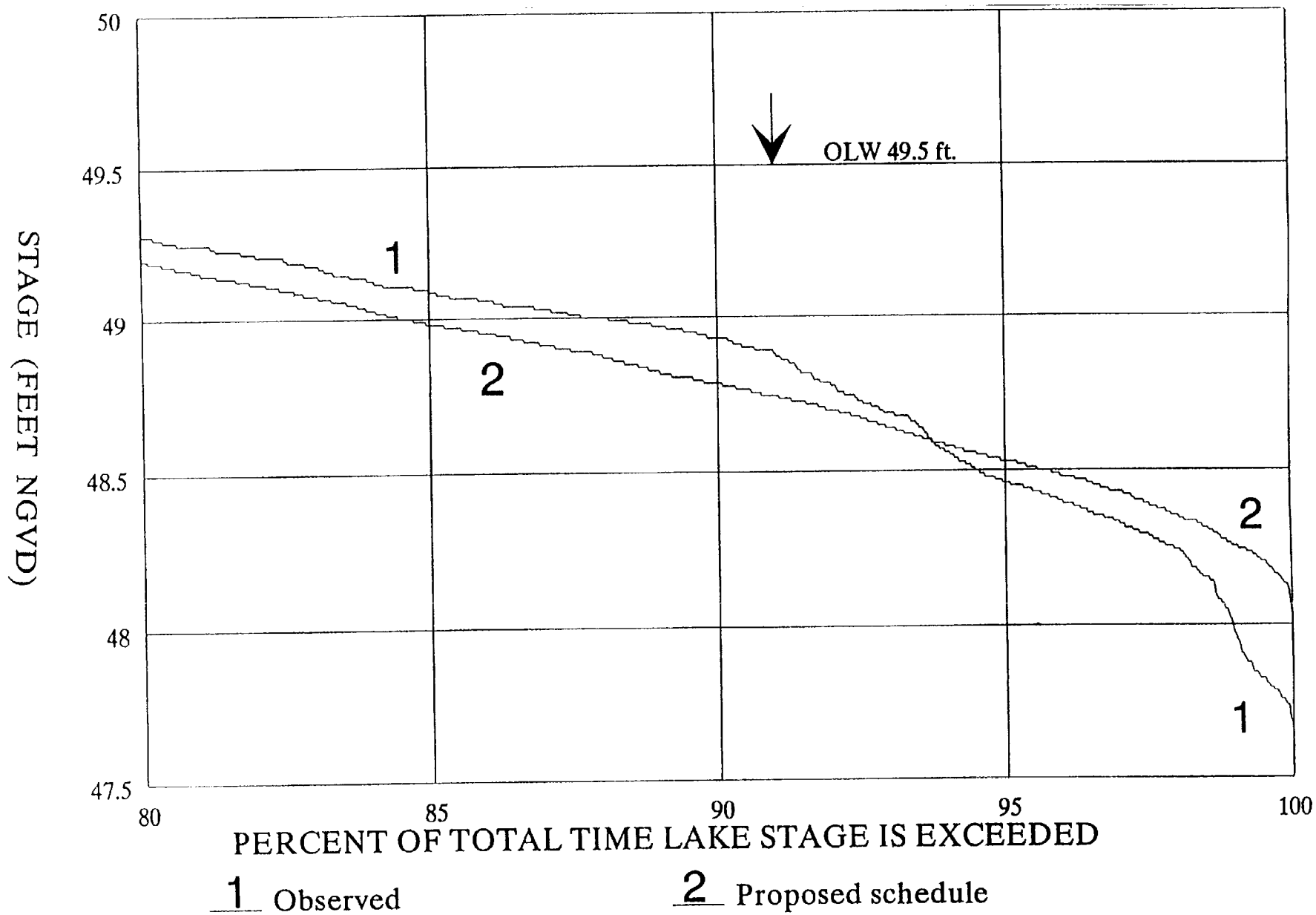


Figure 10

LAKE KISSIMMEE STAGE DURATION COMPARISON

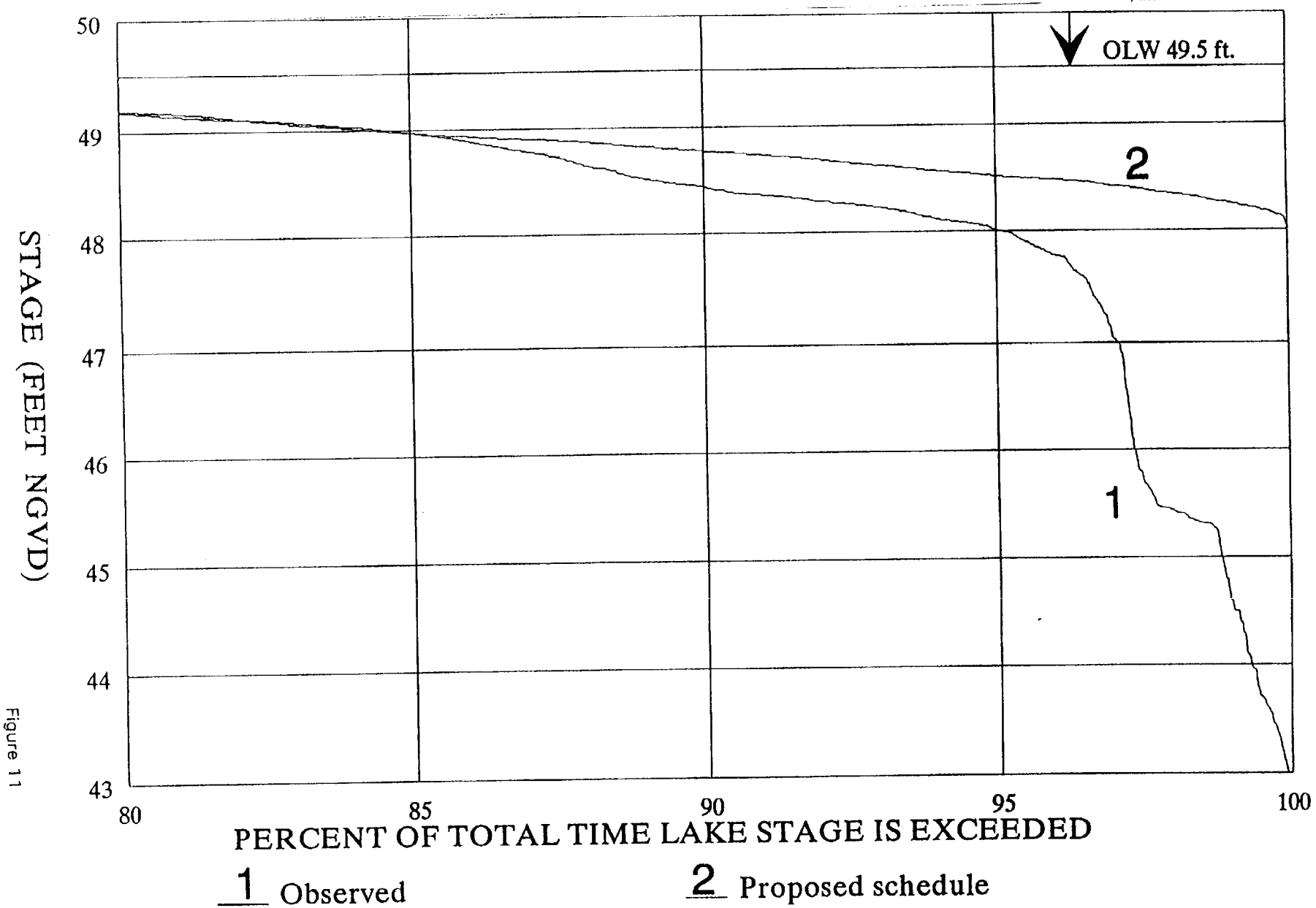


Figure 11

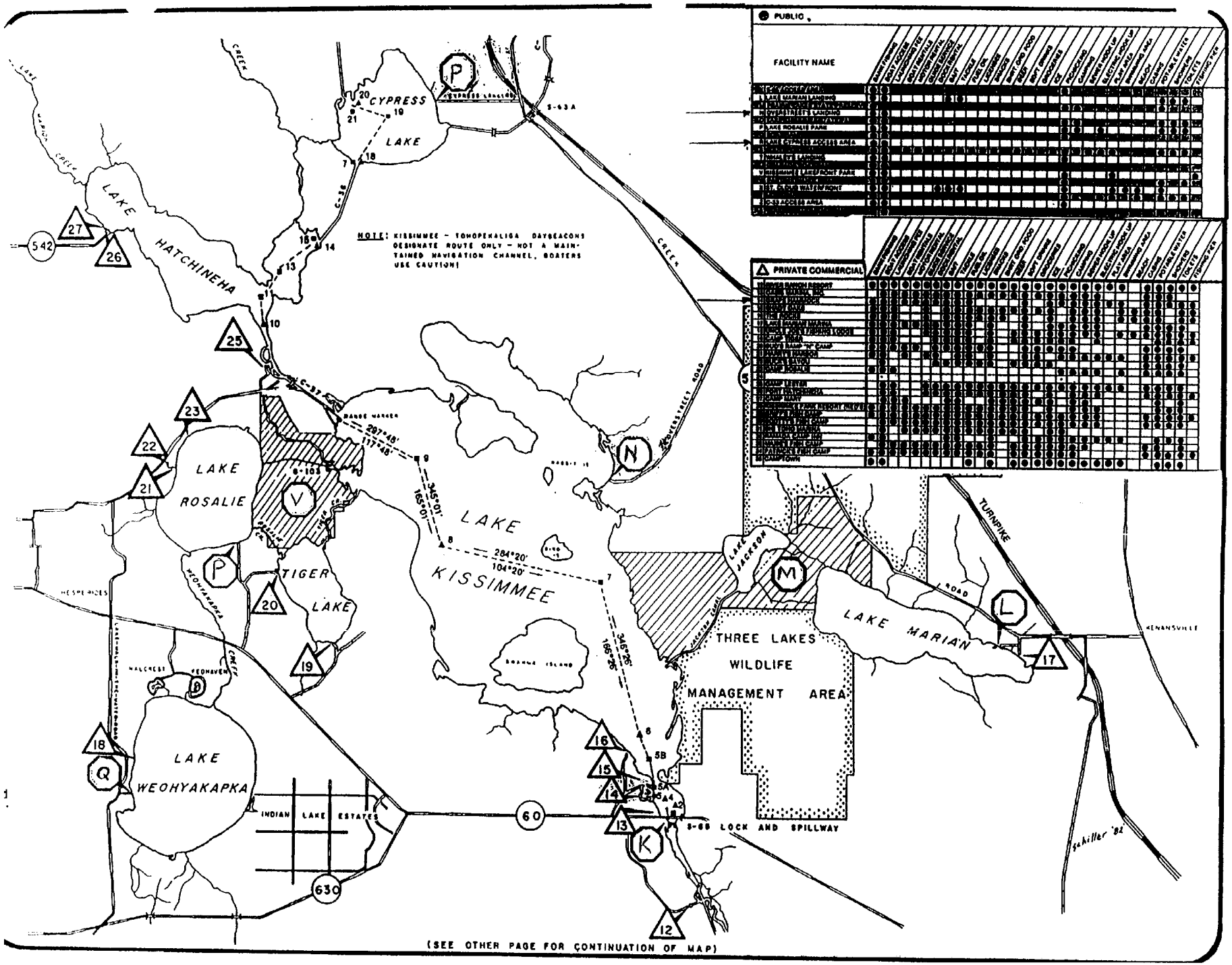

PUBLIC
FACILITY NAME
PRIVATE COMMERCIAL
CYPRESS LAKE
LAKE HATCHINEHA
LAKE ROSALIE
TIGER LAKE
LAKE KISSIMMEE
LAKE WEOHYAKAPKA
LAKE JACKSON
LAKE MARIAN
THREE LAKES WILDLIFE MANAGEMENT AREA
INDIAN LAKE ESTATES
S-63 LOCK AND SPILLWAY
TURNPIKE
KENANSVILLE
HESPERIDES
NOTE: KISSIMMEE - TOHOPEKALIGA DAYBEACONS DESIGNATE ROUTE ONLY - NOT A MAINTAINED NAVIGATION CHANNEL, BOATERS USE CAUTION!
(SEE OTHER PAGE FOR CONTINUATION OF MAP)

Figure 13

Figure 14

Summary. Table 4 is a summary of the estimated impacts from high water on boat use in days. Table 5 is a list of alternative ramps or slips for use.

CONCLUSIONS

