EXECUTIVE SUMMARY

A significant factor in the decline of the Everglades ecosystem functions has been the disruption of the system's historic hydrologic characteristics, specifically, the quantity, timing, and distribution of inflows. Hence, reestablishment of these hydropattern characteristics has been explicitly incorporated into the overall Everglades restoration goals. During the development of the 1993 mediated technical plan, and subsequently, the 1994 Conceptual Design of the Everglades Construction Project (ECP), there was consensus among all the state and federal agencies, and other stakeholders, for the need to include specific construction components to distribute the discharge from the Stormwater Treatment Areas (STAs) into areas needing rehydration - WCA 2A, WCA 3A and the Rotenberger Wildlife Management Area.

Hydropattern restoration is one area of science where unequivocal answers are not available to every question; hence we rely on best professional judgement to supplement available information.

The paper is being prepared as part of the federal dredge and fill regulatory process, which is taking place concurrent with the Programmatic Environmental Impact Statement. The objective of the completed paper will be to provide reasonable assurance that the benefits of the hydropattern restoration components of the Current Plan of the Everglades Construction Project clearly outweigh the potential adverse impacts. This reasonable assurance will be a combination of best available information and an adaptive assessment resource plan that describes how the South Florida Water Management District (District) will continue to improve its resource information base and, if needed, make structural or operational modifications if potential problems arise as a result of implementing the recommended hydropattern restoration projects. This document was compiled as a result of four half-day workshops held June on 6, 7, 13 and 14 and two public workshops held July 19 and August 5, 1996. During those workshops, the benefits and impacts of the proposed hydropattern restoration projects ("Current Plan") and alternatives ("No Action" and so-called "Bypass"plans) were evaluated based on ecologic factors and other considerations (refer to Section 2 for further details of the evaluation methodology).

This document is a compilation of the best professional judgement of District staff regarding the potential benefits and impacts of the proposed hydropattern restoration components, and alternatives, of the Everglades Construction Project. The following major findings are presented.

1. Extent of hydropattern restoration benefits were estimated by comparing simulated hydroperiods for the Current Plan and alternatives with hydroperiod targets suggested by the Natural System Model. A net improvement of 74,240 acres to the Everglades Protection Area and the Rotenberger Wildlife Management Area was calculated for the Current Plan compared to the alternatives.

2. For the 8-yr time frame (1999-2006) evaluated, the Current Plan had the least cumulative phosphorus discharged to the Everglades Protection Area (781 metric tons), the Bypass options released 841 metric tons (60 metric tons more than the Current Plan), while the No Action alternative resulted in an estimated discharge of 1,645 metric tons of phosphorus (865 metric tons more than the Current Plan). The No Action alternative has the greatest extent of adverse impacts of all the options considered. In general, the Bypass options are more expensive, have slightly more impact than the Current Plan, yet do not have the same regional hydropattern benefits provided by the Current Plan's hydropattern restoration activities. Of all the options

evaluated, the Current Plan provides the best balance of trade-offs between regional hydroperiod benefits versus localized impacts and maximizes environmental benefits to the Everglades Protection Area.

3. Antecedent conditions play a critical role in determining the extent of impacts, particularly, determining the rate of change in existing emergent macrophyte communities. For example, observations in WCA 2A downstream of the S-10 structures suggest that conversion from desirable vegetation communities to cattails is accelerated given the presence of numerous open-water slough communities, whereas a similar conversion in areas downstream of STA-2 would probably be reduced due to an existing dense stand of sawgrass.

4. Active management of cattails, e.g., burning, mechanical removal or herbicide treatment, holds promise as an effective means of ameliorating some adverse impacts of the hydropattern restoration projects, particularly once the phosphorus discharge is reduced to the "no-imbalance" levels. Additional research has been proposed in FY 97 (via SWIM funds) to begin intensive investigations on the efficacy of these techniques that could be used to reverse adverse impacts and to insure there are no collateral damage to adjacent wetlands.

5. For all the water bodies evaluated, the Current Plan options are expected to have no regional short-term or long-term adverse impacts; all the regional impacts are either beneficial over the long-term (WCAs) or negligible over the short-term (Rotenberger). All of the No Action and Bypass options are expected to have regional short-term and long-term adverse impacts, primarily because of continued degradation of vegetation and animal communities not receiving the benefits of hydropattern restoration.

6. The No Action and Bypass options result in delayed implementation of the hydropattern restoration goals. Both options may significantly increase the total cost of the project due to inflation. In addition, the Bypass options necessitate expenditures of millions of public dollars for construction of temporary bypass canals and structures. This money would be better spent on other restoration activities.

7. An appropriate adaptive assessment resource protection plan, including monitoring, research and modeling, with a well-crafted science-based feedback mechanism, should be implemented concurrently with the proposed hydropattern restoration projects. This will reduce the scientific uncertainties, enhance our future ecosystem restoration planning effectiveness, and will allow for detection and correction of any unanticipated adverse impacts.

Section 1. INTRODUCTION AND BACKGROUND

INTRODUCTION - A significant factor in the decline of the Everglades ecosystem functions has been the disruption of the system's historic hydrologic characteristics, specifically, the quantity, timing, and distribution of inflows as a result of construction and operation of the Central and Southern Florida Flood Control Project. One of many tangible effects of this disruption has been

(1) a shift of historic wetland vegetation communities to more terrestrial communities in areas that have been cut off from surface inflows, and

(2) a conversion to deeper water communities in areas that receive greater volumes or are impounded for greater periods (e.g., downstream of the S-6 pump station).

Hence, re-establishment of more natural Everglades's hydropattern characteristics has been explicitly incorporated into the South Florida Water Management District's overall restoration goals. During the development of the 1993 Mediated Technical Plan, and subsequently, the 1994 Conceptual Design of the Everglades Construction Project (ECP), there was consensus among all the state and federal agencies, and other stakeholders, for the need to include specific construction components to distribute the discharge from the Stormwater Treatment Areas (STAs) into areas needing rehydration — specifically, WCA 2A, WCA 3A and the Rotenberger Wildlife Management Area.

The **objective** of this paper is to provide reasonable assurance that the benefits of the hydropattern restoration components of the Current Plan outweigh the potential adverse impacts of implementing the program. This reasonable assurance will be a combination of **best available data and best professional judgement** and an **adaptive assessment resource protection plan** that describes how the South Florida Water Management District (District) will continue to improve its resource information base and, if needed, make structural or operational modifications if potential problems arise as a result of implementing the recommended hydropattern restoration project.

BACKGROUND - In order to achieve the ecological restoration goals of the Everglades, it is imperative to restore as much of the predrainage hydropattern characteristics as possible (Davis and Ogden, 1994; Federal Task Force, Science Sub Group, 1994). This linkage between hydrologic restoration and ecologic restoration was summarized in the June 4, 1996, Draft of the *Integrated Science Plan,* a report of the Science sub-group of the South Florida Ecosystem Restoration Initiative:

> The functional ecology of the predrainage natural system is the theoretical target for restoration. The predrainage system supported the landscape patterns, clean and abundant water supplies, and large populations of wading birds, fish and other wildlife that are essential components of a restored South Florida ecosystem. Using a quantitative estimation of predrainage hydrologic conditions as a theoretical target for remaining natural areas will ensure that restoration efforts lead to change in the desired direction. This approach does not favor one species or community over another, but rather the ecosystem as a whole, made up of the mix of species that occurred here naturally. It may not be possible to entirely regain the original species richness and wildlife abundance of South Florida due to irreversible changes from the expansion of modern human population. Rather, the objective should be to capture the <u>defining</u> characteristics that made the Everglades and other parts of South Florida unique....**Hydrologic restoration is viewed as the prerequisite to ecosystem restoration, and it is the working hypothesis of the South Florida Ecosystem Restoration effort, that once hydrologic restoration is achieved, ecologic restoration will follow, providing water quality is improved and maintained** (emphasis added).

Building on work conducted by others, the concept of restoration of Natural System hydrologic patterns as a restoration target for the Everglades Protection area was endorsed by a scientific working group, an advisory committee established as part of the Lower East Coast Water Supply Planning initiative in 1994 to express the collective characteristics of numerous hydrologic parameters, including spatial distribution of inflow, timing of inflow, hydroperiod, depth, flow volume, and velocity. Unfortunately, hydropattern was never quantitatively defined and restoration performance targets for hydropattern were never established. The undefined charge was to restore the hydropattern of the Everglades Protection Area (EPA) as a means to reverse the degradation of Everglades functional values. However, quantifying this anticipated benefit is difficult because hydropattern has not been quantitatively linked to reversing the degradation of EPA functional ecologic values. In addition, measurable restoration targets for the functional ecologic values have not been set, nor has there been a direct link to engineering design criteria that would allow design of engineering solutions.

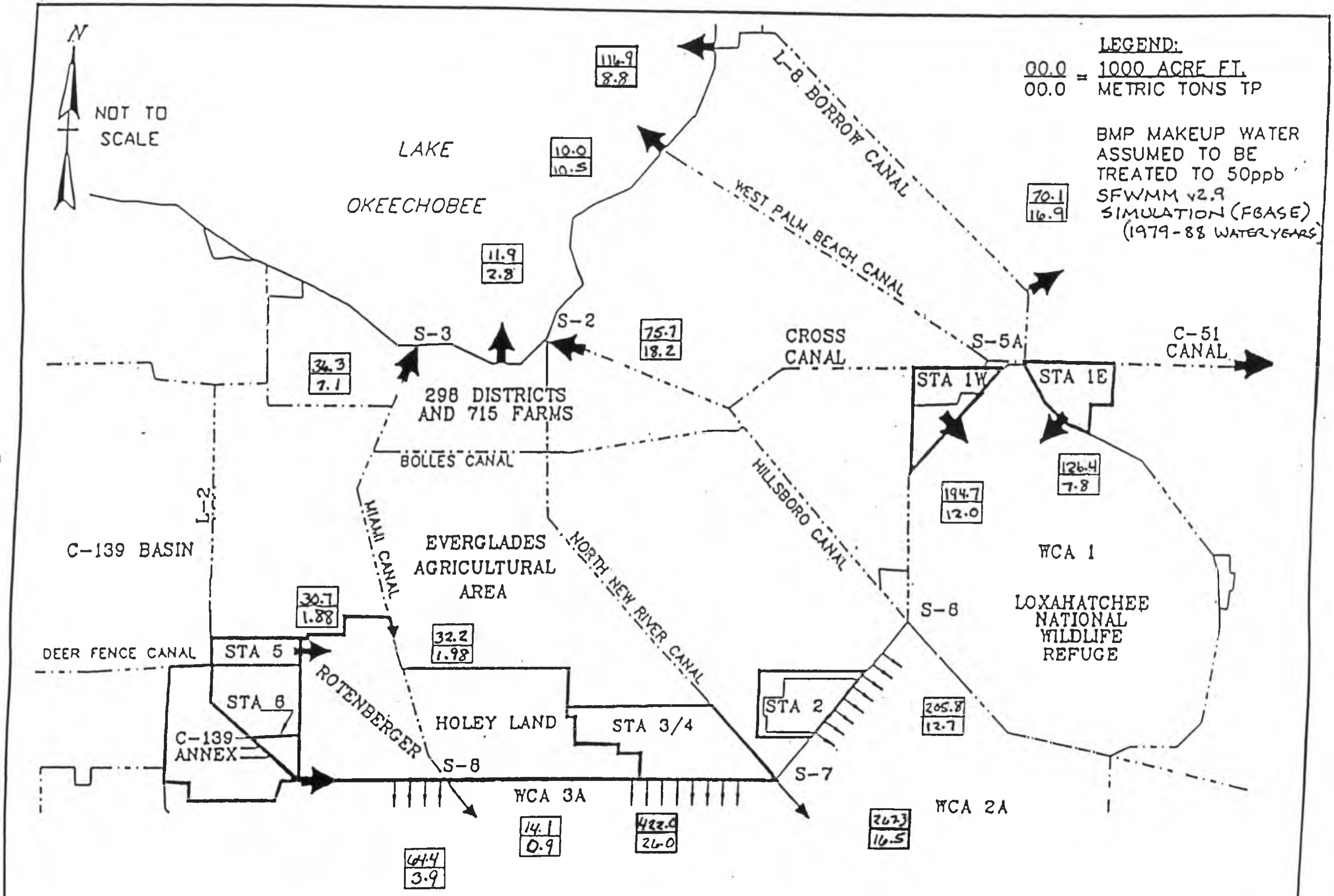
The Everglades Construction Project is a critical initial step in re-establishing the desired hydropattern characteristics. It is one component of a comprehensive set of activities for accomplishing the hydropattern restoration goals of Everglades restoration. Other important activities include:

1. Completion of the District's Lower East Coast (LEC) Regional Water Supply Plan
2. Implementation of Minimum Flows and Levels for the Water Conservation Area and Everglades National Park and part of the LEC Plan
3. The U.S. Corps of Engineers' comprehensive review study of the Central and Southern Florida Project for Flood Control and Other Purposes

These activities are mentioned here only to demonstrate that the proposed projects are the critical first step, and not the end-all, in restoring the natural system hydropatterns within the remaining Everglades.

Issuance of the federal construction permit for the ECP requires that a rigorous "public interest test" be satisfied, requiring reasonable assurance that the project will not result in net harm to the environment. Existing research indicates that phosphorus discharges of 50 ppb to the EPA may cause adverse changes to the ecology of the Everglades, in the form of enriched soil and water column phosphorus, with subsequent ecological consequences manifested in loss of the periphyton mat (thought to be the base of the Everglade's food chain), lowered oxygen levels within the water column, and conversion of native sawgrass communities to cattails (Davis 1994; Browder et al. 1994; SFWMD, 1992), etc. There is a question however, to the uncertainty regarding the extent and permanence of these observed changes. Even though the current plan calls for discharge with 50 ppb phosphorus for an interim period (ranging from 3 to 8 years), until the ultimate phosphorus standard is achieved, there is uncertainty if the current sawgrass marshes are resilient enough to either resist conversion to cattails, or if converted, to revert back to sawgrass after the ultimate phosphorus standard is achieved. A schematic of the ECP flows and anticipated phosphorus loads is presented in Figure 1-1.

A. Federal Settlement Agreement/Consent Decree - The general goal of restoring more natural hydroperiods within the EPA is identified in both the 1991 Settlement Agreement and 1992 Federal Consent Decree; however, the hydropattern restoration components are not explicitly defined. The Settlement



TECHNICAL PLAN DISCHARGES

FIGURE 1.1

Agreement recognized that because of the STA's size and location, the STA's would allow significant hydrologic improvement to downstream natural areas. The Settlement Agreement also noted that the reintroduction of sheetflow into the Everglades had the potential for improving the Everglades hydroperiod.

B. 1994 Everglades Forever Act - The Everglades Forever Act (Act) states that "The Everglades ecological system is endangered as a result of adverse changes in water quality, and in the quantity, distribution, and timing of flows, and therefore, must be restored and protected." The Act also states that "It is the intent of the Legislature to pursue comprehensive and innovative solutions to issues of water quality, water quantity, hydroperiod..." and "The Legislature finds that improved water supply and hydroperiod management are crucial elements to overall revitalization of the Everglades ecosystem." The Act further mandates that "The District shall implement the Everglades Construction Project" defined as "the project described in the February 15, 1994, conceptual design document." Although the hydropattern restoration components and associated completion dates are not explicitly mandated in the EFA, they are implicitly mandated by their inclusion in the 1994 Conceptual Design. The District is subjecting these hydropattern restoration components to a very rigorous public interest test, and evaluating options to the Current Plan, to ensure that the selected projects, at best, avoid all adverse impacts to the Everglades. The State law has flexibility for revisions in the implementation should the Current Plan be found to be not in the public interest with respect to adverse damage to the Everglades. Moreover, the hydropattern restoration components of STA 2, STA 3/4 and STA 5 are explicitly incorporated into the design, construction and operation of the STAs. Nevertheless, the Everglades Forever Act states that hydropattern restoration must be done in a way to maximize environmental benefits and acknowledges that a federal permit for construction is required. To obtain that federal permit there must be a showing that the Everglades Construction Project is in the public interest. Modification or deletion of the hydropattern restoration components would require significant revision to the design, construction, operation, schedule and cost of the STAs. The preliminary schedules proposed in the February 1994 Conceptual Design for the hydropattern restoration projects are as follows:

WCA 2A:	January 1, 1999
East WCA 3A:	October 1, 2003
West WCA 3A:	January 1, 1999 (operation)
Rotenberger Restoration:	January 1, 1999 (operation)

C. Related Milestones - In 1994, the District collaborated with state and federal agencies to identify the most critical problems and challenges that the District will face. One of these challenges was to identify and implement the Central and Southern Florida Flood Control Project's structural and operational modifications needed to restore and protect the ecosystem. The South Florida Ecosystem Restoration Working Group's 1995 Annual Report set as its Priority 10 the need to facilitate implementation of the Everglades Forever Act, including **hydroperiod restoration**. The 1995 Governor's Commission for a Sustainable South Florida recognized that impacts have occurred through the alterations of timing and quantity of freshwater flows. An option considered by the Governor's Commission was the modification of WCA's to enhance wetland habitat, with the understanding that replicating more natural hydropatterns within the WCA's would also help restore natural organic peat and marl soil formation processes and help to reverse the conditions causing the proliferation of undesirable species such as cattails and melaleuca. **The Everglades Coalition embraced the key issues relating to the restoration of storage and natural hydropatterns and hydroperiods.**

D. Linkage Between Hydropattern Restoration and Ecological Functions

As a precursor to the evaluation of the benefits and impacts of the hydropattern restoration projects, it is beneficial to examine the hydrologic characteristics associated with hydropattern improvements.

1. Sheetflow vs. point source discharge - The main hydrologic characteristic of the proposed hydropattern restoration project is to increase the areal distribution of flows across a wetland or through spreader canals or other means, as opposed to single points of discharge from the current pump stations and other water control structures.

2. Water depths

a. **increased average** depths downstream of the spreader canals
b. **decreased average** depths in areas currently receiving point-source discharge
c. **decreased peak** storm depths downstream of the spreader canals
d. **decreased peak** storm depths in areas currently receiving discharge

3. Hydroperiods

a. increased durations of inundation (hydroperiod) downstream of the spreader canals
b. decreased durations of inundation in areas currently receiving discharge

4. Peak inflow rates

a. STAs will attenuate peak storm flow rates (volume per time) and velocities; more like pre- drainage conditions.
b. In addition, peak storm flow rates and velocities will be lower along the spreader canals compared to areas downstream of existing point source discharges.

5. Timing of flows - The spreader canals will increase the duration of storm flows; more like pre-drainage conditions, and will decrease the intervals between storm flows (inter-event times).

6. Diversion of flow and nutrient loads from current point source locations

a. The hydrologic characteristics and associated benefits are described in 1-5 above.
b. Nutrient loading characteristics:
   I. Diversion of considerable tonnage of phosphorus from an existing impacted area to a new generally unimpacted location.
   ii. Spreads out the phosphorus loading along a 3-8 mile front instead of concentrating the loading at a point source.

In general, improved hydropattern prevents further loss of organic soils due to oxidation and subsidence, restores and protects the remaining soils and reduces the frequency and severity of muck fires and impacts to vegetation and wildlife habitat. These benefits are manifested in an increased in the acreage of the Everglades Protection Area that reasonably matches the hydroperiod (+/- 30 days) simulated by the Natural System Model (NSM) or show an improvement towards the NSM target hydroperiod. Concurrently, potential adverse impacts of hydropattern restoration with water containing phosphorus concentrations of approximately 50 ppb include localized loss of periphyton communities, increase in cattail acreage if antecedent conditions are conducive, and localized enrichment of soil phosphorus. **The best professional judgement of the workshop**

participants was that the permanence of these adverse impacts depend on the management of the areas during and after the phosphorus loading; that is, with active management activities, such as burning, removal or herbicide treatment of cattails, the adverse impacts may be ameliorated. Additional research is needed to explore the efficacy of these management techniques.

Adaptive management/assessment

Adaptive assessment provides a conceptual framework for implementing ecosystem restoration activities before complete certainty of the outcome is known. This concept was presented in the June 4, 1996, Draft of the *Integrated Science Plan,* a report of the Science sub-group of the South Florida Ecosystem Restoration Initiative:

> Adaptive assessment establishes a protocol to select among alternative actions and gain useful information regarding ecosystem response to restoration actions that are taken. It acknowledges the imperfection of information used in making resource management decisions and prescribes a structure to improve the resource knowledge base and adjust decisions accordingly. Periodic environmental assessment, using modeling to predict outcomes and monitoring to test the predictions, is the operational foundation of adaptive assessment. Related field and laboratory studies and experiments are used to acquire new information, help design better models, focus monitoring, and interpret monitoring and modeling results. (See Figure 1-2). Predicting effects of alternatives and analyzing consequences of management actions with respect to these objectives should be done in a holistic context and by adhering to principles of adaptive assessment.

The framework for an adaptive assessment resource protection plan was drafted during the workshop and is presented in Section 7. This plan will be finalized over the course of the next several months.

ADAPTIVE ASSESSMENT

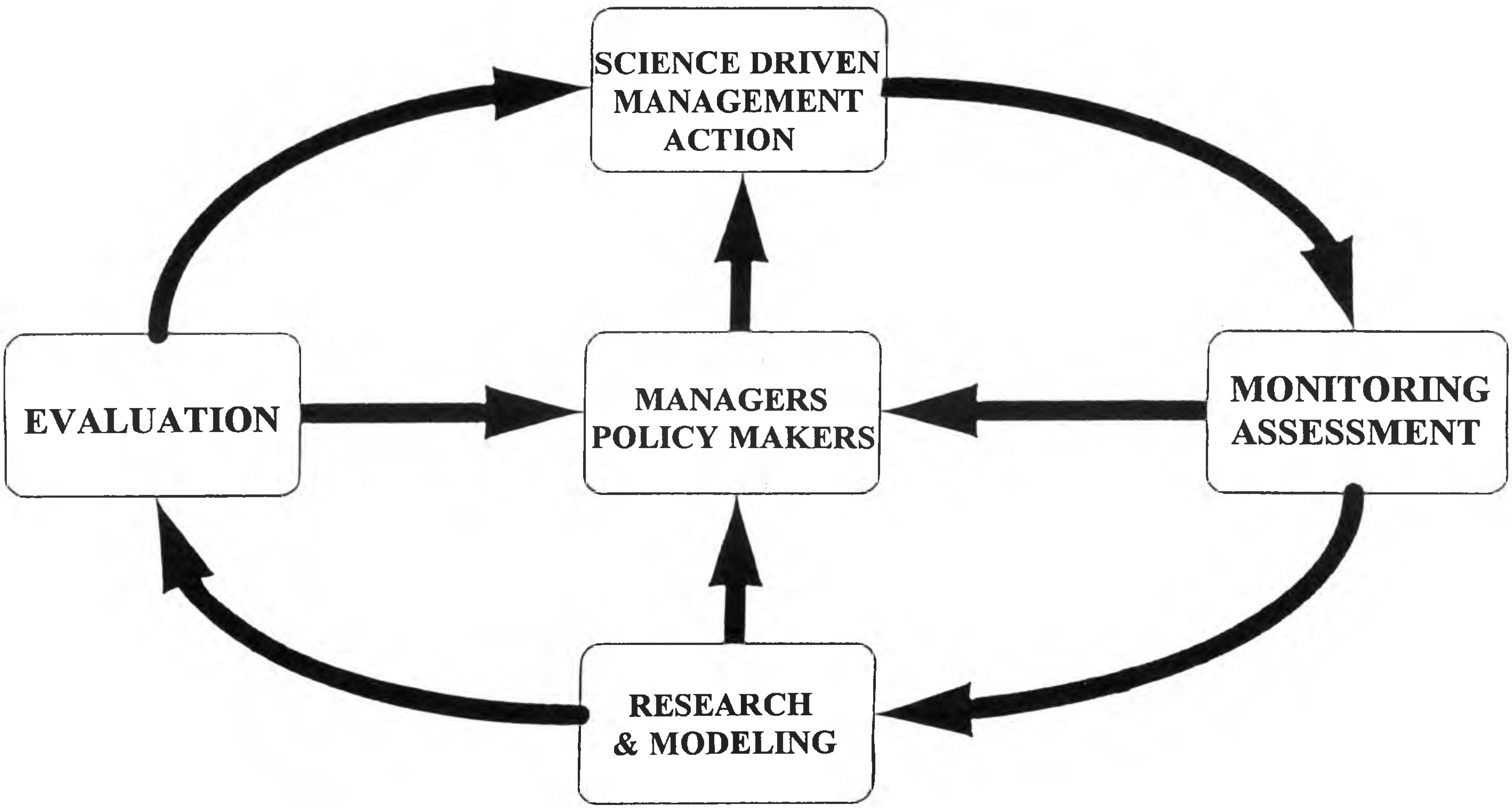


FIGURE 1-2 Adaptive Assessment Concept. (Source: 6/4/96 Draft Integrated Science Plan).

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Section 2. DESCRIPTION OF EVALUATION METHODOLOGY

2.1 General Evaluation of Benefits and Impacts

Evaluating the aggregate benefits and impacts, including their extent and permanence, to the Everglades system functions of the proposed hydropattern restoration components requires assessing the tradeoff between regional hydropattern restoration benefits and potential local impacts of the hydropattern restoration projects. The major difficulty with linking benefits and impacts to the hydropattern restoration efforts is that clear relationships between Everglades ecosystem values and restoring natural system hydropatterns have not been quantified. Key evaluation questions and issues include:

1. What are the local and regional benefits/impacts of the proposed hydropattern restoration efforts or alternative plans?
2. In what time frame will anticipated benefits or impacts be observed?
3. Are the impacts reversible? If so, how long will it take for full or partial recovery?
4. What are the current environmental values of the areas in question?
5. What alternatives to the current plan have been evaluated?
6. Wouldn't there be similar impacts even if the hydropattern restoration components were delayed until the STA discharge achieved the "no-imbalance" in flora or fauna phosphorus limit?
7. What are the "no-imbalance" phosphorus limits for the areas in question?
8. How can we implement proposed hydropattern restoration objectives such that adverse impacts are minimized?
9. What is the best way to evaluate the benefits and impacts of the proposed hydroperiod restoration plan??

Technical Workshops - The initial draft of this paper was compiled as a result of four half-day workshops held June on 6, 7, 13 and 14, 1996. The following District staff provided valuable contributions during this process:

Sue Newman, Ph. D.	Fred Sklar, Ph.D.	Paul McCormick, Ph.D.
Shili Miao, Ph.D.	Dave Swift, M.S.	Tom Kosier, Ph.D.
Tom Fontaine, Ph.D.	Zaki Moustafa, Ph.D.	Zhenquan Chen, Ph.D.
Max Day, M.S., P.E.	Steve Reel, M.S.	Joel Van Arman, M.S.
Carl Fitz, Ph.D.	Cal Neidrauer, M.S., P.E.	Peter David, M.S.
Mike Chimney, Ph.D.	Yegang Wu, Ph.D.	John Mulliken
Jennifer Jorge, Ph.D.	Sally Kennedy	Miller Andress, P.E.
James Lee, M.S., P.E.	Jim Grimshaw, Ph.D.	Tom Teets, M.S.
Neil Larson	Gary Goforth, Ph.D., P.E.	

During the internal workshops, scientists, engineers, and other experts were asked to apply the best available information and expert opinion in determining the extent and permanence of anticipated benefits and adverse impacts of the proposed hydropattern restoration projects, as well as alternative configurations. This was not an easy task considering the degree of uncertainty surrounding the issues. The best available information included direct field observations, related research, hydrologic, water quality and landscape modeling activities, and in many cases, the individual's best professional judgement.

The South Florida Water Management District was the host to two public workshops with stakeholders on July 19, 1996 and August 5, 1996. The workshops provided the public an opportunity to evaluate, critique, and improve this document through an interactive and facilitated process. This document incorporates revision made because of comments and suggestions made during those public activities. Appendix 1 contains a list of public workshop comments and the South Florida Water Management District's responses to them. Appendix 2 and Appendix 3 contain summaries of the two workshops in their entirety and a list of participants.

Evaluation of the Extent and Permanence of Local and Regional Benefits:

Through a combination of existing research and modeling, best professional judgement, and in the face of insufficient scientific information, the anticipated environmental benefit of implementing the hydropattern restoration components were estimated. A primary anticipated benefit is a reversal in the decline of the structural (e.g. species composition) and functional values of the Everglades wetlands (e.g., aquatic productivity) caused by the disruption of predrainage flow characteristics to the EPA. Ideally, the benefits attributable to these functions could be predicted through direct research results, computer model simulations, or where data is unavailable, through expert systems analysis (e.g. best professional judgement). In addition to environmental benefits, one option may be preferred over another because of cost, legal, economic, scheduling or other factors.

A. Existing research - Very little direct research is available to predict the recovery of Everglades structural and functional values as a result of implementing alternative hydrologic regimes. However, a number of modeling efforts, including the Natural System Model (NSM), Everglades Landscape Model (ELM), Across Trophic Level Systems Simulation (ATLSS), the South Florida Water Quality Model (SFWQM), and the Wetlands Water Quality Model (WWQM) are currently under way to evaluate such plans.

B. Expert Systems Analysis- Many existing programs to identify and quantify Everglades ecosystem cause and effect relationships are yet to be completed. In the absence of completed research, there is nevertheless, a significant pool of knowledge to be gleaned from field observation, transferable information from other systems and circumstantial information. **The result is that District and other scientists have an intuitive feel, or best professional judgement, for how the Everglades system will respond.** This expert systems analysis has provided much of the basis for completing the evaluations described below. Knowledgeable professionals were asked to provide their best professional judgement on this topic. Initial discussion focused on establishing an appropriate set of evaluation criteria, identifying spatial scales appropriate to assess benefits and impacts, and recognizing that assessment of the **permanence** of impacts required considering both short-term and long-term scenarios. Site-specific matrices were completed during the four half-day technical workshops and the stakeholder workshops as a means of soliciting best available information and professional judgement regarding the benefits and impacts of each option to the numerous environmental, legal, economic and other relevant factors.

C. Models - The District is developing an Everglades Landscape Model (ELM), and the National Biological Survey (NBS) is developing the Across Trophic Level System Simulation (ATLSS) model. These models seek to predict ecosystem responses to hydrological and nutrient management scenarios, using cause and effect relationships. Both of these models remain under development and were unavailable to assist in this analysis.

Presently, there is not a universally accepted method to accurately measure the structural and functional values of the Everglades ecosystem. As a surrogate, benefits can be inferred from the hydropatterns produced by a particular management option. The estimated benefits of various options can then be compared with each other. One relative measure available to compare the benefits of a proposed hydropattern restoration option is to use the South Florida Water Management Model (SFWMM) to compare the degree to which the option results in a match of the hydroperiod predicted by the Natural System Model (NSM). To date, the SFWMM has simulated the Current Base condition (without the ECP) and a Future (2010) Base condition which includes the ECP, including the hydropattern restoration components.

Evaluation of the Extent and Permanence of Local and Regional Impacts:

The same obstacles that make it difficult to determine the benefits of the three hydropattern restoration options also makes it difficult to determine potential impacts. Similarly, existing research, expert systems analysis, and surrogate modeling can be employed as indicators for system-wide impacts. The anticipated adverse environmental impacts of implementing the hydropattern restoration components may be a local (i.e., downstream of an inflow structure), possibly temporary, decline in one or more of the structural or functional values of the Everglades wetlands (e.g., reduction of aquatic productivity) caused by additional water, additional phosphorus loads and phosphorus concentrations exceeding the no-imbalance level.

A. Existing research - There appear to be three significant factors influencing the expansion of cattail in extant wet prairie, slough and sawgrass communities: antecedent soil conditions (disturbance, including drought, fires, and subsidence, as well as soil nutrient levels), hydrologic characteristics (depth of water, hydroperiod), and inflow phosphorus concentration (Newman et al, 1995). Fire and drought can oxidize the soil, leading to a higher bulk density peat with higher soil phosphorus concentrations (Newman et al, 1994); cattails out compete sawgrass in deeper water and higher phosphorus concentrations (Newman et al, 1994) and cattails tend to out compete sawgrass when inflow phosphorus concentrations are sufficiently higher than background concentrations (Davis 1994). All three of these factors may be present in one or more of the receiving waters downstream from the hydropattern restoration components.

B. Expert Systems Analysis- Knowledgeable professionals were asked to provide their best professional judgement on the effects of hydropattern restoration. Relevant information was compiled in an evaluation matrix during four half-day technical workshops and the two stake holder meetings.

C. Models - The District is developing an Everglades Landscape Model (ELM), and the National Biological Survey (NBS) is developing the Across Trophic Level System Simulation (ATLSS) model. These models are designed to predict ecosystem responses to hydrological and nutrient management scenarios, using cause and effect relationships. Both of these models remain under development and were unavailable to assist in this analysis.

2.2 Definitions of Terms Used in Evaluation Matrix

Evaluation of benefits and impacts necessarily involves trade-offs, with most alternatives yielding both positive and negative influences on the existing ecological communities. For the purpose of this exercise, at least three options were evaluated for each hydropattern restoration project.

1. **Current Plan**: This option is the present design, as contained in the Final General Design Memoranda for the Everglades Construction Project, and is consistent with the scope and timing contained in the 1994

Everglades Forever Act and 1994 Conceptual Design Document. A schematic of the Current Plan major components is provided in Figure 1-1.

2. **No Action Option**: This option considers not building the STAs until the phosphorus discharge is reduced so as not to cause an imbalance in the native populations of flora or fauna (the "no-imbalance" level). During the interim, waters entering the Everglades Protection Area through S-6, S-7 and S-8 would not receive any phosphorus treatment in addition to the EAA on-farm BMPs.

3. **Bypass Option:** This option considers constructing the STAs and bypassing the hydropattern restoration components. The treated STA discharge would be conveyed to the existing point source inflow to the Everglades Protection Area. For example, it was considered that the discharge from STA 2 could be conveyed to S-6 and discharged to WCA 1, or alternatively conveyed to S-7 and discharged to WCA 2A. Once the STAs and additional treatment results in the "no-imbalance" phosphorus level, the hydropattern restoration components could be implemented.

To fully characterize the options, anticipated **short-term** and **long-term** benefits and impacts were evaluated at both **local** and **regional** scales:

Potential **Short-term benefits or impacts:** These impacts are defined as the positive and negative changes anticipated to occur by January 1, 2007. This is the date mandated by the 1994 Everglades Forever Act for the long-term average phosphorus level discharged from the STAs to change from 50 ppb to the "no-imbalance" level due to implementation of additional water quality treatment measures. Please refer to the Programmatic Environmental Impact Statement for a discussion on potentially superior treatment technologies that could achieve this "no-imbalance" level.

Potential **Long-term benefits or impacts:** These impacts are defined as the positive and negative changes anticipated to be present on January 1, 2017, roughly ten years following discharge of the "no-imbalance" phosphorus levels.

Potential **Local benefits or impacts:** Identified as the area within the adverse impact zone, where the phosphorus content may cause ecological degradation, including potential loss of periphyton mat, expansion of cattails and enrichment of soil phosphorus level. Outside of this impact zone, it is assumed that minimal impacts are observable, yet hydroperiod benefits are affected.

Potential **Regional benefits or impacts:** Encompasses the entire Everglades Protection Area and the Rotenberger Wildlife Management Area; assumes that the phosphorus level is low enough beyond the impact zone that there is no adverse impact downstream, or outside, the impact zone, associated with phosphorus levels.

Evaluation of benefits/impacts - General, simplistic guidelines were applied to each of the ecological evaluation criteria:

\+ Indicates an improvement over current conditions
0 Indicates no measurable change from current conditions
\- Indicates degradation from current conditions

Antecedent conditions - One of the most critical factors determining the extent of impacts, specifically, the conversion of desirable Everglades vegetation communities to cattail, is the antecedent conditions in the proposed receiving water body. It was determined that three primary factors affect the presence or absence of cattails within the EPA:

1. Soil phosphorus level (high, medium, low) - total phosphorus expressed on a volume basis; a composite of soil phosphorus concentration and bulk density
2. Vegetation communities (types) - existing periphyton and macrophyte communities.
3. Peat/marl accretion (positive) or negative (subsidence) - The ability of an area to build healthy peat or marl soil as determined by the available soil moisture.

Data or observations were not available for all receiving water areas in questions; District staff relied on expert systems analysis in characterizing antecedent conditions.

Evaluation criteria - General evaluation factors were described in 33 CFR Sec. 320.4, which contains a description of the public interest test applicable to the Corps of Engineers dredge and fill permits. Due to the inability to quantitatively evaluate\ potential benefits or impacts as they may relate to ecological functions using a consistent unit of value, a qualitative assessment was adopted. Alternatives should be compared within each functional evaluation factor (rows) of the matrix, e.g., Table 3.3. WCA-2A Hydropattern Restoration Evaluation Matrix.

After considerable discussion, specific evaluation criteria related to wetland structure and function were incorporated into the evaluation matrix. Initially specific plant and animal species were considered. However, in keeping with the ecosystem-level approach, as opposed to species-specific restoration objectives, composite evaluation criteria were developed.

1. **Vegetation Communities** - Influence on periphyton and emergent macrophyte communities, and aquatic primary and secondary productivity, including food chain production, general habitat, etc.
2. **Animal Communities** - Influence on wildlife habitat, including nesting, spawning, and the use of the area as foraging areas, sanctuaries or refuges, etc.
3. **Hydropattern Characteristics** - Influence on desired hydroperiods, depths, timing and distribution of flows, including downstream flows to Florida Bay and other estuaries.
4. **Groundwater Interactions** - Influence on water tables, and aquifer recharge, including influence on Coastal aquifers, well fields, and estuaries.
5. **Water Quality** - Influence on water quality and water purification functions.
6. **Preservation of organic, hydric soils**- Restoration, maintenance and protection of peat and marl soils, including reduction in the number and frequency of severe muck fires. (Note: organic hydric soil preservation is also a proposed objective of the District's Minimum Flows and Levels criteria for the Water Conservation Areas and the Everglades National Park.)

Two additional criteria were incorporated to consider other public interests:

7. **Additional Time to Implement** - Additional time to implement alternative, compared to Current Plan.
8. **Additional Cost to Implement** - Additional cost to implement alternative, compared to Current Plan.

2.3 Estimates of Cattail Expansion

A very visible adverse impact of elevated nutrient levels in the Everglades Protection Area is the expansion of cattails just downstream of the S-10 structures in WCA 2A (Everglades SWIM Plan, 1992, Davis 1994). As a result of the accumulated years of nutrient loadings moving through these structures, cattails have invaded what once was a sawgrass/tree island open water slough community. The growth of cattails from the early 1970s through the early 1990s is depicted in Figure 2-1. The 1992 Everglades SWIM Plan documents the commensurate phosphorus loadings for the base period 1979-1988. During the initial four day workshops, a relationship between nutrient loads and cattail expansion was developed in order to develop a rough estimate of the extent of impact. A first-order predictive relationship was developed by comparing the expansion of cattails to the average annual loading rate (Tables 2-1 & 2-2). During the early years, a low rate of annual cattail expansion was calculated as 6.33 acres per metric ton of phosphorus load. During the later years, an accelerated annual rate of 17.3 acres per metric ton of phosphorus load was calculated. Rate calculations using data from Wu et al (1996) provided similar rates. While the rates determined during the four day workshops clearly represent a very crude predictive relationship, it represents one method for estimating the potential range of **extent** of adverse impacts associated with the hydropattern restoration alternatives. For each alternative, the potential range of extent of impacts was calculated by multiplying the low rate and high rate of cattail expansion by the product of the anticipated average annual phosphorus load and the duration of discharge until the "no-imbalance" limit is achieved (December 31, 2006). For example, for the Current Plan for the STA 2 hydropattern restoration project, the estimated range of extent of impacts is

6.33 x (12.7 metric tons per year) x (8 years duration) = 644 acres
to
17.3 x (12.7 metric tons per year) x (8 years duration) = 1758 acres

For each alternative, the antecedent conditions can be assessed to determine which end of the range may be more appropriate. For example, the presence of dense sawgrass downstream of STA 2 for the Current Plan suggests the extent would be more towards the low end of the range (644 acres). This conclusion was based on the best professional judgement that cattail expansion is less likely to occur in the densely vegetated area downstream of STA 2 where competition with other plants is more likely than in the open water slough downstream of the S-10s.

During stakeholder meetings, additional methodology for estimating cattail expansion as a function of hydropattern restoration was suggested. That methodology is under review, however, and cannot be elaborated on in this document until the stakeholder review is completed. However, a summary of conclusions (see attachment 3) provided at the stakeholder meetings suggests agreement with the rate of cattail expansion presented here. One major difference in the stakeholders methodology and that presented above is that their model simulates build up of phosphorus in soils. Only after a certain amount of soil phosphorus is accumulated does their model suggest that cattails could successfully invade. This methodology would, in general, predict less cattail invasion than the methodology presented above, since no time lag is assumed between phosphorus loads and cattail growth.

As a result of the comments, discussion and complementary analyses presented at the public workshops, the District revised its methodology to estimate potential cattail expansion acreage. The rates of cattail expansion calculated above (6.33 and 17.3 acres per metric ton of phosphorus load per year) were calculated from cattail data collected at least 10 years after nutrient loads began discharging from the S-10 structures. Hence, those rates do not accurately the initial vegetative response of the ecosystem during the early years of nutrient loading and resultant accumulation in the sediment. It is reasonable to include a time lag when estimating potential acreage of cattail expansion to reflect the accumulation of phosphorus in the soil prior to cattail growth. For the purpose of demonstrating the effects of this time lag, estimates of potential cattail expansion were calculated with time lags of zero (0), one (1), three(3), five (5) seven (7) and 17 years. The 17-year time lag was included for comparison with the alternative analysis presented at the workshop (see Attachment 3 for a summary of the presentation); that analysis predicted that it would take approximately 17 years before phosphorus accumulated in the soil to a sufficient level to stimulate cattail growth.

For calculation purposes, the effects of the time lag were calculated as a linear reduction in the **effective** loading duration. The cattail expansion estimate with a zero-year time lag represents an instantaneous response of cattails to the phosphorus loading, and can be considered as a Worst Case (albeit unlikely) scenario. Similarly, the expansion estimate assuming a 17-yr time lag can be considered as the Best Case scenario. From the example above, the cumulative estimate of cattail expansion assuming a 1-yr time lag and the low rate of expansion for the STA 2 hydropattern restoration project was calculated as

6.33 x (12.7 metric tons per year) x (seven years **effective** duration) = 563 acres

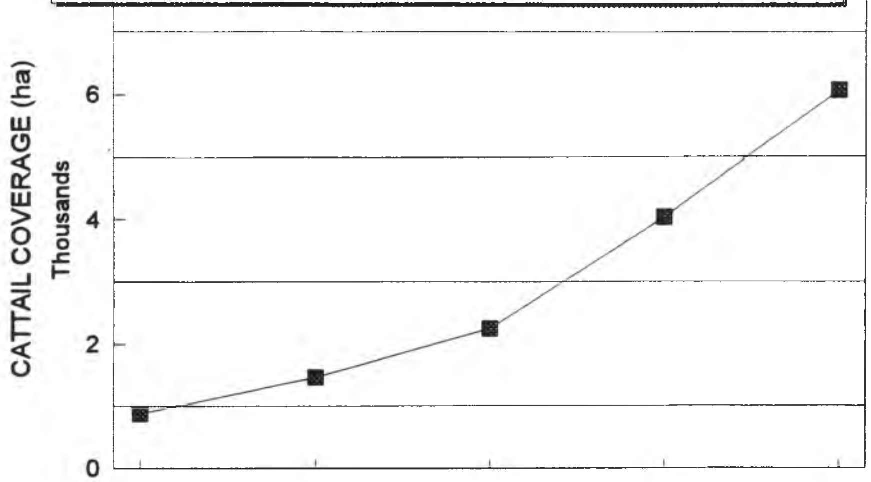
The cumulative estimate assuming a 3-yr time lag used a five year (8 year duration - 3-yr time lag = 5 years) **effective** duration, and so on.

The influence of the time lag was determined for the Current Plan, the No Action and the Bypass alternatives. However, a time lag may not be appropriate for the No Action and Bypass options since the areas receiving nutrient loads in those options are currently receiving loads, and phosphorus has already accumulated in the sediment. For the same reason, it may be more appropriate to calculate the potential cattail expansion in the No Action and the Bypass options using the high rate (17.3 acres per metric ton of phosphorus loading) of expansion. Depending on the assimilative capacity of the existing impacted area, there may or may not be a noticeable time lag response to additional phosphorus loading. Because of the uncertainty, the full range of expansion rates and time lags were calculated for each option.

The sensitivity of this methodology was further evaluated by calculating the cattail expansion estimates under two STA performance scenarios. The STA are presently designed to achieve a long-term flow-weighted average phosphorus concentration of approximately 50 ppb. Recent performance of the Everglades Nutrient Removal (ENR) Project suggest that sustainable discharge concentrations below 50 ppb may be likely. In addition, EAA BMP performance has exceeded the target of 25 % phosphorus load reductions that have been assumed in the STA design. Data from the ENR project and current best professional judgement suggest that appropriately sized and operated constructed wetlands may be able to sustain annual average discharge concentrations of approximately 30 ppb. To evaluate the effect of possible nutrient removal performance better than the design performance, potential cattail expansion estimates were also calculated assuming a 30 ppb discharge concentration.

It is important to note that nutrient impacts such as cattail expansion are not the only impact that can result from nutrient loading. Potential impacts, such as loss of the calcareous periphyton mat, can occur on a much faster time scale. However, for that impact to actually occur requires that these types of algal systems, which are present in sloughs, be the receiving water system. This emphasizes the importance of understanding antecedent conditions in the areas receiving the water from hydropattern restoration efforts. For example, in areas of dense sawgrass (a non-slough environment) such as those found in areas that will receive STA 2 effluent, the largest concern would be whether the soils would build up sufficient soil phosphorus during the interim (50 ppb TP) discharge period for cattails to successfully establish and proliferate.

FIGURE 2-1. Cattail Coverage Downstream of the S-10 Structures



YEAR	1973	1976	1982	1987	1991
■ COVERAGE	877	1464	2252	4039	6070

Table 2-1. Cattail Expansion Downstream of the S-10 Structures

YEAR	CATTAIL COVERAGE hectares	CATTAIL COVERAGE acres	INCREASE IN COVERAGE acres	RATE OF INCREASE acres/year
1973	877	2167		
1976	1464	3618	1451	484
1982	2252	5565	1947	325
1987	4039	9,980	4415	883
1991	6070	14,999	5019	1255

Table 2-2. Phosphorus Loads Downstream of the S-10 Structures

YEAR	S-10's LOAD metric tons	FLOW acre feet	PHOSPHORUS ppb	AVERAGE LOADING metric tons/year	CATTAIL EXPANSION RATE acres/metric tons year
1979	21.09	237,500	71.98		
1980	58.96	492,882	96.97		
1981	37.33	135,238	223.76		
1982	87.69	370,332	191.7	51.3	6.33
1983	86.56	532,576	131.8		
1984	66.25	381,213	140.9		
1985	39.26	313,482	101.5		
1986	53.26	404,764	106.7		
1987	9.59	69,727	111.5	51	17.3
1988	63.04	495,956	103		
AVG.	52.303	343,367	130.8		

2.4 Hydropattern Restoration Benefits Estimated from Regional Modeling

As part of the Lower East Coast water supply planning process, District staff have looked at alternative ways to evaluate the hydroperiod benefits of various alternatives. Two basic tools utilized for this evaluation are the South Florida Water Management Model (SFWMM) and the Natural System Model (NSM). Both models simulate the regional hydrologic response to climatic factors (rainfall, evapotranspiration, etc.). The SFWMM has the capability to simulate regional hydrology as influenced by the water management facilities (canals, pump stations, etc.) under various operational strategies, whereas the NSM provides estimates of regional hydrology that may have existed prior to the construction and operation of the water management facilities. The SFWMM has been thoroughly calibrated and verified with available data, while the NSM is still an evolving tool. Version 2.9 of the SFWMM and version 4.4 of the NSM were utilized to estimate the extent of hydroperiod improvements that could be expected as a result of the Everglades Construction Project (ECP) implementation, including the hydropattern restoration projects. Additional characteristics of the SFWMM are summarized in Figure 2-2.

As a reference, flows associated with the ECP were simulated using the climatic input for the 10-yr base period of 1979-1988. For comparison to planning alternatives, the simulations included anticipated year 2010 influences, such as urban and environmental water supply demands. The resulting flows are presented in Figure 2-3. Simulated stage duration curves and stage hydrographs were prepared from the ECP and NO ECP simulations and are presented in subsequent sections of this document. Locations are referenced spatially by a row number and column number corresponding to the grid shown in Figure 2-4. For consistency among planning comparisons, the 26-year period of record for climatic variables was simulated and are shown in the stage duration and stage hydrograph curves.

To compare the hydroperiod characteristics of the Current ECP Plan with alternatives, the SFWMM was run with and without the ECP features in place. The resulting hydroperiods (defined as the number of days in the year that the area is inundated) in the Everglades Water Conservation Areas and Rotenberger Wildlife Management Area were subsequently compared to the estimated hydroperiods in the same areas as simulated by the NSM. This methodology spatially identifies areas where hydropattern restoration is moving in the right or wrong direction, that is, towards or away from the NSM targets. The methodology gives credit to areas where hydroperiod is improved, but do not match (+ / - 30 days) the estimated NSM hydroperiod target. This methodology was used in this evaluation based on the first of the two public workshops on this subject (July 19). The originally proposed methodology gave credit for hydroperiod improvement only for those areas that showed a hydroperiod that matched the NSM targets within 30 days. During the July 19 workshop, participants strongly supported revising the methodology to account for those areas which showed an improvement or worsening in hydroperiod, rather than just matches to the NSM target. The revised methodology recognizes four categories of hydroperiod results:

1. No change - the mean annual hydroperiod for the ECP simulations does not change (+/-) 30 days as compared to the No ECP simulation. **For example**, if the simulated No ECP hydroperiod for an area is 120 days, and the ECP simulation predicts a hydroperiod of 135 days, the methodology considers this area as **no change** in hydroperiod.

