Everglades Agricultural Area Regional Feasibility Study

Deliverable 2.2 – Final Evaluation Methodology Report

(Contract No. CN040912-WO03 Phase 1)

Prepared for:

South Florida Water Management District (SFWMD)
3301 Gun Club Road
West Palm Beach, FL 33406
(561) 686-8800

Prepared by:

A.D.A. Engineering, Inc.
11401 S.W. 40th Street, Suite 470
Miami, Florida 33165
(305) 551-4608

May 2005

EVERGLADES AGRICULTURAL AREA
REGIONAL FEASIBILITY STUDY

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1.0 INTRODUCTION

The long-term Everglades water quality goal is for all discharges to the Everglades Protection Area (EPA) to achieve and maintain compliance with water quality standards, including phosphorus, as established in Rule 62-302.540, F.A.C., in the EPA. Figure 1 shows an overview of the EPA. Substantial progress towards reducing phosphorus levels discharged into the EPA, has been made by the State of Florida and other stakeholders. The combined performance of the source controls in the EAA and the Stormwater Treatment Areas (STAs) of the Everglades Construction Project (ECP) has exceeded expectations. In addition, some source control measures have been implemented in urban and other tributary basins included in the Everglades Stormwater Program (ESP). Nonetheless, additional measures are necessary to achieve the Everglades water quality goal.

The projects in the October 27, 2003 *Everglades Protection Area Tributary Basins Long-Term Plan for Achieving Water Quality Goals* (Long-Term Plan) (Burns and McDonnell, 2003) were designed to achieve compliance with the water quality standards for the EPA by December 31, 2006. One of the key assumptions during the development of the Long-Term Plan was that Compartments B and C (see Figure 2) would be under consideration for use as part of the Everglades Agricultural Area (EAA) Storage Reservoir Project through FY 2010 and for this reason should not be considered for other Everglades restoration uses until FY 2011. Subsequent to completion of the Long-Term Plan, it was determined that all of the EAA Storage Reservoir Project's water storage goals could be achieved on Compartment A, and that Compartments B and C would not be needed to meet the storage objectives of the EAA Storage Reservoir Project (Phase 1 and 2). In light of the recent availability of land in Compartments B and C, construction of additional stormwater treatment areas is proposed in association with STA-2, STA-5 and STA-6 to assist the STAs in improving water quality entering the EPA. It is also the South Florida Water Management District's (SFWMD) intent to construct additional stormwater treatment areas on the remaining acreage of Compartments B and C.

To meet the objectives of the Long Term Plan an EAA Regional Feasibility Study will be performed to determine the optimal configuration of stormwater treatment areas on Compartments B and C with the objective of assisting the STAs in improving water quality in the EPA. The Study will take into account the anticipated flows and phosphorus loads to the existing STAs, the currently planned STA expansions and enhancements, the EAA Canal Improvements, the EAA Storage Reservoir Project and other currently planned improvements in the EAA region. The Study will include evaluation of alternatives for redistributing the inflow volumes and total phosphorus loads to the various STAs for optimal phosphorus removal performance, both before and after development of the EAA Storage Reservoir Project. For the period before implementation of the EAA Storage Reservoir Project, a 2006 condition simulation will be used. For the period after implementation of the EAA Storage Reservoir Project, it is anticipated that a 2010 condition simulation and a 2015 condition simulation will be used. The Study will also include determining the required improvements to the EAA Canals for transfer of water to balance the flows and loads across the STAs. The evaluations will include but not be limited to cost estimates, schedules and performance projections.

The EAA Regional Feasibility Study is a fact-finding exercise and is not intended to define the final arrangement, location and character of the proposed project. The purpose of the Study is to develop information necessary for the planning, design and construction of future projects in the EAA. Results of the Study will provide Legislature, SFWMD Governing Board, and stakeholders information necessary for the policy decisions needed to determine the optimum combination of water quality treatment solutions.

