FINAL REPORT

Basin Specific Feasibility Studies
Everglades Stormwater Program Basins
Contract C-E024

BROWN AND CALDWELL

HSA Engineers & Scientists
DB Environmental, Inc.
Wetland Solutions, Inc.
Milian, Swain & Associates, Inc.

October 2002

Photographs courtesy of South Florida Water Management District

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Certification

I hereby certify as a Professional Engineer in the State of Florida that the work documented in this report was completed under my direct supervision. This certification is made in accordance with the provisions of the Laws and Rules of the Florida Board of Professional Engineers under Chapter 61G15-29, Florida Administrative Code.

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October 29, 2002

BROWN AND CALDWELL

Ms. Tracey T. Piccone, P.E.
Senior Environmental Engineer
South Florida Water Management District
3301 Gun Club Road
West Palm Beach, FL 33406

060/21853.004

Subject: Contract C-E024
Basin Specific Feasibility Studies/ESP Basins
Final Report

Dear Ms. Piccone:

Brown and Caldwell, in association with HSA Engineers & Scientists, Inc., Milian, Swain & Associates, Inc., DB Environmental, Inc., and Wetland Solutions, Inc., is pleased to submit this final report documenting our team's work on the evaluation of alternatives for the Basin Specific Feasibility Studies in the Everglades Stormwater Program (ESP) basins. This submittal represents completion of work under Contract C-E024 between Brown and Caldwell and the District.

We have enjoyed working with you and the many other District staff whose assistance made successful completion of this project possible. We also wish to thank the many ESP basin stakeholders who provided input to the project. Should there be any further questions regarding the conduct of the work documented in this report, please do not hesitate to contact me.

Sincerely,

BROWN AND CALDWELL

James A. Nissen, P.E., DEE
Senior Project Manager

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Acronyms

ACME	Acme Improvement District
ATTs	Advanced Treatment Technologies
BMPs	Best Management Practices
C&SF	Central and South Florida
CERP	Comprehensive Everglades Restoration Program
cfs	cubic feet per second
CTSS	Chemical Treatment-Solids Separation
DMSTA	Dynamic Model for Stormwater Treatment Areas
EAA	Everglades Agricultural Area
ECP	Everglades Construction Project
EFA	Everglades Forever Act of 1994
EPA	Everglades Protection Area
ERC	Environmental Regulatory Commission
ESP	Everglades Stormwater Program
FDEP	Florida Department of Environmental Protection
FEB	flow equalization basin
FLUCCS	Florida Landuse and Cover Classification System
LWDD	Lake Worth Drainage District
mgd	million gallons per day
O&M	operation and maintenance
NA	Not applicable
P	phosphorus
ppb	parts per billion
PSTA	periphyton stormwater treatment area
RAS	regulatory action strategies
SAV	submerged aquatic vegetation
SFWMD	South Florida Water Management District
STAs	Stormwater Treatment Areas
STSOC	Supplemental Technology Standards of Comparison
TP	total phosphorus
USACE	United States Army Corps of Engineers
WCA	Water Conservation Area

Executive Summary

This report documents work performed by the Brown and Caldwell consulting team related to the preparation of Basin Specific Feasibility Studies for achieving long-term water quality goals for discharges from six Everglades Stormwater Program (ESP) basins that discharge to the Everglades Protection Area (EPA). Discharges from these basins are regulated under the provisions of Florida's Everglades Forever Act of 1994 (F.S. 373.4592). The work was performed for the South Florida Water Management District (District) under Professional Services Contract C-E024.

The goal of the Everglades Forever Act (EFA) is to identify and implement the optimal combination of source controls, stormwater treatment areas (STAs), advanced treatment technologies (ATTs) and/or regulatory programs to ensure that all waters discharged to the EPA achieve long-term water quality goals by December 31, 2006. Permit applications to address this objective must be submitted to the Florida Department of Environmental Protection (FDEP) by December 31, 2003. To facilitate the planning and decision-making process, the District is conducting Basin Specific Feasibility Studies. These studies are intended to combine the results of research and planning studies with regulatory programs and individual basin characteristics to identify an optimal combination of source controls, basin-scale treatment, and diversion options to address long-term water quality objectives.

Dozens of biological and chemical treatment technologies, with potential to achieve very low total phosphorus (TP) concentrations, have been investigated to date. This research has led to two general approaches for treatment of stormwater runoff to meet long-term water quality goals: (1) biological treatment using STAs consisting of emergent vegetation, submerged aquatic vegetation (SAV), periphyton, or some combination of these three vegetation types; and (2) chemical treatment followed by solids separation (CTSS). The results of research on these ATTs have been presented in demonstration project final reports using a standardized format to facilitate their comparison (*Supplemental Technology Standard of Comparison)*. Research efforts continue to refine the engineering requirements, performance characteristics, and costs associated with these treatment technologies.

Basin Specific Feasibility Studies were prepared for the following six ESP basins:

- ACME Basin B
- C-11 West Basin
- Feeder Canal Basin
- L-28 Basin
- North New River Canal Basin
- North Springs Improvement District

Baseline flows and TP loads for each basin were prepared by the District as the basis for analysis of alternatives (*Baseline Data for the Basin Specific Feasibility Studies to Achieve the Long-Term Water Quality Goals for the Everglades, SFWMD, May 2001*). The baseline data sets consisted of simulated daily flow and TP loads for each basin for the 31-year period from 1965 to 1995. The daily flows and loads were estimated by combining simulated flow values from the South Florida Water Management Model with historic TP concentrations from water years 1990-1999.

Project Objective

The objective of the Basin Specific Feasibility Studies documented in this report was to provide a comparative evaluation of alternatives for meeting the long-term water quality goals for discharges from six ESP basins currently contributing flow to the EPA. Accordingly, evaluation and rating of alternatives against common evaluation criteria was performed. However, it is not the purpose of the Basin Specific Feasibility Studies to rank alternatives or to suggest a preferred alternative in any of the basins considered. Rather, the District and other stakeholders will use the information generated in these Basin Specific Feasibility Studies as part of a subsequent decision-making process to recommend an alternative for implementation in each basin.

Methodology For Comparative Evaluation of Alternatives

As input to the Basin Specific Feasibility Studies, the District prepared a draft Evaluation Methodology, dated August 31, 2001, describing the analytical methods to be used in the technical analyses of alternatives and the procedures to be used in rating the alternatives against a common set of evaluation criteria. After a series of subsequent revision drafts, the District finalized the Evaluation Methodology document in July 2002 *(Final Evaluation Methodology for the Water Quality Improvement Strategies for the Everglades, SFWMD, July 31, 2002).*

A key element of the Evaluation Methodology is the definition of the planning level target for TP concentration in discharges to the EPA after December 31, 2006. While it is not known what the numeric standard will ultimately be, it is not unreasonable to expect that it will be close to 10 parts per billion (ppb). Therefore, the Evaluation Methodology for the Basin Specific Feasibility Studies established that all biological and chemical treatment facilities be sized to achieve a long-term TP concentration of 10 ppb, calculated as the geometric mean of the weekly flow-weighted means over the 31-year period of simulation. For chemical treatment facilities with the capability to achieve less than 10 ppb TP, the Evaluation Methodology allows for blending of treated and untreated water to achieve the 10 ppb planning level target.

The Evaluation Methodology requires that capital and annual operation and maintenance (O&M) costs be prepared for the purpose of calculating the 50-year present worth of each alternative. To facilitate the cost estimating process, the District provided general unit cost information for capital improvements and annual O&M expenses to be applied in all ESP basins. These unit costs were originally developed for use in the Supplemental Technology Standard of Comparison (STSOC) demonstration projects and were subsequently updated by the District. The District also developed basin-specific estimates for land acquisition costs based upon acreage requirements provided by Brown and Caldwell.

The Evaluation Methodology includes a total of ten evaluation criteria, consisting of five quantitative criteria and five qualitative criteria. Rating of alternatives against the quantitative criteria is based upon the results of the technical analyses performed as part of these Basin Specific Feasibility Studies. For the qualitative criteria, a numerical plus or minus (+/-) rating is assigned to an alternative based upon

the results of the STSOC demonstration projects, where applicable, and the best professional judgment of the evaluator. The Evaluation Methodology makes no provision for compiling the ratings of the alternatives or recommending an apparent "best alternative" for individual basins as part of the Basin Specific Feasibility Studies. Rather, a consensus-building process will be implemented by the District and other stakeholders following completion of the Basin Specific Feasibility Studies.

Development of Alternatives

Three approaches have been proposed for reducing TP concentrations in future stormwater discharges to the Everglades: source controls, biological treatment, and chemical treatment. Diversion of flow away from the EPA, to Comprehensive Everglades Restoration Plan (CERP) projects or other storage impoundments, has also been proposed in some basins, but this approach is basin-specific and, in most cases, does not require reduction of TP concentration in the runoff being diverted away from the EPA.

As input to the Basin Specific Feasibility Studies, the District developed a final set of alternatives for achieving long-term water quality objectives in each of the six basins being investigated. The alternatives consisted of different combinations of source controls and basin-scale treatment options with the potential to reduce TP concentrations in discharges to the EPA to the planning level target of 10 ppb. Diversions of flow to future CERP projects and other storage facilities that would reduce or eliminate discharges to the EPA were also considered, subject to available information, as alternatives for meeting long-term water quality objectives in some basins.

Biological Treatment Options

In combination with Best Management Practices (BMPs), biological treatment in STAs has been the preferred method to date for reducing the quantity of phosphorus entering the Everglades from stormwater discharges. Approximately 42,000 acres of STAs have been constructed, are presently under construction, or are being designed to reduce TP concentrations in runoff from the EAA to the interim water quality standard of 50 ppb established in the EFA. These STAs have performed very well, and as research on STA optimization has continued, outflow TP concentrations in the 20 to 30 ppb TP range have not been uncommon.

While operating refinements have led to improved performance from these STAs, it is generally acknowledged that these emergent macrophyte STAs, by themselves, are not capable of achieving the very low TP concentrations that will be required to satisfy the long-term water quality objectives of the EFA.

Two of the most promising technologies are wetland treatment systems: SAV, and periphyton-dominated STAs, or PSTAs. Both technologies have been shown to be capable of achieving TP concentrations that approach the planning level target of 10 ppb TP under the proper hydrologic, hydraulic and TP load conditions. These two technologies, either individually, together, or in combination with emergent vegetation STAs, currently offer the greatest potential for achieving long-term water quality goals in the EPA with natural, biological treatment systems.

The Dynamic Model for Stormwater Treatment Areas (DMSTA) was used for the analysis of TP removal performance in STAs. This model has been calibrated with data from research studies on SAV and PSTA, and is a significant advancement over previous models used to predict STA performance. DMSTA was used to define the STA configuration in each basin that achieved the long-term water quality objective of 10 ppb TP using the least amount of land and avoiding hydraulic bypass. If a geometric mean of 10 ppb could not be achieved due to land area constraints associated with a particular alternative, the lowest geometric mean predicted by the model was reported.

A major factor related to the required sizing and configuration of future STAs to satisfy water quality goals is how well the SAV technology will perform at large scale and under varying hydraulic and phosphorus loading conditions. In this investigation, base case conditions were modeled using a DMSTA calibration data set from Cell 4 in STA 1W during the 2-year period from 1998-1999 (SAV-C4). During this period, flow-weighted mean outflow TP concentrations as low as 14 ppb were achieved. Sensitivity analyses were also performed using a more conservative calibration data set (NEWS) that considers all data from SAV research programs, as well as full-scale operating facilities such as Cell 4 at STA 1W. If the base case STAs (sized using the SAV_C4 data set) perform as predicted by NEWS instead of SAV_C4, DMSTA predicts an increase of 2-14 ppb in the long-term geometric mean outflow TP concentration.

Whether the SAV_C4 data set or some other data set, such as NEWS, is better suited for predicting STA performance in a given basin application is a function of how closely the SAV_C4 conditions can be replicated in that basin. To date, conditions similar to those in Cell 4 during 1998 and 1999 have not been replicated in another large scale STA. However, as more SAV operation data becomes available and more is understood about the factors that affect SAV performance, the ability to replicate those conditions should improve. It will be up to the designer of the STA involved to examine the period of record flows and loads being used as the basis of design and select the DMSTA calibration data set which best represents the operating conditions expected over the long-term in that STA.

Chemical Treatment Options

Chemical treatment, in many different forms, has been used effectively to remove phosphorus and other nutrients from stormwater runoff prior to its discharge into rivers, lakes and other receiving waters. Three District-sponsored pilot testing programs have demonstrated the capability of chemical treatment to achieve very low TP concentrations in agricultural and urban stormwater runoff being discharged to the EPA. In all cases, chemical treatment was able to achieve very low effluent TP concentrations, typically on the order of about 6 ppb.

Full-scale chemical treatment scenarios were developed using a fill and draw hydraulic approach. A spreadsheet water balance, using daily flow and TP concentration data from the 31-year period of simulation, was used to determine treatment plant and flow equalization basin (FEB) sizes to achieve a long-term (31-year) geometric mean TP concentration of 10 ppb. For this analysis, the chemical treatment technology was projected to produce an average clarified effluent TP concentration of 6 ppb at average flow and 10 ppb at peak flow. Peak flow was assumed to be 150 percent of average flow.

Uncertainties in the Analysis of Alternatives

The Basin Specific Feasibility Studies for the six ESP basins considered in this investigation represent a significant step toward satisfying the long-term water quality objective for future discharges to the EPA. For the first time, historical flows and phosphorus loads in these basins have been used to estimate the effectiveness of various phosphorus load reduction strategies and to estimate the long-term cost associated with implementation of those various strategies. Nevertheless, there are many uncertainties associated with the alternatives analyses performed in the Basin Specific Feasibility Studies; uncertainties that include the effectiveness of source controls in reducing phosphorus loads, the locations of basin-scale treatment and storage facilities within the ESP basins, and the limited understanding of how advanced biological treatment processes will perform at full scale under the highly pulsed flow regimes of the ESP basins. These uncertainties need to be addressed in subsequent phases of project development and implementation.

ACME Basin B

ACME Basin B is located in the Village of Wellington in central Palm Beach County. Land use is primarily low density residential and agricultural. Drainage is to the Loxahatchee Natural Wildlife Refuge (Refuge) through two pump stations operated by the Acme Improvement District. According to the simulated baseline data set, an average of 31,499 acre-feet of water per year and an average of 3,660 kilograms (kg) of TP per year are discharged to the Refuge. This equates to a flow-weighted mean TP concentration of 94 ppb. The Village of Wellington recently adopted a BMP ordinance that is expected to reduce TP concentrations in discharges to the Refuge. For the purposes of this investigation, it was assumed that BMPs and other source controls would reduce TP concentrations in discharges from ACME Basin B by 25 percent (from 94 ppb to 71 ppb).

A total of four alternatives were evaluated by Brown and Caldwell to address long-term water quality in discharges from ACME Basin B. A fifth alternative was evaluated by Burns & McDonnell and the results of that analysis were incorporated into this report.

Alternative 1 – Diversion to Agricultural Reserve Reservoir (CERP)

Alternative 2 – Chemical treatment

Alternative 3 – Biological treatment (STA on 375 acres of District-owned land)

Alternative 4 – Biological treatment (STA – no land area restriction)

Alternative 5 – Modify STA-1E to Allow Diversion of ACME Basin B Runoff to STA-1E

Table ES-1 summarizes the results of the technical analyses of the five alternatives for ACME Basin B. Complete descriptions of alternatives 1-4, as well as a detailed discussion of the analysis results and evaluation ratings for each alternative, are presented in Section 3 of this report. Burns and McDonnell's analysis of Alternative 5 is presented in Appendix D.

Table ES-1.
Summary of Analysis Results for ACME Basin B Alternatives

Parameter	Base Cond.	Alt. 1Diversion	Alt. 2 CTSS	Alt. 3 STA	Alt. 4 STA	Alt. 5[d] STA 1E
TP Removal Performance						
TP load reduction, percent [a]	25	86	62	72	73	79
TP flow-weighted mean, ppb	71	71	27	19-27[b]	17-26[b]	15-24[b]
TP geometric mean, ppb	71	71	10	12-15[b]	10-14[b]	10[c]-11[b]
Implementation Schedule						
Time to implement, years	-	4	3	6	7	4
Completion date	-	2013	2006	2008	2009	2006
Cost (2002 dollars)						
Capital cost, $ million	-	27.25	26.11	21.81	23.48	7.52
Average O&M cost, $ million/year	-	0.26	1.26	0.26	0.26	0.25
50-year present worth, $ million	-	32.84	53.66	27.22	28.63	12.06
Cost effectiveness, $/kg removal	-	278	631	275	285	112
Qualitative Criteria Ratings						
Operational flexibility, -3/+3	-	0	+1	+1	+1	0
Resiliency to extreme conditions, -4/+4	-	+4	+4	+2	+2	+1
Assessment of full-scale construction/O&M, -3/+3	-	+3	+1	+1	+1	+1
Management of side streams, -3/+3	-	0	-2	0	0	-1
Improvement in non-P parameters, -19/+19	-	0	-3	+5	+5	+2

[a] Base Condition load reduction is relative to original baseline data set; all other TP load reductions are incremental to Base Condition
[b] Range of predicted values using different model calibration data sets
[c] Computed value is less than calibration range; lowest sustainable concentration is reported.
[d] Increased conveyance capacity may be needed for a portion of the C-51W Canal to accommodate the ACME Basin B flows, however, no costs have been included for this potential conveyance capacity increase.

C-11 West Basin

The C-11 West Basin is located in south central Broward County. Land use is almost entirely urban residential and commercial. There is very little undeveloped land remaining in the basin. Drainage is to the C-11 West Canal which conveys water west to the S-9 pump station for discharge into Water Conservation Area (WCA) 3A. As simulated in the baseline data set, an average of 194,167 acre-feet per year of water and an average of 4,065 kg per year of TP are discharged into WCA 3A through the S-9 pump station. This equates to a long-term flow-weighted mean TP concentration of 17 ppb.

Two CERP projects will dramatically reduce discharges of flow and TP load to the EPA beginning in 2007. A majority of the runoff from the C-11 West Basin will be diverted away from the EPA by the Western C-11 Impoundment and Diversion Canal CERP project, currently scheduled for completion

by the end of 2006. Then in 2036, an additional diversion by the North Lake Belt Storage Area CERP project will occur. After 2036, only a very small percentage of the current runoff from the C-11 West Basin will need to be managed.

The flows and loads remaining after the diversions by the two CERP projects were used to analyze alternatives for meeting long-term water quality objectives in discharges from the C-11 West Basin. Three alternatives were analyzed:

Alternative 1 – Chemical treatment

Alternative 2 – Biological treatment (STA)

Alternative 3 – Base Condition

Table ES-2 summarizes the results of the technical analyses of the three alternatives for the C-11 West Basin. Complete descriptions of the alternatives, as well as a detailed discussion of the analysis results and evaluation ratings for each of the alternatives, are presented in Section 4 of this report.

Table ES-2.
Summary of Analysis Results for C-11 West Basin Alternatives

Parameter	Alternative 1 CTSS	Alternative 2 STA	Alternative 3 Base Condition
TP Removal Performance			
TP load reduction, percent	29	39	0
TP flow-weighted mean, ppb	19	14-16[a]	24
TP geometric mean, ppb	10	10-14[a]	21
Implementation Schedule			
Time to implement, years	4	9.5	NA[b]
Completion date	2006	2012	NA[b]
Cost (2002 dollars)			
Capital cost, $ million	109.37	297.54	0
Average O&M cost, $ million/year	0.84	0.24	0
50-year present worth, $ million	120.05	290.64	0
Cost effectiveness, $/kg removal	26,560	48,024	0
Qualitative Criteria Ratings			
Operational flexibility, -3/+3	0	+1	0
Resiliency to extreme conditions, -4/+4	+4	+1	0
Assessment of full-scale construction/O&M, -3/+3	+1	-2	0
Management of side streams, -3/+3	-2	0	0
Improvement in non-P parameters, -19/+19	-3	+5	0

[a] Range of predicted values using different model calibration data sets
[b] Not applicable

Feeder Canal Basin

The Feeder Canal Basin is located in southeastern Hendry County, immediately north of the Big Cypress National Preserve. Land use is primarily agricultural. About 10,000 acres of the Big Cypress Seminole Indian Reservation makes up the southeast corner of the basin. Drainage is to the North Feeder Canal and West Feeder Canal, which make up the eastern and southern borders of the basin, respectively. Flow collected in these canals is discharged through the S-190 Structure (gated spillway) into the L-28 Interceptor Canal, which conveys it about 15 miles southeast for discharged into WCA 3A. An average of 77,179 acre-feet per year of water and an average of 14,854 kg per year of TP are discharged into WCA 3A. This equates to a long-term flow-weighted mean TP concentration of 156 ppb.

Several projects that are ongoing or in the planning stages will impact future discharges to the EPA from the Feeder Canal Basin. These include (1) source controls on the McDaniel Ranch property in the northeast portion of the basin, (2) the Seminole Tribe's Water Conservation Plan, a federally funded Critical Project, and (3) the L-28 Interceptor Modifications CERP project. It is not known how these projects will ultimately affect flows and TP loads from the Feeder Canal Basin, except that TP loads are expected to be reduced significantly. For the purposes of evaluating alternatives, it was assumed that baseline flows would remain the same in the future, but that TP concentrations would be reduced to about 50 ppb consistent with proposed discharge limits in permits and agreements associated with McDaniel Ranch and the Seminole Tribe.

Two alternatives were considered in the Feeder Canal Basin for meeting long-term water quality objectives in discharges to the EPA:

Alternative 1 – Biological treatment (STA)

Alternative 2 – Base Condition

Table ES-3 summarizes the results of the technical analyses of the two alternatives for the Feeder Canal Basin. Complete descriptions of the alternatives, as well as a detailed discussion of the analysis results and evaluation ratings for each alternative, are presented in Section 5 of this report.

Table ES-3.
Summary of Analysis Results for Feeder Canal Basin Alternatives

Parameter	Alternative 1 STA	Alternative 2 Base Condition
TP Removal Performance		
TP load reduction, percent	54	0
TP flow-weighted mean, ppb	26-40[a]	58
TP geometric mean, ppb	10-13[a]	27
Implementation Schedule		
Time to implement, years	7.5	NA[b]
Completion date	2010	NA[b]
Cost (2002 dollars)		
Capital cost, $ million	91.95	0
Average O&M cost, $ million/year	0.66	0
50-year present worth, $ million	105.45	0
Cost effectiveness, $/kg removal	698	0
Qualitative Criteria Ratings		
Operational flexibility, -3/+3	+2	0
Resiliency to extreme conditions, -4/+4	+2	0
Assessment of full-scale construction/O&M, -3/+3	-1	0
Management of side streams, -3/+3	0	0
Improvement in non-P parameters, -19/+19	+5	0

[a] Range of predicted values using different model calibration data sets
[b] Not applicable

L-28 Basin

The L-28 Basin is located immediately east of the Feeder Canal Basin where Broward, Collier, Hendry, and Palm Beach Counties come together. Land use is primarily agricultural. Portions of the Seminole and Miccosukee Indian Reservations and the Big Cypress National Preserve are located within the basin. Drainage is generally to the east to the L-28 Borrow Canal, which conveys runoff from the basin to the S-140 pump station. The S-140 pump station discharges flow directly into WCA 3A. An average of 83,806 acre-feet per year of water and an average of 3,982 kg per year of TP are discharged into WCA 3A. This equates to a long-term flow-weighted mean TP concentration of 39 ppb.

The Seminole Tribe's Water Conservation Plan and the Miccosukee Tribe's Water Management Plan, both federally funded Critical Projects that are scheduled for completion by 2005 and 2010, respectively, may impact future stormwater flows and TP loads from the L-28 Basin. However, these impacts cannot be quantified at this time. Because of this, and because TP loads from the L-28 Basin are already relatively low, the effects of these projects were not included in the evaluation. The

simulated baseline flows and loads over the 31-year period of simulation were used for the evaluation of alternatives in this basin.

Two alternatives were considered in the L-28 Basin for meeting long-term water quality in discharges to the EPA:

Alternative 1 – Biological treatment (STA)

Alternative 2 – Base Condition

Table ES-4 summarizes the results of the technical analyses of the two alternatives for the L-28 Basin. Complete descriptions of the alternatives, as well as a detailed discussion of the analysis results and evaluation ratings for each alternative, are presented in Section 6 of this report.

Table ES-4.
Summary of Analysis Results for L-28 Basin Alternatives

Parameter	Alternative 1 STA	Alternative 2 Base Condition
TP Removal Performance		
TP load reduction, percent	66	0
TP flow-weighted mean, ppb	12-15[a]	39
TP geometric mean, ppb	10-11[a]	39
Implementation Schedule		
Time to implement, years	8.5	NA[b]
Completion date	2011	NA[b]
Cost (2002 dollars)		
Capital cost, $ million	35.70	0
Average O&M cost, $ million/year	0.40	0
50-year present worth, $ million	43.11	0
Cost effectiveness, $/kg removal	327	0
Qualitative Criteria Ratings		
Operational flexibility, -3/+3	+2	0
Resiliency to extreme conditions, -4/+4	+2	0
Assessment of full-scale construction/O&M, -3/+3	-2	0
Management of side streams, -3/+3	0	0
Improvement in non-P parameters, -19/+19	+4	0

[a] Range of predicted values using different model calibration data sets
[b] Not applicable

North New River Canal Basin

The North New River Canal (NNRC) Basin is located in east central Broward County, immediately north of the C-11 West Basin. Land use in the basin is primarily high density urban residential and commercial development. Agricultural and rural land uses are rapidly being replaced with urban land uses as development in the basin continues.

Drainage in the NNRC Basin is to the North New River Canal which conveys urban stormwater runoff east for discharge through the G-54 Structure (Sewell Lock). When water levels are low in WCA 3A, the G-123 pump station is used to discharge excess water from the North New River Canal, if available, to WCA 3A. Because the G-123 pump station is located at the far western end of the North New River Canal, limited amounts of urban drainage from the NNRC Basin backflow west to the pump station. An average of 1,781 acre-feet per year of water and an average of 40 kg per year of TP are discharged to WCA 3A through the G-123 pump station. This equates to a long-term flow-weighted mean TP concentration of 18 ppb.

A CERP project, scheduled for completion by 2018, will include a divide structure across the North New River Canal at Markham Park. This divide structure will eliminate the mixing of urban stormwater runoff with seepage water from WCA 2B. After the CERP project is completed, the G-123 pump station will be taken out of service and seepage water will be routed south in a new canal to the Everglades National Park. Urban stormwater runoff from the NNRC Basin will continue to be conveyed east through the North New River Canal.

Three alternatives were considered for addressing long-term water quality objectives in discharges to the EPA prior to completion of the CERP project in 2018:

Alternative 1 – Chemical treatment (2007-2018)

Alternative 2 – Shut down G-123 pump station in 2006

Alternative 3 – Base Condition

Table ES-5 summarizes the results of the technical analyses of the three alternatives for the NNRC Basin. Complete descriptions of the alternatives, as well as a detailed discussion of the analysis results and evaluation ratings for each alternative, are presented in Section 7 of this report.

Table ES-5.
Summary of Analysis Results for NNRC Basin Alternatives

Parameter	Alternative 1 CTSS	Alternative 2 G-123 off 2006	Alternative 3 Base Condition
TP Removal Performance			
TP load reduction, percent	80[a]	100[a]	76[a]
TP flow-weighted mean, ppb	15[b]	NA[c]	18[b]
TP geometric mean, ppb	10[b]	NA[c]	18[b]
Implementation Schedule			
Time to implement, years	4	0	NA
Completion date	2006	2006	2018
Cost (2002 dollars)			
Capital cost, $ million	30.99	0	0
Average O&M cost, $ million/year	0.58	0	0
50-year present worth, $ million	31.86	0	0
Cost effectiveness, $/kg removal	379,328	0	0
Qualitative Criteria Ratings			
Operational flexibility, -3/+3	0	0	0
Resiliency to extreme conditions, -4/+4	+4	0	0
Assessment of full-scale construction/O&M, -3/+3	+1	0	0
Management of side streams, -3/+3	-2	0	0
Improvement in non-P parameters, -19/+19	-3	0	0

[a] Includes TP load reduction due to CERP

[b] 2007 to 2018 only

[c] Not applicable

North Springs Improvement District

The North Springs Improvement District (NSID) Basin is located in northern Broward County. It is bordered on the west by the L-36 Borrow Canal and WCA 2A and on the north by the Palm Beach County line. Land use in the basin is primarily urban residential. Some agricultural land still exists in the northern portion of the basin, but this is rapidly being converted to urban land uses as development continues.

Drainage from the basin is collected in series of interconnected canals and lakes and is conveyed to two pump stations, NSID Pump No. 1 and NSID Pump No. 2. Both pump stations discharge to the L-36 Borrow Canal which conveys the water north to the Hillsboro Canal. However, when the L-36 and Hillsboro Canal reach capacity and cannot accept any additional flow, discharges to the L-36 Borrow Canal from both NSID pump stations are stopped and NSID Pump No. 1 discharges up to 200,000 gallons per minute (gpm) of flow directly into WCA 2A. An average of 6,168 acre-feet per year of water and an average of 293 kg per year of TP are discharged into WCA 2A through NSID Pump No. 1. This equates to a long-term flow-weighted mean TP concentration of 39 ppb.

The Hillsboro Site 1 CERP Project, scheduled for completion by late 2007, will include the construction of a large water storage area on the north side of the Hillsboro Canal. NSID bypass flows have been included in the planning of this CERP project. Therefore, only diversion alternatives were considered for this basin.

Three diversion alternatives were considered for the management of discharges to the EPA from the NSID Basin:

Alternative 1 – Temporary off-site diversion (2007) with permanent diversion to Hillsboro Site 1 Project (CERP)

Alternative 2 – Permanent off-site diversion (Non-CERP)

Alternative 3 – Base Condition

Table ES-6 summarizes the results of the technical analyses of the three alternatives for the NSID Basin. Complete descriptions of the alternatives, as well as a detailed discussion of the analysis results and evaluation ratings for each alternative, are presented in Section 8 of this report.

Table ES-6.
Summary of Analysis Results for NSID Basin Alternatives

Parameter	Alternative 1 Temporary Diversion	Alternative 2 Permanent Diversion	Alternative 3 Base Condition
TP Removal Performance			
TP load reduction, percent	100[a]	100[a]	98[a]
TP flow-weighted mean, ppb	NA[c]	NA[c]	39[b]
TP geometric mean, ppb	NA[c]	NA[c]	39[b]
Implementation Schedule			
Time to implement, years	4	4	NA
Completion date	2006	2006	2007
Cost (2002 dollars)			
Capital cost, $ million	26.98	107.97	0
Average O&M cost, $ million/year	0.08	0.29	0
50-year present worth, $ million	26.06	110.51	0
Cost effectiveness, $/kg removal	88,956	7,543	0
Qualitative Criteria Ratings			
Operational flexibility, -3/+3	0	+2	0
Resiliency to extreme conditions, -4/+4	+4	+4	0
Assessment of full-scale construction/O&M, -3/+3	+3	+3	0
Management of side streams, -3/+3	0	0	0
Improvement in non-P parameters, -19/+19	0	0	0

[a] Includes TP load reduction due to CERP
[b] 2007 only
[c] Not applicable

1. Introduction

This report documents work performed by the Brown and Caldwell consulting team related to the preparation of Basin Specific Feasibility Studies for achieving long-term water quality goals in discharges from six Everglades Stormwater Program (ESP) basins that discharge to the Everglades Protection Area (EPA). Discharges from these basins are regulated under the provisions of Florida's Everglades Forever Act of 1994 (F.S. 373.4592). The work was performed for the South Florida Water Management District (District) under Professional Services Contract C-E024.

1.1 Background

The 1994 Everglades Forever Act (EFA) established both interim and long-term water quality goals for restoration and preservation of the EPA. As defined in the EFA, the EPA consists of the Arthur R. Marshall Loxahatchee National Wildlife Refuge (Water Conservation Area 1); Water Conservation Areas 2A, 2B, 3A and 3B; and Everglades National Park.

Activities have been underway by the District, the Florida Department of Environmental Protection (FDEP), the U.S. Army Corps of Engineers (USACE), other governmental agencies, and private landowners for the past 8 years to achieve the interim goal of reducing total phosphorus (TP) discharges to the EPA from the Everglades Agricultural Area (EAA) and other sources to a long-term, flow-weighted mean concentration of 50 parts per billion (ppb). These activities have included source controls, such as on-farm 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 EAA runoff from seven hydrologic basins, all of which drain to the EPA.

Concurrent with the ECP, the District is implementing the ESP, which includes the eight other tributary basins that discharge flow to the EPA. As called for in the EFA, one of the primary goals of the ESP is to assure that discharges to the EPA from non-ECP basins also meet the long-term water quality objectives. ESP activities to date have included evaluating existing programs, permits and water quality data; establishing additional water quality monitoring programs; developing regulatory action strategies (RAS) for new permits and modifications to existing permits; and working with local communities and drainage districts through cooperative agreements to implement local programs for improving water quality.

Additionally, the District and other groups are conducting water quality research projects, developing ecosystem-wide planning programs (e.g. the Comprehensive Everglades Restoration Plan, or CERP) and formulating regulatory programs, all designed to ensure a sound basis for future decision making related to satisfaction of long-term water quality goals.

The EFA requires that the FDEP establish a long-term numerical standard for TP discharges to the EPA. The EFA further states that if FDEP does not adopt this standard by December 31, 2003, the standard shall default to 10 ppb. The existing USACE permit for the ECP requires that, "…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 Environmental Regulatory Commission (ERC)." Recently, the FDEP proposed a 10 ppb geometric mean TP concentration as the numeric phosphorus criterion for the freshwater portions of the EPA. Accordingly, for the Basin Specific Feasibility Studies, the District used a planning level water quality target of 10 ppb TP (computed as a geometric mean) for all discharges to the EPA as a whole and individually from each ECP and ESP tributary basin.

The EFA mandates that Advanced Treatment Technologies (ATTs) be investigated to achieve the long-term numerical standard for TP. Research on ATTs has been sponsored by the District, the FDEP, the USACE and other agencies over the past 7 years and will continue. Dozens of biological and chemical treatment technologies, with potential to achieve very low TP concentrations, have been investigated to date. This research has led to two general approaches for meeting long-term water quality goals: (1) biological treatment using STAs consisting of emergent vegetation, submerged aquatic vegetation (SAV), periphyton, or some combination of these three vegetation types; and (2) chemical treatment followed by solids separation (CTSS). The results of research on these ATTs have been presented in demonstration project final reports using a standardized format to facilitate their comparison (*Supplemental Technology Standard of Comparison).* Research efforts continue to refine the engineering requirements, performance characteristics, and costs associated with these treatment technologies.

The goal of the EFA is to identify and implement the optimal combination of source controls, STAs, ATTs and/or regulatory programs to ensure that all waters discharged to the EPA achieve long-term water quality goals by December 31, 2006. Permit applications to satisfy this objective must be submitted to the FDEP by December 31, 2003. To facilitate the planning and decision-making process, the District is conducting Basin Specific Feasibility Studies. These studies are intended to combine the results of research and planning studies with regulatory programs and individual basin characteristics to identify an optimal combination of source controls and basin-scale treatment to meet long-term water quality objectives.

1.2 Project Objective

The objective of the Basin Specific Feasibility Studies documented in this report was to provide a comparative evaluation of alternatives for meeting the long-term water quality goals for discharges from six ESP basins currently contributing flow to the EPA. Accordingly, evaluation and rating of alternatives against common evaluation criteria was performed. However, it is not the purpose of the Basin Specific Feasibility Studies to rank alternatives or to suggest a preferred alternative in any of the basins considered. Rather, the District and other stakeholders will use the information generated in these Basin Specific Feasibility Studies as part of a subsequent decision-making process to recommend an alternative for implementation in each basin.

1.3 Description Of Work

Basin Specific Feasibility Studies were conducted for six ESP basins that discharge to the EPA. The six basins investigated in this project are as follows:

1. ACME Basin B
2. C-11 West Basin
3. Feeder Canal Basin
4. L-28 Basin
5. North New River Canal Basin
6. North Springs Improvement District Basin

The locations of the six basins are illustrated in Figure 1-1. The basins include a wide variety of land uses. The C-11 West, North New River Canal, and North Springs Improvement District Basin are densely developed urban basins. ACME Basin B is characterized by rural and low-density residential development and agriculture, and the Feeder Canal and L-28 Basins are dominated by agricultural land uses.

Preparation of the Basin Specific Feasibility Studies included three major elements of work:

1. Peer review and finalization of the draft Evaluation Methodology prepared by the District for use in evaluating the alternatives in this project.
2. Peer review and finalization of draft alternatives prepared by the District for meeting water quality goals in each basin.
3. Evaluation and rating of alternatives in each basin according to the final Evaluation Methodology established in Item 1 above.

A detailed discussion of the methodology used to evaluate alternatives is presented in Section 2. Descriptions of the alternatives in each basin and the results of the evaluations performed on the alternatives are presented in Sections 3 through 8. Supporting documentation is included in the appendices.

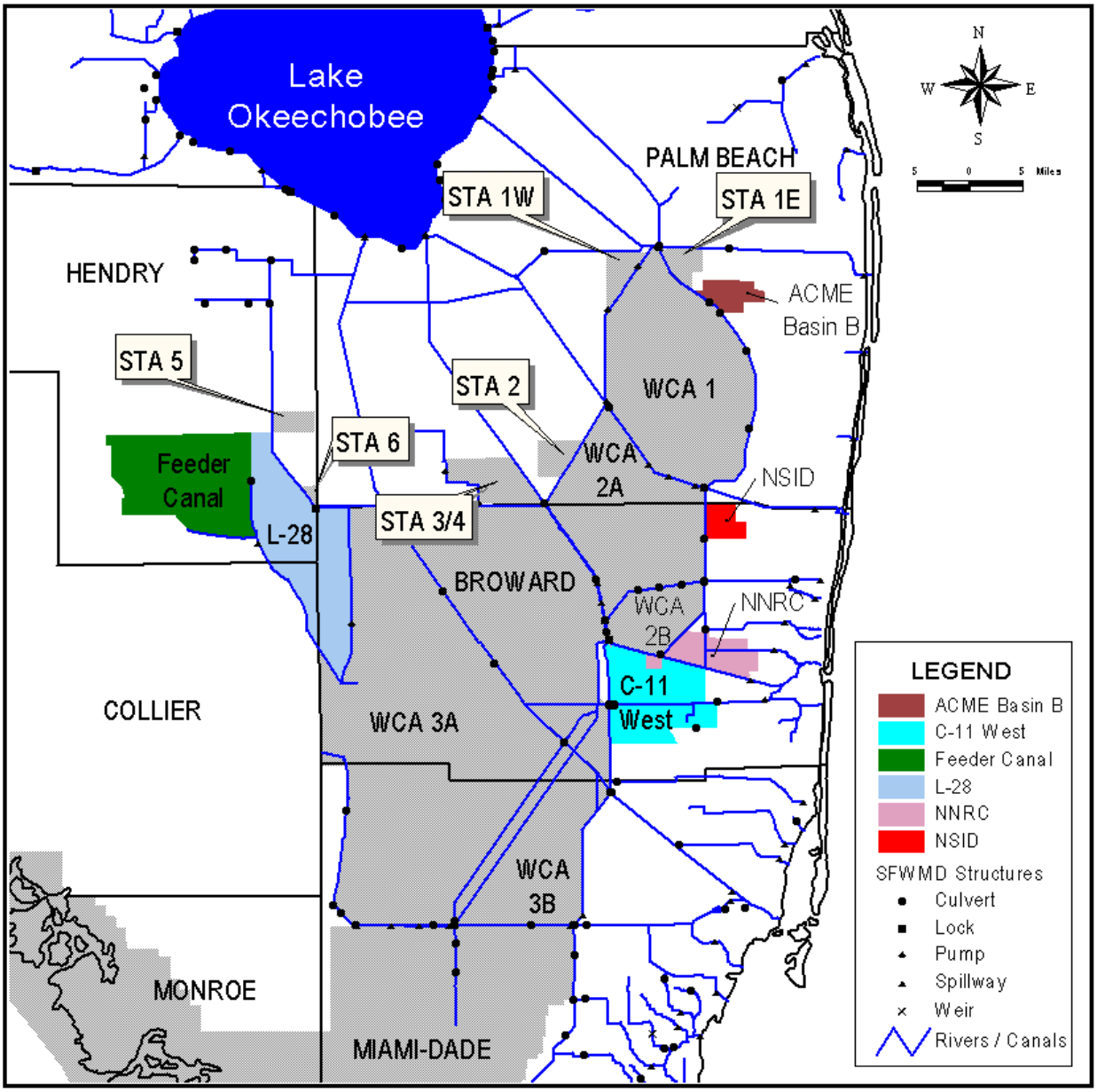


Figure 1-1.
Everglades Stormwater Program Basins

2. Basis For Development And Evaluation Of Alternatives

This section includes background information that provides the basis for the development and evaluation of alternatives in the Basin Specific Feasibility Studies. The baseline flows and loads for each of the six Everglades Stormwater Program (ESP) basins investigated are presented, followed by a summary of the evaluation methodology used to evaluate the alternatives. Also included is an overview of how source controls and biological and chemical treatment technologies were analyzed during the alternatives evaluation. Finally, uncertainties associated with the investigations are discussed. To the extent practicable, these uncertainties will require further study and clarification prior to the design and construction of any capital improvements in the ESP basins.

2.1 Baseline Flows and Loads

Baseline flows and total phosphorus (TP) loads for each basin were simulated by the South Florida Water Management District (District) as the basis for analysis of alternatives in this investigation (*Baseline Data for the Basin Specific Feasibility Studies to Achieve the Long-Term Water Quality Goals for the Everglades, SFWMD, May 2001*). The baseline data set consists of daily flow and TP loads for each basin for the 31-year period from 1965 to 1995. The daily flows and loads were estimated by combining simulated flow values from the South Florida Water Management Model with historic TP concentrations from water years 1990-1999. Table 2-1 summarizes the simulated average annual discharge and TP load to the Everglades Protection Area (EPA) from each basin.

Table 2-1
Summary of Simulated Baseline Flows and Phosphorus Loads, 1965-1995

Basin	EPA Receiving Water	Mean Annual Discharge to EPA, acre-feet	Mean Annual TP Load to EPA, kg	Flow-weighted Mean TP Concentration, ppb
ACME Basin B	WCA 1	31,499	3,660	94
C-11 West	WCA 3A	194,167	4,063	17
Feeder Canal	WCA 3A	77,179	14,854	156
L-28	WCA 3A	83,806	3,982	39
North New River Canal	WCA 3A	1,781	40	18
North Springs Improvement District	WCA 2A	6,168	293	39

Source: Baseline Data for the Basin Specific Feasibility Studies to Achieve the Long-Term Water Quality Goals for the Everglades, SFWMD, May 2001

For alternatives involving future diversions of flow to Comprehensive Everglades Restoration Program (CERP) projects, additional post-diversion data sets were prepared by the District to simulate those future conditions. Those additional data sets are described in detail in subsequent sections of this report dealing with the basins involved.

2.2 Methodology For Comparative Evaluation of Alternatives

As input to the Basin Specific Feasibility Studies, the District prepared a draft Evaluation Methodology, dated August 31, 2001, describing the analytical methods to be used in the technical analyses of alternatives and the procedures to be used in rating the alternatives against a common set of evaluation criteria. The Brown and Caldwell consulting team was tasked with providing peer review of the draft Evaluation Methodology document. On October 15, 2001, the Brown and Caldwell team submitted a letter report to the District summarizing the peer review comments. This letter report, as well as the comments of others who reviewed the draft Evaluation Methodology document, was made available for public review on the District's website. After a series of subsequent revision drafts, the District finalized the Evaluation Methodology document in July 2002 *(Final Evaluation Methodology for the Water Quality Improvement Strategies for the Everglades, SFWMD, July 31, 2002)*. Important elements of the final Evaluation Methodology are summarized in Section 2.2.1 through 2.2.4 below.

2.2.1 Planning Level Water Quality Target for Total Phosphorus

A key element of the Evaluation Methodology is the definition of the planning level target for TP concentration in discharges to the EPA after December 31, 2006. The Everglades Forever Act (EFA) requires the Florida Department of Environmental Protection (FDEP) to adopt a numeric phosphorus standard for discharges to the EPA by the end of 2003. If it does not, a default criterion of 10 ppb TP will be set. The FDEP has proposed a 10 ppb geometric mean TP concentration as the numeric phosphorus criterion for the freshwater portions of the EPA. While it is not known what numeric standard will ultimately be adopted, it is reasonable to expect that it will be close to 10 ppb. Therefore, the Evaluation Methodology for the Basin Specific Feasibility Studies established that all biological and chemical treatment facilities be sized to achieve a long-term TP concentration of 10 ppb, calculated as the geometric mean of the weekly flow-weighted means over the 31-year period of simulation. For chemical treatment facilities with the capability to achieve less than 10 ppb TP, the Evaluation Methodology allows for blending of treated and untreated water to achieve the 10 ppb planning level target.

2.2.2 Analysis of Phosphorus Reduction Options

Three approaches have been proposed for reducing TP concentrations in future stormwater discharges to the Everglades: source controls, biological treatment, and chemical treatment. Diversion of flow away from the EPA, to CERP projects or other storage impoundments, has also been proposed in some basins, but this approach is basin-specific and, in most cases, does not require reduction of TP concentration in the runoff being diverted away from the EPA. The

Evaluation Methodology identifies the general concepts to be used in analyzing source controls, biological treatment options, and chemical treatment options. Each of these are briefly described below.

2.2.2.1 Source Controls

For the purpose of the Basin Specific Feasibility Studies, source controls are practices that can be implemented locally or at the basin level to reduce the quantity of phosphorus in stormwater runoff. These practices may include urban and agricultural best management practices (BMPs), educational programs, and regulatory actions, all focused on reducing the TP load in stormwater discharges generated within the basin.

For urban land uses, BMPs may include practices such as leaving buffer strips between developments and drainage canals, controlling illicit discharges, use of low phosphorus content fertilizers, and detention ponds. For agricultural land uses, BMPs may include fertilizer management, flow diversions, stormwater detention and/or retention, use of cover crops and buffer strips, animal waste management, and canal maintenance. An important element in the successful implementation of urban and agricultural BMP programs is public education. Making people aware of the problem and the part they can play in solving it is critical, particularly with voluntary BMP programs.

Regulatory programs target drainage structures or systems where new permits or modifications to existing permits can be used to improve water quality. Regulatory programs can also include basin rules where BMPs and other practices to improve water quality are regulated by rule.

Source controls, primarily in the form of agricultural BMPs, have been highly successful in reducing TP loads in stormwater runoff from the Everglades Agricultural Area (EAA). On the order of 50 percent of the TP load has been eliminated as the result of on-farm management practices in the EAA over the past 6 years. Unfortunately, similar data on which to base projections of future TP reduction from BMPs in the ESP basins do not presently exist. Agricultural land uses in ACME Basin B, Feeder Canal Basin, and the L-28 Basin are substantially different than in the EAA and very little data has been generated from implementation of urban BMPs in Florida, particularly with respect to TP reduction.

Given the lack of available data directly related to the potential performance of source controls in the ESP basins, it was necessary to make several assumptions for use in the analysis of alternatives. These assumptions included the following:

1. Source controls will not change the 31-year baseline flows for the basin.

2. Source controls could be implemented and the associated TP reductions could be achieved by December 31, 2006.

3. In some basins, a specific TP load reduction was assumed for the base case analysis as a result of implementing source controls. Additionally, in all six ESP basins investigated, sensitivity analyses

were preformed to determine the impact of varying levels of TP load reduction form source controls on treatment facility sizing and TP discharges to the EPA.

Because source control programs are likely to vary widely between basins, and because no representative cost data are available regarding their implementation, capital and operating costs associated with implementation of source controls were not considered in this analysis. This does not adversely impact the evaluation of alternatives, however, because source controls were applied uniformly to all alternatives for a given basin and an alternative was compared only against other alternatives within the same basin. Therefore, differences in the cost of source controls between basins do not influence the evaluation of any individual alternative or group of alternatives.

2.2.2.2 Biological Treatment Options

For the purposes of the Basin Specific Feasibility Studies, biological treatment is defined as the treatment of stormwater runoff in constructed wetland treatment systems, referred to as stormwater treatment areas (STAs). Depending on the TP concentration in the stormwater to be treated, the required outflow TP concentration, and other factors specific to the basin and the STA site involved, the types of vegetative communities best suited for a particular STA may include emergent macrophytes, submerged aquatic vegetation, and/or periphyton. In the past, STA designs have been based on a steady-state model that relies on settling rate to predict phosphorus removal performance. Recently, an improved analytical tool for predicting phosphorus removal in STAs was developed *(Kadlec and Walker, 2001)*. Referred to as the Dynamic Model for Stormwater Treatment Areas (DMSTA), this model incorporates much of the knowledge gained from the operation of existing full-scale STAs, as well as research studies into advanced biological treatment technologies. The Evaluation Methodology established that DMSTA be used to analyze all of the alternatives with biological treatment components. A more detailed description of DMSTA and how it was applied in the ESP basin investigations is presented in Section 2.4.

The Evaluation Methodology requires that the baseline flows and loads for each basin be used in DMSTA to identify the vegetative community (or communities) and the STA configuration that is capable of achieving the planning level water quality target of 10 ppb TP on the least possible land area. If it is not possible to achieve the planning level target of 10 ppb, the Evaluation Methodology requires that the lowest sustainable TP concentration be reported. The results of the analyses of biological treatment options using DMSTA are presented in Sections 3 through 6 of this report.

2.2.2.3 Chemical Treatment Options

Chemical treatment followed by solids separation (CTSS) has been shown in several demonstration projects to be capable of reducing TP concentrations well below the 10 ppb planning level target *(HSA Engineers & Scientists, 2000, 2001, 2002)*. Consequently, CTSS is considered a potentially viable alternative to biological treatment for reduction of TP concentrations in discharges to the Everglades.

Conceptually, the CTSS process is similar to conventional water treatment processes where metal salts (iron and aluminum) are used to precipitate out constituents of concern, in this case phosphorus. The solids generated by the precipitation process are separated from the water column by sedimentation or filtration processes and the treated water is discharged to a downstream receiving water body, in this case a Water Conservation Area (WCA). The residual solids are either disposed of on-site in a dedicated disposal area, or dewatered and hauled to a permitted disposal facility off-site. A more detailed description of the CTSS process analyzed for the Basin Specific Feasibility Studies is presented in Section 2.5.

Because stormwater runoff typically has high peak flows compared to average annual flows, flow equalization is normally used to allow a smaller capacity CTSS treatment plant to be constructed. HSA Engineers & Scientists developed a CTSS spreadsheet model that allows the investigator to identify the least costly combination of CTSS treatment capacity and flow equalization storage volume (*Chemical Treatment Followed by Solids Separation Advanced Technology Demonstration Project, HSA Engineers & Scientists, December 2001*). The Evaluation Methodology established that the CTSS spreadsheet model could be used to analyze those alternatives including chemical treatment components. A discussion of the CTSS spreadsheet model is presented in Section 2.5.

2.2.3 Cost Estimates

The Evaluation Methodology requires that capital and annual operation and maintenance (O&M) costs be prepared for the purpose of calculating the 50-year present worth of each alternative. To facilitate the cost estimating process, the District provided general unit cost information for capital improvements and annual O&M expenses to be applied in all ESP basins. These unit costs were originally developed for use in the Supplemental Technology Standard of Comparison (STSOC) demonstration projects and were subsequently updated by the District. The District also developed basin-specific estimates for land acquisition costs based upon acreage requirements provided by Brown and Caldwell.

2.2.3.1 Capital Costs

Capital costs include costs for initial implementation of an alternative, including construction of pumping stations, water control structures, levees, canals, impoundments, and other facilities necessary for the conveyance, storage and/or treatment of stormwater flows from the ESP basins. The District provided unit costs for many of the capital cost components comprising the alternatives. Where unit costs for capital cost components were not provided by the District, they were developed by the Brown and Caldwell team.

It should be noted that siting of conveyance, storage and treatment facilities was not an objective of the Basin Specific Feasibility Studies. Therefore, in most basins, the locations of these facilities are not defined. Because of this, it is not possible to quantify certain capital costs that may be associated with implementation of some alternatives. Examples of these costs include (1) wetlands mitigation costs, and (2) costs for internal drainage system improvements. Except where specific cost estimates were prepared by the District for these improvements, they were not quantified for any of the

alternatives evaluated. In no case were costs for these improvements included in the 50-year present worth analysis.

In addition to the cost of actual construction, capital costs also include costs associated with planning and design, construction management and program management. Additionally, in planning level investigations such as this, it is customary to include a contingency to account for unforeseen project requirements and for project elements that cannot be fully defined until site-specific data is available. In this analysis, capital costs were developed as follows:

1. Base construction costs were estimated using unit cost data supplied by the District.

2. Planning and design costs were estimated at 10 percent of the base construction costs.

3. Construction and program management costs were estimated at 10 percent of the base construction cost.

4. A 30 percent contingency cost was applied to the total of Item Nos. 1-3 above.

Total capital cost was computed as the total of Item Nos. 1-4 above. Spreadsheets detailing capital cost estimates for each of the ESP basin alternatives are included in Appendix A of this report.

Equipment refurbishment and replacement costs were also considered in the estimation of project costs. For example, pumping stations were assumed to be refurbished every 25 years at 25 percent of their original construction cost and chemical feed equipment was assumed to be refurbished every 10 years at 60 percent of its original cost. These costs are considered recurring capital costs. However, no design, construction management or contingency allowances were applied to these costs in future years.

2.2.3.2 Land Acquisition Costs

Land acquisition is required in some ESP basin alternatives for biological or chemical treatment facilities. For other alternatives, right-of-way is required for diversion canals or additional land area is required for construction of storage and pumping facilities.

Wherever land or right-of-way acquisition was needed to implement an alternative, Brown and Caldwell provided an estimate of the acreage required to the District. The District's Real Estate Division reviewed the acreage requirements and estimated an approximate price for land acquisition based upon previous transaction data. A separate contingency factor ranging from 10 percent to 40 percent was applied to the estimated land cost at the direction of the District.

2.2.3.3 Annual Operation and Maintenance (O&M) Costs

Annual O&M costs include all expenses associated with the operation and maintenance of facilities comprising an alternative. Examples include (1) labor, spare parts, energy consumption, and building and grounds maintenance at pumping stations; (2) vegetation control and maintenance of

canals, levees, culverts and control structures at STAs; and (3) labor, chemical utilization, process control testing, and maintenance of chemical feed equipment and other facilities at chemical treatment plants. The District provided unit costs for most of the annual O&M cost components included in the alternatives. Where unit costs for O&M cost components were not provided by the District, they were developed by the Brown and Caldwell team. At the direction of the District, a 30 percent contingency factor was applied to the sum of the annual O&M costs for each alternative to account for unforeseen project requirements. Spreadsheets detailing estimates of annual O&M costs for each of the ESP basin alternatives are included in Appendix A of this report.

2.2.3.4 Present Worth

A 50-year present worth was calculated for each alternative. The 50-year present worth period was assumed to begin in the first year that costs would be incurred during implementation of an alternative. For example, if implementation of an alternative begins in 2003 and the alternative begins operation in 2007, its present worth would be calculated over the period 2003-2052 with all costs brought back to 2002 dollars. Likewise, if the implementation of an alternative begins in 2009 and operations begin in 2014, the present worth would be calculated over the period 2009-2058 with all costs brought back to 2002 dollars.

In calculating present worth, all future costs were escalated at the rate of 3 percent per year to account for the effects of inflation. As described in the Evaluation Methodology, a discount rate of 6-3/8 percent was used to bring escalated future costs back to 2002 dollars. The discount rate, net of inflation, was therefore 3-3/8 percent.