2. Improvement - the mean annual hydroperiod from the ECP simulations moves in the right direction towards a more rainfall driven, natural system hydropattern (currently defined by the NSM). **For example**, if the simulated No ECP hydroperiod for an area is 120 days, the NSM suggests a target hydroperiod of 210

Simulated Performance of the Everglades Construction Project (ECP) using the South Florida Water Management Model (SFWMM) {8/5/96 CN}

Simulated Performance of the Everglades Construction Project (ECP) using the South Florida Water Management Model (SFWMM)

- **Purpose: to estimate the likely changes in WCA hydropatterns resulting from the latest STA designs & the current operational intent of the ECP**

8/5/96 CN

Brief Overview of the SFWMM

- **Regional-scale, continuous simulation, hydrologic model**
  - Lake Okeechobee to Florida Bay
    - includes basins tributary to Lake Okeechobee
  - 2mi x 2mi grid cells (7000 sq.miles)
  - 1965-90 simulation period (daily stress period)
  - 1979-90 calibration/validation period
- **Simulates all key hydrologic processes**
  - rainfall, ET, infiltration, percolation, overland flow, groundwater flow, canal/structure flows
- **Simulates current or proposed structures**
  - reservoirs, STAs, pumps, spillways, etc
- **Simulates current or proposed system operational rules**

SFWMM Key Assumptions

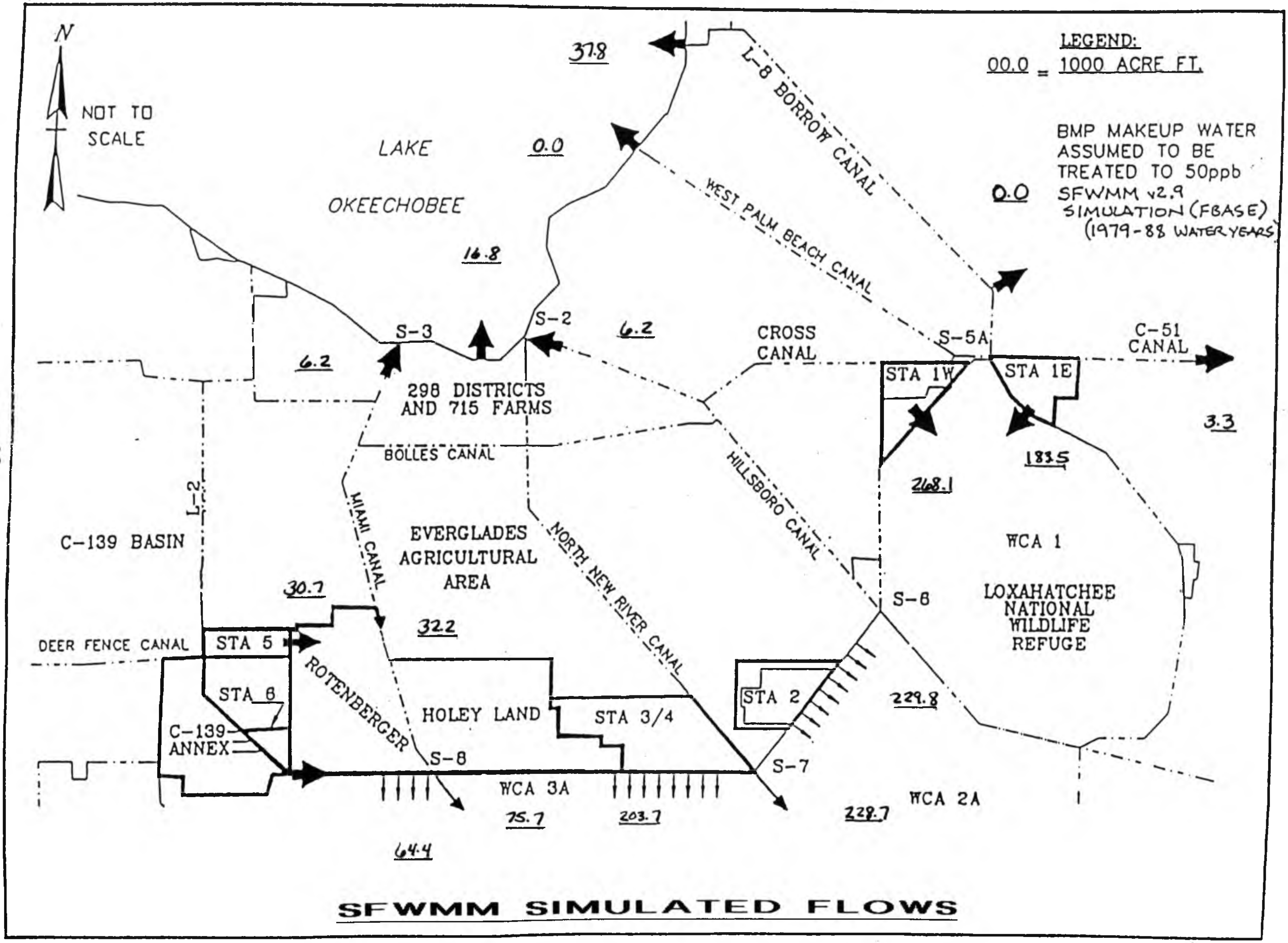
- **Current Plan (aka 2010 Base)**
  - 2010 projected land use & associated demands
  - Kissimmee River Restoration
  - Current (Run25) Lake Okee. Regulation Schedule
  - New WCA-1 Regulation Schedule
  - USACOE Modified Water Deliveries GDM
  - USACOE C-111 GRR
  - ECP (BMP's, BMP Replacement Water, STAs)
- **No-Action (aka NOECP)**
  - 2010 Base without STAs

Primary reasons for differences between SFWMM simulated flows and flows used for ECP design

- **Lake Okeechobee regulatory (flood control) discharges {136kaf/yr less ~50%}**
- **BMP replacement water deliveries {193kaf/yr more}**
- **Southern L-8 runoff {74kaf/yr more}**
- **EAA backpumping & backflow to L.Okee**
- **et al**

- **Net Effect = ~110kaf/yr more to WCAs (WCA1:+180; WCA2: +50; n.e.WCA3A: -120)**

FIGURE 2-2



N
NOT TO SCALE
LEGEND:
00.0 = 1000 ACRE FT.
BMP MAKEUP WATER ASSUMED TO BE TREATED TO 50ppb
0.0
SFWMM v2.9 SIMULATION (FBASE) (1979-88 WATER YEARS)
37.8
LAKE OKEECHOBEE
0.0
L-8 BORROW CANAL
WEST PALM BEACH CANAL
16.8
S-3
S-2
6.2
6.2
CROSS CANAL
S-5A
C-51 CANAL
STA 1W
STA 1E
3.3
298 DISTRICTS AND 715 FARMS
BOLLES CANAL
183.5
268.1
L-2
C-139 BASIN
MIAMI CANAL
EVERGLADES AGRICULTURAL AREA
NORTH NEW RIVER CANAL
HILLSBORO CANAL
WCA 1
LOXAHATCHEE NATIONAL WILDLIFE REFUGE
S-6
30.7
32.2
DEER FENCE CANAL
STA 5
ROTENBERGER
STA 6
C-139 ANNEX
HOLEY LAND
STA 3/4
STA 2
229.8
S-8
S-7
WCA 3A
WCA 2A
75.7
203.7
228.7
64.4
SFWMM SIMULATED FLOWS

FIGURE 2.3

SFWMM Grid Superimposed Over Study Area

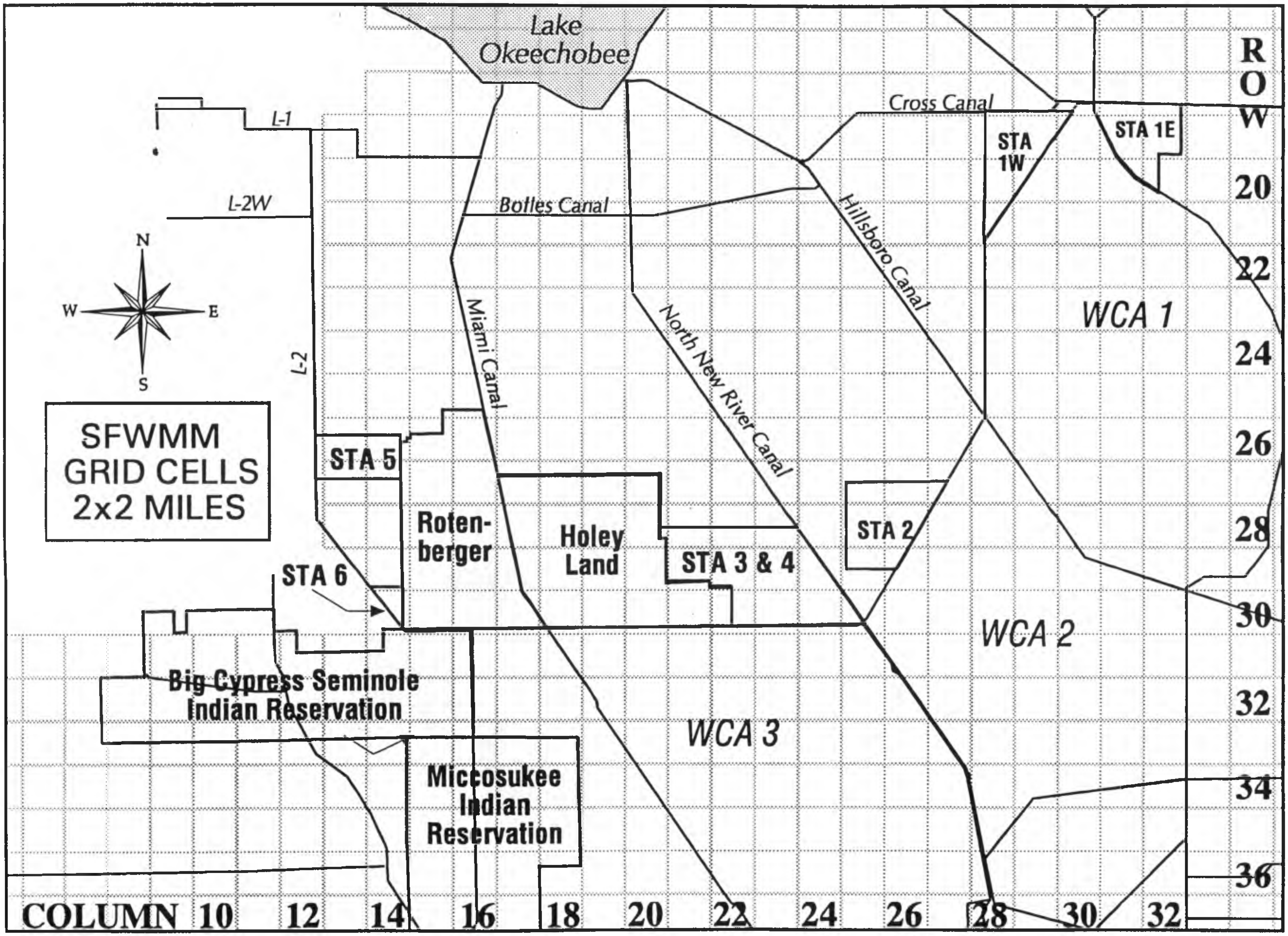


FIGURE 2-4

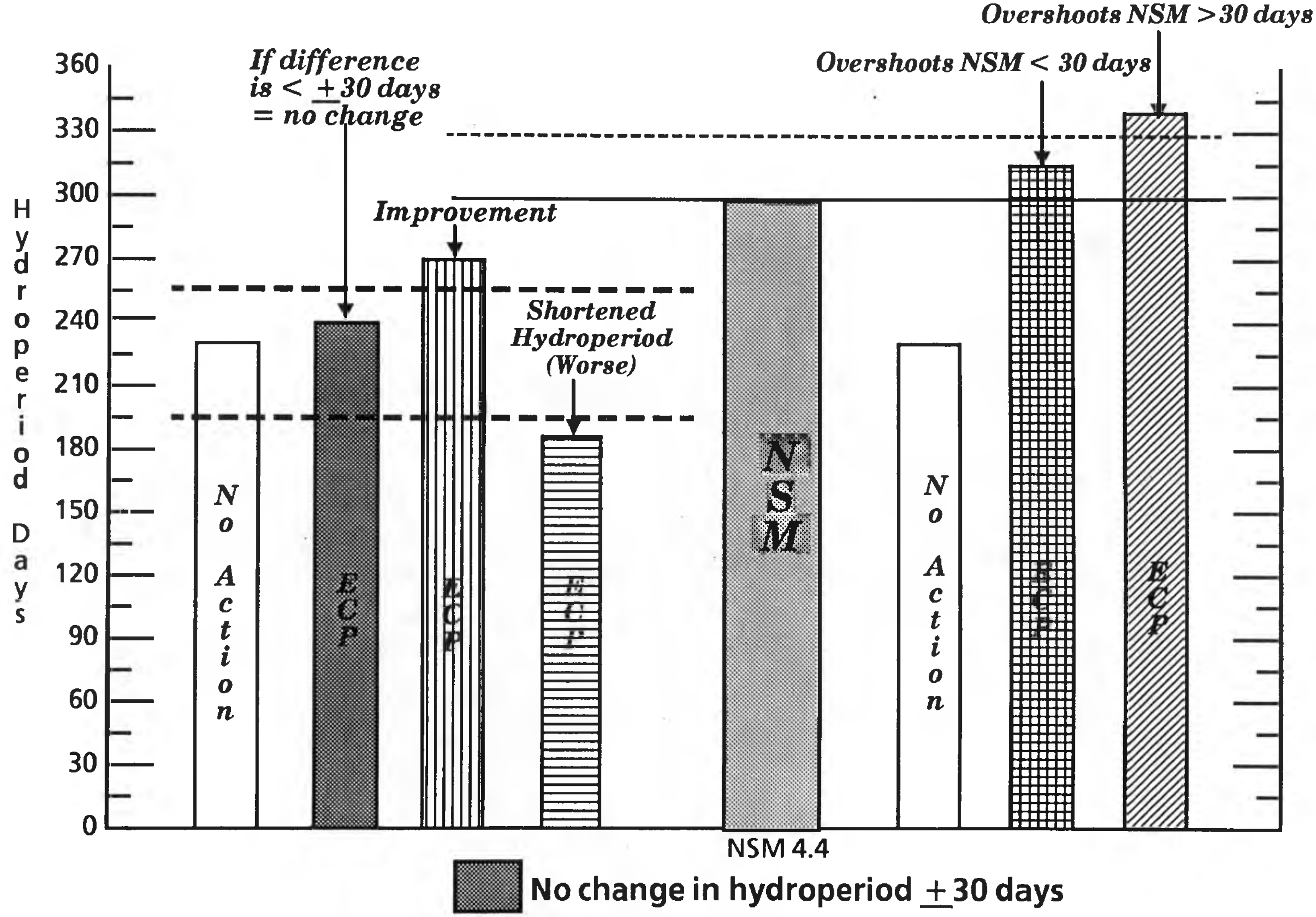
days, and the ECP simulations predict a hydroperiod of 175 days, the methodology considers this area as an **improvement** in hydroperiod (see Figure 2-5).

3. Worsening - the mean annual hydroperiod from the ECP simulations moves in the wrong direction away from a more rainfall driven, natural system hydropattern (currently defined by the NSM). **For example**, if the simulated No ECP hydroperiod for an area is 180 days, the NSM suggests a target hydroperiod of 210 days, and the ECP simulations predict a hydroperiod of 150 days, the methodology considers this area as a **worsening** in hydroperiod.

4. Overshoots NSM - the mean annual hydroperiod from the ECP simulations moves in the right direction towards the more rainfall driven, natural system hydropattern (currently defined by the NSM), but exceeds the target. For example, if the simulated No ECP hydroperiod for an area is 180 days, the NSM suggests a target hydroperiod of 210 days, and the ECP simulations predict a hydroperiod of 220 days, the methodology considers this area as an **overshoot** of the hydroperiod. If the overshoot is less than or equal to 30 days, the methodology still considers this an improvement. If the overshoot is greater than 30 days, the methodology considers this an adverse impact.

These four categories are presented graphically in Figure 2-5. The individual results of this methodology are presented and discussed in the specific sections of this document relating to each hydropattern project. Figure 2-6 summarizes the regional results of this analysis.

Legend for Hydroperiod Benefits/Impacts Map (see next page)



Benefit (Hydropattern restoration is moving in the right direction)

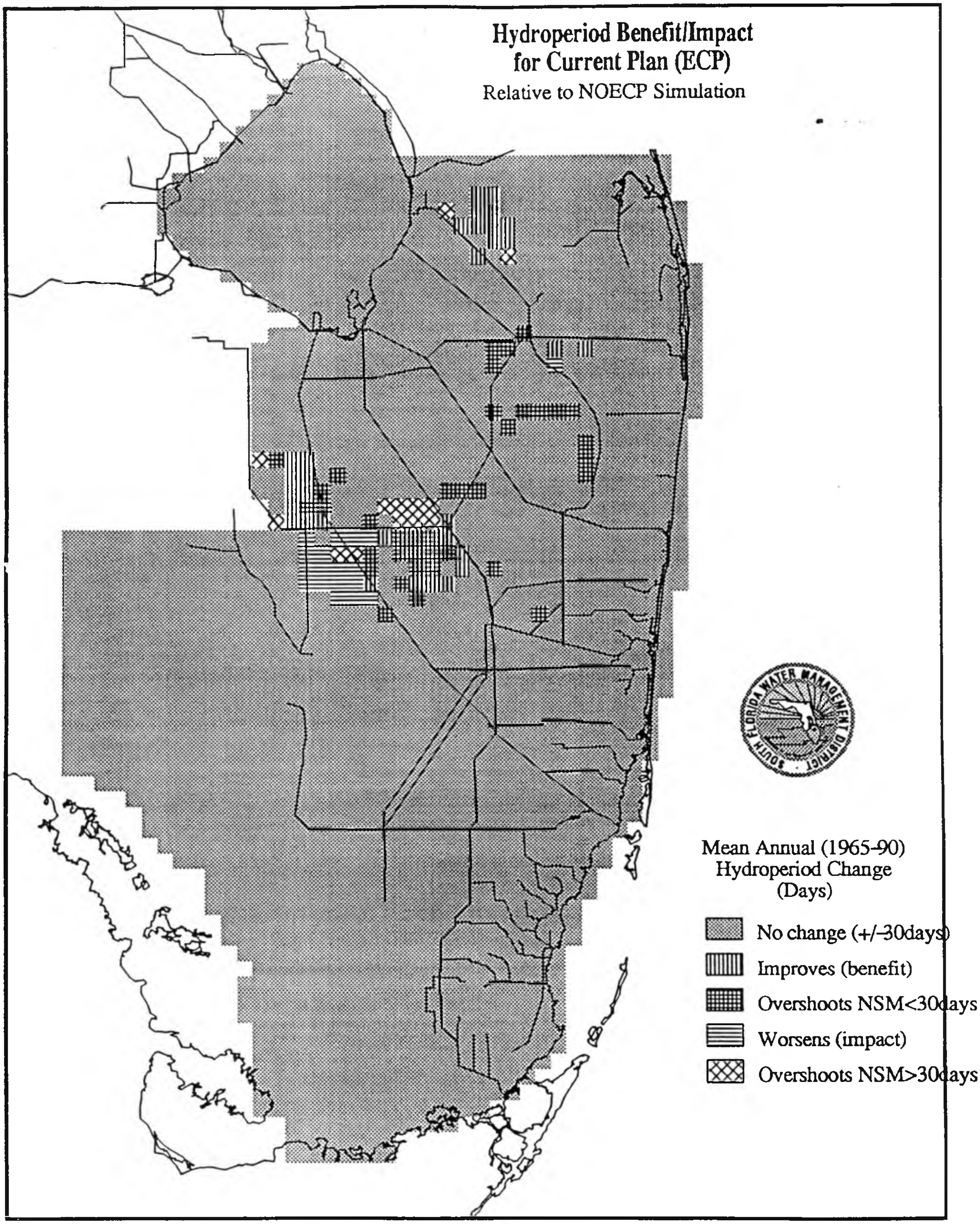
- Improves Hydroperiod but less than NSM
- Overshoots NSM < 30 days

Impact (Hydropattern restoration is moving in the wrong direction)

- Shortens Hydroperiod relative to No Action
- Overshoots NSM > 30 days

FIGURE 2-5

FIGURE 2-6


Hydroperiod Benefit/Impact
for Current Plan (ECP)
Relative to NOECP Simulation
Mean Annual (1965-90)
Hydroperiod Change
(Days)
No change (+/-30days)
Improves (benefit)
Overshoots NSM<30days
Worsens (impact)
Overshoots NSM>30days

Section 3. WCA 2A HYDROPATTERN RESTORATION

3.1. Introduction

The **Current Plan** calls for the initial discharge of water at 50 ppb total phosphorus (until the time that no imbalance levels are set) from STA 2 to be spread along approximately 7.5 miles of the northwest boundary of WCA 2A (see Figure 3-1). For this alternative, the **local impact zone** is immediately downstream of the spreader canal. The estimated range of **extent of impacts** was calculated from the simple relationship between cattail expansion and phosphorus loading observed in WCA 2A and presented below. The **regional area** under consideration is the Everglades Protection Area (EPA) downstream and outside of the impact zone which receives hydropattern benefits and no adverse water quality.

The **No Action** plan would continue the discharge of untreated water through S-6 into the Loxahatchee National Wildlife Refuge (see Figure 3-2). For this alternative, the **local impact zone** is immediately downstream of the S-6 and S-10 structures, which is the present receiving water. Adverse impacts have been observed at the existing discharge locations over a period of thirty years. The No Action alternative would exacerbate the present situation by continuing to discharge untreated water, and could result in an incremental increase in the area of impact, located immediately downstream of the already degraded area. The extent of adverse impact is calculated to be proportional to the nutrient load over time (see Section 2.3). The **regional area** under consideration is the Everglades Protection Area downstream of the local impact zone and the Rotenberger area. This area includes the northern WCAs which are presently over drained, and will remain over drained under the No Action alternative.

Bypass Option No. 1: STA 2 discharge would be routed up along the L-6 borrow canal to the vicinity of existing pump station S-6, where the treated water would flow into WCA 1 (see Figure 3-3). For this alternative, the **local impact zone** is immediately downstream of the S-6 and S-10 structures, which is the present receiving water. Adverse impacts have been observed at the existing discharge locations. Relative to the current plan, the Bypass option would exacerbate the present situation by continuing to discharge water above the "no-imbalance" level, and could result in an incremental increase in the area of impact, located immediately downstream of the already degraded area. The extent of adverse impact is calculated to be proportional to the nutrient load over time (see Section 2.3). The **regional area** under consideration is the Everglades Protection Area downstream of the local impact zone and the Rotenberger area. This area includes northern WCA 3A which is presently over drained, and will remain over drained under the Bypass alternative.

Bypass Option No. 2: STA 2 discharge would be routed southwest to the vicinity of the S-7 pump station, where the water would flow into WCA 2A (Figure 3-4). For this alternative, the **local impact zone** is downstream of S-7 pump station (North New River Canal) and NW WCA 2A. Adverse impacts have been observed at the existing discharge locations. The Bypass option would exacerbate the present situation by continuing to discharge water above the "no-imbalance" level, and would result in an incremental area of impact, located immediately downstream of the already degraded area. The extent of adverse impact is calculated to be proportional to the nutrient load over time (see Section 2.3). The **regional area** under consideration is the Everglades Protection Area downstream of the local impact zone and the Rotenberger area. This area includes the northern WCAs which are presently over drained, and will remain over drained under the Bypass alternative.

The local antecedent conditions for each of these alternatives are summarized in Table 3-1.

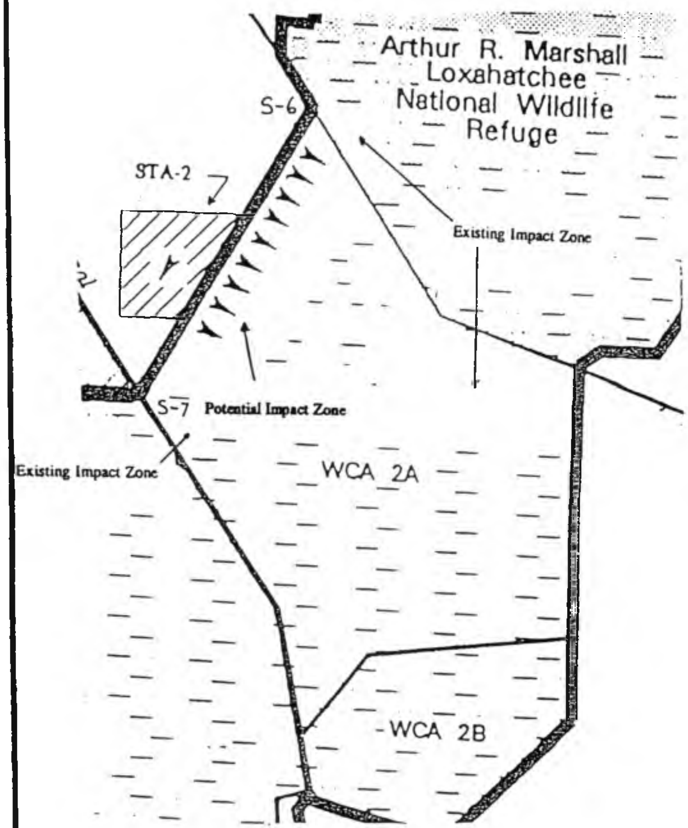


Figure 3-1. WCA-2A Hydropattern Restoration Current Plan

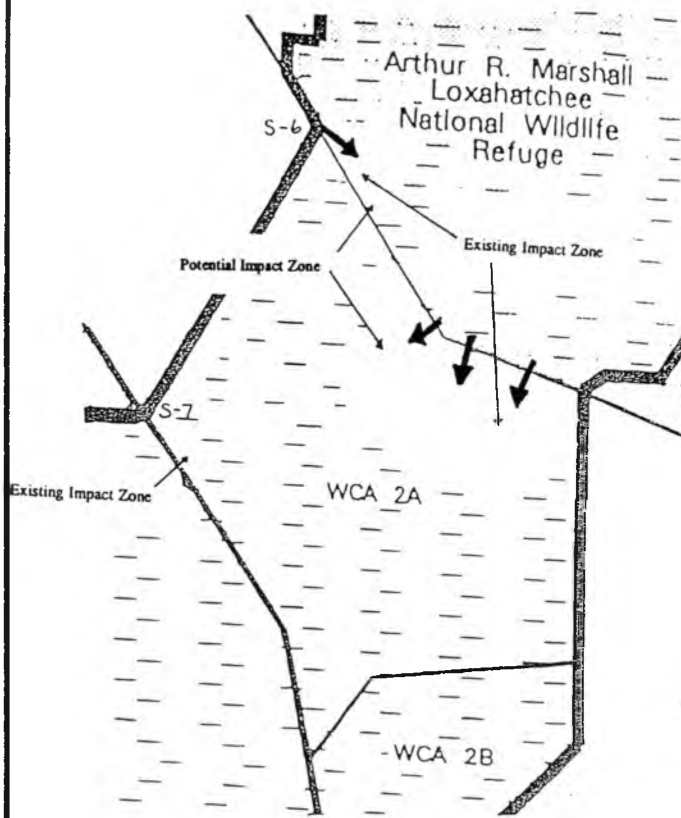


Figure 3-2. WCA-2A Hydropattern Restoration - No Action Plan

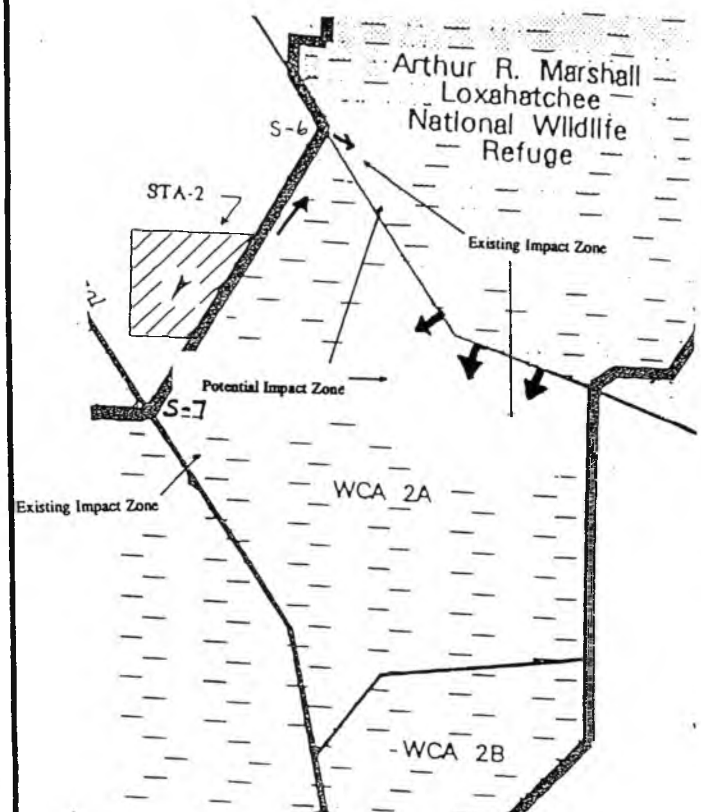


Figure 3-3. WCA-2A Hydropattern Restoration - Bypass # 1 Plan

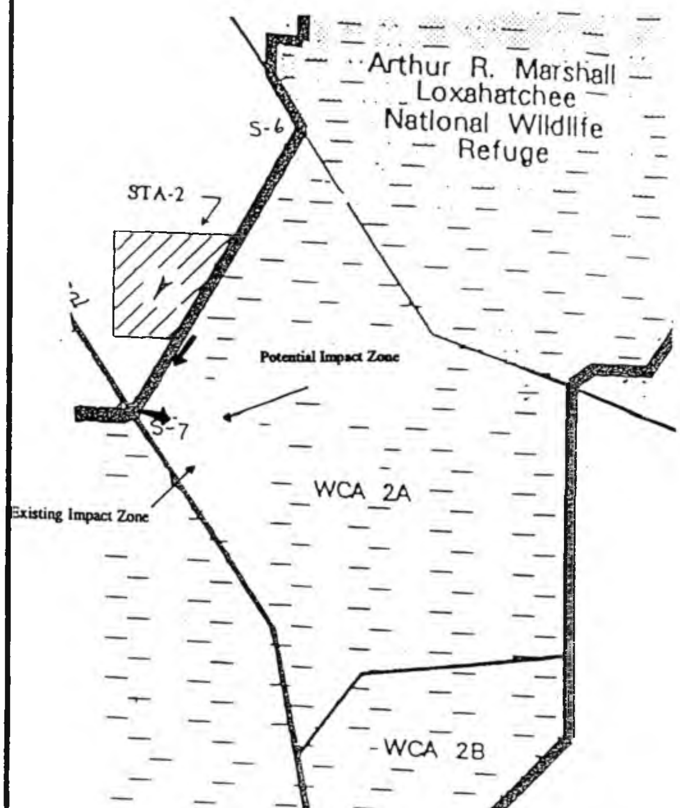


Figure 3-4. WCA-2A Hydropattern Restoration - Bypass # 2 Plan

Table 3-1. WCA 2A Local Antecedent Conditions

Evaluation Criteria	Current Plan	No Action	Bypass Option 1 & Option 2	
			Bypass to S-6	Bypass to S-7
1. Soil Phosphorus Level (high, medium, low)	Medium	High	High	High
2. Vegetation Communities (types)	Dense Sawgrass	Dense Sawgrass, Cattail	Cattail	Cattail
3. Peat/Marl Accretion (positive, subsidence)	Subsidence	Positive	Positive	Positive

3.2 Anticipated Benefits and Impacts:

Stage duration curves and stage hydrographs within the northern WCA 2A are presented in Figures 3-5 and 3-6. The locations of these results are shown in Figure 2-4 as a triangle within the northern WCA 2A. In Figure 3-5, three stage duration curves are shown. The dashed curve represents the percentage of time that the water depth on the left axis is equaled or exceeded in the NSM simulation. The solid line curve represents the percentage of time that the water depth on the left axis is equaled or exceeded in the ECP simulation. The dashed line curve with small squares represents the percentage of time that the water depth on the left axis is equaled or exceeded in the No ECP simulation. The same line definition applies to the stage hydrographs in Figure 3-6.

The ECP Current Plan simulations resulted in approximately 7,680 acres of improved hydroperiod within WCA 2A when compared to the No ECP simulations. Hydroperiod comparisons are presented Figure 3-7.

The ECP provides a direct hydropattern benefit to WCA 1 through the diversion of current discharges from S-6 to STA 2 for treatment and subsequent release to WCA 2A. This benefit was estimated to account for about 23,000 acres of improved hydroperiod compared to the No ECP simulations. The No Action and Bypass (to WCA 1) options associated with this hydropattern project are both represented in the NO ECP simulation. These results are shown in Figures 2-6 and 3-8.

The total acreage of hydroperiod benefits for the ECP Current Plan for WCA 2A was estimated to be approximately 31,000 acres in both WCA 1 and WCA 2A.

An estimate of the **extent** of adverse impacts was calculated from the simple relationship between phosphorus loading and observed cattail expansion derived in Section 2.3, and is summarized in Table 3-2 for each of the alternatives evaluated. For the No Action and Bypass options, the acreage estimated is **in addition to** any existing areas impacted by elevated nutrient conditions.

Table 3-2. WCA 2A Hydropattern Restoration Project - Estimates of Potential Cattail Impacts (acres)

	Current Plan		No Action		Bypass to S-6		Bypass to S-7	
With 50 ppb discharge from STAs								
Average Annual Load (metric tons per year)	12.7		27.2		12.7		12.7	
					(2-yr delay)		(2-yr delay)	
	Low Rate	High Rate	Low Rate	High Rate	Low Rate	High Rate	Low Rate	High Rate
Estimate of cattail acreage								
Zero time lag	643	1758	1377	3764	827	2259	827	2259
1-yr time lag	563	1538	1205	3294	746	2040	746	2040
3-yr time lag	402	1099	861	2353	586	1600	586	1600
5-yr time lag	241	659	517	1412	425	1161	425	1161
7-yr time lag	80	220	172	471	172	471	172	471
17-yr time lag	0	0	0	0	0	0	0	0
With 30 ppb discharge from STAs								
Average Annual Load (metric tons per year)	7.6		16.3		7.6		7.6	
	Low Rate	High Rate	Low Rate	High Rate	Low Rate	High Rate	Low Rate	High Rate
Estimate of cattail acreage								
Zero time lag	386	1055	826	2259	496	1356	496	1356
1-yr time lag	338	923	723	1976	448	1224	448	1224
3-yr time lag	241	659	517	1412	351	960	351	960
5-yr time lag	145	395	310	847	255	696	255	696
7-yr time lag	48	132	103	282	103	282	103	282
17-yr time lag	0	0	0	0	0	0	0	0

Note: Actual impacts may be lower with implementation of active management practices. Impacts from the No Action and Bypass options would occur downstream of their discharge points. Impacts are **cumulative** impacts through the year 2006.

Results of the potential cattail expansion calculations are presented in Table 3-2 and Figure 3-9. For the 50 ppb discharge scenario and using the Low Rate relationship between phosphorus loading and cattail expansion, estimates of potential cattail expansion for the Current Plan range from 0 acres for the Best Case (17-yr time lag) to 643 acres for the Worst Case (instantaneous or zero time lag). For the same scenario, estimates of potential cattail expansion for the No Action alternative range from 0 acres for the Best Case (17-yr time lag) to 1377 acres for the Worst Case (zero time lag); this Worst Case estimate represents an increase of 743 acres (114%) over the Current Plan. For the Bypass options, the delay in operation of STA 2 due to the additional time for design and construction of the bypass results in an additional 2 years of untreated discharge to the Everglades Protection Area, equating to an estimated additional phosphorus load of 54 metric tons of phosphorus. The estimates of potential cattail expansion for the Bypass options reflect this additional load (compared to the Current Plan) and range from 0 acres for the Best Case (17-yr time lag) to 827 acres for the Worst Case (zero time lag); this Worst Case estimate represents an increase of 184 acres (29%) over the Current Plan. In light of the antecedent conditions downstream of the hydropattern project, and the importance of the time lag before impacts occur, District staff best professional judgement suggests that the Best Case is the more likely scenario.

Normalized Stage Duration Curves at R43 C27
Downstream of STA-2

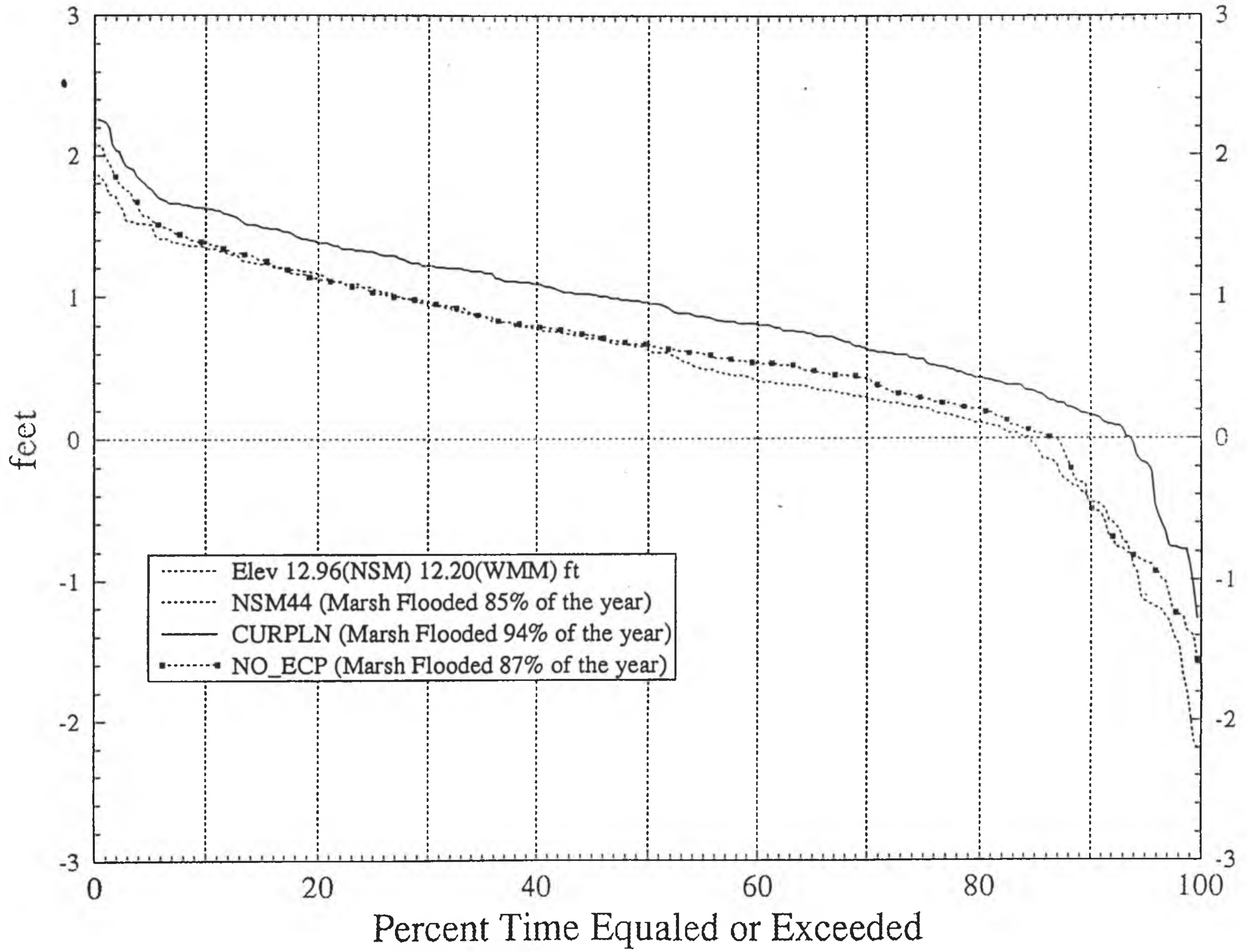


FIGURE 3-5

Note: Normalized stage is stage referenced to Land Elevation. Thus, values above zero indicates ponding while below zero indicates depth to the water table.

Fri Aug 2 09:37:31 1996

Environmental, Level II, WCA
SFWMM Simulation

Normalized Stage Hydrograph at R43 C27
Downstream of STA-2

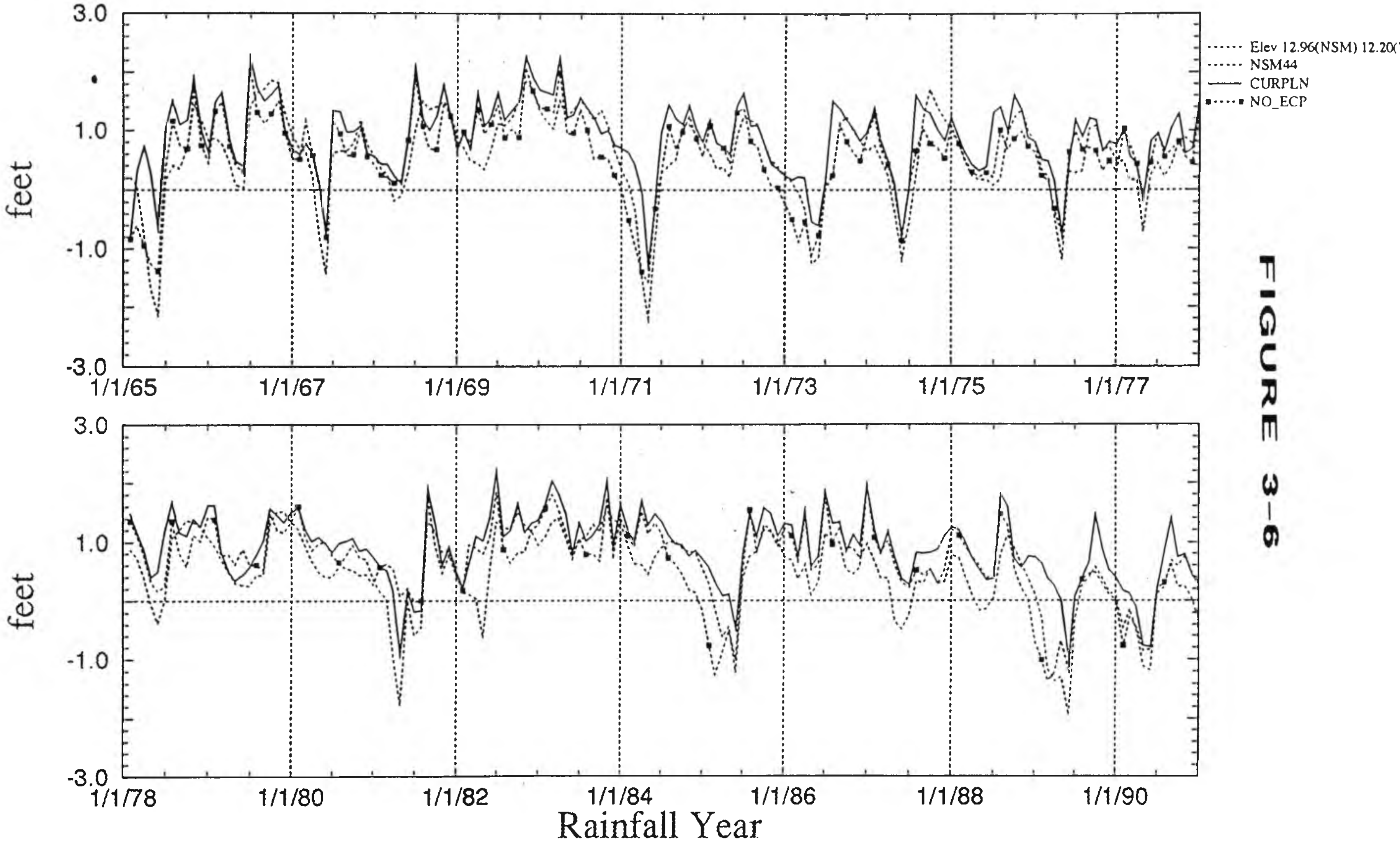


FIGURE 3-6

Note: Normalized stage is stage referenced to Land Elevation. Thus, values above zero indicates ponding while below zero indicates depth to the water table.

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Environmental, Level II, WCA
SFWMM Simulation

Hydroperiod Improvement Relative to No Action (NOECP) for WCA-2A (104960 acres) over the 26 yr. simulation

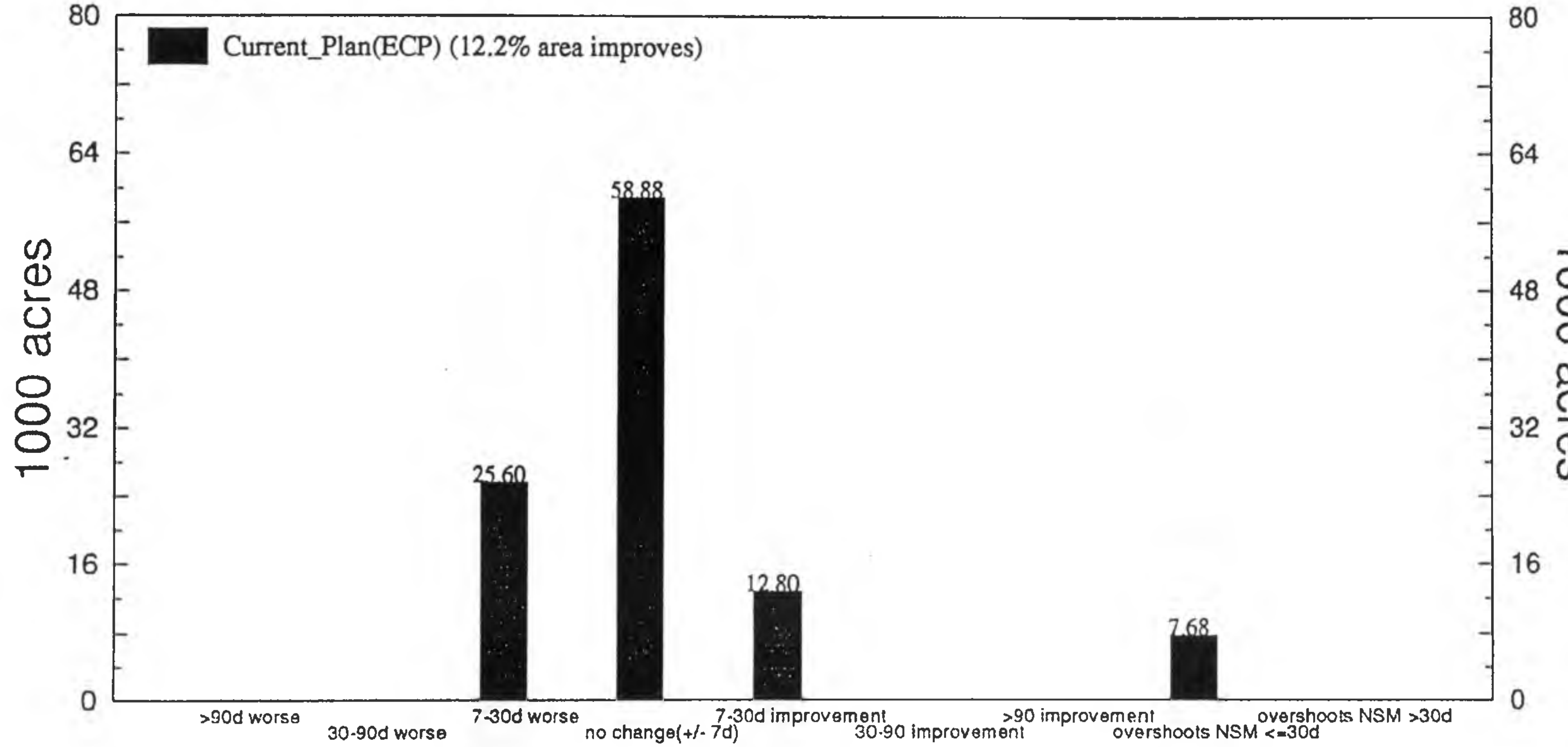

FIGURE 3-7

Note: NSM=Natural System Model; BASE=Baseline for measuring improvement (e.g. 2010-Base); ALT=Alternative to compare with BASE

'Improvement' means the mean annual hydroperiod resulting from the alternative is 'moving in the right direction'. For example if the hydroperiod for ALT is longer than that of the BASE, and is getting closer to that of the NSM, the hydroperiod of ALT is said to improve.

'Worse' means that the hydroperiod resulting from ALT is 'moving in the wrong direction'. For example, if the hydroperiod for ALT is shorter than that of the BASE, and is getting farther from the NSM, then the hydroperiod is said to get worse.

'Overshoots' means the hydroperiod resulting from ALT is 'moving toward the NSM', but goes past the NSM hydroperiod. For e.g., if the respective hydroperiods of the BASE=270, the NSM=310, and the ALT=350, then the ALT hydroperiod is said to overshoot the NSM hydroperiod.

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SFWMM Simulation

Hydroperiod Improvement Relative to No Action (NOECP) for WCA-1 (145920 acres) over the 26 yr. simulation

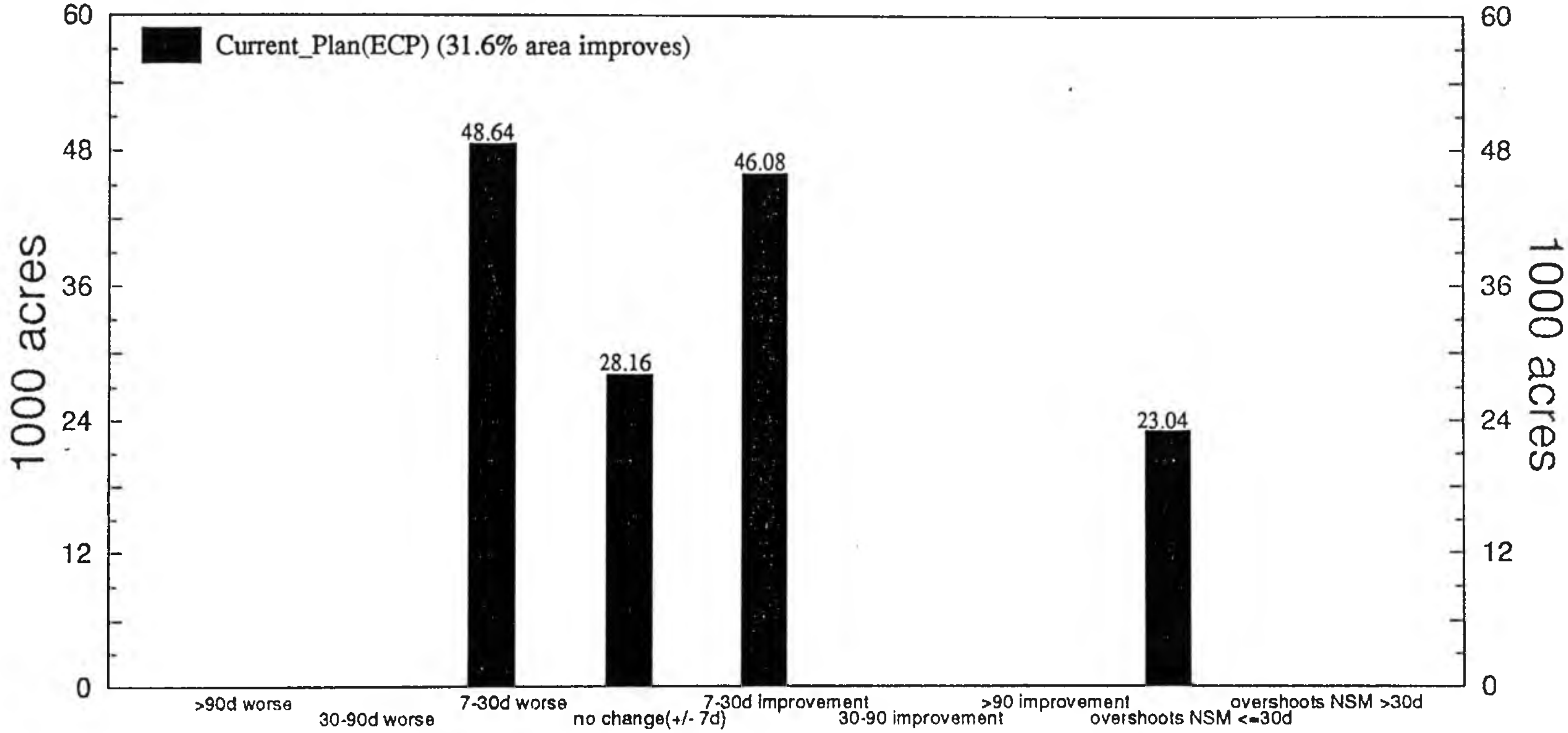


FIGURE 3-8

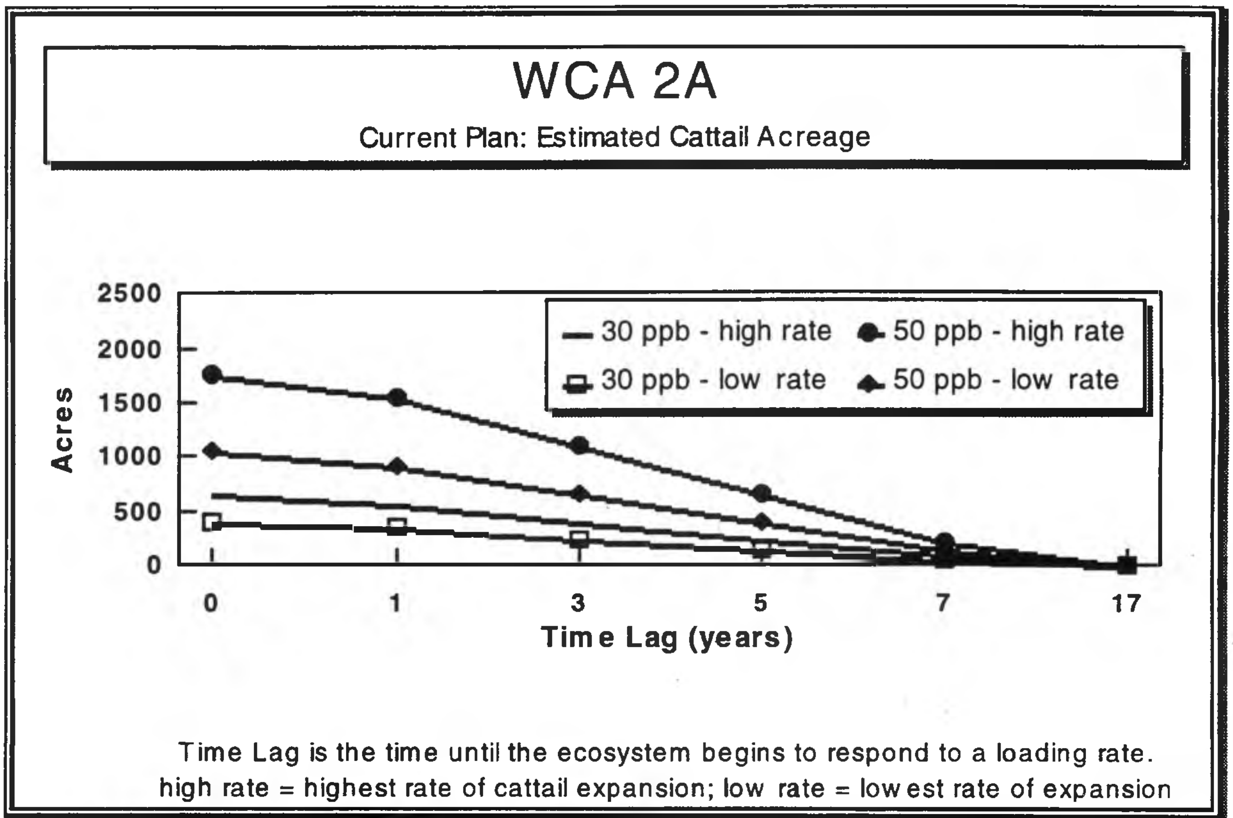
Note: NSM=Natural System Model; BASE=Baseline for measuring improvement (e.g. 2010-Base); ALT=Alternative to compare with BASE

'Improvement' means the mean annual hydroperiod resulting from the alternative is 'moving in the right direction'. For example if the hydroperiod for ALT is longer than that of the BASE, and is getting closer to that of the NSM, the hydroperiod of ALT is said to improve.

'Worse' means that the hydroperiod resulting from ALT is 'moving in the wrong direction'. For example, if the hydroperiod for ALT is shorter than that of the BASE, and is getting farther from the NSM, then the hydroperiod is said to get worse.

'Overshoots' means the hydroperiod resulting from ALT is 'moving toward the NSM', but goes past the NSM hydroperiod. For e.g., if the respective hydroperiods of the BASE=270, the NSM=310, and the ALT=350, then the ALT hydroperiod is said to overshoot the NSM hydroperiod.

Fig. 3-9 Influence of Time Lag on Estimate of Potential Cattail Impact in WCA 2A



The results of the evaluation are presented in Table 3-3 and are described below.

Using an alternate modeling methodology presented by one of the stakeholders (Walker, pers. comm.), the time required to exceed the most conservative soil P criterion for initiation of cattail expansion (10 cm soil depth and 610 mg/Kg) was five years. However, the time required to exceed the soil P criterion which best reproduced the initial 20 year cattail expansion in WCA-2A (20 cm depth and 720 mg/kg) ranged from 17 to 42 years. These findings suggest that cattails would not expand during the period of 50 ppb discharge. In addition, if the extent of cattails is controlled by fragmentation of existing populations (Wu et al., 1996), the rate of cattail expansion would be expected to be slower than that predicted based on soil P concentrations alone.

Results of the entire evaluation process which incorporate the estimates of cattail expansion and NSM-hydropattern match are summarized in Table 3-3 and are described below.

