Loxahatchee River Restoration Local Initiative and Mecca Site Evaluation

Project No. WUD 19-060 CSA No. 11

Deliverable 3.2.1:

Final Alternatives Evaluation Results Technical Memorandum

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Appendix A – Deliverable 2.1 and 2.2 Draft Alternative Development and Screening Technical Memorandum dated October 31, 2019

- Summary of Modeling Methodology, Tools and Technologies
- Alternatives Simulated in the LRWRP Draft PIR

Appendix B – Dry Season and Wet Season Targets for PB Alternatives

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Background

On April 30, 2019, the Palm Beach County (County) Board of County Commissioners (BCC) was briefed by County staff on the Draft Integrated Project Implementation Report (PIR) and Environmental Impact Statement (EIS) for the Loxahatchee River Watershed Restoration Project (Loxahatchee Project or LRWRP) prepared by the U.S. Army Corps of Engineers dated March 2019. After hearing numerous public comments and a robust discussion, the BCC provided direction to staff to communicate the County's support of state and federal efforts to restore the Loxahatchee River watershed, communicate key County and stakeholder concerns and express interest in collaborating with the USACE and the South Florida Water Management District (SFWMD) to reconsider the Mecca Reservoir.

Then on July 2, 2019, the BCC approved the Loxahatchee River Watershed Restoration Local Initiative and Mecca Site Evaluation (Local Initiative). This study was intended to provide technical information on additional alternatives that address County concerns with the Loxahatchee Project, augment the technical information in the March 2019 LRWRP Draft PIR and assist in future County collaboration with USACE and SFWMD.

County concerns included incompatibility of the proposed 20-foot embankment height of the Mecca Reservoir with adjacent lands and additional flood risks to adjacent residents and existing County-owned Water Utilities Department infrastructure. Another concern was that the Loxahatchee Project did not address excess stormwater runoff from the L-8 Basin, which continues to negatively impact the Lake Worth Lagoon due to undesirable discharges of excess L-8 Basin stormwater runoff. Achieving Everglades water quality requirements will prove to be challenging without additional storage to address excess L-8 Basin runoff.

The focus of the Local Initiative was to develop alternatives comprised of components or elements already considered during the preparation of the LRWRP Draft PIR, as well as components that have been proposed by stakeholders, referred to as local initiative elements, and conduct evaluations using the USACE/SFWMD existing suite of performance measures. The complete list of local initiative elements considered is summarized in Deliverable 2.1 and 2.2 Draft Alternative Development and Screening Technical Memorandum dated October 31, 2019 and is included in Appendix A for reference. Figure 1 below shows the Local Initiative Study Area.

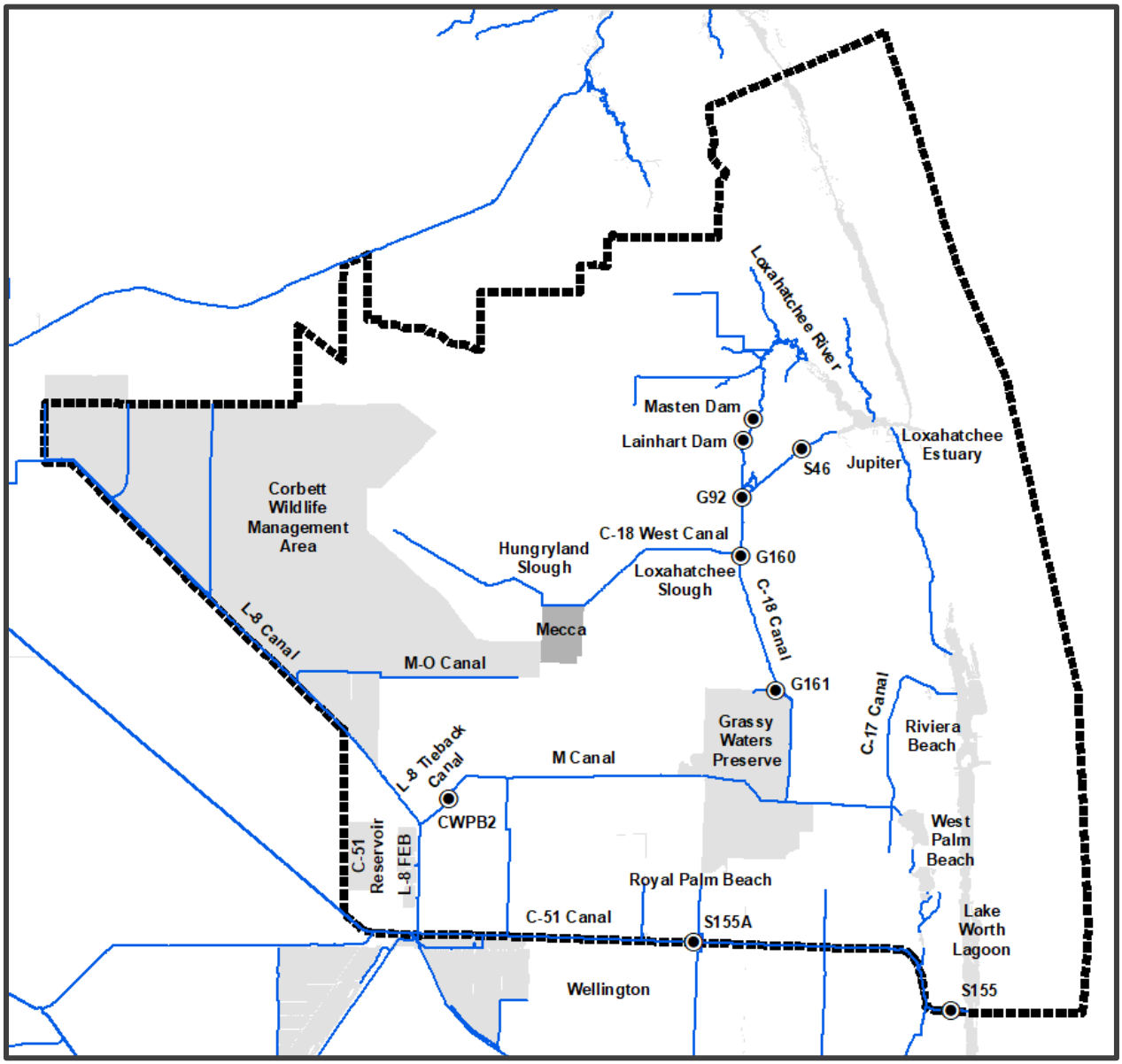


Figure 1: Loxahatchee River Watershed Restoration Local Initiative and Mecca Site Evaluation Study Area

Project Development and Objectives

The main objective of this Local Initiative study was to incorporate County and stakeholder input to develop alternatives that would address concerns related to the proposed Loxahatchee Project, particularly the Mecca reservoir embankment height, compatibility with surrounding and adjacent land uses, the potential for increased flood risk for communities adjacent to the proposed Mecca reservoir and continued discharges of excess L-8 Basin stormwater runoff to the Lake Worth Lagoon.

The modeling effort was an expedited feasibility study to evaluate different components of the Local Initiative. The effort focused on examining the viability of the components to meet the Local Initiative objectives. This document summarizes the feasibility study and explains the formulation and screening of alternatives, the modeling framework and modeling results.

Modeling Tools

Meeting the Local Initiative's objectives required technical work to understand the existing modeling tools and water budgets, collaboration with the County's Water Resources Task Force, consultation with stakeholders and local experts, and meetings and communication with SFWMD staff to understand their customized MODFLOW model with specialized packages for simulation, and pre- and post-processing, referred to as the Lower East Coast Sub-Regional North Palm (LECsR-NP) model.

The Loxahatchee Project modeling process included three hydrologic components which are eventually linked to provide a closed water budget and meet the requirements of the project goals. These components included:

1. A groundwater component, which builds on previously conducted work as well as adapts to the inclusion and testing of new components.
2. Evapotranspiration (ET)-Recharge package/program which partitions precipitation within the study area into numerous water budget terms to be used in the other components.
3. A surface water component, which shares budget terms with the saturated zone components and routes the flow of water through the system.

LRWRP only simulated four alternatives that were based on the latest calibrated LECsR-NP model. The figure below served as a guide to help determine the relative merits of the alternatives and provide the overall framework and modeling constraints.

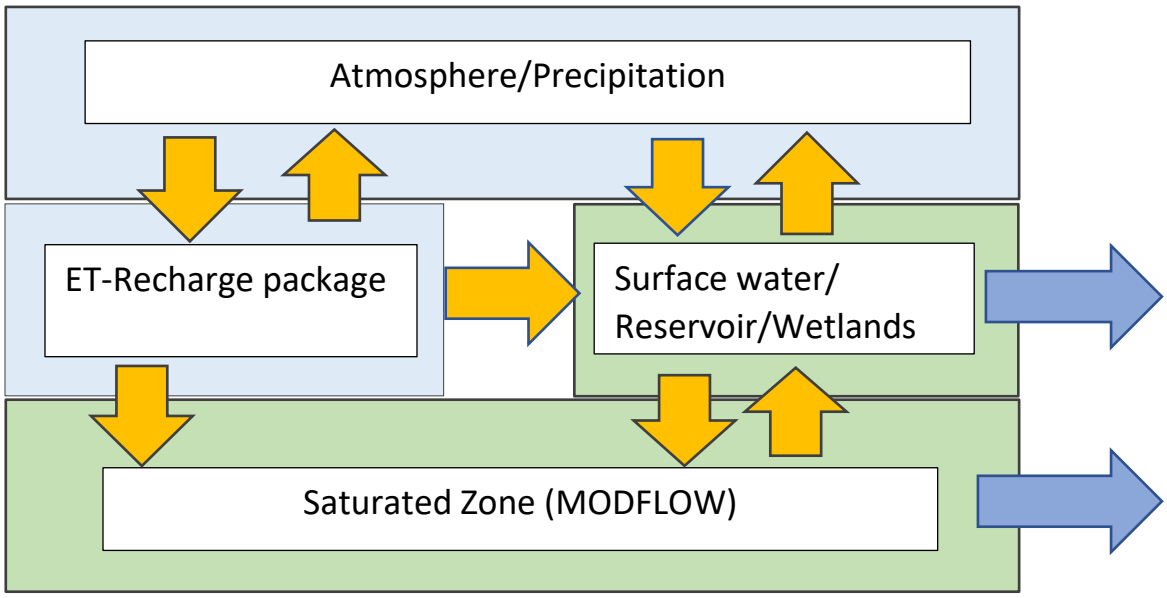


Figure 2: Overall Modeling Process Used in LRWRP

Notes:

- Arrows show water budget inputs/outputs
  - Yellow arrows – Water stays in the model control volume
  - Blue arrows – Water leaves the model control volume

- Green boxes show which processes were modeled in this Local Initiative Study

Due to the need to stay within the PIR authorization schedule for the USACE, this Local Initiative modeling and study had to be completed by early December 2019. Therefore, the modeling effort only involved the components in the green boxes in Figure 2.

Another compelling reason for staying within the green boxes for this modeling effort was to ensure the model calibration remained consistent with the LRWRP's Tentatively Selected Plan (TSP). Modifying any of the components of the ET-Recharge package, which produces runoff into the MODFLOW model and evapotranspiration from the saturated zone, would have resulted in the requirement to perform model recalibration, and therefore the results and the alternative benefits from this study would not have been an appropriate comparison to the results of LRWRP.

