Chapter 5C: Update for the Restoration Strategies Science Plan

Edited by Larry Schwartz, Jeremy McBryan
and Megan Jacoby

SUMMARY

In June 2012, the State of Florida and the U.S. Environmental Protection Agency (USEPA) reached consensus on new restoration strategies (see Chapter 5A of this volume) for further improving water quality in the Everglades. Based on months of scientific and technical discussions, these strategies will expand water quality improvement projects to achieve an ultra-low total phosphorus (TP) water quality standard established for the Everglades. An NPDES permit along with a new state-issued Everglades Forever Act (EFA) watershed permit established stringent TP limits—a Water Quality Based Effluent Limit, or WQBEL—for water discharged into the Everglades Protection Area. The NPDES and EFA watershed permits and associated Consent Orders also require that the District develops and implements a Science Plan to enhance the understanding of mechanisms and factors that affect phosphorus treatment performance, particularly those that are key drivers to performance at low TP concentrations (<20 micrograms per liter, or µg/L).

The Science Plan is a strategic, high-level document that will be revised and updated as needed. Implementation of the Science Plan is guided by the Five-Year Work Plan, which is comprised of Detailed Study Plans (DSPs). Results from these studies may be used to inform the design and operations of water quality projects, which will ultimately improve capabilities to manage achievement of WQBELs. Related data and information gathered from these studies will also be incorporated into the development and refinement of the District's operational guidance tools.

This chapter provides a summary of the progress to date and future activities on the DSPs. As the proposed study plans of the Science Plan are further detailed and implemented, this chapter in future SFERs will integrate and synthesize information to effectively communicate plan findings. The findings will be used to gauge progress toward optimizing phosphorus treatment performance (see Chapter 5B of this volume) and achieving the WQBEL for TP (SFWMD, 2012a). This information will then be used to identify needed policy and management actions, key areas of uncertainty, and essential information gaps to direct future Science Plan efforts.

INTRODUCTION

In accordance with the Everglades Water Quality Restoration Framework Agreement between the U.S. Environmental Protection Agency (USEPA), Region IV, and Florida Department of Environmental Protection (FDEP), dated June 12, 2012 (FDEP and USEPA, 2012) and the Restoration Strategies Regional Water Quality Plan (SFWMD, 2012b), the *Science Plan for the Everglades Stormwater Treatment Areas* (STAs) has been established to investigate the critical factors that collectively influence the total phosphorus (TP) reduction and treatment

performance in the STAs (SFWMD, 2013). It is expected that the results from the Science Plan will be used to enhance the design and operations of projects under the Restoration Strategies Program, which will ultimately improve capabilities of the STAs to achieve compliance with the state's water quality criteria for TP. The Science Plan is also intended to fulfill the requirements of the Consent Orders between the FDEP and the SFWMD (dated August 15, 2012) associated with the National Pollutant Discharge Elimination System (NPDES) Watershed Permits and Everglades Forever Act (EFA) Watershed Permits for the Everglades STAs (OGC Nos. 12-1148 and 12-1149, respectively), issued on September 10, 2012.

Pursuant to the Consent Orders, the Science Plan was developed by the South Florida Water Management District (SFWMD or District) in consultation with representatives designated by the FDEP and USEPA (Technical Representatives), on behalf of the state and federal agencies, respectively. Published in June 2013, the complete version of the Science Plan, including the Five-Year Work Plan of the individual studies, is available on the District's website at www.sfwmd.gov/rs_scienceplan. Eight proposed studies outlined in the Five-Year Work Plan were reviewed and received approval to move forward by the District's Restoration Strategies Steering Group. One additional study outlined in the Five-Year Work Plan has yet to be developed. Eight Detailed Study Plans (DSPs) were developed that lay out the framework for the science and research to be undertaken during the initial phase of Science Plan implementation.

The DSPs lay out the framework for the science and research to be undertaken during the initial phase of science plan implementation. The DSPs include background information, study objectives and hypotheses, proposed methodology, and activities and milestones. The complete DSPs are available at www.sfwmd.gov/rs_scienceplan. Summary information on the progress of the DSPs is provided below.