TABLE 3-3. WCA 2A HYDROPATTERN RESTORATION EVALUATION MATRIX

Evaluation Criteria	Current Plan		No Action		Bypass Option 1 and Option 2 Bypass to S-6		Bypass to S-7	
Local (Impact Zone) Benefits/Impacts								
	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term
1.Vegetation communities	-	0	-	-	0	+	-	-
2.Animal communities	-	0	-	-	0	+	-	-
3. Drainage characteristics	+	+	0	0	0	0	0	0
4. Groundwater interaction	+	+	0	0	0	0	0	0
5. Water quality	-	0	-	-	0	+	-	+
6. Organic soil preservation	+	+	0	0	0	0	0	0
Regional (Everglades Protection Area) Benefits/Impacts								
1.Vegetation communities	+	+	-	-	-	-	-	-
2. Animal communities	+	+	-	-	-	-	-	-
3. Drainage characteristics	+	+	0	0	0	0	0	0
4. Groundwater interaction	+	+	0	0	0	+	0	0
5. Water quality	+	+	-	+	-	+	-	+
6. Organic soil preservation	+	+	-	-	-	-	-	-
Other Considerations								
1. Additional cost to implement	No		Deferred Costs		$7-9 Million		$35 Million	
2. Additional time to implement	No		No		18-24 months		18-24 months	

\+ Indicates improvement over current conditions; 0 Indicates no measurable change; - Indicates degradation

1. Vegetative Communities -

For the **Current Plan**:
- the **short-term local impacts** are negative, reflecting adverse impacts to ecological functions due to 50 ppb of phosphorus that outweigh the positive impact of the improved hydropattern characteristics. See the discussion in Section 2.3 for a description of the general impacts associated with elevated nutrient loadings. It is anticipated that due to the existing dense sawgrass communities downstream of the proposed spreader canal, the potential for cattail expansion will be significantly less than that observed downstream of the S-10 structures.
- the **long-term local impacts** may well be negligible or positive, depending on how effective cattail management is in retarding the expansion of cattails, and how soon the phosphorus is leached from the soil. It is anticipated that the periphyton community will recover quicker than the macrophyte community.
- the **short-term and long-term regional impacts** are positive due to sheetflow benefits and diversion of phosphorus load from the existing point source discharge location.

For the **No Action option**:
- the **short-term and long-term local impacts** are negative due to continued phosphorus enrichment at high phosphorus levels.
- additional **short-term local negative impact** because of continued degradation due to continued high water conditions downstream of S-6 and the S-10 structures.
- both **short-term and long-term regional impacts** are negative due to continued degradation as a result of high phosphorus levels and inadequate hydropattern.

For the **Bypass No. 1 option,**
- the net **short-term local impacts** are negligible, reflecting a balance of negative impacts due to continued point source discharge and higher water depths and benefits due to lower phosphorus levels.
- the **long-term local impacts are +** due to discharge of the "no-imbalance" phosphorus level.
- the **regional short-term and long-term impacts** are negative due to continued degradation in northern WCA 2A without hydropattern restoration.

For the **Bypass No. 2 option**:
- the **short-term and long-term local impacts** are negative due to additional water and phosphorus loads downstream of S-7.
- the **regional short-term and long-term impacts** are negative due to continued degradation in northern WCA 2A without hydropattern restoration.

2. Animal Communities -
For the Current Plan:
- the **short-term local impacts** are negative, reflecting adverse impacts to ecological functions (particularly reduced quality of habitat) due to 50 ppb of phosphorus that outweigh the positive impact of the improved hydropattern characteristics.
- the **long-term local impacts** may well be negligible or positive, depending on how effective cattail management is in removing cattails, and how soon the phosphorus is leached from the soil.

- the **short-term and long-term regional impacts** are positive due to sheetflow benefits and diversion of phosphorus load from the existing point source discharge location.

For the **No Action option**:
- the **short-term and long-term local impacts** are negative due to continued phosphorus enrichment at high phosphorus levels.
- both **short-term and long-term regional impacts** are negative due to continued degradation as a result of high phosphorus levels and inadequate hydropattern.

For the **Bypass No. 1 option**:
- the net **short-term local impacts** are negligible, reflecting a balance of negative impacts due to continued point source discharge and benefits due to lower phosphorus levels.
- the **long-term local impacts** are positive due to discharge of the "no-imbalance" phosphorus level.
- the **regional short-term and long-term impacts** are negative due to continued degradation.

For the **Bypass No. 2 option**:
- the **short-term local impacts** are negative due to additional water and phosphorus loads downstream of S-7.
- the **long-term local impacts** are negative due to additional water and phosphorus loads downstream of S-7.
- the **regional short-term and long-term impacts** are negative due to continued degradation in northern WCA 2A without hydropattern restoration.

3. Hydropattern Characteristics -
For the **Current Plan**:
- the **short-term and long-term local and regional impacts** are positive due to the hydropattern improvement benefits.

For the **No Action option**:
- the **short-term and long-term local and regional impacts** are negligible due to no change in drainage characteristics.

For the **Bypass options**:
- the **short-term and long-term local and regional impacts** are negligible due to no change in drainage characteristics.

4. Groundwater Interactions -
For the **Current Plan**:
- the **short-term and long-term local and regional impacts** are positive due to the hydropattern improvement benefits.

For the **No Action option:**
- the **short-term and long-term local and regional impacts** are negligible due to no change in drainage characteristics.

For the **Bypass options**:

- the **short-term and long-term local and regional impacts** are negligible due to no change in drainage characteristics.

5. Water Quality -
For the **Current Plan:**
- the **short-term local impacts** are negative, reflecting adverse impacts to ecological functions due to 50 ppb of phosphorus that outweigh the positive impact of the improved hydropattern characteristics.
- the **long-term local impacts** may well be negligible or positive, depending on how effective cattail management is in removing cattails, and how soon the phosphorus is leached from the soil.
- the **short-term and long-term regional impacts** are positive due to sheetflow benefits and diversion of phosphorus load from the existing point source discharge location.

For the **No Action option,**
- the **short-term and long-term local impacts** are negative due to continued vegetation community degradation due to phosphorus enrichment at high phosphorus levels.
- additional **short-term local negative impact** because of continued degradation due to continued high water conditions downstream of the S-6 and S-10 structures.
- **short-term regional impacts** are negative due to continued vegetative community degradation as a result of high phosphorus levels and inadequate hydropattern.
- **long-term regional impacts** are positive due to reduced phosphorus attributable to BMPs, even though there remains an inadequate hydropattern.

For the **Bypass No. 1 option** when the flow volume is the same,
- the net **short-term local impacts** are negligible, reflecting a balance of - due to continued point source discharge and + due to lower phosphorus levels.
- the **long-term local impacts** are + due to discharge of the “no-imbalance” phosphorus level.
- the **regional short-term impacts** are negative due to continued degradation of the vegetative community which does not receive hydropattern benefits, even though the phosphorus concentrations are reduced.
- the **regional long-term impacts** are positive due to the reductions in phosphorus concentrations.

For the **Bypass No. 2 option,**
- the **short-term local impacts** are -, due to additional water and phosphorus loads downstream of S-7.
- the **long-term local impacts** are -, due to additional water and phosphorus loads downstream of S-7.
- **short-term regional impacts** are negative due to continued vegetative community degradation as a result of high phosphorus levels and inadequate hydropattern.
- **long-term regional impacts** are positive due to reduced phosphorus, even though there remains an inadequate hydropattern.

6. Organic Soil Preservation -

For the **Current Plan**,

- the short-term and long-term local and regional impacts are positive due to the hydropattern improvement benefits, particularly sheetflow, greater surface area and water depths.
- the short-term and long-term local impacts are negligible due to continuation of the same hydrology.

For the **No Action option, the short-term and long-term regional impacts** are negative due to continued degradation as a result of not restoring regional hydropattern.

For the **Bypass options, the short-term and long-term regional impacts** are negative due to continued degradation as a result of not restoring regional hydropattern.

Summary

Although each alternative has some potential for adverse impact, the evaluation suggests that the **Current Plan** provides the best balance of regional hydropattern benefits against the potential impacts and maximizes the environmental benefits to the Everglades Protection Area.

Section 4. EAST WCA 3A HYDROPATTERN RESTORATION

4.1. Introduction

The **Current Plan** calls for approximately 60% of the discharge from STA 3/4 to be spread along approximately 5 miles of the north boundary of WCA 3A, with approximately 38% sent to S-7, and the balance sent to S-8 (see Figure 4-1). For this alternative, the **local impact zone** is immediately downstream of the spreader canal (approx. 60% of average annual flow); plus downstream of S-7 pump station (North New River Canal) and NW WCA 2A (approx. 38% of average annual flow); plus downstream of S-8 pump station (Miami Canal gaps) (approx. 2% of average annual flow). The estimated range of **extent of impacts** was calculated from the simple relationship between cattail expansion and phosphorus loading observed in WCA 2A and presented below. The **regional area** under consideration is the Everglades Protection Area (EPA) downstream and outside of the impact zone which receives hydropattern benefits and no adverse water quality.

The **No Action** plan would continue the discharge of untreated water through S-7 into WCA 2A and S-8 into WCA 3A (see Figure 4-2). For this alternative, the **local impact zone** is immediately downstream of the S-7 pump station (North New River Canal) and NW WCA 2A (current average annual flow); plus downstream of S-8 pump station (Miami Canal gaps) (current average annual flow)into WCA 3A. Adverse impacts have been observed at the existing discharge locations. The No Action alternative would exacerbate the present situation by continuing to discharge untreated water, and would result in an incremental area of impact, located immediately downstream of the already degraded area. The extent of adverse impact is calculated to be proportional to the nutrient load over time (see Section 2.3). The **regional area** under consideration is the Everglades Protection Area downstream of the local impact zone and the Rotenberger area. This area includes the northern WCAs which are presently over drained, and will remain over drained under the No Action alternative.

Bypass Option: STA 3/4 discharge would be routed to the existing S-7 and S-8 pump stations, where the treated water would flow into WCA 2A and WCA 3A, respectively (see Figure 4-3). For this alternative, the **local impact zone** is immediately downstream of the S-7 pump station (North New River Canal) and NW WCA 2A (current average annual flow); plus downstream of S-8 pump station (Miami Canal gaps) (current average annual flow)into WCA 3A. Adverse impacts have been observed at the existing discharge locations. The Bypass option would exacerbate the present situation by continuing to discharge water above the "no-imbalance" level, albeit at decreased concentrations relative to the no action alternative, and would result in an incremental area of impact, located immediately downstream of the already degraded area. The extent of adverse impact is calculated to be proportional to the nutrient load over time (see Section 2.3). The **regional area** under consideration is the Everglades Protection Area downstream of the local impact zone and the Rotenberger area. This area includes the northern WCAs which are presently over drained, and will remain over drained under the bypass alternative. The local antecedent conditions for each of these alternatives is summarized in Table 4-1.

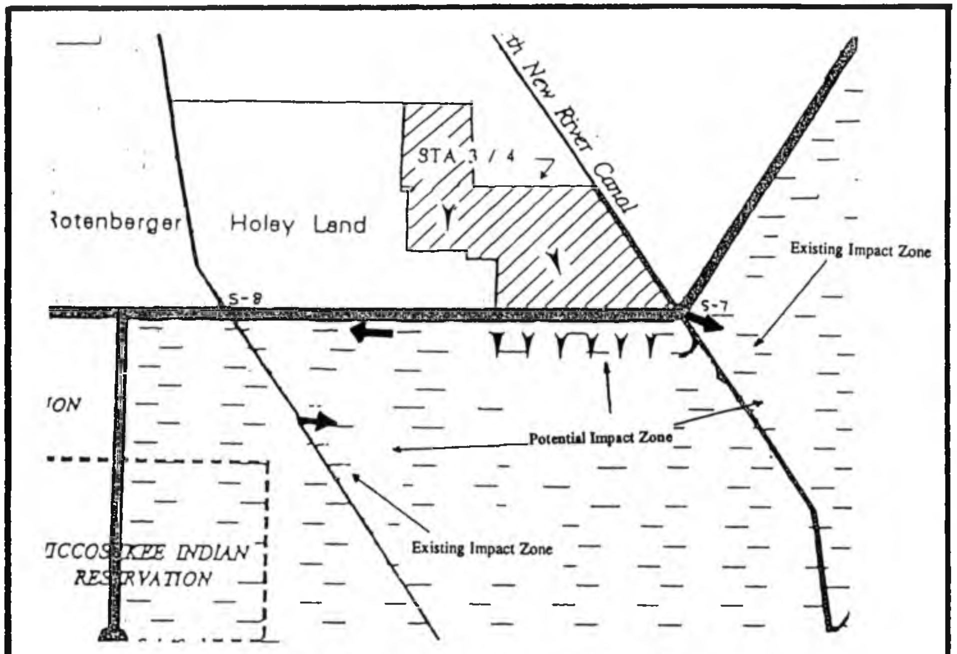


Figure 4-1. East WCA-3A Hydropattern Restoration - Current Plan

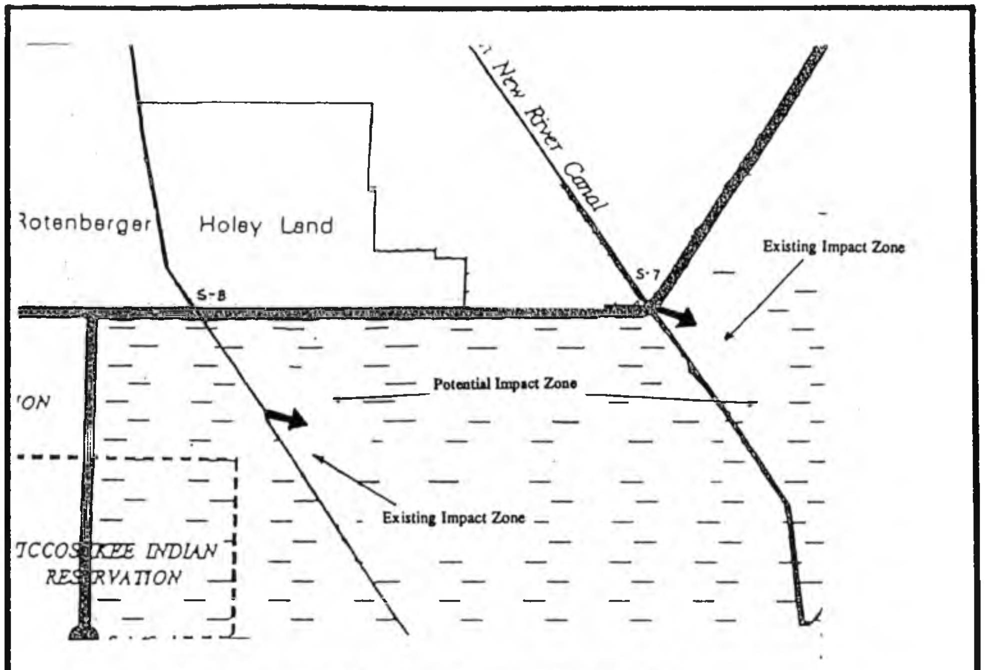


Figure 4-2. East WCA-3A Hydropattern Restoration - No Action Plan

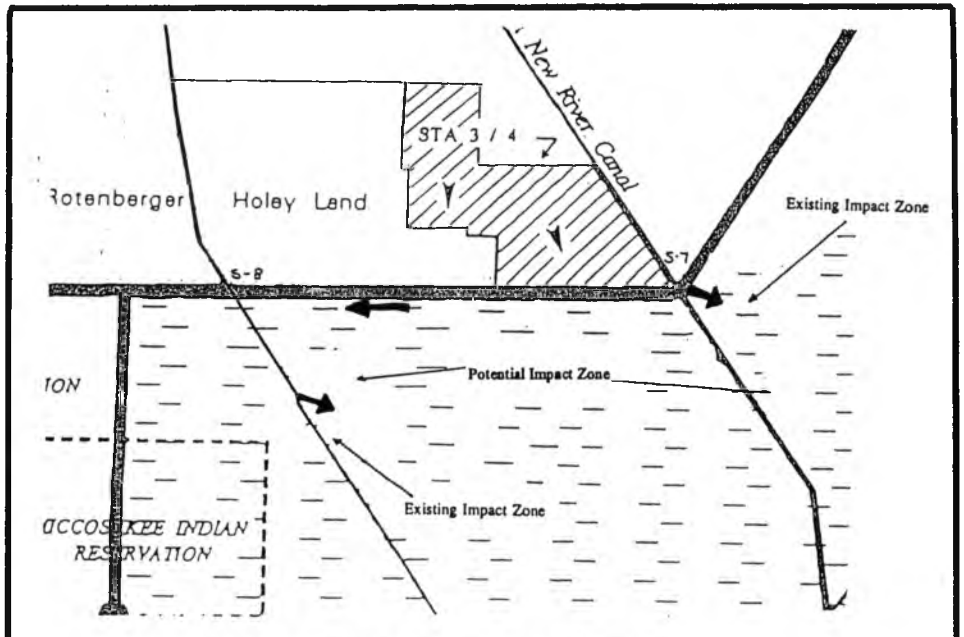


Figure 4-3. East WCA-3A Hydropattern Restoration - Bypass Plan

Table 4-1. East WCA 3A Local Antecedent Conditions

Evaluation Criteria	Current Plan	No Action	Bypass to S-7 and S-8
1. Soil Phosphorus Level (high, medium, low)	High	High	High
2.Vegetation Communities (types)	Shrubs, Sawgrass	Cattail	Cattail
3. Peat/Marl Accretion (positive, subsidence)	Subsidence	Positive	Positive

4.2 Anticipated Benefits and Impacts:

Stage duration curves and stage hydrographs within the northeastern WCA 3A are presented in Figures 4-4 through 4-7. The locations of these results are shown in Figure 2-4 as a triangle within the northeastern WCA 3A. In Figures 4-4 through 4-7, three stage curves are shown. The dashed curve represents the percentage of time that the water depth on the left axis is equaled or exceeded in the NSM simulation. The solid line curve represents the percentage of time that the water depth on the left axis is equaled or exceeded in the ECP simulation. The dashed line curve with small squares represents the percentage of time that the water depth on the left axis is equaled or exceeded in the No ECP simulation.

It is appropriate to concurrently examine the hydropattern effects of both the eastern and western WCA 3A projects on the entire northern WCA 3A system because of the associated structural and operational strategies. In general, the area east of the Miami Canal receives significant areal benefits (approximately 59,000 acres) because of the ECP projects distribute discharges from STA 3/4 that currently go into WCA 2A from S-7, and to central WCA 3A from S-8. In fact, the majority of this acreage (approximately 38,400 acres) overshoots the NSM target, indicating too much water may be discharged in this area. However, at the same time, a worsening of the hydroperiod for approximately 49,000 acres was suggested by the methodology, indicating additional water would be beneficial. The net effect is approximately 10,000 acres of benefits attributable to the ECP projects. These results are shown in Figures 2-6 and 4-8.

The methodology suggests that the current discharge configuration and operational assumptions for STA 3/4 need to be reviewed and possibly revised to improve hydroperiod in WCA 3A, particularly west of the Miami Canal. The Lower East Coast planning process has already initiated evaluation of alternative STA discharge configuration to address this situation. The design process for STA 3/4 contemplated that changes would occur prior to the beginning of the detail design. The current schedule for design of STA 3/4 has the flexibility to allow for completion of this planning process to identify the optimal discharge configuration and operational strategies before commencing detail design in 1999-2000.

<u>Cattails.</u> An estimate of the **extent** of adverse impacts was calculated from the simple relationship between phosphorus loading and observed cattail expansion derived in Section 2.3, and is summarized in Table 4-2 for each of the alternatives evaluated. For the No Action and Bypass options, the acreage estimated is **in addition to** any existing areas impacted by elevated nutrient conditions.

Normalized Stage Duration Curves at R41 C24
Downstream of STA-3&4

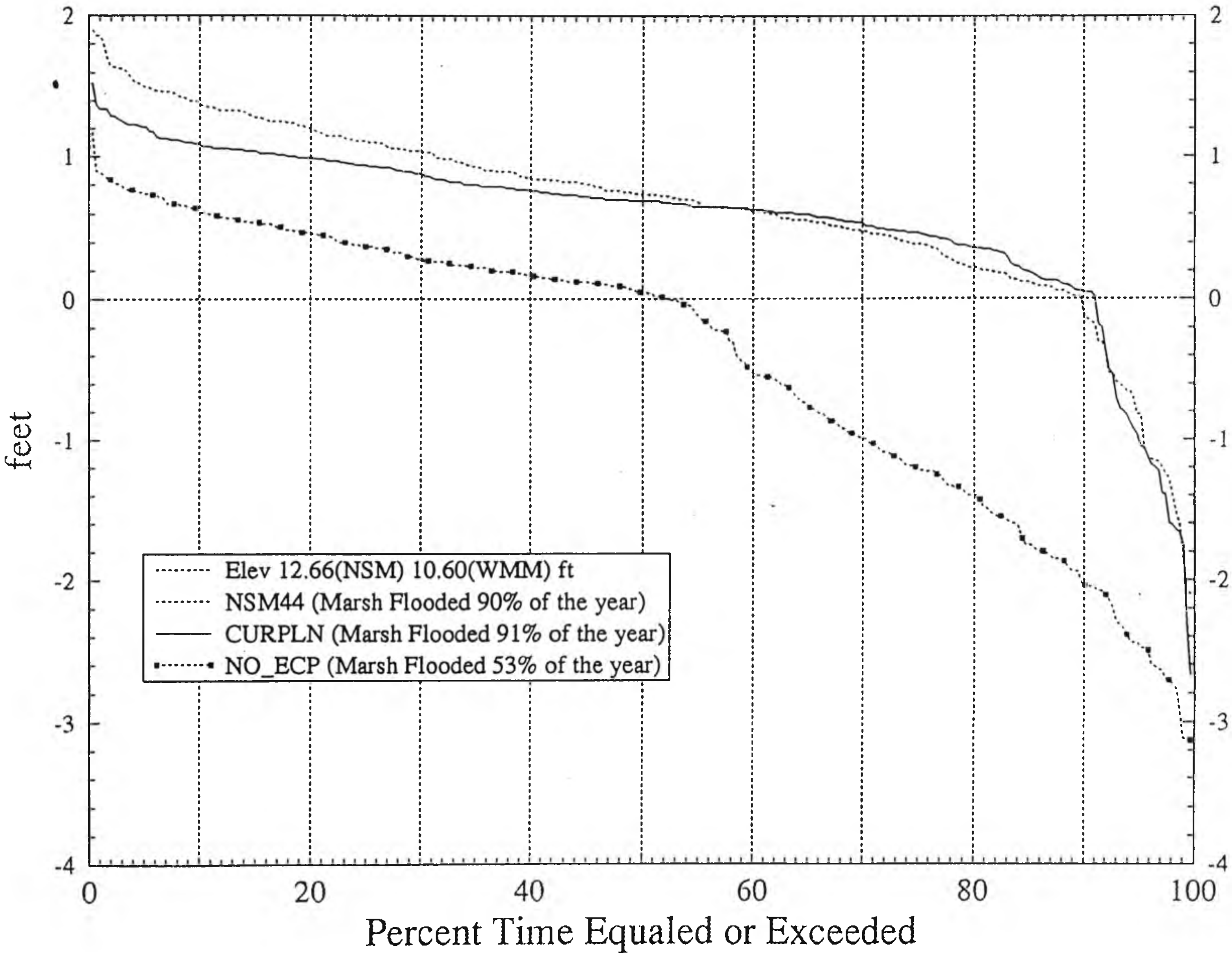


FIGURE 4-4

Note: Normalized stage is stage referenced to Land Elevation. Thus, values above zero indicates ponding while below zero indicates depth to the water table.

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Environmental, Level II, WCA
SFWMM Simulation

Normalized Stage Hydrograph at R41 C24
Downstream of STA-3&4

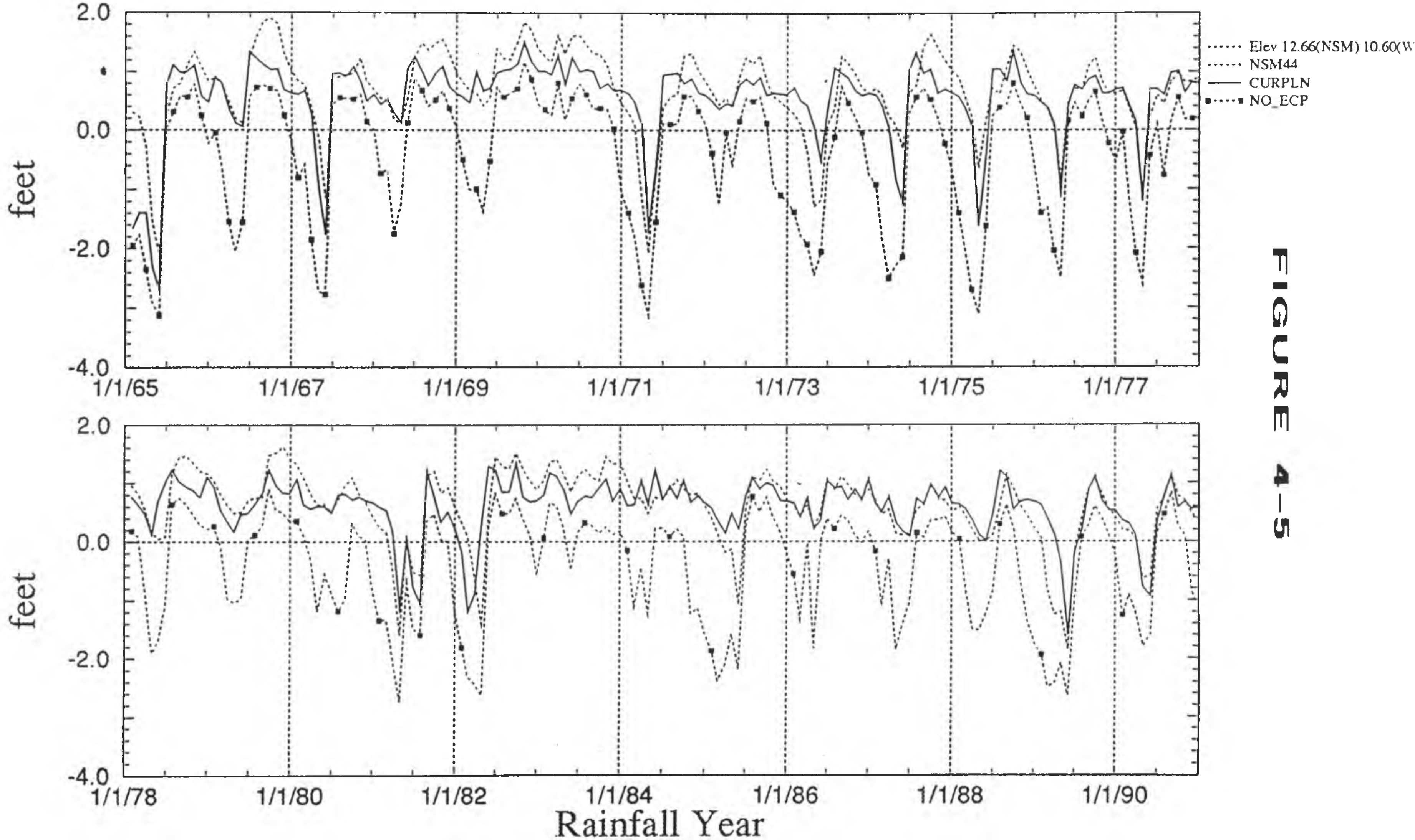

FIGURE 4-5

Note: Normalized stage is stage referenced to Land Elevation. Thus, values above zero indicates ponding while below zero indicates depth to the water table.

Normalized Stage Duration Curves at R41 C22
Downstream of STA-3&4

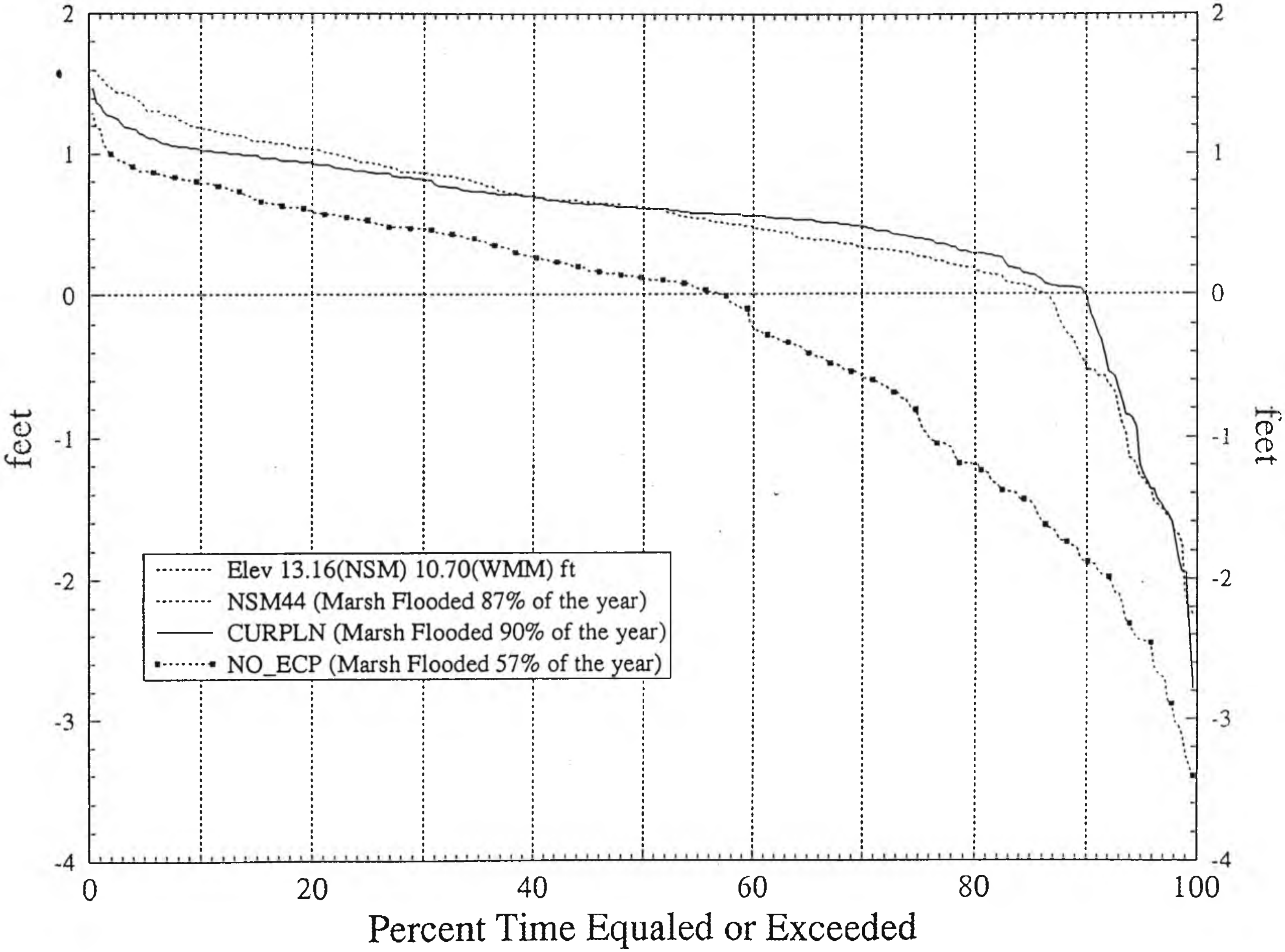

FIGURE 4-6

Note: Normalized stage is stage referenced to Land Elevation. Thus, values above zero indicates ponding while below zero indicates depth to the water table.

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Environmental, Level II, WCA
SFWMM Simulation

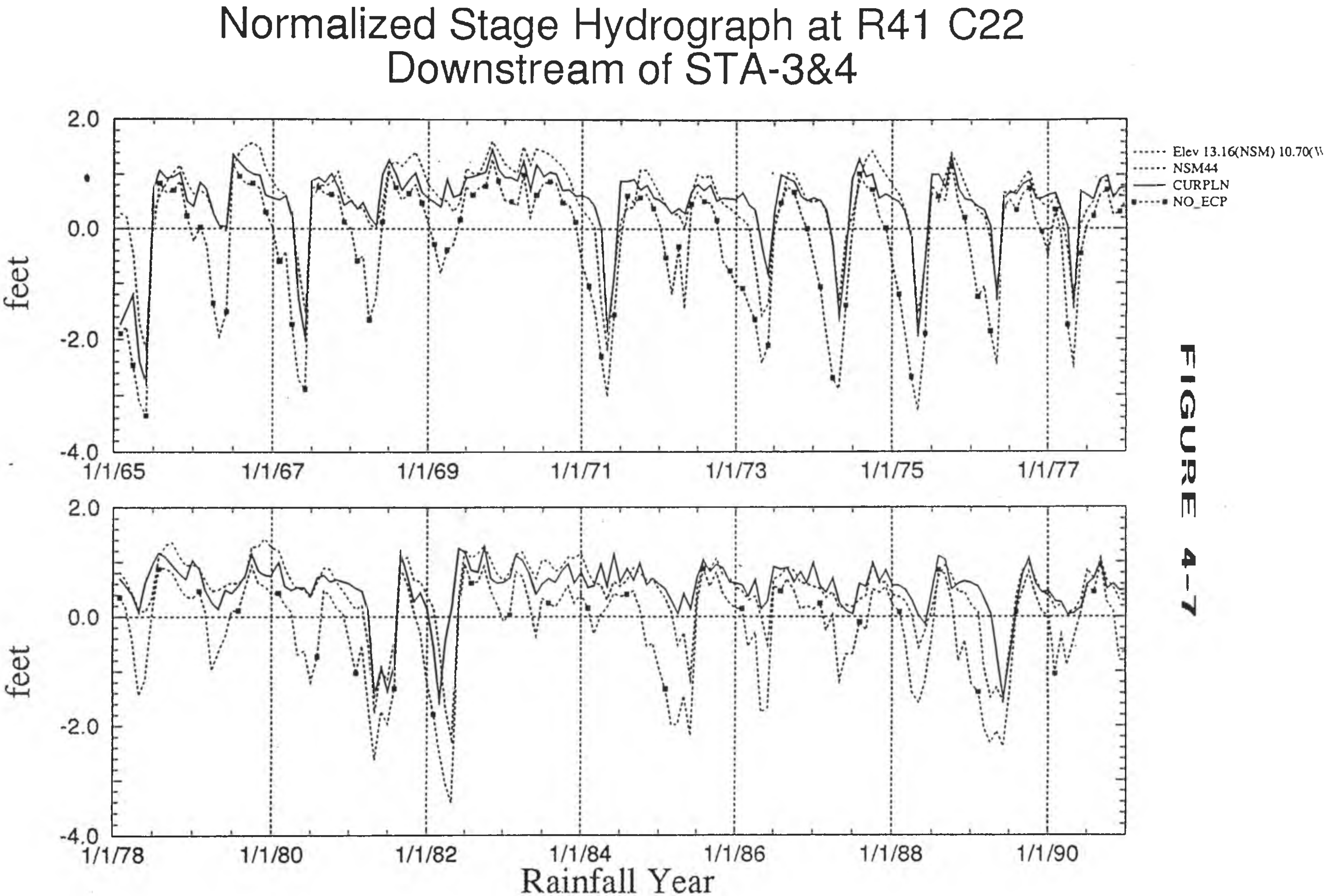


FIGURE 4-7

Note: Normalized stage is stage referenced to Land Elevation. Thus, values above zero indicates ponding while below zero indicates depth to the water table.

Fri Aug 2 17:09:47 1996

Environmental, Level II, WCA
SFWMM Simulation

Hydroperiod Improvement Relative to No Action (NOECP) for WCA-3A North (204800 acres) over the 26 yr. simulation

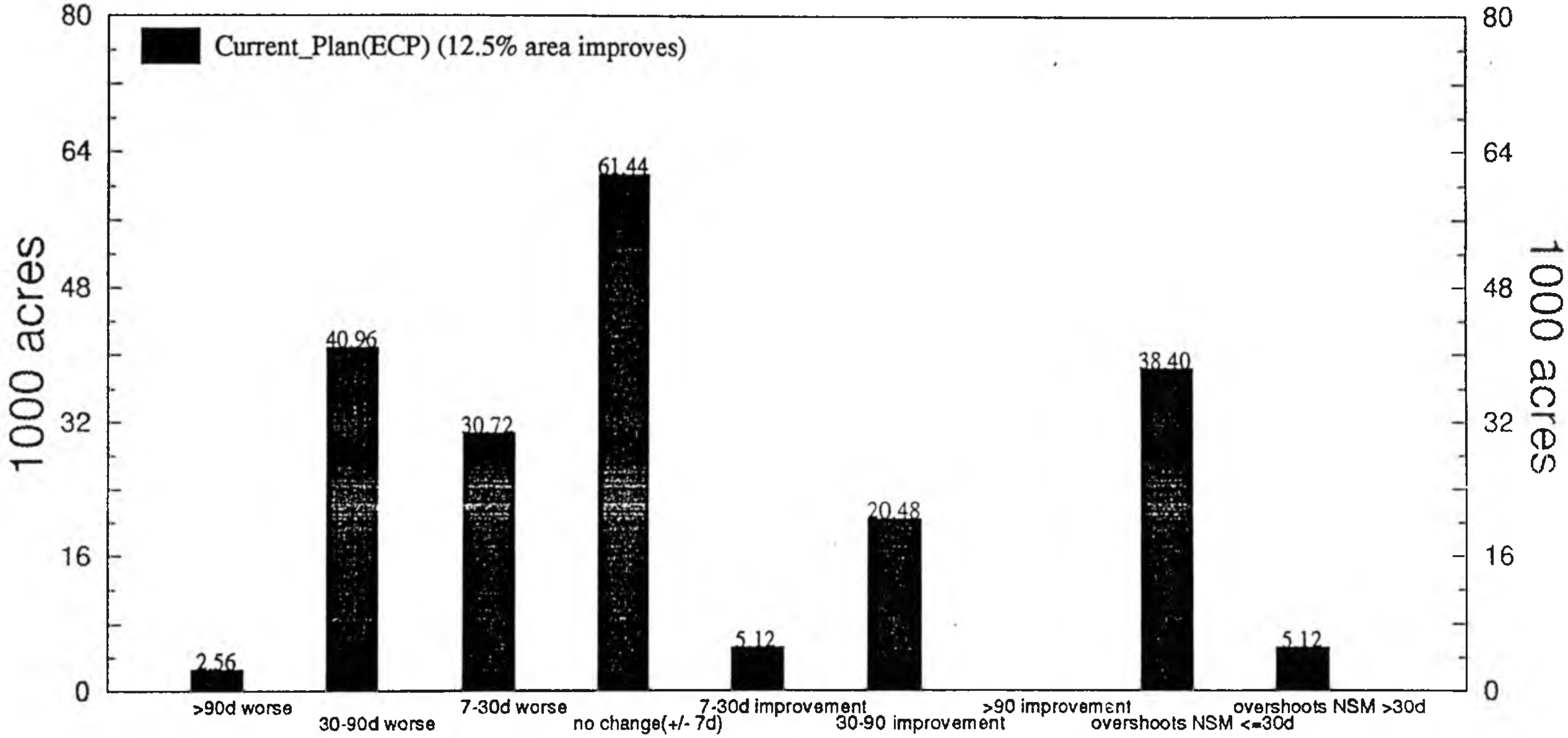


FIGURE 4-8

Note: NSM=Natural System Model; BASE=Baseline for measuring improvement (e.g. 2010-Base); ALT=Alternative to compare with BASE

'Improvement' means the mean annual hydroperiod resulting from the alternative is 'moving in the right direction'. For example if the hydroperiod for ALT is longer than that of the BASE, and is getting closer to that of the NSM, the hydroperiod of ALT is said to improve.

'Worse' means that the hydroperiod resulting from ALT is 'moving in the wrong direction'. For example, if the hydroperiod for ALT is shorter than that of the BASE, and is getting farther from the NSM, then the hydroperiod is said to get worse.

'Overshoots' means the hydroperiod resulting from ALT is 'moving toward the NSM', but goes past the NSM hydroperiod. For e.g., if the respective hydroperiods of the BASE=270, the NSM=310, and the ALT=350, then the ALT hydroperiod is said to overshoot the NSM hydroperiod.

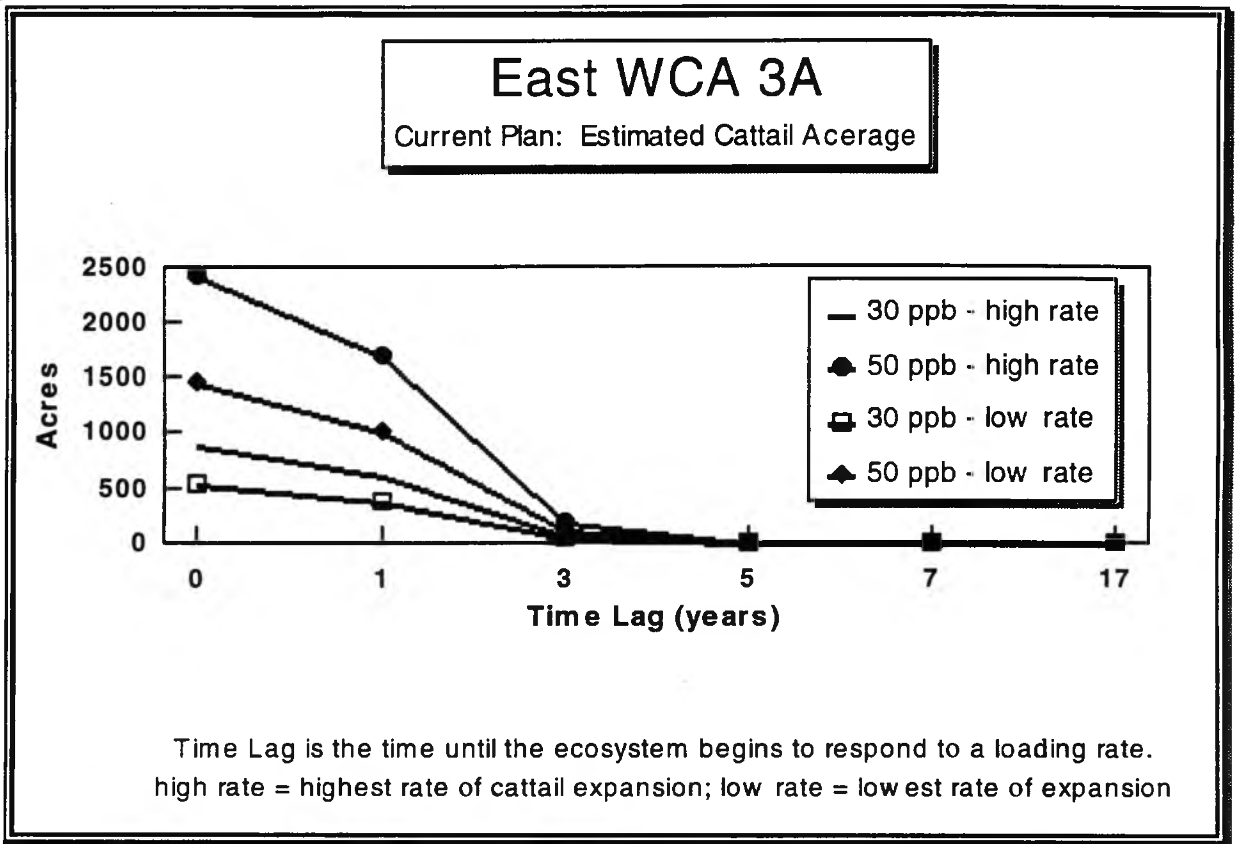
Table 4-2. East WCA 3A Hydropattern Restoration Project - Estimates of Impacts (acres)

	Current Plan		No Action		Bypass to S-7, S-8	
With 50 ppb discharge from STAs						
Average Annual Load (metric tons per year)	43.4		110.3		43.4	
	Low Rate	High Rate	Low Rate	High Rate	Low Rate	High Rate
Estimate of cattail acreage						
Zero time lag	893	2440	2269	6202	893	2440
1-yr time lag	618	1689	1571	4293	618	1689
3-yr time lag	69	188	175	477	69	188
5-yr time lag	0	0	0	0	0	0
7-yr time lag	0	0	0	0	0	0
17-yr time lag	0	0	0	0	0	0
With 30 ppb discharge from STAs						
Average Annual Load (metric tons per year)	26.0		36		14.8	
	Low Rate	High Rate	Low Rate	High Rate	Low Rate	High Rate
Estimate of cattail acreage						
Zero time lag	536	1464	1361	3721	536	1464
1-yr time lag	371	1014	943	2576	371	1014
3-yr time lag	41	113	105	286	41	113
5-yr time lag	0	0	0	0	0	0
7-yr time lag	0	0	0	0	0	0
17-yr time lag	0	0	0	0	0	0

Note: Actual impacts may be lower with implementation of active management practices. Impacts from the No Action and Bypass options would occur downstream of their discharge points. Impacts are cumulative impacts through the year 2006.

Results of the potential cattail expansion calculations are presented in Table 4-2 and Figure 4-9. For the 50 ppb discharge scenario and using the Low Rate relationship between phosphorus loading and cattail expansion, estimates of potential cattail expansion for the Current Plan range from 0 acres for the Best Case (17-yr time lag) to 893 acres for the Worst Case (instantaneous or zero time lag). For the same scenario, estimates of potential cattail expansion for the No Action alternative range from 0 acres for the Best Case (17-yr time lag) to 2269 acres for the Worst Case (zero time lag); this Worst Case estimate represents an increase of 1376 acres (154%) over the Current Plan. The estimates of potential cattail expansion for the Bypass options range from 0 acres for the Best Case (17-yr time lag) to 893 acres for the Worst Case (zero time lag. In light of the antecedent conditions downstream of the hydropattern project, and the importance of the time lag before impacts occur, District staff best professional judgement suggests that the Best Case is the more likely scenario.

Fig. 4-9 Influence of Time Lag on Estimate of Potential Cattail Impact in East WCA 3A



Using an alternate modeling methodology presented by one of the stakeholders (Walker, pers. comm.), the time required to exceed the most conservative soil P criterion for initiation of cattail expansion (10 cm soil depth and 610 mg/Kg) or the soil P criterion which best reproduced the initial 20-year cattail expansion in WCA-2A (20 cm depth and 720 mg/kg) would not be reached in WCA 3A by 2007 when Phase II controls are implemented. However, it was suggested at the second stakeholder workshop that additional predictions of cattail spread in WCA 3A would be more appropriately based on the rate of spread of cattails in the Holey Land, and not WCA-2A. Comparison of the soil and water conditions of these two areas is underway. If proved more appropriate, these simulations will be run for later evaluations of hydropattern restoration. As with WCA-2A, if the extent of cattails is controlled by fragmentation of existing populations (Wu et al., 1996), the rate of cattail expansion would be expected to be slower than that predicted based on soil P concentrations alone.

Results of the entire evaluation process which incorporate the estimates of cattail expansion and NSM-hydropattern match are summarized in Table 4-3 and are described below.

TABLE 4-3. EAST WCA-3A HYDROPATTERN RESTORATION EVALUATION MATRIX

Evaluation Criteria	Current Plan		No Action		Bypass to S-7 and S-8	
Local (Impact Zone) Benefits/Impacts						
	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term
1.Vegetation communities	-	0	-	-	-	+
2.Animal communities	-	0	-	-	-	+
3. Drainage characteristics	+	+	0	0	0	0
4. Groundwater interaction	+	+	0	0	0	0
5. Water quality	-	0	-	-	-	+
6. Organic soil preservation	+	+	0	0	0	0
Regional (Everglades Protection Area) Benefits/Impacts						
1.Vegetation communities	+	+	-	-	-	-
2. Animal communities	+	+	-	-	-	-
3. Drainage characteristics	+	+	0	0	0	0
4. Groundwater interaction	+	+	0	0	0	0
5. Water quality	+	+	-	+	-	+
6. Organic soil preservation	+	+	-	-	-	-
Other Considerations						
1. Additional cost to implement	No		Deferred Costs		TBD	
2. Additional time to implement	No		No		TBD	

+ Indicates improvement over current conditions; 0 Indicates no measurable change; - Indicates degradation

1. Vegetative Communities -

For the **Current Plan**:

- the **short-term *local* impacts** are negative, reflecting adverse impacts to ecological functions due to 50 ppb of phosphorus that outweigh the positive impact of the improved hydropattern characteristics. See the discussion in Section 2.3 for a description of the general impacts associated with elevated nutrient loadings. It is anticipated that due to the existing dense sawgrass communities downstream of the proposed spreader canal, the extent of cattail growth will be significantly less than that observed downstream of the S-10 structures.
- the **long-term *local* impacts** may well be negligible or positive, depending on how effective cattail management is in retarding the expansion of cattails, and how soon the phosphorus is leached from the soil. It is anticipated that the periphyton community will recover quicker than the macrophyte community.
- the **short-term and long-term *regional* impacts** are positive due to sheetflow benefits and diversion of phosphorus load from the existing point source discharge location.

For the **No Action option**:

- the **short-term and long-term *local* impacts** are negative due to continued phosphorus enrichment at high phosphorus levels.
- both **short-term and long-term *regional* impacts** are negative due to continued degradation as a result of high phosphorus levels and inadequate hydropattern.

For the **Bypass option,**

- the net **short-term *local* impacts** are negligible, reflecting a balance of negative impacts due to continued point source discharge and higher water depths and benefits due to lower phosphorus levels.
- the **long-term *local* impacts** are + due to discharge of the "no-imbalance" phosphorus level.
- the **short-term and long-term *regional* impacts** are negative due to continued degradation in northern WCA 3A without hydropattern restoration.

2. Animal Communities -

For the **Current Plan:**

- the **short-term *local* impacts** are negative, reflecting adverse impacts to ecological functions (particularly reduced quality of habitat) due to 50 ppb of phosphorus that outweigh the positive impact of the improved hydropattern characteristics.
- the **long-term *local* impacts** may well be negligible or positive, depending on how effective cattail management is in removing cattails, and how soon the phosphorus is leached from the soil.
- the **short-term and long-term *regional* impacts** are positive due to sheetflow benefits and diversion of phosphorus load from the existing point source discharge location.

For the **No Action option**:

- the **short-term and long-term *local* impacts** are negative due to continued phosphorus enrichment at high phosphorus levels.
- both **short-term and long-term *regional* impacts** are negative due to continued degradation as a result of high phosphorus levels and inadequate hydropattern.

For the **Bypass option**:

- the net **short-term *local* impacts** are negligible, reflecting a balance of negative impacts due to continued point source discharge and benefits due to lower phosphorus levels.
- the **long-term *local* impacts** are positive due to discharge of the "no-imbalance" phosphorus level.
- the **short-term and long-term *regional* impacts** are negative due to continued degradation.

3. Hydropattern Characteristics -
For the **Current Plan**:

- the **short-term and long-term *local* and *regional* impacts** are positive due to the hydropattern improvement benefits.

For the **No Action option**:

- the **short-term and long-term *local* and *regional* impacts** are negligible due to no change in drainage characteristics.

For the **Bypass option**:

- the **short-term and long-term *local* and *regional* impacts** are negligible due to no change in drainage characteristics.

4. Groundwater Interactions -
For the **Current Plan**,

- the **short-term and long-term *local* and *regional* impacts** are positive due to the hydropattern improvement benefits.

For the **No Action option:**

- the **short-term and long-term *local* and *regional* impacts** are negligible due to no change in drainage characteristics.

For the **Bypass option**:

- the **short-term and long-term *local* and *regional* impacts** are negligible due to no change in drainage characteristics.

5. Water Quality -
For the Current Plan:

- the **short-term *local* impacts are** negative, reflecting adverse impacts to ecological functions due to 50 ppb of phosphorus that outweigh the positive impact of the improved hydropattern characteristics.
- the **long-term *local* impacts** may well be negligible or positive, depending on how effective cattail management is in removing cattails, and how soon the phosphorus is leached from the soil.
- the **short-term and long-term *regional* impacts** are positive due to sheetflow benefits and diversion of phosphorus load from the existing point source discharge location.

For the **No Action option,**
- the **short-term and long-term *local* impacts** are negative due to continued vegetation community degradation due to phosphorus enrichment at high phosphorus levels.
- the **short-term *regional* impacts** are negative due to continued vegetative community degradation as a result of high phosphorus levels and inadequate hydropattern.
- the **long-term *regional* impacts** are positive due to reduced phosphorus, even though there remains an inadequate hydropattern.

For the **Bypass option,**
- the net **short-term *local* impacts** are negligible, reflecting a balance of - due to continued point source discharge and + due to lower phosphorus levels.
- the **long-term *local* impacts** are + due to discharge of the "no-imbalance" phosphorus level.
- the **short-term *regional* impacts** are negative due to continued degradation of the vegetative community which does not receive hydropattern benefits, even though the phosphorus concentrations are reduced.
- the **long-term *regional* impacts** are positive due to the reductions in phosphorus concentrations.

6. Organic Soil Preservation -
For the **Current Plan,**
- the **short-term and long-term *local* and *regional* impacts** are positive due to the hydropattern improvement benefits, particularly sheetflow, greater surface area and water depths.

For the **No Action option,**
- the **short-term and long-term *local* impacts** are negligible due to continuation of the same hydrology.

- **the short-term and long-term *regional* impacts** are negative due to continued degradation as a result of not restoring regional hydropattern.

For the **Bypass option,**
- **the short-term and long-term *local* and *regional* impacts** are negative due to continued degradation as a result of not restoring regional hydropattern.

Summary

Although each alternative has some potential for adverse impact, the evaluation suggests that the **Current Plan** provides the best balance of regional hydropattern benefits against the potential impacts and maximizes the environmental benefits to the Everglades Protection Area.

Section 5. WEST WCA-3A HYDROPATTERN RESTORATION

5.1. Introduction

The **Current Plan** calls for the discharge from STA 6 to be spread along approximately 3 miles of the northwest boundary of WCA 3A (see Figure 5-1). For this alternative, the **local impact zone** is immediately downstream of the spreader canal along the L-4 levee. The estimated range **of extent of impacts** was calculated from the simple relationship between cattail expansion and phosphorus loading observed in WCA 2A and presented below. The **regional area** under consideration is the Everglades Protection Area (EPA) downstream and outside of the impact zone which receives hydropattern benefits and no adverse water quality.