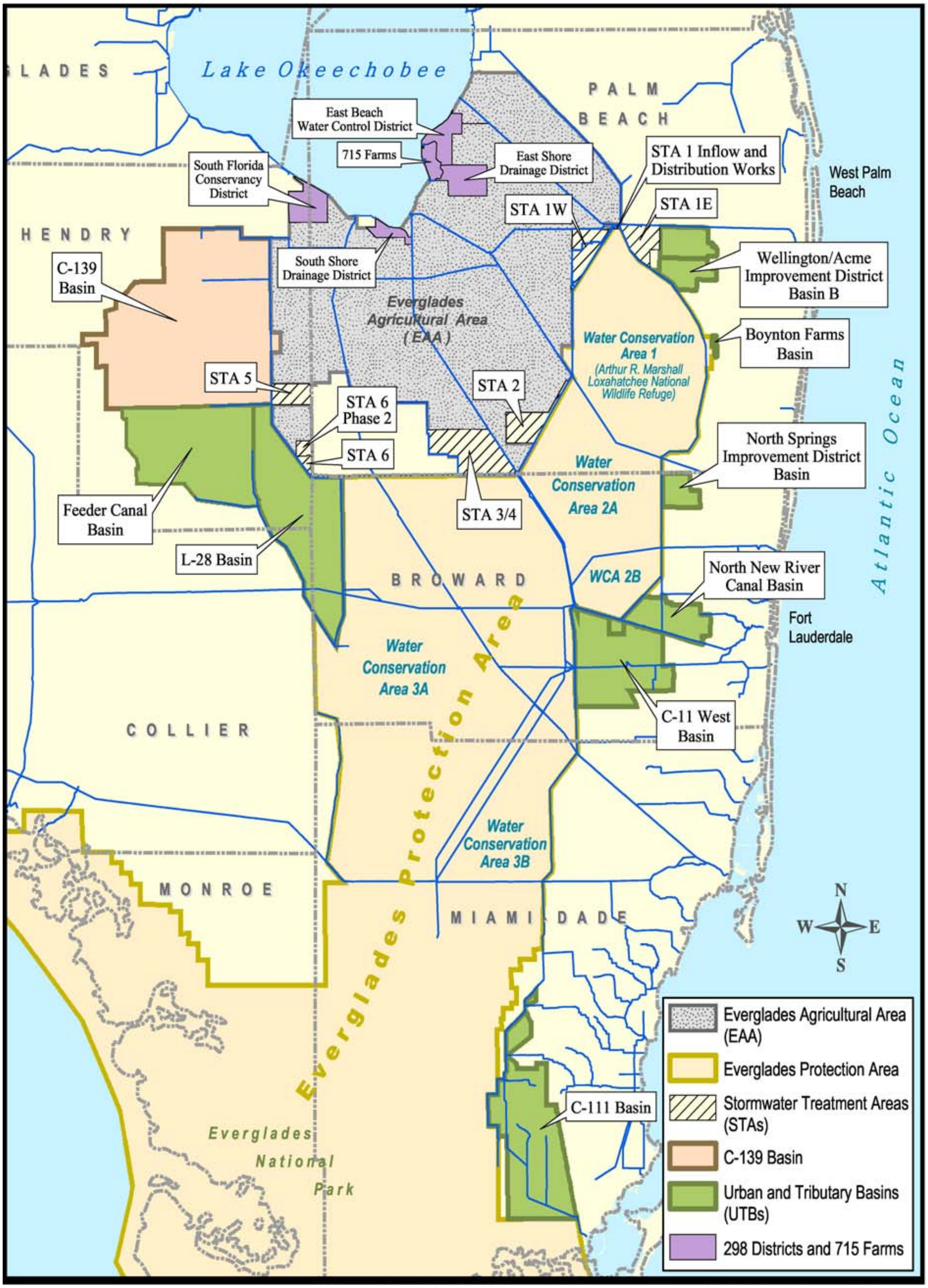

Figure 1 – Overview of the Everglades Protection Area

Because the EAA Storage Reservoir and the EAA Canal Improvements Projects have specific goals and objectives, the Study will be conducted in a manner to ensure that these goals are not impacted in the alternatives development and evaluation phases. Close coordination by the ADA Team with the SFWMD staff and other consultants working on the EAA Storage Reservoir, the EAA Canal Improvements, the Everglades Construction Project, the Long-Term Plan, CERP, and the Study will be critical in ensuring that goals and objectives of these programs are not compromised.

The Study will be conducted in increments, with the initial focus being an operational analysis of moving water and associated phosphorus loads from the eastern EAA basins (e.g., the S-5A basin) to the central and western areas. This operational analysis will identify potential changes to the SFWMD's canal system and structures to meet the water quality improvement goals. Specific areas to be evaluated in this initial phase include:

1. Providing operational flexibility to redirect STA-1W inflows and/or outflows to the Hillsboro Canal and then to either STA-2 via the S-6 pump station, or to Compartment B and/or STA-3/4 via the North New River Canal.
2. Reducing flows and loads (up to an average of 30,000 acre-feet per year) to STA-1E from the S-5A Basin.
3. Balancing flows and loads across the STAs taking into account the proposed Bolles and Cross Canal Improvements and the recently completed Ocean Canal conveyance improvements.

Subsequent tasks of the Study will include an evaluation of the following potential projects, improvements, and operational modifications:

1. Optimizing configuration of STAs on Compartments B and C with the objective of assisting the STAs in improving water quality in the EPA.
2. Optimizing usage of the EAA Storage Reservoirs with the objective of achieving this project's goals including providing flow equalization for the STAs.
3. Adding redundancy to current STA treatment facilities by providing the ability to take treatment cells off line for maintenance, construction of enhancements, or other purposes.
4. Minimizing potential for overloading the STAs during times of higher than normal runoff or Lake Okeechobee releases.
5. Improving the phosphorus removal performance of the STAs or otherwise reducing the risk associated with uncertainties in treatment performance projections in the Long-Term Plan.
6. Providing a hydraulic connection of STA-5, STA-6 and Compartment C to the Miami Canal (and Lake Okeechobee).
7. Improving the L-7 and L-40 conveyance, if needed to minimize potential adverse water quality impacts to the interior of Refuge.

Alternatives considered during the Feasibility Study will be evaluated with respect to capital and Operation and Management (O&M) cost estimates, implementation schedules, cash flow analysis, real estate acquisition schedules and costs, flood impact and protection analyses, environmental benefits, and water quality performance projections for the STAs.

This document presents a proposed evaluation methodology for evaluating the EAA Regional Feasibility Study alternatives. This evaluation methodology will use information from hydraulic and water quality modeling to be performed as part of the EAA Feasibility Study. This Feasibility Study is being completed as recommended in the Revised Part 2 of the Long Term Plan for Achieving Water Quality Goals (November 2004) which can be found at the following location: http://www.sfwmd.gov/org/erd/longtermplan/documents.shtml .

