

**Broward County Water Preserve Area
Regional Evaluation Report
Prepared by RECOVER
June 1, 2005**

1.0 Introduction and Purpose

The Broward County Water Preserve Area (BCWPA) project team has completed the plan formulation phase of their project and requested Restoration Coordination and Verification (RECOVER) prepare a regional evaluation report of the final project alternative. The role of RECOVER is to organize and apply scientific and technical information in ways that are most effective in supporting the objectives of the Comprehensive Everglades Restoration Plan (CERP). One of the primary missions of RECOVER is to work with the project team to evaluate and maximize the contribution made by each project to the system-wide performance of CERP.

The RECOVER Evaluation Team (ET) is an interagency and interdisciplinary scientific and technical team charged with developing and using performance measures for evaluating alternative plans developed for Project Implementation Reports (PIRs). The purpose of ET evaluations is to determine the performance of each alternative toward meeting system-wide goals and objectives through the use of system-wide performance measures, project performance measures, and best professional judgment. For evaluating alternative restoration projects, the ET has developed a suite of approximately 40 hydrological performance measures and approximately eight ecological performance measures that are under review for use in the evaluation of project alternatives. Performance measures are calculated using output from the South Florida Water Management Model (SFWMM), which is the primary hydrologic simulation model for the CERP. The SFWMM is a regional scale model that provides simulations of hydrologic conditions at a 2-mile by 2-mile spatial resolution. Due to the large-scale resolution of the model and the relatively small hydrologic influence of some CERP projects, ET performance measures will not always provide discernable differences in system-wide performance. In these instances RECOVER will use project performance measures and best professional judgment to evaluate project alternatives.

The purpose of this regional evaluation is to 1) review project goals and objectives in the context of CERP system-wide goals and objectives, 2) inform the project team of the compatibility of proposed project alternatives with regional CERP restoration goals and performance expectations, 3) identify improvements for project performance that would improve its regional performance, and 4) provide decision-makers required information regarding regional performance expectations of the BCWPA project. RECOVER performed an initial review for the Water Preserve Areas (WPAs) Feasibility Study in 2002 (Appendix A3 of the WPA Feasibility Study and attached as Appendix A of this report).

2.0 Project Background

In 1993, the National Audubon Society proposed the concept of a buffer strip in Broward County between the natural system and development to the east as part of an overall Everglades restoration plan. The buffer would capture water lost to tide, control seepage, treat urban runoff, provide habitat connectivity, and serve as a recreational area. The buffer strip concept was included in several studies involving the South Florida Water Management District (SFWMD) and the U.S. Army Corps of Engineers (Corps). All subsequent studies agreed the buffer strip concept was feasible. The Central and Southern Florida (C&SF) Project Comprehensive Review Study (Restudy) continued the concept (referring to it as the Water Preserve Areas) and included 28 Water Preserve Area (WPA) components. The WPA Feasibility Study (WPAFS) developed those possibilities and recommended six separate projects, including the BCWPA project.

The BCWPA is located along the eastern edge of the remaining Everglades ecosystem and on the western edge of Ft. Lauderdale and its suburbs and reaches from the northern boundary of the North New River Canal to the southern boundary of the C-6 canal. The BCWPA project contains three components, which together will provide an interconnected series of marshlands, impoundments, stormwater treatment areas (STAs), conveyance, and aquifer recharge areas;

C-9 STA/Impoundment- The purpose of the C-9 STA/Impoundment is to initially provide storage. Once online, the STA/impoundment will provide treatment of runoff stored in the North Lake Belt Storage Area. The STA/Impoundment will also enhance groundwater recharge within the basin, provide seepage control for WCA-3, and provide flood protection for the western C-9 basin.

C-11 Impoundment- The purpose of the C-11 Impoundment is to divert and treat runoff from the western C-11 basin that is presently discharged into WCA-3A.

WCA-3A/3B Levee Seepage Management Area - The purpose of the seepage management area is to control seepage from WCA-3 by improving groundwater elevations, and to provide flood protection for the western C-11 basin.

3.0 Evaluation

3.1 Project Goals and Objectives – Consistency with the Comprehensive Plan

The primary goals of the CERP are to 1) enhance ecologic values and 2) enhance economic values and social well-being. The goals of the BCWPA project are to:

- Retain water in the natural system.
- Capture and store excess water.
- Provide water conveyance while minimizing natural area impacts.
- Provide a buffer between natural and developed areas.
- Preserve and protect wetlands outside the Everglades Protection Area (increase spatial extent).

Due to its location and function as a source of water, which reduces demands on the natural system, objectives for the BCWPA project were specifically developed to meet the ecological objectives of the CERP:

- Objective 1: Restore habitat function and species diversity in WCA-3.
- Objective 2: Increase the spatial extent of wetland function.
- Objective 3: Improve hydroperiods and hydropatterns in WCA-3.
- Objective 4: Reduce the loading of excess nutrients into WCA-3.
- Objective 5: Reduce seepage out of WCA-3.
- Objective 6: Maximize the amount of water retained in the natural system.

The following table illustrates how the project goals and objectives relate to the goals and objectives of CERP.

CERP Goals and Objectives	Project Goals and Objectives
Enhance Ecological Values	
<ul style="list-style-type: none"> • Increase the total spatial extent of natural areas 	<ul style="list-style-type: none"> • Increase the spatial extent of wetland function. • Improve hydropatterns in WCA-3. • Reduce loading of excess nutrients into WCA3. • Retain water for the natural system.
<ul style="list-style-type: none"> • Improve habitat and functional quality 	<ul style="list-style-type: none"> • Restore habitat function and species diversity in WCA-3. • Increase the spatial extent of wetland function. • Improve hydropatterns in WCA-3. • Reduce loading of excess nutrients into WCA3. • Reduce seepage from WCA-3. • Retain water for the natural system.
<ul style="list-style-type: none"> • Improve native plant and animal species abundance and diversity 	<ul style="list-style-type: none"> • Reduce loading of excess nutrients into WCA-3. • Retain water for the natural system.
Enhance Economic Values and Social Well Being	
<ul style="list-style-type: none"> • Increase availability of fresh water (agricultural/municipal & industrial) 	<ul style="list-style-type: none"> • Reduce seepage from WCA-3. • Retain water for the natural system.
<ul style="list-style-type: none"> • Reduce flood damages (agricultural/urban) 	<ul style="list-style-type: none"> • Reduce seepage from WCA-3.
<ul style="list-style-type: none"> • Provide recreational and navigation opportunities 	N/A
<ul style="list-style-type: none"> • Protect cultural and archeological resources and values 	N/A

3.2 Alternative Description

The BCWPA project team initially considered the alternatives evaluated in the WPAFS. The team used additional screening criteria to develop a single modified alternative based on project objectives and constraints. This modified alternative was selected due to such issues as seepage out of the STAs/Impoundments, operations of the seepage management area, project objectives, and constraints. The selected plan (WPA-SP) contains the following elements:

C-9 STA/Impoundment-1,739-acre impoundment with a maximum depth of 4-feet. The WPA SP also recommends the further investigation of 40 million gallons per day (MGD) Aquifer Storage and Recovery (ASR) wells to help control seepage during prolonged periods of a full impoundment.

C-11 Impoundment-1,695-acre impoundment divided into two compartments. The northern compartment would be 205 acres in size with a maximum water depth of 2 feet. The southern compartment would be 1,490 acres in size with a maximum water depth of 4 feet.

WCA-3A/3B Seepage Management Area-4,312 acre buffer strip with three newly proposed control structures. The seepage management area is a modification of an existing buffer strip, the East Coast Buffer, and includes adjusted operations to fully optimize this area and provide the greatest onsite and offsite benefits.

A comparison of the BCWPA design storage specified in the Restudy and the WPA-SP is outlined below.

The WPA-SP provides approximately 81% of the storage supplied by the Restudy design. The difference in acreages between the Restudy and WPAFS alternatives for the C-9 STA/Impoundment is the removal of a narrow strip of land approximately 800 acres extending from the northwest corner of the proposed STA/Impoundment. The inability to control seepage in this narrow strip that directly abuts existing urban development was the ultimate factor in excluding it from the WPA-SP and releasing the lands to the Florida Department of Transportation (FDOT) for wetland compensatory mitigation.

Component	Restudy	WPA-SP
C-9 STA/Impoundment	6400 acre-ft	6956 acre-ft
C-11 Impoundment	10000 acre-ft	6370 acre-ft
TOTAL	16400 acre-ft	13326 acre-ft

During the Restudy and the WPAFS, the combined effects of the proposed WPAs were modeled and analyzed. These WPA components would serve to both store and treat water to offset the impacts to the natural system caused by local stormwater drainage and water supply issues. Although each of the WPAs would produce local benefits within the vicinity of the project, these projects are also necessary to “jump start” the ecological effects of CERP projects. Collectively the Water Preserve Area projects provide the only opportunities to significantly reduce water losses to tide on the Lower East Coast, reduce

seepage losses from the Water Conservation Areas, and provide an alternative source of water to meet Lower East Coast urban and agricultural demands other than the Everglades. It is also important to note that the WPAs would serve as buffers between the remaining natural system and development.

4.0 System-wide Performance of the Plan

During the Restudy and the WPAFS, the combined effects of all the CERP projects on the regional system were modeled, analyzed and determined to provide ecological benefits to the south Florida ecosystem. However, the magnitude of the incremental system-wide benefits resulting from implementing individual CERP projects, relative to the level of ecological improvements brought about by the entire Comprehensive Plan, is difficult to discern for projects that primarily affect the timing and distribution of water at this scale. Collectively the WPA projects provides an opportunity to significantly reduce water losses to tide on the Lower East Coast, reduce levee seepage losses from the WCAs, and provide an alternative source of water to meet Lower East Coast urban and agricultural demands. One of the biggest improvements is the rehydration of a 4,300 ± acre buffer between WCA-3 and urbanized portions of Broward County through the seepage management area project component. This is the largest opportunity to expand historic wetlands outside of the existing Everglades Protection Area.

Because modeling completed previously for the WPAFS addressed alternatives developed during the PIR, there were no additional SFWMM runs performed for the project's plan formulation and evaluation. Consequently, there were no additional or new model simulations available for RECOVER to evaluate. The regional evaluations that RECOVER originally performed for the WPAFS in 2001 are presented in Appendix A to document the performance of the WPAs based on the SFWMM v3.5 model output. These evaluations describe the performance of Alternative 2, Alternative 3 and WPA-Preliminary Selected Plan (PSP). These model runs represent the CERP with the WPA alternative plans.

