APPENDIX E

PLAN FORMULATION SCREENING

This page intentionally left blank

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

This page intentionally left blank

E PLAN FORMULATION SCREENING

This plan formulation appendix serves as supplemental supporting information to Section 3 of the main report. It addresses (1) storage and treatment north of the redline, (2) distribution and conveyance in northern WCA 3A, (3) distribution and conveyance in southern WCA 3A, WCA 3B, and ENP, and (4) seepage management.

E.1 STORAGE AND TREATMENT – NORTH OF THE REDLINE

This section provides supporting information regarding the identification of management measures, screening of management measures, formulation of options and the Multi-Criteria Decision Analysis (MCDA) and cost effectiveness results for storage and treatment components of CEPP north of the redline (**Figure E.1- 1**).

STORAGE & TREATMENT MEASURES/COMPONENTS/OPTIONS
EAA – North of the Redline

PURPOSE

Increase the quantity of water that can be delivered from Lake Okeechobee and the Everglades Agricultural Area (EAA) to WCA 3A within state water quality standards with improved seasonal timing.

CEPP OBJECTIVES

1 Restore seasonal hydroperiods & freshwater distribution to support a natural mosaic of wetland/upland habitat in Everglades system.

3 Reduce water loss out of natural system to promote appropriate dry season recession rates for wildlife utilization.

5 Reduce high volume discharges from Lake Okeechobee to improve quality of oyster & SAV habitat in northern estuaries.

6 Increase availability of water supply to the Lake Okeechobee Service Area.

1 SCREEN MANAGEMENT MEASURES 3.2.1.1

1 Identify available "new" water (water budget)

2 Canvass CERP efforts for measures and identify new measures

3 Determine consistency with CEPP objectives

4 Screen & optimize configurations of measures (sizes, locations, combinations) based on:

- Operational flexibility
- Environmental effectiveness
- Human health and safety
- Constructability
- Land available
- Cost

RESULT

Storage

- Above-ground Storage Reservoirs
- Lake Okeechobee Operations
- Flow Equalization Basin (FEB)

Treatment

- Stormwater Treatment Areas (STAs)

2 LOCATE MANAGEMENT MEASURES 3.2.1.2

1 Identify Region – north, south, east, west of Lake Okeechobee based on:

- Inflow
- Linkage to flow areas
- Land available
- Suitable substrate
- Existing infrastructure

RESULT

South of Lake - EAA

2 Identify Footprint based on:

- Infrastructure
- Socio-political & environmental concerns
- Hydrology
- Construction efficiency

RESULT

- Existing lands acquired by the State of Florida (A1 & A-2)
- Future Without Project Condition indicates an FEB on A-1

3 FORMULATE OPTIONS 3.2.1.3

1 **Reservoir Sizing and Operations Screening (RESOPS)** model to predict benefits attributed to configurations

2 **Lake Okeechobee Operations (LOOPS)** model to determine optimal configurations with changes to Lake Okeechobee operations

RESULT

27 options of 9 storage and treatment configurations and 3 Lake Okeechobee operational measures

DEEP RESERVOIR

- (6') Reservoir (24,000 ac) w/STA (4,000 ac)
- (6') Reservoir (11,000 ac) w/STA (17,000 ac)
- (12') Reservoir (24,000 ac) w/STA (4,000 ac)
- (12') Reservoir (21,000 ac) w/STA (7,000 ac)
- (12') Reservoir (17,000 ac) w/STA (11,000 ac)

OTHER

- FEB (28,000 ac)
- STA (28,000 ac)
- Shallow (4') Reservoir (24,000 ac) w/STA (4,000 ac)
- Shallow (4') Reservoir (14,000 ac) w/STA (14,000 ac)

4 EVALUATE OPTIONS 3.2.1.4

1 Multi-Criteria Decision Analysis (MCDA)

LEVEL 1

CEPP Objectives

- Additional Flow to Everglades
- Everglades Dry Standard
- Estuary condition
- Increased Water Available (Water Supply)

LEVEL 2

Other Important Considerations

- Lake Water Levels
- Adaptability (Robustness & Future CERP Increment Compatibility)
- On-site Habitat (Wildlife Utilization, Vegetation, Hydrology)

2 Cost-Effectiveness Evaluation

- Two cost-effective options:
  - (12') Reservoir (21,000 ac) w/STA (7,000 ac)
  - FEB (28,000 ac)

RESULT

28,000-ac FEB reasonably maximizes benefits while minimizes costs

Flow Equalization Basin (FEB) is an above-ground impoundment that would provide surface water storage, flow equalization, and also some limited water quality improvement function

Figure E.1- 1. Overview of Storage and Treatment Screening

E.1.1 Storage and Treatment Management Measures

This section lists and describes major features and activities (i.e. management measures) and the rational for their inclusion or exclusion as the basis for alternative development. Management measures were compiled from previous CERP planning efforts and new measures were identified for CEPP. An array of 13 distinct management measures (9 storage measures and 4 treatment measures) was identified with multiple size and configuration potentials for each measure.

E.1.1.1 Storage Management Measures

Higher Lake Levels: Raising water levels within Lake Okeechobee would require substantial modifications to the Herbert Hoover Dike. The USACE is currently conducting a project to strengthen and secure the existing dike, and any increase in water levels above the design specifications of the current HHD rehabilitation would require a commensurate increase in the dike dimensions for human health and safety concerns.

Higher water levels within Lake Okeechobee could also cause significant impacts to the littoral zone. The lake's natural resources are dependent on the littoral zone since it provides nursery areas, spawning areas, foraging areas, and roosting areas required for the completion of aquatic fauna and higher trophic level (e.g., wading bird) life cycles. The frequency and duration of inundation of the lake littoral zone would increase with higher lake levels. High lake stages result in loss of beneficial littoral zone plant communities in favor of introduced exotics (e.g., torpedo grass) as well as impacts to wading birds and other water-dependent wildlife.

Operational Changes in Lake Okeechobee: Operational changes could be utilized to optimize timing and distribution of deliveries into and through Water Conservation Area 3. Excess flows that are normally discharged to the estuaries would be delivered south to the Everglades. Water quality treatment facilities will be necessary to treat additional flows. Operational changes in Lake Okeechobee will help achieve the objective of providing water supply, while being incidental to the objective of fulfilling the ecological needs of the South Florida ecosystem. Water retained in the Lake for delivery to the Everglades that is not identified for the natural system will be available for water supply. This can be considered excess water that would not be of beneficial use to the environment.

Partition Lake Okeechobee: Compared with simply holding the entire lake at a higher stage, compartmentalized storage within a partitioned lake would allow for greater storage capacity and more flexible control of regulatory releases to the estuaries and Water Conservation Areas. However, fragmentation of the lake would be a substantial ecological concern, restricting movement of the native aquatic animal species. Higher water levels within certain compartments would damage the littoral zone, disrupting natural cycles of native flora and fauna. Algal blooms would likely increase with the restricted water circulation. Navigation would also be disrupted within the Lake, and substantial visual aesthetic impacts would occur. Partitioning of Lake Okeechobee was previously considered in CERP and other C&SF studies, and eliminated as a measure due to the environmental criteria. Due to these factors, this measure has been eliminated from further consideration.

Dredging of Lake Okeechobee for Storage: This measure consists of dredging sediment from Lake Okeechobee and depositing it in an approved spoil site. Dredging of the Lake would allow for increased water storage capacity, decreasing the need for discharges to the estuaries and improving the timing and distribution of water deliveries to Water Conservation Area 3. Although this measure is feasible from an engineering perspective, the costs to dredge such a massive waterbody would be excessive. Additionally, disposal of the spoil material would require a massive containment area located near the

Lake for return water, creating environmental concerns with such a large discharge of fill material required. There may also be concerns regarding relocations and community displacement if such a large site were required to be constructed adjacent to the Lake. As such, this measure was eliminated from further consideration.

Above-Ground Storage Reservoir: Above-ground storage reservoirs would be utilized to capture and hold normal and peak flows. Water would then be discharged when flows are needed for the natural system. Water depths in above-ground reservoirs typically range from approximately 4-14 feet, with vegetation management and dam safety concerns being the limiting factors. Deep Storage reservoirs have relatively high construction costs when compared to shallow reservoirs due to additional dam safety requirements; however, both shallow and deep reservoirs are operationally flexible and offer the potential to improve the timing and distribution of water to the natural system. Storage reservoirs would experience dryouts during extended drought periods and do not offer substantial wildlife habitat value. Above-Ground Storage Reservoir was retained for consideration in alternative development.

***Ecoreservoir*:** An Ecoreservoir could be utilized for water storage; however, it is predominantly designed and maintained to encourage habitat utilization and recreational opportunities. The secondary function of water storage limits the primary uses, which forces a trade-off for onsite habitat benefits, and leads to significantly increased costs per unit volume of water stored. Water levels are maintained at 4 feet or less to encourage the growth of vegetation. Embankment side slopes are shallow (12:1) and vegetated to promote wildlife use, making land requirements more extensive and increasing the risk of levee failure by including vegetation on the levee embankment and protection system. Construction and maintenance costs can be as much as 3 times higher than an above-ground storage reservoir with the same storage volume and as such is an inefficient means to store and deliver large quantities of water when creation of onsite habitats is not a primary objective. Operational flexibility is limited and hydraulic capabilities are inadequate to meet natural system flow quantity and timing demands. An ecoreservoir was considered and eliminated in the River of Grass study and, due to the factors mentioned above, was eliminated from consideration for the CEPP

***Flowthrough Wetland (Flow Equalization Basin (FEB))*:** A Flowthrough Wetland, also known as a Flow Equalization Basin (FEB), is an above-ground, impoundment that would provide for surface water storage, flow equalization, and also some limited water quality improvement function. Levee design would be similar to that of a 4-foot Above-Ground Storage Reservoir; however, operations would be optimized for storage and wetland establishment. The Flowthrough Wetland would receive water flows from Lake Okeechobee and have a targeted depth of 1-3 feet to sustain the growth of hydrophytic vegetation, thereby limiting high water events and dry downs. A Flowthrough Wetland, in addition to providing water storage capacity for the natural system, would also help control the rate of water flow from Lake Okeechobee to the Stormwater Treatment Areas by minimizing hydraulic surges and providing more consistent flows. Additionally, some nutrient reduction will occur within the Flowthrough Wetland; however, unlike an STA, design and operation is not optimized for water retention times and nutrient retention. A Flowthrough Wetland would likely be forward compatible with future CERP projects, enabling conversion to a deep reservoir or STA with limited infrastructure removal. Consequently, a Flowthrough Wetland was retained for consideration in alternative development.

***Dry/Wet Flow Way*:** A Flow Way measure is an above-ground, impoundment that would be operated like a flowing wetland system. Maximum water depths would be no higher than 4-feet with minimal engineering or alteration of land topography. Vegetation would be allowed to naturally recruit and would also be unmanaged except for exotic removal. Similar to an ecoreservoir, operational flexibility is limited and hydraulic capabilities are inadequate to meet natural system flow quantity and timing demands. Cost is similar to that of an ecoreservoir (12:1 embankment slopes), and with extremely limited storage and treatment capabilities is an inefficient means to meet the downstream objectives in the CEPP study area A Flow Way measure was considered and eliminated during the River of Grass study; and, due to the factors mentioned above, was eliminated from consideration for the CEPP.

Localized Aquifer Storage and Recovery (ASR)**:** ASR is the storage of available water deep within the aquifer, and the recovery of that water for use when there are system demands. Preliminary results from the Pilot Study that is currently being finalized seem to indicate that ASR may be feasible in regards to toxicology, groundwater migration, etc. ASR must be used in combination with other water storage and water quality improvement management measures as it is not sufficient to meet any project objectives as a stand-alone measure. Due to the uncertainties that currently exist with ASR technologies, supplementing other storage measures with ASR storage is not being considered for this increment of CEPP. Future opportunity exists to incorporate ASR technology through other CERP efforts.

E.1.1.2 Water Quality Treatment Measures

Stormwater Treatment Areas**:** Stormwater Treatment Areas have been successfully utilized to reduce nutrients, mainly phosphorous, before discharging water into the natural system. Stormwater Treatment Areas are constructed and managed as shallow, above-ground impoundments and are vegetated to increase nutrient uptake. Most consist of flow paths that include upstream Emergent Vegetation Treatment Cells, and downstream Submerged Vegetation Treatment Cells. Water is directed through the treatment system through engineered hydraulics, maximizing water retention times to achieve nutrient retention. Optimal water levels are typically maintained to promote wetland vegetation survival and prevent exotic colonization and spread.

Chemical Precipitation**:** Chemical precipitation using ferric chloride, aluminum or other salts of iron can be utilized for phosphorous removal from water. Although the amount of land required for chemical precipitation is substantially less than an STA, there are some drawbacks to using this process to improve water quality. The chemicals required for chemical precipitation are expensive and would render the method non-cost effective due to the large volume of water to be treated and the corresponding massive scale of treatment required. Additionally, excessive sludge and waste products would require disposal, adding to the substantial costs and creating an environmental issue with sludge disposal. Although the excess waste product could potentially be utilized for fertilizer, it is likely that the nutrients would just re-enter the Everglades system if applied to the EAA or other areas surrounding the Lake. As such, due to the excessive costs and environmental concerns, this measure was eliminated from further consideration.

Dredging of Lake Okeechobee near Primary Canal Intakes**:** This measure would involve dredging sediment from Lake Okeechobee in the vicinity of canal intakes to the WCAs. The removal of the sediment should decrease the amount of residual nutrients that would be suspended in the water before flowing to the Water Conservation Areas. Although it is likely that this measure would have some success in nutrient removal, it would likely be on an extremely small scale, and substantial treatment would still be required before water could flow into the WCAs. Due to the relative inefficiency of this measure, it was eliminated from consideration.

Hybrid Wetland Treatment Technology (HWTT): HWTT systems employ chemical treatment systems for Phosphorus (P) removal and utilize wetland vegetation to the maximum extent possible to minimize chemical amendment use. Chemical coagulants are added, either continuously or intermittently, to the front end of the treatment system, which contains one or more deep zones to capture the resulting floc material. A fundamental concept of the HWTT technology is that the floc resulting from coagulant addition generally remains active and has the capability of additional P sorption. Both active and passive reuse of floc material is practiced in this technology. Passive re-use refers to the accumulation of viable flocs on plant roots and stems that are situated near the front-end and mid-regions of the systems. Active re-use refers to the mechanical resuspension of settled floc. HWTT systems in use in the Northern Everglades system have shown promising results with mean inflow TP concentration reduction ranging from 70 to 95%. Although HWTT has been shown to be cost effective for smaller watersheds and aquatic systems, there remains a high level of technological and cost uncertainty in applying HWTT to large watershed treatment efforts. For this reason, HWTT has not been considered for this increment of CEPP, but as further investigation of HWTT is gained through the Northern Everglades Watershed effort there may be a potential to adopt the technology in future increments of CEPP.

E.1.2 Screening of Storage and Treatment Management Measures

Table E.1-1 summarizes the results of the preliminary screening of management measures and identifies the four management measures that are retained: above ground storage reservoir, Lake Okeechobee operational changes, flow equalization basin, and stormwater treatment area. Measures not retained are marked with “x”.

Table E.1-1. Summary of screening of management measures for storage and treatment

		Screening Criteria						
	Management Measure	Project Objectives	Operational Flexibility	Environmental Effects	Human Health and Safety	Constructability/ Technical Uncertainty	Land Requirement	Efficiency (Cost)
Storage Measures	Higher Lake Levels			x	x			
	Lake Okeechobee Operational Changes		Retained					
	Partition Lake Okeechobee			x		x		x
	Dredge Lake Okeechobee			x				x
	Above-Ground Reservoir		Retained					
	Ecoreservoir	x	x				x	x
	Flow Equalization Basin		Retained					
	ASR					x		
	Dry/Wet Flow Way	x	x				x	x
Treatment Measure	Chemical Precipitation	x		x				x
	STA		Retained					
	Dredging Canal Intakes	x						
	HWTT	x				x		x

E.1.2.1 Siting of Storage and Treatment Components

Reservoirs, flow equalization basins, and stormwater treatment areas require large land areas to function. Several regional and local sites for these management measures were analyzed and screened or retained.

E.1.2.1.1 Regional Siting

Storage North of Lake Okeechobee**:** Storage areas located north of Lake Okeechobee would be located on tributaries of the Kissimmee River (or other smaller basins) and not on the main channel. Much of the excess flow from the Upper Kissimmee River basin could not be collected with this arrangement. The storage areas would be able to make releases indirectly to the lake where it could be distributed to all downstream users and targets. Storage north of Lake Okeechobee could not store excess water from Lake Okeechobee, the Caloosahatchee River Basin, St. Lucie Canal basin, or the EAA basin. Storage north of the lake could meet the northern estuaries and seasonal hydroperiod objectives; however, due to the extended time to route water from a reservoir to the Water Conservation Areas, a northern reservoir would not be able to meet the rainfall responses, or timing, objectives. It is likely that this water, if passed through the Lake or through perimeter canals subject to agricultural runoff, may need to undergo additional water quality treatment to meet applicable standards. The increased conveyance and treatment time would greatly inhibit the ability to increase the effectiveness and efficiency of water deliveries to the Water Conservation Areas. Due to these factors, storage and treatment measures in this location for the CEPP was not further considered.

Storage in the Caloosahatchee River Basin (West of Lake Okeechobee)**:** Storage in the Caloosahatchee River Basin could catch both excess basin flow and regulatory releases from Lake Okeechobee (and indirectly from the inflows to the lake). Once stored, the water could be used for meeting municipal and industrial (M&I) water supply and estuary flow targets; however, back pumping water into Lake Okeechobee would necessitate construction of STAs in addition to significant back pumping infrastructure (lifting water over two lock and dam structures). Excess water from the EAA basin would not be available as storage inflows. Due to these factors, for the CEPP, additional quantity/quality measure in this location over the C-43 West Basin Reservoir project was not further considered.

Storage in the St. Lucie Basin (East of Lake Okeechobee): The St. Lucie Canal (that runs from Lake Okeechobee to the St. Lucie estuary) does not follow a natural runoff basin, so the storage in the St. Lucie would typically receive regulatory releases from Lake Okeechobee (and indirectly from the inflows to the lake). Once there, the releases would most likely feed M&I water supply demands and estuary flow targets. Excess water from the EAA basin would not be available as storage inflows. Due to these factors, for the CEPP, additional storage and treatment measure in this location over the Indian River Lagoon project was not further considered.

Storage in the EAA (South of Lake Okeechobee): Storage areas within the EAA would have the advantage of being able to store excess water from within the EAA basin and upstream sources (i.e. Lake Okeechobee and its inflow sources). Because of the existing canal system in the EAA, storage located between the Miami River and North New River Canals would be strategically located to store excess runoff from significant portions of the EAA basin. Storage in the EAA could be used to meet Everglades and Florida Bay targets. Meeting the downstream water needs would require only a minimal amount of new outflow/delivery infrastructure. Due to these factors, storage and treatment measure in this location for the CEPP was considered further.

After considering the possible regional geographic areas, the location for the storage and treatment measures within the EAA was selected based upon the factors shown in **Table E.1-2.**

Table E.1-2. Regional Siting Criteria

Infrastructure
• Use of existing major canal networks (Miami Canal, Bolles & Cross Canal and North New River Canal) • Proximity to move water from water source (Lake Okeechobee) • Proximity to existing public works (STAs, existing pump stations, roads, minor canal networks)
Environmental
• Using previously impacted lands
Hydrology
• Reduce regulatory releases to the northern estuaries • Hydraulic connection to Lake Okeechobee with flexibility to manage high water levels • Improve the timing of environmental deliveries to the WCAs
Construction Efficiency
• Topography • Muck depths • Construction and maintenance access • Seepage Management • Availability of construction material

E.1.2.1.2 Local Siting Evaluation

It is unlikely that any other component of CERP has been modeled and evaluated more than the EAA Storage Reservoir. Siting of the EAA Reservoir was studied as part of the Reconnaissance Phase of ERP as well as in the Feasibility Phase of CERP. Additionally, the EAA Reservoir was authorized as part of WRDA 2000 and studied as part of the EAA Storage Reservoirs Phase 1, PIR. The EAA Storage Reservoir was also evaluated in the 2007 Reservoir Optimization study.

Findings from the Reconnaissance Study and continued evaluations during the CERP Feasibility Study were used to support the 1997 purchase of the 50,000 acre tract from the Talisman Sugar Corporation. The Department of the Interior and the State of Florida completed the $133.5 million transaction to help restore more natural flows of water through the southern parts of Florida and into Everglades National Park.

CERP confirmed the need for 360,000 ac-ft of storage or 60,000 acres (with a 6-foot depth) for the EAA Reservoir. CERP evaluated a great number of sizes associated with storage in the EAA. More than 100 screening model runs were completed to support the findings that between 40,000 and 60,000 acres, with a maximum of 6 feet deep, were needed. Additional special investigations were conducted using the SFWMM to evaluate four scenarios (where sizing ranged from zero acres to 80,000acres at 20,000acre intervals) of the EAA storage reservoir to support the recommended configuration and size of 60,000 acres of the CERP Recommended Plan.

The Reservoir Optimization study investigated if possible trade-offs could be used to find the most "efficient" reservoir configuration. It was noted that the EAA Storage Reservoir, because of its strategic location could replace the storage from several other planned storage areas. However, the report concluded that the CERP storage features are the most cost effective option to achieve the benefits of CERP, partially because no other storage areas could replace the 40,000 acres needed to capture

240,000 acre-feet of excess Lake Okeechobee water (water that is otherwise discharged to the Northern Estuaries).

The River of Grass (ROG) study, conducted by the SFWMD from 2008 to 2010, identified the need and availability of greater flows passing through the EAA than did the Restudy. Even assuming a greater than CERP amount of storage would be located north of the Lake (as identified in the Lake Okeechobee Phase II Technical Plan, 2008), ROG indicated the need for storage in the EAA to be far greater than the Restudy. A screening-level sensitivity analysis of water storage in the EAA supported an optimal storage range of between 800,000 and 1,200,000 ac-ft. Even assuming 12-foot maximum depths, this represented between 66,700 and 100,000 acres of land.

The CERP identified the need for 360,000 ac-ft of water storage in the EAA and incorporating knowledge gained from updated science demonstrates that the need for flows passing through the EAA is even higher than envisioned in the CERP. This suggests that storage greater than 360,000 ac-ft is likely needed if CERP goals and objectives are going to be fully achieved. Therefore, the storage and treatment management measures south of Lake Okeechobee are recommended to be located on and maximize the usage of the previously purchased A-1 and A-2 Compartments of the EAA land south of Lake Okeechobee that are owned by the State of Florida(**Figure E.1- 2**). The identified project lands are located between and adjacent to the North New River and Miami Canals, which reduces the need to construct any additional conveyance features to move water from Lake Okeechobee to the project features and the Water Conservation Areas. The project lands are adjacent to existing treatment facilities (STA 3/4 and STA 2) that are currently being used for environmental purposes, creating a unique ability to optimize C&SF operations.

A Flow Equalization Basin (FEB) on the A-1 compartment is being financed, constructed, and operated by the SFWMD, however the formulation of management measures assumed this could be modified and incorporated into the CEPP as long as project constraints were not violated. This feature is included in the Future Without Project condition (FWO).

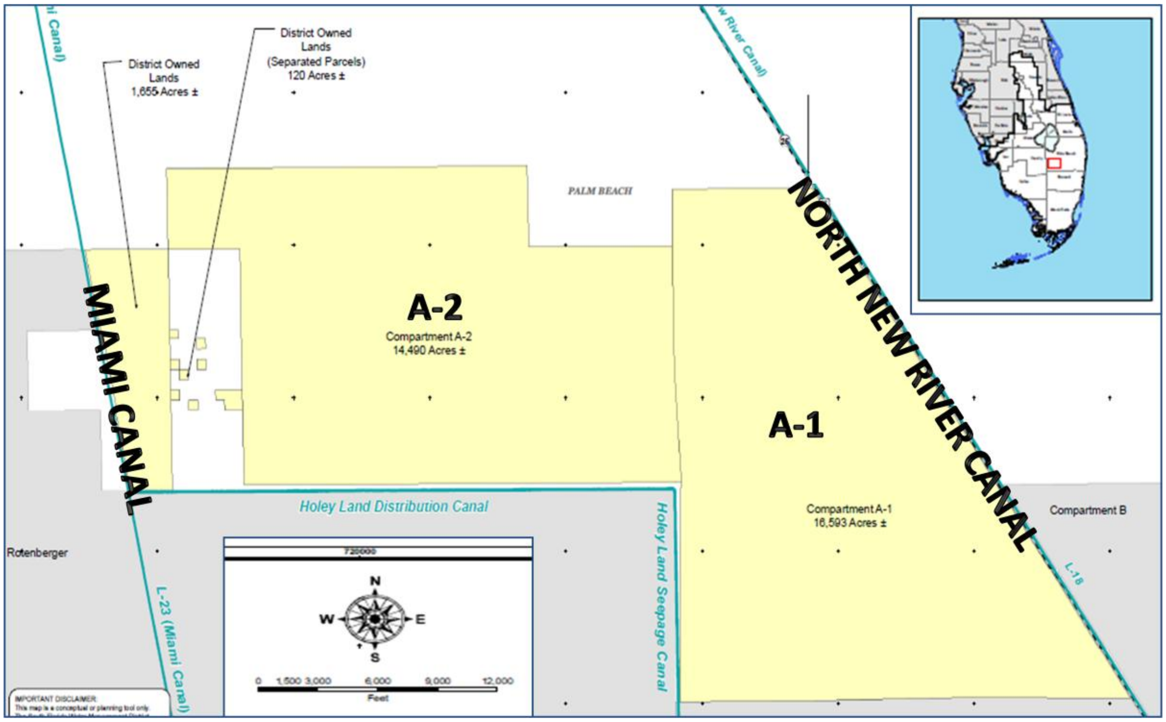

Figure E.1- 2. A-1 and A-2 Footprints within the EAA

E.1.3 Formulation of Storage and Treatment Options

The combinations of storage and treatment management measures included shallow reservoirs (4 foot depth), deep reservoirs (6 foot and 12 foot depth) and FEBs (4 ft depth emergent marsh storage) combined with existing and new stormwater treatment areas (STA), as well as standalone STAs on the identified EAA footprint. The Reservoir Sizing and Operations Screening (RESOPS) model was used to predict benefits attributed to thousands of iterations of management measure combinations. The RESOPS model is a screening model with batch processing capabilities, developed during the SFWMD Northern Everglades and River of Grass planning efforts that is useful to screen a large number of storage and treatment features. This tool is useful to assess performance of these measures and components using a large and flexible suite of evaluation criteria and considerations early in the plan formulation techniques. During batch processing, a computer program incorporates a large set of diverse data files as input, processes the data, and generates multiple sets of output data files. These outputs can be analyzed for trends in performance.

The result of the RESOPS modeling effort led to identification of nine highly functioning combinations of storage and treatment configurations to undergo further detailed analysis. These highly functioning combinations were selected by identifying the combined storage and treatment configurations on the EAA footprint that maximized water deliveries, timing of flow and reduction in discharge to the Northern Estuaries for each of the retained management measures. **Figure E.1- 3** contains an example of the RESOPS output.

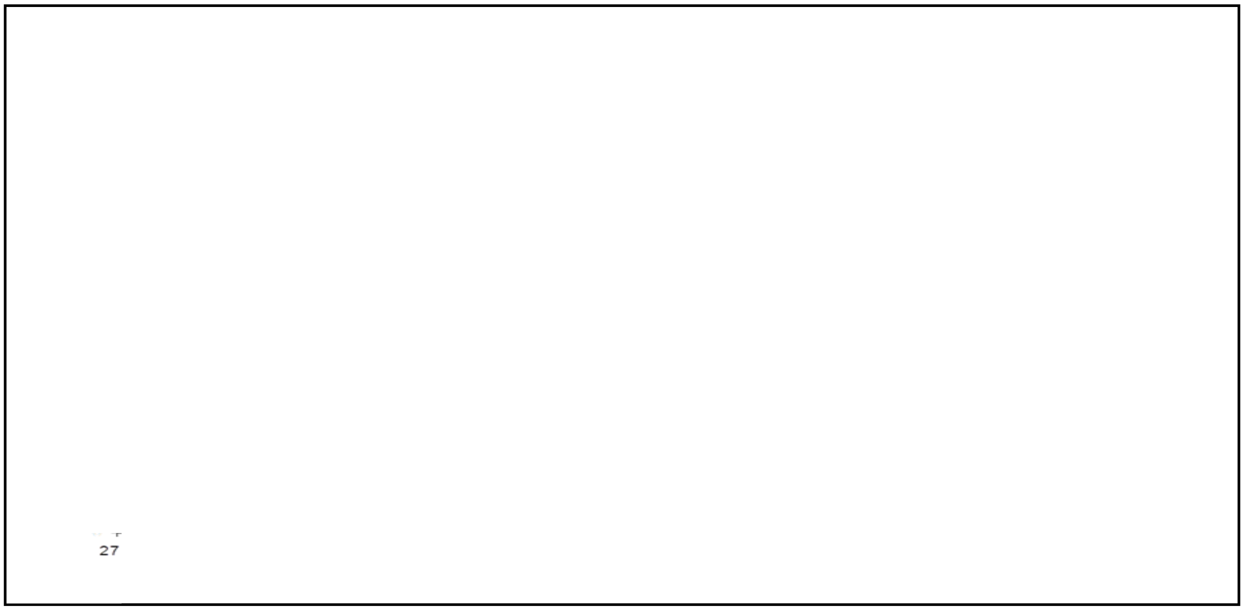

Figure E.1- 3. Performance curves for 4-foot storage and stormwater treatment area combinations on the Talisman property

In addition to determining the configuration of storage and treatment management measures, consideration was given to incorporating operational flexibility in Lake Okeechobee when additional storage capacity is available by using the Lake Okeechobee Operations Screening (LOOPS) model. Existing Lake Okeechobee regulatory release protocols balance multiple objectives for Lake Okeechobee and system management. Simply adding discharges to storage in addition to existing regulatory protocols may over-drain the Lake and impact system performance. Efficient Lake Okeechobee regulatory releases in concert with discharges to storage will maintain or enhance system performance.

The nine highly functioning combinations of storage and treatments measures were combined with three operational measures for Lake Okeechobee operations: water supply optimized, estuary performance optimized and Lake Okeechobee performance optimized. These 27 storage and treatment options (**Table E.1-** 3) were evaluated with the MCDA process and a subset was identified to be included in the final array of alternatives.