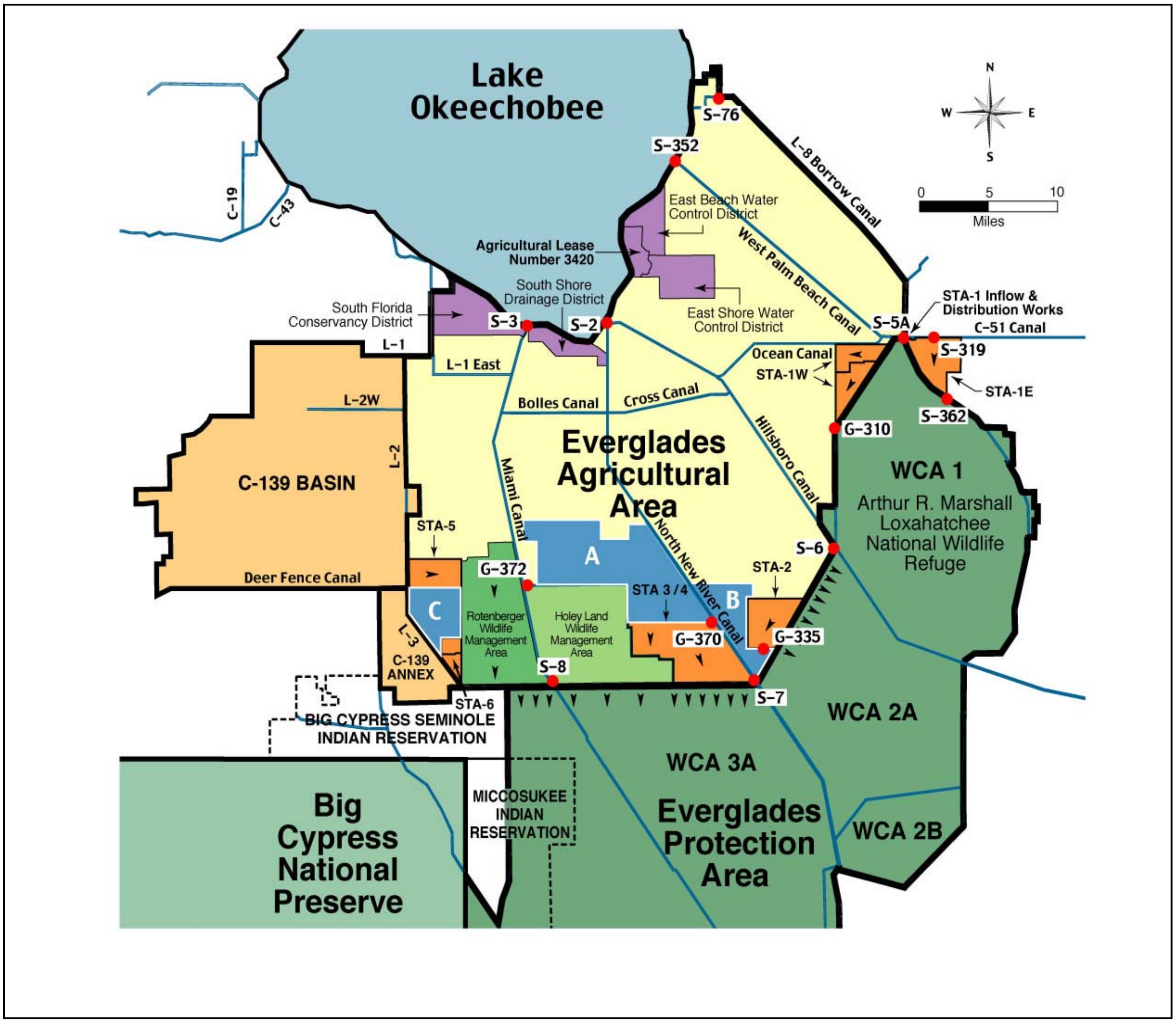

Figure 2 – EAA Study Area

2.0 EVALUATION METHODOLOGY

The EAA Regional Feasibility Study is being conducted to determine the optimal configuration and operation of additional treatment areas on Compartments B and C, and to evaluate alternatives for balancing the flows and phosphorus loads to the STAs to optimize treatment performance. The EAA Regional Feasibility Study will also evaluate alternatives for optimizing the EAA Storage Reservoir Project, including the EAA Canal Improvements, in concert with the optimized STAs. This evaluation methodology will provide a common basis for evaluating the various alternatives that will be developed as part of the EAA Regional Feasibility Study.

2.1 Proposed Evaluation Criteria

2.1.1 General Discussion

The main objective of the alternatives considered during this project is to optimize the phosphorus removal performance of the STAs. This will be evaluated using DMSTA and the desired output will be a minimum TP load and a balanced minimum outflow Total Phosphorus (TP) concentration across the STAs. An uncertainty analysis will be performed for each alternative, using the tools provided by DMSTA.

Criteria for evaluating alternatives will be categorized into **Technical Factors**, **Environmental Factors**, and **Economic Considerations**. The evaluation criteria for each factor are summarized below:

Technical Factors:
- Long-Term Phosphorus Concentration Achieved
- Flood impact analysis
- Operational flexibility
- Reservoir operation factors
- Implementation schedule including real estate acquisition

Environmental Factors:
- Redistribution of flows and TP loads to receiving waters
- Maintain desirable water levels in the Loxahatchee Wildlife Refuge

Economic Considerations:
- Capital and O&M cost estimates (50-Year Present Worth) including real estate acquisition costs
- Cash flow analysis

2.1.2 Summary of Criteria Evaluations of Alternatives

In conducting the evaluation, the Consultant shall report the results of evaluating each of the criteria for each alternative. The Consultant shall use best professional judgment to evaluate the qualitative criteria and shall provide a short narrative to support the qualitative evaluation; however no weighting factors or ratings will be applied.

The proposed methods for evaluating these criteria are described below.

2.2 Evaluation Criteria

The evaluation criteria are summarized in Table 1, and the following subsections provide a description of the evaluation criteria.

2.2.1 Technical Factors

Long-Term Phosphorus Concentration Achieved
The phosphorus removal performance of each of the alternatives will be evaluated using DMSTA. The long-term phosphorus concentration for the STA discharges will be reported as a flow-weighted mean for each alternative. An uncertainty analysis will be performed for each alternative, using the tools provided by DMSTA. DMSTA simulates the flows and phosphorus removal within water quality treatment facilities. Additional information on the proposed approach for evaluating the water quality performance of the alternatives is shown in Section 4.0 of this document.

Flood Impact Analysis. The hydraulic analysis will determine the flooding impact of alternatives that all have equal storm inflows from EAA farms. Hydrologic and hydraulic modeling results will provide predicted water levels at multiple locations along the Ocean, West Palm Beach, Hillsboro, Cross, Bolles, North New River, Miami, and the L Canals. If predicted water surface elevations are above the known critical Top-of-Canal elevations, modeling results will show the linear feet of canal with stages above the critical Top-of-Canal elevations. If there is no flooding indicated in the model results, peak stages at critical locations will be documented for each of the alternatives. Target canal stages during irrigation periods (these elevations are less than critical Top-of-Canal elevations) are known for EAA canals. The length of canals above those target stages will be documented. Below are the evaluation factors for the flood impact analysis.