OVERVIEW OF DETAILED STUDY PLANS

USE OF SOIL AMENDMENTS/MANAGEMENT TO CONTROL P FLUX

Overall Study Plan Summary

The purpose of this study is to investigate whether internal loading of phosphorus (P) in the STAs (i.e., the flux of soluble P from the soil to the overlying water column) can be reduced by application of soil amendments or management techniques and thereby reduce total P (TP) outflow concentrations. This study will be conducted in three phases, with a STOP/GO decision made at the conclusion of each of the first two phases. Phase I will involve (1) data mining and synthesis of past District-supported research relevant to this study, (2) continuation of an existing literature review on technologies for controlling soil P flux in wetlands or lakes and (3) to the extent practicable, assessing the feasibility of implementing any of these technologies at full-scale in the STAs. Phase II may involve screening candidate technologies identified in Phase I through small-scale laboratory or field tests to assess their ability to sequester P and, if warranted, select a subset of technologies for further investigation in Phase III.

Phase III will involve conducting large-scale field trials using some form of enclosure at the outflow regions in one or more of the existing STAs or within the STA-1W expansion area. The experimental approach for the field trials will be to compare the ability of treated enclosures to reduce outflow TP concentrations with the performance of a control (untreated) enclosure. The field trials will be of sufficient size to minimize uncertainty surrounding the scale-up of the technology/technologies in the STAs. The successful outcome of this study will be to identify a technology or set of technologies that when implemented will sufficiently reduce TP concentrations at the STA outflows in order to achieve the permitted Water Quality Based

Effluent Limit (WQBEL) for TP. These technologies may be applied during construction or during operation of an STA to meet the discharge limits.

Study Schedule

- Phase I: Initiate FY2014 Complete FY2014
- Phase II: Initiate FY2014, if warranted Complete FY2015
- Phase III: Initiate FY2015, if warranted Complete FY2020

Progress to Date (Water Year 2014)

- Developed Draft DSP
- Initiated Phase I
  - Completed Literature Review
  - Summarized past District findings relevant to controlling P flux
  - Compiled list of issues to be addressed for STOP/GO for Task II

Future Activities (Water Year 2015)

- Complete Phase I report
- Determine STOP/GO for Task II
- Initiate implementation of Task II, if warranted

DEVELOPMENT OF OPERATIONAL GUIDELINES FOR FEB AND STA REGIONAL OPERATION PLANS

Overall Study Plan Summary

The purpose of this is study is to develop toolsets and methodologies that support the development of operational guidance and regional operation plans for Flow Equalization Basins (FEBs)/STAs that best enable Everglades STAs to consistently achieve the WQBELs for TP. This is a three and a half year effort, which will include hydrologic, hydraulic, and water quality modeling in support of the development of operational guidance for the A1, L-8, and C-139 Annex FEBs, associated STAs and the surrounding regional water management infrastructure. The study is expected to support a larger series of efforts spread across the construction, implementation and monitoring work associated with the Restoration Strategies program. As project planning and design efforts proceed, information from this study will continually be incorporated into modeling support provided to various restoration strategies project components.

Study Schedule

- Task 1: Information gathering Initiate FY2013 Complete FY2014
- Task 2: Field test execution Initiate FY2013 Complete FY2016
- Task 3: Identify potential model refinements Initiate FY2014 Complete FY2016
- Task 4: Development of operating protocols Initiate FY2014 Complete FY2016

Progress to Date (Water Year 2014)

- Developed Draft DSP
- Conducted information gathering sessions and prepared summary document
- Completed STA-2 Cell3 wave test
- Progressed with operations tool development
- Conducted STA1-W test cell steady state field experiment

- Evaluated STA1-W test cell transient test monitoring precision and suspended test
- Prepared STA-3/4 Cell 2A wave test
- Initiated systems control and optimization contract and received preliminary report

Future Activities (Water Year 2015)

- Implementation of DMSTA code changes
- Finalize initial optimization for weekly model tool
- Developed approach for analysis of vegetation roughness from STA-2 Cell 3 testing
- Continue analysis of available data from STA-1W test cell steady state field experiment and PSTA pulse test
- Implement STA-3/4 Cell 2A wave test
- Identify and implement systems control and optimization model refinements