Alternative Development Approach

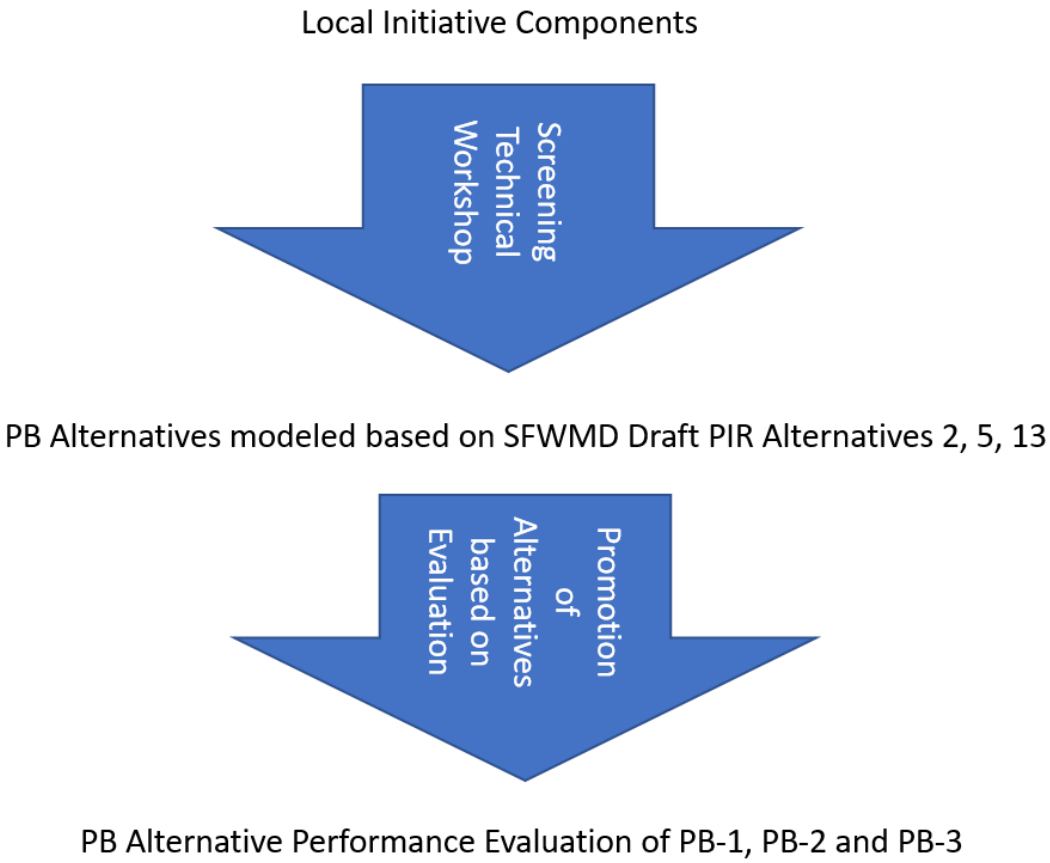
The alternatives development, screening and selection process had 3 Phases:

Phase I: A technical workshop phase for identification of components for various alternatives.

Phase 2: An alternative development and screening phase where alternatives were formulated and modeled based on LRWRP Draft PIR Alternatives 2, 5 and 13.

Phase 3: An evaluation phase where the three screened local initiative alternatives were modeled based on LRWRP Draft PIR Alternative 2 and were evaluated with relevant LRWRP performance measures.

This process of alternative development, screening and evaluation is summarized below and will be described in more detail in the following sections.



Phase 1: Alternative Development and Screening

The Local Initiative used a screening approach which including leveraging the experience and professional judgment of stakeholders, discussions with local experts involved in the project and lessons learned from the modeling efforts that SFWMD modelers shared in meetings with the study team. The screening approach began with the Water Resources Task Force (WRTF) meeting that occurred on July 25, 2019. The consensus of the WRTF was to hold a technical workshop of local experts and stakeholders to obtain input regarding elements to be included in the Local Initiative alternatives.

Screening Technical Meeting

The screening continued on August 16, 2019 during a technical workshop of local experts and stakeholders facilitated by the Kimley-Horn team. The objective of this technical workshop was to obtain detailed input from stakeholders regarding the alternatives in the LRWRP Draft PIR and discuss elements being considered for inclusion into the proposed Local Initiative alternatives.

Detailed discussion of the objectives and elements that were discussed at this workshop can be found in Deliverable 2.1 and 2.2 found in Appendix A.

A graphical map and summary of the Local Initiative or PB alternatives that were developed as a result of the screening initiative are presented in Figures 3, 4 and 5. In addition, a summary of the operational flows for the Local Initiative or PB Alternatives is described in the section following Figures 3, 4 and 5.

Alternative PB-1

Alternative PB-1 consists of the existing 720-acre Indian Trail Improvement District (ITID) impoundment, the proposed 640-acre ITID impoundment and GL land (1,100 acres). With all three of these areas combined, this alternative provides a contiguous piece of land to meet the water storage needs for Loxahatchee River restoration, provide flood mitigation to ITID, and eliminates the need for the proposed 20-foot Mecca Reservoir replacing it with a shallow storage / wetland at the Mecca site. This also provides a relatively short pathway between the storage element and the Loxahatchee River.

Elements of this alternative include the following:

- Mecca as shallow storage / wetland
    - 1590 acres of land with a maximum simulated depth of 2.4 ft; which gives the Mecca facility an approximate capacity of 4000 acre-feet
- ITID-Grand
    - 2127 acres of land (including existing 720-acre and proposed 640-acre ITID impoundments) with an average simulated water depth of 3.6 ft giving it an approximate volume of 7700 acre-feet. The average simulated water depth is used for calculation because of varying topography at this site. This is the same approach used in LRWRP PIR.
- G-160 and G-161 structures constructed and operating consistent with LRWRP Draft PIR Alternative 5
- Grassy Waters Preserve Triangle consistent with LRWRP Draft PIR Alternative 5
- No ASR wells

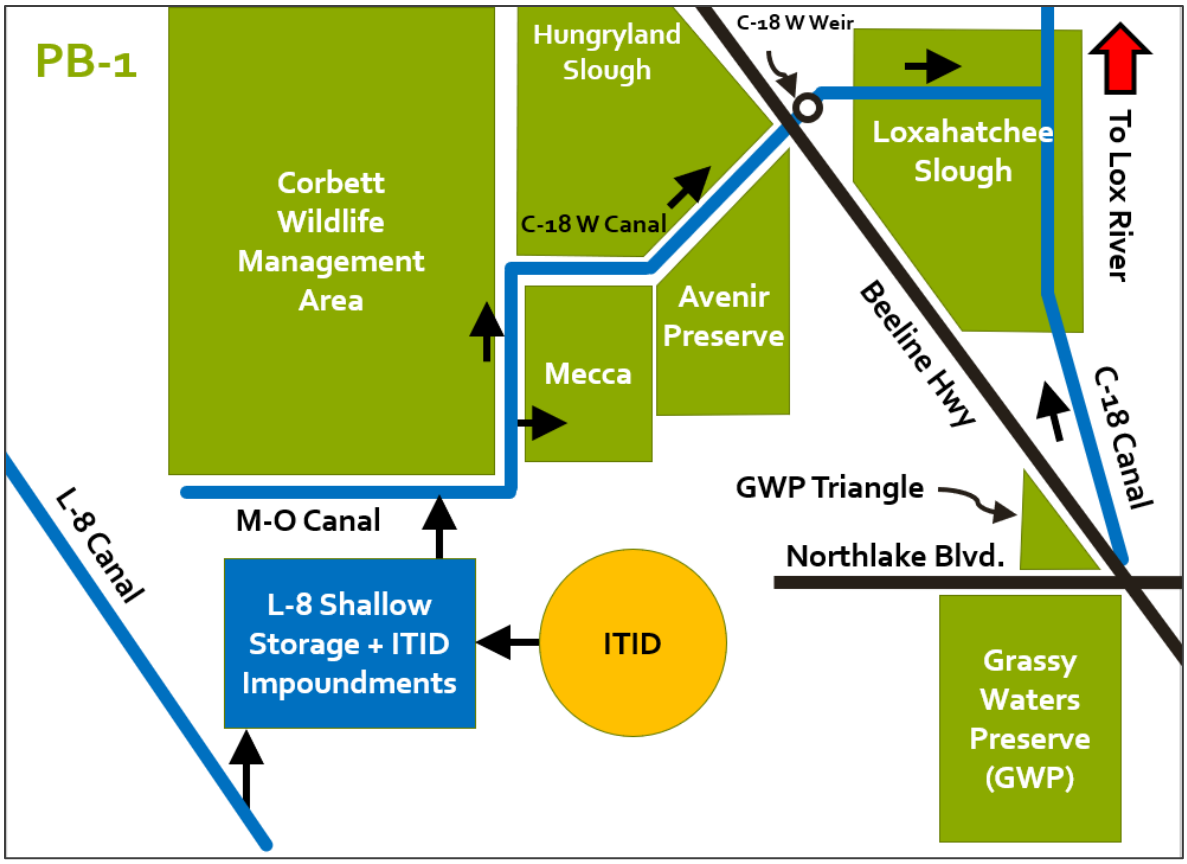


Figure 3: Alternative PB-1

Alternative PB-2

Alternative PB-2 includes the C-51 Reservoir (Phase 2) with 20,000 acre-feet of storage and a shallow storage / wetland at the Mecca site. Alternative PB-2 also includes a GL Canal to convey water from the C-51 Reservoir to the M-O Canal.

Elements of this alternative include the following:

- Mecca as shallow storage / wetland
  - 1590 acres of land with a maximum simulated depth of 2.4 ft; which gives the Mecca facility an approximate capacity of 4000 acre-feet
- C-51 Reservoir (Phase 2)
  - 20,000 acre-feet of storage with GL Canal (connecting L-8 and M-O Canals). This was simulated with the storage facility was outside of the model domain; much like the ASR simulation in the SFWMD alternatives.
- Structures G-160 and G-161 constructed and operating consistent with LRWRP Draft PIR Alternative 5
- Grassy Waters Preserve Triangle consistent with LRWRP Draft PIR Alternative 5
- No ASR wells

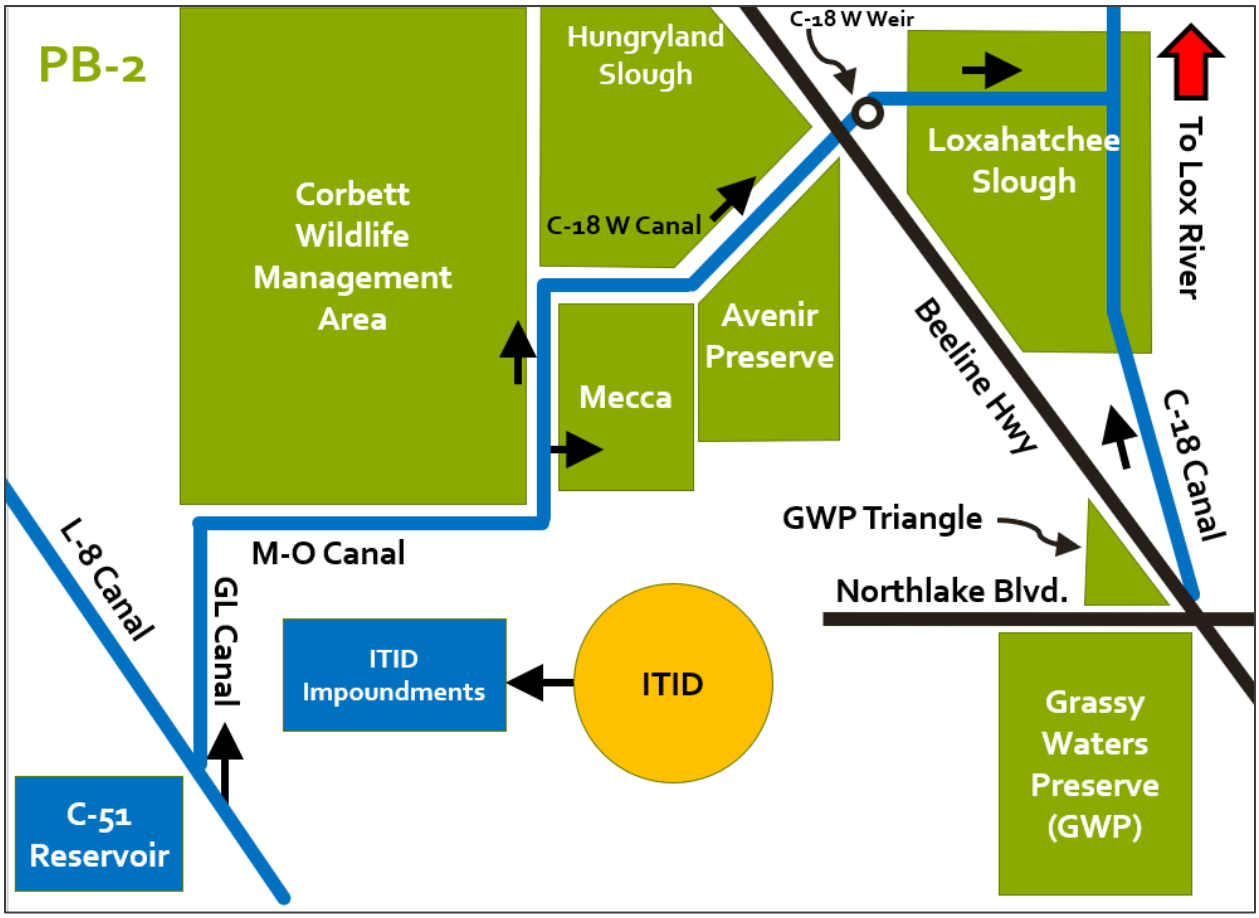


Figure 4: Alternative PB-2

Alternative PB-3

Alternative PB-3 includes the C-51 Reservoir (Phase 2) with 12,300 acre-feet of storage, a shallow 4,000 acre-feet of storage / wetland at the Mecca site, and ITID-Grand with 7,700 acre-feet of storage which includes the 1,100-acre L-8 Shallow Storage (GL) integrated with the existing 720-acre and proposed 640-acre ITID impoundments. **Note: For PB-3, ITID-Grand and the C-51 Reservoir were modeled as single integrated storage element, which is a simplification. The storage volumes for each element provided herein are for conceptual planning purposes.**