2.2.4 Evaluation Criteria

The Evaluation Methodology includes a total of ten evaluation criteria, consisting of five quantitative criteria and five qualitative criteria. Rating of alternatives against the quantitative criteria is based upon the results of the technical analyses performed as part of these Basin Specific Feasibility Studies. For the qualitative criteria, a numerical plus or minus (+/-) rating is assigned to an alternative based upon the results of the STSOC demonstration projects, where applicable, and the best professional judgment of the evaluator. The Evaluation Methodology makes no provision for compiling the ratings of the alternatives or recommending an apparent "best alternative" for individual basins as part of the Basin Specific Feasibility Studies. Rather, a multi-criteria decision making process will be implemented by the District and other stakeholders in the next phase of work subsequent to completion of the Basin Specific Feasibility Studies.

Table 2-2 provides a summary of the ten criteria used in evaluating the various alternatives. The following paragraphs provide additional detail on the procedures used in rating alternatives against the evaluation criteria.

Phosphorus Load Reduction. This criterion measures the percentage reduction in the phosphorus load discharged to the EPA as a result of implementing an alternative. The calculation is made over

the 50-year period from January 1, 2007 to December 31, 2056 and is expressed as a percentage of the base case phosphorus load calculated over that same 50-year period.

Note that the percentage phosphorus reduction calculated for this criterion is defined as the total phosphorus reduction associated with an alternative, including reductions from CERP projects which are not being evaluated in this investigation but which contribute to the overall phosphorus reduction performance of some alternatives.

Table 2-2
Summary of Evaluation Criteria

Criterion	Type	Rating or Unit
Technical Performance Criteria		
1. Phosphorus load reduction	Quantitative	Percent of base case TP load
2. Phosphorus concentration achievable		
a. Long-term flow-weighted mean	Quantitative	Total phosphorus, ppb
b. Long-term geometric mean	Quantitative	Total phosphorus, ppb
3. Implementation schedule	Quantitative	Time, in years, starting in January 2003
4. Operational flexibility	Qualitative	+ 3 best/- 3 worst
5. Resiliency to extreme condition	Qualitative	+ 4 best/- 4 worst
6. Assessment of full-scale construction and operation	Qualitative	+ 3 best/- 3 worst
7. Management of side streams	Qualitative	+ 3 best/- 3 worst
Environmental Criteria		
8. Improvement in non-phosphorus parameters	Quantitative	+ 19 best/- 19 worst
Economic Criteria		
9. 50-year present worth	Quantitative	Total PW of all capital and O&M costs in 2002 dollars
10. Cost-effectiveness	Quantitative	50-year PW divided by 50-year TP load reduction, dollars/kg

Phosphorus Concentration. This criterion measures the capability of an alternative to achieve the phosphorus levels required to meet the long-term water quality objectives for the EPA. Both the flow-weighted mean TP concentration and the geometric mean TP concentration for future discharges to the EPA are reported, based upon the results of DMSTA simulations for STAs and CTSS model simulations for alternatives involving chemical treatment. Note that this criterion was not evaluated for diversion alternatives in which all stormwater discharges are diverted away from the EPA by December 31, 2006.

Implementation Schedule. This criterion measures the time required to implement an alternative, including land acquisition, design, permitting and construction. For alternatives with biological and chemical treatment alternatives, the implementation schedule also includes time for process start-up

and stabilization to achieve full treatment capability. For these alternatives, information provided by the research teams in STSOC demonstration project reports provides the basis for estimating the implementation schedule. For other alternatives, the evaluator's experience and best professional judgement provide the basis for estimating implementation schedule. The rating given to each alternative is expressed as the time duration, in years, to fully implement the alternative and achieve a stable treatment system, if applicable, assuming a start date of January 1, 2003.

Operational Flexibility. This criterion assesses the potential for the alternative to add operational flexibility to the South Florida hydraulic conveyance system and the Everglades Water Conservation Areas, while still meeting water quality objectives. Factors to be considered under this criterion include peak flow attenuation, available storage capacity, and effect on green space and wildlife habitat. A qualitative assessment is made of each alternative according to the following rating guidelines:

Rating	Assessment Description
+1 to +3	Alternative increases operational flexibility of the regional system.
0	Alternative has no impact on operational flexibility of the regional system.
-3 to -1	Alternative reduces operational flexibility of the regional system.

For alternatives with biological and chemical treatment components, the assessment is made based upon information contained in the applicable STSOC demonstration project report. For all other alternatives, the assessment is made on the basis of the experience and best professional judgment of the evaluator.

Resiliency to Fire, Flood, Drought and Hurricane. This criterion provides a qualitative assessment of an alternative to withstand the effects of extreme conditions such as fire, flood, drought and hurricane by estimating its ability to maintain or reestablish water quality objectives during and after such events. Ratings for this evaluation criterion range from +4 to –4 and are assigned based upon the following guidelines for each extreme event:

Rating	Assessment Description
+1	Alternative is generally resilient to extreme event.
0	Event has no influence on performance of alternative.
-1	Alternative shows general lack of resiliency to extreme event.

For alternatives with biological and chemical treatment components, the assessment is made based upon information contained in the applicable STSOC demonstration project report. For all other alternatives, the assessment is made on the basis of the experience and best professional judgment of the evaluator.

Assessment of Full Scale Construction and Operation. This criterion provides an assessment of the potential of an alternative to succeed at full scale. Factors considered in the evaluation of alternatives against this criterion include (1) confidence level for scale-up of the technologies used, (2) history of previous applications and their similarity to application in the Everglades, (3) history of previous success or failure in meeting project objectives, (4) constructability issues, and (5) factors requiring further study. Ratings for this criterion range from +3 to –3 and are assigned based upon the following guidelines:

Rating	Assessment Description
+1 to +3	Alternative has been successfully constructed and operated at the proposed scale; no scale-up problems are anticipated.
0	Alternative has not been constructed and operated at the proposed scale; no scale-up problems anticipated.
-3 to -1	Alternative has not been constructed and operated at the proposed scale; scale-up is a concern.

For alternatives with biological and chemical treatment components, the assessment is made based upon information contained in the applicable STSOC demonstration project report. For all other alternatives, the assessment is made on the basis of the experience and best professional judgment of the evaluator.

Management of Side Streams. This criterion provides an assessment of the level of effort required to manage side streams generated by implementation of an alternative. The level of effort required to manage side streams is dependent upon various factors such as the type of side stream generated (residual solids, wastewaters requiring separate treatment or disposal, harvested vegetation, seepage, etc.), the volume of side stream flow or material generated, and the method of disposal. Ratings for this evaluation criterion range from +3 to –3 and are assigned based upon the following guidelines:

Rating	Assessment Description
+1 to +3	Net benefit from management of side streams.
0	No side streams generated, or little or no effort required to manage side streams.
-3 to -1	Alternative requires extensive effort and/or cost to manage side streams or there is a net adverse impact from management of side streams.

For alternatives with biological and chemical treatment components, the assessment is made based upon information contained in the applicable STSOC demonstration project report. For all other alternatives, the assessment is made on the basis of the experience and best professional judgment of the evaluator.

Level of Improvement in Non-Phosphorus Parameters. This criterion provides an assessment of how non-phosphorus water quality parameters are likely to be impacted by implementation of an alternative. The STSOC demonstration projects included testing for 19 non-phosphorus water quality parameters. Using the data generated and the analyses performed during those investigations, ratings ranging from +19 to -19 are assigned to each alternative, based on the following guidelines for each non-phosphorus water quality parameter. The 19 non-phosphorus water quality parameters considered are as follows: aluminum, ammonia, calcium, chloride, dissolved oxygen, iron, magnesium, nitrate-nitrite, potassium, silica, sodium, sulfate, total kjeldahl nitrogen, total alkalinity, temperature, pH, specific conductance, turbidity, and color.

Rating	Assessment Description
+1	Improvement in water quality
0	No change in water quality
-1	Deterioration of water quality

For those alternatives without biological or chemical treatment components, it was assumed that there will be no significant change in non-phosphorus water quality.

50-Year Present Worth. This criterion measures the total capital and O&M costs for an alternative over a 50-year period in present (2002) dollars. Future costs were escalated at the rate of 3 percent per year to account for the effects of inflation. The discount rate was assumed to be 6-3/8 percent.

Note that costs for implementation of source control programs, and for construction and operation of federal Critical Projects and CERP Projects were not included in the present worth analysis. Only those public works projects to be constructed and operated to meet the water quality goals of the EFA were included in the analysis. For the purposes of the Basin Specific Feasibility Studies, integration of these projects with CERP and other projects, was assumed to occur at no additional cost. These costs may need to be evaluated during subsequent phases of analysis.

Cost-Effectiveness. Some alternatives may be more costly than others, but may also provide more value in terms of their ability to meet long-term water quality objectives. This criterion measures the cost-effectiveness of alternatives by calculating the unit cost of phosphorus removal. The calculation is made by dividing the total 50-year present worth of the alternative (in 2002 dollars) by the total kilograms of phosphorus removed over the 50-year period from 2007 to 2056.

For consistency purposes, only the kilograms of phosphorus removed by the public works projects included in the 50-year present worth analysis were considered in the cost effectiveness.

2.3 Development of Alternatives

As input to the Basin Specific Feasibility Studies, the District developed a preliminary set of alternatives for achieving long-term water quality objectives in each of the six basins being investigated. The preliminary alternatives consisted of different combinations of source controls and basin-scale treatment options with the potential to reduce TP concentrations in discharges to the EPA to the planning level target of 10 ppb. Diversions of flow to future CERP projects and other storage facilities that would reduce or eliminate discharges to the EPA were also considered as alternatives for meeting long-term water quality objectives in some basins. The Brown and Caldwell consulting team was tasked with providing peer review of the District's preliminary alternatives as the District made them available. The Brown and Caldwell team responded in three letter reports to the District, dated November 30, 2001, December 12, 2001 and January 17, 2002, summarizing the peer review comments. These letter reports were made available for public review on the District's website soon after their submittal. In addition, a summary report of all Brown and Caldwell peer review comments on the preliminary alternatives was submitted to the District on February 5, 2002 and posted to the District's website.

The final sets of alternatives for ACME Basin B, Feeder Canal Basin, L-28 Basin, North New River Canal Basin and North Springs Improvement District Basin were published by the District on February 27, 2002. The final set of alternatives for the C-11 West Basin was published by the District on March 21, 2002. Table 2-3 provides a summary of the components comprising the base case alternatives for each basin. Detailed discussions of the alternatives are provided in Sections 3 through 8 of this report. Copies of the District's alternatives development documents for the six basins are available on the District's website and are made part of this report by reference.

Table 2-3
Summary of Alternatives Investigated

Basin	Alternative	Primary Components of Base Case Alternative
ACME Basin B	1	Source controls Diversion to the Agricultural Reserve Reservoir (2013)
	2	Source controls Chemical treatment
	3	Source controls Biological treatment (limited to District-owned land)
	4	Source controls Biological treatment (no limit on land area)
C-11 West	1	Source controls Diversion to Western C-11 Impoundment (2006) Additional diversion to C-9 Reservoir (2036) Chemical treatment of discharges to EPA
	2	Source controls Diversion to Western C-11 Impoundment (2006) Additional diversion to C-9 Reservoir (2036) Biological treatment of discharges to EPA
	3	Source controls Diversion to Western C-11 Impoundment (2006) Additional diversion to C-9 Reservoir (2036)
Feeder Canal	1	Source controls Biological treatment
	2	Source controls only
L-28	1	Source controls Biological treatment
	2	Source controls only
North New River Canal	1	Source controls Chemical treatment of discharges to EPA (2006-2018) 100% diversion by CERP (2018)
	2	Source controls Discontinued use of G-123 (2006) 100% diversion by CERP (2018)
	3	Source controls Continued use of G-123 (2006-2018) 100% diversion by CERP (2018)
North Springs Improvement District (NSID)	1	Source controls Temporary diversion to rock pits (2007) Diversion to Hillsboro Site 1 CERP Project (2008)
	2	Source controls Permanent diversion
	3	Source controls Diversion to Hillsboro Site 1 CERP Project (2008)

2.4 Biological Treatment Options

In combination with BMPs, biological treatment in STAs has been the preferred method to date for reducing the quantity of phosphorus entering the Everglades from stormwater discharges. Approximately 42,000 acres of STAs have been constructed, are presently under construction, or are being designed to reduce TP concentrations in runoff from the EAA to the interim water quality standard of 50 ppb established in the EFA. These STAs have performed very well, and as research on STA optimization has continued, outflow TP concentrations in the 20 to 30 ppb TP range have not been uncommon.

Initially, the STAs were designed to rely primarily on emergent macrophytes to remove phosphorus from stormwater as it passed through the STA. While operating refinements have led to improved performance from these STAs, it is generally acknowledged that these emergent macrophyte STAs, by themselves, are not capable of achieving the very low TP concentrations that will be required to satisfy the long-term water quality objectives of the EFA.

Over the past 10 years or so, and particularly in the past 6 years, research into advanced biological treatment technologies with the capability to achieve very low outflow TP concentrations has intensified. Two of the most promising technologies are wetland treatment systems: submerged aquatic vegetation, or SAV, and periphyton-dominated STAs, or PSTAs. Both technologies have been shown to be capable of achieving TP concentrations that approach the planning level target of 10 ppb TP under the proper hydrologic, hydraulic and TP load conditions. These two technologies, either individually, together, or in combination with emergent vegetation STAs, currently offer the greatest potential for achieving long-term water quality goals in the EPA with natural, biological treatment systems.

2.4.1 Treatment Process Description

The following paragraphs provide brief summaries of the SAV and PSTA technologies as advanced biological treatment technologies for meeting long-term water quality goals in the EPA.

2.4.1.1 Submerged Aquatic Vegetation (SAV)

In a SAV-dominated STA, stormwater flow passes through a wetland treatment system composed of submerged vegetation. Phosphorus is removed by plant uptake as well as by co-precipitation with $CaCO_3$ under high pH conditions in the water column. Phosphorus removed from the water column by SAV communities is deposited as part of a relatively stable, high calcium, marl sediment. SAV is a promising wetland treatment technology because it has been shown to be effective in removing phosphorus from inflow sources ranging from less than 50 ppb TP to more than 100 ppb. Figure 2-1 illustrates a schematic for a typical SAV-dominated STA.

A number of mesocosm, test cell, and full-scale research studies have been conducted on the SAV treatment technology. One such experiment was conducted in the District's North Test Cell 15 where TP concentration in post-BMP water from the EAA was reduced from 73 ppb to 23 ppb. Cell 4 in STA 1W, about 358 acres in area, has supported a stable SAV community since 1995. The flow-weighted mean TP inflow and outflow concentrations for Cell 4 for the period February 1995 through September 2001 were 52 ppb and 22 ppb, respectively. During 1998 and 1999, when conditions were most favorable for SAV performance, the flow-weighted mean outflow TP concentration was 14 ppb. Full documentation of the SAV technology and its performance to date in research studies can be found in the STSOC demonstration project report *(Supplemental Technology Standard of Comparison (STSOC) Analysis for Submerged Aquatic Macrophyte/Limerock Technology, Final Report, DB Environmental, Inc., May, 2002).*

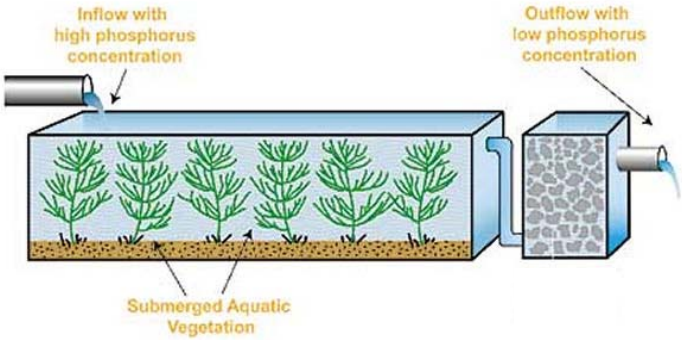


Figure 2-1.
Typical SAV STA Schematic

2.4.1.2 Periphyton-Based STAs (PSTA)

Periphyton-based STAs, or PSTAs, rely on algae and other microbiological systems to remove phosphorus from the water column. Periphyton have been shown to have much higher phosphorus uptake rates than emergent vegetation, and in some natural Everglades systems (e.g. C-111 Basin), periphyton-dominated wetland communities have been associated with very low TP concentrations in the water column. This has led researchers to believe that the PSTA concept may be beneficial in achieving long-term water quality objectives for stormwater discharges to the Everglades. Figure 2-2 illustrates a schematic for a typical PSTA.

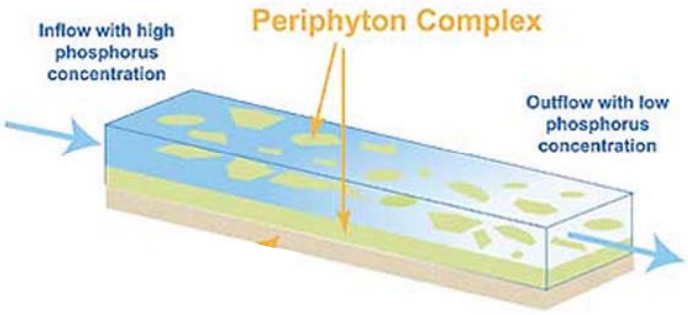


Figure 2-2.
Typical PSTA Schematic

Since 1998, the District has been sponsoring research to better understand the phosphorus removal capabilities of PSTA, as well as the hydrologic, hydraulic, ecological and loading parameters associated with successful implementation of the technology. A comprehensive presentation of the studies performed and the scientific data produced since the inception of the PSTA research program was published in *2001 (PSTA Phase 1 and Phase 2 Summary Report, CH2M HILL, October 2001).* This research has shown that PSTA is capable of achieving very low TP concentrations

under the right conditions (flow-weighted mean of 12 ppb over a 21-month period in one experiment). However, the research has also shown that PSTA is most effective on inflows with TP concentrations generally less than about 25 or 30 ppb, suggesting that the technology would normally have to be applied downstream of STA cells dominated by emergent vegetation or SAV. TP removal performance also appears to be sensitive to other factors, including soil type and water depth. For example, shellrock and limerock surfaces in mesocosm and test cell experiments generally outperformed peat-based systems.

A technical and economic analysis to document how a full-scale PSTA system could be applied to an existing STA employing emergent vegetation was recently completed *(Conceptual Design and Planning Level Cost Estimate for a Full-Scale Periphyton Stormwater Treatment Area, CH2M HILL, Draft Report, November 2001)*. Four larger-scale PSTAs (5 acres each) are currently being operated by the District (*PSTA Research and Demonstration Project, Phase 3 Interim Report No. 1, August-October 2001, CH2M Hill, April 2002)*. Additional full-scale research is needed before the phosphorus removal capabilities of the PSTA concept can be more fully understood. Nevertheless, PSTA offers an opportunity to achieve water quality goals in discharges to the EPA where relatively low TP inflows already exist.

2.4.2 Dynamic Model for Stormwater Treatment Areas (DMSTA)

DMSTA was used for the analysis of TP removal performance in STAs. This model has been calibrated with data from research studies on SAV and PSTAs, and is a significant advancement over previous models used to predict STA performance. Specifically, DMSTA considers the following factors that were not considered in the steady-state design model used previously for STA designs (*Burns and McDonnell, 1994; Walker, 1993, 1995*):

- Temporal variations in inflow volume, load, rainfall, and evapotranspiration
- Hydraulic compartments (cells, internal levees for flow redistribution)
- Hydraulic efficiency (number of stirred tanks in series)
- Cell aspect ratio (length/width)
- Water level regulation
- Outflow regulation (discharge vs. water level)
- Compartmentalization of biological communities
- Dry-out frequency and supplemental water needs
- Bypass frequency, quantity, and quality
- Seepage collection and management

DMSTA was developed to provide a single platform for estimating the performance of a variety of treatment wetland options, including wetlands dominated by emergent macrophytes, SAV, and periphyton. The model provides a flexible set of options for parameter selection, water balance, internal hydraulics, and cell configuration (*Walker and Kadlec, 2001; Walker, 1998*). DMSTA only estimates TP removal performance and is not currently expected to be expanded for use in estimating treatment wetland performance for other water quality parameters.

2.4.2.1 Application of DMSTA to Analysis of Biological Treatment Alternatives

DMSTA was used to define the STA configuration in each basin that achieved the long-term water quality objective of 10 ppb TP using the least amount of land and avoiding hydraulic bypass. If a geometric mean of 10 ppb could not be achieved due to land restrictions, the lowest geometric mean concentration predicted by the model was reported.

Emergent vegetation, SAV, and PSTA were all considered individually and in combination with one another to identify the technology or combination of technologies that provided maximum TP removal performance. To minimize land area while maintaining a geometric mean outflow TP concentration of 10 ppb, a number of STA design factors were varied. These included the percentage of the total STA land area taken up by individual vegetative communities, the number and size of internal cells, and the maximum allowable water depth. The analysis required that outflow TP concentration and land area requirements be balanced with the potential for hydraulic bypass and the frequency and duration of dryout periods which could be damaging to the vegetative communities in the STAs. In some cases, reservoirs were considered upstream of the STAs to store water and allow a smaller STA to be constructed.

The simulated stormwater discharges to the EPA from the six basins considered in this study are highly variable, creating a pulsed flow regime to any treatment facilities being designed to accommodate them. For example, peak simulated daily flows range from about 10 to over 100 times the average daily flow depending on the basin being evaluated. To prevent hydraulic bypass during a peak storm event, a large STA would typically be required. However, a large STA would likely dry out too frequently and for too long a duration during normal or dry years to allow the 10 ppb water quality target to be achieved on a consistent basis. Therefore, the challenge of the DMSTA modeling effort was to identify the optimal combination of land area, vegetative communities, cell partitioning, and in some cases, upstream reservoir sizing that would allow the planning level water quality target to be met without hydraulic bypass and without excessive dryout.

For each biological treatment alternative, a number of iterative DMSTA runs were made at first to screen vegetative communities (and combinations of communities) for application in the particular basin. The vegetative partitioning scenarios that were tested in each basin as part of the initial screening process are summarized in Table 2-4. Once one or two vegetative communities or combinations of vegetative communities were identified as being the most promising, more detailed analyses were made on each by varying the land area, number of cells, etc. to identify the optimal configuration. The optimal STA configuration was then evaluated as the base case alternative

according to the procedures and criteria identified in the District's Evaluation Methodology document.

Table 2-4
Summary of DMSTA Vegetation Partitioning Scenarios

Run	ACME Basin B	Feeder Canal	L-28	C-11 West
	71 ppb [a]	58 ppb [a]	39 ppb [a]	22 ppb [a]
1	Emergent/SAV/PSTA	Emergent/SAV/PSTA	Emergent/SAV/PSTA	Emergent/SAV/PSTA
2	Emergent/PSTA	Emergent/PSTA	Emergent/PSTA	Emergent/PSTA
3	Emergent/SAV	Emergent/SAV	Emergent/SAV	Emergent/SAV
4	SAV/PSTA	SAV/PSTA	SAV/PSTA	SAV/PSTA
5	SAV	SAV	SAV	PSTA
6				SAV

[a] Base case flow-weighted mean TP inflow concentrations from SFWMD

DMSTA provides the modeler with a number of calibration data sets that can be used to simulate TP removal performance from emergent vegetation, SAV and periphyton-based treatment systems. The DMSTA calibration data set used in this investigation for emergent vegetation was based on data from the Boney Marsh wetland system. The DMSTA calibration data set used for SAV was based on 1998-1999 data from STA-1W Cell 4 (SAV_C4). The DMSTA calibration data set used for PSTA was based on data from South Test Cell 8 at STA-1W. These calibration data sets were provided to Brown and Caldwell by the District in the most recent version of DMSTA, dated April 12, 2002. The District determined that these data sets were the most appropriate to use in the base case analyses of biological treatment alternatives in the Basin Specific Feasibility Studies.

If a reservoir was being considered, the DMSTA Reservoir Model option was used. The maximum reservoir storage volume and the ratio of maximum inflow to mean inflow were adjusted to simulate a flow-equalization basin upstream of the STA. It was conservatively assumed that phosphorus removal would not occur in the storage reservoir. While the hydraulic residence time within the reservoir was not constrained, DMSTA releases water from the reservoir to the STA as soon as there is capacity in the STA to accommodate it. Therefore, DMSTA does not treat a reservoir as a true storage facility that can be used to supply water to a STA during dry weather periods to reduce the effects of dryout on wetlands vegetation. Rather, DMSTA simulates the reservoir as a flow equalization basin (FEB), intended to reduce the potential for hydraulic bypass.

2.4.2.2 Sensitivity and Uncertainty Analyses

A number of sensitivity analyses were performed to determine how the base case DMSTA results might change if different calibration data sets were used and other model parameters were varied.

Sensitivity Testing Using the NEWS Calibration Data Set. To test the sensitivity of DMSTA results to the SAV_C4 and PSTA calibration data sets, a sensitivity analysis was performed on each biological treatment alternative using a DMSTA calibration data set that incorporates all SAV and

PSTA research data into a single model calibration. Referred to as Non-Emergent Wetland System, or NEWS, this calibration data set is believed to provide a somewhat less optimistic forecast of TP removal performance than the SAV_C4 and PSTA data sets used in the base case analyses. In this series of sensitivity analyses, the optimized STA configuration developed for the base case analysis was rerun using the NEWS calibration data set and the outflow TP concentrations were recorded for comparison with the results of the base case analysis.

Sensitivity Testing Within DMSTA. DMSTA includes a routine for testing the sensitivity of the model results to each input variable. All phosphorus cycling and design parameters (except initial conditions and the discharge exponent) are modified by a sensitivity factor (both positive and negative), and the simulation is re-run. The sensitivity factor is a user-specified percentage.

For each change in an input variable (both positive and negative), DMSTA computes the average absolute change relative to the base value and the average absolute change as a percent of the base value for the following output variables:

1. Treated Flow-weighted Mean Outflow TP concentration (excluding bypass)

2. Total Flow-weighted Mean Outflow TP concentration (including bypass)

3. Composite Geometric Mean Outflow TP concentration (excluding bypass)

4. Outflow Load (including bypass)

The internal DMSTA sensitivity analysis was performed for all base case biological treatment alternatives. The sensitivity factors used were 25 percent and 50 percent. The results of these sensitivity analyses are presented with the base case DMSTA output files in Appendix B of this report. Generally the results of the DMSTA sensitivity analyses demonstrate that the DMSTA simulations are more sensitive to the inflow load than other model inputs.

Uncertainty Analyses Within DMSTA. The DMSTA model includes an algorithm for estimating statistical uncertainties in the model output. These estimates are based on a combined error estimate that includes the following components:

1. Uncertainty in the phosphorus cycling parameters from the model calibration

2. Uncertainty in other user-controlled model inputs

3. Inherent model error from the calibration

4. Sensitivity of the model output to changes in each input value

The coefficient of variation (CV) is the standard error divided by the mean and is estimated by DMSTA for input data, model parameters, model error, and total error using methods described by Walker (*1982*). The uncertainty results are for the combined outflow(s) from the modeled STA.

The results of the internal DMSTA uncertainty analyses are presented with the base case DMSTA output files in Appendix B of this report.

2.4.3 General Assumptions for Analysis of Biological Treatment Alternatives

A number of other general assumptions were made with respect to the evaluation of biological treatment alternatives. These included the following:

1. The TP outflow concentrations predicted by DMSTA assume that a stabilized treatment process has been established within the STA. This may take several years to achieve based upon the results of research studies. To account for this initial start-up and stabilization period in TP load reduction calculations, it was assumed that outflow TP concentration would decrease linearly from the untreated inflow concentration to the steady-state outflow concentration predicted by DMSTA over the duration of the start-up and stabilization period (typically 2 to 4 years).

2. Average water depths in a STA were controlled within the range of depths associated with the DMSTA calibration data sets for the vegetative communities involved. Generally, maximum water depth in STAs was assumed to be 4.5 feet. In one case, the C-11 West Basin, the maximum water depth was allowed to exceed 4.5 feet on a few occasions during the 31-year period of simulation to avoid hydraulic bypass and to reduce the frequency and duration of dryout periods.

3. Dryout for both SAV and PSTA is assumed to occur when water depths are simulated below 15 cm by DMSTA. The effects of dryout on TP removal performance have not been researched extensively. However, guidance from the research teams suggest that short periods of dryout should not materially affect the predicted long-term TP removal performance of the STA, particularly if care is taken in restarting the treatment process when inflow returns. Longer periods of dryout will most likely affect TP removal performance within a STA; however, the extent of that effect is still unknown at this time.

4. For modeling within DMSTA, it was assumed that each discrete cell within a STA represented 3 tanks in series (TIS), an indication of good hydraulic efficiency through the STA.

5. The phosphorus removal performance observed during advanced treatment technology research can be replicated at full-scale in the ESP basins on a long-term basis. It was assumed that water quality characteristics of the waters being treated in the ESP basins are similar to the water quality characteristics in the waters that were tested in the various research and demonstration studies making up the calibration data sets used in DMSTA. This could be an important issue to pursue further during subsequent investigations and designs since there are many unanswered questions about the effects of certain water quality parameters such as calcium, alkalinity, and phosphorus speciation on TP removal performance in advanced biological treatment systems.

6. It was assumed that TP removal would occur only within the STA. No TP removal was assumed in upstream storage reservoirs or in conveyance systems moving water to or from the STA. Reservoirs upstream of STAs were modeled to attenuate peak flows; water is released as soon as there is capacity in the STA. While there is data to suggest that TP removal occurs in reservoirs through processes such as sedimentation, there is limited data on TP removal in reservoirs operated primarily for peak flow attenuation. Further analysis of such reservoirs is necessary before an estimate of TP removal performance can be made.

7. In all but one ESP basin, siting of STAs was not performed. In the absence of site-specific information, it was assumed that the slope of the land in the STA would be zero and that the STA would be generally rectangular in shape. The one exception to this was in ACME Basin B, where the STA was to be located on a specific tract of land already owned by the District.

8. Inflow seepage was not considered in the analyses. Outflow seepage was estimated at 0.008 centimeters per day per centimeter of head based on DMSTA simulations of STA 2.

9. It was assumed that 50 percent of seepage water would be collected and returned to the STA and that 50 percent would be lost to groundwater. The TP concentration of the seepage water was assumed to be equal to that in the STA water column up to a maximum of 20 ppb.

10. Rainfall and reference evapotranspiration (ET) data, provided by the District, were incorporated into DMSTA for these analyses. Rainfall was assumed to have a TP concentration of 20 ppb. No adjustments to the reference ET data were made as it was assumed that actual ET for treatment wetlands is the same as the reference ET (*Treatment Wetlands, Kadlec and Knight, 1996*).

11. Basin flows and loads were represented by the simulated baseline data sets, as adjusted for source controls and CERP projects. Baseline flow data were not modified to account for the STA acreage that would no longer contribute to runoff. The acreage involved was typically a very small percentage of the total basin area and elimination of runoff from this acreage would not have materially affected the baseline flows used in the analyses.

12. It was assumed that flood protection within all basins would be maintained at current levels.

2.5 Chemical Treatment Options

Chemical treatment, in many different forms, has been used effectively to remove phosphorus and other nutrients from stormwater runoff prior to its discharge into rivers, lakes and other receiving waters. Three District-sponsored pilot testing programs have demonstrated the capability of chemical treatment to achieve very low TP concentrations in agricultural and urban stormwater runoff being discharged to the EPA. A STSOC demonstration project was performed on post-BMP and post-STA waters at STA 1W in 2000 *(Chemical Treatment Followed by Solids Separation Advanced Technology Demonstration Project, HSA Engineers & Scientists, December 2000).* Subsequent pilot testing was done for the Village of Wellington on runoff from ACME Basin B (rural residential and agricultural land use) and for the District at the S-9 Pumping Station on runoff from the C-11 West

Basin *(HSA Engineers & Scientists, 2001, 2002)*. In all cases, chemical treatment was able to achieve very low effluent TP concentrations, typically on the order of about 6 ppb.

2.5.1 Treatment Process Description

The Chemical Treatment-Solids Separation (CTSS) process uses metal (iron and aluminum) salts routinely used in municipal water treatment facilities. The readily available phosphorus (e.g., soluble reactive phosphorus) is converted to aluminum phosphate in the presence of alum, and to iron phosphate with ferric chloride addition. Total dissolved phosphorus and particulate phosphorus are removed by the coagulation and settling process. Once these compounds are formed, polymers are added to enhance flocculation and settling through a "bridging effect". Long polymer molecules provide bridges, linking the precipitated phosphorus to form longer flocs. Anionic polymers have been shown to be very effective in aiding primary settling when used in conjunction with iron and aluminum metal salts and several were evaluated for demonstration. A residual management program to evaluate dewatering and disposing of the settled flocs or solids focused on the by-product reuse offsite, onsite precipitation recovery/reuse, as well as onsite and/or offsite landfill and applications to agricultural lands.

The demonstration project conducted by the District evaluated the feasibility of using chemical coagulation and flocculation coupled with solids separation using inclined plate settlers to remove TP from agricultural stormwater runoff (post-BMP water) and STA discharge (post-STA water).

On EAA stormwater, CTSS pilot units rated for up to 12 gpm were operated for 25 consecutive days at optimum operating conditions treating post-BMP waters ranging from 100 to 300 ppb of TP, and post-STA waters ranging from 15 to 40 ppb of TP. Average total phosphorus effluent concentrations of 6 ppb TP were achieved on both post-BMP and post-STA feedwaters during the demonstration testing. The CTSS technology also demonstrated the ability to remove 80 to 90 percent of the mercury from the waters it treated. A report on this demonstration project is available (*HSA, December, 2000*).

CTSS field trials in the EAA were completed at the end of 1999 and the pilot treatment units became available for use at other testing locations. To assess the effectiveness of chemical treatment processes on the stormwater runoff from ESP basins, one of the CTSS pilot units was moved to the Wellington/Acme Improvement District Pump Station No. 2. The pilot unit was operated during the spring and summer months of 2000 at this location to determine the amount of phosphorus reduction achievable with chemical treatment on ACME Basin B stormwater runoff. The pilot operations again produced treated effluents with TP concentrations less than 10 ppb using hydraulic loading rates and chemical dosages similar to those used during the original 1999 testing on EAA stormwater (*HSA, December, 2001*).

Chemical treatment pilot testing was also performed in the C-11 West Basin, a highly urbanized basin located in south central Broward County. According to the simulated baseline data set, the S-9 pump station discharges an average of approximately 194,000 acre-feet per year of water directly to WCA 3A. The flow-weighted mean TP concentration of these discharges is approximately 17 ppb

(*SFWMD, November 2001*). Phosphorus reduction pilot testing near the S-9 Pump Station within the C-11 West Basin was conducted during the fall of 2001. The pilot treatment facility (12 gpm capacity) again showed the ability of CTSS technology to reduce outflow TP concentration to less than 10 ppb (*HSA, June, 2002*).

2.5.2 Application of CTSS Technology to the Analysis of Alternatives

Water treatment technologies generally operate best (*e.g.*, consistently produce the highest quality effluent) within a controlled range (average to peak flow rates of ≤ 1.5:1) of influent flows. The wide fluctuations of flows associated with stormwater runoff typically require full-scale water treatment systems to be coupled with flow equalization basins (FEB) to store runoff from peak rainfall events until it can be treated. The water stored in the FEB is treated by the plant during the subsequent hours and days following a storm event. Stormwater received when the FEB is at capacity bypasses the treatment plant. The untreated water is mixed with treated water in a blending basin prior to discharge to the receiving water body. Figure 2-3 illustrates a schematic for a typical CTSS facility.

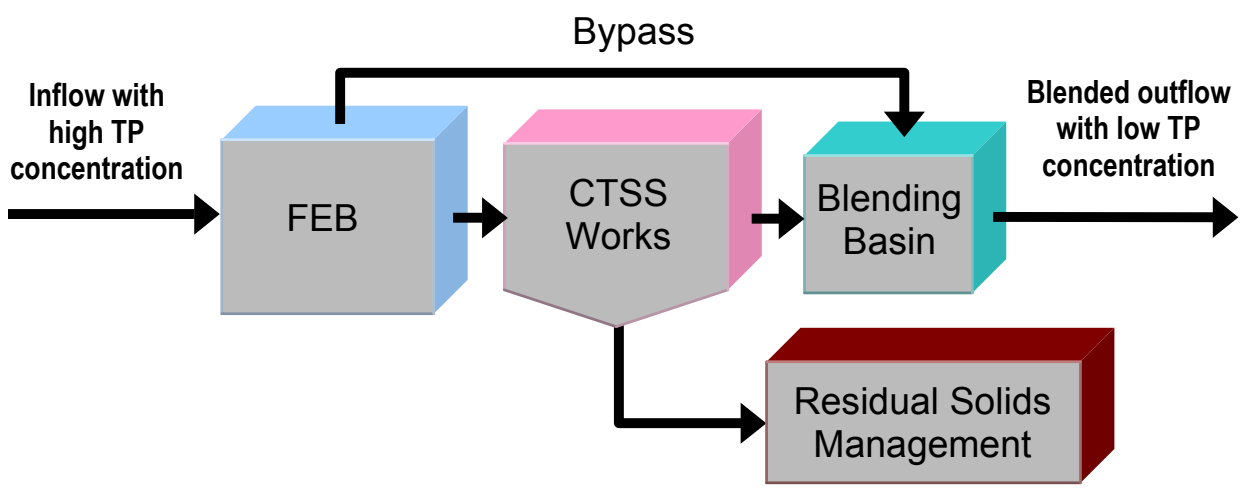


Figure 2-3.
Typical CTSS Facility Schematic

Two residual management options were considered: (1) disposal to a dedicated land application site and (2) dewatering via centrifuge or filter press and hauling of dewatered cake to a local landfill for disposal. After an initial screening of the two alternatives, disposal to a dedicated land application site was selected as the preferred option. In this option, residual solids would be discharged to gravity thickening ponds where solids levels would increase from approximately 3 to 15 percent. Supernatant from the thickening ponds would be returned to either the FEB or the head of the CTSS plant. Thickened solids from the ponds would be periodically (4 times per year) discharged to the land application area. The land application area would be periodically tilled and cover cropped to maintain soil conditions. The application rate of 28.4 tons of dry solids per acre per year is typical of application rates used for water treatment plant residuals. CTSS residuals are very similar to water treatment plant residuals (*HSA, December 2000*).

Full-scale design will include a blending basin. The blending basin serves two purposes: (1) provides some mixing between any by-passed (untreated) water and the treated water prior to discharge, and (2) buffers any minor variations in pH and alkalinity (i.e. conditioning) that may be introduced by the treatment process prior to discharge to the downstream receiving marsh.

2.5.2.1 CTSS Spreadsheet Model

Full-scale CTSS treatment scenarios for application in ACME Basin B, the C-11 West Basin, and the North New River Canal Basin were developed using a fill and draw hydraulic approach. A spreadsheet water balance, using daily flow and total phosphorus concentration data from the 31-year period of simulation, was used to determine treatment plant and FEB sizes to achieve a long-term (31-year) geometric mean TP concentration of 10 ppb. For this analysis, the chemical treatment technology was projected to produce an average clarified effluent TP concentration of 6 ppb at average flow and 10 ppb at peak flow. Peak flow was assumed to be 150 percent of average plant flow, consistent with the assumptions made in previous demonstration projects for the District. Surface water treatment plants using similar technology as the CTSS plants usually have peaking factors of 2 times average flow and can achieve satisfactory performance when operating at peak flows for sustained periods of time. However, they are not trying to achieve 10 ppb TP or less. Therefore, a conservative approach was taken in these evaluations.

The long-term geometric mean concentration was calculated using the flow-weighted weekly effluent TP concentrations. A number of treatment plant capacity and FEB size combinations were run in order to arrive at the optimum combination.

2.5.2.2 Sensitivity Analysis

In order to test the response of the system design (FEB size and treatment plant capacity) to a decreased treated effluent quality, a sensitivity analysis was conducted assuming an average clarified effluent TP concentration of 8 ppb at average flow and 13 ppb at peak flow.

2.5.3 General Assumptions for Analysis of CTSS Alternatives

General assumptions used in analyzing CTSS alternatives in the Basin Specific Feasibility Studies are summarized below:

1. The CTSS treatment process will consist of chemical addition (aluminum chloride), rapid mixing and coagulation, polymer addition, flocculation, and sedimentation using plate settlers. No filtration subsequent to sedimentation was assumed.

2. The CTSS process will produce an average clarified effluent TP concentration of 6 ppb at the average daily design flow rate.

3. The full-scale CTSS system can operate at a peak flow (50 percent greater that its average daily design flow rate) for reasonable time periods. The CTSS process will produce an average effluent TP concentration of 10 ppb when operated at peak flow.

4. Current flood protection levels will be maintained.

5. The FEB will not provide any phosphorus removal. While the CTSS STSOC demonstration project (*HSA, December, 2000*) assumed 20 percent TP removal in the FEB, a conservative approach was utilized for this evaluation (similar to reservoirs upstream of STAs). The FEB was modeled to attenuate peak flows; water is released as soon as there is capacity in the treatment works. Further analysis on the management of FEBs is required to estimate TP removal performance.

6. Rainfall and ET in the FEB were disregarded in the water balance.

7. The side water depth in the FEB will be allowed to fluctuate from a minimum of 0.5 feet to a maximum of 4.5 feet.

8. The CTSS treatment facility will ramp up to peak flow when water depth in the FEB reaches 3.5 feet.

9. The blending basin was sized with a 3-day hydraulic retention time based on the CTSS plant average daily design flow rate.

10. Outflow seepage will be routed to the head of the FEB/treatment works.

11. Seepage water concentration is assumed to be equal to the FEB TP concentration up to a maximum of 20 ppb.

12. Untreated water will be blended with the CTSS effluent to achieve the target discharge concentration, as necessary.

13. The phosphorus removal performance observed during advanced treatment technology research can be replicated at full-scale in the ESP basins on a long-term basis. The full-scale treatment scenario was based on a scale-up of the 12 gpm CTSS urban pilot data. (*HSA, December, 2000*).

2.6 Uncertainties in the Analysis of Alternatives

The Basin Specific Feasibility Studies for the six ESP basins considered in this investigation represent a significant step toward addressing the long-term water quality objective for future discharges to the EPA. For the first time, historical flows and phosphorus loads in these basins have been used to estimate the effectiveness of various phosphorus load reduction strategies and to estimate the long-term cost associated with implementation of those various strategies. Nevertheless, there are many uncertainties associated with the alternatives analyses performed in the Basin Specific Feasibility Studies; uncertainties that include the effectiveness of source controls in reducing phosphorus loads, the locations of basin-scale treatment and storage facilities within the ESP basins, and the limited understanding of how advanced biological treatment processes will perform at full scale under the highly pulsed flow regimes of the ESP basins.

Presented below are some of the more significant areas of uncertainty identified during completion of the Basin Specific Feasibility Studies. They are identified here not to diminish the importance of the work performed, but rather to put it into context and to highlight where additional information would benefit decision making with respect to the alternative selected for implementation in each basin.

2.6.1 Uncertainty Associated with CERP Projects

Most of the ESP basins have Critical Projects or CERP Projects planned for them that will influence the baseline flow or inflow TP concentration in the basin, either in the short-term or long-term future. Many of the CERP Projects, in particular, are in a very conceptual stage at the present time. Therefore, when a biological treatment alternative assumes a future CERP project will result in a certain level of phosphorus load reduction to the EPA, there is uncertainty added to the evaluation process because the CERP project might be modified in concept or might be accelerated or delayed in time. For this evaluation, the CERP project schedules in effect as of July 2001 were used. Sensitivity analyses have been conducted to cover many of the "what-if" scenarios in the ESP basins. Nevertheless, the level of uncertainty is greater for those alternatives that rely most heavily on an assumed result from a future Critical Project or CERP Project.

2.6.2 Uncertainty Associated with Source Controls

Analysis of the base case alternative in each basin was based upon achieving an assumed level of phosphorus reduction through source controls. In some of the urban basins, where inflow TP concentrations are already low, the level of phosphorus reduction was conservatively assumed to be zero percent. However, in other basins, it was assumed that source controls could reduce TP concentrations by 25 percent or more for the base case alternatives.

There are data from the EAA over the past 8 to 10 years to document that TP concentrations can be reduced by 50 percent or more through implementation of agricultural BMPs in that area. However, there are little, if any, data to document what reductions might be possible in other agricultural basins tributary to the EPA or in highly urbanized basins in South Florida. Sensitivity analyses performed during these Basin Specific Feasibility Studies suggest that land area requirements for STAs are impacted significantly by the inflow TP concentration. If the effectiveness of source controls is significantly overstated or understated, the land area acquired for STA development could similarly be overestimated or underestimated. Until source control programs in the ESP basins are implemented and data on their effectiveness become available, the uncertainty associated with source controls will remain. The Village of Wellington recently adopted a BMP Ordinance, and data indicating the effectiveness of the Wellington source control program on phosphorus loads from ACME Basin B are expected soon.

2.6.3 Uncertainty Associated with Site Location

The purpose of the Basin Specific Feasibility Studies in the ESP Basins was to objectively compare alternatives for meeting long-term water quality objectives, not to site individual conveyance, storage

and treatment facilities on specific tracts of land. Siting of facilities will be accomplished in subsequent phases of work.

While evaluating alternatives independent of siting considerations facilitates the objective comparison of technologies or water quality management strategies, the lack of site characteristics introduces another significant measure of uncertainty into the evaluation process. Examples of uncertainties that arise due to the lack of knowledge about site locations and characteristics include the following:

1. Whether or not there is a sufficient amount of land available in a practicable location within the basin to support an alternative without extraordinary means being required to acquire it. It was assumed in the Basin Specific Feasibility Studies that sufficient land area will be available and that the land can be acquired within a reasonable time period. This may not always be the case. For the purposes of evaluating alternatives, the District estimated the time required to acquire the necessary land to range from about 1 to 3 years, depending on the basin involved.

2. The characteristics of soil and underlying rock strata and their effect on seepage rates; also, their effect on the economic viability of some treatment technologies such as PSTA. Assumptions were made concerning these issues during the Basin Specific Feasibility Studies. These assumptions will require confirmation during subsequent phases of work.

3. The requirements for inflow and outflow canals and pumping stations, seepage canals and pumping stations, control structures, and other support facilities for biological and chemical treatment alternatives cannot be defined without a site being identified. Assumptions in this regard were made for the purposes of preparing capital and O&M costs for the alternatives in the Basin Specific Feasibility Studies. However, actual site location and shape could result in a completely different configuration being required.

4. The need for improvements to the interior drainage system of some basins to implement an alternative was recognized, but was not quantified or included in the cost estimates for the alternatives. This represents a significant level of uncertainty, not only with respect to the overall cost of implementation for an alternative, but also with respect to the impact on property owners within the basins.

Site location and characteristics can also have a major effect on the beneficial and adverse environmental impacts associated with an alternative. However, as stated previously, the Evaluation Methodology for the Basin Specific Feasibility Studies does not include siting of facilities in most of the basins. Therefore, it was not possible to consider specific environmental impacts in this investigation, other than water quality in discharges to the EPA.

2.6.4 Uncertainty Associated with Cost Estimates

The cost estimates developed for the Basin Specific Feasibility Studies were based on unit costs for the major capital and O&M components associated with implementation of alternatives. These unit

costs may be low or high depending on site characteristics, which have not been identified. To account for unforeseen project requirements, a 30 percent contingency factor was applied to both the capital and annual O&M cost estimates developed for each alternative. Similarly, contingencies ranging from 10 to 40 percent were applied to land acquisition costs. It is intended that these contingency factors will balance the uncertainties associated with the analyses conducted, as documented in this report, and provide a reasonable projection of overall cost for the alternatives being evaluated. Nevertheless, there is always some probability in planning level investigations that the cost estimates provided may be high or low.

2.6.5 Uncertainty Associated with DMSTA

DMSTA is a powerful tool for predicting TP removal performance from different STA plant communities. DMSTA represents a significant improvement over earlier models that were used in support of previous STA designs. Nevertheless, there are a number of uncertainties associated with the use of DMSTA, particularly in planning level investigations where much of the input data must be estimated or assumed. These uncertainty factors include (1) the application of DMSTA calibration data sets to the ESP basins, (2) the effects of antecedent soil phosphorus, (3) the effects of phosphorus speciation and other water quality parameters, (4) the effects of STA hydraulic efficiency, and (5) the effects of STA dryout. The following paragraphs provided a brief discussion of each uncertainty factor.

2.6.5.1 Application of DMSTA Calibration Data Sets to ESP Basins

DMSTA predictions of TP removal performance in STAs are based on historical data relating how other wetland treatment systems of the same type performed under a certain set of hydraulic and TP load conditions. The similarity, or lack of similarity, between the water quality characteristics of the basin being investigated and the calibration data set being used in DMSTA to predict TP removal performance either decreases or increases the level of uncertainty associated with the analysis.

Much of the data used to compile calibration data sets for use in DMSTA originated from research studies and operation of full-scale facilities treating stormwater from the EAA. In these Basin Specific Feasibility Studies, the assumption has been made that water quality characteristics in the ESP basins being investigated are similar to the water quality characteristics associated with the DMSTA calibration data sets. Since much of the data used by DMSTA is based on studies performed on post-BMP and post-STA water from the EAA, this may not be a valid assumption, at least for some of the ESP basins.

In each of the basins with biological treatment alternatives, SAV was included in at least part of the STA because of its greater TP removal efficiency compared to the other STA plant communities. There remains significant uncertainty in the projection of long-term phosphorus reductions achievable by large-scale SAV communities, and hence, the evaluation incorporated two calibration data sets. The calibration data set used to predict performance in SAV cells was the SAV_C4 data set, which is based on 24 months of data (1998-1999) from Cell 4 in STA 1W. It is important to note that the SAV_C4 calibration data set represents very favorable conditions for TP removal

(relatively uniform hydraulic and TP loading) and does not take into account the highly pulsed flow and phosphorus loadings characteristic of the ESP basins. Accordingly, a more conservative approach to prediction of STA performance may be appropriate in some of these basins, particularly the highly urbanized basins with very high peak day flow compared to average day flow.

Sensitivity runs were made on all base case STA analyses using the NEWS calibration data set within DMSTA. The NEWS calibration data set considers a wider range of SAV data and generally results in reduced TP removal performance by SAV plant communities in a STA, compared to the SAV_C4 calibration data set. The sensitivity runs provide a means of establishing a more conservative prediction of possible performance in the base case STAs sized with the SAV_C4 calibration data set. This means that if the NEWS calibration data set more closely represents conditions in a particular basin or STA, more land may be required to achieve the 10 ppb target than is reflected by the base case analysis results. It will be up to the designer of the STA involved to examine the period of record flows and loads being used as the basis of design and select the DMSTA calibration data set which best represents the operating conditions expected over the long-term in that STA.

2.6.5.2 Antecedent Soil Phosphorus

District research on STA optimization (*SFWMD, 2001*), SAV (*DB Environmental, Inc., 2002*), and PSTA (*CH2M HILL, 2001*), as well as other published data (*Kadlec and Knight, 1996*) has indicated that in some cases antecedent soil phosphorus can contribute to reduced STA treatment performance. Labile phosphorus may be readily released from some soils in response to flooding and continue to be released over a prolonged time period due to the effects of rooted macrophytes acting as a nutrient pump and/or due to periodic soil disturbance.

In new STAs, a significant portion of the released labile phosphorus may be re-sequestered in initial biomass growth. However, continuing releases of labile phosphorus from soil storage result in elevated background TP concentrations (C^* or C_0) that are achievable by the STA technology. In other words, it is likely that C^* varies with the labile TP concentration of antecedent soils. However, it has been hypothesized that this antecedent soil effect will diminish over time as new soils are accreted. Thus, if STA data sets used to calibrate DMSTA are based on systems constructed on soils with less labile phosphorus than the proposed STA being simulated, then TP reduction performance is likely to be over estimated. There is no generally agreed upon method for incorporating this effect into DMSTA at this time. In the future and during final STA design, it would be beneficial to calibrate the DMSTA model with data sets from systems with different and known labile TP levels so this parameter can be added to the model and the design adjusted accordingly.

2.6.5.3 Phosphorus Speciation and Calcium Considerations

Phosphorus is present in stormwater runoff in a variety of chemical forms. The aggregate species most typically determined are:

- Total phosphorus (TP)

- Total dissolved phosphorus (TDP)
- Soluble reactive phosphorus (SRP)

These three analyses can also be used to calculate:

- Dissolved organic phosphorus (DOP = TDP-SRP)
- Total particulate phosphorus (TPP = TP-TDP)

District research has found that these various phosphorus fractions behave differently in STAs, with some easily removed and others more or less recalcitrant (*SFWMD, 2001; DB Environmental, Inc., 2002; CH2M HILL, 2001*). DMSTA and other calibrated single-technology models do not discriminate between phosphorus species and therefore these models are insensitive to the potentially large variations in phosphorus speciation between basins. If basin runoff is known to be predominantly in the SRP form, then a higher removal rate constant should be used than for a basin with a higher proportion of DOP. This level of estimation accuracy was not available in these Basin Specific Feasibility Studies but should be more completely evaluated during final STA design.

Additionally, calcium appears to play a role in the TP removal performance of STAs, particularly those involving SAV and PSTA. The mechanisms involved are not yet well understood. However, TP removal performance in SAV communities with high calcium levels in the water column appears to be better than in SAV communities with low calcium levels in the water column. (*DB Environmental, Inc., 2002*) Much of the data used in DMSTA for predicting SAV and PSTA performance comes from treatment of post-BMP and post-STA water from the EAA, which is typically high in calcium. Stormwater from the ESP basins, particularly the urban basins such as C-11 West, may not be as calcium rich, thereby introducing some additional uncertainty into the predictions made by DMSTA for TP removal performance in these basins.

2.6.5.4 STA Hydraulic Efficiency

District research has provided a wealth of new information concerning the hydraulic efficiency of STAs (*SFWMD, 2001; DB Environmental, Inc., 2002; CH2M HILL, 2001*). Much of this work was recently summarized by Kadlec (*2001*) and previous work on this subject was summarized in Kadlec (*1994*) and Kadlec and Knight (*1996*).

Two aspects of hydraulic efficiency are especially important for STA performance. The first is the effective volume available for treatment. Nominal hydraulic residence time and actual, measured hydraulic residence time may be different because of a difference in the nominal and actual effective volume in the STA. The actual volume may be different than the nominal volume due to topographic irregularities or due to areas that are bypassed by flows. Gross short-circuiting may actually bypass large wetland areas, effectively eliminating them from the P removal process.

A second important aspect of hydraulic efficiency is the degree of mixing. Based on theory, a completely mixed reactor will have poorer treatment performance than a reactor with plug flow

(*Kadlec and Knight, 1996*). Most treatment wetlands are intermediate between completely mixed and plug flow. This condition can be reported as the number of completely mixed stirred tank reactors in series (tanks in series, or TIS). The actual degree of hydraulic mixing is expected to be especially critical as the TP concentration approaches background.

In these Basin Specific Feasibility Studies, it was assumed, for the purpose of DMSTA modeling, that each discrete cell in a STA represents 3 TIS. While this is believed to be a reasonable assumption, DMSTA is sensitive to the assumed number of TIS. Also, the linking of multiple cells in series increases the total TIS and enhances predicted STA performance in DMSTA. While theory predicts this type of enhanced performance, there is limited data from actual STAs to verify it. Therefore, it is possible that increased performance due to a large number of cells in series may be optimistic.

2.6.5.5 STA Dryout

All of the major wetland treatment technologies (emergent, SAV, and PSTA) have been partially tested for the effects of dryout on TP removal performance (*SFWMD, 2001; DB Environmental, Inc., 2002; CH2M HILL, 2001*). From these studies, it is clear that dryout may significantly reduce performance of all wetland technologies.