It is important to note the following regarding the WPA FS modeling data:

- The WPA-PSP model run completed for the WPAFS includes all WPA components, not just those from the BCWPA project.
- The WPA-PSP alternative modeled during the WPAFS includes the installation of 40 MGD ASR wells associated with the C-9 STA/Impoundment, while the WPA-SP, as recommended for the BCWPA project does not include ASR wells.

Included below is a summary of RECOVER's conclusions from its 2001 evaluation of the WPA-PSP. For the detailed evaluations, please see Appendix A of this report.

4.1 Summary

The WPA-PSP simulation performs almost identically to the Comprehensive Plan in most areas within the region. It is expected to provide the same of level of benefits as were anticipated at the conclusion of the Restudy process. Performance in Everglades National Park, Biscayne Bay and Lower East Coast Service Area 2 varies from D13R but not necessarily due to the WPA components.

Flows to the Park were reduced slightly (-45,000 ac ft) while flows to the Bay increased slightly (+32,000 ac ft). Variables in the WPA-PSP simulation prevent concluding that the PSP is the causative factor. Compared to D13R, there are two variations in the WPA-PSP in addition to the WPA components themselves. The public water supply withdrawal locations were modified to reflect the distribution developed in the Lower East Coast Regional Water Supply Plan and the surface water flow targets were met for Pond Apple Slough from the C-11 Canal. Modeling these additional variables at the same time as the WPA Plan made it more difficult to clearly determine which regional effects were due to the WPA components, which could be attributed to these additional variables, and which were a combination of the two. RET members were apprised of the effects of these added variables during the RET meeting on November 14, 2000 and regional evaluators were confident they were able to properly discern the separate effects in the WPA-PSP simulation.

In the Lower East Coast Service Area 2, the number of locally triggered water restrictions increased in WPA-PSP due to the change in public water supply withdrawal distribution. Compared to D13R, in WPA-PSP a greater percentage of withdrawals are located further east closer to the coast and the trigger wells. With an increase in withdrawals in the same model grid cell as the trigger well, groundwater stages cannot be maintained as easily above the shortage criteria even though the distance between the wells may be significant. The number and duration of restrictions reflects the same pattern as the Lower East Coast Regional Water Supply Plan LEC-1R simulation, which has a similar distribution. The increase in the number of water restrictions in WPA-PSP does not reflect changes associated with the WPA components.

4.2 Regional Effects

Lake Okeechobee

In the WPA-PSP, Lake Okeechobee stages were very similar to D13R and slightly higher than WPA-Alt. 3 stages (+0.1 ft) during drier times. Water supply from Lake Okeechobee to the LEC was 6% (4,100 ac.ft/yr) less than in D13R and water supply to the environment was 3% (3,900 ac.ft/yr) more than in D13R. Lake Okeechobee triggered water shortages were reduced by one occurrence in Lower East Coast Service Area 2. The volume of cutbacks in the Lake Okeechobee Service Area was slightly more (by 27,000 ac.ft over the 31 year simulation period) than in D13R.

WCAs

Hydrologic characteristics in the conservation areas were very similar in WPA-PSP to both WPA-Alt.3 and D13R. At most there were 1 to 2% differences in inundation duration, and high/low water exceedences in some of the indicator regions

Everglades National Park (ENP)

Although there was less net inflow into the ENP, WPA-PSP performance, measured in terms of inundation duration, was similar to that of D13R. In the Rockland Marl Marsh (IR 8) there was a 2 % reduction (with respect to D13R) in average annual hydroperiod, while in NE Shark River Slough (IR 11) there was 1% increases in average annual hydroperiod.

Biscayne Bay

There was 32,000 ac.ft/yr more flow to Biscayne Bay in the WPA-PSP simulation than in D13R. By comparison the WPA-Alt.3 simulation had 29,000 ac.ft/yr less flow to Biscayne Bay than in D13R. North Biscayne Bay received 10,000 ac.ft/yr more water in the PSP simulation than D13R due to increased flow from the North Lakebelt storage area to S-29 via the C-9 canal. South Biscayne Bay received 22,000 ac.ft/yr more water due to the reduction of wellfield withdrawals in the vicinity of the C-102 and C-103 canals.

Water Supply

Redistribution of wellfield withdrawals resulted in an increase in the locally triggered phase 1 water restrictions at Hollywood from 4 in D13R to 15 in the WPA-PSP and from 0 at N. Lauderdale in D13R to 4 in WPA-PSP.

WPA-PSP components resulted in 4,000 less water supply to the LEC from Lake Okeechobee and 20,000 ac.ft/yr less supply from the WCA's to the LEC. Service area-1 supply from ASR decreased by 17,000 ac.ft/yr compared to D13R. In Service area-2 which received only supply from Lake Okeechobee and the WCA's in D13R, 33,000 ac.ft/yr was supplied from ASR and 15,000 ac.ft/yr from local storage in the PSP. Supply from the WCA's was reduced by 30,000 ac.ft/yr and Lake Okeechobee supply reduced by 9,000 ac.ft/yr. In service area-3, water supply from local reservoirs decreased by 16,000 ac.ft/yr in the PSP compared to D13R while ASR supplied 14,000 ac.ft/yr. Supply from Lake Okeechobee to Service area-3 increased 4,000 ac.ft/yr in the PSP and supply from the WCA's increased by 11,000 ac.ft/yr compared to D13R.

5.0 Summary

Collectively the WPA projects take advantage of an opportunity to reduce water losses to tide on the Lower East Coast, reduce seepage losses from the Water Conservation Areas, and provide an alternative source of water to meet Lower East Coast urban and agricultural demands.

The results of a limited review of the WPA-PSP performance in 2001 revealed that the plan achieves most, but not all of the performance targets for the Comprehensive Plan. This review also revealed a critical need to evaluate the regional effects of the implementation sequencing and its interim operations. The RECOVER ad-hoc group concluded that an evaluation of the interim operations is necessary to fully measure the effects of changes to plan recommendations. Based on the future operations, the actual benefits of the WPA components will be balanced with the system-wide objectives. The operational plans will be developed at a later date to find this balance.

The BCWPA selected alternative achieves its intended functions and will contribute towards achieving CERP's goals and objectives. The BCWPA is a small piece of the overall CERP plan; yet the restoration success of CERP will depend on the collective contribution of all projects rather than the individual performance of one project.

APPENDIX A

RECOVER ACTIVITIES

**CENTRAL AND SOUTHERN FLORIDA PROJECT WATER
PRESERVE AREA FEASIBILITY STUDY
DRAFT INTEGRATED FEASIBILITY REPORT
SUPPLEMENTAL IMPACT STATEMENT**

October 2001

APPENDIX A3
RECOVER ACTIVITIES

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APPENDIX A3 RECOVER ACTIVITIES

This section presents the results of the Regional Evaluation Team (RET) analysis on the Water Preserve Areas Feasibility Study. The RET performed several analyses of the feasibility study, starting with Alternative 2 and proceeding through the Preliminary Selected Plan. Alternative 1 was not assessed as the South Florida Water Management Model was not re-run for Alternative 1. From a regional perspective, the model run for D13R was used for Alternative 1. The regional model was run for all subsequent alternatives.

A3.1 REGIONAL EVALUATION OF WATER PRESERVES AREA FEASIBILITY STUDY – ALTERNATIVE 2

A conference call was held on April 19, 2000 to compare the Comprehensive Plan and the Water Preserve Area Feasibility Study's Alternative 2. RET members used the performance measures generated by the AET to determine whether this WPA alternative met or exceeded the benefits found in the Comprehensive Plan. The following is a summary of RET member reports. This analysis will be used to further refine the WPA plan. If necessary, the RET may evaluate subsequent alternatives and will evaluate the selected plan.

A3.1.1 REGIONAL EVALUATIONS

A3.1.1.1 Total System –

Compared to D13R, average annual overland flow across western Alligator Alley was down in dry season (1,000 ac-ft/year, -0.06%) and wet season (2,000 ac-ft/yr, -1.0%). Eastern Alligator Alley flows were down in the dry season (4,000 ac-ft/yr, -1.3%). The biggest differences were from February to May. Average annual flows across Tamiami Trail from 40 mile bend to L-67ext were down in the dry season (4,000 ac-ft/year, -2.0%) and down wet season (6,000 ac-ft/year, -2.5%) with the biggest differences between June to October. Flows across the eastern half of Tamiami Trail from L-67ext to L-30 increased by 8,000 ac-ft (+3% - dry) season and by 5,000 ac-ft/year (+2% - wet) over D13R with greater differences between September and December. Average annual westward flows through Shark River Slough west of L-31N were down 25,000 ac-ft/yr (-17.0%, dry) and 20,000 ac-ft (-18.0%, wet) with greatest differences from August to December. Westward flows across the L-67 extension were down 17,000 ac-ft/yr (-0.6%, dry) and 17,000 (-0.6%, wet) with the greatest differences between June and December.

A3.1.1.2 Lake Okeechobee

There were only very minor differences (clearly not significant ecologically or statistically) between the D13R and WPA Alt. 2 model output with respect to high and low lake stages.

A3.1.1.3 St. Lucie and Caloosahatchee Estuaries and Lake Worth Lagoon

There was no change in the performance of WPA Alt 2 compared to D-13 R, for St Lucie and Caloosahatchee Estuaries.

There was a small positive change (3 additional months of 0 cfs flow, and 1 month of a decrease in >500cfs flow) in the decrease in flows to Lake Worth Lagoon.

A3.1.1.4 Northern and Central Everglades

In general, the performance of WPA-2 in the remnant northern Everglades (Water Conservation Areas) was not significantly different from AltD13R. Mean hydroperiod distribution in WPA-2 for the remaining Everglades (including ENP) closely matched values for AltD13R. Inundation patterns (number of events, duration per event, and percent of year inundated) also closely matched AltD13R performance. A greater number of inundation events were generally balanced by a shorter duration per event consequently, the difference in percentage of inundation was never greater than 1%. A comparison of the two runs by indicator region is itemized below.

Note all comparisons are WPA 2 against Alt. D13R - so "more events" means more events in WPA 2 than in Alt. D13R. Comparisons are based on the Inundation Duration Summary Table and cross-referenced to the High/Low Water Summary Tables to see if trends were reflected in them.

WCA-1

- IR 26 no significant difference
- IR 27 more events (18 Vs 17), but of shortened duration (85 Vs 90).