Table E.1- 3. Initial Storage and Treatment Options evaluated with MCDA

Storage and Treatment Configuration	Lake Okeechobee Operations
Flow-Through Wetland/FEB	Water Supply Optimized Estuarine Performance Optimized Lake Performance Optimized
28,000 acres	
4ft Shallow Storage & STA	
24,000 acre Res & 4,000 acre STA	
14,000 acre Res & 14,000 acre STA	
6ft Deep Storage & STA	
24,000 acre Res & 4,000 acre STA	
11,000 acre RES & 17,000 acre STA	
12 ft Deep Storage & STA	
24,000 acre Res & 4,000 acre STA	
21,000 acre Res & 7,000 acre STA	
17,000 acre Res & 11,000 acre STA	
STA	
28,000 acres	

E.1.4 Evaluation Criteria for Storage and Treatment Options

Performance of the 27 combinations of reservoirs, flow equalization basins, and stormwater treatment areas, and Lake Okeechobee operations were evaluated using seven screening criteria (**Table E.1-4**). Four of the criteria are directly related to primary objectives of the project (Level 1). Three of the seven criteria, while not directly addressing project objectives, describe effects important to the selection of storage and treatment options (Level 2). Methods of analysis and the results for the seven screening criteria are in the following sections.

Table E.1-4. Criteria used in the Storage and Treatment MCDA evaluation

Criteria	*Project Objectives*
	Level 1
Additional Flow to The Everglades	*Restore Natural Mosaic of Wetland and Upland Habitat*
Timing Of Flows to the Everglades	*Reduce Dry-downs and Over-Drainage*
Estuary Conditions	*Reduce High Volume Discharges to the Northern Estuaries*
Water Supply Cutbacks	*Increase Availability of Water Supply*
	Level 2
Lake Okeechobee Conditions	*N/A*
Adaptability	*N/A*
On-Site Habitat	*N/A*

E.1.4.1 Additional Flows to the Everglades (Level 1)

E.1.4.1.1 Criteria Description

This criterion was developed based on the set of CEPP project objectives related to restoring seasonal hydroperiods and freshwater distribution, and surface water depths within the project area. In the pre-drainage system, inundation patterns supported an expansive system of freshwater marshes including longer hydroperiod sawgrass "ridges" interspersed with open-water "sloughs", and higher elevation marl prairies. The depth, distribution and duration of surface flooding largely determined the vegetation patterns, as well as the distribution, abundance, seasonal movements, and reproductive dynamics of aquatic and terrestrial animals in the Everglades. Resumption of sheet flow and related patterns of hydroperiod and water depth will significantly help to restore and sustain the microtopography, directionality, and spatial extent of ridges and sloughs and improve the health of tree islands in the ridge and slough landscape.

The desired restoration condition for the Everglades ridge and slough landscape as it pertains to this criterion is to restore the natural patterns of flow volume characteristic of the pre-drainage Everglades.

E.1.4.1.2 Evaluation Tool Used

RESOPS was used to evaluate the options in terms of the increase in the *Total Volume of Additional Average Annual Flow* (1000-acre-feet or k-ac-ft) delivered across the "red line" from the EAA to WCA 3A, in excess of what would have been delivered by STA's 2, 3/4, 5 and 6, if CEPP was not implemented. This additional flow volume was made possible by reducing in-lake triggered high discharges to the northern estuaries and calculated for each year over the period of simulation (1965-2005), and averaged.

E.1.4.1.3 Scoring Methodology

Potential storage and treatment components which improved the volume of water delivered across the "red line" scored more favorably. Storage and treatment components were ranked on a scale of (1-4) to estimate the degree to which each project component performed. The Natural Systems Regional Simulation Model (NSRSM) version 3.3 predicts an average annual total flow volume across the "red line" of 2.1 million acre-feet. The range of *Total Volume of Additional Average Annual Flow* to the Everglades varied from 0 to 250 (k-ac-ft). A review of the data indicated that the majority of flow occurred within the 100 to 250 (k-ac-ft) range. A scale of (1-4) was used to best separate the performance of project components based on this existing range of additional flow. The scoring methodology is defined below.

<u>4 (Best)</u> – The project component received a score of 4 if the *Total Volume of Additional Average Annual Flow* fell within the high 200 to 250 (k-ac-ft) range, between 225-250.
<u>3 (Good)</u> – The project component received a score of 3 if the *Total Volume of Additional Average Annual Flow* fell within the low 200 to 250 (k-ac-ft) range, between 200 and 225.
<u>2 (Fair)</u> – The project component received a score of 2 if the *Total Volume of Additional Average Annual Flow* fell within the high 150 to 200 (k-ac-ft) range.
<u>1 (Worst)</u> – The project component received a score of 1 if the *Total Volume of Additional Average Annual Flow* fell within the high 100 to 150 (k-ac-ft).

E.1.4.1.4 Criteria Results

Results are presented in **Table E.1-5**.

Table E.1-5. Additional flows to the Everglades results

Storage and Treatment Component	Additional Flows	Rating
Flow-Through Wetland/FEB 28,000	L (200-250)	3
4ft Shallow Storage & STA 24,000 Res & 4,000 STA 14,000 Res & 14,000 STA	H (150-200) H (150-200)	2 2
6ft Deep Storage & STA 24,000 Res & 4,000 STA 11,000 Res & 17,000 STA	H (150-200) M (150-200)	2 2
12ft Deep Storage & STA 24,000 Res & 4,000 STA 21,500 Res & 6,500 STA 17,000 Res & 11,000 STA	H (100-150) H (200-250) H (200-250)	1 4 3
STA 28,000 STA	M (100-150)	1

E.1.4.2 Everglades Dry Standard Score (Level 1)

E.1.4.2.1 Criteria Description

The Everglades Standard Scoring methodology was developed during the River of Grass (ROG) planning efforts to measure how well a RESOPS simulation matches the magnitude and timing of a defined Everglades Demand Target. The RESOPS simulates monthly flows for a 41 year simulation period (1965-2005). A spreadsheet model was developed to compare the monthly flows to target flow (NSRSM v3.3) discharging into the Everglades at the red line.

The NSRSMv3.3 is a natural system Regional Simulation Model (RSM) used to simulate flows across the red-line boundary along the northern edges of the Everglades in a fully decompartmentalized future system (an ROG type scenario). The NSRSM v3.3 has an estimated average of 2.1 million acre-feet/yr across the red line, whereas existing flows are estimated at 1.4 million acre-feet/yr. A plot of the estimated average monthly flows for the 41 year simulation period for the target flows vs. existing flows is shown in **Figure E.1- 4**. The gray line represents the target flows at the redline (NSRSM v3.3), the red line represents existing conditions, and the green line represents an alternative flow scenario that moves from existing conditions towards the NSRSM target.

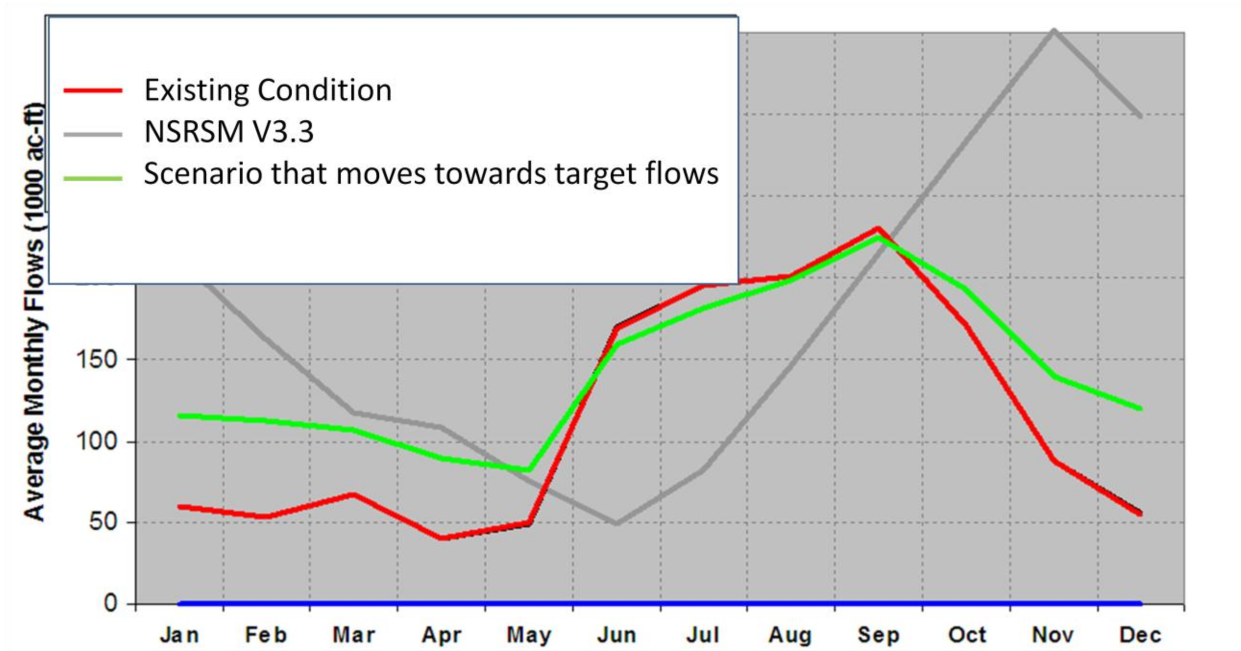

Figure E.1- 4. Seasonality of Flows to the Everglades: The red line represents the existing conditions, the gray line is the natural system target flow and the green line shows an alternative that moves towards target flows

The Everglades Dry Standard Score was developed to provide a measure on how well alternatives are meeting target flows during the dryer portion of the year when there are limited discharges to the Everglades. From reviewing existing real time data at the S-8 pump station it was determined that the current system provides most of the discharge at the peak of the wet season, and that deliveries typically diminish starting in the October time frame. The deliveries further diminish with the approaching dry season, and only event driven deliveries are made during the dry season. The S-8 usually starts wet season discharges in the June time frame, providing more regular discharges, normally peaking in August or September. This is illustrated in a plot of the measured S-8 discharge for the time period between May 2003 and January 2005 (**Figure E.1- 5**). During 2003 and 2004 the wet season discharges started in June and extended through about mid October.

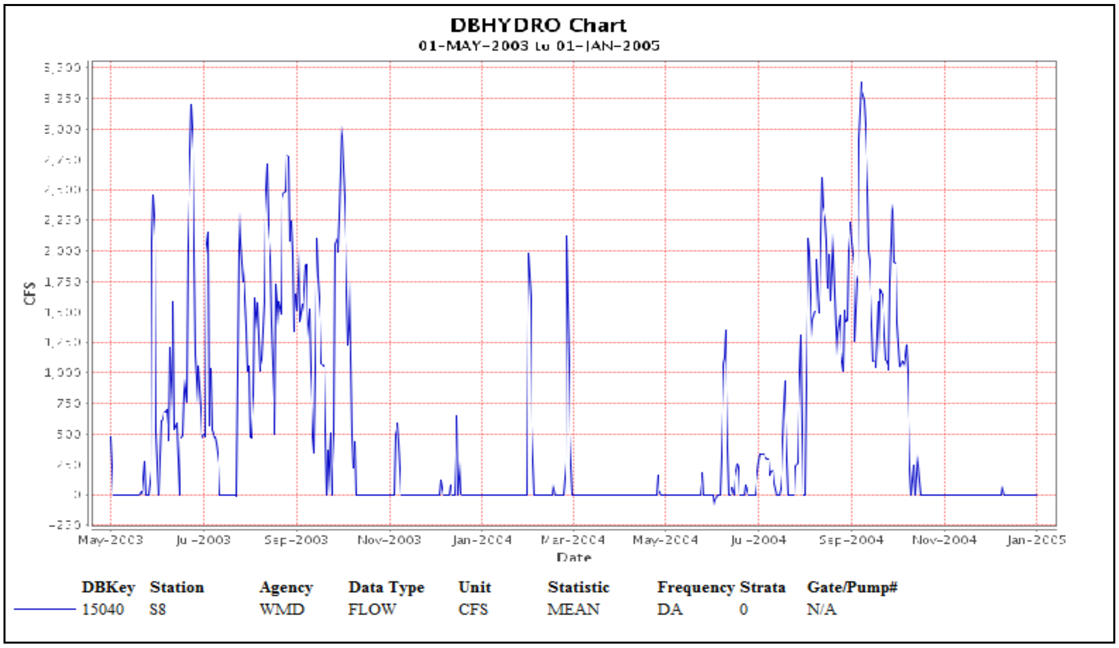

Figure E.1- 5. S-8 Pump Station plot of the measured S-8 discharge for the time period between May 2003 and January 2005

The Everglades Dry Standard Score provides a score of 0 to 100 based upon how well each alternative performs relative to the target during the dryer months (October through May). Monthly flows of each alternative run are compared to the target flows to determine the shortfall of inflow volumes relative to the target for each month of the simulation period (starting on January 1, 1964 through December 1, 2005). An accumulating penalty is calculated based on relative divergence from the target. The Dry Standard Score calculates shortfall during months between October and May and provides a score that weights later dry season months as more critical based upon the following relationship:

$$ESS_D = 100 - \left[\frac{\sum_{i=1}^{n} (Shortfall_i * \omega_m)}{n} \right]$$

where:
ESS_D = Everglades Standard Score $_{Dry}$ (between 0 and 100),
i = Time step in months
n = Number of months simulated (in this case n=41*12)
Shortfall = Percentage of relative shortfall volume delivered to Everglades compared to desired target inflow (limited to between 0% and 100%) defined as:

$$\frac{(Target\ Inflow_i - Glades\ Inflow_i)}{Target\ Inflow_i}$$

ω_m = Normalized monthly weighting factor:

The normalized weight factor (**Table E.1-6**) was generated based on providing higher weights to later dry season months, and zero weight to wet months June through September. Providing supplemental flows during the mid to later wet season is ecologically important to reverse the current adverse effects of marsh dry out during the dry months. February has a weight factor of 1, April has the highest weight factor of 1.5, and October has the lowest weight factor of 0.65 signifying that it is more than twice as important to meet the target flows in April than it is in October to avoid dry outs.

Table E.1-6. Normalized weighting factor used in the Dry Standard Score

Month	ω_m	Month	ω_m
Jan	0.875	**Jul**	0
Feb	1.0	**Aug**	0
Mar	1.25	**Sep**	0
Apr	1.5	**Oct**	0.625
May	1.25	**Nov**	0.75
Jun	0	**Dec**	0.75

The weight factors were developed based on the primary goal of avoiding dry outs in the Everglades. The importance of restoring flow amplitude and shifting the peak discharge from September to November was a secondary goal. The green line alternative shown on the Seasonality of Flows to the Everglades. **Figure E.1- 4** represents a 77% Dry Season Standard Score, the existing conditions red line represents a 62% score and the target NSRSM v3.3 gray line has a score of 100%.

E.1.4.2.2 Evaluation Tool Used

This methodology measures how well a spreadsheet simulation model (RESOPS) matches the magnitude and timing of a defined Everglades Demand Target. The RESOPS simulates monthly flows for a 41 year simulation period (1965-2005) and provides the ability to compare monthly flows to target flow (NSRSM v3.3) discharging into the Everglades at the red line.

E.1.4.2.3 Scoring Methodology

The Everglades Dry Standard Score provides a score of 0 to 100 based upon how well each alternative performs relative to the target during the dryer months (October through May). Monthly flows of each alternative run are compared to the target flows to determine the shortfall of inflow volumes relative to the target for each month of the simulation period (starting on January 1, 1964 through December 1, 2005).

To get a better understanding of what the scores mean as we move from an existing degraded system towards restoration flows, a spread sheet was created to generate hypothetical test runs to ensure that the weights generated were appropriate and that interpretations were ecological based and fit the descriptions of the scores as provided below.

"*Best" Narrative (DSS Score ≥90) – rating = 4.* The "best" portion of the DSS score is the top fraction of the possible range of conditions that corresponds to flow conditions that has all the characteristic restoration value needed to prevent soil oxidation and peat fires, while creating hydrology needed to enhance habitat microtopography. At this DSS score, long term average water depths will likely match long term average pre-drainage water depths (ca. 3 feet at the end of the wet season, ca. 1 foot at the end of the dry season); water surfaces will fall in response to seasonal and interannual climatic variability; and hydrologic conditions will sustain the elevation differences between sloughs, sawgrass ridges and tree islands. The average water depths are such that even during the driest of years associated with the natural, weather-driven interannual variability, the peat soils never, or extremely rarely, dry out to the point of significant oxidation. Instead, the water depths, including the interannual variability in depths, are such that the populations of larger, multi-yeared fish can persist. At this DSS score the potential for persistence of outflows from the Everglades into Florida Bay to prevent hypersalinity and sustain submerged aquatic vegetation is extremely high.

"Good" Narrative (75≥DSS Score<90) – rating = 3. The "good" portion of the DSS score is the top fraction of the possible range of conditions that corresponds to flow conditions that has most of the characteristic restoration value needed to prevent soil oxidation and peat fires, while creating hydrology needed to sustain habitat microtopography. This condition might be referred to as the sub-optimal but "sustainable" condition. Note that the definition is somewhat complex. If the Ridge and Slough landscape is ecologically and geomorphologically in "Best" condition, then "Good" hydrologic conditions are defined as those that are able to sustain the landscape in this "Best" ecological condition. That is, the hydrologic conditions can be somewhat reduced from "Best" hydrologic conditions, but reduced only to the extent that they are still able to sustain an existing "Best" ecological condition. This differs from "Fair" in that it does not set the landscape on a trajectory toward "Worst." If the landscape is already ecologically and geomorphologically somewhat diminished from "Best" conditions, then "Good" hydrological conditions may still be able to maintain the ecological status quo, but these hydrological conditions will not be able to move the landscape upward back toward "Best".

"Fair" Narrative (60>DSS Score<75) – rating = 2. The "fair" portion of the DSS score is the bottom fraction of the possible range of conditions that corresponds to flow conditions that have minimal restoration value, especially in terms of soil oxidation, peat fires, and is likely not to be able to prevent loss of habitat microtopography. This condition might be referred to as continued "degrading" condition. Ecologically, the landscape shows some of the aspects described under "Worst." It differs from the "Worst" condition described above in that the Ridge and Slough landscape would not yet have completely arrived at all the ecological worst endpoints. However the "Fair" condition is by definition the set of hydrologic conditions that keeps the Ridge and Slough landscape on a trajectory toward the "Worst" endpoint. If hydrologic conditions remain in the "Fair" condition, the landscape will over time degrade into the ecological "Worst" condition.

"Worst" Narrative (DSS Score ≤ 60)- rating = 1. The "worst" portion of the DSS score is the bottom fraction of the possible range of conditions that corresponds to flow conditions that have no restoration value or make conditions worse, especially in terms of soil oxidation, peat fires, and continued loss of habitat microtopography. At this DSS score, water depths are low enough that sloughs are, on average, dry (surface water absent) for more than three months of the year. These hydrologic conditions spell the end of the Everglades as a wetland. Populations of larger, multi-year fish are eliminated and populations of smaller fish (e.g., mosquito fish) are greatly reduced if not eliminated. Water lilies disappear and sloughs are invaded by sawgrass. Tree islands and ridges are invaded by dryland species. Elevation differences between sawgrass ridges and sloughs will continue to disappear; tree island peats will oxidize or burn and the full landscape will become microtopographically "flattened."

E.1.4.2.4 Criteria Results

Results are presented in **Table E.1-7**.

Table E.1-7. Everglades Dry Standard Score Results

Storage and Treatment Component	DSS Score	Rating
Flow-Through Wetland/FEB 28,000	(73-76)	2
4ft Shallow Storage & STA		
24,000 Res & 4,000 STA	(73-76)	2
14,000 Res & 14,000 STA	(73-76)	2

6ft Deep Storage & STA 24,000 Res & 4,000 STA 11,000 Res & 17,000 STA	 (73-76) (73-76)	 2 2
12ft Deep Storage & STA 24,000 Res & 4,000 STA 21,500 Res & 6,500 STA 17,000 Res & 11,000 STA	 (76-79) (76-79) (76-79)	 3 3 3
STA 28,000 STA	 (67-70)	 2

E.1.4.3 Estuary Performance (Level 1)

E.1.4.3.1 Criteria Description

The benefits to the St. Lucie and Caloosahatchee Estuaries are predicted to be a reduction in high flows. Two high flow indicators for each estuary were used to evaluate the alternatives. A 41 year period of daily discharges to the two estuaries was reduced to a times series of mean monthly flows (n=492 months). The number of mean monthly flows greater than 2800 and 4500 cfs at S-79 were used to evaluate alternatives for the Caloosahatchee (**Table E.1-8**). Total flows greater than 2000 cfs and greater than 3000 cfs were used to evaluate alternatives for the St. Lucie (**Table E.1-9**). Total flow was calculated as the sum of discharge from a time series at S-80 (located on C-44) and a time series containing discharge from sources other than the C-44 canal.

Table E.1-8. Mean monthly flows at S-79 *

Caloosahatchee (S79)		Number of Months in Five Flow Ranges				
MEAN MONTHLY FLOWS		**<450**	**450-2800**	**2801-4500**	**>2800**	**>4500**
WSE + C43 RES		68	340	39	84	45
LORS08 + C43 RES		38	375	38	79	41
ADP + C43 RES		24	382	39	86	47
LOW + LOKOPT + C43RES		75	344	30	73	43
LOW + WSOPT + C43RES		81	342	28	69	41
LOW + ESTOPT + C43 RES		66	352	37	74	37
MED + LOKOPT + C43RES		78	340	31	74	43
MED + WSOPT + C43RES		82	343	27	67	40
MED + ESTOPT + C43 RES		82	342	36	68	32
HIGH + LOKOPT + C43RES		86	355	32	71	39
HIGH + WSOPT + C43RES		82	343	27	65	38
HIGH + ESTOPT + C43 RES		74	348	36	70	34

Located at the head of the Caloosahatchee Estuary in various flow classes. The >2800 cfs and >4500 classes were used as indicators. N=492 months.

Table E.1-9. Total mean monthly flows to the St. Lucie Estuary*

St. Lucie (S80+SLETRIB)		Number of Months in Five Flow Ranges				
MEAN MONTHLY FLOWS		**<350**	**350-2000**	**2001 - 3000**	**>2000**	**>3000**
WSE + C43 RES		140	279	38	73	35

LORS08 + C43 RES		120	300	39	72	33
ADP + C43 RES		136	283	38	73	35
LOW + LOKOPT + C43RES		148	274	36	70	34
LOW + WSOPT + C43RES		148	276	32	68	36
LOW + ESTOPT + C43 RES		138	289	35	65	30
MED + LOKOPT + C43RES		150	272	37	70	33
MED + WSOPT + C43RES		149	277	31	66	35
MED + ESTOPT + C43 RES		149	280	39	63	24
HIGH + LOKOPT + C43RES		151	276	34	65	31
HIGH + WSOPT + C43RES		150	277	34	65	31
HIGH + ESTOPT + C43 RES		144	286	34	62	28

**Data displayed in various flow classes. The >2000 cfs and >3000 classes were used as indicators. N=492 months.*

E.1.4.3.2 Evaluation Tool Used

RESOPS was used as a preliminary screening tool used to compare monthly flows to target flow at the S-79 and S-80 structures. Further analysis was conducted using the LOOPs model in combination with a C-43 model. LOOPS is a hydrologic routing screening model that simulates Lake Okeechobee stages and discharges through the primary outlets as prescribed by a user-defined regulation schedule. The C-43 model is a hydrologic routing model that simulates the effects of the C-43 reservoir, which can alter flows observed at S-79.

E.1.4.3.3 Scoring Methodology

Rather than assign alternatives to quartiles, this initial screening sought to identify trends by ranking alternatives. For each estuary, alternatives were ranked by each of the two indicators (n=2 ranks/alternative). These were averaged to derive a single ranking of alternatives for each estuary (**Table E.1-10**). A final ranking, considering both estuaries was derived by averaging the ranks for each estuary. Ranking was from 1 to 12 with 1 being the best and 12 being worst with respect to reduction of high flows.

E.1.4.3.4 Criteria Results

Results are presented in **Table E.1-10.** Ranking of Options on Estuary Performance*

- When both estuaries are considered together from a high flow perspective, all nine of the options ranked higher than the three base cases, but all ranked similarly.
- Within each range of water delivery (Low, Medium, High), the alternatives optimized for estuarine performance ranked highest for estuary performance.

Table E.1-10. Ranking of Options on Estuary Performance*

	St. Lucie Estuary				**Caloosahatchee Estuary**				
	>2000	**>3000**	**Rank**		**>2800**	**>4500**	**Rank**		**FINAL**
WSE + C43 RES	11.5	10	10.75		11	11	11		10.9
LORS08 + C43 RES	10	6.5	8.25		10	7.5	8.75		8.5
ADP + C43 RES	11.5	10	10.75		12	12	12		11.4

LOW + LOKOPT + C43RES	8.5	8	8.25		7	9.5	8.25		8.3
LOW + WSOPT + C43RES	7	12	9.5		4	7.5	5.75		7.6
LOW + ESTOPT + C43 RES	4	3	3.5		8.5	3	5.75		4.6
MED + LOKOPT + C43RES	8.5	6.5	7.5		8.5	9.5	9		8.3
MED + WSOPT + C43RES	6	10	8		2	6	4		6.0
MED + ESTOPT + C43 RES	2	1	1.5		3	1	2		1.8
HIGH + LOKOPT + C43RES	4	4.5	4.25		6	5	5.5		4.9
HIGH+ WSOPT + C43RES	4	4.5	4.25		1	4	2.5		3.4
HIGH+ ESTOPT + C43 RES	1	2	1.5		5	2	3.5		2.5

**For each estuary, alternatives were ranked by each of two high flow indicators. These were averaged to produce a single ranking of alternatives for each estuary. Ranks for the two estuaries were averaged to provide a final ranking of alternative. The top highest ranking alternatives are identified by shading (1= most benefit, 12=least benefit).*

E.1.4.4 Water Supply (Level 1)

E.1.4.4.1 Criteria Description

During droughts Lake Okeechobee levels can fall below the Water Shortage Trigger. When this occurs, a reduced volume of water is delivered to meet demands, otherwise described as "demands not met" or "cutback volume" (**Figure E.1-6**). Water supply performance for LOSA will be measured by calculating the total cutback volumes (water demand not met) for the eight worst drought years during the 41-year period of analysis.

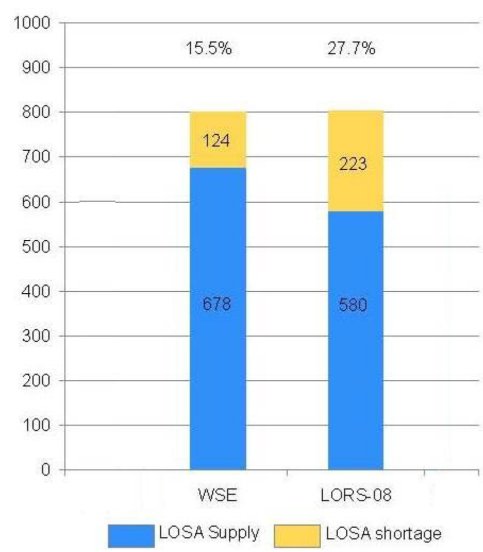

Figure E.1-6. Baseline water supply cutbacks

E.1.4.4.2 Evaluation Tool Used

LOOPS is a hydrologic routing screening model that simulates Lake Okeechobee stages and discharges through the primary outlets as prescribed by a user-defined regulation schedule. LOOPS was the model used to consider the volumes of water delivered to be "fixed" and the model would be used to identify Lake Okeechobee operations that take advantage of the flexibility within LORS to provide better deliveries to the estuaries (less high flows, more detail on time series of deliveries), evaluate Lake Okeechobee stage through time, and improve water supply for the Lake Okeechobee Service Area (reduced water supply cutbacks) for each of the flow volumes selected from the Tier 1 modeling.

E.1.4.4.3 Scoring Methodology

Water supply performance of the various options were rated by assigning scores relating to four categories of outcome, with a score of one being the worst, and four being the best.

The existing condition (LORS 08) is considered to be unacceptable by agricultural interests in the Lake Okeechobee Service Area. The current operations yield LOSA water shortage cutbacks occurring more frequently than 1-in-10 years, for longer durations, and at increased severities leading to economic damages. The water control plan that existed prior to the implementation of LORS 08, the WSE (2000 LORS-Water Supply/Environment) provided a higher level of service by limiting water restrictions imposed on agricultural permit holders. WSE has been identified as the target for the water supply performance. The intermediate categories are an equal proportion of the volume between WSE and LORS 08.

The average LOSA demand for the 8 drought years (1968, 73, 74, 81, 82, 89, 90, 01) is approximately 803,000 ac-ft. The percentage of water demands not delivered on average increased noticeably from WSE (15.5%) to LORS 2008 (27.7%). This average percentage cutback represents an average volume of 124,000 ac-ft and 223,000 ac-ft respectively. Converting this average volume into total volume, the total WSE cutbacks for the eight worst drought years totaling 992,000 ac-ft and the total cutback volume for LORS08 is 1,784,000 ac-ft.

4 - Total volume of cutbacks less than 992,000 ac-ft for eight worst drought years.
3 – Total volume of cutbacks between 992,000 ac-ft and 1,392,000 ac-ft for eight worst drought years.
2 – Total volume of cutbacks between 1,392,000 ac-ft and 1,784,000 ac-ft for eight worst drought years.
1 – Total volume of cutbacks is greater than 1,784,000 ac-ft for eight worst drought years.

E.1.4.4.4 Criteria Results

Results are presented in **Figure E.1- 7**. The highest performing scenarios (140-WS and 190-WS) improve water supply by reducing cutbacks over LORS 08 (~25%), and over Adaptive Protocols (AP) 5.50 (~20%) (**Table E.1-11**). Lake Okeechobee operations optimized for estuarine performance yield no water supply benefits. The high flow scenario provides less benefit for water supply than either the low or medium flow scenarios.