The processes related to potential net TP release following dryout are not well understood, but probably include one or more of the following: oxidation of sediment organic P, decomposition of macrophyte and algal vegetation, re-suspension of particulate P, oxidation-reduction reactions, and mineralization. There is generally a net increase in TP concentration in the water column following dryout. STA management dictates holding this higher TP water until much of the TP can be re-adsorbed by the soils and biota prior to any downstream release.

At the present time, DMSTA does not simulate this operational scenario and, therefore, cannot be used to predict the effects of dryout on long-term STA performance. None of the major calibration data sets within DMSTA include data from systems where frequent or extended periods of dryout occurred. Therefore, DMSTA predictions of base case STA performance in ESP basins where frequent dryout is expected should be considered optimistic.

The issue of dryout in STAs serving the ESP basins highlights the importance of selecting the proper DMSTA calibration data set. The base case analyses all used the SAV_C4 calibration data set, which represents favorable conditions for SAV treatment performance. In many of the ESP basins, it may not be possible to reproduce those favorable conditions for TP removal because of the highly pulsed flow regimes involved. Therefore, while SAV technology may be capable of achieving this level of treatment performance under favorable conditions, it may be prudent to use a more conservative approach during design of STAs in some of the ESP basins where dryout is expected to be frequent and sometimes of extended duration.

2.6.5.6 STA Seepage Rates

When seepage rates were adjusted up to 50 percent (+/-) during the DMSTA sensitivity analyses, the average percent change of the predicted TP concentrations and TP load was less than one percent. This demonstrates that the effect of seepage rates on predicted TP concentrations and TP load is minimal. Seepage rates may, however, contribute to increased dryout and decreased hydraulic retention time. These two factors may impact STA performance and should be evaluated in subsequent analyses. Local seepage rates should be obtained prior to detailed design. In addition, construction techniques should be implemented that will not substantially impact the anticipated seepage rates.

3. Evaluation of Alternative Water Quality Combinations for ACME Basin B

This section presents results of the evaluation of alternative water quality improvement strategies for Acme Improvement District Basin B. Descriptions of the alternatives are presented, followed by results of the technical analyses and rating of the alternatives according to the Evaluation Methodology described previously in Section 2 of this report. It should be emphasized that the evaluations presented herein are not intended to indicate or recommend a preferred alternative, but rather to provide information for decision-making in subsequent phases of work.

3.1 Basin Characteristics

The Acme Improvement District (ACME) covers an area of about 19,000 acres in Central Palm Beach County that generally comprises the jurisdictional limits of the Village of Wellington. Recently, ACME was reorganized to become a dependent district of the Village. The boundaries of ACME are illustrated in Figure 3-1. Generally, the area is bounded by Southern Boulevard and

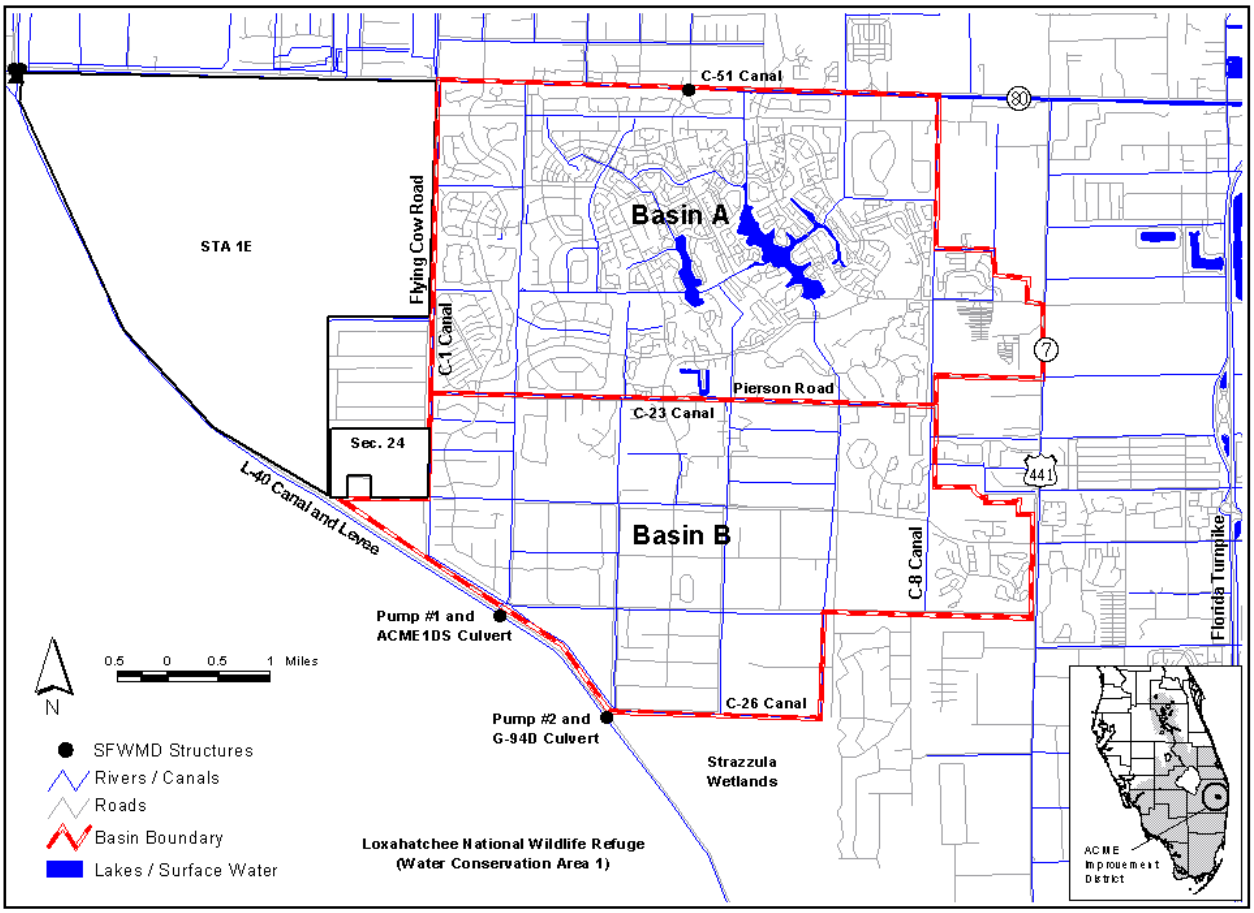


Figure 3-1.
Acme Improvement District Basin Map

Canal C-51 on the north, Flying Cow Road and Canal C-1 on the west, Levee L-40 and Canal C-26 on the south, and Canal C-8 on the east. Stormwater Treatment Area (STA) 1 East borders the area to the west and the Loxahatchee National Wildlife Refuge (Refuge, Water Conservation Area 1 or WCA 1) borders the area to the southwest.

ACME's drainage area is divided into two basins: Basin A and Basin B. The two basins are divided by Pierson Road and Canal C-23. Basin A is characterized by low and medium-density residential development, whereas Basin B is predominated by rural land uses. Drainage from Basin A is routed north and discharged to Canal C-51. Drainage from Basin B is routed south and discharged to the Refuge. During very large storm events, drainage from Basin A overflows into Basin B. This investigation addresses only that drainage which is generated from ACME Basin B and discharged to the Refuge, including any overflows from Basin A.

ACME Basin B encompasses an area of about 8,800 acres south of Pierson Road and Canal C-23 in the Village of Wellington. Land use consists primarily of rural residential development and agriculture. There are also a number of horse farms and other equestrian facilities in the basin. A summary of the current land uses in ACME Basin B is provided in Table 3-1.

Table 3-1.
Breakdown of Land Use in ACME Basin B

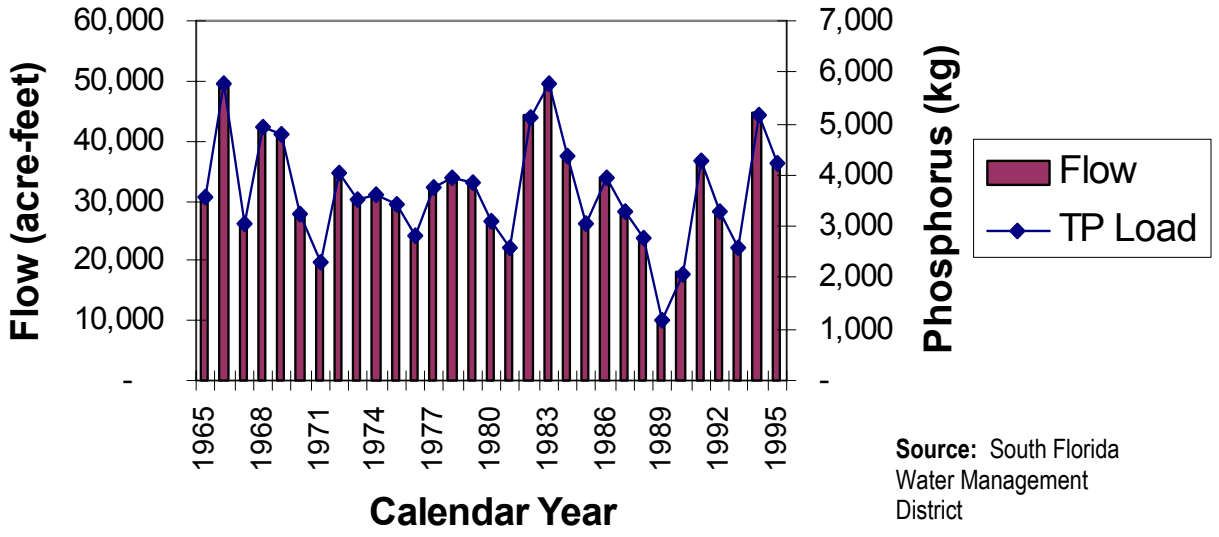
Land Use Category	Percentage of Basin Area
Agriculture	47.9
Rangeland	5.0
Transportation, Communication, and Utilities	1.8
Upland Forests	4.4
Urban and Built-Up	35.4
Water	2.2
Wetlands	3.3
Total	**100.0**

Source: 1995 SFWMD GIS Land Use data according to the Florida Land Use and Cover Classification System (FLUCCS).

Drainage from ACME Basin B is collected in a network of interconnected lakes and canals that are operated by ACME to provide water supply and flood protection throughout the basin. Two pumping stations, both located along the L-40, are used to discharge water into the L-40 borrow canal inside the Refuge. ACME Pump No. 1 conveys water from Canals C-2, C-25 and C-27 through the ACME 1DS structure into the Refuge. ACME Pump No. 2 conveys water from Canals C-4 and C-26 through the South Florida Water Management District's (District's) G-94D Structure to the Refuge. Pump No. 1 has a permitted capacity of 100,000 gallons per minute (gpm) or 222 cubic feet per second (cfs). Pump No. 2 has a permitted capacity of 120,000 gpm or 267 cfs.

The District used historical rainfall, flow and water quality data to develop a 31-year set of simulated baseline flows and total phosphorus (TP) loads from ACME Basin B for the period from 1965 to 1995 *(Baseline Data for the Basin Specific Feasibility Studies to Achieve the Long-Term Water Quality Goals for the Everglades, SFWMD, May 2001).* The simulated flows and loads are presented graphically in Figure 3-2. Flows ranged from about 10,000 to 50,000 acre-feet per year (average 31,499 acre-feet per year). The peak daily flow, 505 cfs, occurs throughout the 31-year period of simulation with a maximum continuous duration of 10 days. The ratio of peak day flow to average day flow over the 31 years is about 12:1.

Simulated phosphorus loads ranged from about 1,200 to 5,800 kilograms (kg) TP per year (average 3,660 kg TP per year) over the 31-year period of simulation. The flow-weighted mean TP concentration over the 31-year period of simulation was estimated to be 94 ppb.



Source: South Florida Water Management District

Figure 3-2.
Simulated Flows and Loads for ACME Basin B

3.2 Alternative Water Quality Combinations

The District provided Brown and Caldwell with four alternative water quality improvement strategies, consisting of source controls, Comprehensive Everglades Restoration Program (CERP) projects, and basin-scale treatment facilities for addressing long-term water quality objectives for discharges to the Everglades Protection Area (EPA). These alternatives were described in the District publication entitled *Final Water Quality Improvement Strategies for the Everglades: Alternative Combinations for Wellington/ACME Basin B, February 27, 2002* and were based on documents provided by the Village of Wellington's Surface Water Action Team (SWAT). The components of the four alternative water quality combinations are summarized in Table 3-2.

In 2000, the Village of Wellington passed a BMP ordinance as part of the Village's cooperative efforts with the District to improve water quality in discharges to the Everglades. The ordinance

places controls on the storage and application of fertilizer and includes an educational component on the proper use of fertilizers and irrigation practices. Of particular importance in ACME Basin B are requirements for the storage, handling and transport of waste materials from livestock operations, including horse farms and equestrian facilities. It is likely that high TP concentrations in runoff from these facilities have contributed significantly to the overall phosphorus load entering the refuge from this basin.

Table 3-2.
Alternative Water Quality Combinations for ACME Basin B

Alternative	Project Component
1	Source controls Diversion to Agricultural Reserve Reservoir (CERP)
2	Source controls Chemical Treatment
3	Source controls Biological Treatment (on 375 acres of District land)
4	Source controls Biological Treatment (unconstrained by land area)

It should also be noted that a fifth alternative for ACME Basin B was evaluated separately by the consulting engineering firm of Burns & McDonnell. This alternative involves treatment of ACME Basin B flows in STA 1E as part of that larger scale wetland treatment project. The results of the evaluation of this alternative are included in Appendix D of this report, as well as in the Burns & McDonnell report on Basin Specific Feasibility Studies for the ECP basins, which is posted to the District's web site.

Since the Village of Wellington BMP ordinance has been in effect for only a short time, water quality improvements resulting from its implementation have yet to be quantified. For the purposes of evaluation in this investigation, it was assumed that implementation of source controls would (1) have no affect on the 31-year baseline flows simulated by the District, and (2) would reduce the annual TP load in runoff from ACME Basin B by 25 percent. These assumptions were applied uniformly to the evaluation of all four alternatives and had the net effect of reducing the flow-weighted mean TP concentration in runoff from ACME Basin B from 94 ppb to 71 ppb. A revised baseline data set, reflecting these assumptions, was prepared by the District for the evaluation of alternatives and is considered to be the Base Condition for ACME Basin B in these investigations.

Other assumptions made for the evaluation of alternatives for ACME Basin B included the following:

1. The control elevation for pump operation in ACME Basin B canals was assumed to be 12 feet NGVD based upon current operating practices and permit conditions.

2. The current level of flood protection within the basin must be maintained. Pumping capacity was assumed to be 505 cfs, consistent with the simulated maximum flow discharged over the 31-year period and the combined capacities of existing ACME Pump No. 1 and ACME Pump No. 2.

3. The CERP impoundment previously planned for the southeast corner of ACME Basin B (Section 34) was not considered in this investigation.

Presented below are more detailed descriptions of the four alternative water quality combinations for ACME Basin B and the results of the investigation performed to rate them against the criteria contained in the Evaluation Methodology.

3.3 Alternative 1 – Diversion to Agricultural Reserve Reservoir

Alternative 1 involves source controls and the diversion of runoff from the ACME Basin B south to a CERP impoundment, the Palm Beach County Agricultural Reserve Reservoir, to be constructed immediately east of the Refuge by 2013. Source controls, to be implemented by 2006, will reduce phosphorus loads in runoff from the basin by an assumed 25 percent on average. However, because stormwater will no longer be discharged into the EPA after the diversion, no further treatment of the stormwater was evaluated. During the period 2007-2013, untreated stormwater discharges from ACME Basin B to the Refuge will continue.

The Palm Beach County Agricultural Reserve Reservoir, designated CERP Component VV, is an above-ground impoundment to be located adjacent to the Refuge and south of Canal C-16 in the Lake Worth Drainage District (LWDD). As currently proposed, the impoundment will provide about 20,000 acre-feet of water storage. The reservoir will be filled during the wet season with excess water from the western portions of the LWDD, and in this alternative, ACME Basin B. Water will be returned to the LWDD system to help maintain canal stages during the dry season. *(C&SF Project Comprehensive Review Study, Final Integrated Feasibility Report and Programmatic EIS, USACOE/SFWMD, April 1999)*

The original concept for this alternative was to divert ACME Basin B runoff south and discharge it into the LWDD system *(Water Quality Cleanup Options Opinion of Probable Cost, Village of Wellington Surface Water Action Team)*. However, the LWDD has expressed concern about accepting runoff from ACME Basin B into its system, citing capacity limitations and water quality concerns. Therefore, it was assumed that if this alternative is to be implemented, it will need to be done in such a way that there is no mixing of ACME Basin B and LWDD waters upstream of the Agricultural Reserve Reservoir.

The LWDD has also maintained that there is insufficient capacity in the reservoir for drainage from ACME Basin B and that the LWDD will be adversely impacted by seepage from any canal(s) that are constructed to convey ACME Basin B water to the reservoir. In response to LWDD concerns, District staff have indicated that it was the best professional judgement of the Water Preserve Area

(WPA) Team that, based on modeling conducted for the WPA Feasibility Study, sufficient capacity will be available in combination with planned ASR wells. If the diversion alternative is selected for further analysis, additional modeling to verify the available capacity will be conducted in concert with the Agricultural Reserve Reservoir Project Implementation Report (PIR) activities. Identification of impacts to the LWDD system due to seepage from a diversion canal associated with this alternative are beyond the scope of this investigation and will also need to be assessed in future phases of work should this alternative be selected for further study.

3.3.1 Project Elements

A new pumping station would be constructed on the southeast corner of Section 34 at the intersection of the C-7 and C-26 Canals. A new canal would be constructed from this point south for a distance of about 6.7 miles to the Agricultural Reserve Reservoir. Approximately four miles of this distance would be a 200-foot wide strip along the eastern edge of the Strazzulla property. This canal alignment was evaluated as an alternative to another alignment that would require purchasing land from and relocating approximately 70 to 90 private owners. The alignment along the eastern edge of Strazzulla was used because it would minimize impacts to private landowners and because the District considered it to be the most cost-effective use of taxpayers' money.

To determine the approximate size of facilities required, the baseline flows from ACME Basin B were reviewed to identify the peak storm flow event during the 31-year period of simulation. This review identified a simulated peak flow of 505 cfs extending over a period of about 10 days as the result of a peak rainfall event in September 1977. This sustained peak flow event was used for sizing the diversion facilities.

The pumping stations and diversion canal were modeled using Stormwater Management Model (SWMM) Version 4.46. Both the upstream and downstream pumping stations were assumed to have capacities of 505 cfs, equal to the simulated peak flow from ACME Basin B during the 31-year period of simulation. Redundancy was assumed to be provided by the existing ACME Pump No. 1 and Pump No. 2, at least one of which will remain available in the event of an emergency.

The diversion canal was assumed to be partially excavated and partially constructed above grade with berms to provide the necessary cross-sectional area. Assuming a hydraulic gradient of 1-foot over the 6.7-mile canal length, it was determined that the maximum canal cross-sectional area required is about 860 square feet (ft^2).

The conceptual diversion canal was assumed to cross three utility easements; and therefore, improvements to the utilities and their respective service roads are required. The diversion canal was also assumed to pass under 95th street (just north of the L-23W canal); therefore, a culvert system will be required to convey flow under the roadway. A siphon structure was assumed to be required for the diversion canal to pass under the L-23W Canal and avoid any mixing of ACME Basin B and LWDD waters.

Implementation of Alternative 1 will require acquisition of right-of-way for the pumping stations, diversion canal and siphon and control structures. For the purposes of estimating land acquisition costs, an average right-of-way width of 200 feet along the 6.7-mile length of canal was assumed, as well as an additional 5 acres for each of the upstream and downstream pumping stations. The land area requirement for this alternative was estimated to total about 176 acres.

3.3.2 Sensitivity Analysis

In the base case for this alternative (25 percent load reduction due to source controls), the TP load to the EPA would be 2,745 kg per year for the first 7 years of the 50-year analysis period (2007-2013) and then zero kg per year after the diversion is implemented beginning in 2014. The total TP load discharged to the EPA during the period from 2007 to 2056 is 19,125 kg. Sensitivity analyses were conducted to calculate the TP load associated with discharges to the EPA from ACME Basin B using zero percent and 50 percent load reductions due to source controls. For the zero percent load reduction case, the average annual TP load to the EPA for the first 7 years is 3,660 kg per year and the 50-year TP load is 25,620 kg. For the 50 percent load reduction case, the average annual TP load to the EPA for the first 7 years is -1,830 kg per year and the 50-year TP load is 12,810 kg.

3.3.3 Implementation Schedule

The Agricultural Reserve Reservoir is scheduled to come on line in the year 2013. It is estimated that the diversion alternative will take 4 years to implement as indicated in Table 3-3. Therefore, if the diversion facilities are to be available when the Agricultural Reserve Reservoir comes on-line, right-of-way acquisition should begin no later than 2010.

Table 3-3
Implementation Schedule for ACME Basin B Alternative 1

Project Component	Time Duration (months)
Land acquisition	12
Design and permitting	12
Contractor procurement	6
Construction	18
Total	**48**

3.3.4 Cost Estimates

Capital costs and average annual operation and maintenance (O&M) costs for Alternative 1 were estimated using unit costs provided by the District and supplemented, where necessary, by Brown and Caldwell. The methodology for preparing cost estimates was presented previously in Section 2 of this report. A summary of the capital and O&M cost estimates is presented in Table 3-4. Capital

costs, including land acquisition and contingency, were estimated to total $27.25 million. The cost of land acquisition was estimated by the District to be $0.37 million. This includes the cost of land within the Strazzulla property already owned by the District. Average annual O&M costs were based on pumping an average of 31,500 acre-feet of water per year from ACME Basin B to the Agricultural Reserve Reservoir and were estimated to total $0.26 million per year. Detailed breakdowns of the capital and O&M cost estimates for Alternative 1 are presented in Appendix A.

Table 3-4.
Cost Estimates for ACME Basin B Alternative 1

Cost Component	Estimated cost, million dollars
Capital Costs	
Construction	
Diversion canal	4.10
Pumping stations (2)	8.79
Siphon and control structures	4.34
Subtotal	17.23
Planning, engineering and design (10%)	1.72
Program and construction management (10%)	1.72
Subtotal	20.68
Contingency (30%)	6.20
Total, construction costs	26.89
Land Acquisition	
Right-of-way and land purchase	0.14
Contingency (25%)	0.04
Land previously acquired (Strazzulla)	0.19
Total, Land Acquisition costs	0.37
Total, Capital costs	27.25
Average Annual O&M Costs	
Pumping Stations	0.15
Diversion Canal	0.02
Control structures	0.03
Subtotal	0.20
Contingency (30%)	0.06
Total, Annual O&M costs	0.26
50-year Present Worth (2010-2059)	
Capital costs (2010-2013)	25.39
O&M costs (2014-2059)	6.48
Replacement Costs	0.96
Total, 50-year present worth	32.84

It should be noted that additional capital costs may be necessary for internal drainage improvements within Basin B to convey water to the new diversion pump station and for wetland mitigation costs associated with impacts to the Strazzulla property. Defining these improvements is beyond the scope of the Basin Specific Feasibility Studies. However, for this alternative, the District prepared a preliminary estimate of $4.85 million for potential mitigation costs if a 4-mile long, 200-foot wide strip along the eastern edge of the Strazzulla property were to be used for a diversion canal. Because estimates of potential mitigation costs for other alternatives were not prepared, this cost is not included in the capital cost estimate or the 50-year present worth estimate for Alternative 1 for consistency purposes.

Estimates of 50-year present worth were prepared covering the period 2010-2059. Capital costs were assumed to be incurred during the period 2010-2013. O&M costs for diversion to the Agricultural Reserve Reservoir were assumed to begin in 2014. The present worth of the anticipated capital costs is estimated to be $25.39 million, the present worth of the average annual O&M costs is estimated to be $6.48 million, and the present worth of the pump station rehabilitation costs is estimated to be $0.96 million for a combined 50-year present worth of $32.84 million for ACME Basin B Alternative 1.

3.3.5 Evaluation Ratings

Alternative 1 was rated against the ten evaluation criteria defined in the Evaluation Methodology document *(Final Evaluation Methodology for the Water Quality Improvement Strategies for the Everglades, SFWMD, July 31, 2002)* and discussed previously in Section 2 of this report. Table 3-5 summarizes the ratings given to Alternative 1 based on the results of this investigation.

Phosphorus Load Reduction. This alternative reduces the TP load discharged to the EPA from ACME Basin B by 86 percent over the 50-year analysis period.

Long-Term TP Concentration Achieved. This criterion has only short-term applicability to the evaluation of Alternative 1 because, after 2013, all ACME Basin B flows will be diverted away from the EPA. Reducing the long-term TP concentration in the water being diverted to the Agricultural Reserve Reservoir is not a primary objective of the alternative. During the period from 2007 to 2013, the flow-weighted mean TP concentration is projected to be 71 ppb and the geometric mean TP concentration is projected to be about 71 ppb.

Implementation Schedule. It is projected that this alternative will take approximately 4 years to implement. However, since the Agricultural Reserve Reservoir will not be available until some time in 2013, the diversion cannot occur until that time. Assuming that the diversion can actually start in January 2014, the total time for implementation starting in January 2003 would be 11 years. **Rating: 11 years.**

Operational Flexibility. This alternative does not materially impact the operational flexibility of the South Florida hydraulic conveyance system or the Everglades Water Conservation Areas. Runoff from ACME Basin B will still have only one discharge point, the Agricultural Reserve Reservoir. If

the existing ACME pump stations remain, water from ACME Basin B could be pumped into the Refuge in an emergency, but since the water would not be treated, this practice may be in violation of water quality standards. **Rating: 0.**

Resiliency to Extreme Conditions. This alternative provides a high level of resiliency to fire, flood, drought and hurricane. **Rating: +4.**

Assessment of Full Scale Construction and Operation. There are no significant constructability, operability or scale-up issues associated with this alternative, although the impact of seepage from the diversion canal on the LWDD system should be investigated during design. **Rating: +3.**

Management of Side Streams. Other than the possibility of some seepage, there are no side streams generated by this alternative that would require significant management effort and cost. **Rating: 0.**

Improvement in Non-P Parameters. Other than effects that may be derived from source controls, this alternative is not expected to result in any change to non-P water quality parameters. **Rating: 0.**

50-Year Present Worth. The total 50-year present worth of the capital, O&M and pump station rehabilitation costs associated with this alternative is $32.84 million.

Cost-Effectiveness. The total TP load removed over the 50-year analysis period is estimated to total 118,035 kg. Based upon a 50-year present worth of $32.84 million, this translates to a cost-effectiveness rating of $278 per kg TP removed.

Table 3-5.
Summary of Evaluation Ratings for ACME Basin B Alternative 1

Evaluation Criteria	Unit	Rating
Technical Performance Criteria		
Phosphorus Load Reduction	Percent	86
Long-Term TP Concentration Achieved [a]		
Flow-weighted mean	ppb	71
Geometric mean	ppb	71
Implementation Schedule	Years	11
Operational Flexibility	+3/-3	0
Resiliency to Extreme Conditions	+4/-4	+4
Assessment of Full-Scale Construction and Operation	+3/-3	+3
Management of Side Streams	+3/-3	0
Environmental Criteria		
Improvement in Non-P Parameters	+19/-19	0
Economic Criteria		
50-year Present Worth	Million dollars	32.84
Cost-Effectiveness	Dollars/kg removed	278

[a] Flow-weighted mean and geometric mean are applicable only to discharges from 2007-2013.

3.4 Alternative 2 – Chemical Treatment

Alternative 2 combines source controls with chemical treatment to address long-term water quality objectives for discharges to the EPA. In this alternative, it is assumed that source controls will achieve a 25 percent reduction in TP load by December 2006. A chemical treatment-solids separation (CTSS) treatment facility would be constructed on the 375 acres of land owned by the District west of ACME Basin B in Section 24, Township 44 South, Range 40 East. The treated effluent from the CTSS treatment facility, with a geometric mean TP concentration not exceeding 10 ppb, would be discharged into the Refuge.

3.4.1 Technical Analysis of Chemical Treatment Technology

To determine the optimal combination of flow equalization basin (FEB) size and CTSS treatment plant capacity, a spreadsheet model, developed by HSA Engineers & Scientists, Inc., was used *(Chemical Treatment-Solids Separation Advanced Technology Demonstration Project, Final Report, HSA Engineers & Scientists, December 2000)*. This model was described previously in Section 2 of this report, as were the operating assumptions regarding FEB operation, CTSS treatment plant operation and performance, and blending of CTSS plant effluent with untreated water from the FEB. Three CTSS scenarios were modeled: a base case assuming the CTSS treatment plant could produce an effluent with 6 ppb TP under average design flow conditions and 10 ppb TP under maximum design flow conditions (150 percent of average daily design flow); and two sensitivity cases described below. The sizes and capacities of the CTSS facilities required under each of these three cases, as well as the TP removal performance achieved, are summarized in Table 3-6.

Given the size and irregular shape of the District's 375-acre site that is to be used for this alternative, the FEB area was capped at 200 acres to assure that all required facilities could be accommodated on the site. For the base case scenario, a 25-mgd treatment facility achieves a geometric mean blended outflow TP concentration of 10 ppb. The flow-weighted mean TP concentration in the blended outflow is predicted to be 27 ppb. Approximately 9 acres will be required for the outflow blending basin and an estimated 52 acres will be required for residual solids thickening and land disposal. Overall TP load reduction resulting from chemical treatment is projected to be 62 percent.

Table 3-6.
CTSS Facility Components and Predicted TP Removal Performance for ACME Basin B Alternative 2

Facility Component/Parameter	Base Case	Sensitivity Case 1 (50%)	Sensitivity Case 2 (8 ppb/13 ppb)
TP Removal Performance			
Average basin TP load, kg/year	3,660	3,660	3,660
TP source control reduction, percent	25	50	25
TP load to CTSS, kg/year	2,745	1,830	2,745
CTSS plant effluent TP conc., ppb			
Average Flow	6	6	8
Maximum Flow (150 percent)	10	10	13
CTSS blended outflow TP conc., ppb			
Flow-weighted mean	27	23	18
Geometric mean	10	10	10
Total CTSS outflow TP load, kg/year	1,044	890	702
Average TP load reduction, kg/year	1,701	940	2,043
Total 50-year TP load reduction, percent	62	51	74
Pumping Station Capacity (cfs)			
Inflow	505	505	505
CTSS Influent from FEB	60	45	115
Outflow	505	505	505
Flow Equalization Basin			
Area, acres	200	200	200
Max. side water depth, feet	4.5	4.5	4.5
Max. storage volume, MG	290	290	290
CTSS Treatment Works			
Average design flow, mgd	25	20	50
Maximum design flow, mgd	38	30	75
Blending Basin			
Area, acres	9	8	18
Average HRT, days	3	3	3
Residuals Management Facility			
Area, acres	52	47	60

3.4.2 Project Elements

The elements of a CTSS treatment facility, as applied in this investigation, were described in detail in Section 2 of this report. The CTSS process is similar in concept to conventional surface water treatment for potable drinking water purposes. The process includes inflow pumping, flow equalization, chemical dosing, coagulation, flocculation, sedimentation, effluent blending and

mixing, and residual solids management. Depending on the application, intermediate and outflow pumping may also be required.

A schematic layout of how the CTSS treatment facility could be configured on the District's 375-acre site in Section 24 is illustrated in Figure 3-3. An inflow pumping station would be located at the C-1 Canal and would discharge flow to a FEB. A smaller intermediate pump would deliver flow from the FEB to the CTSS treatment works. Flow would pass through the CTSS treatment works by gravity and discharge into a blending basin where it would be mixed with untreated flows from the FEB (when necessary hydraulically). Outflows from the blending basin would have a maximum geometric mean concentration of 10 ppb TP and would be discharged into the L-40 Borrow Canal by means of a new outflow pumping station. An on-site residuals solids management facility, consisting of a thickening pond and dedicated land disposal area, would also be required.

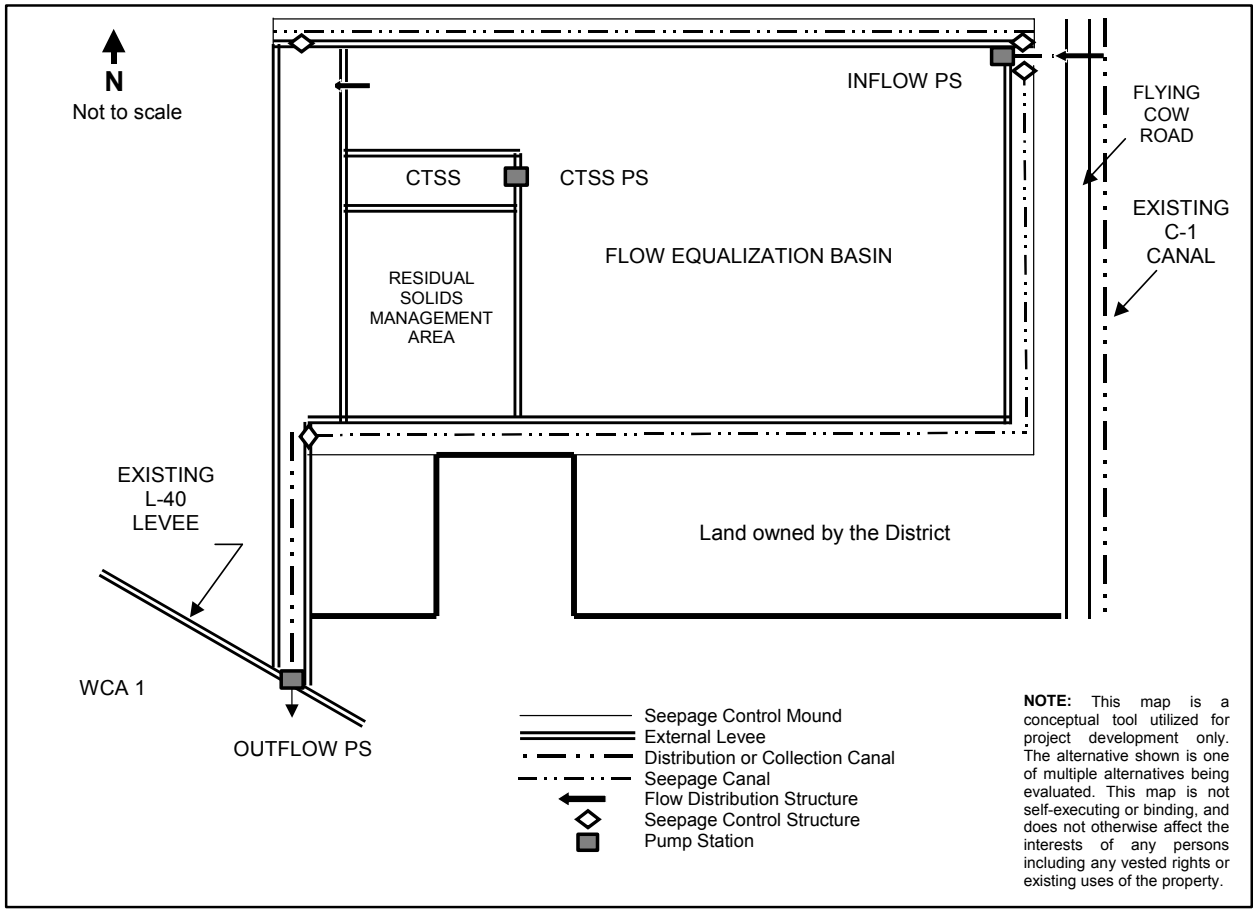


Figure 3-3.
Example CTSS Schematic for ACME Basin B Alternative 2

3.4.3 Sensitivity Analysis

Two additional analyses were performed to test the sensitivity of treatment plant performance criteria and additional reductions in TP load due to source controls. The results are presented in Table 3-6. The sensitivity analyses performed are as follows:

1. *Sensitivity Case 1:* Assume base case CTSS plant effluent (6 ppb/10 ppb), but with 50 percent of the TP removed as a result of source controls instead of 25 percent as originally assumed.

2. *Sensitivity Case 2:* Assume 8 ppb TP in the CTSS plant effluent under average flow conditions and 13 ppb TP under maximum flow conditions with 25 percent of the TP removed as a result of source controls.

3.4.3.1 Sensitivity Case 1

The first sensitivity case was analyzed to test the impact of increased source controls resulting in 50 percent of the TP removed instead of 25 percent as assumed in the base case. In this case, a 20-mgd treatment facility achieves a geometric mean blended outflow TP concentration of 10 ppb. The amount of land required for a blending basin and for residual solids management area is slightly less than the base case. In comparison to the base case, the increase in source control efforts reduces the annual TP load discharged to the EPA by approximately 150 kg per year and decreases the present-worth cost of the alternative by approximately $3 million (Note: the cost of source control programs has not been evaluated as a part of the Basin Specific Feasibility Studies).

3.4.3.2 Sensitivity Case 2

The second sensitivity case was analyzed to test the impact of reduced CTSS treatment performance (8 ppb/13 ppb) on the size of the CTSS components required to achieve the 10 ppb TP water quality goal. Since the size of the FEB cannot be increased substantially due to site constraints, the average daily design flow rate of the CTSS treatment works must be increased to 50 mgd to accommodate the greater volume of water being treated. Intermediate pump station capacity and acreage required for residuals management are also increased accordingly. Note, however, that the TP load reduction is slightly higher than the base case alternative as a result of blending less water from the FEB with treated effluent from the CTSS plant. In comparison to the base case, the increase in the design flow rate, intermediate pump station capacity and residuals management area reduces the annual TP load discharged to the EPA by approximately 350 kg per year and increases the present-worth cost of the alternative by approximately $11 million.

3.4.4 Implementation Schedule

Since it has been assumed that all CTSS project components will be sited on 287 acres of the 375 acres available in Section 24 that are already owned by the District, no land acquisition will be required. It is estimated that approximately 36 months will be required to implement this alternative if no unforeseen delays are encountered. A breakdown of this implementation schedule is presented in Table 3-7. If implementation begins in early 2003, the project could be on-line as much as a year

before the December 31, 2006 deadline mandated in the Everglades Forever Act. However, given the uncertainty surrounding permit issues, it is possible that permit approval could take longer than 6 months. Still, if the project experiences no undue delays, there is reason to believe it could be complete by December 2006.

Table 3-7.
Implementation Schedule for ACME Basin B Alternative 2

Project Component	Time Duration (months)
Design and Permitting	18
Contractor Procurement	6
Construction	9
Start-up	3
Total	**36**

3.4.5 Cost Estimates

Capital costs and average annual O&M costs for Alternative 2 were estimated using unit costs provided by the District and supplemented, where necessary, by Brown and Caldwell. The methodology for preparing cost estimates was presented previously in Section 2 of this report. A summary of the capital and O&M cost estimates for the base case analysis is presented in Table 3-8. Capital costs, including land acquisition and contingency, were estimated to total $26.11 million. Average annual O&M costs were estimated to total $1.26 million per year. Detailed breakdowns of the capital and O&M cost estimates for Alternative 2 are presented in Appendix A.

Estimates of 50-year present worth were prepared covering the period 2004-2053 using the procedure described in Section 2. Capital costs were assumed to occur over the period 2004-2006. O&M costs were assumed to occur over the period 2006-2053. The combined 50-year present worth for ACME Basin B Alternative 2 is estimated to be $53.66 million.

Table 3-8.
Cost Estimates for ACME Basin B Alternative 2

Cost Component	Estimated cost, million dollars
Capital Costs	
Construction Costs	
Pumping Stations (3)	8.15
Flow Equalization Basin and Blending Basin	1.98
CTSS Treatment Works	3.41
Residual Solids Management	0.50
Control Structures and Misc.	0.67
Subtotal	14.72
Planning, engineering and design (10%)	1.47
Program and construction management (10%)	1.47
Subtotal	17.66
Contingency (30%)	5.30
Total, construction costs	22.96
Land Previously Acquired	3.16
Total, Capital costs	26.11
Average Annual O&M Costs	
Pumping Stations	0.14
Flow Equalization and Blending Basins	0.01
CTSS Treatment Works	0.77
Residual Solids Management	0.03
Control Structures and Misc.	0.02
Subtotal	0.97
Contingency (30%)	0.29
Total, Annual O&M costs	1.26
50-year Present Worth (2004-2053)	
Capital costs	25.05
O&M costs	27.06
Replacement Costs	1.54
Total, 50-year present worth	53.66

In addition, a cost estimate was prepared for both of the sensitivity cases for this alternative. A summary of the 50-year present worth estimates for the sensitivity cases is presented in Table 3-9. Full cost estimate breakdowns for the two sensitivity cases are presented in Appendix A.

Table 3-9.
Summary of Present Worth Cost Estimates for ACME Basin B Alternative 2

Present Worth Component (million dollars)	Base Case	Sensitivity Case 1 (50%)	Sensitivity Case 2 (8 ppb/13 ppb)
Capital costs	25.05	23.50	30.93
O&M costs	27.06	25.52	31.59
Replacement costs	1.54	1.41	2.13
Total, 50-year present worth	53.66	50.43	64.65

3.4.6 Evaluation Ratings

Alternative 2 was rated against the ten evaluation criteria defined in the Evaluation Methodology document *(Final Evaluation Methodology for the Water Quality Improvement Strategies for the Everglades, SFWMD, July 31, 2002)* and discussed previously in Section 2 of this report. Table 3-10 summarizes the ratings given based on the results of this investigation.

Phosphorus Load Reduction. Approximately 62 percent of the TP load generated in ACME Basin B over the 50-year analysis period is removed by the CTSS treatment facility in this alternative.

Long-Term TP Concentration Achieved. CTSS technology has the demonstrated capability to achieve effluent TP concentrations below 10 ppb. For this alternative, the CTSS treatment facilities were sized to produce a blended outflow having a long-term geometric mean TP concentration of 10 ppb. The corresponding long-term flow-weighted mean TP concentration is projected to be 27 ppb.

Implementation Schedule. This alternative can be constructed and placed into operation in a period of 36 months. **Rating: 3 years.**

Operational Flexibility. The 200-acre FEB in this alternative must be operated in conjunction with the CTSS treatment works. Therefore, the storage capacity associated with the FEB may not always be available when needed to provide additional operating flexibility to the South Florida hydraulic conveyance system and the Everglades Water Conservation Areas. **Rating: +1.**

Resiliency to Extreme Conditions. This alternative provides a high level of resilience to fire, flood, drought and hurricane. **Rating: +4.**

Assessment of Full-Scale Construction and Operation. There are many documented examples of chemical treatment systems constructed at the scale proposed in this alternative for potable water, wastewater and stormwater treatment applications. Scale-up issues are not expected to be significant. Still, CTSS technology has not been implemented at full scale with the sole objective of meeting a 10 ppb TP standard. This introduces some level of uncertainty regarding full-scale operation in the Everglades. **Rating: +1.**

Management of Side Streams. CTSS technology generates side streams, which must be managed at considerable cost and effort to the project. The most notable side stream is residual solids that must be disposed of either on-site or at a permitted disposal facility off-site. These solids are not hazardous, but must be disposed of properly in an environmentally safe manner. There is ongoing research that may identify beneficial uses for these residual solids. However, there is no assurance that these beneficial uses will ultimately prove viable. **Rating: -2.**

Improvement in Non-P Parameters. The STSOC report for CTSS prepared by HSA Engineers & Scientists, Inc. includes information on non-phosphorus water quality parameters collected during research activities. Information from Post-BMP and Post-STA testing indicated the following: an improvement in dissolved oxygen, turbidity, and color, a deterioration in alkalinity, pH, conductivity, chloride, iron, and aluminum, and no significant change in the other 10 non-P water quality parameters. **Rating: -3.**

50-Year Present Worth. The total 50-year present worth of the capital, O&M and equipment replacement costs associated with this alternative is estimated to be $53.66 million.

Cost-Effectiveness. The total TP load removed over the 50-year analysis period is estimated to total 85,050 kg. Based upon a 50-year present worth of $53.66 million, this translates to a cost-effectiveness rating of $631 per kg TP removed.

Table 3-10.
Summary of Evaluation Ratings for ACME Basin B Alternative 2

Evaluation Criteria	Unit	Rating
Technical Performance Criteria		
Phosphorus Load Reduction	Percent	62
Long-Term TP Concentration Achieved		
Flow-weighted mean	ppb	27
Geometric mean	ppb	10
Implementation Schedule	Years	3
Operational Flexibility	+3/-3	+1
Resiliency to Extreme Conditions	+4/-4	+4
Assessment of Full-Scale Construction and Operation	+3/-3	+1
Management of Side Streams	+3/-3	-2
Environmental Criteria		
Improvement in Non-P Parameters	+19/-19	-3
Economic Criteria		
50-year Present Worth	Million dollars	53.66
Cost-Effectiveness	Dollars/kg removed	631

3.5 Alternative 3 – Biological Treatment on Section 24 (375 Acres)

Alternative 3 combines source controls with biological treatment in a STA to address long-term water quality objectives for discharges to the EPA. This alternative assumes that source controls will achieve a 25 percent reduction in TP load in the basin by 2006. To further reduce TP loads, a STA would be constructed on the 375 acres of land owned by the District west of ACME Basin B in Section 24, Township 44 South, Range 40 East. Outflow from the STA would be discharged into the Refuge.

3.5.1 Technical Analysis of Biological Treatment Technology

The Dynamic Model for Stormwater Treatment Areas (DMSTA) was used to determine the most effective combination of wetland vegetation communities for the STA in this alternative, given the baseline flows and loads for ACME Basin B (adjusted for TP reduction by source controls) and the fixed land area available. A discussion of DMSTA and how it was applied in the Basin Specific Feasibility Studies for the ESP basins was presented previously in Section 2 of this report. Emergent vegetation, submerged aquatic vegetation (SAV), and periphyton (PSTA) were all considered individually and in combination with one another to identify the technology or combination of technologies that provided maximum phosphorus removal performance. Also considered in the evaluation were factors such as cell partitioning to improve hydraulic efficiency through the STA, maximum allowable water depth, frequency and duration of dryout periods, and the occurrence of hydraulic bypass during major storm events.

The following combinations of vegetation communities were simulated with DMSTA to establish the apparent best base case scenario for evaluation in this alternative:

- Emergent
- Emergent/SAV
- Emergent/SAV/PSTA
- SAV
- SAV/PSTA

For each of these combinations of vegetation communities, the 375 acres of land currently owned by the District on Section 24 was divided into a varying number of cells to test the effect of cell partitioning on STA performance. The goal was to maximize treatment efficiency while preventing hydraulic bypass and minimizing the frequency and duration of dryout periods. The benefit of increased TP removal efficiency achieved by constructing additional cells was balanced against the increased construction cost associated with internal levees and the increased potential for hydraulic bypass.

The results of this iterative screening process indicated that a 100 percent SAV-dominated STA, partitioned into three cells, provides the best overall TP removal performance and protection against bypass and dryout. This STA requires 297 acres of active treatment cells, and is projected by DMSTA to achieve a long-term flow-weighted mean TP concentration of 19 ppb and a long-term

geometric mean TP concentration of 12 ppb. A summary of the TP removal performance and the size and operating characteristics of the STA for ACME Basin B Alternative 3 is presented in Table 3-11.

Table 3-11.
STA Components and Predicted TP Removal Performance for ACME Basin B Alternative 3

Facility Component / Parameter	Base Case (25%)	Sensitivity Case 1a (0%)	Sensitivity Case 1b (50%)	Sensitivity Case 2 (40%)	Sensitivity Case 3 (NEWS)
TP Removal Performance [a]					
Average basin TP load, kg/year	3,660	3,660	3,660	3,660	3,660
TP source control reduction, percent	25	0	50	40	25
TP load to STA, kg/year	2,745	3,660	1,830	2,196	2,745
STA outflow TP conc., ppb					
Flow-weighted mean	19	23	15	17	27
Geometric mean	12	15	9	10	15
STA Outflow TP load, kg/year	725	853	584	642	1,039
Average TP load reduction, kg/year	2,020	2,807	1,246	1,554	1,706
Total 50-year TP load reduction, percent	74	77	68	71	62
Pumping Station Capacity (cfs)					
Inflow	505	505	505	505	505
Outflow	505	505	505	505	505
Stormwater Treatment Area					
Type	SAV	SAV	SAV	SAV	NEWS
Area of Treatment Cells, acres	297	297	297	297	297
No. of Cells	3	3	3	3	3
Max. Operating Water Depth, feet	4.5	4.5	4.5	4.5	4.5
No. of Dryout Occurrences [b]	2	2	2	2	2
Average Duration of Dryout, months [b]	1.5	1.5	1.5	1.5	1.5
Maximum Duration of Dryout, months [b]	2	2	2	2	2

[a] TP Removal Performance data obtained from DMSTA model results and does not include the effects of start-up or stabilization periods.

[b] Dryout is assumed to occur when DMSTA predicts water depths of 15 cm or less in the STA.

A general discussion of the potential uncertainties related to the construction and operation of a STA was previously presented in Section 2 of this report. While many uncertainties cannot be quantified within the DMSTA model framework, the frequency and approximate duration of STA dryout throughout the analysis period can be predicted by DMSTA. For SAV, it was assumed that dryout occurs when DMSTA predicts water depths to be less than 15 cm. For this alternative, DMSTA predicted only two occurrences of dryout throughout the entire 31-year period of simulation, one for a period of about one month and the other for a period of about two months.

Based on the results of the DMSTA modeling for this alternative, it appears that dryout should not materially affect the predicted long-term TP removal performance of the STA, particularly if care is taken in restarting the treatment process when inflow returns.

3.5.2 Project Elements

A schematic layout of how the STA could be configured on the District's 375-acre site in Section 24 is illustrated in Figure 3-4. A new inflow pumping station with a capacity of 505 cfs would be located at the C-1 Canal and would deliver flow to the STA by means of an inflow canal and a series of culverts. Flow would pass through the three treatment cells and be collected in an outflow canal downstream of Cell 3. A new outflow pumping station and control structure would be constructed to discharge flow to the L-40 Borrow Canal inside the Refuge. Seepage would be collected in canals along the exterior levees on the north and south sides of the STA and would be returned to the C-1 Canal. A series of control structures in the seepage canals would allow them to be isolated from the C-1 Canal and would allow delivery of seepage water to the outflow canal in the event of high water elevations in the C-1 Canal.

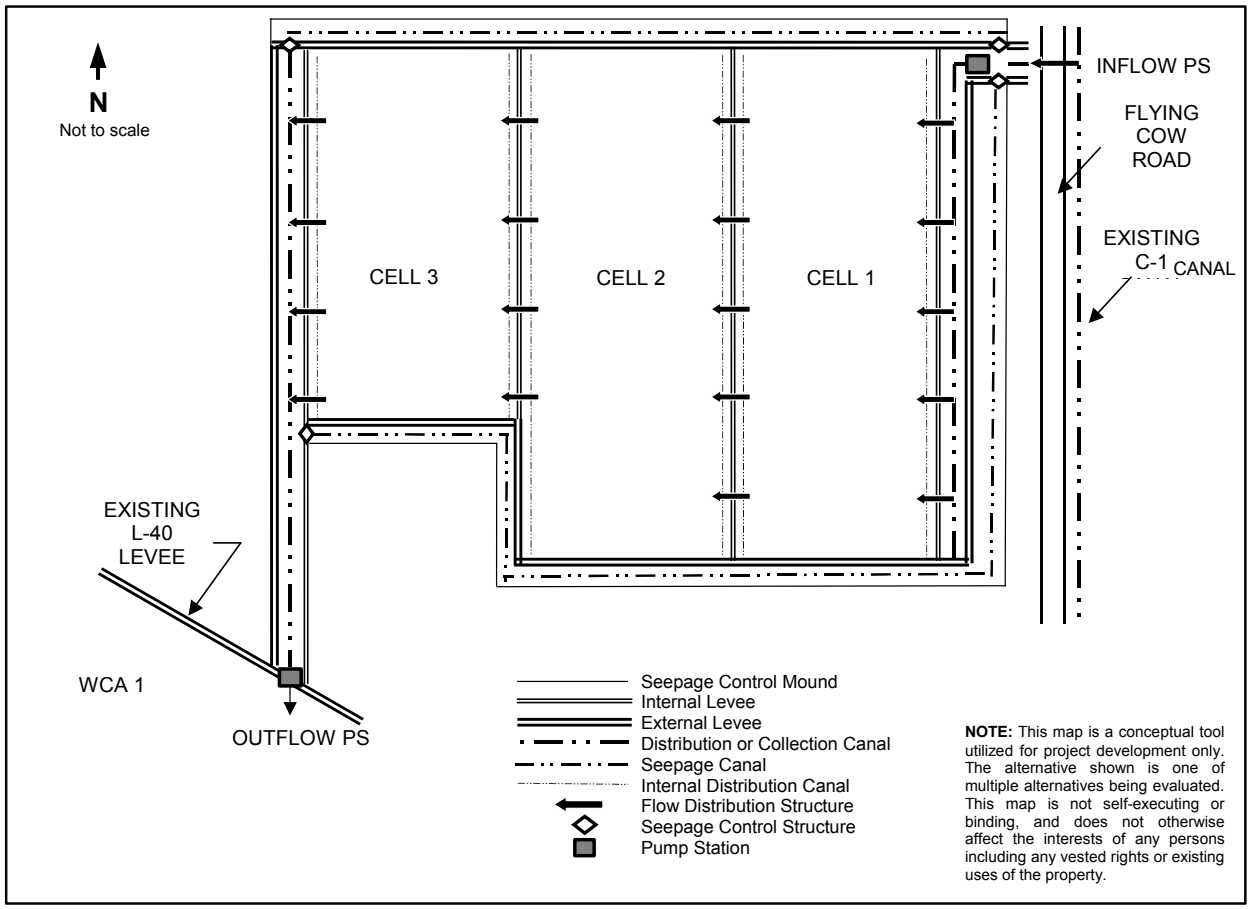


Figure 3-4.
Example STA Schematic for ACME Basin B Alternative 3

Approximately 120 acres of land immediately to the south of the District's 375-acre site on Section 24 currently drains to the north and would be cut off by the STA and related structures proposed in this alternative. Routing drainage from this land through or around the proposed STA would be both difficult and costly. A more practical approach would be to collect the runoff and divert it either east to the C-1 Canal for treatment in the STA serving ACME Basin B or divert it west for treatment in STA 1E. Diverting it west to STA 1E is probably most appropriate since the flow may have already been included in the original design of that facility. Detailed analysis of how best to collect and divert the flow from this land is beyond the scope of this study. The issue should be addressed, however, in future phases of work should this alternative be selected for further investigation. For the purposes of evaluation in this study, a capital cost of $100,000 has been allocated for rerouting drainage from the 120 acres to the appropriate treatment facility.

Modifications to some canals within the ACME Basin B drainage system may be needed for water to be conveyed to the new inflow pumping station instead of ACME's two existing pumping stations Definitions of these improvements, however, is beyond the scope of these Basin Specific Feasibility Studies. No costs for internal canal improvements were included in the cost estimates for this alternative.

3.5.3 Sensitivity Analyses

A number of analyses were conducted to test the sensitivity of the DMSTA model results to changes in key assumptions that were used for the base case analysis. The results are presented in Table 3-11. The sensitivity analyses performed are as follows:

1. *Sensitivity Case 1:* Determine the effect of zero percent and 50 percent load reductions due to source controls on outflow TP concentration from the base case STA.

2. *Sensitivity Case 2:* Determine the percent load reduction required from source controls to achieve a long-term geometric mean outflow TP concentration of 10 ppb from the base case STA.

3. *Sensitivity Case 3:* Using the base case STA configuration, determine TP removal performance using the NEWS data set as an indication of a more conservative STA performance.

4. *Sensitivity Case 4:* Determine DMSTA sensitivity to adjustments in phosphorus cycling and design parameters of ±25 percent and ±50 percent using the internal DMSTA sensitivity analysis tool.