The **No Action** plan would continue the discharge of untreated water through S-8 into the WCA 3A (see Figure 5-2). For this alternative, the **local impact zone** is downstream of G-155 into northwest corner of WCA 3A and the S-8 pump station where the Miami Canal overflows into the marsh (existing locations). Adverse impacts have been observed at the existing discharge locations. The No Action option would exacerbate the present situation by continuing to discharge untreated water, and would result in an incremental area of impact, located immediately downstream of the already degraded area. The extent of adverse impact is calculated to be proportional to the nutrient load over time (see Section 2.3). The **regional area** under consideration is the Everglades Protection Area downstream of the local impact zone and the Rotenberger area. This area includes the northern WCAs which are presently over drained, and will remain over drained under the No Action alternative.

The **Bypass Option** would route treated water to S-8 for discharge into WCA 3A (see Figure 5-3). For this alternative, the **local impact zone** is downstream of G-155 into northwest corner of WCA 3A and the S-8 pump station where the Miami Canal overflows into the marsh (existing locations). Adverse impacts have been observed at the existing discharge locations. The Bypass option would exacerbate the present situation by continuing to discharge water above the "no-imbalance" level, and would result in an incremental area of impact, located immediately downstream of the already degraded area. The extent of adverse impact is calculated to be proportional to the nutrient load over time (see Section 2.3). The **regional area** under consideration is the Everglades Protection Area downstream of the local impact zone and the Rotenberger area. This area includes the northern WCAs which are presently over drained, and will remain over drained under the Bypass alternative.

The local antecedent conditions for each of these alternatives is summarized in Table 5-1.

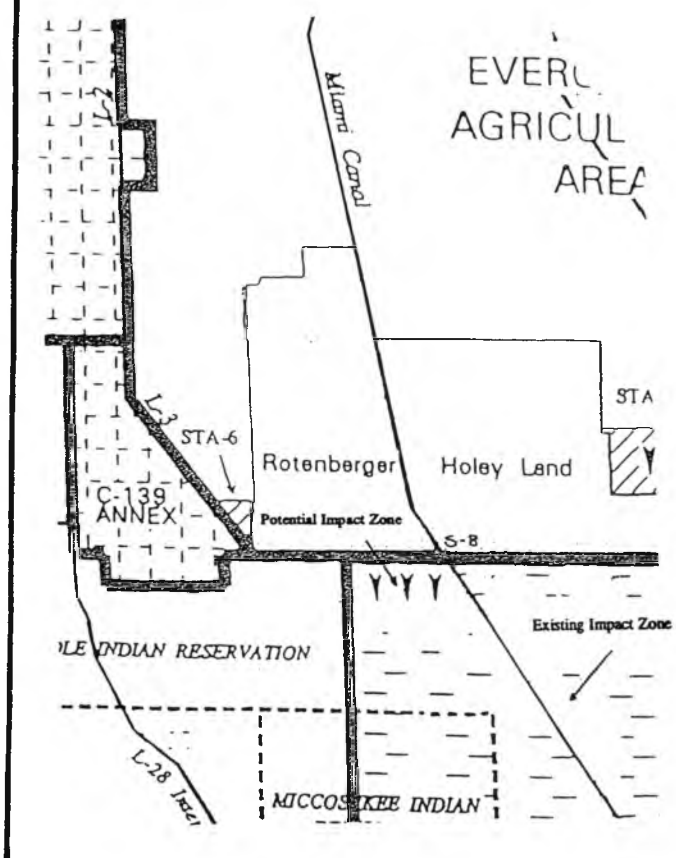


Figure 5-1. West WCA-3A Hydropattern Restoration - Current Plan

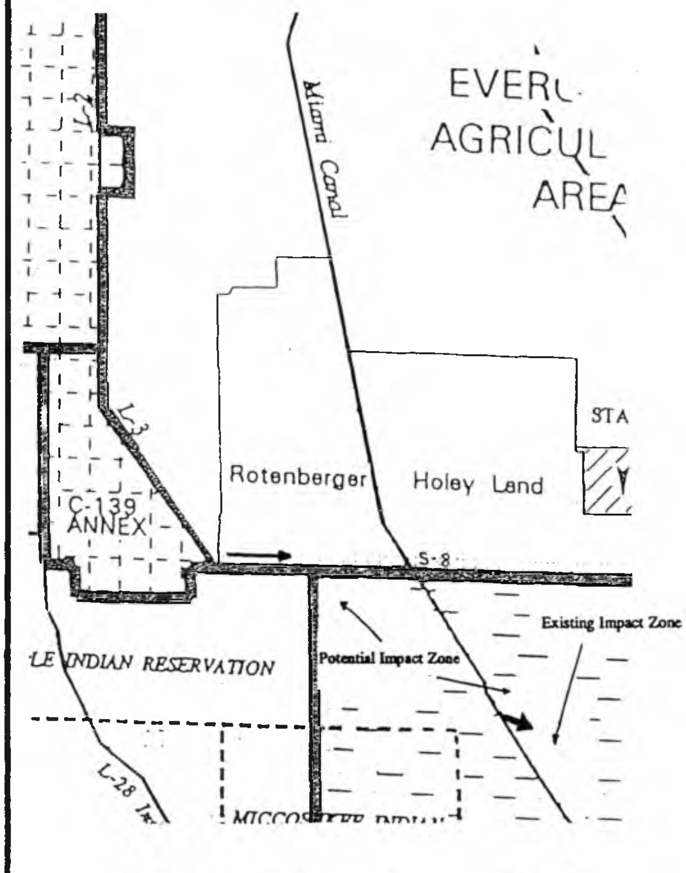


Figure 5-2. West WCA-3A Hydropattern Restoration - No Action Plan

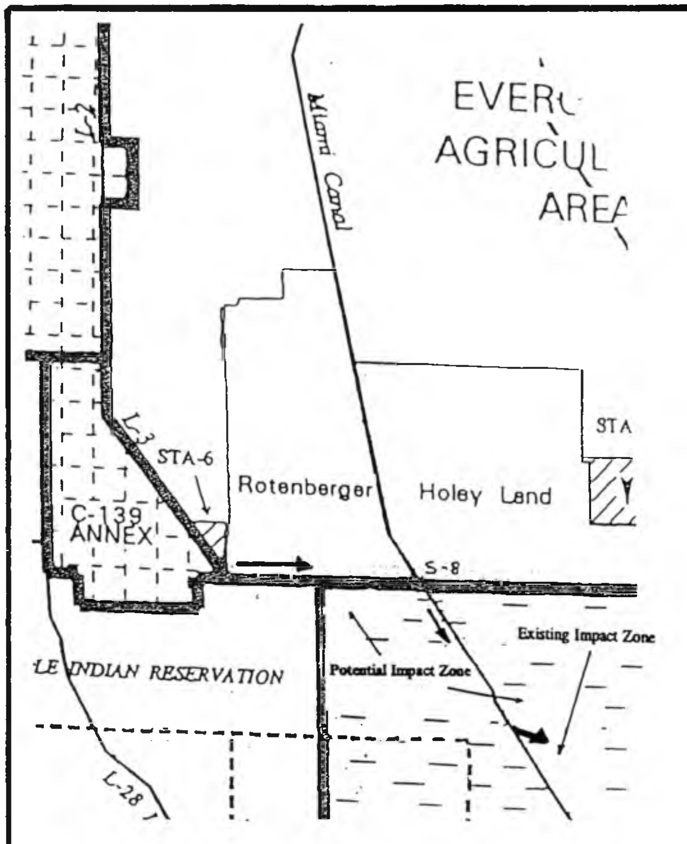


Figure 5-3. West WCA-3A Hydropattern Restoration - Bypass Plan

Table 5-1. West WCA 3A Local Antecedent Conditions

Evaluation Criteria	Current Plan	No Action	Bypass to S-8
1. Soil Phosphorus Level (high, medium, low)	High	High	High
2.Vegetation Communities (types)	Shrubs, Sawgrass	Shrubs, Sawgrass	Cattail
3. Peat/Marl Accretion (positive, subsidence)	Subsidence	Subsidence	Positive

5.2. Anticipated Benefits and Impacts:

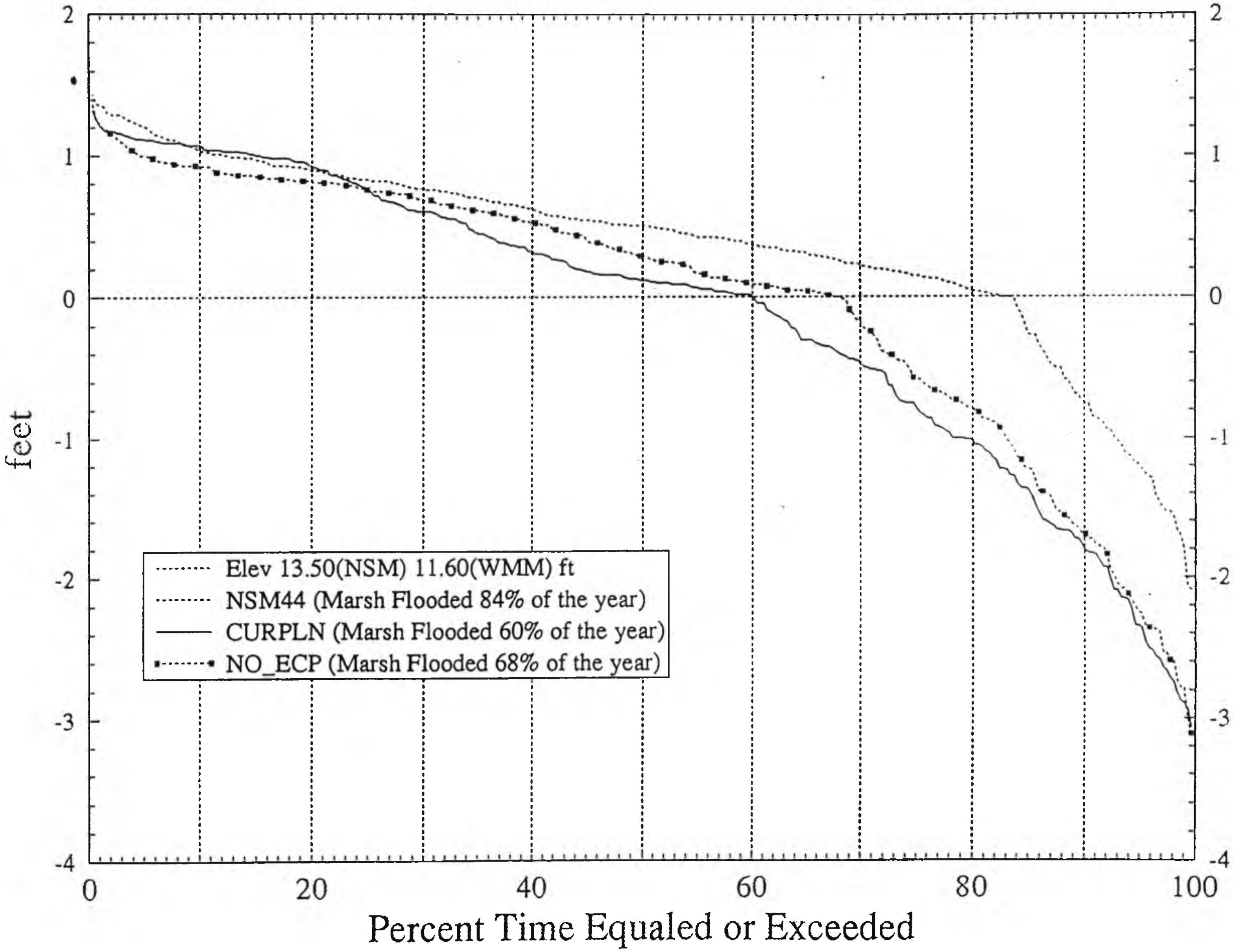
Stage duration curves and stage hydrographs within the northwestern WCA 3A are presented in Figures 5-4 and 5-5. The locations of these results are shown in Figure 2-4 as a triangle within the northwestern WCA 3A. In Figure 5-4, three stage duration curves are shown. The dashed curve represents the percentage of time that the water depth on the left axis is equaled or exceeded in the NSM simulation. The solid line curve represents the percentage of time that the water depth on the left axis is equaled or exceeded in the ECP simulation. The dashed line curve with small squares represents the percentage of time that the water depth on the left axis is equaled or exceeded in the No ECP simulation. The same line definition applies to the stage hydrographs in Figure 5-5.

It is appropriate to concurrently examine the hydropattern effects of both the eastern and western WCA 3A projects on the entire northern WCA 3A system because of the associated structural and operational strategies. In general, the area east of the Miami Canal receives significant areal benefits (approximately 59,000 acres) because of the ECP projects distribute discharges from STA 3/4 that currently go into WCA 2A from S-7, and to central WCA 3A from S-8. In fact, the majority of this acreage (approximately 38,400 acres) overshoots the NSM target, indicating too much water may be discharged in this area. However, at the same time, a worsening of the hydroperiod for approximately 49,000 acres was suggested by the methodology, indicating additional water would be beneficial. The net effect is approximately 10,000 acres of benefits attributable to the ECP projects. These results are shown in Figures 2-6 and Figure 5-6.

The methodology suggests that the current discharge configuration and operational assumptions for STA 3/4 need to be reviewed and possibly revised to improve hydroperiod in WCA 3A, particularly west of the Miami Canal. The Lower East Coast Regional Water Supply planning process has already initiated evaluation of alternative STA discharge configuration to address this situation. The design process for STA 3/4 has the time and flexibility to allow for completion of this planning process to identify the optimal discharge configuration and operational strategies before commencing detail design in 1999-2000.

Cattails. An estimate of the **extent** of adverse impacts was calculated from the simple relationship between phosphorus loading and observed cattail expansion derived in Section 2.3, and is summarized in Table 5-2

Normalized Stage Duration Curves at R41 C17
Downstream of STA-5&6



Note: Normalized stage is stage referenced to Land Elevation. Thus, values above zero indicates ponding while below zero indicates depth to the water table.

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Environmental, Level II, WCA
SFWMM Simulation

FIGURE 5-4

Normalized Stage Hydrograph at R41 C17
Downstream of STA-5&6

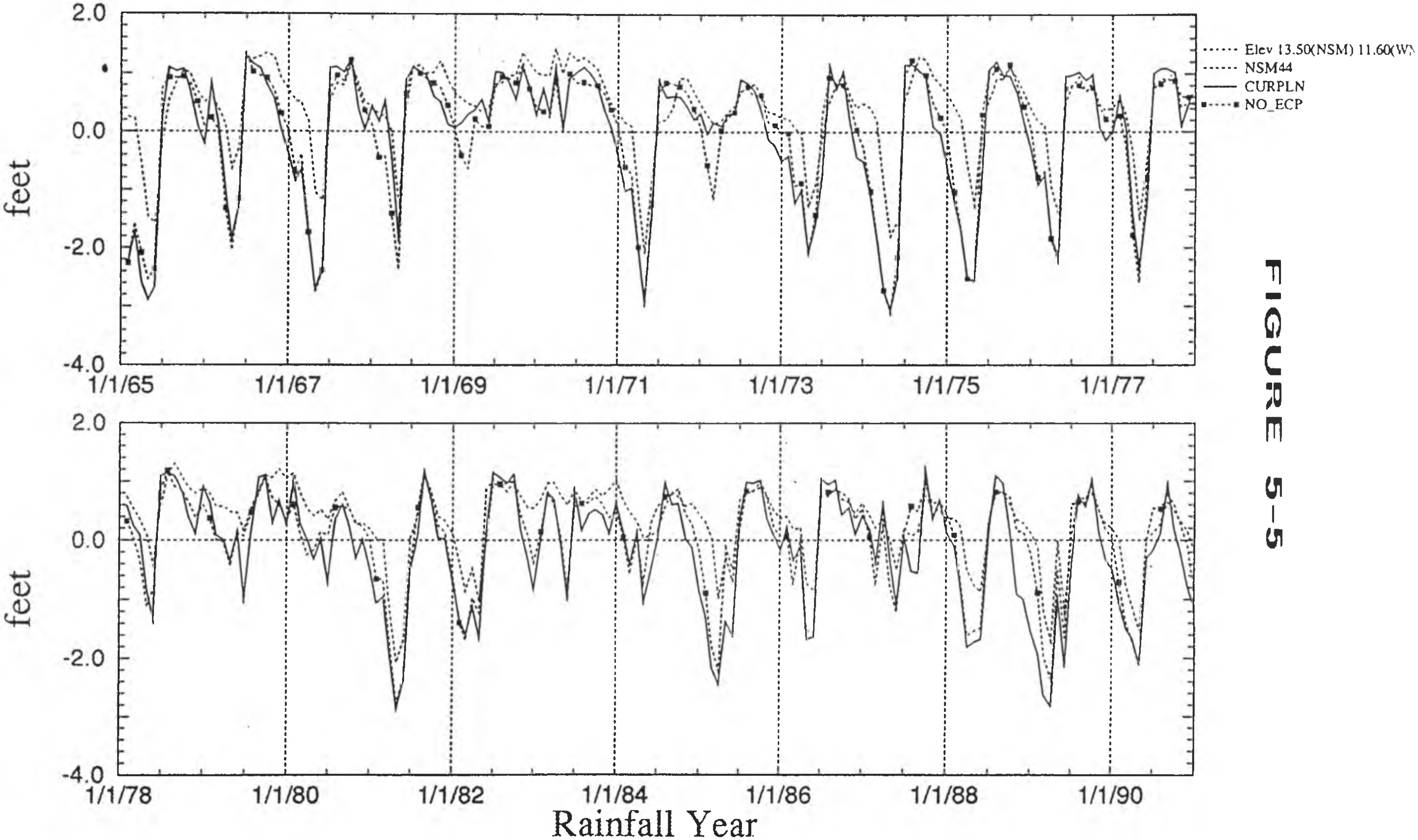

FIGURE 5-5

Note: Normalized stage is stage referenced to Land Elevation. Thus, values above zero indicates ponding while below zero indicates depth to the water table.

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Environmental, Level II, WCA
SFWMM Simulation

Hydroperiod Improvement Relative to No Action (NOECP) for WCA-3A North (204800 acres) over the 26 yr. simulation

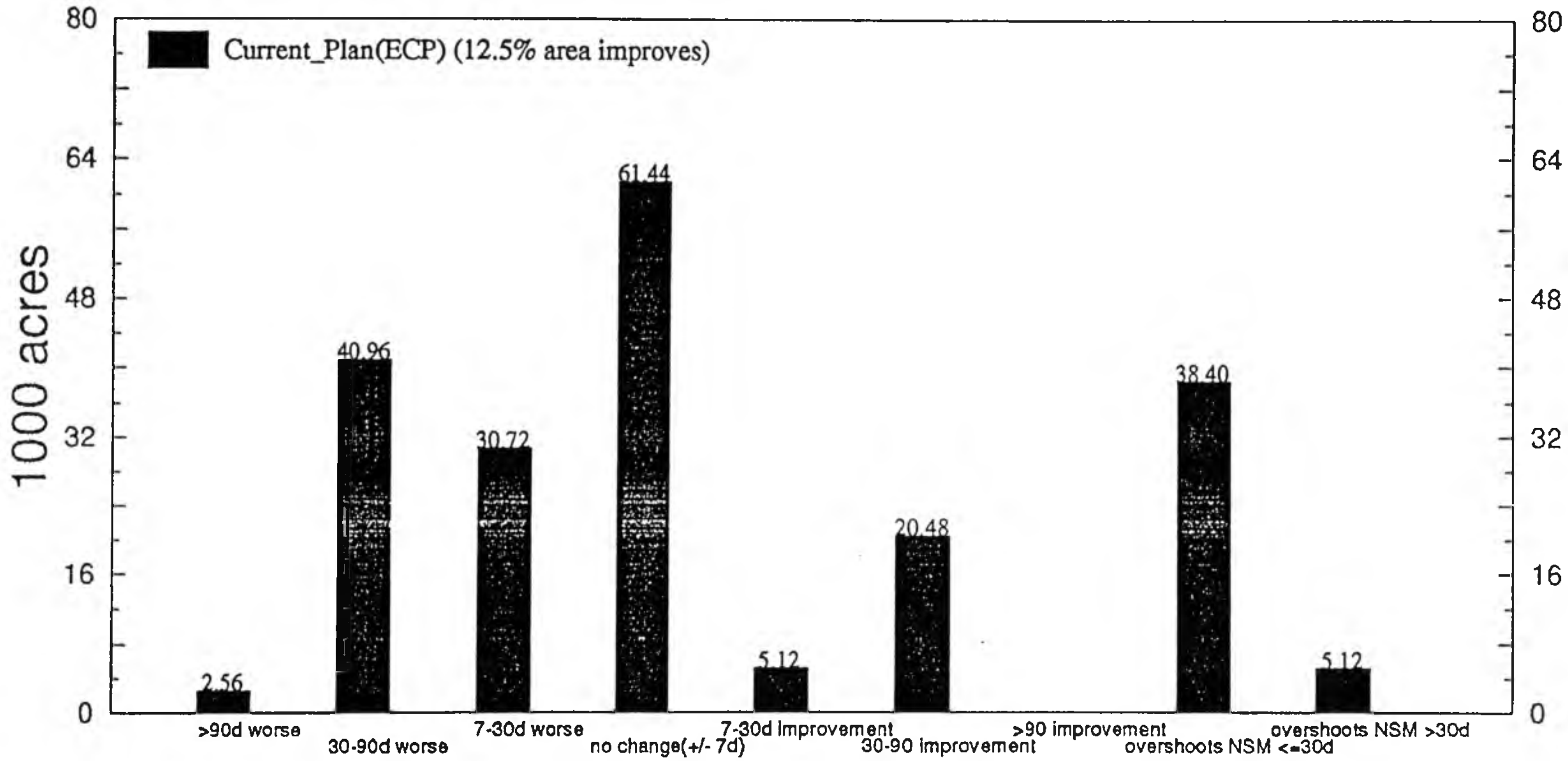

FIGURE 5-6

Note: NSM=Natural System Model; BASE=Baseline for measuring improvement (e.g. 2010-Base); ALT=Alternative to compare with BASE

'Improvement' means the mean annual hydroperiod resulting from the alternative is 'moving in the right direction'. For example if the hydroperiod for ALT is longer than that of the BASE, and is getting closer to that of the NSM, the hydroperiod of ALT is said to improve.

'Worse' means that the hydroperiod resulting from ALT is 'moving in the wrong direction'. For example, if the hydroperiod for ALT is shorter than that of the BASE, and is getting farther from the NSM, then the hydroperiod is said to get worse.

'Overshoots' means the hydroperiod resulting from ALT is 'moving toward the NSM', but goes past the NSM hydroperiod. For e.g., if the respective hydroperiods of the BASE=270, the NSM=310, and the ALT=350, then the ALT hydroperiod is said to overshoot the NSM hydroperiod.

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SFWMM Simulation

for each of the alternatives evaluated. For the No Action and Bypass options, the acreage estimated is **in addition to** any existing areas impacted by elevated nutrient conditions.

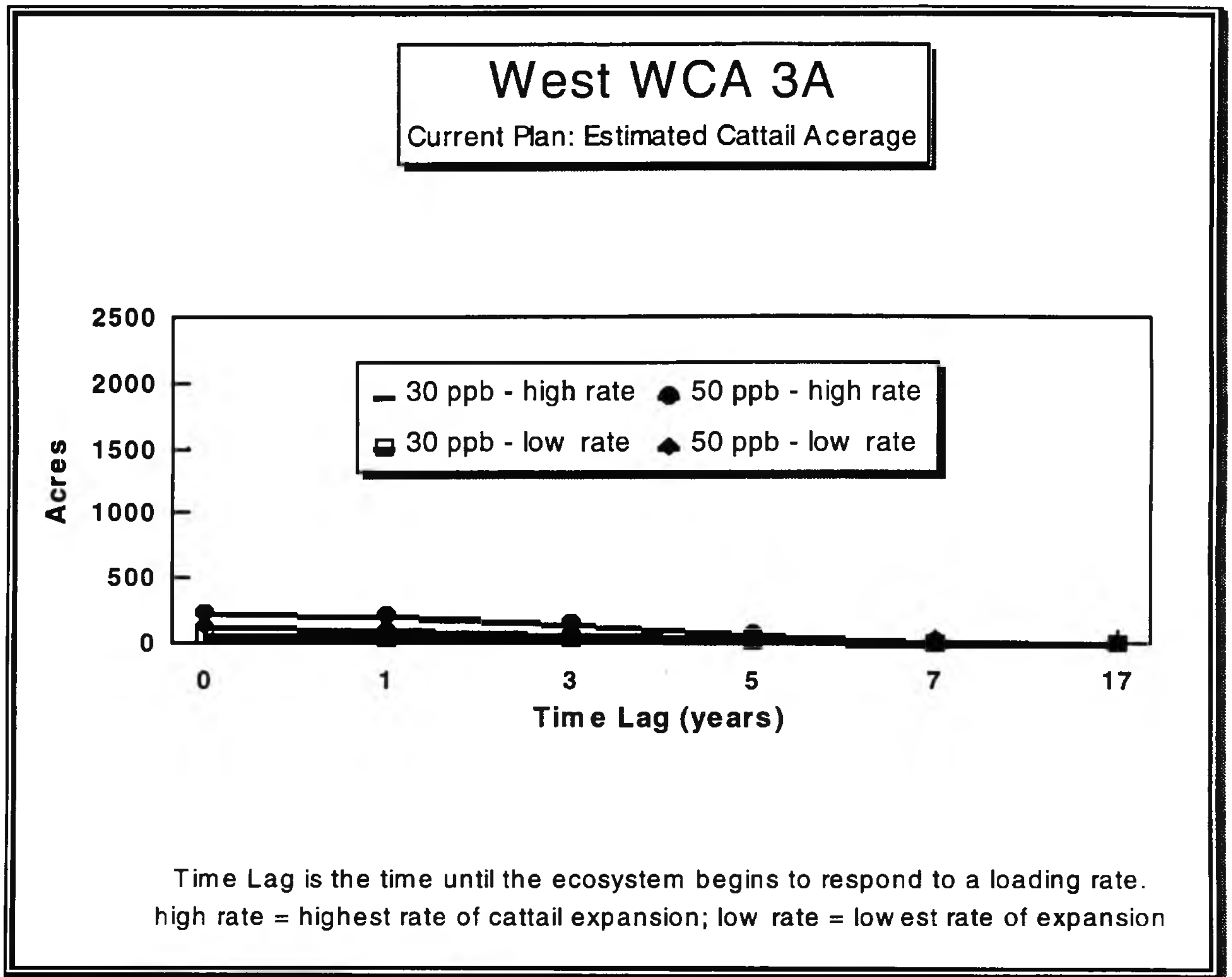
Table 5-2. West WCA 3A Hydropattern Restoration Project - Estimates of Impacts (acres)

	Current Plan		No Action		Bypass to S-8	
With 50 ppb discharge from STAs						
Average Annual Load (metric tons per year)	1.7		7.4		1.7	
	Low Rate	High Rate	Low Rate	High Rate	Low Rate	High Rate
Estimate of cattail acreage						
Zero time lag	86	235	375	1024	86	235
1-yr time lag	75	206	328	896	75	206
3-yr time lag	54	147	234	640	54	147
5-yr time lag	32	88	141	384	32	88
7-yr time lag	11	29	47	128	11	29
17-yr time lag	0	0	0	0	0	0
With 30 ppb discharge from STAs						
Average Annual Load (metric tons per year)	1.0		4.4		1.0	
	Low Rate	High Rate	Low Rate	High Rate	Low Rate	High Rate
Estimate of cattail acreage						
Zero time lag	52	141	225	614	52	141
1-yr time lag	45	124	197	538	45	124
3-yr time lag	32	88	141	384	32	88
5-yr time lag	19	53	84	230	19	53
7-yr time lag	6	18	28	77	6	18
17-yr time lag	0	0	0	0	0	0

Note: Actual impacts may be lower with implementation of active management practices. Impacts from the No Action and Bypass options would occur downstream of their discharge points. Impacts are **cumulative** impacts through the year 2006.

Results of the potential cattail expansion calculations are presented in Table 5-2 and Figure 5-7. For the 50 ppb discharge scenario and using the Low Rate relationship between phosphorus loading and cattail expansion, estimates of potential cattail expansion for the Current Plan range from 0 acres for the Best Case (17-yr time lag) to 86 acres for the Worst Case (instantaneous or zero time lag). For the same scenario, estimates of potential cattail expansion for the No Action alternative range from 0 acres for the Best Case (17-yr time lag) to 375 acres for the Worst Case (zero time lag); this Worst Case estimate represents an increase of 289 acres (336%) over the Current Plan. The estimates of potential cattail expansion for the Bypass options range from 0 acres for the Best Case (17-yr time lag) to 86 acres for the Worst Case (zero time lag), which was the same as the Current Plan. In light of the antecedent conditions downstream of the hydropattern project, and the importance of the time lag before impacts occur, District staff best professional judgement suggests that the Best Case is the more likely scenario.

Fig. 5-7 Influence of Time Lag on Estimate of Potential Cattail Impact in West WCA 3A



Using an alternate modeling methodology presented by one of the stakeholders (Walker, pers. comm.), the time required to exceed the most conservative soil P criterion for initiation of cattail expansion (10 cm soil depth and 610 mg/Kg) or the soil P criterion which best reproduced the initial 20-year cattail expansion in WCA-2A (20 cm depth and 720 mg/kg) would not be reached in WCA 3A by 2007 when Phase II controls are implemented. In addition, if the extent of cattails is controlled by fragmentation of existing populations (Wu et al., 1996), the rate of cattail expansion would be expected to be slower than that predicted based on soil P concentrations alone.

Results of the entire evaluation process which incorporate the estimates of cattail expansion and NSM-hydropattern match are summarized in Table 5-3 and are described below.

TABLE 5-3. WEST WCA 3A HYDROPATTERN RESTORATION EVALUATION MATRIX

Evaluation Criteria	Current Plan		No Action		Bypass to S-8	
Local (Impact Zone) Benefits/Impacts						
	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term
1.Vegetation communities	-	0	-	-	-	-
2.Animal communities	-	0	-	-	-	-
3. Drainage characteristics	+	+	0	0	0	0
4. Groundwater interaction	+	+	0	0	0	0
5. Water quality	-	0	-	-	-	+
6. Organic soil preservation	+	+	0	0	0	0
Regional (Everglades Protection Area) Benefits/Impacts						
1.Vegetation communities	+	+	-	-	-	-
2. Animal communities	+	+	-	-	-	-
3. Drainage characteristics	+	+	0	0	0	0
4. Groundwater interaction	+	+	0	0	0	0
5. Water quality	+	+	-	+	-	+
6. Organic soil preservation	+	+	-	-	-	-
Other Considerations						
1. Additional cost to implement	No		Deferred Costs		$4.3 Million	
2. Additional time to implement	No		No		TBD	

+ Indicates improvement over current conditions; 0 Indicates no measurable change; - Indicates degradation

1. Vegetative Communities -

For the **Current Plan**:

- the **short-term *local* impacts** are negative, reflecting adverse impacts to ecological functions due to 50 ppb of phosphorus that outweigh the positive impact of the improved hydropattern characteristics. See the discussion in Section 2.3 for a description of the general impacts associated with elevated nutrient loadings. It is anticipated that due to the existing dense sawgrass communities downstream of the proposed spreader canal, the extent of cattail growth will be significantly less than that observed downstream of the S-10 structures.
- the **long-term *local* impacts** may well be negligible or positive, depending on how effective cattail management is in retarding the expansion of cattails, and how soon the phosphorus is leached from the soil. It is anticipated that the periphyton community will recover quicker than the macrophyte community.
- the **short-term and long-term *regional* impacts** are positive due to sheetflow benefits and diversion of phosphorus load from the existing point source discharge location.

For the **No Action option**:

- the **short-term and long-term *local* impacts** are negative due to continued phosphorus enrichment at high phosphorus levels.
- both **short-term and long-term *regional* impacts** are negative due to continued degradation as a result of high phosphorus levels and inadequate hydropattern.

For the **Bypass option,**

- the net **short-term *local* impacts** are negligible, reflecting a balance of negative impacts due to continued point source discharge and higher water depths and benefits due to lower phosphorus levels.
- the **long-term *local* impacts** are + due to discharge of the "no-imbalance" phosphorus level.
- the **short-term and long-term *regional* impacts** are negative due to continued degradation in northern WCA 3A without hydropattern restoration.

2. Animal Communities -

For the **Current Plan:**

- the **short-term *local* impacts** are negative, reflecting adverse impacts to ecological functions (particularly reduced quality of habitat) due to 50 ppb of phosphorus that outweigh the positive impact of the improved hydropattern characteristics.
- the **long-term *local* impacts** may well be negligible or positive, depending on how effective cattail management is in removing cattails, and how soon the phosphorus is leached from the soil.
- the **short-term and long-term *regional* impacts** are positive due to sheetflow benefits and diversion of phosphorus load from the existing point source discharge location.

For the **No Action option**:

- the **short-term and long-term *local* impacts** are negative due to continued phosphorus enrichment at high phosphorus levels.
- both **short-term and long-term *regional* impacts** are negative due to continued degradation as a result of high phosphorus levels and inadequate hydropattern.

For the **Bypass option**:
- the net **short-term *local* impacts** are negligible, reflecting a balance of negative impacts due to continued point source discharge and benefits due to lower phosphorus levels.
- the **long-term *local* impacts** are positive due to discharge of the "no-imbalance" phosphorus level.
- the **short-term and long-term *regional* impacts** are negative due to continued degradation.

3. Hydropattern Characteristics -
For the **Current Plan**:
- the **short-term and long-term *local* and *regional* impacts** are positive due to the hydropattern improvement benefits.

For the **No Action option**:
- the **short-term and long-term *local* and *regional* impacts** are negligible due to no change in drainage characteristics.

For the **Bypass option**:
- the **short-term and long-term *local* and *regional* impacts** are negligible due to no change in drainage characteristics.

4. Groundwater Interactions -
For the **Current Plan,**
- the **short-term and long-term *local* and *regional* impacts** are positive due to the hydropattern improvement benefits.

For the **No Action option:**
- the **short-term and long-term *local* and *regional* impacts** are negligible due to no change in drainage characteristics.

For the **Bypass option:**
- the **short-term and long-term *local* and *regional* impacts** are negligible due to no change in drainage characteristics.

5. Water Quality -
For the **Current Plan:**
- the **short-term *local* impacts** are negative, reflecting adverse impacts to ecological functions due to 50 ppb of phosphorus that outweigh the positive impact of the improved hydropattern characteristics.
- the **long-term *local* impacts** may well be negligible or positive, depending on how effective cattail management is in removing cattails, and how soon the phosphorus is leached from the soil.
- the **short-term and long-term *regional* impacts** are positive due to sheetflow benefits and diversion of phosphorus load from the existing point source discharge location.

For the **No Action option,**

- the **short-term and long-term *local* impacts** are negative due to continued vegetation community degradation due to phosphorus enrichment at high phosphorus levels.
- both **short-term and long-term *regional* impacts** are negative due to continued vegetative community degradation as a result of high phosphorus levels and inadequate hydropattern.

For the **Bypass option,**

- the net **short-term *local* impacts** are negligible, reflecting a balance of - due to continued point source discharge and + due to lower phosphorus levels.
- the **long-term *local* impacts** are + due to discharge of the "no-imbalance" phosphorus level.
- the**short-term *regional* impacts** are negative due to continued degradation of the vegetative community which does not receive hydropattern benefits, even though the phosphorus concentrations are reduced.
- the **long-term *regional* impacts** are positive due to the reductions in phosphorus concentrations.

6. Organic Soil Preservation -

For the **Current Plan,**

- the **short-term and long-term *local* and *regional* impacts** are positive due to the hydropattern improvement benefits, particularly sheetflow, greater surface area and water depths.

For the **No Action option,**

- the**short-term and long-term *local* and *regional* impacts** are negative due to continued degradation as a result of not restoring regional hydropattern.

For the **Bypass option,**

- the**short-term and long-term *local* and *regional* impacts** are negative due to continued degradation as a result of not restoring regional hydropattern.

Summary

Although each alternative has some potential for adverse impact, the evaluation suggests that the **Current Plan** provides the best balance of regional hydropattern benefits against the potential impacts and maximizes the environmental benefits to the Everglades Protection Area.

Section 6. ROTENBERGER HYDROPATTERN RESTORATION

6.1. Introduction

The **Current Plan** calls for the discharge from STA 5 to be split - approximately 49% will be discharged to the Rotenberger Wildlife Management Area and spread along approximately 2 miles of the northwest boundary; the balance of the discharge from STA 5 will be routed around the north end of the Rotenberger area and ultimately discharged to the Miami Canal (see Figure 6-1). For this alternative, the **local impact zone** is immediately downstream of the spreader canal within the Rotenberger area. The estimated range of **extent of impacts** was calculated from the simple relationship between cattail expansion and phosphorus loading observed in WCA 2A and presented below. The **regional area** under consideration is the Everglades Protection Area (EPA) and Rotenberger area downstream and outside of the impact zone which receives hydropattern benefits and no adverse water quality.

The **No Action** plan would continue the discharge of untreated water through the L-3 canal into the WCA 3A (see Figure 6-2). For this alternative, the **local impact zone** is downstream of G-155 into northwest corner of WCA 3A (existing location). Adverse impacts have been observed at the existing discharge locations. The No Action option would exacerbate the present situation by continuing to discharge untreated water, and would result in an incremental area of impact, located immediately downstream of the already degraded area. The extent of adverse impact is calculated to be proportional to the nutrient load over time (see Section 2.3). The **regional area** under consideration is the Everglades Protection Area and the Rotenberger area downstream of the local impact zone. This area includes the northern WCAs and the Rotenberger area which are presently over drained, and will remain over drained under the No Action alternative.

The **Bypass Option** would route treated water to the Miami Canal and on to S-8 for discharge into WCA 3A (see Figure 6-3). For this alternative, the **local impact zone** is downstream of the S-8 pump station where the Miami Canal overflows into the marsh. Adverse impacts have been observed at the existing Miami Canal overflow locations. The Bypass option would exacerbate the present situation by continuing to discharge water above the "no-imbalance" level, and would result in an incremental area of impact, located immediately downstream of the already degraded area. The extent of adverse impact is calculated to be proportional to the nutrient load over time (see Section 2.3). The **regional area** under consideration is the Everglades Protection Area and the Rotenberger area downstream of the local impact zone. This area includes the northern WCAs and the Rotenberger area which are presently over drained, and will remain over drained under the Bypass alternative.

The local antecedent conditions for each of these alternatives is summarized in Table 6-1.

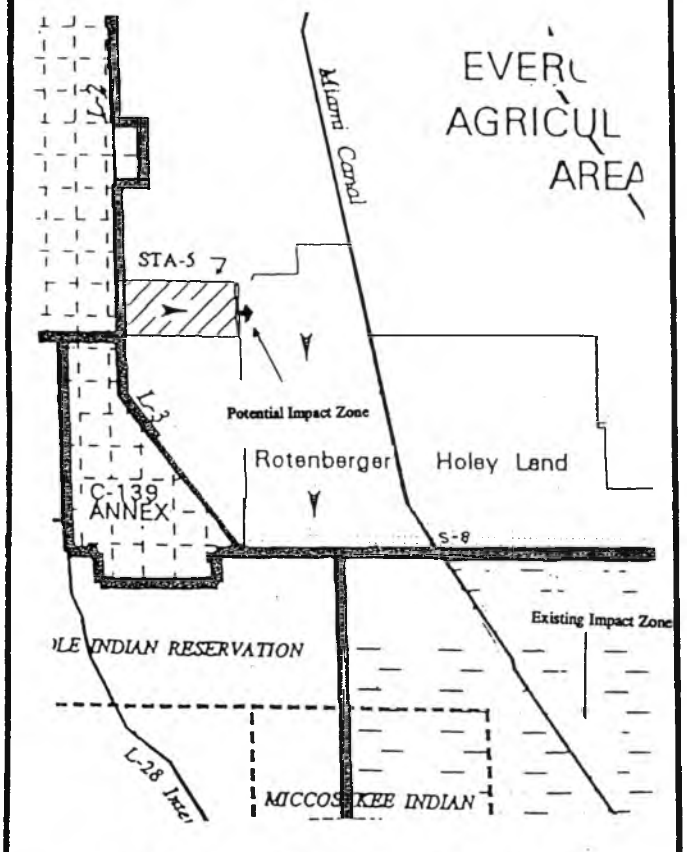


Figure 6-1. Rotenberger Hydropattern Restoration - Current Plan

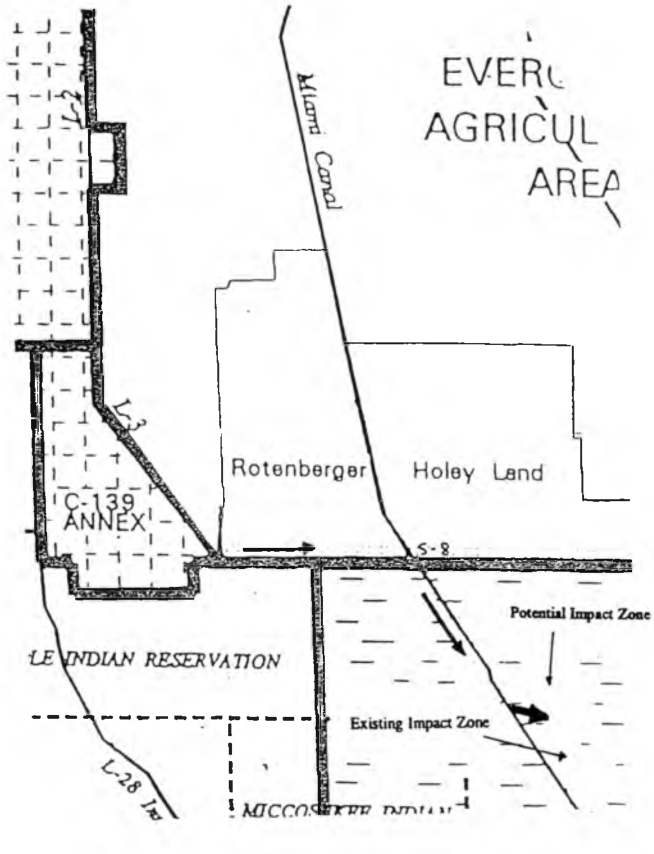


Figure 6-2. Rotenberger Hydropattern Restoration - No Action Plan

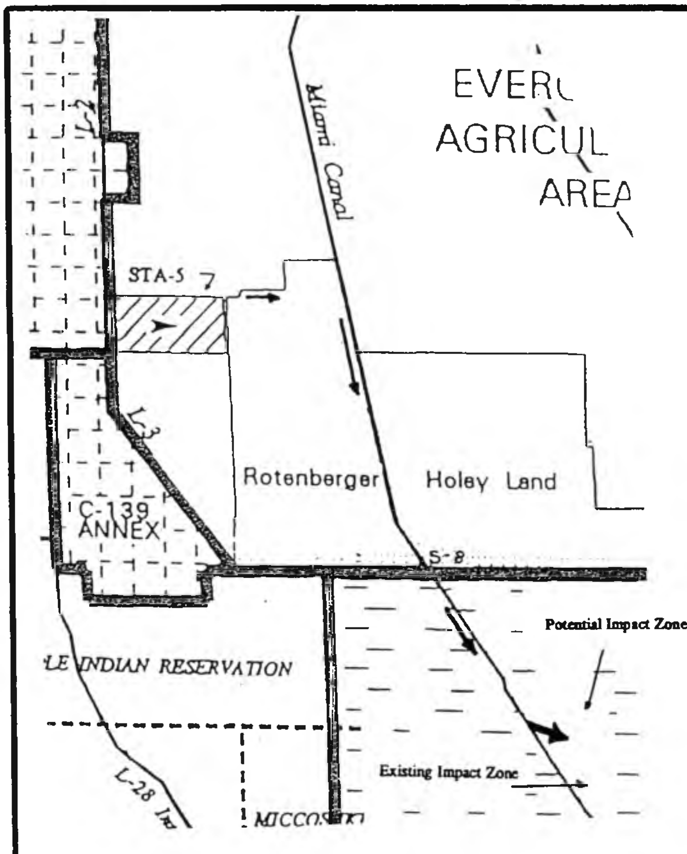


Figure 6-3. Rotenberger Hydropattern Restoration - Bypass Plan

Table 6-1. Rotenberger Local Antecedent Conditions

Evaluation Criteria	Current Plan	No Action	Bypass to S-8
1. Soil Phosphorus Level (high, medium, low)	High	High	High
2. Vegetation Communities (types)	Sawgrass & Grass	Sawgrass & Grass	Cattail
3. Peat/Marl Accretion (positive, subsidence)	Subsidence	Subsidence	Positive

6.2. Anticipated Benefits and Impacts:

Stage duration curves and stage hydrographs within the Rotenberger WMA are presented in Figures 6-4 and 6-5. The locations of these results are shown in Figure 2-4 as a triangle within the Rotenberger WMA. In Figure 6-4, three stage duration curves are shown. The dashed curve represents the percentage of time that the water depth on the left axis is equaled or exceeded in the NSM simulation. The solid line curve represents the percentage of time that the water depth on the left axis is equaled or exceeded in the ECP simulation. The dashed line curve with small squares represents the percentage of time that the water depth on the left axis is equaled or exceeded in the No ECP simulation. The same line definition applies to the stage hydrographs in Figure 6-5.

Over the course of 10 months, the District convened multiple public meetings to gather input and address concerns regarding the proper timing and volumes of water from STA 5 to be discharged to the Rotenberger WMA to achieve the desired hydropattern benefits. The Current Plan reflects the results of these efforts, and includes a preliminary operational schedule for the Rotenberger WMA of 0-1 foot. The results of the hydroperiod benefits evaluation reaffirm that positive characteristics of the Current Plan, identifying benefits to 100 percent of the area (approximately 28,000 acres) when compared to the No ECP simulation. These results are shown in Figures 2-6 and 6-6.

Cattail. An estimate of the extent of adverse impacts was calculated from the simple relationship between phosphorus loading and observed cattail expansion derived in Section 2.3, and is summarized in Table 6-2 for each of the alternatives evaluated. For the No Action and Bypass options, the acreage estimated is **in addition to** any existing areas impacted by elevated nutrient conditions.

Table 6-2. Rotenberger Hydropattern Restoration Project - Estimates of Impacts (acres)

	Current Plan		No Action		Bypass to S-8	
With 50 ppb discharge from STAs						
Average Annual Load (metric tons per year)	2.9		20.3		3.9	
	Low Rate	High Rate	Low Rate	High Rate	Low Rate	High Rate
Estimate of cattail acreage						
Zero time lag	147	401	1028	2810	197	540
1-yr time lag	128	351	899	2458	173	472
3-yr time lag	92	251	642	1756	123	337
5-yr time lag	55	151	385	1054	74	202
7-yr time lag	18	50	128	351	25	67
17-yr time lag	0	0	0	0	0	0
With 30 ppb discharge from STAs						
Average Annual Load (metric tons per year)	1.7		20		4	
	Low Rate	High Rate	Low Rate	High Rate	Low Rate	High Rate
Estimate of cattail acreage						
Zero time lag	88	241	617	1686	118	324
1-yr time lag	77	211	540	1475	104	283
3-yr time lag	55	151	385	1054	74	202
5-yr time lag	33	90	231	632	44	121
7-yr time lag	11	30	77	211	15	40
17-yr time lag	0	0	0	0	0	0

Note: Actual impacts may be lower with implementation of active management practices. Impacts from the No Action and Bypass options would occur downstream of their discharge points. Impacts are cumulative impacts through the year 2006.

Results of the potential cattail expansion calculations are presented in Table 6-2 and Figure 6-7. For the 50 ppb discharge scenario and using the Low Rate relationship between phosphorus loading and cattail expansion, estimates of potential cattail expansion for the Current Plan range from 0 acres for the Best Case (17-yr time lag) to 147 acres for the Worst Case (instantaneous or zero time lag). For the same scenario, estimates of potential cattail expansion for the No Action alternative range from 0 acres for the Best Case (17-yr time lag) to 1028 acres for the Worst Case (zero time lag); this Worst Case estimate represents an increase of 881 acres (599%) over the Current Plan. The Bypass option results in increased loads to the Everglades Protection Area compared to the Current Plan due to the additional treatment provided by the Rotenberger under the Current Plan. The estimates of potential cattail expansion for the Bypass options range from 0 acres for the Best Case (17-yr time lag) to 197 acres for the Worst Case (zero time lag); this Worst Case estimate represents an increase of 50 acres (34%) over the Current Plan. In light of the antecedent conditions downstream of the hydropattern project, and the importance of the time lag before impacts occur, District staff best professional judgement suggests that the Best Case is the more likely scenario.

