BASELINE DATA
FOR THE
BASIN-SPECIFIC FEASIBILITY STUDIES
TO ACHIEVE THE
LONG-TERM WATER QUALITY GOALS
FOR
THE EVERGLADES

Prepared by the
South Florida Water Management District

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BASELINE DATA FOR THE
BASIN-SPECIFIC FEASIBILITY STUDIES

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SECTION 1. EXECUTIVE SUMMARY

Florida's 1994 Everglades Forever Act (F.S. 373.4592) and the federal Everglades Settlement Agreement (Case No. 88-1886-CIV-HOEVELER) establish both interim and long-term water quality goals designed to restore and protect the Everglades Protection Area. Activities are currently underway to meet the **interim** goal of reducing phosphorus levels in discharges from the Everglades Agricultural Area and other sources to the Everglades Protection Area to a long-term annual flow-weighted mean concentration of 50 parts per billion (ppb). These activities include the implementation of Everglades Agricultural Area Best Management Practices (BMPs) and the construction of over 42,000 acres of Stormwater Treatment Areas (STAs) through the Everglades Construction Project (ECP). The ECP captures and treats water from seven hydrologic basins. Concurrent with implementation of the ECP, the District is implementing the Everglades Stormwater Program (ESP) to address the water quality issues associated with discharges from the remaining eight non-ECP Everglades tributary basins. Also concurrent with these activities, the District and other groups are conducting water quality research, ecosystem-wide planning (e.g., the Comprehensive Everglades Restoration Plan or CERP), and regulatory programs to ensure a sound foundation for science-based decision making for long-term water quality solutions.

At the present time, waters entering the Everglades meet virtually all State water quality standards, with the exception of phosphorus, dissolved oxygen and a few other parameters. The **long-term** water quality goal is for all discharges into the Everglades Protection Area to achieve compliance with State water quality standards. No later than December 31, 2006, additional water quality improvement measures will be implemented to achieve this long-term water quality goal. By December 2003, long-term water quality improvement plans are to be developed and permit applications submitted that will describe the long-term water quality solutions. It is anticipated that conceptual engineering plans will be developed by September 2003 in order to provide the information for these permit applications and water quality improvement plans. To meet these deadlines, the District is evaluating the feasibility of alternative water quality solutions, to be completed by June 2002. A baseline set of flow and water quality data was developed and is summarized in this document.

Baseline data sets for flow and water quality were compiled for each of the seven hydrologic basins of the ECP and six of the ESP basins. The most recent ten-year period covering May 1989 through April 1999 was selected as the period of record in developing the baseline water quality data set. For those basins without complete water quality data through this period, the most complete data set was used. Methods of Quality Assurance and Quality Control utilized in the compilation of the resulting data set were consistent with those used in the 2000 Everglades Consolidated Report (SFWMD 2000). In addition to phosphorus, dissolved oxygen and specific conductance were identified as parameters of concern to be addressed in the long-term solutions which will be developed during the evaluation of alternatives.

To fully capture the hydrologic variability anticipated in each basin, a time period longer than ten years was preferred for the baseline flow data set. A thirty-year period is generally preferred to capture climatic variability. Unfortunately, most basins do not have a 30-year flow period of record. Even for those basins with a 30-year flow period of record, changes in the regional water management system have occurred over the last three decades which likely will not be replicated in the future. To provide system-wide consistency in flow period of record and overall water balance, and to enable forecasting of future conditions, it was decided to use simulated flows from the District's regional South Florida Water Management Model (SFWMM). To develop baseline flows, the SFWMM was used to simulate current operational conditions (including full operation of the STAs) and utilized rainfall for the 31-year period between January 1965 and December 1995. Note that the goal was not to recreate the 31-year period of record flows, but rather, to simulate the expected hydrologic response in each of the basins as a result of the 31-year rainfall history.

The observed water quality data and simulated flows were combined for each basin to create a complete 31-year period of daily flow and phosphorus data. The methodology used to combine the flow and water quality data preserved the key features critical to subsequent design work: hydrologic variability over a sufficiently long time frame and variability in phosphorus concentrations across a wide range of flows. The long-term estimate of baseline flows and phosphorus concentrations for each of the thirteen basins is presented in Table 1-1.

Table 1-1. Summary of Estimated Baseline Flows and Phosphorus Concentrations

Basin/STA	Mean Annual STA Inflow (acre-feet)	STA Inflow Phosphorus Concentration (parts per billion)	Mean Annual Discharge to EPA (acre-feet)	Discharge Phosphorus Concentration (parts per billion)
C-51 West - STA-1 East	133,331	176	136,406	50
S-5A - STA-1 West	160,335	139	161,902	34
S-6 – STA-2	233,473	100	229,273	48
S-7/S-8 - STA-3/4	660,889	88	637,901	49
C-139 - STA-5	85,637	167	83,776	38
STA-6 (Sections 1 and 2)	80,532	121	74,930	34
Acme Basin B	Not applicable	Not applicable	31,499	94
North Springs Improvement District Basin	Not applicable	Not applicable	6,168	39
N. New River Canal Basin	Not applicable	Not applicable	1,781	18 (see note 3)
C-11 West Basin	Not applicable	Not applicable	194,167	17
L-28 Basin	Not applicable	Not applicable	83,806	39
Feeder Canal Basin	Not applicable	Not applicable	77,179	156

NOTES:

1. Estimates of flow are simulation results (Calendar Year: January to December).
2. For the design period 1979-88, discharges from the STAs are assumed to achieve a long-term average phosphorus concentration of 50 ppb, with the exception of STA-1 West and STA-6. STA-1 West encompasses the Everglades Nutrient Removal Project, which has averaged 22 ppb for the last 5 years, and is assumed to achieve 35 ppb.
3. Phosphorus concentration for North New River Canal Basin (G-123) is the arithmetic mean – there were no flow data available to calculate the flow-weighted mean concentration.

SECTION 2. INTRODUCTION

Florida's 1994 Everglades Forever Act (F.S. 373.4592) and the federal Everglades Settlement Agreement (Case No. 88-1886-CIV-HOEVELER) establish both interim and long-term water quality goals designed to restore and protect the Everglades Protection Area. As defined in the Act and the Settlement Agreement, the Everglades Protection Area includes Water Conservation Areas 1, 2A, 2B, 3A, 3B, the Arthur R. Marshall Loxahatchee National Wildlife Refuge, and the Everglades National Park. Figure 2-1 is an overview of the Everglades Protection Area.

Throughout this document, the term "Basin-Specific" is analogous to "STA-Specific" for the Everglades Construction Project basins and "Basin-Specific" for the Everglades Stormwater Program basins. The purpose of this document is the development of a baseline flow and water quality data set. This baseline data set will be used in the upcoming basin-specific feasibility studies which will integrate research, planning and other available information into water quality solutions to ensure that all waters discharged into the EPA achieve water quality goals by December 31, 2006. Table 2-1 is a summary of the hydrologic basins included in this document.

Table 2-1. Everglades Protection Area Tributary Basins included in Feasibility Studies

Basin/STA	Basin Area (acres)	Primary Discharge Structures
C-51 West - STA-1 East	50,880	S-362
S-5A - STA-1 West	124,352	G-251, G-310
S-6 – STA-2	84,992	G-335
S-7/S-8 - STA-3/4	212,928	S-7, S-8
C-139 - STA-5	168,437	G-344s
STA-6 Section 1	10,400	G-607
Acme Basin B	8,680	Acme1DS, G-94D
North Springs Improvement District Basin	7,422	NSID-1
N. New River Canal Basin	19,200	G-123
C-11 West Basin	51,840	S-9
L-28 Basin	71,790	S-140
Feeder Canal Basin	72,324	S-190

Activities are currently underway to meet the interim goal of reducing phosphorus levels in discharges from the Everglades Agricultural Area and other sources to the Everglades Protection Area to a long-term annual flow-weighted mean concentration of 50 parts per billion (ppb). These activities include the implementation of Everglades Agricultural Area Best Management Practices (BMPs) and the construction of over 42,000 acres of Stormwater Treatment Areas (STAs) through the Everglades Construction Project (ECP). The ECP captures and treats water from seven hydrologic basins, all of which are included in this baseline data set. Concurrent with implementation of the ECP, the District is implementing the Everglades Stormwater Program (ESP) to address the water quality issues associated with discharges from the remaining eight non-ECP Everglades tributary basins. Of these eight basins, six are included in this baseline data set. The remaining two ESP basins, C-111 Basin and Boynton Farms Basin, will be addressed through other District programs.

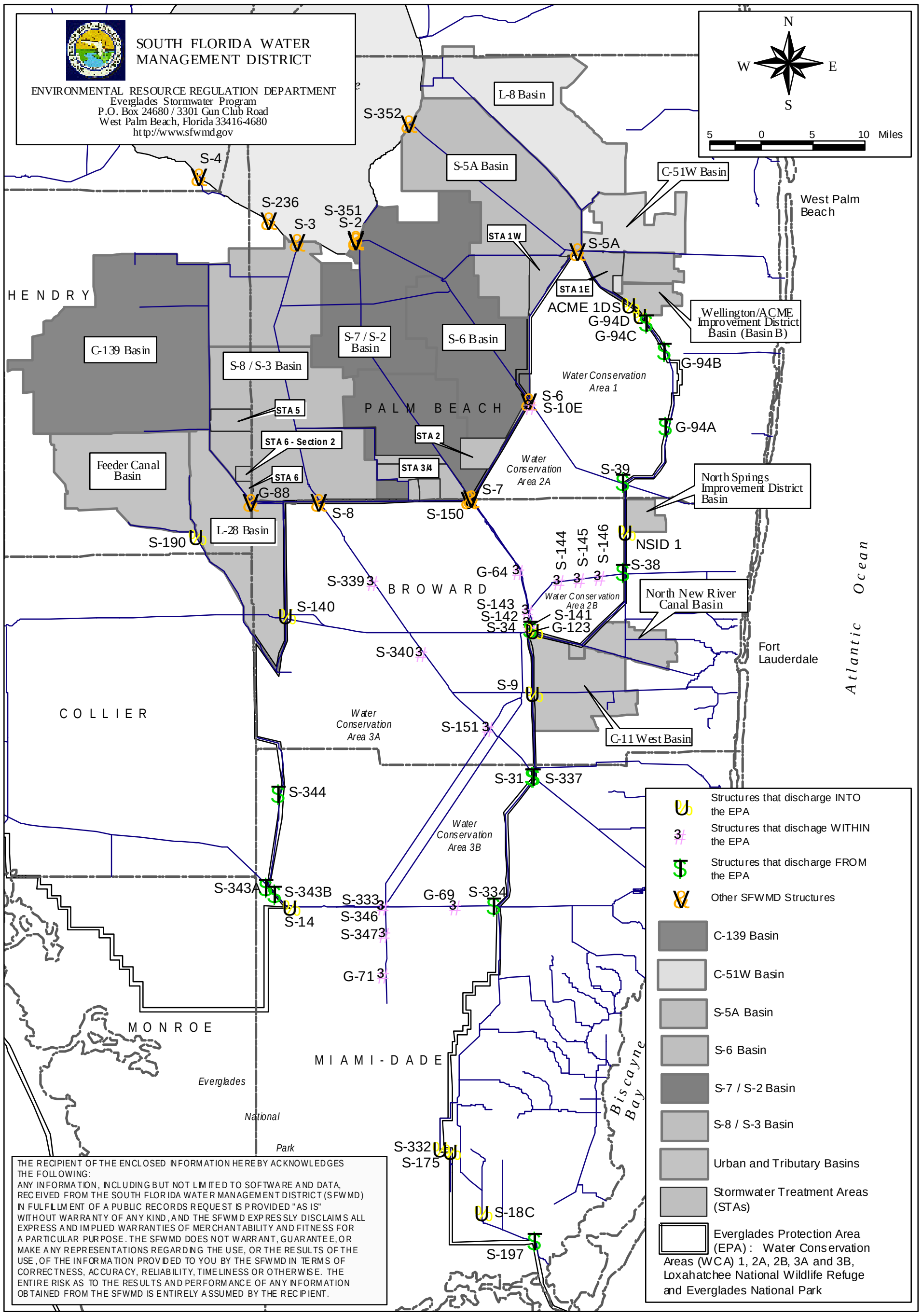


Figure 2-1. Overview of Everglades Protection Area.

Also concurrent with these activities, the District and other groups are conducting water quality research, ecosystem-wide planning (e.g., the Comprehensive Everglades Restoration Plan or CERP), and regulatory programs to ensure a sound foundation for science-based decision-making.

In accordance with the Everglades Forever Act, current research activities will provide the basis for the determination of the final EPA phosphorus criteria and are to be completed by December 31, 2001. Also in accordance with the Act, the EPA phosphorus criterion shall be 10 ppb in the event the Florida Department of Environmental Protection (DEP) does not adopt by rule such criterion by December 31, 2003. The Act further mandates that the Florida Department of Environmental Protection (DEP) establish the relationship between discharge levels and the water quality in the EPA. The Corps of Engineers Permit for the Everglades Construction Project requires "For the purposes of planning, 10 ppb (phosphorus) shall be used as the design parameter pending adoption of the numeric criterion by the DEP or ERC."

An additional objective of the Everglades Forever Act is the restoration of a suitable hydroperiod in the Everglades Protection Area. Efforts are currently underway to develop a comprehensive program of operational practices to increase the total quantity of flows to the EPA at an ecologically optimum timing and distribution. Hydroperiod restoration is crucial to the revitalization of the Everglades ecosystem and will therefore be a key element in the overall restoration effort. The Act established a preliminary target of 28% increase in flow to the EPA compared to the 1979-88 period; the C&SF Restudy subsequently estimated an increase of approximately 19%. The Act further states that the Everglades Program will contribute to the restoration of the Rotenberger and Holey Land tracts. The Everglades Construction Project provides a first step toward restoration by improving hydroperiod with treated water for the Rotenberger tract and by providing a source of treated water for the Holey Land.

The long-term goal of the Everglades Program restoration effort is to combine point source, basin-level and regional solutions in a system-wide approach to ensure that all waters discharged into the Everglades Protection Area meet the numeric phosphorus criterion and other applicable state water quality standards by December 31, 2006. In order to achieve this goal, the District is implementing a strategy to ensure all water quality standards are met on a basin by basin basis. This strategy consists of conducting basin-specific feasibility studies which will integrate information from research, regulation, and planning studies to determine the optimal combination of BMPs, optimized STAs, advanced treatment technologies, Water Preserve Areas, etc., to meet the final water quality objectives. The relationship between the overall restoration activities is presented in Figure 2-2.

Although unanticipated, there may be substantive changes in the underlying design criteria that occur during the course of the feasibility studies, including inflow volumes, phosphorus loads, regional reservoirs, BMP performance, STA performance and/or design outflow phosphorus criteria. In recognition of these potential changes, this baseline data set may be further refined to ensure that the most accurate and timely information available is incorporated into the feasibility studies.

Some of the more critical time frames of the Everglades restoration effort are identified below.

<u>Legislative and Permit-related Deadlines</u>:

- By December 31, 2003, the District shall submit to the DEP a permit modification to incorporate proposed changes to the ECP and its EFA mandated permits.
- All water delivered to the EPA to achieve compliance with state water quality standards by December 31, 2006.

The District's objective is to conduct basin-specific feasibility studies and conceptual designs for the Everglades Protection Area tributary basins (7 ECP basins and 6 ESP basins). Since the seven ECP basins discharge to six STAs, the feasibility studies for the ECP basins will be STA-specific, and the feasibility studies and conceptual designs will be developed for the six STAs.

Therefore, it is envisioned that a total of twelve feasibility studies/conceptual designs will eventually be developed (6 STAs and 6 ESP basins). These feasibility studies and conceptual designs will integrate information from ongoing STA construction and operation activities, ongoing STA design activities (STA-1E, STA-3/4, and STA-6 Sec. 2), and ongoing research, regulation, and planning studies to determine the optimal combination of BMPs, optimized STAs, and advanced treatment technologies to meet the final water quality and water quantity objectives for the benefit of the Everglades.

The conceptual design documents will be developed through completion of the following four activities.

1. **Characterize basin-specific baseline flows and water quality levels.** District flow and water quality data will be analyzed, compiled and combined with simulated flows to establish a baseline set of flows and water quality levels for each basin. This document is the work product of this activity.

2. **Identify alternative combinations of water quality solutions (BMPs, STA Optimization, advanced treatment technologies, etc.)** Alternative combinations of potential water quality solutions will be identified for each basin. Available information on advanced treatment technologies, enhanced BMPs and STA optimization will be incorporated into this effort. It may be that best professional judgement will be relied upon if definitive research results are not available at the time decisions are required during this activity. It is likely that capital projects, regulatory programs or other activities, in addition to the long-term treatment solutions, will be implemented in the basins prior to

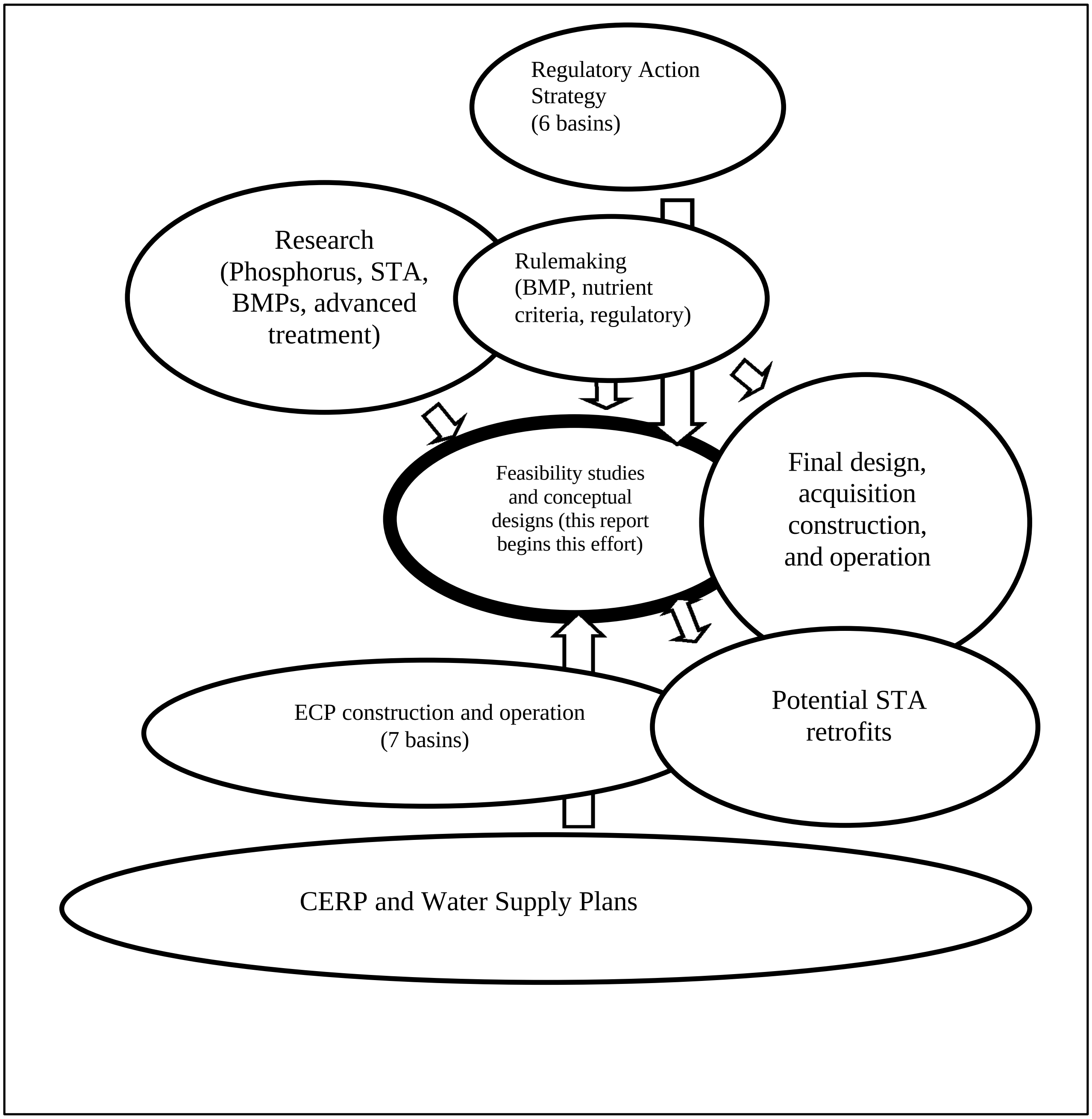


Figure 2-2. Relation Between the Overall Restoration Activities.

December 31, 2006 that could influence the flows and water quality levels. Examples include CERP and the Lower East Coast Water Supply Plan. Projects anticipated to be implemented prior to December 31, 2010 will be identified and potential adjustments to the baseline flows and concentrations will be quantified. Projects planned to be completed between December 31, 2006 and December 31, 2010 will be highlighted. The adjusted flows and water quality levels will be used in the subsequent feasibility studies. Subsequent refinement of the baseline data is anticipated, as additional information becomes available.

3. **Evaluate the alternative combinations based on technical, environmental, economic, financial, and other factors and recommend an optimal combination for each basin.**

4. **Develop basin-specific conceptual designs.**

A schematic of these activities is presented in Figure 2-3.

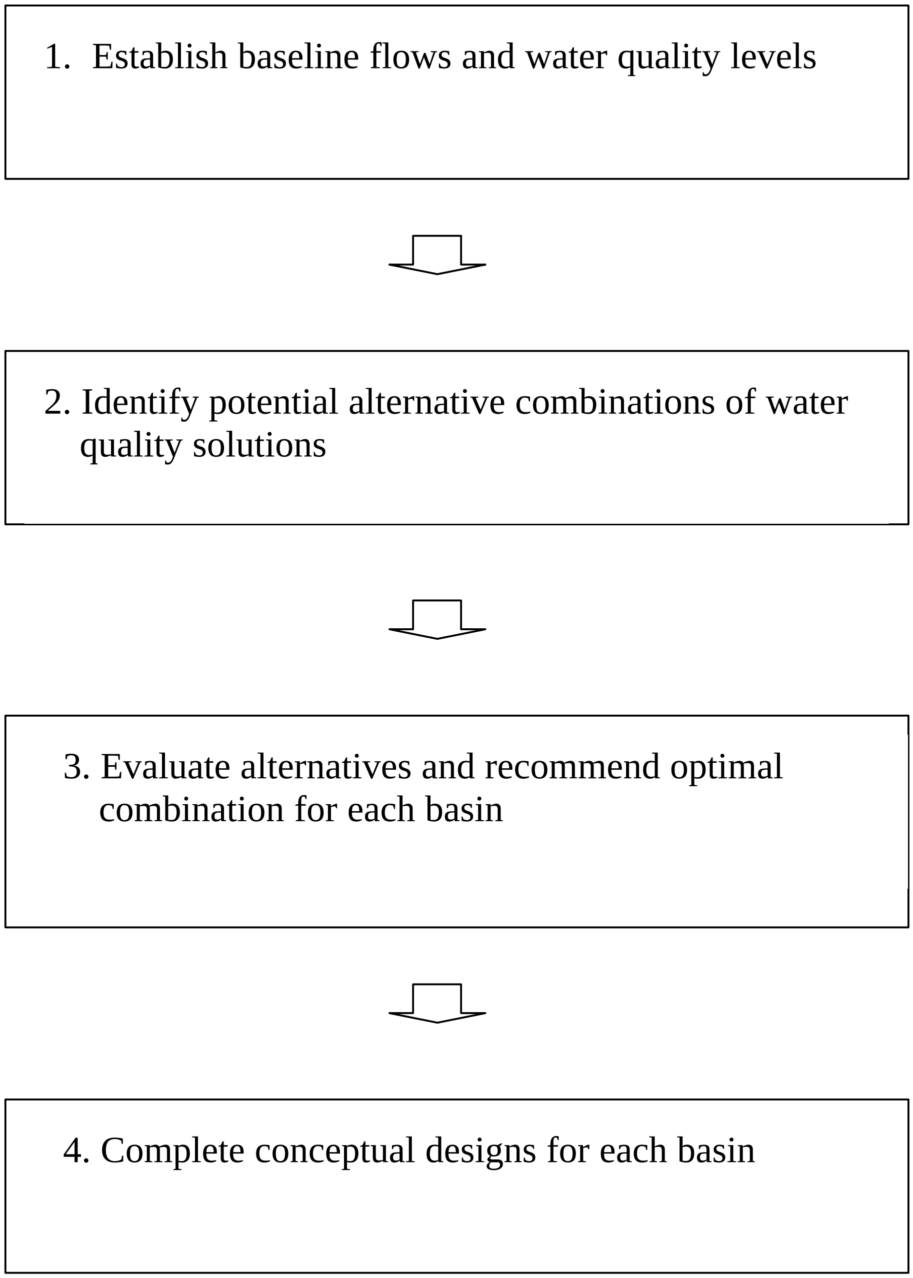


Figure 2-3. Schematic of Activities Leading to Conceptual Engineering Designs.

SECTION 3. METHODOLOGY

A. General

The goal of this work effort is to develop a baseline flow and water quality data set that will be subsequently used in evaluating alternative combinations of water quality improvement solutions. In general, the key requirement is that the data set should reflect anticipated ranges and average flows and water quality levels. Since the baseline data set will be used to evaluate alternatives, as opposed to detail engineering design or making detailed estimates of project performance (these will come later), absolute precision is not as important now as it will be for those subsequent purposes. In addition, the evaluation of alternatives will likely include sensitivity analyses that may have +/- 50% brackets … e.g., if average TP=40 ppb, the alternatives evaluation may use 20 ppb, 40 ppb and 60 ppb. With this being the case, it is important not to spend an inordinate effort in achieving too much precision in the baseline data set. The data set is anticipated to be refined in the future, as further information becomes available. The baseline data set should be developed for conditions upstream and downstream of the STAs to allow for new water quality improvement solutions either upstream or downstream of the STAs. The key objectives in creating the baseline data set are to capture hydrologic variability and to capture basin-specific water quality characteristics.

Baseline data sets for flow and water quality were compiled for each of the thirteen hydrologic basins. The ten-year period covering May 1989 through April 1999 was selected as the period of record in developing the baseline water quality data set. This period corresponds to Water Years 1990 through 1999 and was selected based on best professional judgement of District staff. For those basins without complete water quality data through this period, the most complete data set was used. Methods of Quality Assurance and Quality Control utilized in the compilation of the resulting data set were consistent with those used in the 2000 Everglades Consolidated Report (SFWMD 2000).

To fully capture the hydrologic variability anticipated in each basin, a longer time period than ten years was preferred for the baseline flow data set. A thirty-year period is generally used to reflect climatic variability. Unfortunately, most basins do not have a 30-year flow period of record. Even for those basins with a 30-year flow period of record, changes in the regional water management system have occurred over the last three decades which likely will not be replicated in the future. To provide system-wide consistency in flow period of record, and overall water balance, it was decided to use simulated flows from the District's regional South Florida Water Management Model (SFWMM). The SFWMM simulation modeled current operational conditions (including full operation of the STAs) and utilized rainfall for the 31-year period between 1965 and 1995. Note that the goal was not to recreate the 31-year period of record flows, but rather, to simulate the expected hydrologic response in each of the basins as a result of the 31-year rainfall history.

The observed water quality data and simulated flows were combined for each basin to create a complete 31-year period of daily flow and phosphorus data. The methodology used to combine the flow and water quality data preserved the key features critical to subsequent design work: hydrologic variability over a sufficiently long time frame and variability in phosphorus concentrations across a wide range of flows.

For each STA, inflow volumes and phosphorus loads were calculated to reflect the phosphorus quality upstream of the STA, in case a long-term solution would be applied upstream of an STA. In addition, outflow volume and phosphorus loads were estimated, to provide a basis for a treatment technology downstream of an STA.

B. Flow

Historic flow records were obtained from the District's hydrologic database using the "DBHYDRO" data retrieval system. Within the District, monitoring sites exist which have multiple sensors. District staff gather data from these sites from several sources on a quarterly basis and analyze them. Then, one set of continuous data is generated for each site. These continuous data sets are then stored in the District's database as "preferred" (PREF) data sets. Consistent with Chapter 40E-63, F.A.C., the "preferred" data set for each site was used when available. For the stations on the south boundary of the Everglades Agricultural Area, stormwater runoff volumes and pass-through water from Lake Okeechobee were estimated. Historically, pass-through water was released from the Lake either for downstream water supply purposes or when regulatory releases were made from the Lake. This pass-through volume was estimated by comparing the daily volume released from the structures on the Lake and the volume passing through the southern boundary structures, using the method consistent with the EAA Regulatory program.

The SFWMM was utilized to generate a thirty-one year set of discharges from each of the thirteen basins, including the six Stormwater Treatment Areas. The simulation results were analyzed on a basin-by-basin level to identify obvious discrepancies between observed and simulated flow values**. (Note: Obvious discrepancies in the ALT1 simulation used to produce the May 2000 report were corrected in the December 2000 simulation, BASERR1 which was used to produce this May 2001 document. Also, C-139 Basin discharges were handled differently from the other basins. This is described more fully in *Appendix 16-1 May 2001 Report Revisions* and in the basin-specific sections of this document.)** Output from the SFWMM utilizes a calendar year beginning January 1 and ending December 31, therefore all references to years in the simulation sections of this report correspond to the period from January 1 to December 31.

The SFWMM is a regional-scale model used to evaluate the interaction of water supply and demand with hydrologic conditions in Palm Beach, Broward and Dade counties and portions of seven other counties in South Florida. The model simulates physical processes in the natural (coupled surface water and ground water) and man-made (canals, structures, and reservoirs) systems in South Florida. It includes management guidelines and policy-based operational rules established, mostly by the U.S. Army Corps of Engineers, for operating the Central and Southern Florida Project for Flood Control and Other Purposes (C & SF Project). As a planning tool, the model can be used to predict the response of the hydrologic system to proposed changes in hydraulic infrastructure and/or operating rules. The design of the model takes into consideration the distinct hydrologic and geologic features of subtropical South Florida which include: 1) the strong interaction between canals and the highly permeable surficial aquifer, especially in the eastern portion of the region; and 2) the dominance of evapotranspiration, and overland flow and groundwater movement within the Water Conservation Areas (WCAs) and Everglades National Park (ENP).

Initial work on the model started as early as the 1970s. The South Florida Water Management District (SFWMD) under contract (DACW17-81-C-0035) completed the model for the U.S. Army Corps of Engineers. Technical Publication 84-3 (TP84-3) "South Florida Water Management Model Documentation Report" was released in February 1984. Since then, major data and algorithm enhancements have been made to the model, particularly during development of the Lower East Coast Regional Water Supply Plan (SFWMD, 1993).

The SFWMM has evolved through the years, driven by the need to evaluate more and more complex water management options. The model undergoes periodic recalibration efforts consisting of matching historical water levels (at canals and monitoring points) and flows (through structures) with simulated values. In 1997, the model was recalibrated using a 1979 – 1995 period of record. In general, the purpose of this effort was to verify and/or improve the predictive capability of the model by: (1) incorporating the best available data; (2) introducing new/improved algorithms into the model; and (3) adjusting calibration parameters to obtain a close agreement between model output and historical flow and/or stage data. Also in 1997, the period of simulation for the model was extended to include the period from 1965 to 1995.

A fixed time step of one day is used in the model. The selection of this time step is consistent with the minimum time increment for which hydrologic data such as rainfall, evaporation and structure discharge are generally available. Rainfall and evaporation are primary driving processes. Data required to describe the physical features of the modeling domain such as land elevation and land use types are readily available from the District's GIS database. Many physical parameters such as seepage rate factors, overland flow roughness coefficients and aquifer transmissivity were estimated within reasonable ranges. Documentation of the various input parameters included in the simulation used to generate the baseline data set is presented in Appendix 3-2.

The bulk of the computer code is comprised of operational rules that drive the human management of the entire system. The close relationship between the natural hydrology and hydraulic infrastructure in South Florida makes the SFWMM unique.

For the STAs, simulated inflows were categorized by source, e.g., runoff and Lake Okeechobee releases.

C. Phosphorus

The District monitors phosphorus and other water quality parameters at several hundred stations throughout South Florida. The locations of the water quality stations used in compiling the baseline data set are shown in Figure 3-1. Comprehensive quality assurance and quality control procedures are followed in sample collection, handling, analyses, and database management. After undergoing these quality assurance and quality control procedures, data are maintained in one of the most extensive databases in Florida. For the

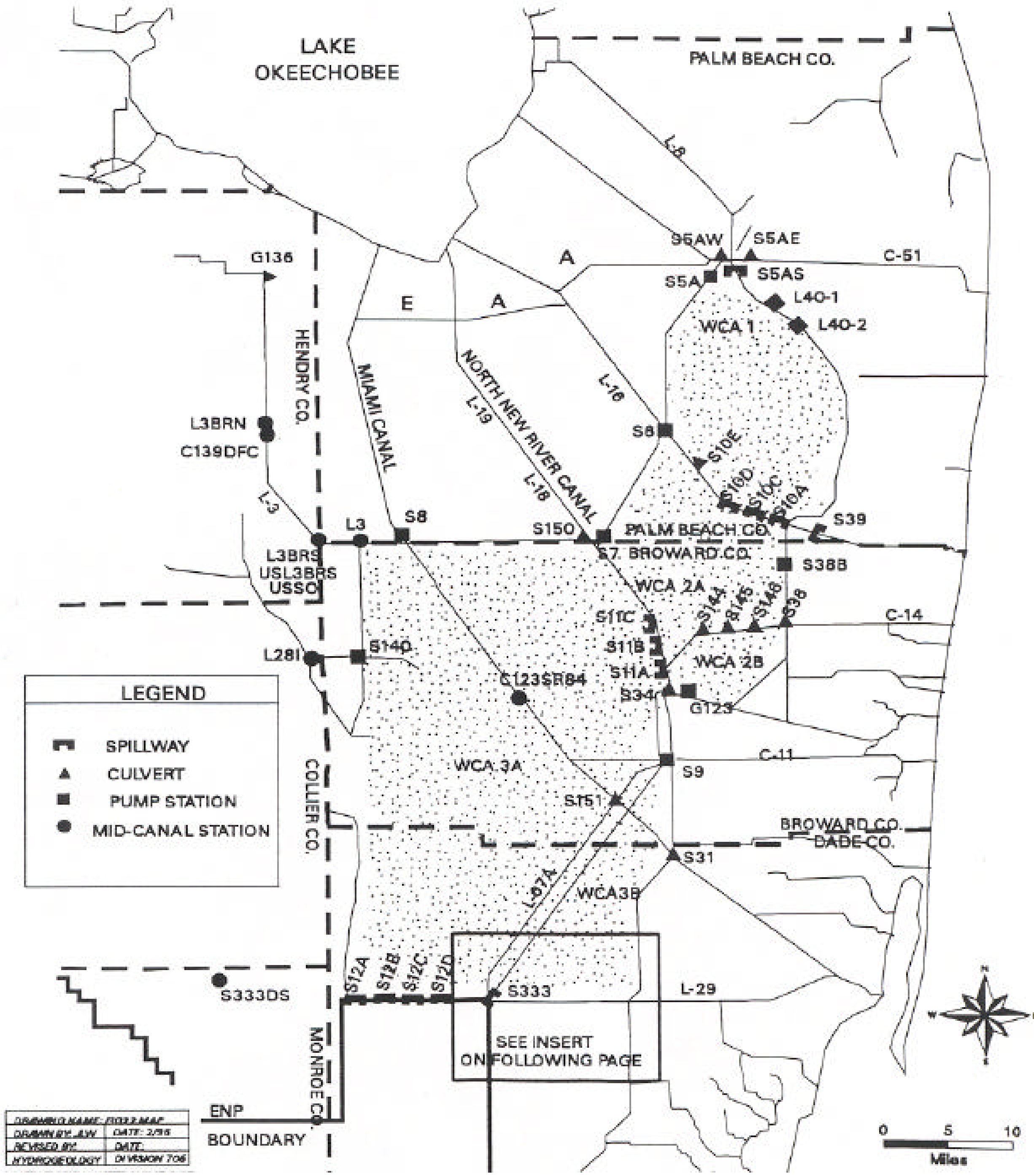


Figure 3-1. Location of Water Quality Sampling Stations

purpose of compiling the baseline data set, phosphorus data from each of the basins were analyzed and compiled into long-term flow-weighted annual concentrations. The flow-weighted means were calculated first by calculating the total TP loads using the methodology consistent with the methodology used in preparation of the *Everglades Consolidated Report* and in the Everglades Agricultural Area regulatory program, then dividing by the total flow for the period. The exception was for G-123 in the North New River Canal Basin since this structure had no flow data available. In this case, arithmetic averages of grab samples were used to calculate the long-term mean.

For consistency with other District programs, historic water quality data were compiled and analyzed based on a water year beginning on May 1 and ending on April 30. All references to water years in the water quality sections of this report correspond to the period from May 1 to April 30.

Two additional calculations were employed for the EAA basins. For the EAA pump stations S-5A, S-6, S-7 and S-8, historic flows were separated into runoff and Lake Okeechobee releases to differentiate the volumes and phosphorus concentrations of each. In addition, in recognition that 100% of the landowners within the EAA had Best Management practices in place for the water years May 1995 – April 1999, the baseline phosphorus concentration for those basins used the most recent 4-yr flow-weighted average.

The following methodology, consistent with the methodology used in the preparation of the *Everglades Consolidated Report* and in the Everglades Agricultural Area regulatory program, was used for TP load calculation:

1) Data retrieval

Daily flow and TP concentration data were retrieved from the District’s databases by executing SQL commands (scripts) of a database program ORACLE at a UNIX workstation. Daily mean flow (unit in cfs) data were retrieved from the “dm_daily_data” table. Total phosphorus concentration (unit in mg/L ppm) data were retrieved from the “wqdora.sample” table.

2) Outlier checking

A statistics based outlier detection algorithm was incorporated for EAA Basin TP load calculation program codes to eliminate outliers for the base period data (10/1/1978 – 9/30/1991). The algorithm tests the significance of residual of each data, from largest one to next, and so on, from the regression of TP concentrations on flow for the ten-year base period. Only one value was eliminated by this detection method.

3) Calculate the daily load and sum for monthly load for each structure

The following protocol for calculating total phosphorus loads is based on the EAA model. The computational algorithms are retained for computing loads and concentrations to have the computations yield the output in the same consistent manner. However, the program needs to be expanded to accommodate different sites and flows (ESP sites).

The algorithm of the calculation program is:

a) Eliminate grab sample TP data if flow data show that there was no flow or the flow was reversed on the sampling day at the sampled site.
b) Fill in the daily grab TP concentrations by interpolating the values of adjacent two grab sample data.
c) If there are auto-sampler data, fill in the daily auto-sampler TP concentrations for the fourteen days including and prior to the auto-sampler values.
d) Compare daily loads for the days both grab and auto-sampler loads exist. Calculate the ratio by dividing the sum of grab load with the sum of auto-sampler load.
e) If there is a gap longer than fourteen days, fill in the missing daily TP values for the period by the interpolated grab concentrations multiplied by the ratio.
f) Calculate daily load by multiplying daily TP concentration by corresponding daily flow.
g) Sum up daily loads.