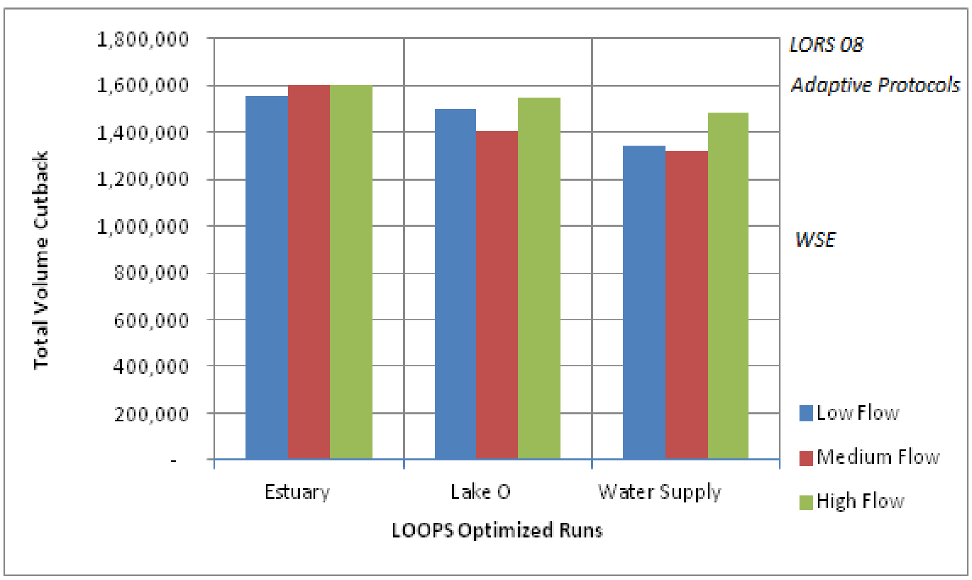

Figure E.1- 7. Water Supply Cutbacks by Lake Okeechobee Operation for each of the flow projections

Table E.1-11. Cutback percentages of flow options compared to baseline water supply cutbacks

	Baselines		
	WSE	LORS08	AP5.50
Cutback %	15.5%	27.7%	24.9%
Low Flow	LOKOPT	WSOPT	ESTOPT
Cutback %	23.3%	20.9%	24.2%
Med. Flow	LOKOPT	WSOPT	ESTOPT
Cutback %	21.9%	20.5%	24.9%
High Flow	LOKOPT	WSOPT	ESTOPT
Cutback %	24.1%	23.1%	24.9%

Table E.1-12. Cutback volume of flow options compared to baseline water supply cutbacks

140-Est	1,553,834	2
140-LO	1,496,046	2
140-WS	1,341,947	3
190-Est	1,598,779	1
190-LO	1,406,155	2
190-WS	1,316,264	3
240-Est	1,598,779	1
240-LO	1,547,413	2
240-WS	1,483,205	2

E.1.4.5 Lake Okeechobee (Level 2)

E.1.4.5.1 Explanation of the Criterion

Although there are currently four RECOVER approved Lake Okeechobee performance measures, the challenge in using them to evaluate and rank alternatives using hydrologic model output is typically that differences between the various alternatives tend to be small, and there has been no formal way of balancing the importance of each performance measure against the others and treating them as a meaningful group. The performance measures include the standard score above 17 feet NGVD, standard score below 10 feet NGVD, standard score above stage envelope and standard score below stage envelope.

E.1.4.5.2 Evaluation Tool Used

LOOPS is a hydrologic routing screening model that simulates Lake Okeechobee stages and discharges through the primary outlets as prescribed by a user-defined regulation schedule. LOOPS was the model used to consider the volumes of water delivered to be "fixed" and the model would be used to identify Lake Okeechobee operations that take advantage of the flexibility within LORS to provide better deliveries to the estuaries (less high flows, more detail on time series of deliveries), evaluate Lake Okeechobee stage through time, and improve water supply for the Lake Okeechobee Service Area (reduced water supply cutbacks) for each of the flow volumes selected from the Tier 1 modeling.

E.1.4.5.3 Scoring Methodology

In the case of evaluating Lake Okeechobee model output for CEPP screening above the red line, it was decided to assign relative weights to each of the four performance measures, which themselves are all normalized to a scale of 0 to 100%, and then to combine the weighted scores to obtain a Lake Okeechobee total value for each screening alternative. The weighting factors used were as follows: standard score above 17 feet NGVD 50%, standard score below 10 feet NGVD 25%, standard score above stage envelope 15% and standard score below stage envelope 10%. The assignment of weighting factors was based on nearly 20 years of Lake Okeechobee data which generally indicate that the most significant factor affecting Lake ecological health are stages above 17feet NGVD which tend to have devastating and cascading effects on lake vegetation and their associated faunal communities. Following stages over 17 feet NGVD, the most important ecological factors in descending order are then considered to be stages under10 feet NGVD which dry out the entire littoral zone, and deviations above and below the stage envelope which, though ecologically sub-optimal do not necessarily mediate against a viable vegetation community although the relative ratio and distribution of terrestrial, emergent wetland, and submerged vegetation may vary over a wide geographic range.

The decision to sum the resultant performance measure weighted values to obtain a cumulative score for each alternative was based on the assumption that total Lake ecological performance is based on the combined effect of the key hydrologic conditions reflected by the performance measures as they are distributed over the course of the period of record (POR). Rather than using a descriptive narrative approach to establishing quartile rankings for Lake Okeechobee, it was decided to use a series of ranges and thresholds of cumulatively weighted scores instead. This decision was based on the difficulty of establishing sufficiently quantitative narrative descriptions that adequately reflected the interactions between the key hydrologic factors represented by the Lake Okeechobee RECOVER performance measures and could still be directly used to evaluate the scores generated by the alternative ranking process. The quartile ranges **(Table E.1-13**) and thresholds (below) were developed based on model output for the most recent best performing and worst performing Lake Okeechobee operating schedules; LORS 2008 (Lake Okeechobee Regulation Schedule 2008) plus Adaptive Protocols and WSE (Water Supply and Environment) respectively.

Table E.1-13. Quartile scoring for Lake Okeechobee performance

Quartile	Cumulative Score	
4	>90%	Best
3	80%-90%	to
2	70%-80%	
1	< 70%	Worst

E.1.4.5.4 Criteria Results

Adaptive Protocols yielded a cumulative score above the mid 80% range (**Table E.1-14**). While Adaptive Protocols is probably the best recent schedule and resolves a large portion of the Lake's over 17 feet NGVD issues, it also results in more frequent events below 10 feet NGVD, which while potentially damaging, are less so than extreme high lake stage events. It also has relatively modest scores for time within the stage envelope (standard score above and standard score below the envelope) which could stand significant improvement. Therefore Quartile 3 was set to encompass the range characterized by the Adaptive Protocols run and considering that improving low Lake Stage events and the time within the Lake stage envelope would result in additional improvements in lake performance the threshold for the transition to Quartile 4 was set at 90%. Using a similar approach, the WSE base run yielded a score in the mid 70% range (**Table E.1-14**). WSE results in too many excessively high, potentially ecologically damaging, lake stages and also has relatively modest scores within the stage envelope (with a tendency for excursions to be in the less preferred above rather than below the envelope range) which could likewise stand significant improvement). Hence the range for Quartile 2 was set to encompass the performance of WSE. Anything with performance markedly worse than WSE would most likely have dire consequences for lake ecology, so the threshold for a descent into Quartile 1 was set at 70%.

Using the method described, all the results, except for the WSE base run fall into Quartile 3 (**Table E.1-14**). Within Quartile 3, the best performer is Adaptive Protocols and the worst performer is the estuarine optimization for medium everglades flow. The medium everglades flow Lake Okeechobee optimization run score is nearly the same as the Adaptive Protocols score which makes it the preferred option from the perspective of Lake Okeechobee ecology. However, there are several options that are either as good as, nearly as good as, or slightly better than LORS 08, which despite its tendency to cause more low lake stage events than Adaptive Protocols, is an acceptable schedule from a Lake ecology perspective. These runs include the Lake Okeechobee optimization for low everglades flow, the water supply optimization for medium everglades flow, and the Lake Okeechobee optimization for high everglades flow. It should be noted that none of the estuarine optimization runs performed as well as LORS 08, primarily because they appear to both remove some degree of protection from events above 17 feet NGVD while at the same time increasing the occurrence of events below 10 feet NGVD; indicating an operating schedule with more excursions into both the upper and lower ranges of potentially ecologically damaging Lake stage.

Table E.1-14. Lake Okeechobee results

	Baselines			Low Everglades Flow			Medium Everglades Flow			High Everglades Flow		
Lake Operation	WSE	LORS08	AP5.50	LOKOPT	WSOPT	ESTOPT	LOKOPT	WSOPT	ESTOPT	LOKOPT	WSOPT	ESTOPT
SSA	51.3	81.0	76.3	67.8	61.2	67.2	71.1	63.5	66.9	69.3	66.7	69.9
SSB	70.0	30.7	41.4	48.9	56.3	47.0	50.5	57.4	45.2	47.9	50.8	45.5
SS>17	78.6	99.1	98.7	97.5	95.7	96.1	97.6	95.9	95.6	97.3	96.6	96.2
SS<10	95.7	86.1	90.3	90.4	92.3	90.0	91.0	92.1	89.2	89.7	89.8	89.3
Weighted SS	77.9	86.3	87.5	86.4	85.7	85.3	87.3	86.3	84.7	86.2	85.8	85.5

E.1.4.6 Adaptability (Level 2)

E.1.4.6.1 Criteria Description

Adaptability was composed of three sub-criteria.

- Flexibility: Speed, ease, efficiency of moving water to adjust to changing conditions such as storms or other real-time needs.
- Robustness: Ability to function effectively in the face of variability and uncertainty of future events (NRC 2007). Ability to perform under broad shifts, such as climate change.
- Future compatibility: Efficiency of using this configuration to complement future CEPP increments.

E.1.4.6.2 Evaluation Tool Used

There was no specific model used to evaluate the adaptability of storage and treatment options, but a rigorous examination of the option's conceptual design was conducted by an interdisciplinary team of scientists, engineers and planners to identify expected trends and use best professional judgment to score options. The following parameters were used to help guide ratings.

- Greater degree of storage → more flexibility and robustness.
- Greater degree of STAs → Less flexibility and robustness.
- FEB or shallow storage → Easier to retrofit.
- STA → Difficult to retrofit

E.1.4.6.3 Scoring Methodology

Components and operations easy and most efficient to adjust = 4
Components and operations are moderately simple to adjust = 3
Components and operations adjustment is expensive and time consuming = 2
Components and operations difficult or slow to adjust = 1

E.1.4.6.4 Criteria Results

Results are presented in **Table E.1-15**.

Table E.1-15. Results of adaptability analysis

	-	Flexibility of Operations	Robustness	Future compatibility	Average Rating
4' Reservoir	**24000 Res & 4000 STA**	2	2	**4**	**3**
	14000 RES & 14000 STA	2	2	3	**2**
6' Reservoir	**24000 Res & 4000 STA**	3	3	3	**3**
	11000 RES & 17000 STA	2	2	2	**2**
12' Reservoir	**24000 Res & 4000 STA**	**4**	**4**	3	**4**
	21500 Res & 6500 STA	**4**	**4**	3	**4**
	17000 Res and 11000 STA	3	3	2	**3**
FEB	**All FEB**	**1**	2	**4**	**2**
STA	**All STA**	**1**	**1**	2	**1**

E.1.4.7 On-site Habitat (Level 2)

E.1.4.7.1 Criteria Description

Measure of the potential for wetland and aquatic wildlife within the footprint of the storage and treatment components.

- Based on Florida regulatory methodologies
- Not to be utilized to compare to natural areas within the Everglades (WCA 3, ENP, etc.)
- 3 sub-criteria:
    - Wildlife Utilization
    - Vegetation
    - Hydrology
- Descriptions are specific to the component types

E.1.4.7.2 Evaluation Tool Used

There was no specific model used to evaluate the on-site habitat for storage and treatment options, but an evaluation was conducted by an interdisciplinary team of scientists and planners to rate each storage and treatment feature (STA, FEB, 4 ft reservoir, 6’ reservoir and 12’ reservoir) based on Florida regulatory methodologies for vegetation, hydrology and wildlife utilization as described below (**Table E.1- 16**). The scores were averaged to give one on-site habitat score for each storage and treatment option. Those scores were then used to calculate a score for each storage and treatment combination based upon the acreage for each feature (**Table E.1- 17**)

E.1.4.7.3 Scoring Methodology

Performance of the various options were rated by assigning scores relating to four categories of outcome, with a score of one being the worst, and four being the best.

A. Vegetation:

4 – Desirable species and cover/ no dense cattail; healthy vegetation, strong natural recruitment; <10% exotic
3 – Moderate vegetative cover/some dense cattail; healthy with sufficient natural recruitment; <25% exotics
2 – Limited vegetative cover/large areas of dense cattail; vegetation stressed, little natural recruitment (plantings necessary); <50% exotics or undesirable species
1 – Little or no vegetative cover/dense cattail throughout; unhealthy vegetation, no natural recruitment, plantings difficult to establish; >50% exotics or undesirable species

B. Hydrology

4 – Supports favorable habitat; fish, aquatic species populations flourishing; no dry downs or dryouts; optimal dissolved oxygen levels.
3 – Adequate support of habitat; fish, aquatic species sustained; dry downs and/or dryouts during droughts only; sufficient dissolved oxygen.
2 – Highly fluctuating or poorly maintained water levels; sparse populations of fish and aquatic species; intermittent dry downs and/or dryouts; reduced dissolved oxygen.
1 – Water levels inadequate to sustain habitat; fish and amphibian mortality evident; frequent and/or severe dry downs and/or dryouts; insufficient dissolved oxygen.

C. Wildlife Utilization

4 – Substantial avian and reptile utilization; abundant cover and food; ample foraging and nesting; fish, macroinvertebrate and amphibian populations thriving.
3 – Some avian and small to medium-sized reptile utilization; adequate cover and food; sufficient foraging and nesting; fish, macroinvertebrate and amphibian populations sustainable.
2 – Minimal wildlife utilization; sparse cover and inadequate food; limited foraging and nesting; poor maintenance of fish, macroinvertebrate and amphibian populations.
1 – No wildlife utilization; little/no cover or food; foraging and nesting areas absent; deficient fish, macroinvertebrate and amphibian populations.

E.1.4.7.4 Criteria Results

A. Vegetation

STA Rating: 3 Moderate vegetative cover with some dense areas of cattail (area not managed for cattail reduction); Most vegetation healthy with substantial natural recruitment and sustained growth occurring.
FEB Rating: 3 Moderate vegetative cover with some dense areas of cattail (area not managed for cattail reduction); Most vegetation healthy with substantial natural recruitment and sustained growth occurring.
4' Reservoir rating: 1 Little to no vegetative cover due to substantially fluctuating water levels throughout; Any vegetation becoming established unhealthy; plantings unable to become established.
6' Reservoir rating: 1 Little to no vegetative cover due to substantially fluctuating water levels throughout; Any vegetation becoming established unhealthy; plantings unable to become established.
12' Reservoir Rating: * Not rated. This area would not be able to maintain vegetation.

B. Hydrology

STA Rating: 4 STA would remain hydrated with water levels supporting favorable habitat; no dry downs or dryouts; aquatic organisms would flourish.
FEB Rating: 4 FTW would remain hydrated with water levels supporting favorable habitat; no dry downs or dryouts would occur; aquatic organisms would flourish.
4' Reservoir rating: 2 Highly fluctuating water levels with frequent dry downs and dryouts during drought periods; reduced DO levels due to shallowness; sparse populations of fish and aquatic species poorly maintained.
6' Reservoir rating: 2 Highly fluctuating water levels with frequent dry downs and dryouts during drought periods; reduced DO levels due to shallowness; sparse populations of fish and aquatic species poorly maintained.
12' Reservoir rating: 3 Adequate water levels some fluctuation; dry downs and dryouts during drought periods; sufficient DO levels when flooded; fish and aquatic species populations sustainable.

C. **Wildlife Utilization**

STA Rating: 4 Substantial utilization by numerous avian species and reptiles; abundant cover and food sources for migratory animals; ample foraging and nesting areas for resident species.
FEB Rating: 4 Substantial utilization by numerous avian species and reptiles; abundant cover and food sources for migratory animals; ample foraging and nesting areas for resident species.
4' Reservoir rating: 2 Poor wildlife utilization with food sources becoming established only during wet periods; Foraging areas mainly absent; Minimal fish, macroinvertebrate and amphibian populations with significant mortality during droughts.
6' Reservoir rating: 2 Poor wildlife utilization with food sources becoming established only during wet periods; Foraging areas mainly absent; Minimal fish, macroinvertebrate and amphibian populations with significant mortality during droughts.
12' Reservoir rating: 2 Poor wildlife utilization with food sources becoming established only during wet periods; Foraging areas mainly absent; Minimal fish, macroinvertebrate and amphibian populations with significant mortality during droughts.

Table E.1- 16. Rating for each feature for vegetation, hydrology and wildlife utilization.

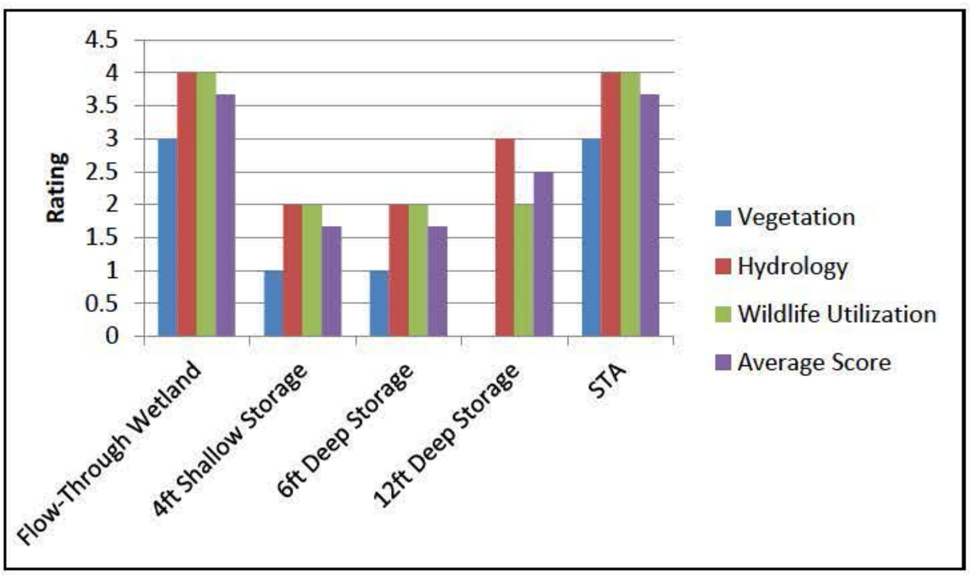

Table E.1- 17. Onsite Habitat Ratings

Storage and Treatment Combination	Vegetation Acreage (combined ranking factor*acreage)	Hydrology Acreage (combined ranking factor*acreage)	Wildlife Utilization Acreage (combined ranking factor*acreage)	Onsite Habitat Total (average of the three)	Onsite Habitat Rating (average of the three based on % of acreage)
4ft Shallow Storage & STA					
24000 Res & 4000 STA	9000	16000	16000	**13667**	**2**
14000 RES & 14000 STA	14000	21000	21000	**18667**	**3**
12 ft Deep Storage & STA					
24000 Res & 4000 STA		22000	16000	**19000**	**3**
21000 Res & 7000 STA		22750	17500	**20125**	**3**
17000 Res and 11000 STA		23750	19500	**21625**	**3**
6ft Deep Storage & STA					
24000 Res & 4000 STA	9000	16000	16000	**13667**	**2**
11000 RES & 17000 STA	15500	22500	22500	**20167**	**3**
Flow-Through Wetland/FEB					
28000	21000	28000	28000	**25667**	**4**
STA					
28000 STA	21000	28000	28000	**25667**	**4**

E.1.5 Storage and Treatment Options – MCDA and Cost Effective Results

The screening effort resulted in 2 cost-effective measures with wide differences in costs. The results of the level 2 criteria supported the Level 1 analysis, and did not lead to the identification of further options to be considered for inclusion in the final array of alternatives. **Table E.1-18** provides sums of the scores from **Tables E.1-5, E.1-7, E.1-12, E.1-15, and E.1-17.** There are two cost effective options that were identified. These options performed best in the MCDA analysis for the lowest comparative cost. The two alternatives are as follows:

- A 28,000 acre Flow Equalization Basin (FEB) with Lake Okeechobee operations optimized for water supply is the least cost option at an expected cost range of $700-900 million. This option is estimated to provide approximately 200,000 ac/ft of additional water annually to the Everglades system.
- A 12ft Deep Reservoir, also optimized with Lake Okeechobee operations focused on water supply, provides the greatest benefits to the everglades. This reservoir is sized at 21,000 acres with an additional 7,000 acre STA to handle the water stored that would exceed the limitations of the existing STA system. The expected cost is $1.8-2.0 billion.

Table E.1-18. Results of scoring for all storage and treatment criteria

Management Measure Configuration			Level 1 Objectives Sub Total	Level 1 + Level 2 Total Score	Total Cost (Capital and O&M)
Flow-Through Wetland/FEB					
FEB	Reservoir	LO Ops			
28000		190-Est	6	12	700 - 900
		190-WS	8	14	700 - 900
		190-LO	7	13	700 - 900
4ft Shallow Storage & STA					
STA	Reservoir	LO Ops			
4000	24000	190-Est	5	9	770 - 970
		190-LO	6	10	770 - 970
		190-WS	7	11	770 - 970
14000	14000	190-Est	5	10	950 - 1050
		190-LO	6	11	950 - 1050
		190-WS	7	12	950 - 1050
6ft Deep Storage & STA					
STA	Reservoir	LO Ops			
4000	24000	190-Est	5	10	1020 - 1220
		190-WS	7	12	1020 - 1220
		190-LO	6	11	1020 - 1220
17000	11000	190-Est	5	10	1144 - 1344
		190-WS	7	12	1144 - 1344
		190-LO	6	11	1144 - 1344
12 ft Deep Storage & STA					
STA	Reservoir	LO Ops			
4000	24000	140-Est	6	13	1765 - 1915
		140-WS	7	14	1765 - 1915
		140-LO	6	13	1765 - 1915
7000	21000	240-Est	8	15	1820 - 1960
		240-WS	9	16	1820 - 1960
		240-LO	9	16	1820 - 1960
11000	17000	190-Est	7	13	1900 - 2030
		190-WS	9	15	1900 - 2030
		190-LO	8	14	1900 - 2030
STA					
STA	Reservoir	LO Ops			
28000		140-Est	5	11	1020 - 1120
		140-WS	6	12	1020 - 1120
		140-LO	5	11	1020 - 1120

E.2 DISTRIBUTION AND CONVEYANCE – NORTHERN WCA 3A

CEPP considered previously conducted plan formulation, screening and modeling data from the Decomp Study effort, which helped provide a basis for identification of the initial array of options to be analyzed through the CEPP formulation process. This initial array utilized the existing water budget entering WCA 3A, and while providing invaluable insight and information, further modification and evaluation of these options was needed when considering the additional water provided by the FEB and Lake Okeechobee operational refinements. **Sections E.2.3, E.2.4 and E.2.5** describe the process and results of the previous screening and modeling using the existing water budget. **Section E.2.6** contains details of the analysis used to build upon and modify the conclusions drawn from the preliminary modeling and screening effort.

E.2.1 Northern Distribution and Conveyance Management Measures

E.2.1.1 Northern Distribution Management Measures

Spreader Canal: A Spreader Canal along the L-5 levee could be utilized to distribute freshwater flows more effectively and promote hydropattern development and restoration. The spreader canal would need an appropriately-sized pump station to deliver flows into the segment of canal. The C-111 Spreader Canal Design Test demonstrated that a Spreader Canal feature can be extremely effective in reducing water recession rates during the dry season, which would promote the restoration of seasonal hydroperiods, improve surface water depths and durations, and also contribute to timing improvements for water deliveries by encouraging a more natural distribution of water across the EAA/WCA 3A boundary. A spreader canal was retained for further consideration in alternative development.

Levee Removal: Levees such as the L-67A would be completely removed in order to re-establish water flows. The removal of the levees would restore the sheet flow directionality and improve hydroperiods by ensuring a more consistent distribution of water. Additionally, the removal of these barriers would eliminate substantial fragmentation that inhibits animal movement and decreases habitat value. Material would be disposed of onsite through the incorporation into other features or may need to be transported offsite, which would increase project costs. Levee removal, with significant potential benefits, was retained as a measure for possible inclusion into components and alternatives.

Levee Gaps: Levees such as the L-67A would be degraded in certain areas to allow water flows from WCA 3A to WCA 3B. The levee gaps may have control structures for operational control to prevent water flows into WCA 3B during extreme high water events. Some improvements in habitat value would occur with the increased water flows from this measure, with reduced fragmentation leading to a healthier ecosystem. This measure would likely be less costly when compared to complete levee removal if the material is not needed for related management measure construction; however, there would be more likelihood that some hydropattern restoration may be impeded by remaining portions of the levees. As such, levee gaps, although not quite as effective as levee removal but with possible cost savings, was retained as a management measure.

Pump Stations: Pump stations could be constructed to introduce water at additional locations along the L-5 and provide greater distribution of water into WCA 3. Additionally, pump stations may be necessary to supplement some components such as spreader or collection canals. This measure was retained for further consideration.

Levee/Berm Construction: The construction of levees/berms within the WCAs could be utilized to guide surface water along preferential flow paths for distribution. Certain portions of WCA 3 may be situated in an area where additional structures are necessary to steer water flows into the area. The strategic placement of these levees/berms could reduce ponding in some areas while diverting surface flows to other areas that are typically dry. Additionally, levee/berm construction could direct water away from the eastern levees, reducing the possible need for seepage control with increased flows into the WCAs. This measure was retained.

Flow-through Wetlands (Restored Wetlands): A Flow-through is a measure that is similar to the Flow Way feature that was evaluated as a water storage measure. A Flow-through would be used primarily for the distribution of freshwater, promoting the restoration of seasonal hydroperiods within the remnant Everglades areas in the EAA. A Flow-through would not be utilized within the areas identified for the quantity/quality measures. Areas that could be utilized as a Flow-through include the Holey Land and other possible large tracts of land.

Conveyance Canal Modifications (L-5 and L-6): The L-5 and L-6 canals would be widened to allow for the benefits diversion of treated water from STA 2 into Northern WCA 3A, in lieu of being discharged into WCA 2A. This would entail potential excavation of the canals and the construction of control structures to ensure proper routing of water. This measure would provide needed water to WCA 3A and prevent further exaceration of ponding issues in WCA 2.

E.2.1.1.1 Holey Land Flow-through Wetland Screening

The desire to integrate restoration of Holey Land into the Central Everglades Planning Project was brought up by many stakeholders both during the scoping phase and during the formulation phase. The Holey Land Wildlife Management Area consists of approximately 35,336 acres situated directly south of the A2 parcel considered for CEPP treatment and storage features. Although Holey Land restoration was not a specific goal of CEPP it was recognized that utilizing Holey Land as a flow through system could potentially provide additional added benefits to WCA 3A deliveries by providing additional storage and potentially improved deliveries.

Preservation and restoration efforts for Holey Lands have been ongoing since the early 1970's when the State of Florida Board of Trustees purchased much of the land in the Holey Lands and Rotenberger tracts. The initial restoration plans were formalized in 1983 when Florida Fish and Wildlife Conservation Commission (FWC formerly GFC), Florida Department of Environmental Protection (FDEP formerly DER) and South Florida Water Management District entered into a Memorandum of Understanding (MOU) for the Holey Land and Rotenberger Project. The MOU established a general agreement about how the State would proceed with restoration of the Holey Land and Rotenberger tracts and provided a funding source for the project. In 1984 FDEP issued a permit (06 and 50-0809209) to "restore natural vegetation and characteristics to Holey Land." Permit authorized construction of a 50 cfs pump station, levees and 3 outflow structures, and included monitoring requirements for vegetation surveys and water quality sampling.

Project construction was completed by 1992 and operations of the 750 cfs G 200A pump station started operations in November 1992. The initial operations were implemented according to a water regulation schedule of 11.5' to 13.5' NGVD to establish a maximum intended inundation depth of 2 feet as part of an "Initial Operational Plan" that was formalized in 1990. Based upon monitoring, better understanding of the topography and observation of the system response the Fish and Wildlife Commission recommended modifying the Initial Operational Plan, some of which was implemented to address high water concerns. The inability to get water out of Holey Land was part of the part of the recognized problem as the outflow structures were located along the higher grounds along the south project boundary. The new operations were never formalized. In 2005, hurricane Wilma damages the G 200A pump station beyond repairs, and the project has not been operational since then.

When considering integrating restoration of the Holey Land into CEPP we tried to build on what we had learned from the past, and we used the following Fish and Wildlife Conservation Commission's (FWC) recommended goals for Holey Land to aid in designing a restoration plan:

- The average depth of the interior of the marsh that ranges from:
  0.75 to 1.0 ft above average ground elevation for Holey Land WMA. The maximum depth should not exceed 1.5 ft and the minimum depth should not fall below -0.5 ft.
- The hydroperiod should range from 80-90% annually over at least 50% of Holey Land WMA.
- Recession rates: Average 0.05 ft/week from January 1 to June 1.
- Ascension rates: Average 0.05 – 0.10 ft/week from June 1 to October 1; not exceed 0.25ft/wk.
- Water quality should not exceed 40ppb.
- Water flow patterns should be consistent with that of the topography.
- Holey Land WMA should be a flow-through system.

A preliminary Holey Land Alternative was developed as part of the RESOPS modeling effort that was carried out north of the Red Line. For these preliminary runs we assumed replacement of G-200A pump station at the northeast corner (3 units-250 cfs each), and 3 outflow control structures similar to G204, G205 and G206 (3 structures - 250 cfs outflow each), located along the lower ground elevations at the east side of the Holey Land parcel. The estimated cost for the infrastructure was $16 million (compared to preliminary relative cost of $175 million for the FEB).

A method for determining water depths at the center of Holey Land was developed to help determine how the system could be operated using the proposed infrastructure (Predicting Water Levels at the center of Holey Land Report, May 2012). It was concluded that the FWC goals of having a flow through system with maximum water depth of 1.5 feet could be achieved by operating the inflow and outflow structures in a pulse like manner. In order not to stage up too high on the downstream side (east side of Holey Land parcel), the engineer found that you must limit deliveries to 7 days at 750 cfs, then shut down for 7 days before you start pumping again (7 days on/off to avoid higher ponding along east side) . This meant that maximum inflows are 21,000 acre-feet/month.

Refined RESOPS modeling was done to determine how much addition benefits could be derived based upon Level 1 screening criteria. Specifically additional flows and dry season score were calculated to ensure that the proposed design refinements would meet the overall project objectives of improving deliveries to the Everglades. Refinements to RESOPS were done by placing Holey lands downstream of the Reservoir (FEB) feature and upstream of the STA. If water was available in the reservoir and was not needed for the STAs and Everglades deliveries, RESOPS was modified to allow deliveries to Holey Land. The refined RESOPS runs predicted that ~31 kac-ft of water on an average annual basis could be sent to Holey Land. Provisional outcomes of DMSTA indicated that when considering FEB hydraulic constraints, a smaller amount of ~ 21 kac-ft could be passed into Holey Land and under the assumption that no additional treatment is provided, this would raise the average annual "mixed" outflow concentration by about 0.5 ppb. This would still keep us under the WQBEL annual average target of 13.0 ppb.

In the end the consideration of integrating restoration of Holey Land by allowing discharges from the proposed new FEB to be redirected to the Holey Land as described above by the proposed new infrastructure, was eliminated from consideration due to water quality concerns raised by environmental stakeholder groups (Florida Wildlife Federation and others). The stakeholder groups felt that there was not sufficient treatment in the FEB and that we should not consider discharging water into Holey Land that does not first come through one of the Everglades Stormwater Treatment Areas (STAs), where higher treatment can be achieved to meet the discharge requirements that are protective of the Everglades Protection Area marsh (13 ppb WQBEL). Holey Land is not part of the Everglades where the long term 10 ppb standard applies, however, Holey Land is an Outstanding Florida Waters where special consideration is given to water quality and that the project is clearly in the public interest. Since there was not broad public support for the proposed Holey Land Alternative, this alternative was eliminated from consideration.