The following sections briefly describe the results of these sensitivity analyses.

3.5.3.1 Sensitivity Case 1

For Sensitivity Case 1, the original baseline phosphorus loads (zero percent load reduction from source controls) were modeled with DMSTA using the same land area, cell configuration and vegetation partitioning as in the base case. For this case, the flow-weighted mean TP concentration is 23 ppb and the geometric mean TP concentration is 15 ppb. This results in an increase of about 125 kg per year in the average annual TP load discharged to the EPA compared to the base case.

An additional sensitivity case, assuming a 50 percent load reduction due to source controls, was also modeled using the same STA design as the base case. The flow-weighted mean and geometric mean TP concentrations for this scenario are 15 ppb and 9 ppb, respectively. This results in a decrease of about 140 kg per year in the average annual TP load discharged to the EPA compared to the base case.

3.5.3.2 Sensitivity Case 2

For Sensitivity Case 2, the inflow load was adjusted to varying degrees of load reduction as anticipated from the implementation of source controls. The percentage of load reduction required to achieve a long-term geometric mean of 10 ppb (on Section 24 District-owned land) was determined to be 40 percent using the same land area, cell configuration and vegetation partitioning as the base case. The base case scenario does not reach the planning level target of 10 ppb geometric mean. By increasing the load reduction due to source controls from 25 percent to 40 percent, a geometric mean of 10 ppb can be obtained on land currently owned by the District.

3.5.3.3 Sensitivity Case 3

The District's Evaluation Methodology directed that for all base case DMSTA simulations involving SAV plant communities the SAV_C4 calibration data set be used. In Sensitivity Case 3, the base case STA was tested with the NEWS calibration data set as an indication of more conservative STA performance. The flow-weighted mean and geometric mean TP concentrations for this scenario are 27 ppb and 15 ppb, respectively. The predicted flow-weighted mean and geometric mean TP concentrations are higher than the predictions of the base case analysis. The higher concentrations predicted by using the NEWS data set represent the uncertainty associated with TP removal performance by SAV communities.

3.5.3.4 Sensitivity Case 4

For Sensitivity Case 4, the sensitivity analysis tool within DMSTA was used. This tool allows the user to input a sensitivity scale factor, and to select the input parameter sets to be adjusted (phosphorus cycling and/or STA design parameters). The sensitivity analysis tool then adjusts each non-zero input variable by the sensitivity scale factor (both plus and minus), one at a time, and reruns the simulation. This sensitivity case was conducted on the base case STA design. The key phosphorus cycling parameters and STA design parameters were adjusted by ±25 percent and ±50 percent. It appears from the results of the sensitivity analysis that all phosphorus cycling parameters are relatively insensitive to adjustments up to 50 percent. As expected, it appears that the inflow fraction (volume of stormwater) and the surface area (STA footprint) were the two STA design parameters that were sensitive to adjustments up to 50 percent. Complete sensitivity analysis results are provided in Appendix B.

3.5.4 Uncertainty Analyses

An uncertainty analysis tool was provided with the DMSTA model to assess the affects of uncertainty in model input parameters on DMSTA model results. Uncertainty analyses were performed for this alternative using the methodology described in Section 2. The uncertainty analyses were performed for the ±25 percent and ±50 percent DMSTA sensitivity simulation case (Sensitivity Case 3 as discussed above). The results of the uncertainty analyses provide the 10th, 50th and 90th percentile values for the treated flow-weighted mean outflow concentration, total flow-weighted mean outflow concentration, outflow geometric mean (composites) and total outflow load. Results of the uncertainty analyses are contained in Appendix B.

3.5.5 Implementation Schedule

A projected schedule for implementation of Alternative 3 is presented in Table 3-12. Since the project will be constructed on land already owned by the District, no additional land acquisition will be required. Design and permitting are expected to take 18 months to complete, and bidding, contractor selection and contract award are anticipated to require another 6 months. Construction of the STA, pumping stations and control structures is estimated to take 12 months to complete. Total time to complete construction (design through construction) is estimated to be 36 months, or 3 years.

Following construction, a process start-up and stabilization period must occur. The STSOC research suggests a 12-month period for initial development of the SAV plant communities and an additional 1-3 years for maturation and stabilization of the process *(STSOC Analysis for Submerged Aquatic Macrophyte/Limerock Technology, DB Environmental, Inc., Final Report, May 2002)*. For the purposes of this evaluation, a 12-month start-up period and a 24-month stabilization period were assumed. Using these assumptions, a total of 72 months, or 6 years, will be required before the STA can be expected to achieve the TP removal performance predicted by DMSTA. This assumes that design begins in January 2003 and the STA will come on-line in early 2006, but predicted performance will not be achieved until late 2008. The start-up and stabilization periods have been accounted for and reflected in the phosphorus load reduction calculations.

Table 3-12.
Implementation Schedule for ACME Basin B Alternative 3

Project Component	Time Duration (months)
Design and Permitting	18
Contractor Procurement	6
Construction	12
Process Start-up	12
Process Stabilization	24
Total	**72**

3.5.6 Cost Estimates

Capital costs and average annual O&M costs for Alternative 3 were estimated using unit costs provided by the District and supplemented, where necessary, by Brown and Caldwell. The methodology for preparing cost estimates was presented previously in Section 2 of this report. A summary of the capital and O&M cost estimates is presented in Table 3-13. Capital costs, including contingency, were estimated to total $21.81 million. Average annual O&M costs were estimated to total $0.26 million per year. Detailed breakdowns of the capital and O&M cost estimates for Alternative 3 are presented in Appendix A.

Table 3-13.
Cost Estimates for ACME Basin B Alternative 3

Cost Component	Estimated cost (million dollars)
Capital Costs	
Construction Costs	
Pumping Stations (2)	7.58
STA Works	1.88
Inflow/Outflow Canals	1.65
Seepage Canals	0.14
Drainage Improvements on Adjacent Land	0.10
Subtotal	11.34
Planning, engineering and design (10%)	1.13
Program and construction management (10%)	1.13
Subtotal	13.60
Contingency (30%)	4.09
Total, construction costs	17.69
Land Previously Acquired	4.12
Total, Capital costs	21.81
Average Annual O&M Costs	
Pumping Stations	0.14
STA	0.02
Control Structures and Misc.	0.04
Subtotal	0.20
Contingency (30%)	0.06
Total, Annual O&M costs	0.26
50-year Present Worth (2003-2052)	
Capital costs (2003-2008)	21.04
O&M costs (2009-2052)	5.35
Replacement Costs	0.83
Total, 50-year present worth	27.22

Estimates of 50-year present worth were prepared covering the period 2003-2052 using the procedure described in Section 2. Capital costs were assumed to occur over the period 2003-2005. O&M costs were assumed to occur over the period 2006-2052. The combined 50-year present worth for ACME Basin B Alternative 3 is estimated to be $27.22 million.

3.5.7 Evaluation Ratings

Alternative 3 was rated against the ten evaluation criteria defined in the Evaluation Methodology document *(Final Evaluation Methodology for the Water Quality Improvement Strategies for the Everglades, SFWMD, July 31, 2002)* and discussed previously in Section 2 of this report. Table 3-14 summarizes the ratings given based on the results of this investigation.

Phosphorus Load Reduction. Approximately 72 percent of the TP load generated in ACME Basin B over the 50-year analysis period is removed by the STA. This load calculation includes the effect of the STA start-up and stabilization periods.

Long-Term TP Concentration Achieved. Because of the fixed land area available, it is not possible to meet the target water quality goal of 10 ppb TP with this alternative. DMSTA simulations predict a long-term flow-weighted mean TP concentration of 19 ppb and a long-term geometric mean TP concentration of 12 ppb.

Implementation Schedule. This alternative is expected to take approximately 6 years to fully implement. If project implementation is begun in January 2003, a fully stabilized biological treatment process should not be expected before the end of 2008. **Rating: 6 years.**

Operational Flexibility. The additional storage provided in the STA provides a marginal increase in the operational flexibility of the South Florida hydraulic conveyance system and the Everglades Water Conservation Areas. **Rating: +1.**

Resiliency to Extreme Conditions. Per the STSOC report by DB Environmental, Inc., a SAV-dominated STA should be highly resilient to fire and flood, generally resilient to hurricane, and highly sensitive to prolonged drought. A few short-duration dryout periods are expected in the STA proposed for this alternative, but no prolonged dryout periods (in excess of 2 months) were predicted by DMSTA over the 31-year period of simulation. **Rating: +2.**

Assessment of Full-Scale Construction and Operation. A 100 percent, SAV-dominated STA has not been constructed at full scale. The size of the STA in this alternative, however, is similar to Cell 4 in STA 1W that has been operated as a SAV-dominated treatment system for more than 5 years. Therefore, factors associated with scale-up, constructability and full-scale operation are not as significant as they might be in much larger treatment systems. **Rating: +1.**

Management of Side Streams. The only side stream generated by the STA in this alternative is seepage. Seepage is not expected to have significant positive or negative impact on surrounding lands. **Rating: 0.**

Improvement in Non-P Parameters. The STSOC report for SAV prepared by DB Environmental, Inc. includes information on non-phosphorus water quality parameters collected during research activities. Information from ENR Cell 4, South Test Cell 9, and North Test Cell 15 indicated the following: an improvement in ammonia, dissolved oxygen, iron, specific conductance, turbidity and color, a deterioration in pH, and no significant change in the other 12 non-P water quality parameters. **Rating: +5.**

50-Year Present Worth. The total 50-year present worth of the capital, O&M and pump station rehabilitation costs associated with this alternative is $27.22 million.

Cost-Effectiveness. The total TP load removed over the 50-year analysis period is estimated to total 98,970 kg. Based upon a 50-year present worth of $27.22 million, this translates to a cost-effectiveness rating of $275 per kg TP removed.

Table 3-14.
Summary of Evaluation Ratings for ACME Basin B Alternative 3

Evaluation Criteria	Unit	Rating
Technical Performance Criteria		
Phosphorus Load Reduction [a]	Percent	72
Long-Term TP Concentration Achieved		
Flow-weighted mean	ppb	19
Geometric mean	ppb	12
Implementation Schedule	Years	6
Operational Flexibility	-3 / +3	+1
Resiliency to Extreme Conditions	-4 / +4	+2
Assessment of Full-Scale Construction and Operation	-3 / +3	+1
Management of Side Streams	-3 / +3	0
Environmental Criteria		
Improvement in Non-P Parameters	-19 / +19	+5
Economic Criteria		
50-year Present Worth	Million dollars	27.22
Cost-Effectiveness	Dollars/kg removed	275

[a] Phosphorus load reduction includes the effect of STA start-up and stabilization periods.

3.6 Alternative 4 – Biological Treatment

Alternative 4 combines source controls with biological treatment in a STA to address long-term water quality objectives for discharges to the EPA. This alternative assumes that source controls will achieve a 25 percent reduction in TP load in the basin by 2006. To further reduce TP loads, a STA would be constructed on land owned by the District west of ACME Basin B in Section 24, Township 44 South, Range 40 East. Outflow from the STA would be discharged into the Refuge. This alternative is similar in concept to Alternative 3 previously described. However, in this alternative, STA size would not be constrained by the 375 acres already owned by the District in Section 24. Additional land would be acquired as needed, to construct a STA capable of achieving the target water quality goal of 10 ppb TP.

3.6.1 Technical Analysis of Biological Treatment Technology

DMSTA was used to determine the most effective combination of wetland vegetative communities for the STA in this alternative, given the adjusted baseline flows and loads for ACME Basin B. A discussion of DMSTA and how it was applied in the Basin Specific Feasibility Studies for the ESP basins was presented previously in Section 2 of this report. Emergent vegetation, SAV, and PSTA were all considered individually and in combination with one another to identify the technology or combination of technologies that achieved the target water quality goal while generally minimizing land area and cost. Also considered in the evaluation were factors such as cell partitioning to improve hydraulic efficiency through the STA, maximum allowable water depth, frequency and duration of dryout periods, and the occurrence of hydraulic bypass during major storm events.

The results of this iterative screening process indicated that a 100 percent SAV-dominated STA, partitioned into three cells, provides the best overall performance. This STA requires 346 acres of active treatment cells, and is projected by DMSTA to achieve a long-term flow-weighted mean TP concentration of 17 ppb and a long-term geometric mean TP concentration of 10 ppb. A summary of the TP removal performance and the size and operating characteristics of the STA for ACME Basin B Alternative 4 is presented in Table 3-15.

A general discussion of the potential uncertainties related to the construction and operation of a STA was previously presented in Section 2 of this report. While many uncertainties cannot be quantified within the DMSTA model framework, the frequency and approximate duration of STA dryout throughout the analysis period can be predicted by DMSTA. For SAV, it was assumed that dryout occurs when DMSTA predicts water depths to be less than 15 cm. For this alternative, DMSTA predicted only two occurrences of dryout throughout the entire 31-year period of simulation, one for a period of about one month and the other for a period of about two months. Based on the results of the DMSTA modeling for this alternative, it appears that dryout should not materially affect the predicted long-term TP removal performance of the STA, particularly if care is taken in restarting the treatment process when inflow returns.

Table 3-15.
STA Components and Predicted TP Removal Performance for ACME Basin B Alternative 4

Facility Component / Parameter	Base Case (25%)	Sensitivity Case 1a (0%)	Sensitivity Case 1b (50%)	Sensitivity Case 2 (NEWS)
TP Removal Performance [a]				
Average basin TP load, kg/year	3,660	3,660	3,660	3,660
TP source control reduction, percent	25	0	50	25
TP load to STA, kg/year	2,745	3,660	1,830	2,745
STA outflow TP conc., ppb				
Flow-weighted mean	17	18	17	26
Geometric mean	10	10	10	14
STA Outflow TP load, kg/year	650	663	631	978
Average TP load reduction, kg/year	2,095	2,997	1,199	1,767
Total 50-year TP load reduction, percent	76	82	66	64
Pumping Station Capacity (cfs)				
Inflow	505	505	505	505
Outflow	505	505	505	505
Stormwater Treatment Area				
Type	SAV	SAV	SAV	NEWS
Area of Treatment Cells, acres	346	403	260	346
No. of Cells	3	3	3	3
Max. Operating Water Depth, feet	4.5	4.5	4.5	4.5
No. of Dryout Occurrences [b]	2	2	2	2
Average Duration of Dryout, months [b]	1.5	1.5	1.5	1.5
Maximum Duration of Dryout, months [b]	2	2	2	2

[a] TP Removal Performance data obtained from DMSTA model results and does not include the effects of start-up or stabilization periods.

[b] Dryout is assumed to occur when DMSTA predicts water depths of 15 cm or less in the STA.

3.6.2 Project Elements

A schematic layout of how the STA could be configured is illustrated in Figure 3-5. A new inflow pumping station would be located at the C-1 Canal and would deliver flow to the STA by means of an inflow canal and a series of culverts. Flow would pass through the three treatment cells and be collected in an outflow canal downstream of Cell 3. A new outflow pumping station would be constructed to discharge flow to the L-40 Borrow Canal inside the Refuge. Seepage would be collected in canals along the exterior levees on the north and south sides of the STA and would be returned to the C-1 Canal. A series of control structures in the seepage canals would allow them to be isolated from the C-1 Canal and would allow delivery of seepage water to the outflow canal in the event of high water elevations in the C-1 Canal.

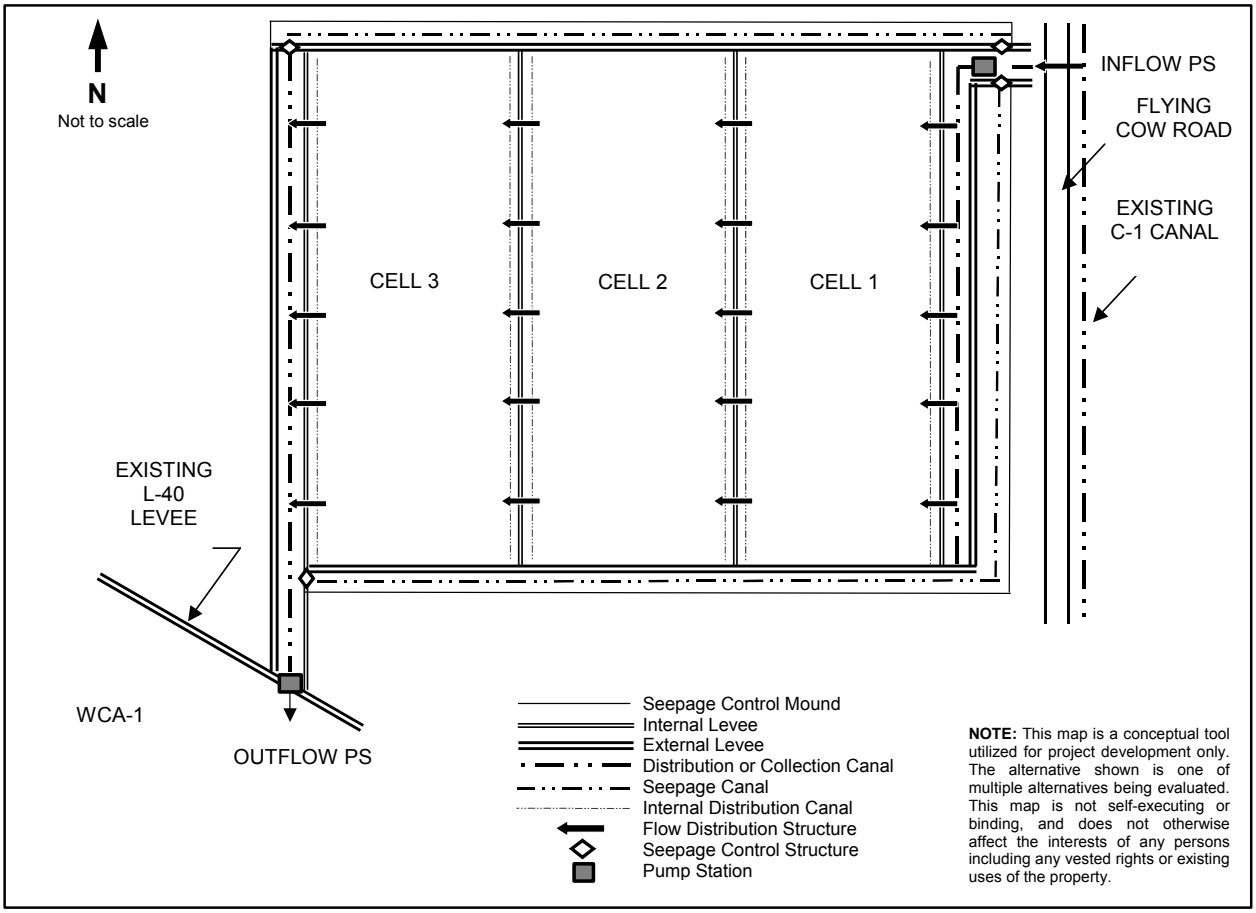


Figure 3-5.
Example STA Schematic for ACME Basin B Alternative 4

3.6.3 Sensitivity Analyses

A number of analyses were conducted to test the sensitivity of the DMSTA model results to changes in key assumptions that were used in the base case analysis. The results are presented in Table 3-15. The sensitivity analyses performed are as follows:

1. *Sensitivity Case 1:* Using the base case STA configuration, determine the amount of land required for a STA assuming zero percent and 50 percent TP load reduction due to source controls.

2. *Sensitivity Case 2:* Using the base case STA configuration, determine TP removal performance using the NEWS data set as an indication of a more conservative STA performance.

3. *Sensitivity Case 3:* Determine DMSTA sensitivity to adjustments in phosphorus cycling and design parameters of ±25 percent and ±50 percent using the internal DMSTA sensitivity analysis tool.

The following sections briefly describe the results of these sensitivity analyses.

3.6.3.1 Sensitivity Case 1

For Sensitivity Case 1, DMSTA was used to determine the amount of land required for a STA to achieve a geometric mean TP concentration of 10 ppb. A case using the original baseline data (zero percent TP load reduction due to source controls) and a case using 50 percent of the inflow TP load removed as a result of source controls were simulated with DMSTA. These cases used the same cell configuration and vegetation partitioning as the base case. The required land area for a STA with zero percent TP load reduction is 403 acres, which is 57 acres more than the base case scenario. The required land area for a STA with 50 percent TP load reduction is 260 acres, which is 86 acres less than the base case scenario. This land area does not include the associated internal and external works required for operation of the STA.

3.6.3.2 Sensitivity Case 2

The District's Evaluation Methodology directed that for all base case DMSTA simulations involving SAV plant communities the SAV_C4 calibration data set be used. In Sensitivity Case 2, the base case STA was tested with the NEWS calibration data set as an indication of more conservative STA performance. The flow-weighted mean and geometric mean TP concentrations for this scenario are 26 ppb and 14 ppb, respectively. The predicted flow-weighted mean and geometric mean TP concentrations are higher than the predictions of the base case analysis. The higher concentrations predicted by using the NEWS data set represent the uncertainty associated with TP removal performance by SAV communities.

3.6.3.3 Sensitivity Case 3

For Sensitivity Case 3, the sensitivity analysis tool within DMSTA was used. This tool allows the user to input a sensitivity scale factor, and to select the input parameter sets to be adjusted (phosphorus cycling and/or STA design parameters). The sensitivity analysis tool then adjusts each non-zero input variable by the sensitivity scale factor (both plus and minus), one at a time, and reruns the simulation. This sensitivity case was conducted on the base case STA design. The key phosphorus cycling parameters and STA design parameters were adjusted by ±25 percent and ±50 percent. It appears from the results of the sensitivity analysis that all phosphorus cycling parameters are relatively insensitive to adjustments of up to 50 percent. As expected, it appears that the inflow fraction (volume of stormwater) and the surface area (STA footprint) were the two STA design parameters that were sensitive to adjustments of up to 50 percent. Complete sensitivity analysis results are provided in Appendix B.

3.6.4 Uncertainty Analysis

An uncertainty analysis tool was provided with the DMSTA model to assess the affects of uncertainty in model input parameters on DMSTA model results. Uncertainty analyses were performed for this alternative using the methodology described in Section 2. The uncertainty analyses were performed for the ±25 percent and ±50 percent DMSTA sensitivity simulation case (Sensitivity Case 3 as discussed above). The results of the uncertainty analyses provide the 10th, 50th and 90th percentile values for the treated flow-weighted mean outflow concentration, total flow-

weighted mean outflow concentration, outflow geometric mean (composites) and total outflow load. Results of the uncertainty analyses are contained in Appendix B.

3.6.5 Implementation Schedule

A projected schedule for implementation of Alternative 4 is presented in Table 3-16. Additional land acquisition, prior to design and permitting, is assumed to require approximately 12 months. Design and permitting are expected to take 18 months to complete, and bidding, contractor selection and contract award are anticipated to require another 6 months. Construction of the STA, pumping stations and control structures is estimated to take 12 months to complete. Total time for construction completion (design through construction) is estimated to be 36 months, or 3 years.

Table 3-16.
Implementation Schedule for ACME Basin B Alternative 4

Project Component	Time Duration (months)
Land Acquisition	12
Design and Permitting	18
Contractor Procurement	6
Construction	12
Process Start-up	12
Process Stabilization	24
Total	**84**

Following construction, a process start-up and stabilization period must occur. The STSOC research suggests a 12-month period for initial development of the SAV plant communities and an additional 1-3 years for maturation and stabilization of the process *(STSOC Analysis for Submerged Aquatic Macrophyte/Limerock Technology, DB Environmental, Inc., Final Draft, May 2002)*. For the purposes of this evaluation, a 12-month start-up period and a 24-month stabilization period were assumed. Using these assumptions, a total of 84 months, or 7 years, will be required before the STA can be expected to achieve the TP removal performance predicted by DMSTA. This assumes design begins in January 2003 and the STA will come on-line in early 2006, but predicted performance will not be achieved until late 2009. The start-up and stabilization periods have been accounted for and reflected in the phosphorus load reduction calculations.

3.6.6 Cost Estimates

Capital costs and average annual O&M costs for Alternative 4 were estimated using unit costs provided by the District and supplemented, where necessary, by Brown and Caldwell. The methodology for preparing cost estimates was presented previously in Section 2 of this report. A summary of the capital and O&M cost estimates is presented in Table 3-17. Capital costs, including land acquisition and contingency, were estimated to total $23.48 million. Average annual O&M costs were estimated to total $0.26 million per year. Detailed breakdowns of the capital and O&M cost estimates for Alternative 4 are presented in Appendix A.

Estimates of 50-year present worth were prepared covering the period 2003-2052 using the procedure described in Section 2. Capital costs were assumed to occur during the period 2003-2006. O&M costs were assumed to occur over the period 2007-2052. The combined 50-year present worth for ACME Basin B Alternative 4 is estimated to be $28.63 million.

Table 3-17.
Cost Estimates for ACME Basin B Alternative 4

Cost Component	Estimated cost (million dollars)
Capital Costs	
Construction Costs	
Pumping Stations (2)	7.58
STA Works	2.12
Inflow/Outflow Canals	1.49
Seepage Canals	0.12
Subtotal	11.32
Planning, engineering and design (10%)	1.13
Program and construction management (10%)	1.13
Subtotal	13.59
Contingency (30%)	4.08
Total, construction costs	17.66
Land Acquisition	
Right-of-way and land purchase	1.21
Contingency (40%)	0.49
Land previously acquired	4.12
Total, Land Acquisition costs	4.97
Total, Capital costs	23.48
Average Annual O&M Costs	
Pumping Stations	0.14
STA	0.02
Control Structures and Misc.	0.04
Subtotal	0.20
Contingency (30%)	0.06
Total, Annual O&M costs	0.26
50-year Present Worth (2003-2052)	
Capital costs (2003-2009)	22.60
O&M costs (2010-2052)	5.20
Replacement costs	0.83
Total, 50-year present worth	28.63

3.6.7 Evaluation Ratings

Alternative 4 was rated against the ten evaluation criteria defined in the Evaluation Methodology document *(Final Evaluation Methodology for the Water Quality Improvement Strategies for the Everglades, SFWMD, July 31, 2002)* and discussed previously in Section 2 of this report. Table 3-18 summarizes the ratings given based on the results of this investigation.

Phosphorus Load Reduction. Approximately 73 percent of the TP load generated in ACME Basin B over the 50-year analysis period is removed by the STA. This load calculation includes the effect of the STA start-up and stabilization periods.

Long-Term TP Concentration Achieved. DMSTA simulations of the STA in this alternative predict a long-term flow-weighted mean TP concentration of 17 ppb and a long-term geometric mean TP concentration of 10 ppb.

Implementation Schedule. This alternative is expected to take approximately 7 years to fully implement. If project implementation begins in January 2003, a fully stabilized biological treatment process should not be expected before the end of 2009. **Rating: 7 years.**

Operational Flexibility. The additional storage provided in the STA provides a marginal increase in the operational flexibility of the South Florida hydraulic conveyance system and the Everglades Water Conservation Areas. **Rating: +1.**

Resiliency to Extreme Conditions. Per the STSOC report by DB Environmental, Inc., a SAV-dominated STA should be highly resilient to fire and flood, generally resilient to hurricane, and highly sensitive to prolonged drought. Frequent short-duration dryout periods are expected in the STA proposed for this alternative, but no prolonged dryout periods (in excess of 2 months) were predicted by DMSTA over the 31-year period of simulation. **Rating: +2.**

Assessment of Full-Scale Construction and Operation. A 100 percent, SAV-dominated STA has not been constructed at full scale. The size of the STA in this alternative, however, is similar to Cell 4 in STA 1W, which has been operated as a SAV-dominated treatment system for more than 5 years. Therefore, factors associated with scale-up, constructability and full-scale operation are not as significant as they might be in much larger treatment systems. **Rating: +1.**

Management of Side Streams. The only side stream generated by the STA in this alternative is seepage. Seepage is not expected to have significant positive or negative impact on surrounding lands. **Rating: 0.**

Improvement in Non-P Parameters. The STSOC report for SAV prepared by DB Environmental, Inc. includes information on non-phosphorus water quality parameters collected during research activities. Information from ENR Cell 4, South Test Cell 9, and North Test Cell 15 indicated the following: an improvement in ammonia, dissolved oxygen, iron, specific conductance, turbidity and color, a deterioration in pH, and no significant change in the other 12 non-P water quality parameters. **Rating: +5.**

50-Year Present Worth. The total 50-year present worth of the capital, O&M and pump station rehabilitation costs associated with this alternative is estimated to be $28.63 million.

Cost-Effectiveness. The total TP load removed over the 50-year analysis period is estimated to total 100,559 kg. Based upon a 50-year present worth of $28.63 million, this translates to a cost-effectiveness rating of $285 per kg TP removed.

Table 3-18.
Summary of Evaluation Ratings for ACME Basin B Alternative 4

Evaluation Criteria	Unit	Rating
Technical Performance Criteria		
Phosphorus Load Reduction [a]	Percent	73
Long-Term TP Concentration Achieved		
Flow-weighted mean	ppb	17
Geometric mean	ppb	10
Implementation Schedule	Years	7
Operational Flexibility	-3 / +3	+1
Resiliency to Extreme Conditions	-4 / +4	+2
Assessment of Full-Scale Construction and Operation	-3 / +3	+1
Management of Side Streams	-3 / +3	0
Environmental Criteria		
Improvement in Non-P Parameters	-19 / +19	+5
Economic Criteria		
50-year Present Worth	Million dollars	28.63
Cost-Effectiveness	Dollars/kg removed	285

[a] Phosphorus load reduction includes the effect of STA start-up and stabilization periods.

3.7 Alternative 5 - Modify STA 1E to Allow Diversion of ACME Basin B Runoff to STA-1E

A fifth alternative for ACME Basin B was evaluated separately by the consulting engineering firm of Burns & McDonnell. This alternative involves treatment of ACME Basin B flows in STA 1E as part of that larger scale wetland treatment project. The results of the evaluation of this alternative are included in Appendix D of this report, as well as in the Burns & McDonnell report on Basin Specific Feasibility Studies for the ECP basins, which is posted to the District's web site. For reference, the evaluation ratings for Alternative 5 are included in Table 3-19.

3.8 Summary of Alternative Evaluations

A summary of the evaluation ratings for the four alternatives investigated in ACME Basin B is presented in Table 3-19. The District and other project stakeholders will use this information in support of future decisions regarding which alternative(s) to select for further study or conceptual design.

Table 3-19.
Summary of Evaluation Ratings for ACME Basin B Alternatives

Evaluation Criteria	Unit	Rating					
		Base Cond.	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5[d]
Technical Performance Criteria							
Phosphorus Load Reduction [a]	Percent	25	86	62	72	73	79
Long-Term TP Concentration Achieved							
Flow-weighted mean	ppb	71	71	27	19-27[b]	17-26[b]	15-24[b]
Geometric mean	ppb	71	71	10	12-15[b]	10-11[b]	10[c]-11[b]
Implementation Schedule	Years	-	11	3	6	7	4
Operational Flexibility	-3 / +3	-	0	+1	+1	+1	0
Resiliency to Extreme Conditions	-4 / +4	-	+4	+4	+2	+2	+1
Assessment of Full-Scale Construction/O&M	-3 / +3	-	+3	+1	+1	+1	+1
Management of Side Streams	-3 / +3	-	0	-2	0	0	-1
Environmental Criteria							
Improvement in Non-P Parameters	-19 / +19	-	0	-3	+5	+5	+2
Economic Criteria							
50-year Present Worth	Million dollars	-	32.84	53.66	27.22	28.63	12.06
Cost-Effectiveness	Dollars/kg removed	-	278	631	275	285	112

[a] Base Condition load reduction is relative to original baseline data set; all other TP load reductions are incremental to Base Condition.

[b] Range of predicted values using different model calibration data sets.

[c] Computed value is less than calibration range; lowest sustainable concentration is reported.

[d] Increased conveyance capacity may be needed for a portion of the C-51W Canal to accommodate the ACME Basin B flows, however, no costs have been included for this potential conveyance capacity increase.

4. Evaluation of Alternative Water Quality Combinations for the C-11 West Basin

This section presents results of the evaluation of alternative water quality improvement strategies for the C-11 West Basin. Descriptions of the alternatives are presented, followed by results of the technical analysis and rating of the alternatives according to the Evaluation Methodology described previously in Section 2 of this report. It should be emphasized that the evaluations represented herein are not intended to indicate or recommend a preferred alternative, but rather only to provide information for decision-making in subsequent phases of work.

4.1 Basin Characteristics

The C-11 West Basin covers an area of about 46,000 acres (72 square miles) in south central Broward County. Current water management activities in the basin provide flood protection, drainage, water supply, protection from saltwater intrusion and seepage collection from Water Conservation Area (WCA) 3A. The four primary canals in the basin are the C-11 West, the C-11 South, the L-37 Borrow Canal, and the section of the L-33 Borrow Canal between the C-11 West Canal and Pines Boulevard. Currently, stormwater runoff from the C-11 West Basin is pumped into WCA 3A through the District's S-9 pump station. Seepage flows from WCA 3A are also returned through the S-9 pump station. A map of the C-11 West Basin is presented in Figure 4-1.

The C-11 West Basin Critical Project is scheduled for completion by December 2002 and includes structural and operational changes to the water management system by isolating WCA 3A seepage from C-11 West Basin runoff. The proposed divide structure (S-381) and a proposed set of smaller pumps (S-9A) will contain and return seepage to WCA 3A. During non-storm conditions, the S-9A pumps would operate continuously and would maintain C-11 West Canal elevations. Therefore, it is expected that the phosphorus levels going into WCA 3A will be reduced by back pumping clean seepage water and by decreasing operation of the larger S-9 pumps, which cause scour and drawdown.

Two future Comprehensive Everglades Restoration Program (CERP) projects will affect surface water management in the C-11 West Basin. The Western C-11 Impoundment and Diversion Canal CERP Project, scheduled for completion in January 2006, consists of a 1,600-acre stormwater treatment area/impoundment within the C-11 West Basin and approximately 8 miles of canal that will divert flood waters to other CERP storage areas or WCA 3A. This impoundment will be located north of the C-11 West Canal and east of U.S. Highway 27. In addition, the North Lake Belt Storage CERP Project, scheduled for completion in June 2036, will also affect the amount of stormwater flows pumped into WCA 3A through S-9 and seepage flows returned to WCA 3A through S-9A.

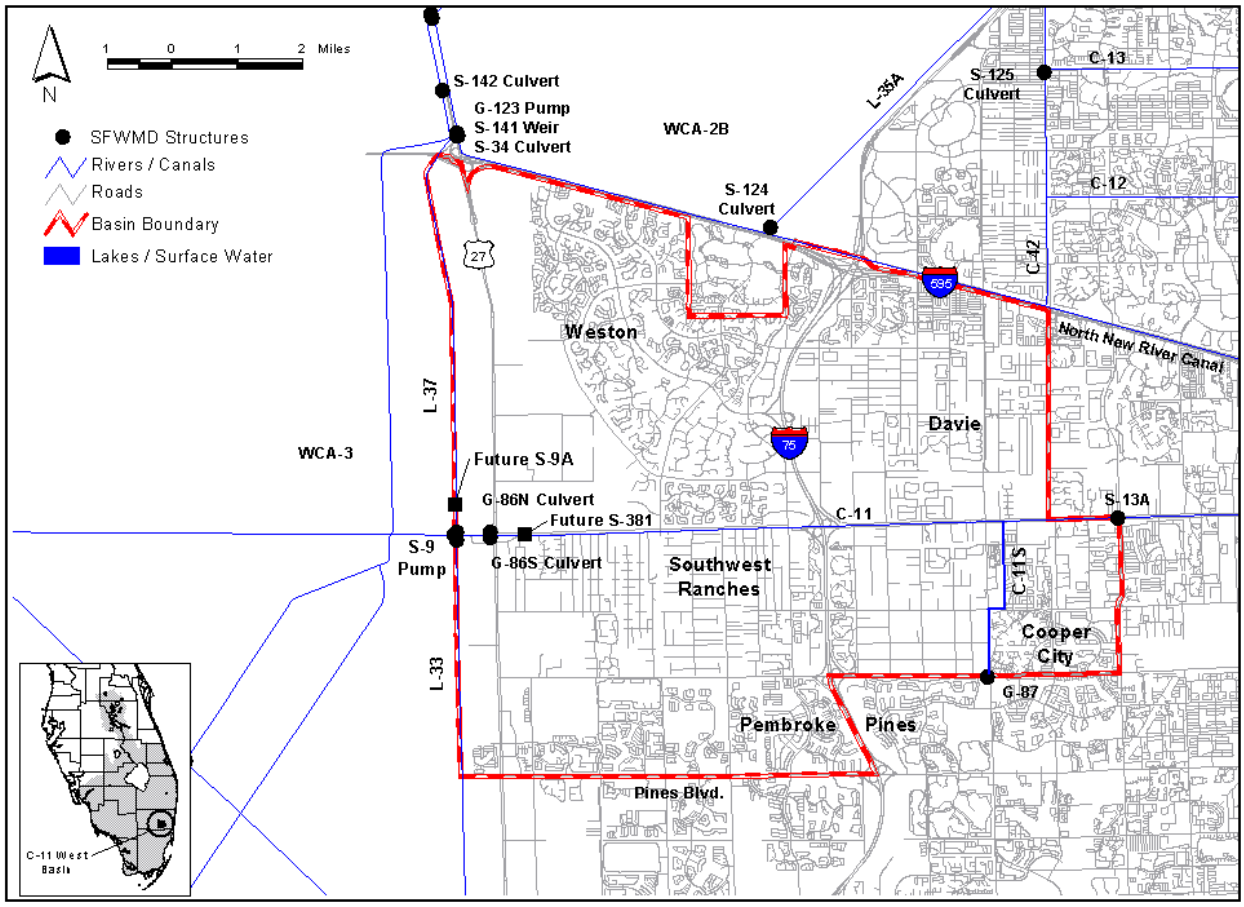


Figure 4-1.
C-11 West Basin Map

Land use in the C-11 West Basin is primarily urban residential and commercial development. Agricultural and rural land uses continue to be converted to urban land uses as development continues in the basin. A summary of the land use breakdown as it existed in 1995 is presented in Table 4-1. However, there is very little undeveloped land currently available in the basin and land values have increased dramatically in recent years.

Table 4-1.
Breakdown of Land Use in the C-11 West Basin

Land Use Category	Percentage of Basin Area
Agriculture	23.8
Barren Land	5.8
Rangeland	0.1
Transportation, Communication, and Utilities	7.1
Upland Forests	7.6
Urban and Built-Up	41.6
Water	7.4
Wetlands	6.6
Total	**100.0**

Source: 1995 SFWMD GIS Land Use data according to the Florida Land Use and Cover Classification System (FLUCCS).

The South Florida Water Management District (District) used historical rainfall, flow and water quality data to develop two sets of simulated baseline flows and total phosphorus (TP) loads to the Everglades Protection Area (EPA) from the C-11 West Basin over the 31-year period from 1965 to 1995 *(Baseline Data for the Basin Specific Feasibility Studies to Achieve the Long-Term Water Quality Goals for the Everglades, SFWMD, May 2001)*. The anticipated effects of the C-11 West Basin Critical Project, the Western C-11 Impoundment and Diversion Canal CERP Project, and the North Lake Belt Storage Area CERP Project were estimated to develop revised simulated C-11 West Basin baseline data sets. Additionally, seepage flows and loads from WCA 3A were separated from the C-11 West Basin runoff flows and loads by the District. Only basin runoff flows and loads were considered in sizing of treatment facilities and in evaluating alternatives in this investigation.

The first set of basin runoff flows and loads is applicable for the initial evaluation period (2006-2036) and approximates the changes anticipated by the C-11 West Basin Critical Project and the Western C-11 Impoundment and Diversion Canal CERP Project. The second set of runoff flows and loads is applicable for the subsequent evaluation period (2036-2056) and approximates the additional changes anticipated by the North Lake Belt Storage Area CERP Project. Together, these two revised baseline data sets represent the Base Condition for runoff flows from the C-11 West Basin for the period 2007-2056.

The simulated basin runoff flows and loads for the two evaluation periods for the C-11 West Basin are presented graphically in Figures 4-2 and 4-3. In the first evaluation period (2006-2036), a majority of the simulated runoff flow from the C-11 West Basin will have been diverted to the Western C-11 Impoundment. Simulated basin runoff flows remaining during this period range from about 3 to about 47,000 acre-feet per year (average 18,283 acre-feet per year). The average daily flow is 25 cfs. The peak simulated daily flow (2,933 cfs) occurs once during the 31-year period of simulation for a period of 1 day. The ratio of peak day flow to average day flow is 116:1. There is

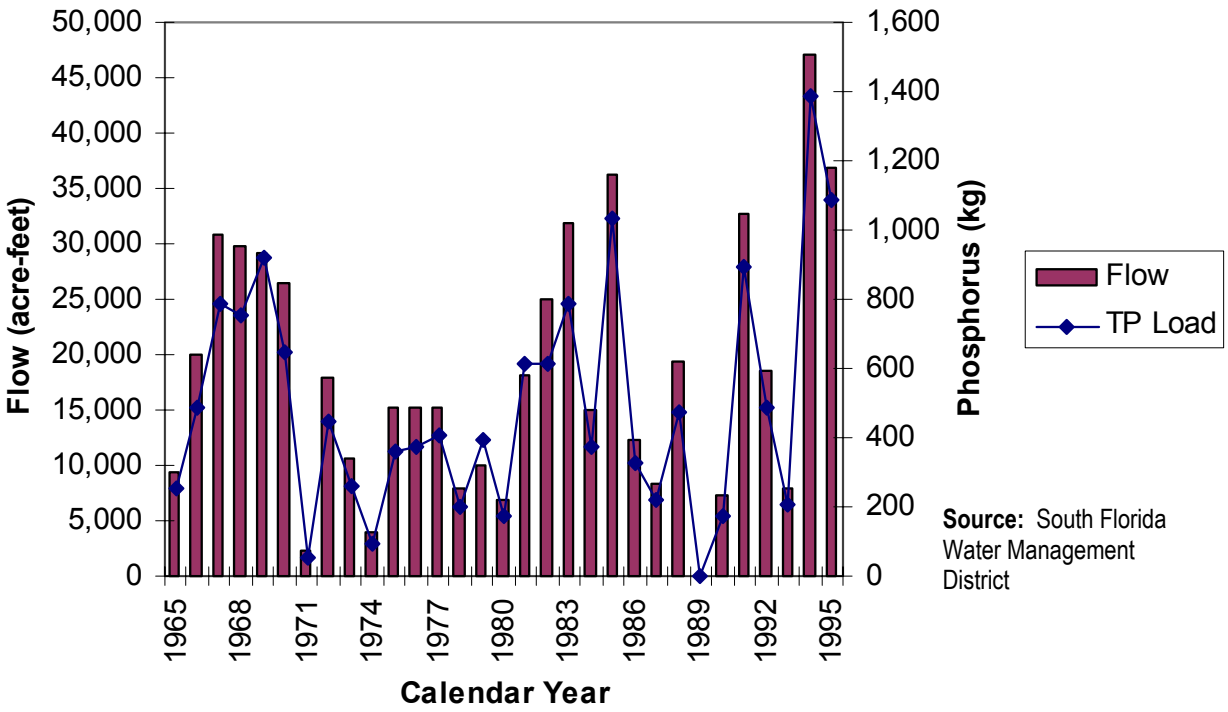


Figure 4-2.
Simulated Runoff and Loads for the C-11 West Basin (2006-2036 Evaluation Period)

no basin runoff flow or very low basin runoff flow (less than 2 cfs) for a continuous period of approximately one year during the 31-year period of simulation.

After the subsequent diversion of additional basin runoff flow to the North Lake Belt Storage Area CERP Project in 2036, almost all of the original basin runoff flow will have been diverted away from WCA 3A. Simulated basin runoff flows for the second evaluation period (2036-2056) range from 0 to about 8,446 acre-feet per year (average 885 acre-feet per year). The peak daily basin runoff flow (2930 cfs) occurs once during the 31-year period of simulation for a period of 1 day. There are only 19 days of basin runoff flow predicted during the entire 31-year period; therefore, there are extended periods of zero basin runoff flow, ranging in duration from 9 months to 10 years. The average daily basin runoff flow is 1 cfs over the 31-year period of simulation.

Simulated phosphorus loads to the EPA from C-11 West Basin runoff flows were predicted to range from about 0.5 to 1,390 kilograms (kg) TP per year (average 493 kg TP per year) for the period from 2006 to 2036. The flow-weighted mean TP concentration was estimated by the District to be 22 ppb during this period.

For the period 2036 to 2056, simulated phosphorus loads to the EPA from C-11 West Basin runoff flows were predicted to range from 0 to about 322 kg TP per year (average 31 kg TP per year). The flow-weighted mean TP concentration was estimated by the District to be 28 ppb during this period.

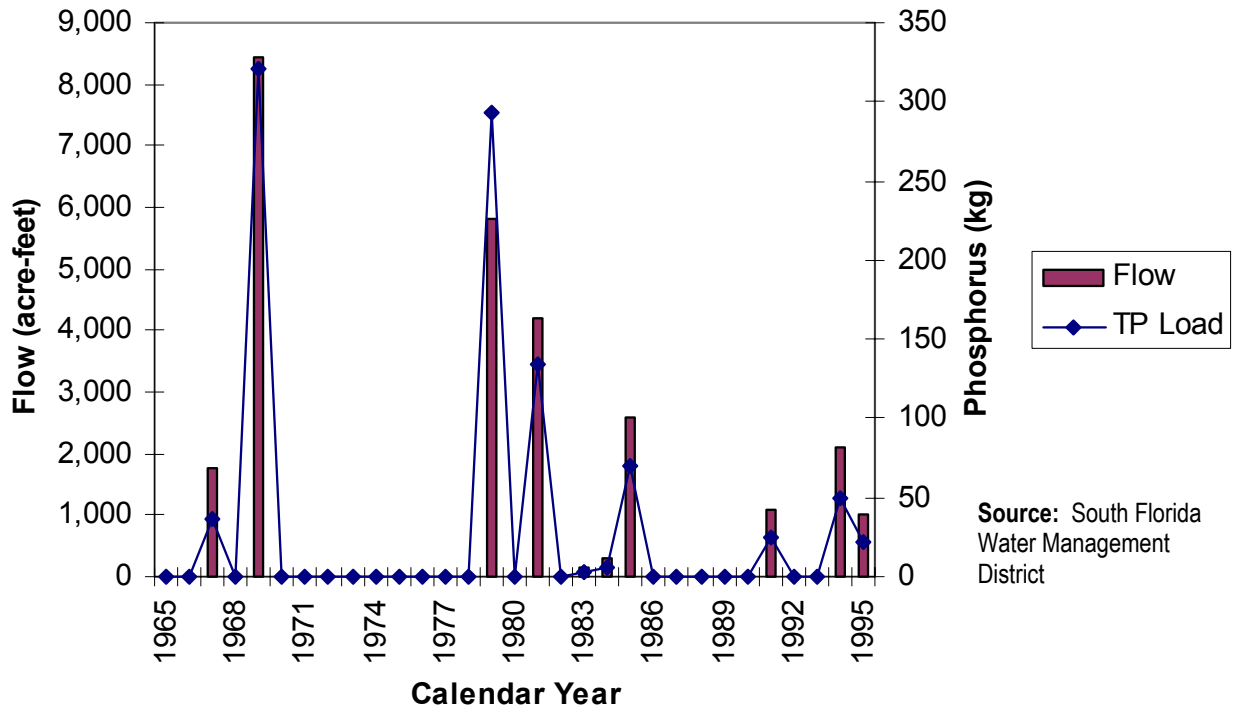


Figure 4-3.
Simulated Runoff and Loads for the C-11 West Basin (2036-2056 Evaluation Period)

4.2 Alternative Water Quality Combinations

The District formulated a series of three alternative water quality improvement strategies for the C-11 West Basin for the purpose of addressing long-term water quality objectives for discharges of basin runoff flow to the EPA. These alternatives were described in the District publication entitled *Final Water Quality Improvement Strategies for the Everglades: Alternative Combinations for the C-11 West Basin, March 21, 2002*. The components of the three alternative water quality combinations are summarized in Table 4-2.

Table 4-2.
Alternative Water Quality Combinations for the C-11 West Basin

Alternative	Project Component
1	Source controls Chemical treatment
2	Source controls Biological treatment
3	Source controls only (Base Condition)

Assumptions made for the evaluation of alternatives for the C-11 West Basin are as follows:

1. The current level of flood protection within the basin must be maintained as the result of implementing any of the alternative water quality combinations. Pumping capacity was assumed to be 2,933 cfs, consistent with the maximum basin runoff flow discharged over the 31-year period of simulation.

2. All alternatives assume implementation of the C-11 West Basin Critical Project by December 2002, the Western C-11 Impoundment and Diversion Canal CERP Project by January 2006, and the North Lake Belt Storage Area CERP Project by June 2036.

3. Seepage flows from WCA 3A were separated from the basin runoff flows and loads by the District and were not addressed, either in flow and load calculations or in sizing of treatment facilities. Only the simulated C-11 West Basin runoff flows remaining after the CERP diversions in 2006 and 2036 were used during the evaluation of alternatives.

Presented below are more detailed descriptions of the three alternative water quality combinations for the C-11 West Basin and the results of the investigations performed to evaluate them against the criteria contained in the District's Evaluation Methodology.

4.3 Alternative 1 – Chemical Treatment

Alternative 1 combines source controls with chemical treatment to address long-term water quality objectives for discharges of basin runoff flow to the EPA. In this alternative, a chemical treatment-solids separation (CTSS) treatment facility would be constructed within the C-11 West Basin. The effluent from the CTSS treatment facility, with a long-term geometric mean TP concentration not exceeding 10 ppb, would be discharged into WCA 3A through the S-9 pump station.

4.3.1 Technical Analysis of Chemical Treatment Technology

The optimal combination of flow equalization basin (FEB) size and CTSS treatment plant capacity was determined using a spreadsheet model developed by HSA Engineers & Scientists, Inc. *(Chemical Treatment-Solids Separation Advanced Technology Demonstration Project, Final Report, HSA Engineers & Scientists, December 2000).* This model was described previously in Section 2 of this report, as were the operating assumptions regarding FEB operation, CTSS treatment plant operation and performance, and blending of CTSS plant effluent with untreated water from the FEB. Two CTSS scenarios were modeled: (1) a base case assuming the CTSS treatment plant could produce an effluent with 6 ppb TP under average design flow conditions and 10 ppb TP under maximum design flow conditions (150 percent of average daily design flow); and (2) a sensitivity case in which it was assumed that the CTSS plant could only achieve 8 ppb and 13 ppb TP under average and maximum day flow conditions, respectively. The sizes and capacities of the CTSS facilities required under each of these cases, as well as the TP removal performance achieved, are summarized in Table 4-3.

For the 2006-2036 base case scenario, a 35-mgd treatment facility, combined with a 100-acre FEB, achieves a geometric mean blended outflow TP concentration of 10 ppb. The flow-weighted mean TP concentration in the blended outflow is predicted to be 15 ppb. Approximately 13 acres are required for the outflow blending basin and an estimated 25 acres are required for residual solids thickening and land disposal.

Table 4-3.
CTSS Facility Components and Predicted TP Removal Performance for C-11 West Basin Alternative 1

Facility Component/Parameter	Base Case (2006-2036)	Base Case (2036-2056)	Sensitivity Case (2006-2036)	Sensitivity Case (2036-2056)
TP Removal Performance				
Average basin TP load, kg/year	493	31	493	31
TP load to CTSS, kg/year	493	31	493	31
CTSS plant effluent TP conc., ppb				
Average Flow	6	6	8	8
Maximum Flow (150 percent)	10	10	13	13
CTSS blended outflow TP conc., ppb				
Flow-weighted mean	15	25	12	25
Geometric mean	10	10	9 [a]	12 [a]
Total CTSS outflow TP load, kg/year	345	27	259	27
Average TP load reduction, kg/year	148	4	180	4
Total 50-year TP load reduction, percent	30	13	37	13
Pumping Station Capacity (cfs)				
Inflow	2,933	2,930	2,933	2,930
CTSS Influent from FEB	80	50	200	120
Flow Equalization Basin				
Area, acres	100	100	100	100
Max. side water depth, feet	4.5	4.5	4.5	4.5
Max. storage volume, MG	147	147	147	147
CTSS Treatment Works				
Average design flow, mgd	35	20	135	50
Maximum design flow, mgd	50	30	200	75
Blending Basin				
Area, acres	13	7	32	18
Average HRT, days	3	3	3	3
Residuals Management Facility				
Area, acres	25	1	36	1

[a] The 50-yr geometric mean equals 10 ppb.

For the 2036-2056 base case scenario, a 20-mgd treatment facility achieves a geometric mean blended outflow TP concentration of 10 ppb. After 2036, therefore, part of the original 35-mgd CTSS plant can be decommissioned and taken out of service. The flow-weighted mean TP concentration in the blended outflow is predicted to be 25 ppb. Approximately 7 acres are required for the outflow blending basin and an estimated 1 acre is required for residual solids thickening and land disposal. The overall TP load reduction resulting from chemical treatment over the 50-year period is projected to be about 29 percent for the base case scenario.

The sensitivity analysis was performed to test the impact of reduced CTSS treatment performance (8 ppb/13 ppb) on the size of the CTSS components required to achieve the 10 ppb TP water quality goal. Keeping the FEB at 100 acres, the average daily design flow rate of the CTSS treatment works must be increased to 135 mgd to accommodate the greater volume of water being treated. For the period 2036-2056, however, the treatment plant capacity can be downsized to 50 mgd. Intermediate pump station capacity and acreage required for residuals management can also be downsized accordingly. Note, however, that the TP load reduction is higher than the base case alternative as a result of blending less water from the FEB with treated effluent from the CTSS plant.

4.3.2 Project Elements

The elements of a CTSS treatment facility, as applied in this investigation, were described in Section 2 of this report. The CTSS process is similar in concept to conventional surface water treatment for potable drinking water purposes. The process includes inflow pumping, flow equalization, chemical dosing, coagulation, flocculation, sedimentation, effluent blending and mixing, and residual solids management. Depending on the application, intermediate and outflow pumping may also be required.

A schematic layout of how the CTSS treatment facility could be configured in the C-11 West Basin is illustrated in Figure 4-4. An inflow pumping station would discharge flow to the 100-acre FEB. A smaller intermediate pump would deliver flow from the FEB to the CTSS treatment works. Flow would pass through the CTSS treatment works by gravity and discharge into the 13-acre blending basin where it would be mixed with untreated flows from the FEB (when necessary hydraulically). Outflows from the blending basin would have a maximum geometric mean concentration of 10 ppb TP and would be discharged into WCA-3A by means of the existing S-9 pump station. A dedicated outflow canal would be needed to convey treated water from the CTSS plant to the pump station. A 25-acre on-site residuals solids management facility, consisting of a thickening pond and dedicated land disposal area, would also be required. The total land area requirement for the alternative, including land for the inflow pump station, canals, etc. is estimated to be about 168 acres.