Phosphorus data were also eliminated from the data sets according to the following methodology. For a complete list of eliminated data, see Appendix 3-1.

1) Data labeled with collection code "24" at a site without an auto-sampler were eliminated from the data set.
2) Water quality data labeled "LAB" were eliminated from the data set since these samples are for quality control purposes only.

Phosphorus data with values less than the Method Detection Limit (MDL) of 4 ppb were replaced with 4 ppb.

Basin-specific assumptions and other nuances are described in the individual basin sections.

D. Other Water Quality Parameters

In addition to phosphorus, Everglades restoration goals include achieving and maintaining compliance with all water quality standards. To identify additional parameters of concern, the District's water quality database was examined for all parameters. Those parameters that had individual samples greater than state water quality standards in more than 5 percent of all the samples were identified as parameters of concern, consistent with the methodology used in the *Everglades Consolidated Report* (SFWMD, January 2000). In general, dissolved oxygen was a parameter of concern for all the stations. Due to the seasonal and temporal variability of dissolved oxygen, attempting to develop a mass balance on this water quality parameter is not appropriate. For the S-5A and S-6 pump stations, specific conductance was identified as a parameter of concern. While the specific conductance at G-251 (the outflow from the Everglades Nutrient Removal Project) exceeded the numeric criterion, the standard is written to allow for exceedence up to 50% above background levels. In the case of the ENR, the permit was written to use the inflow as the background value. The resulting comparison identified considerably less than 5% of the data as exceeding the standard during the period of record.

In lieu of compiling baseline data sets for specific conductance at S-5A and S-6, and dissolved oxygen at all the stations, it will be noted that the long-term solutions developed during the evaluation of alternatives should include provisions for addressing the specific conductance and dissolved oxygen of discharges.

The following methodology was used to eliminate data from the data sets. For a complete list of eliminated data, see Appendix 3-1.

1) Water quality data labeled "LAB" were eliminated from the data set since these samples are for quality control purposes only.
2) DO and FIELD COND. data labeled with collection code "24" were eliminated from the data set since these parameters are not measured with auto-samplers.
3) Data with obvious mis-coding errors were eliminated from the data set (see Appendix 3-1).

E. Combining Flow with Phosphorus Data

The observed water quality data and simulated flows were combined for each basin to create a complete 31-year period of daily data. Numerous methods of combining simulated flow with observed phosphorus data were evaluated. The key factors in evaluating the various methods are presented below in order of priority.

1. Does the method preserve the long-term (31-year) hydrologic variability (minimum, average and maximum) associated with the 31-year rainfall/runoff characteristics for each basin?
2. Does the method preserve the observed variability in phosphorus concentrations?
3. Does the method preserve the observed long-term flow-weighted mean phosphorus concentrations?
4. Is the method consistent across all the basins?

A summary of the alternative methods of combining flow and phosphorus data is presented in Appendix 3-3.

Preserving the long-term hydrologic variability was accomplished by using the 31-year simulation record of the SFWMM.

The November 1999 draft baseline data report proposed using the flow-weighted mean concentrations in lieu of variable phosphorus values. However, the feedback we received on the November 1999 draft report indicated strong support for capturing the variability of phosphorus as a higher priority than preserving the long-term flow-weighted mean phosphorus concentrations. Hence, the present report re-examined the possibility of capturing phosphorus variability. In order to preserve the variability associated with the phosphorus data, regression relationships were developed for phosphorus as a function of flow. The results are summarized in Table 3-1. For the EAA basins, it was necessary to separate stormwater runoff from Lake Okeechobee releases that passed through the southern stations (S-5A, S-6, S-7, S-150 and S-8) prior to developing the regression relationships. Since the phosphorus data came from 7-day composite samplers that collect water regardless of the source, there was no way to separate discrete phosphorus values between Lake releases and EAA runoff. Hence, it was necessary to use the daily interpolated flow and phosphorus data. This may have introduced some bias into the regression results. Nevertheless, this was the only way to segregate Lake releases from runoff for the purpose of the regressions.

In addition, for the EAA, Feeder Canal and C-139 Basins, the regression relationships improved (as measured by the total sum of squares of the residuals) when the data were grouped into wet season and dry season data sets. To determine if the slope of the regression equation is significantly different from zero, a T-value was calculated for the estimate of the slope. For the EAA, C-139, Feeder Canal, and C-11 West Basins, the slopes were significantly different from zero. For the other basins, the slopes were not significantly different from zero, and hence, the use of the mean phosphorus value is just as good a predictor of phosphorus as the regression equation. A final factor in applying a regression equation is whether or not the residuals are normally distributed, as determined by 95% of the residuals falling within two standard deviations of the mean. For the EAA, C-139, and C-11 West Basins, the residuals were normally distributed, while for the Feeder Canal Basin, approximately 94.5% of the residuals were within two standard deviations of the mean.

In summary, for the EAA, Feeder Canal, and C-139 Basins, seasonal regression equations were applied to daily simulated flow results to develop a 31-year baseline set of daily phosphorus values. For the C-11 West Basin, because the residual sum of squares for the total data set and the residual sum of squares for the combined seasonal data sets were equivalent, the total data set regression equation was applied to the daily simulated flows. For the other basins, with the exception of the North New River Canal Basin, the long-term (1990-1999) flow-weighted mean concentration was applied to the 31-year period of simulated flows. For the North New River Canal Basin, because there was no flow data for G-123, the long-term (1990-1999) mean concentration was applied to the 31-year period of simulated flows.

The November 1999 draft baseline report recommended applying a constant phosphorus concentration to the daily STA outflows. Feedback on the draft report indicated that this method gave the perception that outflow concentrations are insensitive to inflow concentrations, and that this may lead to the misperception that STA performance is insensitive to inflow levels of phosphorus. To address this issue, the daily STA outflow phosphorus concentrations were calculated as a constant fraction of the daily inflow concentrations, where this fraction was derived as the ratio of the target outflow loads to the total inflow loads for the 1979-88 design period. The result was a time series of variable outflow phosphorus concentrations that preserved the target STA outflow concentrations. A summary of this analysis is presented in Table 3-2. **(Note: In this May 2001 document, the procedure used to develop the ratio for calculating the outflow loads was modified for STA-5 and STA-6. For a complete description of the procedure used for these two STAs, refer to the individual report sections.)**

Table 3-1. Summary of Basin-Specific Regression Analyses

Basin	Years	Season	Slope ppb/cfs	Intercept ppb	R-squared	Standard Error of Estimate ppb	Sum of Squares residuals	Seasonal Improve-ment	Slope T value	Flow-weighted mean ppb
S-5A	96-99	Total	0.02513	117.3	15.8%	52.5	2079970		11.913	163.9
S-5A	96-99	Dry	0.03475	129.3	19.3%	61.5	1206913		8.723	
S-5A	96-99	Wet	0.02305	106.3	22.2%	39.6	681143	9%	11.143	
S-6	96-99	Total	0.01332	69.1	7.3%	34.0	805926		7.429	88.4
S-6	96-99	Dry	0.02884	64.7	20.4%	36.2	349119		8.257	
S-6	96-99	Wet	0.00812	71.1	3.5%	31.1	414513	5%	3.966	
S-7	96-99	Total	0.03046	50.8	18.9%	35.7	910897		12.900	85.2
S-7	96-99	Dry	0.05302	46.4	28.7%	42.6	543332		10.980	
S-7	96-99	Wet	0.02080	53.7	16.7%	27.0	300838	7%	9.086	
S-8	96-99	Total	0.01672	64.2	10.3%	39.0	1470682		10.510	90.8
S-8	96-99	Dry	0.00820	53.6	3.6%	28.0	358708		4.134	
S-8	96-99	Wet	0.01246	80.9	5.6%	42.6	914359	13%	5.451	
C139	90-99	Total	0.19646	76.3	35.8%	60.2	13211409		45.075	169.1
C139	90-99	Dry	0.20116	59.3	38.7%	41.0	3044454		33.743	
C139	90-99	Wet	0.15644	102.8	24.9%	70.0	8987942	9%	24.643	
G136	90-99	Total	0.64699	83.2	20.2%	68.5	8064483		20.871	153.6
G136	90-99	Dry	0.82696	63.0	28.6%	60.6	2447644		16.335	
G136	90-99	Wet	0.51048	99.5	14.0%	70.9	5277407	4%	13.064	
STA-6	98-99	Total	0.12677	31.5	24.0%	18.7	96902		9.285	19
STA-6	98-99	Dry	0.19185	23.9	34.0%	19.8	76494		10.066	
STA-6	98-99	Wet	0.02376	47.7	5.0%	10.0	8040	13%	2.008	
S9Comp	97-99	Total	0.00952	12.8	19.2%	5.3	2570		4.628	16
S9Comp	97-99	Dry	0.00956	12.8	10.8%	5.2	1233		2.331	
S9Comp	97-99	Wet	0.00945	12.9	22.3%	5.6	1338	0%	3.517	
S140	90-99	Total	0.00317	37.2	0.17%	17.0	34296		0.455	39
S140	90-99	Dry	0.00160	29.8	0.13%	12.3	5588		0.221	
S140	90-99	Wet	-0.00275	42.8	0.09%	17.7	25083	11%	-0.264	
S190	90-99	Total	0.15011	58.9	38.0%	45.1	176799		7.295	117
S190	90-99	Dry	0.01122	50.1	52.0%	31.7	32055		5.891	
S190	90-99	Wet	0.19298	59.2	37.9%	48.1	122788	12%	5.688	
NSID	90-99	Total	-0.01078	44.5	7.0%	23.9	23446		-1.76	39
NSID	90-99	Dry	-0.05990	40.8	5.6%	15.4	4051		-1.001	
NSID	90-99	Wet	-0.14451	47.4	8.6%	29.5	19110	1%	-1.437	
ACME1	90-99	Total	0.06596	74.6	0.5%	61.8	187173		0.508	84
ACME1	90-99	Dry	0.00994	74.4	0.04%	40.5	21316		0.068	
ACME1	90-99	Wet	0.11473	72.6	1.1%	69.5	164060	1%	0.627	
ACME2	90-99	Total	0.43996	55	13.4%	60.0	176653		2.752	106
ACME2	90-99	Dry	0.21164	78.6	6.8%	54.3	44153		1.05	
ACME2	90-99	Wet	0.68276	31.7	20.3%	62.4	124698	4%	2.857	

Table 3-2. Summary of STA Outflow Analysis

STA	Anticipated Outflow Concentration (ppb) For 1979-88 Design Period	Outflow Coefficient
STA-1 East	50	0.299
STA-1 West	35	0.222
STA-2	50	0.459
STA-3/4	50	0.573
STA-5	58	0.193
STA-6	47	0.274

SECTION 4. STA-1 EAST (INCLUDING C-51 WEST BASIN)

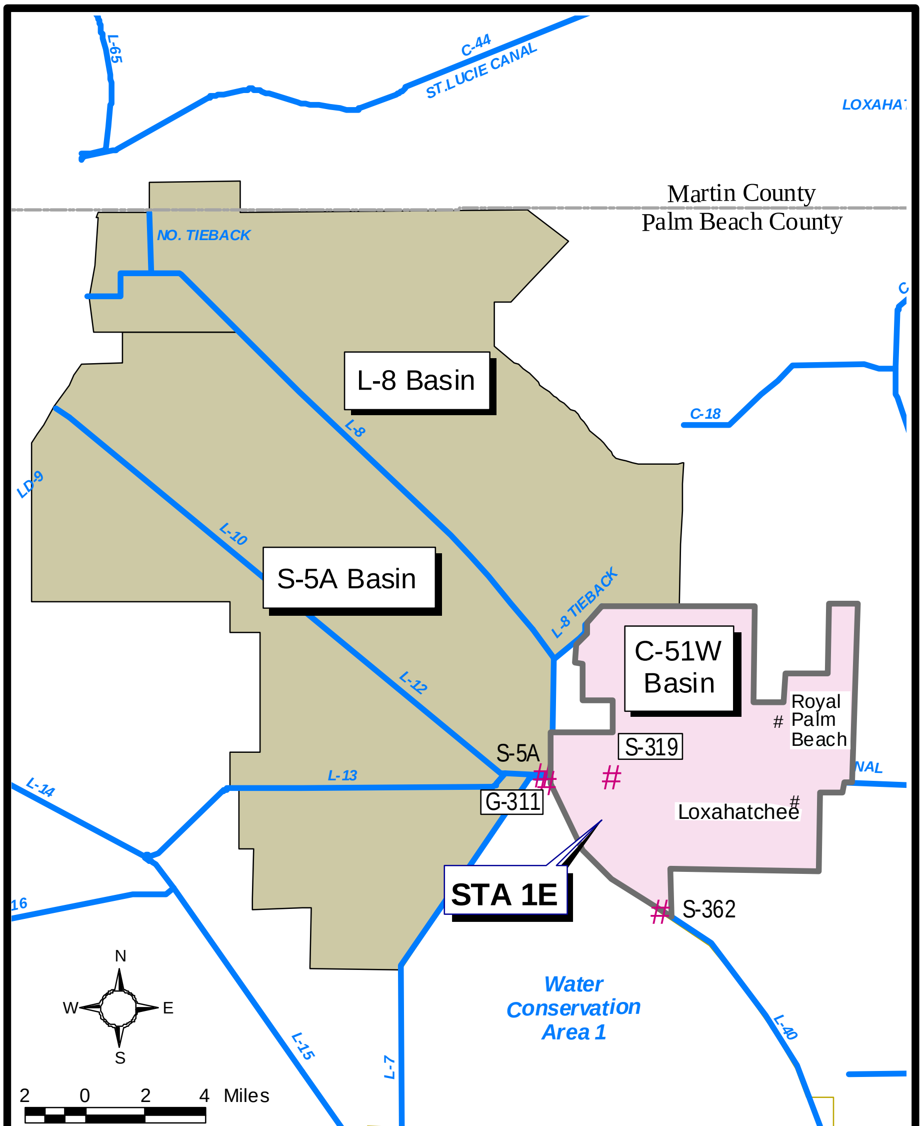
The C-51 West Basin has an area of 79.5 square miles and is located in eastern Palm Beach County. The project canals and water control structures in the basin have three primary functions: (1) to provide flood protection and drainage for the basin, (2) to pass through to tidewater, under certain conditions, discharges of flood flows from the L-8 Basin, and (3) to supply water to the basin during periods of low natural flow. C-51 is the primary canal in the C-51 West Basin. There are five project structures controlling flow in the basin: G-124, S-5AE, S-5AW, S-5AS, and S-5A. A schematic of the C-51W Basin is presented in Appendix 1-1.

The L-8 drainage basin is 171.2 square miles in area and is located in northwestern Palm Beach County and southwestern Martin County. The project canals and water control structures in the basin have four primary functions: (1) to protect the agricultural areas to the southwest of the L-8 basin by intercepting surface water flows originating in the L-8 basin; (2) to remove excess water from the L-8 Basin to storage in either Lake Okeechobee or Water Conservation Area 1(WCA 1); (3) to supply water from Lake Okeechobee or WCA 1 to the L-8 Basin for irrigation of agricultural lands; and (4) to transfer water from storage in WCA 1 to Lake Okeechobee. The project canals and water control structures in the basin have two secondary functions: (1) to supply water from the L-8 Basin, WCA 1 or Lake Okeechobee to the City of West Palm Beach water supply system and (2) to accept discharges of excess water from the City of West Palm Beach water supply system. There are three project canals in the L-8 Basin: (1) the L-8 borrow canal, (2) the North Tieback Levee borrow canal, and (3) the L-8 Tieback Levee borrow canal. There are seven project structures controlling flow in the L-8 Basin: S-5A, S-5AE, S-5AS, S-5AW, S-76, Culvert #10A, and an unnamed weir in the L-8 Tieback Levee borrow canal.

The basins tributary to STA-1 East are presented in Figure 4-1. STA-1 East will treat stormwater flows from the C-51 West Basin, the S-5A Basin, at times the L-8 Canal Basin, and Lake Okeechobee releases during periods of high lake stages (if available treatment capacity exists in the treatment area). The Corps of Engineers is presently designing STA-1 East, and close coordination between the District and the Corps will continue into the design of long-term water quality solutions.

For the purpose of this analysis, inadequate historic data were available for the C-51 West Basin, and recent data collection efforts have also been problematic. For this reason, the estimated average phosphorus concentration of 185 ppb reported in the 1994 Conceptual Design (Burns and McDonnell) was applied to the simulated inflows to develop the daily phosphorus values.

A summary of simulated inflows for STA-1 East for the 31-year period (1965-1995) is presented in Table 4-1 and Figure 4-2. A summary of simulated outflows for STA-1 East for the 31-year period (1965-1995) is presented in Table 4-2 and Figure 4-3.



Tributary Basin Map - STA 1 East
Figure 4-1

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Table 4-1. Summary of Baseline Flows and Phosphorus Loads - STA-1 East Inflows

Calendar Year	Total Inflow (acre-feet)	Phosphorus (kg)	Phosphorus (ppb)
1965	137,409	28,092	166
1966	209,599	44,157	171
1967	99,623	22,224	181
1968	197,867	40,922	168
1969	168,609	37,090	178
1970	158,121	34,365	176
1971	84,602	18,442	177
1972	94,035	21,425	185
1973	95,809	21,146	179
1974	109,668	23,929	177
1975	126,695	27,108	173
1976	95,340	21,234	181
1977	133,003	28,931	176
1978	125,649	28,004	181
1979	109,315	23,815	177
1980	101,798	22,315	178
1981	109,585	23,100	171
1982	158,549	34,844	178
1983	197,261	43,121	177
1984	141,562	30,612	175
1985	109,999	24,349	179
1986	117,302	26,090	180
1987	119,019	26,518	181
1988	105,621	22,976	176
1989	57,267	12,883	182
1990	79,120	17,818	183
1991	143,783	32,486	183
1992	180,934	37,220	167
1993	132,907	28,145	172
1994	253,271	54,996	176
1995	179,924	39,093	176
Average	133,331	28,950	176
Minimum	57,267	12,883	166
Maximum	253,271	54,996	185

Notes:
1. A phosphorus concentration of 185 ppb was applied to the runoff from the C-51 West basin (Burns & McDonnell, 1994) and to the runoff from the Rustic Ranches subdivision.
2. A variable phosphorus concentration was applied to the runoff at S-5A/G-250, based on the daily regression analysis. For the S-5A basin dry season, the standard error of the estimate was 61.5 ppb, and for the wet season, the standard error of the estimate was 39.6 ppb.
3. A phosphorus concentration of 140 ppb was applied to the Lake releases, equal to the mean of the last ten years.

Table 4-2. Summary of Baseline Flows and Phosphorus Loads - STA-1 East Outflows

Calendar Year	Total Outflow (acre-feet)	Phosphorus (kg)	Phosphorus (ppb)
1965	128,937	7,814	49
1966	220,498	13,129	48
1967	96,659	6,229	52
1968	205,434	12,140	48
1969	179,046	11,044	50
1970	166,879	10,044	49
1971	75,068	4,779	52
1972	95,795	6,300	53
1973	96,387	6,097	51
1974	113,077	6,954	50
1975	125,271	7,685	50
1976	97,225	6,237	52
1977	134,151	8,490	51
1978	131,125	8,225	51
1979	111,666	6,863	50
1980	104,282	6,559	51
1981	110,282	6,632	49
1982	165,275	10,341	51
1983	207,503	12,763	50
1984	147,109	8,996	50
1985	108,571	6,591	49
1986	121,135	7,577	51
1987	123,373	7,584	50
1988	107,596	6,724	51
1989	52,572	3,346	52
1990	79,540	4,941	50
1991	151,360	9,569	51
1992	186,054	10,923	48
1993	135,579	8,374	50
1994	268,909	16,436	50
1995	182,232	11,200	50
Average	136,406	8,406	50
Minimum	52,572	3,346	48
Maximum	268,909	16,436	53

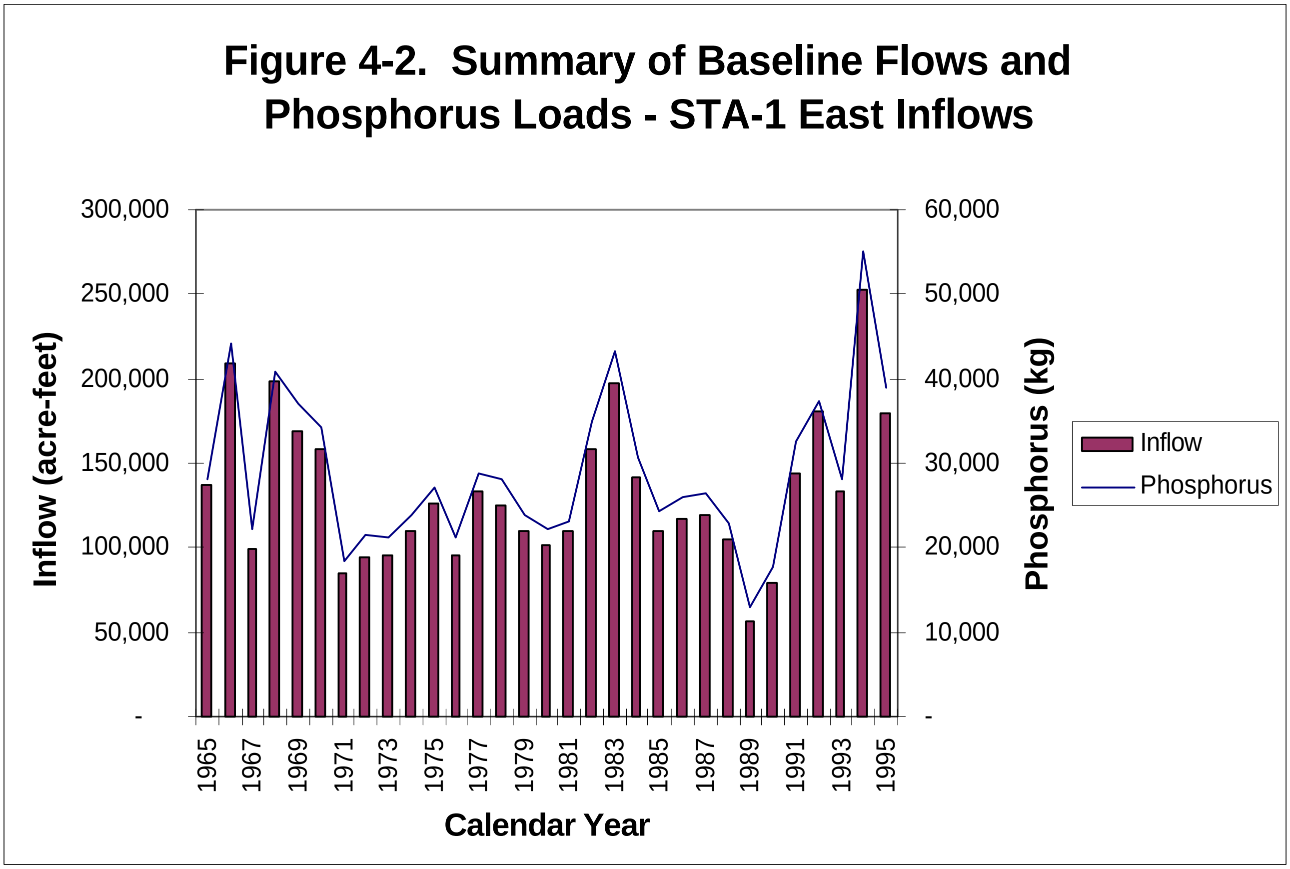


Figure 4-2. Summary of Baseline Flows and Phosphorus Loads - STA-1 East Inflows
300,000
250,000
200,000
150,000
100,000
50,000
-
60,000
50,000
40,000
30,000
20,000
10,000
-
Inflow (acre-feet)
Phosphorus (kg)
Inflow
Phosphorus
1965
1967
1969
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
Calendar Year

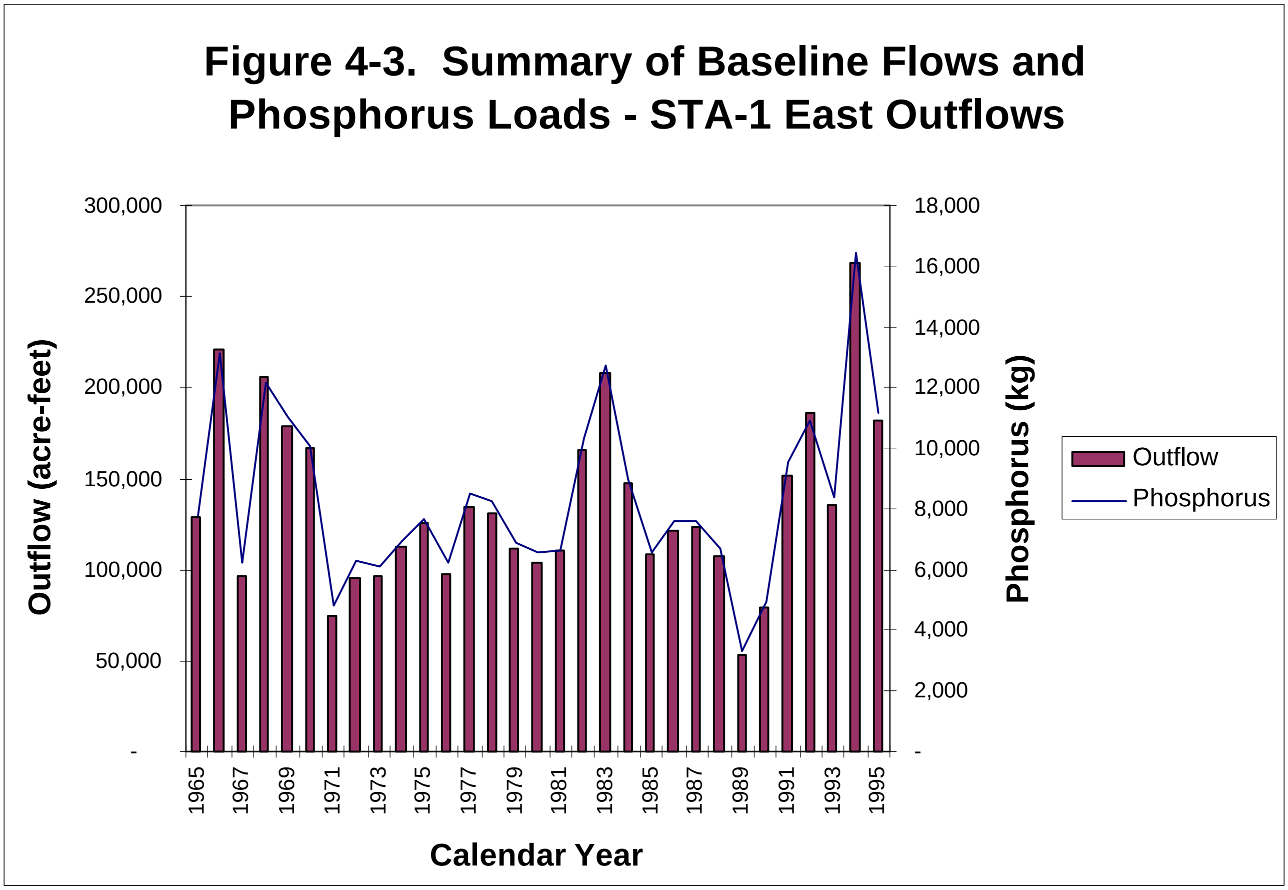


Figure 4-3. Summary of Baseline Flows and Phosphorus Loads - STA-1 East Outflows
300,000
250,000
200,000
150,000
100,000
50,000
-
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
-
Outflow (acre-feet)
Phosphorus (kg)
Outflow
Phosphorus
1965
1967
1969
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
Calendar Year

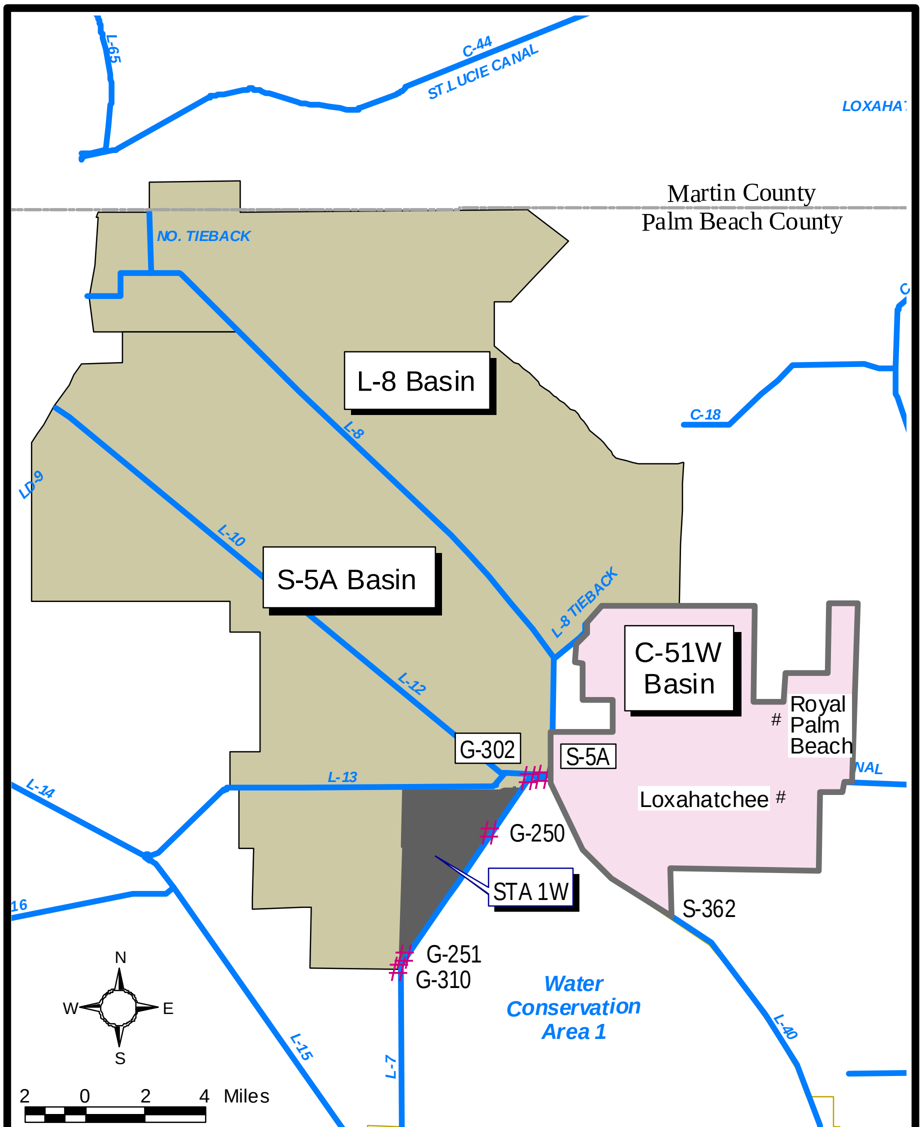
SECTION 5. STA-1 WEST (INCLUDING S-5A BASIN)

The S-5A drainage basin is 194.3 square miles in area and is located in northwestern Palm Beach County. The project canals and water control structures in the S-5A Basin have four primary functions: (1) to remove excess water from the S-5A Basin to storage in Water Conservation Area 1 (WCA 1), and under some flood conditions, to storage in Lake Okeechobee; (2) to prevent over-drainage of the S-5A Basin; (3) to supply water from WCA 1, Lake Okeechobee, or the L-8 Basin to the S-5A Basin for irrigation; and (4) to provide conveyance for regulatory releases from Lake Okeechobee to WCA 1 and for water supply releases from the Lake to the C-51 Basin for municipal and agricultural use and to maintain the optimum canal water level to prevent saltwater intrusion. There are two project canals in the S-5A Basin: the L-10/L-12 and L-13 borrow canals. There are six project structures regulating flow in the S-5A Basin: S-5A, S-5AE, S-5AS, S-5AW, S-5AX, and S-352. A schematic of the S-5A Basin is presented in Appendix 1-2.

The basins tributary to STA-1 West are presented in Figure 5-1. STA-1 West will treat stormwater flows from the S-5A Basin, the East Beach Water Control District, the C-51 West Basin and at times the L-8 Canal Basin, as well as Lake Okeechobee releases during periods of high lake stages (if available treatment capacity exists in the treatment area). Historic flow and water quality data from the following structures were compiled to generate the baseline data set:

S-5A Complex (“preferred” DBKEY 15031) – historic flow and water quality data
S-5A south gate
S-5A west gate
G-250 pump station (“preferred” DBKEY 16222 - inflow to the Everglades Nutrient Removal Project [STA-1 West]) – historic flow and water quality data
G-251 pump station (DBKEY 15848 - outflow of the Everglades Nutrient Removal Project [STA-1 West]) – historic flow and water quality data
S-352 Complex on Lake Okeechobee (“preferred” DBKEY 15068) – historic flow and water quality data

Historic flow and phosphorus data (Water Years 1990 – 1999) for these structures for the period of record are presented in Appendix 5-1. A summary of the historic data is presented in Table 5-1 and Figures 5-2 through 5-4. Table 5-1 also shows the flow-weighted mean phosphorus concentration for Water Years 1996 through 1999 – the last four years with 100% of the EAA Best Management Practices in place.



