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Reference: Task 4.3 Deliverable, Final Letter Report, Task 4: Phase II SOW Analysis Proposals; EAA Basin Data Evaluation, Contract ST061287-WO01

Dear Mr. Pescatore,

BPC Group Inc. (BPC) is pleased to submit this final letter report presenting the development of multiple analysis proposals in an effort to develop the Phase II SOW for this contract.

INTRODUCTION

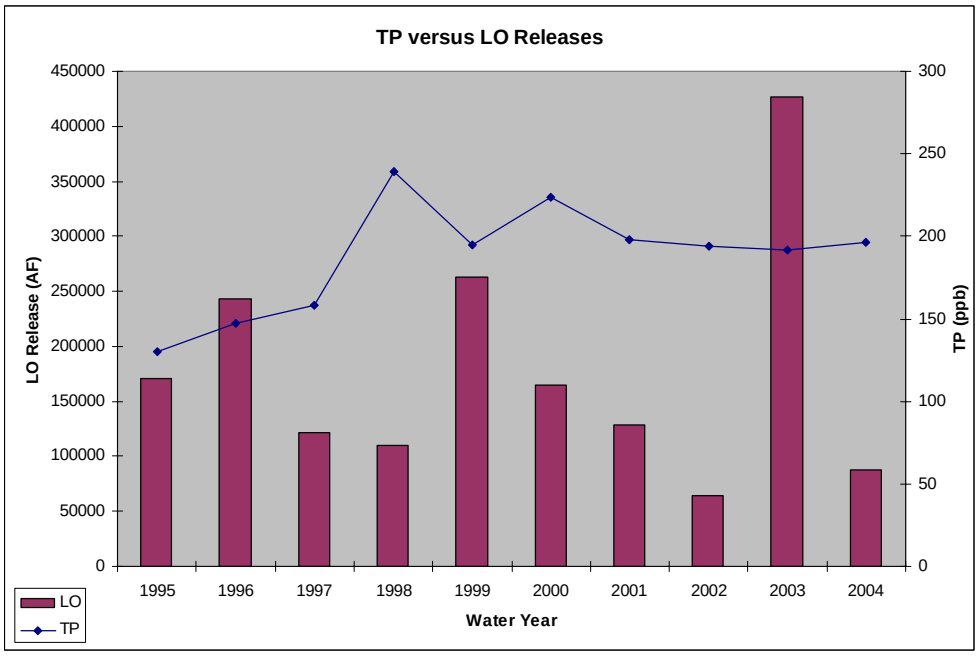
Florida's 1994 Everglades Forever Act (EFA), F.S. 373.4592, established long-term water quality goals designed to restore and protect the Everglades Protection Area (EPA). As defined in the Act, the EPA includes Water Conservation Areas (WCAs) 1, 2A, 2B, 3A, 3B, the Arthur R. Marshall Loxahatchee National Wildlife Refuge and the Everglades National Park. A primary component of the EFA is the Everglades Construction Project which includes a combination of phosphorus source control programs using mandatory best management practices (BMPs) and downstream treatment within manmade stormwater treatment areas (STAs).

During the 2003 legislative session, the 1994 EFA was amended to include reference to the March 17, 2003, Conceptual Plan for Achieving Long-term Water Quality Goals (Long-Term Plan). Although the Long-Term Plan for the Everglades Agricultural Area (EAA) recognized that the combined performance of the EAA BMP regulatory program and the STAs has exceeded expectations, supplemental adaptive management measures were identified to ultimately achieve water quality goals in the EPA. Accordingly, the Process Development and Engineering (PDE) component of the Long-Term Plan's overall water quality improvement strategy directed activities and funds towards "Identifying opportunities to maintain and improve upon the performance of source controls (BMPs) in reducing overall pollutant loads" discharging from specific basins, including the EAA.

In recent years, in response to the published data, the South Florida Water Management District (DISTRICT) has received public inquiries on why differences in phosphorus

concentration and load exist between farms in the EAA and between basins within the EAA. There have been inquiries into the effects of the load coming into the EAA from Lake Okeechobee in the form of irrigation waters and pass through waters. Pass through waters are defined as any water deliveries from Lake Okeechobee through the EAA canals. The DISTRICT is interested in exploring trends in the Lake Okeechobee inflows as well as trends in the distribution of these inflows. Additionally, there have been questions raised about the perceived effects of the 2005 hurricanes on the water quality of the EAA and the spatial distribution of flows and loads. As a result of the large number of influences on the EAA Basin it is important to determine the relationships between these influences and how they have changed with time.