Elements of this alternative are:

- Mecca as shallow storage / wetland
  - 1590 acres of land with a maximum simulated depth of 2.6 ft; which gives the Mecca facility an approximate capacity of 4000 acre-feet
- C-51 Reservoir (Phase 2) and ITID-Grand
  - 20,000 acre-feet of storage. This alternative simulated ITID-Grand and C-51 as one integrated storage facility
- Structures G-160 and G-161 constructed and operating consistent with LRWRP Draft PIR Alternative 5
- Grassy Waters Preserve Triangle consistent with LRWRP Draft PIR Alterative 5
- No ASR wells

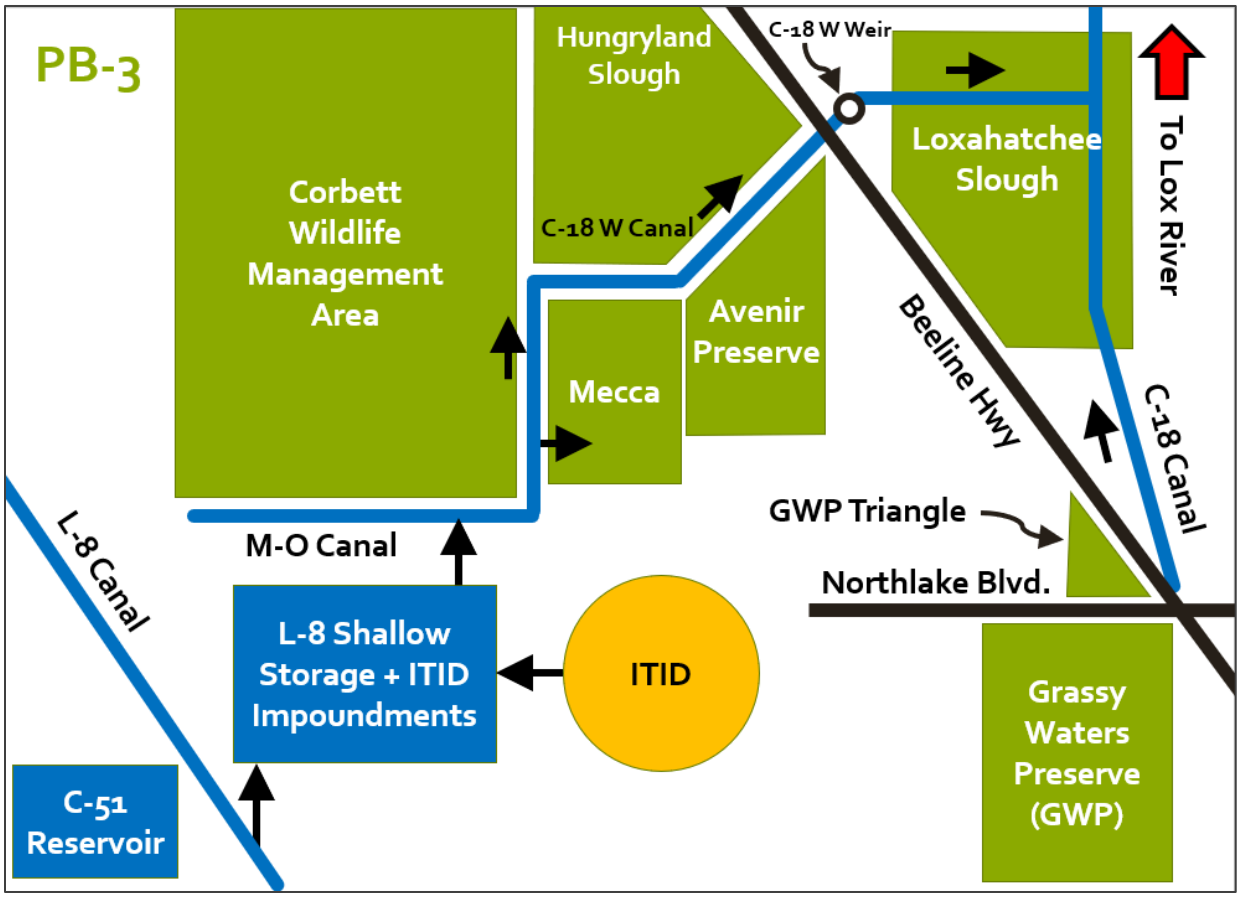


Figure 5: Alternative PB-3

Description of Operations for the Local Initiative or PB Alternatives

In the three Local Initiative or PB alternatives, water supply for the City of West Palm Beach comes from Lake Okeechobee, through the L-8 and L-8 Tieback Canals, and then through the M-Canal to the Grassy Waters Preserve also known as the West Palm Beach Water Catchment Area.

Different storage feature options were used in each of the PB Alternatives as can be seen in Figures 3 through 5. Water flows to the Northwest Fork of the Loxahatchee River, for all of the PB Alternatives, are accomplished through routing flows through the M-O Canal, then to the C-18 West Canal to Structure G-92 and then finally to the Loxahatchee River.

In the PB Alternatives, the ITID-Grand feature shown on the graphics represents an above ground storage reservoir component. It has an effective storage footprint of 2,127 acres and a maximum water depth of 7 feet. The average simulated water depth was used for calculation of optimal size of storage facility, resulting in a size of 7,700 acre-feet.

Inflows into ITID-Grand are from the L-8 Canal up to 200 cubic feet per second (cfs). Outflows from ITID-Grand to Mecca are sent to the M-O Canal, up to 200 cfs, when stages in the M-O Canal allow and when Mecca shallow storage / wetland has the capacity. All three of the PB

Alternatives are simulated with a new canal feature that provides a connection from the M-O Canal to the Mecca shallow storage / wetland. The ITID M-O pump station with a discharge capacity of 1,100 cfs is simulated in all 3 PB alternatives, as was in PIR Alternative 2.

The Mecca shallow storage / wetland has a 300 cfs inflow pump station on the north side and a 250 cfs inflow pump station on the west side. Outflow is to the C-18 West Canal, up to 200 cfs, via gravity water control structure. Also simulated in all three of the PB Alternatives is a bentonite seepage wall 30 feet deep on the south and east sides of Mecca shallow storage, exactly as simulated in LRWRP Draft TSP.

In all three of the PB alternatives, the C-18 West Weir was simulated at its existing location in the C-18 West Canal on the northeast side of the Beeline Highway (State Road 710). The weir crest elevation was modeled at its existing elevation of 17.6 feet National Geodetic Vertical Datum of 1929 (NGVD29).

Flow targets for the Northwest Fork of the Loxahatchee River are included in all PB alternatives, exactly as simulated in all LRWRP Draft PIR Alternatives, as follows:

- Wet season (June - November: 120 days over 110 cfs at Lainhart Dam
- Dry Season (December - May): 69 cfs daily flow at Lainhart Dam

Phase 2: Alternatives Modeling Formulation

The LRWRP Draft PIR states that the LECsR-NP model used for alternatives analysis in that study was the best tool to evaluate the problems within the Loxahatchee River watershed and can be applied for the specific purpose of differentiating between alternatives and to promote the best performing alternative. This same approach and model were used in the evaluation of the Local Initiative alternatives in this study.

During development of the Local Initiative alternatives, the team performed experimental model simulation and testing on the LRWRP Draft PIR Alternatives 13, 5 and 2 to determine how best to utilize these within the foundational goals and framework of each of the Local Initiative alternatives to be evaluated. For a detailed description of the LRWRP Draft PIR Alternatives and their components, refer to Appendix A - Deliverable 2.1 and 2.2 for this feasibility study.

ASR wells were not simulated in this study so that the maximum size of above-ground storage required to meet the target restoration flows of the Loxahatchee River could be determined. Below is a summary of how these alternatives were simulated and how they performed.

Local Initiative Alternatives Assessment Utilizing Draft PIR Alternative 13

LRWRP Draft PIR Alternative 13 was utilized and modified to incorporate alternative storage elements such as the ITID-Grand and C-51 Reservoir. Since one of the components of PIR Alternative 13 was Mecca as a natural storage area, this allowed the Local Initiative alternative to be simulated in conjunction with the Mecca shallow storage / wetland. The Mecca shallow storage / wetland area was simulated as a flow-through shallow natural storage element with preferential pathways of flow based on topography and was not controlled by structures. The Mecca natural storage area was simulated as directly connected to the Loxahatchee River.

Initial runs also simulated the C-18 West Weir located west of Beeline Highway at a crest elevation of 18.5 NGVD 29.

To assess the flow targets for the Loxahatchee River in the new simulations, water was conveyed from the local initiative alternative storage elements to the Mecca natural storage area and then to the Loxahatchee River. Based on the results of initial simulations, this approach did not achieve desired results.

Local Initiative Alternatives Assessment Utilizing Draft PIR Alternative 5

Local Initiative alternatives modeled using this alternative as a starting point included lowering the embankment height and the maximum water depths of the Mecca Reservoir and turning off the ASR wells. These model runs simulated the C-18 West Weir in its existing location northeast of the Beeline Highway on the C-18 West Canal at its existing crest elevation of 17.6 feet NGVD29.

Although these scenarios showed good results for the Loxahatchee River performance measures, none scored as well as the TSP itself. This is because the Mecca reservoir and ASR wells provided capacity to capture and store C-18 West Basin water when excess water is available and release it to the Loxahatchee River when needed. This was one of the conclusions of the LRWRP project.

Local Initiative Alternatives Assessed Utilizing Draft PIR Alternative 2

After developing and simulating Local Initiative alternatives based on LRWRP Draft PIR Alternatives 13 and 5 and reviewing the preliminary results, and due to the fact that Alternative 2 already had C-18 West and L-8 Shallow as storage components, it was determined that the most reasonable and efficient approach was to develop the final three Local Initiative alternatives in this study using LRWRP Draft PIR Alternative 2 as a starting point.

Local Initiative Alternatives Storage Features

ITID-Grand

For the Local Initiative or PB alternatives, the ITID-Grand feature is simulated as an above ground storage reservoir component. It has a footprint of 2,127 acres and an average water depth of 3.6 feet, resulting in a possible optimal storage volume of approximately 7,700 acre-feet; the average simulated water depth is used to calculate the optimal reservoir size due to the varying topography at this location.

Inflows into ITID-Grand are from the L-8 Basin and up to 200 cfs from the ITID drainage basin. Outflow from ITID-Grand is to the Mecca shallow storage / wetland feature. When stages allow in the M-O Canal and when the Mecca shallow storage / wetland has capacity, up to 200 cfs flows through the M-O Canal.

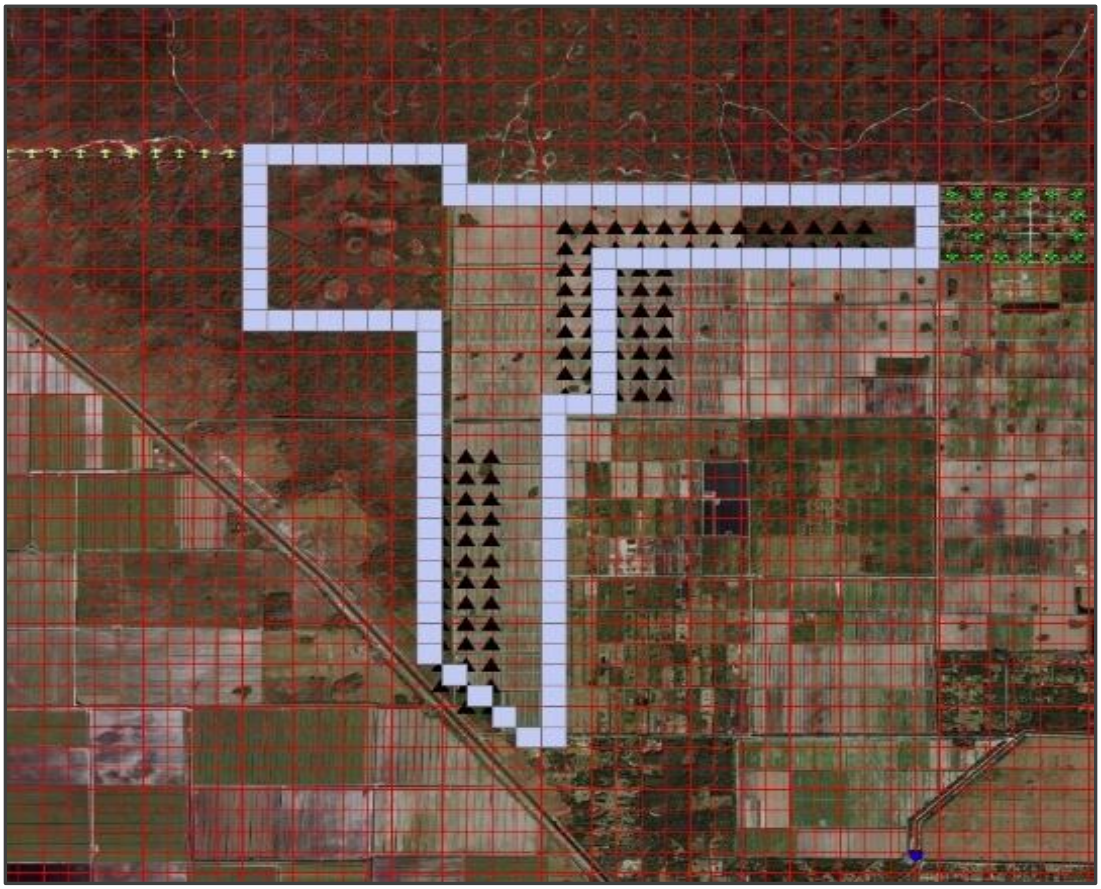


Figure 6: ITID-Grand Configuration

C-51 Reservoir (Phase 2)

The C-51 Reservoir (Phase 2) was simulated to be 20,000 acre-feet in Alternative PB-2 and 12,300 acre-feet in Alternative PB-3.