Tributary Basin Map - STA 1 West

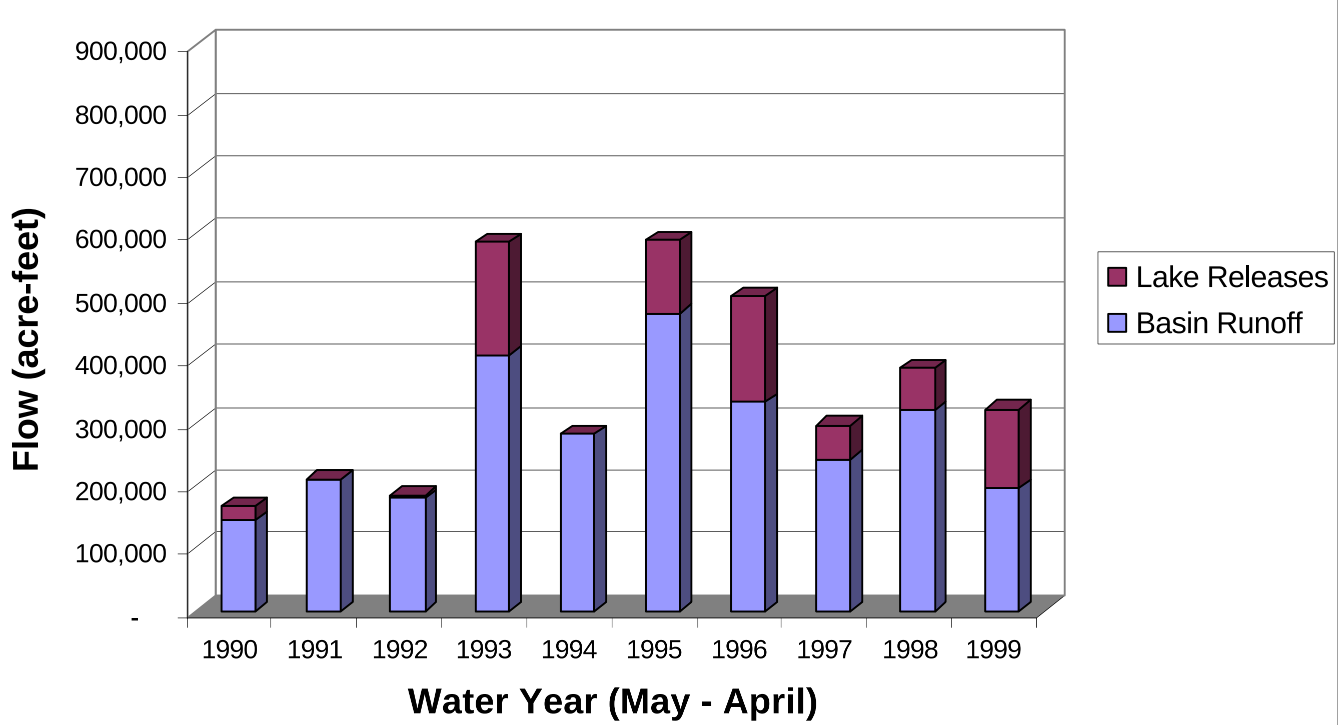
Figure 5-1

ERRD/ESP CMIESSAU REV. 21-JAN-2000 ecp-sta1w.apr ecp-sta1w-L

Table 5-1. Summary of Historic Flow and Phosphorus Data – S-5A Basin (May to April Water Years)

Runoff (Period of record: May 1989 – April 1999)	
Minimum annual (acre-feet)	143,956
Average annual (acre-feet)	278,394
Water Year 1996-99 average (acre-feet)	271,665
Maximum annual (acre-feet)	474,581
Runoff phosphorus (Period of record: May 1989 – April 1999)	
Minimum annual (ppb)	138
Flow-weighted average annual (ppb)	182
Water Year 1996-99 average (ppb)	164
Maximum annual (ppb)	294
Lake releases (Period of record: May 1989 – April 1999)	
Minimum annual (acre-feet)	0
Average annual (acre-feet)	73,979
Maximum annual (acre-feet)	179,718
Lake releases phosphorus (Period of record: May 1989 – April 1999)	
Minimum annual (ppb)	86
Flow-weighted average annual (ppb)	140
Maximum annual (ppb)	229

Figure 5-2. Summary of Historic Flows - S-5A Basin



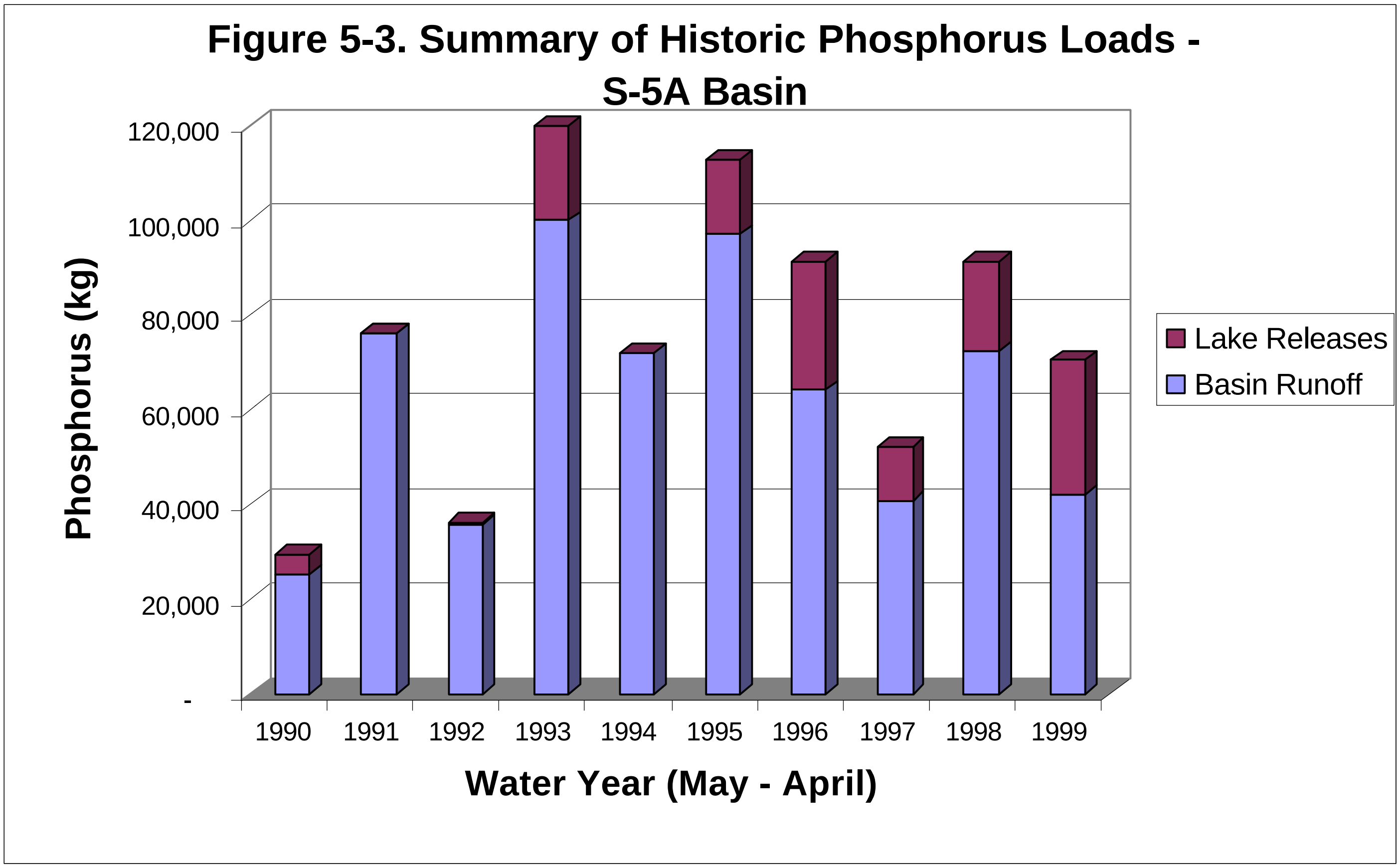


Figure 5-3. Summary of Historic Phosphorus Loads - S-5A Basin
Phosphorus (kg)
120,000
100,000
80,000
60,000
40,000
20,000
-
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
Water Year (May - April)
Lake Releases
Basin Runoff

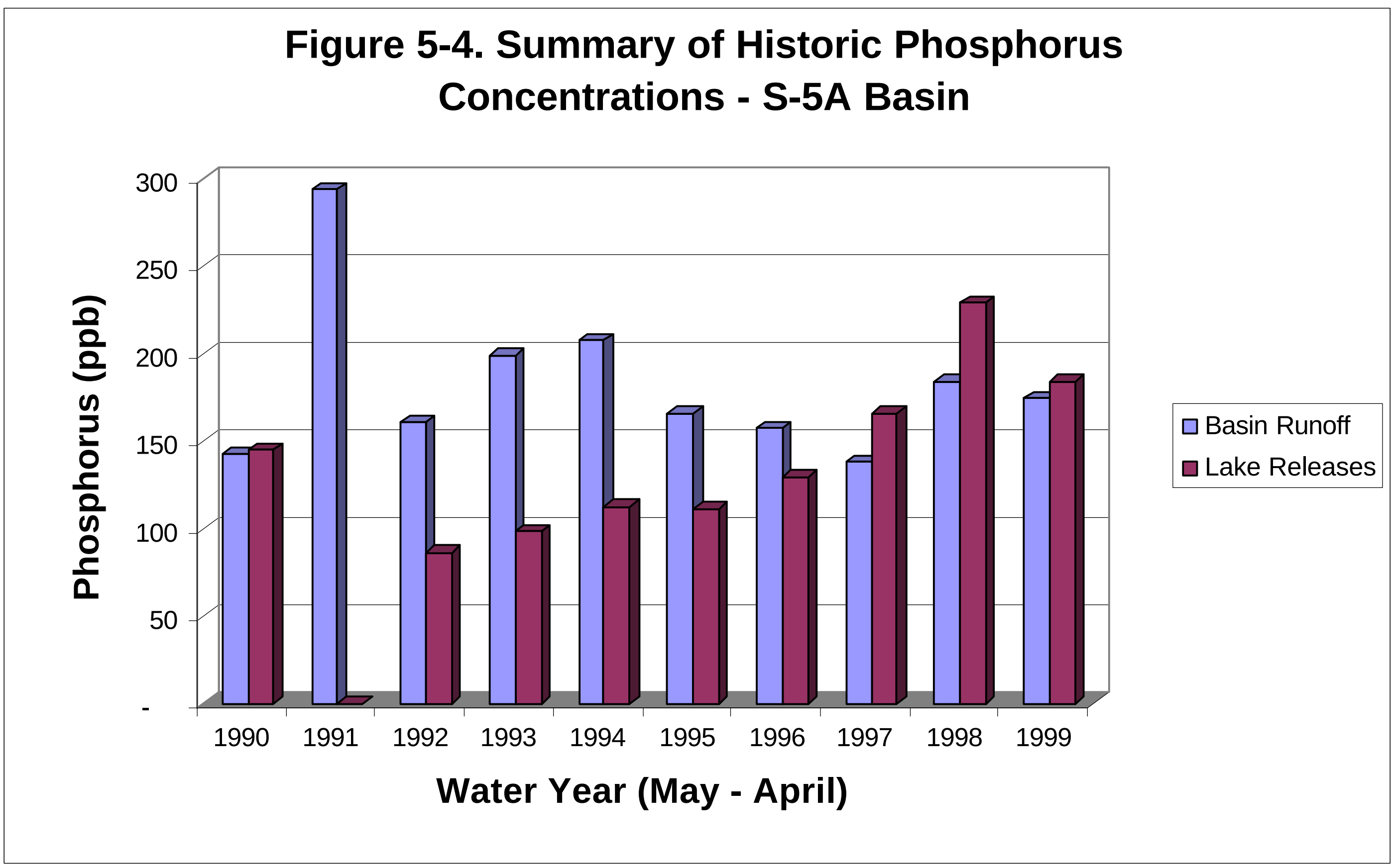


Figure 5-4. Summary of Historic Phosphorus Concentrations - S-5A Basin
Phosphorus (ppb)
300
250
200
150
100
50
-
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
Water Year (May - April)
Basin Runoff
Lake Releases

A seasonal (wet season/dry season) regression equation was applied to the S-5A Basin daily flows to develop a 31-year set of daily phosphorus values. A summary of simulated inflows for STA-1 West for the 31-year period (1965-1995) is presented in Table 5-2 and Figure 5-5. A summary of simulated outflows for STA-1 West for the 31-year period (1965-1995) is presented in Table 5-3 and Figure 5-6.

Table 5-2. Summary of Baseline Flows and Phosphorus Loads - STA-1 West Inflows

Calendar Year	Total Inflow (acre-feet)	Phosphorus (kg)	Phosphorus (ppb)
1965	175,266	28,795	133
1966	200,059	33,396	135
1967	143,331	23,694	134
1968	209,724	34,249	132
1969	206,536	35,257	138
1970	211,001	37,269	143
1971	184,611	30,573	134
1972	86,669	14,279	134
1973	122,008	20,001	133
1974	138,174	22,351	131
1975	169,341	27,406	131
1976	146,802	24,828	137
1977	164,383	29,089	143
1978	199,829	33,770	137
1979	149,006	26,037	142
1980	151,432	26,457	142
1981	88,009	14,695	135
1982	165,307	27,831	136
1983	205,209	37,084	146
1984	149,467	27,160	147
1985	129,158	21,699	136
1986	167,266	29,097	141
1987	133,829	25,112	152
1988	151,657	25,512	136
1989	122,400	20,289	134
1990	71,532	11,517	131
1991	180,800	31,705	142
1992	155,316	26,211	137
1993	197,134	35,396	146
1994	235,354	41,721	144
1995	159,767	26,891	136
Average	160,335	27,399	139
Minimum	71,532	11,517	131
Maximum	235,354	41,721	152

Notes:

1. A phosphorus concentration of 140 ppb was applied to the Lake releases, equal to the mean of the last ten years.
2. A variable phosphorus concentration was applied to the runoff at S-5A/G-250, based on the daily regression analysis. For the S-5A basin dry season, the standard error of the estimate was 61.5 ppb, and for the wet season, the standard error of the estimate was 39.6 ppb.

Table 5-3. Summary of Baseline Flows and Phosphorus Loads - STA-1 West Outflows

Calendar Year	Total Outflow (acre-feet)	Phosphorus (kg)	Phosphorus (ppb)
1965	154,882	6,318	33
1966	208,003	8,946	35
1967	144,189	5,901	33
1968	214,411	8,145	31
1969	219,143	9,461	35
1970	211,587	9,267	36
1971	182,426	7,563	34
1972	81,156	3,870	39
1973	122,994	4,928	32
1974	145,354	5,500	31
1975	164,251	6,709	33
1976	149,592	6,239	34
1977	164,235	7,057	35
1978	195,976	7,917	33
1979	159,342	6,848	35
1980	149,772	7,004	38
1981	87,263	3,377	31
1982	170,738	7,370	35
1983	208,761	9,620	37
1984	149,523	6,812	37
1985	132,979	5,650	34
1986	162,184	6,957	35
1987	146,305	5,873	33
1988	147,757	6,051	33
1989	120,870	4,308	29
1990	71,073	2,665	30
1991	186,637	8,461	37
1992	165,435	6,780	33
1993	194,751	8,169	34
1994	247,443	10,535	35
1995	159,935	6,970	35
Average	161,902	6,815	34
Minimum	71,073	2,665	29
Maximum	247,443	10,535	39

Figure 5-5. Summary of Baseline Flows and Phosphorus Loads - STA-1 West Inflows

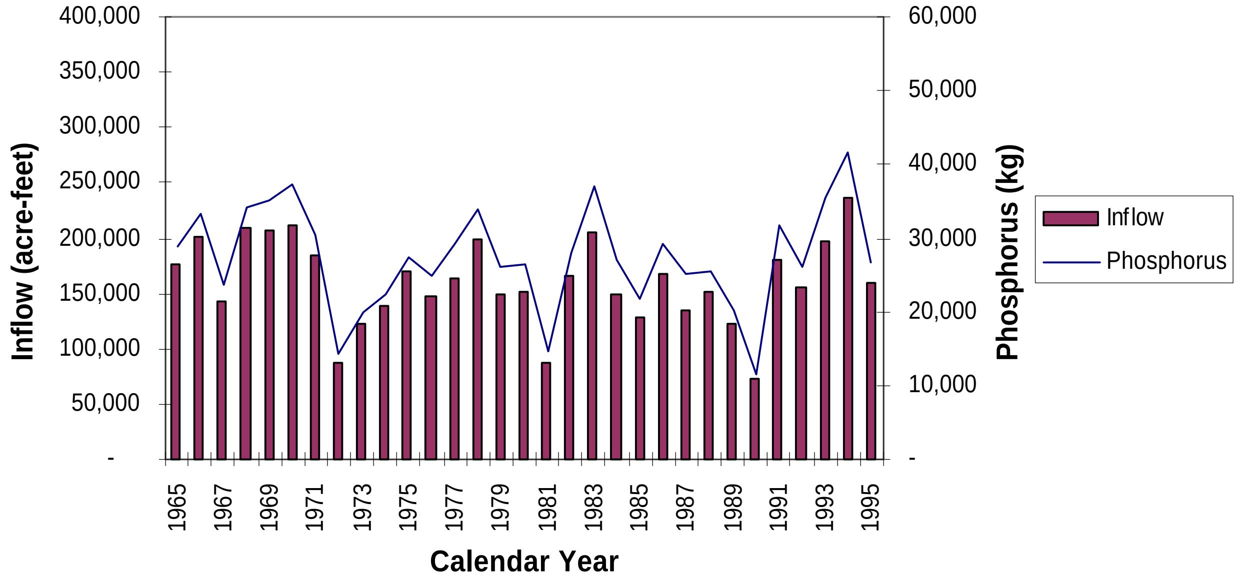
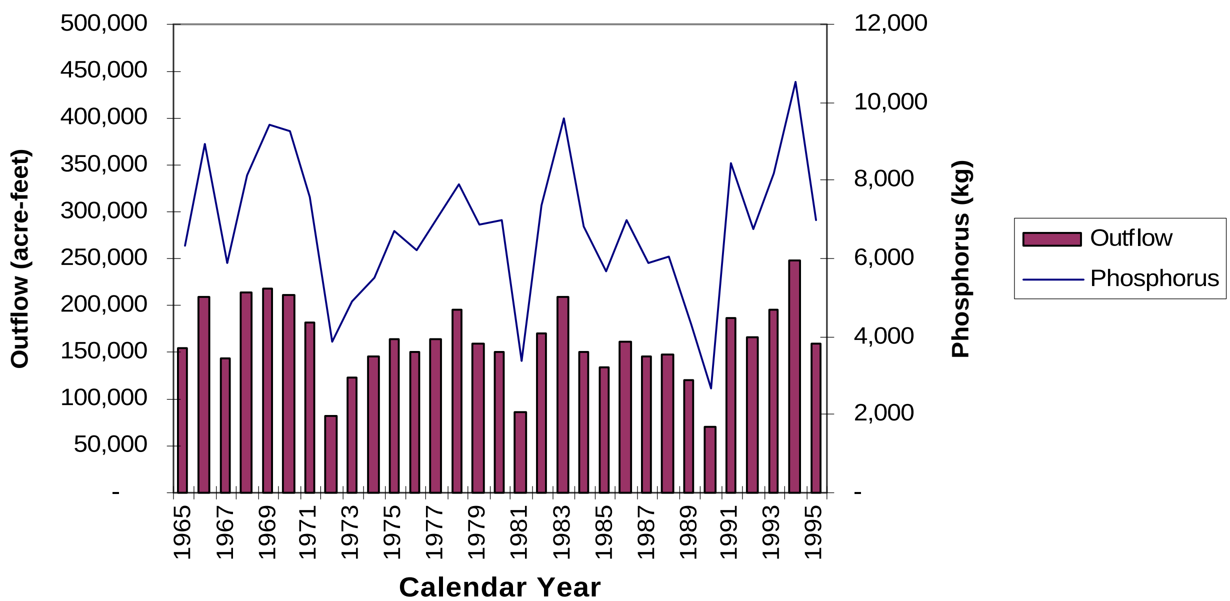


Figure 5-6. Summary of Baseline Flows and Phosphorus Loads - STA-1 West Outflows

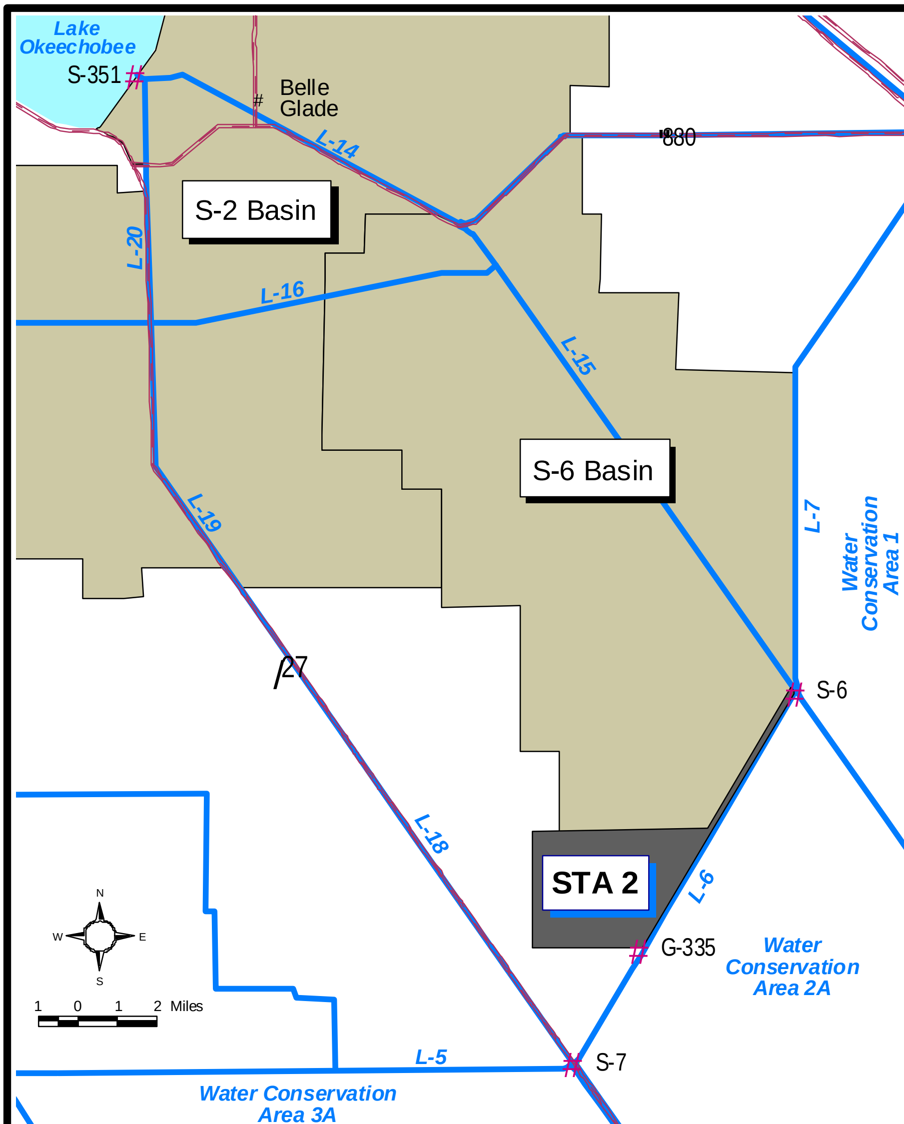


SECTION 6. STA-2 (INCLUDING S-6 BASIN)

The S-6 drainage basin is 132.8 square miles in area and is located in central Palm Beach County. The project canals and water control structures in the S-6 Basin have four primary functions: (1) to remove excess water from the S-6 Basin to storage in Water Conservation Area 1 (WCA 1); (2) to prevent over-drainage of the S-6 Basin; (3) to supply water from Lake Okeechobee to the S-6 Basin as needed for irrigation; and (4) to provide conveyance for regulatory releases from Lake Okeechobee to be passed to storage in WCA 1 and for water supply releases to be passed to eastern Palm Beach and Broward counties. There are two project canals in the S-6 Basin: the Hillsboro Canal and the L-6 borrow canal. Two other, non-project, canals are important in this basin. These are the Cross Canal and the Bolles Canal. The Cross Canal, the Bolles Canal, and the L-6 borrow canal are tributary to the Hillsboro Canal. There are four project structures affecting flows in the S-6 Basin: S-2, S-5AX, S-6, and S-351. A schematic of the S-6 Basin is presented in Appendix 1-3.

The basins tributary to STA-2 are presented in Figure 6-1. STA-2 will treat stormwater flows from the Hillsboro Canal Basin (S-6 Basin), the S-5A Basin, runoff from the Closter Farms, and East Shore Water Control District. In addition, S-6 will bypass Lake Okeechobee releases for downstream water supply and STA-2 will treat Lake releases during periods of high Lake stages (if available treatment capacity exists in the treatment area). Historic flow and water quality data from the S-6 pump station ("preferred" DBKEY 15034), and the S-2/S-351 Complex ("preferred" DBKEY 15021) for Lake releases, were compiled to generate the baseline data set.

Historic flow and phosphorus data (Water Years 1990 – 1999) for these structures for the period of record are presented in Appendix 6-1. A summary of the historic data is presented in Table 6-1 and Figures 6-2 through 6-4. Table 6-1 also shows the flow-weighted mean phosphorus concentration for Water Years 1996-1999 – the last four years with 100% of the EAA Best Management Practices in place.



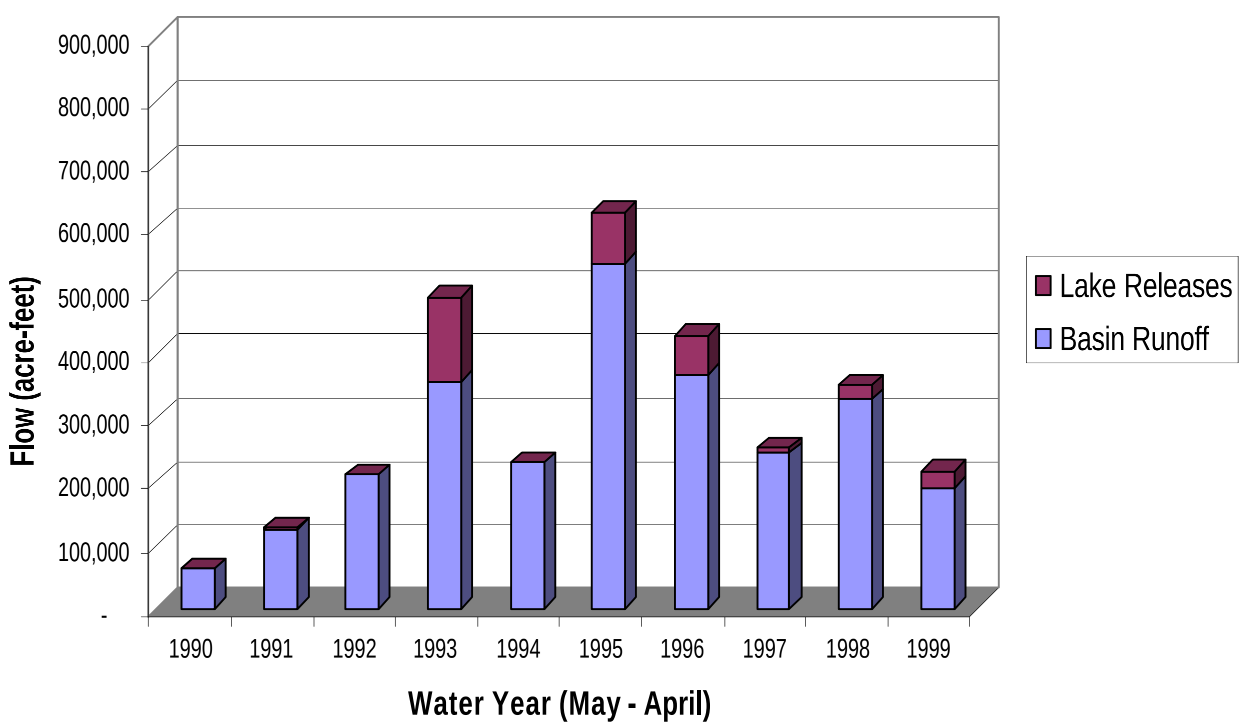
Tributary Basin Map - STA 2

Figure 6-1

Table 6-1. Summary of Historic Flow and Phosphorus Data – S-6 Basin (May to April Water Years)

Runoff (Period of record: May 1989 – April 1999)	
Minimum annual (acre-feet)	62,072
Average annual (acre-feet)	265,553
Water Year 1996-99 average (acre-feet)	282,342
Maximum annual (acre-feet)	542,201
Runoff phosphorus (Period of record: May 1989 – April 1999)	
Minimum annual (ppb)	56
Flow-weighted average annual (ppb)	96
Water Year 1996-99 average (ppb)	88
Maximum annual (ppb)	153
Lake releases (Period of record: May 1989 – April 1999)	
Minimum annual (acre-feet)	0
Average annual (acre-feet)	33,386
Maximum annual (acre-feet)	131,967
Lake releases phosphorus (Period of record: May 1989 – April 1999)	
Minimum annual (ppb)	48
Flow-weighted average annual (ppb)	74
Maximum annual (ppb)	89

Figure 6-2. Summary of Historic Flows - S-6 Basin



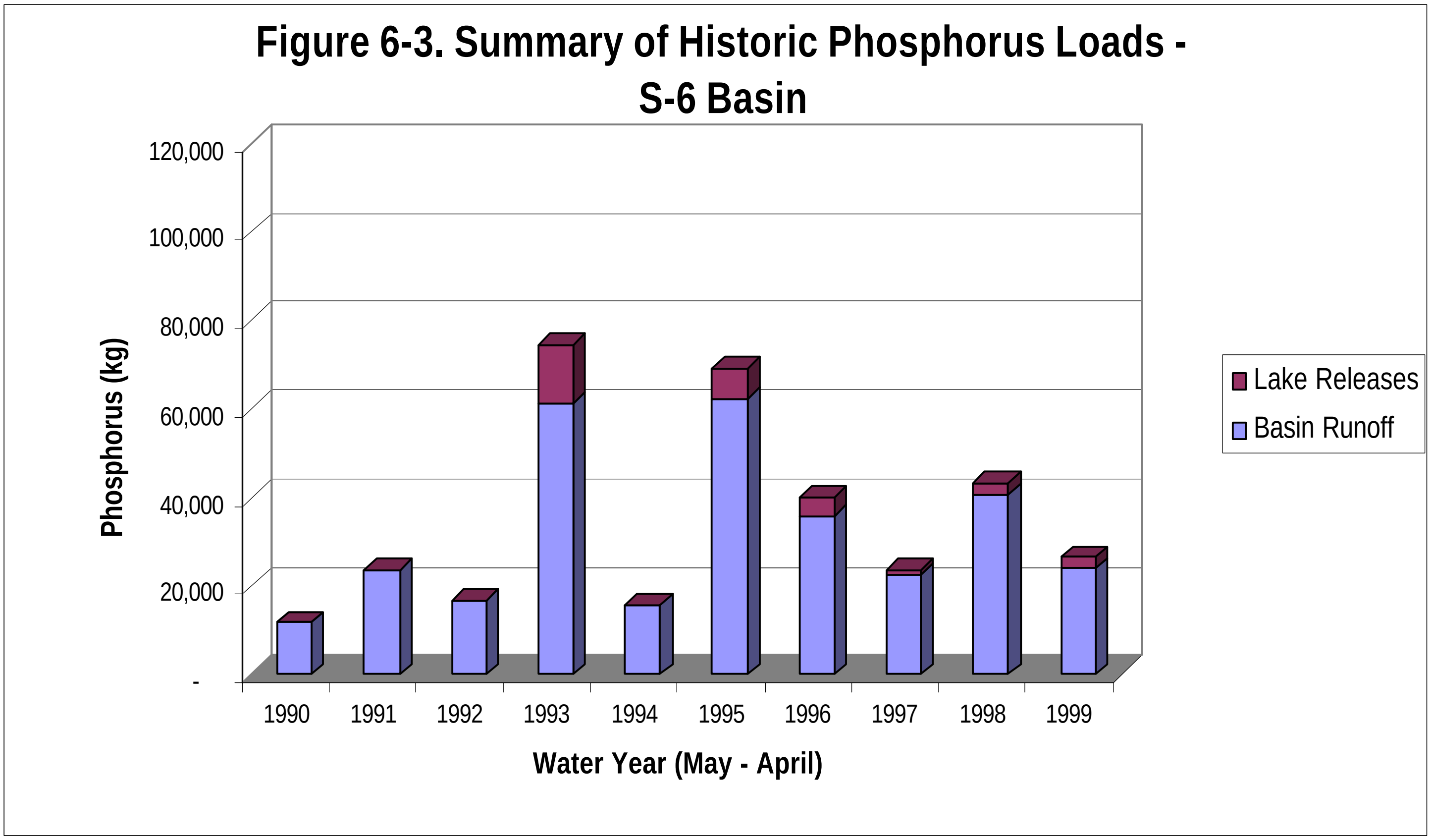


Figure 6-3. Summary of Historic Phosphorus Loads - S-6 Basin
120,000
100,000
80,000
60,000
40,000
20,000
-
Phosphorus (kg)
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
Water Year (May - April)
Lake Releases
Basin Runoff

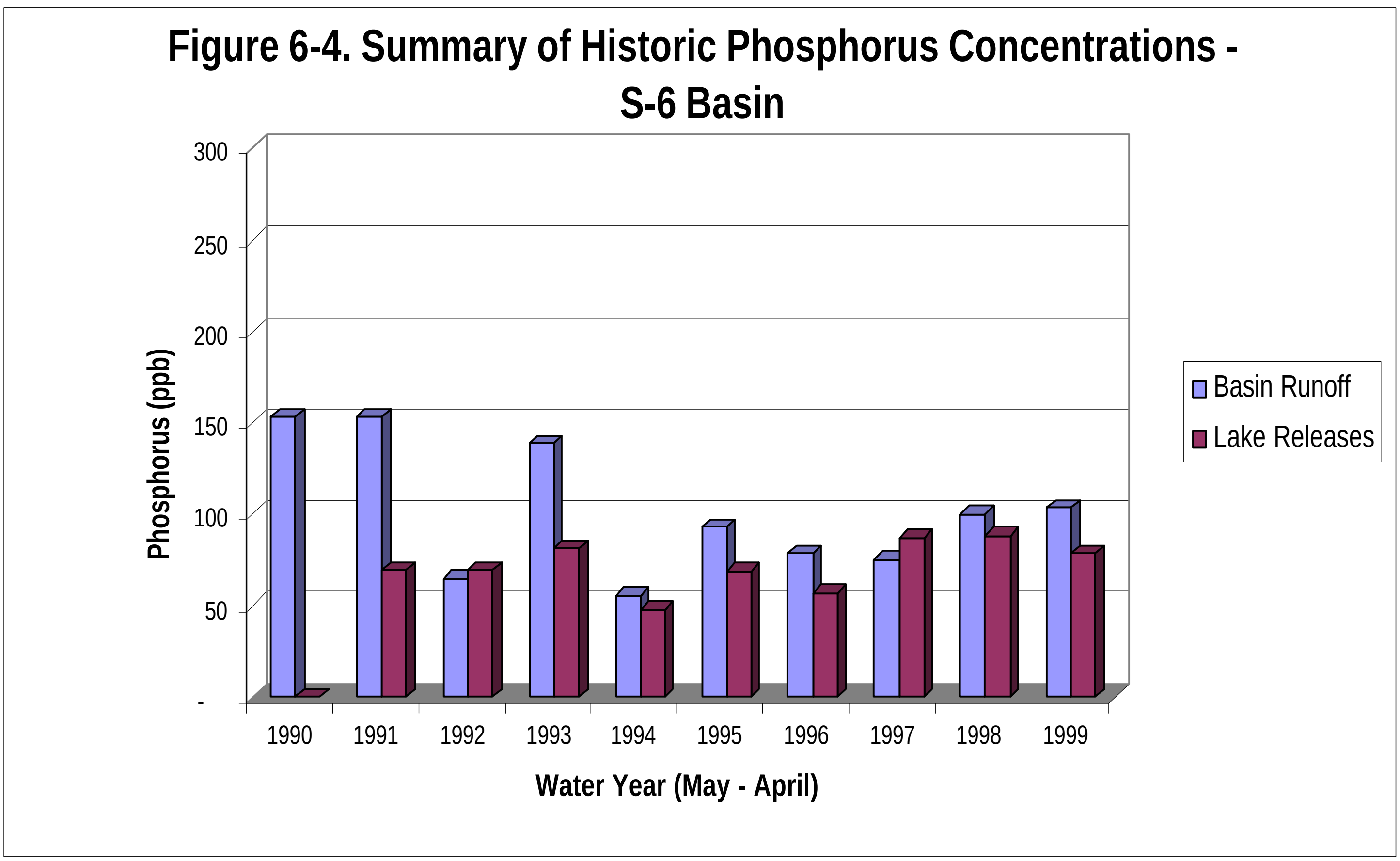


Figure 6-4. Summary of Historic Phosphorus Concentrations - S-6 Basin
300
250
200
150
100
50
-
Phosphorus (ppb)
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
Water Year (May - April)
Basin Runoff
Lake Releases

A seasonal (wet season/dry season) regression equation was applied to the S-6 Basin daily flows to develop a 31-year set of daily phosphorus values. A summary of simulated inflows for STA-2 for the 31-year period (1965-1995) is presented in Table 6-2 and Figure 6-5.

There was an insignificant amount of bypass (0.037% on an average annual basis occurring only 0.044% of the total simulation period) associated with STA-2 in the BASERR1 simulation, however, it is considered essentially zero since the amount is within the accuracy of the SFWMM model.

A summary of simulated outflows for STA-2 for the 31-year period (1965-1995) is presented in Table 6-3 and Figure 6-6.

Table 6-2. Summary of Baseline Flows and Phosphorus Loads - STA-2 Inflows

Calendar Year	Total Inflow (acre-feet)	Phosphorus (kg)	Phosphorus (ppb)
1965	247,983	28,786	94
1966	326,994	37,827	94
1967	204,442	24,209	96
1968	333,965	38,645	94
1969	323,525	39,225	98
1970	280,183	37,366	108
1971	262,718	32,005	99
1972	195,601	23,664	98
1973	176,859	20,599	94
1974	207,831	23,673	92
1975	273,653	32,808	97
1976	193,912	23,692	99
1977	233,563	30,628	106
1978	258,639	31,371	98
1979	264,005	32,192	99
1980	187,630	23,715	102
1981	152,551	19,337	103
1982	280,343	33,566	97
1983	278,658	37,905	110
1984	176,327	22,205	102
1985	209,950	25,314	98
1986	249,028	31,510	103
1987	160,198	22,665	115
1988	157,000	19,129	99
1989	136,962	16,056	95
1990	102,113	11,670	93
1991	226,446	29,806	107
1992	258,106	31,003	97
1993	242,997	32,176	107
1994	382,987	51,366	109
1995	252,490	29,654	95
Average	233,473	28,831	100
Minimum	102,113	11,670	92
Maximum	382,987	51,366	115

Notes:

1. A variable phosphorus concentration was applied to the runoff from the S-5A basin, based on the daily regression analysis. For the dry season, the standard error of the estimate was 61.5 ppb, and for the wet season, the standard error of the estimate was 39.6 ppb.
2. A variable phosphorus concentration was applied to the runoff from the S-6 basin, based on the daily regression analysis. For the dry season, the standard error of the estimate was 36.2 ppb; for the wet season, the standard error was 31.1 ppb.
3. A phosphorus concentration of 206 ppb was applied to the Ch. 298 District's runoff (Burns & McDonnell, 1994).
4. A phosphorus concentration of 74 ppb was applied to the Lake releases, equal to the mean of the last ten years.

Table 6-3. Summary of Baseline Flows and Phosphorus Loads - STA-2 Outflows

Calendar Year	Total Outflow (acre-feet)	Phosphorus (kg)	Phosphorus (ppb)
1965	232,143	12,813	45
1966	329,003	17,477	43
1967	198,576	11,042	45
1968	334,560	18,050	44
1969	324,392	18,349	46
1970	280,012	17,620	51
1971	254,998	14,506	46
1972	192,221	11,370	48
1973	169,421	9,451	45
1974	201,234	10,760	43
1975	267,811	15,652	47
1976	189,668	10,972	47
1977	227,911	14,817	53
1978	247,367	15,148	50
1979	265,369	15,738	48
1980	177,101	11,674	53
1981	146,069	8,577	48
1982	278,175	15,766	46
1983	268,295	17,741	54
1984	168,683	10,706	51
1985	205,588	11,814	47
1986	234,729	14,809	51
1987	164,637	10,869	54
1988	146,015	8,601	48
1989	131,194	7,441	46
1990	94,548	5,258	45
1991	224,472	14,227	51
1992	258,344	14,303	45
1993	242,582	14,769	49
1994	393,108	24,039	50
1995	259,231	13,901	43
Average	229,273	13,492	48
Minimum	94,548	5,258	43
Maximum	393,108	24,039	54

Figure 6-5. Summary of Baseline Flows and Phosphorus Loads - STA-2 Inflows

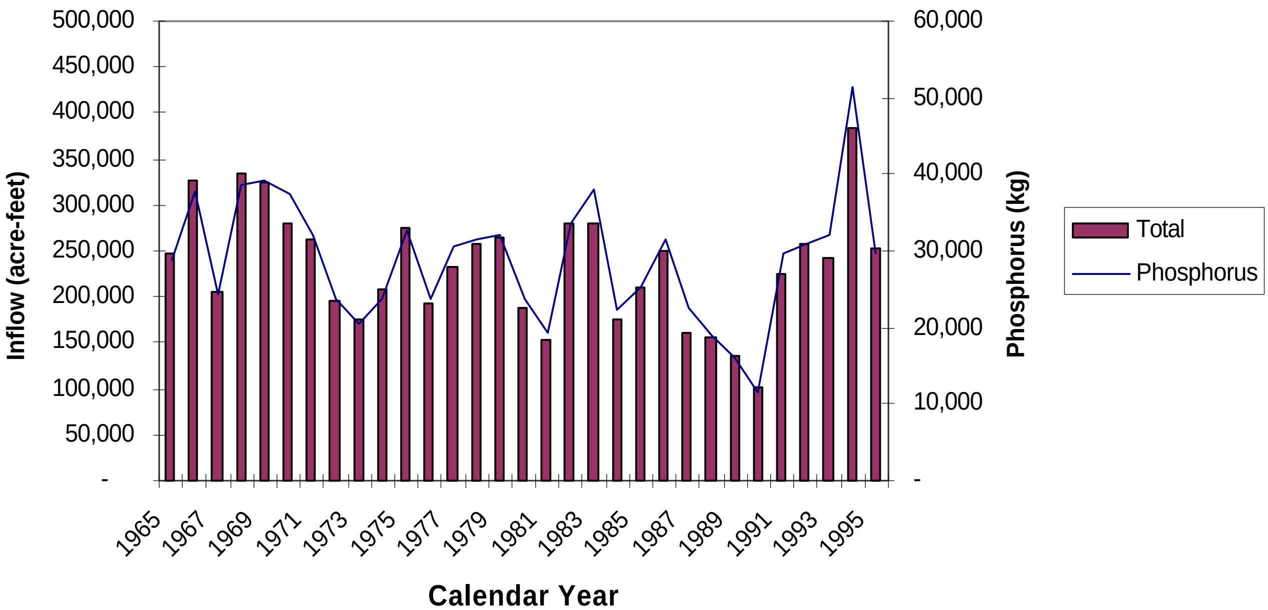
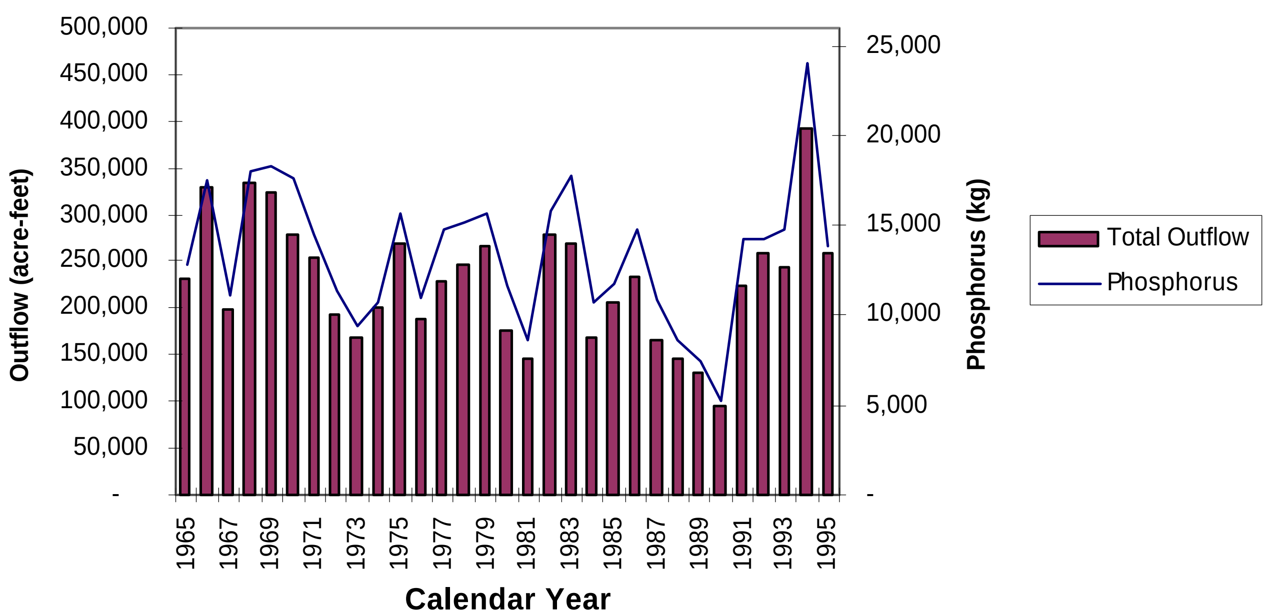


Figure 6-6. Summary of Baseline Flows and Phosphorus Loads - STA-2 Outflows



SECTION 7. STA-3/4 (INCLUDING S-7 AND S-8 BASINS)

The S-7 drainage basin is 131.3 square miles in area and is located in south-central Palm Beach County. The project canals and water control structures in the S-7 Basin have four primary functions: (1) to remove excess water from the S-7 Basin to storage in Water Conservation Areas (WCAs) 2A and 3A; (2) to prevent over-drainage of the S-7 Basin; (3) to supply water from Lake Okeechobee to the S-7 Basin as needed for irrigation; and (4) to provide conveyance for regulatory releases from Lake Okeechobee to be passed to storage in WCAs 2A and 3A and for water supply releases to be passed to eastern Broward County. There are three project canals in the S-7 Basin: the North New River Canal, the L-6 borrow canal, and the L-5 borrow canal. There are four project structures affecting flow in the S-7 Basin: S-2, S-7, S-150, and S-351. A schematic of the S-7 Basin is presented in Appendix 1-4.