E.2.1.2 Northern WCA 3A Conveyance Management Measures

Plug Canal to Marsh Grade: A series of large, earthen plugs or others of acceptable material would be constructed within strategic segments of the Miami Canal in order to eliminate canal flow, promote natural hydropatterns and reduce any drainage effects that may be occurring. Some recreational opportunities such as fishing may be diminished as a result of the reductions and possible elimination of open canal area. Modeling for the Decomp PIR planning effort demonstrated that some plug configurations may be nearly as hydrologically effective as some partial backfill configurations. As such, plugging of the canal to marsh grade was retained as a potential measure.

Backfill Canal to Marsh Grade: Portions or entire lengths of the existing Miami Canal could be completely backfilled with clean fill material to marsh grade. Backfill of the canal would promote sheet flow and eliminate any drainage effects and alteration of hydropatterns that are occurring. It would also restore the ecological connectivity of WCA 3. Some recreational opportunities such as fishing may be diminished as a result of the reduction in open canal area. Backfilling of the Miami Canal was demonstrated to be effective during a previous modeling effort conducted for the Decomp PIR planning effort. As such, backfilling of the canal to marsh grade was retained as a potential measure.

Spoil Mound or Berm Removal**:** The Miami Canal traverses approximately 26 miles within WCA 3A, running in a southeasterly direction until it reaches the L-67 A/C system at S-151. Excavated material from the canal construction was placed alongside the canal as spoil mounds or berms. A number of these have been planted with native vegetation by the Florida Fish and Wildlife Conservation Commission (FWC) and differ from natural tree islands by vegetation communities present, soil composition, elevation gradients, and shape; some have also been colonized by exotic vegetation. With this measure, existing spoil mounds or portions of the berms would be removed to promote improved sheet flow and improve freshwater distribution. FWC planted areas could be retained and/or reshaped to promote habitat utilization. Spoil would either be utilized for other project purposes such as backfill or would be transported offsite for proper disposal. Spoil mound or berm removal and reshaping was retained as a measure.

Above- or In-Ground Pipeline: Pipelines would be constructed to convey water down the Miami Canal to the South Dade Conveyance System. Substantial backfill would be required to augment a pipeline. Pipelines would allow for the re-establishment of surface landscapes, promoting re-vegetation and sheet flow characteristics. Although pipelines may be effective in routing water and allowing restoration above those areas, there would likely be excessive construction and maintenance costs. For an in-ground pipeline, there may be some hindrance of lateral groundwater movement on a local scale.

Secondary effects would likely occur as a result of the construction, particularly if any significant excavation and/or blasting are required. Also, water entering the pipeline would likely be of relatively poorer quality than water that currently exists in well fields and canals in the area where the pipe would discharge. Water discharging from the pipeline would need to be treated for nutrients, and other water quality concerns such as dissolved oxygen. Water discharged from the pipeline would also not receive the benefits of natural treatment through ground and surface water interactions with the surrounding marsh.

For an Above-Ground Pipeline, although maintenance and construction costs could likely be minimized, there would be a tremendous aesthetic impact on the Everglades system. A visible pipeline constructed through the central part of the historical River of Grass would be an extremely detrimental effect on a cultural resource. Due to the factors documented above, both an in-ground and above-ground pipeline were eliminated from consideration.

***Shallowing of Canals*:** Canals would be partially filled to elevations slightly less than marsh grade. Conveyance capacity of the canal would be reduced, lessening the drainage effects and improving local hydrology. The shallowed canal may allow for some "spillage" into the surrounding marsh. Although there would likely be some short-term improvement in flows some distance from the canal, wetland and riverine systems have shown tendencies to either return to historical patterns or develop new, unpredictable flow paths. As such, it is extremely unlikely that the shallowing measure would be highly effective, and may actually disrupt the formation of natural hydropatterns once surface water depths have been restored. Recreational opportunities such as fishing may be diminished.

In addition, modeling was conducted during the Decomp PIR effort to examine the efficacy of a shallowing measure by testing a reduced canal conveyance (50% backfill) capacity of the Miami Canal. Modeling results indicated that overall performance of the reduced canal conveyance simulation was almost identical to no backfill simulation. Shallowing the canal did not remove the drainage effects of the existing canal on the adjacent landscape. As such, this measure was eliminated from further consideration.

Cap Canals: A concrete slab could be constructed across the canal and covered with clean fill material to marsh grade. Water could still be delivered within the existing canal while sheet flow would still occur across the capped portion. This measure would be difficult to maintain as any work within the canal would require removal of the surface material and cap from a flooded marsh. Additionally, the cost for maintenance would be extremely high given the time required and other issues such as possible dewatering for surface cap removal. Additionally, there would still likely be hydraulic effects associated with the canal, and a system would be created where groundwater flows were not consistent with surface water directionality. As such, due to concerns with groundwater uncertainties and high maintenance with associated costs, this measure has been eliminated from further consideration.

E.2.2 Screening of Distribution and Conveyance Management Measures

These distribution and Conveyance measures were screened using the following criteria:

Effectiveness: ability to meet objectives and avoid constraints
Environmental Effects: avoidance of substantial negative impacts
Maintenance: avoid measures that are difficult / costly to manage and maintain

Screening results are presented in **Table E.1-19**. Measures not retained are marked with "x". Management Measures such as littoral shelves in canals, creation of tree islands, exotic removal along levees, etc., were not evaluated in the initial screening process as those features would generally not influence modeling outcome or affect comparison of alternatives; however, they will be considered during design of the final array of alternatives as there may be associated costs and construction requirements with these minor features.

Table E.1-19. Northern WCA 3A Management Measure Screening Results

	Screening Criteria		
	Effectiveness/ Project Objectives	**Maintenance Considerations**	**Environmental & Secondary Effects**
DISTRIBUTION (Across WCA 3A) – Hydropattern Restoration Features			
Spreader Canal	Retained		
Levee Removal	Retained		
Levee Degradation/Gaps	Retained		
New Pump Station/Pump Station Modifications	Retained		
Levee/Berm Construction	x		
Flow-through Wetland (Holey Land WMA)			x
Conveyance Canal Modifications (L-5 and L-6)	Retained		
CONVEYANCE (To/Within WCA 3A) - Miami Canal Features			
Plug Miami Canal to Marsh Grade	Retained		
Backfill Miami Canal to Marsh Grade	Retained		
Spoil Mound Removal along Miami Canal	Retained		
Above/In-Ground Pipeline		x	x
Shallowing of Miami Canal	x		x
Cap Miami Canal		x	

E.2.2.1 Preliminary Formulation of Distribution Components

E.2.2.1.1 Siting of Distribution Components

Northern WCA 3A contains three primary conveyance canals that were identified as an efficient means to locate distribution measures:

- L-4 (west of the Miami Canal),
- L-5 (between the North New River Canal and the Miami Canal),
- Remnant L-5 (South of STA 3/4 the L-5 Canal).

Three reaches were established that correspond to these three canals to systematically identify the most efficient locations to distribute water across Northern WCA 3A. Two additional reaches were established which essentially bisect the Northern extent of WCA 3A and were included as management measure locations. Six Hydropattern Restoration Features (HRF) locations were identified from the physical characteristics of Northern WCA 3A and the existing canal system to evaluate locations to distribute water across Northern WCA 3A. Hydropattern Restoration Features are management measures along the northern boundary of WCA 3A that provide a means for distributing treated STA discharges into northern WCA 3A in a manner that will aid in restoration of natural sheetflow from the northern boundary of WCA 3A to the south

All combined HRF alternative configurations were initially developed to maintain the current design capacity of approximately 4,200 cfs. The existing inflows to northern and eastern WCA 3A are through the S-8 pump station (design capacity of 4,170 cfs), the S-7 pump station (design capacity of 2,490 cfs) via the S-11 structures, and S-150 (design capacity of 1000 cfs) (**Figure E.1- 8**).

Three configurations were established that essentially trisect Northern WCA 3A

- East (remnant L-5 from the STA3/4 outlet canal to S-7)
- West (West of S-8): L-4 canal from L-28 intersection to S-8
- Mid (L-5 Canal from S-8 to the STA 3/4 outlet canal)

Two configurations sub-divide Northern WCA 3A

- West of G-205 (western half of Northern WCA 3A)
- East of G-205 (eastern half of Northern WCA 3A)

One distributes water across the entire Northern WCA 3A boundary

- Full (L-4/L-3 intersection to S-150)

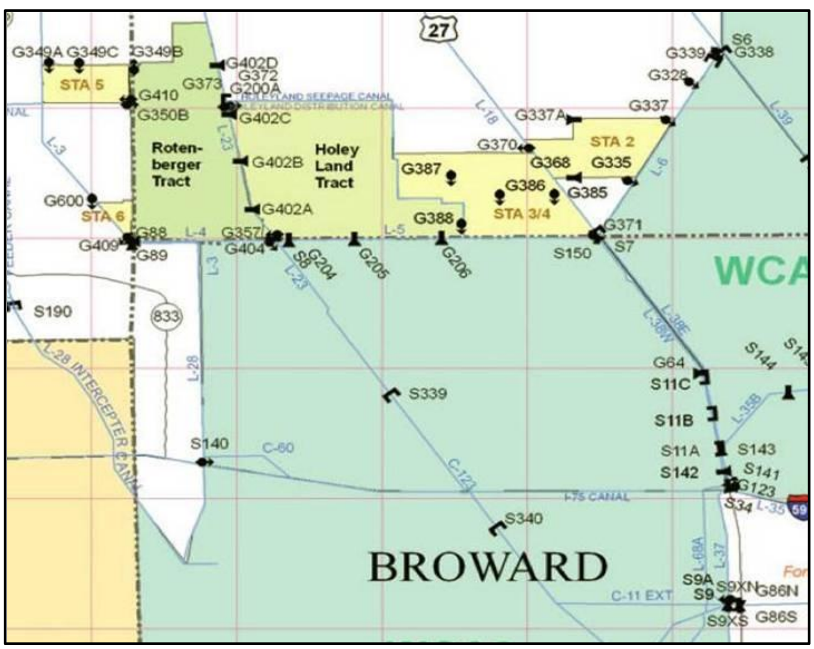

Figure E.1- 8. WCA 3 Structures Map

E.2.2.1.2 Initial Distribution Screening Criteria

Screening criteria were developed to further reduce the initial list of HRF management measures. The screening criteria include 1) flexibility to move water where most needed, 2) promotes longer flow path through WCA 3A (connectivity), 3) maximizes sheetflow objectives (overall distribution – includes minimizing short-circuiting along eastern and western boundaries), 4) minimizes likelihood to increase phosphorus movement from impacted areas, 5) best addresses dry-outs in over-drained areas, 6) maximizes potential to restore and sustain ridge and slough pattern and tree islands where desired, 7) improves conditions for wading birds (foraging/nesting), 8) maximizes spatial extent, and are further described below:

1) Flexibility to move water where most needed

The northwest area of WCA 3A is subject to prolonged dry-outs causing loss of peat soils through oxidation and fires which alters the historical water depth to soil elevation gradients in this region. This has contributed to encroachment of undesirable vegetation such as cattail and willow that are replacing the sawgrass and wet prairie communities. Rehydrating this part of the Everglades will require adaptive management of the flow regimes and water depths over an extended period of time to both stimulate vegetation pattern changes and to allow time for the plant communities to adjust to new conditions. Accordingly, alternatives that provide the greatest flexibility in distributing water flows to meet environmental objectives are more desirable than options with less flexibility. In addition, the quantity of treated water generated by the regional STAs (principally STA 3/4 and STA 5/STA 6/Compartment C; Compartment C is assumed operational for the future without project condition) varies significantly on a seasonal basis (historical STA treatment volumes are provided in **Table E.1-20**.

Table E.1-20. Quantity of Treated Water from STA 3/4.

STA-3/4			
Water Year	Treatment Area (acres)	Inflow Flow (acre ft)	Outflow Flow (acre ft)
2004	6,500	23,303	27,708
2005	12,059	671,442	648,872
2006	14,253	697,161	749,092
2007	16,161	388,471	355,423
2008	16,543	302,539	294,621
Total	13,703	2,082,916	2,075,716
Avg (exce. 1st yr)	14,754	514,903	512,002

Features that provide more capability to utilize different sources of treated water promote efficiency in delivering treated water to the marsh and allow the sheetflow objectives to be optimized over the greatest areal extent of the marsh while reducing point source deliveries. Options would be implemented to optimally use the maximum volume of treated water made available annually and distribute this volume as needed to meet specific objectives within the marsh. The current water distribution to WCA 3A relies on point-source inputs along the north border of WCA 3A via S-8 and S-150 or along the eastern border through S-7 (into WCA-2A) and subsequently through the S-11 structures. Depending on hydrologic conditions, in some years, more water may be needed to hydrate the area below the L-4 levee with less water needed on the east side below the remnant L-5 canal near S-150. Options which minimize the volume of water delivered through the existing point source locations and distribute water in the form of sheetflow across the northern boundary of WCA 3A, along the L-4, L-5 Levee and canal system are preferred. This requires integration of the existing infrastructure, to the maximum extent practicable, together with any newly-proposed structures associated with a specific alternative.

2) Promotes longer flow path through WCA 3A (connectivity)

This criterion was selected with the understanding that not all alternatives or management measures have the same potential for system scale restoration. The existing landscape has natural surface contours which promote related flows through the Greater Everglades marshes. The predominant topography slopes from the northwest (NW) to southeast (SE), roughly paralleling the Miami Canal (**Figure E.1- 9**). Historically, once flow reached the SE corner of the current WCA 3, water then turned to the south and west through Northeast Shark River Slough. Currently, flow generally stops at the L-67A Levee and moves south and west (entering ENP through the S-333 and the S-12 structures). The flow path from the NW to the SE is the longest flow path in the northern portion of the Everglades system. Flows entering the NW edge of WCA 3A have the greatest potential for hydrating maximum acreage if only a portion of the HRF is constructed. The flow path measurements, estimated below, correspond to the current system configuration.

EMAPS Estimates (GIS/Mapping tool)
S-8 to L-67A: Straight line – 27.47 miles (15.38 miles to I-75); Topographic - 35 miles (when accounting for contours and change in flow direction approaching L-67A)
Mid/Central HRF to L-67A: Straight line – 25 miles
Eastern HRF to L-67A: Straight line – 20.87 miles

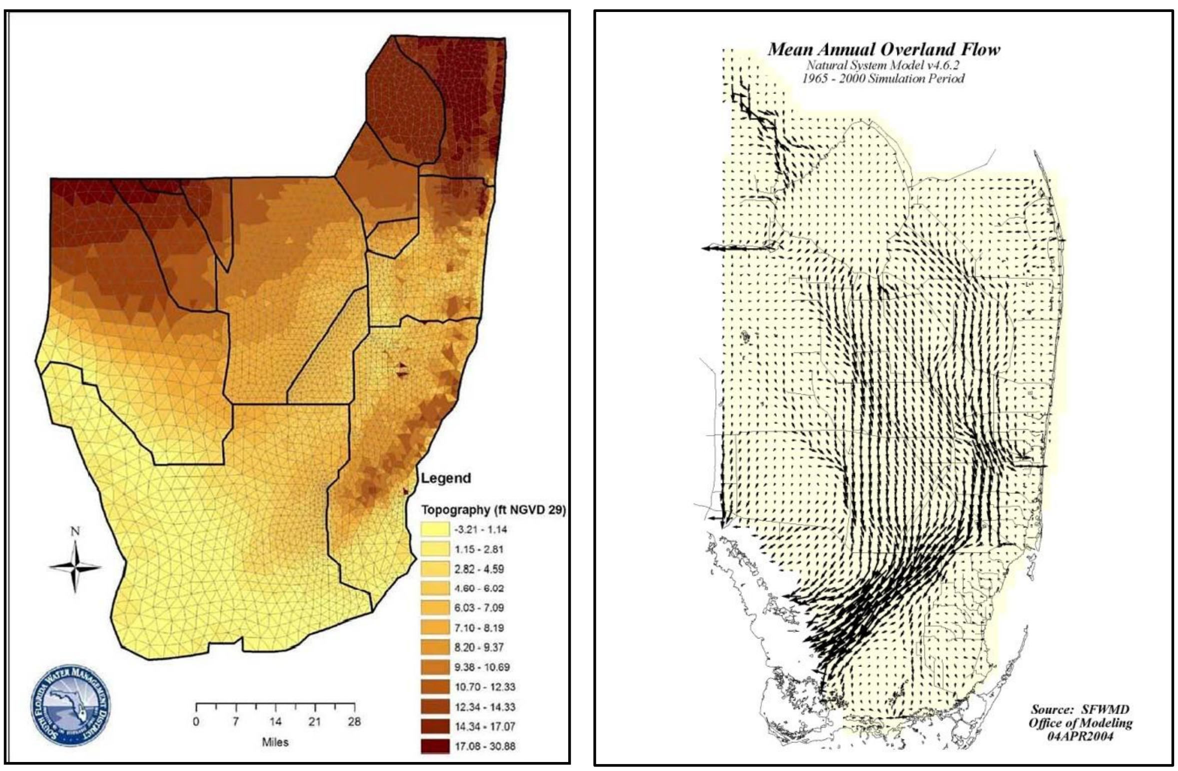

Figure E.1- 9. RSM Topography Contour Map and Mean Annual Overland Flow Map from Natural Systems Model (Version 4.6.2)

3) Maximizes sheetflow objectives (overall distribution – includes minimizing short-circuiting along eastern and western boundaries)

In order to maximize sheetflow objectives, management measures and related options should maximize the timing, distribution and continuity of sheetflow across WCA 3A. Sheetflow is generally defined as overland flow or down-gradient movement of water taking the form of a shallow, continuous layer over relatively smooth soil or rock surfaces, not concentrated within large channels. The direction of sheetflow in the pre-drainage Everglades as modeled by the Natural Systems Model (NSM) Version 4.6.2) can also be noted in **Figure E.1- 9**. Miami Canal backfill and the HRF components must function in concert and must function within the existing managed C&SF regional system. Interactions of flows may not always be beneficial under the varying configurations of each management measure. If water from the spreader canal feature immediately re-enters the Miami Canal (for example, in partial fill alternatives), the benefit of the spreader is reduced or negated via short-circuiting due to the canal. Flows down the eastern edge of WCA 3A may interact with S-11 flows leading to unfavorable ponding in northeast WCA. Additionally, alternatives that primarily focus inflows along the eastern boundary of WCA 3A would reduce the spatial extent of the marsh that historically served as a quasi-source area for surface and ground water flows from higher topographic areas (notably northwest WCA 3A) during the normal annual dry down cycle.

4) Minimizes likelihood to increase phosphorus movement from impacted areas (large volume inflow in small area)

This criterion is based upon the observation that medium to high flows through high phosphorus cattail regions will transport this phosphorus to downstream communities as a pollutant. There are high density regions of cattail along the Miami Canal, especially along its eastern border. A high density region of cattail can also be found in the eastern region of northern WCA 3A. The cattail-rich eastern region developed due to overdrained soils creating high phosphorus concentrations as a result of soil oxidation processes. Rehydration of this eastern region with water meeting state water quality standards is expected to decrease cattail expansion. With most inflows having TP concentrations of 10 ppb, project alternatives that change the way the water enters and flows through the wetlands reduced the overall water quality risk from phosphorus in most situations compared to the FWO. While there may be some resuspension of phosphorus from peat soil rewetting that could lead to some areas experiencing an increase in cattail, this did not appear to increase the eutrophication risk in the wetlands as a whole. Any resuspension of phosphorus from soils would likely be taken up quickly by phosphorus-limiting periphyton species and cycle through the peatland system processes; even if water column measurements indicate phosphorus concentrations are at natural background concentrations.

5) Best addresses dry-outs in over-drained areas

This criterion is based on the fact that northern WCA 3A is overdrained and its natural hydroperiods have been shortened. Reducing dryouts in this area will reduce the loss of peat due to peat fires and oxidation, and allow the accumulation of peat to resume. This, in turn, may shift vegetative communities from cattail back to sawgrass, through the mechanisms of restoring the ridge and slough microtopography (peat accumulation on the ridges) and the ability of inundated peat soils to sequester phosphorus. Rehydrating northern WCA 3A has the potential to increase wildlife diversity and abundance with the restoration of the aquatic food web.

6) Maximizes potential to restore and sustain ridge and slough pattern and tree islands where desired

Similar to the *maximizing sheetflow* objectives, this criterion is focused on sheetflow and the timing, distribution (including spatial extent) and depth of flows. Project components with the greatest capacity to deliver water across the full extent of the northern WCA 3A boundary are most likely to sustain and restore ridge and slough habitat. Additionally, flexibility in the location and timing of deliveries will facilitate adaptive management activities and achievement of stated project goals and objectives. This criterion differs from others in several ways-it *promotes longer flow path through WCA 3A* and is specific to topography and the existing surface slopes of the system (physical aspects affecting flow). *Promotes longer flow path through WCA 3A* is focused on maximizing the spatial extent of sheetflow benefit by getting the water where it is needed (while recognizing the constraints associated with specific management measures/partial spreader). The *Maximizes sheetflow objectives* is focused on understanding the interaction of components that may disrupt the normal pathway of water flow through the marsh and associated functions of transport. *Maximum potential to restore and sustain ridge and slough pattern and tree islands where desired* is focused not only on the physical aspects of topography and the interaction of flows but also specific needs associated with ridge and slough maintenance and restoration. This includes depth, timing, and flow components of hydroperiod that may distribute the required nutrients (particulate and dissolved constituents) as well as meeting the physiological water needs of the plant communities necessary to restore the ridge and slough landscape. Specific areas of northern WCA 3A have been identified where the potential to maintain or restore a mosaic of desired vegetation could be achieved with one or more rehydration management measures. The timing and distribution of reintroducing water flow could change as the marsh begins to adapt to new flow conditions. Alternatives or management measures that increase the flexibility to target the particular geographic areas for restoration and allow adaptive changes to the flow distribution are more desirable.

7) Improves conditions for wading birds (foraging/nesting)

This criterion is focused on the landscape heterogeneity and its ability to support fish refugia and a diverse depth pattern so wading birds can forage for longer periods, early in the dry season, and over large areas. It is also focused upon where wading birds currently feed during droughts and floods. During floods, the eastern sections of northern WCA 3A remain too deep for wading bird foraging, but the western region, with its remnant ridge and slough landscape and its higher topography, can support fish production and wading bird foraging with hydropattern restoration even during floods. During droughts, the water depths in eastern sections of northern WCA 3A are too shallow, but can support fish with hydropattern restoration.

8) Maximizes Spatial extent

This criterion is based upon the ability of the project components to provide sheetflow and hydropattern over the largest spatial extent. This criterion will review the removal of discontinuities and barriers to sheet flow. The performance measure target will be restoration of the project footprint.

E.2.2.1.3 Preliminary Evaluation of Distribution Components

The preceding criteria were applied to each HRF location; a qualitative value scale was given separately to each screening criterion. The relative qualitative value scales were assigned scores of Low, Medium or High, which correspond to the rankings of 1, 2 or 3 respectively. The standards of Low, Medium and High were selected as evaluation scores to reflect the degree of success each HRF location was expected to achieve with respect to each given criterion relative to the other locations. Explanations of scores are as follows:

High	Medium	Low
• High probability of success with a low uncertainty in achieving the desired outcome of the criterion. There is also a high degree of relevance to accomplishing project objectives.	• There is a moderate likelihood of achieving the desired target of the criterion.	• There is a lower probability of success of achieving the desired outcome of the given criterion, in relation to other alternatives. There is a high degree of uncertainty whether the objectives would be accomplished.

The following matrix (**Table E.1- 21**) summarizes the ranking and scoring of the hydropattern restoration feature locations:

Table E.1- 21. Evaluation of Distribution (HRF) Configurations

Criteria	Full		West of G-205		East of G-205		West		Mid		East	
Flexibility to move water where most needed	High	3	Medium	2	Medium	2	Low	1	Low	1	Low	1
Promotes longer flow path through WCA 3A (connectivity)	High	3	High	3	Medium	2	Medium	2	Low	1	Low	1
Maximizes sheetflow objectives (overall distribution- includes minimizing shortcircuiting along eastern and western boundaries)	High	3	Medium	2	Medium	2	Low	1	Low	1	Low	1
Minimizes likelihood to increase P movement from impacted areas (large volume inflow in small area)	High	3	Medium	2	Medium	2	Low	1	Low	1	Low	1
Best addresses dry outs in over-drained areas	High	3	Medium	2	Medium	2	Medium	2	Medium	2	Medium	2
Improves conditions for wading birds (foraging/nesting)	High	3	Medium	2	Medium	2	Low	1	Low	1	Medium	2
Maximum potential to restore and sustain ridge and slough pattern and tree islands where desired	High	3	Medium	2	Medium	2	Medium	2	Low	1	Low	1
Maximizes spatial extent	High	3	Medium	2	Medium	2	Low	1	Low	1	Low	1
Total Score		24		17		16		11		9		10
Average Score		3.0		2.125		2		1.4		1.1		1.3
Overall Value	HIGH		MEDIUM		MEDIUM		LOW		LOW		LOW	

E.2.2.2 Preliminary Formulation of Conveyance Components

E.2.2.2.1 Siting of Formulation Components

The formulation of conveyance components focuses on determining the best locations for placement of backfill and plugs in the Miami Canal in order to minimize negative effects caused by the canal and restore more natural hydropatterns in WCA 3A. To aid in incrementally building Miami Canal configurations (the entire Miami Canal 27.65 miles from S-8 to S-151), the Miami Canal was divided into three segments for initial quantitative screening using hydrologic modeling tools. The reasons for splitting the canal into segments are listed below:

- *Hydrologic response*: The North segment is the driest, the Central segment has the steepest gradient topography, and the South segment tends to pond more than the North and Central segments.
- *Cost and available fill factors*: Depending on the acreage of the Miami Canal to be filled, there may not be enough on-site spoil mound material to completely backfill the Miami Canal from S-8 to S-151.
- *Infrastructure*: There are two water control structures that essentially divide the Miami Canal into three equal lengths.

The following are the three Miami Canal sections as defined by the existing water control structures:

- NORTH only: 9.45 miles (S-8 to S-339);
- CENTRAL only: 8.45 miles (S-339 to S-340);
- SOUTH only: 9.75 miles (S-340 to S-151);

To assist with the determination of optimal Miami Canal plug length and spacing, RMA-2 modeling was used to evaluate varying lengths and spacing of plugs along the Miami Canal. Further details of the RMA analysis integrated into CEPP from the CERP Decomp project formulation effort, including limitations and assumptions can be found in Appendix A – Engineering, Annex A-2 – Hydrologic Modeling.

Results of Evaluation of the Conceptual Components for the Miami Canal:

- Reduced dryouts will be achieved in the Northern segment with backfill or plug, and the improvement in dryouts will be limited to the northwestern area of WCA 3A.
- Ponding is reduced in eastern WCA 3A with the backfilling or plugging of the Southern segment, possibly due to the redistribution of flows.
- Redistribution of sheetflow throughout northern WCA 3A is most closely achieved through backfilling/plugging the Northern segment.
- Backfilling/plugging the full extent of the Miami Canal encompasses all of the above effects observed for the individual segment backfill.
- Benefits from backfilling/plugging the Miami Canal will be localized.
- RMA-2 modeling shows that removing the spoil mounds alone can improve sheetflow to a limited degree; the RMA-2 model application, while useful as a screening tool, does not represent ground water interaction
- RMA-2 also revealed that certain plug length and spacing combinations were comparable to the observed hydrologic performance of the full backfill scenario. A 4,000 ft plug with 2,000 ft spacing provided performance most comparable to the complete backfill scenario with an allowance for additional imported fill.

An array of 23 Miami canal components was developed by incorporating the results of the conceptual Miami canal components in conjunction with the three identified reaches (**Table E.1- 22**). Each of these combinations incorporates spoil mound removal, however the exact location and extent of the spoil removal was not identified until the evaluation of the final array, as there is stakeholder concern over impacts to upland refuge and upland restoration sites on the spoil mounds

Table E.1- 22. Miami Canal Components

Miami Canal Component	Description
1	Spreader canal West of S-8 with complete backfill of the Northern canal. Remove spoil mounds along the entire length of the canal except for those portions which contain FWC plantings.
2	Complete backfill of northern segment, plug the Central segment and Southern segment with the remaining fill. Preserve FWC plantings
3	Spreader canal on L-4 levee. Plug Northern and Southern sections of the canal leaving Central section as is. The northern and southern levees east and west of the canal will be used to make the plugs in the respective areas.
4	Evenly spaced plugs between S-8 and S-151: with 800 feet spacing between plugs. The plug length is based on available fill (~1,100 ft plugs). The spoil mounds will be utilized for the plug material. Plug length will be adjusted based on fill material available. Remove FWC plantings.
5	Evenly spaced plugs between S-8 and S-151: with 1,500 feet spacing between plugs. The plug length is based on available fill (~2,100 ft plugs). The spoil mounds will be utilized for the plug material. Plug length will be adjusted based on fill material available. Remove FWC plantings.
6	Evenly spaced plugs between S-8 and S-151: with 3,000 feet spacing between plugs. The plug length is based on available fill (~4,300 ft plugs). The spoil mounds will be utilized for the plug material. Plug length will be adjusted based on fill material available. Remove FWC plantings.
7	Complete backfill of Northern and Southern sections of the Miami Canal. Remove all spoil mounds (levee) along the Miami Canal. Remove FWC plantings.
8	Complete backfill (S-8 to S-151) of the entire canal and remove all spoil mounds (levees).
9	Only degrade non-enhanced spoil mounds and create tree islands with the levee material.
10	Complete backfill (S-8 to S-151) and create tree islands.
11	Spreader canal 2 – 3 miles south of S-8, extends across WCA 3A with low berm (0.5 feet) allowing for shallow ponding north of spreader. Full backfill from spreader south to S-151 using spoil material and spreader canal excavations as fill. Imported fill is necessary.
12	Backfill from S-8 to I-75 leaving south of I-75 as is. Remove spoil mounds north of I-75.
13	Complete backfill of Central and South regions, removing the adjacent spoil mounds.
14	Complete backfill of North and Central regions using spoil mounds from the entire length of the Miami Canal. Leave FWC plantings.
15	Spreader south of S-8 to accommodate get-away capacity needs,beyond that backfill the canal as far as available fill material allows. Fill material will come from spoil mounds. No imported fill
16	Plug the entire Miami Canal with plugs that are 4,000 feet and spacing 2,000 feet. S-8 Spreader Canal. Import additional fill. Preserve FWC plantings.
17	Plug the North and South regions with plugs that are 4,000 feet and spacing 2,000 feet. S-8 spreader canal. Import additional fill. Preserve FWC plantings.
18	Plug the North, Central, and South (S-340 to C-11, only) regions with plugs that are 4,000 feet and spacing 2,000 feet. Import additional fill. Preserve FWC plantings.
19	Plug the North and South (C-11 to S-151, only) regions with plugs that are 4,000 feet and spacing 2,000 feet. S-8 spreader canal. Import additional fill. Preserve FWC plantings.
20	Plug the entire Miami Canal with 1,000 feet plugs and spacing 3,000 feet (increase length to use of all available fill). Use on-site spoil mounds only. Preserve FWC plantings.