Mecca Shallow Storage / Wetland:

The Mecca shallow storage / wetland is simulated as a shallow impoundment / wetland that stores water when there is excess, and releases water when the Loxahatchee River needs it. Mecca Shallow Storage has a 300 cfs capacity pump station on the northern side and a 250 cfs capacity pump station on the west side. Outflow from this storage element is to C-18W canal, up to 200 cfs. A bentonite seepage wall at 30 ft depth simulated in SFWMD Alternative 2 on the south and east sides of this shallow storage were not removed, they are present in all of the PB alternatives.

Structures

- **G-160:** This structure has a maximum capacity of 2,000 cfs for flood control. The structure is opened when the stage within the Loxahatchee Slough is greater than 15.5 feet NGVD29 in the dry season, rising to 17.5 feet NGVD29 in the wet season.
- **G-161**: This structure delivers a maximum of 20 cfs to meet the demands of the Loxahatchee River.

Operational Strategies for the Local Initiative Alternatives

1. Lake Okeechobee water is routed to Grassy Waters Preserve through the City of West Palm Beach's M-Canal to provide water supply consistent with the LRWRP Draft PIR Alternatives.

2. Priority of operations for restoration flows into Loxahatchee Slough:
    - Flow way 2, and then Flow way 1
    - Flow way 2 consists of the C-51 Reservoir (Phase 2), ITID-Grand and the Mecca shallow storage / wetland. Water is routed eastward through ITID's M-O Canal, to the C-18 West Canal to Structure G-92 and then on to the Northwest Fork of the Loxahatchee River. A new canal connects the M-O canal to the Mecca shallow storage component. Source water is primarily L-8 Basin, and Lake Okeechobee.
    - Flow way 1 consists of Structure G-161, which can move water from Grassy Waters Preserve, under certain operational conditions, into the C-18 Canal and

then to the Northwest Fork of the Loxahatchee River via Structures G-92 and the Lainhart Dam.

Figure 7: Flow Way Locations as shown in LRWRP Draft PIR

Phase 3: Alternative Evaluation Results

USACE Guiding Criteria Background

There are four guiding criteria of the USACE's Principles and Guidelines as described in Section 4 of the LRWRP Draft PIR. They are effectiveness, efficiency, acceptability and completeness.

1. Effectiveness is the extent to which an alternative plan alleviates the specified problems and achieves the specified opportunities;
2. Efficiency is the extent to which identified plans maximize environmental benefits compared to costs;
3. Acceptability is the workability of the alternative plan with respect to laws and public policies;
4. Completeness is the extent to which an alternative can provide for all investments.

This study focused on one (1) of the four (4) criteria, Effectiveness. Effectiveness was to be evaluated using the same five (5) objectives and approach as documented in Section 4.1 of the LRWRP Draft PIR, which are dependent on the hydrologic model output and are listed below.

- **Objective 1 – Flows to the Loxahatchee River** – Restore the wet and dry season flows to the Northwest Fork of the Loxahatchee River flood plain.
- **Objective 2 – Estuarine Communities** – Restore and/or maintain oysters, sea grass and other estuarine communities in the Loxahatchee River Estuary.
- **Objective 3 – Area of Wetlands** – Increase natural extent of wetlands.
- **Objective 4 – Connectivity** – Restore connections between natural areas to improve the hydrology, sheet flow, hydroperiods, natural storage and vegetative communities.
- **Objective 5 – Plant and Animal Abundance and Diversity** – Restore native plant and animal species abundance and diversity in Loxahatchee River watershed natural areas, river and estuary.

For this study, the hydrologic output results of the modeling were evaluated utilizing Objective 1 to determine the benefits to the Loxahatchee River. Evaluating the other four objectives was based on the previous work of the Draft PIR Alternatives upon which the Local Initiatives were based. For example, if the flows for the Loxahatchee River are greater than or equal to the flows contained within the Draft PIR's TSP for the dry and wet season, then we can conclude that the benefits for the remaining criteria and objectives, which are also based on flows to the river, are greater than or equal to those proposed within the Draft PIR. Therefore, this study focused the evaluation criteria on Objective 1.

Objective 1 – Flows to the Loxahatchee River: Restore wet and dry season flows of water to the National Wild and Scenic Northwest Fork of the Loxahatchee River and the river floodplain. The wet season (June – November) restoration target is daily flow greater than 110 cfs for greater than 120 days. The dry season (December – May) restoration target is 100 percent of time with 30-day rolling average greater than 69 cfs. Flow targets are assessed at Lainhart Dam.

Table 1 compares the effectiveness criteria for Objective 1 for wet and dry season flows and the Minimum Flows and Level (MFL) exceedances. An exceedance of MFL criteria occurs when Lainhart Dam flows are less than 35 cfs for more than 20 consecutive days.

Table 1: Alternatives Objective 1 Comparisons

Wet and Dry Season Flows	FWO	Alt 2	Alt 5R	Alt 10	Alt 13	Alt PB-1	Alt PB-2	Alt PB-3
Wet Season	78%	98%	98%	100%	98%	100%	100%	100%
Dry Season	65%	87%	91%	95%	80%	88%	88%	88%
MFL Exceedances	17	0	0	0	12	0	0	0

Although according to the table, wet season flows of the PB runs are improved by about 2 percent over the TSP and dry season flows are about 3 percent lower than the TSP, considering uncertainties in modeling and data, these results are considered comparable to one another. These results demonstrate that the three Local Initiative alternatives have the potential to meet the Loxahatchee River restoration targets as effectively as the Draft PIR TSP.

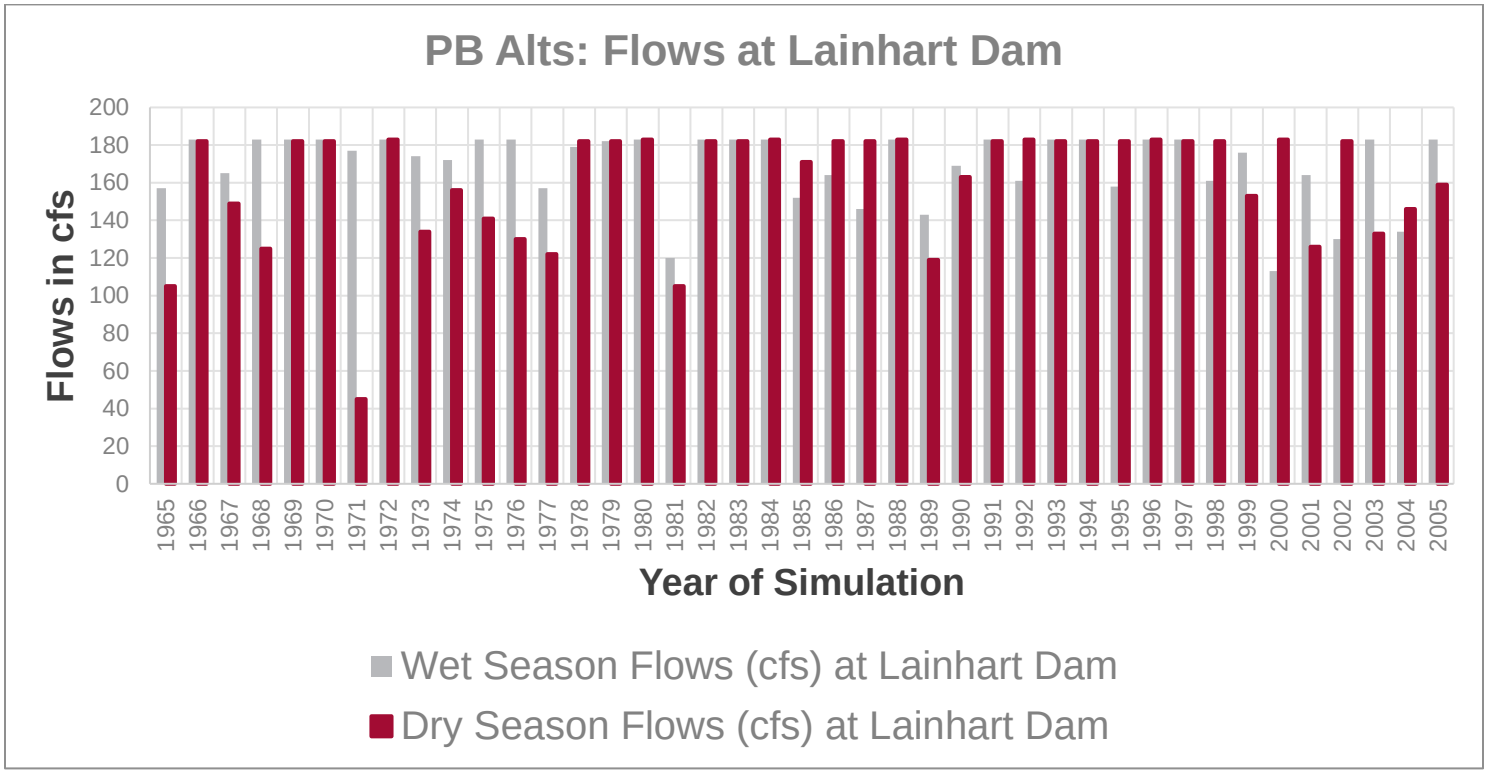


Figure 8: Lainhart Flows for PB Alternatives

Dry Season Flows (cfs) at Lainhart Dam (# 30 consecutive days from Dec-May flow > 69 cfs)
Wet season flows (cfs) at Lainhart Dam (# 30 consecutive days days flows > 110 cfs for > 120 days)

In addition, the storage available at ITID-Grand and the C-51 Reservoir for each of the Local Initiative alternatives as shown in the table below was used as a surrogate to evaluate the potential of the Local Initiative alternatives to reduce harmful discharges to the Lake Worth Lagoon. Since the Draft PIR TSP has no storage features to capture and store excess L-8 Basin stormwater runoff, all three Local Initiative alternatives outperform the TSP in this regard, with Alternatives PB-2 and PB-3 performing higher than PB-1.

ITID-Grand and Mecca Shallow Storage are modeled as above ground storage elements. Table 4 shows the average depths of water at ITID-Grand and Mecca for the three PB Alternatives. All 3 alternatives achieve flow restoration targets for the Loxahatchee River that are similar to the TSP with the Mecca site as a shallow storage feature with average water depths ranging from 0.9 to 1.1 feet and maximum depths ranging from 2.4 to 2.6 feet.

Some of the modeled runs did show an occasional water level spike, which is due to the daily time steps within the model and the fact that the watershed inflows are brought into the model as external time series in a single modeled time step, without being distributed temporally as in reality. This may be due to the fact that LECsR-NP is a groundwater model, that has an added surface water simulation capability. Therefore, watershed inflows into surface water systems, and groundwater recharge are externally processed and results of this are time-series that act as boundary conditions into the groundwater model. The time-series are daily cumulative values and so the storage elements simulated in the model show some water level spikes. If the model had sub-daily time steps, the equations being solved for every time step would result in a smoother water level being simulated. So, the water level spikes are an artifact of modeling, and noise in simulations.

ITID-Grand shows a maximum depth of 7.1 feet and minimum depth of less than 1 foot in Alternatives PB-1 and PB-3. The average depth of ITID-Grand in PB-1 is 3.6 feet and in PB-3 is 5.1 feet, this is because ITID-Grand and the C-51 Reservoir were modeled as one storage element in PB-3, which is a simplification. In PB-2, the C-51 Reservoir is the storage that works in unison with and as a back-up for Mecca shallow storage; so, water depths for ITID-Grand for the PB-2 model run in the table are blank.