The S-8 drainage basin is 201.4 square miles in area and is located in southwestern Palm Beach County and in southeastern Hendry County. The project canals and water control structures in the S-8 Basin have five primary functions: (1) to remove excess water from the S-8 Basin to storage in Water Conservation Area 3A (WCA 3A); (2) to prevent over-drainage of the S-8 Basin; (3) to supply water from Lake Okeechobee to the S-8 Basin as needed for irrigation; (4) to provide conveyance for regulatory releases from Lake Okeechobee to storage in WCA 3A; and (5) to receive discharges of excess water from the L-3 borrow canal when these discharges will not cause flooding in the S-8 Basin. There are two project canals in the S-8 Basin: the Miami Canal and the L-4 borrow canal. There are four project structures affecting flow in the S-8 Basin: S-3, S-8, S-354, and G-88. A schematic of the S-8 Basin is presented in Appendix 1-5.

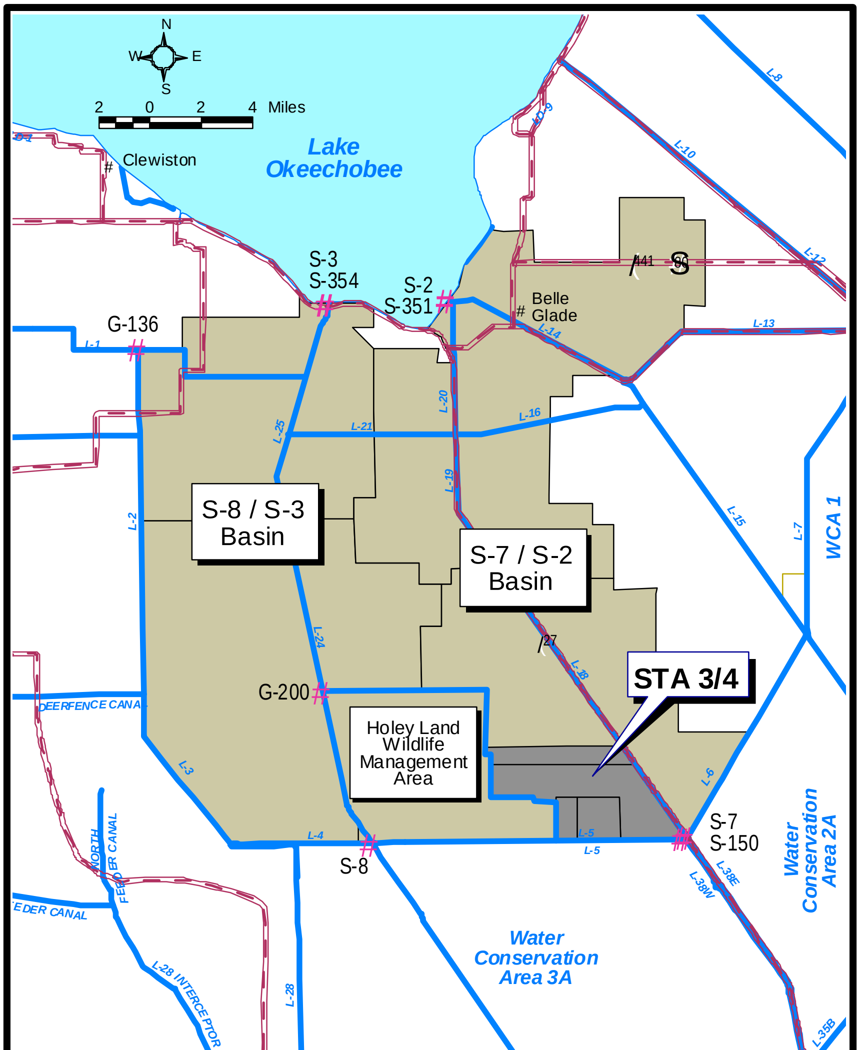
The basins tributary to STA-3/4 are presented in Figure 7-1. STA-3/4 will treat stormwater flows from the Miami Canal Basin, the North New River Canal Basin, as well as runoff from the South Shore Drainage District and South Florida Conservancy District. In addition, STA-3/4 will treat Lake Okeechobee regulatory releases if available treatment capacity exists in the treatment area. Historic flow and water quality data from the following structures were compiled to generate the baseline data set:

S-7 pump station (“preferred” DBKEY 15037)
S-8 pump station (“preferred” DBKEY 15040)
S-150 gate (“preferred” DBKEY 15041)
S-2 pump station and structure S-351 for Lake releases (“preferred” DBKEY 15021)
S-3 pump station and structure S-354 for Lake releases (“preferred” DBKEY 15018)
G-136 (C-139 basin runoff to the Miami Canal) (“preferred” DBKEY 15195)
G-200 (inflow to Holey Land) (“preferred” DBKEY 15736)

Historic flow and phosphorus data (Water Years 1990 – 1999) for these structures for the period of record are presented in Appendix 7-1 and 7-2. A summary of the historic data is presented in Tables 7-1 and 7-2 and Figures 7-2 through 7-7. Tables 7-1 and 7-2 also show the flow-weighted mean phosphorus concentration for Water Years 1996 through 1999 – the last four years with 100% of the EAA Best Management Practices in place.

The G-136 portion of the C-139 Basin historic data used in this section of the report came from the Excel spreadsheet "c139_final_flows&loads.xls" dated March 8, 2001, prepared by W. Walker for the C-139 Rulemaking effort. The spreadsheet uses flow and phosphorus data from various sources, locations and structures. For a complete description of the data sources, please refer to the document titled "Final Report - Models for Tracking Runoff & Phosphorus Loads from the C139 Basin" dated November 17, 2000, by W. Walker.

A summary of the G-136 historic data is presented in Figures 8-2 through 8-4 and Appendix 8-1.



Tributary Basin Map - STA 3/4

Figure 7-1

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Table 7-1. Summary of Historic Flow and Phosphorus Data – S-7 Basin (May to April Water Years)

Runoff (Period of record: May 1989 – April 1999)	
Minimum annual (acre-feet)	163,167
Average annual (acre-feet)	248,686
Water Year 1996-99 average (acre-feet)	205,535
Maximum annual (acre-feet)	390,473
Runoff phosphorus (Period of record: May 1989 – April 1999)	
Minimum annual (ppb)	68
Flow-weighted average annual (ppb)	91
Water Year 1996-99 average (ppb)	85
Maximum annual (ppb)	116
Lake releases (Period of record: May 1989 – April 1999)	
Minimum annual (acre-feet)	1,461
Average annual (acre-feet)	106,154
Maximum annual (acre-feet)	345,675
Lake releases phosphorus (Period of record: May 1989 – April 1999)	
Minimum annual (ppb)	55
Flow-weighted average annual (ppb)	71
Maximum annual (ppb)	111

Table 7-2. Summary of Historic Flow and Phosphorus data – S-8 Basin (May to April Water Years)

Runoff (Period of record: May 1989 – April 1999)	
Minimum annual (acre-feet)	85,766
Average annual (acre-feet)	287,063
Water Year 1996-99 average (acre-feet)	324,976
Maximum annual (acre-feet)	454,974
Runoff phosphorus (Period of record: May 1989 – April 1999)	
Minimum annual (ppb)	60
Flow-weighted average annual (ppb)	110
Water Year 1996-99 average (ppb)	91
Maximum annual (ppb)	201
Lake releases (Period of record: May 1989 – April 1999)	
Minimum annual (acre-feet)	6,211
Average annual (acre-feet)	79,203
Maximum annual (acre-feet)	395,310
Lake releases phosphorus (Period of record: May 1989 – April 1999)	
Minimum annual (ppb)	47
Flow-weighted average annual (ppb)	67
Maximum annual (ppb)	102

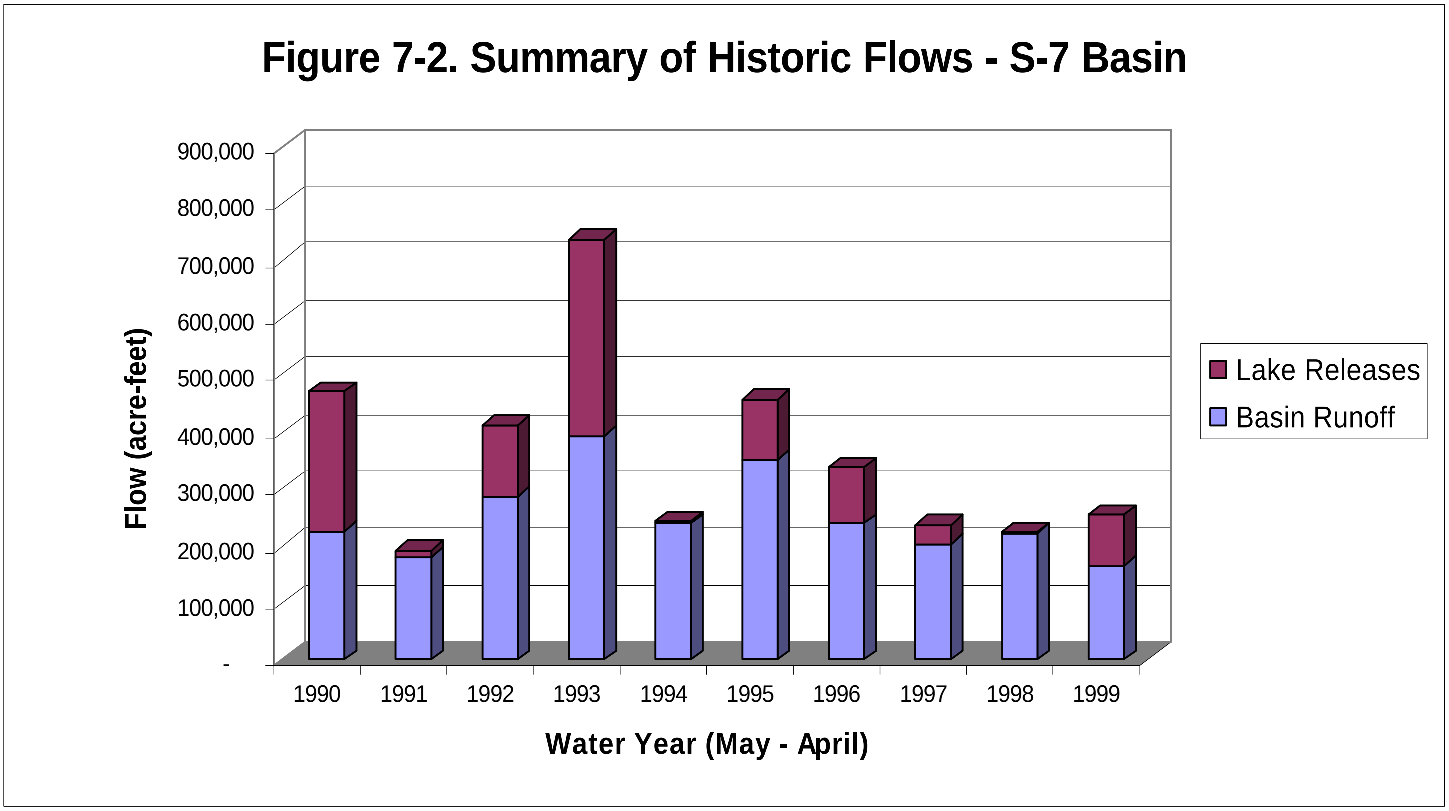


Figure 7-2. Summary of Historic Flows - S-7 Basin
Flow (acre-feet)
900,000
800,000
700,000
600,000
500,000
400,000
300,000
200,000
100,000
-
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
Water Year (May - April)
Lake Releases
Basin Runoff

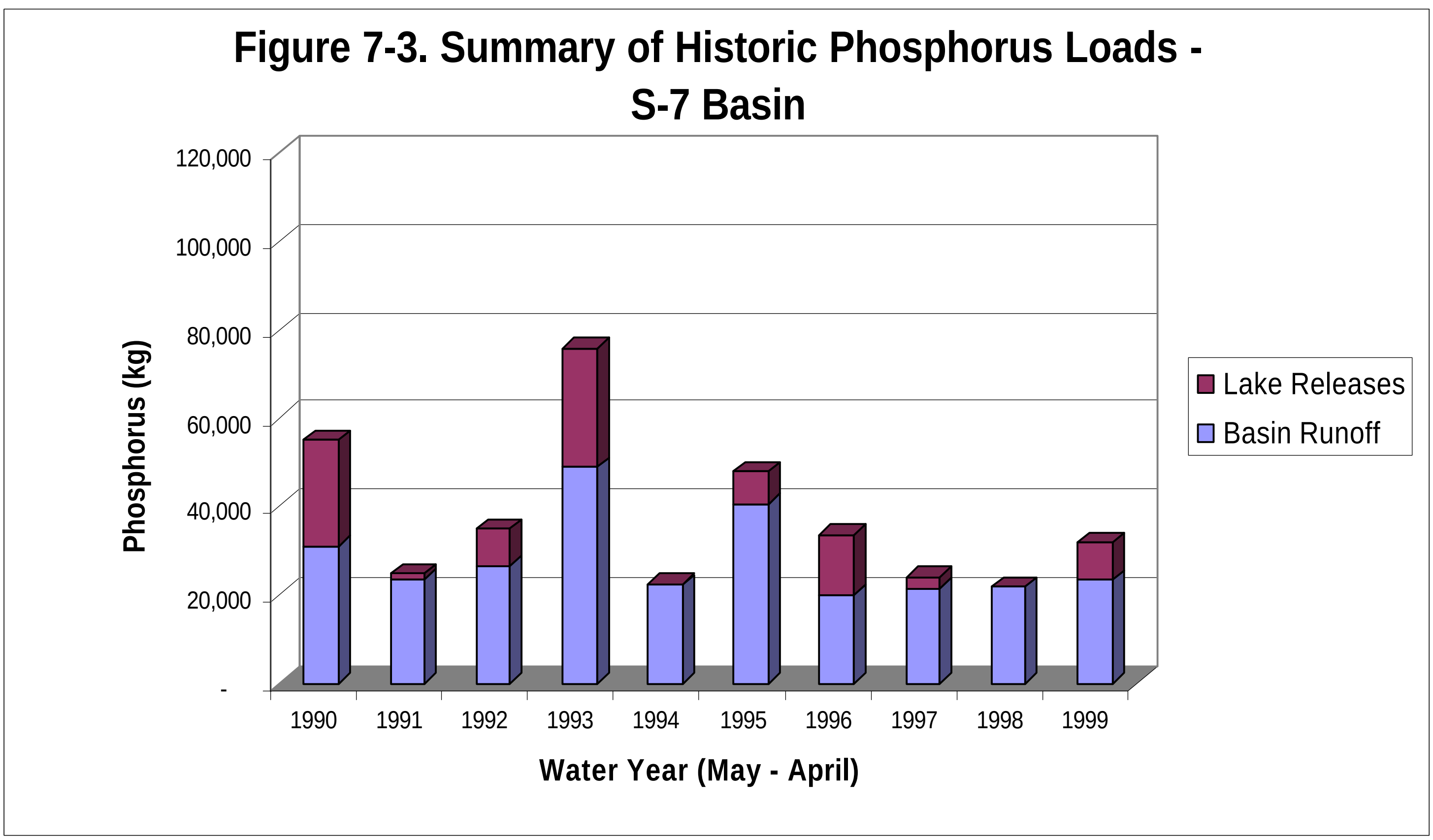


Figure 7-3. Summary of Historic Phosphorus Loads - S-7 Basin
Phosphorus (kg)
120,000
100,000
80,000
60,000
40,000
20,000
-
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
Water Year (May - April)
Lake Releases
Basin Runoff

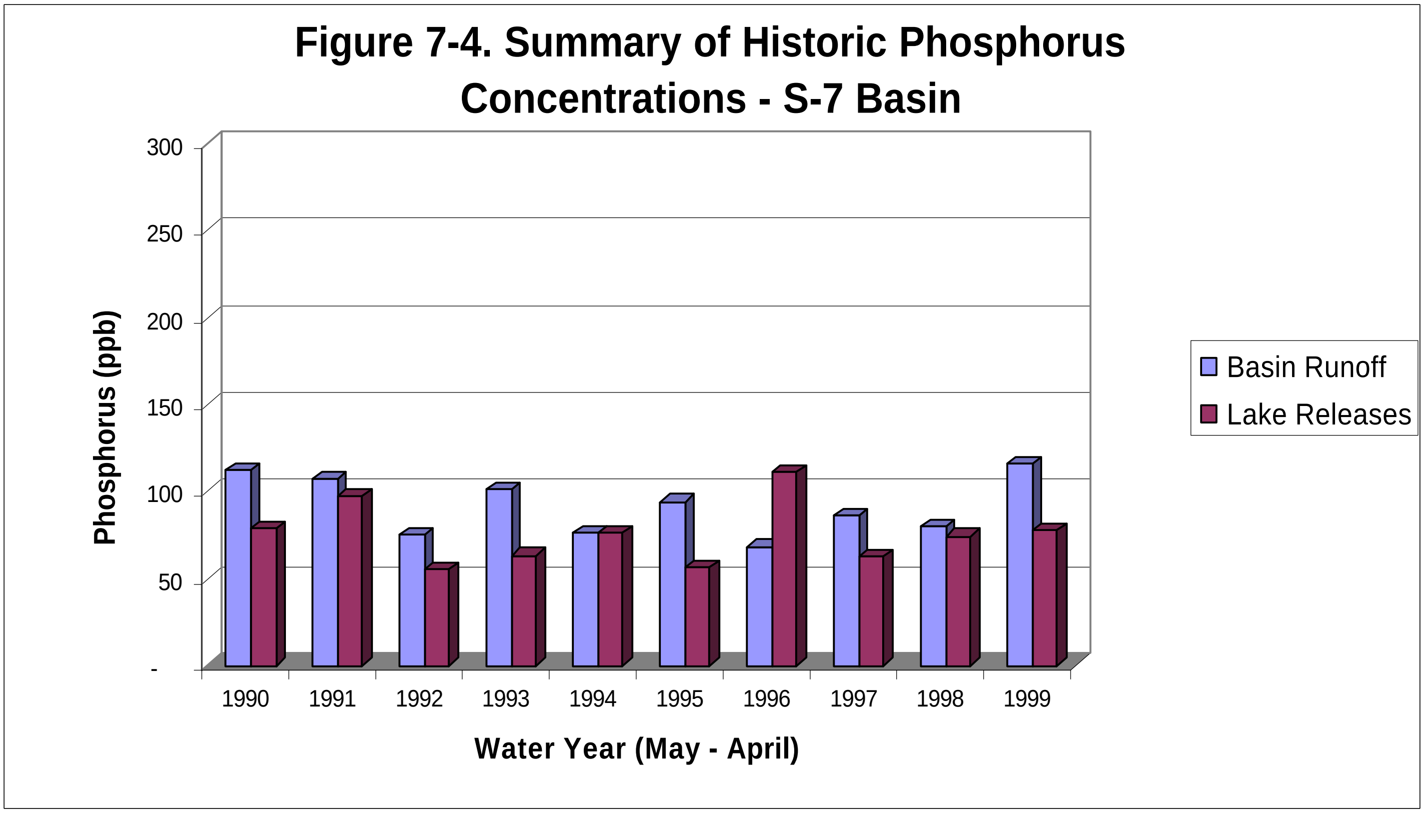


Figure 7-4. Summary of Historic Phosphorus Concentrations - S-7 Basin
Phosphorus (ppb)
300
250
200
150
100
50
-
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
Water Year (May - April)
Basin Runoff
Lake Releases

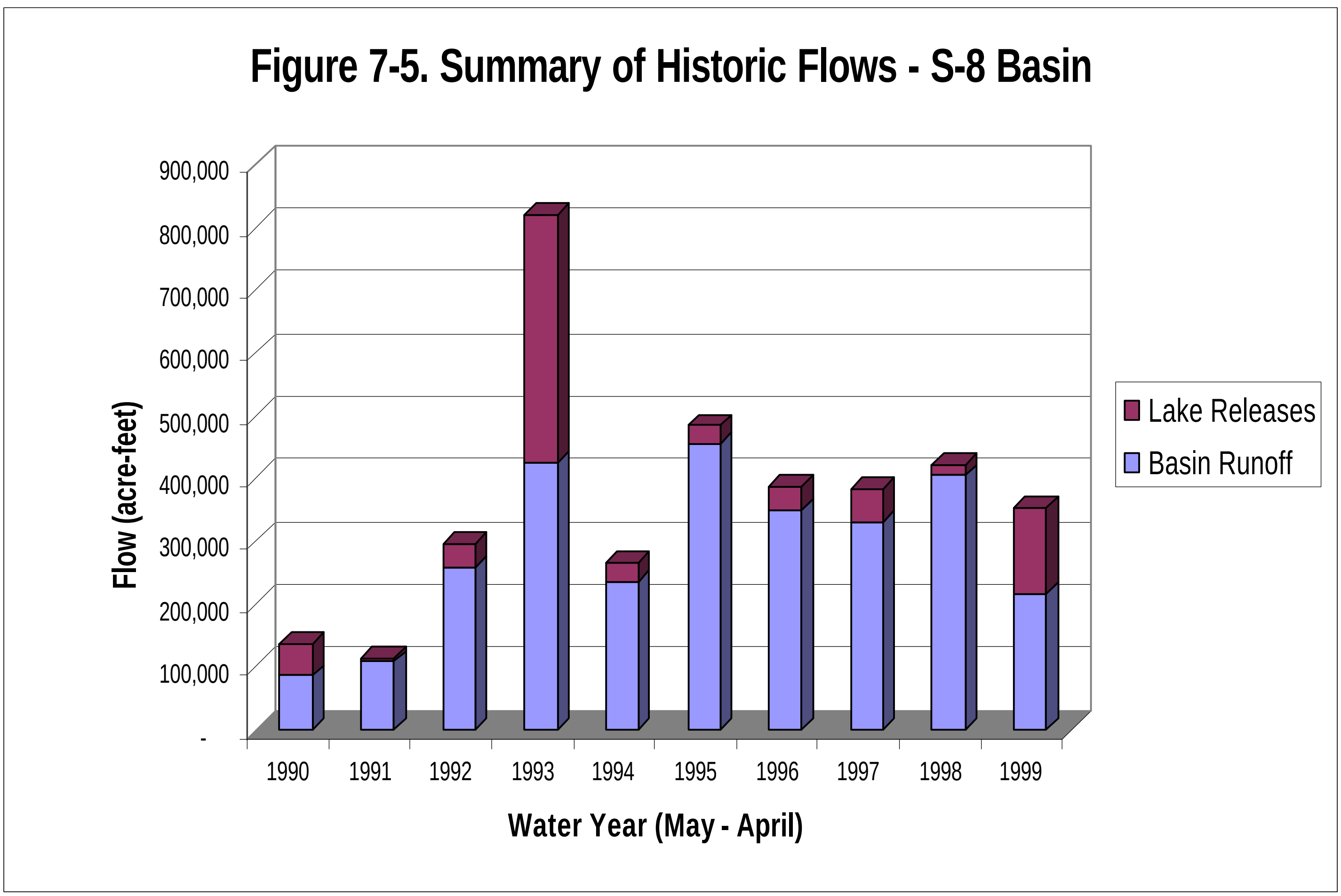


Figure 7-5. Summary of Historic Flows - S-8 Basin
Flow (acre-feet)
900,000
800,000
700,000
600,000
500,000
400,000
300,000
200,000
100,000
-
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
Water Year (May - April)
Lake Releases
Basin Runoff

Figure 7-6. Summary of Historic Phosphorus Loads - S-8 Basin

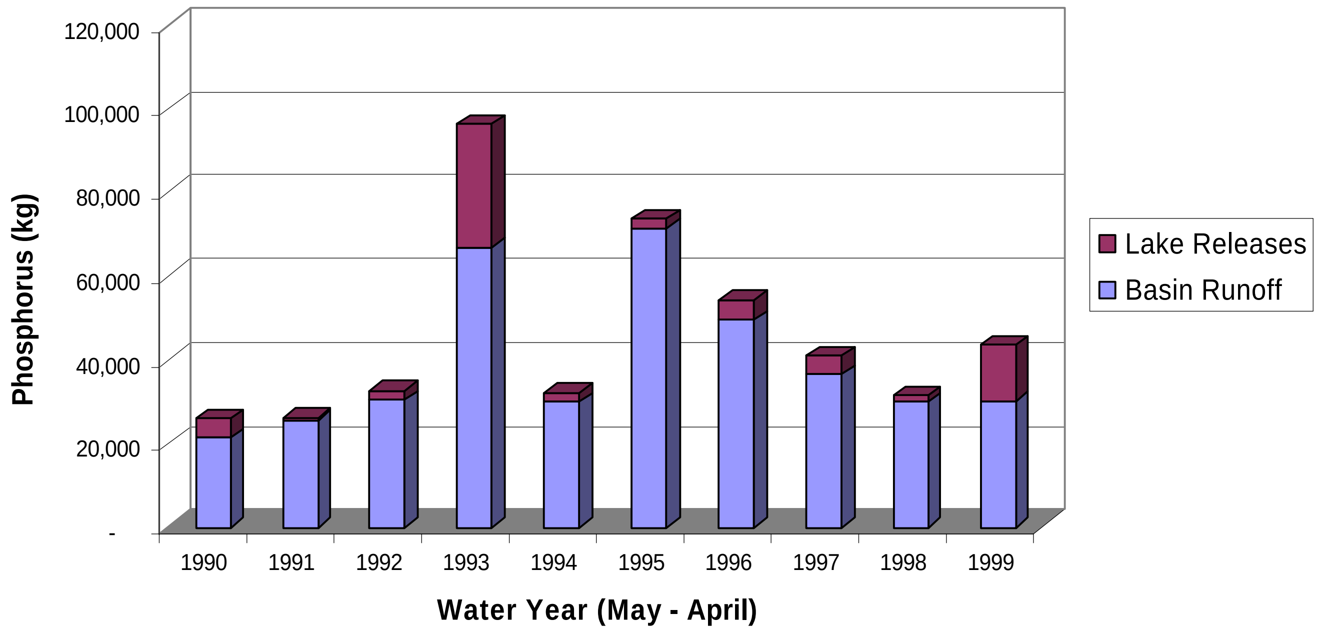
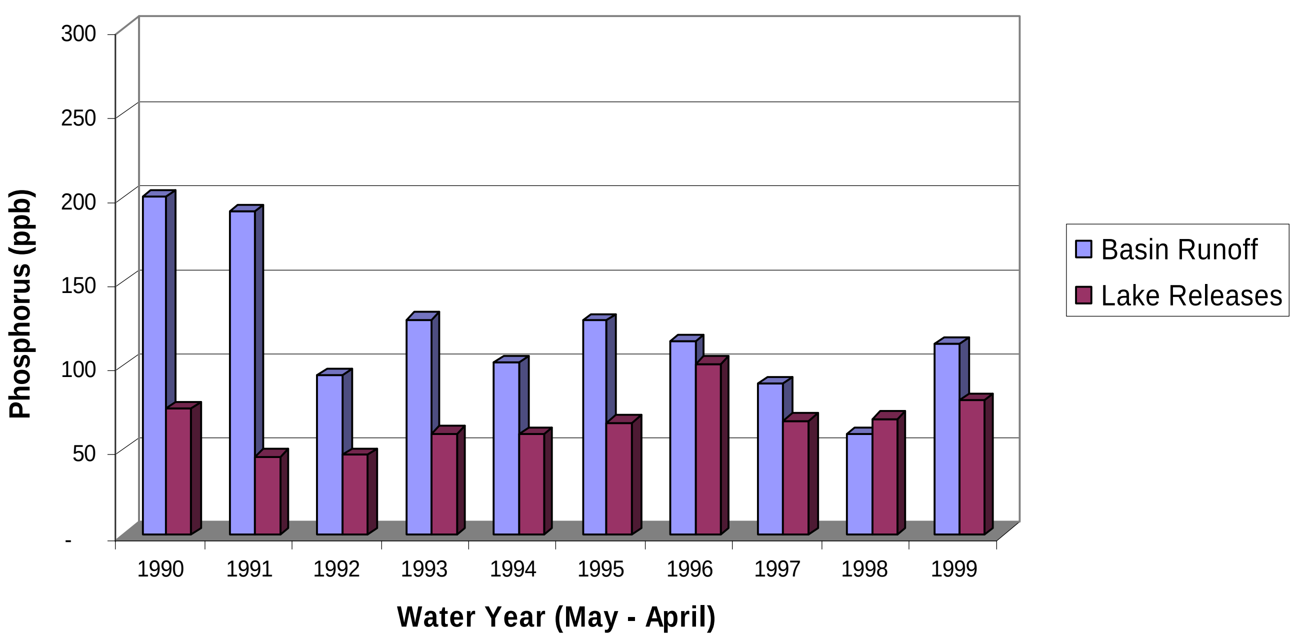


Figure 7-7. Summary of Historic Phosphorus Concentrations - S-8 Basin



Seasonal (wet season/dry season) regression equations were applied to the S-7 Basin and the S-8 Basin daily flows to develop a 31-year set of daily phosphorus values.

Using data from the spreadsheet "c139_final_flows&loads.xls", a seasonal (wet season/dry season) regression equation was developed for the G-136 portion of the data for Water Years 90-99. The 31-year set of daily phosphorus values for G-136 was then developed using two different procedures – one for the period January 1965 to September 1978, and one for the period October 1978 to December 1995. For the period January 1965 to September 1978, the seasonal regression equation was applied to the SFWMM daily flows for G-136 to develop daily phosphorus values. For the period October 1978 to December 1995, the daily flows, loads and concentrations for G-136 were used unaltered from the spreadsheet "c139_final_flows&loads.xls".

A summary of simulated inflows for STA-3/4 for the 31-year period (1965-1995) is presented in Table 7-3 and Figure 7-8. A summary of simulated outflows for STA-3/4 for the 31-year period (1965-1995) is presented in Table 7-4 and Figure 7-9.

Table 7-3. Summary of Baseline Flows and Phosphorus Loads - STA-3/4 Inflows

Calendar Year	Total Inflow (acre-feet)	Phosphorus (kg)	Phosphorus (ppb)
1965	664,814	75,166	92
1966	872,230	94,919	88
1967	753,216	79,745	86
1968	779,859	90,523	94
1969	1,250,096	127,644	83
1970	1,247,697	123,396	80
1971	600,760	69,978	94
1972	419,555	48,044	93
1973	416,950	45,503	88
1974	549,488	61,726	91
1975	633,463	72,605	93
1976	413,396	46,117	90
1977	503,064	58,762	95
1978	657,763	73,456	91
1979	876,965	89,882	83
1980	886,211	83,636	77
1981	257,751	29,066	91
1982	603,372	76,061	102
1983	1,004,104	110,742	89
1984	799,761	79,380	80
1985	498,124	55,153	90
1986	608,664	74,855	100
1987	508,222	56,047	89
1988	411,243	44,544	88
1989	306,756	32,232	85
1990	236,892	24,348	83
1991	643,941	69,685	88
1992	685,274	75,313	89
1993	744,187	77,239	84
1994	768,571	93,065	98
1995	885,162	93,768	86
Average	660,889	72,019	88
Minimum	236,892	24,348	77
Maximum	1,250,096	127,644	102

Notes:

1. A variable phosphorus concentration was applied to the runoff from the S-8 basin, based on the daily regression analysis. For the dry season, the standard error of the estimate was 28.0 ppb; for the wet season, the standard error was 42.6 ppb.
2. A variable phosphorus concentration was applied to the runoff from the S-7 basin, based on the daily regression analysis. For the dry season, the standard error of the estimate was 42.6 ppb; for the wet season, the standard error was 27.0 ppb.
3. The 90-99 flow-weighted mean phosphorus concentration of 67 ppb was applied to Miami Canal Lake releases.
4. The 90-99 flow-weighted mean phosphorus concentration of 71 ppb was applied to the N. New River Canal Lake releases.
5. A phosphorus concentration of 100 ppb was applied to the Ch. 298 District's runoff (Burns & McDonnell, 1994).
6. A phosphorus concentration of 136 ppb was applied to the S-236 basin runoff (Burns & McDonnell, 1994).
7. A variable phosphorus concentration was applied to the G-136 flows, based on the regression analysis. For the dry season, the standard error of the estimate was 60.6 ppb; for the wet season, the standard error was 70.9 ppb.