Miami Canal Component	Description
21	Plug the North and South regions with plugs that are 1,000 feet and spacing 3,000 feet (increase length to use of all available fill). Use on-site spoil mounds only. Preserve FWC plantings.
22	Plug the North, Central, and S-340 to C-11, 1,000 feet plugs and spacing 3,000 feet (increase length to for use of all available fill).Use on-site spoil mounds only. Preserve FWC plantings.
23	Plug the North and C-11 to S-151, with 1,000ft plugs spaced 3,000 feet (vary length to use of all available fill). S-8 spreader canal. Use on-site spoil mounds only. Preserve FWC plantings.

E.2.2.2.2 Initial Evaluation of Conveyance (Miami Canal) Components

Table E.1- 23 includes the criteria used to evaluate the Miami Canal components. All preliminary options were assumed to include, at minimum, a spreader canal feature at S-8 that would be sized consistent with savings clause design criteria agreed to by the USACE and SFWMD.

Table E.1- 23. Criteria for Miami Canal Configurations

Risk and Uncertainty
Objectives: No associated project objectives **Explanation:** This deals with the implementability of an alternative, including constructability, public perception, and risks associated with planning constraints (water quality, savings clause, etc). There is a degree of uncertainty associated with our ability to predict potential ecological impacts and benefits (sheetflow/ reducing dryouts/ spatial connectivity). This poses risks to achieving goals and objectives (benefits). **Target**: The risks associated with building, planning constraints, and special interest groups are minimal. The benefits and impacts of the alternative are relatively certain compared to other alternatives **Metric:** 1 would be assigned to each alternative for each type of risk and uncertainty. The alternatives would be put in sequential order based on the total number of risks, from the most risk (highest number) to the lowest risk (lowest number or zero) and divided into thirds (highest third, middle third, lowest third). Scoring: -1 for highest third; 0 for middle third; 1 for lowest third.
Reduce Dryouts in Northern WCA 3A
Objectives addressed: -Improve sheetflow and hydropatterns, reducing dryouts, and peat loss in northern WCA 3A by removal of Miami Canal and water conveyance capacity. -Increase the abundance of forage fish and crayfish populations in WCA 3A. -Increase spatial extent and restore vegetative composition, habitat function, and ridge and slough patterning. **Explanation:** Due to presence of canals and levees, the north end of WCA 3A is overdrained and its natural hydroperiod has been shortened. By reducing dryouts in this area, vegetative communities are expected to shift from cattail to sawgrass, peat fires will be reduced, peat will accumulate, ridge and slough landscapes will return, phosphorus will be buried (leading to a more oligotrophic system), and wildlife diversity and abundance will increase as aquatic food webs are restored. The small marsh fishes and macroinvertebrates (crayfish, apple snails) help form the link between the algal and detrital food web bases of the Everglades and the larger fishes, alligators and wading birds that feed upon them. In the freshwater Everglades, population densities of marsh fishes are directly proportional to the duration of uninterrupted flooding. Reducing drought in northern WCA 3A may restore wildlife diversity and abundance.

Target: Reduction in dry conditions in northern WCA 3A. Reduce the amount of time the water table is below ground surface and therefore increase hydroperiods in northern WCA 3A.

Metric: Use best professional judgment and available model output to determine which alternatives may reduce dry conditions in northern WCA 3A. Alternatives that are expected to distribute water in a way that reduces dry conditions will score positively.

Scoring:
+2 Positive Net Effect
0 No Net Effect
-2 Negative Net Effect

Reduce Ponding in Southeastern/ Central WCA 3A

Objectives addressed:
-Improve sheetflow and hydropatterns, reducing ponding in WCA 3A by removal of Miami Canal and water conveyance capacity.
-Improve hydrology and hydrologic recession rates to increase wading bird foraging and nesting success.
-Increase spatial extent and restore vegetative composition, habitat function, and ridge and slough patterning, including tree islands.

Explanation: The southeastern portion of WCA 3A is affected by high water and prolonged periods of inundation created by impoundment structures. Open water sloughs have replaced sawgrass habitat and negatively impacted tree islands. Prolonged deep water may kill and prevent woody growth that wading birds use as nesting substrate as well as disrupt a wading bird's foraging ability through loss of shallow feeding habitat and changes of fish species composition. This ponding effect may thwart the alligator's ability to lay eggs at nest elevations that would not be flooded in the wet season, thus drowning nests.

Target: Relieve ponding in eastern WCA 3A. Decrease frequency and duration of extreme high events in the vicinity of Indicator Regions 118 and 119. Reduce the amount of time water depths are above 2.5 feet.

Metric: Use best professional judgment and available model output to determine which alternatives may relieve ponding in southeastern WCA 3A. Alternatives that will redistribute water from the southeastern corner of WCA 3A (in a northeast to southwest direction) will score positively.

Scoring:
+2 Positive Net Effect
0 No Net Effect
-2 Negative Net Effect-

Water Quality

Objectives addressed:
-Restore vegetative composition and habitat function
-Increase the abundance of forage fish populations in WCA 3A

Explanation: Water quality determines the vegetative composition of WCA 3A. Areas of high phosphorus are dominated by cattail, which is undesirable habitat. High phosphorus in the water column can affect algal species composition as well as other water quality parameters (dissolved oxygen, turbidity, etc) which can adversely affect forage fish populations.

Target: No net effect, or net positive effect, on water column concentration, load, soil concentration, and flora. The primary focus will be on nutrients (phosphorus and nitrogen), but other constituents can be examined as appropriate (sulfur, mercury, etc.)

Metric: Use best professional judgment and model output to assess anticipated flow paths, changes in water distribution, distribution and timing of nutrient loads, dry-out potential, impacted and un-impacted wetland areas, and areas of special concern (e.g. sawgrass stands). Evaluators should consider each major component within an alternative (spreader canal, canal plug, etc.) in order to assess the overall impact. Alternatives that have a net positive effect on water column concentrations, loads, soil concentrations and flora will score positively.
Scoring:
+2 Positive Net Effect
0 No Net Effect
-2 Negative Net Effect

Degree of Increased Sheetflow

Objectives Addressed:
-Improve sheetflow and hydropatterns, reducing ponding in WCA 3A.
-Improve hydrology and hydrologic recession rates to increase wading bird foraging and nesting success.
-Increase spatial extent and restore vegetative composition, habitat function, and ridge and slough patterning, including tree islands.

Explanation: Sheetflow is one of the defining characteristics of the Everglades. The broad distribution of water across the landscape encourages the development of a peat-based ecosystem. Sheetflow also distributes nutrients broadly across the landscape which is a condition for oligotrophy. This is opposed to channeling and/or concentrating water along levees and canals. This measure is an indication of uninterrupted flow patterns caused by discontinuities in the system.

Target: This target is defined by maximizing the correlation of flow velocities within and outside of the canal footprint, specifically:

Metric: Rank alternatives/measures by effectiveness of establishing the sheetflow target. Then score the alternatives relative to their ranking.
A qualitative approach was used for application of this criterion.

Spatial Extent of Ecologic and Hydrologic Connectivity

Objectives addressed:
- Remove/reduce effects of landscape discontinuities and remove barriers to sheet flow related to the Miami Canal
- Increase fish and wildlife connectivity in WCA 3A
- Increase spatial extent of wetland habitats within the Miami Canal corridor.

Explanation:
The intent of this criterion is to screen those alternatives that do not significantly remove barriers to natural hydropatterns (depth, duration, and spatial extent).

Target: complete restoration of the project footprint ~ 989 acres (145,964 x 295 ft / 43,560). Scores from each alternative will be normalized with 100 being equal to 989 acres.

Metric: Area of wetland previously occupied by the Miami Canal and associated spoil mounds was calculated by multiplying the average width of canal and spoil mound by the linear length of canal and spoil removed. A rough GIS analysis provided the following average value for combined width of canal and spoil:

Total Canal Length = 145,964 ft; Canal Width = 75 ft; Average Spoil Width = 220 ft

The screening criteria evaluation led to the components being ranked from 1 to 23 in a multi-agency exercise. Implementation cost estimates were used to distinguish between similarly ranked components. The following assumptions regarding cost were made:

- A lower cost alternative is more desirable, hence an alternative that provides about the same predicted performance (for the selected screening criteria) as another, but costs less, should rank higher;
- Importing fill is more costly than using only on-site fill;
- Filling individual segments (North, Central, or South) would be less expensive than filling the entire extent of the canal;
- Using only one staging area (for example, only filling the canal from the North, rather than from both North and South) would be less costly than using two staging areas;
- The more plugs used, the more costly the alternative (this was used to distinguish between alternatives that were similar in all aspects apart from the number of plugs, plug length, and plug spacing).

The results of the technical working group application of the screening criteria are listed in **Table E.1- 24**, below. The table illustrates the ranking of the configurations from 1 to 23, 1 being the best configuration.

Table E.1- 24. Ranking of Conveyance Components

Miami Canal Component	Description	Rank Order
8 and 10	Complete backfill (S-8 to S-151) of the entire canal and remove all spoil mounds (levees). Spreader canal.	1
18	Import additional fill. Plug the North, Central, and South (S-340 to C-11, only) regions with plugs that are 4,000 feet and spacing 2,000 feet. S-8 spreader canal.	2
14	Complete backfill of North and Central regions using spoil mounds from the entire length of the Miami Canal. Leave FWC plantings.	3
2	Complete backfill of Northern segment, plug the Central segment and Southern segment with the remaining fill. Preserve FWC plantings	4
22	Use on-site spoil mounds only. Plug the North, Central, and South (S-340 to C-11, only) regions with plugs that are 1,000 feet and spacing 3,000 feet (increase length to accommodate for use of all available fill). S-8 spreader canal.	5
12	Backfill from S-8 to I-75 leaving south of I-75 as is. Remove spoil mounds north of I-75.	6
16	Import additional fill. Plug the entire Miami Canal with plugs that are 4,000 feet and spacing 2,000 feet. S-8 Spreader Canal.	7
7	Complete backfill of Northern and Southern sections of the Miami Canal. Remove all spoil mounds (levee) along the Miami Canal. Remove FWC plantings.	8

Miami Canal Component	Description	Rank Order
15	Spreader of S-8 to accommodate get-away capacity needs. Beyond that point, backfill the canal as far south as available fill material allows. Fill material will come from spoil mounds. Do not import.	9
20	Use on-site spoil mounds only. Plug the entire Miami Canal with plugs that are 1,000 feet and spacing 3,000 feet (increase length to accommodate for use of all available fill). S-8 spreader canal.	10
4	Evenly spaced plugs between S-8 and S-151: with 800 feet spacing between plugs. The plug length is based on available fill (~1,100 ft plugs). The spoil mounds will be utilized for the plug material. Plug length will be adjusted based on fill material available	12
11	Spreader canal 2 – 3 miles south of S-8, extends across WCA 3A with low berm (0.5 feet) allowing for shallow ponding north of spreader. Full backfill from spreader south to S-151 using spoil material and spreader canal excavations as fill. Imported fill	13
21	Use on-site spoil mounds only. Plug the North and South regions with plugs that are 1,000 feet and spacing 3,000 feet (increase length to accommodate for use of all available fill). S-8 spreader canal.	14
5	Evenly spaced plugs between S-8 and S-151: with 1,500 feet spacing between plugs. The plug length is based on available fill (~2,100 ft plugs). The spoil mounds will be utilized for the plug material. Plug length will be adjusted based on fill material available.	15
1	Spreader canal West of S-8 with complete backfill of the Northern canal. Remove spoil mounds (levees) along the entire length of the canal except for those portions which contain FWC plantings.	16
17	Import additional fill. Plug the North and South regions with plugs that are 4,000 feet and spacing 2,000 feet. S-8 spreader canal.	17
6	Evenly spaced plugs between S-8 and S-151: with 3,000 feet spacing between plugs. The plug length is based on available fill (~4,300 ft plugs). The spoil mounds will be utilized for the plug material. Plug length will be adjusted based on fill material available.	18
23	Use on-site spoil mounds only. Plug the North and South (C-11 to S-151, only) regions with plugs that are 1,000 feet and spacing 3,000 feet (increase length to accommodate for use of all available fill). S-8 spreader canal.	19
3	Spreader canal on L-4 levee. Plug Northern and Southern sections of the canal leaving Central section as is. The northern and southern levees east and west of the canal will be used to make the plugs in the respective areas.	20
19	Import additional fill. Plug the North and South (C-11 to S-151, only) regions with plugs that are 4,000 feet and spacing 2,000 feet. S-8 spreader canal.	21
13	Complete backfill of Central and South regions, removing the adjacent spoil mounds. Leave the Northern region as is.	22
9	Leave Miami Canal as is. Degrade non-enhanced spoil mounds and create tree islands with the levee material.	23

E.2.2.2.3 Formulation of Conveyance (Miami Canal) Components

From this ranking, four discrete conveyance configurations were developed. The following general assumptions were made for the Miami Canal backfill components: a) treat FWC plantings consistently across alternatives, b) treat S-8 get-away spreader consistently across alternatives; the spreader canal will be for mitigation purposes only and the location and design will be optimized by the design team (note: this assumption was prior to integration of the HRF component into the PIR 1 project scope), and c) backfill and plugs will be designed to fill to surrounding marsh grade, accounting for material compaction following initial placement. The description and intent of each of the final four Miami Canal backfill configurations are provided below.

Miami Canal backfill North, plug Central and South (Component 2)

Complete backfill of North section. Plug Central and South (entire southern reach), with 1,000ft plug and 3,000ft spacing. If necessary, the size of the plug may be larger in order to utilize all available on-site fill material.

Best Combination of Complete Fill and Plugging: This component represents a combination of backfill and plug configurations. 2x2 model output suggests that backfilling the Northern segment produces benefits of reducing dry-outs in northern WCA 3A. By using full backfill in this segment, uncertainties associated with plugs are reduced. Plugging the remainder of the Miami Canal potentially allows for the additive benefits of a full extent backfill to be achieved at a lower cost than full backfill of the entire canal). The RMA-2 modeling results identified the overall optimal plug length/spacing ratio to be 4,000:2,000, when fill is not limited to the project spoil mound material on site and 1,000:3,000 as the optimal plug/spacing combinations, when fill material is limited to that available on the project site.

Miami Canal Component backfill North, Central and South (Component 8/10)

Complete backfill of all three sections (S-8 to S-151) using all available on-site fill material and importing additional fill that is required. This component matches the Yellow Book version for filling the Miami Canal and removing its effects from the system.

Miami Canal Component backfill North and Central (Component 14)

Complete backfill of North section and Central section (S-8 to S-340) using all available on-site fill material and importing additional fill that is required.

This component ranked the highest for the midsize components to complete the full range of components, as required by USACE and NEPA planning guidance. This component focuses on the high priority north (for the purposes of reducing dryouts in northern WCA 3A) and with the backfill of the reach between S-339 and S-340, further contributes to project objectives of increased spatial extent of wetlands and removal of barriers to sheetflow. It also ranked third highest overall in the initial screening analysis for Miami Canal components.

Miami Canal Component plug North, Central and South from S-340 to C-11 (Component 18)

Plug the North, Central, and South (S-340 to C-11 extension) sections: would be initiated from the north and south terminus of the Miami Canal proceeding symmetrically from both ends until need to shift to smaller 1,000ft plugs and 3,000ft spacing based on available fill. Use all available on-site fill material. No additional fill will be imported.

Best Complete Plug Using Available Fill: This component is a hybrid modification of previous components. The North and South (S-340 to C-11 extension) sections proved to be the best areas to backfill in order to reduce dryouts and ponding respectively from the 2x2 modeling of conceptual alternatives. The RMA-2 modeling results identified the overall optimal plug length/spacing ratio to be 4,000:2,000, when fill is not limited to the project spoil mound material on site. 1,000:3,000 was the optimal plug/spacing combination, when fill material is limited to that available on the project site. Further design will determine the break points in the North and South for using 4,000:2,000 plug length/spacing with available fill, and then transitioning to using 1,000:3,000 plug length/spacing in the Central section. Due to water quality issues at S-9, the Southern section starts where the C-11 extension meets the Miami Canal.

E.2.3 Formulation of Distribution and Conveyance Options- Northern WCA 3A

The initial array of options for distribution and conveyance were developed by combining the retained Miami Canal backfill features of the conveyance screening and the retained hydropattern restoration features of the distribution screening. Fifteen possible combinations (three HRF and five Miami Canal backfill) of remaining HRF locations and Miami Canal backfill options were organized into a matrix to identify options that were candidates for further detailed modeling. Of the fifteen combinations, a subset of seven of these were identified to undergo further modeling with the Regional Simulation Model (RSM) based on a sequencing strategy developed to maximize the amount of information learned with each successive round of modeling runs simulated. As part of the modeling strategy, this subset was not considered absolute as refinements and modifications to the options remaining to be modeled were expected as initial modeling results were analyzed.

All “no action” options for the HRF were eliminated from further consideration. The Regional Simulation Model Glades and Lower East Coast Service Area (RSM-GL) simulations suggest that implementing Miami Canal backfill without a HRF would provide only limited benefits. Without a HRF, water would continue to be introduced into northern WCA 3A as a point source, which does not contribute to the project objective of increasing sheetflow in the marsh. The North and Central configurations of the Miami Canal were not identified to be modeled in the preliminary array because it is reasonable to assume that comparing an option for the North segment backfilled to one with the Full Miami Canal backfilled will provide sufficient information to infer whether a North plus Central combination should be further examined. Additionally, only one plugging scenario is needed to determine if plugging performs as well as backfilling while reducing costs.

As a result of the modeling strategy, seven combinations of options were identified for to be brought forward for detailed RSM modeling (“**No**” denotes no further action, “**Yes**” indicates a recommendation for further consideration). The matrix below (**Table E.1-25**) identifies the options resulting from the modeling strategy analysis.

Table E.1-25. HRF and Miami Canal combinations modeled in RSM-GL.

	Miami Canal Components				
HRF Component	**Full Backfill**	**Full Plug**	**North and Central**	**North**	**No Action**
Full HRF	**Yes, A**	**Yes, C**	**No**	**Yes, B**	**Yes, F**
HRF West of G-205	**Yes, D**	**No**	**Yes, G**	**Yes, E**	**No**
No HRF	**No**	**No**	**No**	**No**	**No**

Seven options identified to be further evaluated:

A. Full HRF and Complete Backfill of Miami Canal (S-8 to S-151)
B. Full HRF and North Backfill of Miami Canal (S-8 to S-339)
C. Full HRF and Plugging of Miami Canal (S-8 to S-151) with 4,000 ft plug with 2,000 ft spacing (Optimal Plug/Spacing Configuration – RMA-2)
D. West of G-205 HRF and Complete Backfill of Miami Canal (S-8 to S-151)
E. West of G-205 HRF and North Backfill of Miami Canal (S-8 to S-339)
F. Full HRF Only
G. West of G-205 HRF and I-75 Backfill of Miami Canal (S-8 to I-75)

E.2.4 Evaluation Criteria for Distribution and Conveyance Options - Northern WCA 3A

There were two levels of criteria evaluated. Level 1 corresponded to the primary objectives of CEPP and Level 2 assessment was used to ensure other ecologically significant considerations and other stakeholder concerns were included in determination of what options were carried forward. Level 1 criteria include project performance measures and hydrologic mapping results. Level 2 criteria include excessive ponding, adaptability, ecologic connectivity, and recreational impacts.

E.2.4.1 Project Performance Measures (Level 1)

Project performance measures (PMs) were developed to quantify ecological benefits within the Greater Everglades Region and were used to evaluate the degree to which proposed project configurations were likely to meet restoration objectives. To make the correlation between hydrologic output and ecosystem functions, the project team utilized PMs developed from the Greater Everglades Ridge and Slough Conceptual Ecological Model (CEM) which is used in CERP as a non-quantitative planning tool that identifies the major anthropogenic drivers and stressors on natural systems, the ecological effects of these stressors, and the best biological attributes or indicators of these ecological responses. PMs utilized to evaluate project configurations are briefly described below. Each PM may contain one or more sub-metrics.

PM 1.0 Inundation Duration in the Ridge and Slough Landscape – Provides a measure of the percent period of record of inundation.

- PM 1.1 – Percent Period of Record of Inundation (PPOR) Inundated

PM 2.0 Sheetflow in the Ridge and Slough Landscape – Provides a measure of the timing, distribution, and continuity of sheetflow across the landscape.

- PM 2.1 – Timing of Sheetflow
- PM 2.2 –Continuity of Sheetflow
- PM 2.3 –Distribution of Sheetflow

PM 3.0 Hydrologic Surrogate for Soil Oxidation – Provides a measure of cumulative drought intensity to reduce exposure of peat to oxidation.

- PM 3.1 – Drought Intensity Index

PM 5.0 Slough Vegetation Suitability – Provides a measure to evaluate the hydrologic suitability for slough vegetation.

- PM 5.1 – Hydroperiod
- PM 5.2 – Dry down
- PM 5.3 – Dry Season Depth
- PM 5.4 – Wet Season Depth

The analysis for CEPP was restricted to portions of northern WCA 3A (Zones 3A-NW, 3A-NE, and 3A-MC) as hydrologic improvements were not apparent in the southern portions of WCA 3A, 3B, and ENP (Zones 3A-C, 3A-S, 3B, ENP-N) as a result of the evaluation of the project configurations. Zones 3A-NW, 3A-NE, 3A-MC, 3A-C, 3A-S, 3B, and ENP-N were identified during plan formulation efforts to evaluate the spatial extent of the project's effects within the Greater Everglades. Hydrologic model output for each of the PM sub-metrics was produced by the Regional Simulation Model version 2.3.1 Glades-LECSA Implementation (RSMGL) for indicator regions and/or transects within each of these project zones (**Figure E.1- 10**). For this analysis, PM sub-metrics 2.1 and 5.3 were not used, as there was little differentiation in PM sub-metric scores between project configurations.

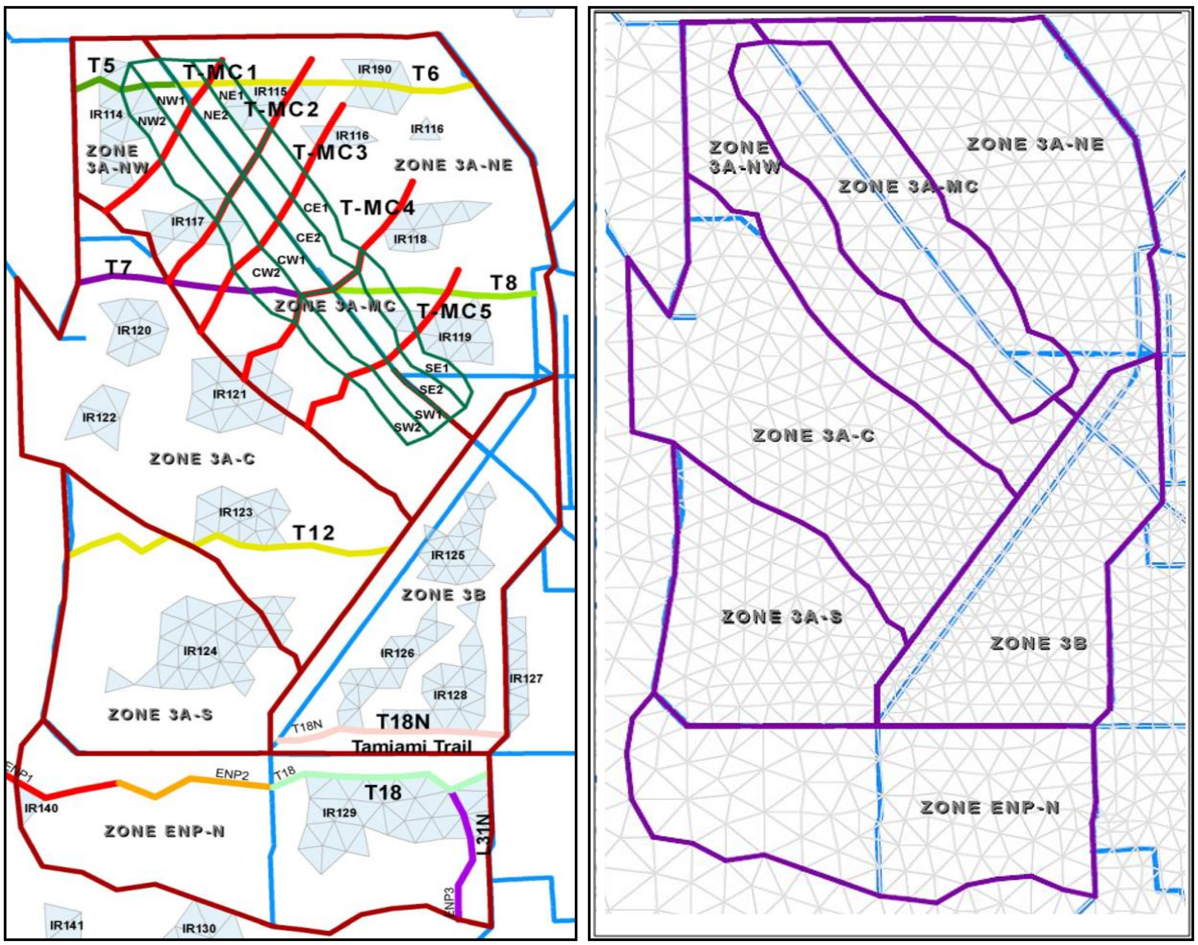

Figure E.1- 10. Indicator Regions, Transects, and Zones Within RSMGL Model Mesh

In order to establish what constitutes the minimum rating (*i.e.* rating = 1) on the 1-4 rating scale, reference degraded sites within the existing RSMGL model mesh were chosen based on output from the Existing Conditions Baseline (ECB). The ECB was used to set the minimum rating (1) for each PM sub-metric. The ECB provided the best available RSMGL representation of current habitat quality within the project area. The reference degraded sites (*i.e* indicator regions and/or transects within the RSMGL model mesh), are fully degraded as a result of the existing hydrologic conditions and are all located in northern WCA 3A.

The target for each PM sub-metric was used to set the maximum rating (*i.e.* rating = 4) on the 1-4 rating scale. Even quartiles were then calculated based on the range of values between the ECB and target for each PM sub-metric. Values in the top 25% of the range were assigned a quartile rating of 4; the next 25% were assigned a rating of 3, and so forth. This was repeated for each of the PM sub-metrics within zones 3A-NE, 3A-NW, and 3A-MC for each of the project configurations modeled.

The following example is provided for PM sub-metric 1.1 in Zone 3A-NE (**Table E.1-26**). The ECB score at the reference degraded site for PM 1.1 is equal to 70 Percent Period of Record of (PPOR) of Inundation. The target score for Zone 3A-NE for PM 1.1 is equal to 90.0 PPOR of Inundation. The score for Zone 3A-NE for PM 1.1 for project configuration A is equal to 89.4 PPOR. Configuration A received a rating of 4 based on the calculation of even quartiles.

Table E.1-26. Example Ratings (1-4) Scale for Zone 3A-NE for PM 1.1 Percent Period of Record Inundated

PM Sub-Metric Score	Rating	PM-Sub-Metric Score
70 (ECB Value at Reference Degraded Site)	< Rating 1 (Worst) ≤	75.0
75.0	< Rating 2 (Fair) ≤	80.0
80.0	< Rating 3 (Good) <	85.0
85.0	< Rating 4 (Best) ≤	90.0 (Target Value)

Ratings for each PM sub-metric were then averaged across the three zones (Zones 3A-NW, 3A-NE, and 3A-MC) for each project configuration. If a PM had more than one sub-metric (i.e. PM 2.0 and PM 5.0), sub-metric ratings were first averaged within each zone before being averaged across zones. Ratings were then sub-totaled to determine the configuration rank (**Table E.1-27**).

Table E.1-27. Level 1 Screening Criteria: Performance Measure Results

Configuration			Performance Measures				
	HRF	Miami Canal	PM 1.1 Inundation Duration	PM 2.2, 2.3Distribution/ Continuity of Sheetflow	PM 3.1 Soil Oxidation	PM 5.1, 5.2, 5.4 Slough Vegetation	Subtotal
E	West G-205	North S-339	3.7	2.4	3.7	2.7	12.4
G	West G-205	North I-75	4.0	3.0	4.0	2.8	13.8
D	West G-205	Full	4.0	3.0	4.0	2.8	13.8
B	Full	North S-339	3.7	2.4	3.3	2.7	12.0
A	Full	Full	4.0	3.0	4.0	2.7	13.7
C	Full	Plug Full	4.0	3.0	4.0	2.7	13.7
F	Full	None	3.0	1.4	2.7	2.3	9.4

Overall the top tier of project configurations include A, C, D, and G. Configurations with moderate performance include Band E. Configuration F was the weakest performing.

Hydrologic improvements were apparent in northern WCA 3A with implementation of each project configuration. Hydrologic improvements primarily occur north of I-75 with "existing" flow volumes. Implementation of a HRF and full backfill of the Miami Canal offer more hydrologic improvement in comparison to the HRF and backfill of northern Miami Canal (to S-339) or HRF only. Filling north of I-75 provides more hydrologic improvement in comparison to options filling only north of S-339.

E.2.4.2 Hydrologic Mapping Results (Level 1)

Additional RSMGL (Version 2.3.1) output was utilized to evaluate project configurations in addition to PM results including hydroperiod distribution maps, ponding depth maps, and overland flow vector maps. Maps for the project area were used that depicted average annual calculations for the 36-year period of record as well as calculations for a wet year (1995), dry year (1989) and an average year (1978). Performance of each project configuration for each of the six project objectives was compared to the Future Without (FWO) project condition as well as the performance of each configuration relative to the performance of the remaining configurations. A rating of (1-4) was used to best separate the performance of project configurations. Best professional judgment was used to apply each rating. A rating of 1 showed marginal to no improvement over the FWO. A rating of 2 showed the next least amount of improvement over the FWO. A rating of 3 showed intermediate improvement over the FWO and a rating of 4 showed the greatest improvement over the FWO.). Overall the top tier of performing configurations are A, C, D, and G. Project configurations with moderate performance are B and E. Configuration F was the weakest performing.

Project configurations were also rated on a scale of (1-4) by calculating the amount of average annual overland flow (1000-acre-feet or k-ac-ft) each configuration delivered across a set of transects in WCA 3A. Hydrologic model output for each of the transects was produced by RSMGL. Transect locations and flows are depicted in **Figure E.1- 11**. The analysis for CEPP was restricted to portions of northern WCA 3A (Transects 5, 6, 7, and 8) as hydrologic improvements were not apparent in the southern portions of WCA 3A, 3B, and ENP (Transect 12) as a result of the evaluation of the project configurations. Project configurations which improved the total volume of overland flow across transects 5, 6, 7, and 8 scored more favorably. The maximum amount of flow for configuration A was used to set the maximum rating (*i.e.* rating = 4). The minimum amount of overland flow for configuration G was used to set the minimum rating (*i.e.* rating = 1). Even quartiles were then calculated based on the range of values between the minimum and maximum. Values in the top 25% of the range were assigned a rating of 4; the next 25% were assigned a rating of 3, and so forth. The rating methodology is defined in **Table E.1-28**.