Normalized Stage Hydrographs at Rotenberger
(average of Cells R43 C16 & R46 C15)

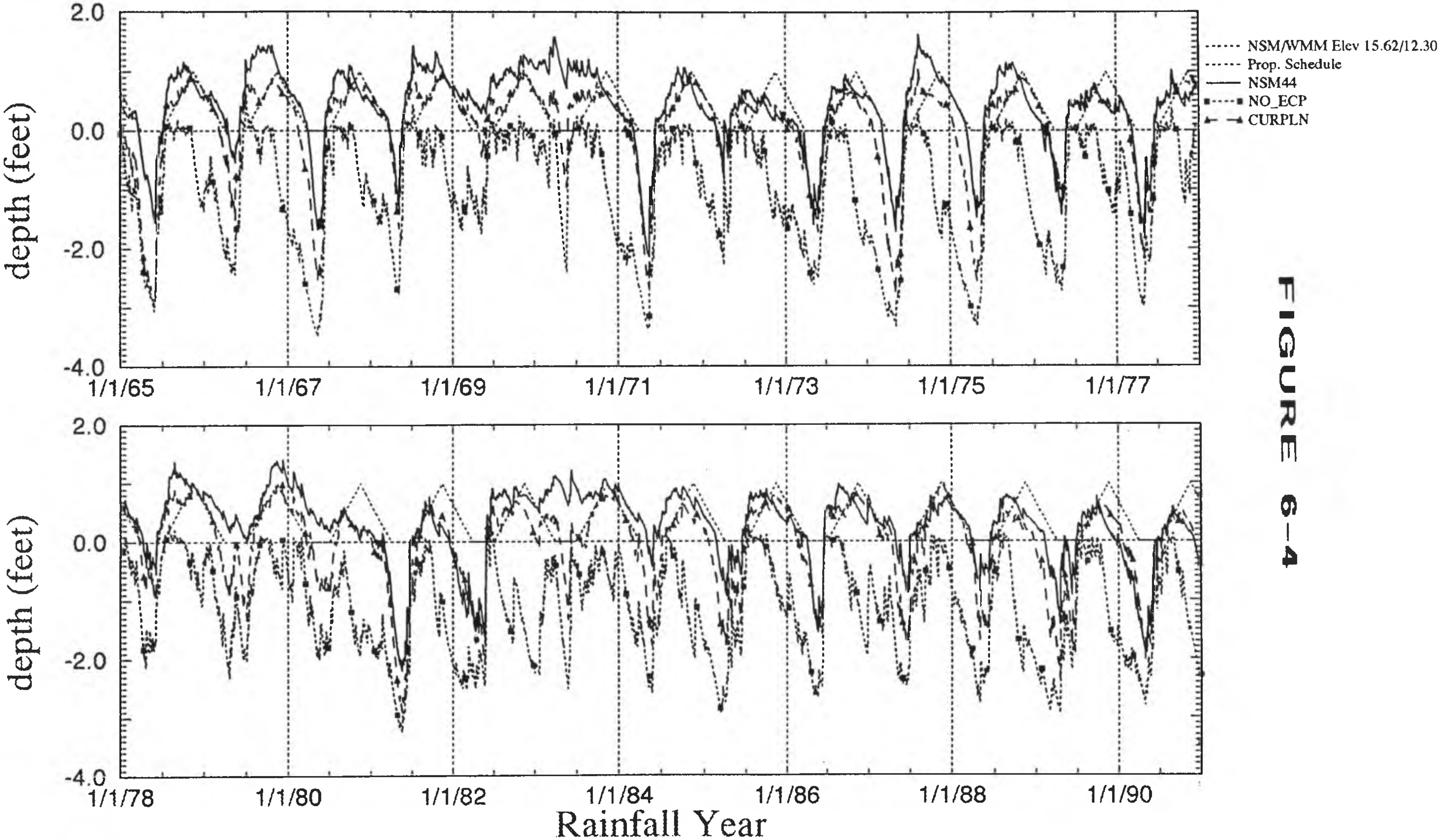


FIGURE 6-4

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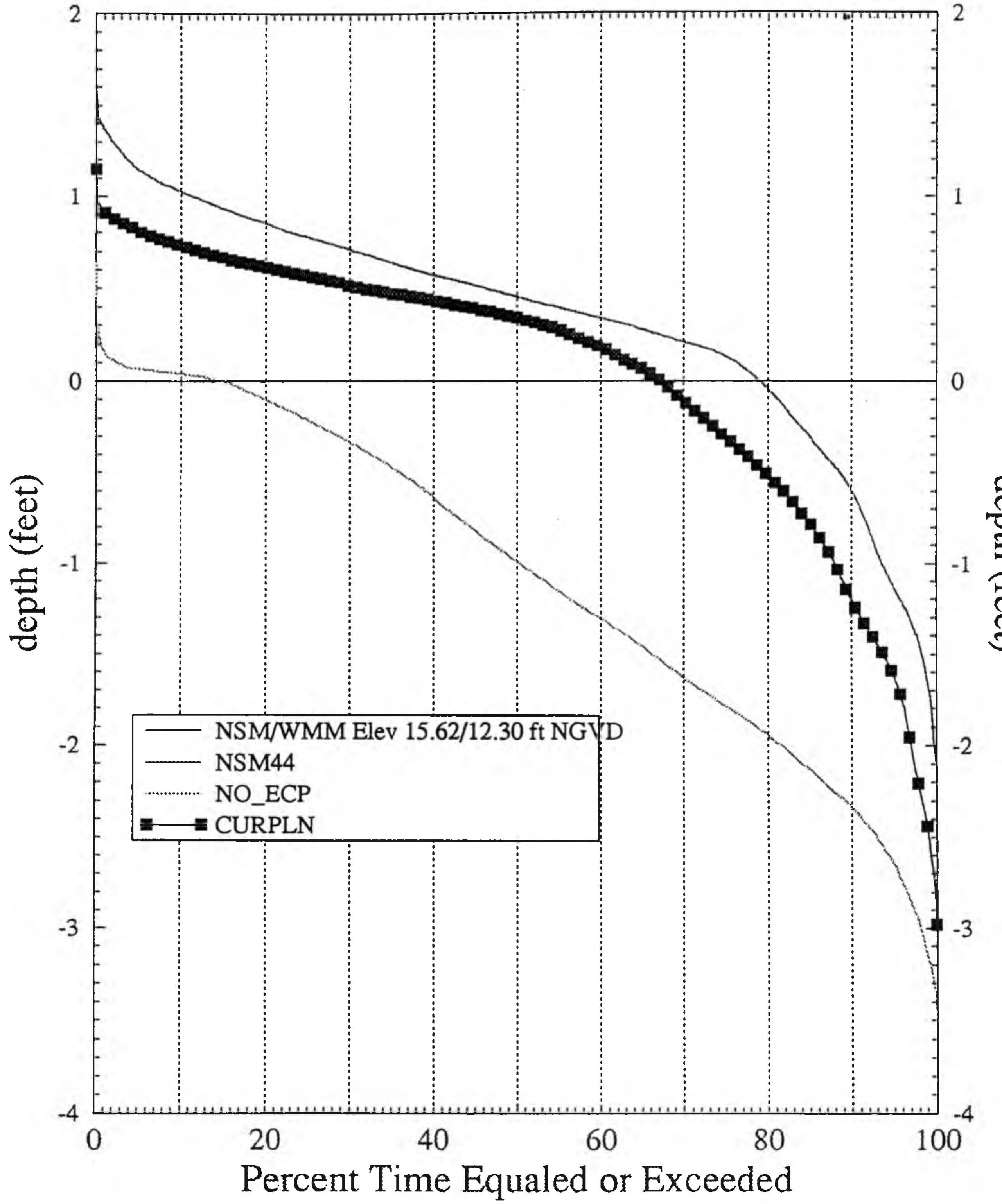
SFWMM Simulation

FIGURE 6-5

Normalized Stage Duration Curves at Rotenberger (avg of Cells R46 C15 & R43 C16)



Hydroperiod Improvement Relative to No Action (NOECP) for ROTENBERGER (33280 acres) over the 26 yr. simulation

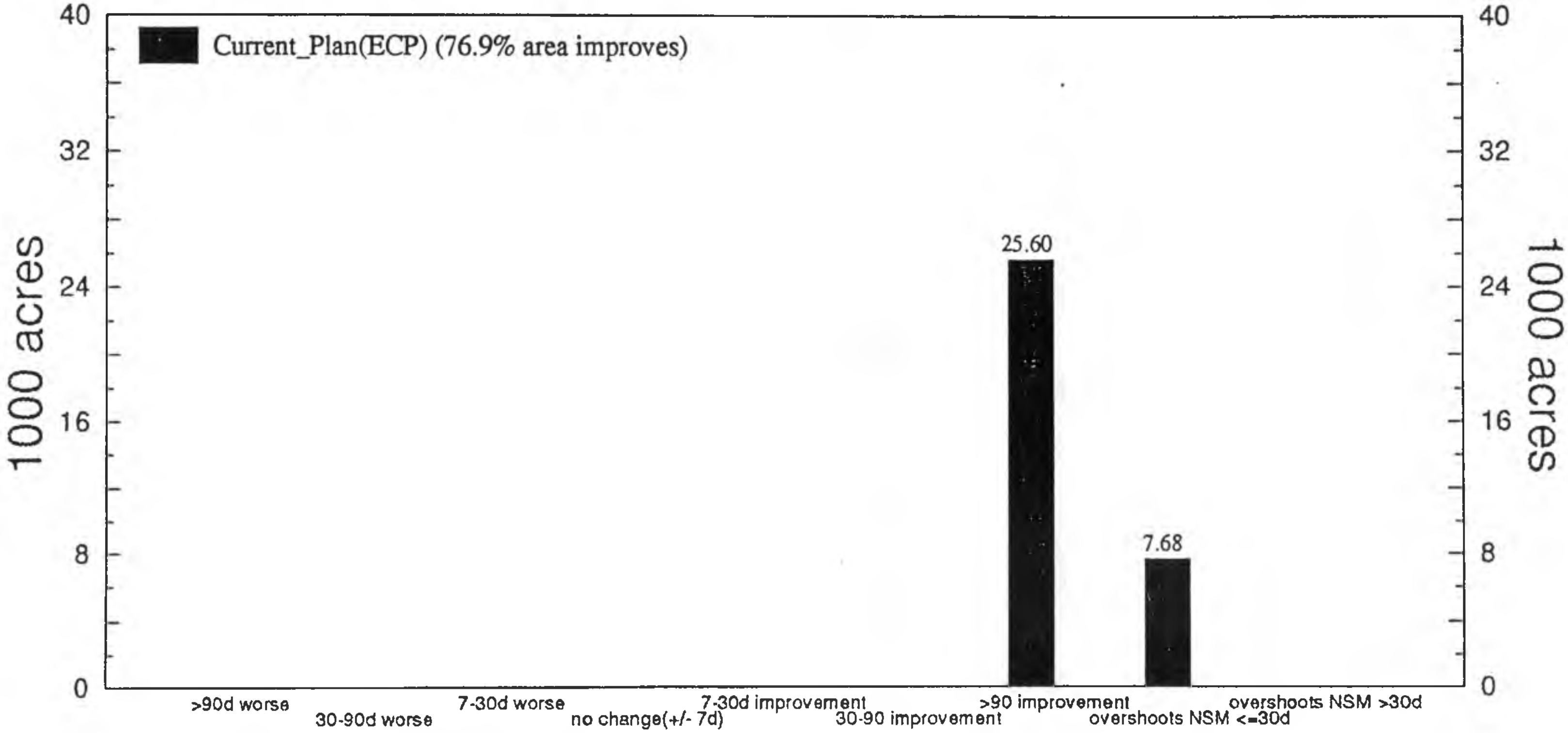


FIGURE 6-6

Note: NSM=Natural System Model; BASE=Baseline for measuring improvement (e.g. 2010-Base); ALT=Alternative to compare with BASE

'Improvement' means the mean annual hydroperiod resulting from the alternative is 'moving in the right direction'. For example if the hydroperiod for ALT is longer than that of the BASE, and is getting closer to that of the NSM, the hydroperiod of ALT is said to improve.

'Worse' means that the hydroperiod resulting from ALT is 'moving in the wrong direction'. For example, if the hydroperiod for ALT is shorter than that of the BASE, and is getting farther from the NSM, then the hydroperiod is said to get worse.

'Overshoots' means the hydroperiod resulting from ALT is 'moving toward the NSM', but goes past the NSM hydroperiod. For e.g., if the respective hydroperiods of the BASE=270, the NSM=310, and the ALT=350, then the ALT hydroperiod is said to overshoot the NSM hydroperiod.

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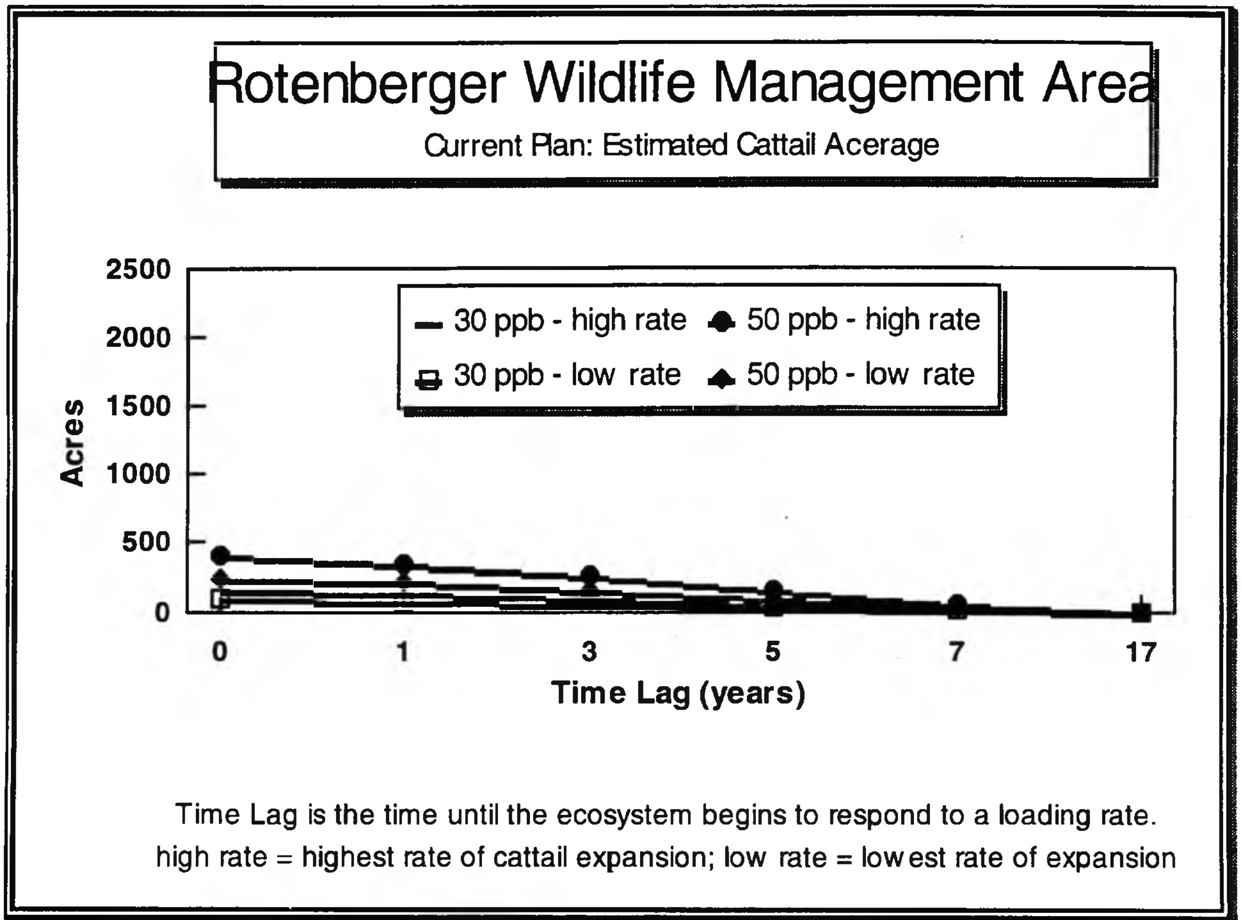
SFWMM Simulation

Fig. 6-7. Influence of Time Lag on Estimate of Potential Cattail Impact in the Rotenberger Wildlife Management Area.



Using an alternate modeling methodology presented by one of the stakeholders (Walker, pers. comm.), the time required to exceed the most conservative soil P criterion for initiation of cattail expansion (10 cm soil depth and 610 mg/Kg) or the soil P criterion which best reproduced the initial 20-year cattail expansion in WCA-2A (20 cm depth and 720 mg/kg) would not be reached in the Rotenberger Wildlife Management Area by 2007 when Phase II controls are implemented. In addition, if the extent of cattails is controlled by fragmentation of existing populations (Wu et al., 1996), the rate of cattail expansion would be expected to be slower than that predicted based on soil P concentrations alone.

Results of the entire evaluation process which incorporate the estimates of cattail expansion and NSM-hydropattern match are summarized in Table 6-3 and are described below.

TABLE 6-3. ROTENBERGER HYDROPATTERN RESTORATION EVALUATION MATRIX

Evaluation Criteria	Current Plan		No Action		Bypass to S-8	
Local (Impact Zone) Benefits/Impacts						
	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term
1.Vegetation communities	-	0 with mgmt.	-	-	-	+
2.Animal communities	-	0 with mgmt.	-	-	-	+
3. Drainage characteristics	+	+	0	0	0	0
4. Groundwater interaction	+	+	0	0	0	0
5. Water quality	-	0	-	-	-	+
6. Organic soil preservation	+	+	0	0	0	0
Regional (Everglades Protection Area) Benefits/Impacts						
1.Vegetation communities	0	0	0	0	-	+
2. Animal communities	0	0	0	0	-	+
3. Drainage characteristics	0	0	0	0	0	0
4. Groundwater interaction	0	0	0	0	0	0
5. Water quality	0	0	0	+	-	+
6. Organic soil preservation	0	0	-	-	-	-
Other Considerations						
1. Compliance with State Law	Yes		No		No	
2. Compliance with proposed modified federal Consent Decree	Yes		No		No	
3. Additional cost to implement	No		Deferred Costs		$4.8 Million	
4. Additional time to implement	No		No		TBD	

+ Indicates improvement over current conditions; 0 Indicates no measurable change; - Indicates degradation

1. Vegetative Communities -

For the **Current Plan,**

- the **short-term** ***local*** **impacts** are anticipated to be negative, reflecting adverse impacts to ecological functions due to 50 ppb of phosphorus that outweigh the positive impact of the improved hydropattern characteristics, including reducing the incidence of fires. Fires have been suggested as a major determinant of cattail expansion. See the discussion in Section 2.3 for a description of the general impacts associated with elevated nutrient loadings.
- the **long-term** ***local*** **impacts** may well be negligible or positive, depending on how effective cattail management is in removing cattails, and how soon the phosphorus is leached from the soil.
- the **short-term and long-term** ***regional*** **impacts** are negligible due to the relatively insignificant quantity of water and phosphorus being treated in the Rotenberger area compared to the remaining flows and loads.

For the **No Action option,**

- the **short-term and long-term** ***local*** **impacts** are negative due to continued phosphorus enrichment at high phosphorus levels.
- both **short-term and long-term** ***regional*** **(WCAs and Rotenberger) impacts** are negligible due to the relatively insignificant quantity of water and phosphorus being treated in the Rotenberger area compared to the remaining flows and loads; as a trade off, the continued dehydration of the Rotenberger will continue to degrade that environment.

For the **Bypass option** that will result in more water downstream **to S-8,**

- the **short-term** ***local*** **and** ***regional*** **impacts** are negative due to more water, therefore more load, even though the phosphorus concentration is reduced; in addition, the continued dehydration of the Rotenberger will continue to degrade that environment.
- the **long-term** ***local*** **and** ***regional*** **impacts** are + due to discharge of the "no-imbalance" phosphorus level; as a trade off, the continued dehydration of the Rotenberger will continue to degrade that environment.

2. Animal Communities -

For the **Current Plan,**

- the **short-term** ***local*** **impacts** are anticipated to be negative, reflecting adverse impacts to ecological functions (particularly reduced quality of habitat) due to 50 ppb of phosphorus that outweigh the positive impact of the improved hydropattern characteristics, including reducing the incidence of fires. Fires have been identified as a major determinant of cattail expansion.
- the **long-term** ***local*** **impacts** may well be 0 or positive, depending on how effective cattail management is in removing cattails, and how soon the phosphorus is leached from the soil.
- the **short-term and long-term** ***regional*** **impacts** are negligible due to the relatively insignificant quantity of water and phosphorus being treated in the Rotenberger area compared to the remaining flows and loads.

For the **No Action option,**

- the **short-term and long-term** ***local*** **impacts** are negative due to continued phosphorus enrichment at high phosphorus levels.
- both **short-term and long-term** ***regional*** (WCAs and Rotenberger) impacts are negligible due to the relatively insignificant quantity of water and phosphorus being treated in the Rotenberger area compared to the remaining flows and loads; as a trade off, the continued dehydration of the Rotenberger will continue to degrade that environment.

For the **Bypass option,**

- the **short-term *local* and *regional* impacts** are negative due to more water, therefore more load, even though the phosphorus concentration is reduced; in addition, the continued dehydration of the Rotenberger will continue to degrade that environment.
- the **long-term *local* and *regional* impacts** are + due to discharge of the "no-imbalance" phosphorus level; as a trade off, the continued dehydration of the Rotenberger will continue to degrade that environment.

3. Hydropattern Characteristics

For the **Current Plan,**

- the **short-term and long-term *local* impacts** are positive due to the hydropattern improvement benefits.
- the **short-term and long-term *regional* impacts** are negligible due to the relatively insignificant quantity of water and phosphorus being treated in the Rotenberger area compared to the remaining flows.

For the **No Action plan,**

- the **short-term and long-term *local* and *regional* impacts are 0** due to no change in drainage characteristics.

For the **Bypass plan,**

- the **short-term and long-term *local* and *regional* impacts are** negligible due to the relatively insignificant quantity of water and phosphorus being treated in the Rotenberger area compared to the remaining flows.

4. Groundwater Interactions

For the **Current Plan,**

- the **short-term and long-term *local* impacts** are positive due to the hydropattern improvement benefits.
- the **short-term and long-term *regional* impacts** are negligible due to the relatively insignificant quantity of water and phosphorus being treated in the Rotenberger area compared to the remaining flows.

For the **No Action plan,**

- the **short-term and long-term *local* and *regional* impacts** are 0 due to no change in drainage characteristics.

For the **Bypass plan,**

- the **short-term and long-term *local* and *regional* impacts** are negligible due to the relatively insignificant quantity of water and phosphorus being treated in the Rotenberger area compared to the remaining flows.

5. Water Quality

For the **Current Plan,**

- the **short-term *local* impacts** are anticipated to be negative, reflecting adverse impacts to ecological functions due to 50 ppb of phosphorus that outweigh the positive impact of the improved hydropattern characteristics, including reducing the incidence of fires. Fires have been identified as a major determinant of cattail expansion.
- the **long-term *local* impacts** may well be 0 or positive, depending on how effective cattail management is in removing cattails, and how soon the phosphorus is leached from the soil.
- the **short-term and long-term *regional* impacts** are negligible due to the relatively insignificant quantity of water and phosphorus being treated in the Rotenberger area compared to the remaining flows and loads.

For the **No Action option,**

- the **short-term and long-term *local* impacts** are negative due to continued phosphorus enrichment at high phosphorus levels.
- the **short-term *regional* impacts** are negligible due to the relatively insignificant quantity of water and phosphorus being treated in the Rotenberger area compared to the remaining flows and loads; as a trade off, the continued dehydration of the Rotenberger will continue to degrade that environment.
- the **long-term *regional* impacts** are positive due to the reduction in phosphorus concentrations; as a trade off, the continued dehydration of the Rotenberger will continue to degrade that environment.

For the **Bypass option,**

- the **short-term *local* and *regional* impacts are negative** due to more water, therefore more load, even though the phosphorus concentration is reduced; in addition, the continued dehydration of the Rotenberger will continue to degrade that environment.
- the **long-term *local* and *regional* impacts** are + due to discharge of the "no-imbalance" phosphorus level; as a trade off, the continued dehydration of the Rotenberger will continue to degrade that environment.

6. Organic Soil Preservation

For the **Current Plan,**

- the**short-term and long-term *local* impacts** are positive due to the hydropattern improvement benefits.
- the **short-term and long-term *regional* impacts** are negligible due to the relatively insignificant quantity of water and phosphorus being treated in the Rotenberger area compared to the remaining flows.

For the **No Action plan,**

- the **short-term and long-term *local* impacts** are 0 due to no change in drainage characteristics.
- the **short-term and long-term *regional* impacts** are negative due to continued degradation in the Rotenberger area.

For the **Bypass plan**,

- the **short-term and long-term *local* impacts** are 0 due to no change in drainage characteristics.
- the **short-term and long-term *regional* impacts** are negative due to continued degradation in the Rotenberger area.

Summary

Although each alternative has some potential for adverse impact, the evaluation suggests that the **Current Plan** provides the best balance of regional hydropattern benefits against the potential impacts and maximizes the environmental benefits to the Everglades Protection Area.

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Section 7. ADAPTIVE ASSESSMENT RESOURCE PROTECTION PLAN

One objective of this paper is to provide reasonable assurance that the benefits of the selected hydropattern restoration alternatives outweigh the potential impacts. This reasonable assurance will be a combination of **best available information** and an **adaptive assessment resource plan** that describes how the District will continue to improve the resource information base and, if needed, make structural or operational modifications if major problems are detected. Adaptive assessment is a process that integrates **monitoring, modeling, research, and evaluation to develop scientifically sound management actions**. The following description of this adaptive assessment philosophy was presented in the June 4, 1996, Draft of the *Integrated Science Plan* for the South Florida Ecosystem Restoration Initiative:

> Adaptive assessment establishes a protocol to select among alternative actions and gain useful information regarding ecosystem response to restoration actions that are taken. It acknowledges the imperfection of information used in making resource management decisions and prescribes a structure to improve the resource knowledge base and adjust decisions accordingly. Periodic environmental assessment, using modeling to predict outcomes and monitoring to test the predictions, is the operational foundation of adaptive assessment. Related field and laboratory studies and experiments are used to acquire new information, help design better models, focus monitoring, and interpret monitoring and modeling results. (See Figure 7-1). Predicting effects of alternatives and analyzing consequences of management actions with respect to these objectives should be done in a holistic context and by adhering to principles of adaptive assessment.

The framework for an adaptive assessment resource protection plan was drafted during the initial four day workshops and was enhanced at the subsequent stakeholder meetings. This plan will be refined over the course of the next several months.

7.1. Recommended Monitoring

Clear objectives must be defined in order to conduct a meaningful monitoring program. To aid in the definition of monitoring objectives, District staff and shareholders developed the following list of questions:

- What is the monitoring supposed to tell us? Over what temporal and spatial scales?
- What parameters must be monitored in order to assess the degree of impact or benefit?
- What parameters represent an early warning system to prevent or correct impacts?
- What monitoring is necessary for support of modeling and research?
- Once a monitoring program is established, how rapid must monitoring data be analyzed in order to implement changes?

Given these questions, staff and shareholders recommended that development and implementation of a monitoring program, beginning prior to operation of STAs, is essential in order to establish baseline conditions for detecting benefits and impacts:

- <u>Vegetation communities</u> - Transect and aerial or satellite photography will be conducted annually to detect changes in the extent and composition of the periphyton, sawgrass, cattails and other vegetation communities. Maps will be prepared and calculations made of areal extent of each vegetation community and annual changes in extent. Participants noted that baseline vegetation maps have already been initiated for each of the WCAs and the Rotenberger area as well as the ENP and Big Cypress Nature Preserve.

- Animal Communities - The District, the National Audubon Society, the USACE, the ENP, and other parties have sponsored Systematic Reconnaissance Flights to monitor wading bird populations within the Everglades Protection Area. Continuation of this monitoring program could provide data for evaluating local impacts and documenting the hydropattern benefits of the region. Other animal communities should be examined for their ability to serve as indicators of ecosystem health.

- Soil and water column data - Sampling transects will be established downstream of the spreader canals to monitor total phosphorus, and other water quality parameters, including mercury, in the water column and soils. Speciation of phosphorus in the water column and sediment should be given consideration. Bulk density of soils should be noted at sampling sites. The latter two recommendations are important because they are important to understanding mechanisms of plant growth and phosphorus uptake.

- Hydrologic - Water depths will be monitored along transects downstream of the spreader canals. Water depths and hydroperiods will be compared to the regional South Florida Water Management Model projections, and NSM or other appropriate restoration targets. Measurement of flow vectors and velocities, or conservative tracers, would aid in determining how successful sheet flow has been established.

- Success indicators - The Science Subgroup of the South Florida Ecosystem Restoration Initiative is developing measurable success indicators. Where appropriate, these could be adopted to help assess the impacts and benefits of the hydropattern restoration projects.

ADAPTIVE ASSESSMENT

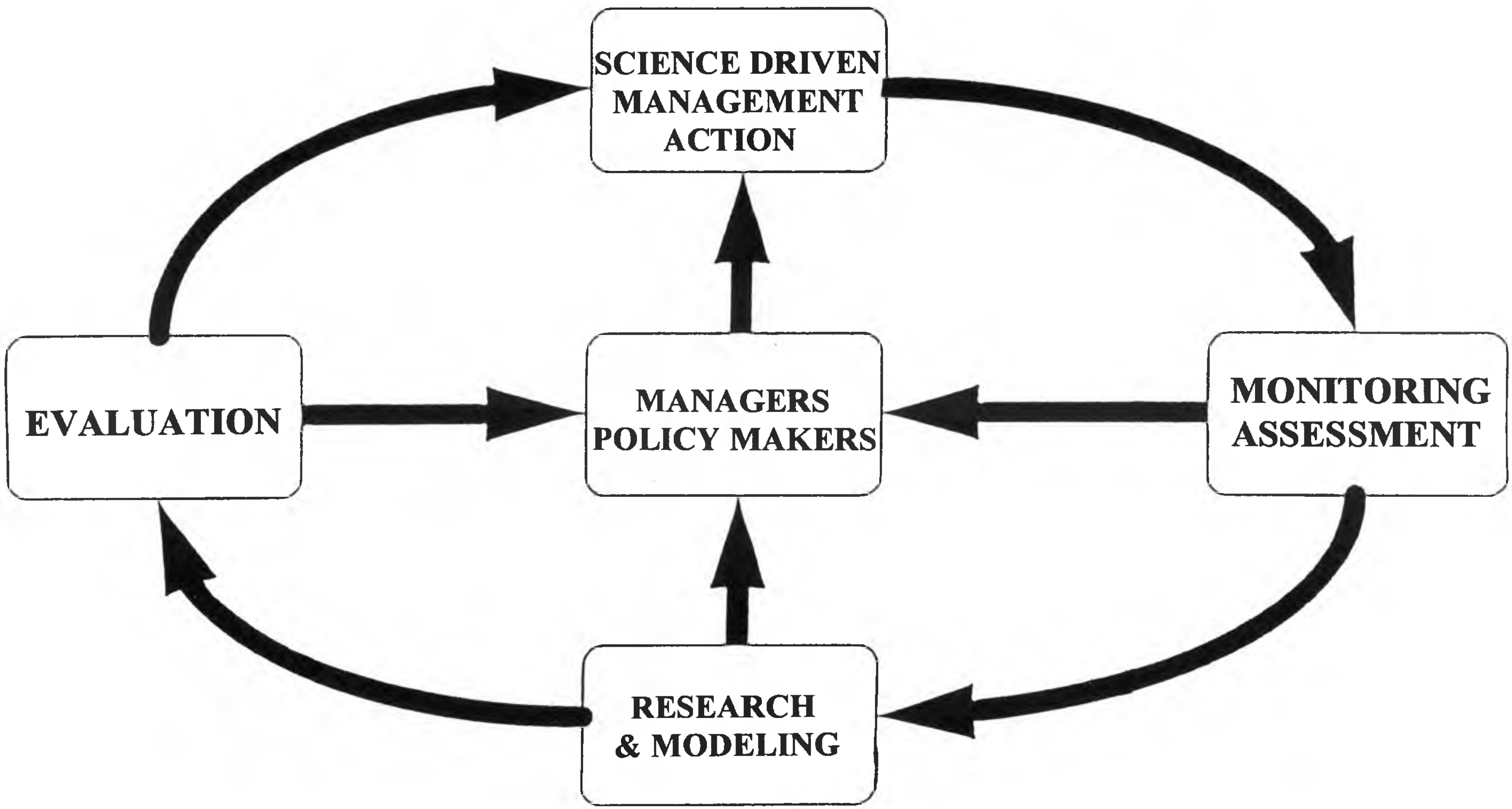


FIGURE 7-1 Adaptive Assessment Concept. (Source: 6/4/96 Draft Integrated Science Plan).

7.2. Recommended Research

Clear objectives must also be defined in order to conduct a meaningful, applied research program. The following research issues that would aid in understanding and predicting the impacts and benefits of hydropattern restoration were recommended for further investigation:

- Soil-water interactions: How do phosphorus and other water quality constituents flux between soil and water as a function of initial soil phosphorus and water column phosphorus conditions? Could this be determined by transplanting cores from oligotrophic to eutrophic areas and vice versa? How are soil-water fluxes affected by past fires or drought conditions that have oxidized the soils?

- Indicators of impact or benefit: Could mesocosms for phosphorus dosing experiments, such as those used in WCA-2A, be deployed in WCA 3A to assess a priori the impacts/benefits of hydropattern restoration efforts that include 50 ppb and later, lowered, total phosphorus concentrations?

- Reversibility of impacts: Once affected by nutrient input, how long will it take for soil, water, and vegetative conditions to return to baseline states? Are there existing areas in the Everglades that received high nutrient loads in the past, that can be used to assess reversibility?

- Vegetation competition and invasion: What plant species is most likely to be successful in colonizing areas affected by hydropattern restoration? Is their success due to resident seed banks, vegetative growth, ability to withstand certain hydrologic conditions, superior competition for nutrients, light, etc.? Will the most successful colonizing species be replaced by other species if hydropatterns or phosphorus loads are altered? How long will this take?

- Active management of exotic or nuisance species: What management activities could be researched in order to reduce the time to reverse any adverse impacts brought about by hydropattern restoration? For instance, cattail management in Cell 4A of the ENR project has been very effective. Specifically, a combination of maintaining high water levels (>30 cm) and annual spot treatment with herbicide has been effective at limiting the spread of cattails in the area. Research could be conducted to determine combinations of water depths, herbicide treatments, post herbicide burning (or not), season, etc. leading to optimal control of cattails. Please note that any herbicide efficacy research will include ways to avoid secondary or collateral impacts to adjacent wetlands. According to the District's Vegetation Management Division, large scale cattail control is a relatively easy process using a helicopter to apply a herbicide, with cost estimates of about $150 per acre. This type of control should become less expensive as cattail acreage goes up, and when combined with other control measures may represent an effective way of "resetting" the ecosystem for conditions that favor other desirable species when nutrient loads are delivered at no-imbalance levels.

- Mitigation: Will there be a functional loss of habitat due to cattail expansion and is there a way to mitigate it? Could experiments be conducted to determine ways to improve the habitat within a cattail monoculture, e.g, through selective clearing by burning, herbicide application or harvesting? Experiments could be conducted in the ENR project or in the cattail-infested area downstream of the S-10 structures.

7.3. Recommended Modeling

Results from the monitoring and research identified above will be used to further develop and test landscape, water quality and hydrologic models. The goal of these models is to synthesize information into cause and effect relationships, and then test how ecosystem components respond when presented with various natural and management scenarios. Model results will be feedback to management so that mid course operational corrections, if necessary, can be implemented. In addition, modeling will feedback to definition of further monitoring and research needs. The status of Everglades ecological and water quality modeling, with recommendations for needed monitoring data and research is:

- Everglades Landscape Model (ELM). The SFWMD is developing the ELM which is designed to understand and predict landscape level vegetation changes that occur as a result from natural and management scenarios. The ELM has completed an initial calibration stage and is being used on a very limited basis at this time to predict the effects of management scenarios. Algorithm development and related experimental research still continue to define conditions that lead to "habitat switching," such as the conditions that lead to cattails invading sloughs.

- Across Trophic Level System Simulation (ATLSS). The NBS is developing the ATLSS model. This model focuses largely on higher trophic level responses to changes in the environment. The ATLSS is still in the algorithm development stage, and relies on completion of research on food web interactions.

- South Florida Water Quality Model (SFWQM). The SFWMD is building the SFWQM, which will be used to predict the fate and transport of phosphorus throughout the EPA. As a surrogate for ecological response, the SFWQM could be run to estimate the spatial extent of the downstream receiving water and associated sediments that would have phosphorus concentrations above the "no-imbalance" concentration as a result of each option. By making the appropriate assumptions, the spatial extent of the water body with concentrations greater than the "no-imbalance" level could be estimated. This could serve as an estimate of the extent of adverse impacts. The SFWQM has finished an initial calibration and is undergoing further calibration at this time. Research on sediment-water nutrient interactions, and monitoring of nutrient concentrations and fluxes throughout the EPA are necessary for improving the predictive capability of the SFWQM.

- Wetlands Water Quality Model (WWQM). The WWQM is under development by the SFWMD with the intent of using it to understand and predict phosphorus retention by the Stormwater Treatment Areas (STAs). It will have the capability to predict the expansion and subsequent recession of the water column and soil phosphorus concentrations after the "no-imbalance" discharge limit is achieved in December 2006.

- SAWCAT. A probabilistic cattail expansion model was developed by Wu et al (1996) and gives predictions of temporal and spatial cattail growth in WCA-2A if nutrient inputs go uncurtailed. This model could be used to predict the area of cattail expansions in other parts of the Everglades, given appropriate initial conditions.

- The STA design model. The STA design model (Walker, 1995) was modified to include mass balances on the water-column and surface soils in the areas downstream of hydropattern restoration facilities. Impacts of hydropattern restoration have been assessed by comparing simulated spatial and temporal increases in soil phosphorus levels with threshold criteria associated with cattail expansion. One advantage of this approach over that described in Section 2 is that this model must accumulate sufficient phosphorus in the sediment compartments in order to reach the threshold for cattail to grow. This type of computation puts a realistic "lag" into the simulation of cattail response to phosphorus loads. This work is still under review, but should be available soon.

Recommendations common to most models include the need for (a) accurate integration with operations plans, (b) linkages to other models as appropriate, (c) more detailed elevation data, and (d) identification of "who is doing what," and a repository of data available from all groups conducting research and monitoring, and (e) the need for endpoints that denote when benefits or impacts have occurred.

7.4. Science-driven Feedback Mechanism

If the results of the post-hydropattern restoration vegetation monitoring and transect soil and water column chemistry sampling indicate either a significant acceleration or deceleration rate of cattail growth or soil enrichment compared to predicted, the following process is proposed:

1. Communicate the findings to the Corps of Engineers, US EPA, Florida DEP, and other interested parties.
2. Convene a workshop to review the findings and determine the reason for the changes as well as identify alternative management actions that can ameliorate impacts, including, but not limited to, the following options if they have been proven effective:
   a. Harvest the cattails;
   b. Apply herbicide to cattail areas;
   c. Create more gaps in the spreader canal levees to slow the water velocity;
   d. Accelerate the implementation of superior technologies; or
   e. Modify the operation of the hydropattern restoration components as appropriate.

3. Implement frequent reporting to document and communicate the success of the feedback mechanisms.

4. Incorporate the results of these activities into future planning and implementation of subsequent ecosystem restoration activities.

Section 8. SUMMARY OF FINDINGS

Hydropattern restoration is one area of science where unequivocal answers are not available to every question; hence we rely on best professional judgement to supplement available information. This document is a compilation of the best professional judgement of District staff regarding the potential benefits and impacts of the proposed hydropattern restoration components, and alternatives, of the Everglades Construction Project. The following major findings are presented.

1. Extent of hydropattern restoration benefits were estimated by comparing simulated hydroperiods for the Current Plan and alternatives with hydroperiod targets suggested by the Natural System Model. A net improvement of 74,240 acres to the Everglades Protection Area and the Rotenberger Wildlife Management Area was calculated for the Current Plan compared to the alternatives.

2. Using the simulation results of the SFWMM, estimates of annual phosphorus loads and load reductions were calculated for each of the alternatives; results are presented in Tables 8-1 through 8-3 and Figures 8-1 through 8-3. For the 8-yr time frame (1999-2006) evaluated, the Current Plan had the least cumulative phosphorus discharged to the Everglades Protection Area (781 metric tons), the Bypass options released 841 metric tons (60 metric tons more than the Current Plan), while the No Action alternative resulted in an estimated discharge of 1,645 metric tons of phosphorus (865 metric tons more than the Current Plan). The No Action alternative has the greatest extent of adverse impacts of all the options considered. In general, the Bypass options are more expensive, have slightly more impact than the Current Plan, yet do not have the same regional hydropattern benefits provided by the Current Plan's hydropattern restoration activities. Of all the options evaluated, the Current Plan provides the best balance of trade-offs between regional hydroperiod benefits versus localized impacts.

3. Antecedent conditions play a critical role in determining the extent of impacts, particularly, determining the rate of change in existing emergent macrophyte communities. For example, observations in WCA 2A downstream of the S-10 structures suggest that conversion from desirable vegetation communities to cattails is accelerated given the presence of numerous open-water slough communities, whereas a similar conversion in areas downstream of STA-2 would probably be reduced in due to an existing dense stand of sawgrass.

4. Active management of cattails, e.g., burning, removal or herbicide treatment, holds promise as an effective means of ameliorating some adverse impacts of the hydropattern restoration projects, particularly once the phosphorus discharge is reduced to the "no-imbalance" levels. Additional research has been proposed in FY 97 (via SWIM funds) to begin intensive investigations on the efficacy of these techniques that could be used to reverse adverse impacts and to insure there are no collateral damage to adjacent wetlands.

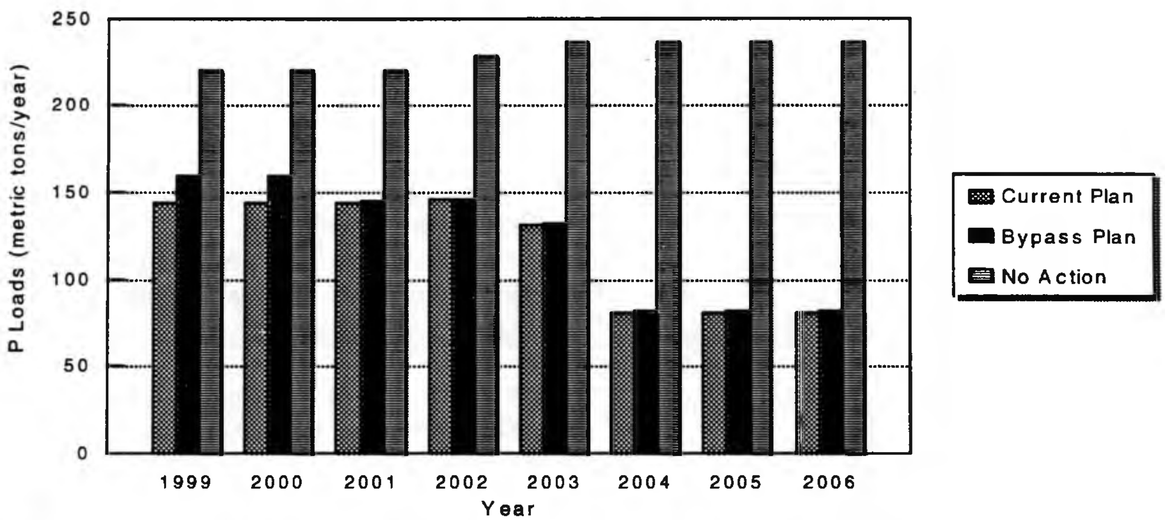
5. For all the water bodies evaluated, the Current Plan options are expected to have no regional short-term or long-term adverse impacts; all the regional impacts are either positive (WCAs) or negligible (Rotenberger). All of the No Action and Bypass options are expected to have regional short-term and long-term adverse impacts, primarily because of continued degradation of vegetation and animal communities not receiving the benefits of hydropattern restoration.

Table 8-1. Total Phosphorus Annual Loads to the Everglades Protection Area

	Current Plan		No Action Plan		Bypass Plan	
Year	Flow	Load	Flow	Load	Flow	Load
	1000 AF/yr	(MT/yr)	1000 AF/yr	(MT/yr)	1000 AF/yr	(MT/yr)
1999	1250	143	1250	220	1250	159
2000	1250	143	1250	220	1250	159
2001	1250	143	1250	220	1250	144
2002	1287	145	1287	229	1287	146
2003	1321	131	1321	237	1321	132
2004	1321	81	1321	237	1321	82
2005	1321	81	1321	237	1321	82
2006	1321	81	1321	237	1321	82

Fig. 8-1. Annual Phosphorus Loads

Comparison of Alternatives



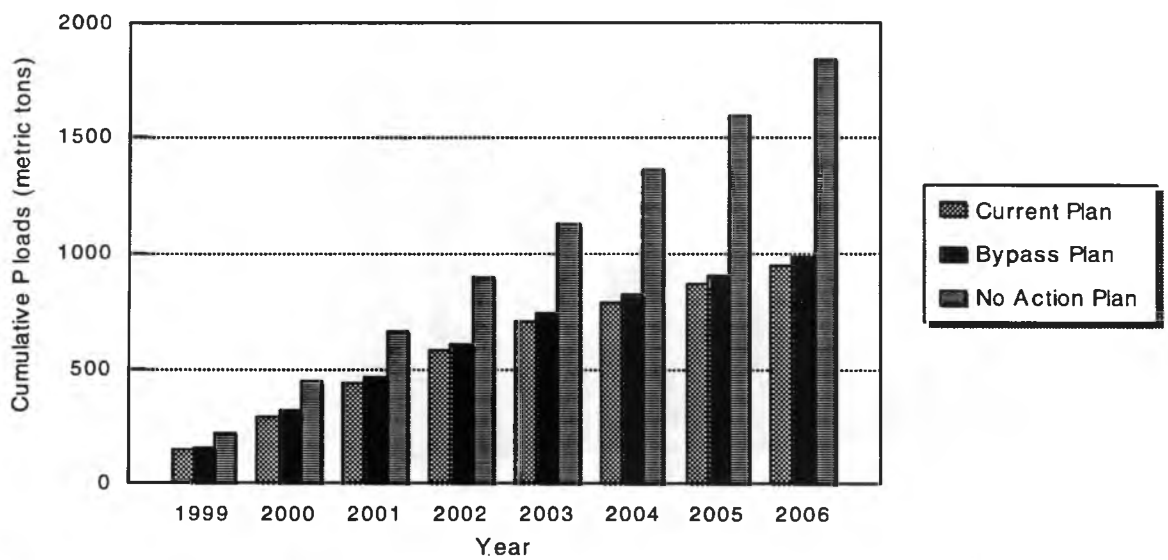
1. For the purpose of these comparisons, the flow volumes for each alternative were assumed to be equivalent.
2. A delay of two years for the operation of STA 2 was assumed for the Bypass options for the WCA 2A project.
3. For the purpose of these comparisons, STA discharge was assumed to be 50 ppb upon the date of initial operation.
4. For the purpose of these estimates, ECP design flows (plus BMP make up water)were used for all STAs except STA 5 and 6; SFWMM flows were used for STA 5 and 6.
5. No delay was assumed for the STA 3/4, Rotenberger or west WCA 3A bypass options.
6. Flows and loads were prorated when STAs came on line mid-year.
7. EAA basin phosphorus concentrations were assumed reduced 25% due to BMPs.
8. Phosphorus discharged from Rotenberger was assumed to be at 25 ppb.

Table 8-2. Cumulative Phosphorus Loads to the Everglades Protection Area

Year	Current Plan (metric tons)	No Action Plan (metric tons)	Bypass Plan (metric tons)
1999	143	220	159
2000	287	440	318
2001	430	660	462
2002	576	889	608
2003	706	1126	740
2004	787	1362	822
2005	867	1599	903
2006	948	1835	985

Fig. 8-2. Cumulative Phosphorus Loads

Comparsion of Alternatives



Assumptions:

1. For the purpose of these comparisons, the flow volumes for each alternative were assumed to be equivalent.
2. A delay of two years for the operation of STA 2 was assumed for the Bypass options for the WCA 2A project.
3. For the purpose of these comparisons, STA discharge was assumed to be 50 ppb upon the date of initial operation.
4. For the purpose of these estimates, ECP design flows (plus BMP make up water) were used for all STAs except STA 5 and 6, SFWMM flows were used for STA 5 and 6.
5. No delay was assumed for the STA 3/4, Rotenberger or west WCA 3A bypass options.
6. Flows and loads were prorated when STAs came on line mid-year.
7. EAA basin phosphorus concentrations were assumed reduced 25% due to BMPs.
8. Phosphorus discharged from Rotenberger was assumed to be at 25 ppb.

Table 8-3. Phosphorus Load Reductions to the Everglades Protection Area.

Year	Current Plan		No Action Plan		Bypass plan	
	(metric tons)	%	(metric tons)	%	(metric tons)	%
1999	77	35%	0	0	61	28%
2000	153	35%	0	0	122	28%
2001	230	35%	0	0	198	30%
2002	313	35%	0	0	281	32%
2003	419	37%	0	0	385	34%
2004	575	42%	0	0	540	40%
2005	731	46%	0	0	695	43%
2006	887	48%	0	0	850	46%

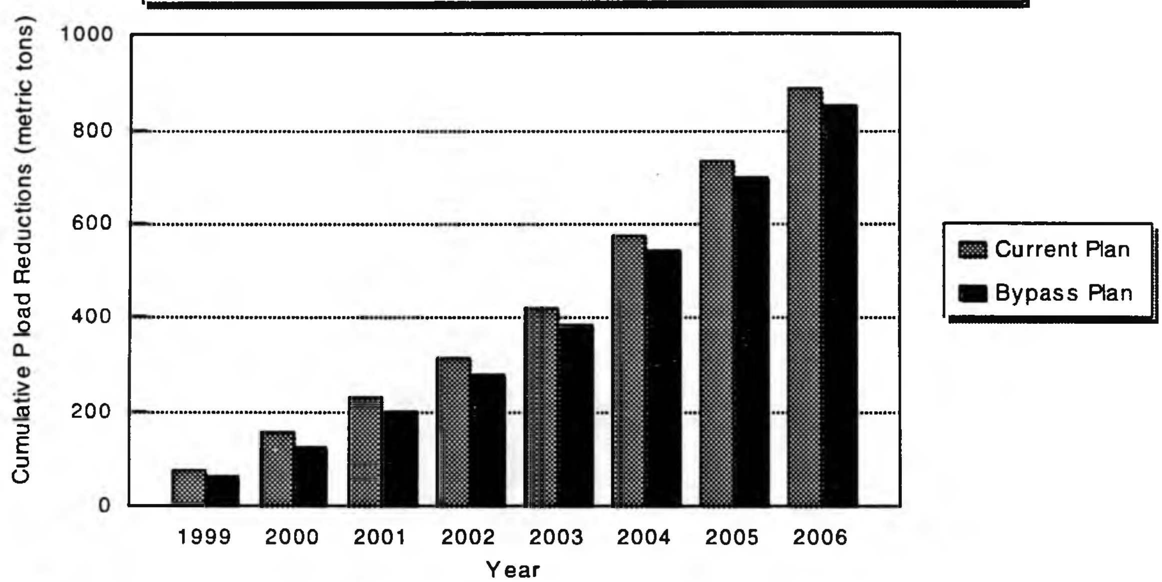


Fig. 8-3. Phosphorus Load Reductions
Compared to the No Action Alternative

Assumptions:
1. For the purpose of these comparisons, the flow volumes for each alternative were assumed to be equivalent.
2. A delay of two years for the operation of STA 2 was assumed for the Bypass options for the WCA 2A project.
3. For the purpose of these comparisons, STA discharge was assumed to be 50 ppb upon the date of initial operation.
4. For the purpose of these estimates, ECP design flows (plus BMP make up water) were used for all STAs except STA 5 and 6; SFWMM flows were used for STA 5 and 6.
5. No delay was assumed for the STA 3/4, Rotenberger or west WCA 3A bypass options.
6. Flows and loads were prorated when STAs came on line mid-year.
7. EAA basin phosphorus concentrations were assumed reduced 25% due to BMPs.
8. Phosphorus discharged from Rotenberger was assumed to be at 25 ppb.

6. Subject to legal interpretation, the No Action and Bypass options may violate the scope and time frames mandated in the 1994 Everglades Forever Act and may violate the hydropattern restoration intent of the Federal Consent Decree. These options result in delayed implementation of the hydropattern restoration goals of Everglades Restoration and as a result, would probably cost millions of public dollars more than the Current Plan due to inflation. In addition, the Bypass options necessitate expenditures of millions of public dollars for construction of temporary bypass canals and structures. This money would be better spent on other restoration activities.

7. The acreage within the water conservation areas which should show an improvement in hydroperiod is summarized in Table 8-4. Results of these modeling efforts indicate that the Current Plan results in an improvement of more that 74,000 acres of restored Everglades wetlands.

8. An appropriate adaptive assessment resource protection plan, including monitoring, research and modeling, with a well-crafted science-based feedback mechanism, should be implemented concurrently with the hydropattern restoration projects. This will reduce the scientific uncertainties, enhance our future ecosystem restoration planning effectiveness, and will allow for detection and correction of any unanticipated adverse impacts.

Table 8-4. Hydroperiod Benefit Summary (from SFWMM simulation results)

AREA	Acres Improved	Acres Worsened	Net Change (acres)
WCA-1 (145,920 acres)	23,040 (15.8%)	0	23,040 (15.8%)
WCA-2A (104,960 acres)	7,680 (7.3%)	0	7,680 (7.3%)
North WCA-3A (204,800 acres)	58,880 (28.7%)	48,640 (23.8%)	10,240 (5.0%)
Rotenberger WMA (33,280 acres)	33,280 (100%)	0	33,280 (100%)
Total (488,960 acres)	122,880 (25.1%)	48,640 (9.9%)	74,240 (15.2%)

Notes:

1. Areas are to nearest 2560 acres ($4mi^2$ x $640ac/mi^2$) as estimated by the SFWMM.
2. "Acres Improved" are areas predicted to have the hydroperiod improved due to the Current ECP Plan by greater than 30 days more than the No ECP results up to 30 days over the NSM hydroperiod.
3. "Acres Worsened" are areas predicted to have the hydroperiod worsened due to the Current ECP Plan by greater than 30 days more than the No ECP results and greater than 30 days over the NSM hydroperiod.

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APPENDIX 1

Response to Public Workshop Comments

THE SOUTH FLORIDA WATER MANAGEMENT DISTRICT RESPONSE TO PUBLIC HYDROPATTERN RESTORATION WORKSHOP COMMENTS

First Public Workshop: July 19, 1996 **Second Public Workshop: August 5, 1996**

#	Comment	Action and Future Assignment
	July 19, 1996 Workshop	
	Comments from the July 19, 1996 Workshop on the Technical Plan Participants were asked to provide their comments regarding the presented Technical Plan and review the proposed benefits and impacts. The following is the list of comments and questions provided by the participants and recorded in the July 19 workshop.	
1	Rename Technical Plan (Fig. 1.1) as the General Design Memorandum figure.	Figure 1.1 is being revised and was presented in draft form at the second workshop August 5. The revised figure will be called *Simulated Performance of the Everglades Construction Project (ECP) using the South Florida Water Management Model (SFWMM)*
2	Does the S-8 pump station have the capacity to implement the By-Pass alternative?	The South Florida Water Management District is carrying out the directives of the Everglades Forever Act to construct the Everglades Construction Project according to the Conceptual Design and the various General Design Memoranda. Should a hydropattern bypass option be set in motion, a hydraulic study would be made to determine if S-8, S-7 and S-6 can handle the redirected flows. If not, additional pump stations could be required at significant additional cost to the
3	Do the No Action or By-Pass alternatives involve sending water to tide?	No additional water will go to tide because of the bypass option.
4	Table 1-1 and 1-2 are redundant, there are places within these tables where things are listed as both a benefit and an impact. Breaking these tables into long term and short term components may accomplish the desired objective and allow something to be both a short term impact but a long-term benefit or the opposite. An example was increased average depths of water which may both improve biological abundance and cause adverse impacts.	Several comments suggest that Table 1-1 and table 1-2 obscure rather than clarifies the issues discussed in Section 1. The South Florida Water Management District removed both tables from the revised document leaving the detailed discussions to illuminate the issues the section contains.
5	Investigate whether S-8, S-7, and S-6 can accommodate by-pass flow without lowering current flood protection and include the attenuation capacities of the STA's in the calculations.	The South Florida Water Management District is carrying out the directives of the Everglades Forever Act and will construct the Everglades Construction Project according to the Conceptual Design and the various General Design Memoranda. Should a hydropattern bypass option be set in motion, a hydraulic study would be made to determine if S-8, S-7 and S-6 would have the required capacities. The study could also determine if the required level of flood protection would be provided by the existing facilities. If not, additional pump stations may be required at significant additional cost to the Everglades Construction Project.

THE SOUTH FLORIDA WATER MANAGEMENT DISTRICT RESPONSE TO
PUBLIC HYDROPATTERN RESTORATION WORKSHOP COMMENTS

First Public Workshop: July 19, 1996 **Second Public Workshop: August 5, 1996**

#	Comment	Action and Future Assignment
6	Table 1.1, can benefits be changed to reflect long-term and short term components?	Several comments suggest that Table 1-1 and table 1-2 obscure rather than clarifies the issues discussed in Section 1. The South Florida Water Management District removed both tables from the revised document leaving the detailed discussions to illuminate the issues the section contains.
7	Revise definitions (particularly "short term") to reflect the following: a. length of time, b. duration of impact, c. reversibility, and d. spatial extent.	
8	Benefits of the Current Plan are all short term because they will all occur anyway whenever the water quality standards are implemented.	Noted.
9	All of alternatives are a violation of Tribal Rights if they provide unacceptable water, and the Miccosukee Tribe will not accept water that will degrade Tribal Lands.	Noted. The District is complying with the the Consent Decree per requested modifications, with the Everglades Forever Act, and with all applicable federal and state laws.
10	The Miccosukee Tribe has applied to EPA to be able to set water quality standards. These are to be approved for as an ONRW (Outstanding Natural Resource Water) so that water will have to meet whatever standards are set by the tribe prior to discharge.	Noted.
11	Cattail impacts will not be allowed on Miccosukee Tribal lands (which also have a series of over-drainage problems in addition).	Noted.