WCA-2A

- IR 24 fewer events (18 to 17), but shift to longer duration (78 to 83), and shorter % (88 to 87).

- IR 25 more events (17 Vs 16) of shorter duration (87 Vs 93).

WCA-2B

- IR 23 fewer events (20 Vs 19) of longer duration (69 Vs 66).
- IR 61 more events (48 Vs 45) of shorter duration (21 Vs 22).
- IR 62 same pattern - 54 events Vs 50, and lasting 18 Vs 19 weeks.
- IR 63 no difference
- IR 64 more events (6 Vs 5) for a shorter duration (266 Vs 319).
- IR 65 more events (16 Vs 14) of shorter duration (93 Vs 106).

WCA-3A

- IR 14 no difference
- IR 17 fewer events (15 Vs 16) but of longer duration (102 Vs 96).
- IR 18 increase in length of events only. Change in % (97 Vs 96) may be a factor of how the % is calculated.
- IR 19 more events (14 Vs 13) of shorter duration (108 Vs 116), for an increase in % of 94 from 93.
- IR 20 no difference
- IR 21 more events (33 Vs 32) for a shorter duration (41 Vs 42)
- IR 22 more events (21 Vs 17) for a shorter duration (72 Vs 90), and a shorter % (94 Vs 95). IR 68 no difference
- IR 69 fewer events (14 Vs 15) for longer duration (110 Vs 102)

WCA-3B

- IR 15 Duration of events goes down from 398 to 318 weeks, with only one more event (5 Vs 4).
- IR16 Similar effect, only more pronounced - The duration of events goes from 315 to 224 weeks, while the number of events increases (7 Vs 5), and the % decreases (97 Vs 98).
- IR 66 fewer events (10 Vs 11) of longer duration (155 Vs 142), and a lower % (96 Vs 97).
- IR 67 more events (25 Vs 22) of shorter duration (54 Vs 62), and a lower % (83 Vs 84).

A3.1.1.5 Holey Land and Rotenberger Wildlife Management Areas

No real difference between the D13R and WPA 2, as modeled. Two additional observations in regards to WPA-2 performance are noted.

1. Inflows to WCA-3A through S-9 have decreased from 23K acre ft. in AltD13R to 5.6 acre ft. in WPA-2. This is considered a positive change in regards to reducing water quality impacts relating to S-9 discharges.

2. Conditions in Corbett WMA (I.R. 30) are wetter in WPA-2 than AltD13R. There are two more inundation events (56 in D13R Vs 58 in WPA-2) with an increase in duration of one week per event. Hydroperiod had increased to 16% of the year in WPA -2 compared to 11% in D13R. This is a significant difference in performance for this area and will be investigated.

A3.1.1.6 Southern Everglades

The mean annual volume of water flowing down Shark River Slough is 42,000 acre feet less in WPA2 than in alternative D13R. Annual overland flow across central Shark River Slough averages 1,099,000 af in WPA2 compared to 1141 af in D13R. The reduced flow appears to be manifested in very small changes in performance in many indicator regions of Everglades National Park.

One additional dry-down over the 31-year period of record occurs in NE and Mid Shark River Slough and in the Rockland, Ochopee and Mid-Perrine Marl Marsh indicator regions for WPA2 compared to D13R. In each case, however, the additional dry-down is associated with a brief (1-2 week) inundation period during which water depth was <0.2 feet. The ecologically significant number of dry-downs and mean duration of uninterrupted flooding, given the 0.2 foot criterion, are the same for both WPA2 and D13R.

Water stages at the P33 gage, which are relevant to salinity regimes in the coastal Basins of Florida Bay, are slightly lower for WPA2 compared to D13R. A stage of 6.3 feet msl, below which undesirable high-salinity events occur, is equaled or exceeded 60% of the period of record in WPA2 compared to 62% in D13R. A stage of 7.3 feet msl, above which desirable low-salinity events occur, is equalled or exceeded 4% of the period of record in WPA2 compared to 5% in D13R.

Although the reduced performance of WPA2 relative to D13R is minor, it is of concern because Everglades National Park may already be below flow and hydroperiod targets in D13R, and the goal of the PIR's is to increase that performance rather than to further decrease it. It is also of concern because if PIR's are allowed to perform only slightly poorer than D13R, their cumulative effect could be a substantial reduction in performance for the Everglades. Subsequent model scenarios for the WPA's should restore flows to Shark River Slough to those equaling, and preferably exceeding, those simulated in D13R.

A3.1.1.7 Big Cypress

There were only minor affects on the Cypress Swamp region consisting of a slight reduction in flow through Lostman's Slough.

A3.1.1.8 Biscayne Bay

The changes to the estuaries were minor, but primarily positive.

- Snake Creek, 4 months of increase, 1 in the dry season;
- Miami River 3 months increase wet season, 1 month decrease dry season;
- Central Bay 4 months increase dry season, 7 months increase wet season, some slightly negative
- South Bay, 2 months decrease dry season, 3 months decrease wet season
- No change in the surface water flows to North Bay.

A3.1.1.9 Lake Okeechobee Service Area

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All water supply performance measures and indicators for the Lake Okeechobee Service Area (LOSA) show a deterioration under WPA-2 as compared to the Recommended Plan (D13R). The SFWMM results indicate there would be an additional year with water restrictions (6 instead of 5). While the restrictions would be in place only one month during the added year (1991), there would also be an additional month of water restrictions in 1974 and 1990 as well. Total supply-side management cutbacks under Alternative 2 are 109,000-acre feet (14%) more than they were under the Recommended Plan. Overall, the changes would not significantly worsen performance, but definitely move in the wrong direction.

Underpinning the deteriorated performance are increases in most years in the supplemental volumes needed from Lake Okeechobee to meet demands. Such increases would come about because of increased demands downstream of the EAA that result from declining amounts of water available. It is likely that the reduced utilization of the West Miami-Dade reuse plant that resulted from the effort to modify hydroperiods in the Bird Drive Basin has played a significant role in this change since it removes significant water from the water budget.

A3.1.1.10 Lower East Coast Service Area

The WPA Alt 2 performs similar to D13R since it improves performance compared to "without project". The level of certainty improves for public water suppliers in the Lower East Coast dependent on regional water deliveries and coastal canal stages are maintained. However performance in WPA Alt 2 is slightly diminished compared to the D13R simulation. The number of water supply

restriction events due to low Lake Okeechobee stages increases by one. One additional month of restrictions occur in 1991 due to Supply-side Management cutbacks, which affect the entire Lower East Coast Service Area. This resource associated cutback is followed by four months of dry season restrictions. The increase in the quantity of demand not met is not significant but the additional restriction event increases the frequency enough to exceed the 1-in-10 year level of certainty for water supply in the Lower East Coast Service Area.

When comparing WPA Alt 2 to D13R, some minor changes in surface water flows into and from the Lower East Coast Service Area also occurred. Regional water deliveries from the WCAs and Lake Okeechobee to Service Area 1 decline while water provided by the reservoirs increases during drought events and on average. The opposite trend occurs in Service Area 3. The volume of water delivered from the WCAs and Lake Okeechobee to Service Area 3 increases while water provided by the reservoirs declines. The increase in water provided by the reservoirs in Service Area 1 is 8,000 acre-feet on average annually (an 88% increase compared to D13R) and the decrease in water delivered from the reservoirs in Service Area 3 is 13,000 acre-feet on average annually (17.5% decrease compared to D13R). The surface water flows to tide are similar for WPA Alt-2 and D13R except for the C-14. The average annual flow to tide decreases by 15,000 acre/feet at S-37A. This change in performance is linked to the redirection of North Springs Improvement District surface water flows to the Hillsboro Impoundment.

A3.1.2 WPA Alternative 2 - Hydrologic Evaluation

In the WPA-2 simulation there was on average approximately 50,000 ac-ft/yr less flow through the S356 structures into the ENP buffer area and ENP. About half of this can be accounted for by the reduction in the Bird Drive Reuse and the remainder is due to a reduction in levee seepage from WCA-3.

Reuse water discharged into the Bird Drive recharge area was reduced by 55,000 ac-ft/yr in the WPA-2 simulation. As a result, about 30,000 ac-ft/yr less groundwater flowed from the Bird Drive recharge area and the cells to the north and south of the recharge area, to the cells to the west of it in the WPA-2 simulation than in Alt D13R. In the SFWMM, the S356 structures discharge water from the L31N canal into the ENP (in reality this would be via the buffer area, which is not simulated in the SFWMM due to the scale of the model grid cells). The L31N canal flows through the cells adjacent and west of the Bird Drive recharge area, so with less groundwater flow to these cells, stages in L31N were lower and there was less flow to the ENP through the S356 structure.

There was 28,000 ac-ft/yr less levee seepage from WCA-3 to the L33 and L30 canals in the WPA-2 simulation than in Alt D13R. Hence the flow from L30 south through S355 into L31N was reduced by 27,000 acre feet accounting for other half of the reduction in flow from the L31N canal through the S356 structures into ENP. The reduction in levee seepage was due to less backpumping through S9 into WCA-3A (17,000 ac-ft/yr less) and slightly lower stages in WCA-3B.

A3.2 REGIONAL EVALUATION REPORT OF THE WATER PRESERVES AREA FEASIBILITY STUDY – ALTERNATIVE 3

The Water Preserve Area Feasibility Study Team (WPA Team) requested the Regional Evaluation Team (RET) to complete an evaluation of Alternative 3. The evaluation compares Alternative 3 to the Comprehensive Plan, Alternative D13R. The evaluation focuses on system-wide performance and robustness of the plan being evaluated as simulated with the South Florida Water Management Model.

A3.2.1 REGIONAL EVALUATIONS

A3.2.1.1 Lake Okeechobee

The hydrologic performance of Lake Okeechobee in WPA-Alt 3 is virtually identical to WPA Alt 2 and D13R and meets its targets.

A3.2.1.2 St. Lucie and Caloosahatchee Estuaries, and Lake Worth Lagoon

The St. Lucie and Caloosahatchee estuary performance measures for WPA Alternative 3 are not significantly different from D13R. In each case, the alternative is better than target. WPA Alt 3 is a slight improvement over D13R in Lake Worth lagoon.

Performance measure: Number of times the salinity envelope criteria were not met for the St. Lucie Estuary (SLE).

	<350cfs	>2000cfs	Reg. Releases from Lake O.
D13R	51	16	0
WPA-3	51	17	0
Target	178	23	0

Performance measure: Number of times high discharge flows are >2000cfs and >3000cfs for the SLE.