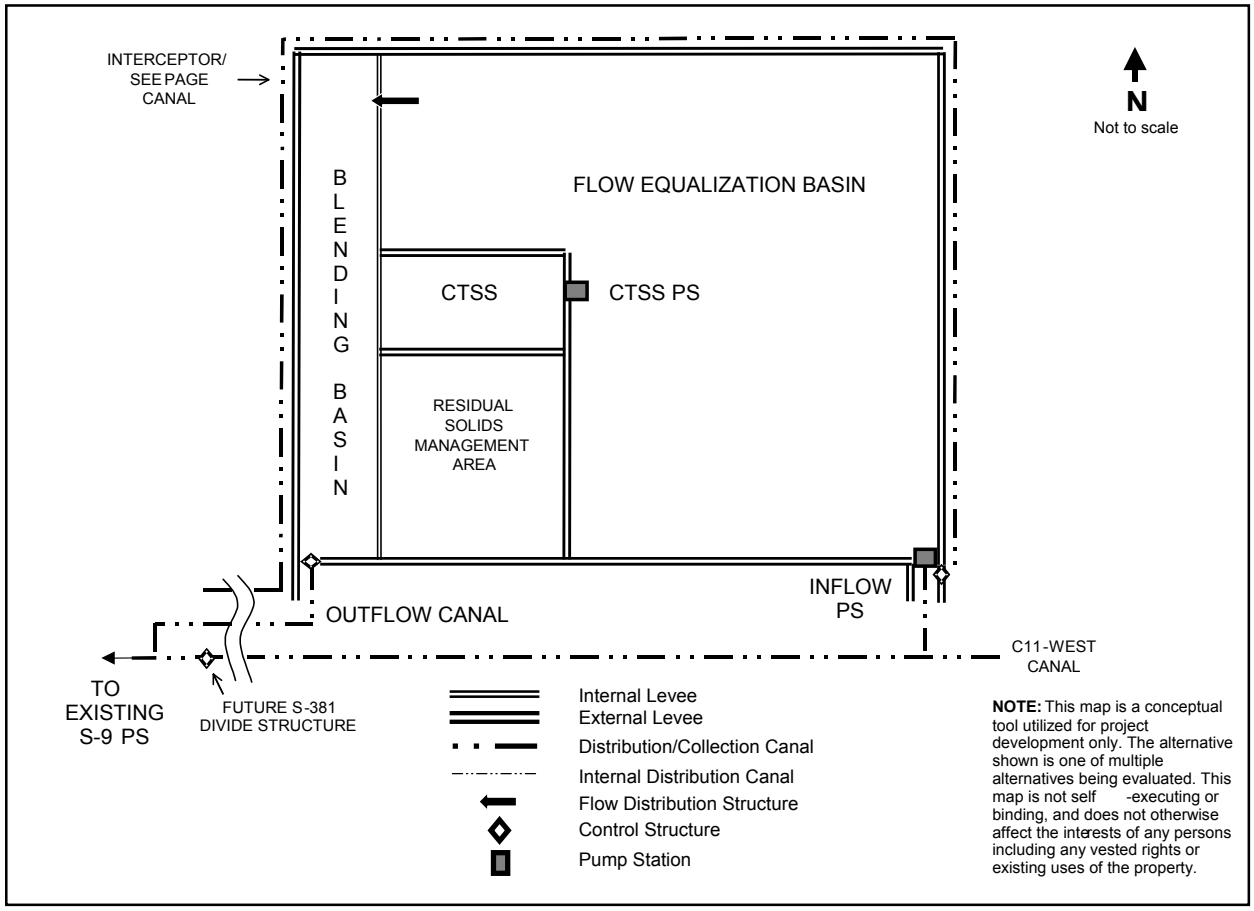


Figure 4-4.
Example CTSS Schematic for C-11 West Basin Alternative 1

4.3.3 Implementation Schedule

Land acquisition, prior to design and permitting, is assumed to require approximately 12 months. It is estimated that approximately 48 months will be required to implement this alternative if no unforeseen delays are encountered. A breakdown of this implementation schedule is presented in Table 4-4. If land acquisition begins in early 2003, the project could be on-line by the December 31, 2006 deadline mandated in the Everglades Forever Act. However, given the uncertainty surrounding permit issues, it is possible that permit approval could take longer than 6 months. Still, if the project experiences no undue delays, there is reason to believe it could be complete by December 2006.

Table 4-4
Implementation Schedule for C-11 West Basin Alternative 1

Project Component	Time Duration (months)
Land acquisition	12
Design and permitting	18
Contractor procurement	6
Construction	9
Start-up	3
Total	**48**

4.3.4 Cost Estimates

Capital costs and average annual O&M costs for Alternative 1 were estimated using unit costs provided by the District and supplemented, where necessary, by Brown and Caldwell. The methodology for preparing cost estimates was presented previously in Section 2 of this report. A summary of the capital and O&M cost estimates is presented in Table 4-5. Capital costs, including land acquisition and contingency, were estimated to total $109.37 million. Average annual O&M costs over the 50-year period were estimated at $0.84 million per year. A detailed breakdown of the capital and O&M cost estimates for Alternative 1 are presented in Appendix A.

Estimates of the 50-year present worth were prepared covering the period 2003-2052. Capital costs were assumed to occur during the period 2003-2006. O&M costs were assumed to occur over the period 2007-2052. The present worth of the capital costs was calculated to be $104.91 million. The present worth of the average annual O&M costs was calculated to be $11.77 million and the present worth of major equipment replacement costs was calculated to be $3.38 million. The combined 50-year present worth for C-11 West Basin Alternative 1 is estimated to be $120.05 million.

In addition, a cost estimate was prepared for the CTSS sensitivity case, which considered reduced treatment performance compared to the base case. A summary of the 50-year present worth estimate for the sensitivity case is presented in Table 4-6. Full cost estimate breakdowns for the sensitivity case are presented in Appendix A.

Table 4-5.
Cost Estimates for C-11 West Basin Alternative 1

Cost Component	Estimated cost, million dollars
Capital Costs	
Construction Costs	
Pumping Stations (2)	22.80
Flow Equalization Basin and Blending Basin	1.48
CTSS Treatment Works	4.63
Seepage/Drainage Control	0.64
Residual Solids Management	0.70
Control Structures and Misc.	1.98
Subtotal	32.22
Planning, engineering and design (10%)	3.22
Program and construction management (10%)	3.22
Subtotal	38.66
Contingency (30%)	11.60
Total, construction costs	50.26
Land Acquisition	
Right-of-way and land purchase	50.40
Right-of-way and land purchase associated costs	1.00
Contingency (15%)	7.71
Total, Land Acquisition costs	59.11
Total, Capital costs	109.37
Average Annual O&M Costs (2006-2036 / 2036-2056)	
Pumping Stations	0.12/ 0.05
Flow Equalization and Blending Basins	0.005 / 0.005
CTSS Treatment Works	0.58/ 0.36
Residual Solids Management	0.042 / 0.024
Control Structures and Misc.	0.022 / 0.022
Subtotal	0.76 / 0.47
Contingency (30%)	0.23 / 0.14
Total, Annual O&M costs	0.99 / 0.60
50-year Present Worth (2003-2052)	
Capital costs	104.91
O&M costs	11.77
Replacement Costs	3.38
Total, 50-year present worth	120.05

Table 4-6.
Summary of Present Worth Cost Estimates for C-11 West Basin Alternative 1

Present Worth Component (million dollars)	Base Case (6 ppb/10 ppb)	Sensitivity Case (8 ppb/13 ppb)
Capital costs	104.91	139.15
O&M costs	11.77	14.26
Replacement costs	3.38	5.80
Total, 50-year present worth	120.05	159.20

4.3.5 Evaluation Ratings

Alternative 1 was rated against the ten evaluation criteria defined in the Evaluation Methodology document *(Final Evaluation Methodology for the Water Quality Improvement Strategies for the Everglades, SFWMD, July 31, 2002)* and discussed previously in Section 2 of this report. Table 4-7 summarizes the ratings given based on the results of this investigation.

Phosphorus Load Reduction. Approximately 29 percent of the TP load generated by stormwater runoff in the C-11 West Basin over the 50-year analysis period is removed by the CTSS treatment facility in this alternative.

Long-Term TP Concentration Achieved. CTSS technology has the demonstrated capability to achieve effluent TP concentrations below 10 ppb. For this alternative, the CTSS treatment facilities were sized to produce a blended outflow having a long-term geometric mean TP concentration not exceeding 10 ppb. The long-term flow-weighted mean TP concentration is 19 ppb.

Implementation Schedule. Based on the assumptions made in this investigation regarding the time required to acquire land and obtain the necessary permits, it is estimated that this alternative can be constructed and placed into operation in a period of 48 months. **Rating: 4 years.**

Operational Flexibility. The 100-acre FEB in this alternative provides additional storage capacity. However, the FEB must be operated in conjunction with the CTSS treatment works. Therefore, the storage capacity associated with the FEB may not be available when needed to provide additional operating flexibility to the South Florida hydraulic conveyance system and the Everglades Water Conservation Areas. **Rating: 0.**

Resiliency to Extreme Conditions. This alternative provides a high level of resiliency to fire, flood, drought and hurricane. **Rating: +4.**

Assessment of Full Scale Construction and Operation. There are many documented examples of chemical treatment systems constructed at the scale proposed in this alternative for potable water, wastewater and stormwater treatment applications. Scale-up issues are not expected to be significant. Still, CTSS technology has not been implemented at full scale with the sole objective of meeting a 10

ppb TP standard. This introduces some level of uncertainty regarding full-scale operation in the Everglades. **Rating: +1.**

Management of Side Streams. CTSS technology generates side streams, which must be managed at considerable cost and effort to the project. The most notable side stream is residual solids that must be disposed of either on-site or at a permitted disposal facility off-site. These solids are not hazardous, but must be disposed of properly in an environmentally safe manner. There is ongoing research that may identify beneficial uses for these residual solids. However, there is no assurance that these beneficial uses will ultimately prove viable. **Rating: -2.**

Improvement in Non-P Parameters. The Supplemental Technology Standard of Comparison (STSOC) demonstration project report for CTSS, prepared by HSA Engineers & Scientists, includes information on non-phosphorus water quality parameters collected during research activities. Information from post-BMP and post-STA testing indicated the following: an improvement in dissolved oxygen, turbidity, and color, a deterioration in alkalinity, pH, conductivity, chloride, iron, and aluminum, and no significant change in the other 10 non-P water quality parameters. **Rating: -3.**

50-Year Present Worth. The total 50-year present worth of the capital and O&M costs associated with this alternative is $120.05 million.

Cost-Effectiveness. The total TP load removed over the 50-year analysis period is estimated to total 4,520 kg. Based upon a 50-year present worth of $120.05 million, this translates to a cost-effectiveness rating of $26,560 per kg TP removed.

Table 4-7.
Summary of Evaluation Ratings for C-11 West Basin Alternative 1

Evaluation Criteria	Unit	Rating
Technical Performance Criteria		
Phosphorus Load Reduction	Percent	29
Long-Term TP Concentration Achieved		
Flow-weighted mean	ppb	19
Geometric mean	ppb	10
Implementation Schedule	Years	4
Operational Flexibility	+3/-3	0
Resiliency to Extreme Conditions	+4/-4	+4
Assessment of Full-Scale Construction and Operation	+3/-3	+1
Management of Side Streams	+3/-3	-2
Environmental Criteria		
Improvement in Non-P Parameters	+19/-19	-3
Economic Criteria		
50-year Present Worth	Million dollars	120.05
Cost-Effectiveness	Dollars/kg removed	26,560

4.4 Alternative 2 – Biological Treatment

Alternative 2 combines source controls with biological treatment in a STA to address long-term water quality objectives for discharges of basin runoff flow to the EPA.

4.4.1 Technical Analysis of Biological Treatment Technology

The Dynamic Model for Stormwater Treatment Areas (DMSTA) was used to determine the most effective combination of wetland vegetation communities for the STA in this alternative, given the baseline flows and loads for the C-11 West Basin. A discussion of DMSTA and how it was applied in the Basin Specific Feasibility Studies for the ESP basins was presented previously in Section 2 of this report. Emergent vegetation, submerged aquatic vegetation (SAV), and periphyton (PSTA) were all considered individually and in combination with one another to identify the technology or combination of technologies that provided maximum phosphorus removal performance. Also considered in the evaluation were factors such as cell partitioning to improve hydraulic efficiency through the STA, maximum allowable water depth, frequency and duration of dryout periods, and the occurrence of hydraulic bypass during major storm events.

The following combinations of vegetation communities were simulated with DMSTA to establish the apparent best base case scenario for evaluation in this alternative:

- Emergent
- Emergent/SAV
- Emergent/SAV/PSTA
- SAV
- SAV/PSTA

For each of these combinations of vegetation communities, the treatment area was divided into a varying number of cells to test the effect of cell partitioning on STA performance. The goal was to maximize treatment efficiency while preventing hydraulic bypass and minimizing the frequency and duration of dryout periods. The benefit of increased TP removal efficiency achieved by constructing additional cells was balanced against the increased construction cost associated with internal levees and the increased potential for hydraulic bypass.

Also, because of the extreme variation in runoff flows that will be discharged from the C-11 West Basin after diversion to the Western C-11 Impoundment occurs, a number of additional operational scenarios were analyzed to determine if a more cost-effective approach to STA development could be identified. These included (1) use of a reservoir upstream of the STA, (2) increasing the allowable maximum water depth in the STA from 4.5 feet to 5.5 feet, and (3) allowing hydraulic bypass during the largest storm events.

DMSTA predicted that a 100 percent SAV-dominated STA could achieve the 10 ppb geometric mean TP target using the least amount of land in each of the operational scenarios analyzed. The

following paragraphs summarize the results of the analyses performed on the operational scenarios to define the base case STA for evaluation in this alternative.

Scenario 1 – Standard STA. Using a standard STA operation, with a maximum water depth of 4.5 feet, DMSTA predicted that approximately 1,600 acres of SAV treatment cells would be required to avoid hydraulic bypass. However, in this scenario, DMSTA predicted outflow TP concentrations below the 10 ppb planning level target for TP concentration (11 ppb flow-weighted mean, 8 ppb geometric mean). Also, because of the size of the STA involved, DMSTA predicted frequent dryout periods, many for extended periods of time.

Scenario 2 – Reservoir Option. Using a reservoir upstream of the STA in Scenario 1, the land area required to achieve the 10 ppb TP target was reduced from 1600 acres to 1200 acres. In this scenario, a 600-acre reservoir would be constructed upstream of a single 600-acre SAV treatment cell. Both the reservoir and the STA would have a maximum water depth of 4.5 feet. No phosphorus removal was assumed to occur in the reservoir. In this scenario, no hydraulic bypass occurred, but dryout was not significantly improved over Scenario 1. The effect of the reservoir upstream of the STA was much greater in reducing total land area requirements than it was in reducing dryout.

Scenario 3 – Increased Maximum Water Depth. As an alternative to the reservoir option, the maximum allowable water depth in the STA was increased from 4.5 feet to 5.5 feet. This scenario resulted in a dramatic reduction in the land area required to achieve the 10 ppb TP target, as well as a significant improvement with respect to dryout. A single SAV cell of about 550 acres was found to be the least land intensive option for meeting water quality objectives without hydraulic bypass in this scenario.

Scenario 4 – Hydraulic Bypass Option. To test the impact of hydraulic bypass on STA requirements, maximum flows to the STA were capped at 1700 cfs. This resulted in six hydraulic bypasses during the 31-year period of simulation (average of one bypass every 5 years) totaling approximately 7,400 acre-feet of water. Assuming a 5.5-foot maximum water depth in the STA, this scenario required about 500 acres of SAV treatment area, only about 10 percent less than required in Scenario 3. Furthermore, there was no improvement in dryout conditions over Scenario 3.

Given the tradeoffs offered by the four scenarios described above, Scenario 3 was chosen for evaluation as the base case STA in Alternative 2. This scenario provides the best compromise between TP removal performance, land area requirements, dryout effects and hydraulic bypass. Water depths in the STA exceed the standard maximum of 4.5 feet only 3 times during the 31-year period of simulation, approaching 5.1 feet on one occasion. These three events are not expected to materially affect the TP removal performance of the STA. The average water depth in the STA over the 31-year period of simulation is 2.1 feet (64 cm), which is well below the average allowable for SAV plant communities in DMSTA.

Dryout is still a significant concern for meeting water quality treatment objectives with a STA in the C-11 West Basin, however, due to the extreme variations in basin runoff flows that are projected.

For the base case scenario described above (Scenario 3), DMSTA predicted dryout to occur 16 times during the 31-year period of simulation, with an average duration of 4 months. The longest duration of dryout predicted by DMSTA was approximately 16 months. It is not well understood what effect these frequent and sometimes long dryout periods will have on long-term TP removal in a SAV-dominated STA. However, it is possible that the effect could be significant and that seeding with SAV plant material could become a common operating procedure in such STAs after major dryout events.

DMSTA cannot simulate the effects of dryout on STA performance unless the calibration data set used in DMSTA to perform the simulation includes data from STA operations that encountered significant dryout events. The SAV_C4 calibration data set used for the base case analysis does not include any significant dryout events. Therefore, the predictions made by DMSTA for the base case STA in the C-11 West Basin using this data set should be considered optimistic.

4.4.1.1 Base Case STA Operations, 2006-2036

For the years 2006-2036, the results of the DMSTA modeling process indicated that a 100 percent SAV-dominated STA, operated as one cell with a maximum water depth of 5.5 feet, provides the best overall TP removal performance and protection against bypass and dryout. This STA requires 556 acres of active treatment area, and is projected by DMSTA to achieve a long-term flow-weighted mean TP concentration of 14 ppb and a long-term geometric mean TP concentration of 10 ppb. Total land area requirements are conservatively estimated at approximately 730 acres, pending facility siting and conceptual design.

A summary of the TP removal performance and the size and operating characteristics of the base case STA for Alternative 2 during the period 2006-2036 is presented in Table 4-8.

4.4.1.2 Base Case STA Operations, 2036-2056

After the additional diversion of C-11 West Basin flows to the North Lake Belt Storage CERP project in 2036, there will not be sufficient runoff flow generated on a continuing basis to sustain STA operations of any kind. During this period, only peak runoff flows from major storm events that are not presently accounted for in CERP projects will require management. Peak runoff flow rates on the order of 2,900 cfs will remain, but there will also be extended periods, sometimes years, when no basin runoff flow requires treatment.

To address this condition, it was assumed that the base case STA would not be operated as a treatment facility during this period, but rather as a reservoir with zero discharge. This operating condition was modeled within DMSTA to determine how much of the stormwater generated during this period could be accommodated in the STA without modification. The analysis showed that all of the remaining C-11 West Basin runoff flows could be stored in the STA except for runoff flows from five storm events over the 31-year period of simulation. The total volume of water that would be bypassed from the five events was estimated to be about 10,000 acre-feet.

Table 4-8.
STA Components and Predicted TP Removal Performance for C-11 West Basin Alternative 2

Facility Component / Parameter	Base Case	Sensitivity Case 1 (25%)	Sensitivity Case 2 (NEWS)
TP Removal Performance [a]			
Average basin TP load, kg/year	493	493	493
TP source control reduction, percent	0	25	0
TP load to STA, kg/year	493	370	493
STA outflow TP conc., ppb			
Flow-weighted mean	14	14 [b]	16
Geometric mean	10	10 [b]	14
STA Outflow TP load, kg/year	277	237	328
Average TP load reduction, kg/year	216	133	165
Total 50-year TP load reduction, percent	44	36	33
Pumping Station Capacity (cfs)			
Inflow	2,933	2,933	2,933
Stormwater Treatment Area			
Type	SAV	SAV	SAV
Area of Treatment Cells, acres	556	544	556
No. of Cells	1	1	1
Max. Operating Water Depth, feet	5.5	5.5	5.5
No. of Dryout Occurrences [c]	16	16	16
Average Duration of Dryout, months [c]	4	4	4
Maximum Duration of Dryout, months [c]	16	16	16

[a] TP Removal Performance data obtained from DMSTA model results and does not include the effects of start-up or stabilization periods.

[b] Actual DMSTA predicted outflow concentrations are less than the calibration limits for SAV. Therefore, calibration limits reported.

[c] Dryout is assumed to occur when DMSTA predicts water depths of 15 cm or less in the STA.

Runoff that bypasses the STA (reservoir) could be discharged to WCA 3A through the S-9 pumping station or could be incorporated into the planning and design of projects to be implemented under CERP, if permitted. For the purposes of evaluating Alternative 2, it was assumed, at District direction, that bypass flows would be accommodated by CERP projects and that no C-11 West Basin runoff flows would be discharged to the EPA after 2036.

4.4.2 Project Elements

Siting of the STA within the C-11 West Basin was not a part of the Basin Specific Feasibility Studies. However, location of the STA impacts the project elements required to implement Alternative 2.

For evaluation purposes, therefore, it was necessary to make some general assumptions on where a STA in the C-11 West Basin might logically be located.

Because the major conveyance conduit in the C-11 West Basin is the C-11 West Canal, it would make sense that the STA be located in relatively close proximity to that canal. Furthermore, since treated water will be conveyed west to the S-9 pump station for discharge to WCA 3A for the period 2006 to 2036, it would make sense that the STA would be located in the western portion of the basin instead of the eastern portion of the basin. Therefore, for analysis purposes, it was assumed that the STA would be located somewhere in the western side of the C-11 West Basin and in relatively close proximity to the C-11 West Canal.

A schematic layout of how the STA could be configured in the C-11 West Basin is illustrated in Figure 4-5. A new inflow pump station with a capacity of 2,933 cfs would deliver flow to the STA by means of an inflow canal and a series of culverts. Flow would pass through the single 556-acre treatment cell and be collected in an outflow canal. A new outflow control structure and outflow canal would be constructed to deliver flow to the existing C-11 West Canal, west of the S-381 divide structure. The existing C-11 West Canal would be used to convey treated water to the existing S-9 pump station for delivery to the WCA. Seepage from the STA and local basin runoff from the vicinity of the STA would be intercepted by canals along the exterior levees of the STA and would be returned to the STA inflow canal. The total land area required to implement Alternative 2, exclusive of the canals required to convey basin runoff flows to and from the STA site, is estimated to be approximately 730 acres. Due to the fact that this basin is almost completely developed, and very little vacant land is currently available, it is possible that 730 acres will not be available to implement this alternative. It is important to note that if all 730 acres cannot be acquired, the STA may not achieve the outflow TP concentrations predicted by DMSTA.

4.4.3 Sensitivity Analyses

A number of analyses were conducted to test the sensitivity of the DMSTA model results to changes in key assumptions that were used in the base case analysis. The results are presented in Table 4-8. The following sensitivity analyses were performed:

1. *Sensitivity Case 1:* Using the base case STA configuration (100 percent SAV, one cell, 5.5' maximum depth) determine the amount of land required for a STA assuming 25 percent of the inflow TP load is removed as a result of source controls.

2. *Sensitivity Case 2:* Using the base case STA configuration, determine TP removal performance using the NEWS calibration data set as an indication of more conservative STA performance.

3. *Sensitivity Case 3:* Determine DMSTA sensitivity to adjustments in phosphorus cycling and design parameters of ±25 percent and ±50 percent using the internal DMSTA sensitivity analysis.

The following sections briefly describe the results of these sensitivity analyses.

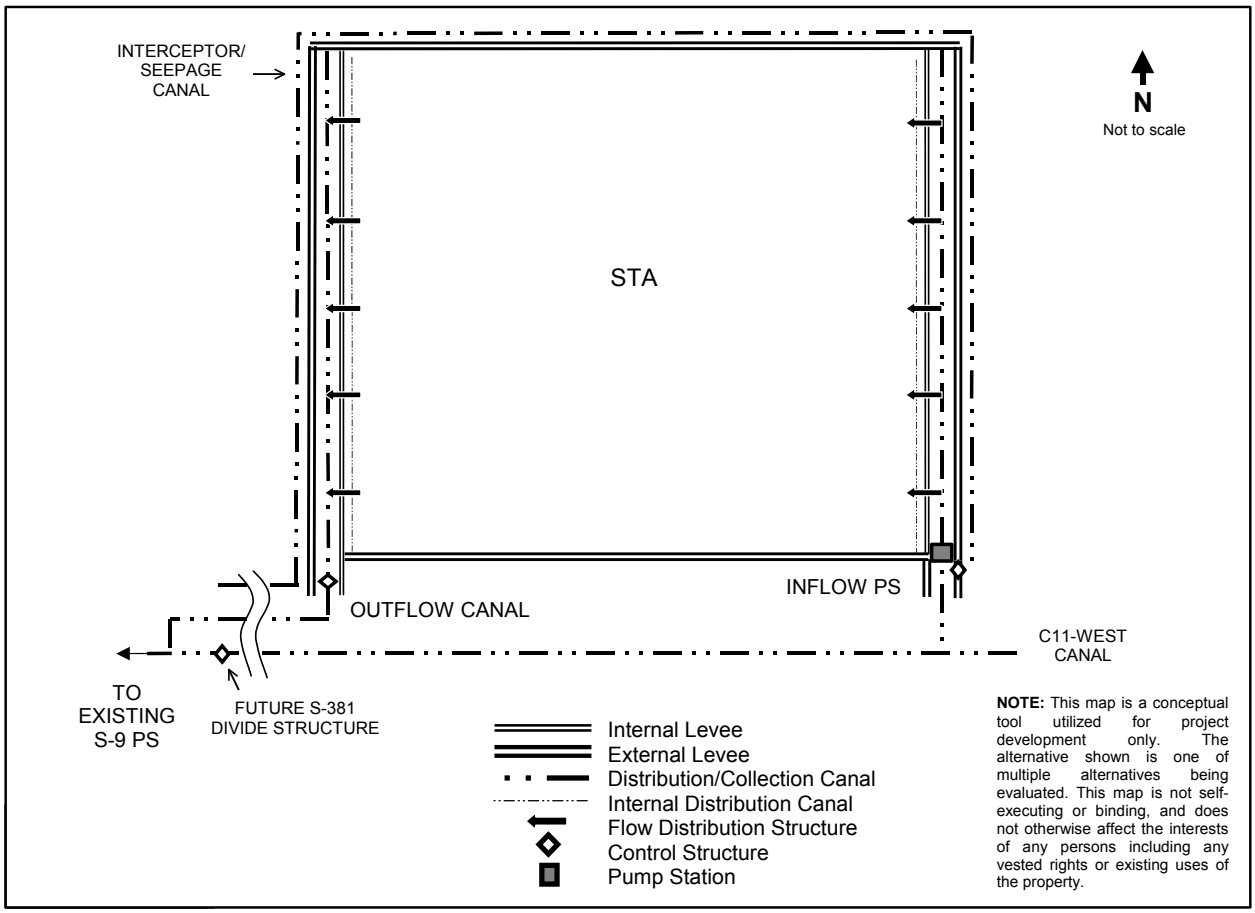


Figure 4-5.
Example STA Schematic for C-11 West Basin Alternative 2

4.4.3.1 Sensitivity Case 1

For Sensitivity Case 1, DMSTA was used to determine the amount of land required for a STA to achieve a geometric mean TP concentration of 10 ppb with 25 percent of the inflow TP load removed as a result of source controls. This case used the same cell configuration and vegetation partitioning as the base case. The required treatment area for a STA with 25 percent TP load reduction is 544 acres. This land area does not include the associated internal and external works required for operation of the STA.

4.4.3.2 Sensitivity Case 2

The District's Evaluation Methodology directed that the SAV_C4 calibration data set be used for all base case DMSTA simulations involving SAV plant communities. In Sensitivity Case 2, the base case STA was tested using the NEWS calibration data set as an indication of more conservative STA performance. The flow-weighted mean and geometric mean TP concentrations for this scenario are 16 ppb and 14 ppb, respectively.

4.4.3.3 Sensitivity Case 3

For Sensitivity Case 3, the sensitivity analysis tool within DMSTA was used. This tool allows the user to input a sensitivity scale factor, and to select the input parameter sets to be adjusted (phosphorus cycling and/or STA design parameters). The sensitivity analysis tool then adjusts each non-zero input variable by the sensitivity scale factor (both plus and minus), one at a time, and reruns the simulation. This sensitivity case was conducted on the base case STA design. The key phosphorus cycling parameters and STA design parameters were adjusted by ±25 percent and ±50 percent. It appears from the results of the sensitivity analysis that the results of the DMSTA simulations are relatively insensitive to all phosphorus cycling parameters for adjustments up to ±50 percent. As expected, the inflow fraction (volume of stormwater) and the surface area (STA footprint) are the two STA design parameters that are sensitive to adjustments up to ±50 percent. Complete sensitivity analysis results for the base case STA simulation are provided in Appendix B.

4.4.4 Uncertainty Analyses

An uncertainty analysis tool is provided with the DMSTA model to assess the affects of uncertainty in model input parameters on DMSTA model results. Uncertainty analyses were performed for this alternative using the methodology described in Section 2. The uncertainty analyses were performed for the ±25 percent and ±50 percent DMSTA sensitivity analyses (Sensitivity Case 3 as discussed above). The results of the uncertainty analyses provide the 10th, 50th and 90th percentile values for the treated flow-weighted mean outflow concentration, total flow-weighted mean outflow concentration, outflow geometric mean (composites) and total outflow load. Results of the uncertainty analyses are contained in Appendix B.

4.4.5 Implementation Schedule

A projected schedule for implementation of Alternative 2 is presented in Table 4-9. Land acquisition, prior to design and permitting, is assumed to require approximately 36 months because of the difficulty anticipated in acquiring large areas of land in this heavily developed basin. Design and permitting are expected to take 18 months to complete, and bidding, contractor selection and contract award are anticipated to require another 6 months. Construction of the STA, pump station and control structures is estimated to take 18 months to complete. Total time to complete construction (land acquisition through construction) is estimated to be 78 months, or 6.5 years.

Following construction, a process start-up and stabilization period must occur. The STSOC research suggests a 12-month period for initial development of the SAV plant communities and an additional 1-3 years for maturation and stabilization of the process *(Final STSOC Analysis for Submerged Aquatic Macrophyte/Limerock Technology, DB Environmental, Inc., May 2002)*. For the purposes of this evaluation, a 12-month start-up period and a 24-month stabilization period were assumed. Using these assumptions, a total of 114 months, or 9.5 years, will be required before the STA can be expected to achieve the TP removal performance predicted by DMSTA. If land acquisition begins in January 2003, the STA would be expected to come on-line in July 2009. However, predicted performance will not be achieved until July 2012. The start-up and stabilization periods have been

accounted for and reflected in the phosphorus load reduction calculations, since they occur after December 31, 2006.

Table 4-9.
Implementation Schedule for C-11 West Basin Alternative 2

Project Component	Time Duration (months)
Land Acquisition	36
Design and Permitting	18
Contractor Procurement	6
Construction	18
Process Start-up	12
Process Stabilization	24
Total	**114**

4.4.6 Cost Estimates

Capital costs and average annual O&M costs for Alternative 2 were estimated using unit costs provided by the District and supplemented, where necessary, by Brown and Caldwell. The methodology for preparing cost estimates was presented previously in Section 2 of this report. A summary of the capital and O&M cost estimates is presented in Table 4-10. Capital cost for implementation of the STA and associated infrastructure, including design, construction, construction management and contingencies were estimated to total approximately $44.54 million. However, the cost of acquiring 730 acres of land (including contingencies) in the C-11 West Basin was estimated by the District to be $253.00 million. Average annual O&M costs were estimated to total $0.24 million per year. A detailed breakdown of the capital and O&M cost estimates for Alternative 2 are presented in Appendix A.

An estimate of the present worth for Alternative 2 was prepared covering the period 2003-2052. Capital costs were assumed to be incurred during the period 2003-2009. O&M costs were assumed to be incurred during the period from 2010-2052. The present worth of the capital costs was calculated to be $285.09 million. The present worth of the average annual O&M costs was calculated to be $3.06 million, and the present worth of pumping station equipment replacement costs was calculated to be $2.50 million. The combined present worth cost for C-11 West Basin Alternative 2 was calculated to be $290.64 million.

Table 4-10.
Cost Estimates for C-11 West Basin Alternative 2

Cost Component	Estimated cost (million dollars)
Capital Costs	
Construction Costs	
Inflow Pumping Station	22.00
STA Works	2.64
Inflow/Outflow Canals	3.27
Seepage Canals	0.63
Subtotal	28.55
Planning, engineering and design (10%)	2.86
Program and construction management (10%)	2.86
Subtotal	34.26
Contingency (30%)	10.28
Total, construction costs	44.54
Land Acquisition	
Right-of-way and land purchase	219.00
Right-of-way and land purchase associated costs	1.00
Contingency (15%)	33.00
Total, Land Acquisition costs	253.00
Total, Capital costs	297.54
Average Annual O&M Costs (2006-2036 / 2036-2056)	
Pumping Station	0.16 / 0.07
STA (reservoir from 2036-2056)	0.04 / 0.01
Control Structures and Misc.	0.05 / 0.01
Subtotal	0.25 / 0.09
Contingency (30%)	0.07 / 0.03
Total, Annual O&M costs	0.32 / 0.12
50-year Present Worth (2003-2052)	
Capital costs	285.09
O&M costs	3.06
Replacement costs	2.50
Total, 50-year present worth	290.64

4.4.7 Evaluation Ratings

Alternative 2 was rated against the ten evaluation criteria defined in the Evaluation Methodology document *(Final Evaluation Methodology for the Water Quality Improvement Strategies for the Everglades, SFWMD, July 31, 2002)* and discussed previously in Section 2 of this report. Table 4-11 summarizes the ratings given based on the results of this investigation.

Phosphorus Load Reduction. Approximately 39 percent of the TP load generated in the C-11 West Basin over the 50-year analysis period is removed by the STA. This load calculation includes the effect of STA start-up and stabilization periods, which occur after December 31, 2006.

Long-Term TP Concentration Achieved. DMSTA simulations of the STA in this alternative predict a long-term flow-weighted mean TP concentration of 14 ppb and a long-term geometric mean TP concentration of 10 ppb.

Implementation Schedule. Based on the assumptions made in this investigation, this alternative is expected to take approximately 9.5 years to fully implement. If project implementation begins in January 2003, a fully stabilized biological treatment process should be expected by July 2012. **Rating: 9.5 years.**

Operational Flexibility. The additional storage provided in the STA provides a marginal increase in the operational flexibility of the South Florida hydraulic conveyance system and the Everglades Water Conservation Areas. **Rating: +1.**

Resiliency to Extreme Conditions. Per the STSOC report by DB Environmental, Inc., a SAV-dominated STA should be highly resilient to fire and flood, generally resilient to hurricane, and highly sensitive to prolonged drought. Frequent dryout periods, many of extended duration, were predicted by DMSTA for the STA in the C-11 West Basin over the 31-year period of simulation. **Rating: +1.**

Assessment of Full-Scale Construction and Operation The size of the STA in this alternative is similar to Cell 4 in STA 1W, which has been operated as a SAV-dominated treatment system for more than 5 years. However, there are uncertainties associated with the effects of dryout on the treatment capabilities and management of these systems. Significant dry down is expected to occur in the STA for the C-11 West Basin. **Rating: -2.**

Management of Side Streams. The only side stream generated by the STA in this alternative is seepage. Seepage is not expected to have significant positive or negative impact on surrounding lands. **Rating: 0.**

Improvement in Non-P Parameters. The STSOC report for SAV, prepared by DB Environmental, Inc., includes information on non-phosphorus parameters collected during research activities. Information from ENR Cell 4, South Test Cell 9, and North Test Cell 15 indicated an improvement in ammonia, dissolved oxygen, iron, specific conductance, turbidity and color; a deterioration in pH; and no significant change in the other 12 non-P water quality parameters. **Rating: +5.**

50-Year Present Worth. The total present worth of the capital, O&M and replacement costs associated with this alternative over the period 2003 - 2052 is estimated to be $290.64 million.

Cost-Effectiveness. The total TP load removed over the period 2007-2056 is estimated to total 6,052 kg. The cost effectiveness of Alternative 2 is calculated to be $48,024 per kg of TP removed.

Table 4-11.
Summary of Evaluation Ratings for C-11 West Basin Alternative 2

Evaluation Criteria	Unit	Rating
Technical Performance Criteria		
Phosphorus Load Reduction [a]	Percent	39
Long-Term TP Concentration Achieved		
Flow-weighted mean	ppb	14
Geometric mean	ppb	10
Implementation Schedule	Years	9.5
Operational Flexibility	-3 / +3	+1
Resiliency to Extreme Conditions	-4 / +4	+1
Assessment of Full-Scale Construction and Operation	-3 / +3	-2
Management of Side Streams	-3 / +3	0
Environmental Criteria		
Improvement in Non-P Parameters	-19 / +19	+5
Economic Criteria		
50-year Present Worth	Million dollars	290.64
Cost-Effectiveness	Dollars/kg removed	48,024

[a] Phosphorus load reduction includes the effect of STA start-up and stabilization periods.

4.5 Alternative 3 – Source Controls (Base Condition)

Alternative 3 assumes that the planned diversions to proposed CERP projects will occur as scheduled, and that a basin-wide source control program will be implemented in the C-11 West Basin. Both of these assumptions were also made for the evaluation of Alternatives 1 and 2. However, where Alternative 1 assumed CTSS treatment and Alternative 2 assumed STA treatment for remaining runoff flows from the C-11 West Basin, Alternative 3 assumes that these remaining runoff flows would be discharged into WCA 3A through the S-9 pump station without additional treatment.

4.5.1 Technical Analysis of Alternative 3

If no additional treatment is provided to C-11 West Basin runoff flows, no TP load reduction will be achieved. This will result in an average of 308 kg per year of TP being discharged to WCA 3A over the 50-year period from 2007-2056 due to runoff. The projected long-term flow-weighted mean TP concentration is about 24 ppb and the projected long-term geometric mean TP concentration is about 21 ppb.

A sensitivity analysis was also performed to determine the impact on TP loads and concentrations if an additional 25 percent of the baseline TP load in C-11 West Basin runoff could be removed with source controls. With an additional 25 percent load reduction due to source controls, the average

annual TP load discharged to WCA 3A over the period 2007-2056 from basin runoff would be reduced to about 231 kg per year.

4.5.2 Project Elements

The components of a basin-scale source control program in an urban basin such as the C-11 West Basin were generally described in Section 2 of this report. There are no other project elements associated with this alternative.

4.5.3 Implementation Schedule

It is assumed, as it has been for all alternatives in these Basin Specific Feasibility Studies, that basin-scale source control programs can be implemented by December 2006 if implementation begins in January 2003. There are no other project elements requiring implementation in this alternative.

4.5.4 Cost Estimates

Cost estimating for source control programs was not included in the scope of work for these Basin Specific Feasibility Studies. Since there are no other project elements associated with alternative, no cost estimates were prepared.

4.5.5 Evaluation Ratings

Alternative 3 was rated against the ten evaluation criteria defined in the Evaluation Methodology document *(Final Evaluation Methodology for the Water Quality Improvement Strategies for the Everglades, SFWMD, July 31, 2002)* and discussed previously in Section 2 of this report. Because there are no capital improvements to be implemented as part of this alternative, some of the evaluation criteria are not applicable or have reduced significance. Table 4-12 summarizes the ratings given to Alternative 3 based on the results of this investigation.

Phosphorus Load Reduction. This alternative results in zero TP load reduction compared to the 31-year period of simulation TP load. Therefore, the TP load reduction for this alternative is zero percent.

Long-Term TP Concentration Achieved. This alternative results in a long-term flow weighted mean TP concentration of 24 ppb and a long-term geometric mean TP concentration of 21 ppb.

Implementation Schedule. This alternative only requires implementation of source controls. It has been assumed for the purposes of evaluation that source control programs can be in place by December 2006. **Rating: 4 years.**

Operational Flexibility. This alternative provides no increase or decrease in the operational flexibility of the South Florida hydraulic conveyance system and the Everglades Water Conservation Areas. **Rating: 0.**

Resiliency to Extreme Conditions. This alternative has no capital improvements that could be sensitive or resilient to fire, flood, drought or hurricane conditions. **Rating: 0.**

Assessment of Full-Scale Construction and Operation. This alternative has no capital improvements. Therefore, an assessment of risk associated with full-scale construction and operation of such improvements is not applicable. **Rating: 0.**

Management of Side Streams. There are no side streams associated with this alternative. **Rating: 0.**

Improvement in Non-P Parameters. In accordance with the District's Evaluation Methodology, alternatives with no public works components (capital improvements) were assumed to have no impact on non-phosphorus water quality parameters. **Rating: 0.**

50-Year Present Worth. Since the costs of source controls are not considered in the Basin Specific Feasibility Studies, and there are no capital improvements to be constructed and operated, the 50-year present worth of Alternative 3 is zero.

Cost-Effectiveness. Since there are no costs or load reductions for this alternative, the cost-effectiveness rating of Alternative 3 is zero.

Table 4-12.
Summary of Evaluation Ratings for C-11 West Basin Alternative 3

Evaluation Criteria	Unit	Rating
Technical Performance Criteria		
Phosphorus Load Reduction	Percent	0
Long-Term TP Concentration Achieved		
Flow-weighted mean [a]	ppb	24
Geometric mean [b]	ppb	21
Implementation Schedule	Years	4
Operational Flexibility	-3 / +3	0
Resiliency to Extreme Conditions	-4 / +4	0
Assessment of Full-Scale Construction and Operation	-3 / +3	0
Management of Side Streams	-3 / +3	0
Environmental Criteria		
Improvement in Non-P Parameters	-19 / +19	0
Economic Criteria		
50-year Present Worth	Million dollars	0
Cost-Effectiveness	Dollars/kg removed	0

[a] The flow-weighted mean TP concentration is a weighted average of the flow-weighted mean TP concentrations from the two periods of simulation.

[b] The geometric mean TP concentration was calculated from the weekly flow-weighted means. The geometric mean TP concentration is a weighted average of the geometric mean TP concentrations from the periods of simulation.

4.6 Summary of Alternative Evaluations

A summary of the evaluation ratings for the three alternatives investigated in the C-11 West Basin is presented in Table 4-13. The District and other project stakeholders will use this information in support of future decisions regarding which alternative(s) to select for further study or conceptual design.

Table 4-13.
Summary of Evaluation Ratings for C-11 West Basin Alternatives

Evaluation Criteria	Unit	Rating		
		Alt. 1	Alt. 2	Alt. 3
Technical Performance Criteria				
Phosphorus Load Reduction	Percent	29	39	0
Long-Term TP Concentration Achieved				
Flow-weighted mean	ppb	19	14-16[a]	24
Geometric mean	ppb	10	10-14[a]	21
Implementation Schedule	Years	4	9.5	4
Operational Flexibility	-3 / +3	0	+1	0
Resiliency to Extreme Conditions	-4 / +4	+4	+1	0
Assessment of Full-Scale Construction/O&M	-3 / +3	+1	-2	0
Management of Side Streams	-3 / +3	-2	0	0
Environmental Criteria				
Improvement in Non-P Parameters	-19 / +19	-3	+5	0
Economic Criteria				
50-year Present Worth	Million dollars	120.05	290.64	0
Cost-Effectiveness	Dollars/kg removed	26,560	48,024	0

[a] Range of predicted values using different model calibration data sets.

High land values in the C-11 West Basin cause land-intensive stormwater treatment facilities to be very expensive. The Water Conservation Area 3A and 3B Levee Seepage Management Project (formerly known as the East Coast Buffer Strip), described in the Water Preserve Areas Feasibility Study (*Central and Southern Florida Project Water Preserve Areas Feasibility Study - Draft Integrated Feasibility Report and Supplemental Environmental Impact Statement, USACE and SFWMD, October 2001)*, offers a potential alternative to siting a new STA in the C-11 West Basin if a portion of the project could be devoted to stormwater treatment. The seepage management area, as currently designed, encompasses approximately 4,300 acres of mixed wetland communities and is scheduled to be complete by October 2008.

5. Evaluation of Alternative Water Quality Combinations for the Feeder Canal Basin

This section presents results of the evaluation of alternative water quality improvement strategies for the Feeder Canal Basin. Descriptions of the alternatives are presented, followed by results of the technical analysis and rating of the alternatives according to the Evaluation Methodology described previously in Section 2 of this report. It should be emphasized that the evaluations represented herein are not intended to indicate or recommend a preferred alternative, but rather only to provide information for decision-making in subsequent phases of work.

5.1 Basin Characteristics

The Feeder Canal Basin covers an area of about 72,000 acres (113 square miles) in southeastern Hendry County. It is located west of Water Conservation Area (WCA) 3A, southwest of the Everglades Agricultural Area (EAA), and north of the Big Cypress National Preserve. A portion of the Big Cypress Seminole Indian Reservation (approximately 10,000 acres) is located in the southeast corner of the basin. A map of the Feeder Canal Basin is presented in Figure 5-1.

The surface water management system within the Feeder Canal Basin provides flood protection and drainage, in addition to conveying excess runoff to WCA 3A for water supply and other environmental uses. A system of secondary canals feeds two primary canals, the North Feeder Canal and the West Feeder Canal, which merge at the southeast corner of the basin. These two primary canals receive all of the runoff from the basin. The runoff is discharged by gravity through the S-190 gated spillway structure and conveyed about 15 miles through the L-28 Interceptor Canal to WCA 3A. The L-28 Interceptor Canal is bermed on both sides so that only runoff from the Feeder Canal Basin can be conveyed through it.

Agricultural lands and wetlands account for approximately 90 percent of the basin area. A summary of land uses in the Feeder Canal Basin is provided in Table 5-1.

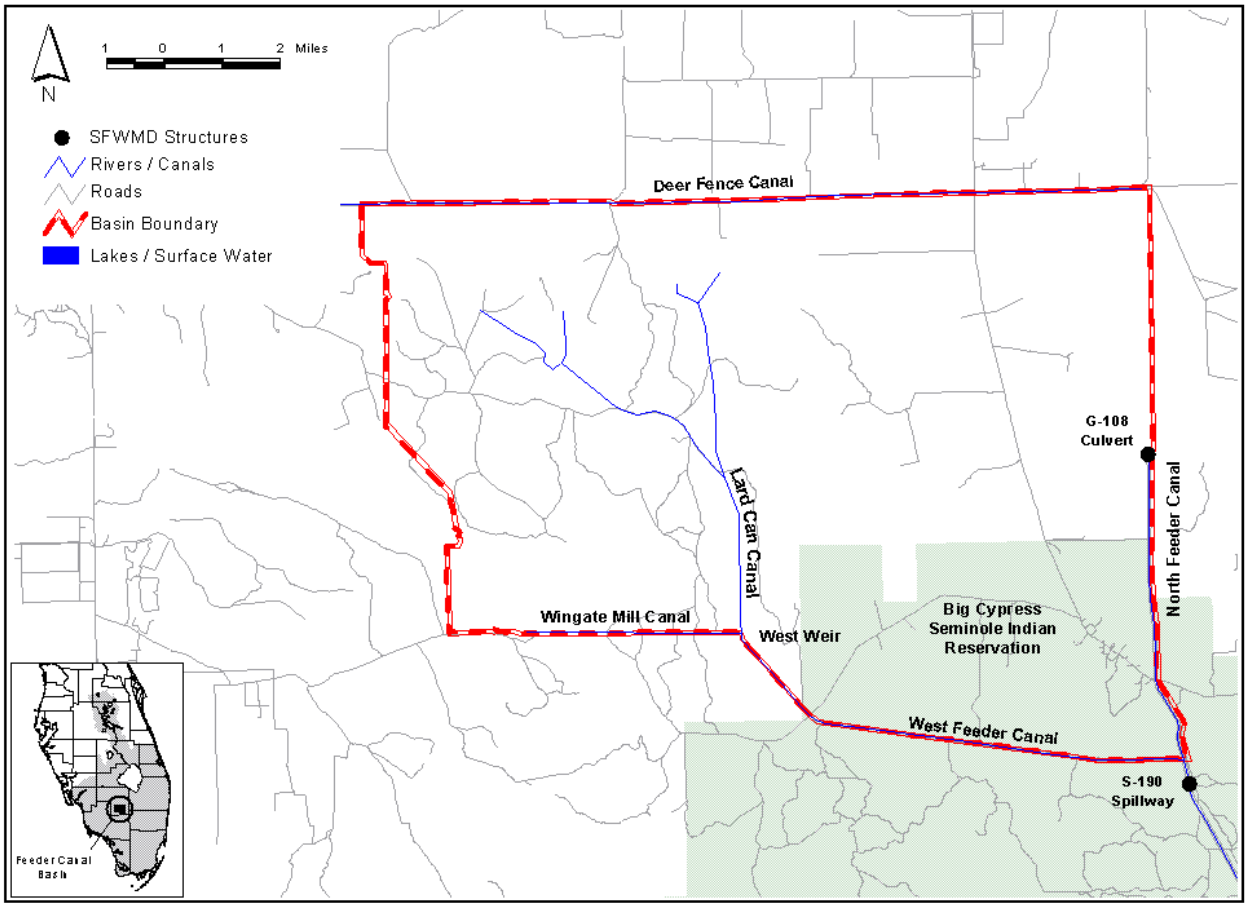


Figure 5-1.
Feeder Canal Basin Map

Table 5-1.
Breakdown of Land Use in the Feeder Canal Basin

Land Use Category	Percentage of Basin Area
Agriculture	56.2
Barren Land	0.6
Rangeland	1.0
Transportation, Communication, and Utilities	0.5
Upland Forests	7.0
Urban and Built-Up	0.2
Water	0.4
Wetlands	34.1
Total	**100.0**

Source: 1995 SFWMD GIS Land Use data according to the Florida Land Use and Cover Classification System (FLUCCS)

The South Florida Water Management District (District) used historical rainfall, flow and water quality data to develop simulated 31-year baseline flows and total phosphorus (TP) loads from the Feeder Canal Basin *(Baseline Data for the Basin Specific Feasibility Studies to Achieve the Long-Term Water Quality Goals for the Everglades, SFWMD, May 2001)*. The simulated flows and loads are presented graphically in Figure 5-2. Simulated flows ranged from about 11,000 to 181,000 acre-feet per year (average 77,179 acre-feet per year). The average daily flow over the 31-year period of simulation was 107 cfs. The peak daily flow was 5,067 cfs. The peak daily flow to average daily flow ratio was calculated to be about 48:1.

Simulated phosphorus loads ranged from about 1,200 to 38,000 kilograms (kg) TP per year (average 14,854 kg TP per year). The flow-weighted mean TP concentration over the 31-year period of simulation was estimated to be 156 ppb.

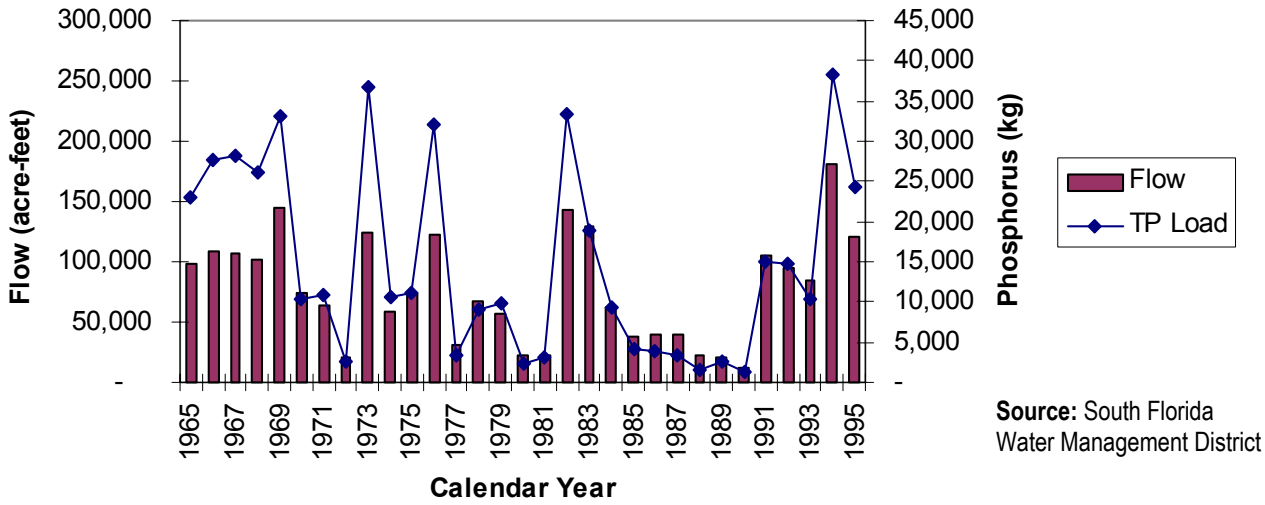


Figure 5-2.
Simulated Flows and Loads for the Feeder Canal Basin

A number of ongoing and planned future projects have the potential to significantly reduce the baseline phosphorus load currently being generated in the Feeder Canal Basin. These include (1) a major source control project on the McDaniel Ranch property, (2) a Central and South Florida Restoration Critical Project on the Big Cypress Seminole Indian Reservation, and (3) the Big Cypress/L-28 Interceptor Canal Modifications Comprehensive Everglades Restoration Plan (CERP) Project.

McDaniel Ranch is a large area of privately owned land (34.5 sections) in the northeastern portion of the basin that is a primary contributor of runoff to the North Feeder Canal. Historically, TP concentrations in runoff from this area have been very high as well. Recently, McDaniel Ranch was issued a master permit by the District that requires stormwater discharges to meet a 50 ppb TP

concentration limit. A system to provide stormwater detention and pre-treatment prior to discharge is currently being implemented. Construction is expected to be completed by December 2006.

The Seminole Tribe Big Cypress Reservation Water Conservation Plan (WCP) is a Federal Critical Restoration Project being funded by the U.S. Army Corps of Engineers (USACE) under Section 528 of the Water Resources Development Act (WRDA) of 1996. Phase I of the WCP, scheduled for completion in January 2003, includes canal improvements designed to ensure delivery of water supply from the S-409 pump station to the reservation. Phase II of the WCP, scheduled for completion by late 2005, involves improvements designed to improve water quality, restore wetlands and increase water conveyance capacity within the reservation. Phase II improvements include a number of "treatment areas" to provide detention of stormwater for various flood protection and ecological purposes. Following completion of the WCP, discharges from the Big Cypress Seminole Indian Reservation are expected to comply with the 50 ppb TP concentration limit included in the USACE permit for the project.

The Big Cypress/L-28 Interceptor Modifications CERP Project is scheduled to be completed in June 2015 and is intended to work in conjunction with the Seminole Tribe's WCP. As currently planned, this project would include three primary components: (1) degradation of berms along the West Feeder Canal and L-28 Interceptor Canal to allow for the sheet flow of water into the Big Cypress National Preserve, (2) conversion of the S-190 Structure from a gated spillway to a pump station, and (3) construction of two STAs to meet applicable water quality standards in downstream receiving water bodies including WCA 3A.

It is not possible to quantify the aggregate effects these projects will have on the future quantity and quality of stormwater discharges from the Feeder Canal Basin. Therefore, for the purposes of evaluating alternatives in this investigation, it was assumed that there would be no reduction in the 31 years of simulated baseline flows. It was also assumed that TP concentrations in future discharges from the entire Feeder Canal Basin (after December 31, 2006) would be consistent with the limits established in the discharge permits for McDaniel Ranch and the Seminole Tribe's WCP. Based on these assumptions, the District projected an average annual phosphorus load of 5,563 kg per year from the Feeder Canal Basin to use for the analysis of alternatives. This equates to a flow-weighted mean TP concentration of 58 ppb over the 31-year period of simulation.

5.2 Alternative Water Quality Combinations

The District formulated a series of two alternative water quality combinations, consisting of source controls and basin-scale treatment facilities for addressing long-term water quality objectives for the Everglades Protection Area (EPA). These alternatives were described in the District publication entitled *Final Water Quality Improvement Strategies for the Everglades: Alternative Combinations for the Feeder Canal Basin, February 27, 2002*. The components of the two alternative water quality combinations are summarized in Table 5-2.

Table 5-2.
Alternative Water Quality Combinations for the Feeder Canal Basin

Alternative	Project Component
1	Source controls Biological Treatment
2	Source controls only (Base Condition)

In evaluating the alternatives for the Feeder Canal Basin, a number of general assumptions were necessary. These included the following:

1. As discussed above, the baseline phosphorus loads for future discharges were reduced by the District for consistency with anticipated TP permit conditions associated with ongoing projects within the basin.

2. It was assumed that the Big Cypress/L-28 Interceptor Modifications CERP Project will provide adequate capacity (combination of sheet flow to the Big Cypress National Preserve and pumping capacity at the S-190 Structure) to accommodate all outflows from the Feeder Canal Basin.