THE SOUTH FLORIDA WATER MANAGEMENT DISTRICT RESPONSE TO PUBLIC HYDROPATTERN RESTORATION WORKSHOP COMMENTS

First Public Workshop: July 19, 1996 **Second Public Workshop: August 5, 1996**

#	Comment	Action and Future Assignment
12	Add a column called Aquatic Productivity to both Tables 1-1 and 1-2.	Several comments suggest that Table 1-1 and Table 1-2 obscure rather than clarifies the issues discussed in Section 1. The South Florida Water Management District removed both tables from the revised document leaving the detailed discussions to illuminate the issues the section contains.
13	Change wording for fires to Reduction of Severe Fires and Peat Fires in Table 1-1.	
14	Change wording to Improved/Degraded Wildlife Habitat in Table 1-1 and Table 1-2.	
15	Do not agree that spreading water out will result in decreased water purification. Suggested change to "decreased water quality" from decreased water purification in Table 1-1 and Table 1-2.	
16	The group requests clarification of the meaning of the words "short term" soil impacts. Generally they do not agree that soil impacts are short term. Clarify this statement to reflect that soil impacts are not generally short term and that vegetation changes are also not short term. (Refers to Table 1-2)	
17	A major benefit of Hydroperiod Restoration is "areal decrease in nutrient loading." Change the wording from diversion of nutrient loads in Table 1-1 and Table 1-2 to "diversion and dispersal" or "diffusion" of nutrient loads.	
18	Marks in all columns of Table 1-1 and Table 1-2, that have modified titles, must be shifted to reflect the modified wording.	
19	Change the title of Table 1-2 to potential adverse impacts, remove the words short term.	
20	The words local definition in the text is self defining and should be modified to reflect the specific geographic areas under consideration.	
21	Add a column in Table 1-1 and Table 1-2 to address a potential shift to "undesirable vegetative communities"	

THE SOUTH FLORIDA WATER MANAGEMENT DISTRICT RESPONSE TO PUBLIC HYDROPATTERN RESTORATION WORKSHOP COMMENTS

First Public Workshop: July 19, 1996 **Second Public Workshop: August 5, 1996**

#	Comment	Action and Future Assignment
	Questions and Comments from the July 19, 1996 Workshop on Methods and Adaptive Assessment Participants were asked to provide their comments regarding the presented methodologies used to develop the Technical Plan and to comment on the process of adaptive assessment. The following is the list of comments and questions provided by the participants and recorded in the July 19 workshop.	
22	Were there other participants beyond Distinct Staff involved in the original four workshops? (No) Who were the "other scientists" referred to in the text? The language in the text implying this referred to future participants in this process.	The South Florida Water Management District held four internal workshops with invited District staff as participants. Those workshops developed the hydropattern restoration position paper that formed the basis for discussions in the July 19 and August 5, 1996 public workshops.
23	[The South Florida Water Management District] may want to use the Holey Land phosphorus/Cattail rate data to apply to WCA-3 rather than using data from WCA-2A. Would want to use the data from whatever is the most appropriate and representative area for antecedent conditions of the area of interest. Use weight vs. volume data for calculations (loading?) Some disagreement on this issue.	This comment is being considered by the South Florida Water Management District research group.
24	There is a dilemma between the re-hydration of over dried lands vs. the impacts from increased phosphorous or other nutrients.	Noted. The dilemma is the focus of the evaluation.
25	Natural System Model (NSM) - An area of concern is that this process does not really represent an issue for WCA-1 since the hydroperiod for WCA-1 is controlled by the regulation schedule.	WCA-1 is included in the South Florida Water Management District's evaluation of the options because the current plan contemplates diversion of S-6 to STA 2 and then to WCA 2A, and the No Action and Bypass (to S-6) option would involve sending water to WCA 1.

THE SOUTH FLORIDA WATER MANAGEMENT DISTRICT RESPONSE TO PUBLIC HYDROPATTERN RESTORATION WORKSHOP COMMENTS

First Public Workshop: July 19, 1996 **Second Public Workshop: August 5, 1996**

#	Comment	Action and Future Assignment
26	NSM impacts to tree islands could result from water depths proposed for WCA-2A. The South Florida Water Management District will use existing data for hydroperiod and hydropattern to compare model runs for the NSM as part of the LECRWSP which will also look at a rainfall driven model. There is a new process being developed as part of the Lower East Coast Regional Water Supply Planning process. It is a tool to calculate the number of acres of wetland that would benefit from hydroperiod improvement. The South Florida Water Management District wants to be able to quantify the number of acres of hydroperiod improvement and the number of acres of ponding improvement (their respective changes). This would serve as a means of assessing the process if people who worked in the area were able to look at a set of time series hydrographs and the output of spatial coverage. This would also provide the tools the biologists need to make the evaluations (time series hydrographs and stage duration curves).	The South Florida Water Management District presentation by Cal Neidrauer and Dave Swift at the second public workshop August 5 responded to this comment in detail. The new process showed hydroperiod improvements in east WCA-3, WCA-2 and a problem area of reduced hydroperiod in west WCA-3A. The reduced hydroperiod area of concern will be the subject of consideration to determine how the South Florida Water Management District can revise its current operations strategies to increase hydroperiod benefits to that area. STA 3/4 will not be designed before 6/99 and design modifications to that treatment area could eliminate the predicament. The revised *Evaluation of Benefits and Impacts of the Hydropattern Restoration Components of the Everglades Construction Project* will contain maps and stage-duration curves to support the presentations made by Cal Neidrauer and Dave Swift at the August 5 workshop.
27	Place a map in the text to refer to stage duration curve to show stage duration curves for the alternatives proposed above.	The response to comment 26 is applicable here.
28	Put stage duration curves in the plan showing how the NSM and SFWMM are related to actual difference in ground surface elevation	
29	Using Stage duration curves, you want to find cells in the model output that are more representative of regional influence. Should show a section further downstream of the changes and STAs that are more regionally representative of downstream conditions. Show a stage duration curve and a period of record or a time series analyze for the area and data chosen. A good place for these locations would be to choose a section where there is a water gauge located.	
30	Include a hydro graph for the no-action and by pass options.	
31	Provide a spatial look at the grid cells of the NSM- add this as a figure and the relationships between cells.	
32	Add a hydroperiod difference map.	

THE SOUTH FLORIDA WATER MANAGEMENT DISTRICT RESPONSE TO PUBLIC HYDROPATTERN RESTORATION WORKSHOP COMMENTS

First Public Workshop: July 19, 1996 **Second Public Workshop: August 5, 1996**

#	Comment	Action and Future Assignment
33	Remember that the results presented represent a current set of assumptions which may change with different future regulation schedules	Agreed
34	Alternative to the NSM -- as and alternative to the NSM can use the number of acres vs hydroperiod or ponding changes predicted (or observed?). This must include a table with the assumptions, definitions and also provide: A) stage duration curves B) time series hydrographs.	The response to comment 26 is applicable here..
35	Must add whatever model was used to take into consideration the subsidence of WCA-3A (as well as subsidence elsewhere). This requires topographic data for this area which does not exist and must be collected. Must include recommendations for topographic data wherever it does not reflect accurate current conditions. WCA-3A is the priority.	In addition to the other maps and data representations provided in the *Simulated Performance of the Everglades Construction Project (ECP) using the South Florida Water Management Model (SFWMM).*
36	Several people felt that the current methodology of using the NSM to determine aerial extent changes or benefits was inappropriate and the LECRWSP approach may be a better choice. This applied only to the Table 2-3 and associated discussions in the text to quantify the area of benefit against the NSM.	The methodology was refined as suggested. The South Florida Water Management District is evaluating several options for displaying the data. Examples will be included in the *Simulated Performance of the Everglades Construction Project (ECP) using the South Florida Water Management Model (SFWMM)* report.

July 19, 1996 Workshop Breakout Discussion of the Four Hydropattern Project Tables

The entire group was assigned the task of reviewing the assumptions in the evaluation of each hydropattern restoration project and comment on the assignment of the values +, -, and o to each category in the tables for each project. This was done as a group breakout project where everyone was asked to choose an are based on their expertise. The four hydropattern restoration projects were: 1) Water Conservation Area East-3A, 2) Water Conservation Area West-3A, 3) Rotenberger Tract, and 4) Water Conservation Area-2A. They were asked to circle values in cells of the table that the group consensus did not agree with the District and change values if there was consensus within the breakout group over the change and the new value. The following are the breakout group consensus comments for each hydropattern project by area.

Water Conservation Area East-3A

#	Comment	Action and Future Assignment
37	Some factors are redundant (soil protection, water purification, diversion of nutrients) and inappropriate.	Tables 1-1 and 1-2 were removed from the document to avoid confusion.

THE SOUTH FLORIDA WATER MANAGEMENT DISTRICT RESPONSE TO PUBLIC HYDROPATTERN RESTORATION WORKSHOP COMMENTS

First Public Workshop: July 19, 1996 **Second Public Workshop: August 5, 1996**

#	Comment	Action and Future Assignment
38	Current Plan for long term animal communities go from 0 to + as animal communities move into the new habitat it will become a positive. In a current "no action" condition plant and animal communities are adapted to current conditions so any changes may have a negative affect	Comment may need clarification. If emphasis is on long term benefits, animal communities would be expected to change as a function of hydropattern restoration, perhaps negatively in the short term, but should show improvement over long term as habitat improves.
39	Criteria for animal communities disturbance usually increases abundance and diversity even if it does not remain stable.	Comment needs clarification. We are not sure what is meant by criteria usually increases abundance...
40	Include information and figures to show regional conditions and data.	Comments needs clarification.
41	Regional information needs more support for back-up explanation.	Comments needs clarification.
42	Use as factors for animal communities similarities to native reference community structure.	Agreed. Native reference community structure needs clear definition in order to do so.
43	Factors for Animal Communities should be reworded A) Drop wildlife habitat since this really refers to healthy vegetative communities B) Drop biological diversity and abundance- may be more undesirable species in high phosphorous environments that would show up as a false positive for high biological diversity.	Tables 1-1 and 1-2 were removed from the document to avoid confusion.
44	Criteria -- Animal Communities- Disturbance usually increases abundance and diversity even if it does not remain stable.	Need to know whether these increases occur in short or long time frames in order to know where to assign + or - .
45	WCA-3 antecedent soil conditions are different from WCA-2 re: soil [P], disturbance water depth/hydroperiod is factor which may override [P] in water, needs to be addressed (re: Newman *et al.*, 1996)	Noted. Blue document acknowledges that Holey Land cattail experience may be more applicable to WCA 3. Model for predicting WCA-3 impacts in revision by stakeholder consultant.
46	Evaluation of "No Action" plan was based on knowledge of the future everglades demands will reduce hydroperiods and the volume of water delivered to WCA-3A	Noted. Is this future everglades demands or urban and agricultural demands?
47	Much of the impacts depend on factors unaffected by STA construction (i.e., water availability, regional restoration efforts, water supply planning options, rainfall cycles).	These factors are accounted for in STA design documents and LECRWSP planning efforts.

THE SOUTH FLORIDA WATER MANAGEMENT DISTRICT RESPONSE TO PUBLIC HYDROPATTERN RESTORATION WORKSHOP COMMENTS

First Public Workshop: July 19, 1996 **Second Public Workshop: August 5, 1996**

#	Comment	Action and Future Assignment
48	Table 4-1 peat and marl accretion in impact zone.	Comments needs clarification. Does this comment suggest that the word "positive" should be substituted for "subsidence" in current plan column?
49	By-pass long term assumptions are that hydroperiod restoration would be instituted in 2007 when background levels [P] are attained without a description of how these levels will be reached.	Noted
West Water Conservation Area 3A:		
50	Definitions of time frames (short and long) are serious issues that need resolution.	Noted.
51	How can water qualities improve in "Long Term" for "No-Action" and for "By-Pass" ?	BMPs still remain in effect.
52	Keep discharge until background water quality levels can be delivered.	Noted.
53	Map of impacted areas is in error. It shows impacts only on the northeast side of Miami. Should also show on the south West side.	Map will be changed to show any impacts.
	Rotenberger Tract	
54	Add column to Table 6.3 which defines local as all of Rotenberger (not just the impact zone). Cattail expansion is likely in areas other than the discharge area.	Definition of "local" needs to remain consistent from area to area.
55	Question short term impact on water quality of the Current Plan alternative (Current condition is unknown.).	Noted. Can we find out more about current conditions.
56	Long term impacts of the "By-pass" option should be similar to that of the Current Plan.	True for cattail expansion estimates. What about other aspects of Table 5-3?
57	Where does the 4.8 million dollar cost associated with the"By-pass"option come from	TBD

#	Comment	Action and Future Assignment
Water Conservation Area-2A		
58	Documentation behind methodology needs to be clarified.	Agreed. The revised *Evaluation of Benefits and Impacts of the Hydropattern Restoration Components of the Everglades Construction Project* will contain expanded methodology descriptions.
59	Table 1-1 and 1-2, must add reduction of severity of fires.	Tables 1-1 and 1-2 were removed from the document to avoid confusion.
60	Benefits to diversity to regional but negative to regional(sic).	Comment needs clarification.
61	Customize matrix to WCA-2A	Comment needs clarification.
62	Antecedent Conditions (sic)	Comments needs clarification.
63	Table 6-1 No Action and By-Pass should be the same	Disagree.
64	Matrices, add points: Compliance with Tribal Laws Remove "proposed modified" Reference to Tribal Lands	Noted
65	Evaluation of.... By-pass option **Local**= where the water goes **Regional**= includes where the water is diverted from.	Noted
66	If Cattail management is effective then long term impacts for Current Plan is 0 if not, ...	
67	Evaluation based on the long-term operation of hydroperiod restoration components; but the impacts must be considered in the same local area.	

THE SOUTH FLORIDA WATER MANAGEMENT DISTRICT RESPONSE TO PUBLIC HYDROPATTERN RESTORATION WORKSHOP COMMENTS

First Public Workshop: July 19, 1996 **Second Public Workshop: August 5, 1996**

#	Comment	Action and Future Assignment
	Action Items and Changes in Methodology Participants were asked to provide consensus comments on action items for the next workshop. The following are group consensus items	
68	Change wording of Factors to reflect "more natural" or reference communities in place of diversity and abundance.	Tables 1-1 and 1-2 were removed from the document to avoid confusion.
69	Customize matrices for different regions verses local areas. Customization should reflect scale and region.	Can an example be furnished?
70	Tables on antecedent conditions should be the same for all options- Gary's response: antecedent conditions are different because each option defines a different area. Needs to be better explained in text.	Answer is in comment section. Move it to Action and Future Assignment column.
71	Check antecedent conditions table for "No Action" and "By-Pass", these should be the same Table 6-1.	Same as 63
72	Add compliance with Tribal Law and the Federal Indian Land Claimant Settlement Act.	
73	Consider Adaptive Assessment in detail in the next workshop on August 5th.	Adaptive assessment technology was discussed in detail during the August 5, 1996 workshop and comments on that discussion are contained in this document.
74	Participants in the first public workshop July 19 were asked to evaluate hydropattern restoration evaluation matrices.	Marked copies of the matrices are included in the workshop summary prepared by the facilitator. The documents contain little or no annotation that would permit a direct evaluation of the proposed change. We therefore have not dealt with the proposed changes in this document.
	August 5, 1996 Workshop	
	Comments from the August 5 Workshop on the Methodology Section	
75	Dr. Bill Walker asked if there was any consideration given to delays and the impacts that may be caused to the system by delays. Dr. Walker said that the delay could also be estimated as ecological impacts and that additional cost could be estimated and added to the cost of impacts.	Noted.

THE SOUTH FLORIDA WATER MANAGEMENT DISTRICT RESPONSE TO PUBLIC HYDROPATTERN RESTORATION WORKSHOP COMMENTS

First Public Workshop: July 19, 1996 **Second Public Workshop: August 5, 1996**

#	Comment	Action and Future Assignment
76	Dr. Mike Zimmermann (Everglades National Park) said that the impacts of 50 ppb will not only result in cattail changes but will also result in changes in the other communities including microbial communities that will be more sensitive to changes than will cattails. Dr. Zimmermann said this is of more concern when considering the build up of phosphorus in the sediment and the equilibrium that exists between phosphorus in the sediment and phosphorous in the soil. That equilibrium will continue even when the inflows of phosphorus stops so that the changes in periphyton can be expected for far longer. In addition, it is important to look at other plant communities beyond sawgrass, particularly periphyton and macrophytes.	Dr. Walker answered that his work was a surrogate for organisms that respond over the same range of phosphorus concentrations and that this work is still under review.
77	Blake Sasse said that he would like the information from the cattail expansion in the Holey Land to be used in addition to the cattail expansion rate for WCA-2A.	Refer to Comment 23.
	August 5, 1996 Workshop Adaptive Assessment Break-Out Groups Dr. Tom Fontaine presented a summary of the Adaptive Assessment program as presented in Section 7 of the document "Evaluation of Benefits and Impacts of the Hydropattern Restoration Components of the Everglades Construction Project" (Attachment 7).	
78	John Davis said that he did not see this as fitting in the regulatory process and that the regulatory process would define the criteria. Permitting processes must include quantitative reasonable assurance.	Gary Goforth agreed that this is not a standard regulatory process, and the adaptive management strategy was being proposed to deal with the scientific uncertainty of the projects. This approach has been used in the DEP and NPDES permits for the ENR project. The USACE has dealt with uncertainty in creative ways in the past, e.g., the C-111 and Modified Water Delivery to ENP projects.

THE SOUTH FLORIDA WATER MANAGEMENT DISTRICT RESPONSE TO PUBLIC HYDROPATTERN RESTORATION WORKSHOP COMMENTS

First Public Workshop: July 19, 1996 | **Second Public Workshop: August 5, 1996**

#	Comment	Action and Future Assignment
	August 5, 1996 Workshop Break-Out group results	
Research:		
79	**1. Leading indicator** • Use monitoring measures • Targets • Process for determining and refining targets (underway)	Many of these comments were addressed in rewrite of sections 2 through 6. Some were difficult to incorporate into the rewrite, but are nevertheless valid comments
80	**2. Deterministic models**	
81	**3. Experiments** **Potential Impacts** (1) soil water interaction (1)mesocosum in northern 3A (1)Resistance of vegetation types to change Seed bank germination studies Effects of fire on establishing antecedent conditions and different measures of vegetation Chemical speciation of soils Ecological importance of indicators **Active managers** Research on control of impacts (active management) **Recovery** Reversibility of impacts Water column versus soil Research on vegetation response to hydroperiod changes NSM goals	
82	**4. Baseline development** characteristics of soil vegetation pattern Animals	

THE SOUTH FLORIDA WATER MANAGEMENT DISTRICT RESPONSE TO PUBLIC HYDROPATTERN RESTORATION WORKSHOP COMMENTS

First Public Workshop: July 19, 1996 **Second Public Workshop: August 5, 1996**

#	Comment	Action and Future Assignment
83	5. **Defining actions on levels** **Feedback mechanism** 1. **Monitor specific components** time line interested people including other active researchers, people monitoring and modelers 2. **Interagency Groups and Stakeholders** annual review of information Participation by existing working group 3. **Notification of trends and changes (these are defined in research)** formulate and recalibrates models	Many of these comments were addressed in rewrite of sections 2 through 6. Some were difficult to incorporate into the rewrite, but are nevertheless valid comments.
B. Modeling		
84	1. **Modeling** Baseline data must be planned as soon as possible Strategic modeling plan needs to be developed Local and regional budget-hydrologic Water quality—processes Biological responses More detailed ground data Research to refine processes and responses Experimental and synoptic approach for integration into modeling (tree islands) Measure climatic input Access climate change importance	Many of these comments were addressed in rewrite of sections 2 through 6. Some were difficult to incorporate into the rewrite, but are nevertheless valid comments.

THE SOUTH FLORIDA WATER MANAGEMENT DISTRICT RESPONSE TO PUBLIC HYDROPATTERN RESTORATION WORKSHOP COMMENTS

First Public Workshop: July 19, 1996 **Second Public Workshop: August 5, 1996**

#	Comment	Action and Future Assignment
85	2. **Modeling Process** Sensitivity analysis/uncertainty analysis (risk) Verification Calibration Integration of operations Operational plan Linkages to regional models Merging LECRWSP & ECP and restudy	Many of these comments were addressed in rewrite of sections 2 through 6. Some were difficult to incorporate into the rewrite, but are nevertheless valid comments.
86	3. **Data Processing** Need for clear cataloging of "who is doing what" (solve informational overload) Identify missing pieces See big picture across agencies Then prioritize activities Model extreme conditions Flood, Drought, Fire Operation sensitivity	
87	4. **Need easily modifiable models** Developed modified operational plans based upon models Research feedback Feedback-modeling research monitoring	
88	5. **Establishment of criteria** For success or failure (spatial temporal) that would direct operational or other changes based upon model predictions	
C. Monitoring		
89	• (1)Clearly define objective for monitoring What about the ecosystem do you want to know and understand Design monitoring to give the answer to necessary questions Best define the Benefits and Impacts	Many of these comments were addressed in rewrite of sections 2 through 6. Some were difficult to incorporate into the rewrite, but are nevertheless valid comments.

THE SOUTH FLORIDA WATER MANAGEMENT DISTRICT RESPONSE TO PUBLIC HYDROPATTERN RESTORATION WORKSHOP COMMENTS

First Public Workshop: July 19, 1996 **Second Public Workshop: August 5, 1996**

#	Comment	Action and Future Assignment
90	2. (1)Define Monitoring Program based on Site Specific measures for long term and short term changes Define site specific chemical measures for water and soil quality Define site specific animal measures Define site specific vegetation measures Define hydrologic site specific measures in conjunction with numbers 1,2&3 (of above) Research needs may be identified as a result of information from the previous four steps	Many of these comments were addressed in rewrite of sections 2 through 6. Some were difficult to incorporate into the rewrite, but are nevertheless valid comments.
91	3. (1)Clearly define baseline or reference conditions (in coordination with other researchers monitoring and modeling programs to find out what exists) Define reference communities Define Key Indicators and point of entry for early warning information to prevent or correct impacts Define components of these communities of interest, including: Vegetation, Animals, Water /Soil (sediments) Quality Parameters, and Hydroperiod.	
B. Feedback Mechanisms		
92	1. Analyze all data from monitoring and provide a report with a review of its importance with respect to adjustments which need to be made to the system.	Many of these comments were addressed in rewrite of sections 2 through 6. Some were difficult to incorporate into the rewrite, but are nevertheless valid comments.
93	2. Create a structure (which utilizes existing committees and working groups as possible) to provide information, management and scientific evaluation of information collected.	
94	3. Provide a means to implement changes in operational schedules based on monitoring (go to A again).	Putting research, monitoring and modeling as permit conditions is a precedent that has already been set with the ENR permits. A work around is to have Governing Board participate in and approve permit language before signing.

#	Comment	Action and Future Assignment
August 5, 1996 Workshop Closure		
Dr. Goforth closed the workshop by announcing the Public Workshop on all Technical Issues Involved in the Programmatic Environmental Impact Statement (PEIS) in the District auditorium from 5 pm to 9 pm on August 22, 1996. This will include all technical issues raised to date. The District is attempting to finish the PEIS in the next month and a half and would like all public input.		
Additional Comments from the August 5, 19996 Workshop		
95	Dr. Davis indicated a concern that the District's monitoring, research, and modeling for the ECP may be identified and controlled by the permitting process. This could possibly be removed from the District board and so the amount of money spent will be defined by permitting process.	Noted.
96	Mr. Blake Sasse of the FGFWFC suggested that negative impacts on wildlife and vegetation in the Brown's Farm Water Management Area need to be addressed in the section on STA-2.	Noted.

APPENDIX 2

Summary of the First Public Hydropattern Restoration Technology Workshop

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Workshop Summary

of the

First Public Hydropattern Restoration Technology Workshop

held at the Main Offices of the

South Florida Water Management District
3301 Gun Club Road
West Palm Beach, Florida 33406

on
July, 19 1996

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FIRST PUBLIC HYDROPATTERN RESTORATION TECHNOLOGY WORKSHOP
TABLE OF CONTENTS

DRAFT

DRAFT

I. Background

A. Purpose

These public workshops are being held in support of the Federal 404 permit process and the Programmatic Environmental Impact Statement (PEIS) that the South Florida Water Management District (District) is developing for the Everglades Construction Project (ECP). In developing the hydropattern components of the Everglades Construction Project, the District held four workshops in June 1996 with internal District scientists, engineers, and planners. These workshops were designed to develop the strategy to be followed by the District as part of the hydropattern restoration associated with the Everglades Construction project. The document "Evaluation of Benefits and Impacts of the Hydropattern Restoration Components of the Everglades Construction Project" was developed as a position paper on the topic of hydropattern restoration in conjunction with the Everglades Construction Project.

B. Meeting Goals and Objectives

These public workshops are designed to review the strategies presented in the document "Evaluation of Benefits and Impacts of the Hydropattern Restoration Components of the Everglades Construction Project". Public workshops are envisioned as a process intended to advance completion of a Federal construction permit as part of Federal 404 permitting as well as providing material for the Programmatic Environmental Impact Statement for the Everglades Program. The workshop technique is designed to function as a means of focused evaluation of hydropattern management alternatives by internal and external reviewers.

The goal of this workshop was to receive input on the District's proposed hydropattern restoration proposal and the process by which it was designed. The objectives of the workshop were:

1) To inform interested parties on the methodology and alternatives used in the hydropattern restoration technology projects;
2) To gain a clear understanding of the benefits and impacts of hydropattern restoration;
3) To gain a clear understanding of the strengths and weaknesses of the evaluation method and the adaptive assessment program and to provide recommendations for improvement;
4) To gain a clear understanding of the evaluation of four proposed hydropattern restoration projects.

The District hired outside facilitators to maximize input from all parties participating in the workshop. The results of this workshop represent the combined comments and questions of the participants and not necessarily consensus unless indicated as such.

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II. Workshop Introduction

A. General Background

The meeting began with an introduction by Gary Goforth of the SFWMD who introduced John Rogers of CH2MHill and Sarah Bellmund of Milian, Swain & Associates, Inc. as the facilitators of the Workshop. Dr. Goforth presented an outline of the Everglades Hydropattern Restoration process, as pursued by the District staff, along with goals, principal of which was to "...provide that benefits of the hydropattern restoration components of the Everglades Construction Project outweigh the potential adverse impacts" (p. 3 SFWMD, 1996). The information being solicited is necessary to complete the Army Corps of Engineers (USACE) 404 Wetland permitting process. The process of determining the best means of hydropattern restoration is a highly complex and technical process. In the absence of complete information the District has assembled the available information as well as using the best technical judgement of District scientists and experts to develop the presented strategy for hydropattern restoration. This work has additionally been shaped by the other processes involved in the Everglades Restoration including ETAC (Everglades Technical Advisory Committee) and the STA(Stormwater Treatment Area) design meetings.

B. Meeting Structure

John Rogers presented the objectives of this meeting as well as a description of the meeting process and methodology. Participants were asked to describe their expectations and provided the following:

1. New methodology -- an explanation and discussion
2. More public notice and advance meeting notice
3. Hear everyone's position and debate
4. Open discussion.

This process was originally designed to have three presentations and three small group break out sessions, which were envisioned to provide expanded input. There was a general discussion of this process where several objections to this structure were voiced. Mr. John Davis of Environmental Services Permitting (ESP) and Mr. Gene Duncan of the Miccosukee Tribe objected on the basis that they felt small groups are a way to diffuse objections and that in small groups there is no way for the larger group to know other participants positions. The structure of the meeting and the agenda proposed by the District was therefore discussed and discarded based on the participants views and requests.

At the initiation of the workshop, Drs. Kadlec and Walker requested time to present the conclusions from a paper on a new modeling assessment of phosphorus concentrations in water column and soil downstream of the Everglades stormwater treatment areas. General participants' requests and the proposed paper by Dr. Kadlec and Dr. Walker were seen as such important information that the agenda was modified to accommodate participants suggestions and interest in the reviewing the new method.

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III. Video

A video of a flyover of the area of interest was introduced by Gary Goforth and narrated by Mr. Neil Larson of the District.

IV. Technical Plan Overview

A. General Discussion

Dr. Goforth presented the Current Plan, the No Action Plan and the By-pass Options as they relate to Hydropattern Restoration, as described in the District's position paper, "Evaluation of Benefits and Impacts of the Hydropattern Restoration Components of the Everglades Construction Project". The structure of the meeting was amended to allow the additional presentation of the new methodology by Dr. Kadlec and Dr. Walker. To accommodate this presentation, it was necessary to eliminate the small group break out sessions and have the options reviewed in the larger entire group. (See Attachment 1)

1. Current Plan

The individual general design memoranda (GDM) for each area provide the supporting information to the presented options in the Draft document, "Evaluation of Benefits and Impacts of the Hydropattern Restoration Components of the Everglades Construction Project". Dr. Goforth pointed out, in response to questions, that the numbers in Figure 1-1 will change as the information is revised and models are re-run and as part of the GDM process and that the information is an annual average and for a 10 year simulated period of record. The factors presented in Tables 1-1 and 1-2 are used as a means to quantify the Evaluation Criteria as presented in Figure 3 of the document text.

2. No Action Alternative

This alternative assumes that the STA's will not be implemented but that by January 1, 2007 the water will meet the "no degradation" standards for phosphorous impacts. Therefore, at this time, hydropattern restoration can be fully implemented, as described in the Conceptual Design Document dated February 15, 1994. Under this alternative the STA's will not be operated until the year 2007.

3. By Pass Alternative

Under this alternative, the STA's will be built and operated but water leaving the STA's will be routed into existing receiving points within the Water Conservation Areas (WCA's).

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B. Group Discussion and Comments on the Technical Plan

Participants were asked to provide their comments regarding the presented Technical Plan and review the proposed benefits and impacts. The following is the list of comments and questions provided by the participants and recorded in the workshop.

1. Rename figure Technical Plan (Fig. 1.1) as the General Design Memorandum figure.

2. Does the S-8 pump station have the capacity to implement the By-Pass alternative?

3. Do the No Action or By-Pass alternatives involve sending water to tide?

4. Table 1-1 and 1-2 are redundant, there are places within these tables where things are listed as both a benefit and an impact. Breaking these tables into long term and short term components may accomplish the desired objective and allow something to be both a short term impact but a longterm benefit or the opposite. An example was increased average depths of water which may both improve biological abundance and cause adverse impacts.

5. Investigate whether S-8, S-7, and S-6 can accommodate by-pass flow without lowering current flood protection and include the attenuation capacities of the STA's in the calculations.

6. Table 1.1, can benefits be changed to reflect long-term and short term components?

7. Revise definitions (particularly "short term") to reflect the following:
    a. length of time,
    b. duration of impact,
    c. reversibility, and
    d. spatial extent.

8. Benefits of the Current Plan are all short term because they will all occur anyway whenever the water quality standards are implemented.

9. All of these alternative are a violation of Tribal Rights if they provide unacceptable water, and the Miccosukee Tribe will not accept water that will degrade Tribal Lands.

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10. The Miccosukee Tribe has applied to EPA to be able to set water quality standards. These are to be approved for as an ONRW (Outstanding Natural Resource Water) so that water will have to meet whatever standards are set by the tribe prior to discharge.

11. Cattail impacts will not be allowed on Miccosukee Tribal lands (which also have a series of over-drainage problem in addition).

12. Add a column called Aquatic Productivity to both Tables 1-1 and 1-2.

13. Change wording for fires to Reduction of Severe Fires and Peat Fires.

14. Change wording to Improved/Degraded Wildlife Habitat.

15. Do not agree that spreading water out will result in decreased water purification. Suggested change to "decreased water quality" from decreased water purification.

16. The group requests clarification of the meaning of the words "short term" soil impacts. Generally they do not agree that soil impacts are short term. Clarify this statement to reflect that soil impacts are not generally short term and that vegetation changes are also not short term.

17. A major benefit of Hydroperiod Restoration is "areal decrease in nutrient loading" change the wording from diversion of nutrient loads to "diversion and dispersal" or "diffusion" of nutrient loads.

18. Marks in all columns that have modified titles must be shifted to reflect the modified wording.

19. Change the title of Table 1-2 to potential adverse impacts, remove the words short term.

20. The words local definition in the text is self defining and should be modified to reflect the specific geographic areas under consideration.

21. Add a column for Potential shift to "undesirable vegetative communities"

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V. Methodology and Adaptive Assessment Overview.

A. Presentation of Methodology

The methodology associated with the District's evaluation of benefits and impacts of the Hydropattern Restoration Components of the Everglades Construction Project was presented by Dr. Fontaine. This presentation focused on:

1. The District's definition of time and location;
2. A review of the models and information available;
3. Development of tables of antecedent conditions for each area under consideration, and;
4. Quantifying the impacts using the compiled information and the evaluation criteria with associated factors.

The review and evaluation process used three categories of information: a) existing research from the past and the present as well as compiled antecedent conditions, b) best professional judgement, and c) models. This information was assessed using evaluation criteria and associated hydropattern factors (Attachment 2). Important antecedent conditions considered by the District were soil phosphorus, vegetation communities (including both macrophytes and periphyton) and peat/marl accumulation. Models available for use include the following; Natural Systems Model (NSM), the Everglades Landscape Model (ELM), Across Trophic Level System Simulation (ATLSS), Everglades Water Quality Model (EWQM), SawCat (a sawgrass-cattail model), and others (Walker, Tetra Tech). Using these means as well as adaptive assessment the District seeks to take existing data and apply best judgement which will be modified as the process continues to develop the best most environmentally conservative means to restore hydroperiod and hydropattern downstream of the STA's.

B. Discussion of Methodology

Some participants questioned the methodology applied to arrive at the cattail expansion rate used to develop the alternatives. This methodology is described on page 18 of the Districts' document "Evaluation of Benefits and Impacts of the Hydropattern Restoration Components of the Everglades Construction Projects." These participants did not believe that the technique used accounts for time lags within the system and that the method of quantifying the rate of cattail expansion based on the Jensen and Rutchy (1995) paper or the Rutchy and Vilchek (1994) paper is not valid due to methodology problems. Dr. Fontaine answered that when the rate of cattail expansion was calculated using the two different approaches that the results were within a similar range.

Mr. Federico believed that, based upon the proposed methodology, there was no threshold and that any input in phosphorus would result in a net increase in cattails according to the proposed methodology. Mr. Shulte suggested that different pre-existing conditions (antecedent conditions) determine changes, which can be expected as an area is re-hydrated with any water. These conditions include soil saturation with respect to phosphorus since, if soils are

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already loaded with phosphorus, any re-hydration will cause cattail expansion. These factors may also include fire history, disturbance, and soil density. Several people felt that while this concept of changes due to rehydration was very important, it is important not to consider this to the exclusion of the re-hydration of areas. It was reiterated that this method of approximation of soil phosphorus history was chosen as a conservative one, erring on the side of calculating the most rapid spread of cattails.

C. Questions and Comments on Methods and Adaptive Assessment

Participants were asked to provide their comments regarding the presented methodologies used to develop the Technical Plan and comment on the process of adaptive assessment. The following is the list of comments and questions provided by the participants and recorded in the workshop.

1. Were there other participants beyond Distinct Staff involved in the original four workshops? (No) Who were the "other scientists" referred to in the text? The language in the text implying this referred to future participants in this process.

2. May want to use the Holey Land phosphorus/Cattail rate data to apply to WCA-3 rather than using data from WCA-2A. Would want to use the data from whatever is the most appropriate and representative area for antecedent conditions of the area of interest. Use weight vs. volume data for calculations (loading? Not agreed upon by everyone).

3. There is a dilemma between the re-hydration of over dried lands vs. the impacts from increased phosphorous or other nutrients.

4. Natural Systems Model (NSM)--*An area of concern is that this process does not really represent an issue for WCA-1 since the hydroperiod for WCA-1 is controlled by the regulation schedule. It is however included in the by-pass options, since the by-pass alternative moves water from the diversion of S-6 into WCA-1.

5. * The NSM impacts to tree islands are due to water depths proposed for WCA-2A. Will use existing data for hydroperiod and hydropattern to compare model runs for the NSM as part of the LEC-WSP which will also look at a rainfall driven model. There is a new process being developed as part of the Lower East Coast Water Supply Planning process. It is a tool to calculate the number of acres of wetland that would benefit from hydroperiod improvement. Want to be able to quantify the number of acres of hydroperiod improvement and the number of acres of ponding improvement (their respective changes). This would serve as a means of assessing the process if people who worked in the area were able to look

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at a set of time series hydrographs and the output of spatial coverage. This would provide the tools the biologists need to make the evaluations (time series hydrographs and stage duration curves).

6. Place a map in the text to refer to stage duration curve to show stage duration curves for the alternatives proposed under Number 5 (above).

7. Put stage duration curves in the plan showing how the NSM and WMM are related to actual difference in ground surface elevation.

8. Using Stage duration curves, you want to find cells in the model output that are more representative of regional influence. Should show a section further downstream of the changes and STAs that are more regionally representative of downstream conditions. Show a stage duration curve and a period of record or a time series analyze for the area and data chosen. A good place for these locations would be to choose a section where there is a water gauge located.

9. Include a hydrograph for the no-action and by pass options.

10. Provide a spatial look at the grid cells of the NSM- add this as a figure and the relationships between cells.

11. Add a hydroperiod difference map.

12. Remember that the results presented represent a current set of assumptions which may change with different future regulation schedules.

13. Alternative to the NSM -- as and alternative to the NSM can use the number of acres vs hydroperiod or ponding changes predicted (or observed?). This must include a table with the assumptions, definitions and also provide: A) stage duration curves B) time series hydrographs.

14. Must add whatever model was used to take into consideration the subsidence of WCA-3A (as well as subsidence elsewhere). This requires topographic data for this area which does not exist and must be collected. Must include recommendations for topographic data wherever it does not reflect accurate current conditions. WCA-3A is the priority.

15. Several people felt that the current methodology of using the NSM to determine aerial extent changes or benefits was inappropriate and the LEC approach may be a better choice. This applied only to the Table 2-3 and associated discussions in

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the text to quantify the area of benefit against the NSM.

VI. Presentation of Alternative Methodology

Dr. Kadlec and Dr. Walker presented the methodology and conclusions from their paper "Simulations of Phosphorus Concentrations in Water Column & Soil Downstream of Everglades Stormwater Treatment Areas." This was a modification of the STA design model, by Dr. Walker which was changed to include mass balances on the water column and surface soils in the areas downstream of the proposed hydropattern restoration facilities. Impacts of hydropattern restoration facilities were assessed by comparing simulated spatial and temporal increases in soil phosphorus levels with threshold criteria associated with cattail expansion. This information was presented in some detail, however the final paper was not yet available. It was expected to be completed by the week following the workshop and would be available from either Dr. Kadlec, Dr. Walker or the District. Conclusions were already available and were handed out at the meeting (Attachment 3). A brief question and answer section followed this presentation, however major comments and questions were held until participants had the opportunity to review the final completed paper.

VII. Breakout Discussion of the Four Hydropattern Project Tables

The group was assigned the task of reviewing the assumptions in the evaluation of each hydropattern restoration project and comment on the assignment of the values +, -, and o to each category in the tables for each project. This was done as a group breakout project where everyone was asked to choose an are based on their expertise. The four hydropattern restoration projects were: 1) Water Conservation Area East-3A, 2) Water Conservation Area West-3A, 3) Rotenberger Tract, and 4) Water Conservation Area-2A. They were asked to circle values in cells of the table that the group consensus did not agree with the District and change values if there was consensus within the breakout group over the change and the new value. These Tables are included as Attachment 4. The following are the breakout group consensus comments for each hydropattern project by area.

A. Water Conservation Area East-3A

1. Some factors are redundant (soil protection, water purification, diversion of nutrients) and inappropriate

2. Current Plan for long term animal communities go from 0 to + as animal communities move into the new habitat it will become a positive. In a current "no action" condition plant and animal communities are adapted to current conditions so any changes may have a negative affect

3. Criteria for animal communities disturbance usually increases abundance and diversity even if it does not remain stable.

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4. Include information and figures to show regional conditions and data.

5. Regional information needs more support for back-up explanation.

6. Use as factors for animal communities similarities to native reference community structure.

7. Factors for Animal Communities should be reworded A) Drop wildlife habitat since this really refers to healthy vegetative communities B) Drop biological diversity and abundance- may be more undesirable species in high phosphorous environments that would show up as a false positive for high biological diversity.

8. Criteria -- Animal Communities- Disturbance usually increases abundance and diversity even if it does not remain stable.

9. WCA-3 antecedent soil conditions are different from WCA-2 re: soil [P], disturbance water depth/hydroperiod is factor which may override [P] in water, needs to be addressed (re: Newman *et al.*, 1996)

10. Evaluation of "No Action" plan was based on knowledge of the future everglades demands will reduce hydroperiods and the volume of water delivered to WCA-3A

11. Much of the impacts depend on factors unaffected by STA construction (ie. water availability, regional restoration efforts, water supply planning options, rainfall cycles).

12. Table 4-1 peat and marl accretion in impact zone.

13. By-pass long term assumptions are that hydroperiod restoration would be instituted in 2007 when background levels [P] are attained without a description of how these levels will be reached.

B Water Conservation Area west-3A:

1. Definitions of time frames (short and long) are serious issues that need resolution.

2. How can water qualities improve in "Long Term" for "No-Action" and for "By-Pass" ?

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3. Keep discharge until background water quality levels can be delivered.

4. Map of impacted areas in error. It shows impacts only on the north east side of Miami. Should also show on the south West side.

C. Rotenberger Tract

1. Add column to Table 6.3 which defines local as all of Rotenberger (not just the impact zone). Cattail expansion is likely in areas other than the discharge area.

2. Question short term impact on water quality of the Current Plan alternative (Current condition is unknown.).

3. Long term impacts of the "By-pass" option should be similar to that of the Current Plan.

4. Where does the 4.8 million dollar cost associated with the"By-pass"option come from?

D. Water Conservation Area-2A

1. Documentation behind methodology needs to be clarified.
2. Table 1-1 and 1-2, must add reduction of severity of fires.
3. Benefits to diversity to regional but negative to regional(sic).
4. Customize matrix to WCA-2A
5. Antecedent Conditions (sic)
6. Table 6-1 No Action and By-Pass should be the same.
7. Matrices, add points:
   5. Compliance with Tribal (sic)
   6. Remove "proposed modified"
   7. Tribal Lands

Evaluation of....

8. By-pass option — **Local**= where the water goes; **Regional**= includes where the water is diverted from.

9. If Cattail management is effective - long term impacts for Current Plan is 0 if not, ...

10. Evaluate based on the long-term going d/s (sic) of hydroperiod restoration components; but the impacts must be considered in the same local area

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VIII. Action Items and Changes in Methodology

Participants were asked to provide consensus comments on action items for the next workshop. The following are group consensus items.

1. Change wording of Factors to reflect "more natural" or reference communities in place of diversity and abundance.

2. Customize matrices for different regions versus local areas. Customization should reflect scale and region.

3. Tables on antecedent conditions should be the same for all options- Gary's response: antecedent conditions are different because each option defines a different area. Needs to be better explained in text.

4. Check antecedent conditions table for "No Action" and "By-Pass", these should be the same Table 6-1.

5. Gene Duncan add compliance with Tribal Law and the Federal Indian Land Claimant Settlement Act.

6. Consider Adaptive Assessment in detail in the next workshop on August 5th.

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Attachment 1: Agenda

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Attachment 1

FIRST PUBLIC HYDROPATTERN RESTORATION TECHNOLOGY WORKSHOP

AGENDA

1. Workshop Introduction
   - General Background
   - Meeting Structure

2. Video

3. Technical Plan Overview
   - General Discussion
     - Current Plan
     - No Action Alternative
     - By Pass Alternative
   - Group Discussion and Comments on the Technical Plan

4. Methodology and Adaptive Assessment Overview
   - Presentation and Methodology
   - Discussion of Methodology
   - Questions and Comments on Methods and Adaptive Assessment

5. Lunch Break

6. Presentation of Alternative Methodology

7. Breakout Discussion of the Four Project Tables
   - Water Conservation Area EastA
   - Water Conservation Area Westa
   - Rotenberger Tract
   - Water Conservation Area

8. Action Items and Changes in Methodology

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Attachment 2: Evaluation Criteria

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Attachment 2:

Evaluation Criteria and Associated Hydropattern Factors

Evaluation Criteria	Factors
Vegetation Communities	• Floating and benthic periphyton • Conversion to cattails • Biological abundance and diversity • Wildlife habitat
Animal Communities	• Biological abundance and diversity • Wildlife habitat
Drainage characteristics	• Organic Soil protections • Fires • Aquifer recharge • Water purification • Phosphorous cycling
Groundwater interaction	• Water purification • Aquifer recharge • Organic soil protection
Water quality	• Phosphorous cycling • Water purification • Soil enrichment • Diversion of nutrient loads
Organic soil preservation	• Soil enrichment • Organic soil protection • Reduction of fires • Diversion of nutrient loads

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Attachment 3: Conclusions of Kadlec and Walker paper

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Simulations of Phosphorus Concentrations in Water Column & Soil Downstream of Everglades Stormwater Treatment Areas.

by

W. Walker & R. Kadlec

for

US Department of Interior

July 19, 1996

Draft Conclusions

1. The STA design model (Walker,1995) has been modified to include mass balances on the water-column and surface soils in the areas downstream of hydropattern restoration facilities. Impacts of hydropattern restoration facilities have been assessed by comparing simulated spatial and temporal increases in soil P levels with threshold criteria associated with cattail expansion.

2. Soil P thresholds for cattail expansion estimated from observed spatial variations in soil P and vegetation in WCA-2A and WCA-1 range from 610 to 990 mg/kg for a 10 cm soil depth and from 540 to 720 mg/kg for a 20 cm soil depth. Errors in predicting vegetation types based upon observed soil P levels range from 1% to 19%. Site classification errors are higher when soil P criteria are expressed on a volumetric basis (mg/cm^3).

3. The model successfully predicts observed spatial variations in soil phosphorus concentrations below the S10's, averaged over soil depths of 10 and 20 cm after ~28 years of loading (1962 - 1990). Observed cattail expansion during this period is best simulated with a soil column depth of 20 cm and threshold soil P value of 720 mg/kg. Model simulations using a 10 cm depth and threshold of 610 mg/kg consistently over-predict observed cattail expansion during the first 20 years of discharge are likely to generate conservative estimates of cattail expansion below the STA's over a similar time frame.

4. The steady-state solution of the model yields a linear relationship between long-term average, flow-weighted-mean, water-column concentration and equilibrium soil phosphorus concentration. Under continuously wet conditions, water column concentrations ranging from 10 to 50 ppb correspond to equilibrium soil P levels ranging from 612 to 1211 mg/kg. For the same concentration range, times required to achieve equilibrium soil P levels range from 48 to 19 years,

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respectively, for a 10-cm soil depth and from 96 to 38 years for a 20-cm soil depth. Equilibrium soil P levels decrease and response times increase as hydroperiod (fraction of time soil is wet) decreases.

5. When the STA's are operationing, water-column concentrations in the areas immediately below the STA discharges will increase fom background levels (< 10 ppb) to ~50 ppb. Soil P levels will increase over time scales which are long in relation to expected 4-8 year duration of 50 ppb discharges. Equilibration of soil P levels with 50 ppb water will require ~20 and ~40 years for soil column depths of 10 and 20 cm, respectively.

6. Primarily because of lower initial bulk densities (reflecting historically wetter conditions), soil P levels downstream of STA-2 will respond faster than soil P levels downstream of the other STA's. Times required to exceed the most conservative soil P criterion (10 cm soil depth and 610 mg/kg) range from 5 years for STA-2 to 13 years for STA-6. Times required to exceed the soil P criterion which best reproduces the initial 20-year cattail expansion in WCA-2A (20 cm depth and 720 mg/kg) range from 17 to 42 years.

7. When Phase II controls are implemented in 2007, simulations indicate that soil P levels downstream STA-2 will exceed the most conservative soil P criterion (10 cm, 610 mg/kg) for a distance of ~1 km and area of ~1200 hectares. If the 50 ppb discharge were to be continued past 2007, exceedence of the 20 cm, 720 mg/kg criterion would not occur until 2016, well after implementation of Phase II controls. Simulations indicate that neither soil criterion will be exceeded below STA's 34, 5, or 6 within the relevant time frame.

8. Particularly in the case of STA-2, the model is thought to generate conservative estimates of soil and vegetation response for the following reasons:

   a. In the early years of the project, a portion of the phosphorus removed from the water column will not reach the soil, but will be stored as increased plant biomass. As a result, soil P responses will be slower than predicted by the model.

   b. To the extent that spread of cattails is controlled by fragmentation of existing populations (Wu et al., 1996), the rate of cattail expansion would be lower than that predicted based only upon soil P levels.

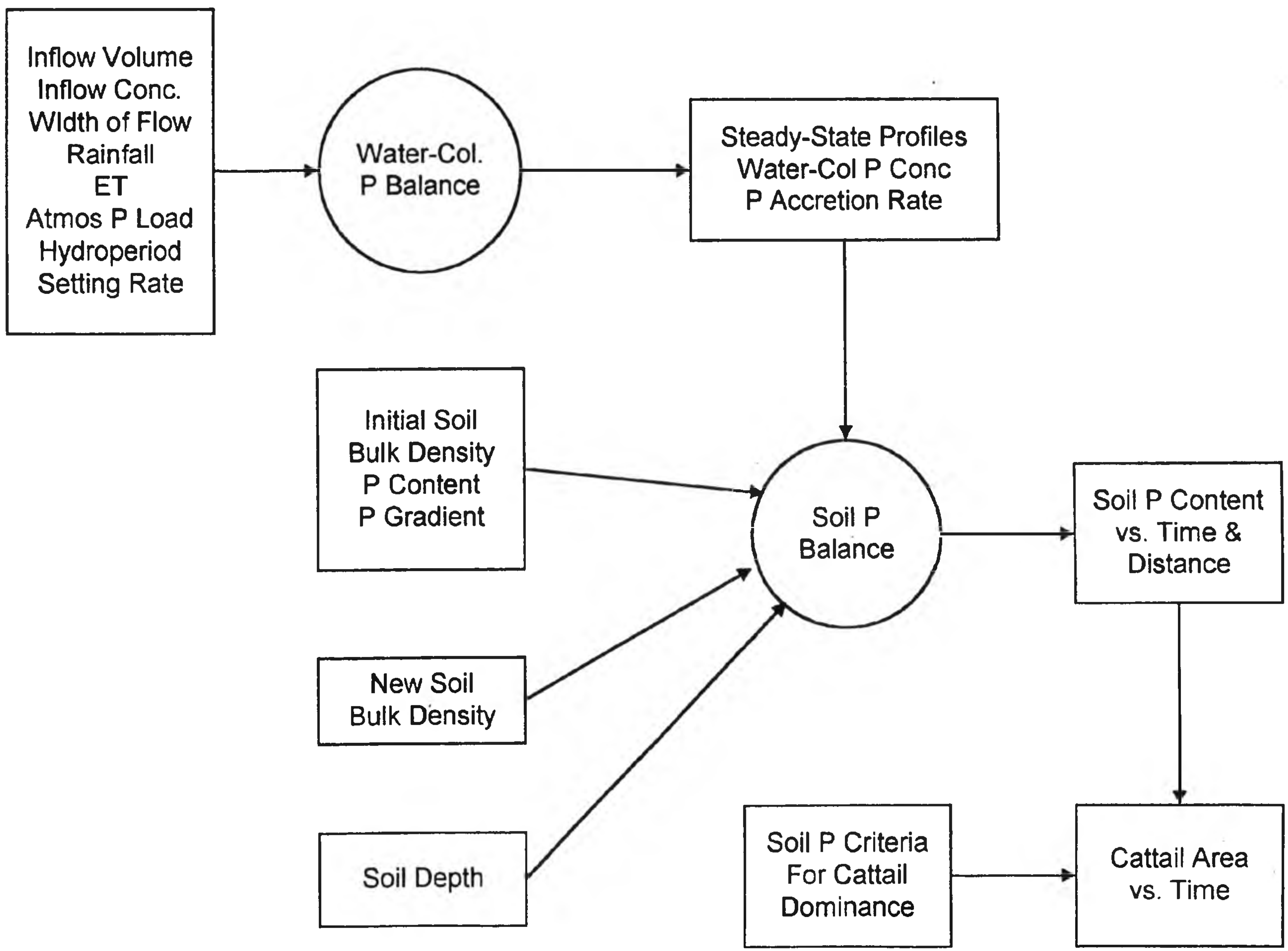
   c. Soil threshold criteria for invasion of cattails into well-established sawgrass communities (e.g., discharge zone for STA-2) may be higher than criteria estimated from historical WCA-2A and WCA-1 data, which primarily reflect invasion into slough communities.

d. Recent projections of STA performance accounting for revised BMP load reductions and seepage (Brown & Caldwell, 1996) indicate average outflow concentrations in the range of 31 to 44 ppb. If this performance is realized, impacts on soil P levels would be lower than those predicted assuming a 50 ppb discharge concentration.

9. If cattail communities actually respond to changes in volumetric soil P content (mg/cm^3) instead of mass content (mg/kg), considerably different results would be obtained. Observed soil phosphorus and vegetation patterns in WCA-2A suggest a volumetric threshold criterion of ~0.06 g/cm^3 for a 10-cm soil depth. Because of high bulk densities (0.18 to 0.23 g/cm^3), soils in the discharge zones of STA's-34,5,& 6 have initial volumetric P concentrations (.08 - .10 mg/cm^3) which exceed the 0.06 mg/cm^3 criterion. Significant changes in volumetric P content in these areas are not expected to result from discharge of 50 ppb water. If a volumetric criterion is appropriate, these areas would be at risk for cattail expansion at any time, regardless of phosphorus concentrations in the inflowing waters. Since observed vegetation patterns in WCA-2A and WCA-1 are more strongly correlated with soil P content expressed on a mass basis, however, there is no evidence to suggest that a volumetric criterion is more appropriate.

10. Impacts on other ecological components (e.g., bacteria, algae, and periphyton) may result from increases in water-column P concentrations. Simulations indicate that water-column concentrations would exceed 10 ppb for distances ranging from 1.8 to 8.6 km downstream of the STA discharges. Such impacts are likely to be more reversible than impacts caused by increases in soil P because water-column P concentrations are more responsive than soil P concentrations to changes in external loading. These impacts would be offset by corresponding decreases in water-column concentrations in areas which would otherwise receive discharges from the hydropattern restoration facilities. Overall, the project is expected to achieve substantial reductions in the area exceeding 10 ppb and in equilibrium soil P levels as a result of the substantial reduction in phosphorus load.