Table 7-4. Summary of Baseline Flows and Phosphorus Loads - STA-3/4 Outflows

Calendar Year	Total Outflow (acre-feet)	Phosphorus (kg)	Phosphorus (ppb)
1965	588,222	35,910	49
1966	852,269	53,940	51
1967	751,001	42,819	46
1968	771,174	49,826	52
1969	1,244,491	70,734	46
1970	1,236,975	70,329	46
1971	579,931	36,756	51
1972	403,595	23,889	48
1973	389,971	23,553	49
1974	518,756	32,827	51
1975	600,278	39,341	53
1976	394,800	23,095	47
1977	480,541	29,375	50
1978	626,464	37,411	48
1979	883,808	53,279	49
1980	857,061	48,240	46
1981	242,860	13,716	46
1982	539,520	38,393	58
1983	949,025	60,499	52
1984	765,136	44,725	47
1985	471,324	28,291	49
1986	541,381	38,739	58
1987	504,140	28,276	45
1988	369,571	24,085	53
1989	288,573	16,780	47
1990	218,890	13,118	49
1991	631,966	35,949	46
1992	674,519	41,657	50
1993	751,854	42,703	46
1994	779,415	48,251	50
1995	867,423	51,643	48
Average	637,901	38,650	49
Minimum	218,890	13,118	45
Maximum	1,244,491	70,734	58

Figure 7-8. Summary of Baseline Flows and Phosphorus Loads - STA-3/4 Inflows

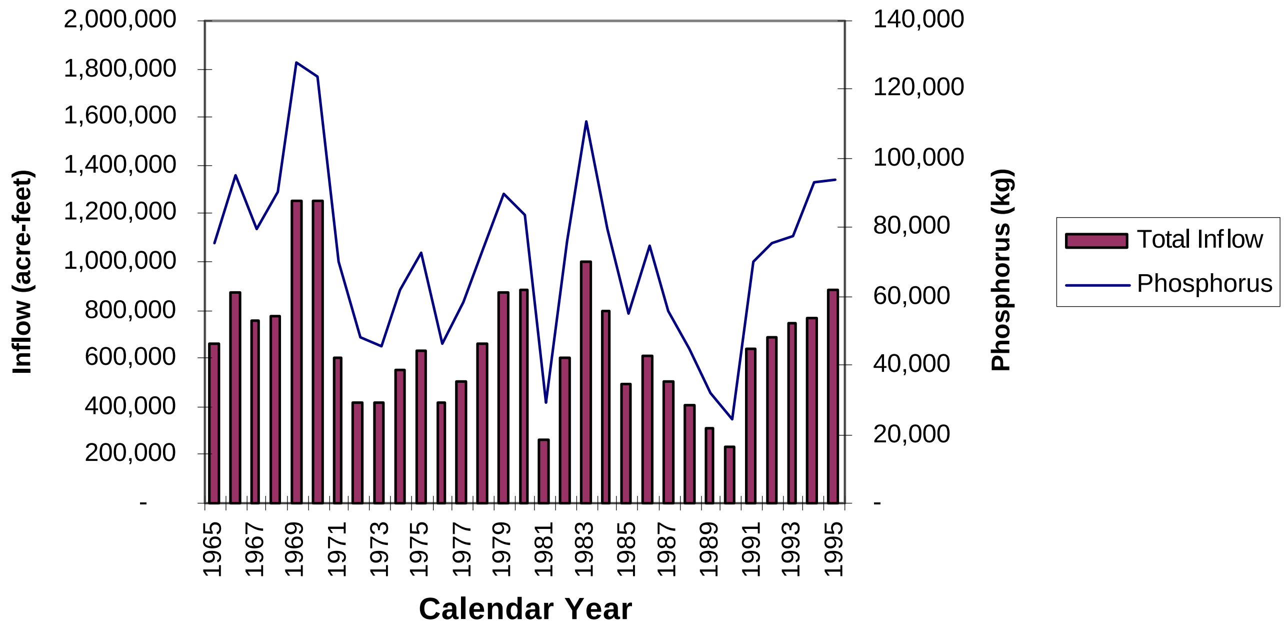
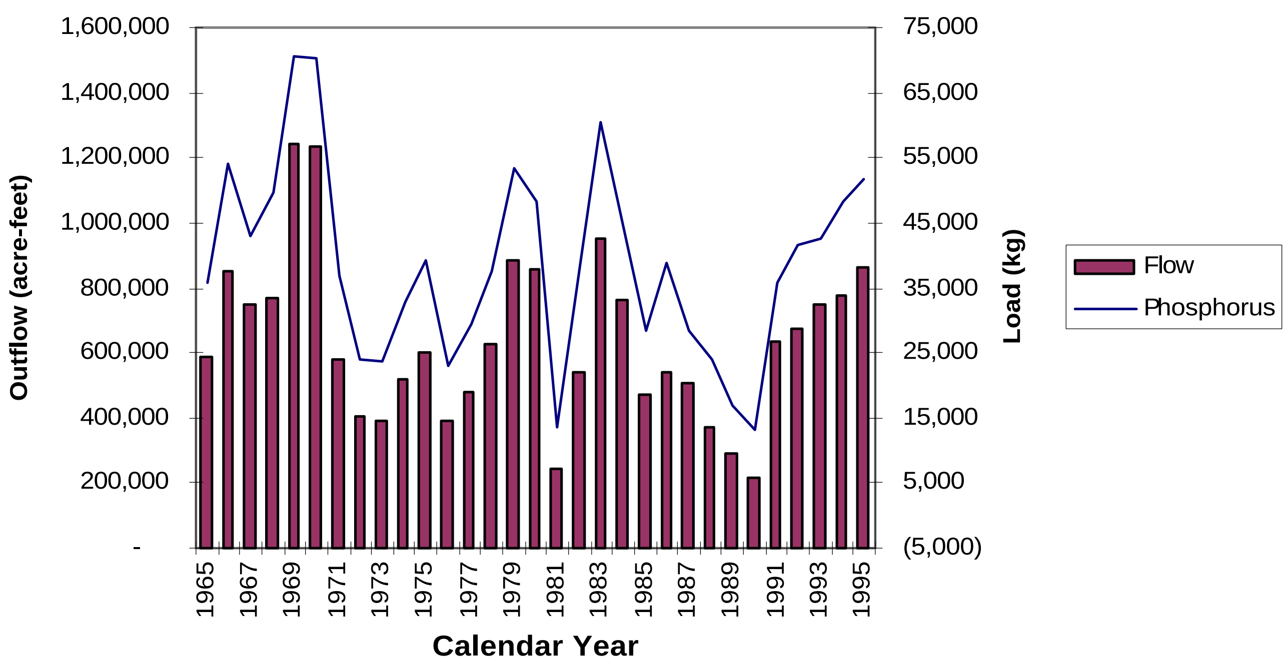


Figure 7-9. Summary of Baseline Flows and Phosphorus Loads - STA-3/4 Outflows



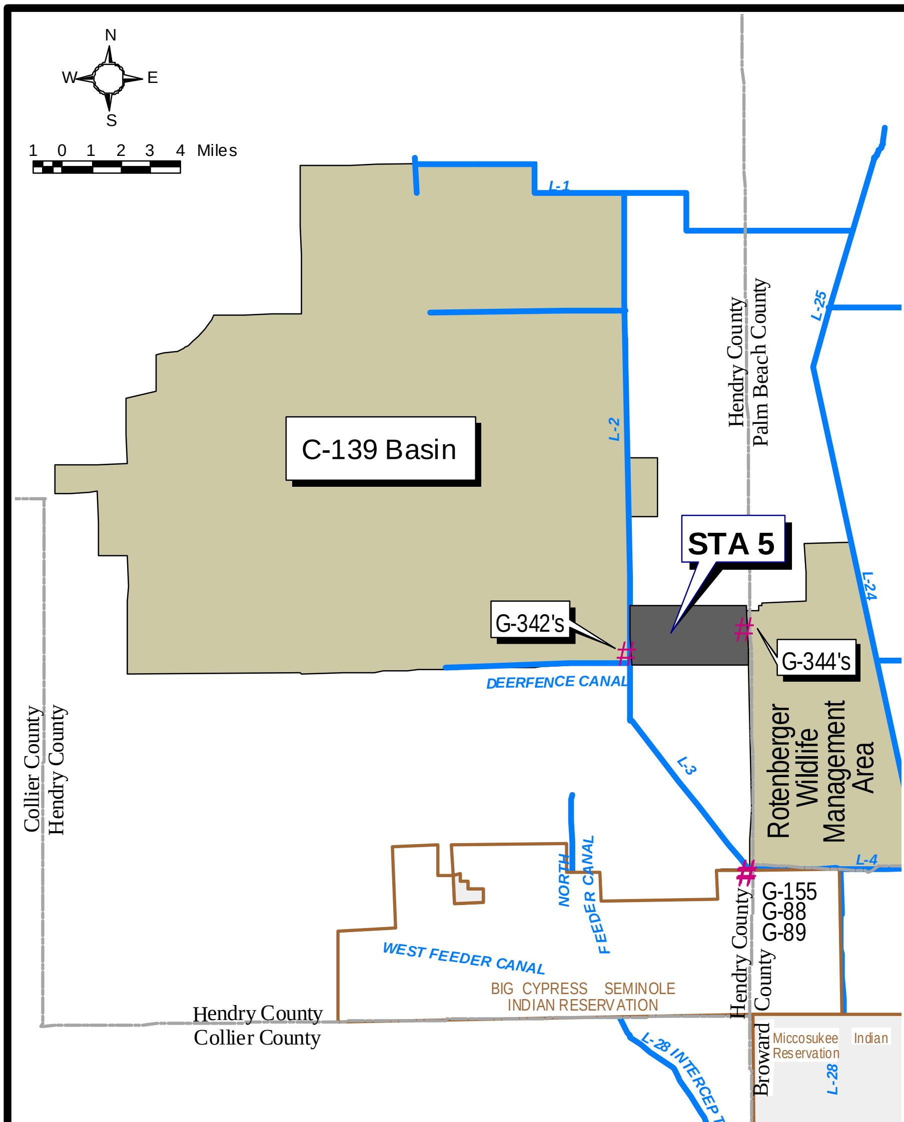
SECTION 8. STA-5 (INCLUDING C-139 BASIN)

The C-139 Basin has an area of 168,437 acres and is located in Hendry County. The primary canals within the C-139 Basin are the L-1, L-2, and L-3 borrow canals. These canals were constructed in the 1950's primarily for fill material to construct the L-1, L-2, and L-3 levees. There are eight structures affecting flow in the C-139 Basin: G-150, G-151, G-152, G-135, G-136, G-88, G-89, and G-155. The majority of basin discharges south through the G-155, G-88 and G-89 structures. A portion of the basin discharges east through structure G-136 to the L-1 East Canal and on to the Miami Canal, where it flows south to S-8. The historic flows and loads for G-136 were included in the section on STA-3/4. A schematic of the C-139 Basin is presented in Appendix 1-6.

The basins tributary to STA-5 are presented in Figure 8-1. STA-5 will treat stormwater flows from the C-139 South Basin.

The C-139 Basin historic data used in this section of the report came from the Excel spreadsheet "c139_final_flows&loads.xls" dated March 8, 2001, prepared by W. Walker for the C-139 Rulemaking effort. The spreadsheet uses flow and phosphorus data from various sources, locations and structures. For a complete description of the data sources, please refer to the document titled "Final Report - Models for Tracking Runoff & Phosphorus Loads from the C139 Basin" dated November 17, 2000, by W. Walker.

Historic flow and phosphorus data (Water Years 1990 – 1999) for these structures for the period of record are presented in Appendix 8-1. A summary of the historic data is presented in Table 8-1 and Figures 8-2 through 8-4.



Tributary Basin Map - STA 5
Figure 8-1

ERRD/ESP CMIESSAU 21-JAN-2000 ecp-sta5.apr ecp-sta5-L

Table 8-1. Summary of Historic Flow and Phosphorus Data – C-139 Basin (May to April Water Years)

Runoff (Period of record: May 1989 – April 1999)	**C-139 South**	**G-136**
Minimum annual (acre-feet)	41,843	1,249
Average annual (acre-feet)	129,342	14,939
Maximum annual (acre-feet)	236,270	35,987
Runoff phosphorus (Period of record: May 1989 – April 1999)		
Minimum annual (ppb)	90	76
Flow-weighted average annual (ppb)	169	150
Maximum annual (ppb)	228	247

Figure 8-2. Summary of Historic Flows - C-139 Basin

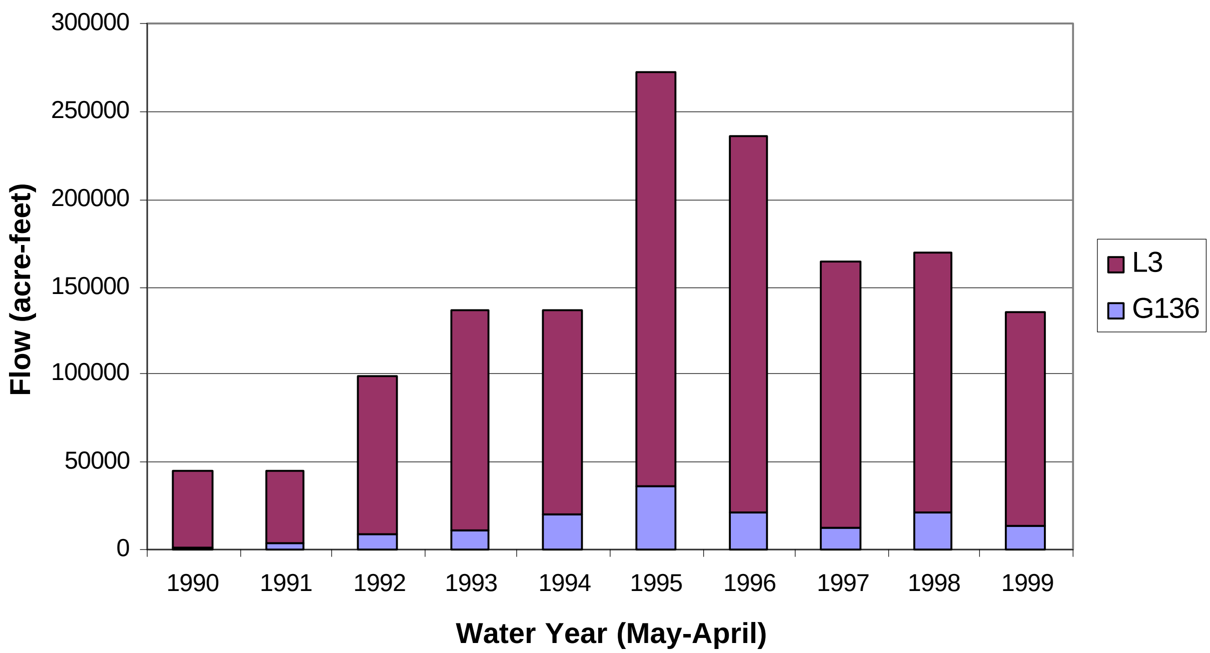


Figure 8-3. Summary of Historic Phosphorus Loads - C-139 Basin

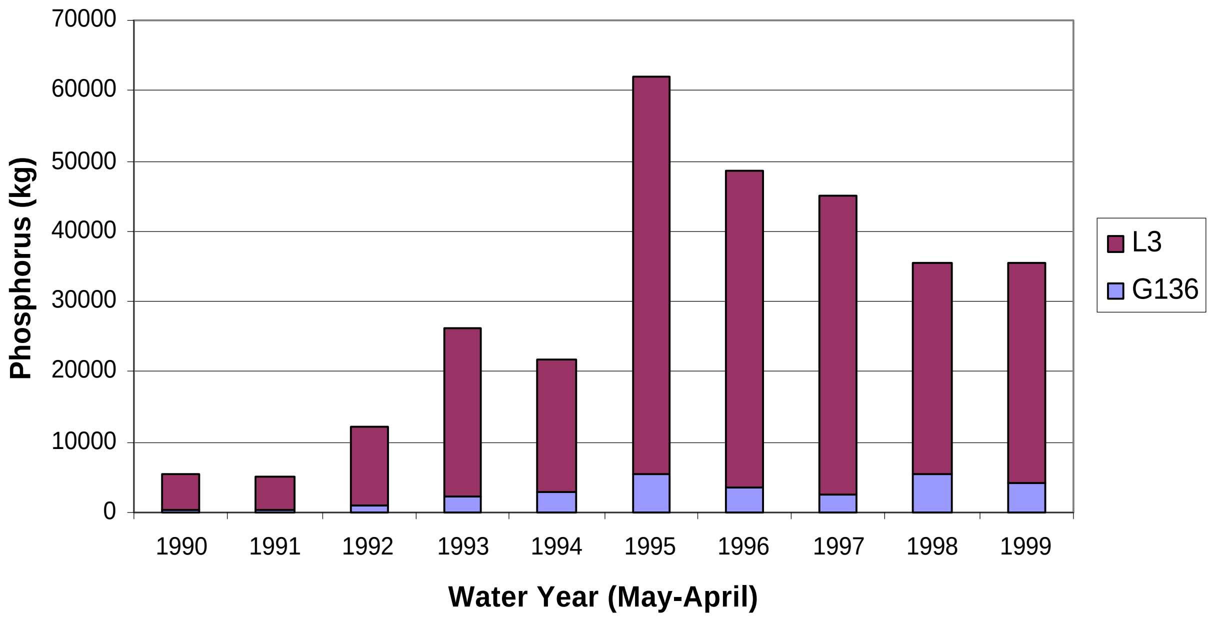
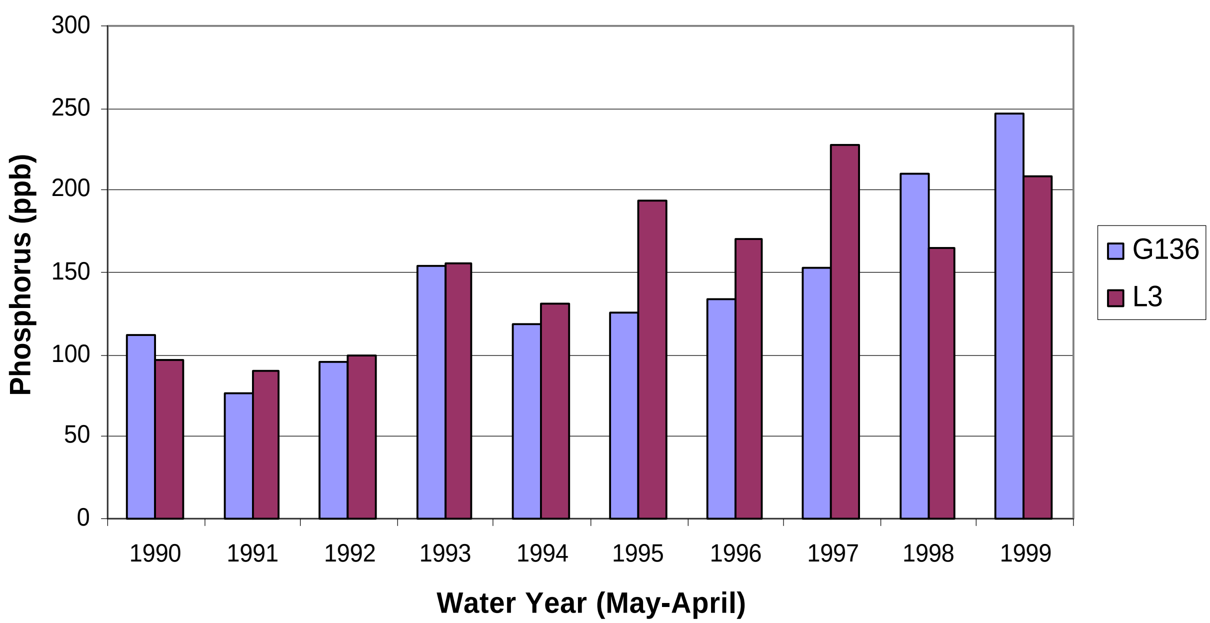


Figure 8-4. Summary of Historic Phosphorus Concentrations - C-139 Basin



Using data from the spreadsheet "c139_final_flows&loads.xls", a seasonal (wet season/dry season) regression equation was developed for the L3 portion of the data for Water Years 90-99. The 31-year set of daily phosphorus values for L3 was then developed using two different procedures – one for the period January 1965 to September 1978, and one for the period October 1978 to December 1995. For the period January 1965 to September 1978, the seasonal regression equation was applied to the SFWMM daily flows for L3 to develop daily phosphorus values. For the period October 1978 to December 1995, the L3 daily flows and loads from the spreadsheet "c139_final_flows&loads.xls" were multiplied by 65% to reflect the design assumption that STA-5 would capture and treat 65% of the C-139 Basin runoff (Burns & McDonnell, 1997). The remaining 35% was assumed to be treated by STA-6 Section 2. The daily phosphorus values for L3 were used unaltered from the "c139_final_flows&loads.xls" spreadsheet.

A summary of simulated inflows for STA-5 for the 31-year period (1965-1995) is presented in Table 8-2 and Figure 8-5. In addition to the simulated inflows, BASERR1 predicted a bypass volume in 1995 (the year with the highest flow during the 31-year simulation period) of 3,040 acre-feet. This equates to an average annual bypass volume of 98 acre-feet and represents only 0.1% of the average annual inflow to STA-5. It is anticipated that the bypass volume would be sent to STA-6 Section 2 for treatment if sufficient capacity is available.

For STA-5, two different procedures were used to develop the daily outflow values for two portions of the 31-year period. For the period January 1965 to September 1978, the SFWMM simulated daily outflows were used unaltered. For the period October 1978 to December 1995, a ratio of the simulated inflows to simulated outflows was applied to the October 1978 to December 1995 portion of the daily inflow data set to develop the daily outflow data set.

The 1997 Final Design Report for STA-5 (Burns & McDonnell, 1997) assumed an average annual inflow for the period 1979-88 of 78,340 acre-feet and an average annual phosphorus concentration of 262 ppb resulting in a 50 ppb outflow concentration for the approximate 4,118 acre treatment area. The revised 31-year inflow data set (including the 1978-95 Walker data set) predicts a much lower average annual phosphorus inflow concentration (167 ppb) with an average annual inflow of 85,637 acre-feet. Using this revised inflow data, the estimated average annual outflow from the 4,118 acre STA-5 was 38 ppb. Due to anomalous large flows and loads in 1982, the 79-88 average outflow phosphorus concentration was increased to 58 ppb.

A summary of simulated outflows for STA-5 for the 31-year period (1965-1995) is presented in Table 8-3 and Figure 8-6.

Table 8-2. Summary of Baseline Flows and Phosphorus Loads - STA-5 Inflows

Calendar Year	Total Inflow (acre-feet)	Phosphorus (kg)	Phosphorus (ppb)
1965	108,566	18,832	141
1966	112,658	21,389	154
1967	103,409	18,666	146
1968	115,309	21,586	152
1969	111,646	19,339	140
1970	90,228	13,871	125
1971	85,604	14,808	140
1972	61,881	10,012	131
1973	69,096	11,872	139
1974	124,621	26,144	170
1975	128,614	24,342	153
1976	68,295	10,816	128
1977	82,051	12,867	127
1978	98,346	15,468	127
1979	110,701	20,756	152
1980	51,548	5,330	84
1981	33,207	4,273	104
1982	163,469	82,597	410
1983	99,847	25,060	203
1984	42,259	9,176	176
1985	59,881	9,364	127
1986	69,954	18,232	211
1987	55,322	16,220	238
1988	43,492	7,887	147
1989	30,119	3,697	99
1990	24,639	2,535	83
1991	61,509	7,698	101
1992	75,502	15,327	165
1993	79,764	12,377	126
1994	121,353	30,791	206
1995	171,862	35,336	167
Average	85,637	17,634	167
Minimum	24,639	2,535	83
Maximum	171,862	82,597	410

Notes:

1. A variable phosphorus concentration was applied to the C-139 basin runoff based on the daily regression analysis. For the dry season, the standard error of the estimate was 41.0 ppb; for the wet season, the standard error was 70.0 ppb.
2. The 1990-99 flow-weighted mean phosphorus concentration of 67 ppb was applied to Miami Canal Lake releases.

Table 8-3. Summary of Baseline Flows and Phosphorus Loads - STA-5 Outflows

Calendar Year	Total Outflow (acre-feet)	Phosphorus (kg)	Phosphorus (ppb)
1965	98,370	3,419	28
1966	113,815	4,145	30
1967	99,064	3,437	28
1968	118,347	4,224	29
1969	115,501	3,731	26
1970	91,871	2,749	24
1971	85,575	2,872	27
1972	58,875	1,903	26
1973	66,094	2,312	28
1974	124,020	4,917	32
1975	127,722	4,653	30
1976	64,682	2,027	25
1977	78,208	2,382	25
1978	94,640	2,983	26
1979	107,778	5,879	44
1980	50,187	4,769	77
1981	32,330	873	22
1982	159,154	18,496	94
1983	97,211	8,511	71
1984	41,143	2,396	47
1985	58,300	1,881	26
1986	68,108	3,986	47
1987	53,861	3,372	51
1988	42,344	1,912	37
1989	29,324	919	25
1990	23,989	616	21
1991	59,886	2,370	32
1992	73,509	3,310	36
1993	77,658	3,094	32
1994	118,149	6,705	46
1995	167,325	7,242	35
Average	83,776	3,938	38
Minimum	23,989	616	21
Maximum	167,325	18,496	94

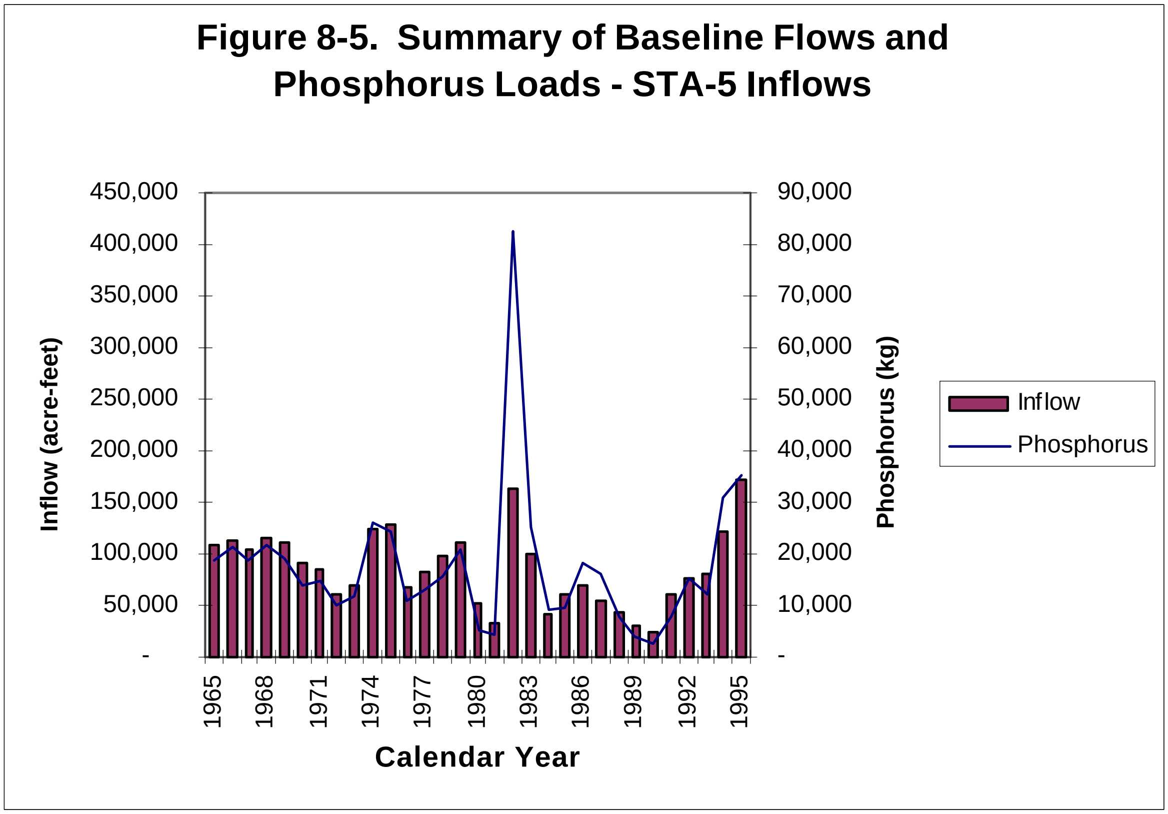


Figure 8-5. Summary of Baseline Flows and Phosphorus Loads - STA-5 Inflows
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
-
Inflow (acre-feet)
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
-
Phosphorus (kg)
Inflow
Phosphorus
1965
1968
1971
1974
1977
1980
1983
1986
1989
1992
1995
Calendar Year

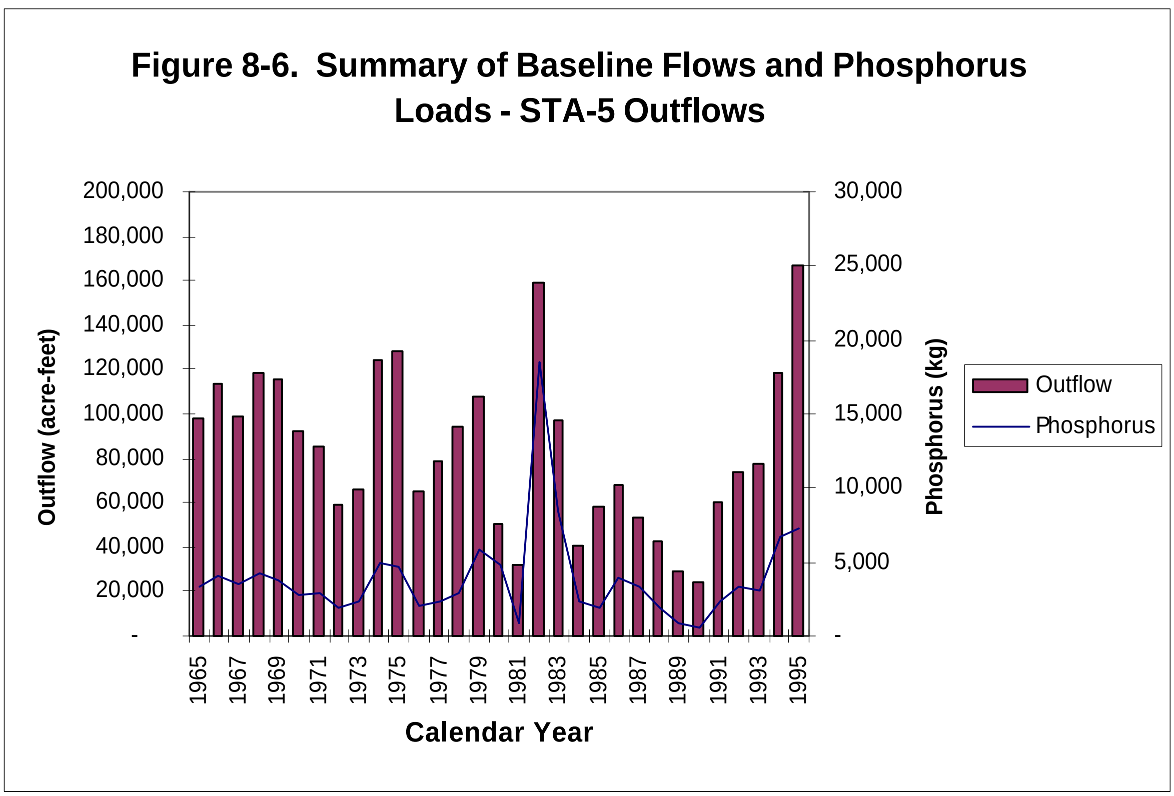


Figure 8-6. Summary of Baseline Flows and Phosphorus Loads - STA-5 Outflows
200,000
180,000
160,000
140,000
120,000
100,000
80,000
60,000
40,000
20,000
-
Outflow (acre-feet)
30,000
25,000
20,000
15,000
10,000
5,000
-
Phosphorus (kg)
Outflow
Phosphorus
1965
1967
1969
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
Calendar Year

SECTION 9. STA-6

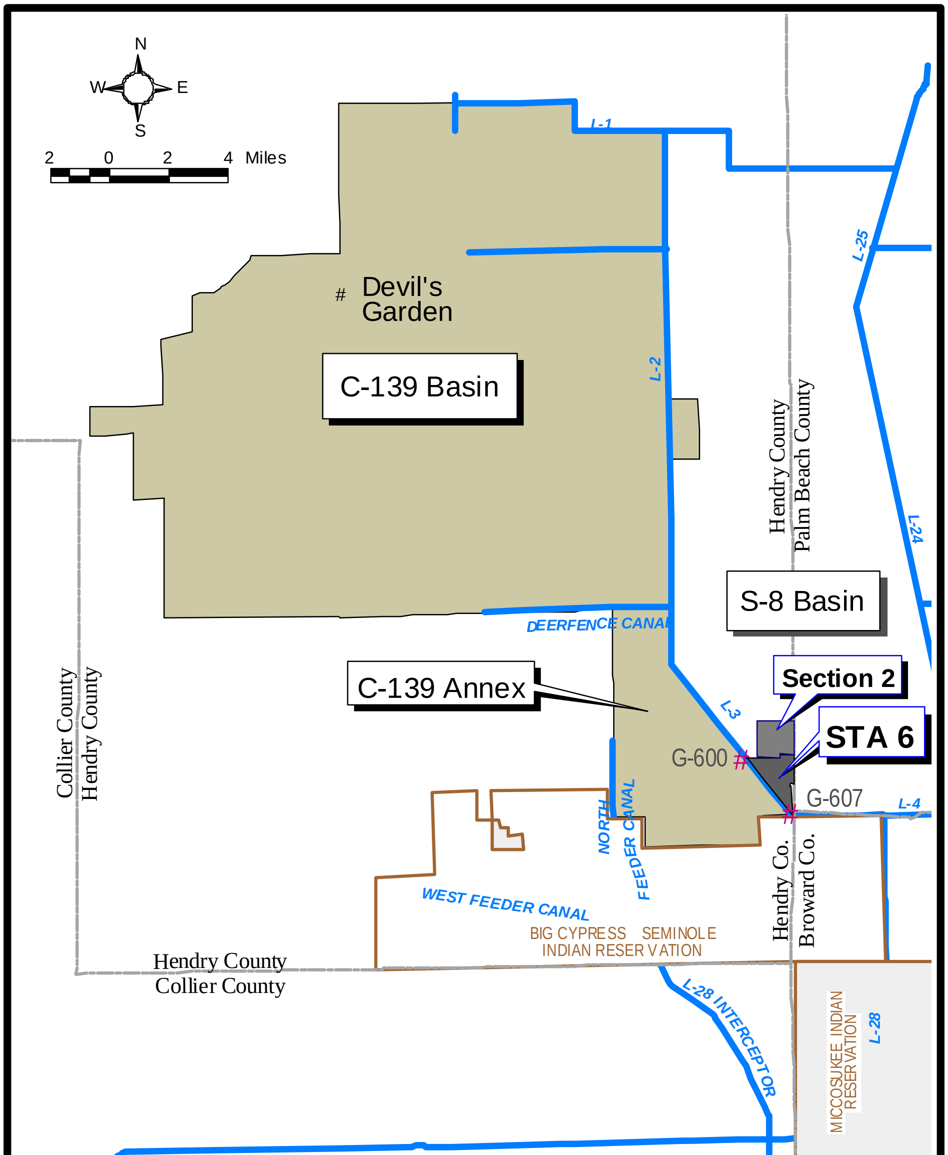
The basins tributary to STA-6 are presented in Figure 9-1. STA-6 Section 1 treats stormwater flows from approximately 10,000 acres north of the treatment area and south of STA-5 and west of the Rotenberger Wildlife Management Area. In the near future, STA-6 will be expanded to include approximately 1,400 additional acres for treatment of C-139 Basin and C-139 Annex flows.

Because STA-6 Section 1 has been operating less than two years, limited historic data were used in this analysis. A summary of the available data for the G-600 inflow pump station ("preferred" DBKEY GG955) and G-607 discharge location (G-606 monitoring location "preferred" DBKEY HD889) is presented in Table 9-1.

Historic flow and water quality data for the period December 1997-April 1999 are presented in Figures 9-2 through 9-4 and in Appendix 9-1.

Table 9-1. Summary of Historic Flow and Phosphorus Data – STA-6 Section 1

	Inflow	**Outflow**
Flow (Period of record: December 1997 – April 1999)		
Average annual (acre-feet)	46,744	33,896
Phosphorus (Period of record: December 1997– April 1999)		
Minimum annual flow-weighted (ppb)	61	22
Flow-weighted average (ppb)	57	19
Maximum annual flow-weighted (ppb)	61	22



Tributary Basin Map - STA 6

Figure 9-1

ERRD/ESP CMIESSAU 20-JAN-2000 ecp-sta6.apr ecp-sta6-L

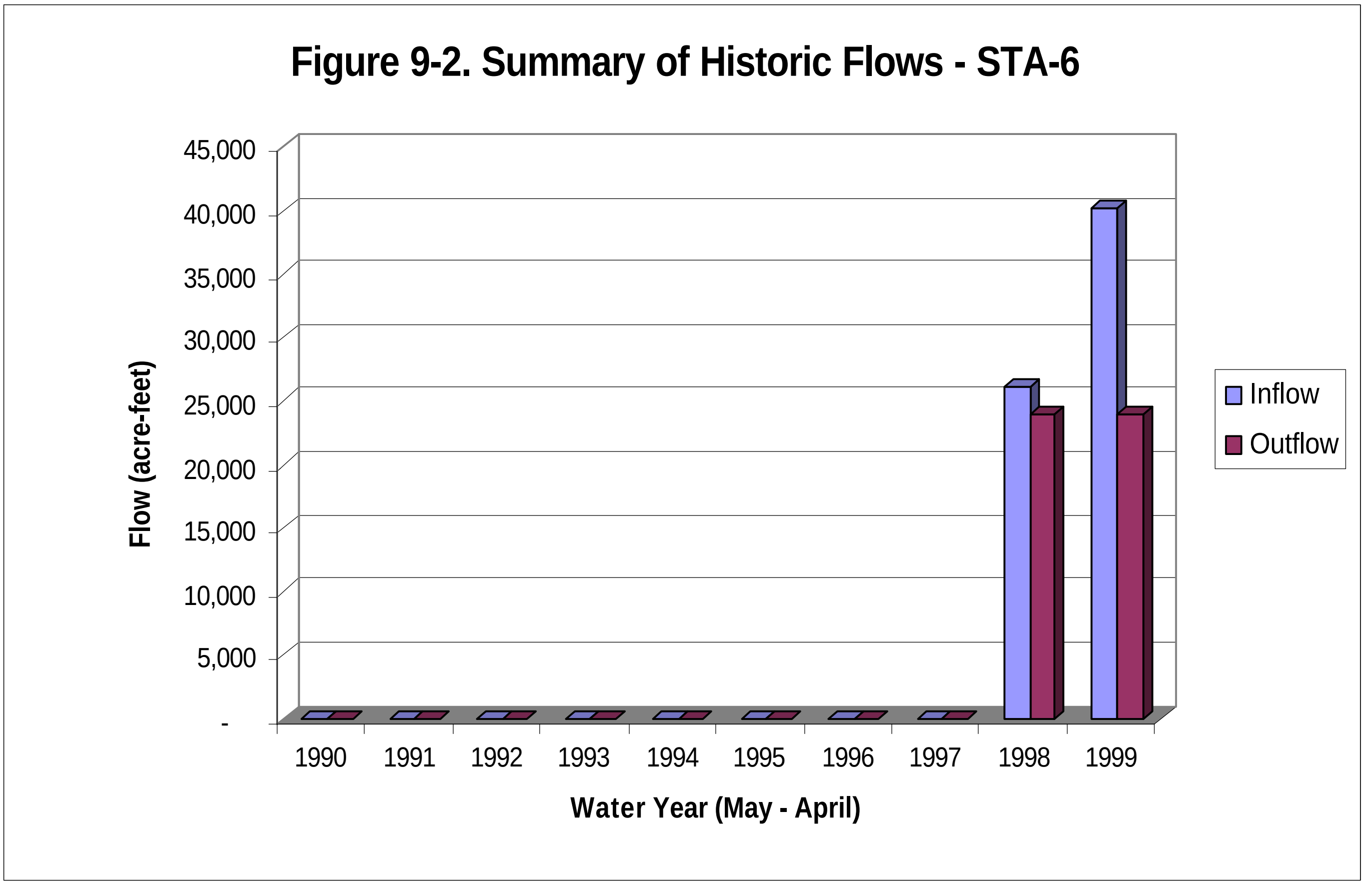


Figure 9-2. Summary of Historic Flows - STA-6
Flow (acre-feet)
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
-
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
Water Year (May - April)
Inflow
Outflow

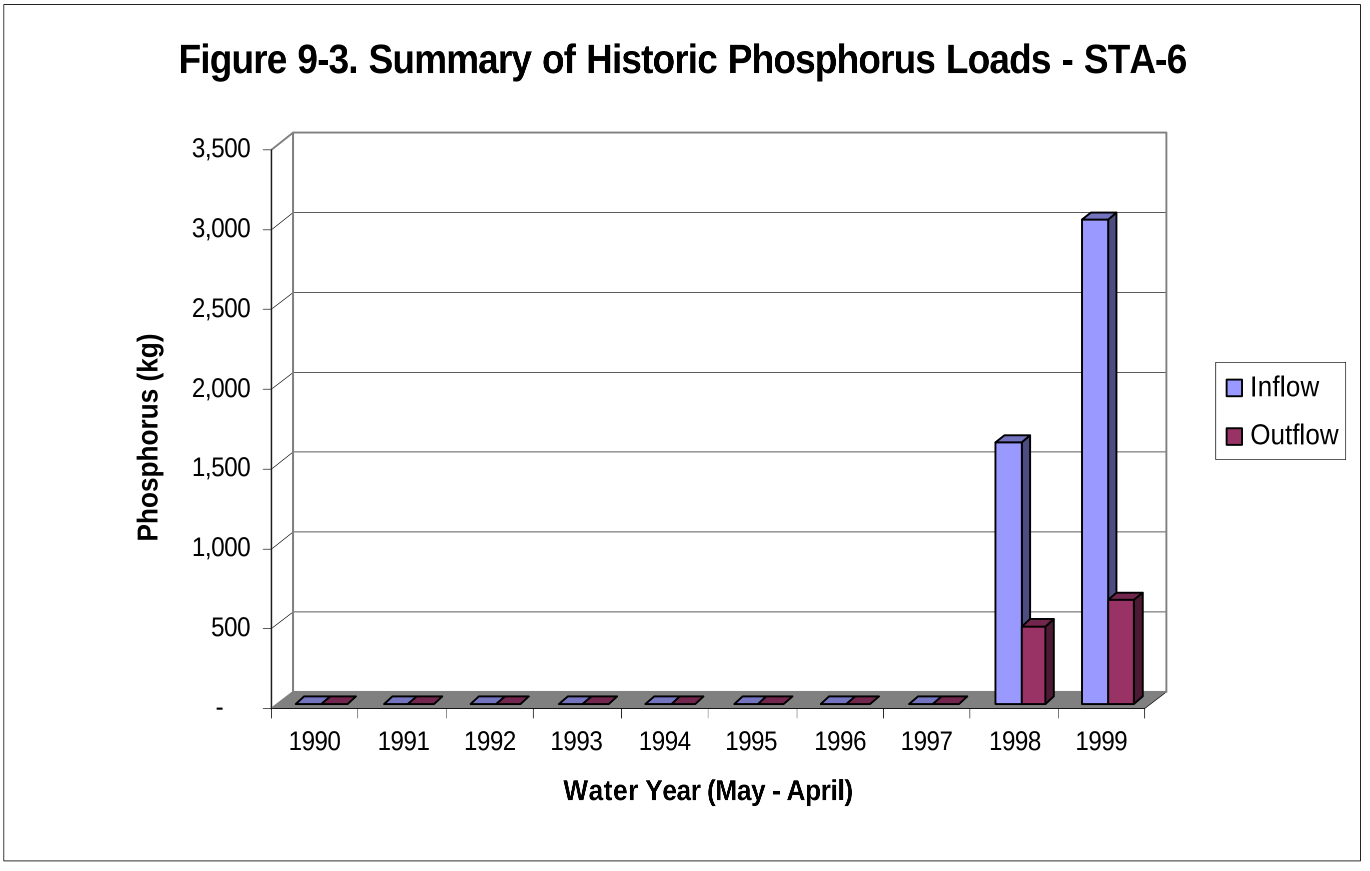
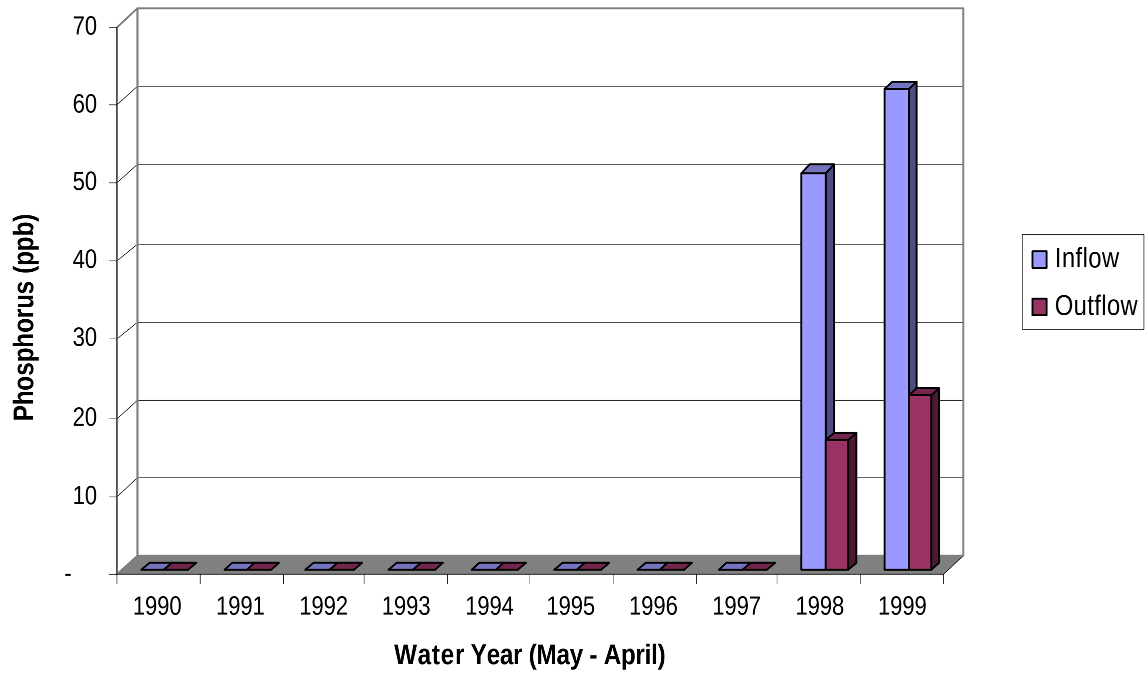


Figure 9-3. Summary of Historic Phosphorus Loads - STA-6
Phosphorus (kg)
3,500
3,000
2,500
2,000
1,500
1,000
500
-
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
Water Year (May - April)
Inflow
Outflow

Figure 9-4. Summary of Historic Phosphorus Concentrations - STA-6



Although the historic data set summary includes STA-6 Section 1 only, for the purpose of long-term water quality planning, the 31-year inflow and outflow data sets include both Sections 1 and 2 of STA-6. The BASERR1 simulation used to develop the revised data sets also included Sections 1 and 2 of STA-6.