3. Basin scale treatment facilities (i.e. STA in Alternative 1) may not be needed after 2015 if the two STAs currently proposed for the Big Cypress/L-28 Interceptor CERP Project are constructed as planned. Separable cost estimates for operating these facilities after 2015 were prepared.

4. The current level of flood protection within the basin must be maintained.

Presented below are descriptions of the two alternative water quality combinations for the Feeder Canal Basin and the results of the investigations performed to rate them against the criteria contained in the Evaluation Methodology.

5.3 Alternative 1 – Biological Treatment

Alternative 1 combines source controls with biological treatment in a STA to address long-term water quality objectives for discharges to the EPA.

5.3.1 Technical Analysis of Biological Treatment Technology

The Dynamic Model for Stormwater Treatment Areas (DMSTA) was used to determine the most effective combination of wetland vegetation communities for the STA in this alternative, given the revised baseline flows and loads for the Feeder Canal Basin. A discussion of DMSTA and how it was applied in the Basin Specific Feasibility Studies for the ESP basins was presented previously in Section 2 of this report. Emergent vegetation, submerged aquatic vegetation (SAV), and periphyton (PSTA) were all considered individually and in combination with one another to identify the technology or combination of technologies that provided maximum phosphorus removal performance. Also considered in the evaluation were factors such as cell partitioning to improve

hydraulic efficiency through the STA, maximum allowable water depth, frequency and duration of dryout periods, and the occurrence of hydraulic bypass during major storm events.

The following combinations of vegetation communities were simulated with DMSTA to establish the apparent best base case scenario for evaluation in this alternative:

- Emergent
- Emergent/SAV
- Emergent/SAV/PSTA
- SAV
- SAV/PSTA

For each of these combinations of vegetation communities, the treatment area was divided into a varying number of cells to test the effect of cell partitioning on STA performance. The goal was to maximize treatment efficiency while preventing hydraulic bypass and minimizing the frequency and duration of dryout periods. The benefit of increased TP removal efficiency achieved by constructing additional cells was balanced against the increased construction cost associated with internal levees and the increased potential for hydraulic bypass.

The results of this iterative screening process indicated that a 100 percent SAV-dominated STA, partitioned into three cells with an upstream storage reservoir, provides the best overall TP removal performance and protection against bypass and dryout. This STA requires 865 acres of active treatment cells and 1,442 acres of reservoir. This scenario is projected by DMSTA to achieve a long-term flow-weighted mean TP concentration of 26 ppb and a long-term geometric mean TP concentration of 10 ppb. A summary of the TP removal performance and the size and operating characteristics of the STA and reservoir for Feeder Canal Basin Alternative 1 is presented in Table 5-3.

The reservoir in this alternative was very effective in reducing the total land area required to achieve the 10 ppb planning level target for TP while avoiding hydraulic bypass. The reservoir was modeled and sized using the DMSTA Storage Reservoir Model (See Section 2). The reservoir accepts flow until it is full and empties as quickly as possible in anticipation of the next storm event. In comparison, DMSTA projected that a STA by itself, designed to achieve 10 ppb TP without hydraulic bypass, would require approximately 3,700 acres of treatment cells. This option requires about 1,400 acres more land than the reservoir/STA option and clearly would have been more costly to implement.

For the purposes of this analysis, it was conservatively assumed that TP would not be removed within the reservoir. However, it is possible that TP removal can occur within a reservoir. Therefore, it is recommended that future analyses investigate the potential for TP removal in reservoirs upstream of STAs and the impact it may have on STA sizing and treatment performance.

A general discussion of the potential uncertainties related to the construction and operation of a STA was previously presented in Section 2 of this report. While many uncertainties cannot be quantified within the DMSTA model framework, the frequency and approximate duration of STA

dryout throughout the analysis period can be predicted by DMSTA. For SAV, it was assumed that dryout occurs when DMSTA predicts water depths to be less than 15 cm. For this alternative, DMSTA predicted only five occurrences of dryout throughout the entire 31-year period of simulation. The maximum duration was 3.5 months and the average duration was 2.7 months. If these predictions hold true, dryout should not materially affect the predicted long-term TP removal performance of the STA, particularly if care is taken in restarting the treatment process when inflow returns.

Table 5-3.
STA Components and Predicted TP Removal Performance for Feeder Canal Basin Alternative 1

Facility Component / Parameter	Base Case (50 ppb)	Sensitivity Case 1a (75 ppb)	Sensitivity Case 1b (100 ppb)	Sensitivity Case 2 (NEWS)	Sensitivity Case 3 (Bypass)
TP Removal Performance [a]					
Average basin TP load, kg/year	14,854	14,854	14,854	14,854	14,854
Flow-weighted mean TP conc., ppb (modified for source controls)	58	88	117	58	58
TP load to STA, kg/year	5,563	8,344	11,125	5,563	5,563
STA outflow TP conc., ppb					
Flow-weighted mean	26	27	27	40	26
Geometric mean	10	10	10	13	10
STA Outflow TP load, kg/year	2,378	2,386	2,355	3,627	2,346
Average TP load reduction, kg/year	3,185	5,958	8,770	1,936	3,217
Total 50-year TP load reduction, percent	57	71	79	35	58
Pumping Station Capacity (cfs)					
Inflow	5,067	5,067	5,067	5,067	2,974
Reservoir					
Area, acres	1,442	1,297	1,189	1,442	990
Max. Operating Water Depth, feet	4.5	4.5	4.5	4.5	4.5
Peak flow to STA, cfs	1,865	1,865	1,865	1,865	1,835
Stormwater Treatment Area					
Type	SAV	SAV	SAV	NEWS	SAV
Area of Treatment Cells, acres	865	1,137	1,335	865	840
No. of Cells	3	3	3	3	3
Max. Operating Water Depth, feet	4.5	4.5	4.5	4.5	4.5
Peak Outflow, cfs	1,865	1,865	1,865	1,865	1,835
No. of Dryout Occurrences [b]	5	5	5	5	5
Average Duration of Dryout, months [b]	2.7	2.7	2.7	2.7	2.7
Maximum Duration of Dryout, months [b]	3.5	3.5	3.5	3.5	3.5

[a] TP Removal Performance data obtained from DMSTA model results and does not include the effects of start-up or stabilization periods.

[b] Dryout is assumed to occur when DMSTA predicts water depths of 15 cm or less in the STA.

5.3.2 Project Elements

Siting of the STA within the Feeder Canal Basin was not a part of the Basin Specific Feasibility Studies. However, location of the STA influences the project elements required to implement this alternative. For evaluation purposes, therefore, it was necessary to make some general assumptions on where a STA in the Feeder Canal Basin might logically be located.

Because the two primary conveyance canals in the Feeder Canal Basin are the North Feeder Canal and the West Feeder Canal, it was assumed that a single STA serving the entire basin would be located in close proximity to one of these primary canals in order to prepare cost estimates. Also, since the point of discharge from the basin is at its southeastern corner where the North Feeder Canal and the West Feeder Canal merge, it was assumed that a STA would be located as close to this corner of the basin as practicably possible to reduce the length of outflow canal required.

A schematic layout of how the reservoir and STA could be configured in the Feeder Canal Basin is illustrated in Figure 5-3. A new inflow pumping station with a capacity of 5,067 cfs would deliver stormwater to the reservoir. An operable control structure would deliver flow from the reservoir into the STA via an inflow canal with a series of culverts. Flow would pass through the STAs three treatment cells and be collected in an outflow canal downstream of Cell 3. The existing S-190

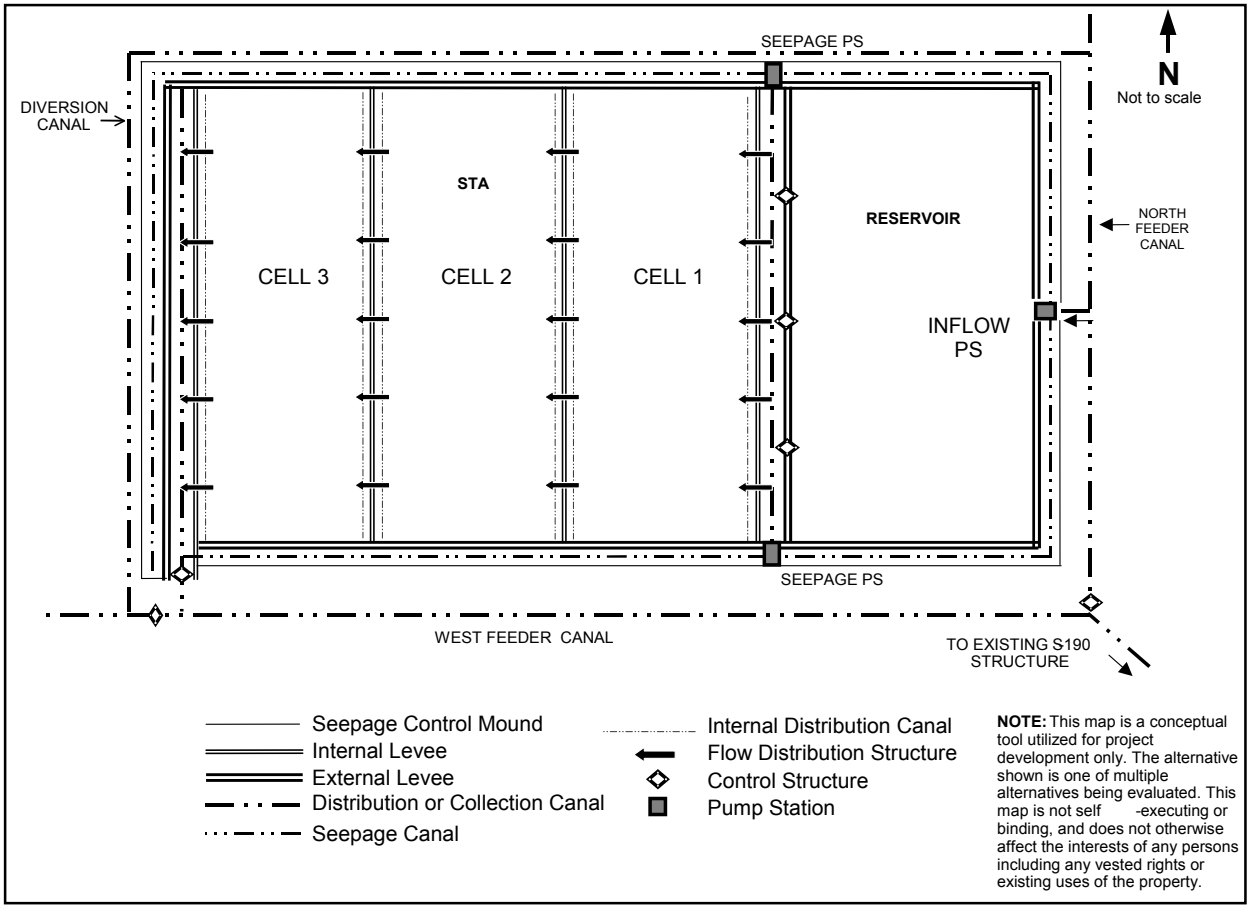


Figure 5-3.
Example STA Schematic for Feeder Canal Basin Alternative 1

structure will be used as the outflow structure for the STA. The length of outflow canal required to convey treated water to the S-190 structure is a function of STA location. Seepage would be collected in canals along the exterior levees on all sides of the STA and reservoir and would be returned to the STA / reservoir system. Two seepage pump stations would allow delivery of the seepage water to the STA inflow canal.

Note from Table 5-3 that the peak outflow from the STA is projected by DMSTA to be about 1900 cfs. The existing S-190 gated spillway structure has sufficient capacity to accommodate this peak flow rate. However, when the S-190 structure is converted to a pump station in 2015 under CERP, its capacity will be reduced to 1460 cfs. Based on direction form the District, it was assumed that the CERP project would be modified, if necessary, to accommodate the additional flow through the S-190 structure if sheet flow from the West Feeder Canal to the Big Cypress National Preserve cannot accommodate all of it.

5.3.3 Sensitivity Analyses

A number of analyses were conducted to test the sensitivity of the DMSTA model results to changes in key assumptions that were used in the base case analysis. The results are presented in Table 5-3. The sensitivity analyses performed were as follows:

1. *Sensitivity Case 1:* Using the base case reservoir STA configuration, determine the amount of land required when the inflow TP concentration is adjusted to 75 ppb and 100 ppb instead of the 50 ppb originally assumed for the case.

2. *Sensitivity Case 2:* Using the base case reservoir STA configuration, determine TP removal performance using the NEWS data set as an indication of more conservative STA performance.

3. *Sensitivity Case 3:* Assume that peak flows with a 10-year return frequency are bypassed and determine the amount of land required for a reservoir/STA to achieve 10 ppb using the SAV_C4 (base case) calibration data set in DMSTA.

4. *Sensitivity Case 4:* Determine DMSTA sensitivity to adjustments in phosphorus cycling and design parameters of ±25 percent and ±50 percent using the internal DMSTA sensitivity analysis tool.

The following sections briefly describe the results of these sensitivity analyses.

5.3.3.1 Sensitivity Case 1

For Sensitivity Case 1, inflow TP concentrations were adjusted to 75 ppb (1a) and 100 ppb (1b) and modeled with DMSTA using the same cell configuration and vegetation partitioning as in the base case. The 75 ppb case required 1,137 acres of STA treatment cells and a reservoir land area of 1,297 acres to achieve a long-term geometric mean outflow TP concentration of 10 ppb without hydraulic bypass. The 100 ppb case required 1,335 acres of STA treatment cells and a reservoir land area of 1,189 acres. These land areas do not include the associated internal and external works required for

operation of the reservoir and STA. The cost estimate for the 75 ppb sensitivity case is presented in Section 5.3.6

5.3.3.2 Sensitivity Case 2

The District's Evaluation Methodology directed that the SAV_C4 calibration data set be used for all base case DMSTA simulations involving SAV plant communities. In Sensitivity Case 2, the base case STA was tested using the NEWS calibration data set as an indication of more conservative STA performance. The flow-weighted mean and geometric mean TP concentrations for this scenario are 40 ppb and 13 ppb, respectively.

5.3.3.3 Sensitivity Case 3

For Sensitivity Case 3, a STA configuration was determined with a modified set of basin inflows that simulate the bypass of 10-year storm event flows. The 10-year storm event flow of 2,974 cfs was estimated by the District and occurred on six days throughout the entire 31-year period or simulation. The land area required for this bypass scenario was determined to be approximately 1,830 acres (840 acres of STA and 990 acres of upstream reservoir). This sensitivity case used the same cell configuration and cell partitioning as in the base case. The present worth cost for the hydraulic bypass sensitivity case is provided in Section 5.3.6

5.3.3.4 Sensitivity Case 4

For Sensitivity Case 4, the sensitivity analysis tool within DMSTA was used. This tool allows the user to input a sensitivity scale factor, and to select the input parameter sets to be adjusted (phosphorus cycling and/or STA design parameters). The sensitivity analysis tool then adjusts each non-zero input variable by the sensitivity scale factor (both plus and minus), one at a time, and reruns the simulation. This sensitivity case was conducted on the base case STA design. The key phosphorus cycling parameters and STA design parameters were adjusted by ±25 percent and ±50 percent. It appears from the results of the sensitivity analysis that all phosphorus cycling parameters are relatively insensitive to adjustments up to 50 percent. As expected, it appears that the inflow fraction (volume of stormwater) and the surface area (STA footprint) were the two STA design parameters that were sensitive to adjustments up to 50 percent. Complete sensitivity analysis results are provided in Appendix B.

5.3.4 Uncertainty Analysis

An uncertainty analysis tool was provided with the DMSTA model to assess the affects of uncertainty in model input parameters on DMSTA model results. Uncertainty analyses were performed for this alternative using the methodology described in Section 2. The uncertainty analyses were performed for the ±25 percent and ±50 percent DMSTA sensitivity analyses (Sensitivity Case 4 as discussed above). The results of the uncertainty analyses provide the 10th, 50th and 90th percentile values for the treated flow-weighted mean outflow concentration, total flow-weighted mean outflow concentration, outflow geometric mean (composites) and total outflow load. Results of the uncertainty analyses are contained in Appendix B.

5.3.5 Implementation Schedule

A projected schedule for implementation of Alternative 1 is presented in Table 5-4. Land acquisition is assumed to require approximately 12 months. Design and permitting are expected to take 18 months to complete, and bidding, contractor selection and contract award are anticipated to require another 6 months. Construction of the STA, pumping stations and control structures is estimated to take 18 months to complete. Total time to complete construction (design through construction) is estimated to be 54 months, or 4.5 years.

Following construction, a process start-up and stabilization period must occur. The Supplemental Technology Standard of Comparison (STSOC) research suggests a 12-month period for initial development of the SAV plant communities and an additional 1-3 years for maturation and stabilization of the process *(Final STSOC Analysis for Submerged Aquatic Macrophyte/Limerock Technology, DB Environmental, Inc., May 2002)*. For the purposes of this evaluation, a 12-month start-up period and a 24-month stabilization period were assumed. Using these assumptions, a total of 90 months, or 7.5 years, will be required before the STA can be expected to achieve the TP removal performance predicted by DMSTA. This assumes land acquisition begins in January 2003 and the STA will come on-line in July 2007, but predicted performance will not be achieved until July 2010. The start-up and stabilization periods have been accounted for and reflected in the phosphorus load reduction calculation in Section 5.3.7, since they occur after December 31, 2006.

Table 5-4.
Implementation Schedule for Feeder Canal Basin Alternative 1

Project Component	Time Duration (months)
Land Acquisition	12
Design and Permitting	18
Contractor Procurement	6
Construction	18
Process Start-up	12
Process Stabilization	24
Total	**90**

5.3.6 Cost Estimates

Capital costs and average annual O&M costs for Alternative 1 were estimated using unit costs provided by the District and supplemented, where necessary, by Brown and Caldwell. The methodology for preparing cost estimates was presented previously in Section 2 of this report. A summary of the capital and O&M cost estimates is presented in Table 5-5. Capital costs, including contingency, were estimated to total about $91.95 million. Average annual O&M costs were estimated to total about $0.66 million per year. A detailed breakdown of the capital and O&M cost estimates for Alternative 1 is presented in Appendix A.

Estimates of 50-year present worth were prepared covering the period 2003-2052. Capital costs were assumed to occur over the period 2003-2007. O&M costs were assumed to occur over the period 2008-2052. The present worth of the capital costs was calculated to be $87.65 million. The present worth of the average annual O&M costs was calculated to be $13.39 million, and the present worth of pumping station equipment replacement costs was calculated to be $4.41 million. The combined 50-year present worth for Feeder Canal Basin Alternative 1 was calculated to be $105.45 million.

Table 5-5.
Cost Estimates for Feeder Canal Basin Alternative 1

Cost Component	Estimated cost (million dollars)
Capital Costs	
Construction Costs	
Pumping Stations	40.48
Reservoir/STA Works	5.94
Inflow/Outflow Canals	6.73
Seepage Canals	3.02
Subtotal	56.16
Planning, engineering and design (10%)	5.62
Program and construction management (10%)	5.62
Subtotal	67.40
Contingency (30%)	20.22
Total, construction costs	87.61
Land Acquisition	
Right-of-way and land purchase	3.62
Contingency (20%)	0.72
Total, Land Acquisition costs	4.34
Total, Capital costs	91.95
Average Annual O&M Costs	
Pumping Stations	0.33
Reservoir/STA Works	0.09
Control Structures and Misc.	0.10
Subtotal	0.51
Contingency (30%)	0.15
Total, Annual O&M costs	0.66
50-year Present Worth (2003-2052)	
Capital costs	87.65
O&M costs	13.39
Replacement costs	4.41
Total, 50-year present worth	105.45

In addition, cost estimates were prepared for Sensitivity Cases 1a (varying level of TP reduction due to source controls) and Sensitivity Case 3 (hydraulic bypass). A summary of the 50-year present worth estimates for these sensitivity cases is presented in Table 5-6. Full cost estimate breakdowns for the sensitivity cases are presented in Appendix A.

Table 5-6.
Summary of Present Worth Cost Estimates for Feeder Canal Basin Alternative 1

Present Worth Component (million dollars)	Base Case	Sensitivity Case 1a (75 ppb)	Sensitivity Case 3 (Bypass)
Capital costs	87.65	88.29	59.15
O&M costs	13.39	13.48	10.76
Replacement costs	4.41	4.41	2.59
Total 50-year present worth	105.45	106.19	72.51

Because so few details associated with the CERP Projects and Critical Projects in this basin were available at the time of this study, an assumption was made that the proposed STA would need to treat all of the basin flows, even though it is thought that these projects will have an impact on these flows. For this reason, a potential exists for cost savings by integrating with the CERP and Critical Projects to meet the goals of all the projects.

5.3.7 Evaluation Ratings

Alternative 1 was rated against the ten evaluation criteria defined in the Evaluation Methodology document *(Final Evaluation Methodology for the Water Quality Improvement Strategies for the Everglades, SFWMD, July 31, 2002)* and discussed previously in Section 2 of this report. Table 5-7 summarizes the ratings given based on the results of this investigation.

Phosphorus Load Reduction. Approximately 54 percent of the TP load generated in the Feeder Canal Basin over the 50-year analysis period is removed by the STA. This load calculation includes the effect of STA start-up and stabilization periods, which occur after December 31, 2006.

Long-Term TP Concentration Achieved. DMSTA simulations of the STA in this alternative predict a long-term flow-weighted mean TP concentration of 26 ppb and a long-term geometric mean TP concentration of 10 ppb.

Implementation Schedule. This alternative is expected to take approximately 7.5 years to fully implement. If project implementation begins in January 2003, a fully stabilized biological treatment process should not be expected before July 2010. **Rating: 7.5 years.**

Operational Flexibility. The reservoir and STA in this alternative will provide about 10,000 acre-feet of water storage. This additional storage should afford water managers a significant increase in the operational flexibility of the South Florida hydraulic conveyance system and the Everglades Water Conservation Areas. **Rating: +2.**

Resiliency to Extreme Conditions. Per the STSOC report by DB Environmental, Inc., a SAV-dominated STA should be highly resilient to fire and flood, generally resilient to hurricane, and highly sensitive to prolonged drought. A few short-duration dryout periods are expected in the STA proposed for this alternative, but no prolonged dryout periods were predicted by DMSTA over the 31-year period of simulation. **Rating: +2.**

Assessment of Full-Scale Construction and Operation. A 100 percent, SAV-dominated STA has not been constructed at full scale. However, Cell 4 in STA 1W has been operated as a SAV-dominated treatment system for more than 5 years. The size of the STA in this alternative is approximately two times the size of Cell 4 in STA 1W; therefore, factors associated with scale-up and full-scale operation are of some concern for this larger treatment system. **Rating: -1.**

Management of Side Streams. The only side stream generated in this alternative is seepage. Seepage is not expected to have significant positive or negative impact on surrounding lands. **Rating: 0.**

Improvement in Non-P Parameters. The STSOC report for SAV prepared by DB Environmental, Inc. includes information on non-phosphorus parameters collected during research activities. Information from ENR Cell 4, South Test Cell 9, and North Test Cell 15 indicated the following: an improvement in ammonia, dissolved oxygen, iron, specific conductance, turbidity and color, a deterioration in pH, and no significant change in the other 12 non-P water quality parameters. **Rating: +5.**

50-Year Present Worth. The total 50-year present worth of the capital, O&M and replacement costs associated with this alternative is $105.45 million.

Cost-Effectiveness. The total TP load removed over the period 2007 to 2056 is estimated to total 151,190 kg. Based upon a 50-year present worth of $ 105.45 million, this translates to a cost-effectiveness rating of $ 698 per kg TP removed.

Table 5-7.
Summary of Evaluation Ratings for Feeder Canal Basin Alternative 1

Evaluation Criteria	Unit	Rating
Technical Performance Criteria		
Phosphorus Load Reduction [a]	Percent	54
Long-Term TP Concentration Achieved		
Flow-weighted mean	ppb	26
Geometric mean	ppb	10
Implementation Schedule	Years	7.5
Operational Flexibility	-3 / +3	2
Resiliency to Extreme Conditions	-4 / +4	2
Assessment of Full-Scale Construction and Operation	-3 / +3	-1
Management of Side Streams	-3 / +3	0
Environmental Criteria		
Improvement in Non-P Parameters	-19 / +19	+5
Economic Criteria		
50-year Present Worth	Million dollars	105.45
Cost-Effectiveness	Dollars/kg removed	698

[a] Phosphorus load reduction includes the effect of STA start-up and stabilization periods.

5.4 Alternative 2 – Source Controls (Base Condition)

Alternative 2 assumes ongoing source control programs in the Feeder Canal Basin (including McDaniel Ranch), the Seminole Tribe's WCP, and the Big Cypress/L-28 Interceptor Modifications CERP Project will all be implemented on schedule as discussed previously in this section. However, where Alternative 1 assumed further biological treatment of stormwater flows in a STA after these projects and programs are implemented, Alternative 2 does not.

5.4.1 Technical Analysis of Alternative 2

If no additional treatment is provided to Feeder Canal Basin flows, no TP load reduction will be achieved because the baseline phosphorus load used in the evaluation of alternatives already included load reductions for source controls and the Seminole Tribe's WCP. This results in an average of 5,563 kg per year of TP being discharged to WCA 3A over the 50-year period from 2007 to 2056. The projected long-term flow-weighted mean TP concentration is about 58 ppb and the projected long-term geometric mean TP concentration is about 27 ppb.

Sensitivity analyses were also performed to determine the impact on TP loads to WCA 3A if the source control projects, Seminole Tribe WCP, and CERP project were not as effective in reducing TP loads as assumed in the revised baseline data set. Two scenarios were examined, one in which TP inflow concentrations were assumed to be reduced to 75 ppb, and another in which TP concentrations were assumed to be reduced to an average of 100 ppb. For the first sensitivity case, the total TP load discharged to WCA 3A over the 50-year period of 2007 to 2056 is estimated to be 417,200 kg for an average of 8,344 kg per year. For the second sensitivity case, the total TP load discharged to WCA 3A over the 50-year period from 2007 to 2056 is estimated to be 556,250 kg for an average of 11,125 kg per year. The long-term flow-weighted mean inflow TP concentrations for these two sensitivity cases were determined to be 88 and 117 ppb, respectively.

5.4.2 Project Elements

The components of a basin-scale source control program in a primarily agricultural basin such as the Feeder Canal Basin were generally described in Section 2 of this report. The McDaniel Ranch source control project, the Seminole Tribe's WCP, and the Big Cypress/L-28 Interceptor Modifications CERP Project were generally described previously in this section. Details regarding these projects can be found on the District's website. There are no other project elements associated with this alternative.

5.4.3 Implementation Schedule

Basin-wide source controls are scheduled for implementation by December 2006. There are no other project elements requiring implementation in this alternative. The McDaniel Ranch source control project is scheduled for completion in 2006, the Seminole Tribe's WCP is scheduled for completion in 2005, and the Big Cypress/L-28 Interceptor Modifications CERP Project is scheduled

for completion in 2015. However, for evaluation purposes, these projects are not part of this alternative and do not affect the schedule for its implementation.

5.4.4 Cost Estimates

Cost estimating for source control programs and projects to be constructed under other funding sources was beyond the scope of these Basin Specific Feasibility Studies. Since there are no other project elements associated with this alternative, no cost estimates were prepared.

5.4.5 Evaluation Ratings

Alternative 2 was rated against the ten evaluation criteria defined in the Evaluation Methodology document *(Final Evaluation Methodology for the Water Quality Improvement Strategies for the Everglades, SFWMD, July 31, 2002)* and discussed previously in Section 2 of this report. Because there are no capital improvements to be implemented as part of this alternative, some of the evaluation criteria are not applicable or have reduced significance. Table 5-8 summarizes the ratings given to Alternative 2 based on the results of this investigation.

Phosphorus Load Reduction. This alternative results in zero TP load reduction compared to the 31-year period of simulation TP load. Therefore, the TP load reduction for this alternative is 0 percent.

Long-Term TP Concentration Achieved. This alternative results in a long-term flow weighted mean TP concentration of 58 ppb and a long-term geometric mean TP concentration of 27 ppb.

Implementation Schedule. Under the assumptions made for evaluation of this alternative, implementation will occur by December 31, 2006. **Rating: 4 years.**

Operational Flexibility. This alternative provides no increase or decrease in the operational flexibility of the South Florida hydraulic conveyance system and the Everglades Water Conservation Areas. **Rating: 0.**

Resiliency to Extreme Conditions. This alternative has no capital improvements that could be sensitive or resilient to fire, flood, drought or hurricane conditions. **Rating: 0.**

Assessment of Full-Scale Construction and Operation. This alternative has no capital improvements. Therefore, an assessment of risk associated with full-scale construction and operation of such improvements is not applicable. **Rating: 0.**

Management of Side Streams. There are no side streams associated with this alternative. **Rating: 0.**

Improvement in Non-P Parameters. In accordance with the District's Evaluation Methodology, alternatives with no public works components (capital improvements) were assumed to have no impact on non-phosphorus water quality parameters. **Rating: 0.**

50-Year Present Worth. Since the costs of source controls are not considered in the Basin Specific Feasibility Studies, and there are no capital improvements to be constructed and operated, the 50-year present worth of Alternative 3 is zero.

Cost-Effectiveness. Since there are no costs or load reductions for this alternative, the cost-effectiveness rating of Alternative 3 is zero.

Table 5-8.
Summary of Evaluation Ratings for Feeder Canal Basin Alternative 2

Evaluation Criteria	Unit	Rating
Technical Performance Criteria		
Phosphorus Load Reduction	Percent	0
Long-Term TP Concentration Achieved		
Flow-weighted mean	ppb	58
Geometric mean	ppb	27
Implementation Schedule	Years	4
Operational Flexibility	-3 / +3	0
Resiliency to Extreme Conditions	-4 / +4	0
Assessment of Full-Scale Construction and Operation	-3 / +3	0
Management of Side Streams	-3 / +3	0
Environmental Criteria		
Improvement in Non-P Parameters	-19 / +19	0
Economic Criteria		
50-year Present Worth	Million dollars	0
Cost-Effectiveness	Dollars/kg removed	0

5.5 Summary of Alternative Evaluations

A summary of the evaluation ratings for the two alternatives investigated in the Feeder Canal Basin is presented in Table 5-9. The District and other project stakeholders will use this information in support of future decisions regarding which alternative(s) to select for further study or conceptual design.

Table 5-9.
Summary of Evaluation Ratings for Feeder Canal Basin Alternatives

Evaluation Criteria	Unit	Rating	
		Alt. 1	Alt. 2
Technical Performance Criteria			
Phosphorus Load Reduction	Percent	54	0
Long-Term TP Concentration Achieved			
Flow-weighted mean	ppb	26-40[a]	58
Geometric mean	ppb	10-13[a]	27
Implementation Schedule	Years	7.5	4
Operational Flexibility	-3 / +3	+2	0
Resiliency to Extreme Conditions	-4 / +4	+2	0
Assessment of Full-Scale Construction/O&M	-3 / +3	-1	0
Management of Side Streams	-3 / +3	0	0
Environmental Criteria			
Improvement in Non-P Parameters	-19 / +19	+5	0
Economic Criteria			
50-year Present Worth	Million dollars	105.45	0
Cost-Effectiveness	Dollars/kg removed	698	0

[a] Range of predicted values using different model calibration data sets.

The reservoir/STA in Alternative 1, sized to achieve the 10 ppb planning level target, represents a large capital investment. Significant cost savings may be possible if the project is more closely integrated with other projects designed to improve water quality in runoff from the Feeder Canal Basin.

Phase II of the Seminole Tribe Big Cypress Reservation WCP, scheduled for completion by late 2005, involves improvements designed to enhance water quality, restore wetlands and increase water conveyance capacity within the reservation. Phase II improvements include a number of "treatment areas" to provide detention of stormwater for various flood protection and ecological purposes. The impact of these improvements on discharges from the Feeder Canal Basin is not known at this time. However, if properly coordinated, elements of the WCP could be used to reduce inflow TP concentrations and attenuate peak flows to the additional STA facilities needed to meet the 10 ppb planning level target.

The Big Cypress/L-28 Interceptor Modifications CERP Project is scheduled to be completed in June 2015 and is intended to work in conjunction with the Seminole Tribe's WCP. As currently planned, the CERP project includes two STAs, the size and location of which are undefined. The CERP project also includes improvements that would allow for a portion of Feeder Canal Basin flows to sheet flow into the Big Cypress National Preserve instead of being discharged into WCA 3A. The impact of the CERP project on the quantity and quality of runoff from the Feeder Canal

Basin cannot be determined at the present time. Once the aggregate effects of the CERP project can be quantified, further analysis should be conducted using the adjusted flows and loads to more accurately predict the land area requirements needed to achieve the planning level target of 10 ppb TP. Careful coordination between the planned CERP project and improvements proposed to meet the goals and objectives of the EFA has the potential to significantly reduce the cost of both programs without sacrificing any of the desired water quality and water quantity benefits.

6. Evaluation of Alternative Water Quality Combinations for the L-28 Basin

This section presents results of the evaluation of alternative water quality improvement strategies for the L-28 Basin. Descriptions of the alternatives are presented, followed by results of the technical analysis and rating of the alternatives according to the Evaluation Methodology described previously in Section 2 of this report. It should be emphasized that the evaluations represented herein are not intended to indicate or recommend a preferred alternative, but rather only to provide information for decision-making in subsequent phases of work.

6.1 Basin Characteristics

The L-28 Basin covers an area of about 72,000 acres (113 square miles). It is located west of Water Conservation Area (WCA) 3A and south of the Everglades Agricultural Area (EAA) at the northeast corner of the Big Cypress National Preserve in Broward, Hendry and Collier Counties. Two of the largest landowners within this basin are the Seminole Tribe of Florida and the Miccosukee Tribe of Indians of Florida. A small portion of the Big Cypress National Preserve is also located in the basin. A map of the L-28 Basin is presented in Figure 6-1.

The surface water management system in the L-28 Basin provides drainage and flood protection in addition to providing water to WCA 3A when necessary for water supply purposes. The L-28 Borrow Canal is the primary drainage canal, running north/south for a distance of approximately 10 miles along the eastern border of the basin. The L-28 Borrow Canal conveys stormwater runoff to the S-140 pump station which discharges it directly into WCA 3A. The S-140 pump station has three pumps with a combined pumping capacity of 1,300 cubic feet per second (cfs). The L-28 Interceptor Canal, which borders the basin on the southeast, conveys discharges from the S-190 Structure (Feeder Canal Basin) to WCA 3A and is separated from the L-28 Basin by a levee.

Wetland and agricultural land uses account for approximately 96 percent of the basin area. A breakdown of the land use in the L-28 Basin is provided in Table 6-1.

The South Florida Water Management District (District) used historical rainfall, flow and water quality data to develop simulated 31-year baseline flows and TP loads from the L-28 Basin *(Baseline Data for the Basin Specific Feasibility Studies to Achieve the Long-Term Water Quality Goals for the Everglades, SFWMD, May 2001)*. The simulated flows and loads are presented graphically in Figure 6-2. Simulated flows ranged from about 50,000 to 130,000 acre-feet per year (average 83,806 acre-feet per year). The average daily flow over the 31-year period of simulation was 116 cfs. The peak daily flow was 1,300 cfs. The ratio of peak day flow to average day flow was calculated to be about 11:1. (**Note:** Stormwater runoff from the C-139 Annex was conveyed to STA 6 in the model simulation used for the Basin Specific Feasibility Studies.)

Simulated phosphorus loads ranged from about 2,300 to 6,200 kilograms (kg) TP per year (average 3,982 kg TP per year). The flow-weighted mean TP concentration over the 31-year period of simulation was estimated to be 39 ppb.

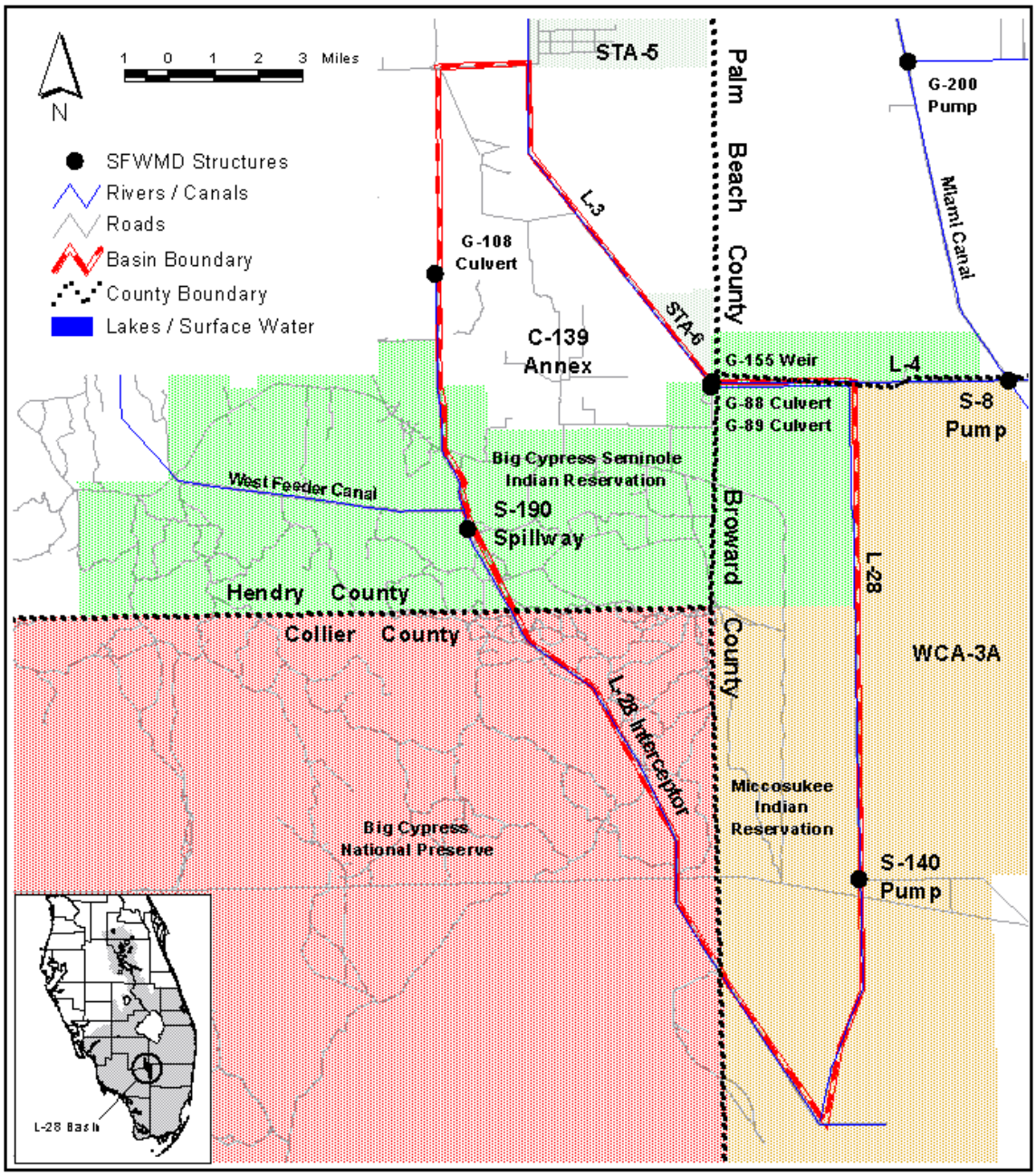


Figure 6-1.
L-28 Basin Map

Table 6-1.
Breakdown of Land Use in the L-28 Basin

Land Use Category	Percentage of Basin Area
Agriculture	35.4
Barren Land	1.2
Rangeland	0.3
Transportation, Communication, and Utilities	0.6
Upland Forests	1.5
Urban and Built-Up	0.1
Water	0.7
Wetlands	60.2
Total	**100.0**

Source: 1995 SFWMD GIS Land Use data according to the Florida Land Use and Cover Classification System (FLUCCS)

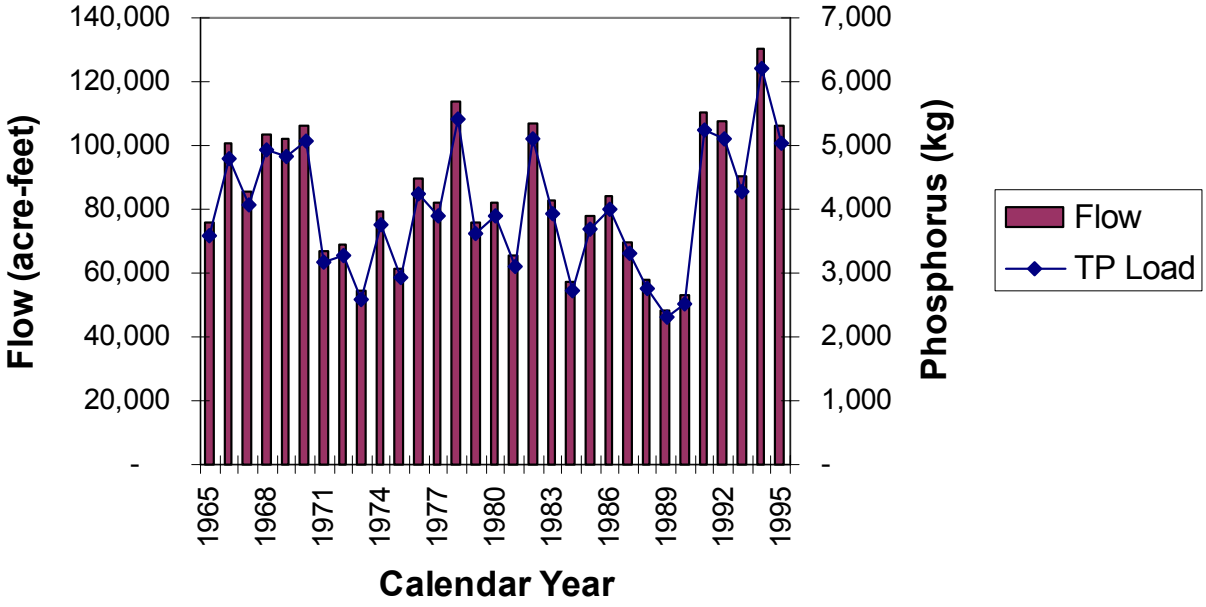


Figure 6-2.
Simulated Flows and Loads for the L-28 Basin

There are two Central and South Florida Restoration Critical Projects planned for the L-28 Basin, the Seminole Tribe Big Cypress Reservation Water Conservation Plan (WCP) and the Miccosukee Water Management Plan (WMP). There is also a Comprehensive Everglades Restoration Program (CERP) project planned to expand and relocate the S-140 pump station.

The Seminole Tribe Big Cypress Reservation WCP is a Federal Critical Restoration Project being funded by the U.S. Army Corps of Engineers under Section 528 of the Water Resources Development Act (WRDA) of 1996. Phase I of the WCP, scheduled for completion in January 2003, includes canal improvements to ensure delivery of water supply from the S-409 pump station to the reservation. Phase II of the WCP, scheduled for completion in September 2005, involves improvements designed to improve water quality, restore wetlands and increase water conveyance capacity within the reservation. Phase II improvements include a number of wetland treatment areas to provide detention of stormwater for various flood protection and ecological purposes. The largest of these areas, some 3,257 acres, is planned for the eastern side of the reservation in the L-28 Basin.

The Miccosukee WMP is a Critical Project to construct a managed wetland on the Miccosukee Tribe's 76,800-acre reservation in western Broward County. The project will convert 900 acres of pasture land on the reservation into wetland retention and detention areas. The project will provide water storage capacity as well as water quality enhancement for water that will be discharged to WCA 3A through the S-140 pump station. This project is being designed to accommodate flows and loads from reservation lands only. Completion of improvements is currently planned for 2010.

CERP Component RR4 includes expanding the S-140 pump station from a capacity of 1,300 cfs to a capacity of 2,000 cfs and relocating it approximately 8 miles to the south. The purpose of the project is to improve hydro-pattern in the northwest corner of WCA 3A and to provide increased water supply to the area. An estimated 285,000 acre-feet per year of additional water from STA 3/4 will be conveyed to the area via the L-4 and L-5 Canals and then by sheet flow through the upper reaches of WCA 3A between the Miami Canal and the L-28 Borrow Canal to the new S-140 pump station.

For the purposes of evaluating alternatives for the L-28 Basin, it was assumed that the existing S-140 pump station will remain in service and will continue to discharge flows from the L-28 Basin to WCA 3A as is presently the case.

At this time, it is not possible to quantify the effects of the two Critical Projects on the future quantity and quality of stormwater discharges from the L-28 Basin. Therefore for the purposes of evaluating alternatives in this investigation, it was assumed that there would be no reduction in either the baseline flows or phosphorus loads predicted for the L-28 Basin over the 31-year period of simulation as a result of these projects.

6.2 Alternative Water Quality Combinations

The District formulated a series of two alternative water quality combinations, consisting of source controls and basin-scale treatment facilities for addressing the long-term water quality objectives for the Everglades Protection Area. These alternatives were described in the District publication entitled *Final Water Quality Improvement Strategies for the Everglades: Alternative Combinations for the L-28 Basin, February 27, 2002*. The components of the two alternative water quality combinations are summarized in Table 6-2.

Table 6-2.
Alternative Water Quality Combinations for the L-28 Basin

Alternative	Project Component
1	Source controls Biological Treatment
2	Source controls only (Base Condition)

The assumptions made for the evaluation of alternatives for the L-28 Basin are as follows:

1. The STA will be sited adjacent to the L-28 Borrow Canal which will serve as the source water and discharge site for the STA. Conveyance of water from the L-28 Borrow Canal to the STA will be through a new pump station. It was assumed that no additional canals will be constructed.

2. The current level of flood protection within the basin must be maintained as the result of implementing any of the alternative water quality combinations. Pumping capacity was assumed to be 1,300 cfs, consistent with the maximum flow discharged over the 31-year period of simulation.

3. There are CERP Projects and Critical Projects planned for this basin; however, it was assumed that they would not directly affect the activities associated with the two alternatives for this basin.

Presented below are descriptions of the two alternative water quality combinations for the L-28 Basin and the results of the investigations performed to rate them against the criteria contained in the Evaluation Methodology.

6.3 Alternative 1 – Biological Treatment

Alternative 1 combines source controls with biological treatment in a STA to reduce phosphorus loads in discharges from the L-28 Basin. Outflow from the STA would be discharged into WCA 3A.

6.3.1 Technical Analysis of Biological Treatment Technology

The Dynamic Model for Stormwater Treatment Areas (DMSTA) was used to determine the most effective combination of wetland vegetation communities for the STA in this alternative, given the baseline flows and loads for the L-28 Basin. A discussion of DMSTA and how it was applied in the Basin Specific Feasibility Studies for the ESP basins was presented previously in Section 2 of this report. Emergent vegetation, submerged aquatic vegetation (SAV), and periphyton (PSTA) were all considered individually and in combination with one another to identify the technology or combination of technologies that provided maximum phosphorus removal performance. Also considered in the evaluation were factors such as cell partitioning to improve hydraulic efficiency through the STA, maximum allowable water depth, frequency and duration of dryout periods, and the occurrence of hydraulic bypass during major storm events.

The following combinations of vegetation communities were simulated with DMSTA to establish the apparent best base case scenario for evaluation in this alternative:

- Emergent
- Emergent/SAV
- Emergent/SAV/PSTA
- SAV
- SAV/PSTA

For each of these combinations of vegetation communities, the treatment area was divided into a varying number of cells to test the effect of cell partitioning on STA performance. The goal was to maximize treatment efficiency while preventing hydraulic bypass and minimizing the frequency and duration of dryout periods. The benefit of increased TP removal efficiency achieved by constructing additional cells was balanced against the increased construction cost associated with internal levees and the increased potential for hydraulic bypass.

The results of this iterative screening process indicated that a STA, divided equally between SAV and PSTA (50 percent each) and partitioned into four cells, provides the best overall TP removal performance and protection against bypass and dryout. This STA requires 1,088 acres of active treatment cells, and is projected by DMSTA to achieve a long-term flow-weighted mean TP concentration of 12 ppb and a long-term geometric mean TP concentration of 10 ppb. A summary of the TP removal performance and the size and operating characteristics of the STA for L-28 Basin Alternative 1 is presented in Table 6-3.

The vegetation partitioning determined for this alternative includes 2 cells each of SAV and PSTA to achieve the 10 ppb water quality goal. SAV cells were required to be simulated upstream of the PSTA cells for the inflow TP concentration to be within the acceptable range for PSTA. Other cell configurations and vegetation partitioning scenarios were either outside of the calibration ranges stipulated within DMSTA or required additional land to achieve the 10 ppb water quality goal.

A general discussion of the potential uncertainties related to the construction and operation of a STA was previously presented in Section 2 of this report. While many uncertainties cannot be

quantified within the DMSTA model framework, the frequency and approximate duration of STA dryout throughout the analysis period can be predicted by DMSTA. For SAV and PSTA, it was assumed that dryout occurs when DMSTA predicts water depths to be less than 15 cm. For this alternative, DMSTA predicted only six occurrences of dryout throughout the entire 31-year period of simulation. The maximum duration was 1.5 months and the average duration was 0.8 months. If these predictions hold true, dryout should not materially affect the predicted long-term TP removal performance of the STA, particularly if care is taken in restarting the treatment process when inflow returns.

Table 6-3.
STA Components and Predicted TP Removal Performance for L-28 Basin Alternative 1

Facility Component / Parameter	Base Case	Sensitivity Case 1 (25%)	Sensitivity Case 2 (NEWS)
TP Removal Performance [a]			
Average basin TP load, kg/year	3,982	3,982	3,982
TP source control reduction, percent	0	25	0
TP load to STA, kg/year	3,982	2,987	3,982
STA outflow TP conc., ppb			
Flow-weighted mean	12	12	15
Geometric mean	10	10	11
STA Outflow TP load, kg/year	1,175	1,188	1,424
Average TP load reduction, kg/year	2,807	1,799	2,558
Total 50-year TP load reduction, percent	70	60	64
Pumping Station Capacity			
Inflow	1,300	1,300	1,300
Stormwater Treatment Area			
Type	50% SAV 50% PSTA	50% SAV 50% PSTA	NEWS
Area of Treatment Cells, acres	1,088	840	1,088
No. of Cells	4	4	4
Max. Operating Water Depth, feet	4.5	4.5	4.5
No. of Dryout Occurrences [b]	6	6	6
Average Duration of Dryout, months [b]	0.8	0.8	0.8
Maximum Duration of Dryout, months [b]	1.5	1.5	1.5

[a] TP Removal Performance data obtained from DMSTA model results and does not include the effects of start-up or stabilization periods.

[b] Dryout is defined as 15 cm or less of water depth in the STA as predicted by DMSTA.

6.3.2 Project Elements

Siting of the STA within the L-28 Basin was not a part of the Basin Specific Feasibility Studies. However, location of the STA influences the project elements required to implement this alternative. For evaluation purposes, therefore, it was necessary to make some general assumptions on where a STA in the L-28 Basin might logically be located.

Because all of the stormwater runoff from the L-28 Basin is collected in the L-28 Borrow Canal, it is logical that a STA serving the entire basin would be located near this canal. Furthermore, since the existing S-140 pump station will be used to discharge treated water into WCA 3A, it is logical that the STA would be located in reasonable proximity to this pump station to reduce the length of new outflow canal required.

A schematic layout of how the STA could be configured in the L-28 Basin is illustrated in Figure 6-3. A new inflow pumping station with a capacity of 1,300 cfs would be located adjacent to the L-28 Borrow Canal and would deliver flow to the STA by means of an inflow canal and a series of culverts. Flow would pass through the four treatment cells and be collected in an outflow canal downstream of Cell 4. A new outflow canal would be constructed to convey treated water by gravity to the L-28 Borrow Canal and the S-140 pump station. Divide structures would be constructed in the L-28 Borrow Canal to separate the inflow and outflow waters. Seepage would be collected in canals along the exterior levees on all sides of the STA and would be returned to the STA inflow canal. A series of control structures in the seepage canals would allow delivery of seepage water to the outflow canal in the event of an emergency.

Analysis of geology and soils maps for the region indicates that the L-28 Basin is in an area where peat soils are shallow and limerock is very near the ground surface. Accordingly, it was assumed that 0-12 inches (average 6 inches) of peat would need to be removed during construction of the PSTA cells in the STA.

6.3.3 Sensitivity Analyses

A number of analyses were conducted to test the sensitivity of the DMSTA model results to changes in key assumptions that were used in the base case analysis. The results are presented in Table 6-3. The sensitivity analyses performed are as follows:

1. *Sensitivity Case 1:* Using the base case STA configuration, determine the amount of land required for a STA with 25 percent of the inflow TP removed as a result of source controls.

2. *Sensitivity Case 2:* Using the base case STA configuration, determine TP removal performance using the NEWS calibration data set as an indication of more conservative STA performance.

3. *Sensitivity Case 3:* Determine DMSTA sensitivity to adjustments in phosphorus cycling and design parameters of ±25 percent and ±50 percent using the internal DMSTA sensitivity analysis tool.

The following sections briefly describe the results of these sensitivity analyses.

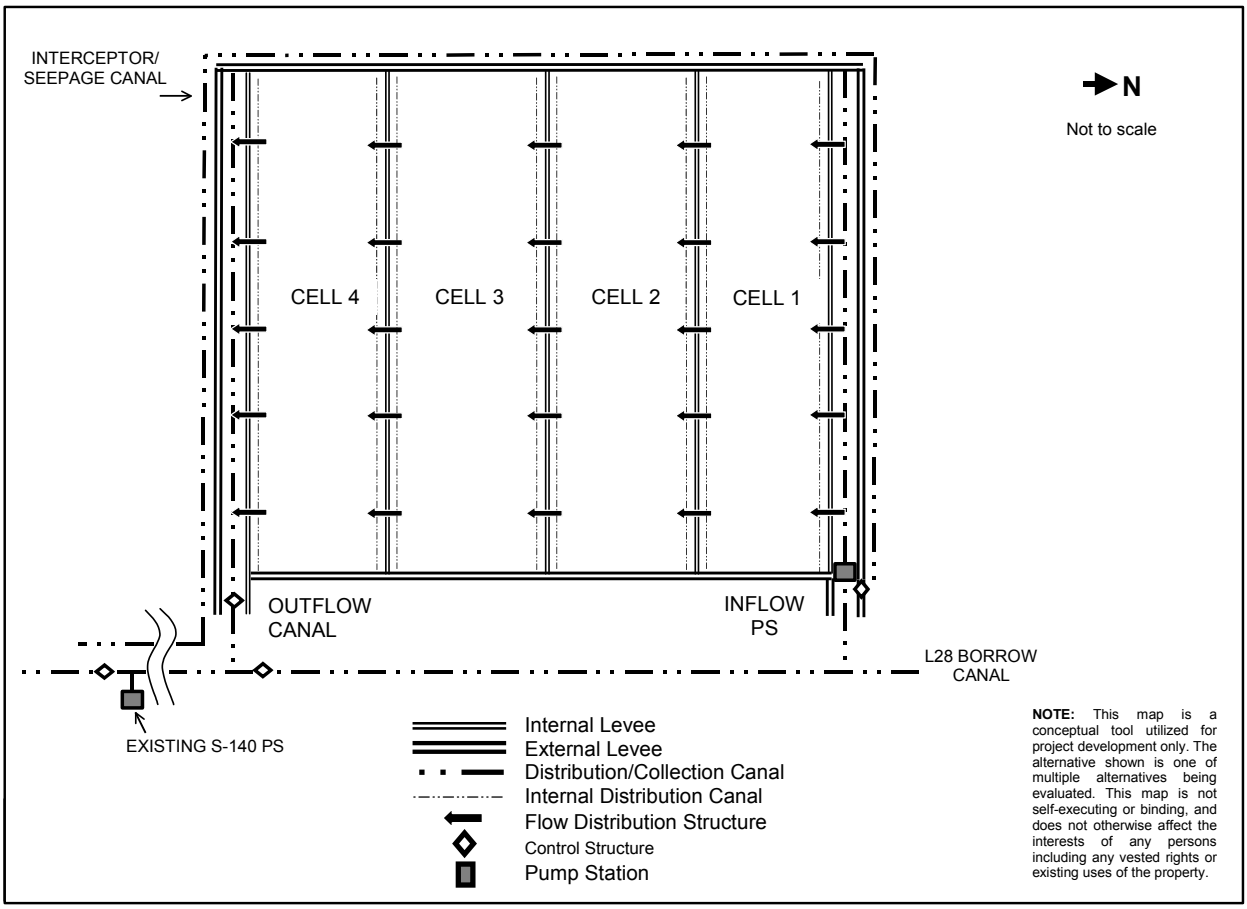


Figure 6-3.
Example STA Schematic for L-28 Basin Alternative 1

6.3.3.1 Sensitivity Case 1

For Sensitivity Case 1, the baseline phosphorus load was reduced by 25 percent and a STA was modeled with DMSTA using the same cell configuration and vegetation partitioning as in the base case. With this load reduction, the land area required for active treatment cells in the STA was estimated to be 840 acres, compared to 1,088 acres for the base case. Additional land area would be required for the internal and external works associated with operation of the STA. Cost estimates for this sensitivity case are presented in Section 6.3.6

6.3.3.2 Sensitivity Case 2

The District's Evaluation Methodology directed that the SAV_C4 calibration data set be used for all base case DMSTA simulations involving SAV plant communities. In Sensitivity Case 2, the base case STA was tested using the NEWS calibration data set for the two SAV cells as an indication of more conservative STA performance. The flow-weighted mean and geometric mean TP concentrations for this scenario are 15 ppb and 11 ppb, respectively.