EVALUATE P SOURCES, FORMS, FLUX AND TRANSFORMATION PROCESSES IN STAS

Overall Study Plan Summary

The purpose of this study is to enhance the understanding of mechanisms and factors that affect P treatment performance of STAs, particularly those that are key drivers to performance at the lower reaches of the treatment flow-ways. Understanding the mechanisms and factors that affect the P treatment performance of STAs at low TP concentrations should provide information to develop strategies that will ultimately improve capabilities of the STAs to achieve permit compliance with WQBELs. In order to understand the mechanisms and factors that affect the P treatment performance of STAs at low TP concentrations it is important to evaluate P sources, forms, flux, and transformation processes along the STA flow-ways. The study will involve data mining, literature review, development of multi-tiered conceptual models, field surveys and studies, and more focused controlled studies. This study plan will be reviewed and enhanced as new information is derived via the data mining, literature review, conceptual model enhancement, and initial surveys.

Study Schedule

• DSP development	Initiate FY2013	Complete FY2015
• Workshop and peer review	Initiate FY2014	Complete FY2015
• Data collection	Initiate FY2015	Complete FY2018
• Data integration synthesis	Initiate FY2017	Complete FY2019

Progress to Date (Water Year 2014)

- Developed Draft DSP
- Completed fauna literature review
- Initiated literature review on other relevant topics
- Contracted organic P methods study
- Contracted and implemented low altitude imagery trial (for vegetation and bird surveys)
- Contracted data mining task and provided data for analysis
- Evaluated methodology for P flux, P sorption, microbial assays, field recon for fauna study, and conceptual model refinement
- Performed sampling equipment inventory
- Evaluated methodology/set-up for cell interior sampling

Future Activities (Water Year 2015)

- Contractor to finalize data mining analysis
  Begin work on organic P methods study
- Develop and contract for P flux measurement, ground survey vegetation sampling, soil characterization, soil sorption, pore water sampling, fauna evaluation, and particulate dynamics
- Develop Standard Operating Procedures for these methodologies
- Complete literature review
- Continue with conceptual model refinement
- Plan and implement study workshop

INVESTIGATION OF STA-3/4 PSTA PERFORMANCE, DESIGN AND OPERATIONAL FACTORS

Overall Study Plan Summary

Implementation of the STA-3/4 Periphyton-based Stormwater Treatment Area (PSTA) Project has been underway since WY2008. Beginning in FY2012, additional research and evaluation efforts were initiated for the PSTA Project and these efforts are continuing as part of the Restoration Strategies Science Plan.

The purpose of this study is to assess the chemical and biological characteristics and the design and operational factors of the PSTA Cell in STA-3/4 (**Figure 5C-1**) that contribute to the superior performance of this technology. Key factors thought to enable the PSTA Cell to achieve ultra-low outflow TP levels will be examined through experiments conducted at a variety of scales, including laboratory bench-scale studies, soil core studies, flow-through mesocosms, and field scale investigations, with the goal of informing design decisions for successful full-scale replication of this technology. The operational ranges under which the PSTA Cell achieved ultra-low outflow TP levels will be determined, and the management practices required to sustain good performance in the PSTA Cell will be identified.

Study Schedule

The PSTA study includes the implementation of various components and report deliverables. **Figure 5C-1** presents the plan components along with the estimated duration.