Seasonal (wet season/dry season) regression equations were applied to the STA-6 daily simulated flows to develop a 31-year set of daily phosphorus values. For the C-139 Runoff portion of the STA-6 inflows, the regression equation developed using the Water Years 90-99 L3 data from "c139_final_flows&loads.xls" was applied to the simulated L3 flows for the period January 1965 to September 1978 to develop the daily phosphorus values for this time period. For the period October 1978 to December 1995, the flow and load values from "c139_final_flows&loads.xls" were multiplied by 35% and used to populate the daily values for this time period. For the L3 flows, the standard error of the estimate was 41.0 ppb for the dry season, and the standard error of the estimate was 70.0 ppb for the wet season. For the USSC flows, a seasonal regression equation was also applied to the daily simulated flows to develop the 31-year set of daily phosphorus values. For the USSC flows, the standard error of the estimate was 19.8 ppb for the dry season, and the standard error of the estimate was 10.0 ppb for the wet season.

A summary of simulated inflows to STA-6 for the 31-year period (1965-1995) is presented in Table 9-2 and Figure 9-5.

The STA-6 simulated outflows were developed using an STA-6 average outflow concentration of 47.25 ppb. This concentration was developed by analyzing the outflow average outflow concentrations for Sections 1 and 2 separately according to the values shown in the following table:

Design Parameter	Section 1	Section 2
Effective Treatment Area (acres)	870	1419 [2]
% of total area	38	62
Ke (Settling Rate) (m/year)	15.95 [1]	10.2
Q (Flow) (acre-feet/year)	31,737	51,781
Phosphorus Load (MT/year)	5.09	8.32
Outflow TP Concentration (ppb)	33.8 [3]	55.5 [3]
Average TP Concentration = 47.25 ppb		

1 Settling rate derived from the assumption that the 79-88 flows and loads would result in average annual outflow concentration of 25 ppb based on exceptional performance to date.
2 Area calculated by Burns & McDonnell based on 79-88 flows and settling rate of 10.2 m/yr.
3 Predicted outflow concentration using 31 year simulated flows and loads and first order STA design model.

In addition to the simulated inflows, BASERR1 predicted an average annual bypass volume of 5,511 acre-feet for STA-6. This volume represents 6% of the average annual inflow to STA-6. Further refinement of the manner in which C-139 Basin discharges are routed to STA-5 and STA-6 in the SFWMM is needed. This will be corrected in a future simulation prior to evaluation of alternatives.

A summary of simulated outflows for STA-6 for the 31-year period (1965-1995) is presented in Table 9-3 and Figure 9-6.

Table 9-2. Summary of Baseline Flows and Phosphorus Loads - STA-6 Inflows

Calendar Year	Total Inflow (acre-feet)	Phosphorus (kg)	Phosphorus (ppb)
1965	92,810	11,750	103
1966	104,617	13,131	102
1967	92,158	11,299	99
1968	108,798	13,680	102
1969	109,044	13,895	103
1970	92,510	12,737	112
1971	81,105	9,501	95
1972	58,073	7,659	107
1973	64,542	7,440	93
1974	106,350	14,240	109
1975	111,076	13,870	101
1976	68,091	7,389	88
1977	83,093	9,567	93
1978	95,446	10,844	92
1979	88,841	13,302	121
1980	47,109	5,280	91
1981	37,971	3,754	80
1982	116,742	46,542	323
1983	85,132	16,217	154
1984	41,591	6,326	123
1985	69,139	7,981	94
1986	72,256	12,333	138
1987	55,518	10,719	157
1988	45,350	5,739	103
1989	41,913	3,766	73
1990	29,850	2,543	69
1991	87,969	14,407	133
1992	78,975	13,018	134
1993	73,094	9,456	105
1994	115,468	22,577	159
1995	141,851	22,604	129
Average	80,532	12,050	121
Minimum	29,850	2,543	69
Maximum	141,851	46,542	323

Table 9-3. Summary of Baseline Flows and Phosphorus Loads - STA-6 Outflows

Calendar Year	Total Outflow (acre-feet)	Phosphorus (kg)	Phosphorus (ppb)
1965	81,113	2,859	29
1966	100,537	3,508	28
1967	84,921	2,929	28
1968	105,105	3,670	28
1969	104,997	3,697	29
1970	91,019	3,457	31
1971	73,373	2,449	27
1972	52,223	1,884	29
1973	58,845	1,909	26
1974	100,037	3,720	30
1975	103,912	3,654	29
1976	63,698	1,918	24
1977	80,596	2,542	26
1978	90,187	2,916	26
1979	63,364	3,522	45
1980	33,441	1,326	32
1981	35,128	813	19
1982	75,789	11,316	121
1983	61,414	4,329	57
1984	41,257	1,604	32
1985	76,515	2,064	22
1986	71,981	3,246	37
1987	52,362	2,833	44
1988	40,481	1,448	29
1989	46,192	872	15
1990	32,549	548	14
1991	84,778	3,331	32
1992	74,598	3,211	35
1993	69,841	2,438	28
1994	116,944	6,093	42
1995	155,643	6,106	32
Average	74,930	3,104	34
Minimum	32,549	548	14
Maximum	155,643	11,316	121

Figure 9-5. Summary of Baseline Flows and Phosphorus Loads - STA-6 Inflows

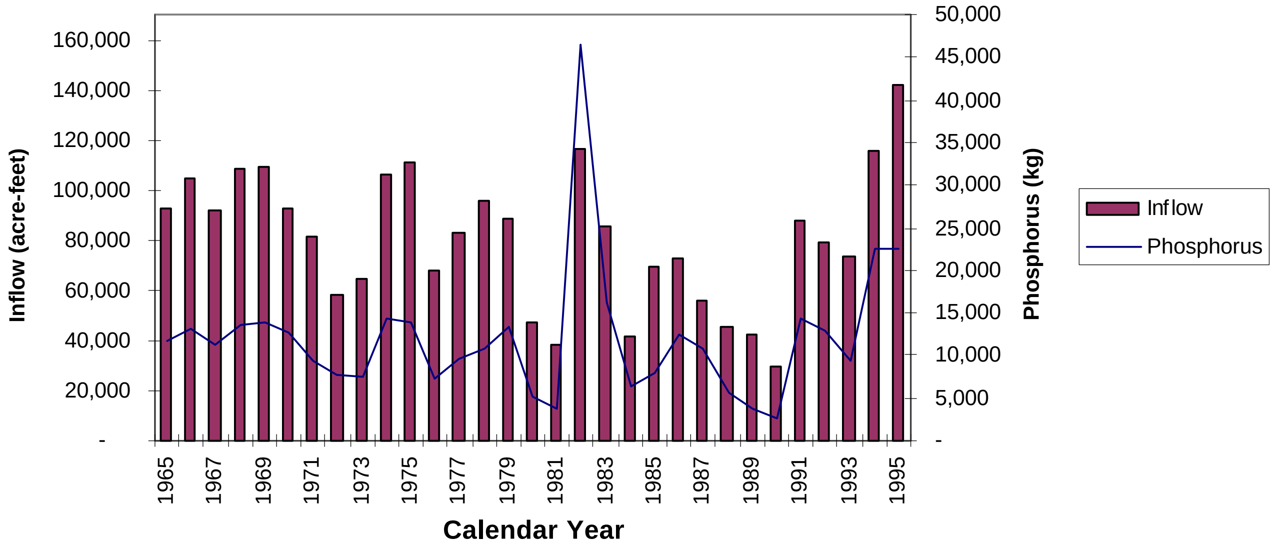
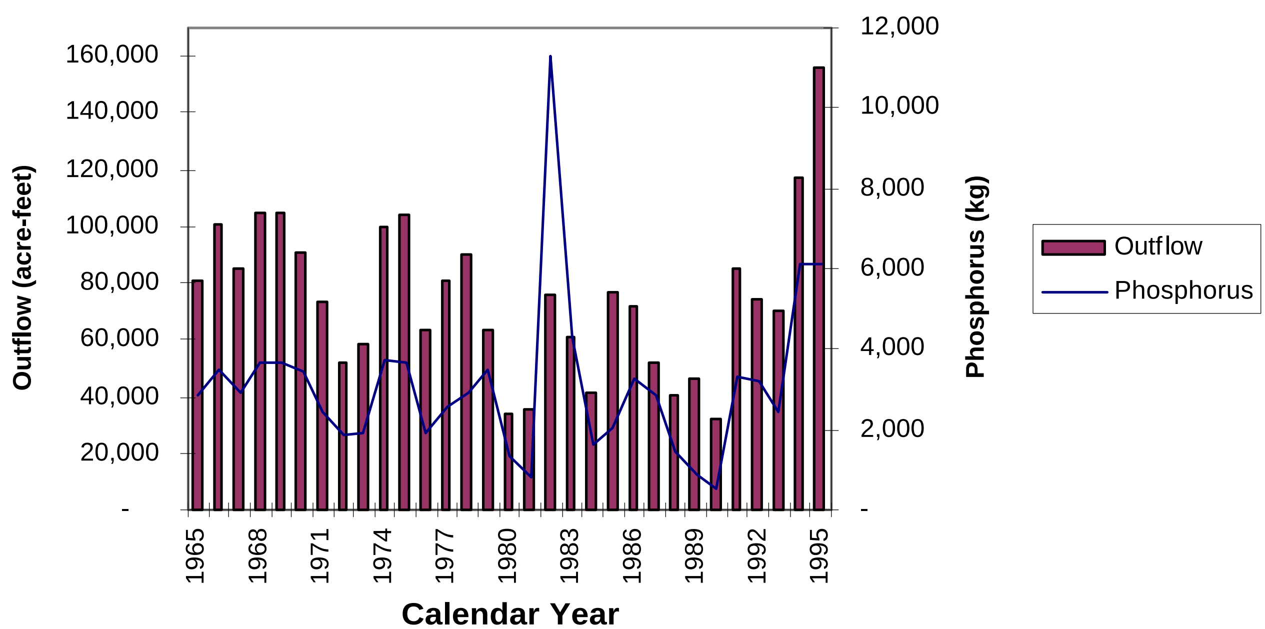


Figure 9-6. Summary of Baseline Flows and Phosphorus Loads - STA-6 Outflows



SECTION 10. ACME BASIN B

Acme Basin B has an area of 8,680 acres and is located in Palm Beach County. A map of Acme Basin B is presented in Figure 10-1 and a schematic is presented in Appendix 1-7. Surface water management is by means of canals, lakes, and discharge pump stations. There are two pump stations regulating discharges from the basin: Pump Station #1 and Pump Station #2. These pump stations discharge through the ACME1DS and G-94D culverts into the L-40 borrow canal within WCA 1. ACME1DS is immediately downstream of Pump Station #1 and G-94D is immediately downstream of Pump Station #2. Note that prior to February 1997, ACME1DS was named L40-1 and G-94D was named L40-2.

Historic flow and water quality data from the following structures were compiled to generate the baseline data set:

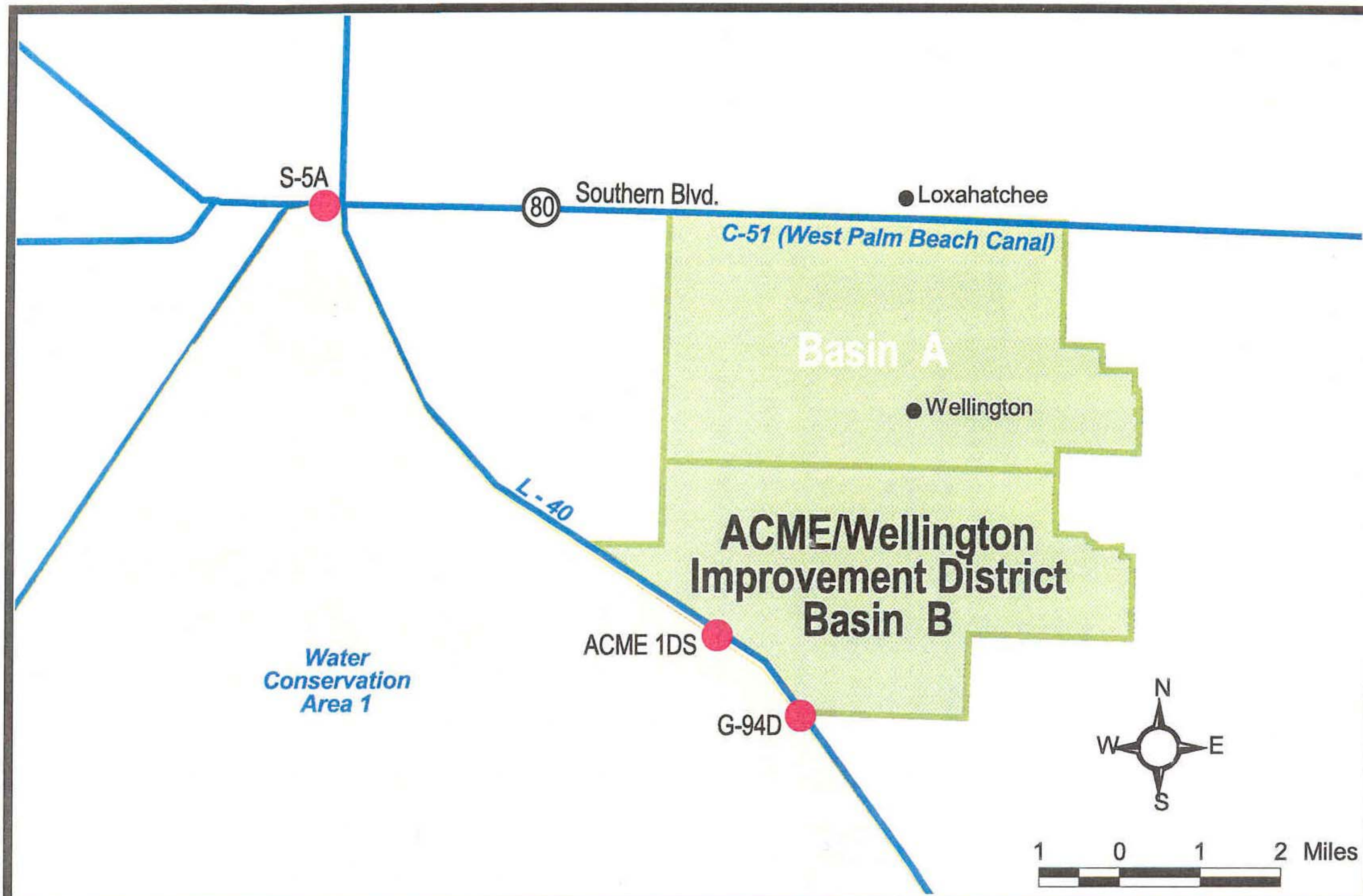
Pump Station #1 (DBKEY 15022 – historic flow data)
Pump Station #2 (DBKEY 15023 – historic flow data)
L40-1 and ACME1DS – historic water quality data
L40-2 and G-94D – historic water quality data

Subsequent to the production of the May 2000 Baseline Data report, it was brought to our attention that there were some problems with the Acme Basin B historic flow data which was used to prepare the report. This data, which is collected and reported by Acme, then entered into DBHYDRO by District staff, contained some miscalculated pump flows during the years 1994 through 1997. In early 2001, the pump flow data was corrected, re-entered into DBHYDRO, then re-extracted for use in this May 2001 revised report.

Historic flow and phosphorus data (Water Years 1990 – 1999) for these structures for the period of record is presented in Appendix 10-1. A summary of the historic data is presented in Table 10-1 and Figures 10-2 through 10-4.

Table 10-1. Summary of Historic Flow and Phosphorus Data - Acme Basin B (May to April Water Years)

Flow (Period of record: May 1989 - April 1999)	
Minimum annual (acre-feet)	5,397
Average annual (acre-feet)	38,654
Maximum annual (acre-feet)	66,149
Phosphorus (Period of record: May 1989 - April 1999)	
Minimum annual (ppb)	47
Average annual (ppb)	94
Maximum annual (ppb)	176



Tributary Basin Map - Acme Basin B
Figure 10-1

ERRD/ESP CMIESSAU REV. 03-DEC-1999 ecp-acme.apr ecp-acme-L

Figure 10-2. Summary of Historic Flows - Acme Basin B

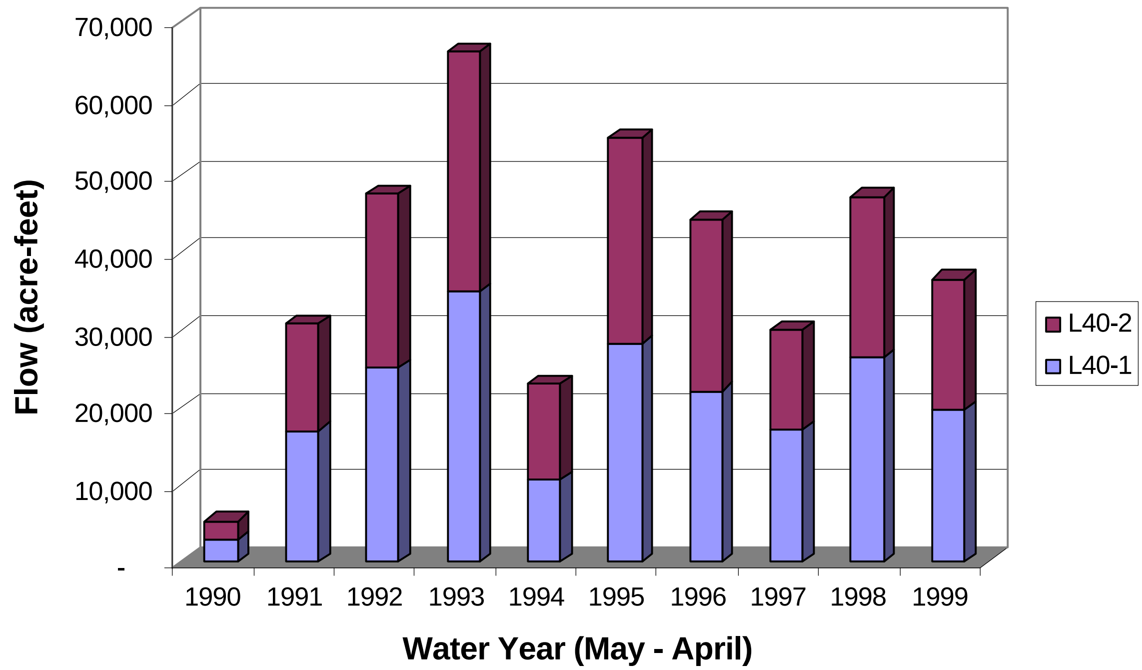
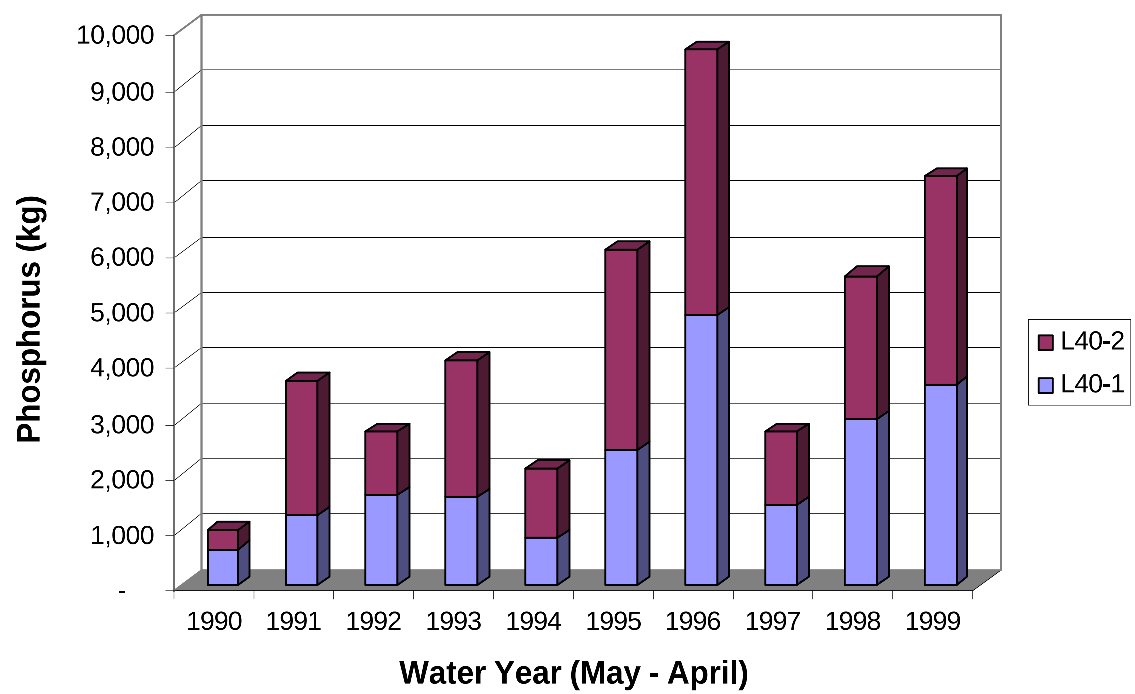


Figure 10-3. Summary of Historic Phosphorus Loads - Acme Basin B



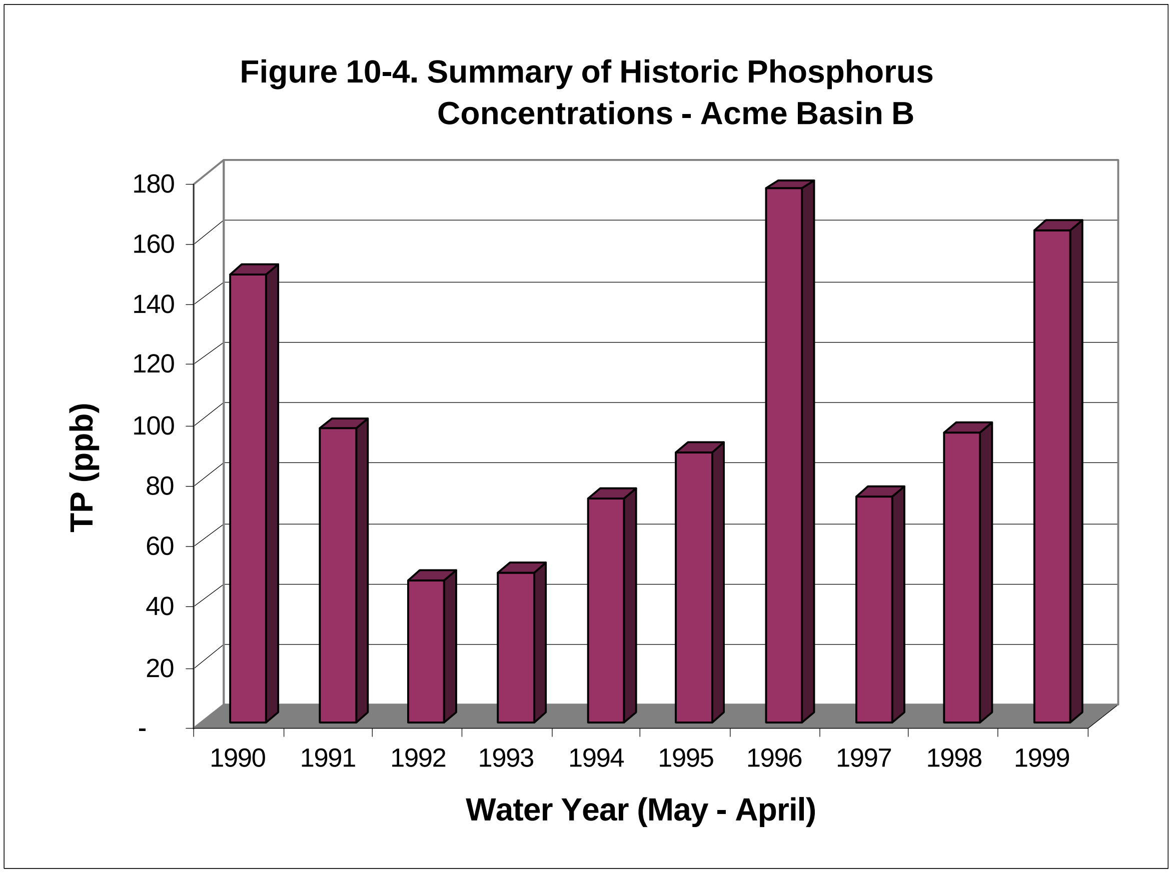


Figure 10-4. Summary of Historic Phosphorus Concentrations - Acme Basin B
TP (ppb)
180
160
140
120
100
80
60
40
20
-
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
Water Year (May - April)

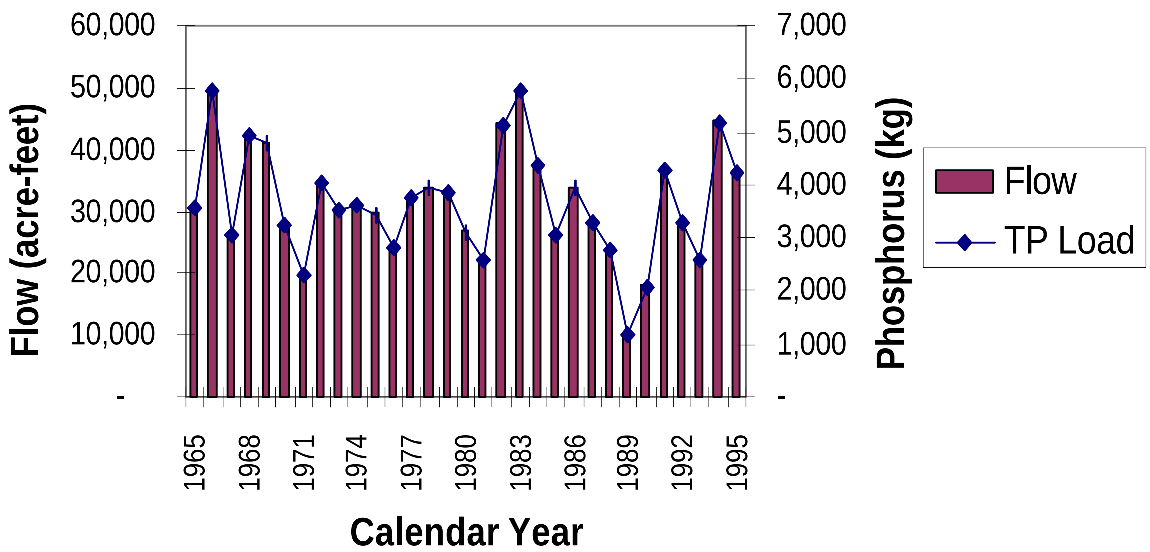
A summary of the combined baseline data set is presented in Table 10-2 and Figure 10-5. The flow-weighted average annual phosphorus concentration of 94 ppb was selected for use in the combined baseline data set.

Table 10-2. Summary of Baseline Flows and Phosphorus Loads - Acme Basin B

Calendar Year	Simulated Flow acre feet	TP Load kg	Calendar Year	Simulated Flow acre feet	TP Load kg
1965	30,876	3,588	1980	26,840	3,119
1966	49,798	5,786	1981	22,203	2,580
1967	26,463	3,075	1982	44,182	5,134
1968	42,296	4,915	1983	49,633	5,767
1969	41,067	4,772	1984	37,456	4,352
1970	27,770	3,227	1985	26,463	3,075
1971	19,921	2,315	1986	33,768	3,924
1972	34,929	4,059	1987	28,270	3,285
1973	30,197	3,509	1988	23,742	2,759
1974	30,989	3,601	1989	9,910	1,151
1975	29,662	3,447	1990	17,979	2,089
1976	24,116	2,802	1991	36,966	4,295
1977	32,398	3,764	1992	28,311	3,290
1978	33,766	3,923	1993	22,065	2,564
1979	33,324	3,872	1994	44,659	5,189
			1995	36,446	4,235
Mean	31,499	3,660			
Minimum	9,910	1,151			
Maximum	49,798	5,786			

Flow weighted mean TP conc. (ppb) = 94

Figure 10-5. Summary of Baseline Flows and Phosphorus Loads - Acme Basin B



SECTION 11. NORTH SPRINGS IMPROVEMENT DISTRICT BASIN

The North Springs Improvement District (NSID) Basin has an area of 7,422 acres and is located in western Broward County. A map of the North Springs Improvement District (NSID) Basin is presented in Figure 11-1 and a schematic is presented in Appendix 1-8. The NSID Basin is a hydrologic tributary basin to the Everglades Protection Area by virtue of the capability to pump excess runoff from the basin to Water Conservation Area 2A. The NSID operates two pump stations to remove excess runoff from the basin for flood control purposes. Excess runoff from the basin can be pumped to either the L-36N canal, the L-36S canal, or WCA 2A by way of Pump Station No. 1, or to the L-36N canal by way of Pump Station No. 2.

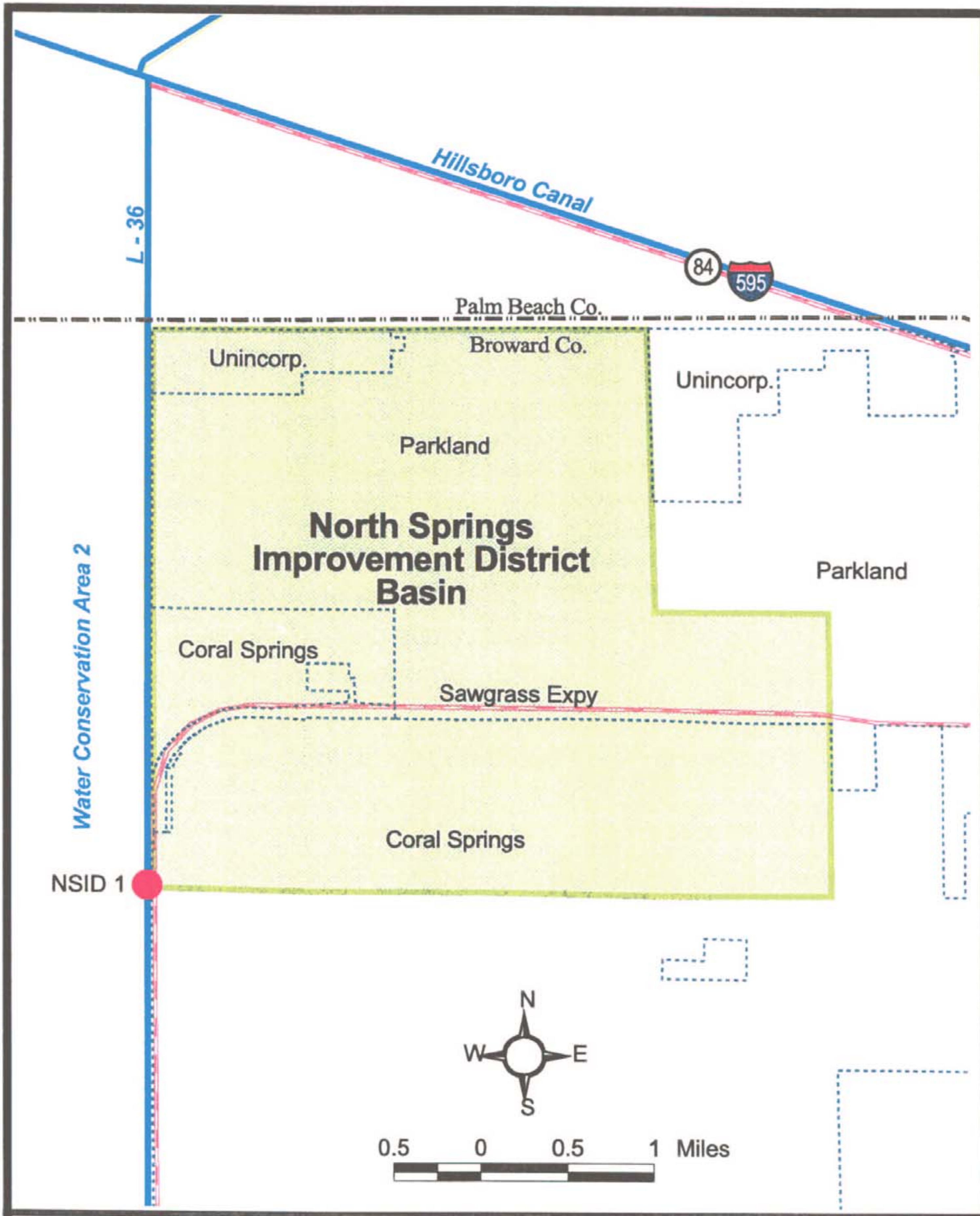
Historic flow and water quality data from the following structures and stations were compiled to generate the baseline data set:

NSID pump 1 - NSPRNG_C2A (DBKEY 15121) – historic flow data
NSPRNG_IN – historic water quality data
NSPRNG_HC (DBKEY 15119) – historic flow (for regression analysis)
NSPRNG_C14 (DBKEY 15120) – historic flow (for regression analysis)

Historic flow and phosphorus data (Water Years 1990 – 1999) for these structures for the period of record is presented in Appendix 11-1. A summary of the historic data is presented in Table 11-1 and Figures 11-2 through 11-4.