Therefore, in recognition of the Long-Term Plan requirement to identify additional opportunities for water quality improvement and to further address public inquiries, this analysis of the EAA Basin and its Sub-Basins (S-5A, S-6/S-2, S-7/S-2, and S-8/S-3) will be conducted as a means to ensuring that the requirement of maintaining the current level of performance as described in section 5.1.1 *EAA Basins [Bc81(1)]* of the Long Term Plan is attained. This analysis (Phase II) will assist the DISTRICT in discriminating between verifiable trends in data and perceived trends in data, helping to focus efforts on identifying additional opportunities for water quality improvement. The verifiable trends will be investigated in Phase II of this project. For example, from the following chart of Lake Okeechobee releases through S-352 and Total Phosphorus concentrations for Water Years 1995 through 2004, an increasing trend in Lake water concentrations by approximately 50% in the released waters over a ten-year period appeared to have no correlation to the volume released per year.



However, the volume released combined with the concentration can have a dramatic effect on the total loads of phosphorus within the basin. One critical objective of this phase will be to attempt to identify the impact of that loading on the S-5A sub-basin performance. The Scoping of Phase II of this project takes into consideration the objectives of section 5.6.4 *Lake Okeechobee Long-Term Trends [Bc86(4)]* of the Long Term Plan.

OBJECTIVES

The primary objective of this project is to develop an understanding of the relationship between Lake Okeechobee inflows, EAA Basin runoff, and downstream points of entry into STA's and the driving factors that govern those relationships. This will be accomplished through a basin level data evaluation (flows, load, concentrations, and any other relevant data) for trends, changes, and significance that will help define the relationships. Understanding those relationships will help focus DISTRICT efforts on identifying areas where the BMP Program can be optimized to enhance the water quality improvements already observed within the EAA Basin. Critical to the effectiveness of a BMP program will be the understanding of the Lake water effect overall and within both spatial and temporal boundaries. Phase II, if conducted, will be devoted to conducting one or more of the analyses that were proposed in Phase I, as clarified at the Interim Coordination Meeting.

RECOMMENDATIONS FOR PHASE II DATA EVALUATION

The focus of the Phase II work will be on detailed data and statistical analyses to identify relevant relationships between Lake water releases and EAA runoff phosphorus concentrations as well as the fate and transport through the major canal network. The work will include and detail the proposed analyses as well as the data required to perform these analyses. This letter report will provide sufficient detail into approaches of further analyses that it can be used as a guide to develop a Scope of Work (SOW) for Phase II.

Overview

The proposed data evaluation process is divided into two categories of recommended activities as given below.

- Recommendation 1: Dataset Selection and Synthesis
- Recommendation 2: Data Evaluation Scenarios

The first recommended category of activities (Recommendation 1) includes some basic data synthesis elements and is essential to be completed prior to the initiation of evaluation scenarios (Recommendation 2). The second recommended category of

activities (Recommendation 2) includes a list of evaluation scenarios that may be implemented based upon the desires of the District. The exact scope of the optional scenarios under Recommendation 2 will be finalized during the preparation of a SOW by the District staff.

Recommendation 1: Dataset Selection and Synthesis

The following task elements are basic and required for all data evaluation and analysis investigations that may be performed under Recommendation 2. As indicated earlier, all task elements listed below in this recommendation category are essential to be completed prior to initiation of Recommendation 2.

- ***Delineation of Basin and Sub-Basins***

  The identification of the basin and sub-basin boundaries and associated structures is essential for quality control as well as statistical validity of conclusions. This task element involves documentation of the existing geographic delineation and confirmation of the boundaries for the basin and sub-basins to be evaluated. This includes the identification of the relevant structures to be considered in the analyses.

- ***Identification of Relevant Datasets for Analysis***

  This involves the identification of the data sets for detailed evaluation. This includes the complete listing of data and associated DBKeys from DBHYDRO. Data that are not incorporated into DBHYDRO may also be included, such as individual sub-basin and farm level data. Based on Phase I evaluation, the available datasets extend from WY78 to WY06. For the purpose of this evaluation, statistical analyses will be performed only on the basin and sub-basin level datasets.

  The datasets that will be used for evaluation include flow, stage, rainfall, runoff, load (phosphorous only), and concentration (phosphorous only) records for basin and sub-basins. No farm level data will be evaluated. The load and runoff calculation spreadsheets referred to at Interim Coordination Meeting (ICM) will also be provided by the DISTRICT for better understanding of the estimation process. The datasets containing at least 15 events will be identified, extracted and reformatted for further analysis.