The proposed water elevation schedule for the upper Kissimmee basin revitalization appears to have minimal adverse impacts. Those impacts occur during extreme high water conditions above lake levels of 53 feet NGVD. The estimated net impacts of the proposed schedule over the observed schedule are discussed in the subsequent paragraphs. Low water impacts with the proposed lake schedules should be a beneficial impact to boat usage based on existing conditions in the area with no apparent adverse impacts.

Lakes Cypress and Hatchineha. The estimated impacts involve ramps and covered boat slips. Lake Cypress has a public boat ramp impacted during high water. Usable alternative boat ramps are available for access. They are within a 30 minute drive from the impacted boat ramp. High water impacts occur at lake levels exceeding 53 feet. The ramp on Lake Cypress has 21 more days of impact with the proposed schedule than with the observed schedule. About 20 covered slips in Lake Hatchineha and C-37 on figure 12 would have a total and net impact of 2 days a year with the proposed schedule. The net and total impact is the same because the observed high water schedule does not get 53.9 feet NGVD for an impact. Such an impact appears minor with the availability of alternative berthing.

Lake Kissimmee. The observed schedule for Lake Kissimmee remains at or below a level of 53 feet NGVD causing no existing impact during high lake levels. Navigational impacts to Lake Kissimmee with the proposed schedule will likely involve overtopping a public boat ramp, isolating a private commercial boat ramp, and raising water levels sufficiently to impact about five covered slips. The boat ramp impacts are possible about 5 days a year on Lake Kissimmee during high water above 53 feet NGVD. The private commercial boat ramp is likely to experience an inundation of the public access (paved road) with high water thus rendering it unusable for boating. Covered slips on the southwest side of the lake can experience less impacted duration but have alternative berthing options to minimize the problem. Duration of extreme high water impacts (water levels exceeding 53.9 feet) on slips should be roughly 1 days a year for Lake Kissimmee.

TABLE 4

HIGH WATER IMPACTS

Summary of Navigational Impacts			
Location	Average boat use a day	Days impacted a year	Impacted Boat-days
Lake Cypress boat ramp	30	21	630
Overstreet's Landing boat ramp	20	5	100
Grape Hammock boat ramp	10	5	50
Port Hatch/Kiss. River Marina slips	20	2	40
Grape Hammock/Shady Oaks slips	5	1	5
TOTAL	85	34	825

TABLE 5

RAMPS AND SLIPS		
Location	Distance to alternative	Alternative capacity?
Lake Cypress boat ramp	12 miles	Yes
Overstreet's Landing boat ramp	27 miles	Yes
Grape Hammock boat ramp	1 mile	Yes
Port Hatch/Kiss. River Marina slips	1 mile	Yes
Grape Hammock/Shady Oaks slips	1 mile	Yes