Table 11-1. Summary of Historic Flow and Phosphorus Data - NSID Basin (May to April Water Years)

Flow (Period of record: May 1989 - April 1999)	
Minimum annual (acre-feet)	239
Average annual (acre-feet)	6,757
Maximum annual (acre-feet)	12,059
Phosphorus (Period of record: May 1989 - April 1999)	
Minimum annual (ppb)	13
Average annual (ppb)	39
Maximum annual (ppb)	74



Tributary Basin Map - North Springs Improvement District Basin
Figure 11-1

ERRD/ESP CMIESSAU REV. 03-DEC-1999 ecp-nsid.apr ecp-nsid-L

Figure 11-2. Summary of Historic Flows - NSID Basin

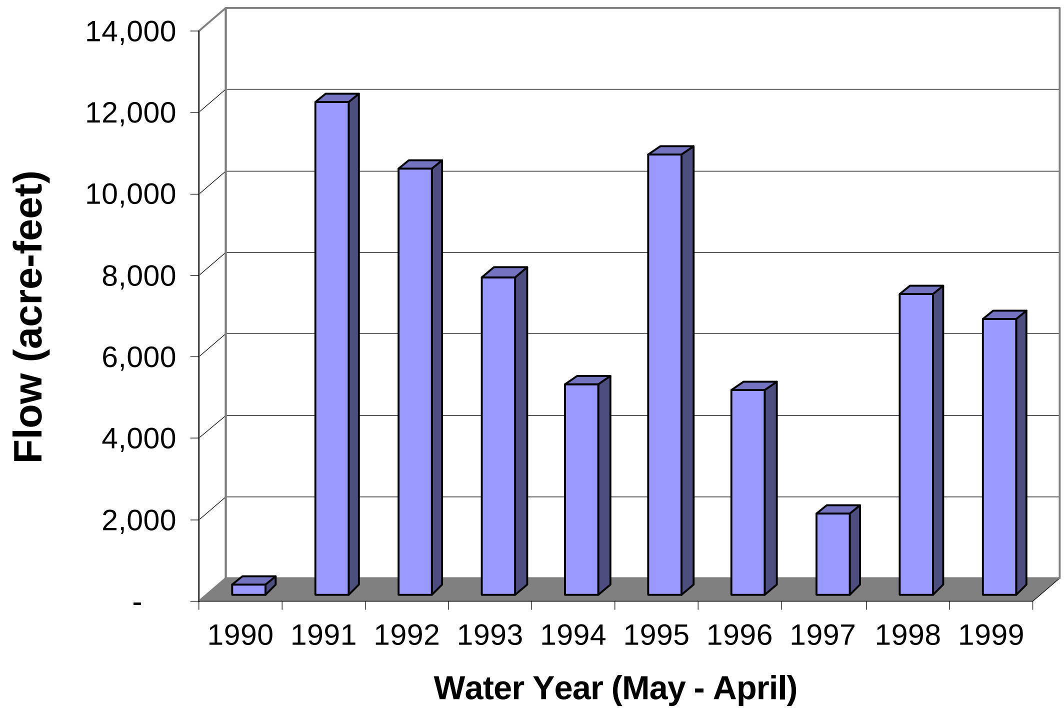
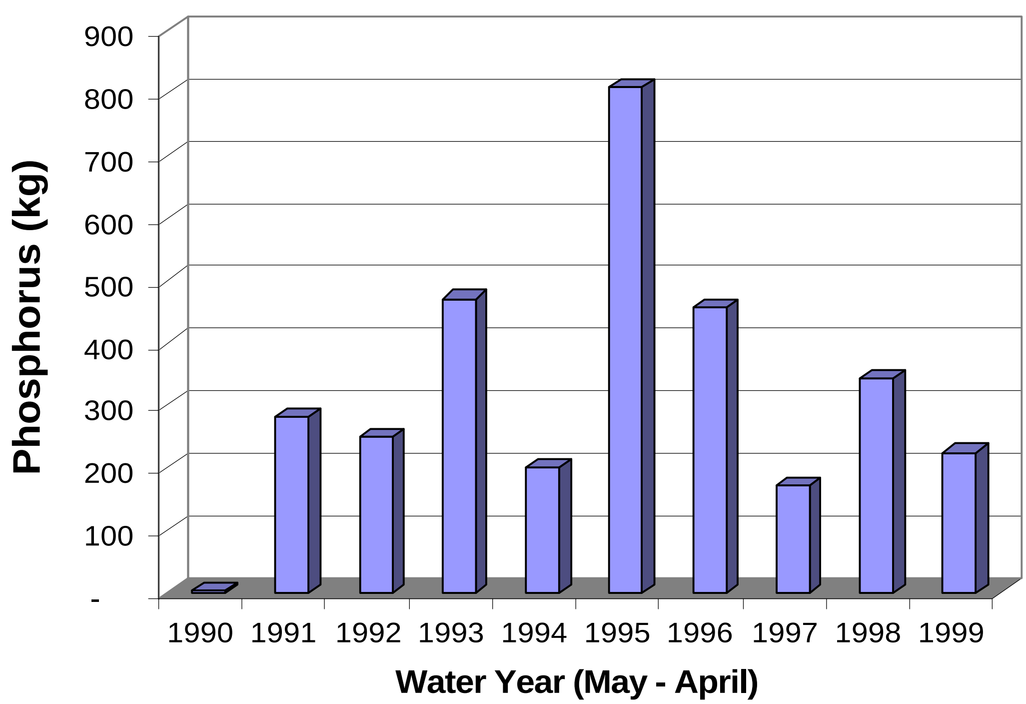


Figure 11-3. Summary of Historic Phosphorus Loads - NSID Basin



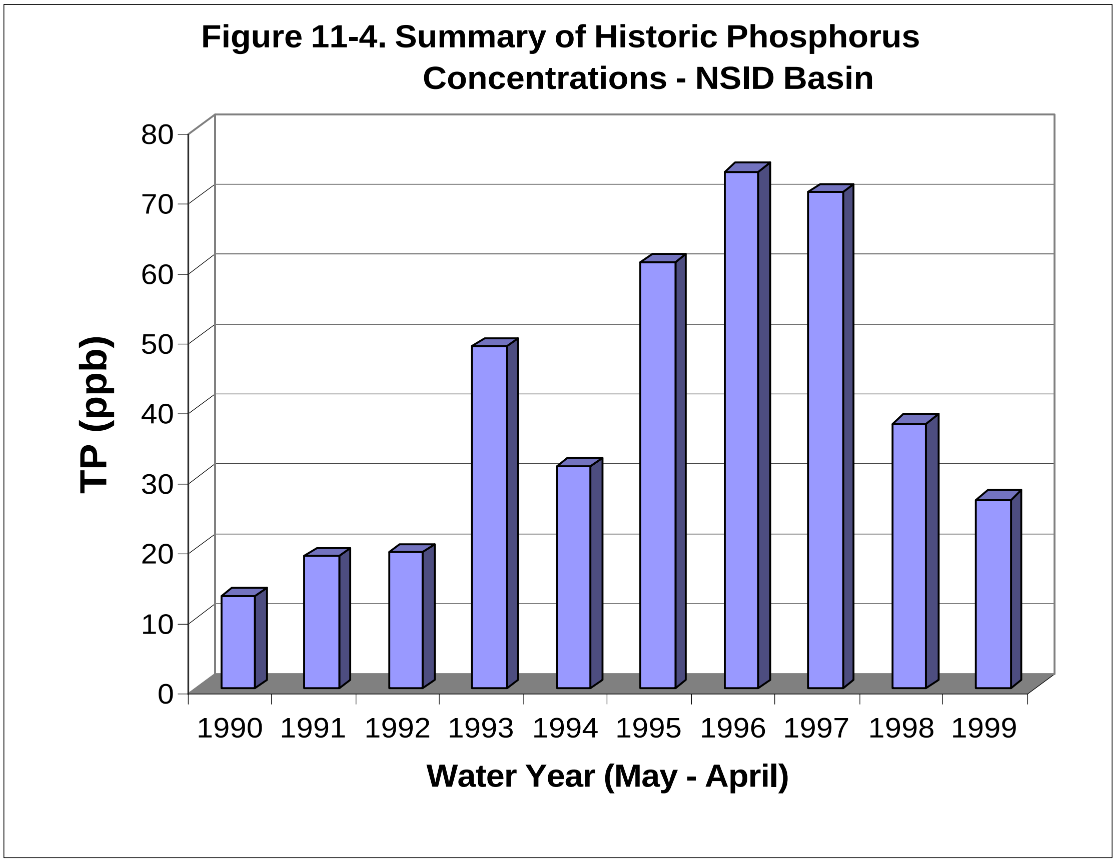


Figure 11-4. Summary of Historic Phosphorus Concentrations - NSID Basin
TP (ppb)
80
70
60
50
40
30
20
10
0
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
Water Year (May - April)

A summary of the simulated flows and phosphorus loads from the 31-year period (1965-1995) is presented in Table 11-2.

BASERR1, the simulation used to develop this May 2001 document, revised the manner in which NSID Basin runoff was simulated. The ALT1 NSID Basin flows required scaling in order to bring them more in line with the historic flow data. With BASERR1, the simulated flows from NSID to WCA-3A (average annual 6,168 acre-feet) were much closer to the historic flow data (average annual 6,757 acre-feet); therefore scaling was not required to develop the NSID baseline daily flow data set.

A summary of the combined baseline data set is presented in Table 11-2 and Figure 11-5. The flow-weighted average annual phosphorus concentration of 39 ppb was selected for use in the combined baseline data set.

Table 11-2. Summary of Baseline Flows and Phosphorus Loads - NSID Basin

Calendar Year	Simulated Flow acre-feet	TP Load kg	Calendar Year	Simulated Flow acre-feet	TP Load kg
1965	8,742	416	1980	4,332	206
1966	15,635	744	1981	11,873	565
1967	5,630	268	1982	14,611	695
1968	13,904	661	1983	11,303	538
1969	8,613	410	1984	2,038	97
1970	1,703	81	1985	8,397	399
1971	1,600	76	1986	3,999	190
1972	1,996	95	1987	4,386	209
1973	6,911	329	1988	4,686	223
1974	3,225	153	1989	277	13
1975	2,316	110	1990	4,381	208
1976	3,550	169	1991	5,110	243
1977	2,383	113	1992	5,697	271
1978	1,931	92	1993	2,963	141
1979	4,436	211	1994	13,684	651
			1995	10,909	519
Mean	6,168	293			
Minimum	277	13			
Maximum	15,635	744			

Flow weighted mean TP conc. (ppb) = 39

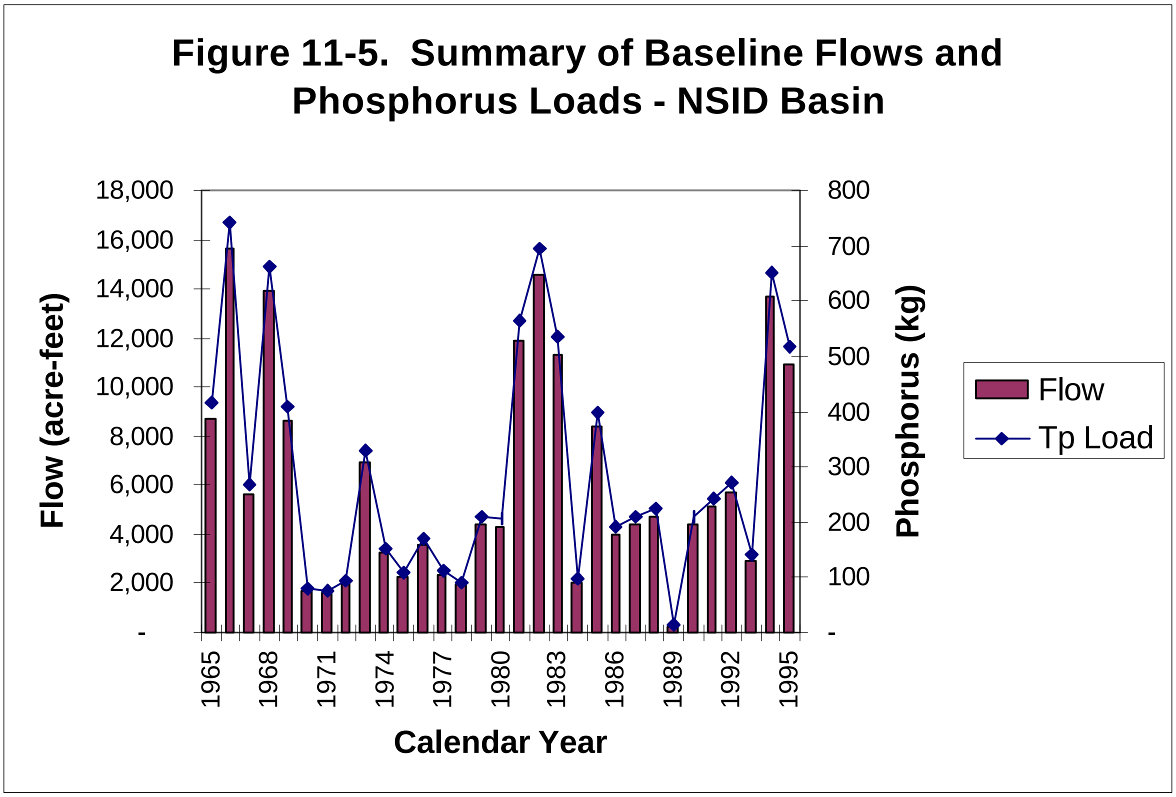


Figure 11-5. Summary of Baseline Flows and Phosphorus Loads - NSID Basin
Flow (acre-feet)
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
-
Phosphorus (kg)
800
700
600
500
400
300
200
100
-
1965
1968
1971
1974
1977
1980
1983
1986
1989
1992
1995
Calendar Year
Flow
Tp Load

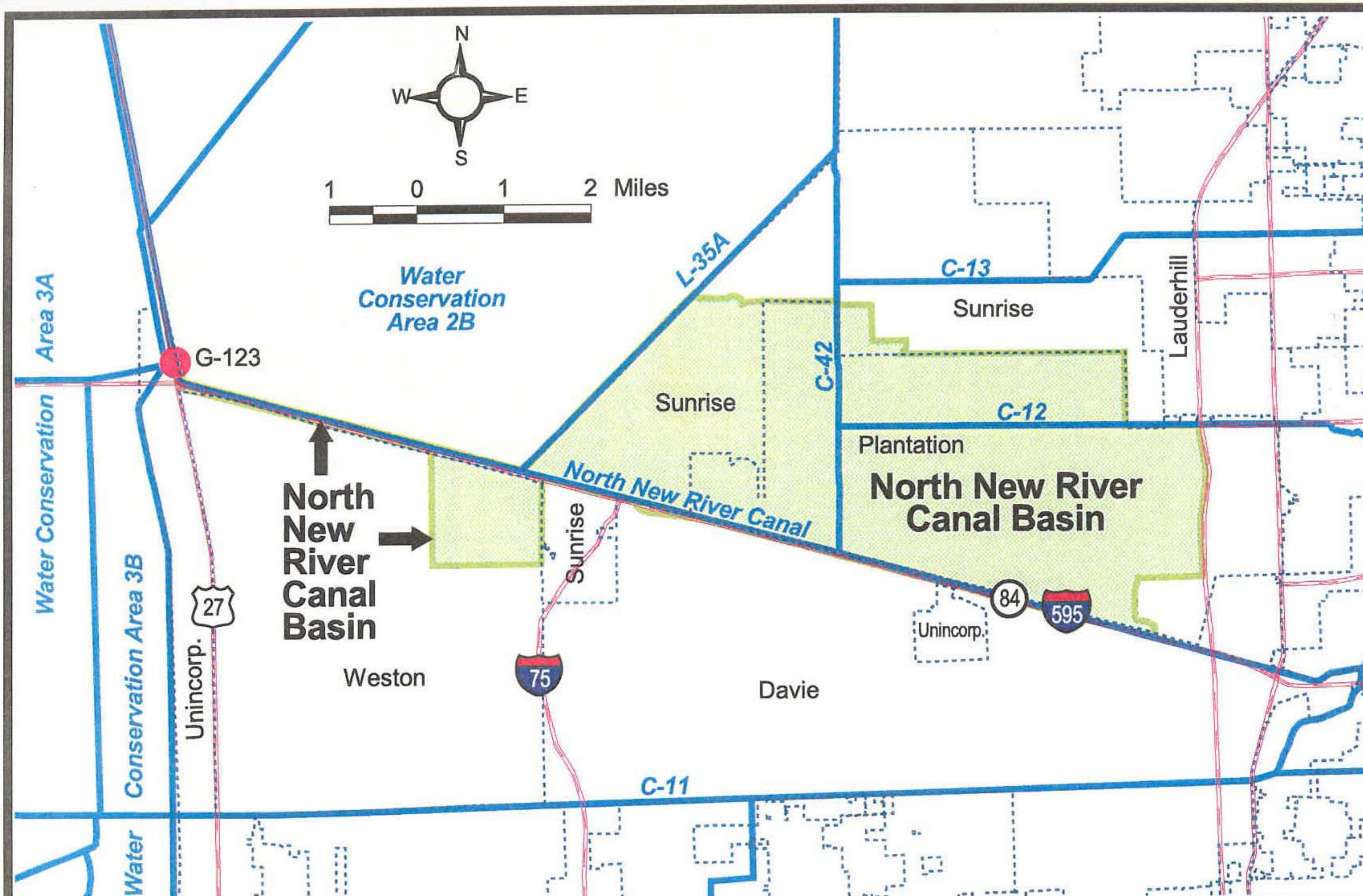
SECTION 12. NORTH NEW RIVER CANAL BASIN (INCLUDING STRUCTURE G-123)

The North New River Canal (NNRC) Basin has an area of approximately 30 square miles and is located in eastern Broward County. A map of the North New River Canal Basin, the basin tributary to G-123, is presented in Figure 12-1 and a schematic is presented in Appendix 1-9. The project canals and control structures in the NNRC basin have four functions: (1) to provide flood protection and drainage of the NNRC basin, (2) to supply water to the basin during periods of low natural flow, (3) to convey excess water from Water Conservation Areas (WCAs) 2A, 2B, and 3A to tidewater, and (4) to intercept and control seepage from WCA 2B. There are three project canals in the NNRC Basin: the NNRC, the L-35A borrow canal, and C-42. There are eight project control structures regulating flow in the NNRC basin: S-34, S-124, S-125, S-141, S-142, S-143, Sewell Lock (G-54), and G-123.

No historic flow data are available for G-123. Historic water quality data from the G-123 structure were compiled to generate the baseline data set. A summary of the historic phosphorus data for the period of record is presented in Table 12-1.

Table 12-1. Summary of Historic Phosphorus Data – North New River Canal Basin

Phosphorus (Period of record: July 1989 – April 1999)	
Minimum (ppb)	4
Arithmetic average (ppb)	18
Maximum (ppb)	51



Tributary Basin Map - North New River Canal Basin
Figure 12-1

ERRD/ESP CMIESSAU REV. 20-JAN-2000 ecp-nnr.apr ecp-nnr-L

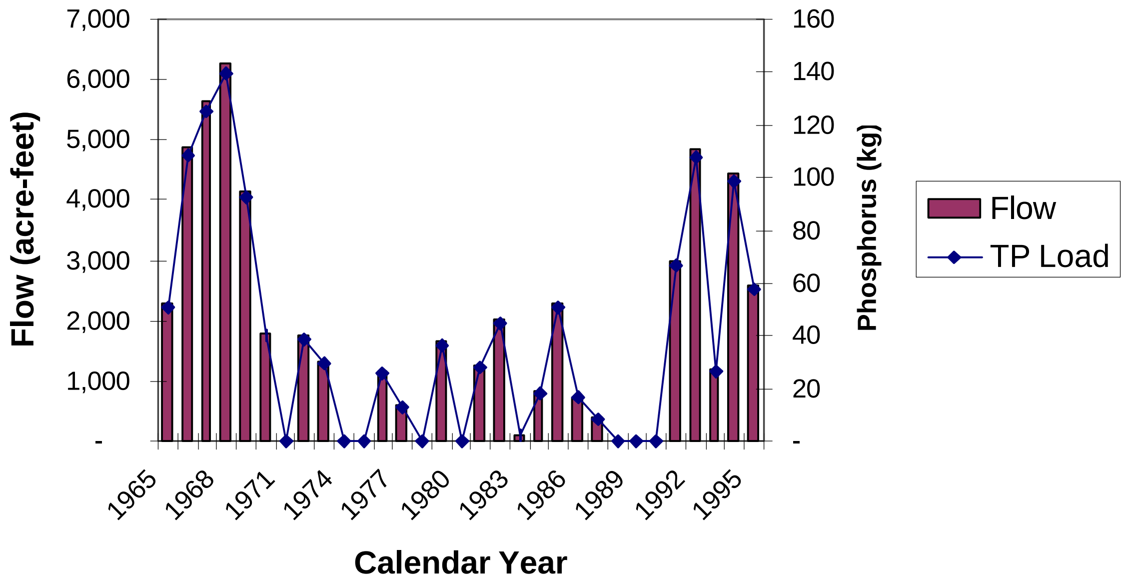
A summary of the combined baseline data set is presented in Table 12-2 and Figure 12-2. The arithmetic average phosphorus concentration of 18 ppb was selected for use in the combined baseline data set.

Table 12-2. Summary of Baseline Flows and Phosphorus Loads - North New River Canal Basin

Calendar Year	Simulated Flow acre feet	TP Load kg	Calendar Year	Simulated Flow acre feet	TP Load kg
1965	2,300	51	1980	-	-
1966	4,867	108	1981	1,274	28
1967	5,632	125	1982	2,029	45
1968	6,271	139	1983	105	2
1969	4,163	92	1984	818	18
1970	1,803	40	1985	2,284	51
1971	-	-	1986	742	16
1972	1,746	39	1987	389	9
1973	1,327	29	1988	-	-
1974	-	-	1989	-	-
1975	-	-	1990	-	-
1976	1,165	26	1991	2,993	66
1977	592	13	1992	4,843	108
1978	-	-	1993	1,201	27
1979	1,649	37	1994	4,442	99
			1995	2,588	57
Mean	1,781	40			
Minimum	-	-			
Maximum	6,271	139			

Average TP conc. (ppb) = 18

Figure 12-2. Summary of Baseline Flows and Phosphorus Loads - North New River Canal Basin (G-123)



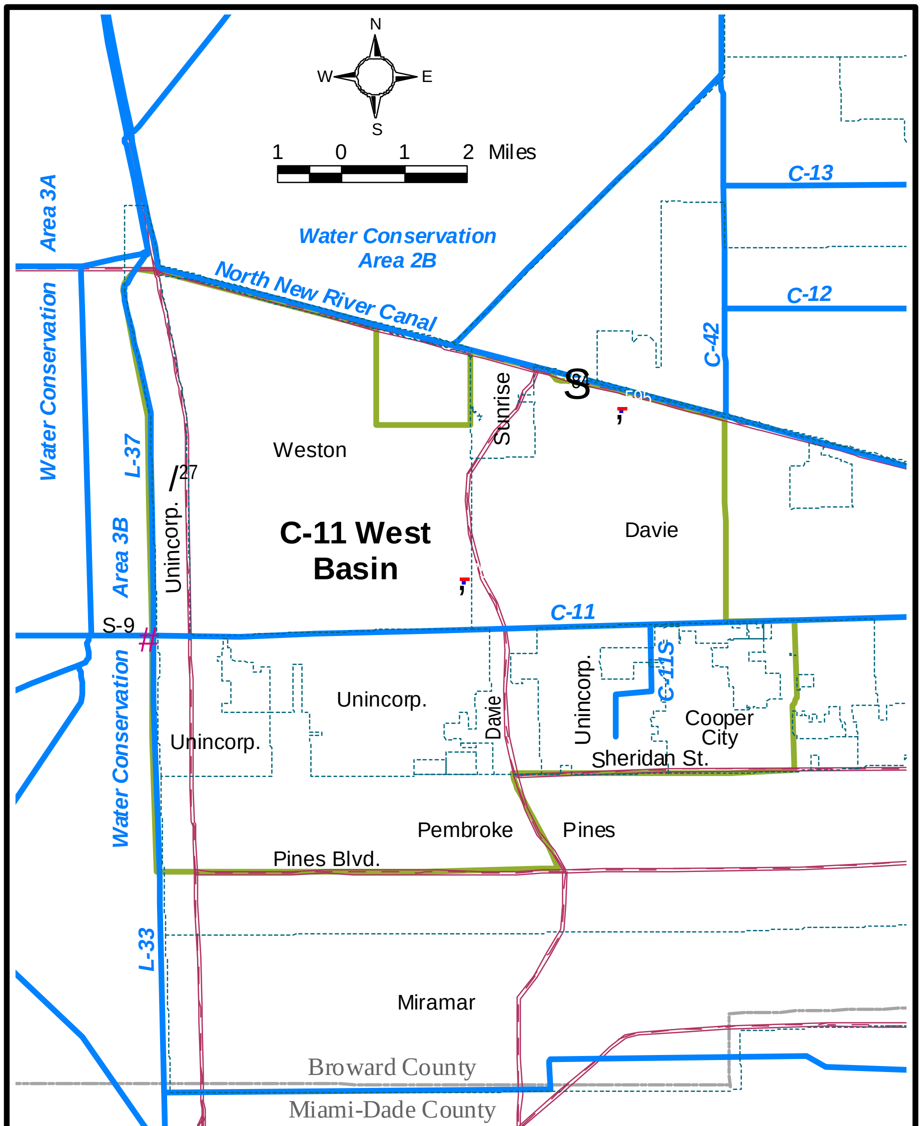
SECTION 13. C-11 WEST BASIN (INCLUDING S-9 PUMP STATION)

The C-11 West Basin has an area of 81 square miles and is located in south central Broward County. A map of the C-11 West Basin is presented in Figure 13-1 and a schematic is presented in Appendix 1-10. The project canals and control structures in the C-11 West Basin have three functions: (1) to provide flood protection and drainage for the basin, (2) to supply water to the basin during periods of low natural flow, and (3) to intercept and control seepage from Water Conservation Area (WCA) 3A. There are four project canals in the C-11 West Basin: (1) C-11, (2) C-11S, (3) the section of the L-33 borrow canal between C-11 and Hollywood Boulevard, and (4) the L-37 borrow canal. There are seven project control structures regulating flow in the C-11 West Basin: S-9, S-9XN, S-9XS, S-13A, G-86N, G-86S, and G-87.

Historic flow and water quality data from the S-9 pump station were compiled to generate the baseline data set (DBKEY 15015). Historic flow and phosphorus data (Water Years 1990 – 1999) for these structures for the period of record is presented in Appendix 13-1. A summary of the historic data is presented in Table 13-1 and Figures 13-2 through 13-4. Prior to December 96, when a composite sampler began collecting samples at S-9, all data were grab samples.

Table 13-1. Summary of Historic Flow and Phosphorus Data - C-11 West Basin (May to April Water Years)

Flow (Period of record: May 1989 - April 1999)	
Minimum annual (acre-feet)	72,674
Average annual (acre-feet)	210,077
Maximum annual (acre-feet)	320,621
Phosphorus (Period of record: May 1989 - April 1999)	
Minimum annual (ppb)	14
Average annual (ppb)	16
Maximum annual (ppb)	20



Tributary Basin Map - C-11 West Basin
Figure 13-1

ERRD/ESP CMIESSAU REV. 21-JAN-2000 ecp-c11w.apr ecp-c11w-L

Figure 13-2. Summary of Historic Flows - C-11 West Basin

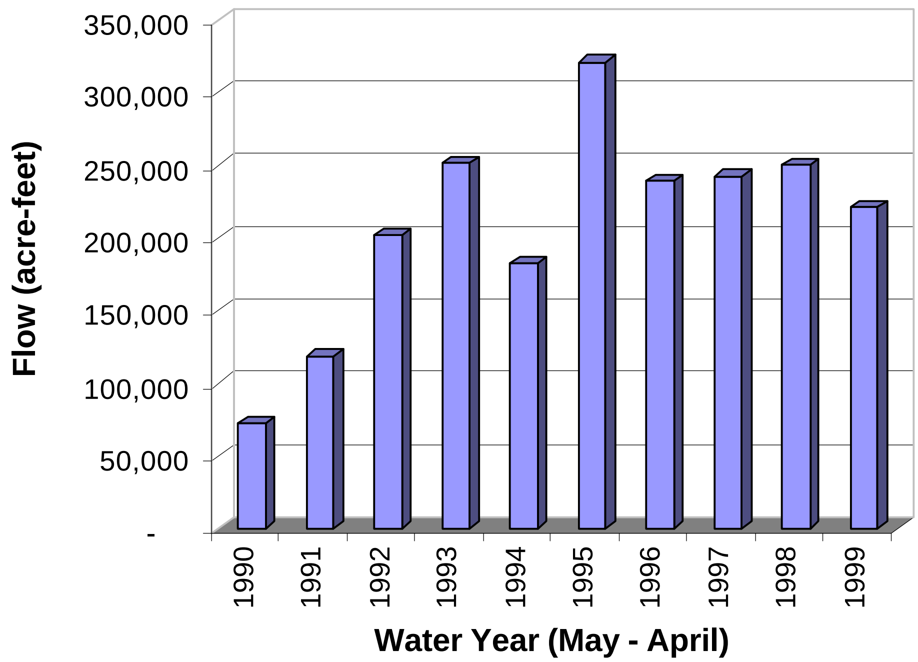


Figure 13-3. Summary of Historic Phosphorus Loads - C-11 West Basin

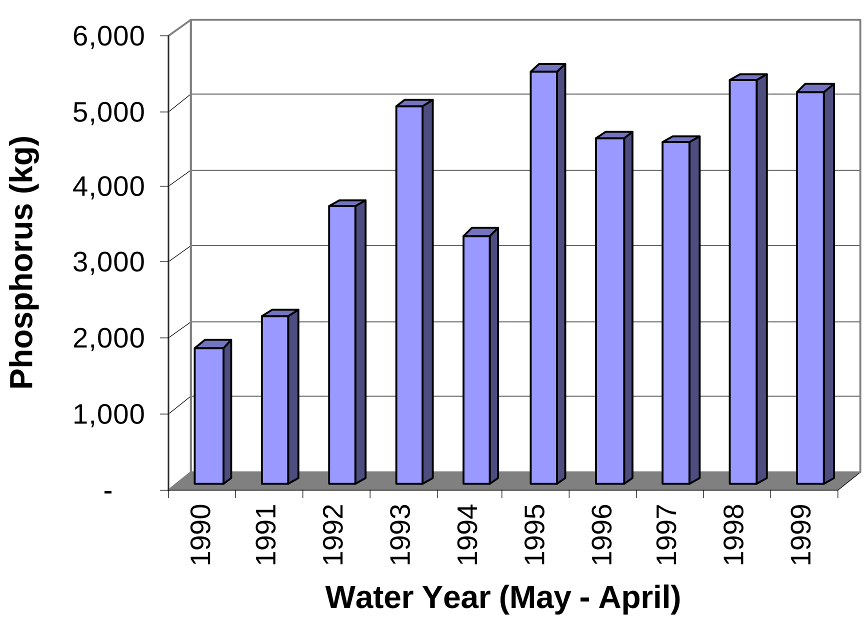
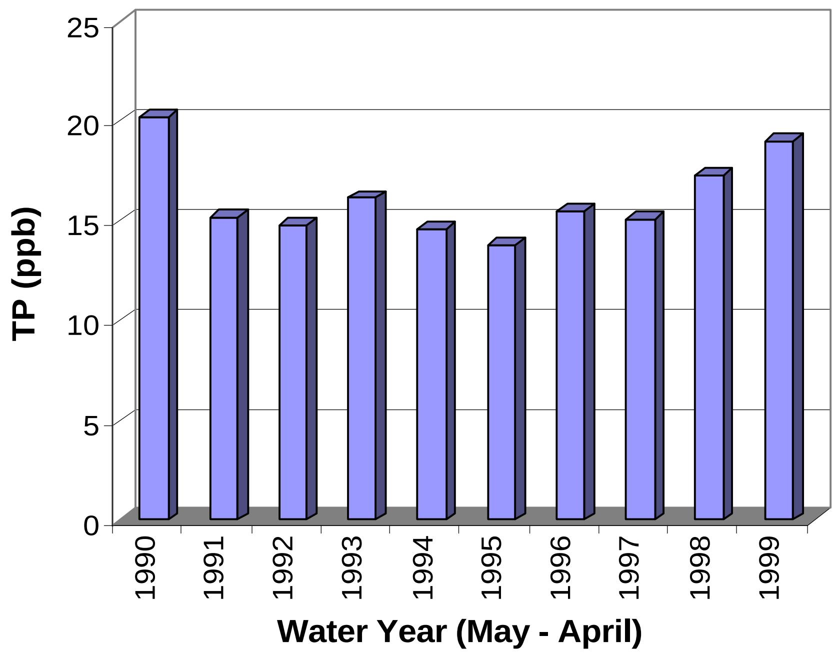


Figure 13-4. Summary of Historic Phosphorus Concentrations - C-11 West Basin



A regression equation based on the 3-year composite sample data set was applied to the daily flows to develop a set of daily phosphorus values. Because the residual sum of squares for the total data set and the residual sum of squares for the combined seasonal data sets were equivalent, the total data set regression equation was applied to the daily simulated flows to develop a 31-year set of daily phosphorus values. For the total data set, the standard error of the estimate was 5.3 ppb.

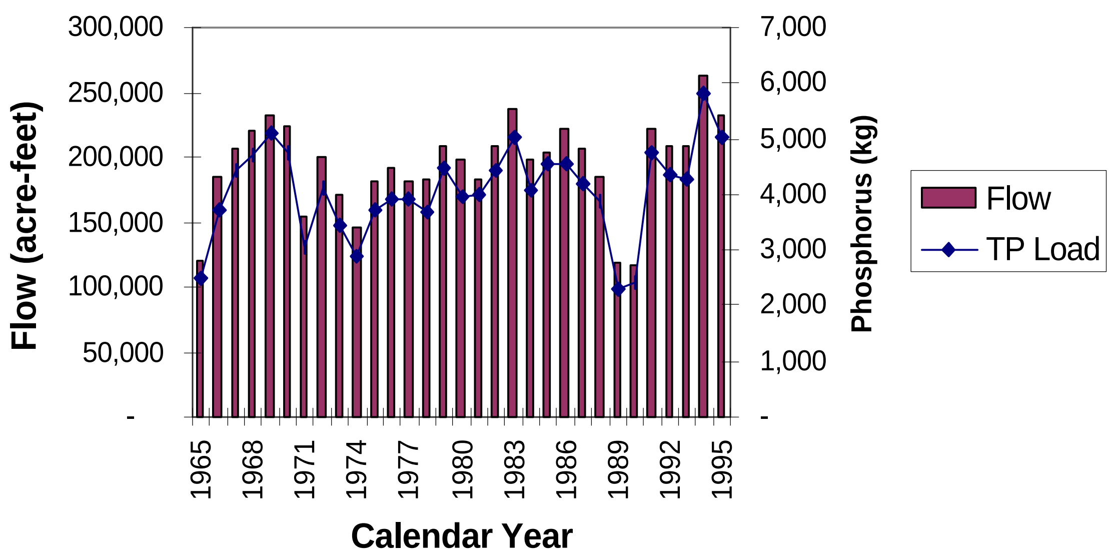
A summary of the combined baseline data set for C-11 West Basin for the 31-year period (1965-1995) is presented in Table 13-2 and Figure 13-5.

Table 13-2. Summary of Baseline Flows and Phosphorus Loads - C-11 West Basin

Calendar Year	Simulated Flow acre feet	TP Load kg	TP Load ppb	Calendar Year	Simulated Flow acre feet	TP Load kg	TP Load ppb
1965	120,419	2,484	17	1980	198,600	3,966	16
1966	184,759	3,735	16	1981	183,585	3,980	18
1967	206,597	4,425	17	1982	209,222	4,432	17
1968	220,188	4,720	17	1983	237,831	5,039	17
1969	231,589	5,104	18	1984	198,136	4,084	17
1970	223,331	4,749	17	1985	203,827	4,553	18
1971	154,060	3,040	16	1986	221,241	4,539	17
1972	200,451	4,104	17	1987	207,379	4,185	16
1973	171,052	3,453	16	1988	184,982	3,893	17
1974	146,043	2,882	16	1989	118,893	2,300	16
1975	180,914	3,712	17	1990	117,196	2,405	17
1976	190,904	3,932	17	1991	222,281	4,756	17
1977	181,966	3,899	17	1992	208,682	4,339	17
1978	183,112	3,665	16	1993	208,966	4,282	17
1979	208,090	4,477	17	1994	262,826	5,807	18
				1995	232,041	5,026	18
Mean	194,167	4,063	17				
Minimum	117,196	2,300	16				
Maximum	262,826	5,807	18				

Flow weighted mean TP conc. (ppb) = 17

Figure 13-5. Summary of Baseline Flows and Phosphorus Loads - C-11 West Basin



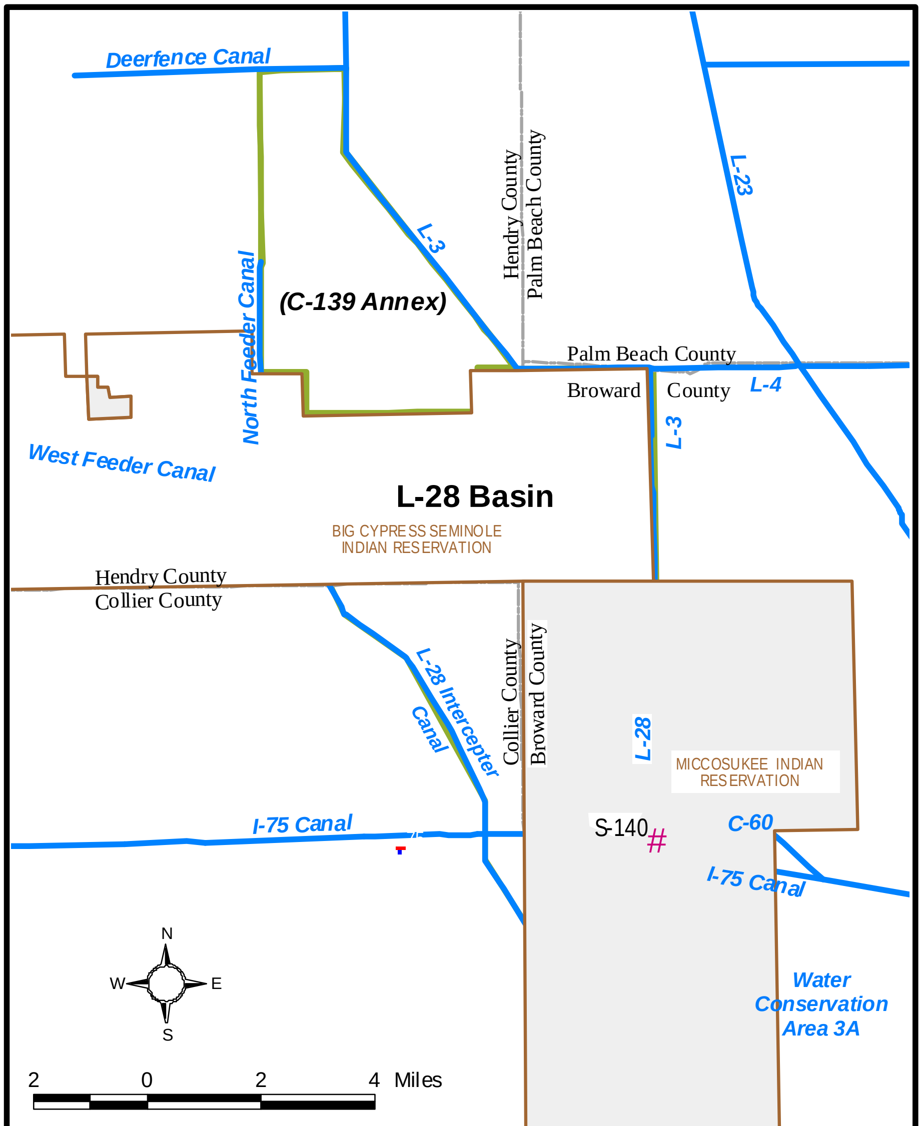
SECTION 14. L-28 BASIN (INCLUDING S-140 PUMP STATION)

The L-28 Basin has an area of approximately 113 square miles and is located in Broward, Hendry, and Collier counties. A map of the L-28 Basin is presented in Figure 14-1 and a schematic is presented in Appendix 1-11. The L-28 Basin canals and control structures have three primary functions: (1) to provide flood protection for the basin, (2) to provide conveyance of excess runoff to Water Conservation Area 3A (WCA 3A) for water supply, and (3) to provide conveyance of excess runoff to WCA 3A for environmental uses. There is one major canal associated with the L-28 Basin, the L-28 borrow canal. The outflow structure for the L-28 Basin, the S-140 pump station, discharges east to WCA 3A through the L-28 levee via a discharge channel.