Table E.1-28. Rating (1-4) Scale for Average Annual Overland Flow (1000 Acre Feet)

Total Average Annual Overland Flow (1000 Acre Feet)	Ratings	Total Average Annual Overland Flow (1000 Acre Feet)
969	< Rating 1 (Worst) ≤	1085
1085	< Rating 2 (Fair) ≤	1201
1201	< Rating 3 (Good) <	1316
1316	< Rating 4 (Best) ≤	1432

The range of average annual overland flow varied from 969 to 1432 (k-ac-ft). Results are shown in **Figure E.1- 11**. Ratings for the hydrologic maps (hydroperiod distribution maps, ponding depth maps, and overland flow vector maps) and average annual overland flow are shown in **Table E.1-29.**

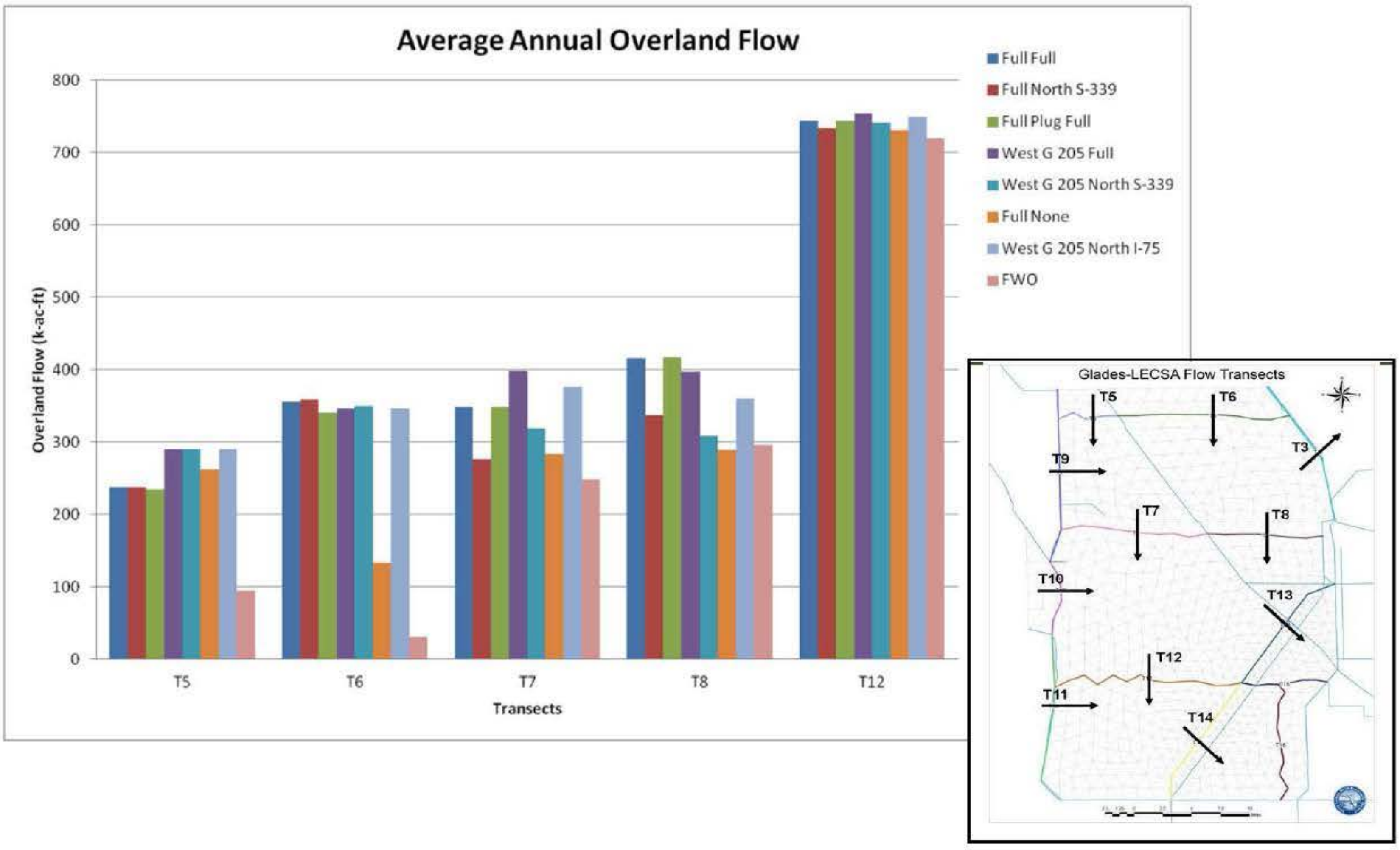

Figure E.1- 11. Average Annual Overland Flow (Thousand Acre Feet)

Table E.1-29. Hydrologic Mapping Results of Level 1 Screening Criteria

Hydrologic Output							
Option	HRF	Miami Canal	Average Annual Ponding Distribution	Average Annual Hydroperiod Distribution	Average Annual Overland Flow Vectors	Average Annual Overland Flow Across Transects	Subtotal
E	West G-205	North S-339	3.0	4.0	2.0	3.0	12
G	West G-205	North I-75	4.0	4.0	3.0	4.0	15
D	West G-205	Full	4.0	4.0	4.0	4.0	16
B	Full	North S-339	3.0	2.0	2.0	3.0	10
A	Full	Full	4.0	3.0	4.0	4.0	15
C	Full	Plug Full	4.0	3.0	4.0	4.0	15
F	Full	None	2.0	1.0	1.0	1.0	5

E.2.4.3 Excessive Ponding (Level 2)

In today's Greater Everglades, undue ponding becomes a seasonal problem in southern WCA 2A/2B, eastern and southern WCA 3A, and southern 3B due to the blockage of sheetflow by levees. In the wet season, rainfall becomes the predominant contribution to surface and groundwater. But, water discharges through water management structures into WCA 2A/B and into WCA 3A are usually increased during the wet season to provide relief to upstream areas. Thus, ponding becomes problematic leading to marsh and habitat degradation. Configurations were rated on a scale of (1-4) by evaluating ponding depths (depths > 2.0 feet) in eastern and southern WCA 3A. Everglades Viewing Windows were used to evaluate ponding depths over a percent period of record from 1965 through 2000 along transects (**Figure E.1- 12**). **Figure E.1- 12** depicts the percent period of record of inundation as well as the percent period of record at which water levels are at 2.0 feet, 2.5 feet and 3.0 feet above ground surface along transect L2 for one of the configurations. Percent period of record is shown relative to locations within the project area or distance in miles along Transect L2. Transect L2 runs from northern WCA 3A to Shark River Slough. To evaluate localized ponding in eastern and southern WCA 3A the last two points in WCA 3A in **Figure E.1- 13** were averaged. These points are depicted in **Figure E.1- 12** with a red circle. To evaluate the relative ponding depths between WCA 3A and WCA 3B and ENP, the first two points in WCA3B and ENP were averaged.

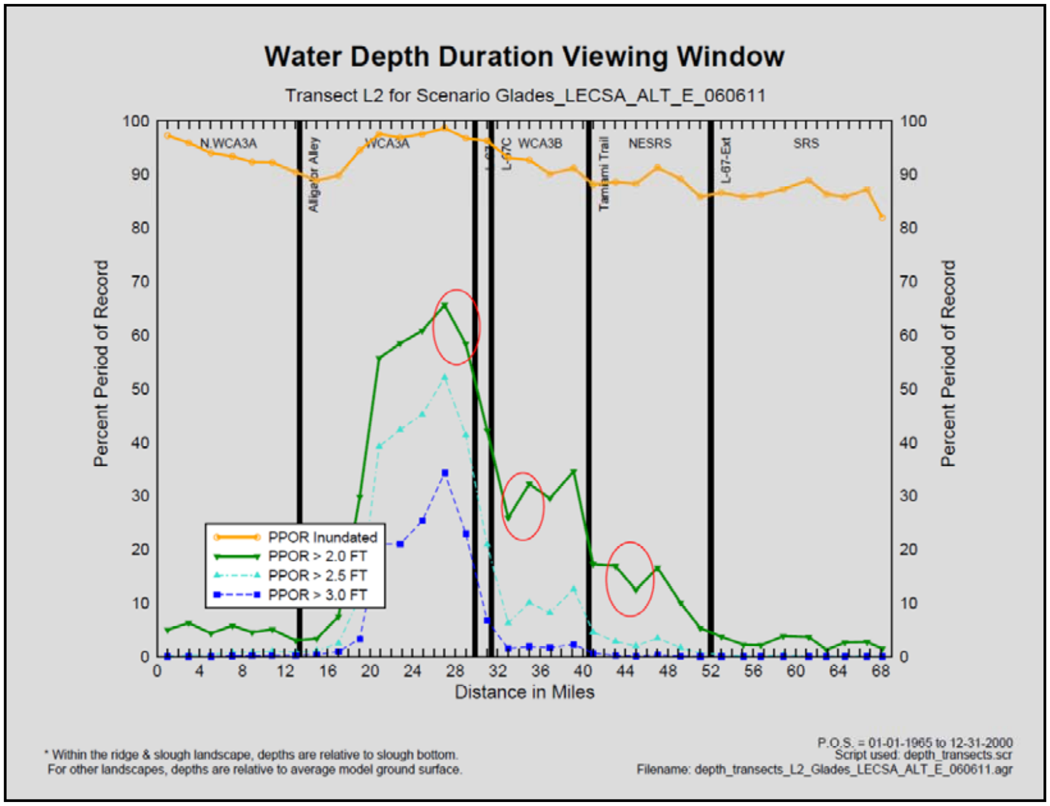

Figure E.1- 12. Everglades Viewing Windows Example Water Depth Duration Graph for Transect L2

Transects L1 in western WCA 3A , L2 through central WCA 3A, and L3 through eastern WCA-3A were chosen for the evaluation (**Figure E.1- 13**). Performance of each project configuration was compared to the FWO project condition.

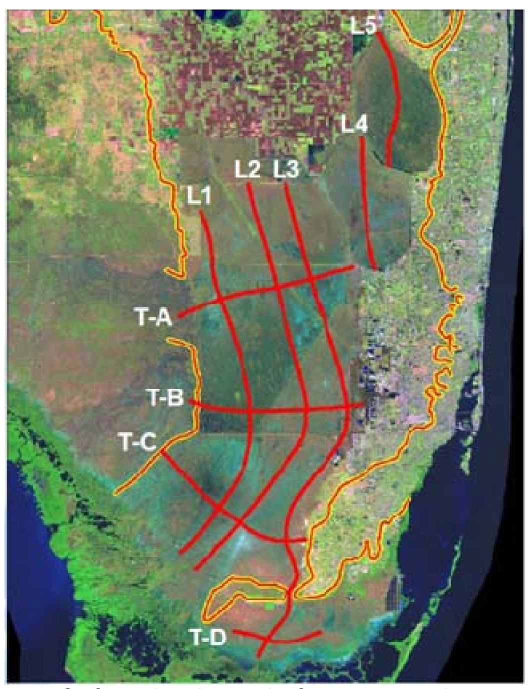

Figure E.1- 13. Transects of the Everglades Viewing Windows Screening Tool

The general trend of this analysis indicated that the project configurations improved ponding relative to the FWO project condition; however differences between alternatives were not discernible. Project configurations performed similarly.

E.2.4.4 Adaptability (Level 2)

Adaptability was measured using two separate metrics; 1) Robustness and 2) Future Compatibility. Robustness was defined as the ability to function effectively in the face of variability and uncertainty of future events. Future compatibility was defined as the efficiency of using the project configuration to complement future CEPP increments. Best professional judgment was used to apply each rating on a scale of (1-4).

Table E.1-30 illustrates the results of the (1-4) ratings. The western HRF was considered more robust than a full HRF as it can deliver water to the location within northern WCA 3A where it is most needed. The project configuration also avoids sending water to eastern areas of WCA 3A which is currently susceptible to excessive ponding. A longer length of fill in the Miami Canal was also considered to be more robust as any remaining canal that is not filled is assumed to continue to drain the area and reduce or limit the ability of the project to maintain expected benefits. The western HRF was considered to be more compatible than the full HRF as it can be modified in the future as needed. Construction of the feature does not prevent adding other conveyance and distribution features to northeastern WCA 3 in the future. A longer length of fill in the Miami Canal was also considered to be more compatible with the future as CERP recommends full fill of the entire length of the Miami Canal. It was also identified that it would be difficult in the future to return to the area and fill and/or gap those portions of the Miami Canal that were not filled.

Table E.1-30. Configurations Based on Adaptability

Configurations Adaptive Management				
Option	HRF	Miami Canal	Robustness	Future Compatibility
E	**West G-205**	**North S-339**	**3**	**3**
G	**West G-205**	**North I-75**	**3**	**3.5**
D	**West G-205**	**Full**	**3.5**	**4**
B	**Full**	**North S-339**	**2**	**2**
A	**Full**	**Full**	**3**	**3**
C	**Full**	**Plug Full**	**2**	**2**
F	**Full**	**None**	**1.5**	**1.5**

E.2.4.5 Ecologic Connectivity (Level 2)

This criterion evaluates increases in wetland acreage and marsh connectivity directly associated with the removal of man-made barriers to flow. The criterion was developed based on the set of CEPP project objectives related to restoring seasonal hydroperiods and freshwater distribution, and surface water depths within the project area. Water management practices beginning in the early 20th century led to the construction of an extensive system of canals, levees, and pump stations crisscrossing the once free-flowing natural system, which in turn has led to human-dominated operations of that system. This channelization, compartmentalization, and physical manipulation of how water flows into the Everglades due to water management operational criteria (i.e., regulation schedules) has altered or eliminated sheet flow and related hydrologic characteristics throughout much of the Everglades. Canals, levees, and roads constructed under the C&SF Project have been identified as causing landscape fragmentation, loss of connectivity of the natural system, alteration of volume, timing, and distribution of regional hydropatterns and degradation of habitat of wetland organisms. The loss of connectivity necessary for sheet flow has resulted in far-reaching effects on ecological processes and habitat. The ridge and slough landscape has become severely degraded in a number of locations and is being replaced with a landscape more uniform in terms of topography and vegetation, with less directionality. The desired restoration condition is to maximize the ecological connectivity and acreage of wetlands in the Everglades by removing or reducing the effects of landscape discontinuities caused by levees, canals, drainage ditches and spoil banks.

Project configurations were rated on a scale of (1-4) to estimate the degree to which each configuration performed with respect to ecologic connectivity. Ecologic connectivity was measured using two separate metrics; 1) Miles of Marsh Reconnected, and 2) Acreage of Marsh Restored.

Miles of Marsh Reconnected: This metric quantified the miles of marsh that are reconnected by backfilling of the Miami Canal from S-8 to S-151. Long, continuous and uninterrupted patterns of sheetflow from north to south are a defining characteristic of the Everglades and the habitat fragmentation caused by canals has disrupted the natural dispersion of organisms in the landscape. The metric captures the extent to which removal of structural barriers restores ecological connectivity across the Miami Canal footprint, thereby restoring the ecology in the marsh surrounding the canal. The target is to degrade / backfill all barriers to sheetflow to marsh elevation from S-8 to S-151. The total length of the Miami Canal from S-8 to A-151 is approximately 28.0 miles. GIS was used to calculate the miles of marsh reconnected for various sections of the Miami Canal (**Table E.1-31**).

Table E.1-31. Miles of Marsh Reconnected for Sections of the Miami Canal

S-8 to S-339 (Miles)	S-339 to I-75(Acres)	I-75 to S-151(Acres)	Total Canal Length
10.5	5.5	12.0	28.0

Acreage of Wetland Restored: Canals and levee systems represent a substantial area of dredged, filled, and degraded wetland habitats that could be restored back to functional, reconnected marshes. This metric quantified the acreage of wetland restored by backfilling of the Miami Canal from S-8 to S-151. This metric captured the differences among configurations in the spatial extent of wetlands adjacent to the Miami Canal. GIS was used to calculate the acreage of marsh restored for various sections of the Miami Canal and directly adjacent disturbed natural area (including spoil mounds) (**Table E.1- 32**).

Table E.1- 32. Acreage of Wetland Restored for Sections of the Miami Canal

S-8 to S-339 (Acres)	S-339 to I-75 (Acres)	I-75 to S-151 (Acres)	
67.3	56.7	131.5	Canal
256.8	77.4	178.0	Disturbed Natural Area
324.10	134.10	309.5	Total (Acres)

Table E.1- 33 illustrates the results of the (1-4) ratings. Project configurations with a full backfill of the Miami Canal from S-8 to S-151 (A and E) connected approximately 28.0 miles of marsh and were rated as providing the greatest amount of ecologic connectivity (Rating = 4). These configurations also restored approximately 767.70 acres of marsh. Project configurations with partial backfill of the Miami Canal (B, C, F, and H) were rated as providing intermediate levels of connectivity. Configuration C is full backfill of the Miami Canal from S-8 to S-151 with 4,000 foot plugs with 2,000 foot spacing. This is equivalent to backfilling approximately 66% of the Miami Canal from S-8 to S-151. Sixty six percent of 28.0 miles is equal to approximately 18.5 miles of marsh reconnected. The same logic is used for acreage of marsh restored. Sixty six percent of 767.70 acres is equal to approximately 506.7 acres of marsh restored. Configurations with no backfill of the Miami Canal (G) were rated as providing the least amount of ecologic connectivity (Rating = 1).

Table E.1- 33. Ratings of Options Based on Ecologic Connectivity

Configurations				Ecologic Connectivity	
Option	**HRF**	**Miami Canal**	**Miles of Marsh Reconnected**	**Acreage of Marsh Restored**	**Subtotal**
E	West G-205	North S-339	10.5	324.1	2
G	West G-205	North I-75	16.0	458.2	3
D	West G-205	Full	28.0	767.7	4
B	Full	North S-339	10.5	324.1	2
A	Full	Full	28.0	767.70	4
C	Full	Plug Full	18.5	506.7	3
F	Full	None	0	0	1

E.2.4.6 Recreational Impacts (Level 2)

Configurations for backfilling and/or plugging the Miami Canal in WCA 3A have brought forth much discussion among recreational stakeholders and project team members on the effects of changes to the landscape. Substantive changes to the landscape will affect stakeholder groups differently in how they access the Miami Canal and the marsh in WCA 3A. Information summarizing how alternative features could potentially affect recreational resources within the project area is summarized below for two main recreational groups; motorized boaters and swamp-geared vehicle users (*i.e.* track vehicles and swamp buggies). There are currently 108 track vehicle users registered with the Florida Fish and Wildlife Conservation Commission (FWC). Weekly bass tournaments and recreational fishing for bass and other species overwhelm the current facilities and provide thousands of documented angler hours. Configurations were rated on a scale of (1-4) to estimate the degree to which each configuration provided recreational access. Ratings were applied based on stakeholder input gathered during PDT meetings during plan formulation. Ratings of project configurations are provided in
.

Backfilling the Miami Canal: Backfill of canals in any manner substantively diminish the accessibility for deeper draft boats; and modifies the canal for nearly all users of the entire region. Such modifications may be either negative or positive, depending upon the type of vehicle usage. Swamp-geared vehicles do not easily cross a canal; plugs would improve their access as plugged canals would no longer be a barrier. Generally, any backfilling will virtually eliminate using bass boats for bass tournaments as these boats would not easily pass shallow water. Many shallow draft boats commonly use the open canal in a manner similar to an "interstate" and access the system before venturing off into the marsh. The shallower draft boats and non-motorized boats would potentially lose less access, as they can often travel in shallower water and could manage to cross plugs under most water conditions. Construction of plugs may lead to the development of a braided trail as users of shallow draft boats maneuver around or across plugs. Airboats less frequently use deeper canals as a means of access due to the inherent hazards of low freeboard and sinking in deep water.

Recommendations by Recreational Users (Recreational Motorized Boaters): Recreational motorized boaters have indicated that backfilling of the Miami Canal to marsh grade and/or with plugs from S-8 to S-151 are undesirable. Recreational motorized boaters have also indicated that the central (S-339 to S-340) and southern (S-340 to S-151) portions of the canal are more heavily used for recreational fishing than the northern portion of the canal (S-8 to S-339) due to the location of boat ramps within the project area. Boat ramps providing access to the northern portion of the canal are located adjacent to the S-8 pump station and are difficult to access while boat ramps located near I-75 and Holiday Park provide convenient access to the central and southern portions of the canal. While a project configuration with plugs would provide remnant deep water pools with potential access for fishing, users have identified boat channels as undesirable due to related speed restrictions and potential damage to boats that would occur during low water conditions.

Hydropattern Restoration Effects (Northern WCA 3A): The creation of a new HRF along the northern boundary of WCA 3A may offer new wildlife refugia and access to the area. Depending on length, depth, and width, the contribution of this feature may create substantial recreation opportunities in the area. If this area is deep enough for bass boats, it could replace some of the recreational opportunities lost to bass fisherman where proposed backfill might occur in the Miami Canal. However, a new HRF across the entire northern boundary of WCA 3A may potentially diminish existing swamp-geared vehicle access into the conservation area if water depths are deeper than 3 ½ feet; unless appropriate access consideration is given during HRF design. Many swamp-geared vehicle users' access points are currently located along the L-4 and L-5 Borrow Canals and Levees.

Recommendations by Recreational Users (Swamp-Geared Vehicles): Swamp-geared vehicle users have indicated that a HRF located along the northern boundary of WCA 3A is undesirable if it precludes current access points along the L-4/L-5 levee. Current configurations for the HRF considered included a full HRF located along the entire northern border of WCA 3A and a western HRF. Components of each feature included degradation of the L-4 Levee/L-5 Levee or a portion thereof and construction of a spreader canal south of Holey Land Wildlife Management Area. A spreader canal has been identified as undesirable; if users are unable to directly access the marsh by driving through the canal due to high water conditions.

Rationale for Ratings

Project configurations with a full backfill of the Miami Canal (A, C, and E) were rated as providing the least amount of access to the canal for recreational motorized boaters (Rating = 1). Project configurations with no backfill of the Miami Canal (G) were rated as providing the greatest amount of access for recreational motorized boaters (Rating = 4). Project configurations with partial backfill of the Miami Canal (B, F, and H) were rated as providing intermediate levels of access (**Table E.1-34**). Construction of the HRF was not considered a limitation to recreational boat access.

Each of the configurations considered below includes a HRF. While it is recognized that a HRF may diminish existing swamp-geared vehicle access into the conservation area; the HRF is more likely to be modified during design for recreational use. In addition, much of the activity in northern WCA 3A is related to current water levels. Northern WCA 3A is currently over drained. Swamp-geared vehicles are used during periods of low water to access camps for deer hunting. As water levels increase with the implementation of CEPP, potential swamp-geared vehicle users may increase their utilization of airboats for hunting. Backfilling the Miami Canal has the potential to more severely limit access to the marsh by recreational motorized boaters. As a result, importance was placed on how much of the Miami Canal was backfilled for those alternatives which contained both potential backfilling and HRF options.

Project configurations with a HRF located across the northern boundary of WCA 3A (Configurations A, C, and E) were rated as providing the least amount of access to the marsh by swamped-geared vehicle users (Rating = 1). Project configurations B, F, and H received a higher rating in comparison to configurations A, C, and E (**Table E.1-34**). These configurations also contained a HRF but backfilled a smaller portion of the Miami Canal and would be more desirable to recreational motorized boaters. Of the seven project configurations considered, configuration F was rated as providing the most amount of access (Rating = 4). This configuration also contained a HRF but did not backfill any portion of the Miami Canal. Construction of a full HRF was not considered to be more of a restriction to swamp-geared vehicles than a western HRF.

Table E.1-34. Ratings Configurations Based on Ability to Provide Access to Recreational Users (Motorized Boaters and Swamp-Geared Vehicle Users)

Configurations			
Option	**HRF**	**Miami Canal**	**Rating**
E	West G-205	North S-339	3
G	West G-205	North I-75	2
D	West G-205	Full	1
B	Full	North S-339	3
A	Full	Full	1
C	Full	Plug Full	1
F	Full	None	4

E.2.5 Distribution and Conveyance Options – MCDA and Cost Effective Results – Northern WCA 3A

Options F, E, G and D were identified as cost effective. **Table E.1-35** summarizes the estimated total construction cost of each project configuration and results of the Level 1 and Level 2 criteria evaluations. The configurations are listed in order of ascending total performance. Cost estimates assumed that only available onsite fill material to be used in backfilling the Miami Canal is located adjacent to the canal on the spoil mounds. These preliminary cost estimates did not assume that the material excavated from the construction of the HRF was suitable to use in the backfilling of the Miami Canal and of sufficient quantity to account for the entire material shortfall after utilization of the spoil mound material, so imported fill would be required

Table E.1-35. Results of Level 1 and 2 Screening for Decomp Project Configurations

	HRF	**Miami Canal**	**Level 1 Subtotal**	**Level 2 Subtotal**	**Total**	**Capital Cost Imported Fill**
E	West G-205	North S-339	24.5	11	35.5	$253,450,000
G	West G-205	North I-75	28.8	11.5	40.3	$308,823,888
D	West G-205	Full	29.8	12.5	42.3	$362,000,000
B	Full	North S-339	22.1	9	31.1	$264,450,000
A	Full	Full	28.7	11	39.7	$373,000,000
C	Full	Plug Full	28.7	8	36.7	$310,000,000
F	Full	None	14.4	8	22.4	$219,000,000

E.2.6 Refinement of Distribution and Conveyance Options - Northern WCA 3A

The options described above utilized the existing water budget entering WCA 3A, and while providing invaluable insight and information on the hydrology of WCA 3A, further modification and evaluation of these cost effective options was warranted when considering the additional water provided by the FEB and Lake Okeechobee operational refinements.

HRF Component Modifications

Each option in the final array includes a scenario with and without the STA-2/Compartment B diversion (Options 1-9 – scenarios a and b). The eastern portion of WCA 3A is currently affected by high water and prolonged periods of inundation created by outflow through the S-11 structures and impoundment structures (features associated with the Miami Canal, L-67A and L-67C Canal). In order to avoid exacerbating and potentially alleviate ponding in this area all configurations assumed that outflows from STA 3/4 currently directed to WCA 2A via the S-7 structure would be re-routed to the HRF when capacity was available. Additionally, in order to further alleviate ponding near the S-11 structures within WCA 3A and potentially reduce high water conditions in WCA 2A, flow from Compartment B and STA-2 was also considered to be re-directed to the HRF via the L-6 and L-5 canals.

The HRF element from Option G was carried forward as it stands and no modifications were made other than adding a scenario with re-direction of flow from Compartment B and STA-2 to the HRF via the L-6 and L-5 canals (Option 1, 2 and 3 of the final suite).

Additionally, due to the increase in available water under CEPP; recommendations were made to extend the HRF west of G-205, east to the G-206 structure (Options 4, 5 and 6 of the final suite) and to also include a HRF to further hydrate portions of northeast WCA 3A (Options 7, 8 and 9 of the final suite (**Table E.1-36**). Extension of the HRF to the G-206 structure would require similar modifications to the L-5 canal and STA 3/4 outflow structures, similar to option G, requiring similar costs for construction. G-206 also marks the western boundary of what was once considered to be the southern extent of sawgrass within WCA 3A. A HRF spanning the full northern boundary of WCA 3A from west of S-8 to G-206 would redistribute sheetflow within the boundaries of the historical ridge and slough landscape. Extending the HRF for these configurations provided needed information on whether the additional water made available from the FEB justified a longer spreader footprint.

Miami Canal Backfill Component Modifications

Option F, while cost effective and the least cost option, was not recommended for further consideration. This configuration includes a HRF spanning the entire northern boundary of WCA 3A, with no backfill of the Miami Canal from S-8 to S-151. The Miami Canal functions as a major, unnatural drainage for WCA 3. In combination with the northern levees of WCA 3 (L-4 and L-5), the Miami Canal has substantially impacted historical sheetflow and natural wetland hydroperiods. As a result, during wet periods, the natural capability of the WCA to store water is lost and the Miami Canal effectively over-drains the area. This project configuration was eliminated as it does not address construction of project features that would eliminate drainage effects associated with the Miami Canal.

Options E, G and D were identified as cost effective. However, a synthesis of the three Miami Canal components of these Options was made to backfill the Miami Canal from S-8 to S-I-75 (similar to Option G) with the addition of strategically placed plugs located directly adjacent to S-340 and/or south of the C-11 Extension. Through the above screening effort it became apparent that hydrologic improvements between backfill and plugging configurations perform similarly, so a hybrid approach of using plugs and backfill was established in order to achieve the benefits of Option D while only incurring a minor increase in cost over Option G. Additionally, as a result of further refinement of the design of the L-5 improvements necessary for conveying STA 3/4 water west, additional quantities of onsite fill was identified which provided the justification for extending the backfill from S-339 to I-75 (in lieu of paying for disposal of the L-5 materials, the fill will be used to backfill the Miami Canal).

These backfill and plug configurations of the Miami Canal were combined with the HRF configurations and the WCA 2 Bypass scenarios to form 18 combinations (**Table E.1-36**) of final options that resulted from the screening effort.

Table E.1-36. Combinations of HRF and Miami Canal Options

Option	HRF	Miami Canal	L-6 Diversion (a, b)
1a, 1b	West G-205	North I-75	With/Without
2a, 2b	West G-205	North I-75, Plug Around S-340	With/Without
3a, 3b	West G-205	North I-75, Plug Around S-340, Plug South of C-11	With/Without
4a, 4b	West G-206	North I-75	With/Without
5a, 5b	West G-206	North I-75, Plug Around S-340	With/Without
6a, 6b	West G-206	North I-75, Plug Around S-340, Plug South of C-11	With/Without
7a, 7b	Full	North I-75	With/Without
8a, 8b	Full	North I-75, Plug Around S-340	With/Without
9a, 9b	Full	North I-75, Plug Around S-340, Plug South of C-11	With/Without

A subset including four of these options was then further evaluated for inclusion in the final array of alternatives. Due to the expedited schedule for CEPP, only a limited number of options were able to be modeled. Focus was placed on modeling options which would allow the project team to evaluate the potential benefits of:

- Extending the HRF to the full northern extent of WCA 3A. Does this provide project benefits which warrant additional costs? Includes Options 4a and 7a. Evaluating hydrologic trends identified in this comparison with the trends identified in the comparison against option 6a were used to determine whether Options 8 or 9 warrant further consideration.
- Incorporating one or more plugs south of I-75. Does this provide project benefits which warrant additional costs? Includes Options 4a and 6a. Information gained from the evaluation of Options 4a and 6a can be applied to options which include the full HRF and plugging south of I-75 (Options 8a, 8b, 9a and 9b), negating the need for these separate model runs. Evaluating hydrologic trends between Options 4a and 6a will also determine if one or more plugs south of I-75 is needed, negating the need for a separate model run of a single plug directly adjacent to the S-340 structure (Option 5a and 5b).
- Options modeled to inform whether the benefits of diverting water from STA 2 to WCA 3A will be captured by evaluating hydrologic trends observed between Options 7a and 7b.