Flood Impact Factor	Quantitative Measure
Flooding of farm fields	Feet of canal above critical Top-of-Canal Elevations
Canal Stage	Peak stage in each canal
	Miles above target stage in each canal

Operational Flexibility. The purpose of this evaluation criterion is to assess the potential for the alternative to add operational flexibility to the existing hydraulic conveyance system while still meeting treatment objectives. Operational flexibility will increase with the number of the anticipated EAA improvements. Examples include canal improvements, canal expansions, canal construction, and structure/pump station construction. Operational flexibility will be evaluated by comparing the proposed system of pumps and canals to the existing system. The quantitative measures of operational flexibility will be:

Operational Flexibility Factor	Quantitative Measure (relative to existing conditions)
Structures/Pump Stations	% Increase in Number of pumps
Operational Modifications	Number of new flow routes
Canal Conveyance	% Increase in Canal Conveyance

Reservoir Operation Factors. Reservoir storage volume is only one measure of the utility of a given alternative. Examples of technical factors that influence the effective use of storage volume include the volume of average annual reservoir discharges, effect on peak flow reduction, and minimizing reservoir dry-out. This evaluation will be based on output from the hydraulic analyses. The specific factors to be used are:

Effective Use of Storage Volume Factor	Quantitative Measure
Reservoir storage	Average annual reservoir discharge volume, acre-feet
Effect on peak flow reduction	Alternative Peak flow/base peak flow
Minimizing reservoir dry-out	Number of days with average depth < 1 foot

Implementation Schedule including Real Estate Acquisition. The purpose of this evaluation criterion is to evaluate the length of time required to design, construct, acquire land, and achieve full treatment capability, including any treatment start-up and stabilization time. The implementation schedule (in years from 2006 to full operation) for each of the alternatives will be determined and then reported.

2.2.2 Environmental Factors

Redistribution of Flows and TP Loads to Receiving Waters. The proposed projects will deliver different flows to certain receiving waters in relation to existing conditions. The annual average discharge and total TP load to each of the Water Conservation Areas (WCAs) will be estimated for each of the alternatives. The annual loads to the WCAs will also be estimated for each alternative.

Maintain Desirable Water Levels in the Loxahatchee Wildlife Refuge. The redistribution of flows to receiving waters may potentially result in different flows and water levels within the Refuge. Water levels different from existing conditions will be evaluated to determine if the change is beneficial, insignificant or adverse to Refuge habitat. Average water levels in the Refuge will not be calculated, however a change in the annual discharge volume and the hydropattern of those discharges will be used as a surrogate of a positive or negative impact to Refuge water levels. If deliveries are reduced, the regulation schedule for the Refuge will be reviewed and it will be determined if make-up waters can be treated and discharged to the Refuge to make-up for the reduction. If deliveries are increased, the regulation schedule for Refuge releases will be reviewed to determine if additional releases are necessary to maintain desirable water levels within the Refuge.

Decreases in hard-water discharges to the refuge may be beneficial. A comparison will be made to target hardness levels. Hardness impacts will be assessed by calculating the average hardness level using average hardness levels from incoming sources (e.g. Lake Okeechobee, Dupuis Reserve, EAA runoff).

2.2.3 Economic Considerations

Capital and O&M Cost Estimates including Real Estate. The purpose of this evaluation criterion is to determine the costs associated with each alternative. The total cost estimate for each alternative shall include capital (design and engineering, equipment, land acquisition, construction and civil work), associated program management costs, and operation and maintenance costs, and will be reported as a 50-year present worth. For the 50-year period of analysis, all design and engineering costs shall be escalated to the estimated center of the design and engineering phase, all land acquisition costs shall be escalated to the estimated center of the land acquisition phase, and all construction and program management costs shall be escalated to the estimated center of the construction period. Annual O&M costs shall be escalated to the year that they occur. The escalation rate shall be established at 3% and the discount rate should be established at 6-3/8%.

There have been numerous construction projects within the EAA in the past 10 years that provide an ample supply of construction unit costs. Unit costs reported in various recent planning and design documents such as the Revised Part 2 of the Long-Term Plan (Nov. 2004), the Basis of Design Report prepared by Brown and Caldwell for STA-2 Cell 4, and the Basis of Design Reports prepared by URS Corp. for STA-5 Flow-way 3 and STA-6 Section 2, are also available references. Unit costs and adjustment factors for those unit costs will be obtained from projects with similar construction elements to the work anticipated within the EAA. Operating costs will be estimated in a similar manner. Costs of electricity, diesel, pump maintenance, levee maintenance are also documented in similar documents as described above. Land acquisition cost estimates will be obtained from SFWMD.

Cash Flow Analysis. A cash flow analysis will be performed to determine the timing of cash outlays. Annual costs of project implementation will be determined using the detailed information provided in the cost estimate and the implementation schedule. The timing of cash flow outlays will be compared to the anticipated revenue stream, and alternatives that deviate significantly from the revenue stream will be noted, if revenue stream information can be made available by the SFWMD accounting department. In any event, the cash flow requirements will be developed and reported for each of the alternatives.

2.3 Methodology for Overall Criteria Evaluation

Each alternative will be evaluated according to the criteria listed above and entered into a criteria evaluation summary matrix (see Table 1). Background information will be provided by the Consultant for each criterion to justify the criterion value given in the summary matrix.

Table 1 – Evaluation Criteria Quantitative Values

Evaluation Criterion	Quantitative Measure	Comment
Technical Factors		
1. Long-Term Phosphorus Concentration Achieved	Parts per billion (ppb) flow-weighted mean concentration	See Section 4.0 for details
2. Flood Impact Analysis		
• Flooding of Farm Fields	Feet of canal above critical Top-of-Canal stages	Provide by canal
• Canal Stage	Peak stage	Provide for each canal
• Canal Stage	Miles of canal above target irrigation stages	Provide for each canal
3. Operational Flexibility		
• Structures/Pump Stations	% Increase in Number of structures/pumps	
• Operational Modifications	Number of new flow routes	
• Canal Conveyance	% Increase in Canal Conveyance	
4. Reservoir Operation Factors		
• Reservoir Discharge Volume	Avg Annual reservoir discharge volume, acre-feet	
• Effect on peak flow reduction	Alt. Peak flow/base peak flow	
• Minimizing reservoir dry-out	No. days with average depth < 1 foot	
5. Implementation Schedule including Real Estate	No. years to full treatment and operational capability	
Environmental Factors		
6. Redistribution of flows and loads	Report flows and loads to WCAs	
7. Impact to Refuge	Report changes in flow and hardness	Make-up waters will be identified if possible
Economic Considerations		
8. Capital & O&M Cost including Real Estate	$____ Present Worth	50-year Present Worth
9. Cash Flow Analysis	$ per year	