Model Structure



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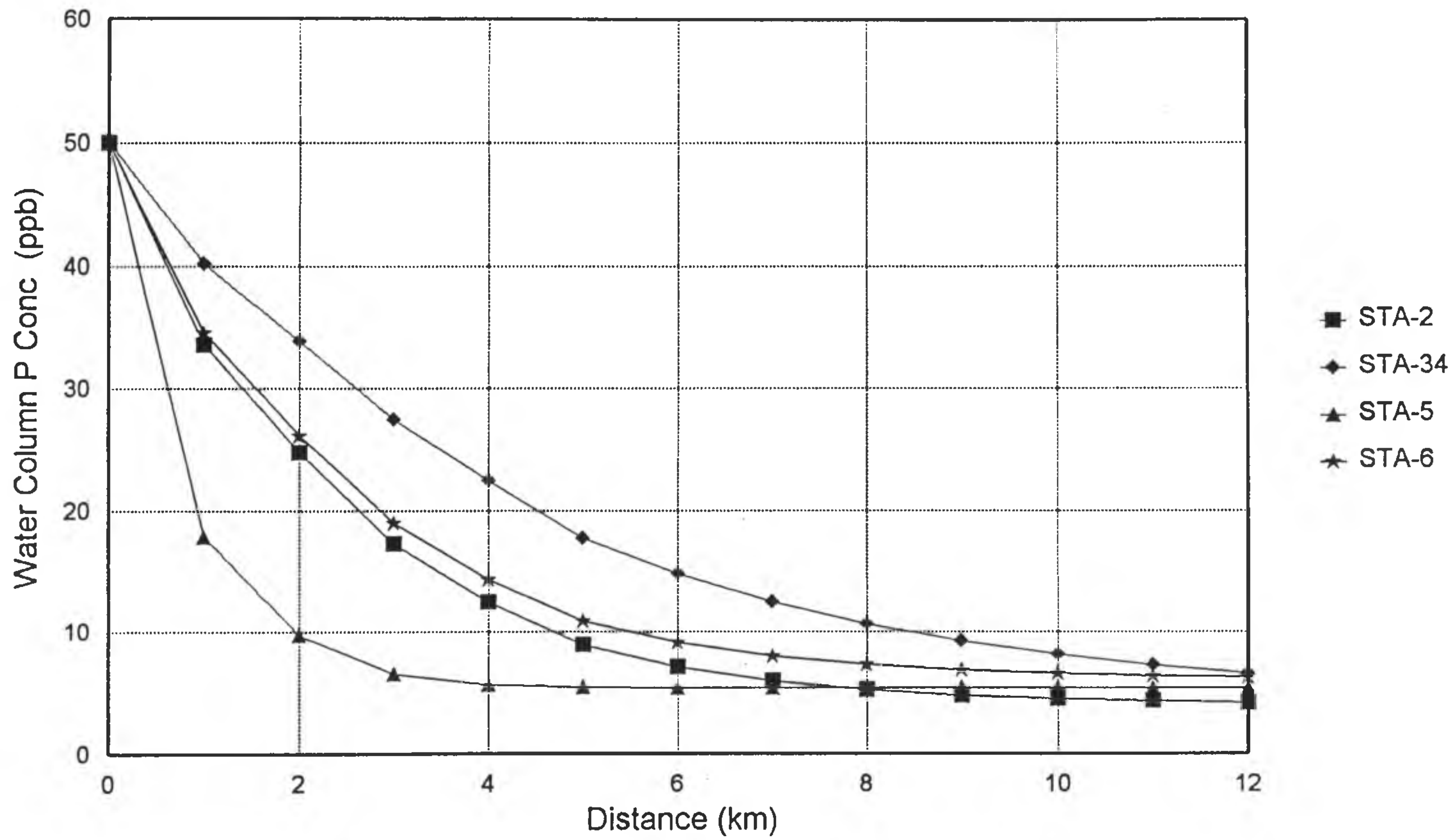
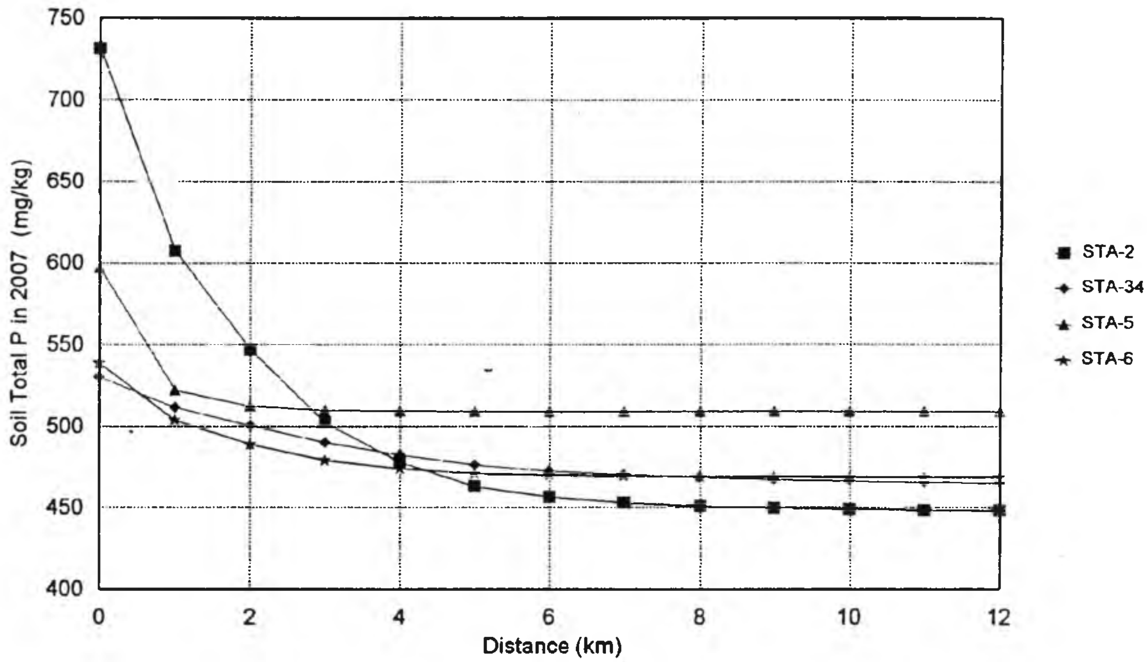
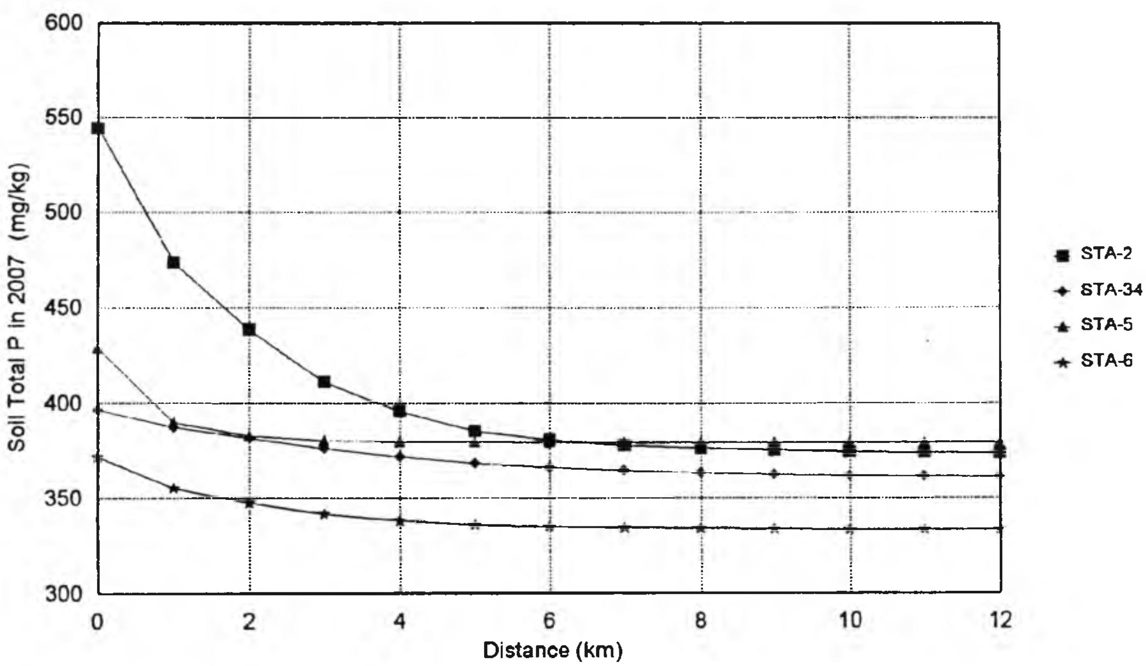
Steady-State Water-Column Phosphorus Profiles



Predicted Soil P Profiles in Year 2007



Soil Depth = 10 cm, Threshold = 610 to 990 mg/kg



Soil Depth = 20 cm, Threshold = 540 to 720 mg/kg

Attachment 4: Consensus Comments on Tables As Provided By Participants in Breakout Groups

TABLE 4-3. EAST WCA-3A HYDROPATTERN RESTORATION EVALUATION MATRIX

Evaluation Criteria	Current Plan		No Action		Bypass to S-7 and S-8	
Impact Zone:	536 - 1465 acres		1190 - 3250 acres		536 - 1465 acres	
Local (Impact Zone) Benefits/Impacts						
	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term
1. Vegetation communities	-	0	-	-	-	+
2. Animal communities	-	0	-	-	-	+
3. Drainage characteristics	+	+	0	0	0	0
4. Groundwater interaction	+	+	0	0	0	0
5. Water quality	-	0	-	-	-	+
6. Organic soil preservation	+	+	0	0	0	0
Regional (Everglades Protection Area) Benefits/Impacts						
1. Vegetation communities	+	+	-	-	-	-
2. Animal communities	+	+	-	-	-	-
3. Drainage characteristics	+	+	0	0	0	0
4. Groundwater interaction	+	+	0	0	0	0
5. Water quality	+	+	-	+	-	+
6. Organic soil preservation	+	+	-	-	-	-
Other Considerations						
1. Compliance with State Law	Yes		No		No	
2. Compliance with proposed modified federal Consent Decree	Yes		No		No	
3. Additional cost to implement	No		Deferred Costs		TBD	
4. Additional time to implement	No		No		TBD	

+ Indicates improvement over current conditions; 0 Indicates no measurable change; - Indicates degradation

DRAFT Summary

TABLE 5-3. WEST WCA 3A HYDROPATTERN RESTORATION EVALUATION MATRIX

Evaluation Criteria	Current Plan		No Action		Bypass to S-8	
Impact Zone:	198 - 540 acres		824 - 2251 acres		198 - 540 acres	
Local (Impact Zone) Benefits/Impacts						
	2007 Short-term	2017 Long-term	2007 Short-term	2007 Long-term	2007 Short-term	2017 Long-term
1. Vegetation communities	-	0	-	-	-	-
2. Animal communities	-	0	-	-	-	-
3. Drainage characteristics	+	+	0	0	0	0
4. Groundwater interaction	+	+	0	0	0	0
5. Water quality	-	0	-	-	-	+
6. Organic soil preservation	+	+	0	0	0	0
Regional (Everglades Protection Area) Benefits/Impacts						
1. Vegetation communities	+ ?	+ ?	-	-	- ?	-
2. Animal communities	+	+	-	-	-	-
3. Drainage characteristics	+	+	0	0	0	0
4. Groundwater interaction	+	+	0	0	0	0
5. Water quality	+	+	-	+ ?	-	+
6. Organic soil preservation	+	+	-	-	-	-
Other Considerations						
1. Compliance with State Law	Yes		No		No	
2. Compliance with proposed modified federal Consent Decree	Yes		No		No	
3. Additional cost to implement	No		Deferred Costs		$4.3 Million	
4. Additional time to implement	No		No		TBD	

+ Indicates improvement over current conditions; 0 Indicates no measurable change; - Indicates degradation

TABLE 3-3. WCA 2A HYDROPATTERN RESTORATION EVALUATION MATRIX

Evaluation Criteria	Current Plan		No Action		Bypass Option 1 and Option 2 — Bypass to S-6		Bypass to S-7	
Impact Zone:	644 - 1758 acres		1856 - 5067 acres		644 - 1758 acres		644 - 1758 acres	
Local (Impact Zone) Benefits/Impacts								
	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term
1. Vegetation communities	-	0	-	-	[illegible]	+	-	-
2. Animal communities	-	0	-	-	0	+	-	-
3. Drainage characteristics	+	+	0	0	0	0	0	0
4. Groundwater interaction	+	+	0	0	0	0	0	0
5. Water quality	-	0	-	-	0	+	-	+
6. Organic soil preservation	+	+	0	0	0	0	0	0
Regional (Everglades Protection Area) Benefits/Impacts								
1. Vegetation communities	+	+	-	-	-	-	-	-
2. Animal communities	+	+	-	-	-	-	-	-
3. Drainage characteristics	+	+	0	0	0	0	0	0
4. Groundwater interaction	+	+	0	0	0	+	0	0
5. Water quality	+	+	-	+	-	+	-	+
6. Organic soil preservation	+	+	-	-	-	-	-	-
Other Considerations								
1. Compliance with State Law	Yes		No		No		No	
2. Compliance with proposed modified federal Consent Decree	Yes		No		No		No	
3. Additional cost to implement	No		Deferred Costs		$7-9 Million		$35 Million	
4. Additional time to implement	No		No		18-24 months		18-24 months	

+ Indicates improvement over current conditions; 0 Indicates no measurable change; - Indicates degradation

July 13, 1996 Working Draft - Comments Welcome!

bypass? long-term

Same as Bypass?

~~considered within the same area of Bypass~~

TABLE 3-3. WCA 2A HYDROPATTERN RESTORATION EVALUATION MATRIX

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Evaluation Criteria	Current Plan	No Action	Bypass Option 1 and Option 2 Bypass to S-6	Bypass to S-7

1. Documentation behind methodology needs to be clarified
2. Table 1-1, 1-2
   Reduction of Severity of Fires
3. Benefits to diversity to regional but (-) to regional
4. Customize matrix to WCA 2A
5. Antecedent condition
6. Table 6-1 No Action ~~Bypass~~ Bypass should be the same
7. Matrices:
   5. Compliance w/ Tribal
   6. Remove "proposed modified"
   7. Tribal Lands

Evaluation of
1. Bypass - Local = where the water goes
   Regional = includes where the water is diverted from
2. If cattail mgmt is effective - long-term impacts for Current Plan is 0, if not, ~~No Action and Bypass~~
3. Evaluate based on long-term going d/s to HR components; but impacts to be considered in same local area.
(?)

	-	-	-	-	-
	-	-	-	-	-
	0	0	0	0	0
	0	0	+	0	0
	+	-	+	-	+
	-	-	-	-	-

...nsiderations

		No	No	No
		No	No	No
3. Additional cost to implement	No	Deferred Costs	$7-9 Million	$35 Million
4. Additional time to implement	No	No	18-24 months	18-24 months

\+ Indicates improvement over current conditions; 0 Indicates no measurable change; - ~~Indicates~~ Degradation over current

No Action and Bypass options

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Local Impacts

	short-term	long-term
Short-term receiving site	as-is	as-is
avoidance site	(-) Current plan	Same as No Action, Bypass

Should all be (+)!! or (0) since both water and HR are roste

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Mtg: HydroPattern Restoration Workshop Date: 7/19/96

ATTENDANCE LIST Please Print

PARTICIPANT	ORGANIZATION	PHONE NUMBER	FAX NUMBER
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LORRAINE HEISLER	GFC	"	"
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Doug Morrison ✓	National Audubon	305-371-6399	-6398
Jimmy Brooks	DEP	904 921 9723	
Ted Jarrell	USFWS	732-3684	369-7190
Zhengdum Chen	SFWMD	687-6652	
Dale Gawlik	SFWMD		
Mark Kraus	National Audubon	305 371 6399	305 371 6398
H. Carl Fitz	SFWMD	686-8800 x 2032	

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Mtg: [illegible] Restoration Workshop Date: 7/1?/96

ATTENDANCE LIST Please Print

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[illegible]	SFWMD	687-[illegible]	
Bill Porter	COE	305 232-2253	
[illegible]	[illegible]FC	[illegible]	-6128
[illegible]	SFWMD		
Steve Reel	"		
Phil Parsons	FSCL	904-681-0311	
Steve Miller	SJRWMD	904-329-4357	
D. Swift	SFWMD		
Dean Powell	SFWMD	904/687-6787	
Herb Zebuth	FDEP	561 681-6665	
Dianne Owen	UF	954-565-3035	954 568-2311
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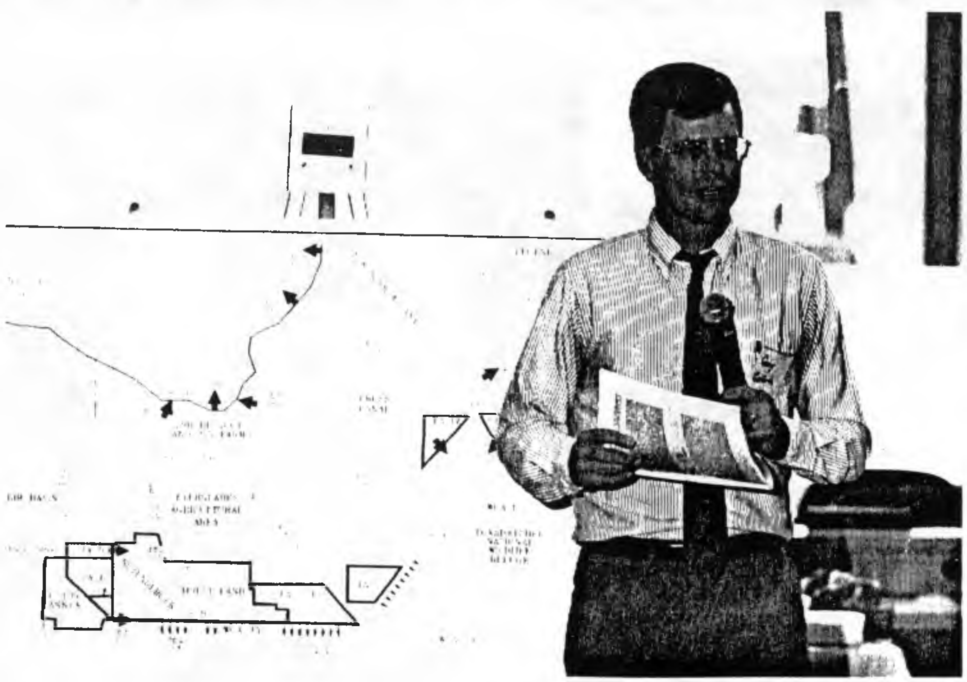
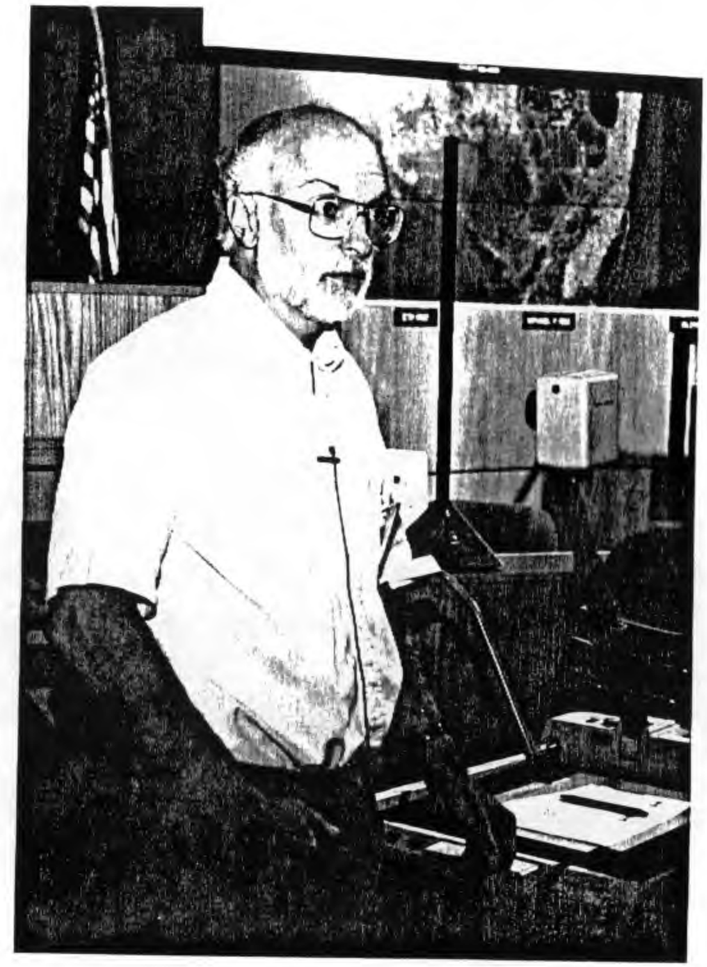
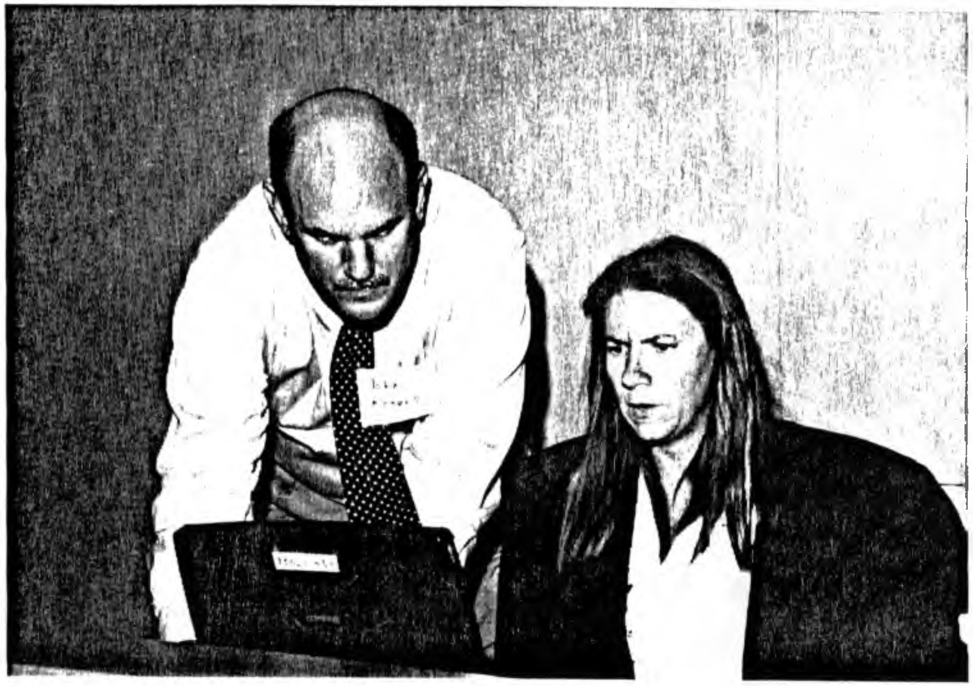
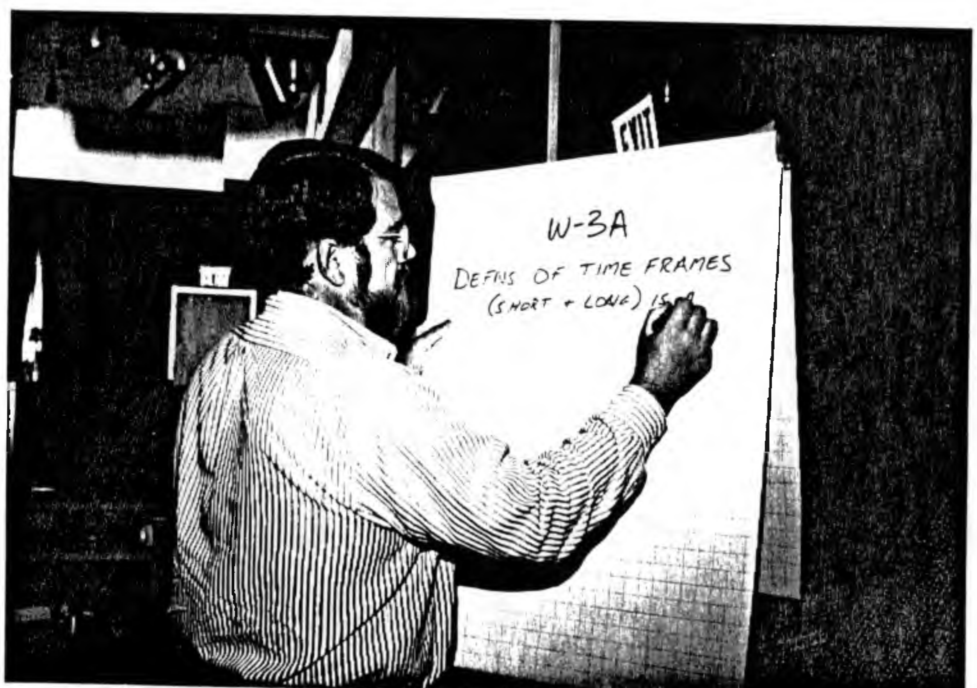
Alex Vazquez	~~Ate~~ Brown & Caldwell	407/471-0354	
Jennifer Jorge	SFWMD		
Mary Hudson Kelley	TEC	954 473-6180	
G F Goforth	SFWMD	687-6280	
Melissa Gross-Arnold	Lewis, Longman & Walker	640-0820	
Max W. Day	SFWMD	687-6247	
James Lee	SFWMD	687-6584	
Neil Larson	SFWMD	687-6292	
~~Gary Goforth~~	~~SFWMD~~	~~687-6282~~	
~~Bill Walter~~			
~~Rob Kohler~~			








W-3A
DEFNS OF TIME FRAMES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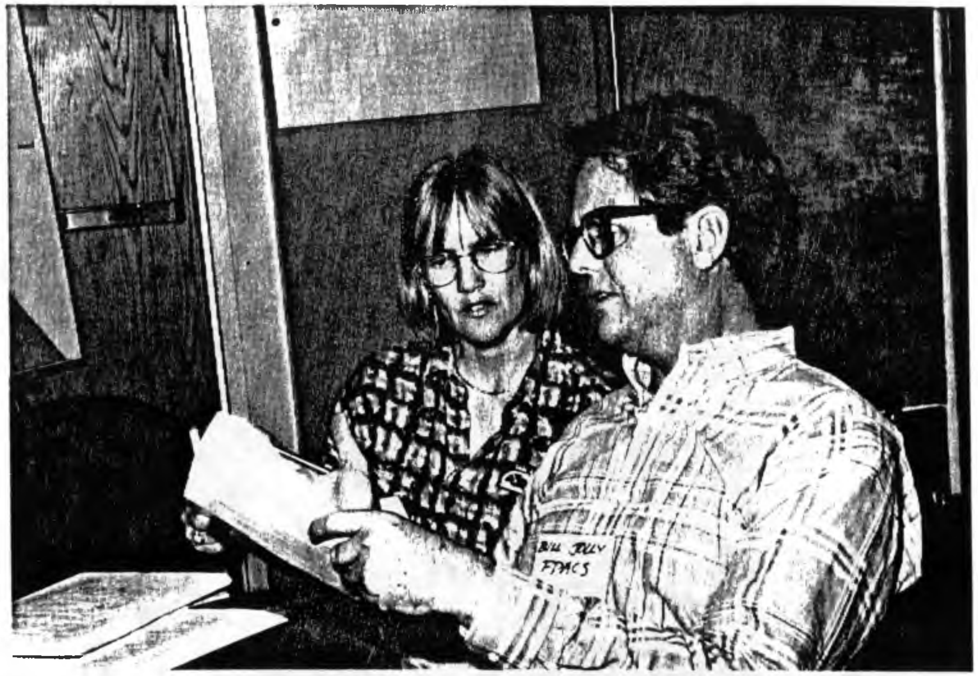
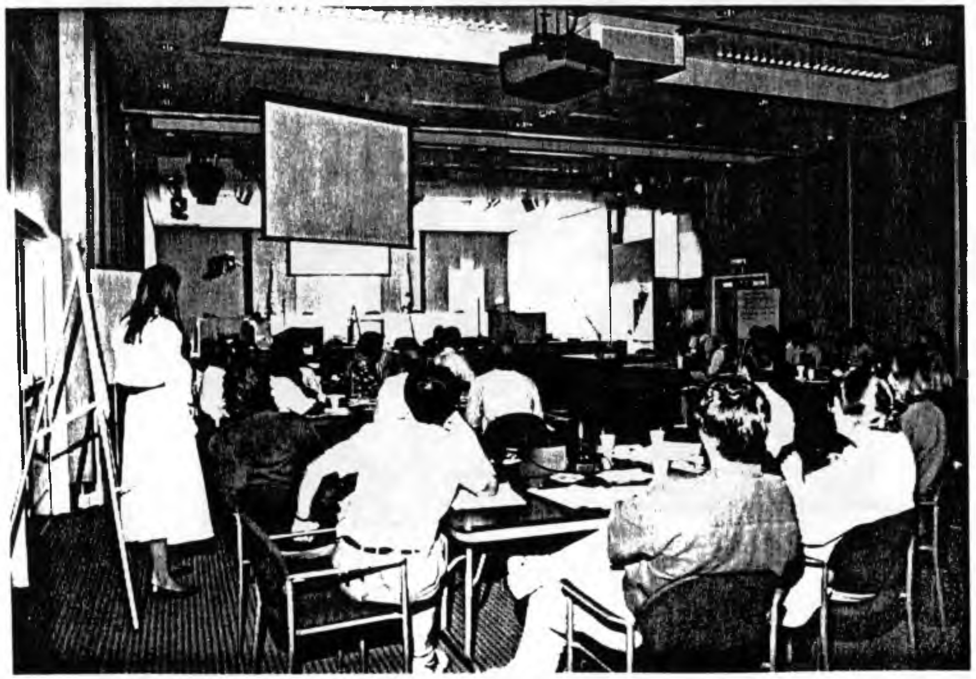

BILL JOLLY
FTACS

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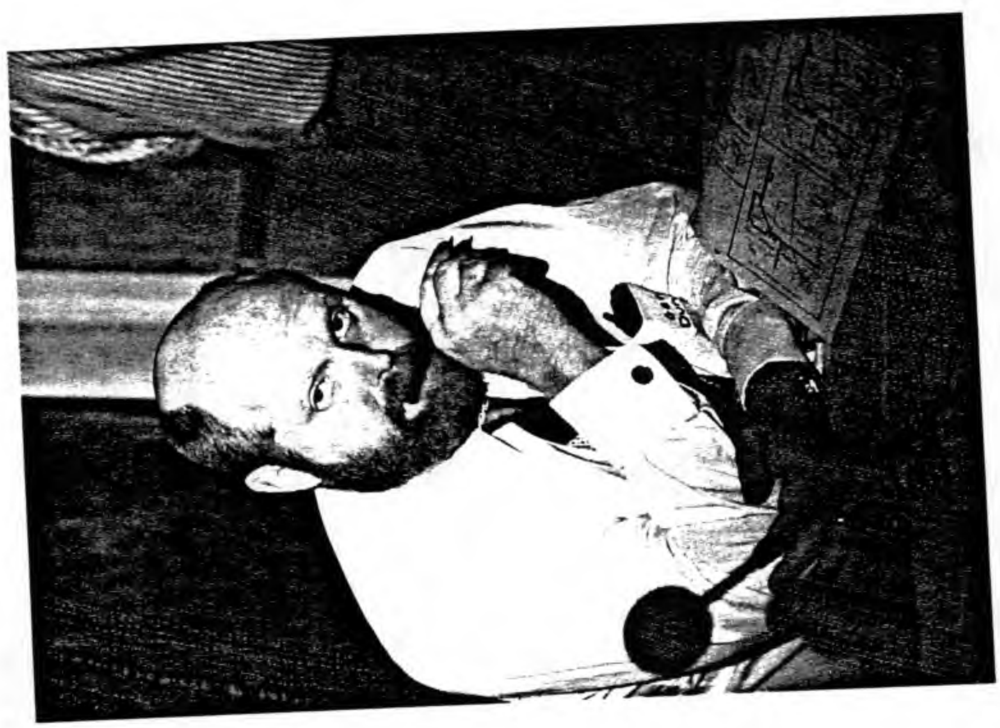

Attachment 7: Adaptive Assessment Presentation

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Adaptive Assessment Resource Protection Plan

- Reasonable assurance = best present information
  +
  adaptive assessment resource plan

- Adaptive assessment = acknowledgement of the imperfection of information used
  +
  a protocol for evaluating ecosystem response to restoration actions
  +
  a plan for improving knowledge bases and adjusting restoration decisions accordingly
  +
  a plan for scientific & engineering feedback

A Protocol for Evaluating Ecosystem Response to Restoration Actions

- Develop & implement a pre- & post operation monitoring plan

Vegetation communities:	transects & aerial/satellite photos
Animal communities:	Systematic Reconnaissance Flights, transects for fish & invertebrates
Soil & water column:	transects located downstream of spreader canals; monitor for nutrients, Hg, etc.
Hydrologic:	water depths & hydroperiods monitored and compared with SFWMM, NSM, ELM, etc.
Other parameters:	recommendations from Science Sub-Group and other organizations

A plan for improving knowledge bases and adjusting restoration decisions accordingly

- Conduct research on ways to reverse any adverse impacts
- Conduct research on downstream areas to further define relation between vegetation communities, phosphorus inputs, seed banks, antecedent conditions, water depth and hydroperiod.
- Construct models for predicting nutrient fate and transport and long term ecological effects, including possible trend reversals, of restoration actions.

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A plan for soliciting scientific & engineering feedback

- Workshops
- Informal discussions
- Presentations at professional societies
- Peer review of manuscripts
- Establishment of a web site
- Annual reports

APPENDIX 3

Summary of the Second Public Hydropattern Restoration Technology Workshop

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Summary of the
Second Public Hydropattern Restoration
Technology Workshop

held at the main offices

of the

South Florida Water Management District
3301 Gun Club Road
West Palm Beach, FL 33406

August 5, 1996

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Second Public Hydropattern Restoration Technology Workshop

Table of Contents

List of Attachments

Attachment 1:	Agenda
Attachment 2:	Water Management District Model Base Flows Map
Attachment 3:	Grid Cell Configuration from the LEC-SFWWM Output
Attachment 4:	Information to be Included in the August 16, 1996 Version of the District's Hydroperiod Restoration Plan
Attachment 5:	Slides Presented by Mr. Cal Neidrauer
Attachment 6:	Slides Presented by Mr. David Swift
Attachment 7:	Adaptive Assessment Presentation
Attachment 8:	Attendance List

I. Background

A. Purpose

This is the second public Hydropattern Restoration Technology Workshop. These workshops were designed to aid the South Florida Water Management District (District) in developing and reviewing hydropattern restoration components of the Everglades Construction Project (ECP). The document "Evaluation of Benefits and Impacts of the Hydropattern Restoration Components of the Everglades Construction Project" is designed to describe the proposed methods to achieve hydropattern restoration and associated benefits in conjunction with the ECP. Public input and participation are a critical step in the Federal 404 permit process and the Programmatic Environmental Impact Statement (PEIS) of the District's Everglades Construction Project.

B. Goals

The second public workshop was designed to achieve closure on issues introduced in the first public workshop and provide a substantive review of the Districts proposed Adaptive Assessment Methodology. The goals of this workshop were A) to review proposed modifications in the District's original strategy, B) to correct any misinterpretation or omissions from the first public workshop, and C) to provide substantive review of the proposed Adaptive Assessment Methodology.

II. Workshop Introduction

The workshop was introduced by Mr. John Rogers (Workshop Facilitator). This workshop agenda is included as Attachment 1. Mr. Rogers laid out the workshop as follows: comments, corrections or ideas from last meeting may be given to Ms. Sarah Bellmund. This agenda was to follow up on the last meeting and provide information on what actions are being taken in moving forward with information from the last meeting. This workshop was to include a short discussion on methodology of hydropattern benefits, and then was proposed to conclude with the methodology section with any additional thoughts or ideas on how to improve the methodology itself. The next portion of the meeting was proposed as a presentation on adaptive assessment methodology to be followed by breakout sessions focusing on the three areas of adaptive assessment, monitoring, modeling, and research. These groups will then make short presentations on their ideas and findings and the group will have an open discussion. The meeting then was proposed to conclude with a series of action items.

Dr. Gary Goforth began the workshop with an overview of the previous workshop's findings. The first workshop was very beneficial and the District received many comments. The District's document "Evaluation of Benefits and Impacts of the Hydropattern Restoration Components of the Everglades Construction Project" will be revised to address comments and the revised document will be available by August 16, 1996. The goal will be to mail to all attendees a copy of this document. Some of these comments have already been addressed, some are being addressed and some are still being evaluated. Some of these comments may be best addressed in other forums such as the Stormwater Treatment Area (STA) design workshop, the Everglades Technical Advisory Committee (ETAC) or other portions of the Technical Review process.

The Walker and Kadlec paper promised for review was still not available (as of August 5, 1996). It is being prepared for the Department of the Interior and is still being reviewed by Interior staff prior to official release. Dr. Tom Fontaine will work directly with Dr. Walker to attempt to incorporate as much of this methodology as possible in the existing process.

III. Summary of Hydropattern Benefits

Cal Neidrauer was introduced as senior supervising professional working on the South Florida Water Management Model (SFWMM). He introduced a handout on the water management district model base flows (Attachment 2.). Mr. Neidrauer works with Mr. Dave Swift, who discussed specific hydropattern restoration benefits. Attachment 3 shows a grid cell specification of the Water Management Model as requested from the first workshop. The package of information in Attachment 4 is information that will be included in the August 16 version of the update of the District's Hydropattern document. Mr. Niedraurer presented the results of the analysis to determine the likely changes in WCA (Water Conservation Area) hydropatterns resulting from the latest STA designs and the current operational intent of the ECP (Attachment 5- slide 1). An overview of the SFWMM is found in Attachment 5- slide 2. This model is an excellent tool for the simulation of proposed structural modifications in the system. The key SFWMM assumptions are found in Attachment 5- slide 3. These assumptions were derived from the projections and requirements of the Lower East Coast Water Supply Plan (LEC-WSP). It is based on a year 2010 projected land use planning horizon. Two simulations were run one using the current plan and one using a no-action (no ECP) using the exact same criteria. The primary reasons for differences between the SFWMM simulated flows and the flows using the ECP designs (in Attachment 2) are found in Attachment 5- slide 4. Mr. Niedraurer did not go into details however he said he would be happy to discuss this information in detail separately.

Dr. Goforth interjected that much of the differences between the ECP design flows and the simulated flows are based on assumptions on operational criteria which are not finalized and can be changed. This exercise has been good that it has identified differences which can be addressed. These are being reviewed and will be addressed in future planning processes. Mr. Neidrauer referenced information in the Chapter 7 of the February 1994 conceptual design document on intended operation saying that these are preliminary in nature an that these are meant to serve as a basis for initial hydrologic modeling. Mr. Swift then began a discussion of the differences in operation of the SFWMM with and without the ECP.

Dave Swift's presentation, as a follow up on discussions from the first workshop, was on the performance measures defined by the LEC process and designed to compare hydroperiod benefits of alternatives. The LEC Water Supply Plan is moving toward maintaining rainfall driven hydroperiods. He has worked on developing a means of quantifying the hydrologic benefits which may be derived from operating the system. He presented this proposed alternative method for evaluating hydroperiod benefits (Attachment 6). Mr. Swift redefined categories (Attachment 6-page 3) to be able to quantify a more natural, rainfall driven hydroperiod restoration. This new proposed method allows benefits to be credited if hydroperiod improves and moves toward a more rainfall driven system for more than 30 days even if it does not achieve Natural Systems Model targets. This is quantified on the map in Attachment 6- page 4. The explanation for the legend of this map is quantified on Attachment 6-

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page 5. The results from this analysis are shown on page 6 of Attachment 6 for the benefits of the ECP versus the No Action Plan for Hydroperiod. The logic for choosing ±30 days is that this is seen as a significant window of time from an ecological viewpoint.

Dr. John Davis asked, What did that majority grey area on the map represent? Mr. Swift answered that they represent 'no change' and not a significant differences between the ECP and the No ECP simulations. Bill Walker asked why choose 30 days why not use 15 days or 7 days. Mr. Swift's answer was that generally this was a rough means of showing this information and that shorter periods of time were much more ephemeral and that, in general the 15 day picture was roughly the same as the 30 day picture. The 30 day period was seen as one that would be lasting and represent more real benefits or impacts. Mr. Niedraurer said that they had reviewed histograms for several time frames and that this data can be reviewed if anyone is interested. The District's proposal to address areas which are not seen a having a benefit are shown in Attachment 6, page 7.

Dr. Davis questioned the accuracy of the model since it showed cells juxtaposed to each other with substantially different hydroperiods and that a 2x2 mile area is really an accurate representation. Mr. Swift said that this was in most cases due to a very short change of time where it may exceed the criteria by 2 or 3 days rather than a large period of time. Mr. Tom McVicar asked about two cells near the Miami Canal where they are shown as overshooting the NSM and are next to some large areas which area shown as too dry. Mr. Neidrauer answered that this was due to the way the post processing program worked and how it dealt with areas that have water levels which start too high (above the NSM) and then go below the NSM where the other areas are actually drier and then get even drier. Mr. McVicar said that the modelers may want to use other values rather than mean years because the system will allow much more flexibility and operational changes if non-mean years were used. It is possible to route water differently and this may actually result in bigger benefits if there is more operational flexibility. Mr. Niedraurer said that this was a good idea and that it was the direction the planning process intended to review. This really fell within the general area of operational criteria and that it should be considered when operational schedules were developed. Mr. McVicar said that some of the apparent reductions may actually be improvements due to operational flexibility. Mr. Niedraurer said that as part of the Seminole Water issue and the design of STA 5 and 6/Rotenberger was the need to possibly increase the size of the G-404 pump station as a means to get more of the flows out into the northwest WCA-3A.

Blake Sasse from the Florida Game and Fresh Water Fish Commission (FGFWFC) asked if the numbers for the Rotenberger Tract included the STA. Mr. Swift answered no, that the reason the acreage was so high was that some areas included canal overlap during the rough calculation of the output from the SFWMM. Mr. Sasse suggested that all of Rotenberger will not be a hydroperiod improvement in reality Rotenberger is only 28,000 acres and the area that will be improved may really not be the entire area. He suggested that the District use the Game Commission Schedule as a target rather than the NSM. Mr. Niedraurer said that a schedule is different than a hydroperiod and that surprisingly the hydroperiod resulting from the NSM is very similar to the hydroperiod resulting from the Game Commission schedule. The LEC plan is using the restoration of natural rainfall driven hydroperiods as a means of achieving a more natural system.

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IV. Comments from Methodology Section of First Workshop

Mr. Rogers turned the system over to the audience for any suggested improvements in methodology that may have arisen from last week. Dr. Bill Walker asked if there was any consideration given to delays and the impacts that may be caused to the system by delays. One scenario he proposed was that if one alternative which is that it is more favorable to hydropattern restoration is suggested, however that this may cause a time delay which causes increased impacts due to phosphorus. Dr. Goforth answered that this issue was considered as an example, on page 31, the table showed the additional cost and additional time to implement. Dr. Walker said that the delay could also be estimated as ecological impacts and that additional cost could be estimated and added to the cost of impacts.

Dr. Mike Zimmermann (Everglades National Park) said that the impacts of 50 ppb will not only result in cattail changes but will also result in changes in the other communities including microbial communities that will be more sensitive to changes than will cattails. This is of more of a concern when considering the build up of phosphorus in the sediment and the equilibrium that exists between phosphorus in the sediment and phosphorus in the soil. This equilibrium will continue even when the inflows of phosphorus stop so that the changes in periphyton can be expected for far longer. In addition, it is important to look at other plant communities beyond sawgrass, particularly periphyton and macrophytes. Dr.Walker answered that his work was a surrogate for organisms that respond over the same range of phosphorus concentrations but that this work is still under review.

Blake Sasse asked that the information from the cattail expansion in the Holey Land to be used in addition to the cattail expansion rate for WCA-2A.

V. Adaptive Assessment Break-Out Groups

1. General Description

Dr. Tom Fontaine presented a summary of the Adaptive Assessment program as presented in Section 7 of the document "Evaluation of Benefits and Impacts of the Hydropattern Restoration Components of the Everglades Construction Project" (Attachment 7). This included a means of evaluating the results providing reasonable assurance and using adaptive assessment. Development of a monitoring plan includes the following components; vegetation communities, animal communities, soil and water column information, hydrologic information, and other parameters. This involves research to further define relationships and modeling to predict changes that may occur. The District's plan for scientific feedback includes; workshops, informal discussions, presentation at professional societies, peer review of manuscripts, establishment of a web site, and annual reports. John Davis said that he did not see this as fitting in the regulatory process and that the regulatory process would define the criteria. Permitting processes must include quantitative reasonable assurance. Dr. Goforth agreed that this is not a standard regulatory process, and the adaptive management strategy was being proposed to deal with the scientific uncertainty of the projects. This approach has been used in the Department of Environmental Protection (DEP) and National Pollutant Discharge and Elimination System (NPDES) permits for the Everglades Nutrient Removal (ENR) Project. The Corps of Engineers had dealt with the uncertainty of permitting in creative ways in the past, such as in the C-111 GRR and the Modified Water Delivery to Everglades National Park (ENP) projects.

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2. Break-Out group results

Break-out groups were divided into Research, Modeling, and Monitoring. The consensus comments on structure by the group is presented under each heading. The groups were asked to consider 1) What actions should be included in the process, 2) Prioritize Activities, 3) Define appropriate feedback. Activities that were prioritized are listed with a (1) for Research and Monitoring, this indicated a high priority. Unfortunately no other prioritization was listed by the groups and the Modeling group did not provide any prioritization beyond saying that the list was roughly in order of priority.

A. Research:

Activities included in program[(1)---indicates high priority]

1. **Leading indicator**
   - Use monitoring measures
   - Targets
   - Process for determining and refining targets (underway)
2. **Deterministic models**
3. **Experiments**
   - **Potential Impacts**

     (1) soil water interaction

     (1)mesocosum in northern 3A

     (1)Resistance of vegetation types to change

     Seed bank germination studies

     Effects of fire on establishing antecedent conditions and different measures of vegetation

     Chemical speciation of soils

     Ecological importance of indicators
   - **Active managers**

     Research on control of impacts (active management)
   - **Recovery**

     Reversibility of impacts

     Water column versus soil

     Research on vegetation response to hydroperiod changes

     NSM goals

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4. **Baseline development**
    - characteristics of soil
    - vegetation pattern
    - Animals
5. **Defining actions on levels**

Feedback mechanism

1. **Monitor specific components**
    - time line
    - interested people including other active researchers, people monitoring and modelers
2. **Interagency Groups and Stakeholders**
    - annual review of information
    - Participation by existing working group
3. **Notification of trends and changes (these are defined in research)**
    - formulate and recalibrates models

B. Modeling:

Activities included in program

1. **Modeling**
    - Baseline data must be planned as soon as possible
    - Strategic modeling plan needs to be developed

      Local and regional

        Water budget-hydrologic

        Water quality--processes

        Biological responses
    - More detailed ground data
    - Research to refine processes and responses
    - Experimental and synoptic approach for integration into modeling (tree islands
    - Measure climatic input
    - Access climate change importance

2. **Modeling Process**
    - Sensitivity analysis/uncertainty analysis (risk)
    - Verification
    - Calibration
    - Integration of operations
    - Operational plan
    - Linkages to regional models
    - Merging LECWSP & ECP and restudy

DR...

3. **Data Processing**

- Need for clear cataloging of "who is doing what" (solve informational overload)
  - Identify missing pieces
  - See big picture across agencies
  - Then prioritize activities

- Model extreme conditions

Flood, Drought, Fire

- Operation sensitivity

4. **Need easily modifiable models**

- Developed modified operational plans based upon models
- Research feedback
- Feedback-modeling research monitoring

5. **Establishment of criteria**

- For success or failure (spatial temporal) that would direct operational or other changes based upon model predictions

C. Monitoring:

Activities to be included in the process

1. (1)Clearly define objective for monitoring
   - What about the ecosystem do you want to know and understand
   - Design monitoring to give the answer to necessary questions
   - Best define the Benefits and Impacts

2. (1)Define Monitoring Program based on Site Specific measures for long term and short term changes

   - Define site specific chemical measures for water and soil quality
   - Define site specific animal measures
   - Define site specific vegetation measures
   - Define hydrologic site specific measures in conjunction with numbers 1,2&3 (of above)
   - Research needs may be identified as a result of information from the previous four steps

3. (1)Clearly define baseline or reference conditions (in coordination with other researchers monitoring and modeling programs to find out what exists)
   - Define reference communities
   - Define Key Indicators and point of entry for early warning information to prevent or correct impacts
   - Define components of these communities of interest including: Vegetation, Animals, Water /Soil (sediments) Quality Parameters, and Hydroperiod.

B. Feedback Mechanisms

1. Analyze all data from monitoring and provide a report with a review of its importance with respect to adjustments which need to be made to the system.
2. Create a structure (which utilizes existing committees and working groups as possible) to provide information, management and scientific evaluation of information collected.
3. Provide a means to implement changes in operational schedules based on monitoring (go to A again).

VI. Action Items

Dr. Goforth closed the workshop by announcing the Public Workshop on all Technical Issues Involved in the Programmatic Environmental Impact Statement (PEIS) in the District auditorium from 5 pm to 9 pm on August 22, 1996. This will include all technical issues raised to date. The District is attempting to finish the PEIS in the next month and a half and would like all public input.

VII. Additional Comments

Dr. Davis indicated a concern that the District's monitoring, research, and modeling for the ECP may be identified and controlled by the permitting process. This could possibly circumvent the District board such that the amount of money spent will be defined by permitting process.

Mr. Blake Sasse of the FGFWFC said that negative impacts on wildlife and vegetation in the Brown's Farm Water Management Area (WMA) need to be addressed in the section on STA-2.