	>2000cfs	>3000cfs	
D13R	10	4	
WPA-3	10	4	
Target	23	5	

Performance measure: Number of times the salinity envelope criteria were not met for the Caloosahatchee.

	<3000cfs	>2800	Lake O. releases
D13R	36	10	1
WPA-3	36	10	1
Target	60	22	0

Performance measure: Number of times high discharge flows are >2800cfs and >4500cfs for the Caloosahatchee.

	>2800cfs	>4500cfs	
D13R	11	3	
WPA-3	11	3	
Target	22	6	

Performance measure: Number of times the salinity envelope criteria were not met for the Lake Worth Lagoon

	Flow = 0 cfs	>500 cfs	
D13R	24	108	
WPA-3	28	108	
2050base	42	216	
1995base	30	299	

A3.2.1.3 Northern and Central Everglades

WCA 1 and WCA 2A

Alt WPA-3 results did not differ significantly from D13R. Results from selected regions in WCA-2B and WCA-3A & B indicated a slight reduction in stages compared to D13R resulting in changes to inundation patterns.

WCA 2B

Water levels exceeded -1ft. below ground 93 weeks for 31 year POR in D13R compared to 107 weeks in WPA-3. High water criteria (water depths >2.5ft.) exceedence was identical to D13R at 159 weeks. This area was given a poor rating for restoration in D13R and WPA-3 results do not show any improvement.

WCA 3A (eastern - IR 19)

A high water level criterion was not exceeded as many times in WPA-3 (304 weeks) compared to D13R (316 weeks). Levels exceed low water criteria for 27 weeks in WPA-3 compared to 21 in D13R for the POR. Although the average annual hydroperiod in WPA-3 is identical to D13R (93%), D13r had 13 flooding events lasting 116 weeks per event for the POR, compared to 16 events for WPA-3 lasting 94 weeks per event. The inundation pattern for Alt WPA-3 is within the target window for this area. WPA-3 results are considered to be a slight improvement compared to D13R due to issues relating to high water concerns.

WCA 3B (eastern IR 16)

High water criteria (water depths > 2.5ft.) exceedence was reduced in Alt WPA-3 (82 weeks /POR) compared to D13R (98 weeks/POR) while low water criteria exceedence performance was matched (9 weeks for both runs). Results did not indicate a significant difference in average annual hydroperiod between the two runs however inundation patterns differ slightly. Results for the 31 year POR indicate 5 flooding events in D13R with a duration of 315 weeks per event compared to 9 events in WPA-3 having a duration of 174 weeks per event. Alt WPA-3's inundation pattern is considered a slight improvement over D13R due to high water issues in this area.

A3.2.1.4 Southern Everglades and Florida Bay

The weekly stage hydrographs show the line for Alt 3 practically superimposed over the line for D13R. In a number of years these lines hover around ground level or the -1.5 foot line, so the slightest difference between lines can trigger an "event". The differences between Alt 3 and D13R may or may not be significant in terms of the precision of the model, but it appears that there is a relative tendency for Alt 3 to be very slightly drier during dry periods in the southern Everglades.

Southwest Shark River Slough (IR 9). There were no differences between D13R and WPA Alt 3.

In Mid Shark River Slough (IR 10) the number of weeks where stages exceeded the > 2.5 foot maximum fell from 30 to 28.

Northeast Shark River Slough (IR 11) showed a 1% improvement in hydroperiod. The number of weeks where stages exceeded the maximum of +2.5 feet dropped from 59 to 46 while the number of weeks where stages fell below -1 foot dropped from 6 to 4.

Ochobee Marl Marsh (IR 7) experienced 3 more flooding events, dropping average flood duration from 29 to 26 weeks although the average annual hydroperiod remained at 66%. There was no difference in the number of extreme high or low events. Drydowns were more severe. The number of weeks when water dropped below -1.5 feet increased from 153 in D13R to 157. NSM had 136.

West Perrine Marl Marsh (IR 2) had a 1% increase in hydroperiod, the same average annual hydroperiod, and 1 less low water event. However, there were 4 more weeks where water was below -1.5 feet than in D13R, so low events were less frequent, but ground water levels were lower when they occurred.

Rockland Marl Marsh (IR 8) had a 2% reduction in hydroperiod and 2 more low water events. The number of weeks where water was below -1.5 feet increased from 217 in D13R to 230 in Alts 2 and 3. The NSM had 200 weeks. The stage hydrograph follows D13R very closely except low stages were slightly lower, dropping just below the ground elevation and the -1.5 foot exceedence line during years where D13R and NSM skirted the marks.

The transect east of L-67 showed an increase in flow, but there was a decrease from 40-mile bend to L-67.

A3.2.1.5 Pennsuco

This area meets its D13R targets.

A3.2.1.6 Big Cypress

There were no detectable changes, except for some very minor ones in the Lostman's Slough area of southeast Big Cypress. These sites exhibited a pattern of slightly lower flows (T25) and shorter hydroperiods (IR 13 and 46) in both WPA Alts 2 and 3, but these are not a significant problem.

A3.2.1.7 Biscayne Bay

Biscayne Bay Mean Annual Surface Flows – Alternative 3 impacts surface water deliveries to Biscayne Bay in all areas of the Bay relative to D13R except in North Bay, where minimal improvement is seen in both wet season and dry season. This resulted in failure to meet both wet season and dry season targets in Snake Creek and Central Bay. Please note that targets have not been met in Central Bay for any of the alternatives, including D13R, and in addition, Alternative 3 resulted in the loss of 16,000 acre-feet relative to D13R (9,000 acre-feet in dry season) or 27,000 acre-feet relative to Alternative 2 (13,000 acre-feet in dry season). Although targets continued to be met in South Bay, the reduction of the regional water contribution to the total underscores the importance of relying on an alternative water source to meet the desired targets. Alternative 2 generally functioned better in maintaining and improving surface water flows to Biscayne Bay than either D13R or Alternative 3.

A3.2.1.8 C-111/Perrine Marl Marsh/North C-111

Alt 3 produces substantially the same hydroperiod and hydroperiod characteristics as Alt 2 and D13R.

A3.2.1.9 Model Lands

There are only slight differences among the alternatives. Although the inundation duration table does not indicate any difference among the alternatives, the stage hydrograph and stage duration curve show slight differences under the most extreme dry season low water events. Among such events, Alt 3 produces slightly better results than D13R or Alt 1 or 2.

BDRA Normalized Stage Duration Curve, 1988-95 – Alternative 3 results in hydroperiod conditions (60% hydroperiod) that achieve the goal of maintaining a marl prairie (hydroperiod not to exceed 70%). Wet season water levels are a little lower than recommended to produce ideal habitat, however. Adjustments should be made to increase water levels to approximately 1.5 feet under average wet season conditions, and not to exceed 2 feet under extreme wet season conditions.

A3.2.1.10 Lake Okeechobee Service Area

All water supply performance measures and indicators for the Lake Okeechobee Service Area (LOSA) show a deterioration under WPA-3 as compared to the Recommended Plan (D13R). The performance of WPA-3 did not significantly

recover from the deteriorated performance in WPA-2 and in some aspects is worse. The SFWMM results indicate there would be an additional year with water restrictions (6 instead of 5) in WPA-3 vs. D13R. While the restrictions would be in place only one month during the added year (1991), there would also be an additional month of water restrictions in 1974 as well. Compared to D13R, cutbacks in 1981 last an additional 17 days, while in 1990 they last an additional 54 days. Total supply-side management cutbacks for the 31 year simulation period under WPA-3 are 133,000-acre feet (17%) more than they were under the Recommended Plan. Much of this comes in 1990 when the cutback volume is almost doubled (from 80,710-acre ft. to 159,290-acre ft.).

Overall, for the Lake Okeechobee Service Area, the changes from D13R to WPA-3 are definitely in the wrong direction.

A3.2.1.11 Lower East Coast Service Area - Flood Control

Alt 3 has an impact on 2 of the cells we look at for the southern Dade flood control performance. In cell R20C27 the alt 3 performance is worse than D13R and alt 2, but better than the target. Alt 2 has the best performance at the higher stages, which is the more important area of this graphic. In cell R19C27 alt 3 is better than alt 2 and D13R. However, there is little difference among the 3 runs at the higher stages. Alt 3 is slightly better than the other 2. There was no difference in performance at the higher stages in the other 4 cells to the south.

A3.2.1.12 Lower East Coast Service Area – Water Supply

Generally, WPA-3 performs similar to WPA-2, which is poorer than D13R. The main difference in performance between WPA-3 and D13R is due to limited water supplies in LOK. In Alt 3, there is one more year (1992) of phase 1 restrictions for the entire LECSA due to LOSA cutbacks compared to D13R. This additional restriction performs the same as WPA-2. The additional year of water restriction prevents LECSA2 from meeting a 1-in-10 year level of service.

A new area in Miami-Dade County experiences low local groundwater levels, North Miami, in WPA-3. However only one additional water restriction event occurs, which is not considered significant.

Discharges to tide increase in LECSA2 due to new operations in C-11 Impoundment and Basin. These increases in flows past S-13A and subsequently S-13 benefit Pond Apple Slough as designed in WPA Alt 3. Discharges increase by approximately 45,000 ac-ft on average annually or 10% when compared to D13R and WPA-2. Discharges to tide decrease in LECSA3 by 40,000 ac-ft on average annually (5%) while flows to Central Biscayne Bay decline by 27,000 ac-ft on average annually (13%) when compared to WPA-2. When compared to D13R, flows

to tide from LECSA3 decline by 28,000 ac-ft and to Central Biscayne Bay by 16,000 ac-ft when compared to D13R.

One option to send more water to Biscayne Bay may be the C-9 ASR. It seems that much water may be stored in ASR and not utilized effectively.

A3.2.2 ISSUES AND NOTABLE POINTS

This is the first time ASR has been used in the Acme Basin. They have not been optimized, resulting in reductions in water deliveries to some areas (e.g. Biscayne Bay, NESRS). Operations changes could make them more efficient. Unfortunately, unless technology is developed to clean the water to >10 ppb phosphorus, this water should not be sent to Loxahatchee NWR (WCA-1).

Studies are going on to determine what the seepage rates are. These data will make it easier to determine how much we need to rely on ASR.

The Ag Reserve was not used as a big STA because of concerns about the presence of toxophene in the soils and because the technology does not presently exist to bring the water down to less than 10 ppb phosphorus.