3.0 HYDROLOGIC AND HYDRAULIC ANALYSIS APPROACH

3.1 Requirements for H&H Analysis

Hydrologic and hydraulic and water quality modeling will be done to develop an operating strategy for optimizing STA performance with existing EAA canals. Following this effort, the hydraulic model and the water quality model (DMSTA) will be modified to evaluate different levels of implementation of EAA project elements including the STAs on Compartments B and C, the A-1 Reservoir, and the EAA Canal Improvements. Figure 2 presents a map of the EAA study area.

The EAA Feasibility Study phases and tasks are summarized below to help the reader understand the types of questions that the modeling effort will be addressing. Detailed EAA project phases and tasks are included in the EAA Regional Feasibility Study Final Work Plan.

- **Phase 1 - Task 3**: Evaluate the optimum allocation of hydraulic loading, canal conveyance, and operating strategy to the existing STAs (no DMSTA analysis). This analysis should define the maximum capacity of the Ocean and Cross Canals to convey water from the S-5A basin to the S-7 basin without over-topping of the canal levees.
- **Phase 2 - Task 2**: Evaluate the optimum allocation of hydraulic and phosphorus loading, canal conveyance, and operating strategy to the existing STAs with STA 2 Cell 4, STA 5 Flow-way 3, and STA 6 Section 2.
- **Phase 2 – Task 3**: Evaluate the optimum allocation of hydraulic and phosphorus loading, canal conveyance, and operating strategy to the STAs (Phase 2 – Task 2 configuration), and Compartments B & C. Compartment C inflows will be from C-139 and the C-139 Annex.
- **Phase 2 – Task 4**: Evaluate the optimum allocation of hydraulic and phosphorus loading, canal conveyance, and operating strategy to the STAs (Phase 2 – Task 2 Configuration), Compartments B & C, assuming flows to Compartment C to optimize flows into STA 5 and STA 6.
- **Phase 2 – Task 5**: Evaluate the optimum allocation of hydraulic and phosphorus loading, canal conveyance, and operating strategy for Phase 2 – Task 4 with the A-1 Reservoir.

Phase 1 – Task 3 and Phase 2 – Task 4 are primarily focused on hydraulic analyses to define existing and proposed canal conveyance capacity. The approach for performing these analyses is described in Sections 3.2.2 and 3.2.3, respectively.

3.2 H&H Conceptual Approach

3.2.1 Model Selection

The evaluation of canal conveyance will be conducted with a hydrologic and hydraulic model. The Scope of Work for the EAA Feasibility Study called for a streamlined HEC-RAS model that only includes the main SFWMD canals. An existing calibrated and approved HEC-RAS model for the canals specified in the Scope of Work is not currently available, but would have to be created.

DHI and Tetra Tech are updating a MIKE 11/MIKE SHE model of the EAA for the U.S. Army Corp of Engineers (ACOE), as part of the EAA Project Implementation Report (PIR). DHI, ADA, and Kimley Horn & Associates, Inc. developed the original MIKE 11/MIKE SHE model for SFWMD as part of the original PIR development. This model is described in a January 27, 2005 memo from ADA to SFWMD. ADA proposes to use the MIKE 11 model developed by DHI and Tetra Tech for ACOE. As part of the work for USACE, the MIKE 11 network has been enhanced with additional bridges and culverts where flow is restricted, and the cross section file has been carefully checked for accuracy and additional cross sections have been added from recent surveys.

Below are some perceived key advantages and disadvantages of using the currently available MIKE 11 model in lieu of developing a new HEC-RAS model of the EAA.

Advantages

1. The current MIKE 11 model has all the key hydraulic components of the EAA represented. These components have already been PEER reviewed by SFWMD and ACOE staff. Development of a new HEC-RAS model will not be as comprehensive given the schedule constraints and will require significant PEER review from SFWMD staff.

2. The current scope of work requires that the major EAA canals be included in the model (Miami, North New River, Bolles, Cross Hillsboro, West Palm Beach, Ocean and STA 3/4 Supply Canal). Based on the limited schedule, development of a new HEC-RAS model will be constrained to include mostly these canals. However, to accurately asses the hydraulic response of the EAA system, the L Canals and significant internal canals should be represented in the model. The current MIKE 11 model has these and many other canals represented in the model, including all the major control structures, culverts, bridges and other hydraulic constraints in the system.

3. The MIKE 11 model is a more robust model than HEC-RAS in simulating complex structures and operating conditions. The current MIKE 11 model has the current SFWMD major structures operating rules coded in the model. These rules have been reviewed and verified by SFWMD and ACOE Operations staff. Based on discussions with DHI staff, the current structure operating conditions have been verified during high flow conditions.

4. If the MIKE 11 model is used, it would allow the SFWMD the flexibility to couple the model with the final calibrated MIKE SHE model, if in the future groundwater interactions in the EAA need to be assessed.

5. The HEC-RAS model implements a 4-point implicit solution scheme that uses linearized governing equations of flow (St. Venant). This solution scheme does not take advantage of the iterative schemes available to solve the nonlinear equations of motion and inherently it is less accurate and produces instability in transitional situations. In contrast, the MIKE 11 model uses a 6-point fully implicit scheme that solves the governing nonlinear equations of motions using an iterative solution that is more stable and accurate. It also solves for water levels and discharges at alternating points within the solution domain that provides better mass balance through averaging of flow between consecutive cross sections.

Disadvantages

1. MIKE 11 is a proprietary model which requires purchasing a license to use the model. However, model input files can be viewed without a license by using the software in a demo mode. The software files are readily available from DHI's web site (www.dhisoftware.com). In addition, DHI has recently provided a Public Domain MIKE Viewer that would allow anyone to view modeling results without purchasing the software.