Historic flow and water quality data from the S-140 pump station were compiled to generate the baseline data set (DBKEY 06754). Historic flow and phosphorus data (Water Years 1990 – 1999) for these structures for the period of record are presented in Appendix 14-1. A summary of the historic data is presented in Table 14-1 and Figures 14-2 through 14-4.

Table 14-1. Summary of Historic Flow and Phosphorus Data – L-28 Basin (May to April Water Years)

Flow (Period of record: May 1989 – April 1999)	
Minimum annual (acre-feet)	45,888
Average annual (acre-feet)	116,832
Maximum annual (acre-feet)	238,707
Phosphorus (Period of record: May 1989 – April 1999)	
Minimum annual (ppb)	31
Flow-weighted average annual (ppb)	39
Maximum annual (ppb)	55



Tributary Basin Map - L-28 Basin

Figure 14-1

ERRD/ESP CMIESSAU REV. 21-JAN-2000 ecp-l28.apr ecp-l28-L

Figure 14-2. Summary of Historic Flows - L-28 Basin

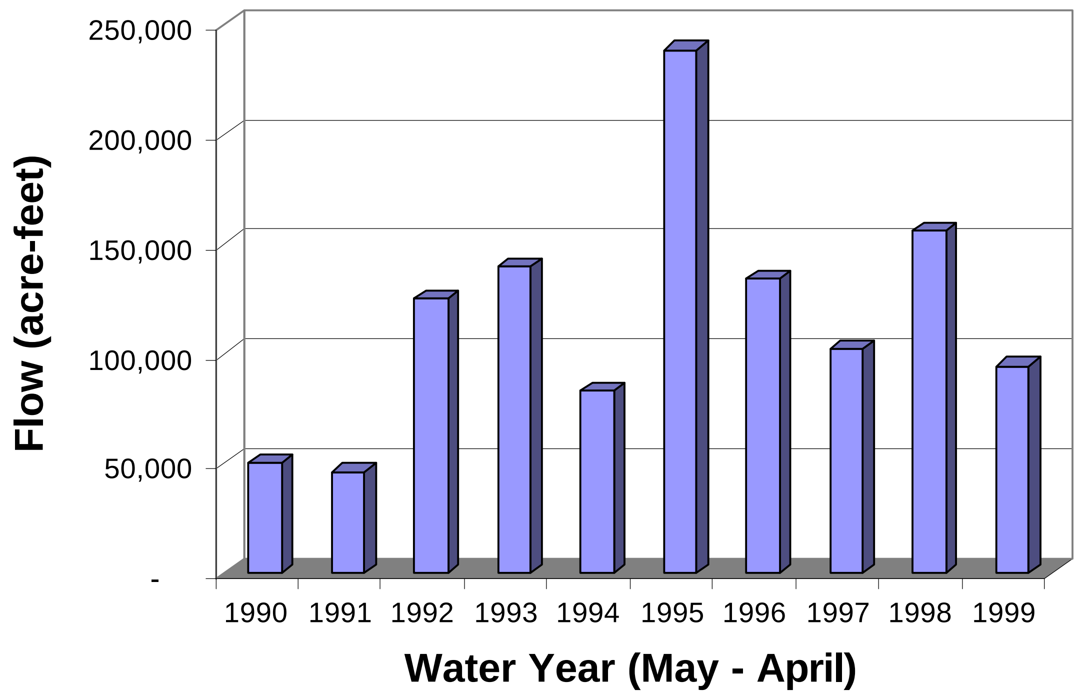


Figure 14-3. Summary of Historic Phosphorus Loads - L-28 Basin

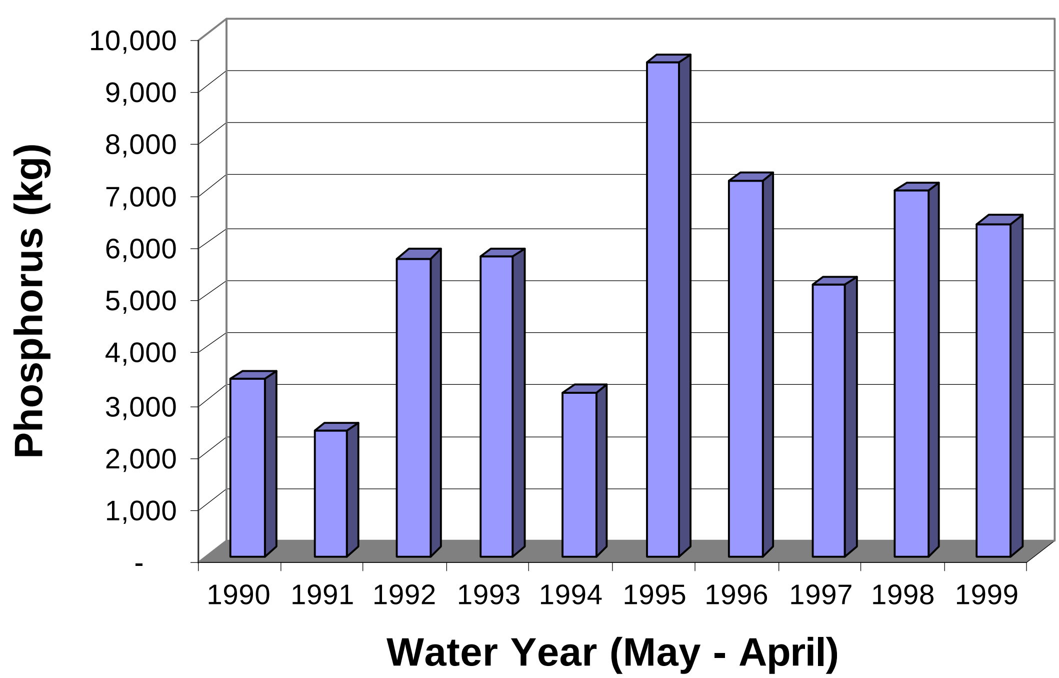
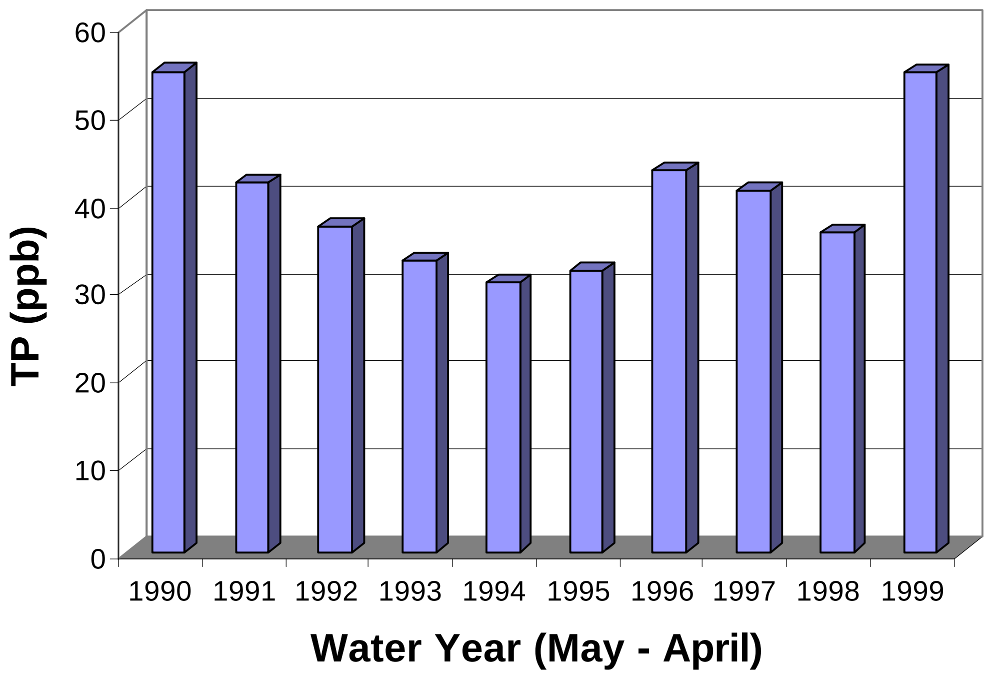


Figure 14-4. Summary of Historic Phosphorus Concentrations - L-28 Basin



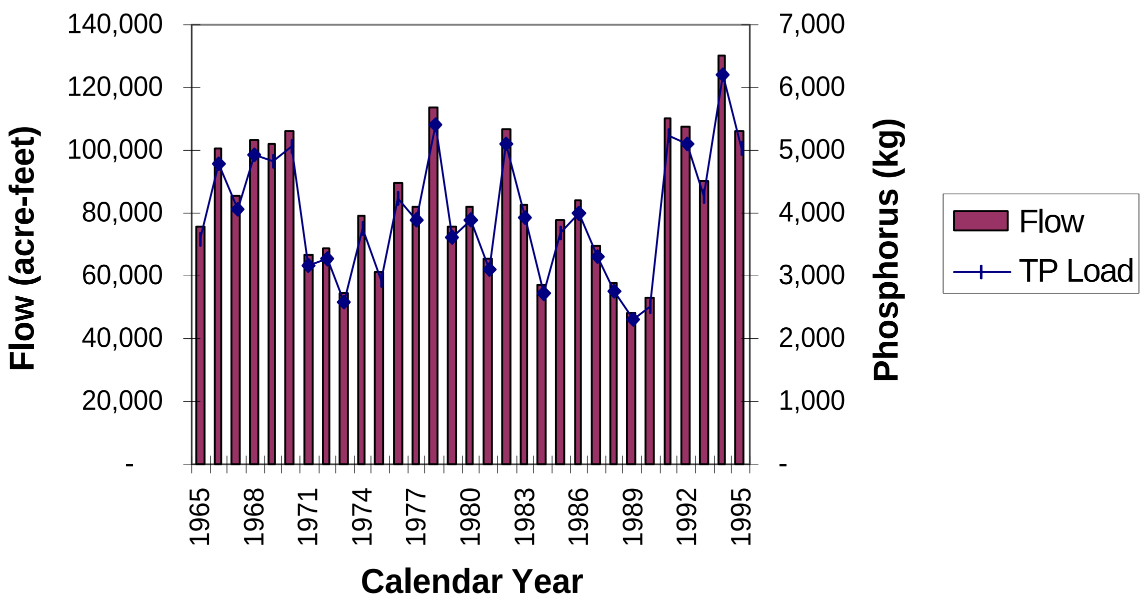
A summary of the combined baseline data set for the 31-year period (1965-1995) is presented in Table 14-2 and Figure 14-5. The flow-weighted average annual phosphorus concentration of 39 ppb was selected for use in the combined baseline data set.

Table 14-2. Summary of Baseline Flows and Phosphorus Loads - L-28 Basin

Calendar Year	Simulated Flow acre feet	TP Load kg	Calendar Year	Simulated Flow acre feet	TP Load kg
1965	75,738	3,599	1980	81,731	3,883
1966	100,731	4,786	1981	65,285	3,102
1967	85,404	4,058	1982	107,200	5,093
1968	103,580	4,921	1983	82,989	3,943
1969	101,817	4,838	1984	57,505	2,732
1970	106,468	5,059	1985	78,017	3,707
1971	67,068	3,187	1986	84,450	4,013
1972	68,645	3,262	1987	69,997	3,326
1973	54,426	2,586	1988	58,130	2,762
1974	79,085	3,758	1989	48,585	2,308
1975	61,345	2,915	1990	53,152	2,525
1976	89,532	4,254	1991	110,584	5,254
1977	82,320	3,911	1992	107,556	5,110
1978	113,828	5,408	1993	90,084	4,280
1979	75,969	3,610	1994	130,505	6,201
			1995	106,264	5,049
Mean	83,806	3,982			
Minimum	48,585	2,308			
Maximum	130,505	6,201			

Flow weighted mean TP conc. (ppb) = 39

Figure 14-5. Summary of Baseline Flows and Phosphorus Loads - L-28 Basin



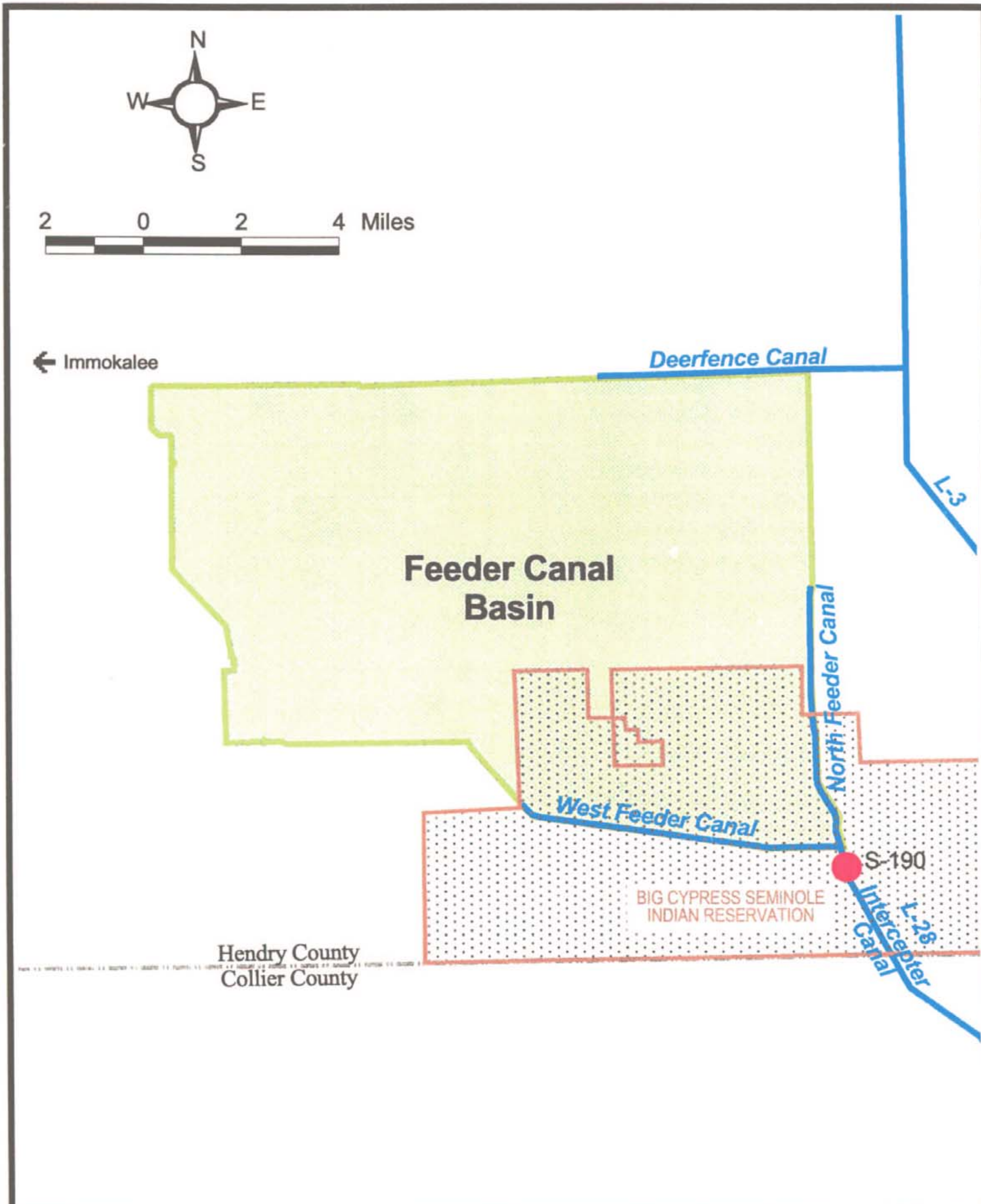
SECTION 15. FEEDER CANAL BASIN (INCLUDING S-190 PUMP STATION)

The Feeder Canal Basin has an area of approximately 113 square miles and is located in Hendry County. A map of the Feeder Canal Basin is presented in Figure 15-1 and a schematic is presented in Appendix 1-12. The Feeder Canal Basin canals and control structures have three primary functions: (1) to provide flood protection and drainage for the basin, (2) to provide conveyance of excess runoff to WCA 3A for water supply, and (3) to provide conveyance of excess runoff to WCA 3A for environmental uses. There are three major canals associated with the Feeder Canal Basin: the L-28 Interceptor Canal, the North Feeder Canal, and the West Feeder Canal. There are three project water control structures in the Feeder Canal Basin: the terminal structure in the North Feeder Canal, the terminal structure in the West Feeder Canal, and the S-190 control structure.

Historic flow and water quality data from the S-190 pump station were compiled to generate the baseline data set (DBKEY 15987). Historic flow and phosphorus data (Water Years 1990 – 1999) for this structure for the period of record are presented in Appendix 15-1. A summary of the historic data is presented in Figures 15-2 through 15-4 and Table 15-1.

Table 15-1. Summary of Historic Flow and Phosphorus Data - Feeder Canal Basin (May to April Water Years)

Flow (Period of record: May 1989 - April 1999)	
Minimum annual (acre-feet)	17,894
Average annual (acre-feet)	79,767
Maximum annual (acre-feet)	199,787
Phosphorus (Period of record: May 1989 - April 1999)	
Minimum annual (ppb)	76
Average annual (ppb)	117
Maximum annual (ppb)	159



Tributary Basin Map - Feeder Canal Basin
Figure 15-1

ERRD/ESP CMIESSAU REV. 21-JAN-2000 ecp-feeder.apr ecp-feeder-L

Figure 15-2. Summary of Historic Flows - Feeder Canal Basin

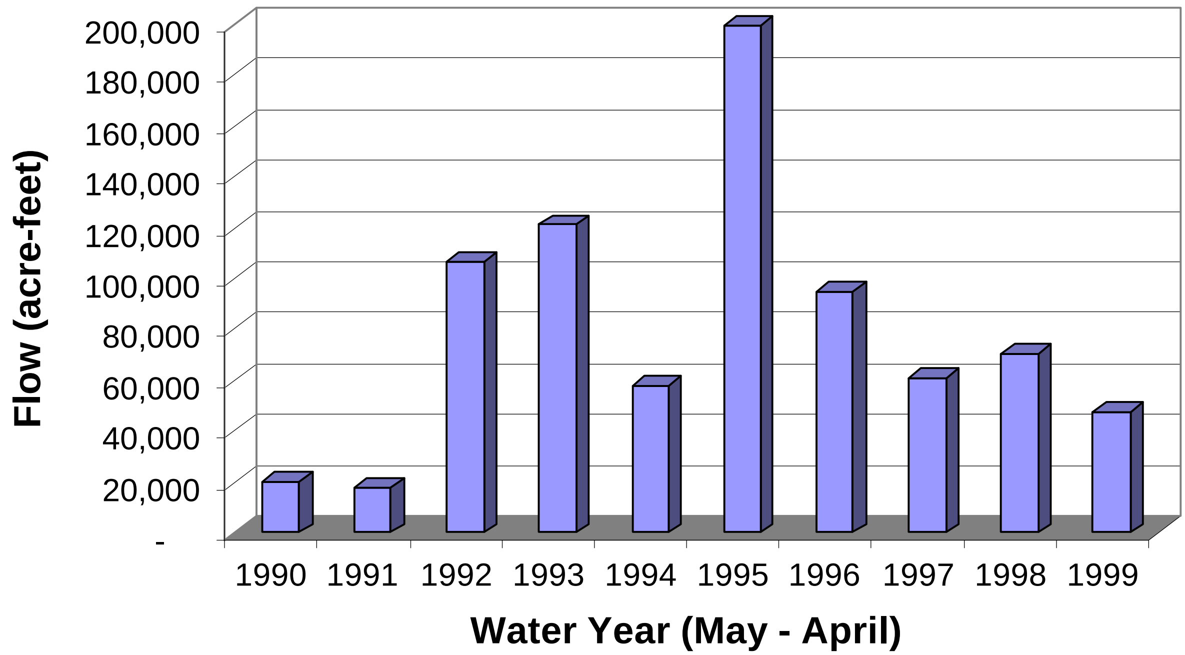


Figure 15-3. Summary of Historic Phosphorus Loads - Feeder Canal Basin

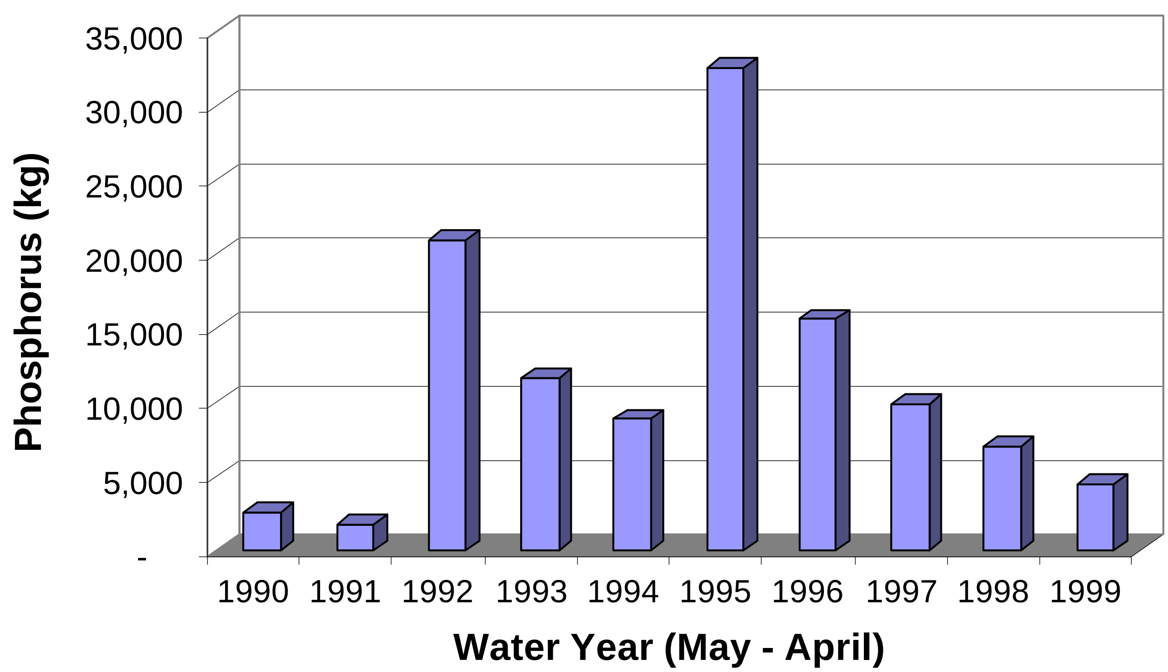
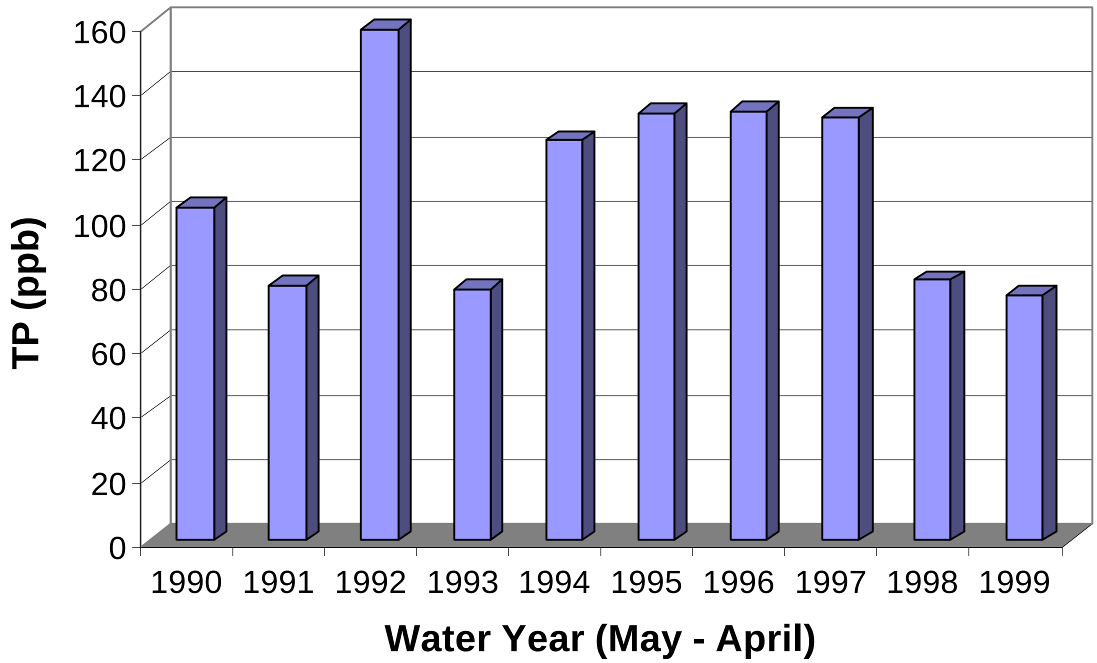


Figure 15-4. Summary of Historic Phosphorus Concentrations - Feeder Canal Basin

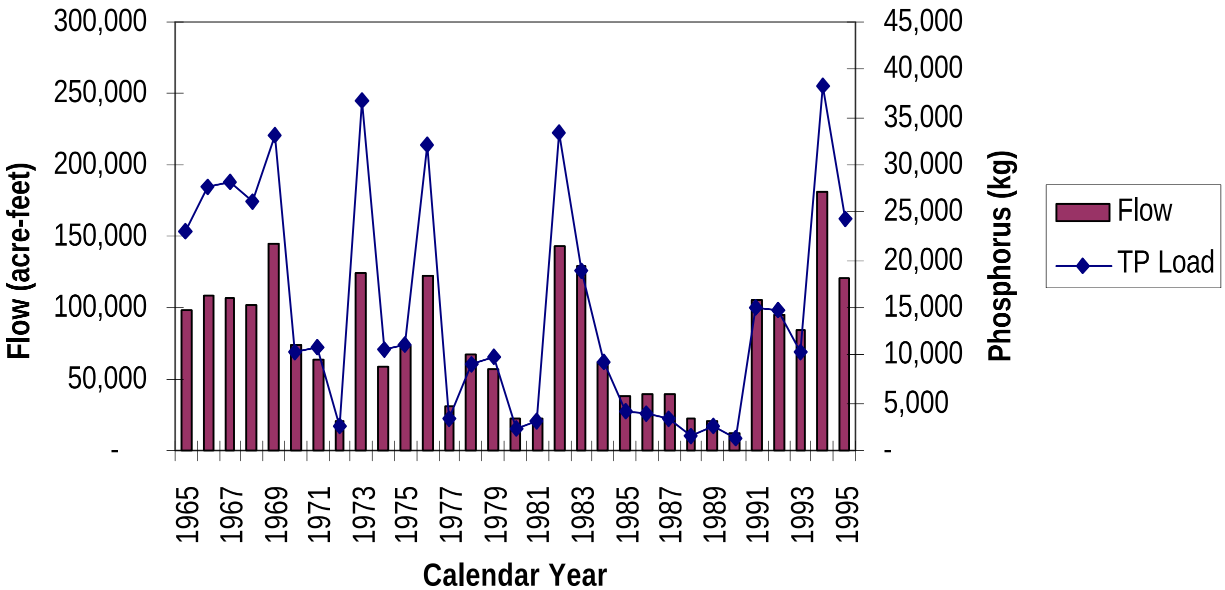


A seasonal (wet season/dry season) regression equation was applied to the Feeder Canal Basin daily flows to develop a set of daily phosphorus values. For the dry season, the standard error of the estimate was 31.7 ppb, and for the wet season, the standard error was 48.1 ppb. Because the simulated flows were significantly greater than the flows used in the regression analysis, the resulting concentrations were significantly greater than the observed concentrations (1079 ppb vs. 279 ppb). Similarly, the resulting 31-year flow-weighted mean concentration was 182 ppb versus the WY90-99 flow-weighted mean concentration of 117 ppb. For this reason, the simulated concentrations were capped at the observed maximum of 279 ppb in the development of the daily data set. A summary of the combined baseline data set for the 31-year period (1965-1995) is presented in Table 15-2 and Figure 15-5.

Table 15-2. Summary of Baseline Flows and Phosphorus Loads - Feeder Canal Basin

Calendar Year	Simulated Flow acre feet	TP Load kg	TP ppb	Calendar Year	Simulated Flow acre feet	TP Load kg	TP ppb
1965	97,419	22,936	191	1980	23,028	2,242	79
1966	108,906	27,741	206	1981	23,126	3,219	113
1967	106,207	28,261	216	1982	143,550	33,327	188
1968	101,786	26,016	207	1983	129,411	18,990	119
1969	144,478	33,033	185	1984	62,577	9,271	120
1970	74,014	10,228	112	1985	38,232	4,246	90
1971	63,980	10,756	136	1986	39,869	3,843	78
1972	21,055	2,656	102	1987	39,203	3,316	69
1973	123,530	36,624	240	1988	22,813	1,635	58
1974	59,211	10,557	145	1989	20,507	2,516	99
1975	73,411	11,043	122	1990	11,464	1,203	85
1976	123,088	32,035	211	1991	105,640	14,953	115
1977	31,268	3,425	89	1992	94,896	14,740	126
1978	66,451	8,985	110	1993	84,846	10,345	99
1979	56,653	9,923	142	1994	180,831	38,199	171
				1995	121,093	24,217	162
Mean	77,179	14,854	156				
Minimum	11,464	1,203	58				
Maximum	180,831	38,199	240				

Figure 15-5. Summary of Baseline Flows and Phosphorus Loads - Feeder Canal Basin



SECTION 16. SUMMARY OF BASELINE DATA

A summary of the combined baseline data set for all thirteen hydrologic basins for the simulated period 1965-1995 is presented in Table 16-1. In addition to phosphorus, dissolved oxygen and specific conductance were identified as parameters of concern to be addressed in the long-term solutions which will be developed during the evaluation of alternatives.

Table 16-1. Summary of Estimated Baseline Flows and Phosphorus Concentrations

Basin/STA	Mean Annual STA Inflow (acre-feet)	STA Inflow Phosphorus Concentration (parts per billion)	Mean Annual Discharge to EPA (acre-feet)	Discharge Phosphorus Concentration (parts per billion)
C-51 West - STA-1 East	133,331	176	136,406	50
S-5A - STA-1 West	160,335	139	161,902	34
S-6 – STA-2	233,473	100	229,273	48
S-7/S-8 - STA-3/4	660,889	88	637,901	49
C-139 - STA-5	85,637	167	83,776	38
STA-6 (Sections 1 and 2)	80,532	121	74,930	34
Acme Basin B	Not applicable	Not applicable	31,499	94
North Springs Improvement District Basin	Not applicable	Not applicable	6,168	39
N. New River Canal Basin	Not applicable	Not applicable	1,781	18 (see note 3)
C-11 West Basin	Not applicable	Not applicable	194,167	17
L-28 Basin	Not applicable	Not applicable	83,806	39
Feeder Canal Basin	Not applicable	Not applicable	77,179	156

NOTES:

1. Estimates of flow are simulation results (Calendar Year: January to December).
2. For the design period 1979-88, discharges from the STAs are assumed to achieve a long-term average phosphorus concentration of 50 ppb, with the exception of STA-1 West and STA-6. STA-1 West encompasses the Everglades Nutrient Removal Project, which has averaged 22 ppb for the last 5 years, and is assumed to achieve 35 ppb.
3. Phosphorus concentration for North New River Canal Basin (G-123) is the arithmetic mean – there were no flow data available to calculate the flow-weighted mean concentration.

SECTION 17. REFERENCES

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2. Burns & McDonnell, 1994. Conceptual Design for the Everglades Protection Project. February 1994.

3. Walker, William W., Jr., Ph.D., STA & Reservoir Performance Measures for the Everglades Restudy, January 25, 1999.

4. Technical Publication: *A Primer to the South Florida Water Management Model (version 3.5)*; South Florida Water Management District; April 1999.

5. Technical Memorandum: *An Atlas of the Everglades Agricultural Area Surface Water Management Basins*; South Florida Water Management District; September, 1989.

6. Technical Memorandum: *An Atlas of Eastern Palm Beach County Surface Water Management Basins*; South Florida Water Management District; June, 1988.

7. Technical Memorandum*: An Atlas of Eastern Broward County Surface Water Management Basins*; South Florida Water Management District; November, 1987.

8. *Western Basins Environmental Assessment, Report Nos. 1, 2, and 4 through 8*; prepared for the South Florida Water Management District by Mock, Roos, and Associates; January 6, 1993.

9. Technical Memorandum: *North Springs Improvement District Water Quality Data Evaluation*; South Florida Water Management District; June 1999.

10. *Permit Application for District Structures Discharging into, within, or from the Everglades Protection Area and are not included in the Everglades Construction Project*, submitted to the Florida Department of Environmental Protection by South Florida Water Management District, October 1994.

11. *Rules of the South Florida Water Management District – Everglades Program Chapter 40E-63, F.A.C.*, last updated October 1999.

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13. SFWMD, 1999. User's Guide to Accessing the South Florida Water Management District Hydrometeorologic and Water Quality Database "DBHYDRO", June 1999.

14. SFWMD, 1992. Surface Water Improvement and Management Plan for the Everglades; Planning Document, March 13, 1992.

15. Walker, William W., Jr., Ph.D., *Final Report – Models for Tracking Runoff & Phosphorus Loads from the C-139 Basin*, Prepared for SFWMD, November 17, 2000.

16. Burns & McDonnell, 1997. Final Design Report for STA-5. September 1997.

APPENDICES

Appendix 1-1	C-51W Basin Schematic
Appendix 1-2	S-5A Basin Schematic
Appendix 1-3	S-6 Basin Schematic
Appendix 1-4	S-7 Basin Schematic
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Appendix 1-7	Acme Basin B Schematic
Appendix 1-8	NSID Basin Schematic
Appendix 1-9	North New River Canal Basin Schematic
Appendix 1-10	C-11W Basin Schematic
Appendix 1-11	L-28 Basin Schematic
Appendix 1-12	Feeder Canal Basin Schematic
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Appendix 3-2.	SFWMM Input Parameters
Appendix 3-3.	Combining Flow with Phosphorus Data
Appendix 5-1.	Historic Flows and Loads – S-5A Basin
Appendix 6-1.	Historic Flows and Loads – S-6 Basin
Appendix 7-1.	Historic Flows and Loads – S-7 Basin
Appendix 7-2.	Historic Flows and Loads – S-8 Basin
Appendix 8-1.	Historic Flows and Phosphorus - C-139 Basin
Appendix 9-1.	Historic Flows and Loads – STA-6
Appendix 10-1.	Historic Flows and Phosphorus - Acme Basin B
Appendix 11-1.	Historic Flows and Phosphorus - NSID Basin
Appendix 13-1.	Historic Flows and Phosphorus - C-11 West Basin (S-9 Pump Station)
Appendix 14-1.	Historic Flows and Phosphorus - L-28 Basin (S-140 Pump Station)
Appendix 15-1.	Historic Flows and Phosphorus - Feeder Canal Basin (S-190)

CROSS REFERENCES TO SPREADSHEETS

Table	Spreadsheet Name
1-1.	various
2-1.	not based on spreadsheet
3-1.	historic-sum.xls, c139_final_flows&loads.xls, and acme-sum.xls
3-2.	various
4-1.	sta1E inflow tp.xls
4-2.	sta1E_out tp.xls
5-1.	s5a-sum.xls
5-2.	sta1w inflow tp.xls
5-3.	sta1W_out tp.xls
6-1.	s6-sum.xls
6-2.	sta2 inflow tp.xls
6-3.	sta2_out tp.xls
7-1.	s7-sum.xls
7-2.	s8-sum.xls
7-3.	sta34 inflow tp.xls
7-4.	sta34 outflow tp.xls
8-1.	c139_final_flows&loads.xls
8-2.	STA5 inflow tp.xls
8-3.	sta5_out tp.xls
9-1.	sta6-sum.xls
9-2.	sta6_inflow tp.xls
9-3.	sta6_out tp.xls
10-1.	acme-sum.xls
10-2.	acme-simulated-flow-tp.xls
11-1.	NSID-sum.xls
11-2.	nsid-simulated-flow-tp.xls
12-1.	nnrc simulated flow tp.xls *linked to* fswqsum111299.xls
12-2.	nnrc simulated flow tp.xls
13-1.	S-9-sum.xls
13-2.	c11w-simulated-flow-tp.xls
14-1.	S140-sum.xls
14-2.	L-28-basin-simulated-flow-tp.xls
15-1.	S190-sum.xls
15-2.	feeder-simulated-flow-tp.xls
16-1.	various

Figure	**Spreadsheet Name**
2-1.	not based on a spreadsheet
2-2.	not based on a spreadsheet
2-3.	not based on a spreadsheet
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4-1.	not based on a spreadsheet
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4-3.	sta1E_out tp.xls
5-1.	not based on a spreadsheet
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5-3.	s5a-sum.xls
5-4.	s5a-sum.xls
5-5.	sta1w inflow tp.xls
5-6.	sta1W_out tp.xls
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6-3.	s6-sum.xls
6-4.	s6-sum.xls
6-5.	sta2 inflow tp.xls
6-6.	sta2_out tp.xls
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7-4.	s7-sum.xls
7-5.	s8-sum.xls
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7-7.	s8-sum.xls
7-8.	sta34 inflow tp.xls
7-9.	sta34 outflow tp.xls
8-1.	not based on a spreadsheet
8-2.	c139_final_flows&loads.xls
8-3.	c139_final_flows&loads.xls
8-4.	c139_final_flows&loads.xls
8-5.	STA5 inflow tp.xls
8-6.	sta5_out tp.xls
9-1.	not based on a spreadsheet
9-2	sta6-sum.xls
9-3.	sta6-sum.xls
9-4.	sta6-sum.xls
9-5.	sta6_inflow tp.xls (also in EAA basin historic.xls)
9-6.	sta6_out tp.xls
10-1.	not based on a spreadsheet
10-2.	acme-sum.xls
10-3.	acme-sum.xls
10-4.	acme-sum.xls
10-5.	acme-simulated-flow-tp.xls

11-1. not based on a spreadsheet
11-2. NSID-sum.xls
11-3. NSID-sum.xls
11-4. NSID-sum.xls
11-5. nsid-simulated-flow-tp.xls
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12-2. nnrc simulated flow tp.xls
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13-3. S-9-sum.xls
13-4. S-9-sum.xls
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14-3. S140-sum.xls
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15-3. S190-sum.xls
15-4. S190-sum.xls
15-5. feeder-simulated-flow-tp.xls
Appendix 3-3. various

Appendices

Appendix 3-1.	not based on a spreadsheet
Appendix 3-2.	not based on a spreadsheet
Appendix 3-3.	various
Appendix 5-1.	s5a-sum.xls
Appendix 6-1.	s6-sum.xls
Appendix 7-1.	s7-sum.xls
Appendix 7-2.	s8-sum.xls
Appendix 8-1.	c139_final_flows&loads.xls
Appendix 9-1.	sta6-sum.xls
Appendix 10-1.	acme-sum.xls
Appendix 11-1.	NSID-sum.xls
Appendix 13-1.	S-9-sum.xls
Appendix 14-1.	S140-sum.xls
Appendix 15-1.	S190-sum.xls