The Pond Apple Slough project is a mitigation area for I-595 and is a deep water slough. It was not included in the hydrologic evaluation of D13R because at the time there was no way to model it, a fact true of most of the OPE's and Critical Projects. Now that the WPA project's finer-scale model allows us to see its effects on the regional system, it needs to be included even though we are comparing pond apples to oranges by comparing model results to D13R. While this new straw does take a significant amount of water, that water serves to prevent saltwater intrusion, so it is not accurate to say that water is "lost to tide".

Alt 3 is the first alternative to eliminate S-9 pumping into the Water Conservation Areas, a water quality benefit although there is a trade-off with water quality. Remaining flows through S-9 (16,000 ac-ft) are all under 500 cfs, meaning it is all seepage from the WCAs, therefore it is good quality water.

In Alt 3, the amount of reuse was $\frac{1}{2}$ of the amount in D13R because the size of the receiving body, the Bird Drive basin reservoir, was reduced. The amount of reuse should be increased and used to make up for some of the losses to Biscayne Bay.

There are problems with the way Bird Drive was modeled that exaggerate its reduction in capacity. As it was, the Bird Drive reservoir had the capacity to go to 4-feet in Alt 3 but never did, implying there is more storage capacity that there appears to be.

Rather than sending WCA-2B levee seepage water straight to the Park, this Alternative sends it by way of L-33 to the Central Lake Belt until it is full. That improved the timing of flows in to the park.

A3.2.3 RECOMMENDATIONS

- The WPA team has not had time to optimize the operations in this model, particularly the use of ASR. Optimization will likely improve the performance of this alternative. The best way to be certain would be to model a scenario in which the use of captured water is optimized in natural systems.
- Possibly add another STA, reroute the 40,000 ac-ft of ACME basin runoff through the STA and back into WCA-1 rather than to ASR.
- Make more efficient use of Central Palm Beach County and Site-1 ASR, perhaps using Site-1 water for Pond Apple Slough.
- Optimize flows to Pond Apple Slough. Does it need 44,000 ac-ft?
- Use C-9 ASR more efficiently. Can it be used to meet the Biscayne Bay deficit?
- Refine the modeling of the Bird Drive reservoir so as to have similar local L31N contributions to D13R.

A3.2.4 OVERVIEW OF HYDROLOGICAL EFFECTS OF ALTERNATIVE 3

Simulation of the Water Preserve Area Alternative 3 in the South Florida Water Management Model was undertaken primarily to evaluate the impacts of detailed design changes on the regional system. In this evaluation WPA Alt. 3 is compared to the preferred Restudy alternative D13R.

In general WPA Alt. 3 results in:

- slightly lower Lake Okeechobee stages,
- increased cutbacks in the Lake Okeechobee service area,
- one more Lake Okeechobee triggered water cutback in all the Lower East Coast service areas,
- improved timing of hydroperiods, but reduced flow to Everglades National Park (-80,000 ac.ft/yr), and
- reduced flow to Biscayne Bay (-29,000 ac.ft/yr)

For the most part these effects are due to increased injection to ASR's in the WPA components which, on average result in an additional 62,000 ac.ft/yr being left in ASR storage. Local restoration in Pond Apple Slough resulted in 44,000 ac.ft/yr being unavailable to the regional system and increased flow to tide by 39,000 ac.ft/yr. Reduced capacity of Bird Drive reservoir reduced the availability of reuse water by 21,000 ac.ft/yr.

Regional effects are discussed in more detail below, followed by a discussion of where the water went as a result of WPA component changes.

Note that due to the regional scale of the SFWMM (2 x 2 mile grid) several simplifying assumptions were made in the regional scale modeling of the WPA Alt. 3 components. In the SFWMM representation of WPA Alt. 3 scale limitations magnified reductions in flow to ENP.

A3.2.4.1 Regional Hydrologic Effects

Lake Okeechobee

Lake Okeechobee had slightly lower stages (-0.1 ft) than D13R during drier times. Regulatory releases to the WCA's were down 3% (-2,700 ac.ft/yr) and injection into Lake Okeechobee ASR was also 3% (-6,900 ac.ft/yr) less. Water supply to the LEC increased by 16% (11,100 ac.ft/yr) and environmental water supply increased by 4 % (6,000 ac.ft/yr). Lower lake stages increased the frequency of lake induced water shortages by 1 from 5 to 6 Lake Okeechobee triggered shortages in each of the Lower East Coast service areas. The volume of cutbacks in the Lake Okeechobee Service Area was increased by a total 134,000 ac-ft over the 31 year simulation period, with most of the increases coming in a the few dry years indicated in Table1.

Table 1. Years in which supply side management cutbacks increased significantly.

Year	Alt D13R	WPA Alt. 3	Increase from D13R to WPA Alt. 3
	SSM Cutback Volume (1000 ac.ft)		(1000 ac.ft)
977	5.4	16.0	+ 10.6
981	484.9	514.6	+ 29.7
990	80.7	159.3	+ 78.6
991	3.5	12.2	+ 8.7

Water Conservation Areas

Hydrologic characteristics in the conservation areas were very similar in WPA-Alt 3 to D13R. The average annual duration of high water was 1% less in East WCA-3B (IR-16) and East WCA-3A (IR-19). At the same time there was a 1% increase in the average annual duration of low water in the same two regions. WCA-3B was slightly drier in WPA-Alt3 with 1 % shorter average annual hydroperiod in West WCA-3B (IR-15).

On average there was a reduction of 23,000 ac.ft/yr in levee seepage from WCA-3 to the Lower East Coast with a corresponding increase in groundwater flow of 23,000 ac.ft/yr.

Everglades National Park

Net inflow into the ENP (defined as all inflows minus levee seepage) was on average 80,000 ac.ft/yr less than Alt D13R (see Table 2) and 26,000 ac.ft/yr less than WPA-Alt 2. The reduction in net inflow was predominantly due to less flow through the S-356 structures. Outflow through the Shark River Slough diagonal transect was 52,000 ac.ft/yr less than D13R.

Although there was less net inflow into the ENP, WPA Alt. 3 performance, measured in terms of inundation duration, was similar to that of D13R. In the Rockland Marl Marsh and New Shark River Slough indicator regions (IR 8 & 12) there were 1 % reductions in average annual hydroperiod, while in the Ochopee Marl Marsh and NE Shark River Slough indicator regions (IR 7 & 11) there were 1% increases in average annual hydroperiods. In NE-SRS timing of water delivery in dry times was improved maintaining slightly longer hydroperiods.

Table 2. Summary of flows into and out of ENP

	Alt D13R	WPA-Alt 3	Difference
INFLOW			
Overland flow	970	965	-5
Groundwater flow	7	6	-1
S356 A,B	294	227	-67
S332's – levee seepage*	80	73	-7
Net Inflow (% of NSM inflow)	(82%) 1351	(78%) 1271	-80
OUTFLOW			
Groundwater to east	195	180	-15
SRS diagonal transect (% NSM)	(73%) 1141	(70%) 1089	-52

* inflow through the S332 structures is reduced by levee seepage so as to account for any possible recycling of levee seepage back into the ENP through the S332 structures

Biscayne Bay

There was 29,000 ac.ft/yr less flow to Biscayne Bay than in Alt. D13R. Reductions occurred in both the wet and dry season and were distributed through North, Central and Southern bay.

A3.2.4.2 Where the Water Went

Water Conservation Areas

In WPA Alt. 3 there was a net decrease of 35,000 ac.ft/yr of inflow into WCA-1 compared to D13R. Most of this difference was due to 40,000 ac.ft/yr of ACME basin runoff that went to WCA-1 in D13R. There was no direct runoff from the ACME basin to WCA-1 in WPA Alt.3, but an increase of 7,000 ac.ft/yr in runoff to WCA-1 through STA-1E. The remainder of the difference in inflow was due to less flow through STA-1W.

In WPA Alt.3 there was 21,000 ac.ft/yr less inflow to WCA-2A through the S-10's and a corresponding 6,000 ac.ft/yr less outflow to WCA-2B through the S-144, 145, and 146 structures and 15,000 ac.ft/yr less outflow through the S-11 structures.

In WCA-2B, as a result of 6,000 ac.ft/yr less inflow, there was 1,000 ac.ft/yr less outflow through S-34, and 5,000 ac.ft/yr less outflow via the eastern flow-way to Everglades National Park.

In WCA-3A, there was a net decrease in structural inflow of 6,000 ac.ft/yr balanced by a 15,000 ac.ft/yr decrease in overland outflow, a 3,000 ac.ft/yr increase in levee seepage and a 6,000 ac.ft/yr increase in structural outflow.

In WCA-3B the decrease in structure inflow (-11,000 ac.ft/yr) was balanced by a decrease in structure outflow (-13,000 ac.ft/yr) mostly through reduced S-31 environmental releases (-11,000 ac.ft/yr). There was decreased levee seepage (-25,000 ac.ft/yr) increased groundwater outflow (+21,000 ac.ft/yr) and increased overland outflow (+6,000 ac.ft/yr).

WPA components

As shown in Table 3, on average 62,000 ac.ft/yr more water was lost (injected and not recovered) to ASR with the WPA Alt. 3 components than in Alt. D13R.

ACME. In addition to the reduction of ACME basin runoff into WCA-1, in WPA Alt. 3 ASR was included with the ACME basin reservoir in an attempt to improve local

flood protection. On average 10,000 ac.ft/yr was not recovered from ACME ASR which had a 38% recovery efficiency.

Table 3. ASR losses. (Injection minus recovery). Units are 1,000 ac.ft/yr.

ASR	D13R	WPA Alt. 3	Increase in loss from D13R to WPA alt 3
ACME Basin ASR	not modeled	10	10
Central PBC Reservoir ASR	13	17	4
Site 1 ASR	33	53	20
C-9 ASR	not modeled	28	28
Total			62

Central Palm Beach County Reservoir. ASR associated with the Central PBC reservoir was used less efficiently in WPA Alt 3 (43%) than in D13R (69%) because some of the demand previously met by Central PBC ASR was met by the new ACME Basin ASR. In WPA Alt.3 an additional 4,000 ac.ft/yr was not recovered from ASR.

Site-1 Reservoir. Inflow to the Site 1 (Hillsboro) reservoir was 26,000 ac.ft/yr more than in D13R primarily due to inflow from the North Springs Improvement District and the subsequent reduction of 17,000 ac.ft/yr in flow to tide via the C-14 canal. The increase in injection to Site 1 ASR was 17,000 ac.ft/yr more than D13R, however the demand on water from Site-1 ASR remained much the same, resulting in a reduction in ASR efficiency from 41% in D13R to 27% in WPA Alt. 3. On average 20,000 ac.ft/yr more water remained in the Site 1 ASR bubble than in D13R.