Table 2: Comparison of Maximum, Minimum and Average Depths of Storage Components

PBC Alt	ITID-Grand			Mecca Shallow Storage		
	Water Depths (feet)			Water Depths (feet)		
	Maximum	Average	Minimum	Maximum	Average	Minimum
PB-1	7.1	3.6	0.05	2.4	1.1	0.0
PB-2	NA	NA	NA	2.4	0.9	0.0
PB-3	7.1	5.1	0.3	2.6	1.1	0.0

Note: ITID-Grand was not simulated in PB-2 so no water depths are available. The C-51 Reservoir was the storage feature in PB-2. For PB-3, ITID-Grand water depths are for a single integrated storage element that includes both ITID-Grand and the C-51 Reservoir.

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Executive Summary

Due to the limited time available to meet the goals and objectives of the schedule for the Congressional Authorization of the Draft PIR, this modeling effort had to be condensed into a much smaller timeframe than that which was available during the original modeling efforts contained within the PIR alternative development.

This project was a feasibility study to determine if an alternative existed that could provide equal benefits for the Loxahatchee River to those found in the TSP of the Draft PIR. Therefore, rather than a detailed modeling effort that could examine every small-scale performance measure or indicators, the strategy was to remain within the present LECsR-NP model calibration and water budgets and to demonstrate that with minor modifications there existed the possibility of alternatives to the TSP that could successfully address many of the Palm Beach County stakeholder concerns.

The results of this study indicate that there are viable options to the Draft PIR's Tentatively Selected Plan, and that given additional time for expanding the level of modeling effort, providing for additional detailed model runs and the evaluations of additional operating rule options, that the proposed alternatives in this study could result in even greater benefits than the TSP as demonstrated herein.

This study demonstrated that there were no exceedances or violations of the minimum flows and levels to the Loxahatchee River and that the alternatives proposed are consistent with the USACE plan. In addition, the storage components proposed herein can also provide for storage of the L-8 Basin runoff that was not previously captured by the originally proposed Mecca Reservoir component contained within the Draft PIR's TSP. This is due to the fact that this study proposed storage within the L-8 Basin in a location that is accessible to the runoff within the L-8 Basin.

In addition, the study results indicate that the alternatives proposed in this study could provide additional benefits such as improvements to the Lake Worth Lagoon by retaining surface water flows from the L-8 Basin, providing flood control to the Indian Trails Improvement District, and the creation of ancillary wetlands resulting in the recharging of the surficial aquifer system.

Conclusions

Storage Elements simulated in this study:

- ITID-Grand: The ITID-Grand is simulated as an above ground storage reservoir component. It has an effective footprint area of 2,127 acres and an average water depth of 3.6 feet and a maximum depth of 7 feet.

- Mecca Shallow Storage: The Mecca shallow storage has a footprint of 1,590 acres, an average water depth of 1.1 feet and a maximum water depth of 2.4 – 2.6 feet.

- C-51 Reservoir: up to 20,000 acre-feet of below ground reservoir storage.

Table 3: PB Alternatives Formulated and Evaluated Compared with USACE Plan

	Alternatives			
	PB-1	PB-2	PB-3	USACE PLAN
Mecca Shallow Storage	X	X	X	
ITID-Grand Impoundment	X		X	
C-51 Reservoir		X	X	
Capture Excess L-8 Basin Stormwater Runoff	X	X	X	
Aquifer Storage and Recovery Wells				X
Mecca Deep Storage Reservoir				X

The following are the conclusions of this study:

- ITID-Grand (which includes the 1,100-acre L-8 Shallow Storage (GL) integrated with the existing 720-acre and proposed 640-acre ITID impoundments) is a plausible option to provide target flows to the Loxahatchee River, when coupled with shallow storage at Mecca (concluded from runs based on Draft PIR Alternative 2).
- C-51 Reservoir is a plausible option to provide target flows to the river, when coupled with shallow storage / wetland at Mecca (concluded from runs based on Draft PIR Alternative 2).
- Mecca, as a flow-through wetland feature without additional storage, does not show promise as a viable option to meet the targets of the Loxahatchee River (concluded from runs based on Draft PIR Alternative 13).
- Mecca as a reservoir with reduced height and without ASR wells does not have the potential to meet the restoration targets of the Loxahatchee River (concluded from Draft PIR Alternative 5 based runs).

- Mecca shallow storage / wetland is an element that seems very important because of its proximity to the river; during dry times, it has the ability to meet the needs of the river without much conveyance losses (concluded from runs based on Draft PIR Alternative 2).

Table 4: Modeling Results Comparisons

	Alternatives				
	PB-1	PB-2	PB-3	USACE PLAN	USACE FUTURE WITHOUT PROJECT
Percent of Time Target River Flows Achieved (Wet Season)	100	100	100	98	78
Percent of Time Target River Flows Achieved (Dry Season)	88	88	88	91	65
River Minimum Flow and Level Exceedances	0	0	0	0	17
Storage Available to Reduce Undesirable Discharges to the Lake Worth Lagoon (acre-feet)	12,000	24,000	24,000	0	0

Appendix A

Deliverable 2.1 and 2.2 Draft Alternative Development and Screening Technical Memorandum dated October 31, 2019

Loxahatchee River Restoration Local Initiative and Mecca Site Evaluation

Project No.: WUD 19-060 CSA No. 11

Prepared by:

Kimley-Horn and Associates, Inc.

KHA Job # 144840028

Kimley»Horn

TECHNICAL MEMORANDUM

Deliverable 2.1 Draft Alternative Development and Screening Technical Memorandum and Deliverable 2.2 Draft Alternative Screening Technical Memorandum

Background

The Loxahatchee River Watershed Restoration Local Initiative Evaluation is a study to provide technical support to Palm Beach County (County) on the feasibility of alternatives that can address the County's concerns with the tentatively selected plan (TSP) documented in the U.S. Army Corps of Engineers' (USACE) Loxahatchee River Watershed Restoration Project (LRWRP) Draft Project Implementation Report (PIR) and Environmental Impact Statement (EIS). As part of this evaluation, it is necessary to develop and screen various components prior to the detailed simulation of the promoted alternatives.

One of the objectives of this study was to collaborate with Palm Beach County and its stakeholders to obtain input to assist in developing components and alternatives that could address the concerns regarding the proposed LRWRP. The County and key stakeholders have expressed interest in reconsidering the deep reservoir proposed for the Mecca site so that it is more compatible with adjacent lands, has less flood risk potential and is more aesthetically pleasing. In addition, there are stakeholder concerns that the LRWRP does not address excess stormwater discharges from the L-8 Basin that can result in negative impacts to the Lake Worth Lagoon without additional storage components.

The Water Resources Task Force (WRTF) was created by Resolution by Palm Beach County to identify and evaluate opportunities and impediments to providing future water supply, conservation, wastewater treatment, and reuse or reclaimed water opportunities in the most efficient and cost-effective manner practicable. On July 25th the WRTF held their 3rd regular meeting to discuss various issues, one of which was an update provided by County staff on the Loxahatchee River Restoration Local Initiative and Mecca Site Evaluation. It was noted that the County and their consultant would be reviewing technical tools and information and would be working to optimize or improve the Loxahatchee project by assessing additional alternatives and local initiative elements and would be providing the tools that could be used for future County water resources planning and management. At this meeting the WRTF Board and local stakeholders provided comments and input for the direction of the collaboration and suggested that the WRTF's Working Group be included as part of this process. The WRTF Technical/Professional Working Group is a collective of local experts and stakeholders that advise the WRTF on technical, environmental, and other professional subject matters. (See Appendix A for the WRTF July 25, 2019 meeting summary).

This memorandum outlines the approach used to develop and screen alternative components and documents the results of incorporating information provided by stakeholders. The promoted alternatives from Task 2 outlined herein will be further evaluated in Task 3 of this project using the existing suite of modeling tools provided by the South Florida Water Management District and the effectiveness criteria used in the Draft PIR. (See Appendix B for description of modeling methodology and tools).

Alternative Development and Screening

As part of this project it was necessary to meet with numerous South Florida Water Management District (SFWMD) staff that worked on the original planning, modeling and alternatives selection process in development of the LRWRP Draft PIR/EIS. This was necessary to ensure that this project is utilizing the most up to date modeling tools, assumptions and methodologies used in simulating the alternatives in the LRWRP project and Draft PIR. This effort was also intended to enable comparison of the impacts and benefits of each of the Local Initiative alternatives with the TSP or other PIR alternatives as appropriate. (See Appendix C for maps of the Draft PIR Alternatives and the TSP Alternative 5R).

One of the screening tools considered was the spreadsheet tool developed and utilized during the L-8 Reservoir replacement and storage options for the Restoration Strategies planning efforts that assisted the SFWMD in providing the justification for the purchase of the Mecca property from Palm Beach County. However, this spreadsheet screening tool was not kept current with LECsR-NP after the screening process was completed and was not used in the alternatives' development and therefore, was not a tool that could be used for screening without substantial work to update it. Since the promoted alternatives will need to be modeled with LECsR-NP anyway, the team decided to use an alternative development and screening approach based on best professional judgment and experience of local technical experts, including representatives from the Water Resources Task Force Technical Professional Working Group to assist in promoting the 3 final alternatives. During the PIR alternatives development process, a qualitative screening method was also used by USACE to screen alternatives. Therefore, in collaboration with the County and technical experts familiar with the proposed Loxahatchee Local Initiative project features, our team developed a suite of possible alternative components to be considered and screened them to a final array of three Local Initiative alternatives for further evaluation.

On August 16, 2019 the Kimley-Horn team hosted a Loxahatchee River Local Initiative Technical Workshop. This technical workshop was to go through the Palm Beach County Local Initiative elements and provide input to the project team to assist in promoting the top 3 alternatives for further evaluation. Technical Workshop attendees included Palm Beach County staff, local stakeholders, the Water Resources Task Force Technical Professional Working Group members and SFWMD representatives. Meeting notes and a list of attendees from the technical meeting and its discussions is included in in Appendix A.

County Local Initiative Elements (or variation of existing components) Considered:

- Connect Indian Trail Improvement District (ITID) Reservoir to Moss Property, former farm owned by FWC) for rehydration and for improved water quality.
- Construction of new outfall structure from Moss Property to the L-8 Canal.
- Utilize Avenir as a wetland flow through.
- Relocate the C-18 Weir to the southwest side of the Beeline Highway and Florida East Coast railroad and increase the water levels within the C-18 Canal to 18.5 feet.
- Clean out the ditch northeast of the train trestle on State Road 710 to improve hydration of the Loxahatchee Slough.
- Add ASR wells to the C-18 West Canal.
- Utilize ASR wells with various levels of recovery for Alternatives in the Draft PIR.
- Varying the number of ASR wells in selected alternatives.
- Utilize the ITID additional 640-acre area coupled with the GL Property (L-8 Shallow) which is adjacent to the ITID existing impoundment that could be used for additional storage for ITID stormwater runoff and for the release of water during dry time for the Loxahatchee River. This could be simulated as Alternative 12 without the C-51 - 25,000 acre-feet of storage. Could also add ASR wells to this alternative either at ITID or GL shallow storage or Mecca natural area. Also need to add flow paths through Avenir for this alternative as it was originally simulated without flow paths.
- Construct “GL Canal” and pump station to send water north to ITID “M-O” Canal (from either C-51 Reservoir, Moss Property or “GL Flow-way”).
- Construct structure connecting possible “GL Flow-way” to possible “GL Canal”.
- Alternative 12 with Mecca as natural wetland area minus Avenir.
- Mecca as natural area with GL (L-8 Shallow) as storage and treatment.
- Mecca as natural area with C-51 as storage and GL as treatment.
- Clean out of FEC Railroad trestle, Gentle Ben Flow way by closing off Bee Line Highway weir that feeds C-18 and could send water to the triangle and provide water quality benefit.
- Add Flow way 3 benefits to Alternative 10 and lower the C-51 Storage from 44,000 acre-feet to 25,000 acre-feet. Mecca as Natural Storage. Add ASR to Mecca Natural area.
- Solve for the delta storage required for the Loxahatchee River by using Mecca as natural area and backing into the storage requirement.