2. MIKE 11 does not include the WSPRO bridge routine as included in the HEC-RAS model. However, this routine would only be required if bridge scour would need to be evaluated.

3. Control structure and culverts are more complex to incorporate in MIKE 11 than HEC-RAS. However, the MIKE 11 structure routines are more robust than HEC-RAS, and most of the existing structures have already been programmed by DHI.

The MIKE 11 model representing existing conditions is available from the ACOE. This model includes all the STAs including STA 3/4. Based on discussions with the Interagency Modeling Center, Office of Model and SFWMD staff, it was concluded that the best approach is to use the existing MIKE 11 model of the EAA and enhance the model, where appropriate, with readily available data.

3.2.2 Phase 1 – Task 3: Determine the Existing Capacity of EAA Canals

The MIKE 11 model will be used to determine the existing 2006 capacity of EAA canals to convey as much water as possible from the S-5A basin to the S-6, S-7, and S-8 basins. The following modifications will be made to conduct this analysis:

1. MIKE 11 will be used in the analysis in steady state mode.
2. Add farm runoff at the canal locations of each permitted farm discharge (some inputs may be merged together where they are very close together). This runoff will be in the range of 3/8 inch per day steady-state, however higher discharge rates will be evaluated for selected EAA basins. This rate is used because the intent of the analysis is to determine how to manage EAA runoff at less than design levels. At 3/4 inches/day runoff from all EAA basins, all EAA outflow pumps must run at full capacity. It is not possible to route water from one basin to another under this scenario as it takes every pump running at full capacity to maintain desirable canal water surface elevations. An assessment will be made with higher runoff from the S-5A basin, S-2/S-6/S-7 basin, and the S-3/S-8 basin to evaluate conveyance in the Cross Canal, North New River, and the Bolles Canal. The assumption of 3/4"/day discharge from the entire EAA will be tested once Compartments B&C and the Reservoirs A-1 and A-2 are in place (Tasks 5 and 6 of Phase 2).
3. Existing canal capacity remains unchanged.
4. Improvements made in 2004 are added to the model (e.g. G-311, G-341, G-371, G-373, and STA 5 outlet canal).
5. Check STA 3/4 drawings to make sure there are details on G-371 and G-373.
6. Review Design Drawings for G-341 dimensions and follow-up with SFWMD to fill any data gaps. Also review Nova 2003 S-5A Diversion Letter Report.
7. Find dimensions and/or capacity for G-311 gated spillway inflow from the STA-1 Inflow Basin to STA-1E (which is on the east side of WCA 1 south of S-5A and west of canal L-40).
8. Add STA 1E to the model without including all internal cell dynamics, and add C-51W.
9. Check how DHI added STA 3/4 and modify if they did not have enough detail.
10. STA improvements (STA-2 Cell 4 and STA 5 Flow-way 3 and STA 6 Section 2) are included. Use Brown and Caldwell Basis of Design Report information for STA-2 Cell 4, and URS Basis of Design Report (BODR) information for STA-5 and STA-6.
11. Compartment B east of North New River and Compartment C in-between STA 5 and 6 are not included for initial tasks.

12. S-6, S-7, S-8, G-370, and G-372 pump flows will be at maximum capacity (regulatory schedule constraints in WCA 3A will be ignored). S-7 and S-8 flows will be taken from the STA 3/4 Operations Plan. Outflow gate S-150 will be closed because SFWMD Operations staff report that water is pulled from WCA 3A through S-150 when S-7 is pumping at full capacity .
13. The Holeyland and Rotenberger Tract wetlands will be included in the MIKE 11 network. Rainfall and ET will be included in the mass balance for these systems. Seepage inflows and/or losses calculated by the US ACE MIKE SHE model may be included as a boundary condition.
14. Outflow gates G-88 and G-155 will be removed and tailwater elevations will be assumed to be average levels using measured data from DBHYDRO. G-89 will remain closed. Details will be obtained from *URS 2005. Preliminary Hydraulics Modeling Report – STA 5/6 Expansions Design. March 10, 2005*.
15. S-2 and S-3 remain off unless headwater water levels exceed 13 ft NGVD.
16. Drainage from the Chapter 298 Districts and Agricultural Lease 3420 is routed to the following canals:
    a. EBWCD flows to both the WPB and Hillsboro Canals
    b. Lease 3420 and ESWCD flow to the Hillsboro Canal
    c. SFCD and SSDD flow to the Miami Canal
17. Rainfall, evapo-transpiration from the land surface, seepage from Lake Okeechobee and WCA 1, and groundwater elevation changes are ignored. Rainfall and ET are included for canals, STAs, and reservoirs.
18. L-8 canal is included in the network but it flows primarily to C-51 and STA 1E.
19. Runoff from C-139 used in the MIKE SHE/MIKE 11 model being used by ACOE will be checked using the most recent STA 5 inflow data set, G-406 flows, and G-136 flows.

Once these changes are made to the MIKE 11 model, the model will be run with increasing runoff and increasing S-5A and S-6 pump rates until the water levels in the Ocean and Cross Canals (and possibly the Bolles Canal, which is west of the North New River) reach elevations that cause over-topping of the levees. Once this point is reached, the flow through STA 1W and 2 will be extracted from the model results. These flow rates will be maximum flows than can be achieved without expanding the dimensions of the Ocean and Cross Canals. This analysis will also define the existing capacity of the Ocean, Cross and Bolles Canals to deliver water from the S-5A basin to the S-6, S-7, and S-8 basins. This will be evaluated by increasing runoff rates from selected EAA basins in various combinations.

3.2.3 Phase 2 – Task 4: Optimum EAA Canal Improvements for Optimum Existing STAs and STAs on Compartments B & C and the A-1 Reservoir

This analysis will evaluate a number of potential canal improvements to optimize flows and loads across the STAs including STAs on Compartments B&C and taking into account the Reservoir A-1. The 2010 SFWMM (2x2) run will be a basis for additional changes to the model. There are a number of structural features that will be present in 2010 that will be added to the MIKE 11 model. These features are:

1. All Dupuis Reserve flows are directed to Lake Okeechobee.
2. All L-8 runoff flows to either the Palm Beach Catchment Area through the M Canal, the Palm Beach Aggregates Mining Pit, to STA 1E, or to C-51.
3. Farm runoff will be modeled as with Phase 1 – Task 3, except that runoff range will be 3/4 - 1.5 inches/day since additional canal and pump station capacity will be available.