C-11. In the C-11 basin, on average 44,000 ac.ft/yr more water was sent through S-13A to restore Pond Apple Slough in WPA Alt. 3 than in D13R. As a result, flow to tide from the C-11 basin increased by 39,000 ac.ft/yr and runoff from the C-11 basin to the North Lakebelt storage area decreased by 44,000 ac.ft/yr

C-9. The C-9 reservoir was not modeled in D13R. As modeled in WPA Alt.3, the C-9 reservoir captures runoff from the C-9 basin, reducing C-9 flow to the North Lakebelt storage area by 11,000 ac.ft/yr. ASR associated with the C-9 reservoir is 15% efficient with on average 28,000 ac.ft/yr more injection to ASR than recovery from it. The C-9 ASR was also introduced to improve local flood protection.

North Lakebelt. In addition to the cumulative 55,000 ac.ft/yr inflow reduction to NLB storage from the C-11 and C-9 basins (discussed above) there was also 7,000 ac.ft/yr less inflow to NLB storage from the C-6 west basin. As a result

there was 58,000 ac.ft/yr less flow from NLB storage to Biscayne Bay. The NLB Water Redistribution Area introduced in WPA Alt.3 required on average 8,000 ac.ft/yr to maintain.

Central Lakebelt. Due to less inflow to the CLB storage from WCA-3B (-12,000 ac.ft/yr) there was available capacity in CLB storage to receive more water from the L33 canal (+10,000 ac.ft/yr). Flow from CLB storage to Everglades National Park was reduced (-4,000 ac.ft/yr) however the timing of flow improved.

S-335. Inflow into L31N through S-335 was 38,000 ac.ft/yr less in WPA Alt. 3 than in D13R. This reduction was due to less flow from WCA-2B (-5,000 ac.ft/yr), less flow from CLB storage (-4,000 ac.ft/yr), less levee seepage into L-30 and L-33 (-25,000 ac.ft/yr) and less flow from L-33 to L-30 as more water flowed from L-33 to CLB storage. The reduction in levee seepage was offset by an increase in groundwater flow out of WCA-3, however the levee seepage reduction would have had a more direct effect on flow into L-30.

Bird Drive. In WPA Alt. 3, Bird Drive reservoir was simulated adjacent to ENP and the Bird Drive recharge area adjacent and to the east of the reservoir. Consequently in the SFWMM representation of WPA Alt. 3, L31N was modeled as a single cell reach rather than a 4 cell reach as in D13R, resulting in approximately 30,000 ac.ft/yr less local flow to L31N from the cells in which it was located. Hence reduced S-356 flows to ENP (-67,000 ac.ft/yr) were partly due to less flow through S-335 discussed above and partly due to the way the Bird Drive Reservoir and L31N canal were modeled at the 2 x 2 mile scale. As modeled in WPA Alt. 3, the local runoff that previously went into L31N, was able to offset the reduction of flow to Biscayne Bay from NLB storage by about 30,000 ac.ft/yr making the total reduction in flow to Biscayne Bay 29,000 ac.ft/yr. Furthermore in WPA Alt. 3, only 21,000 ac.ft/yr less reuse water was sent to the Bird Drive Reservoir because of its smaller capacity than in D13R. The Bird Drive reservoir as modeled in WPA Alt. 3 did appear to have a beneficial effect on the timing of hydroperiods in North East Shark River Slough, reducing groundwater flow out of ENP to the east by 15,000 ac.ft/yr.

A3.3 REGIONAL EVALUATION OF WATER PRESERVE AREA FEASIBILITY STUDY PRELIMINARY SELECTED PLAN (WPA- PSP)

The Water Preserve Area Feasibility Study Team (WPA Team) requested the Regional Evaluation Team (RET) to complete an evaluation of the their Preliminary Selected Plan (WPA-PSP). The evaluation compares WPA-PSP to the Comprehensive Plan, Alternative D13R. The evaluation focuses on system-wide performance and robustness of the plan being evaluated as simulated with the South Florida Water Management Model.

A3.3.1 Summary

The WPA-PSP simulation performs almost identically to the Comprehensive Plan in most areas within the region. It is expected to provide the same of level of benefits as were anticipated at the conclusion of the Restudy process. Performance in Everglades National Park, Biscayne Bay and Lower East Coast Service Area 2 varies from D13R but not necessarily due to the WPA components.

Flows to the Park were reduced slightly (-45,000 ac ft) while flows to the Bay increased slightly (+32,000 ac ft). Variables in the WPA-PSP simulation prevent concluding that the Preliminary Selected Plan is the causative factor. Compared to D13R, there are two variations the WPA-PSP in addition to the WPA components themselves. The public water supply withdrawal locations were modified to reflect the distribution developed in the Lower East Coast Regional Water Supply Plan and the surface water flow targets were met for Pond Apple Slough from the C-11 Canal. Modeling these additional variables at the same time as the WPA Plan made it more difficult to clearly determine which regional effects were due to the WPA components, which could be attributed to these additional variables, and which were a combination of the two. RET members were apprised of the effects of these added variables during the RET meeting on November 14, 2000 and regional evaluators were confident they were able to properly discern the separate effects in the WPA-PSP simulation.

In the Lower East Coast Service Area 2, the number of locally triggered water restrictions increased in WPA-PSP due to the change in public water supply withdrawal distribution. Compared to D13R, in WPA-PSP a greater percentage of withdrawals are located further east closer to the coast and the trigger wells. With an increase in withdrawals in the same model grid cell as the trigger well, groundwater stages cannot be maintained as easily above the shortage criteria even though the distance between the wells may be significant. The number and duration of restrictions reflects the same pattern as the Lower East Coast Regional Water Supply Plan LEC-1R simulation, which has a similar distribution. The increase in the number of water restrictions in WPA-PSP does not reflect changes associated with the WPA components.

A3.3.2 REGIONAL EVALUATIONS

A3.3.2.1 Total System

Continuity performance measures were virtually identical to D13R.

Flow volumes across the transects in the upper part of the system either meet or exceed D13R during both wet and dry seasons. However, south of Tamiami

Trail, the story is different. In these areas, D13R did not meet NSM flow volumes. Results of this model run showed lower flows still.

Table 6. Difference between flow volumes across transects (in ac-ft) between WPA PSP and D13R in the southern Everglades.

Transect	Wet Season – D13R (ac-ft)	Dry Season – D13R (ac-ft)
T19	-23,000	-9,000
T20	-6,000	-8,000
T21	-13,000	-16,000
T-22	-2,000	-2,000
T-23	-2,000	-3,000

A3.3.2.2 Lake Okeechobee –

In regard to Lake Okeechobee, the hydrologic performance of the WPA-PSP is virtually identical to that of D13R.

A3.3.2.3 St Lucie and Caloosahatchee Estuaries and Lake Worth Lagoon

The WPA-PSP performance matches D13R in St Lucie Estuary, Caloosahatchee Estuary and Lake Worth Lagoon. There is no difference between WPA-PSP and D13R.

A3.3.2.4 Big Cypress

There were no detectable changes in the Big Cypress from WPA-PSP, except for some very minor differences in the Lostman's Slough area of southeast Big Cypress, where the pattern of slightly lower flows (T25) seen in WPA Alts 2 and 3 were still present. The slightly shorter hydroperiods (IR 13 and 46) seen in both WPA Alts 2 and 3 have now reverted to D13R conditions.

A3.3.2.5 North and Central Everglades

Inundation pattern results (# of events, weeks/event, hydroperiod) for indicator regions in the northern and central Everglades show little significant difference in performance between Alt D13R and WPA-PSP. Slight differences in frequency of inundation occur in East WCA 3B; 5 events for the 31 year POR lasting 315 weeks/event in D13R vs. 8 events lasting 197 weeks/event in WPA-PSP, however the hydroperiod is the same (98%) in this area for both runs. This same trend is seen in east WCA-3A; slight increase in frequency of inundation without affecting hydroperiod.

A3.3.2.6 Pennsuco Wetlands

The 2x2 model output indicates that the WPA-PSP is similar (96% hydroperiod) to Alt 3, which is nearly indistinguishable from D13R in the regional model and shows extremely long hydroperiods for both Pennsuco North (96%) and Pennsuco South (95%) with water levels hovering near the 2-foot maximum for much of the period of record.

A3.3.2.7 Southern Everglades

Performance of several performance measures declined slightly for the WPA-PSP in the southern Everglades. These are largely due to operational changes and should not be considered as inherent flaws in the physical components of the WPA-PSP.

Based on the hydrologic evaluation, flows into ENP is 45,000 af less under WPA-PSP in comparison to D13R. This translates to a 31,000 af reduction in the 1,152,000 af flow across Mid SRS (T21) compared to D13R. The effects on hydroperiod are negligible.

NE and Mid Shark River Slough have 3 dry events over the period of record in both WPA-PSP and D13R. Mid Shark River Slough has one additional event below ground in WPA-PSP, which appears insignificant considering the margin of error in the model simulations. In Mid-Shark Slough (Indicator Region 10), the number of weeks duration of flooding events was slightly reduced relative to D13R.

The Rockland Marl Marsh experiences 39 dry events in WPA-PSP compared to 35 in D13R. The average annual hydroperiod in the Rockland Marl Marsh (Indicator Region 8) was also slightly lower.

The hydrologic differences between WPA-PSP and D13R appear insignificant regarding their ecosystem effects, although discrepancies should be minimized to prevent the cumulative effects of a number of PIR's from having potentially significant ecosystem impacts. More work should be done to compensate and improve on the performance above that of D13R.

A3.3.2.8 Cape Seaside Sparrow

Most affected is Cape Sable seaside sparrow subpopulation F, but still not a dramatic effect relative to D13R. Performance is slightly inferior to D13R in the Discontinuous Hydroperiod (days/year); that is, hydroperiod is slightly reduced. At the same time, the PSP is slightly inferior to D13R in Number of Consecutive Days when water is below ground between Feb. 15 and July 15 (reduced uninterrupted period of conditions favorable to nesting). It should be noted that the PSP is still

superior to the base cases (moving in the right direction) but falls a little short of D13R.