Screening Results

There are advantages and disadvantages of each of the concepts and/or components presented above. In general terms, the following objectives were used to prioritize the components:

- Ability of an alternative component to capture excess stormwater runoff from L-8 basin that can negatively impact the Lake Worth Lagoon.
- Storage capacity of a component to provide equivalent volume as Mecca
- Ability to hydrate wetlands in the region
- Technical viability of implementation (e.g. available land, efficiency of ASR wells)
- Minimization of conveyance losses during delivery to the Loxahatchee River

The next phase of this project will utilize LECsR-NP which was used by the SFWMD/USACE in the development of the Draft PIR/EIS. This will enable comparison of the County alternatives to those alternatives provided in the Draft PIR. A summary of considerations for several components are provided below:

  - The Moss property is owned by the Florida Fish and Wildlife Conservation Commission and is currently a natural wetland property. Utilizing a connection to the Moss Property would provide an improved natural system but would not provide a significant contribution to the restoration of the Loxahatchee River during the dry season when the River needs the flows the most. The Moss Property is also a wetland area which would have water demands during the dry season and not be able to provide flow to the River. Therefore, it is not an option we should consider at this time because it will not provide substantial timely benefits to the Loxahatchee River.
  - The Avenir Preserve was modeled in all of the PIR alternatives as a natural area providing stormwater runoff relief to the new Avenir housing development. It is currently modeled in all 4 PIR alternatives, as well as the future without scenarios as a wetland and storage component for Avenir development. Due to existing and future permit requirements related to water levels within the Avenir Preserve and its connection to Avenir surface water management system, there are likely very few opportunities to convey additional water into the Avenir Preserve from offsite areas such as Mecca or other areas. In addition, during dry times, when the Loxahatchee River needs water, conveying water to the Avenir Preserve from Mecca or other areas will reduce water that is available to be conveyed to the Loxahatchee River. Therefore, it is recommended that County alternatives simulate the Avenir Preserve similar to the Draft PIR alternatives.
  - The relocation and raising of the C-18 West Weir could provide hydration of lands south and west of the Beeline Highway. This component was not part of the TSP but was modeled in Alternative 13.s. While there may be some benefits to this component, the County is recommending that this component <u>not</u> be included in the final three alternatives to reduce the number of changes from the TSP.
  - The proposed 640-acre ITID impoundment (adjacent to the existing 720-acre ITID impoundment) is a viable component and does not appear to have been

included in any of the Draft PIR alternatives. The land for the proposed 640-acre impoundment is essentially owned by ITID and could be integrated with other proposed storage elements. A pump station to convey water north to the Loxahatchee River via the M-O Canal and C-18 West Canal will likely be required. This was not a component in any of the PIR alternatives because this land was not available to ITID when the screening of the plan components was being developed for modeling. The 640-acre impoundment could be used as a Flow Equalization Basin for water supply and/or as flood control.

- GL Flow-way (aka L-8 Shallow Storage in the Draft PIR): The GL Flow-way has some development restrictions that limit the land use of this area to water resources or agriculture. The proximity of this land to the existing 720-acre ITID impoundment and the proposed 640-acre impoundment makes this an large piece of available land that could address several of the local stakeholder concerns.
- One of the concerns of the TSP raised by the County and other stakeholders was the optimistic performance efficiency assumed for the four (4) Aquifer Storage and Recovery (ASR) wells included in the TSP. In addition, locating ASR wells near drinking water wellfields has the potential to impact adjacent wellfields or drinking water treatment infrastructure. In addition, ASR wells that are not co-located with surface water storage features have limited capabilities due to their relatively low injection rates compared to stormwater runoff flow rates. While there is likely a benefit to co-locating ASR wells with surface water storage components, due to the complex approach used by SFWMD to parameterize ASR wells in LECsR-NP, the level of effort needed to include realistic ASR operational assumptions in County alternatives is expected to exceed the desired timeframes for this study. Therefore, ASR wells are not recommended to be included in the County alternatives.
- Structures G-160 and G-161: These two structures have already been constructed and are operational.
- Grassy Waters Preserve Triangle: There is broad support for this component and it was included in all four PIR alternatives.
- The FEC Railroad trestle ditch was another component that was given consideration. This component could improve hydration of wetlands located in or adjacent to the Loxahatchee Slough, however, the County recommended that this component not be included at this time and be screened out to reduce the number of changes from the TSP.

Three Promoted Alternatives

Based on the information provided above, the following three alternatives are being promoted for further evaluation.

PB-1

This alternative uses the proximity of the existing 720-acre ITID impoundment to the new ITID 640-acre land and GL land (L-8 Shallow – 1,100 acres). With all 3 of these parcels combined, this alternative provides a vast piece of land to meet the needs of the Loxahatchee River, provide flood relief to ITID, eliminates the risk of the proposed 20-foot Mecca embankment to adjacent residents and County Water Utilities Department infrastructure. This also provides a relatively short pathway between the storage element and the Loxahatchee River. Total volume/height will be determined by attempting to match the TSP performance.

Elements of this alternative are:

- Mecca and Avenir as natural storage
- L-8 Shallow Storage (GL) 1,100 acres, ITID 640-ac impoundment and existing ITID 720-acre impoundment
- G-160 and G-161 structures operating as modeled in the alternatives
- Grassy Waters Preserve Triangle as modeled in the alternatives
- No ASR wells
- Moved C-18 Weir to west location at elevation 17.6

PB-2

This alternative uses the C-51 Reservoir, with Mecca as natural storage area and the existing and proposed ITID impoundments. This alternative will use the GL Canal for conveyance rather than the force main as proposed in Alternative 10 of the Draft PIR. The intent is to determine if C-51 reservoir helps address any of the Palm Beach County local initiative; if so, what portion of the C-51 Reservoir could be used to achieve the TSP performance.

Elements of this alternative are:

- Mecca and Avenir as natural storage (as simulated in PIR Alternative 13)
- C-51 Reservoir (size to be determined) with GL Canal (connecting L-8 and M-O Canals)
- Structures G-160 and G-161 are operating as modeling in the Draft PIR Alternatives
- Grassy Waters Preserve Triangle rehydrated as simulated in Draft PIR Alternatives
- No ASR wells
- Moved C-18 Weir to west location at elevation 17.6

PB-3

This alternative will include a portion of the C-51 Reservoir, with Mecca as natural storage, GL (L-8 Shallow Storage (1,100 acres) and the existing and proposed ITID impoundments (720

acres and 640 acres respectively). The total volume, height and footprints of each of the storage features will be determined by attempting to match the TSP performance.

Elements of this alternative are:

- Mecca and Avenir as natural storage (as simulated in PIR Alternative 13)
- C-51 Reservoir (size to be determined)
- L-8 Shallow Storage (GL-Shallow integrated with ITID existing (720-acre) and proposed (640-acre) impoundments (sizes to be determined)
- Structures G-160 and G-161 are operating as modeled in the Draft PIR Alternatives
- Grassy Waters Preserve Triangle rehydrated (as simulated in final 4 PIR Alternatives)
- No ASR wells
- Moved C-18 Weir to west location at elevation 17.6

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Meeting Summary of Water Resources Task Force (WRTF) meeting that occurred on July 25, 2019 and the WRTF Technical Group meeting that occurred at Kimley-Horn offices on August 16, 2019

July 25, 2019 Loxahatchee River Restoration Local Initiative and Mecca Site Evaluation

An overview of recent activities related to United States Army Corp of Engineers (USACE) Loxahatchee River Watershed Restoration Project (LRWRP) (Loxahatchee Project) was provided by County staff. Activities completed included County staff briefing the Board of County Commissioners (BCC) on the motion passed by the WRTF on April 18, 2019 and BCC approval of the following motions at the April 30, 2019 BCC workshop meeting:

- Continue to support state and federal efforts to restore the Loxahatchee River Watershed.
- Communicate key concerns with the proposed project.
- Express interest in collaborating with USACE and South Florida Water Management District to reconsider the Mecca Reservoir to be more compatible with adjacent lands.

The County submitted written comments to USACE on the Loxahatchee Project Draft Report on May 6, 2019. The County participated in meetings with SFWMD on May 20, 2019 and USACE on June 7, 2019 to discuss concerns and potential forward paths. Based on these meetings, the County decided to obtain Consulting Services to conduct a Loxahatchee River Restoration Local Initiative and Mecca Site Evaluation to provide technical information necessary to enable continued collaboration with USACE and SFWMD, to optimize or improve the Loxahatchee Project by assessing additional alternatives and local initiative elements, and to provide tools that can be used for future County water resources planning and management.

One of the key goals would be to enable the County to provide the technical information to SFWMD prior to their Governing Board approval of a letter of support to USACE for the Loxahatchee Project, planned for November 2019. Future activities and timeline for the Loxahatchee Project was provided to the Task Force which included public and agency review of the Final Report and USACE headquarters approval via a Chief's Report in March 2020. The County's consultant then provided a brief overview of the Local Initiative elements and potential concepts/features to be considered for further evaluation. Direction from the WRTF Board was to include the WRTF Technical Working Group in the screening and development process for the proposed alternatives for further consideration and modeling.

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August 16, 2019 Loxahatchee River Restoration Local Initiative and Mecca Site Evaluation
Loxahatchee River Technical Working Group Meeting Minutes

Attendees:
Jeremy McBryan, Palm Beach County (PBC)
Rich Walesky, Director Palm Beach County Board of County Commissioners (BCC)
Jay Foy, Indian Trail Improvement District (ITID)
Albrey Arrington, Loxahatchee River District
Jennifer Leeds, South Florida Water Management District (SFWMD)
Len Lendahl, MacVicar Consulting
Ernie Cox, Family Lands Remembered LLC
Alan Wertepny, Mock Roos
Rama Rani, Kimley-Horn and Associates
Denise Palmatier, Kimley-Horn and Associates

The goal of the meeting was to promote discussion regarding possible alternatives to using the Mecca property as a reservoir. Mecca would instead be represented in the proposed alternatives as a wetland flow through marsh. Therefore, the storage component that Mecca was providing in the LRWRP Project Implementation Report (PIR) would be replaced by other storage component alternatives to meet the flow requirements of the Loxahatchee River.

Summary of Alternative Discussions:

- Moss is a state-owned property by Florida Fish & Wildlife Commission (FWC) and is located north of the L-8 Canal and west of the ITID existing impoundment. This property had previously been considered during high level screening prior to the more detailed evaluation of the final four alternatives contained in the Draft PIR. While this property has improved hydration benefits, further development of the Moss property is not practical at this time. The Moss property was not evaluated during the PIR final four alternatives, and the modeling isn't readily available to allow for a thorough review and comparison required to properly evaluate the value of including the Moss property. Furthermore, the likelihood that Moss could provide flows to the Loxahatchee River are unlikely due to its location as well as the fact that the Moss property will also have its own flow demands to keep the wetlands within the property hydrated. In addition, the direction from the PBC BCC was to concentrate on finding storage for Loxahatchee River and therefore, it was agreed that Moss is not an option at this time.
- GL Storage and ITID Impoundments Discussions:
    - GL has an option within their development agreement that the property should be used as a water supply element or be leased for agriculture. This portion of the GL property will not be developed into residential communities. To utilize GL property as a storage component it was mentioned that it would require a pump station to move flows north towards Mecca and ultimately to the Loxahatchee River. Water can move south from this area by gravity. It was stated that GL storage was also a feature in the Northern Palm Beach County Plan.
    - GL could also provide an STA feature for improving water quality.

  - This option may require a seepage cutoff wall because this area is very porous.
  - If more water can be captured within ITID and put into GL tracts as storage, then the Lake Worth Lagoon could also see benefits.
  - Using GL property would also generate a water supply source and would be a side benefit.
  - ITID has an existing 720-acre impoundment currently being used for flood control. ITID also has an additional 640 acres that could be used as water storage and/or flood control.
  - Don't need high capacity pumps to get water to the Loxahatchee because the required flows are small.
  - ITID plans to excavate the 640 acres below grade for deeper storage and lower levee heights.
  - May consider using existing ITID impoundment as deeper storage by excavating existing wetlands and using Mecca natural area as wetland mitigation.
  - This feature can be storage and treatment plus there is a connection canal to Moss for future consideration and can provide connection to the L-8 Canal.
  - There is an existing North South Canal that is just an agricultural ditch (Cypress Grove Canal Ditch).
- Raising Western C-18 Canal elevations and Relocation of C-18 Weir
  - This would help maintain water levels within the Loxahatchee Slough and Corbett and would generate meaningful additional water flows to the Loxahatchee.
  - A structure would need to be put in just south of the existing C-18 Weir.
  - It would need to have an operable gate.
  - Would need to confirm that the Pratt Whitney area has pumped discharges.
  - Under drought conditions this would not provide sufficient flows to replace Mecca so storage would still be required elsewhere in the system to provide the additional flows required for the Loxahatchee.
  - We could look at a range of increasing water levels within the C-18 West by adding the new control structure.
  - This alternative would need to verify that Caloosa, Avenir, and Mecca and North County Airport are not being flooded.
  - The original plan for Scripps had a conveyance canal at Mecca on the west side as well as providing Mecca as a flow through marsh.
  - This may help get water under SR 710 to the Loxahatchee Slough via a culvert and ditch along the Beeline.
- ASR Wells
  - ASR wells could be located along the C-18 Western Canal, but this might be an issue with the Eastern Utilities.
  - Wells are better located out west to avoid conflict with the utilities.
  - ASR wells need either a storage feature or canal to be co-located with the wells.
  - Each well can only return about 5 mgd or 7.7 cfs.
  - Could consider placing wells in ITID canals and use as storage in their reservoir.