6.3.3.3 Sensitivity Case 3

For Sensitivity Case 3, the sensitivity analysis tool within DMSTA was used. This tool allows the user to input a sensitivity scale factor, and to select the input parameter sets to be adjusted (phosphorus cycling and/or STA design parameters). The sensitivity analysis tool then adjusts each non-zero input variable by the sensitivity scale factor (both plus and minus), one at a time, and reruns the simulation. This sensitivity case was conducted on the base case STA design. The key phosphorus cycling parameters and STA design parameters were adjusted by ±25 percent and ±50 percent. It appears from the results of the sensitivity analysis that all phosphorus cycling parameters are relatively insensitive to adjustments up to 50 percent. As expected, it appears that the inflow fraction (volume of stormwater) and the surface area (STA footprint) are the two STA design parameters that are sensitive to adjustments up to 50 percent. Complete sensitivity analysis results are provided in Appendix B.

6.3.4 Uncertainty Analysis

An uncertainty analysis tool was provided with the DMSTA model to assess the affects of uncertainty in model input parameters on DMSTA model results. Uncertainty analyses were performed for this alternative using the methodology described in Section 2. The uncertainty analyses were performed for the ±25 percent and ±50 percent DMSTA sensitivity analyses (Sensitivity Case 3 as discussed above). The results of the uncertainty analyses provide the 10th, 50th and 90th percentile values for the treated flow-weighted mean outflow concentration, total flow-weighted mean outflow concentration, outflow geometric mean (composites) and total outflow load. Results of the uncertainty analyses are contained in Appendix B.

6.3.5 Implementation Schedule

A projected schedule for implementation of Alternative 1 is presented in Table 6-4. Land acquisition is assumed to require approximately 12 months. Design and permitting are expected to take 18 months to complete, and bidding, contractor selection and contract award are anticipated to require another 6 months. Construction of the STA, pumping stations and control structures is estimated to take 18 months to complete. Total time to complete construction (design through construction) is estimated to be 54 months, or 4.5 years.

Following construction, a process start-up and stabilization period must occur. The Supplemental Technology Standard of Comparison (STSOC) research suggests a 12-month period for initial development of the SAV plant communities and an additional 1-3 years for maturation and stabilization of the process *(STSOC Analysis for Submerged Aquatic Macrophyte/Limerock Technology, Final Report, DB Environmental, May 2002)*. The STSOC research also suggests a 12-month period for initial development of the PSTA plant communities. Stabilization for PSTA, however, has still not been characterized fully within the timeframe of the STSOC research efforts. *(Draft Conceptual Designs and Planning Level Cost Estimates for a Full-Scale Periphyton Stormwater Treatment Area (PSTA), CH2M Hill, November 2001)*. For the purposes of this evaluation, a 12-month start-up period and a 36-month stabilization period were assumed. Using these assumptions, a total of 102 months, or 8.5

years, will be required before the STA can be expected to achieve the TP removal performance predicted by DMSTA. If land acquisition begins in January 2003, the STA will come on-line in July 2007, but predicted performance will not be achieved until July 2011. The start-up and stabilization periods have been accounted for in the phosphorus load reduction calculation in Section 6.3.7.

Table 6-4.
Implementation Schedule for L-28 Basin Alternative 1

Project Component	Time Duration (months)
Land Acquisition	12
Design and Permitting	18
Contractor Procurement	6
Construction	18
Process Start-up	12
Process Stabilization	36
Total	**102**

6.3.6 Cost Estimates

Capital costs and average annual O&M costs for Alternative 1 were estimated using unit costs provided by the District and supplemented, where necessary, by Brown and Caldwell. The methodology for preparing cost estimates was presented previously in Section 2 of this report. A summary of the capital and O&M cost estimates is presented in Table 6-5. Capital costs, including contingency, were estimated to total $35.70 million. Average annual O&M costs were estimated to total about $0.40 million per year. A detailed breakdown of the capital and O&M cost estimates for Alternative 1 is presented in Appendix A.

Estimates of 50-year present worth were prepared covering the period 2003-2052. Capital costs were assumed to occur over the period 2003-2007. O&M costs were assumed to occur over the period 2008-2052. The present worth of the capital costs was calculated to be $34.01 million. The present worth of the average annual O&M costs was calculated to be $8.04 million, and the present worth of pumping station equipment replacement costs was calculated to be $1.06 million. The combined 50-year present worth for Feeder Canal Basin Alternative 1 was calculated to be $43.11 million.

Table 6-5.
Cost Estimates for L-28 Basin Alternative 1

Cost Component	Estimated cost (million dollars)
Capital Costs	
Construction Costs	
Pumping Stations	9.75
STA Works	6.19
Inflow/Outflow Canals	5.24
Seepage Canals	0.84
Subtotal	22.02
Planning, engineering and design (10%)	2.20
Program and construction management (10%)	2.20
Subtotal	26.42
Contingency (30%)	7.93
Total, construction costs	34.34
Land Acquisition	
Right-of-way and land purchase	1.13
Contingency (20%)	0.23
Total, Land Acquisition costs	1.36
Total, Capital costs	35.70
Average Annual O&M Costs	
Pumping Stations	0.19
STA Works	0.04
Control Structures and Misc.	0.08
Subtotal	0.31
Contingency (30%)	0.09
Total, Annual O&M costs	0.40
50-year Present Worth (2003-2052)	
Capital costs	34.01
O&M costs	8.04
Replacement costs	1.06
Total, 50-year present worth	43.11

In addition, cost estimates were prepared for Sensitivity Case 1. A summary of the 50-year present worth estimate for the sensitivity case is presented in Table 6-6. A full cost estimate breakdown for the sensitivity case is presented in Appendix A.

Table 6-6.
Summary of Present Worth Cost Estimates for L-28 Basin Alternative 1

Present Worth Component (million dollars)	Base Case	Sensitivity Case 1
Capital costs	34.01	31.84
O&M costs	8.04	7.84
Replacement costs	1.06	1.06
Total, 50-year present worth	43.11	40.74

Because so few details associated with the CERP Projects and Critical Projects in this basin were available at the time of this study, an assumption was made that the proposed STA would need to treat all of the basin flows and loads, even though it is suspected that these projects will have an impact on these flows and loads. For this reason, a potential exists for cost savings by integrating with the CERP and Critical Projects to meet the goals of all the projects.

6.3.7 Evaluation Ratings

Alternative 1 was rated against the ten evaluation criteria defined in the Evaluation Methodology document *(Final Evaluation Methodology for the Water Quality Improvement Strategies for the Everglades, SFWMD, July 31, 2002)* and discussed previously in Section 2 of this report. Table 6-7 summarizes the ratings given based on the results of this investigation.

Phosphorus Load Reduction. Approximately 66 percent of the TP load generated in the L-28 Basin over the 50-year analysis period is removed by the STA. This load calculation includes the effect of STA start-up and stabilization periods, which occur after December 31, 2006.

Long-Term TP Concentration Achieved. DMSTA simulations of the STA in this alternative predict a long-term flow-weighted mean TP concentration of 12 ppb and a long-term geometric mean TP concentration of 10 ppb.

Implementation Schedule. This alternative is expected to take approximately 8.5 years to fully implement. If project implementation begins in January 2003, a fully stabilized biological treatment process should not be expected before July 2011. **Rating: 8.5 years.**

Operational Flexibility. The additional storage provided in the STA provides water managers a significant increase in the operational flexibility of the South Florida hydraulic conveyance system and the Everglades Water Conservation Areas. **Rating: +2.**

Resiliency to Extreme Conditions. Per the STSOC report by DB Environmental, Inc., a SAV-dominated STA should be highly resilient to fire and flood, generally resilient to hurricane, and highly sensitive to prolonged drought. Per the STSOC report by CH2M Hill, a PSTA-dominated STA should also be resilient to fire, flood, hurricane and drought. A few short-duration dryout

periods are expected in the STA proposed for this alternative, but no prolonged dryout periods are predicted by DMSTA over the 31-year period of simulation. **Rating: +2.**

Assessment of Full-Scale Construction and Operation. A STA designed for 50 percent SAV and 50 percent PSTA has not been constructed and operated at full scale. Therefore, there are uncertainties associated with factors such as scale-up, constructability and full-scale operation. **Rating: -2.**

Management of Side Streams. The only side stream generated by the STA in this alternative is seepage. Seepage is not expected to have significant positive or negative impact on surrounding lands. **Rating: 0.**

Improvement in Non-P Parameters. The STSOC report for SAV prepared by DB Environmental, Inc. includes information on non-phosphorus water quality parameters collected during research activities. Information from ENR Cell 4, South Test Cell 9, and North Test Cell 15 indicated the following: an improvement in ammonia, dissolved oxygen, iron, specific conductance, turbidity and color, a deterioration in pH, and no significant change in the other 12 non-P water quality parameters. The STSOC report for PSTA prepared by CH2M Hill includes information on non-phosphorus water quality parameters collected during research activities. Information from South Test Cell 8 and 13 indicate the following: an improvement in aluminum, ammonia, calcium, nitrate-nitrite, TKN, and total alkalinity, a deterioration in iron and turbidity, and no significant change in the other 11 non-P water quality parameters. **Rating: +4.**

50-Year Present Worth. The total 50-year present worth of the capital, O&M and replacement costs associated with this alternative is $43.11 million.

Cost-Effectiveness. The total TP load removed over the 50-year analysis period is estimated to total 131,931 kg. Based upon a 50-year present worth of $43.11 million, this translates to a cost-effectiveness rating of $327 per kg TP removed.

Table 6-7.
Summary of Evaluation Ratings for L-28 Basin Alternative 1

Evaluation Criteria	Unit	Rating
Technical Performance Criteria		
Phosphorus Load Reduction [a]	Percent	66
Long-Term TP Concentration Achieved		
Flow-weighted mean	ppb	12
Geometric mean	ppb	10
Implementation Schedule	Years	8.5
Operational Flexibility	-3 / +3	+2
Resiliency to Extreme Conditions	-4 / +4	+2
Assessment of Full-Scale Construction and Operation	-3 / +3	-2
Management of Side Streams	-3 / +3	0
Environmental Criteria		
Improvement in Non-P Parameters	-19 / +19	+4
Economic Criteria		
50-year Present Worth	Million dollars	43.11
Cost-Effectiveness	Dollars/kg removed	327

[a] Phosphorus load reduction includes the effect of STA start-up and stabilization periods.

6.4 Alternative 2 – Source Controls (Base Condition)

Alternative 2 assumes that source controls will be implemented in the L-28 Basin by 2006. This assumption was also made for Alternative 1. However, this alternative does not include any other basin-scale components to address the long-term water quality objectives for the Everglades Protection Area.

6.4.1 Technical Analysis of Alternative 2

If no additional treatment is provided to L-28 Basin flows, no TP load reduction will be achieved because the baseline phosphorus load used in the evaluation of alternatives already accounted for load reduction due to source controls, the Seminole Tribe's WCP, and the Miccosukee's WMP. This results in an average of 3,982 kg per year of TP being discharged to WCA 3A over the 50-year period from 2007 to 2056. The projected long-term flow-weighted mean TP concentration is estimated to be about 39 ppb and the projected long-term geometric mean TP concentration is estimated to be 39 ppb.

A sensitivity analysis was also performed to determine the impact on TP loads to WCA 3A if source controls, the Seminole Tribe's WCP, and the Miccosukee WMP resulted in TP load reductions that were 25 percent higher than originally assumed in the base case. In this scenario, the average annual TP load discharged to WCA 3A from the L-28 Basin is estimated to be about 2,987 kg per year.

Over the 50-year period from 2007 to 2056, the total TP load discharged to WCA 3A would be 149,350 kg. The long-term flow-weighted mean and geometric mean TP concentrations would be 29 ppb.

6.4.2 Project Elements

The components of a basin-scale source control program in a primarily agricultural basin such as the L-28 Basin were generally described in Section 2 of this report. The Seminole Tribe's WCP, and the Miccosukee Tribes' WMP were generally described previously in this section. Details regarding these projects can be found on the District's website. There are no other project elements associated with this alternative.

6.4.3 Implementation Schedule

Basin-wide source controls are scheduled for implementation by December 2006. There are no other project elements requiring implementation in this alternative. The Seminole Tribe's WCP is scheduled for completion in 2005 and the Miccosukee Tribe's WMP is scheduled for completion by 2010. However, for evaluation purposes, these projects are not part of this alternative and do not affect the schedule for its implementation.

6.4.4 Cost Estimates

Cost estimating for source control programs and projects to be constructed under other funding sources was beyond the scope of these Basin Specific Feasibility Studies. Since there are no other project elements associated with this alternative, no cost estimates were prepared.

6.4.5 Evaluation Ratings

Alternative 2 was rated against the ten applicable evaluation criteria defined in the Evaluation Methodology document *(Final Evaluation Methodology for the Water Quality Improvement Strategies for the Everglades, SFWMD, July 31, 2002)* and discussed previously in Section 2 of this report. Table 6-8 summarizes the ratings given based on the results of this investigation.

Phosphorus Load Reduction. This alternative results in zero TP load reduction compared to the 31-year period of simulation TP load. Therefore, the TP load reduction for this alternative is zero percent.

Long-Term TP Concentration Achieved. This alternative results in a long-term flow weighted mean TP concentration of 39 ppb and a long-term geometric mean TP concentration of 39 ppb.

Implementation Schedule. Under the assumptions made for evaluation of this alternative, implementation will occur by December 31, 2006. **Rating: 4 years.**

Operational Flexibility. This alternative has no project elements that would increase or decrease the operational flexibility of the South Florida hydraulic conveyance system and the Everglades Water Conservation Areas. **Rating: 0.**

Resiliency to Extreme Conditions. This alternative has no capital improvements that could be sensitive or resilient to fire, flood, drought or hurricane conditions. **Rating: 0.**

Assessment of Full-Scale Construction and Operation. This alternative has no capital improvements. Therefore, an assessment of risk associated with full-scale construction and operation of such improvements is not applicable. **Rating: 0.**

Management of Side Streams. There are no side streams associated with this alternative. **Rating: 0.**

Improvement in Non-P Parameters. In accordance with the District's Evaluation Methodology, alternatives with no public works components (capital improvements) were assumed to have no impact on non-phosphorus water quality parameters. **Rating: 0.**

50-Year Present Worth. Since the costs of source controls are not considered in the Basin Specific Feasibility Studies, and there are no capital improvements to be constructed and operated, the 50-year present worth of Alternative 3 is zero.

Cost-Effectiveness. Since there are no costs or load reductions for this alternative, the cost-effectiveness rating of Alternative 3 is zero.

Table 6-8.
Summary of Evaluation Ratings for L-28 Basin Alternative 2

Evaluation Criteria	Unit	Rating
Technical Performance Criteria		
Phosphorus Load Reduction	Percent	0
Long-Term TP Concentration Achieved		
Flow-weighted mean	ppb	39
Geometric mean	ppb	39
Implementation Schedule	Years	4
Operational Flexibility	-3 / +3	0
Resiliency to Extreme Conditions	-4 / +4	0
Assessment of Full-Scale Construction and Operation	-3 / +3	0
Management of Side Streams	-3 / +3	0
Environmental Criteria		
Improvement in Non-P Parameters	-19 / +19	0
Economic Criteria		
50-year Present Worth	Million dollars	0
Cost-Effectiveness	Dollars/kg removed	0

6.5 Summary of Alternative Evaluations

A summary of the evaluation ratings for the two alternatives investigated in the L-28 Basin is presented in Table 6-9. The District and other project stakeholders will use this information in support of future decisions regarding which alternative(s) to select for further study or conceptual design.

Table 6-9.
Summary of Evaluation Ratings for L-28 Basin Alternatives

Evaluation Criteria	Unit	Rating	
		Alt. 1	Alt. 2
Technical Performance Criteria			
Phosphorus Load Reduction	Percent	66	0
Long-Term TP Concentration Achieved			
Flow-weighted mean	ppb	12-15[a]	39
Geometric mean	ppb	10-11[a]	39
Implementation Schedule	Years	8.5	4
Operational Flexibility	-3 / +3	+2	0
Resiliency to Extreme Conditions	-4 / +4	+2	0
Assessment of Full-Scale Construction/O&M	-3 / +3	-2	0
Management of Side Streams	-3 / +3	0	0
Environmental Criteria			
Improvement in Non-P Parameters	-19 / +19	+4	0
Economic Criteria			
50-year Present Worth	Million dollars	43.11	0
Cost-Effectiveness	Dollars/kg removed	327	0

[a] Range of predicted values using different model calibration data sets.

Because portions of the Big Cypress Seminole Indian Reservation and the Miccosukee Indian Reservation make up a large percentage of the L-28 Basin, it is likely that the Seminole Tribe Big Cypress Reservation WCP and the Miccosukee WMP will affect the quantity and quality of runoff from the basin. It is not possible to determine the impacts that these two programs will have at this time, pending design of improvements. However, both the WCP and WMP include wetland treatment areas, which if properly planned and coordinated, could potentially work in conjunction with the STA proposed in Alternative 1 to reduce the overall cost of satisfying water quality objectives in discharges to the EPA.

7. Evaluation of Alternative Water Quality Combinations for North New River Canal Basin

This section presents results of the evaluation of alternative water quality improvement strategies for the North New River Canal (NNRC) Basin. Descriptions of the alternatives are presented, followed by results of the technical analysis and rating of the alternatives according to the Evaluation Methodology described previously in Section 2 of this report. It should be emphasized that the evaluations represented herein are not intended to indicate or recommend a preferred alternative, but rather only to provide information for decision-making in subsequent phases of work.

7.1 Basin Characteristics

The NNRC Basin covers an area of about 19,000 acres (30 square miles) in eastern Broward County. The basin is located southeast of Water Conservation Area (WCA) 2B, west of the Florida Turnpike and north of Interstate Highway 595. The NNRC Basin is located immediately to the north of the C-11 West Basin, separated only by the North New River Canal which runs generally east-west along the southern boundary of the NNRC Basin. A map of the NNRC Basin is presented in Figure 7-1.

Land use in the NNRC Basin is almost entirely urban residential and commercial development. Portions of the Cities of Sunrise and Plantation comprise the area of the basin north of the North New River Canal. Bonaventure, a heavily developed commercial area, makes up the small area on the west side of the basin that is located south of the North New River Canal. Small amounts of agricultural and undeveloped land still exist, but land values in the basin continue to rise as development continues. A breakdown of the land use in the NNRC Basin is presented in Table 7-1.

The surface water management system in the NNRC Basin has four primary functions: (1) to provide drainage and flood protection, (2) to collect and control seepage from WCA 2B, (3) to convey excess water from WCAs 2A, 2B and 3A to tide, and (4) to supply water to the basin during periods of low natural flow. The three primary canals in the NNRC Basin are the North New River Canal, the L-35 Borrow Canal and the C-42 Canal. The primary water control structures are the G-54 Structure (Sewell Lock) and the G-123 pump station.

Urban stormwater runoff form the NNRC Basin drains south through secondary canals to the North New River Canal. Urban drainage is conveyed east and discharges to tide through the G-54 Structure. When water levels are low in WCA 3A, the G-123 pump station is used to discharge excess water from the North New River Canal, if available, to WCA 3A. Because the G-123 pump station is located at the far western end of the North New River Canal, limited amounts of urban drainage from the NNRC Basin backflow west to the pump station.

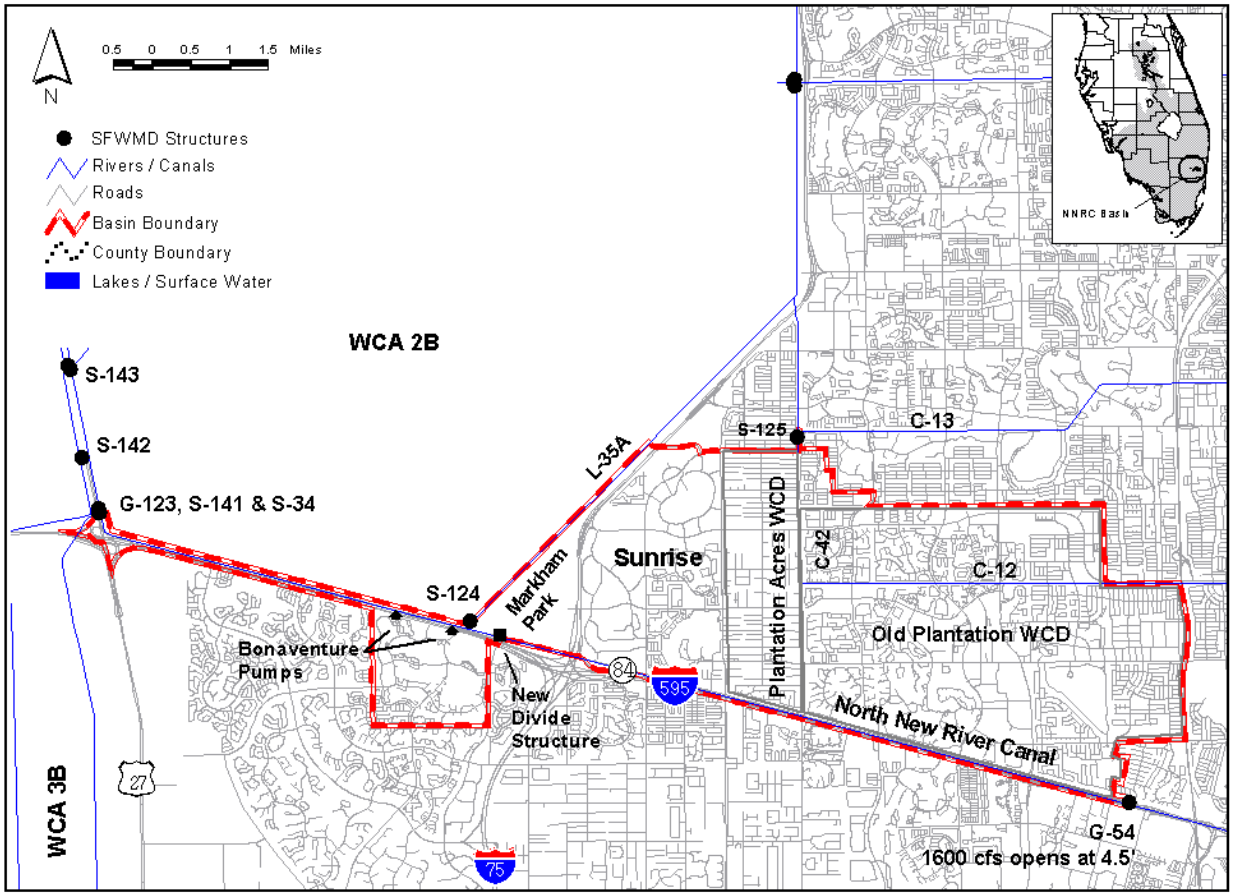


Figure 7-1.
NNRC Basin Map

Table 7-1.
Breakdown of Land Use in the NNRC Basin

Land Use Category	Percentage of Basin Area
Agriculture	2.8
Barren Land	0.9
Rangeland	0.3
Transportation, Communication, and Utilities	6.1
Upland Forests	2.9
Urban and Built-Up	76.8
Water	9.6
Wetlands	0.6
Total	**100.0**

Source: 1995 SFWMD GIS Land Use data according to the Florida Land Use and Cover Classification System (FLUCCS)

The G-123 pump station has four pumps and a maximum pumping capacity of 400 cubic feet per second (cfs). It is currently operated only for the purpose of water supply to WCA 3A.

The South Florida Water Management District (District) used historical rainfall and water quality data to develop simulated 31-year baseline flows and total phosphorus (TP) loads discharged to the Everglades Protection Area (EPA) from the NNRC Basin *(Baseline Data for the Basin Specific Feasibility Studies to Achieve the Long-Term Water Quality Goals for the Everglades, SFWMD, May 2001)*. The simulated flows and loads are presented graphically in Figure 7-2. Simulated flows ranged from about 500 to 6,000 acre-feet per year (average 1,781 acre-feet per year) and simulated TP loads ranged from 0 to 139 kilograms (kg) TP per year (average 40 kg TP per year). The flow-weighted mean TP concentration over the 31-year period was estimated to be 18 ppb. Note that these flows and loads are only those that the District's models predict would have been pumped into WCA 3A through the G-123 Structure over the 31-year period of simulation and do not represent historic flows and loads from the NNRC Basin as a whole.

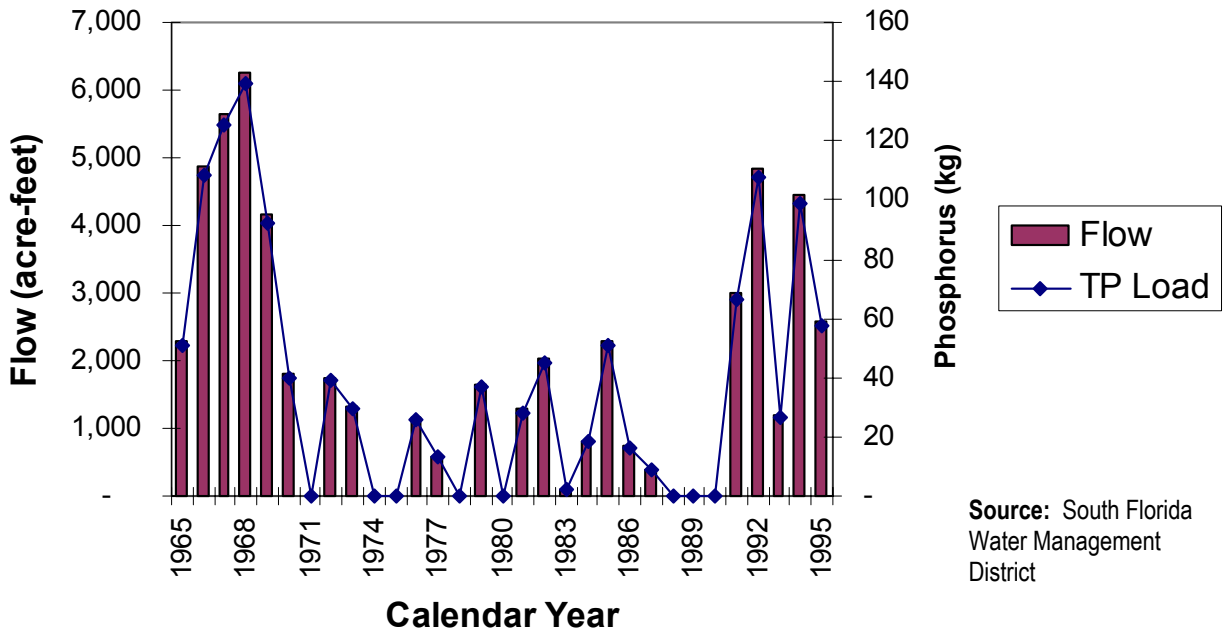


Figure 7-2.
Simulated Flows and Loads for the NNRC Basin

A Comprehensive Everglades Restoration Program (CERP) Project will impact future management of surface water flows from the NNRC Basin. The WCA 2 and WCA 3 Diversion Project (CERP Component YY4), to be completed by 2018, includes the construction of a new basin divide structure across the North New River Canal at Markham Park. The CERP project also will include canals to reroute urban runoff from the Bonaventure pump stations to the North New River Canal downstream (east) of the new divide structure. The new divide structure will effectively eliminate urban runoff from the NNRC Basin from discharging to the EPA. Seepage from WCA 2B that is collected in the L-35 Borrow Canal will be redirected into new canals which will convey it south to

the Everglades National Park. After the CERP project is completed in 2018, all flows to WCA 3A through the G-123 pump station will be eliminated.

7.2 Alternative Water Quality Combinations

The District formulated a series of three alternative water quality improvement strategies, consisting of source controls, CERP projects, and basin-scale treatment facilities, for addressing long-term water quality objectives for the EPA. These alternatives were described in the District publication entitled *Final Water Quality Improvement Strategies for the Everglades: Alternative Combinations for the North New River Canal Basin, February 27, 2002*. The components of the three alternative water quality combinations are summarized in Table 7-2.

Table 7-2.
Alternative Water Quality Combinations for the NNRC Basin

Alternative	Project Component
1	Source controls Chemical treatment (2006-2018) Discontinued use of G-123 pump station after CERP (2018)
2	Source controls only (no basin scale treatment) Discontinued use of G-123 pump station after 2006
3	Source controls only Discontinued use of G-123 pump station after CERP (2018) (Base Condition)

Basin stakeholders have expressed concerns that discontinuing the use of the G-123 pump station may reduce flood protection in the basin. Prior to discontinuing the use of the G-123 pump station, a detailed flood impact analysis will be performed to ensure that the basin's current level of flood protection is maintained.

Presented below are descriptions of the three alternative water quality combinations for the NNRC Basin and the results of the investigations performed to rate them against the criteria contained in the Evaluation Methodology.

7.3 Alternative 1 – Chemical Treatment

Alternative 1 combines source controls with chemical treatment to address long-term water quality objectives for the EPA. In this alternative, a chemical treatment-solids separation (CTSS) treatment facility would be constructed within the NNRC Basin. The effluent from the CTSS treatment facility, with a long-term geometric mean TP concentration not exceeding 10 ppb, would be discharged into WCA 3A through the G-123 pump station during the 12-year period from 2007 to 2018. After 2018, the CTSS treatment facility would be taken out of service since the CERP project would eliminate the use of G-123.

7.3.1 Technical Analysis of Chemical Treatment Technology

To determine the optimal combination of flow equalization basin (FEB) size and CTSS treatment plant capacity, a spreadsheet model, developed by HSA Engineers & Scientists, Inc., was used *(Chemical Treatment-Solids Separation Advanced Technology Demonstration Project, Final Report, HSA Engineers & Scientists, December 2000)*. This model was described previously in Section 2 of this report, as were the operating assumptions regarding FEB operation, CTSS treatment plant operation and performance, and blending of CTSS plant effluent with untreated water from the FEB. Two CTSS scenarios were modeled: (1) a base case assuming the CTSS treatment plant could produce an effluent with 6 ppb TP under average design flow conditions and 10 ppb TP under maximum design flow conditions (150 percent of average daily design flow); and (2) a sensitivity case in which it was assumed that the CTSS plant could only achieve 8 ppb and 13 ppb TP under average and maximum design flow conditions, respectively. The sizes and capacities of the CTSS facilities required under each of these two cases, as well as the TP removal performance achieved in each, are summarized in Table 7-3.

For the base case scenario, a 10-mgd treatment facility, combined with a 30-acre FEB, achieves a geometric mean blended outflow concentration of 10 ppb. The flow-weighted mean TP concentration in the blended outflow is predicted to be 15 ppb. Approximately 3 acres are required for the outflow blending basin and about 1 acre is required for residual solids thickening and land disposal. The total land area required for the base case scenario is estimated to be about 56 acres.

The sensitivity case was analyzed to test the impact of reduced CTSS treatment performance (8 ppb/13 ppb) on the size of the CTSS components required to achieve the 10 ppb TP water quality goal. Holding the size of the FEB constant at 30 acres, the average daily design flow rate of the CTSS treatment works must be increased to 40 mgd to accommodate the greater volume of water being treated. Intermediate pump station capacity and the land areas required for effluent blending and residual solids management are also increased accordingly. Also note that the TP load reduction is slightly higher in the sensitivity case than in the base case as a result of blending less untreated water from the FEB with treated effluent from the CTSS plant.

Table 7-3.
CTSS Facility Components and Predicted TP Removal Performance for NNRC Basin Alternative 1

Facility Component/Parameter	Base Case (6 ppb/10 ppb)	Sensitivity Case (8 ppb/13 ppb)
TP Removal Performance		
Average basin TP load, kg/year	40	40
TP source control reduction, percent	0	0
TP load to CTSS, kg/year	40	40
CTSS plant effluent TP conc., ppb		
Average Flow	6	8
Maximum Flow (150 percent)	10	13
CTSS blended outflow TP conc., ppb		
Flow-weighted mean	15	13
Geometric mean	10	10
Total CTSS outflow TP load, kg/year	34	27
Average TP load reduction, kg/year	6	13
Total 50-year TP load reduction, percent	15	33
Pumping Station Capacity (cfs)		
Inflow	400	400
CTSS Influent from FEB	25	93
Flow Equalization Basin		
Area, acres	30	30
Max. side water depth, feet	4.5	4.5
Max. storage volume, MG	44	44
CTSS Treatment Works		
Average design flow, mgd	10	40
Maximum design flow, mgd	15	60
Blending Basin		
Area, acres	3	14
Average HRT, days	3	3
Residuals Management Facility		
Area, acres	1	2

7.3.2 Project Elements

The elements of a CTSS treatment facility, as applied in this investigation, were described in detail in Section 2 of this report. The CTSS process is similar in concept to conventional surface water treatment for potable drinking water purposes. The process includes inflow pumping, flow equalization, chemical dosing, coagulation, flocculation, sedimentation, effluent blending and mixing, and residual solids management. Depending on the application, intermediate and outflow pumping may also be required.

A schematic layout of how the CTSS treatment facility could be configured in the NNRC Basin is illustrated in Figure 7-3. An inflow pumping station would be located at the North New River Canal (or an inflow canal receiving flow from the North New River Canal) and would discharge flow to a FEB. A smaller intermediate pump would deliver flow from the FEB to the CTSS treatment works. Flow would pass through the CTSS treatment works by gravity and discharge into a blending basin where it would be mixed with untreated flows from the FEB (when necessary hydraulically). Outflows from the blending basin would have a maximum long-term geometric mean concentration of 10 ppb TP and would be discharged into an outflow canal for conveyance to the G-123 pumping station. An on-site residuals solids management facility, consisting of a thickening pond and dedicated land disposal area, would also be required.

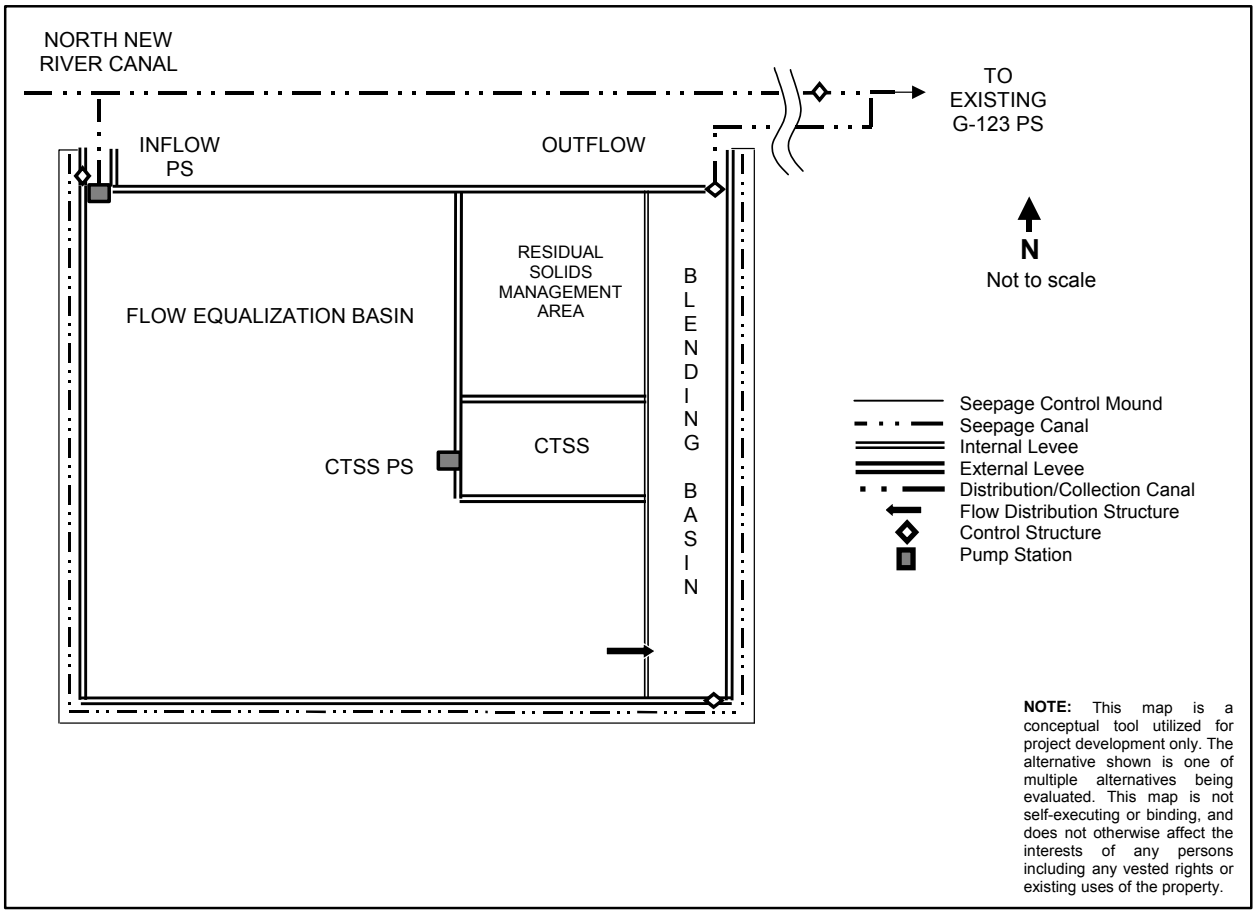


Figure 7-3.
Example CTSS Schematic for NNRC Basin Alternative 1

7.3.3 Implementation Schedule

It is estimated that approximately 48 months will be required to implement this alternative if no unforeseen delays are encountered. A breakdown of this implementation schedule is presented in Table 7-4. If implementation begins in early 2003, the project should be on-line by the December 31, 2006 deadline mandated in the Everglades Forever Act.

Table 7-4.
Implementation Schedule for NNRC Basin Alternative 1

Project Component	Time Duration (months)
Land Acquisition	12
Design and Permitting	18
Contractor Procurement	6
Construction	9
Start-up	3
Total	**48**

7.3.4 Cost Estimates

Capital costs and average annual operation and maintenance (O&M) costs for Alternative 1 were estimated using unit costs provided by the District and supplemented, where necessary, by Brown and Caldwell. The methodology for preparing cost estimates was presented previously in Section 2 of this report. A summary of the capital and O&M cost estimates for the base case analysis is presented in Table 7-5. Capital costs, including land acquisition and contingency, were estimated to total $30.99 million. Average annual O&M costs were estimated to total $0.58 million per year. Detailed breakdowns of the capital and O&M cost estimates for Alternative 1 are presented in Appendix A.

Estimates of 50-year present worth were prepared covering the period 2003-2052. Capital costs were assumed to occur during the period 2003-2006. O&M costs were assumed to occur during the period 2007-2018. The present worth of the capital costs was calculated to be $29.74 million. The present worth of the average annual O&M costs was calculated to be $1.38 million and the present worth of major equipment replacement costs was calculated to be $0.74 million. The combined 50-year present worth for NNRC Basin Alternative 1 was calculated to be $31.86 million.

Table 7-5.
Cost Estimates for NNRC Basin Alternative 1

Cost Component	Estimated cost, million dollars
Capital Costs	
Construction Costs	
Pumping Stations (2)	4.15
Flow Equalization Basin and Blending Basin	0.69
CTSS Treatment Works	1.52
Seepage/Drainage Control	0.05
Residual Solids Management	0.20
Control Structures and Misc.	1.47
Subtotal	8.07
Planning, engineering and design (10%)	0.81
Program and construction management (10%)	0.81
Subtotal	9.68
Contingency (30%)	2.90
Total, construction costs	12.59
Land Acquisition	
Right-of-way and land purchase	15.00
Right-of-way and land purchase associated costs	1.00
Contingency (15%)	2.4
Total, Land Acquisition costs	18.40
Total, Capital costs	30.99
Average Annual O&M Costs	
Pumping Stations	0.04
Flow Equalization and Blending Basins	0.004
CTSS Treatment Works	0.37
Residual Solids Management	0.01
Control Structures and Misc.	0.02
Subtotal	0.45
Contingency (30%)	0.13
Total, Annual O&M costs	0.58
50-year Present Worth (2003-2052)	
Capital costs (2003-2006)	29.74
O&M costs (2007-2018)	1.38
Replacement Costs	0.74
Total, 50-year present worth	31.86

In addition, a cost estimate was prepared for the sensitivity case investigated for this alternative. Table 7-6 summarizes the 50-year present worth for the sensitivity case compared to the base case.

Table 7-6.
Summary of Present Worth Cost Estimates for NNRC Basin Alternative 1

Present Worth Component (million dollars)	Base Case (6 ppb/10 ppb)	Sensitivity Case (8 ppb/13 ppb)
Capital costs	29.74	39.39
O&M costs	1.38	1.52
Replacement costs	0.74	1.54
Total, 50-year present worth	31.86	42.44

7.3.5 Evaluation Ratings

Alternative 1 was rated against the ten evaluation criteria defined in the Evaluation Methodology document *(Final Evaluation Methodology for the Water Quality Improvement Strategies for the Everglades, SFWMD, July 31,2002)* and discussed previously in Section 2 of this report. Table 7-7 summarizes the ratings given based on the results of this investigation.

Phosphorus Load Reduction. Approximately 80 percent of the projected TP load to be discharged from the NNRC Basin to the EPA over the 50-year period from 2007 to 2056 is removed in this alternative. After 2018, 100 percent of the TP load from the NNRC Basin to the EPA is eliminated.

Long-Term TP Concentration Achieved. CTSS technology has the demonstrated capability to achieve effluent TP concentrations below 10 ppb. For this alternative, the CTSS treatment facilities were sized to produce a blended outflow having a long-term geometric mean TP concentration of 10 ppb. The long-term flow-weighted mean TP concentration for this alternative is projected to be 15 ppb. Note, however, that these projected TP concentrations are only applicable for the 12-year period from 2007 through 2018. After 2018, this criterion is not applicable to Alternative 1 because all flows from the NNRC Basin will be diverted away from the EPA.

Implementation Schedule. This alternative can be constructed and placed into operation in a period of 48 months. **Rating: 4 years.**

Operational Flexibility. The 30-acre FEB in this alternative must be operated in conjunction with the CTSS treatment works. Therefore, the storage capacity associated with the FEB may not be available when needed to provide additional operating flexibility to the South Florida hydraulic conveyance system and the Everglades Water Conservation Areas. **Rating: 0.**

Resiliency to Extreme Conditions. This alternative provides a high level of resilience to fire, flood, drought and hurricane. **Rating: +4.**

Assessment of Full-Scale Construction and Operation. There are many documented examples of chemical treatment systems constructed at the scale proposed in this alternative for potable water, wastewater and stormwater treatment applications. Scale-up issues are not expected to be significant. Still, CTSS technology has not been implemented at full scale with the sole objective of

meeting a 10 ppb TP standard. This introduces some level of uncertainty regarding full-scale operation for discharge to the Everglades. **Rating: +1.**

Management of Side Streams. CTSS technology generates side streams, which must be managed at considerable cost and effort to the project. The most notable side stream is residual solids that must be disposed of either on-site or at a permitted disposal facility off-site. These solids are not hazardous, but must be disposed of properly in an environmentally safe manner. There is ongoing research that may identify beneficial uses for these residual solids. However, there is no assurance that these beneficial uses will ultimately prove viable. **Rating: -2.**

Improvement in Non-P Parameters. The STSOC report for CTSS prepared by HSA Engineers & Scientists, Inc. includes information on non-phosphorus water quality parameters collected during research activities. Information from Post BMP and Post STA testing indicated the following: an improvement in dissolved oxygen, turbidity, and color, a deterioration in alkalinity, pH, conductivity, chloride, iron, and aluminum, and no significant change in the other 10 non-P water quality parameters. **Rating: -3.**

50-Year Present Worth. The total 50-year present worth of the capital, O&M and equipment replacement costs associated with this alternative is estimated to be $31.86 million.

Cost-Effectiveness. The total TP load removed over the 50-year period from 2007 to 2056 is estimated to total 84 kg. Based upon a 50-year present worth of $31.86 million, this translates to a cost-effectiveness rating of $379,328 per kg TP removed.

Table 7-7.
Summary of Evaluation Ratings for NNRC Basin Alternative 1

Evaluation Criteria	Unit	Rating
Technical Performance Criteria		
Phosphorus Load Reduction	Percent	80
Long-Term TP Concentration Achieved [a]		
Flow-weighted mean	ppb	15
Geometric mean	ppb	10
Implementation Schedule	Years	4
Operational Flexibility	+3/-3	0
Resiliency to Extreme Conditions	+4/-4	+4
Assessment of Full-Scale Construction and Operation	+3/-3	+1
Management of Side Streams	+3/-3	-2
Environmental Criteria		
Improvement in Non-P Parameters	+19/-19	-3
Economic Criteria		
50-year Present Worth	Million dollars	31.86
Cost-Effectiveness	Dollars/kg removed	379,328

[a] Flow-weighted mean and geometric mean are applicable only to discharges from 2007-2018.

7.4 Alternative 2 – Discontinued Use of G-123 Pump Station in 2006 (No Basin Scale Treatment)

Alternative 2 assumes that the proposed CERP project will be implemented as scheduled in 2018, and that a basin-wide source control program will be implemented in the NNRC Basin. Both of these assumptions were also made for the evaluation of Alternative 1. However, where Alternative 1 assumed CTSS treatment and continued discharge of flow into WCA 3A through 2018, Alternative 2 assumes that operation of the G-123 pump station would be discontinued after 2006 and that flows to WCA 3A from the NNRC Basin would be eliminated.

7.4.1 Technical Analysis of Alternative 2

When operation of the G-123 pump station is discontinued, all flows and loads from the NNRC Basin to the EPA will stop. In Alternative 2, this is assumed to occur by December 31, 2006. If this occurs as assumed, 100 percent of the TP load currently being discharged to WCA 3A from the NNRC basin will be eliminated. This amounts to an average of 40 kg per year and a total of 480 kg TP over the 12-year period from 2007-2018.

During the period from 2007 to 2018, NNRC basin flows that would otherwise have been discharged to WCA through the G-123 pump station, will be conveyed east in the North New River Canal and discharged through the G-54 Structure. It was assumed that there is adequate capacity available in NNRC and at the G-54 structure for this to occur. Flood protection impacts should be evaluated in a subsequent phase of work if this alternative is considered further. After the CERP project is completed in 2018, NNRC Basin flows that would have been pumped into WCA 3A will be redirected south to the Everglades National Park.

7.4.2 Project Elements

The components of a basin-scale source control program in an urban basin such as the NNRC Basin were generally described in Section 2 of this report. There are no other project elements associated with this alternative, other than discontinuing the use of the existing G-123 pump station prior to the CERP project coming on line in 2018.

7.4.3 Implementation Schedule

It is assumed, as it has been for all alternatives in the Basin Specific Feasibility Studies, that basin-scale source control programs can be implemented by December 2006 if implementation begins in January 2003. Discontinuing the use of the G-123 pump station could occur at any time prior to the end of 2006. For the purposes of this analysis, it was assumed that operation of the G-123 pump station would be discontinued on December 31, 2006. There are no other project elements requiring implementation in this alternative.

7.4.4 Cost Estimates

Cost estimating for source control programs was not included in the scope of work for the Basin Specific Feasibility Studies. The District's Evaluation Methodology also establishes that costs associated with operation (or decommissioning) of existing facilities, such as the G-123 pump station, are not to be considered. Since there are no other project elements associated with this alternative, no cost estimates were prepared.

7.4.5 Evaluation Ratings

Alternative 2 was rated against the ten evaluation criteria defined in the Evaluation Methodology document *(Final Evaluation Methodology for the Water Quality Improvement Strategies for the Everglades, SFWMD, July 31, 2002)* and discussed previously in Section 2 of this report. Because there are no capital improvements to be implemented as part of this alternative, some of the evaluation criteria are not applicable or have reduced significance. Table 7-8 summarizes the ratings given to Alternative 2 based on the results of this investigation.

Phosphorus Load Reduction. This alternative eliminates 100 percent of the phosphorus load currently discharged to the EPA from the NNRC Basin beginning in January 2007.

Long-Term TP Concentration Achieved. This criterion is not applicable to the evaluation of Alternative 2 because all NNRC Basin flows will be diverted away from the EPA on or before December 31, 2006. Reducing the long-term TP concentration in the water being diverted away from the EPA is not an objective of this alternative.

Implementation Schedule. It has been assumed, for the purposes of evaluation, that operation of the G-123 pump station will be discontinued after December 31, 2006 and that source control programs can be in place by December 2006. **Rating: 4 years.**

Operational Flexibility. This alternative provides no increase or decrease in the operational flexibility of the South Florida hydraulic conveyance system and the Everglades Water Conservation Areas. **Rating: 0.**

Resiliency to Extreme Conditions. This alternative has no capital improvements that could be sensitive or resilient to fire, flood, drought or hurricane conditions. **Rating: 0.**

Assessment of Full-Scale Construction and Operation. This alternative has no capital improvements. Therefore, an assessment of risk associated with full-scale construction and operation of such improvements is not applicable. **Rating: 0.**

Management of Side Streams. There are no side streams associated with this alternative. **Rating: 0.**

Improvement in Non-P Parameters. In accordance with the District's Evaluation Methodology, alternatives with no public works components (capital improvements) were assumed to have no impact on non-phosphorus water quality parameters. **Rating: 0.**

50-Year Present Worth. Since the costs associated with source controls and decommissioning the G-123 pump station are not considered in the Basin Specific Feasibility Studies, and there are no capital improvements to be constructed and operated, the 50-year present worth of Alternative 2 is zero.

Cost-Effectiveness. Since there are no costs for this alternative, the cost-effectiveness rating of Alternative 2 is zero.

Table 7-8.
Summary of Evaluation Ratings for NNRC Basin Alternative 2

Evaluation Criteria	Unit	Rating
Technical Performance Criteria		
Phosphorus Load Reduction	Percent	100
Long-Term TP Concentration Achieved		
Flow-weighted mean	ppb	NA
Geometric mean	ppb	NA
Implementation Schedule	Years	4
Operational Flexibility	-3 / +3	0
Resiliency to Extreme Conditions	-4 / +4	0
Assessment of Full-Scale Construction and Operation	-3 / +3	0
Management of Side Streams	-3 / +3	0
Environmental Criteria		
Improvement in Non-P Parameters	-19 / +19	0
Economic Criteria		
50-year Present Worth	Million dollars	0
Cost-Effectiveness	Dollars/kg removed	0

7.5 Alternative 3 – Discontinued Use of G-123 Pump Station After 2018 (Base Condition)

Alternative 3 assumes that the proposed CERP project will be implemented as scheduled in 2018, and that a basin-wide source control program will be implemented in the NNRC Basin. Both of these assumptions were also made for the evaluation of Alternatives 1 and 2. However, in this alternative, it was assumed that there would be no basin scale treatment and that operation of the G-123 pump station would continue until the CERP project is implemented in 2018.

7.5.1 Technical Analysis of Alternative 3

During the period 2007 through 2018, NNRC Basin flows that are currently being discharged to WCA 3A through the G-123 pump station will continue to be discharged there. Since no treatment will be provided to these flows, there will be no reduction in TP load or TP concentration compared to the 31-year period of simulation.

After the CERP project is implemented in 2018, 100 percent of the flow and phosphorus load that is now being discharged to WCA 3A from the NNRC Basin will be eliminated. This amounts to an average load reduction of 30 kg per year and a total load reduction of 1,520 kg over the 50-year period from 2007 through 2056. After 2018, seepage from WCA 2B will be redirected south to the Everglades National Park.

7.5.2 Project Elements

The components of a basin-scale source control program in an urban basin such as the NNRC Basin were generally described in Section 2 of this report. There are no other project elements associated with this alternative.

7.5.3 Implementation Schedule

It is assumed, as it has been for all alternatives in these Basin Specific Feasibility Studies, that basin-scale source control programs can be implemented by December 2006 if implementation begins in January 2003. For the purposes of evaluating this alternative, it was assumed that operation of the G-123 pump station would be discontinued in 2018 after the CERP project has been implemented and brought on-line. There are no other project elements requiring implementation in this alternative.

7.5.4 Cost Estimates

Cost estimating for source control programs was not included in the scope of work for these Basin Specific Feasibility Studies. The District's Evaluation Methodology also establishes that costs associated with operation (or decommissioning) of existing facilities, such as the G-123 pump station, are not to be considered. Since there are no other project elements associated with alternative, no cost estimates were prepared.

7.5.5 Evaluation Ratings

Alternative 3 was rated against the ten evaluation criteria defined in the Evaluation Methodology document *(Final Evaluation Methodology for the Water Quality Improvement Strategies for the Everglades, SFWMD, July 31, 2002)* and discussed previously in Section 2 of this report. Because there are no capital improvements to be implemented as part of this alternative, some of the evaluation criteria are not applicable or have reduced significance. Table 7-9 summarizes the ratings given to Alternative 3 based on the results of this investigation.

Phosphorus Load Reduction. During the period 2007 to 2018, there is no phosphorus load reduction associated with this alternative. After the CERP project is completed in 2018, 100 percent of the phosphorus load from the NNRC Basin to WCA 3A will be eliminated. The overall phosphorus load reduction for the 50-year period from 2007 to 2056 is 76 percent.

Long-Term TP Concentration Achieved. This criterion only applies for Alternative 3 during the period 2007 to 2018 while NNRC Basin flows are being discharged to WCA 3A through the G-123 pump station. During this period, the long-term flow-weighted mean TP concentration is projected to be 18 ppb. The long-term geometric mean TP concentration is also projected to be 18 ppb. After 2018, this criterion is not applicable since there will be no NNRC Basin flows discharged to the EPA.

Implementation Schedule. It has been assumed, for the purposes of evaluating this alternative, that source control programs can be in place in the NNRC Basin by December 2006. However, operation of the existing G-123 pump station is assumed to continue until implementation of the CERP project is complete in 2018. Therefore, it will take 16 years to fully implement this alternative. **Rating: 16 years.**

Operational Flexibility. This alternative provides no increase or decrease in the operational flexibility of the South Florida hydraulic conveyance system and the Everglades Water Conservation Areas. **Rating: 0.**

Resiliency to Extreme Conditions. This alternative has no capital improvements that could be sensitive or resilient to fire, flood, drought or hurricane conditions. **Rating: 0.**

Assessment of Full-Scale Construction and Operation. This alternative has no capital improvements. Therefore, an assessment of risk associated with full-scale construction and operation of such improvements is not applicable. **Rating: 0.**

Management of Side Streams. There are no side streams associated with this alternative. **Rating: 0.**

Improvement in Non-P Parameters. In accordance with the District's Evaluation Methodology, alternatives with no public works components (capital improvements) were assumed to have no impact on non-phosphorus water quality parameters. **Rating: 0.**

50-Year Present Worth. Since the costs associated with source controls and decommissioning the G-123 pump station are not considered in the Basin Specific Feasibility Studies, and there are no capital improvements to be constructed and operated, the 50-year present worth of Alternative 3 is zero.