The runoff rate may be different for different areas of the EAA to test canal conveyance in selected canals.

4. STA 2 Cell 4, STA 5 Flow-way 3, and STA 6 Section 2 are in place.
5. Compartments B&C and the A-1 Reservoir are in place. Pump capacities for the A-1 Reservoir will be provided by Black & Veatch, however alternative pump capacities may be evaluated.
6. The pump stations for Compartments B&C will be initially selected using best available judgment plus input from key SFWMD staff. The delivery of water from Compartment B north area to the south area will be made in consultation with SFWMD staff for consistency with assumptions used to develop the 2010 Conditions SFWMM simulation. Levee heights in Compartments B&C will be determined in consultation with SFWMD staff and consultants working on those projects. Runoff entering Compartment C will come primarily from the C-139 and the C-139 Annex basins. C-139 Annex flows will come from recent work conducted for SFWMD and USSC.
7. Canal cross sections and flow restrictions (e.g. bridges) will be modified to the degree necessary to obtain the optimum flow distribution needed for optimum STA performance. Since STA performance will be based, to some degree, on flow attenuation in Reservoir A-1, the determination of optimum STA performance will be determined through an iterative analysis of flow conveyance, flow attenuation, and STA treatment. Therefore, the hydraulic analysis will likely begin prior to having the “final” optimum STA flow distribution from DMSTA analysis. No major changes in cross sectional area will be considered for the North New River and Miami Canal, because these improvements are anticipated for implementation in the 2015 timeframe. Minor improvements to conveyance of the NNR, Hillsboro, or Miami Canals may be evaluated (e.g. replacement of a bridge with low conveyance).

The evaluation criteria that will be used to evaluate alternatives for Task 4 are shown in Table 1.

4.0 WATER QUALITY PERFORMANCE MODELING APPROACH

4.1 Performance Criteria

The primary objective of the EAA Regional Feasibility Study is to identify the optimum distribution of inflow volumes and TP loads to the various stormwater treatment areas of the ECP and to develop alternative plans of improvement to the hydrography of the EAA capable of supporting that distribution. For the purposes of the Feasibility Study, the optimum distribution will be considered as that resulting in a close balance or equivalence in the projected TP concentrations in discharges from the STAs. The metric to be employed in evaluation of the distribution is the long-term flow-weighted mean TP concentration in STA discharges.

It is uncertain that an exact equivalence in flow-weighted mean discharge concentrations will or can result from the analysis. For the purpose of the Feasibility Study, a range of projected discharge concentrations not varying by more than 20% from low to high will be considered an essential balance (e.g., if the lowest projected concentration from any given STA is 12 parts per billion (ppb), the maximum projected concentration from any other STA should be 14.4 ppb or less). A possible exception to that metric is STA-5, which at least initially will be considered as dedicated to treatment of C-319 Basin runoff without other sources of inflow.

4.2 Computational Tools

An updated version of the Dynamic Model for Stormwater Treatment Areas (DMSTA), (Walker and Kadlec, 2001) will be employed in all estimates of TP reduction in the stormwater treatment areas. The version to be employed in this analysis is expected to be delivered to the ADA Team for use in the Feasibility Study on May 24, 2005. It is anticipated that the various computational parameters to be employed in the analysis, and the manner in which the calibration of those parameters was performed, will be discussed at that same time.

It is anticipated that the updated DMSTA will represent a substantial improvement over the April 2002 version employed in the October 2002 *Evaluation of Alternatives for the ECP Basins* (SFWMD, 2002) on which substantial components of the Long-Term Plan are based. Those improvements are expected to result primarily from the availability of a substantial period of record data on the full-scale performance of the existing STAs not available in the calibration of the previous version of DMSTA, as well as substantial modification of the reservoir component.

4.3 Inflow Data

Inflow time series for use in DMSTA will be developed from data furnished by SFWMD. That data will include, but not necessarily be limited to, the following:

- Record data over not less than the ten-year period May 1, 1994 through April 30, 2004 (Water Years 1995-2004), including daily discharges and total phosphorus concentrations at each structure discharging to or from the EAA and the Loxahatchee National Wildlife Refuge, together with such data as may be available on the L-8, C-139, C-139 Annex, and C-51 West Canal east of Structure S-5A.
- The results of South Florida Water Management Model (SFWMM) simulations for hydrologic conditions expected to prevail in 2006 (initial expansions of STA-2 and STA-5 complete), 2010 (full build-out of Compartments B and C complete, together

with Reservoir A-1), and 2015 (as for 2010, but with Reservoir A-2 complete as well). Those results are expected to consist of simulated daily discharges by source for a 36-year period extending from January 1, 1965 through December 31, 2000.

- Daily time series of rainfall and evapotranspiration applicable to each of the existing STAs covering the same 36-year period as the SFWMM simulation results.

The record discharges and concentrations furnished by SFWMD will be analyzed to define daily discharge volumes and total phosphorus loads by source, so that suitable relationships between flow or season and total phosphorus concentration may be defined. (***Phase 2, Task 1.3*****)**

The simulated discharges will be evaluated for reasonableness and specifically compared to similar information presented in the Long-Term Plan and the Supplemental Analysis. It is anticipated that the analysis will specifically address Water Years 1966-2000 (May 1, 1965 through April 30, 2000). Recommendations for any modifications or adjustment considered necessary will be made, and the data adjusted once consensus in those adjustments is reached between SFWMD and other stakeholders. It is anticipated that the comparison will initially take the form of a comparison of average annual volumes by source as taken from the three references. To the extent that comparisons made on that basis result in unreasonably disparate estimates, it may be necessary to compare common periods of simulation results and actual data (e.g., Water Years 1995-2000). This evaluation will be prepared under ***Phase 2, Tasks 1.1 and 1.2***.