- ***Identification of Significant Events***

  This involves the identification of significant events for analytical purposes. Significant events for the purposes of this evaluation are periods of time, usually 7

calendar days or longer (weekly or longer), when releases are continuously being made from Lake Okeechobee into the respective EAA basin. A shorter time period may be appropriate and published works, such as the paper by Baker and McCafferty, will be used to determine the period of time for the purpose of defining the significant flow events. The rainfall events will also be evaluated for identification of significant events, and the minimum time period for significant rainfall events will be determined after the actual rainfall records are reviewed. These events become the relevant basis for analysis to determine relative effects of lake loads and concentrations on the effectiveness of BMPs within the EAA.

- ***Data Synthesis***

  The synchronicity of the time and location of records among all necessary data types (flow, stage, load, concentration, and rainfall) at basin and sub-basin levels will be monitored in defining the datasets. The selected datasets will be reformatted and a database (Excel or Access) will be prepared such that the data would be compatible with the evaluation methodologies. The farm level data will not be used for this process since they are excluded from the statistical analyses; however, the data from IFAS (while limited) will be used during data evaluation scenarios under Recommendation 2 activities.

  Routine statistical analyses consisting of descriptive statistics will be performed on all selected datasets. The descriptive statistical analyses will include both univariate and multivariate statistical analysis techniques to evaluate relevant variables, including dataset trend analyses. The following statistical analyses will be performed on each dataset within the prepared database.

  - Time series plot
  - Trend analysis
  - Box-and-Whisker plot
  - Statistical descriptors and normality test (mean, median, minimum, maximum, quartiles, standard deviation, variance, confidence intervals, skewness, and kurtosis)
  - Correlations

  More advanced and scenario/objective specific statistical analyses will be performed on a specific need basis as described within the next recommendation category task elements.

- ***Dataset Documentation Report***

  A report will be prepared at the completion of data synthesis. This report document details on the data characterization, data limitations, and

appropriateness of datasets for use during data evaluation scenarios listed within the next recommendation category task activities.

Recommendation 2: Data Evaluation Scenarios

The following tasks delineate alternative evaluation scenarios, or options, for the EAA data which will aid in the overall understanding of the relationships between Lake Okeechobee water phosphorus trends and the EAA basin runoff.

- ***Direct Effect of Lake Concentration on Basin Performance***

  According to the Task 3 ICM of February 8, 2007, the most basic question to be answered by this data evaluation, to the extent the conclusions can be substantiated with adequate statistical certainty, is "how does the increase in lake water phosphorous concentrations for irrigation and flow-through operations affect the sub-basin's BMP performance?" The intent of this option would therefore be to determine if there can be drawn a statistically significant correlation between the increase in Lake water concentrations and the performance of the BMP program for individual sub-basins. For example, from the chart presented at the beginning of this report it was shown for the S-5A sub-basin that the average annual concentration of the water released from the lake into that sub-basin had increased by approximately 50% over a ten-year period. Can a significant effect on performance be established for this sub-basin over the period of evaluation that can be linked to this increase?

  An attempt will be made to perform direct evaluation of the concentration records; however, estimated loads may be used instead of concentration if needed. The data records for this evaluation will include inflow and concentration (i.e., outflow and concentration of lake water) into the EAA basin, outflow and concentration from the EAA basin and sub-basins, BMP performance for each sub-basin, rainfall distribution, irrigation and flow-through components (to the best available) of flow, and estimated runoff and load for each sub-basin relevant to the BMP performance. It should be noted that the loads and runoff may need to be re-estimated during this evaluation process based on certain limitations within the regulatory model that is currently being used to report loads and runoff data. A comparison will be drawn between the re-estimated (non-regulatory data) and the reported regulatory data.

  The potential relationships amongst the above listed factors (parameters) may be expressed in a functional form as:

  Outflow (flow) = F_1 (inflow from Lake, runoff, rainfall, irrigation and flow-through components)

Outflow (concentration) = F_2 (F_1, concentration of inflow from Lake, runoff concentration, rainfall concentration, concentration of irrigation and flow-through components if available)

Where, F represents the functional notation.

A factor analysis complemented by a multiple regression analysis may be used to evaluate this effect. Further details on the actual datasets and the exact scope of statistical analyses will be developed at the completion of the dataset synthesis under Recommendation 1.