A3.3.2.9 Model Lands

There are only very slight differences among the alternatives. Although the inundation duration table does not indicate any difference among the alternatives, the stage hydrograph and stage duration curve show slight differences under the most extreme dry season low water events. Among such events, WPA-PSP produces slightly better results than D13R or WPA Alt 3 for Model Lands North, and slightly better results than D13R but identical results to WPA Alt 3 for Model Lands South.

A3.3.2.10 C-111/Perrine Marl Marsh/North C-111

The PSP produces substantially the same hydroperiod and hydropattern characteristics as Alt 3 and D13R.

A3.3.2.11 Biscayne Bay

The WPA-PSP performance shows improvements over both D13R and WPA Alternative 3 for surface water deliveries to Biscayne Bay in Snake Creek and South Bay, and performance equivalent to D13R in Central Bay. By moving public water supply withdrawals west in South Dade, it reduces surface water flows to Biscayne Bay. This reduction was offset by increasing flows from Bird Drive Recharge Area via the C-4 and C-2 canals to South Bay. There has not been a D13R model run with the new wellfield locations to make accurate comparisons. Under such circumstances, it is impossible to fully evaluate the effect of the WPA-PSP on Central and South Bay because of the absence of an appropriate comparison run of D13R.

A3.3.2.12 LOSA

The water supply performance measures and indicators for the Lake Okeechobee Service Area (LOSA) show essentially the same performance under WPA-PSP as compared to the Recommended Plan (D13R).

The “Frequency of Water Restrictions” graphic shows the same years of water restrictions and the same months in each year with the single exception that D13R shows water shortages in March of 1990, while the PSP run does not. In addition, the volumes of supply-side management cutbacks are very close in the two runs as shown in the following table, which focuses on cutbacks by calendar year.

Table 1 – Comparison of Supply-Side Management Cutbacks for Calendar Years in the D13R and Preliminary Selected Plan (PSP) Evaluations Sorted by Amount of Cutback

Calendar Year	D13R Evaluation Cutbacks (acre-feet)	PSP Evaluation Cutbacks (acre-feet)
1981	484,000	496,000
1982	195,000	197,000
1990	81,000	77,000
All Other Years	23,000	31,000

There is a slight concern, because of the increase in cutbacks in 1981, the worst drought year. Along with the 2.5% increase in the volume of supply-side management cutbacks, there was an increase of 3.5% in the number of days under supply-side management with cutbacks, from 225 to 233 days.

Overall, regarding water supply in the Lake Okeechobee Service Area, the D13R and WPA-PSP are evaluated as showing equivalent levels of performance.

A3.3.2.13 Lower East Coast Service Area –

A3.3.2.13.1 South Dade Flood Control

The level of flood mitigation provided in D13R is similar to WPA-PSP in almost all cells evaluated. There is, however, a noticeable increase in the groundwater levels for Cell R12 C28 in the LEC, which raises questions about whether the WPA-PSP has affected flood protection.

The water supply performance measures and indicators for the Lower East Coast Service Area (LESA) show generally the same performance under WPA-PSP as compared to the Recommended Plan (D13R). The main difference is in the performance in Lower East Coast Service Area 2.

A3.3.2.13.2 Water Supply

The “Frequency of Water Restrictions” graphic shows the same number years of water restrictions and the same months in each year for LEC Service Area 1, 3 and North Palm Beach County Service Area. The single exception is Service Area 2, which performs similar to the Lower East Coast Regional Water Supply Plan simulation LEC-1R. The two runs, WPA-PSP and LEC-1R, perform approximately the same since both use the same public water supply distribution. This distribution has a greater volume of water withdrawn near the coast where groundwater gages are located when compared to D13R and accounts for the increase in water

restrictions. The increase in frequency of water restrictions between D13R and WPA-PSP is due primarily to the public water supply wellfield locations and not the WPA components

Canal stages in the 11 primary canals are maintained above minimum flow and level stages. In addition, visual comparison of the stage duration curves in the southern Biscayne Bay area indicate that stages are maintained in WPA-PSP similar to D13R.

In related areas, surface water flows to North Fork of the New River and Pond Apple Slough, S-33 and S-13 respectively, WPA-PSP performs similar to or better than D13R. In D13R, flows to Pond Apple Slough declined significantly, but were reestablished to 1995 Base flow volumes and seasonal distribution in WPA-PSP.

Overall, water supply in the Lower East Service Area, the D13R and WPA-PSP have equivalent levels of performance with some improvement in WPA-PSP due to flows to Pond Apple Slough.

A3.3.2.13.3 Salt Intrusion in Southern Biscayne aquifer

Stage duration curves for the coastal canals show an improved ability to maintain groundwater levels under extreme dry conditions. This is particularly evident in the C-102 (S-21A) and C-103 (S-20F) canals. The hydrographs show that slightly higher groundwater levels are evident during most dry seasons in the period of record, and these results should be thoroughly evaluated for any potential effects on agricultural activities in this region.

A3.3.3 Recommendations

It is recommended that in future comparisons of proposed changes to the Comprehensive Plan that the simulation is limited to the changes under consideration in the PIR or feasibility study. Changes to the Comprehensive Plan to address outstanding performance issues, additional investigations, or improvement to the model should be handled under a separate process such as the CERP Refinement process contemplated for 2001 by the Comprehensive Plan Refinement and Regional Evaluation Teams. A clear process and specific simulations appropriate for evaluation of the WPA project designs needs to be identified.

A3.3.4 WPA-PSP Hydrologic Evaluation

This report provides a regional overview of the WPA Pre-Selected Plan (WPA-PSP) as simulated in the South Florida Water Management Model (SFWMMv3.5).

This overview focuses on differences between the PSP and the preferred Restudy alternative, D13R, and in some cases the previous WPA alternative, WPA-Alt. 3. After a brief summary, details are provided to show where the water went as a result of WPA component changes and the regional effects of these changes.

A3.3.4.1 Summary

Where the water went

Lake Okeechobee net inflow and outflow were the same in the PSP simulation as in D13R.

There was 27,000 ac ft/yr less runoff from the LEC developed area into the WCA's than in D13R. This water was utilized by the PSP components reducing the need for WCA water.

There was 29,000 ac.ft/yr less water delivered from the WCA's to the LEC.

Flow to tide was 50,000 ac.ft/yr more in the PSP than in D13R. This additional water contributed towards meeting environmental needs in the Pond Apple Slough area and Biscayne Bay.

Net inflow to Everglades National Park was 45,000 ac.ft/yr less than in D13R.

A3.3.4.2 Regional performance

Lake Okeechobee stages, and regulatory releases were essentially the same as in D13R.

The volume of Lake Okeechobee Service area cutbacks was not significantly different from those of D13R.

Hydrologic performance of the WCA's was similar in the PSP to that of D13R.

Hydrologic performance in the ENP was similar to that of D13R.

Flow through S13 to Pond Apple Slough was returned to 95 Base levels which are higher than those of D13R.

Flow to Biscayne Bay was closer to the environmental targets than in D13R.

Water supply in the LEC was met more by local storage and ASR than in D13R due to WCA-PSP components.

A3.3.4.3 Details of Where the Water Went

Lake Okeechobee.

Inflow to, and outflow from Lake Okeechobee was essentially the same in the WPA-PSP as in D13R. There was a decrease in water supply from the lake to the Lower East Coast of 4,000 ac.ft/yr and a corresponding increase in environmental water supply to the Everglades of 4,000 ac.ft/yr.

Flow between the Water Conservation Areas and Lower East Coast

There was 27,000 ac ft/yr less runoff from the LEC developed area into the WCA's than in D13R (Table 1). This reduction was primarily due to runoff from the

ACME basin being stored in the ACME basin reservoir and ASR. In D13R there was 40,000 ac.ft/yr of ACME basin runoff directly to WCA-1, while in the PSP only 17,000 ac.ft/yr flowed to WCA-1 through a STA. PSP modifications to the C-9, C-11 reservoir components reduced S-9 discharges from 22,000 ac.ft/yr in D13R to 15,000 ac.ft/yr in the PSP.

Table 1. Differences between the PSP and D13R flows from the LEC to the WCA's. Units are 1,000 ac.ft/yr.

Flows from the LEC to WCA's	PSP-D13R
Runoff from ACME basin	-23
STA 1 E	+3
S-9	-7
Total	-27

PSP component modifications and a redistribution of utility wellfield withdrawals resulted in a redistribution and net reduction in flows from the WCA's to the LEC (Table 2). In ACME basin the reservoir and ASR reduced regional system water supply to Lake Worth Drainage district by 8,000 ac.ft/yr. Better utilization of ASR and increased local storage (C-9 reservoir) resulted in LEC service area 2 demands being met more by local WPA components, reducing regional system flows (from the WCA's) through the S-38 and S-34 structures (Table 1). Modifications to PSP components to permitted more eastward flow to meet Pond Apple Slough and Biscayne Bay environmental needs and resulted in more regional system water being used to meet LEC service area 3 demands via S-337.

Table 2. A difference between the PSP and D13R flows from the WCA's to the LEC. Units are 1,000 ac.ft/yr.

Flows from the WCA's to LEC	PSP-D13R
Water Supply to L-8	-1
Water Supply to Lake Worth Drainage District	-8
S-39	+9
S-38	-34
S-34	-5
S-337	+15
Environmental releases from WCA-2B to relieve excess high stages	+9
Environmental releases from WCA-3A to relieve excess high stages	-3
Environmental releases from WCA-3B to relieve excess high stages	-11
Total	-29

Water Conservation Areas

Inflow to WCA-1 was 21,000 ac.ft/yr less in WPA-PSP than in D13R while outflow from WCA-1 was 15,000 ac.ft/yr less than in D13R. The reduction in flow into WCA-1 was due to much of ACME basin runoff being stored in the ACME basin reservoir and ASR rather than returned directly to WCA-1 as in D13R.

Inflow to WCA-2 was 24,000 ac.ft/yr less than D13R. Of this, 15,000 ac.ft/yr less came in through the S-10 structures and 9,000 ac.ft/yr less came through the S-7 structure. Outflow from WCA-2 to the LEC through S-38 was 34,000 ac.ft/yr less than in D13R while outflow through the new WCA-2B structures to the eastern flow-way was 9,000 ac.ft/yr more in the PSP than in D13R.

Inflow to, and outflow from WCA-3A was essentially the same in the PSP as in D13R. Increased S-337 outflow (+15,000 ac.ft/yr) to meet LEC service area 3 needs was offset by decreased flow to WCA-3B (-7,000 ac.ft/yr), less releases (-3,000 ac.ft/yr) to relieve WCA-3A of excessive high stages and decreased overland flow to the ENP (-8,000 ac.ft/yr).