- The technical team was in agreement that the percentage of recovery used in the LRWRP PIR is unclear to those trying to interpret the modeling results for the four alternatives contained in the PIR as well as the Tentatively Selected Plan (TSP) Alternative 5R.
- The technical group agreed that the amount of water an ASR can take during flood events and the value it could provide was questionable.
- If ASR wells are eliminated altogether from this current evaluation, then the storage that would result from the modeling would be the most conservative for the reservoir element.
- In addition, the amount of time required for the modeling and coding effort to evaluate the various ASR scenarios (i.e., varying the ASR recovery percentages and adding or taking away ASR wells to each alternative), is not sufficient to provide the final results within the time available to meet the deadlines of the timeline of the USACE's Final PIR.
- Eliminating the evaluation of ASR wells results in the elimination of several elements listed in the PBC Local Initiative due to the fact that ASR wells were a component of those alternatives.

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Summary of Modeling Methodology
Tools and Technologies

Groundwater Model – MODFLOW 2000 with additional packages. Model grid size 704 feet x 704 feet 3 layers and 292 rows and 408 columns

- River (RIV) – used to simulate rivers and canals that can contribute or drain water from the groundwater aquifer.
- Drain (DRN) – used to simulate effects of existing drainage canals and ditches. Removes water from the model when the elevation is above the control elevation for the drain and was used to simulate S-46, Lainhart, Kitching Creek, Cypress Creek and Hobe Grove Ditch.
- Reinjection Drain Flow (DRF) – Similar to Drain package except it allows water to be redirected instead of being removed from the model and was used to simulate C-18 Weir, G-92 and G-160.
- Diversion (DIV) – simulated effects of water control structures (pumping stations, gravity flow drains, weirs) used to simulate G-161, Northlake Weir, and Control 2 flows into GWP.
- Wetland (WTL) – Simulates overland flow in wetlands using the upper most model layer.
- Calibration Period – 2006 – 2014
- Calibration Locations – 7 structures, 58 GW Monitoring wells and 61 wetland gauges.
- Structure Flow Locations – Kitching Creek, Hobe Grove Ditch, Cypress Creek, Lainhart, S-46, G-92, G160 and C-18 Weir.

2. Lower East Coast Sub-Regional – North Palm (LECsR-NP) Model
    - 6 Model runs with 2 baseline conditions and 4 project alternatives.
    - Features Included:
        1. ASR Wells simulated using the DIV package.
        2. C-18 West Storage – impoundment simulated using the wetlands package and movement of water simulated using the RDF package.
        3. L-8Shallow Storage – impoundment simulated using the wetlands package and movement of water simulated using the RDF and DIV packages.
        4. C-51 Phase II Reservoir – Reservoir simulated using the wetlands package. Movement of water simulating using RDF and DIV.
        5. Flow-Way 3 Improvements – drain conductance and control elevations revised; diversion package used to redirect and divert flows; flow through marsh simulated using wetlands package; and movement of water in flow through marsh simulated using RDF package.

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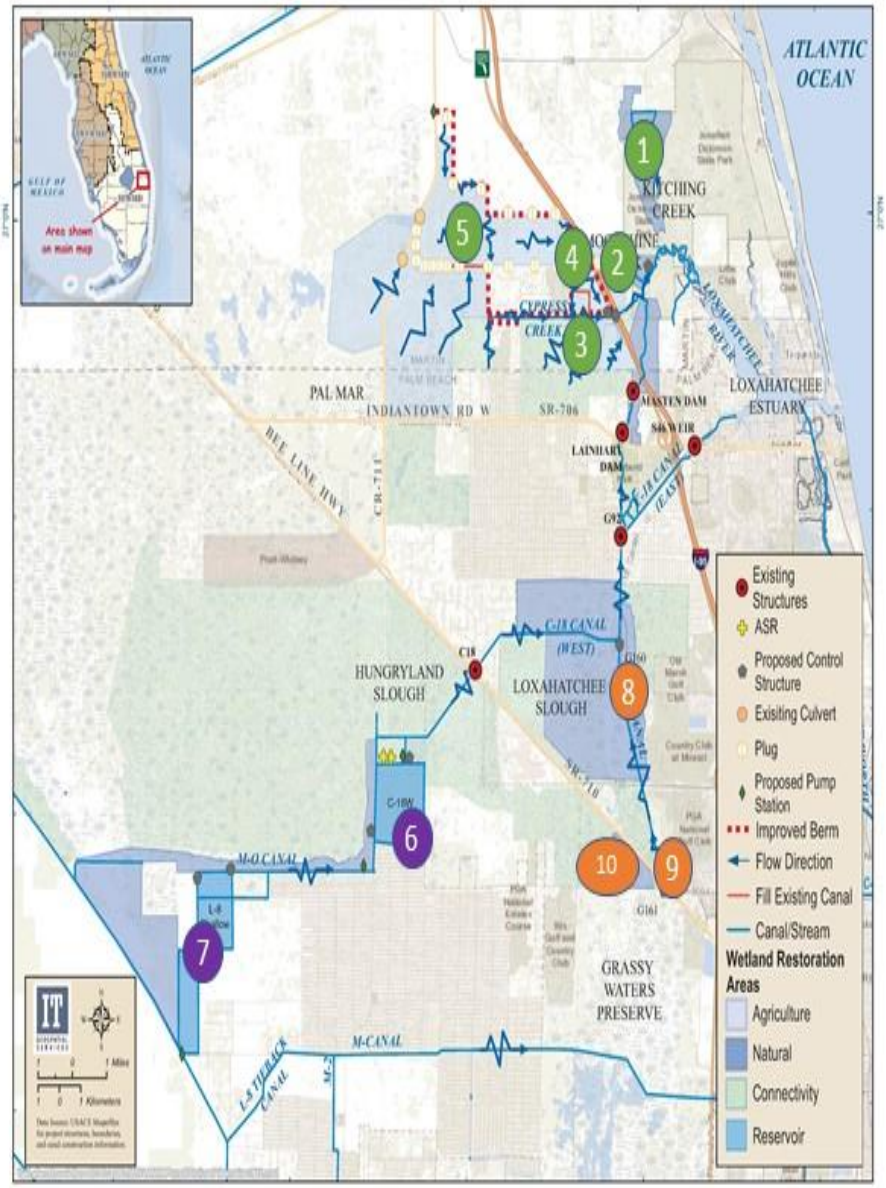
Alternatives Simulated in the Draft PIR/EIS

Alternative 2

1. Kitching Creek (Restoration/hydration): (Spreader canal; weir/plug (Jenkins Ditch)
2. Moonshine Creek (MC) & Gulfstream East (GE) Restoration: Connect HSLCD ditch to MC; clear MC vegetation; weir in Hobe Grove Ditch; grade area to historic topography
3. Cypress Creek Canal (CCC)(Reduce over-drainage): Replace CCC weir to raise control elevation, raise berm at Ranch Colony, automate twin 84" culverts
4. Gulfstream West (GW)(Restoration & reduce over-drainage): Partial backfile & relocate southern end of HSLCD canal; small pump, construct flow through marsh to attenuate flows
5. Pal-Mar East (Restoration & Connectivity): Plug ditches; remove pipes; improve northern berm; construct western berm improve eastern berm; pumps at Thomas Farm to redirect drainage to GW flow- redirect drainage to GW flow-through marsh via north Nine-Gems Canal
6. .C-18W Reservoir (7,200 ac-ft. & 2 ASR wells): Above ground reservoir; inflow pump, discharge structure; seepage control; M-O canal connector and pump
7. L-8 Basin Shallow Storage (4,300 ac-ft., includes pumps and channels)
8. G-160 Structure (Reduce over-drainage): Improve hydroperiod in Loxahatchee Slough
9. G-161 Structure (Connectivity): GWP water to Loxahatchee Slough
10. GWP Triangle (Connectivity): Grade and reconnect



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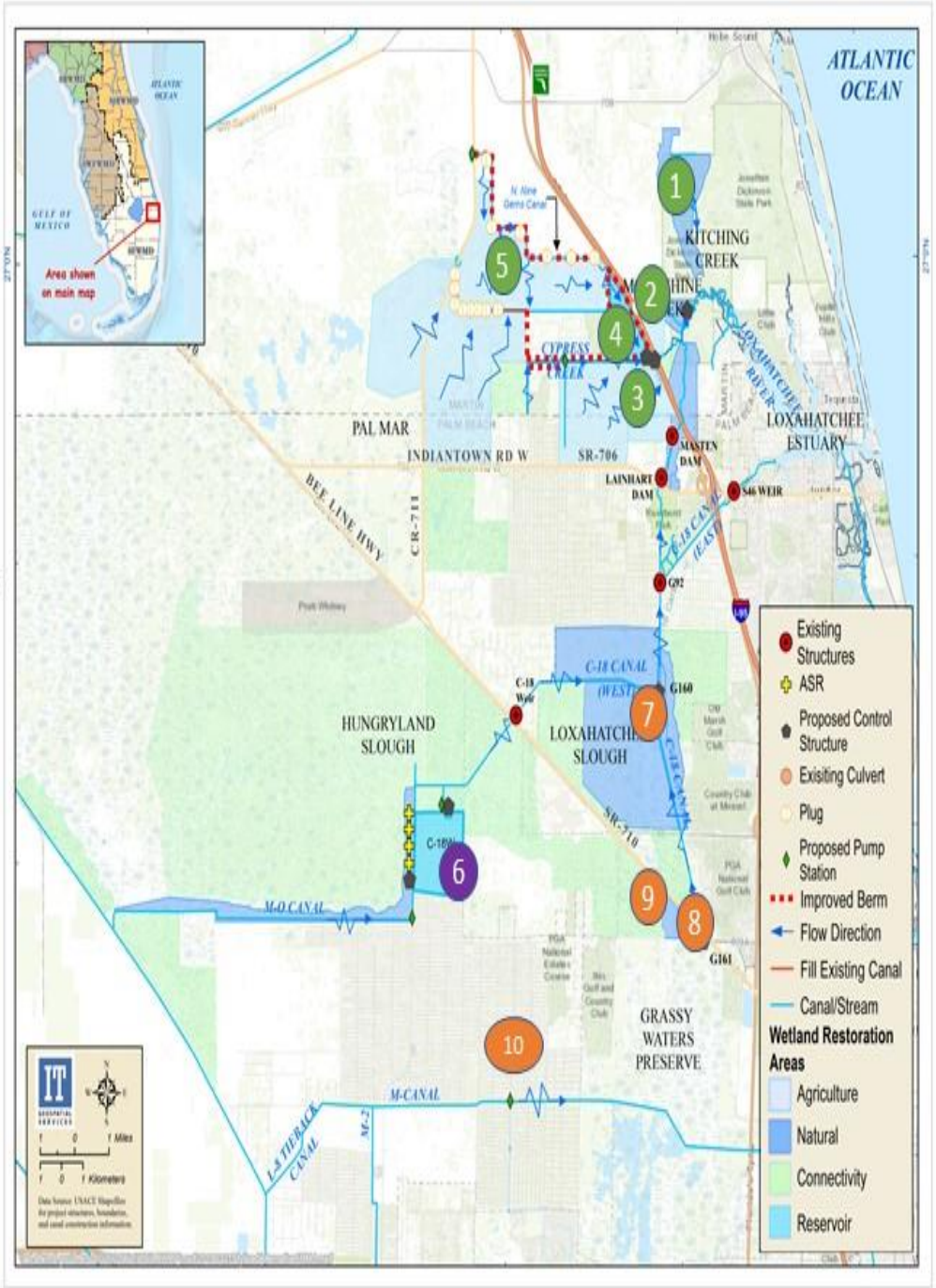
Alternative 5R

1. Kitching Creek (Restoration/hydration): (Spreader canal; weir/plug (Jenkins Ditch)
2. Moonshine Creek (MC) & Gulfstream East (GE) Restoration: Connect HSLCD ditch to MC; clear MC vegetation; weir in Hobe Grove Ditch; grade area to historic topography
3. Cypress Creek Canal (CCC)(Reduce over-drainage): Replace CCC weir to raise control elevation, raise berm at Ranch Colony, automate twin 84" culverts; pump and spreader swale; regrade CC southern forks
4. Gulfstream West (GW)(Restoration & reduce over- drainage): Partial backfile & relocate southern end of HSLCD canal; small pump, construct flow through marsh to attenuate flows
5. Pal-Mar East (Restoration & Connectivity): Plug ditches; remove pipes; improve northern berm; construct western berm improve eastern berm; pumps at Thomas Farm to redirect drainage to GW flow- redirect drainage to GW flow-through marsh via north Nine-Gems Canal
6. . C-18W Reservoir (9,500 ac-ft. & 4 ASR wells): Above ground reservoir; inflow pump, discharge structure; seepage control; M-O canal connector and pump
7. . G-160 Structure (Reduce over-drainage): Improve hydroperiod in Loxahatchee Slough
8. G-161 Structure (Connectivity): GWP water to Loxahatchee Slough
9. GWP Triangle (Connectivity): Grade and reconnect
10. M-1 Pump Station (conveyance): Deliver lower M-1 basin water to M-Canal, GWP and G- 161