Attachment 1: Agenda

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Attachment 1: Agenda

I. Workshop Introduction

II. Summary of Hydropattern

III. Comments from Methodology Section of First Workshop

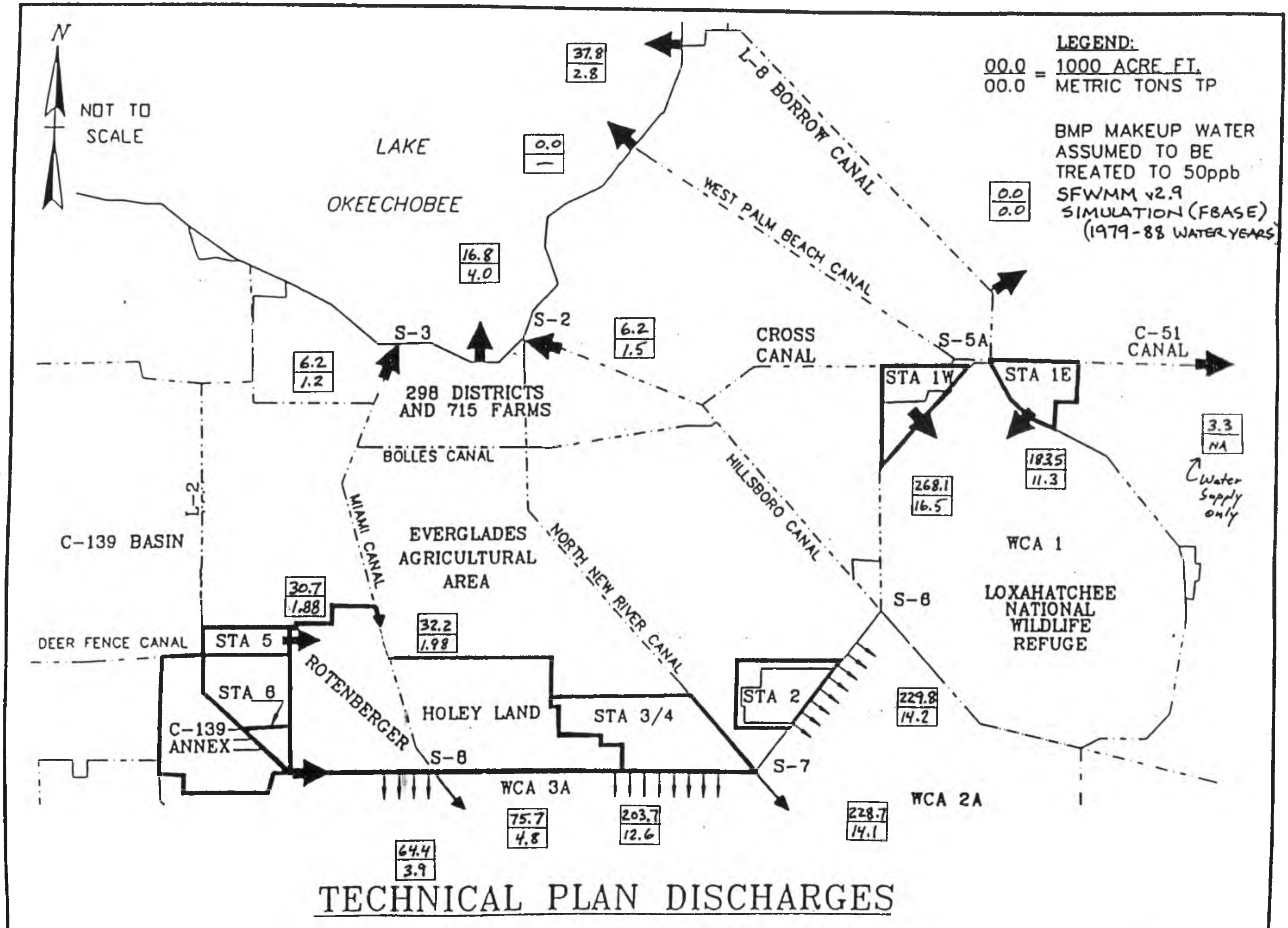
IV. Adaptive Assessment Break-Out Groups

1. Group Discussion

2. Comments

V. Action Items

Attachment 2: Water Management District Model Base Flows Map



TECHNICAL PLAN DISCHARGES

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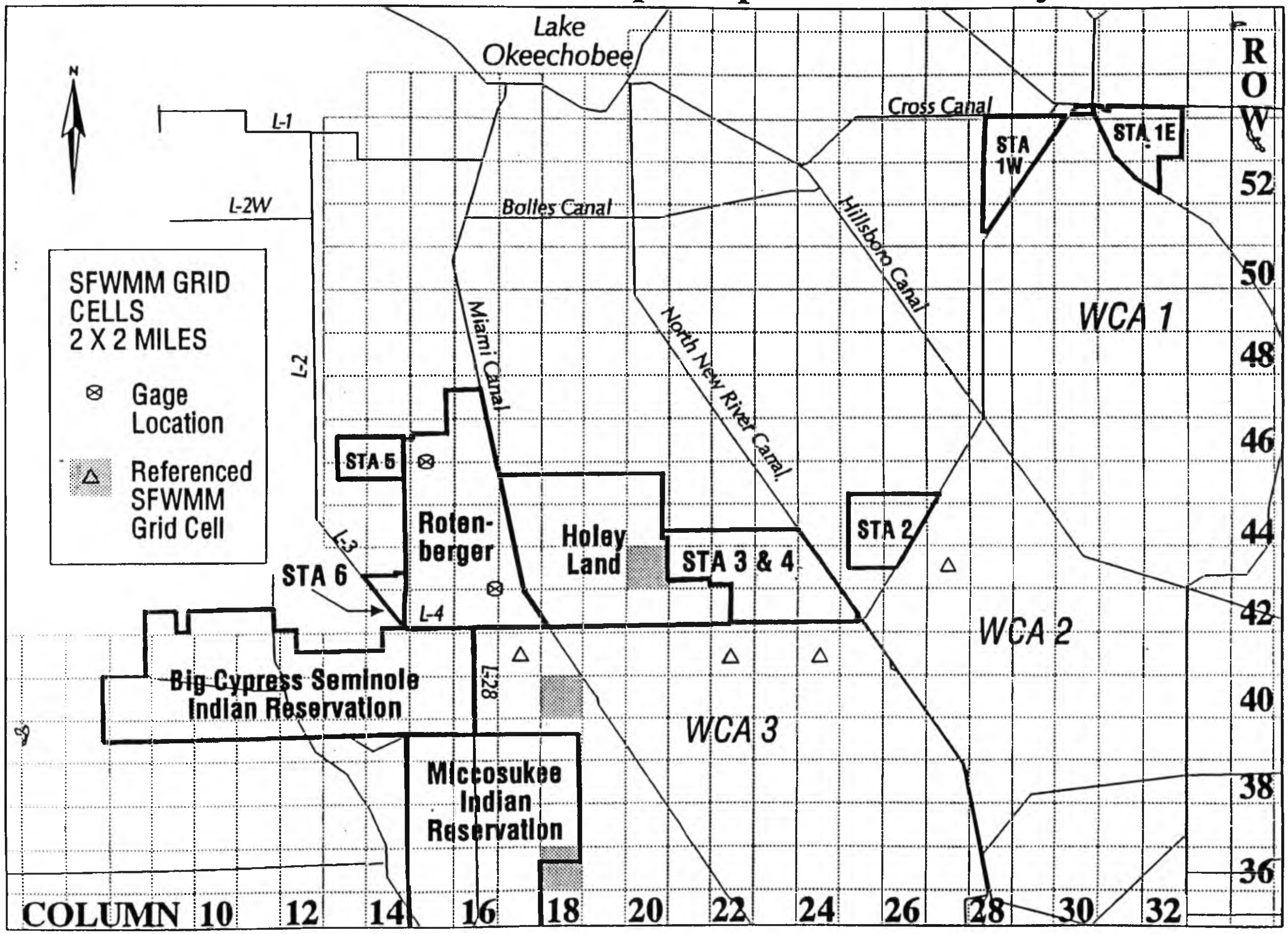
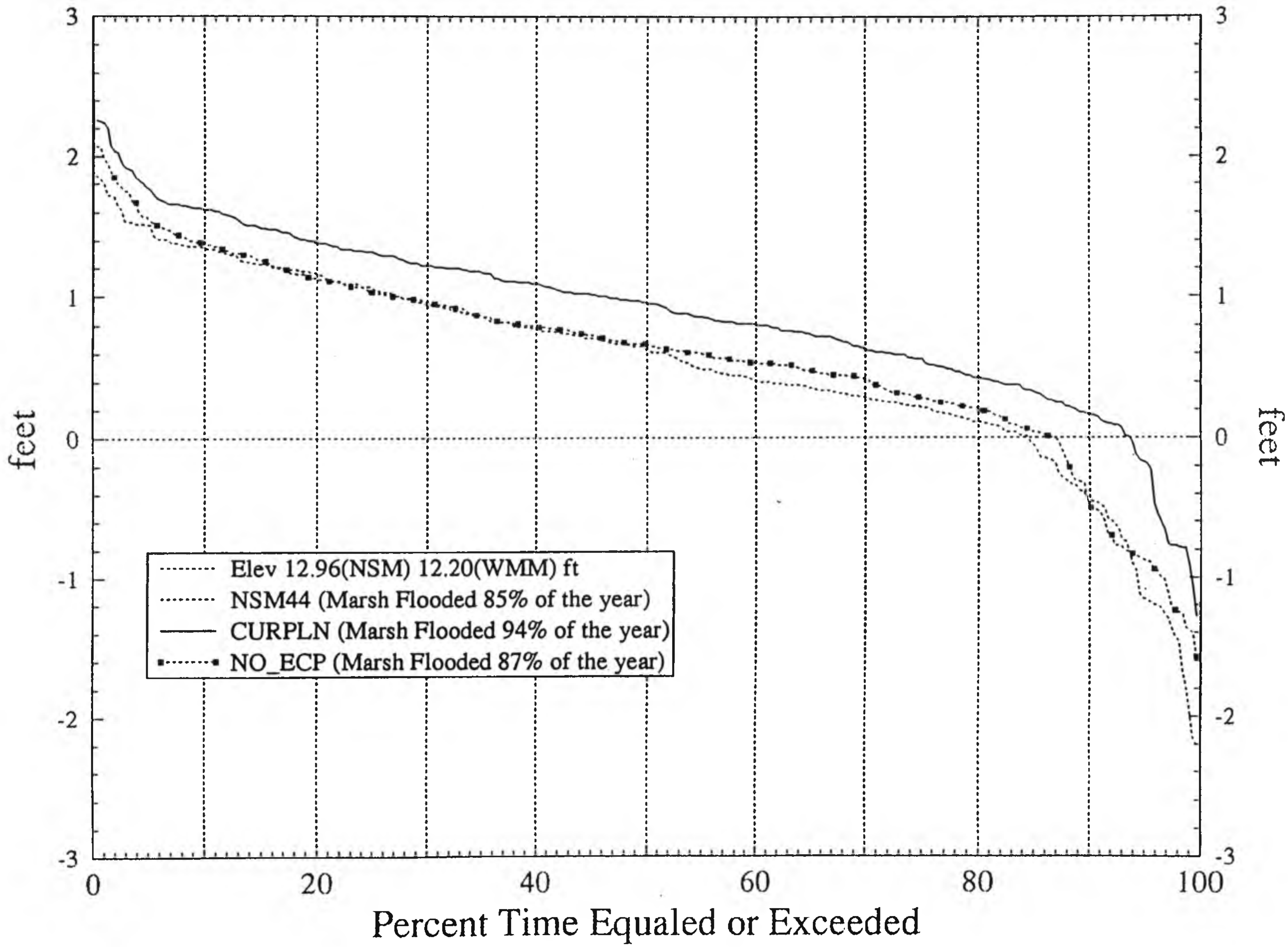
Attachment 3: Grid Cell Configuration from the LEC-SFWMM output

SFWMM Grid Superimposed Over Study Area



Attachment 4: Information to be Included in the August 16, 1996 Version of the District's Hydroperiod Restoration Plan

Normalized Stage Duration Curves at R43 C27
Downstream of STA-2

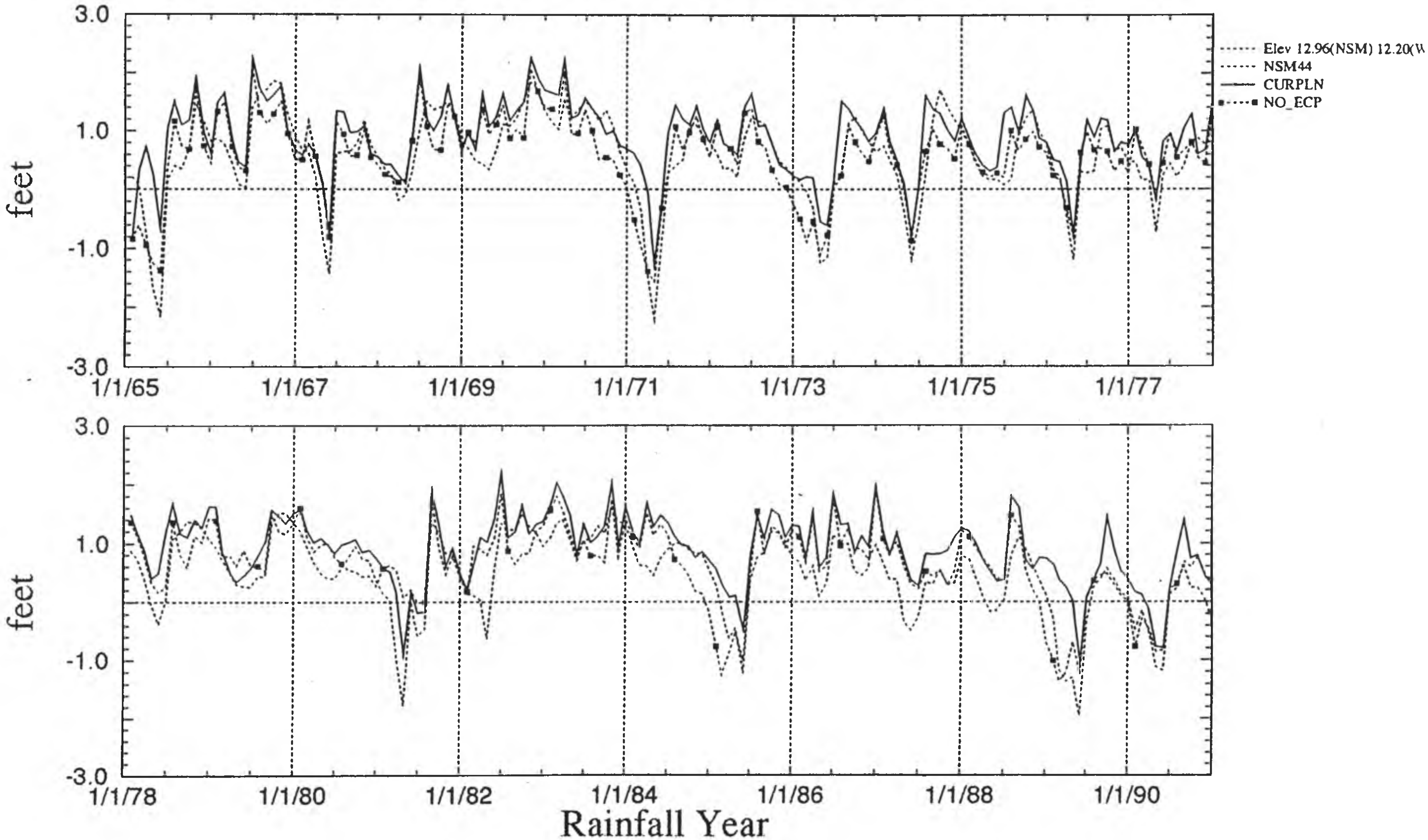


Note: Normalized stage is stage referenced to Land Elevation. Thus, values above zero indicates ponding while below zero indicates depth to the water table.

Fri Aug 2 09:37:31 1996

Environmental, Level II, WCA
SFWMM Simulation

Normalized Stage Hydrograph at R43 C27
Downstream of STA-2

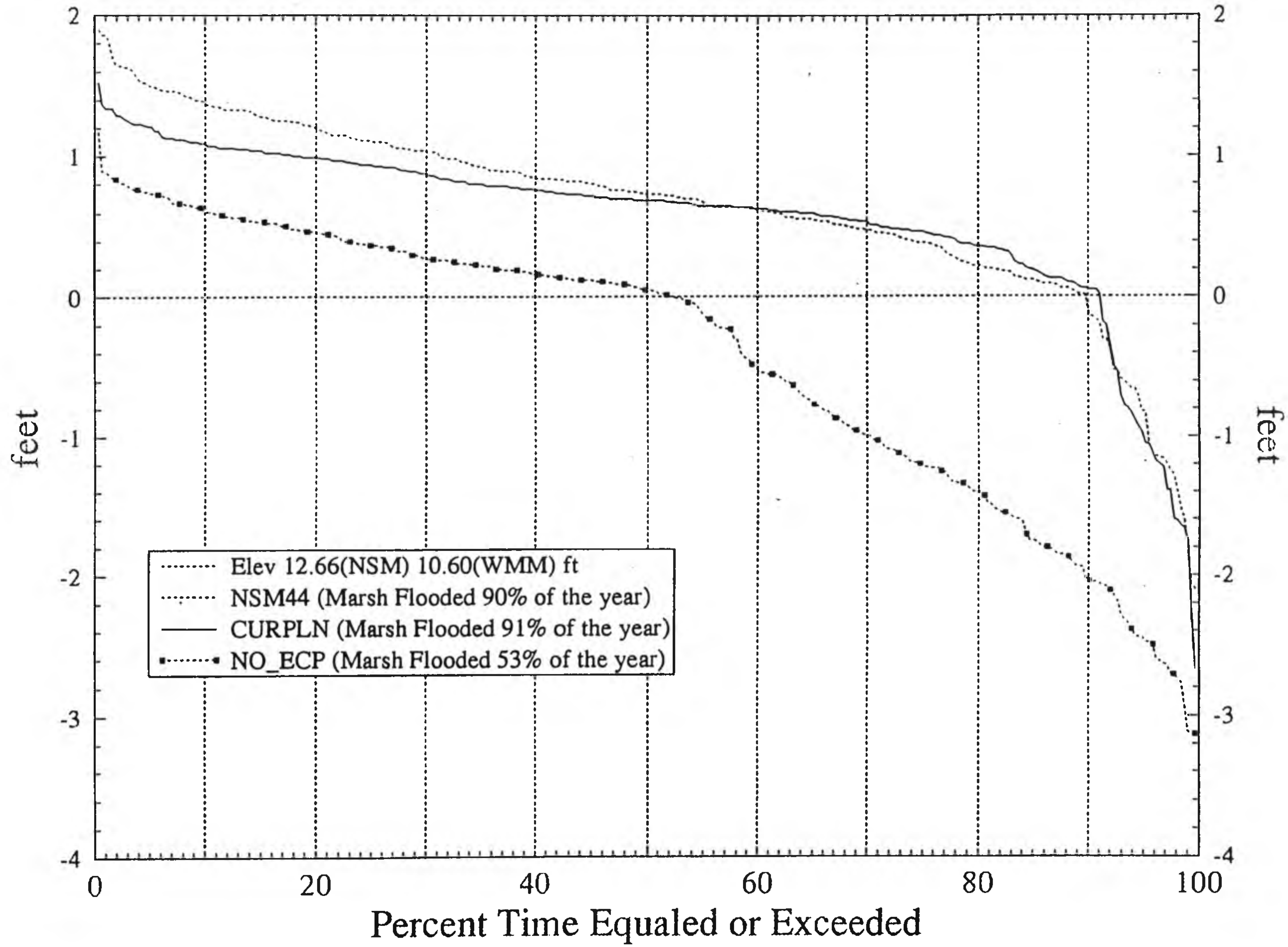


Note: Normalized stage is stage referenced to Land Elevation. Thus, values above zero indicates ponding while below zero indicates depth to the water table.

Fri Aug 2 17:09:44 1996

Environmental, Level II, WCA
SFWMM Simulation

Normalized Stage Duration Curves at R41 C24
Downstream of STA-3&4

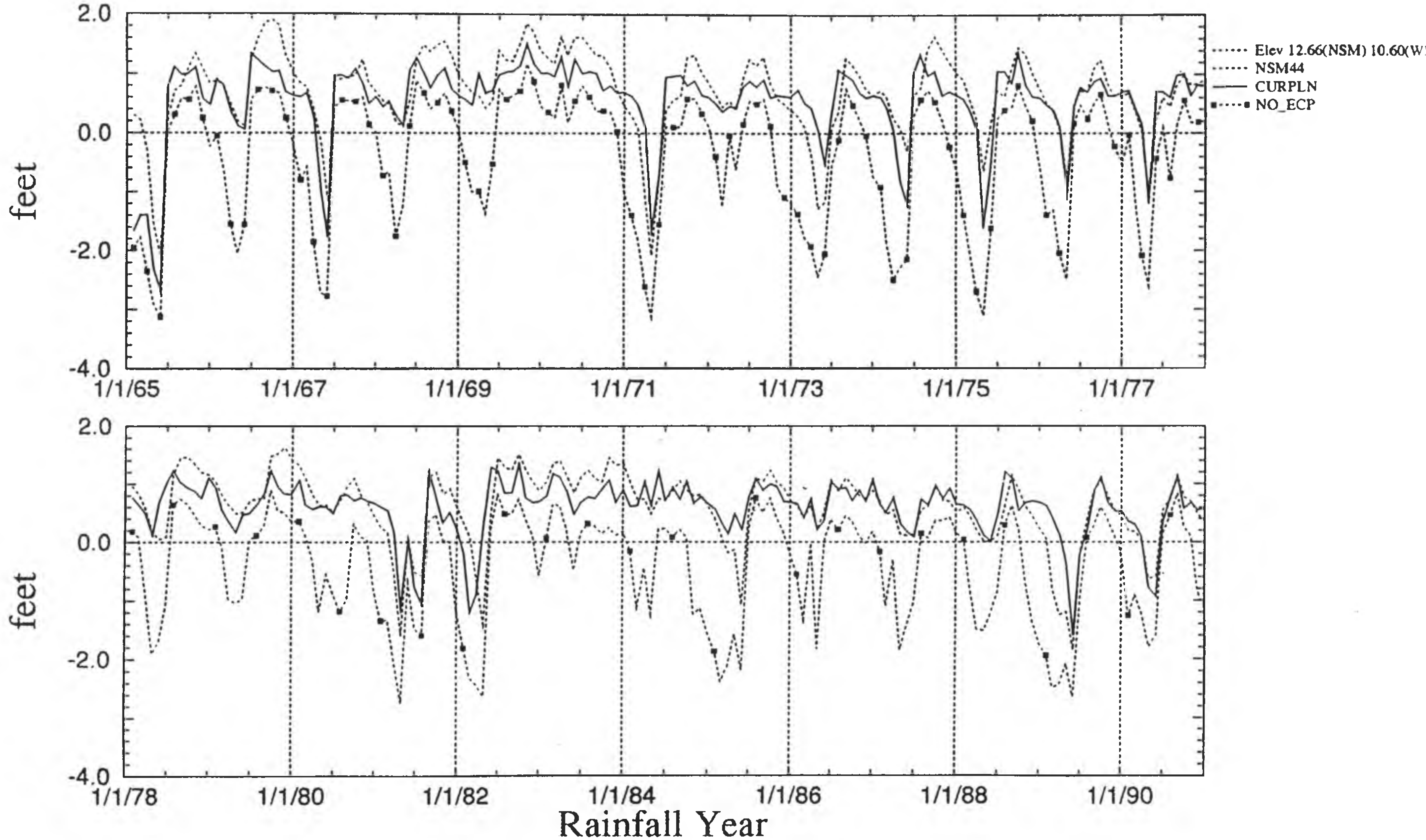


Note: Normalized stage is stage referenced to Land Elevation. Thus, values above zero indicates ponding while below zero indicates depth to the water table.

Fri Aug 2 09:37:52 1996

Environmental, Level II, WCA
SFWMM Simulation

Normalized Stage Hydrograph at R41 C24
Downstream of STA-3&4

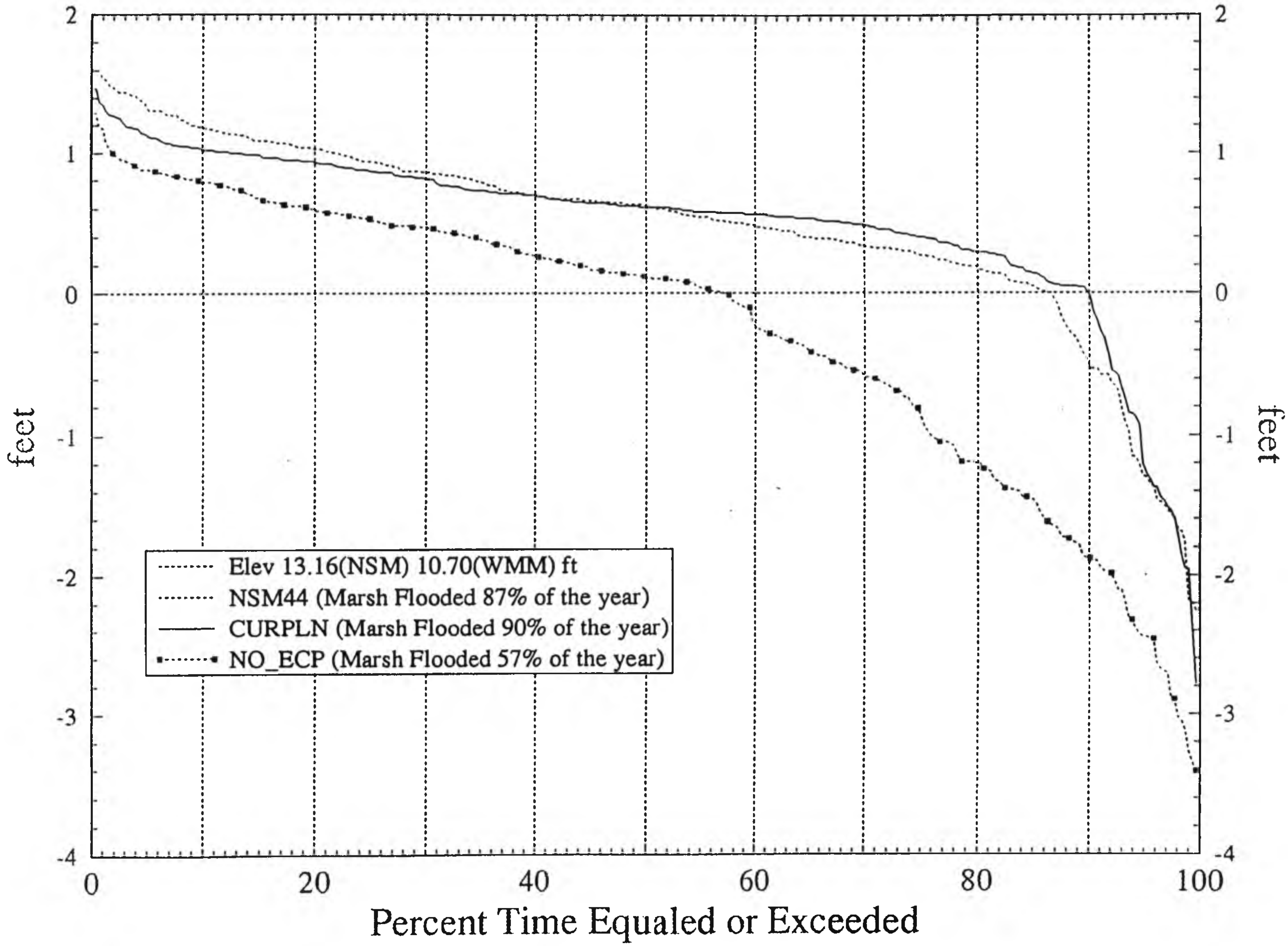


Note: Normalized stage is stage referenced to Land Elevation. Thus, values above zero indicates ponding while below zero indicates depth to the water table.

Fri Aug 2 17:09:49 1996

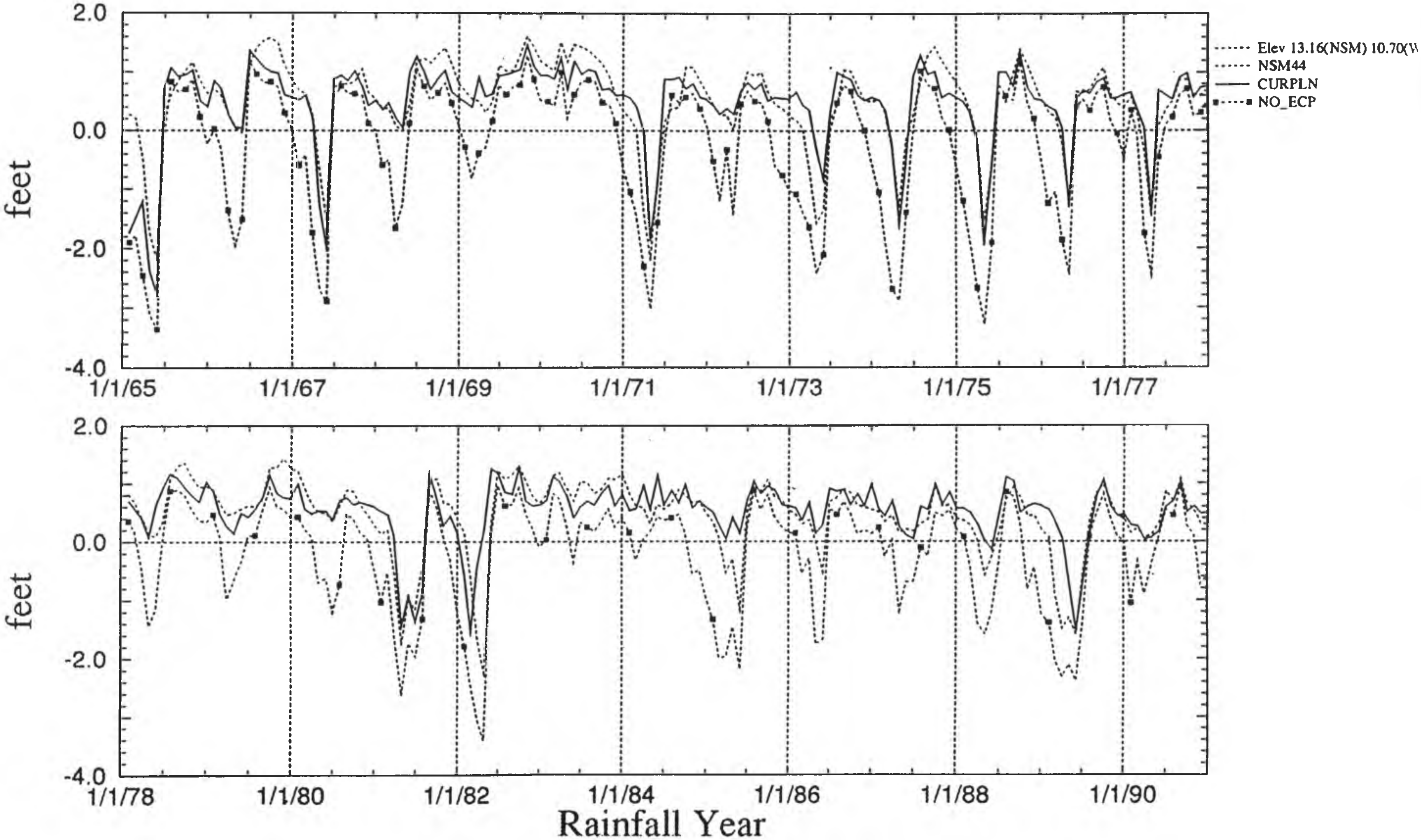
Environmental, Level II, WCA
SFWMM Simulation

Normalized Stage Duration Curves at R41 C22
Downstream of STA-3&4



Note: Normalized stage is stage referenced to Land Elevation. Thus, values above zero indicates ponding while below zero indicates depth to the water table

Normalized Stage Hydrograph at R41 C22
Downstream of STA-3&4

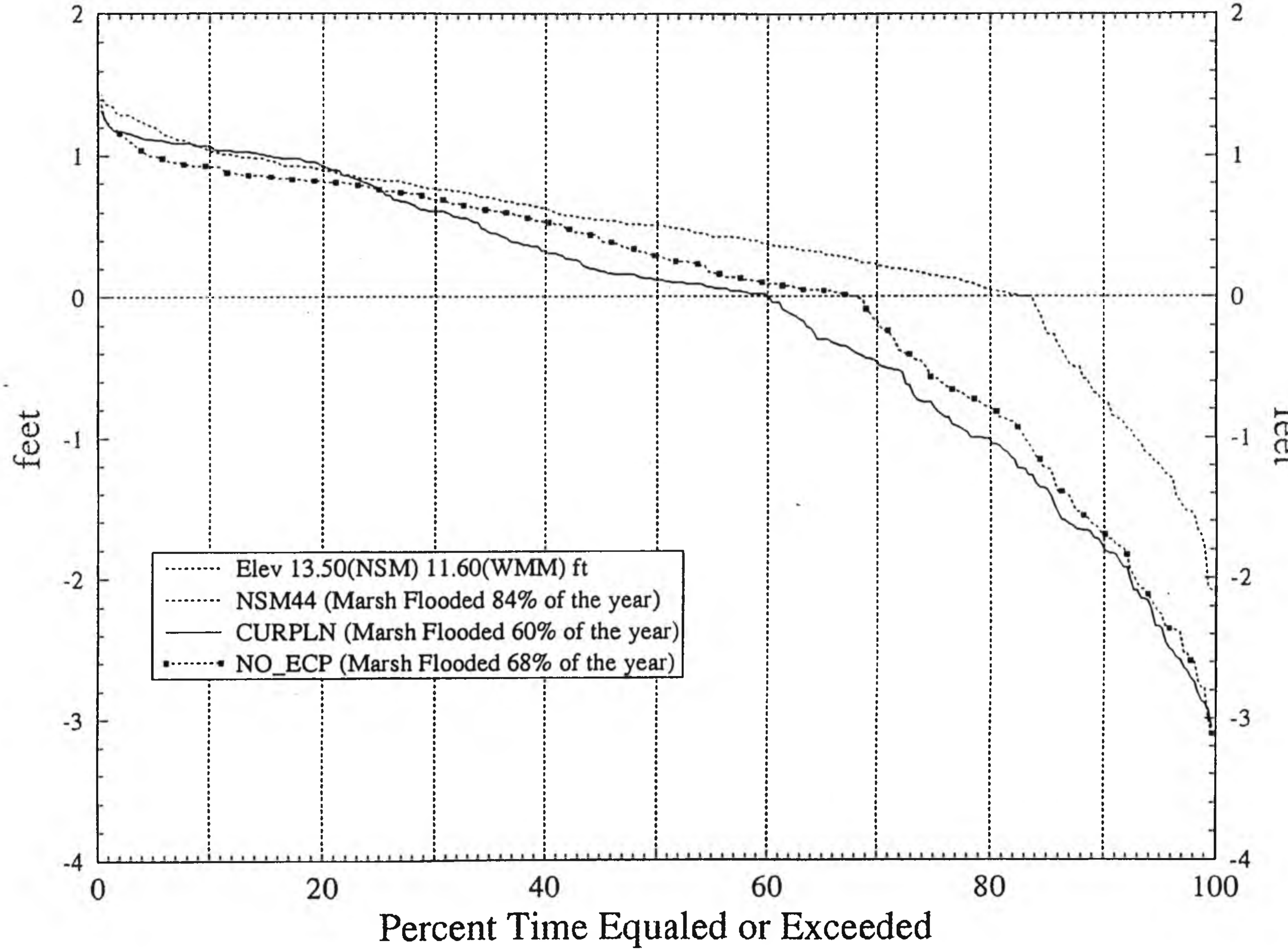


Note: Normalized stage is stage referenced to Land Elevation. Thus, values above zero indicates ponding while below zero indicates depth to the water table.

Fri Aug 2 17:09:47 1996

Environmental, Level II, WCA
SFWMM Simulation

Normalized Stage Duration Curves at R41 C17
Downstream of STA-5&6

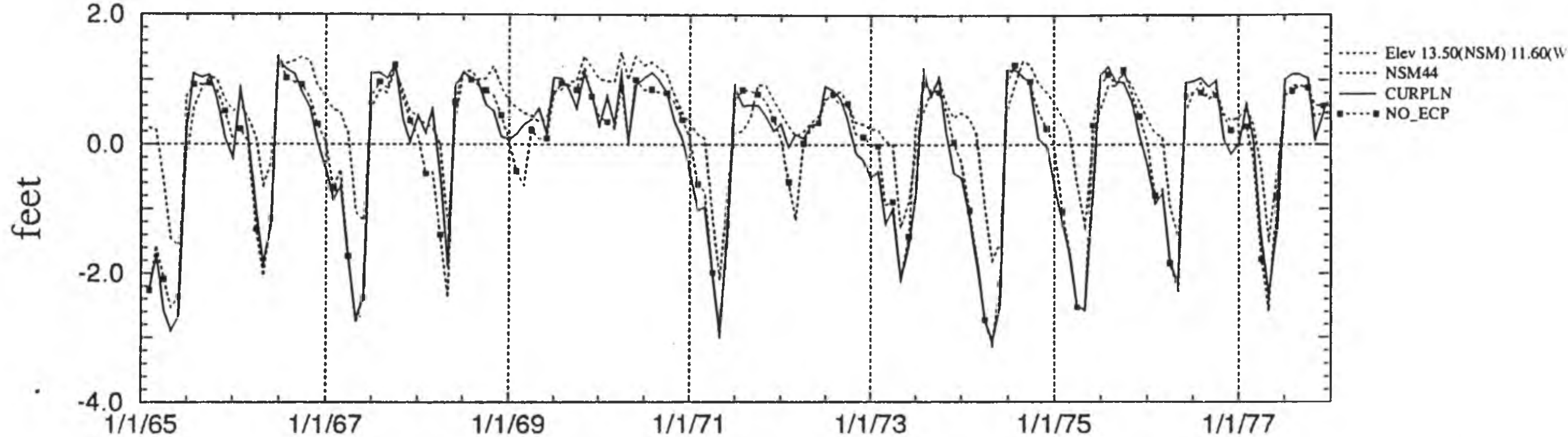


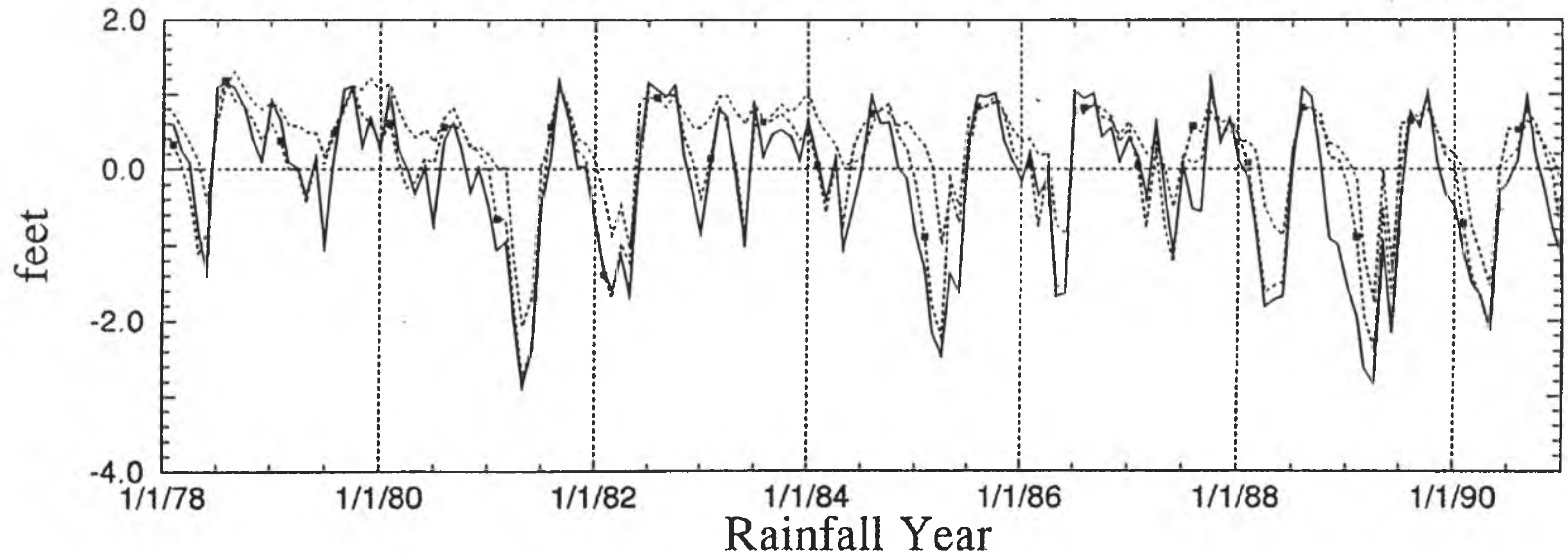
Note: Normalized stage is stage referenced to Land Elevation. Thus, values above zero indicates ponding while below zero indicates depth to the water table.

Fri Aug 2 09:38:34 1996

Environmental, Level II, WCA
SFWMM Simulation

Normalized Stage Hydrograph at R41 C17
Downstream of STA-5&6





Note: Normalized stage is stage referenced to Land Elevation. Thus, values above zero indicates ponding while below zero indicates depth to the water table.

Fri Aug 2 17:09:51 1996

Environmental, Level II, WCA
SFWMM Simulation

Attachment 5: Slides Presented by Mr. Cal Neidrauer

Simulated Performance of the Everglades Construction Project (ECP) using the South Florida Water Management Model (SFWMM) {8/5/96 CN}

Slide 1

Simulated Performance of the Everglades Construction Project (ECP) using the South Florida Water Management Model (SFWMM)

- Purpose: to estimate the likely changes in WCA hydropatterns resulting from the latest STA designs & the current operational intent of the ECP

Slide 2

Brief Overview of the SFWMM

- Regional-scale, continuous simulation, hydrologic model
  - Lake Okeechobee to Florida Bay
    - includes basins tributary to Lake Okeechobee
  - 2mi x 2mi grid cells (7000 sq.miles)
  - 1965-90 simulation period (daily stress period)
  - 1979-90 calibration/validation period
- Simulates all key hydrologic processes
  - rainfall, ET, infiltration, percolation, overland flow, groundwater flow, canal/structure flows
- Simulates current or proposed structures
  - reservoirs, STAs, pumps, spillways, etc
- Simulates current or proposed system operational rules

Slide 3

SFWMM Key Assumptions

- Current Plan (aka 2010 Base)
  - 2010 projected land use & associated demands
  - Kissimmee River Restoration
  - Current (Run25) Lake Okee. Regulation Schedule
  - New WCA-1 Regulation Schedule
  - USACOE Modified Water Deliveries GDM
  - USACOE C-111 GRR
  - ECP (BMP's, BMP Replacement Water, STAs)
- No-Action (aka NOECP)
  - 2010 Base without STAs

Slide 4

Primary reasons for differences between SFWMM simulated flows and flows used for ECP design

- Lake Okeechobee regulatory (flood control) discharges {136kaf/yr less ~50%}
- BMP replacement water deliveries {193kaf/yr more}
- Southern L-8 runoff {74kaf/yr more}
- EAA backpumping & backflow to L.Okee
- et al

- Net Effect = ~110kaf/yr more to WCAs (WCA1:+180; WCA2: +50; n.e.WCA3A: -120)

Attachment 6: Slides Presented by Mr. David Swift

- **Is there a better method available for determining the hydroperiod benefits of the Project?**

Proposed Alternative Method for Evaluating Hydroperiod Benefits:

- Identifies areas where hydropattern restoration is moving in the right or wrong direction (towards or away from the rainfall-driven NSM target)

- Gives credit to areas that are improved, but are less than the NSM hydroperiod target -- these areas may not have been counted by the former method.

- Identifies those areas where (1) no significant change has occurred, (2) hydroperiods have been shortened, and (3) NSM targets have been exceeded less than or more than 30 days.

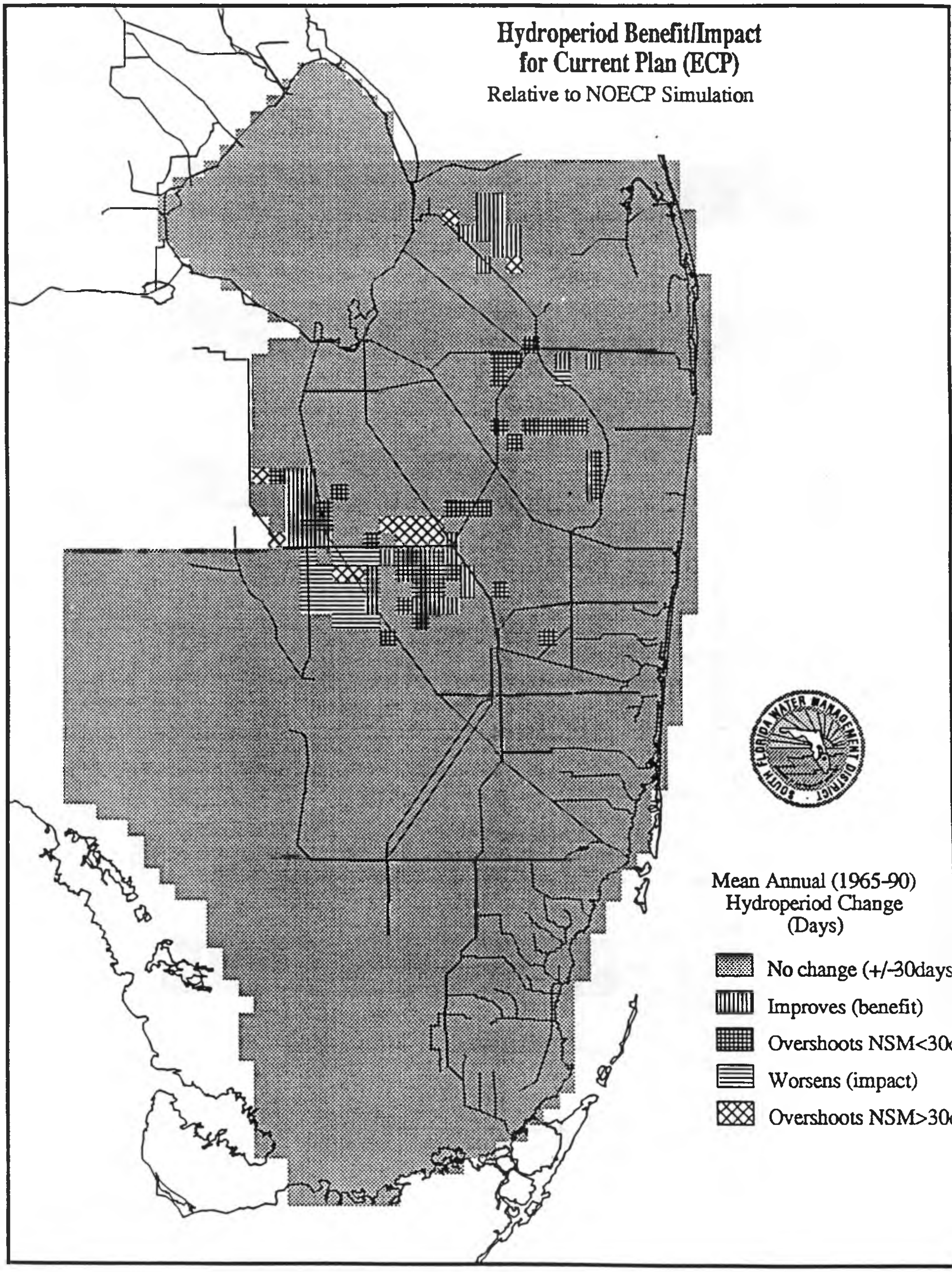
New Lingo (Definitions)

"NO CHANGE" = mean annual hydroperiod does not change greater than ± 30 days as compared to No Action plan.

"IMPROVEMENT" (BENEFIT) = mean annual hydroperiod moves in the *right direction towards* a more rainfall-driven, natural system hydropattern.

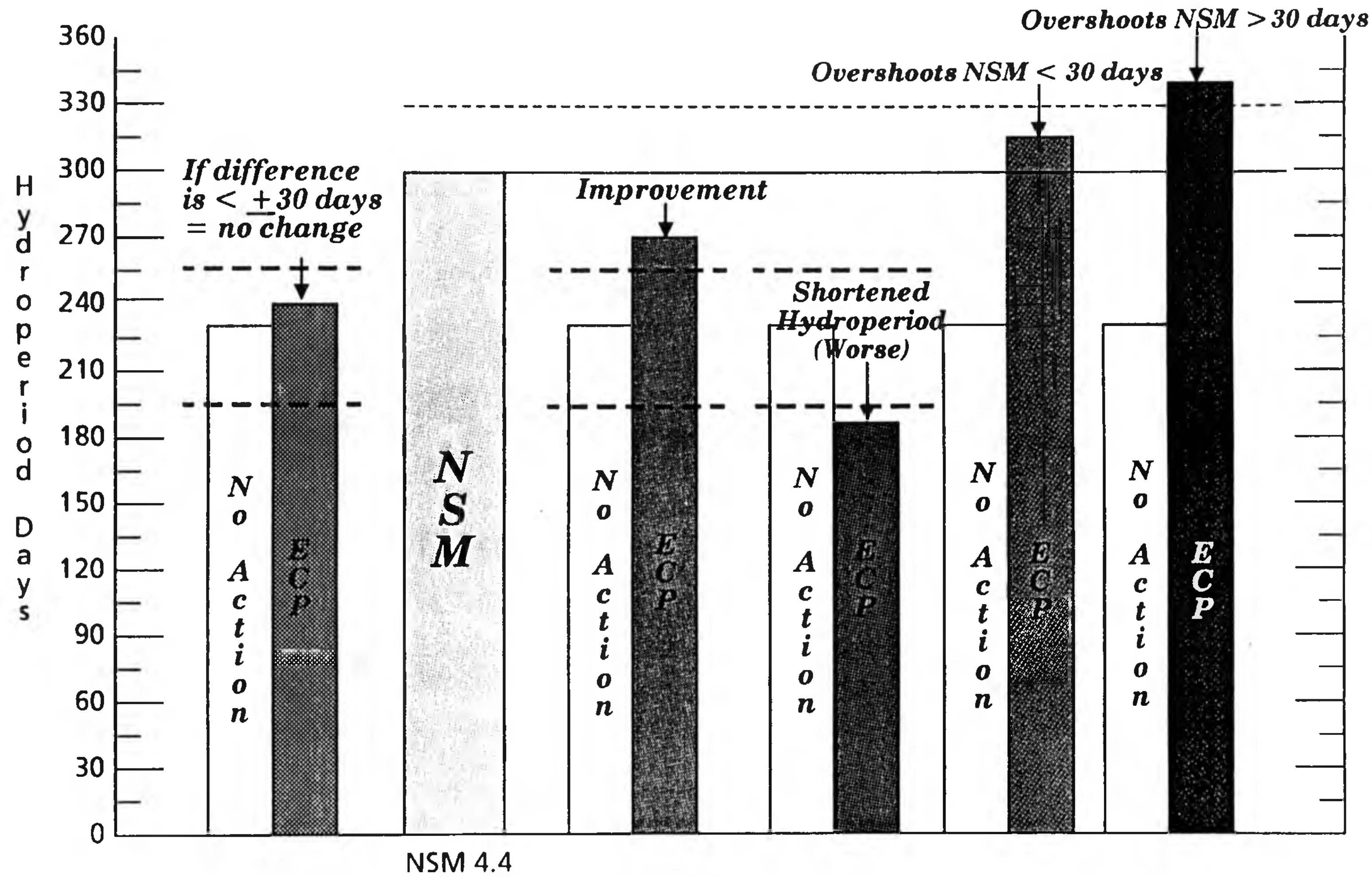
"WORSE" (IMPACT) = mean annual hydroperiod moves in the *wrong direction away* from a rainfall-driven, natural system hydropattern.

"OVERSHOOTS NSM" = mean annual hydroperiod is moving in the right direction but exceeds the NSM hydroperiod target (30 days < NSM target = improvement, > 30 days of NSM target = impact).



Hydroperiod Benefit/Impact
for Current Plan (ECP)
Relative to NOECP Simulation
SOUTH FLORIDA WATER MANAGEMENT DISTRICT
Mean Annual (1965-90)
Hydroperiod Change
(Days)
No change (+/-30days)
Improves (benefit)
Overshoots NSM<30days
Worsens (impact)
Overshoots NSM>30days

Legend for Hydroperiod Benefits/Impacts Map



No change in hydroperiod ±30 days

Benefits

Improves Hydroperiod but less than NSM

Overshoots NSM < 30 days

Impacts

Reduces Hydroperiod relative to No Action

Overshoots NSM >30 days

ECP versus No Action Plan: Hydroperiod Results

<u>Rotenberger WMA:</u>		
Hydroperiod Improvement	**=**	**+ 33,280 acres**
<u>WCA-1:</u>		
Hydroperiod Improvement	**=**	**+ 23,040 acres**
<u>WCA-2A</u>		
Hydroperiod Improvement	**=**	**+ 7,680 acres**
<u>WCA-3A (North)</u>		
Hydroperiod Improvement	**=**	**+ 58,880 acres**
Hydroperiod worse	**=**	**- <u>48,640 acres</u>**

ECP Hydroperiod Benefit = + 74,240 ACRES

How will the District address those areas that show restoration heading in the wrong direction?

- ECP design for STA's 3& 4 is scheduled to allow input from the LEC Planning process.

- The LECRWSP Advisory Committee has recognized this problem and has already modeled several options to fix over-drainage problems in the N.W. portion of WCA-3A (e.g., Alternative 3).

- The LEC Plan will make recommendations for modifying the ECP design and operations to provide a better distribution of water delivered from the STA's to the WCAs.

Table 2-3 (Replacement). Hydroperiod Benefit/Impact Summary (from SFWMM simulation results)

AREA	Acres Improved	Acres Worsened	Net Change (acres)
WCA-1 (145,920 acres)	23,040 (15.8%)	0	23,040 (15.8%)
WCA-2A (104,960 acres)	7,680 (7.3%)	0	7,680 (7.3%)
North WCA-3A (204,800 acres)	58,880 (28.7%)	48,640 (23.8%)	10,240 (5.0%)
Rotenberger WMA (33,280 acres)	33,280 (100%)	0	33,280 (100%)
Total (488,960 acres)	122,880 (25.1%)	48,640 (9.9%)	74,240 (15.2%)

Notes:

1. Areas are to nearest 2560 acres ($4mi^2 x 640ac/mi^2$) as estimated by the SFWMM.
2. "Acres Improved" are areas predicted to have the hydroperiod improved due to the Current ECP Plan by greater than 30 days more than the No ECP results up to 30 days over the NSM hydroperiod.
3. "Acres Worsened" are areas predicted to have the hydroperiod worsened due to the Current ECP Plan by greater than 30 days more than the No ECP results and greater than 30 days over the NSM hydroperiod.

Attachment 7: Adaptive Assessment Presentation

Adaptive Assessment Resource Protection Plan

- Reasonable assurance = best present information
  +
  adaptive assessment resource plan

- Adaptive assessment = acknowledgement of the imperfection of information used
  +
  a protocol for evaluating ecosystem response to restoration actions
  +
  a plan for improving knowledge bases and adjusting restoration decisions accordingly
  +
  a plan for scientific & engineering feedback

A Protocol for Evaluating Ecosystem Response to Restoration Actions

- Develop & implement a pre- & post operation monitoring plan

Vegetation communities:	transects & aerial/satellite photos
Animal communities:	Systematic Reconnaissance Flights, transects for fish & invertebrates
Soil & water column:	transects located downstream of spreader canals; monitor for nutrients, Hg, etc.
Hydrologic:	water depths & hydroperiods monitored and compared with SFWMM, NSM, ELM, etc.
Other parameters:	recommendations from Science Sub-Group and other organizations

A plan for improving knowledge bases and adjusting restoration decisions accordingly

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- Conduct research on ways to reverse any adverse impacts
- Conduct research on downstream areas to further define relation between vegetation communities, phosphorus inputs, seed banks, antecedent conditions, water depth and hydroperiod.
- Construct models for predicting nutrient fate and transport and long term ecological effects, including possible trend reversals, of restoration actions.

A plan for soliciting scientific & engineering feedback

- Workshops
- Informal discussions
- Presentations at professional societies
- Peer review of manuscripts
- Establishment of a web site
- Annual reports

Attachment 8: Attendance List

Mtg: Hydropattern Restoration Technology Workshop Date: August 5, 1996

Please Print

ATTENDANCE LIST

PARTICIPANT	ORGANIZATION	PHONE NUMBER	FAX NUMBER
James Lee	SFWMD	561 6876584	
MIKE ZIMMERMAN	E.N.P.	305 242-7800	7836
Robert Fennema	ENP	305 242 7829	7836
GARY GOFORTH	SFWMD	561 687 6280	- 6729
Blake Sasse	GFC	561-791-4052	-4056
JOHN Leslie	SFWMD	561 687 678	
Art Sengupta	SFWMD	687-6353	
Tom Kosier	SFWMD	68765-33	
Waseem Asghar	SFWMD	687-6326	
Cal Neidrauer	"	687-6506	6729
DAN SCHEIDT	USEPA	706 546-2294	2459
TOM MACVICAR	MFL	689 1708	689 1026
Tony Federico	MFL	689-1708	689-1026
JENNIFER JORGE	SFWMD	6876980	687-6126
Su Jewell	USFWS	732-3684	
MELISSA GROSS-ARNOLD	LEWIS, LONGMAN & WALKER	640-0820	640-5330
Zhenquan Chen	SFWMD	687-6652	
Jayantha Obeysekera	"	687 6503	687 6442
Ken TARBOTON	"	687 6017	"
Gail Sloane	FDEP	904 488-4892	904 922-5380
STEVE LIN	SFWMD	687 6512	
PAUL MCCORMICK	"	X6567	
TOM FONTAINE	"		
Nancy Grassman	Broward DNRP	519-1464	519-1496
Gordon Hu	SFWMD	6720	

Mtg: Hydropattern Restoration Technology Workshop Date: August 5, 1996

Please Print

ATTENDANCE LIST

PARTICIPANT	ORGANIZATION	PHONE NUMBER	FAX NUMBER
Steve Davis	SFWMD	6602	6200
Fred Sklar	SFWMD	6504	6442
Bill Walker	Corps & DOT	508-369-5011	-4230
ED BARBER	FFWA/CARE	904-259-5361	-5966
Kent Loftin	SFWMD/COE		
Russ Reed	COE	904 232-3567	-1888
Tom Teets	SFWMD	6780	
BILL JOLLY	FDACS		
John Davis	ESP		

Page 2

EVALUATION OF BENEFITS AND IMPACTS

OF THE

HYDROPATTERN RESTORATION COMPONENTS

OF THE

EVERGLADES CONSTRUCTION PROJECT

draft

South Florida Water Management District

August 16, 1996

EVALUATION OF BENEFITS AND IMPACTS OF THE HYDROPATTERN RESTORATION COMPONENTS OF THE EVERGLADES CONSTRUCTION PROJECT

TABLE OF CONTENTS

Page

EVALUATION OF BENEFITS AND IMPACTS OF THE HYDROPATTERN RESTORATION COMPONENTS OF THE EVERGLADES CONSTRUCTION PROJECT

LIST OF FIGURES

LIST OF TABLES

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