WCA-3B had 7,000 ac.ft/yr less inflow from WCA-3A (through the L-67 weirs and S-345) and 11,000 ac.ft/yr less outflow to the Central Lakebelt storage area. Slightly lower stages in WCA-3B resulted in levee seepage losses from WCA-3B to the L-30 canal being reduced by 14,000 ac.ft/yr. Groundwater outflow increased by 6,000 ac.ft/yr and overland flow to the ENP increased by 10,000 ac.ft/yr. More overland flow was possible to the ENP because structural inflow was less in the PSP than D13R.

Everglades National Park

Net inflow into the ENP was on average 45,000 ac.ft/yr less than Alt D13R (Table 3) and 19,000 ac.ft/yr more than WPA-Alt 3. The reduction in net inflow was predominantly due to less flow (-47,000 ac.ft/yr) through the S-356 structures. Outflow through the Shark River Slough diagonal transect was 31,000 ac.ft/yr less than D13R. Reduced flow through the S-356 structures was due to less flow through the S-335 structure (-16,000 ac.ft/yr) and PSP modifications to the C-4 structures and Bird Drive recharge area. Reduced S-355 flow was predominantly due to less seepage from WCA-3B to the L-30 canal. The effects of the C-4 and Bird Drive modifications are discussed in more detail under the Bird Drive component later.

Table 3. Everglades National Park average flows. (units = 1,000 ac.ft/yr)

Transect or structure	D13R	WPA-Alt3	WPA-PSP
Inflow from WCA3 to ENP ¹ [sw+gw]	1019	1014	1021
S-356 A,B pumps	294	227	247
S-332 A,B,D pumps	294	276	266
Groundwater outflow ENP to LEC	-195	-180	-182
L-31N Levee Seepage, ENP to LEC	-214	-203	-199

Net Inflow [sw+gw] (% of NSM ³)	(74%) 1198	(70%) 1134	(71%) 1153
SRS-diagonal ² outflow [sw+gw] (% of NSM ⁴)	(73%) 1152	(70%) 1100	(70%) 1121

Notes

- WCA3 to ENP transect flow is across south faces of cells: r23c16-26
- SRS-diagonal transect flow is across west and south faces of cells: r19c16, r18c17, r17c18, r16c19, r15c20, r14c21
- NSM net inflow = 1617 (WCA3-ENP sw+gw =1258, ENP-LEC gw = 28, ENP-LEC sw = -387)
- NSM SRS diagonal outflow = 1577 (sw = 1566, gw = 11)

WPA Components

ACME. In D13R there was, on average 40,000 ac.ft/yr of ACME basin runoff into WCA-1. In WPA-Alt.3 there was no ACME basin runoff returned to WCA-1. In the WPA-PSP simulation, 12,000 ac.ft/yr of ACME basin runoff was returned to WCA-1 through an STA associated with the ACME basin reservoir and 5,000 ac.ft/yr was discharged from the reservoir, through its STA, into WCA-1. 10,000 ac.ft/yr of ACME basin runoff was sent to ASR, with 5,000 ac.ft/yr being recovered from ASR to meet water supply and 2,000 ac.ft/yr returned to the ACME basin reservoir. ARS efficiency was improved considerably compared to WPA Alt.3 (see Table 4).

Table 4. ASR losses (Injection minus recovery) and efficiency (recovery/injection). Units are 1,000 ac.ft/yr and (%)

ASR	D13R	WPA Alt.3	WPA-PSP
ACME Basin ASR	not modeled	10 (38%)	3 (70%)
Central PBC Reservoir ASR	13 (69%)	17 (43%)	12 (63%)
Site 1 ASR	33 (41%)	53 (27%)	25 (65%)
C-9 ASR	not modeled	28 (15%)	26 (70%)
Total (difference with D13R)	46	108 (-62)	66 (-20)

Central Palm Beach County Reservoir. The efficiency of ASR associated with the Central PBC reservoir was increased from a poor efficiency (43%) in WPA-Alt.3 to an efficiency similar to that of D13R (69%) in the PSP (63%).

Site-1 Reservoir. Inflow to the Site 1 (Hillsboro) reservoir was 20,000 ac.ft/yr more than in D13R primarily due to inflow from the North Springs Improvement District. Injection to ASR was increased, and ASR was better-utilized (65% efficient in PSP) by sending ASR water to meet needs in the C-14, C-13 and North New River canals.

C-11. In the C-11 basin, on average 47,000 ac.ft/yr more water, than in D13R, was sent through S13 to achieve similar flows through the structure to those of the 95 Base. 95 Base flows through S13 are desirable to meet Pond Apple Slough environmental needs. In D13R environmental releases through S13 to Pond Apple Slough were inadvertently omitted. Flow to tide at the Dania Cutoff, downstream of S13, were only 27,000 ac.ft/yr more in the PSP than in D13R because of increased wellfield withdrawals directly south of S13.

C-9. The C-9 reservoir was not modeled in D13R. As modeled in the WPA-PSP, the C-9 reservoir captures runoff from the C-9 basin, reducing C-9 runoff to the North Lakebelt storage area by 43,000 ac.ft/yr. The C-9 reservoir also captures C-11 basin excess runoff, reducing C-11 basin flow to the North Lakebelt by 33,000 ac.ft/yr. C-9 ASR provides 45,000 ac.ft/yr to the North Lakebelt storage area. C-9 ASR is also used to meet C-9, C-6 and Snapper Creek water needs.

North Lakebelt (NLBSA). In addition to the reduction in C-11 basin runoff to the NLBSA and modifications to C-9 runoff and ASR to NLBSA discussed above, there was a 10,000 ac.ft/yr increase in runoff from the C-6 west basin to NLBSA. More water was sent down C-9 to improve flow to Biscayne Bay North and less via the Miami canal.

Central Lakebelt (CLBSA). Due to less inflow to the CLBSA from WCA-3B (-11,000 ac.ft/yr) there was available capacity in CLBSA to receive more water from the L-33 canal (+8,000 ac.ft/yr). Flow from CLBSA to Everglades National Park was slightly (-2,000 ac.ft/yr) reduced.

Bird Drive. In the WPA-PSP, Bird Drive reservoir was simulated adjacent to the ENP and the Bird Drive recharge area adjacent and to the east of the reservoir. Consequently in the SFWMM representation of the PSP, L-31N was modeled as a single cell reach rather than a 4-cell reach as in D13R. Separate analysis indicates that this change alone reduces flow through the S-356 structures by about 19,000 ac.ft/yr, however the effect of this change on net ENP inflow is small because groundwater flow out of ENP to the east is also reduced by 15,000 ac.ft/yr. Changes in operation of the pump discharging from the C-4 canal to the Bird Drive reservoir area, resulted in 27,000 ac.ft/yr less inflow into the Bird Drive reservoir in the PSP than in D13R, and 22,000 ac.ft/yr more flow down the C-2 canal. Furthermore an additional 18,000 ac.ft/yr of water was withdrawn from the Bird Drive reservoir and sent to the C-2 canal in an attempt to better meet Biscayne Bay environmental needs. These two changes resulted in 44,000 ac.ft/yr less groundwater seepage out of the Bird Drive reservoir. In D13R a portion of groundwater seepage from the Bird Drive reservoir recharged the L-31N canal and was pumped through the S-356 structures into the ENP. Reduced groundwater seepage out of Bird Drive reservoir in the PSP likely contributes to reduced flow into ENP through the S-356 structures.

A3.3.4.4 Regional Effects

Lake Okeechobee

In the WPA-PSP, Lake Okeechobee stages were very similar to D13R and slightly higher than WPA-Alt. 3 stages (+0.1 ft) during drier times. Water supply from Lake Okeechobee to the LEC was 6% (4,100 ac.ft/yr) less than in D13R and water supply to the environment was 3% (3,900 ac.ft/yr) more than in D13R. Lake Okeechobee triggered water shortages were reduced by one occurrence in Lower East Coast Service Area 2. The volume of cutbacks in the Lake Okeechobee Service Area was slightly more (by 27,000 ac.ft over the 31 year simulation period) than in D13R.

Water Conservation Areas

Hydrologic characteristics in the conservation areas were very similar in WPA-PSP to both WPA-Alt.3 and D13R. At most there were 1 to 2% differences in inundation duration, and high/low water exceedences in some of the indicator regions

Everglades National Park

Although there was less net inflow into the ENP, WPA-PSP performance, measured in terms of inundation duration, was similar to that of D13R. In the Rockland Marl Marsh (IR 8) there was a 2 % reduction (with respect to D13R) in average annual hydroperiod, while in NE Shark River Slough (IR 11) there was 1% increases in average annual hydroperiod.

Biscayne Bay

There was 32,000 ac.ft/yr more flow to Biscayne Bay in the WPA-PSP simulation than in D13R. By comparison the WPA-Alt.3 simulation had 29,000 ac.ft/yr less flow to Biscayne Bay than in D13R. North Biscayne Bay received 10,000 ac.ft/yr more water in the PSP simulation than D13R due to increased flow from the North Lakebelt storage area to S-29 via the C-9 canal. South Biscayne Bay received 22,000 ac.ft/yr more water due to the reduction of wellfield withdrawals in the vicinity of the C-102 and C-103 canals.

Water Supply

Redistribution of wellfield withdrawals resulted in an increase in the locally triggered phase 1 water restrictions at Hollywood from 4 in D13R to 15 in the WPA-PSP and from 0 at N. Lauderdale in D13R to 4 in WPA-PSP.

WPA-PSP components resulted in 4,000 less water supply to the LEC from Lake Okeechobee and 20,000 ac.ft/yr less supply from the WCA's to the LEC. Service area-1 supply from ASR decreased by 17,000 ac.ft/yr compared to D13R. In Service area-2 which received only supply from Lake Okeechobee and the WCA's in

D13R, 33,000 ac.ft/yr was supplied from ASR and 15,000 ac.ft/yr from local storage in the PSP. Supply from the WCA's was reduced by 30,000 ac.ft/yr and Lake Okeechobee supply reduced by 9,000 ac.ft/yr. In service area-3, water supply from local reservoirs decreased by 16,000 ac.ft/yr in the PSP compared to D13R while ASR supplied 14,000 ac.ft/yr. Supply from Lake Okeechobee to Service area-3 increased 4,000 ac.ft/yr in the PSP and supply from the WCA's increased by 11,000 ac.ft/yr compared to D13R.