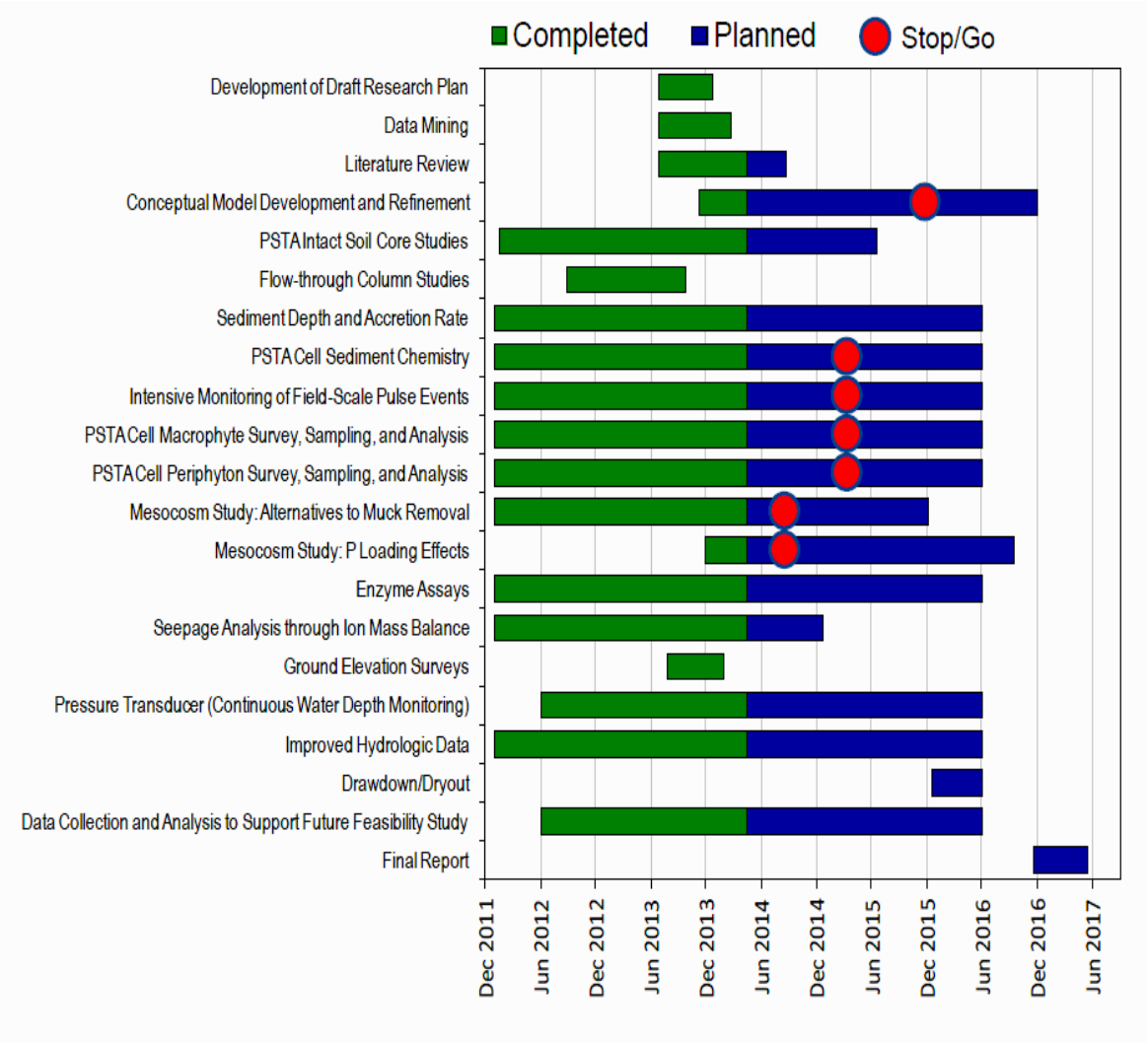

Figure 5C-1. PSTA study plan components and schedule.

Progress to Date (Water Year 2014)

- Developed Draft DSP
- Comprehensive water quality report for the PSTA cell provided by contractor
- Continued routine monitoring program
- New Rapid Phosphorus Analyzers (RPA) deployed in PSTA cell
- Began conceptual model development
- Planned and implemented pulse test in the PSTA cell

Future Activities (Water Year 2015)

- Continue routine monitoring program
- Continue conceptual model development
- Analyze pulse test results
- Provide data an analysis to support feasibility study

EVALUATION OF THE INFLUENCE OF CANAL CONVEYANCE FEATURES ON STA AND FEB INFLOW AND OUTFLOW CONCENTRATIONS

Overall Study Plan Summary

The purpose of this study is to determine if total phosphorous (TP) concentrations or loads change when conveyed through STA inflow or outflow canals. And, if so, what factors influence the changes; for example how much sediment and TP have been accumulated in canals throughout the period of operation, and if remedial field work is needed to address this issue.