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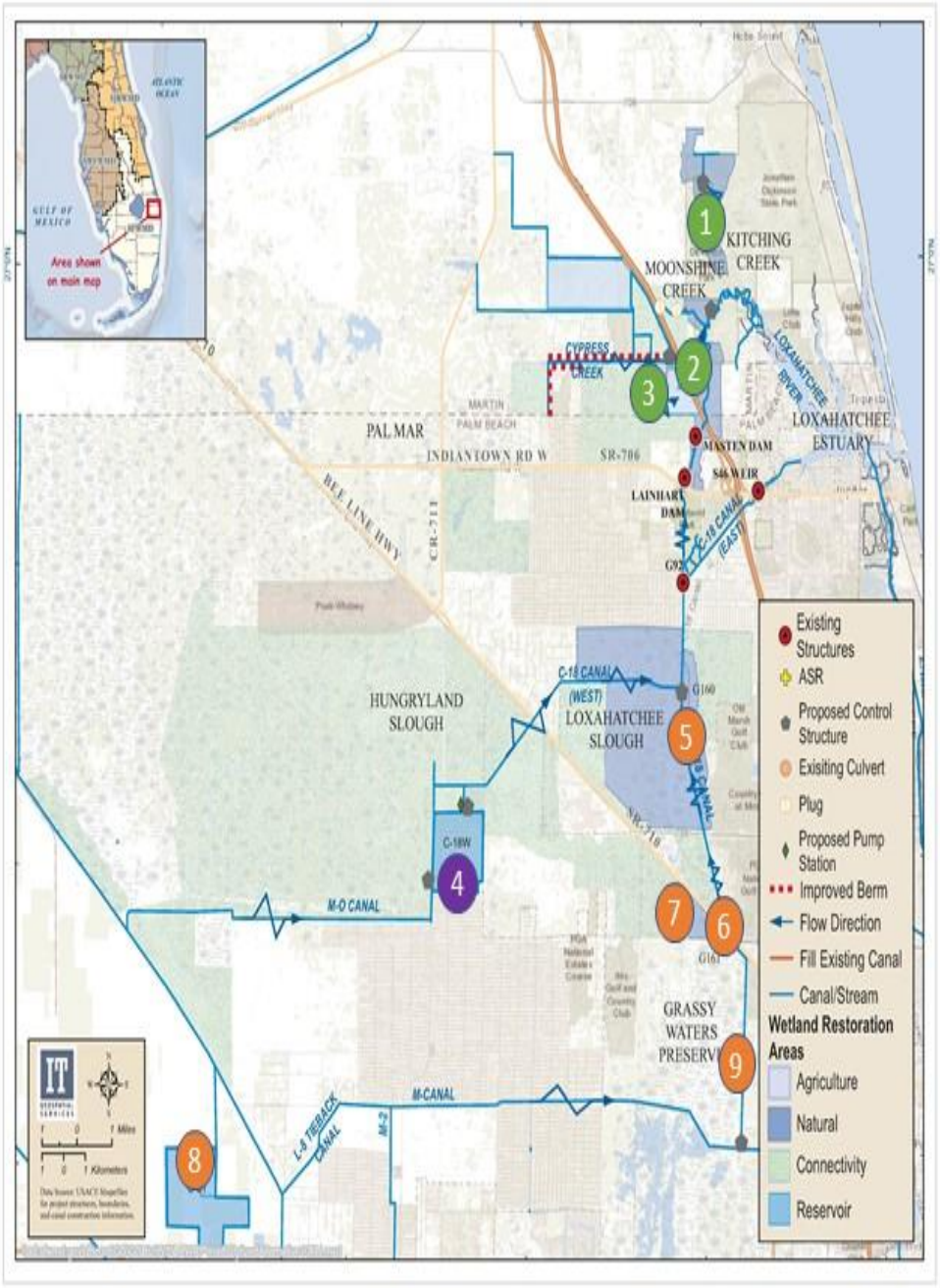
Alternative 10

1. Kitching Creek (Restoration/hydration): (Spreader canal; weir/plug (Jenkins Ditch)
2. Moonshine Creek (MC) & Gulfstream East (GE) Restoration: Connect HSLCD ditch to MC; clear MC vegetation; weir in Hobe Grove Ditch; grade area to historic topography
3. Cypress Creek Canal (CCC)(Reduce over-drainage): Replace CCC weir to raise control elevation, raise berm at Ranch Colony, automate twin 84" culverts
4. C-18W Reservoir (7,200 ac-ft.): Above ground reservoir; inflow pump, discharge structure; seepage control; M-O canal connector and pump
5. G-160 Structure (Reduce over-drainage): Improve hydroperiod in Loxahatchee Slough
6. G-161 Structure (Connectivity): GWP water to Loxahatchee Slough
7. GWP Triangle (Connectivity): Grade and reconnect
8. C-51 Deep Reservoir (Storage): 44,000 ac-ft., includes pump and channels
9. Force Main (conveyance): Pump and pipeline through GWP to connect M-Canal to G-161



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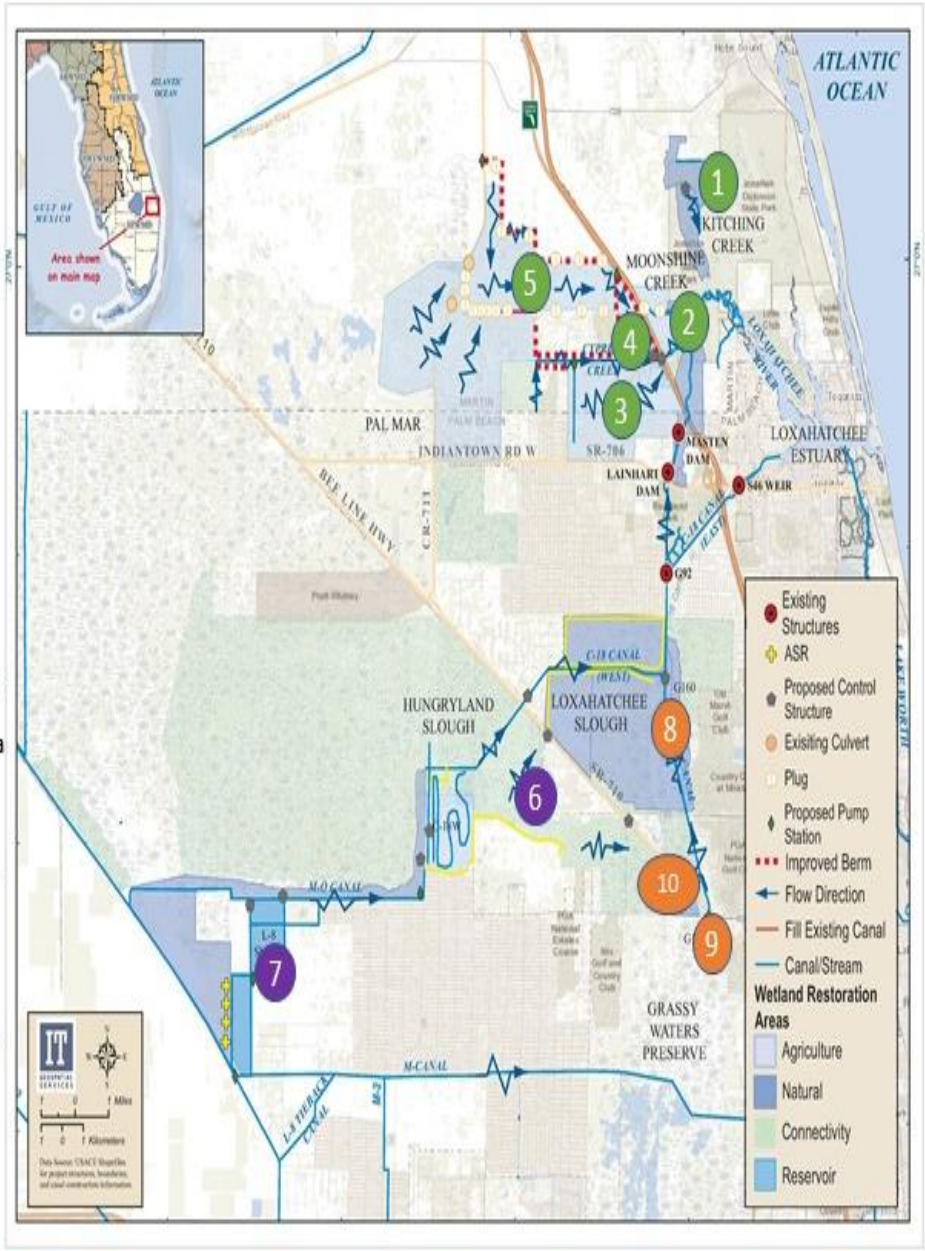
Alternative 13

1. Kitching Creek (Restoration/hydration): (Spreader canal; weir/plug (Jenkins Ditch)
2. Moonshine Creek (MC) & Gulfstream East (GE) Restoration: Connect HSLCD ditch to MC; clear MC vegetation; weir in Hobe Grove Ditch; grade area to historic topography
3. Cypress Creek Canal (CCC)(Reduce over-drainage): Replace CCC weir to raise control elevation, raise berm at Ranch Colony, automate twin 84" culverts; pump and spreader swale; regrade CC southern forks
4. Gulfstream West (GW)(Restoration & reduce over-drainage): Partial backfile & relocate southern end of HSLCD canal; small pump, construct flow through marsh to attenuate flow
5. Pal-Mar East (Restoration & Connectivity): Plug ditches; remove pipes; improve northern berm; construct western berm improve eastern berm; pumps at Thomas Farm to redirect drainage to GW flow- redirect drainage to GW flow-through marsh via north Nine-Gems Canal
6. Natural storage @ C-8 W (Basin Restoration) Restore natural topography; seepage barriers; culverts for Beeline Hwy; backfill interior canals south of C-18W canal; pump station at Mecca; flow-paths through Mecca & Avenir; M-O Canal connector & pump discharge structure; seepage control; M-O canal connector and pump
7. L-8 Basin Shallow Storage (6,500 ac-ft. & 4 ASR wells): includes pumps and channels
8. G-160 Structure (Reduce over-drainage): Improve hydroperiod in Loxahatchee Slough
9. G-161 Structure (Connectivity): GWP water to Loxahatchee Slough
10. GWP Triangle (Connectivity): Grade and reconnect



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Appendix B
Dry Season and Wet Season Targets For PB Alternatives

TARGETS				
	Rolling 30-day avg > 69 cfs 100% of time		Rolling 30-day avg > 110 cfs for > 120 days	
	Dry Season		Wet Season	
Year	Dry Season Flows (cfs) at Lainhart Dam	Percent Target Met	Wet Season Flows (cfs) at Lainhart Dam	Percent Target Met
1965	105	57.69	157	100
1966	182	100.00	183	100
1967	149	81.87	165	100
1968	125	68.68	183	100
1969	182	100.00	183	100
1970	182	100.00	183	100
1971	45	24.73	177	100
1972	183	100.55	183	100
1973	134	73.63	174	100
1974	156	85.71	172	100
1975	141	77.47	183	100
1976	130	71.43	183	100
1977	122	67.03	157	100
1978	182	100.00	179	100
1979	182	100.00	182	100
1980	183	100.55	183	100
1981	105	57.69	120	100
1982	182	100.00	183	100
1983	182	100.00	183	100
1984	183	100.55	183	100
1985	171	93.96	152	100
1986	182	100.00	164	100
1987	182	100.00	146	100

1988	183	100.55	183	100
1989	119	65.38	143	100
1990	163	89.56	169	100
1991	182	100.00	183	100
1992	183	100.55	161	100
1993	182	100.00	183	100
1994	182	100.00	183	100
1995	182	100.00	158	100
1996	183	100.55	183	100
1997	182	100.00	183	100
1998	182	100.00	161	100
1999	153	84.07	176	100
2000	183	100.55	113	94.17
2001	126	69.23	164	100
2002	182	100.00	130	100
2003	133	73.08	183	100
2004	146	80.22	134	100
2005	159	87.36	183	100