- ***Treatment Effects of the EAA Canals***

  The intent of this option is to evaluate the phosphorus removal and/or treatment effects of the EAA canals on the waters released from the Lake. This analysis assumes that the water is released from the lake and flows through the entire canal lengths and discharges through the outflow locations similar to a reservoir effect. No flow diversion occurs at intermittent locations along the length of the canals.

  The treatment would be assessed using the DMSTA2 model with the canal segments being considered as linear reservoirs. The detention times and associated removal efficiencies for the basin segments will be compared between the modeled efficiency and the measured efficiency. The measured efficiency (removal of phosphorous loading) will be calculated from the available DBHYDRO data sets. The modeled efficiency is the model calculated load of phosphorous removal. The model will be implemented repeatedly for each model duration, and which is dictated by the sub-basin level data of flow and concentration. For the purpose of this evaluation, only durations longer than 30 days will be considered for model implementation. However, smaller time periods may be used based on evaluation of flow velocity in the canals.

- ***Impact of Distribution of Lake Releases***

  The intent of this option is to evaluate the relative impacts between EAA sub-basins of the operational decisions related to the release of Lake water. Specifically, a key area of interest is releases that are made for regulatory purposes, i.e., control of Lake stages, as opposed to releases that are made for irrigation purposes that are intended to "remain" within the EAA. Releases that are made to control Lake stages are generally "pass-through" waters that are shortly removed from the EAA system. Releases that are made for irrigation purposes become a part of the EAA runoff equation in that they next show up in the discharges from individual farms. This evaluation would specifically look at

those releases into the EAA basins that become "pass-through" water and are primarily for control of the Lake stages.

The data that will be needed for this evaluation include flow and stage at lake outflow locations, flow and stage at the EAA basin outflow locations, estimation of pass-through waters, and rainfall-runoff relationships for the sub-basin performance. A correlation analysis will be performed and if feasible may be supplemented with a multiple regression analysis. Both the temporal and spatial distribution of datasets will be considered for this evaluation.

- ***Effect on Basin Performance of Prolonged Flow-Through***

  The intent of this option is to evaluate the effect on a specific EAA sub-basin of a period of prolonged "flow-through" of Lake water.

  Regulatory Releases. This option would consider the case for a specific EAA sub-basin of a period of extended flow-through water for regulatory, lake stage control, purposes. This would normally occur during periods of above normal meteorological conditions and would probably involve frequent "cycling" of releases to allow for basin runoff events.

  Irrigation Releases. This option would consider the case for a specific EAA basin of extended releases of Lake water into the EAA, but not necessarily through, for irrigation purposes. This would most likely have occurred during a period of drought and/or water shortage declaration periods when any localized runoff would probably be retained within the basin.

- ***Utilization of Phosphorus Components for Assessing Relationships***

  This option would look at the identification and comparison of the relative variations in the phosphorus components as a means for identifying sources and fates of Lake water versus EAA sub-basin runoff waters. This would involve the evaluation of total phosphorus, suspended phosphorus and dissolved phosphorus ratios during significant events for both the Lake waters and the sub-basin level waters. One objective would be to determine if a significant correlation can be made between the phosphorus components in the post-BMP waters and the Lake releases for a specific sub-basin. A correlation analysis will be performed involving the flow and concentration (total, suspended, and dissolved) of lake water and the runoff from sub-basins.

- ***Effect of Lake Releases on the Basin Rainfall-Runoff relationships***

  This option would evaluate the changes and/or trends of the rainfall-runoff relationships for specific sub-basins and to determine if a significant correlation can be made between the observed changes and Lake releases as well as BMP implementation.

  Changes Due to Lake Releases. This option would compute and evaluate the rainfall-runoff relationships for each sub-basin and compare and contrast the changes with periods of Lake releases either for irrigation or regulatory purposes.

  Changes Due to BMP Implementation. This option would compute and evaluate the rainfall-runoff relationships for each sub-basin and compare and contrast the changes with the implementation of the BMP program. This option would assist the District in the finalization of the BMP make-up water issue.

CLOSURE

In accordance with the scope of Task 4.2, Phase I of this project, an oral presentation of the above proposal was conducted on April 10, 2007 at the District. Your review comments have been considered in the finalization of this letter report.

Thank you for the opportunity to prepare this letter report, and would appreciate the opportunity to continue to provide professional services to the District. Please contact the undersigned if you have any question or need further clarification on any aspects of the contents of this letter report.

Sincerely,
BPC Group Inc.

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