Provided below are detailed results related to the screening of the new distribution and conveyance options in northern WCA 3A (South of the Redline). To evaluate the options listed below, output from the RSM-GL (Version 2.3.1) was utilized. Hydroperiod distribution maps, ponding depth maps, and overland flow vector maps were used that depicted average annual calculations for the 41-year period of record as well calculations for a wet year (1995), dry year (1989) and an average year (1978). Results are presented in **Table E.1- 37, Table E.1- 38**, and **Table E.1- 39**. Best professional judgment was used to evaluate the relative performance of each option.

Table E.1- 37. Results from Refinement Effort: Hydropattern Restoration Feature.

HRF	Ponding Depth			
	Average Year (1978)	Wet Year (1995)	Dry Year (1989)	Period of Record (1965-2000)
W-G206	+	=	+	+
Full		=		
HRF	Hydroperiod			
	Average Year (1978)	Wet Year (1995)	Dry Year (1989)	Period of Record (1965-2000)
W-G206	+	=	+	+
Full		=		
HRF	Average Annual Overland Flow Vectors			
	Average Year (1978)	Wet Year (1995)	Dry Year (1989)	Period of Record (1965-2000)
W-G206	=	=	+	+
Full	=	=		

Table E.1- 38. Results from Refinement Effort: Miami Canal Features

Miami Canal	Ponding Depth			
	Average Year (1978)	Wet Year (1995)	Dry Year (1989)	Period of Record (1965-2000)
I-75 North	=	=	=	=
North I-75, Plug Around S-340, Plug South of C-11	=	=	=	=
Miami Canal	Hydroperiod			
	Average Year (1978)	Wet Year (1995)	Dry Year (1989)	Period of Record (1965-2000)
I-75 North	=	=		=
North I-75, Plug Around S-340, Plug South of C-11	=	=	+	=
Miami Canal	Average Annual Overland Flow Vectors			
	Average Year (1978)	Wet Year (1995)	Dry Year (1989)	Period of Record (1965-2000)
I-75 North	=	=		=
North I-75, Plug Around S-340, Plug South of C-11	=	=	+	=

Table E.1- 39. Results from Refinement Effort: Diversion of Water from STA 2 to WCA 3A

L-6 Diversion	Ponding Depth			
	Average Year (1978)	Wet Year (1995)	Dry Year (1989)	Period of Record (1965-2000)
Without				
With	++	+	++	+
L-6 Diversion	Hydroperiod			
	Average Year (1978)	Wet Year (1995)	Dry Year (1989)	Period of Record (1965-2000)
Without				
With	++	+	++	+
L-6 Diversion	Average Annual Overland Flow Vectors			
	Average Year (1978)	Wet Year (1995)	Dry Year (1989)	Period of Record (1965-2000)
Without				
With	+	+	+	+

+ Denotes Better performance
= Denotes Equal performance

E.3 CONVEYANCE AND DISTRIBUTION – SOUTHERN WCA 3A, 3B AND ENP

This section describes the identification of management measures, screening of management measures, formulation of options and the MCDA and cost effectiveness results for southern conveyance and distribution components of CEPP.

E.3.1 Southern Conveyance and Distribution: Management Measures

This section contains a description of unique Management Measures for conveyance and distribution from WCA 3A to WCA 3B and ENP. The management measures include the major features that form the basis of the options which were then combined with the options from other parts of the system to form the final array of alternatives. Sources of information and ideas for the alignment, sizes, and operations of the new features in the L-67A, L-67C, L-29, and L-30 levees (and their borrow canals), and Tamiami Trail included: CERP report; MWD studies (GDM, 8.5 SMA, TT, CSOP, COP); TTMNS; ERTP; research on tree islands and ridge and slough habitats; Working Group sponsored workshops, and PDT meetings.

Similar to those management measures for distribution and conveyance for northern WCA 3A (south of the Redline), management measures for southern WCA 3A, WCA 3B and ENP were formulated to meet the following project objectives:

Objective 1: Restore seasonal hydroperiods and freshwater distribution to support a natural mosaic of wetland and upland habitat in the Everglades system.

Objective 2: Improve sheetflow patterns and surface water depths and durations in the Everglades system in order to reduce soil subsidence, frequency of damaging fires, decline of tree islands and decrease salt water intrusion.

Objective 4: Restore more natural water level responses to rainfall to promote plant and animal diversity and habitat function

Levee Removal: Levees such as the L-67A would be completely removed in order to re-establish water flows. The removal of the levees would restore the sheet flow directionality and improve hydroperiods by ensuring a more consistent distribution of water. Additionally, the removal of these barriers would eliminate substantial fragmentation that inhibits animal movement and decreases habitat value. Material would be disposed of onsite through the incorporation into other features or may need to be transported offsite, which would increase project costs. Levee removal, with significant potential benefits, was retained as a measure for possible inclusion into components and alternatives.

Levee Gaps: Levees such as the L-67A would be degraded in certain areas to allow water flows from WCA 3A to WCA 3B. The levee gaps may have control structures for operational control to prevent water flows into WCA 3B during extreme high water events. Some improvements in habitat value would occur with the increased water flows from this measure, with reduced fragmentation leading to a healthier ecosystem. This measure would likely be less costly when compared to complete levee removal if the material is not needed for related management measure construction; however, there would be more likelihood that some hydropattern restoration may be impeded by remaining portions of the levees. As such, levee gaps, although not quite as effective as levee removal but with possible cost savings, was retained as a management measure.

Levee/Berm Construction: The construction of levees/berms within the WCAs could be utilized to guide surface water along preferential flow paths for distribution. Certain portions of WCA 3 may be situated in an area where additional structures are necessary to steer water flows into the area. The strategic placement of these levees/berms could reduce ponding in some areas while diverting surface flows to other areas that are typically dry. Additionally, levee/berm construction could direct water away from the eastern levees, reducing the possible need for seepage control with increased flows into the WCAs. This measure was retained.

Flow-through Wetlands (Restored Wetlands): A Flow-through wetland is a measure that is similar to the Flow Way feature that was evaluated as a water storage measure. A Flow-through would be used primarily for the distribution of freshwater, promoting the restoration of seasonal hydroperiods within Everglades areas.

Culverts within Existing Levees: Similar to the Levee Gaps, culverts could be constructed within levees such as the L-67A and L-67C to allow greater distribution of water flows. Culverts may provide greater operational control than levee degradation and could limit the cost of any possible spoil disposal. It is likely that there would also be some type of control structure to manage water flows during periods of extremely high water.

Gated Water Control Structures: Gated structures could be constructed within the borrow canal of the L-67A to allow for controlled passage of water from WCA 3A into WCA 3B or within the L-29 Canal to direct water into the desired location of North East Shark River Slough. L67A structures would likely be combined with Levee Gaps or complete Levee Removal to create a component that would essentially direct the flow of water into WCA 3B. Water that typically flows south in the L-67A borrow canal would slow and pool at the control structure, with some of the water overflowing through the gap in the L-67. The gated water control structures could be completely opened during significant storm events to allow for complete passage of water through conveyance channels such as the L-67A borrow canal. Gated water control structures may also be used in other portions of the study area where water flows in canals need to be managed. This measure was retained.

Weirs: Similar to the Gated structures, weirs could be constructed within the borrow canal of the L-67A to manage water flows and move water from WCA 3A into WCA 3B. Weirs would be less flexible during storms and other extreme high flow events. This measure was retained.

Operational Changes: Operations would be altered to move water more effectively throughout WCA 3. Operational changes may also be necessary to send water to the South Dade Conveyance System for agricultural/environmental water supply and also to manage water for flood risk. This measure is likely to be integral to any component or alternative that is formulated and was therefore retained as a measure.

Pump Stations: Include a pump station to move water from WCA 3A to WCA 3B was determined to be a non-effective means of conveying water as a control structure and gravity is sufficient to convey water across the L-67A. A pump station was included as a means to overcome the hydrologic head impediment to flow from WCA 3B to ENP, as there is uncertainty if gravity alone is sufficient to convey the water due to stage differences in ENP and WCA 3B.

Bridging: Additional bridging of Tamiami Trail would allow for an increase in the capacity of flows entering ENP, and also allow for more effective distribution of water into the Park. Bridging Tamiami Trail would accomplish two purposes: 1) The roadway would be elevated so increased stages in WCA 3B would not cause flooding impacts, and 2) Bridging would allow for increased sheet flow from the Water Conservation Areas into ENP. Additional bridging and subsequent flows could cause increased water levels along the eastern levees in ENP, causing a possible need for increased seepage control. This measure was retained for further consideration.

Elevating Roadway**:** Currently, elevations in Water Conservation Area 3B are kept at 7.5 feet in order to prevent flooding across Tamiami Trail. Water levels could be raised as high as 8.5 feet without any flooding impacts; however, any stage increase above that threshold would require the roadway to be elevated. Under this measure, fill material would be imported to physically raise the elevation of Tamiami Trail. This measure would not include additional culverts under the roadway, but may be combined with additional culverts or additional measures that in combination would allow for greater stages in WCA 3B and increased flows into NESRS. This measure was retained.

Collection Canal: A collection canal would be constructed on the northern side of the L-29 levee in WCA 3B in order to alleviate high water levels. Water would then be passed through the levee via the S-355 structures or another similar structure/s. In addition to relieving high water levels in WCA 3B, this structure could also be combined with other measures that are designed to increase water flow through WCA 3B. A collection canal was retained as a measure for possible inclusion into components and alternatives.

E.3.2 Screening of Distribution and Conveyance Management Measures

Results are presented in **Table E.1-40**. Measures not retained are marked with “x”.

Table E.1-40. Results of Southern WCA 3A, 3B and ENP management measure screening

	Screening Criteria		
	Effectiveness (Project Objectives)	Maintenance Considerations	Environmental & Secondary Effects
Conveyance and Distribution from WCA 3A to WCA 3B			
Levee Removal	Retained		
Levee Degradation/Gaps	Retained		
Levee/Berm Construction	Retained		
Weirs	Retained		
Pump Stations	X	X	
Gated Water Control Structures	Retained		
Culverts within Existing Levees	Retained		
Conveyance and Distribution from WCA 3A/3B to ENP			
Collection Canal	Retained		
Elevate Roadway	Retained		
Gated Water Control Structures	Retained		
Weirs	Retained		
Pump Stations	Retained		
Levee/Berm Construction	Retained		
Operational Changes	Retained		
Bridging	Retained		
Flow-through Wetlands	Retained		

E.3.3 Formulation and Evaluation of Initial Distribution and Conveyance Options

Conceptual alignments were prepared through an interdisciplinary team of stakeholders and resource agencies staff and included general locations of features, although at this stage of the formulation, sizes of features generally were not specified. These conceptual alignments went through a refinement analysis that organized the common and reasonably feasible concepts into two primary flowway concepts that underwent analysis with the iModel screening and sensitivity tool.

The iModel tool relies on output from the RSM-GL regional hydrologic model. Once the RSM-GL output is incorporated, the iModel operates much more quickly than the large H&H regional model. Typical H&H models start with inputs of structure sizes and flow volumes, and produce outputs of water depths and durations at locations throughout the system. The iModel is “inverse” in that inputs to the iModel are ecological targets (water depths and durations) and outputs are the combination of structures and operations of the structures. It uses an optimization method that provides the overall “best” fit to the targets.

iModel can include or not include (i.e., turn on or turn off) individual structures, and compare the performance (achievement of targets) with or without these features. This is used to guide the team toward features and operations that are most suitable to carry forward to the detailed analysis using the RSM-GL regional model. The operations identified in the iModel are an efficient starting point for establishing the operations of features in the detailed regional model.

Two structurally and operationally different concepts were analyzed (**Figure E.1- 14**) – one that had multiple conveyance structures in the L-67 and L-29 levees (Concept 1), and one that had a similar set of conveyance structures but also contained a new levee within WCA 3B that would redirect water flow within WCA 3A and would change the patterns of seepage out of WCA 3B (Concept 2).

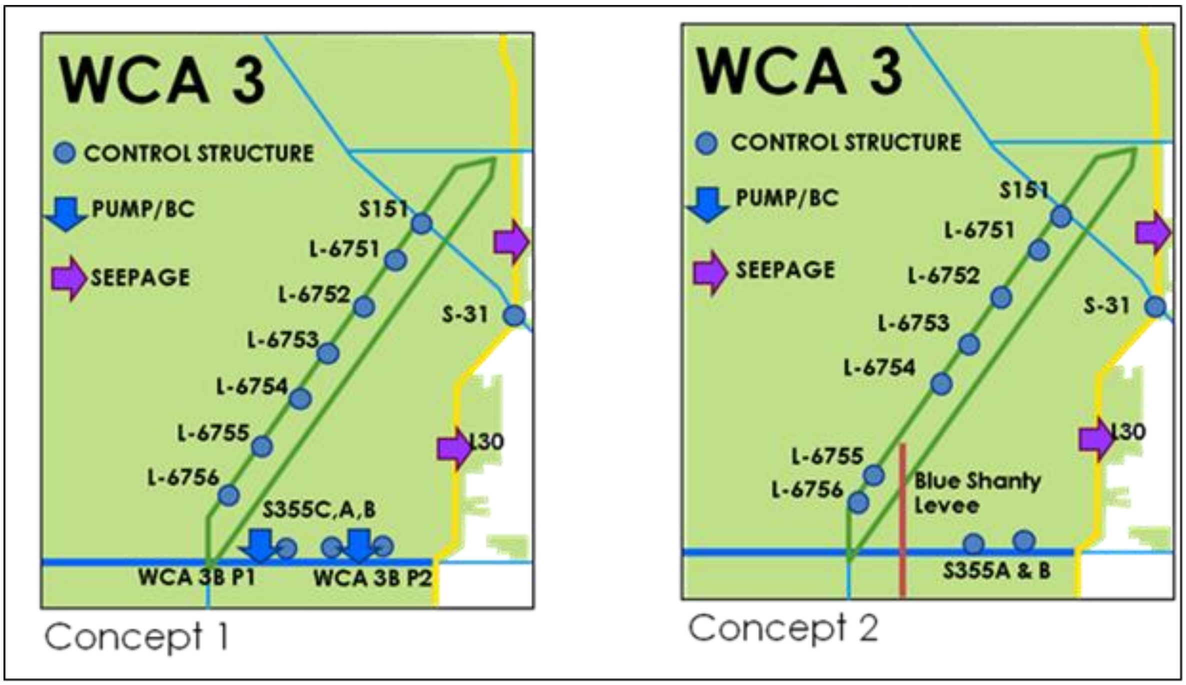

Figure E.1- 14. Configurations Identified for iModel

An iModel set was developed for both configurations. Simple assumptions using the ridge and slough vegetation performance measure were used as initial ecological targets for the iModel to try to achieve. The simulation results were not limited by other real world constraints, such as for seepage effects, levee integrity, or regulation schedules for nearby areas.

E.3.3.1 Refinement of System-Wide Operational Targets

The iModel distributes the existing and new water and develops optimal performance toward the overall hydrologic targets. The two runs (Concept 1, Concept 2) performed well in several locations, given that an average of 200,000 acre-feet of new water was being delivered to the system and that most constraints were not yet included. However, the team recognized that performance in many locations could be better, that some of the performance challenges were due to inconsistencies among the targets, and that seepage must be taken into account. Some of the stage targets elsewhere in the conservation areas and ENP could not be met, and performance in some locations did not meet expectations for restoration. Operational targets were refined prior to further iModel sensitivity runs.

Many factors were considered during the refinement of operational targets for the water conservation areas and ENP. Stages in WCA 1 were to remain unchanged from existing conditions. Stages in WCA 2 were to meet targets provided by the US Fish and Wildlife Service, which differed from the ridge and slough vegetation stage target. These locations were given high importance during subsequent iModel runs. Operational stage targets in WCA 3A, WCA 3B, and ENP considered several realities. Some areas have suffered more from subsidence and soil loss than other areas. For these most degraded areas, smaller incremental changes toward full restoration water depth targets might be more appropriate than large magnitude changes which would make conditions worse rather than better. There was and is a mix of different ecological communities in the water conservation areas. A single slough water depth target would not be suitable for sawgrass plain, marl prairie, and upland habitats, and might not be suitable for all locations that still contain tree islands. Targets were adjusted downward for these locations and, to avoid abrupt changes in water stage or depth, for locations between the deeper ridge and slough habitats and shallower sawgrass, marl, or upland habitats. Locations with adjacent deeper water targets and shallower depth targets required careful balancing.

The stage target for WCA 3B was amended to include a maximum 60 day duration for high water depths. This was added because many of the tree islands in WCA 3B have lost some of their elevation due to oxidation of their soil; their elevations are now much closer to the elevation of the sloughs and surrounding marsh. Deep water for a short time is not a problem, but deep water for a long time would be damaging to tree islands.

The small reductions of the depth targets in northern WCA 3A enabled the creation of a much better pattern of wet season to dry season variability in these northern locations as well as in many locations farther south in the system. Depth targets were kept at existing conditions in central WCA 3A (Site 3A-4) since it contains some of the best remaining ridge and slough habitat in the Everglades. In areas north of this central site, where conditions tend to be too dry, targets were increased relative to existing conditions. In areas south of this central site, where water is often too deep, depth targets were decreased slightly relative to existing conditions. This “pivot” around central WCA 3A minimized the increase of overall average water depths in WCA 3A and the concern about the effects of deep water at the L-29 levee in WCA 3A (WCA 3A Zone A constraint). It also reduced the wedge effect and produced water surface profiles that are closer to parallel to the ground surface (**Figure E.1- 15**).

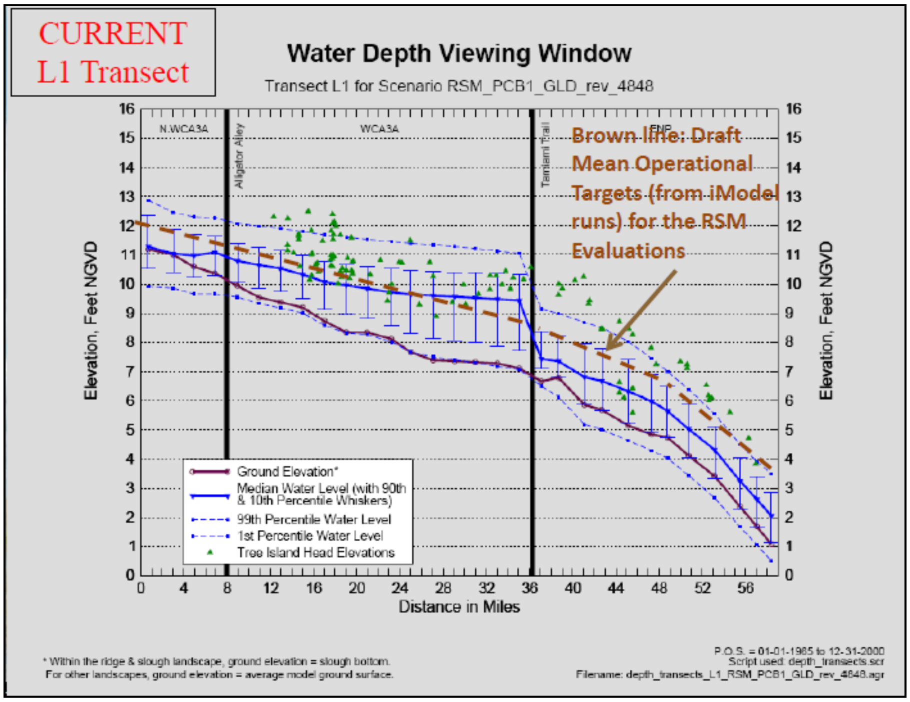

Figure E.1- 15. Water Depth Viewing Window for Transect L1 Extending Through WCA 3 and ENP

The resulting refined operational targets were mostly achievable with the CEPP water budget and provided a relatively smooth water surface gradient approaching parallel to the ground surface that also sloped downward from the northern edge of WCA 3A to southern ENP and Florida Bay.

The team returned to the large table of options for conveyance. Using the iModel with the refined operational targets, conducted multiple sensitivity runs to address the effects of changes in specific structures.

The refined operational targets for CEPP's iModel screening differ from full restoration targets from RECOVER due to a recognition among the agencies that topography, vegetation, and other natural conditions in the WCAs have changed since drainage and therefore achieving the 'full restoration' inundation duration through particular areas that have experienced the most change could have unintended effects. Therefore, for screening, operational targets were developed by the interagency CEPP ecosubteam that were considered reasonable inundation durations with acceptable timing, depths, and frequency of wet periods that would allow the areas to adjust to CEPP's increment of CERP restoration.

The ecological subteam set the targets used in the iModel runs based on the RECOVER Slough Performance Measure (described in **Appendix G**). The targets aim for an increment of restoration that will benefit the areas given the current ecology and elevations (e.g., sawgrass plain in northeastern WCA3. The RECOVER Slough PM provides a target that describes a full-restoration, pre-drainage pattern of hydroperiods within sloughs, with the expectation that suitable water depths for slough vegetation will provide the desired restoration condition for the entire ridge and slough landscape. Four hydrologic metrics are combined to determine suitability for slough vegetation: 1) continuous hydroperiod; 2) continuous dry-down duration below 0.7 ft (20 cm); 3) wet season average water depth; and 4) dry season average water depth. **Figure E.1- 16** shows the modified targets for WCA 3A and 3B. **Figure E.1- 17** shows the modified targets for ENP.

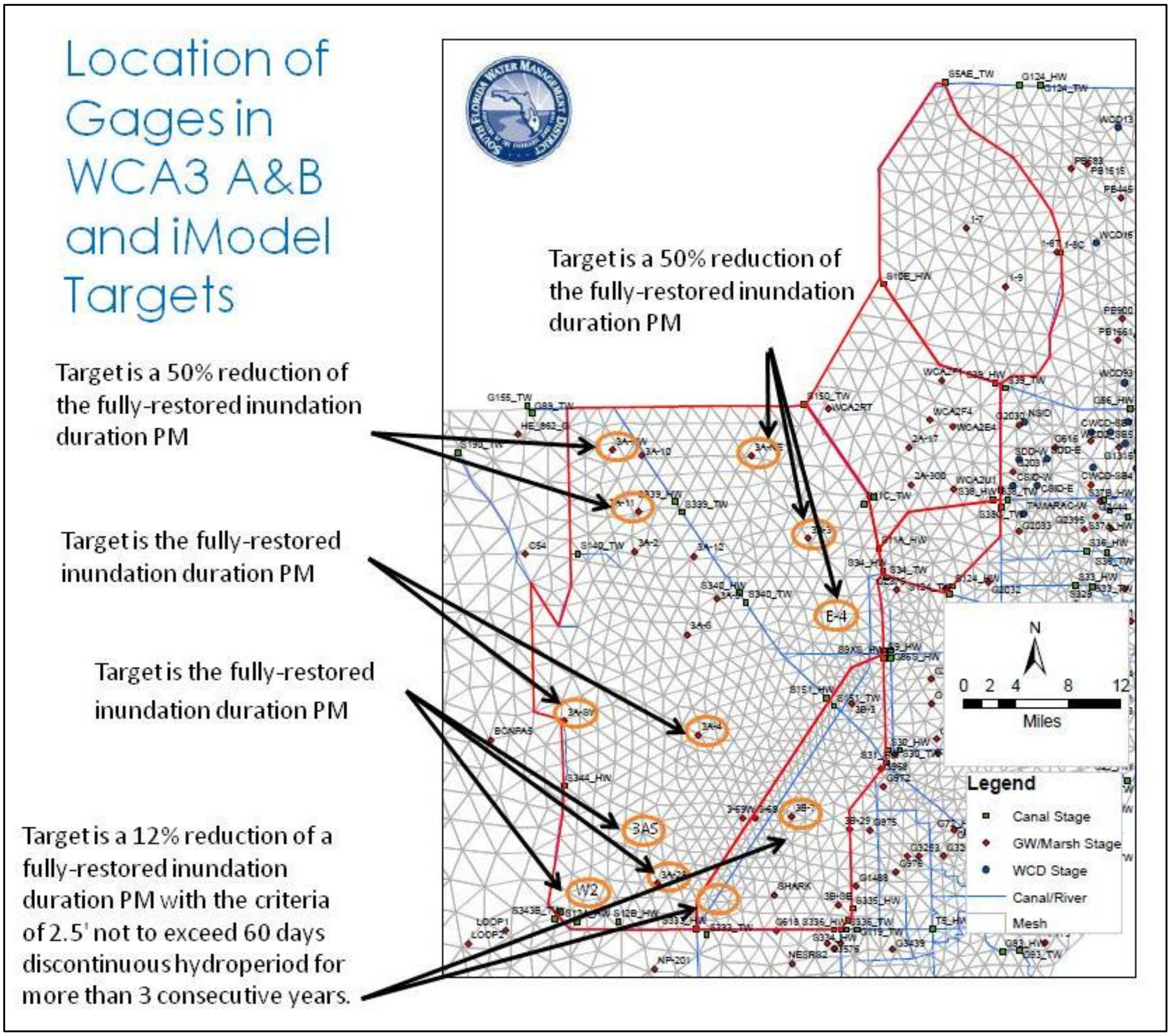

Figure E.1- 16. Locations for measuring inundation and depth in WCA 3A and WCA 3B

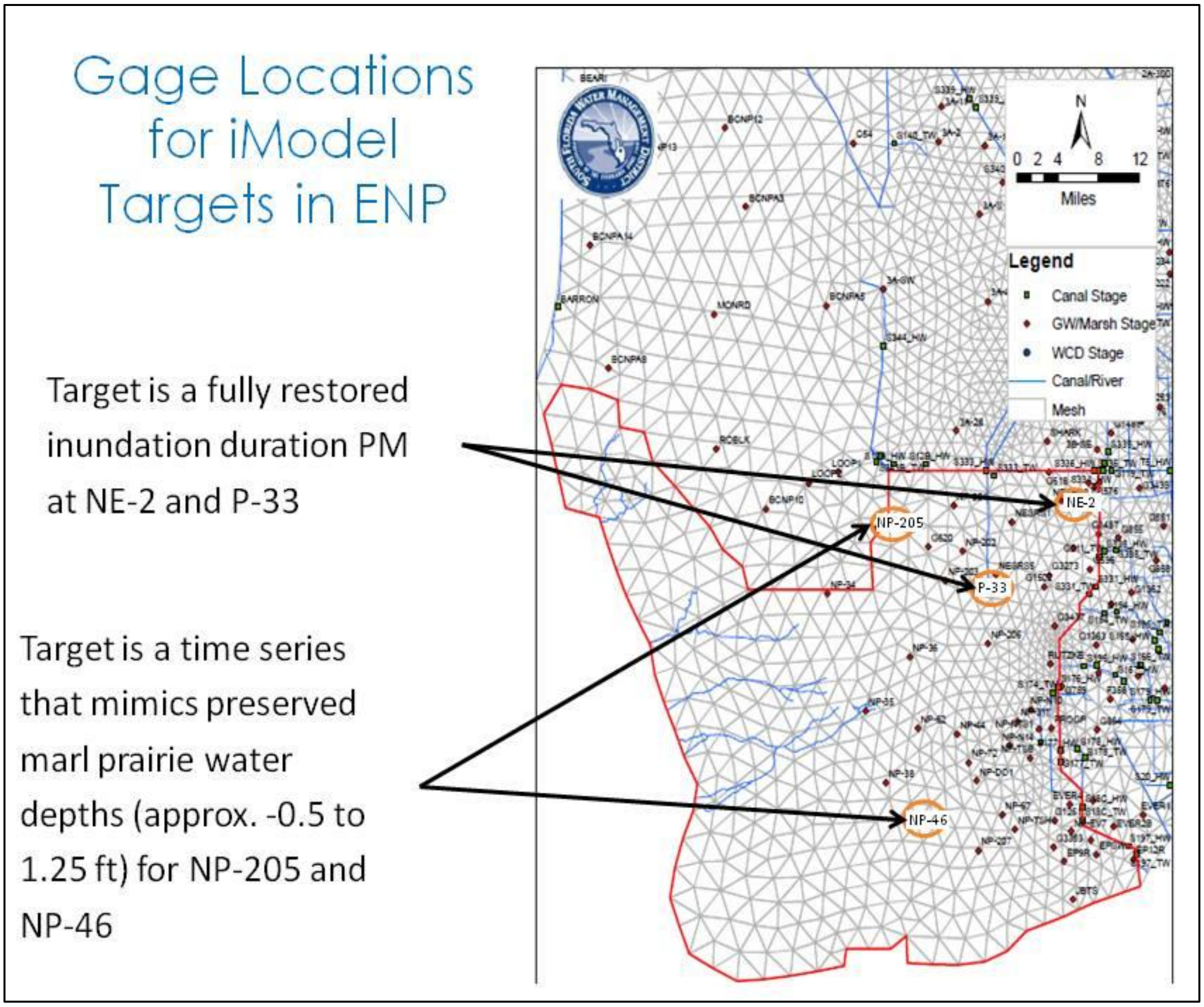

Figure E.1- 17. Locations for measuring inundation and depth in ENP

Removing the L-6 diversion resulted in too much water delivery to WCA 2, in exceeding the depth targets for WCA 2 and in increased discharge from southern WCA 2 through the S-11 structures. These southern discharges resulted in exceeding the WCA 3A Zone A too frequently. Thus, the L-6 diversion must be retained in the CEPP alternatives.

As flows and stages at Site 71 in central WCA 3B were increased, there was increased adverse seepage out of WCA 3B that would increase potential flooding in the developed areas east of WCA 3B. Increased seepage would require additional measures to manage seepage.

An 8.5 foot stage constraint in the L-29 canal did not greatly reduce stages and flows through WCA 3B into ENP. An 8.0 foot stage constraint measurably reduced flows and reduced attainment of stage targets. The major factor establishing the stage constraint in the L-29 canal is Tamiami Trail highway and the amount of modification to the existing highway.

E.3.3.2 Formulation of Initial Options for Distribution and Conveyance – Southern WCA 3A

The structures contained in the two conceptual configurations were assembled into 23 combinations of location and size of features to allow water to flow from WCA 3A into WCA 3B and ENP. Some of these combinations were modified from alternatives addressed in previous studies and others were suggested by agencies and stakeholders. Some of the combinations were deemed to be not substantially different from each other and were removed. Others were screened based on the information on structure size/usage described in the modeling conducted during the refinement of system-wide operational targets. The 23 options and the screening details are described in (**Table E.1-41**). Options not retained are marked with "x". The preliminary screening resulted in 10 options that underwent iModel analysis (**Table E.1-42**).