For this analysis, it is intended that variations of less than 5% in simulated vs. recorded average annual discharges by source be considered as within a reasonable range of error, and the simulated data will be used without adjustment. Variations of greater than 5% will require consideration of potential causes of variation and postulation of means to address and resolve the differentials.

Use of DMSTA requires that not only daily inflow volumes, but also daily inflow TP concentrations, be specified. Previous analyses employed the May 2001 *Baseline Data*, (Goforth and Piccone, 2001). In development of that *Baseline Data*, recorded data on daily discharge and concentration was analyzed to develop a regressed relationship between the two, which in some basins varied by season. It was noted that the regressions resulted in fairly high residual errors.

For this analysis, the sensitivity of DMSTA results to other means of assigning TP concentrations to daily inflows will be assessed (***under Phase 2, Task 1.4***). The daily time series of inflows developed for the October 2002 analysis of STA-1W will be imported to the new version of DMSTA. Each case considered in the 2001 analyses (e.g., Baseline and Alternatives 1 and 2) will be coded into DMSTA and operated. (It should be noted, that these results can be expected to vary from those presented in the October 2002 analysis, given the subsequent changes in DMSTA.) The daily phosphorus concentrations in the inflow time series will then be replaced with concentrations representing the flow-weighted means in the original inflow time series. Those flow-weighted mean concentrations will be computed for monthly flows (i.e., all inflows in January of any given year will be assigned the flow-weighted mean concentration of all January inflows in the original 31-year time series). DMSTA will then again be operated with the replacement inflow time series, and the results compared to those originally obtained. This comparison is intended only to assess the sensitivity of the model to the method of assigning daily inflow TP concentrations, and will not represent a revised estimate of the performance of STA-1W, as the entire inflow time series will be subsequently replaced. To the extent that neither the projected long-term flow-weighted mean nor geometric mean outflow concentration estimates of the two analyses vary by more than 10%, the model will be considered insensitive to the substitution of monthly flow-weighted mean TP concentrations for daily estimates based on regression analyses, and subsequent analyses will proceed on that basis. Should the comparison result in a difference of more than 10% in either estimated outflow concentration, it will be necessary to consult with SFWMD to determine an appropriate modification to the scope of work.

Following completion of each of the above steps, a daily inflow time series for each STA will be developed in which the simulated inflows (adjusted as might be necessary) are coupled with the monthly concentration by source developed under Task 1.4, and established as input files for use in DMSTA (***Phase 2, Task 1.5***).

4.4 Selection of DMSTA Parameters

The April 2001 version of DMSTA included a number of calibration data sets developed primarily from relatively small experimental platforms. There now exist full-scale operating data on a number of completed STAs over time periods of three years or more. With respect to the calibration data sets embodied in DMSTA, it is anticipated that the updated version of the model will principally rely on the operating results from individual cells (categorized by vegetation type) in the full-scale operating STAs. It is anticipated that the authors' recommendations for calibration data sets will be presented in the May 24, 2005 meeting and that the selection of the calibration data sets for use in the Regional Feasibility Study will be made at that time.

In addition to the vegetation calibration data sets, DMSTA requires the input of a number of additional physical parameters, related primarily to cell morphometry, hydraulics, and seepage. For the existing STAs, all of which were modeled for the October 2001 *Evaluation of Alternatives* (SFWMD, 2001), those physical parameters will be established consistent with the original model input, unless a specific reason for modification exists. An example of such a modification is the anticipated capability in the new DMSTA to specify that cells receive returned seepage, which in the April 2002 version of DMSTA were returned to the cell from which they originated.

For initial treatment area expansions (Cell 4 at STA-2, third flow-way at STA-5, and possibly STA-6 Section 2), physical parameters will be estimated based on information contained in then current Basis of Design reports (BODR) for those areas (URS, 2005 and Brown and Caldwell, 2005).

For future build-out of Compartments B and C, it is unlikely that a physical definition of the proposed treatment area works will be available for use in this analysis. For those areas, it will be necessary to develop preliminary estimates of physical parameters in coordination with SFWMD staff and other stakeholders.

4.5 Uncertainty Analysis

Definition of the methodology to be employed in the conduct of uncertainty analyses is dependent on the (presently unknown) capabilities of the revised DMSTA model. Uncertainty analysis methods will be defined following the May 24, 2005 DMSTA meeting.

4.6 DMSTA Analyses to be Conducted

It is anticipated that the following DMSTA analyses will be conducted over the course of the EAA Regional Feasibility Study:

1. For each STA, following development of the inflow time series for 2006 conditions, assuming the initial expansion of STA-2 (Cell 4) and STA-5 (third flow-way) is complete, but without any change in system operation beyond that considered in the SFWMM simulation (***Phase 1, Task 3***);
2. As above, but following hydraulic analysis to assess the extent to which inflows to STA-1W and STA-2 may be directed further westward. The input time series for 2006 conditions will be adjusted to reflect the potential increased diversion resulting from the hydraulic analysis, to the extent identifiable (***Phase 1, Task 3***);
3. A series of iterative analyses to define an optimum allocation of phosphorus and hydraulic loading to the expanded STAs (prior to full build-out of Compartments B and C) (***Phase 2, Task 2***);
4. A series of iterative analyses to define an optimum allocation of phosphorus and hydraulic loading to the STAs following full build-out of Compartments B and C and construction of Compartment A-1 of the EAA Reservoir (***Phase 2, Task 3***). These analyses will be based on the design configuration, including any canal improvements included in that project, and operating "rules" established for the Reservoir in development of the 2010 SFWMM simulation;
5. A series of iterative analyses to optimize the use of the A-1 Reservoir (***Phase 2, Task 5***). In these analyses, the proposed operation of the A-1 Reservoir will be varied to maximize water quality improvement performance of the overall project; the results of these analyses will be used to identify additional canal conveyance improvements required to realize maximum performance.
6. A series of iterative analyses to optimize the use of the A-2 Reservoir (***Phase 2, Task 6***). In these analyses, the proposed operation of the A-1 Reservoir will be varied to maximize water quality improvement performance of the overall project; the results of these analyses will be used to identify additional canal conveyance improvements required to realize maximum performance.

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