The proposed study will be conducted in two phases. In Phase I the goal is to determine if TP concentrations change when conveyed through STA inflow or outflow canals, and if TP concentrations change, what are the factors that may be influencing the change in concentrations. The canals identified for investigation during Phase I are:

- STA-2 supply/inflow canal
- STA-2 outflow canal
- STA-3/4 inflow canal
- STA-1E outflow canal
- STA-1W outflow canal
- STA-1W Inflow Canal between S5A to G302

The findings from Phase I will be compiled in a summary report that will include recommendations for Phase II. The canals to be studied under Phase II will be based on the recommendations from Phase I. The discharge canals for STA-3/4 and STA-5/6 are not included in this study because the canal compliance sites and the flow way outflow structures are identical. If the Phase I results indicate that a canal is behaving as a TP sink or source then Phase II investigations will focus on verifying the Phase I results and determining the causative factors, and providing recommendations for remedial work to address the impacts, if needed, and/or recommendations for future STA/FEB canal designs and/or operations.

Study Schedule

- Phase I Initiate FY2013 Complete FY2016
- Phase II Initiate FY2015 Complete FY2017

Progress to Date (Water Year 2014)

- Developed Draft DSP
  - Initiated literature review (task 1)
  - For some of the selected canals performed:
    - Review of as-built drawings (task 1)
    - Data query of nutrient load program (task 1)
    - Canal field recon inspection (task 1)
    - Water quality concentration data variability and trend analysis (task 2)
    - Seepage flow rate modeling for STA-2 supply/inflow canal (task 3)
    - Estimation of canal sediment and TP accumulation(task 4)
    - Storm event based mass balance (task 5)
    - Correlation analysis for potential influencing factors on water quality changes (task 6)
  - Developed task 1 report

Future Activities (Water Year 2015)

- Finalize task 1
- Continue implementation of tasks 2-6 for remaining selected canals

EVALUATION OF INUNDATION DEPTH AND DURATION FOR CATTAIL SUSTAINABILITY

Overall Study Plan Summary

The purpose of this study is to identify the inundation depth and duration threshold for cattail (*Typha domingensis*) sustainability in the Everglades STAs. Field observations and studies have indicated that prolonged moderate and deep inundation is perhaps a cause for cattail decline in the STA treatment cells, e.g., STA-1E Cell 7 and STA-1W Cell 5A. This study will include three components: (1) the analysis of period-of-record (POR) hydrologic data, (2) an in-situ study, and (3) Test Cell study. The analysis of POR hydrologic data will help define the hydrologic characteristics (including inundation depth, duration, and frequency) that occur in EAV cells.

The in-situ study will be conducted in STA-1W Cell 2A and STA-3/4 Cell 2A and help identify environmental factors influencing cattail sustainability in the STAs. The results of the POR data analysis and the in-situ study will provide useful information to finalize the experimental design of the Test Cell study. In the Test Cell study, healthy cattail stands will be established in the STA-1W North Test Cells and will be allowed to mature. Subsequently, the ecophysiology of cattail will be assessed at variable inundation depths for certain inundation durations. Cattail survival, growth, biomass, reproduction, mortality, photosynthesis, leaf area index (LAI), and tissue nutrient concentration will be examined through field measurements and laboratory analyses. These data will then be used to identify the duration threshold at an inundation depth for cattail sustainability. The ability of the cattail stands to reduce the phosphorus (P) concentration in the water column will be also evaluated. The results of this study are intended to provide data that will facilitate the development of effective hydrologic strategies for sustainable vegetation management in the STAs and FEBs.

Study Schedule

- In-situ study Initiate FY2014 Complete FY2016
- Test cell refurbishment Initiate FY2015 Complete FY2015
- Test cell grow-in Initiate FY2016 Complete FY2016
- Test cell implementation Initiate FY2017 Complete FY2019

Progress to Date (Water Year 2014)

- Developed Draft DSP
- Performed Period of Record (POR) hydrologic data analysis
- Developed preliminary design for test cell refurbishment (soil replacement/water delivery)
- Initiated additional literature review
- Performed field recon and plot set-up for in situ study
- Purchased field equipment
- Contracted in situ study field assistance

Future Activities (Water Year 2015)

- Complete POR hydrologic data analysis
- Finalize design and complete test cell refurbishment (soil replacement/water delivery)
- Finalize additional literature review
- Implement in situ field study
- Prepare for test cell grow-in

STA WATER AND PHOSPHORUS BUDGET IMPROVEMENTS

Overall Study Plan Summary

The purpose of this study is to produce improved annual STA water and phosphorus budgets for STA treatment cells in order to meet the needs of the Restoration Strategies Science Plan. Water budget analysis is an important tool used to understand the treatment performance of STAs, and accurate water budgets are critical to developing accurate phosphorus budgets. Recently reported STA treatment cell annual water and phosphorus budgets contained high error terms (2013 SFER), thereby bringing into question the usability of the data to characterize and understand treatment performance.