Table E.1-41. Features of 23 initial options for conveyance and distribution in southern WCA 3A, 3B, and ENP, and reasoning for removal from further consideration

Option	Title	S-333	3B/L-67A levee	L67C levee	L-29 levee	Blue Shanty levee, 3B	Blue Shanty levee, ENP	Divide in L 29 canal	L-29 canal operational limit	Tamiami Trail Bridge	Tamiami Trail road	L-67 Ext levee	3B Seepage Management	Narrative
1A	No - WCA 3B	2000					TBD	TBD	9.7	TBD - TTNS	TBD - TTNS	TBD	Constrained	
2	No - WCA 3B	Increase capacity					2.6m	Yes	9.7 ft west of divide / 8.5 feet east	2.6m	Road raise - model derived distance from divide	Yes/No	Constrained	Preliminary iModel results have demonstrated little variability in 9.7 vs. 8.5 feet in meeting targets are park. Formulation assumesno constraint from Tamiami Trail in the future with and without project conditions. A divide structure with different elevations in the L-29 would only serve a seepage management function.
3A1	Southerly Orientation 3B	2000	S4, S5, S6 @500cfs	Gaps at structures	355A,B,C		TBD	TBD	9.7	TBD - TTNS	TBD - TTNS	TBD	Unconstrained	
3A2	Southerly Orientation 3B	2000	S4, S5, S6 @750cfs	Gaps at structures	355A,B,C		TBD	TBD	9.7	TBD - TTNS	TBD - TTNS	TBD	Unconstrained	
3B2	Southerly Orientation 3B	2000	S 4, S5, S6 @750 cfs	Gaps at structures	355A,B,C Pump 1		TBD	TBD	9.7	TBD - TTNS	TBD - TTNS	TBD	Unconstrained	
3B3	Southerly Orientation 3B	2000	S 4, S5, S6 @750 cfs	Gaps at structures	355A,B,C Pump 1		TBD	TBD	9.7	TBD - TTNS	TBD - TTNS	TBD	Constrained	
4A	Southwest 3B - Blue Shanty	Existing	S5, S6 and S1-4	Degrade west of Blue Shanty levee	Degrade west of blue shanty levee	From L67A to L-29	TBD	TBD	9.7	TBD - TTNS	TBD - TTNS	TBD	Constrained	
4B	Southwest 3B - Blue Shanty	Existing	S5, S6 and S4	Degrade west of Blue Shanty levee	Degrade west of blue shanty levee	From L67A to L-29	TBD	TBD	9.7	TBD - TTNS	TBD - TTNS	TBD	Constrained	
4C	Southwest 3B - Blue Shanty	Existing	S5, S6	Degrade west of Blue Shanty levee	Degrade west of blue shanty levee	From L67A to L-29	TBD	TBD	9.7	TBD - TTNS	TBD - TTNS	TBD	Constrained	
5	Southwest 3B - Blue Shanty	Existing	Controlled structures	Degrade west of Blue Shanty levee	Controlled structures west blue shanty levee	From L67A to L-29	1m	Yes	9.7 ft west of divide / 8.5 feet east	1m	TTMNS rebuild western	Yes/No	TBD	Preliminary iModel results have demonstrated little variability in 9.7 vs. 8.5 feet in meeting targets are park. Formulation assumes 9.7 future with project condition.

Option	Title	S-333	3B/L-67A levee	L67C levee	L-29 levee	Blue Shanty levee, 3B	Blue Shanty levee, ENP	Divide in L 29 canal	L-29 canal operational limit	Tamiami Trail Bridge	Tamiami Trail road	L-67 Ext levee	3B Seepage Management	Narrative
6A	Southwest 3B	Increase capacity if needed	Controlled structures	Gaps at structures	more 355s; gravity		2.6m		8.5 feet	2.6m		Yes/No	TBD	Preliminary iModel results have identified optimal location of structures to achieve desired system operations and iModel has demonstrated little variability in 9.7 vs. 8.5 feet in meeting targets are park. Formulation assumes 9.7 future with project condition.
6B	Southwest 3B	Increase capacity if needed	Controlled structures	Gaps at structures	more 355s; pump		2.6m		8.5 feet	2.6m		Yes/No	TBD	Preliminary iModel results have identified optimal location of structures to achieve desired system operations and iModel has demonstrated little variability in 9.7 vs. 8.5 feet in meeting targets are park. Formulation assumes 9.7 future with project condition.
	Southwest 3B	Increase capacity	3 structures	3 gaps	more 355s; gravity		2.6m	2.6m	9.7 feet	2.6m	TTMNS rebuild		TBD	Eliminated - Non-compatible with authorized next-steps bridging (road work would have to be constructed then removed - lack of future compatability
	Soutwest 3B	Increase capacity	3 structures	3 gaps	pump		2.6m	2.6m	9.7 feet	2.6m	TTMNS rebuild		TBD	Eliminated - Non-compatible with authorized next-steps bridging (road work would have to be constructed then removed - lack of future compatability
7A	South-Central 3B	Increase capacity if needed	Controlled structures	Gaps at structures	more 355s; gravity		2.6m	2.6m	8.5 feet	2.6m		Yes/No	TBD	Preliminary iModel results have identified optimal location of structures to achieve desired system operations and iModel has demonstrated little variability in 9.7 vs. 8.5 feet in meeting targets are park. Formulation assumes 9.7 future with project condition.
7B	South-Central 3B	Increase capacity if needed	Controlled structures	Gaps at structures	more 355s; pump		2.6m	2.6m	8.5 feet	2.6m		Yes/No	TBD	Preliminary iModel results have identified optimal location of structures to achieve desired system operations and iModel has demonstrated little variability in 9.7 vs. 8.5 feet in meeting targets are park. Formulation assumes 9.7 future with project condition.
	South-Central 3B	Increase capacity	3 structures	3 gaps	more 355s; gravity		2.6m	2.6m	9.7 feet	2.6m	TTMNS rebuild		TBD	Eliminated - Non-compatible with authorized next-steps bridging (road work would have to be constructed then removed - lack of future compatability
	South-Central 3B	Increase capacity	3 structures	3 gaps	pump		2.6m	2.6m	9.7 feet	2.6m	TTMNS rebuild		TBD	Eliminated - Non-compatible with authorized next-steps bridging (road work would have to be constructed then removed - lack of future compatability

Option	Title	S-333	3B/L-67A levee	L67C levee	L-29 levee	Blue Shanty levee, 3B	Blue Shanty levee, ENP	Divide in L 29 canal	L-29 canal operational limit	Tamiami Trail Bridge	Tamiami Trail road	L-67 Ext levee	3B Seepage Management	Narrative
8A	Entire L-67A extent	Increase capacity if needed	6 structures	Gaps at structures	more 355s; gravity		2.6m	2.6m	8.5 feet	2.6m			TBD	Preliminary iModel results have demonstrated little variability in 9.7 vs. 8.5 feet in meeting targets are park. Formulation assumes 9.7 future with project condition.
8B	Entire L-67A extent	Increase capacity if needed	6 structures	Gaps at structures	more 355s; pump		2.6m	2.6m	8.5 feet	2.6m	Road raise - model derived distance from divide		TBD	Preliminary iModel results have demonstrated little variability in 9.7 vs. 8.5 feet in meeting targets are park. Formulation assumes 9.7 future with project condition.
9A	Entire L-67A extent	Increase capacity if needed	6 structures	Gaps at structures	more 355s; gravity		TBD	TBD	9.7	TBD - TTNS	TBD - TTNS	TBD	Unconstrained	
9B	Entire L-67A extent	Increase capacity if needed	6 structures	Gaps at structures	more 355s; pump		5.5	5.5	9.7 ft	5.5	Road Raise		Constrained	Preliminary iModel results have demonstrated little use of several structures on the L-67A when seepage is constrained.
10A	North/South	2000	S2,S3 S5,S6 @500cfs	Gaps at structures	355A,B,C 2 pumps @500cfs		TBD	TBD	9.7	TBD - TTNS	TBD - TTNS	TBD	Unconstrained	

Table E.1-42. Features of the 10 options that were modeled with the iModel screening tool.

Option	Title	S-333	3B/L-67A levee	L67C levee	L-29 levee	Blue Shanty levee, 3B	Blue Shanty levee, ENP	L-29 canal operational limit	Tamiami Trail Bridge	Tamiami Trail road	L-67 Ext levee
1A	No - WCA 3B	2000						9.7	2.6	Road Reconstruction	TBD
3A1	Southerly Orientation 3B	2000	S4, S5, S6 @500cfs	Gaps at structures	355A,B,C			9.7	2.6	Road Reconstruction	TBD
3A2	Southerly Orientation 3B	2000	S4, S5, S6 @750cfs	Gaps at structures	355A,B,C			9.7	2.6	Road Reconstruction	TBD
3B2	Southerly Orientation 3B	2000	S 4, S5, S6 @750 cfs	Gaps at structures	355A,B,C Pump 1			9.7	2.6	Road Reconstruction	TBD
3B3	Southerly Orientation 3B	2000	S 4, S5, S6 @750 cfs	Gaps at structures	355A,B,C Pump 1			9.7	2.6	Road Reconstruction	TBD
4A	Southwest 3B - Blue Shanty	2000	S5, S6 and S1-4	Degrade west of Blue Shanty levee	Degrade west of blue shanty levee	From L67A to L-29	Yes	9.7/8.5 with Divide	2.6	Road Reconstruction	TBD
4B	Southwest 3B - Blue Shanty	2000	S5, S6 and S4	Degrade west of Blue Shanty levee	Degrade west of blue shanty levee	From L67A to L-29	Yes	9.7/8.5 with Divide	2.6	Road Reconstruction	TBD
4C	Southwest 3B - Blue Shanty	2000	S5, S6	Degrade west of Blue Shanty levee	Degrade west of blue shanty levee	From L67A to L-29	Yes	9.7/8.5 with Divide	2.6	Road Reconstruction	TBD
9A	Entire L-67A extent	2000	6 structures	Gaps at structures	more 355s; gravity			9.7	2.6	Road Reconstruction	TBD
10A	North/South	2000	S2,S3 S5,S6 @500cfs	Gaps at structures	355A,B,C 2 pumps @500cfs			9.7	2.6	Road Reconstruction	TBD

E.3.4 Evaluation Criteria for Storage and Treatment Options

The preliminary screening resulted in 10 options that underwent iModel analysis for performance toward restoration (end-point) ecological targets that were developed independently, previous to CEPP, for the Everglades through the interagency RECOVER process (Level 1 below). The full restoration targets from RECOVER differ from the operational targets prepared for CEPP's iModel screening due to a recognition among the agencies that topography, vegetation, and other natural conditions in the WCAs have changed since drainage and therefore achieving the 'full restoration' inundation duration through particular areas that have experienced the most change could have unintended effects. Therefore, for screening, operational targets were developed by the interagency CEPP ecosubteam that were considered reasonable inundation durations with acceptable timing, depths, and frequency of wet periods that would allow the areas to adjust to CEPP's increment of CERP restoration. Expected adjustments include accretion of peat, which will help to restore elevations and plant species composition to pre-drainage conditions, which will help the areas stand ready for additional flows if agencies agree to send such flows in future restoration projects. These options also underwent an analysis for other important screening factors (Level 2 below).

E.3.4.1 Inundation (Level 1)

E.3.4.1.1 Criteria Description

Inundation is defined as the average % time above ground surface elevation. These are estimated for multiple locations throughout WCA 3A, WCA 3B, and ENP in a performance measure known as the Slough PM, developed by RECOVER. These figures also display the operational target adjustments for each location. The operational targets are further discussed in Sections E.3.3.1 and E.3.4 of this appendix.

E.3.4.1.2 Evaluation Tool Used

iModel (See Section E.3.3 for a description)

E.3.4.1.3 Scoring Methodology

Criterion was measured as percent deviation from NSM ridge and slough targets for the average % time above ground surface elevation (GSEL). Options were rated in quadrants (**Table E.1-43**). The quadrants were calculated based on the largest deviation from the target and the smallest deviation from target. However an ecological threshold was established for scoring: Location 3A4 (Site 64) existing condition considered to be sub-optimal but sustainable, so 3A4 Score = 3. Any Option scoring better than Site 64 scored at least Quartile 3.

Table E.1-43. Inundation quadrant rating

Quadrant Rating	
4 - Best	*Midpoint between Max and 3A4 Score <Option X < Max Score*
3	*3A4 Score < Option X < Midpoint between Max and 3A4 Score*
2	*Midpoint between Min and 3A4 Score < Option X < 3A4 Score*
1 –Worst	*Option X < Midpoint between Min and 3A4 Score*

A threshold for significant difference among options was also established. If there was less than 2% difference in inundation duration between minimum and maximum options scores: "Performs Similarly".

E.3.4.1.4 Criteria Results

Results are presented in **Table E.1-44**.

Table E.1-44. Results of iModel Inundation Rating

Option	Title	Inundation WCA 3A	Inundation WCA 3B	Inundation ENP
1A	No - WCA 3B	3.4	2.0	2.0
3A1	Southerly Orientation 3B	3.8	4.0	1.0
3A2	Southerly Orientation 3B	3.8	4.0	1.0
3B2	Southerly Orientation 3B	3.8	4.0	3.0
3B3	Southerly Orientation 3B	3.8	4.0	3.0
4A	Southwest 3B - Blue Shanty	3.8	3.0	1.5
4B	Southwest 3B - Blue Shanty	3.6	3.0	1.5
4C	Southwest 3B - Blue Shanty	3.8	1.0	1.5
9A	Entire L-67A extent	3.8	4.0	1.0
10A	North/South	4.0	4.0	2.0

E.3.4.2 Depth (Level 1)

E.3.4.2.1 Criteria Description

Depth is the average ponding depth (ft) above ground surface elevation. These are estimated for multiple locations throughout WCA 3A, WCA 3B, and ENP.

E.3.4.2.2 Evaluation Tool Used

iModel

E.3.4.2.3 Scoring Methodology

Criterion is measured as percent deviation from NSM ridge and slough targets quantified for the average ponding depth (ft) above ground surface elevation (GSEL). The scoring methodology is consistent with how inundation was calculated (**Section E.3.4.1.3**.)

E.3.4.2.4 Criteria Results

Results are presented in Table E.1-45.

Table E.1-45. Results of iModel Ponding Rating

Option	Title	Depth WCA 3A	Depth WCA 3B	Depth ENP
1A	No - WCA 3B	3 3	1.0	3.3
3A1	Southerly Orientation 3B	3 3	3.0	3.0
3A2	Southerly Orientation 3B	2.7	4.0	3.3
3B2	Southerly Orientation 3B	3 3	3.0	4.0
3B3	Southerly Orientation 3B	3 3	2.0	4.0
4A	Southwest 3B - Blue Shanty	4.0	2.0	3.0
4B	Southwest 3B - Blue Shanty	4.0	2.0	3.0
4C	Southwest 3B - Blue Shanty	4.0	1.0	3.0
9A	Entire L-67A extent	2.7	4.0	3.3
10A	North/South	3 3	4.0	3.7

E.3.4.3 Marl Prairie Recession Rate (Level 1)

E.3.4.3.1 Criteria Description

The Marl Prairie Recession rate was estimated for location NP205 within ENP. The Marl Prairie Recession rate is one of the key criteria for healthy marl prairie habitat. This habitat is less common than and has different requirements than the more widespread ridge and slough habitat in ENP.

E.3.4.3.2 Evaluation Tool Used

iModel

E.3.4.3.3 Scoring Methodology

Each column is the percent of target met for each alternative for the preferred recession rate (first data column) and marginal recession rate (second column). The preferred recession rate was weighted 20% while the marginal recession rate weighted 10% higher than raw score. All options exceeded target in the preferred column while none met the target in the marginal column. Average of the two weighted scores to come with a final number. The scale is equal increments based on the range of results (4 best, 1 worst).

E.3.4.3.4 Criteria Results

Results are presented in **Table E.1-46.**

Table E.1-46. Results of iModel Marl Prairie Rating

	Pref		Marg			
Alt	raw % target achieved	Weighting *.2	raw % target achieved	Weighting *.1	Sum Pref*.2 and Marg*.1	RANK
Opt 1A	148.88	178.65	58.87	64.76	243.41	1
Opt_3A1	153.81	184.57	67.85	74.63	259.21	4
Opt_3A2	162.33	194.80	57.20	62.92	257.72	3
Opt 3B2	157.85	189.42	59.29	65.22	254.64	3
Opt 3B3	166.37	199.64	55.74	61.32	260.96	4
Opt 4A	148.43	178.12	57.20	62.92	241.04	1
Opt 4B	168.16	201.79	50.31	55.34	257.14	3
Opt 4C	154.71	185.65	53.03	58.33	243.98	1
Opt 9A	150.67	180.81	62.84	69.12	249.93	2
Opt_10A	156.50	187.80	62.63	68.89	256.70	3

E.3.4.4 Operational Flexibility and Adaptability (Level 2)

E.3.4.4.1 Criteria Description

Operational flexibility: the speed, ease, efficiency of moving water to adjust changing conditions such as storms or other real-time needs. Robustness was defined as the ability to function effectively in the face of variability and uncertainty of future events.

Adaptability: measured using two separate metrics; 1) Robustness and 2) Future Compatibility. Robustness was defined as the ability to function effectively in the face of variability and uncertainty of future events. Future compatibility was defined as the efficiency of using the project configuration to complement future CEPP increments.

E.3.4.4.2 Evaluation Tool Used

Best professional judgment was obtained from interagency CEPP team members with working experience in WCA operations, ecology, and adaptive management, who could draw from their professional experience to judge the flexibility, robustness, and adaptability of the options.

E.3.4.4.3 Scoring Methodology

The scale is equal increments based on the range of results (4 easiest to adjust, 1 hardest).

E.3.4.4.4 Criteria Results

Results are presented in **Table E.1-47.** General trends include:

- Flexibility: Project configurations with the greatest amount of infrastructure would provide more operational flexibility. Operations can be changed rapidly to meet almost any conditions.

- Future Compatibility: Project configurations with the least amount of infrastructure would be more compatible with future CERP projects. Configurations would not need to be removed or vastly retrofitted in the future.
- Robustness: Project configurations scored similarly to ratings for operationally flexibility. Configurations with the greatest amount of infrastructure would improve ability to function effectively in the future, if there is a need to move more water through the system.

Table E.1-47. Results of the Adaptive Management Rating

Option	Title	Operational Flexibility	Future Compatibility	Robustness
1A	No - WCA 3B	1	4	1
3A1	Southerly Orientation 3B	3	3	2
3A2	Southerly Orientation 3B	3	3	3
3B2	Southerly Orientation 3B	4	2	4
3B3	Southerly Orientation 3B	4	2	4
4A	Southwest 3B - Blue Shanty	3	1	3
4B	Southwest 3B - Blue Shanty	2	1	2
4C	Southwest 3B - Blue Shanty	2	1	2
9A	Entire L-67A extent	3	3	3
10A	North/South	4	2	4

E.3.4.5 Ecologic Connectivity (Level 2)

E.3.4.5.1 Criteria Description

This criterion evaluates increases in wetland acreage and marsh connectivity directly associated with the removal of man-made barriers to flow. The criterion was developed based on the set of CEPP project objectives related to restoring seasonal hydroperiods and freshwater distribution, and surface water depths within the project area. Water management practices beginning in the early 20th century led to the construction of an extensive system of canals, levees, and pump stations crisscrossing the once free-flowing natural system, which in turn has led to human-dominated operations of that system. This channelization, compartmentalization, and physical manipulation of how water flows into the Everglades due to water management operational criteria (i.e., regulation schedules) has altered or eliminated sheet flow and related hydrologic characteristics throughout much of the Everglades. Canals, levees, and roads constructed under the C&SF Project have been identified as causing landscape fragmentation, loss of connectivity of the natural system, alteration of volume, timing, and distribution of regional hydropatterns and degradation of habitat of wetland organisms. The loss of connectivity necessary for sheet flow has resulted in far-reaching effects on ecological processes and habitat. The ridge and slough landscape has become severely degraded in a number of locations and is being replaced with a landscape more uniform in terms of topography and vegetation, with less directionality. The desired restoration condition is to maximize the ecological connectivity and acreage of wetlands in the Everglades by removing or reducing the effects of landscape discontinuities caused by levees, canals, drainage ditches and spoil banks.

E.3.4.5.2 Evaluation Tool Used

GIS and best professional judgment

E.3.4.5.3 Scoring Methodology

Previous method used to calculate and apply criteria does not apply to southern WCA 3A, 3B and ENP options since a majority of the options do not contain removal of levees and/or backfilling of canals. While the Blue Shanty Plans (Options 4A, 4B, and 4C) degrade portions of L-67 C and L-29 Levee, they also construct a levee in WCA 3B, negating the footprint of connectivity re-established. Configurations do increase marsh connectivity by providing hydrologic re-connection from WCA 3A to WCA 3B and ENP. Options were rated on 1 -4 scale.

E.3.4.5.4 Criteria Results

Option 1A provides limited ecological connectivity and no Options provide the level of connectivity CERP envisioned (**Table E.1-48**).

Table E.1-48. Results of the Ecological Connectivity Rating

Option	Title	Rating
1A	No - WCA 3B	1
3A1	Southerly Orientation 3B	2
3A2	Southerly Orientation 3B	2
3B2	Southerly Orientation 3B	2
3B3	Southerly Orientation 3B	2
4A	Southwest 3B - Blue Shanty	2
4B	Southwest 3B - Blue Shanty	2
4C	Southwest 3B - Blue Shanty	2
9A	Entire L-67A extent	2
10A	North/South	2

E.3.5 Distribution and Conveyance Options – MCDA and Cost Effective Results – Southern WCA 3A, 3B and ENP

Table E.1-49 and **Table E.1-50** provide a summary of the scores for both the level 1 and level 2 criteria for the 10 options evaluated with the iModel screening tool.

Table E.1-49. Scores for level 1 criteria and total cost for the 10 options evaluated with the iModel screening tool.

		Level 1								
Option	**Title**	Inundation WCA 3A	Inundation WCA 3B	Inundation ENP	Depth WCA 3A	Depth WCA 3B	Depth ENP	Recession Rates	**Summary Level 1**	Total Cost
1A	No - WCA 3B	3.4	2.0	2.0	3.3	1.0	3.3	1	16.1	6.2
3A1	Southerly Orientation 3B	3.8	4.0	1.0	3.3	3.0	3.0	4	22.1	23
3A2	Southerly Orientation 3B	3.8	4.0	1.0	2.7	4.0	3.3	3	21.8	25.6
3B2	Southerly Orientation 3B	3.8	4.0	3.0	3.3	3.0	4.0	3	24.1	52.5
3B3	Southerly Orientation 3B	3.8	4.0	3.0	3.3	2.0	4.0	4	24.1	52.5
4A	Southwest 3B - Blue Shanty	3.8	3.0	1.5	4.0	2.0	3.0	1	18.3	65.7
4B	Southwest 3B - Blue Shanty	3.6	3.0	1.5	4.0	2.0	3.0	3	20.1	50.4
4C	Southwest 3B - Blue Shanty	3.8	1.0	1.5	4.0	1.0	3.0	1	15.3	45.3
9A	Entire L-67A extent	3.8	4.0	1.0	2.7	4.0	3.3	2	20.8	38.2
10A	North/South	4.0	4.0	2.0	3.3	4.0	3.7	3	24.0	55

Table E.1-50. Scores and total cost for options evaluated with the iModel screening tool.

10A

E.4 SEEPAGE MANAGEMENT

The options for seepage management are formulated upon identification of the WCA 3B and ENP hydrologic conditions (depth and timing) resulting from the distribution and conveyance options. . However, it is possible to initially screen management measures for seepage management based on preliminary metrics. The seepage management measures are intended to address the following objective and constraints:

- Reduce water loss out of the natural system to promote appropriate dry season recession rates for wildlife utilization.

Additionally, measures were considered that would address the following project constraints:

In accordance with Section 601(h)(5) of WRDA 2000 and Chapter 373.1501(4)(d), F.S.
- Avoid any reduction in level of service for flood protection existing as of December 2000 caused by Plan implementation
- Provide replacement sources of water of comparable quantity and quality for existing legal users caused by Plan implementation
- Meet applicable Water Quality Standards

E.4.1 Seepage Management Measures

This section contains a list and description of management measures. The measures are limited to major features and activities that would form the basis for alternatives. Minor features or activities such as ditch plugging and elimination of exotic species of vegetation were not included as measures since comparison between alternatives for seepage management would not be affected.

The measures for Seepage Management are as follows:

Recharge Basin: A recharge basin could be utilized to maintain flows to wellfields that may be eliminated by blockage of lateral groundwater movement. The recharge basin would also provide aquifer protection by maintaining the saltwater-freshwater interface (prevent saltwater intrusion). A recharge basin was included in the Yellow Book. The Bird Drive Recharge Area (BDRA), Component U6 in the Yellow Book, assumed a 2,877 acre above-ground recharge area with water levels fluctuating up to 4 feet above grade. During plan formulation for the Everglades National Park Seepage Management Project (ENPSM), the following concerns were raised about the proposed feature:

- High porosity and transmissivity.
- Ability to hold water onsite for deliveries to the South Dade Conveyance System.
- Potential for flooding impacts to urban areas east of the project site.
- Design and operation may not be feasible.
- Project type is not implementable

Additionally, many parcels within the basin remain in private ownership and may not be available for the project as originally conceptualized. As such, a recharge basin was eliminated from further consideration in the CEPP.

New Pump Stations to Return Water to the Natural System: New pump stations could be utilized to return seepage water to the natural system. Similar to the purposes of the existing S-356 Pump Station, new stations could be positioned along the L-30/L-31N Canals to pump water from the canal into WCA 3B and ENP. Water quality of surface water from the canals may be of concern; however, this measure was retained for possible inclusion in components and alternatives.

Operate or Relocate Existing Pump Stations to Return Water to the Natural System: There is currently a pump station, S-356, that was constructed in order to pump surface water into ENP to return seepage water to the natural system and supplement flows; however, S-356 has never been operated due to a number of constraints that have yet to be resolved. This measure was retained for further consideration.

In-Ground Seepage Barrier: In-ground seepage barriers could be constructed of suitable material to prevent the lateral movement of ground water within the surficial layers of the Biscayne aquifer. Varieties of seepage barriers are based on the material used, design configuration, and the depth of the barrier. Issues that would be addressed include the maintenance of flood protection and quantity and quality of freshwater flow to existing legal water supply wells and the Biscayne Bay system to the east. A 2-mile Pilot Project is currently being constructed by a private entity along the L-31, which may provide opportunities to evaluate the feasibility and performance of this approach, including potential effects on water supply wells. As such, this measure was retained for further consideration.

Raise Canal Stages along L-30/L-31N: Downstream gates on the L-31N could be managed during the dry season in order to maintain higher canal stages. The higher canal stages would reduce the surface water hydraulic head in ENP, thereby reducing seepage out of ENP. However, the increased canal stages could potentially make the developed areas immediately to the east more prone to flooding. Associated canal improvements to the L-30/L-31 Canals and new pumping stations would likely be required for this measure. Additionally, it is likely that raising canal stages would also require additional features to maintain design purposes. For example, necessary associated features may include a flood attenuation reservoir for floodwater storage and new canal construction and/or canal relocation to deliver water to the south for agricultural/environmental water supply. This measure was retained for further consideration in components and alternatives.

Flood Attenuation Reservoir: A flood attenuation reservoir would be utilized to capture water during peak storm events. Water would be discharged into the above-ground impoundment to maintain flood protection for adjacent urban, industrial, and agricultural areas. There would be some residual risk with any potential failure of the structure and reinforced construction features and redundant measures may be required. This measure was retained for further consideration.

Above-Ground Storage for Seepage Gradient (Detention Areas): Detention Areas would consist of unconfined basins running between the L-31N and ENP where water is stacked above the elevation of the water surface in the park, reversing the groundwater gradient created by the canal. The gradient reversal would serve to maintain higher water levels and longer hydroperiods within the natural system, and increase flows to downstream areas within ENP. Detention Areas have been successfully utilized in the C-111 South Dade Project to create a hydraulic ridge and reduce seepage losses occurring across the levees to the east. Detention Areas are operationally flexible and can be optimized for water distribution both within the natural system and into populated areas. Additionally, detention areas are minimally invasive, and do not require significant alteration of the substrate to reduce seepage when compared to a seepage barrier. This measure was retained for further consideration.

Groundwater Wells: Groundwater wells could be utilized to withdraw seepage groundwater and re-distribute that water back into ENP. The amount of withdrawals would need to be managed to ensure that: 1) Enough water is being withdrawn and added back into the natural system and 2) Adequate amounts of seepage water is still flowing to the eastern well fields and areas such as Biscayne Bay. Groundwater wells have extremely high operating costs and would not likely be effective in consistently reducing seepage in the highly transmissive Miami Limestone or Upper Ft. Thompson layers. As such, due to costs and ineffectiveness, this measure was eliminated from consideration.

Line/Pipe canals: Lining or piping the canals was also evaluated as a management measure. Evaluation and assessment of shallow seepage barrier concepts concluded that seepage flows would continue underneath a shallow barrier and would not be effective in reducing seepage. Although lining or piping the canal may prevent seepage out of the canal, the main problem, seepage occurring out of the natural system, would not be affected. As such, this measure would be completely ineffective in reducing seepage on a broad scale and was therefore eliminated from further consideration.

New canals/relocate existing canals: Construction of new canals or relocation of existing canals may be required with the raising of canal stages in the L-30/L-31N Canals or other seepage management measures. The canals may be necessary for agricultural/environmental water supply deliveries in the South Dade Conveyance System and to move excess water in order to reduce flood risks. Any new canal construction/relocation would also have associated water control structures as necessary. Real estate costs for new canal construction and/or canal relocation could be excessive depending on location, and environmental impacts would also need to be considered. This measure was retained for further consideration.

Changes in Operations: Canal stages could be managed to maintain higher levels and manage seepage leaving the Water Conservation Areas and ENP. This measure would likely need to be combined with canal relocation and/or new canal construction, as well as flood attenuation.

Step-down Levees: Step-down levees would consist of a smaller levee that would be constructed east of L-30/L-31N. The step-down levee would provide an additional layer of seepage management, reducing groundwater levels immediately east of the component. Although this measure may be effective in reducing seepage, there would be difficulties for implementation due to the existence of lakes in previously mined areas immediately east of L-31N and high costs. In particular, a large, flooded lake would require that the western portion be filled in order to construct a step-down levee in this area, and therefore this measure is not constructible on a large scale. The Blue Shanty Levee will also function as a step-down level for WCA 3B and has been retained.

E.4.2 Screening of Seepage Management Measures

Table E.1-51 provides an illustration of the preliminary Management Measures considered and the ability to meet the screening criteria and also reasons for elimination if the measure was screened from further consideration. Screening criteria utilized in this analysis includes flooding impacts, costs, effectiveness, and constructability. Flooding was assessed to determine if the measure would cause adverse flooding impacts to the surrounding areas. Effectiveness refers to the ability of the measure to achieve the desired effect. Although preliminary cost estimates were not developed, excessive costs were considered where enough information was available to compare measures and eliminate those with extremely high costs. Land availability refers to whether there is sufficient or suitable property for construction and operation of the measure.

Table E.1-51. Results of Seepage Management Measure Screening

	Reasons for Elimination			
	Flooding	Effectiveness	Cost	Land Availability
Detention Area	Retained			
New Seepage Return Pump Stations	Retained			
Groundwater Wells		x		
Line/Pipe Canals		x	x	
Recharge Basin		x	x	x
Flood Attenuation Reservoir	Retained			
Relocate Existing Canals	Retained			
New Canals	Retained			
Operate / Relocate Existing Pump Stations	Retained			
Changes in Operations	Retained			
Raise Canal Stages	Retained			
Step-Down Levees	Retained			
In-Ground Seepage Barriers	Retained			