The *STA Water and Phosphorus Budget Improvements Study* will be implemented in a phased approach. Phase I included a test case for improving water budgets for individual treatment cells using simplified desktop approaches. Phase II will implement the methodologies investigated during Phase I on an expanded list of treatment cells and will also include developing improved phosphorus budgets for these treatment cells. Phase III, only if determined to be necessary, will include more extensive approaches to further reduce errors in water and phosphorus budgets.

Study Schedule

Phase I - Initiate February 2013 Complete September 2013

Phase II -Initiate October 2013

- STA-2 and STA-3/4 flow data Improvements Complete September 2014
- POR STA-2 & STA-3/4 Water & Phosphorus Budgets Complete September 2015

Phase III TBD, if needed

Progress to Date (Water Year 2014)

- Developed Draft DSP
- Developing improved flow data for entire POR for approximately 60 structures
- Performing hydraulics and rating analysis to improve flow rating on STA-3/4 and STA-2
- Initiated improvement of Water Budget Tool
- Initiated uploading of improved historical flow data

Future Activities (Water Year 2015)

- Finalize report on results of test case to reduce water budget errors
- Continue improvement of Water Budget Tool
- Continue flow data and flow rating improvements and provide summary report
- Continue uploading improved historical flow data

EVALUATION OF SAMPLING METHODOLOGIES FOR TP

Overall Study Plan Summary

The objective of the Restoration Strategies Science Plan is to gather scientific information to reduce phosphorus discharge concentrations to meet WQBELs established in the NPDES permits for the STAs. Integral and fundamental to this objective is the proper collection of representative water quality samples from compliance stations and research programs. However, the unique use of autosamplers in South Florida as the primary method for collecting data for flow-weighted concentrations has been shown in general to produce slightly higher TPO_4 results than grab samples, and on occasion can produce values that are significantly higher. These unexplainable differences are often not large, but they can be a substantial contribution to TP measurements at low concentrations, adding extraneous and unrepresentative noise to analytical values.

In order to meet the low P concentration WQBEL discharge levels it is essential that the Science Plan identify factors that may improperly bias results and begin the process of improving sampling regimes in the STAs and at other water quality monitoring sites to lessen the frequency and magnitude of extraneous noise. Project REST (Remote Environmental Sampling Test) will collect significant amounts of water quality data using a variety of methods under tightly specified conditions to develop a robust database for the study sites, with supplemental information from deployed probes and cameras. Using these methods in concert, issues with each individual method and data stream can be isolated and offending factors identified. The ultimate goal of this project is to make recommendations on how to prevent, mitigate, or minimize for various factors that interfere with representative sampling such that the samples collected for environmental monitoring, compliance and research present the best possible estimate of water column TPO_4 in a cost-effective manner. REST does not have any preconceived goal of supporting one particular sampling regime over another. Rather, it seeks to produce information to optimize TP sampling across a range of environmental conditions and monitoring locations.

Study Schedule

- Task 1 Sampling Equipment Installation — Initiate FY2013 — Complete FY2014
- Task 2 Installation Evaluation — Initiate FY2014 — Complete FY2014
- Task 3 Data Collection Effort — Initiate FY2014 — Complete FY2015
- Task 4 Analysis — Initiate FY2014 — Complete FY2015

Progress to Date (Water Year 2014)

- Developed Draft DSP
- Installed and evaluated equipment at:
    - G310 (discharge from STA1-W), and
    - G380B (inflow to PSTA at STA-3/4
- Initiated monitoring
- Initiated data analysis

Future Activities (Water Year 2015)

- Complete study and provide report with recommendations regarding modifications to sampling practices

LITERATURE CITED

FDEP and USEPA. 2012. Everglades Water Quality Restoration Framework Agreement between U.S. Environmental Protection Agency, Region IV, Atlanta, GA, and Florida Department of Environmental Protection, Tallahassee, FL. June 12, 2012.

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