Cost-Effectiveness. Since there are no costs for this alternative, the cost-effectiveness rating of Alternative 3 is zero.

Table 7-9.
Summary of Evaluation Ratings for NNRC Basin Alternative 3

Evaluation Criteria	Unit	Rating
Technical Performance Criteria		
Phosphorus Load Reduction	Percent	76
Long-Term TP Concentration Achieved [a]		
Flow-weighted mean	ppb	18
Geometric mean	ppb	18
Implementation Schedule	Years	16
Operational Flexibility	-3 / +3	0
Resiliency to Extreme Conditions	-4 / +4	0
Assessment of Full-Scale Construction and Operation	-3 / +3	0
Management of Side Streams	-3 / +3	0
Environmental Criteria		
Improvement in Non-P Parameters	-19 / +19	0
Economic Criteria		
50-year Present Worth	Million dollars	0
Cost-Effectiveness	Dollars/kg removed	0

[a] Flow-weighted mean and geometric mean are applicable only to discharges from 2007-2018.

7.6 Summary of Alternative Evaluations

A summary of the evaluation ratings for the three alternatives investigated in the NNRC Basin is presented in Table 7-10. The District and other project stakeholders will use this information in support of future decisions regarding which alternative(s) to select for further study or conceptual design.

Table 7-10.
Summary of Evaluation Ratings for NNRC Basin Alternatives

Evaluation Criteria	Unit	Rating		
		Alt. 1	Alt. 2	Alt. 3
Technical Performance Criteria				
Phosphorus Load Reduction	Percent	80	100	76
Long-Term TP Concentration Achieved [a]				
Flow-weighted mean	ppb	15	NA	18
Geometric mean	ppb	10	NA	18
Implementation Schedule	Years	4	4	16
Operational Flexibility	-3 / +3	0	0	0
Resiliency to Extreme Conditions	-4 / +4	+4	0	0
Assessment of Full-Scale Construction/O&M	-3 / +3	+1	0	0
Management of Side Streams	-3 / +3	-2	0	0
Environmental Criteria				
Improvement in Non-P Parameters	-19 / +19	-3	0	0
Economic Criteria				
50-year Present Worth	Million dollars	31.86	0	0
Cost-Effectiveness	Dollars/kg removed	379,328	0	0

[a] Flow-weighted mean and geometric mean are applicable only to discharges from 2007-2018.

Basin stakeholders have expressed concerns that discontinuing the use of the G-123 pump station may reduce flood protection in the basin. Prior to discontinuing the use of the G-123 pump station, a detailed flood impact analysis should be performed to ensure that the basin's current level of flood protection is maintained.

8. Evaluation of Alternative Water Quality Combinations for the North Springs Improvement District Basin

This section presents results of the evaluation of alternative water quality improvement strategies for the North Springs Improvement District (NSID) Basin. Descriptions of the alternatives are presented, followed by results of the technical analysis and rating of the alternatives according to the Evaluation Methodology described previously in Section 2 of this report. It should be emphasized that the evaluations represented herein are not intended to indicate or recommend a preferred alternative, but rather only to provide information for decision-making in subsequent phases of work.

8.1 Basin Characteristics

The NSID Basin covers an area of approximately 7,400 acres (11 square miles) in northern Broward County. The basin is bounded on the north by the Palm Beach County line and on the west by the L-36 Borrow Canal and Water Conservation Area (WCA) 2A. A map illustrating the boundaries of the NSID Basin is presented in Figure 8-1. The Sawgrass Expressway (Florida Highway 869) runs in an east-west direction through the basin, turning south along the basin's western border as it approaches WCA 2A. The City of Coral Springs comprises much of the southern half of the basin. The Parkland community comprises much of the northern half of the basin.

Land use in the NSID Basin consists primarily of urban residential development and agriculture. Most of the land in the southern half of the basin is heavily developed with residential subdivisions. The northern half of the basin is currently in the process of being converted from agricultural to urban land use as new residential development continues. A breakdown of land uses in the NSID Basin is provided in Table 8-1. It is expected that over the next 5 to 10 years, most of the remaining undeveloped agricultural land in the basin will be developed into urban residential land use.

Drainage from the NSID Basin is managed in a network of interconnected lakes and canals that are operated by the NSID to provide flood protection throughout the basin. Two pumping stations, NSID Pump No. 1 and NSID Pump No. 2, are used to discharge stormwater north through the L-36 Borrow Canal (L-36N) and then into the Hillsboro Canal through a series of culverts (S-39A). The Hillsboro Canal conveys stormwater to the east, eventually discharging excess flow to tide. However, when the L-36N Canal and the Hillsboro Canal are not capable of accepting additional flow, water from the NSID Basin is discharged into WCA 2A through NSID Pump No. 1.

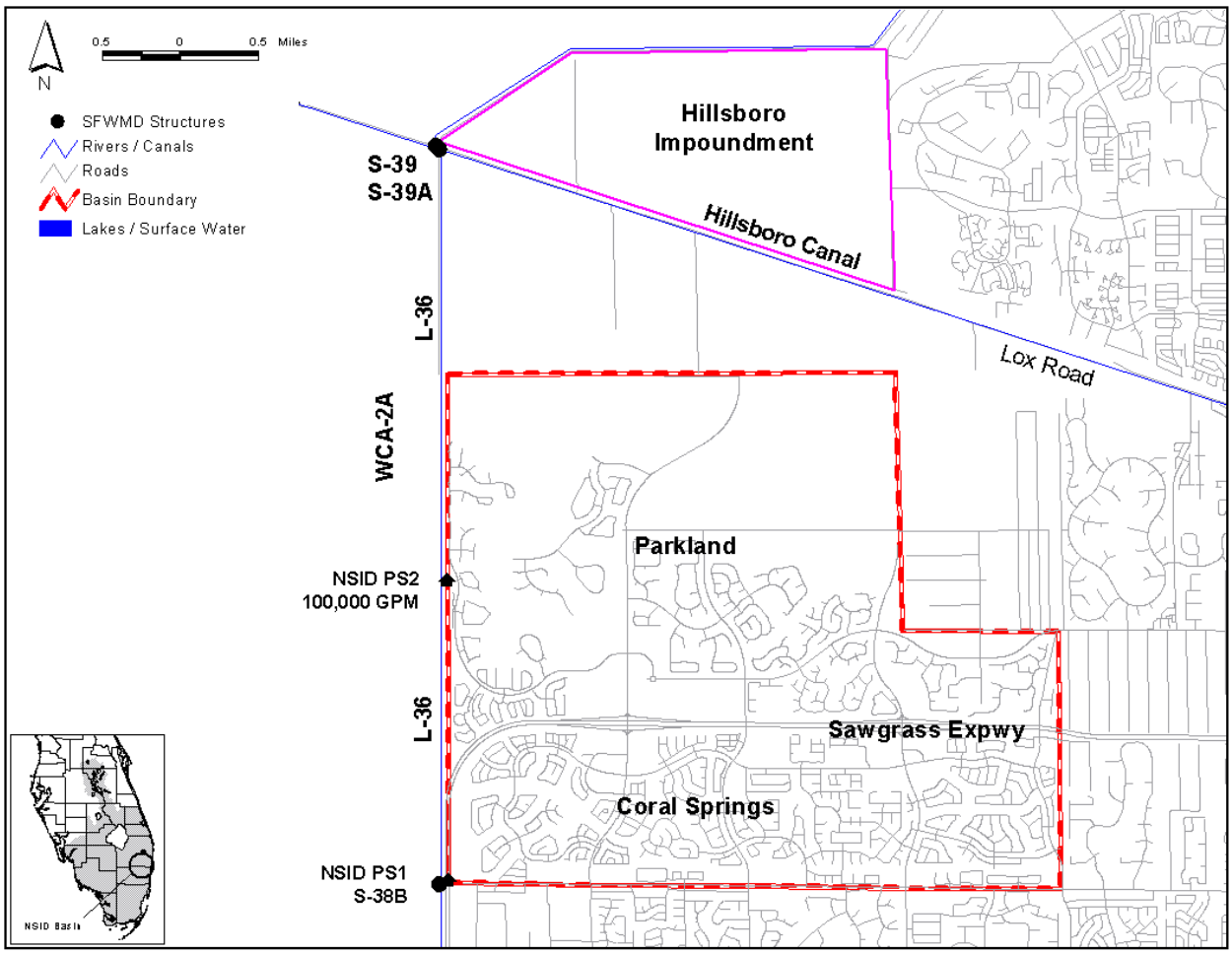


Figure 8-1.
NSID Basin Map

NSID Pump No. 1 has a capacity of 200,000 gallons per minute (gpm) and is located in the extreme southwest corner of the NSID Basin along the L-36 Borrow Canal. There are four 50,000-gpm pumps at this pumping station, each of which discharges through a culvert. Flow from one of these pumps can be directed south into the L-36 Borrow Canal (L-36S). Flow from another one of these pumps can be directed north into the L-36N Canal. Flow from all four pumps (200,000 gpm) can be directed to WCA 2A.

NSID Pump No. 2 has a capacity of 100,000 gpm and is located about 1.5 miles north of NSID Pump No. 1 on the L-36N Canal. Two 50,000-gpm pumps are located at this pumping station, both of which discharge through culverts to the L-36N.

Table 8-1.
Breakdown of Land Use in the NSID Basin

Land Use Category	Percentage of Basin Area
Agriculture	43.8
Barren Land	4.8
Rangeland	6.2
Transportation, Communication, and Utilities	3.3
Upland Forests	0.7
Urban and Built-Up	38.2
Water	2.4
Wetlands	0.6
Total	**100.0**

Source: 1995 SFWMD GIS Land Use data according to the Florida Land Use and Cover Classification System (FLUCCS)

A gaging station is located on the L-36N Canal, just north of NSID Pump No. 2. Whenever the stage at this gage is below Elevation 11.4, NSID Pump No. 1 and NSID Pump No. 2 may discharge up to 50,000 gpm and 100,000 gpm, respectively, to the L-36N Canal and the Hillsboro Canal. However, when the stage at the gaging station reaches Elevation 11.4, neither of the two NSID pumping stations may discharge to the L-36N. When this occurs, NSID Pump No. 1 is permitted to discharge up to 200,000 gpm (444 cfs) of water directly into WCA 2A.

The South Florida Water Management District (District) used historical rainfall, flow and water quality data to develop simulated 31-year baseline flows and total phosphorus (TP) loads from the NSID Basin to the Everglades Protection Area (EPA) *(Baseline Data for the Basin Specific Feasibility Studies to Achieve the Long-Term Water Quality Goals for the Everglades, SFWMD, May 2001)*. The simulated flows and loads are presented graphically in Figure 8-2. Simulated flows ranged from about 200 to 17,000 acre-feet per year (average 6,757 acre-feet per year) and simulated TP loads ranged from about 13 to 774 kilograms (kg) TP per year (average 293 kg TP per year). The flow-weighted mean TP concentration in discharges to the EPA over the 31-year period of simulation was estimated to be 39 ppb. Note that these are not the total flows and loads generated within the NSID Basin, but only the flows and loads from the NSID Basin that would be discharged into WCA 2A based upon the 31-year period of simulation.

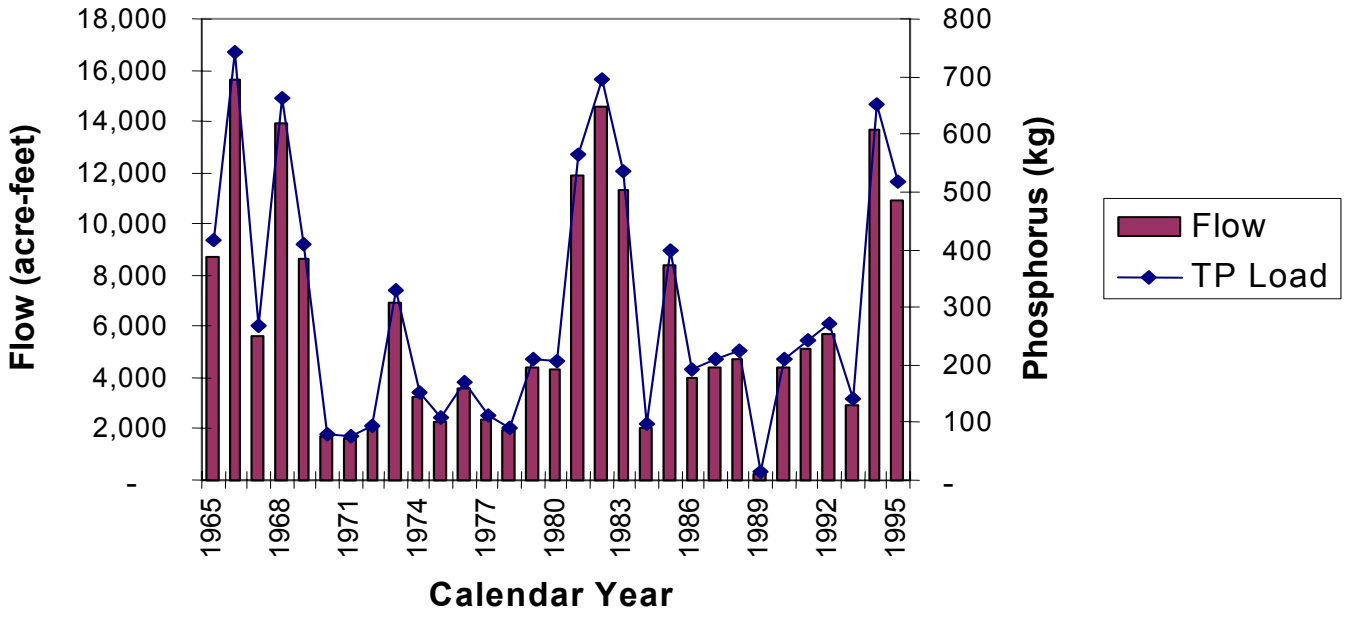


Figure 8-2.
Simulated Flows and Loads for the NSID Basin

8.2 Alternative Water Quality Combinations

The District formulated a series of three alternative water quality improvement strategies for the NSID Basin to address long-term water quality objectives in the Everglades Protection Area (EPA). These alternatives were described in the District publication entitled *Final Water Quality Improvement Strategies for the Everglades: Alternative Combinations for the North Springs Improvement District Basin, February 27, 2002*. The components of the three alternatives are summarized in Table 8-2.

Table 8-2.
Alternative Water Quality Combinations for the NSID Basin

Alternative	Project Component
1	Source controls Temporary diversion to off-site storage impoundment Permanent diversion to Hillsboro Site 1 Project (CERP)
2	Source controls Permanent diversion to off-site storage impoundment
3	Source controls Permanent diversion to Hillsboro Site 1 Project (CERP) (Base Condition)

A large water impoundment is being planned on the north side of the Hillsboro Canal, just north of the NSID Basin, as part of the Comprehensive Everglades Restoration Program (CERP). This impoundment is known as the Hillsboro Site 1 Impoundment, and is part of CERP Component M, Part 1. In this report, the CERP project is referred to as the Hillsboro Site 1 Project. This CERP project will supplement water deliveries to the Hillsboro Canal during dry periods, thereby reducing demands on Lake Okeechobee and the Loxahatchee National Wildlife Refuge. Water from the Hillsboro Canal will be pumped into the reservoir during the wet season or periods when excess water is available. Water will be released back to the Hillsboro Canal to help maintain canal stages during the dry-season. Construction completion for the Hillsboro Site 1 Project is currently scheduled for late 2007.

General assumptions made for the evaluation of the alternatives for the NSID Basin included the following:

1. The current level of flood protection within the basin must be maintained as a result of implementing any of the alternatives. This means that the maximum flow that can be pumped from the NSID Basin into the L-36N is 200,000 gpm, or 444 cfs.

2. For all alternatives, it was assumed that diversion improvements would be sized to accommodate all discharges from the NSID Basin to the EPA and that after a diversion was put in place, no further discharges to the EPA would occur.

3. For alternatives involving diversion to the Hillsboro Site 1 Project, it was assumed that CERP would be responsible for all conveyance system improvements required to convey NSID stormwater flows north to the Hillsboro Canal.

Presented below are descriptions of the three alternatives for the NSID Basin and the results of the investigations performed to rate them against the criteria contained in the Evaluation Methodology.

8.3 Alternative 1 – Temporary Diversion Followed by Permanent Diversion to the Hillsboro Site 1 Project (CERP)

Alternative 1 involves the temporary diversion of excess stormwater flows from the NSID Basin to an off-site storage impoundment until such time as the CERP project is available to accept NSID flows on a permanent basis. At the present time, the CERP implementation schedule calls for the Hillsboro Site 1 Project to be on-line by the end of 2007. Assuming that this schedule holds, the temporary diversion would need to be in place for only about one year before NSID flows could be diverted permanently to the CERP project.

The concept for the temporary diversion alternative is that land north of the NSID Basin that has been mined for construction materials could be acquired or leased for the purpose of storing NSID flows for short periods of time until stages in the L-36N and Hillsboro Canals are low enough that the water can be discharged east. The Bishop Property Rock Pits offer a potentially viable site for

the storage of water because the land is located adjacent to the L-36N and, when fully excavated, the 413-acre site will include nearly 370 acres of open water. Construction of a levee around the site to hold an additional 4.5 feet of water would provide nearly 1,700 acre-feet of water storage. There are probably other candidate sites for the temporary diversion impoundment, but for the purposes of analysis in this investigation, it was assumed that the impoundment in Alternative 1 would be implemented on the Bishop Property Rock Pits site.

Because the alternatives evaluations are based on simulated flows over a 31-year period, it is not possible to speculate on the magnitude of NSID flows that might require diversion and storage during the one year that the temporary diversion is in operation. For analysis purposes, it was assumed that the mean annual flow to the EPA over the 31-year period of simulation, or 6,757 acre-feet per year, would need to be managed during that one year. Additionally, it was assumed that the distribution of discharges from the NSID Basin to the EPA would be such that no more than 1,700 acre-feet of water would need to be stored at the Bishop Property Rock Pits site at any one time. This means that all of the NSID flows for the 12-month period from January 1, 2007 to December 31, 2007, that would otherwise be discharged into the EPA, would be pumped into the Bishop Property Rock Pits site and that the mean annual phosphorus load to the EPA (293 kg) would be eliminated for that year.

Beginning in January 2008, it was assumed that all stormwater flows from the NSID Basin would be routed to the Hillsboro Canal and either stored in the Hillsboro Site 1 Impoundment or managed for other beneficial purposes. Regardless of how the water is managed under CERP, no stormwater flow or phosphorus load from the NSID Basin would be discharged to the Everglades after 2007.

8.3.1 Project Elements

In defining the project elements for this alternative, it was assumed that the improvements required for expansion of the rock pits would be made prior to 2006. The improvements have been proposed by the owner of the site in a permit application currently pending with the District. These improvements include a slurry wall along the west side of the site to reduce seepage from WCA 2A. It was also assumed that all conveyance improvements for moving NSID flows to the Hillsboro Site 1 Project, including improvements to NSID Pump No. 1, NSID Pump No. 2, the L-36N Canal, the Hillsboro Canal, the S-39A Structure, and any new conveyance facilities would be included in the CERP project since conveyance of water from the NSID Basin to the Hillsboro Site 1 Project is a component of that project. Accordingly, the only improvements that would be needed for the temporary diversion would be the construction of a pumping station to divert the water from the L-36N and the construction of the temporary water storage facility itself. A conceptual layout of how such a facility might be configured is illustrated in Figure 8-3.

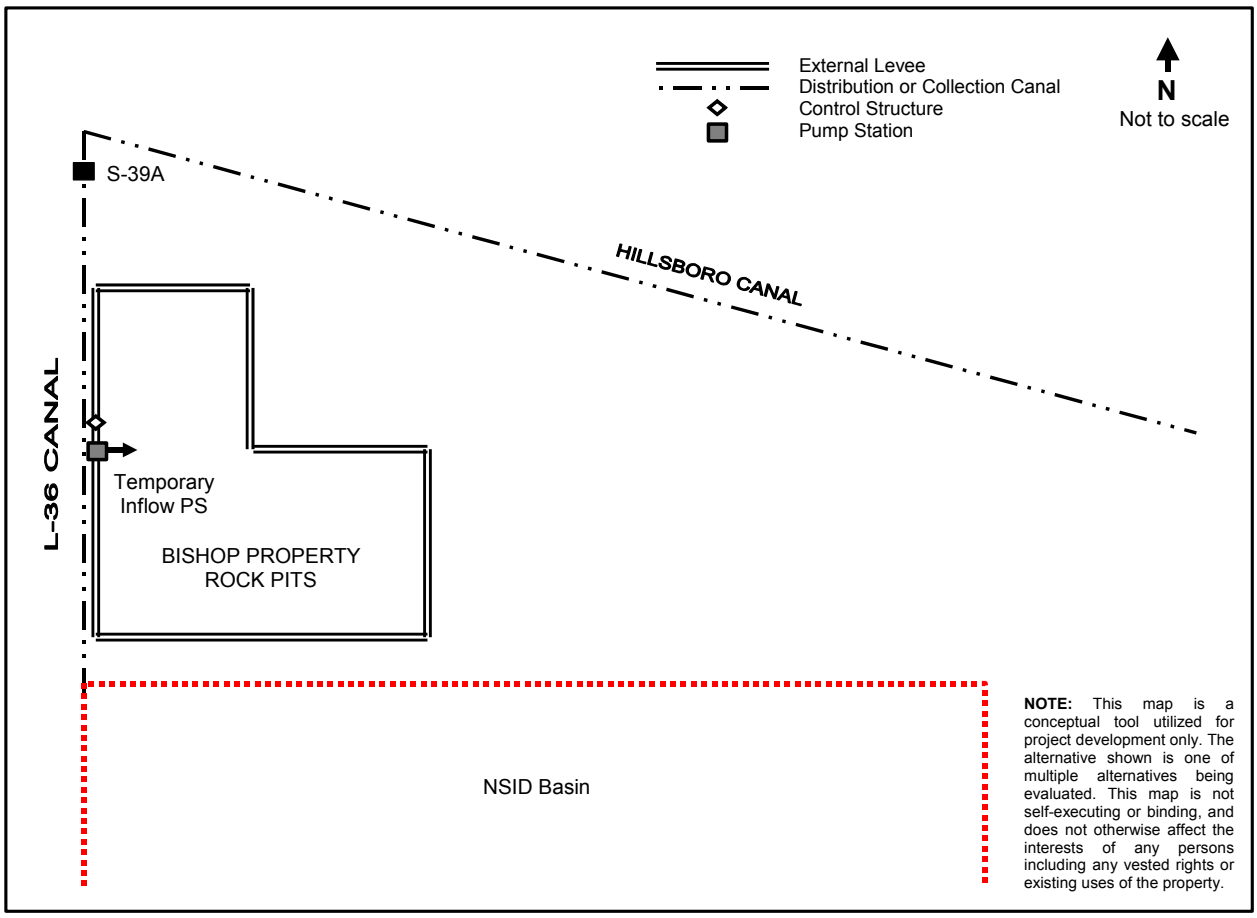


Figure 8-3.
Conceptual Schematic of Temporary Storage Impoundment for NSID Basin Alternative 1

The temporary water storage facility would be formed by constructing 7-foot high levees around the Bishop Property Rock Pit site. The levees would be designed to hold a maximum water depth of 4.5 feet. An inflow canal would be constructed to convey water into the water storage area inside the levees. Little, if any, land preparation inside the water storage area would be needed since most of the site would be open water.

A new pumping station would be constructed along the L-36N adjacent to the Bishop Property Rock Pits site to pump water into the temporary impoundment. It was assumed that the new pumping station would be sized to deliver 100,000 gpm of flow (222 cfs), matching the capacity of the existing NSID Pump No. 2. A 222-cfs pumping station could deliver the maximum 1,700 acre-feet of water to the impoundment in about 92 hours, or a little less than 4 days.

Consideration was also given to construction of an outflow pump station. An outflow pumping station would allow water to be moved out of the impoundment quickly to restore available capacity for the next storm event. After considering the high cost of such a facility and the fact that it would be in operation for only a very short period of time, it was concluded that an outflow pumping station was not a mandatory component of this alternative. Rather, a gated control structure was

assumed for the outflow, which would allow water to flow out of the impoundment by gravity whenever stage in the L-36N allows.

Implementation of Alternative 1 will require acquisition of land for the temporary pumping station, diversion canal, and water storage area. It was assumed, for the purposes of evaluation, that the 413-acre Bishop Property Rock Pits site would be leased for 2 years for this purpose. No other rights-of-way or easements were assumed since diversion would occur directly from the L-36N into the impoundment.

It was assumed that after 1 year of operation (2007), the temporary diversion would be taken out of service and all NSID stormwater would be permanently diverted north to the Hillsboro Canal as part of the CERP project. It was assumed that the temporary pumping station would be removed to avoid ongoing operation and maintenance expenses, but that the levees around the rock pits and the outflow control structure would remain to allow the water storage area to serve in an emergency capacity, if needed. No ongoing operation and maintenance of the water storage area was assumed as part of this alternative.

8.3.2 Implementation Schedule

Permitting, design and construction of improvements for the temporary diversion alternative will need to be coordinated with the proposed expansion of the rock pits themselves and the implementation of CERP improvements associated with the Hillsboro Site 1 Project. Therefore, the actual implementation schedule for Alternative 1 may be somewhat longer than might otherwise be necessary. For the purposes of evaluation, it was assumed that the alternative will take about 3 years to implement. A breakdown of the implementation schedule is presented in Table 8-3. While the schedule for implementing individual components may vary somewhat from that shown in the table, it should be possible to complete the project by December 2006 unless the expansion of the rock pits by the private developer has not been completed by the early part of that year.

Table 8-3
Implementation Schedule for NSID Basin Alternative 1

Project Component	Time Duration (months)
Land acquisition	6
Design and permitting	12
Contractor procurement	6
Construction	12
Total	**36**

8.3.3 Cost Estimates

Capital costs and average annual operation and maintenance (O&M) costs for Alternative 1 were estimated using unit costs provided by the District and supplemented, where necessary, by Brown and Caldwell. The methodology for preparing cost estimates was presented previously in Section 2 of this report. A summary of the capital and O&M cost estimates is presented in Table 8-4.

Table 8-4.
Cost Estimates for NSID Basin Alternative 1

Cost Component	Estimated cost, million dollars
Capital Costs	
Construction	
Temporary Pumping Station	1.41
Water Storage Area	1.29
Outflow Control Structure	0.50
Subtotal	3.20
Planning, engineering and design (10%)	0.32
Program and construction management (10%)	0.32
Subtotal	3.84
Contingency (30%)	1.15
Total, construction costs	4.99
Land Acquisition	
Property lease (2 years)	21.99
Total, Land Acquisition costs	21.99
Total, Capital costs	26.98
Average Annual O&M Costs	
Temporary Pumping Station	0.052
Water Storage Area	0.005
Control structures and misc.	0.006
Subtotal	0.063
Contingency (30%)	0.019
Total, Annual O&M costs	0.082
Demolition Costs	
Temporary Pumping Station	0.35
Total, Demolition Costs	0.35
50-year Present Worth	
Capital costs (2004-2006)	25.69
O&M costs (2007)	0.08
Demolition Costs (2008)	0.30
Total, 50-year present worth	26.06

Initial capital costs, including land acquisition, were estimated to total about $26.98 million. Average annual O&M costs were based on pumping an average of 6,757 acre-feet of water per year from the L-36N to the temporary water storage area and were estimated to total about $82,000 per year. Demolition costs for removal of the temporary pumping station were estimated at approximately $350,000. Detailed breakdowns of the capital, O&M and demolition cost estimates for NSID Alternative 1 are presented in Appendix A.

An estimate of the 50-year present worth for Alternative 1 was prepared covering the period from 2004 to 2053. Capital costs were incurred during the period 2004-2006. O&M costs for diversion to the temporary water storage area were incurred in the year 2007 only. Pumping station demolition costs were assumed to occur in 2008. It was assumed that no other project costs would occur after 2008. The combined present worth of the capital, O&M and demolition costs associated with NSID Alternative 1 was calculated to be $26.06 million.

8.3.4 Evaluation Ratings

Alternative 1 was rated against the ten evaluation criteria defined in the Evaluation Methodology document *(Final Evaluation Methodology for the Water Quality Improvement Strategies for the Everglades, SFWMD, July 31, 2002)* and discussed previously in Section 2 of this report. Table 8-5 summarizes the ratings given based on the results of this investigation.

Phosphorus Load Reduction. This alternative eliminates 100 percent of the phosphorus load currently discharged to the EPA from the NSID Basin beginning in January 2007.

Long-Term TP Concentration Achieved. Evaluation of Alternative 1 against this criterion is not applicable because water will be diverted away from the EPA. Reducing the long-term TP concentration in the water being diverted to the temporary water storage area and ultimately to the Hillsboro Site 1 Project is not an objective of this alternative.

Implementation Schedule. It is estimated that Alternative 1 will take approximately 3 years to implement and that the temporary diversion will be available to begin operations in January 2007. However, assuming a start date of January 2003 for evaluation purposes, the time to complete would be 4 years. **Rating: 4 years.**

Operational Flexibility. Operation of the temporary diversion project for a period of 1 year does not materially impact the operational flexibility of the South Florida hydraulic conveyance system or the Everglades Water Conservation Areas over current conditions. Construction of the Hillsboro Site 1 Project will add significant operational flexibility. However, the benefits of CERP projects are not considered in the evaluation of alternatives in these Basin Specific Feasibility Studies. **Rating: 0.**

Resiliency to Extreme Conditions. The temporary diversion in this alternative provides a high level of resiliency to fire, flood, drought and hurricane. **Rating: +4.**

Assessment of Full Scale Construction and Operation. There are no significant constructability, operability or scale-up issues associated with this alternative, although the impact of seepage from

the temporary water storage area on surrounding land should be investigated during design. **Rating: +3.**

Management of Side Streams. Other than the possibility of some seepage, there are no side streams generated by this alternative that would require significant management effort and cost. **Rating: 0.**

Improvement in Non-P Parameters. Other than effects that may be derived from source controls in the NSID Basin, this alternative is not expected to result in any change to non-P water quality. **Rating: 0.**

50-Year Present Worth. The total 50-year present worth of the capital and O&M costs associated with this alternative is $26.06 million.

Cost-Effectiveness. The total TP load removed by the temporary diversion project operating for 1 year is estimated to total 293 kg. Based upon a 50-year present worth of $26.06 million, this translates to a cost-effectiveness rating of $88,956 per kg TP removed.

Table 8-5.
Summary of Evaluation Ratings for NSID Basin Alternative 1

Evaluation Criteria	Unit	Rating
Technical Performance Criteria		
Phosphorus Load Reduction	Percent	100
Long-Term TP Concentration Achieved		
Flow-weighted mean	ppb	NA
Geometric mean	ppb	NA
Implementation Schedule	Years	4
Operational Flexibility	+3/-3	0
Resiliency to Extreme Conditions	+4/-4	+4
Assessment of Full-Scale Construction and Operation	+3/-3	+3
Management of Side Streams	+3/-3	0
Environmental Criteria		
Improvement in Non-P Parameters	+19/-19	0
Economic Criteria		
50-year Present Worth	Million dollars	26.06
Cost-Effectiveness	Dollars/kg removed	88,956

8.4 Alternative 2 – Permanent Off-Site Diversion (Non-CERP)

Alternative 2 assumes that excess stormwater flows from the NSID Basin would not be routed to the Hillsboro Site 1 Project. Instead, these flows would be diverted to a permanent water storage facility to be located in or near the NSID Basin. The primary advantage of this alternative is that capacity in the Hillsboro Site 1 Project may be made available for other beneficial purposes. The primary disadvantage is the additional cost associated with constructing a separate diversion system and impoundment for only NSID flows.

The concept for the permanent diversion alternative is simple. NSID flows that would have been discharged to the EPA would instead be pumped into an impoundment. Water would be held in the impoundment until such time as the stage elevation in the L-36N is low enough that it can accept additional flow. Outflow from the storage impoundment would be discharged to the Hillsboro Canal and managed to the benefit of the region.

Details of how the L-36N and the Hillsboro Canal will be operated after the Hillsboro Site 1 Project has been constructed have yet to be defined. Further, it is not clear how the operation of the new CERP facilities will impact the operation of NSID Pump No. 1 and NSID Pump No. 2.

To define a basis for how the Alternative 2 diversion scenario might operate, a historical data analysis was performed to determine if a correlation exists between stage elevation in the Hillsboro Canal and discharges from the NSID Basin to the EPA. The analysis showed that no correlation exists. Discharges from NSID to the EPA occurred at both high and low stages in the Hillsboro Canal, suggesting that discharges to the EPA occurred not only for flood protection purposes, but for water supply purposes in WCA 2A as well.

To evaluate this alternative, therefore, it was necessary to make a number of assumptions regarding how the diversion project would be operated. These included the following:

1. It was assumed that the NSID impoundment would be located along the L-36N Canal using the same Bishop Property Rock Pits site that was considered for the evaluation of Alternative 1. If the rock pits site was not large enough to provide sufficient storage volume, it was assumed that additional land would be acquired to provide it. Any such land would not necessarily have to be adjacent to the rock pits site, but was assumed to be in close enough proximity that a common conveyance system could be used to access it.

2. Inflow to the NSID impoundment from the L-36N was assumed to occur whenever NSID Pump No. 1 discharged flow to the EPA over the 31-year period of flow simulation, up to a maximum flow rate of 200,000 gpm (444 cfs).

3. Outflow from the NSID impoundment to the L-36N was allowed to occur only on days when NSID Pump No. 1 did not discharge flow to the EPA over the 31-year period of flow simulation. It was assumed that, on these days, stage in the L-36N was low enough to accept

additional flow as evidenced by the fact that no discharge to the EPA occurred. Outflow pumping rate was evaluated as a variable in the calculation of the required storage volume.

4. The maximum depth of water stored in the rock pits site was assumed to be 4.5 feet, as was assumed in Alternative 1. The maximum depth of water stored in any supplemental impoundment area was assumed to be 8 feet, consistent with the maximum water depth currently being considered for the impoundments in the Hillsboro Site 1 Project.

5. No flow from the NSID Basin could be discharged to the EPA. It was assumed that all stormwater flows discharged to the EPA through NSID Pump No. 1 over the 31-year period of flow simulation must be stored in the new NSID impoundment.

Using these general assumptions, a fill and draw spreadsheet model was developed to determine the maximum amount of water storage required to accommodate all excess NSID flows over the 31-year period of flow simulation. Flows were assumed to be pumped into the NSID impoundment on the same days and at the same rate as the District's simulations indicate that they would have been discharged to the EPA historically. On days when no flows were pumped into the NSID impoundment, flow was pumped out at rates varying from 80,000 gpm (89 cfs) to 200,000 gpm (cfs). The spreadsheet model was used to identify the maximum amount of water in storage at any one time over the 31-year period of simulation using the different outflow pumping rates. The maximum storage volume was then converted to land area requirements for use in preparing cost estimates.

The results of the analysis showed that the Bishop Property Rock Pits site is undersized to accommodate simulated peak flows from the NSID Basin over the 31-year period of simulation. To accommodate these peak flows, it was determined that approximately 7,100 acre-feet of storage volume is required with an outflow pumping capacity of 200,000 gpm (444 cfs). At the assumed maximum allowable water depths noted above, this storage volume requires about 1080 acres of impoundment area in addition to the 413 acres assumed to be available on the rock pits site. Taking into account the acreage required for pump stations, levees, canals and other works associated with the impoundment, the total land area required is approximately 1,700 acres. At lower outflow pumping rates, the land area requirements are increased.

It should also be noted that since diversion to the Hillsboro Site 1 Project will not occur in this alternative, it is unlikely that CERP will fund the conveyance system improvements to move water north through the L-36N to the Hillsboro Canal. Accordingly, it was assumed that all such improvements would be accomplished as part of this alternative, whereas in Alternatives 1 and 3 they were assumed to be part of the CERP project.

8.4.1 Project Elements

Development of the rock pit site into a water storage area would be accomplished as previously described in Alternative 1. Ten-foot high levees, capable of holding 8 feet of water, would be constructed around the supplemental impoundment area. This supplemental water storage area

would preferably be partitioned so that some storage cells would be used only during large storm events. Ideally, the cells used most frequently would be those located the farthest away from existing development. A conceptual layout of how such a facility might be configured on land adjacent to the rock pits is illustrated in Figure 8-4.

In the assumed configuration, a pumping station would be constructed along the L-36N north of the rock pits. The pumping station structure would house both inflow and outflow pumps, which would pump water in to and out of the NSID impoundment through a common inflow/outflow canal. Gated control structures would be needed in the L-36N to control flow in that canal during inflow and outflow pumping. Water being pumped into the NSID impoundment would be routed into storage cells through gated culverts. The rock pit area would typically be the first area filled, with the other cells being used as needed to accommodate larger volumes of stormwater.

At present, NSID Pump No. 1 can only pump 50,000 gpm (111 cfs) north to the L-36N. The configuration of this pumping station must be modified so that it can deliver at least 100,000 gpm (222 cfs) north to the L-36N. This flow, plus the 100,000 gpm of flow from NSID Pump No. 2 would make up the 200,000 gpm (444 cfs) capacity that needs to be discharged into the new impoundment to maintain the current level of flood protection in the NSID Basin.

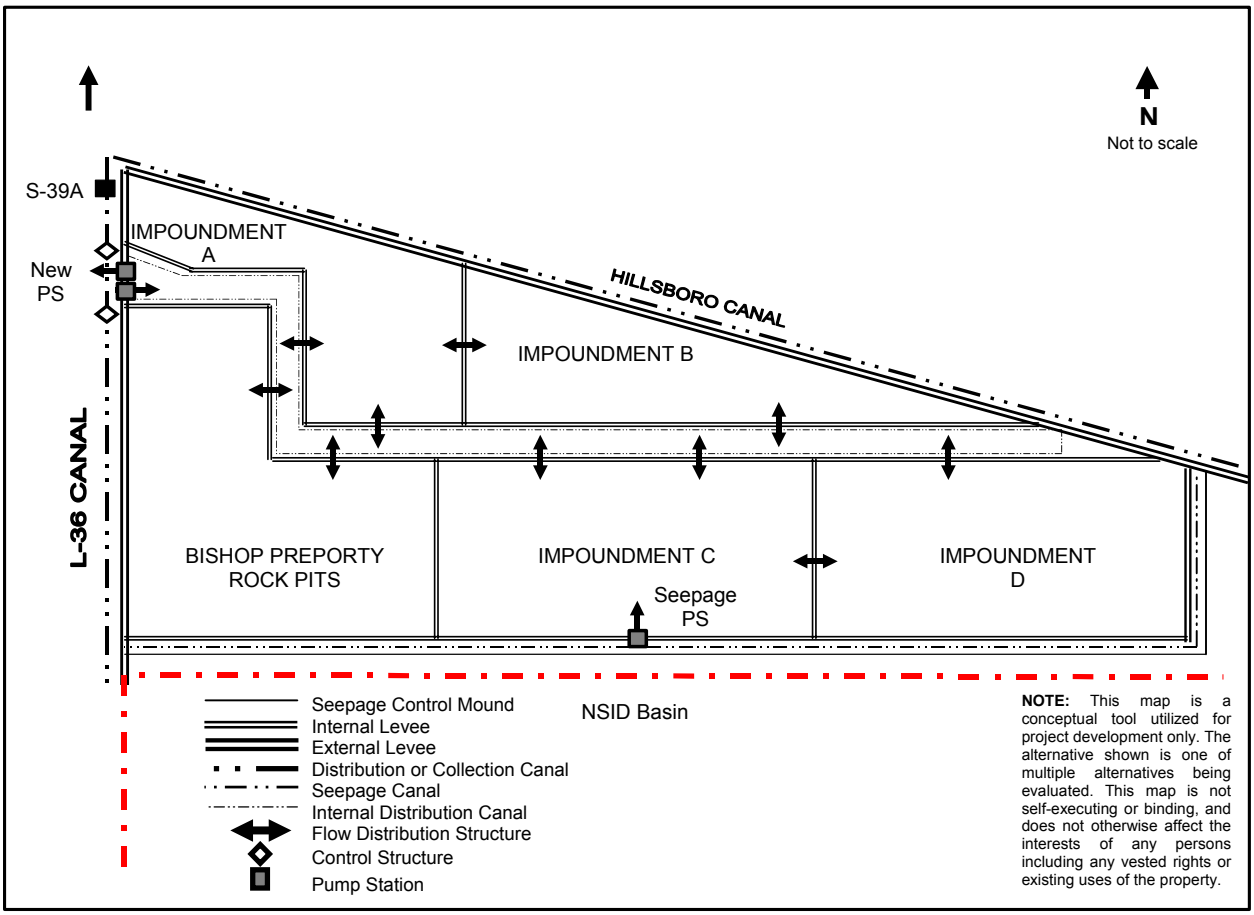


Figure 8-4.
Conceptual Schematic of Permanent Storage Impoundment for NSID Basin Alternative 2

The capacity of the L-36N to carry the additional flow was also investigated. As-built cross-sections for the canal are not available since it was originally constructed for borrow purposes only. However, visual observations of the canal, combined with recent bathymetric data supplied by the District, suggests that the canal has the capacity to carry 100,000 gpm of flow between NSID Pump No. 1 and NSID Pump No. 2, and 200,000 gpm of flow between NSID Pump No. 2 and the new diversion pumping station north of the rock pits, without extensive modification or widening. The bathymetric data, however, shows some significant build-ups of sediment along certain reaches of the canal. Therefore, it was assumed that the L-36N would be dredged as part of Alternative 2 to assure that the requisite flows can be delivered to the new impoundment.

8.4.2 Implementation Schedule

Permitting, design and construction of improvements for the permanent diversion alternative will need to be coordinated with the proposed expansion of the rock pits themselves and the implementation of CERP improvements associated with the Hillsboro Site 1 Project. Therefore, the implementation schedule for Alternative 2 may be somewhat longer than might otherwise be the case. For the purposes of evaluation, it was assumed that the alternative will take about 4 years to implement. A breakdown of the implementation schedule is presented in Table 8-6. While the schedule for implementing individual components may vary somewhat from that shown in the table, it should be possible to complete the project by December 2006 unless the expansion of the rock pits by the private developer has not been completed by the early part of that year.

Table 8-6.
Implementation Schedule for NSID Basin Alternative 2

Project Component	Time Duration (months)
Land acquisition	12
Design and permitting	12
Contractor procurement	6
Construction	18
Total	**48**

8.4.3 Cost Estimates

Capital costs and average annual O&M costs for Alternative 2 were estimated using unit costs provided by the District and supplemented, where necessary, by Brown and Caldwell. The methodology for preparing cost estimates was presented previously in Section 2 of this report. A summary of the capital and O&M cost estimates is presented in Table 8-7.

Initial capital costs, including land acquisition, were estimated to total about $107.97 million. Average annual O&M costs were based on pumping an average of 6,757 acre-feet of water per year

from the L-36N Canal to NSID impoundment and were estimated to total about $293,000 per year. Detailed breakdowns of the capital and O&M cost estimates for NSID Alternative 2 are presented in Appendix A.

Table 8-7.
Cost Estimates for NSID Basin Alternative 2

Cost Component	Estimated cost, million dollars
Capital Costs	
Construction	
New pump stations	7.90
Modifications to NSID Pump No. 1	0.50
Water storage area and associated works	12.77
L-36N control structures and dredging	1.05
Subtotal	22.22
Planning, engineering and design (10%)	2.22
Program and construction management (10%)	2.22
Subtotal	26.66
Contingency (30%)	8.00
Total, construction costs	34.66
Land Acquisition	
Right-of-way and land purchase	58.65
Contingency (25%)	14.66
Total, Land Acquisition costs	73.31
Total, Capital costs	107.97
Average Annual O&M Costs	
Inflow/Outflow pumping station	0.16
Water storage area	0.03
Control structures	0.03
Subtotal	0.22
Contingency (30%)	0.07
Total, Annual O&M costs	0.29
50-year Present Worth	
Capital costs (2003-2006)	103.75
O&M costs (2007-2052)	5.93
Replacement Costs	0.83
Total, 50-year present worth	110.51

An estimate of the 50-year present worth for Alternative 2 was prepared covering the period 2003-2052. Capital costs were assumed to be incurred during the period 2003-2006. O&M costs were assumed to be incurred during the period 2007-2052. The present worth of the capital costs was calculated to be $103.75 million. The present worth of the O&M costs was calculated to be $5.93 million, and the present worth of pump station equipment replacement costs was estimated to be $0.83 million. The combined present worth of the capital, O&M and equipment replacement costs associated with NSID Alternative 2 was calculated to be $110.51 million.

8.4.4 Evaluation Ratings

Alternative 2 was rated against the ten evaluation criteria defined in the Evaluation Methodology document *(Final Evaluation Methodology for the Water Quality Improvement Strategies for the Everglades, SFWMD, July 31, 2002)* and discussed previously in Section 2 of this report. Table 8-8 summarizes the ratings given based on the results of this investigation.

Phosphorus Load Reduction. This alternative eliminates 100 percent of the phosphorus load currently discharged to the EPA form the NSID Basin beginning in January 2007.

Long-Term TP Concentration Achieved. This criterion is not applicable to the evaluation of Alternative 2 because all NSID flows will be diverted away from the EPA. Reducing the long-term TP concentration in the water being diverted to the NSID impoundment is not an objective of this alternative.

Implementation Schedule. It is estimated that Alternative 2 will take approximately 4 years to implement, beginning in January 2003, and that the diversion project will be available to begin operations in January 2007. **Rating: 4 years.**

Operational Flexibility. Operation of the diversion project in Alternative 2 will add significantly to the operational flexibility of the South Florida hydraulic conveyance system over current and planned conditions. Construction of the NSID impoundment will make additional storage capacity available in the Hillsboro Site 1 Project and provide water managers with additional options for managing the region's water resources. **Rating: +2.**

Resiliency to Extreme Conditions. This alternative provides a high level of resiliency to fire, flood, drought and hurricane. **Rating: +4.**

Assessment of Full Scale Construction and Operation. There are no significant constructability, operability or scale-up issues associated with this alternative, although the impact of seepage from the NSID impoundment on surrounding land should be investigated during design. **Rating: +3.**

Management of Side Streams. Other than the possibility of seepage, there are no side streams generated by this alternative that would require significant management effort and cost. **Rating: 0.**

Improvement in Non-P Parameters. Other than effects that may be derived from source controls in the NSID Basin, this alternative is not expected to result in any change to non-P water quality. **Rating: 0.**

50-Year Present Worth. The total 50-year present worth of the capital, O&M and equipment replacement costs associated with this alternative is $110.51 million.

Cost-Effectiveness. The TP load removed by this alternative during the 50-year period from 2007 to 2056 is estimated to total 14,650 kg. Based upon a 50-year present worth of $110.51 million, this translates to a cost-effectiveness rating of $7,543 per kg TP removed.

Table 8-8.
Summary of Evaluation Ratings for NSID Basin Alternative 2

Evaluation Criteria	Unit	Rating
Technical Performance Criteria		
Phosphorus Load Reduction	Percent	100
Long-Term TP Concentration Achieved		
Flow-weighted mean	ppb	NA
Geometric mean	ppb	NA
Implementation Schedule	Years	4
Operational Flexibility	+3/-3	+2
Resiliency to Extreme Conditions	+4/-4	+4
Assessment of Full-Scale Construction and Operation	+3/-3	+3
Management of Side Streams	+3/-3	0
Environmental Criteria		
Improvement in Non-P Parameters	+19/-19	0
Economic Criteria		
50-year Present Worth	Million dollars	110.51
Cost-Effectiveness	Dollars/kg removed	7,543

8.5 Alternative 3 – Diversion To Hillsboro Site 1 CERP Project (Base Condition)

Alternative 3 is similar to Alternative 1 in that source controls would be implemented within the NSID Basin and excess stormwater flows, which now are discharged to WCA 2A through NSID Pump No. 1, would be diverted to the Hillsboro Site 1 Project, which will be on-line by the end of 2007. However, in this alternative, no temporary diversion would be constructed to manage NSID flows prior to the Hillsboro Site 1 Project becoming available. Instead, excess stormwater flows from the NSID Basin would be discharged to WCA 2A, just as they are now, for that interim period which is currently expected to be 1 year.

8.5.1 Project Elements

Implementation of this alternative involves only source controls and a CERP component, neither of which are being considered in the alternatives evaluations in the Basin Specific Feasibility Studies. Although not detailed specifically in CERP planning documents, conveyance of NSID flows to the Hillsboro Site 1 Project is part of that CERP component. Accordingly, it was assumed that all such conveyance improvements, including any required modifications or expansions to the existing NSID pumping stations, improvements to the L-36N and Hillsboro Canals, and improvements to existing water control structures would be made by CERP. Under this assumption, there would be no additional project elements necessary to implement this alternative.

8.5.2 Implementation Schedule

It has been assumed that source controls can be implemented in all ESP basins, including the NSID Basin, by December 2006. Construction of the Hillsboro Site 1 Project is not scheduled to be completed until late 2007.

8.5.3 Cost Estimates

Costs for implementing source controls and CERP projects were not considered in the Basin Specific Feasibility Studies. Since there are no other project elements associated with Alternative 3, no cost estimates were prepared.

8.5.4 Evaluation Ratings

Alternative 3 was rated against the ten evaluation criteria defined in the Evaluation Methodology document *(Final Evaluation Methodology for the Water Quality Improvement Strategies for the Everglades, SFWMD, July 31, 2002)* and discussed previously in Section 2 of this report. Table 8-9 summarizes the ratings given based on the results of this investigation.

Phosphorus Load Reductions. This alternative eliminates 98 percent of the phosphorus load that would be discharged from the NSID Basin to the EPA during the 50-year period from 2007 to 2056.

Long-Term TP Concentration Achieved. This criterion has marginal applicability to the evaluation of Alternative 3 because, after 2007, all NSID flows will be diverted away from the EPA. Reducing the long-term TP concentration in the water being diverted away from the EPA is not an objective of this alternative. For the 1 year (2007) in which NSID flows will be discharged to the EPA, both the long-term flow-weighted and geometric mean TP concentrations would be about 39 ppb.

Implementation Schedule. Construction of the Hillsboro Site 1 CERP Project is not scheduled to be completed until the end of 2007. Assuming a start-date of January 2003, the estimated completion time would be 5 years. **Rating: 5 years.**

Operational Flexibility. There are no project elements specific to this alternative. Therefore, the alternative has no impact on the operational flexibility of the South Florida hydraulic conveyance system outside of that already being provided by CERP. **Rating: 0.**

Resiliency to Extreme Conditions. There are no project elements in this alternative to be rated against this criterion. **Rating: 0.**

Assessment of Full Scale Construction and Operation. There are no project elements in this alternative to be rated against this criterion. **Rating: 0.**

Management of Side Streams. There are no project elements in this alternative to be rated against this criterion. **Rating: 0.**

Improvement in Non-P Parameters. Other than effects that may be derived from source controls in the NSID Basin, this alternative is not expected to result in any changes to non-P water quality. **Rating: 0.**

50-Year Present Worth. There are no implementation costs associated with this alternative. Therefore, the 50-year present worth is zero.

Cost-Effectiveness. This alternative does not include any project elements of its own to remove phosphorus load from the EPA. The only phosphorus load removed is due to diversion of NSID flows to the Hillsboro Site 1 Project under CERP. Since there is no phosphorus load removed, and no costs incurred, the cost-effectiveness rating of Alternative 3 is zero.

Table 8-9.
Summary of Evaluation Ratings for NSID Basin Alternative 3

Evaluation Criteria	Unit	Rating
Technical Performance Criteria		
Phosphorus Load Reduction	Percent	98
Long-Term TP Concentration Achieved [a]		
Flow-weighted mean	ppb	39
Geometric mean	ppb	39
Implementation Schedule	Years	5
Operational Flexibility	+3/-3	0
Resiliency to Extreme Conditions	+4/-4	0
Assessment of Full-Scale Construction and Operation	+3/-3	0
Management of Side Streams	+3/-3	0
Environmental Criteria		
Improvement in Non-P Parameters	+19/-19	0
Economic Criteria		
50-year Present Worth	Million dollars	0
Cost-Effectiveness	Dollars/kg removed	0

[a] Flow-weighted mean and geometric mean are applicable only to discharges for 2007.

8.6 Summary of Alternative Evaluations

A summary of the evaluation ratings for the three alternatives investigated in the NSID Basin is presented in Table 8-10. The District and other project stakeholders will use this information in support of future decisions regarding which alternative(s) to select for further study or conceptual design.

Table 8-10.
Summary of Evaluation Ratings for NSID Basin Alternatives

Evaluation Criteria	Unit	Rating		
		Alt. 1	Alt. 2	Alt. 3
Technical Performance Criteria				
Phosphorus Load Reduction	Percent	100	100	98
Long-Term TP Concentration Achieved				
Flow-weighted mean	ppb	NA	NA	39[a]
Geometric mean	ppb	NA	NA	39[a]
Implementation Schedule	Years	4	4	5
Operational Flexibility	-3 / +3	0	+2	0
Resiliency to Extreme Conditions	-4 / +4	+4	+4	0
Assessment of Full-Scale Construction/O&M	-3 / +3	+3	+3	0
Management of Side Streams	-3 / +3	0	0	0
Environmental Criteria				
Improvement in Non-P Parameters	-19 / +19	0	0	0
Economic Criteria				
50-year Present Worth	Million dollars	26.06	110.51	0
Cost-Effectiveness	Dollars/kg removed	88,956	7,543	0

[a] Flow-weighted mean and geometric mean are applicable only to discharges for 2007.

The permanent diversion option in Alternative 2 requires the acquisition of about 1,700 acres of land to impound stormwater flows form the NSID Basin that would otherwise be discharged into WCA 2A. However, only two or three storm events during the entire 31-year period of simulation require that all of this acreage be used for water storage purposes. Accordingly, it would be appropriate for future phases of investigation to consider refinements of the permanent non-CERP diversion alternative evaluated in this investigation. Two refinements that could be considered include the following:

1. Treat the water in a STA and discharge to WCA 2A. A flow-through treatment system would theoretically require less land because treated water could be discharged on a continuing basis. However, water depths would need to be controlled at a maximum of 4.5 to 5 feet, which is less than currently assumed for the impoundment.

2. Allow limited bypassing to WCA 2A during the largest storm events.

Also, since the stage in the L-36N determines whether discharges occur from the NSID Basin to WCA 2A, alternatives that provide additional on site storage and/or other conveyance options and reduce the dependence on the L-36N could decrease or eliminate NSID basin discharges to WCA 2A. While the basin is currently planned to be built out by 2006, coordination between the District and the developers could provide for additional on site storage and conveyance systems that would reduce discharges to the L-36N. A basin scale modeling study would provide additional information on the effect of adding conveyance capacity from the NSID basin directly to the Hillsboro Canal.

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Appendix A
Cost Estimate Details

APPENDIX A
ACME BASIN B - Alternative 1 Cost Estimate

	Item/Task	Unit	Unit cost	Quantity	Total	Comments/Explanation
1	**Capital costs**					
1.1.1	Equipment		$ -		$ -	
1.1.2	Residuals management		$ -		$ -	
1.2	Freight		$ -		$ -	
1.3	Installation		$ -		$ -	
1.4	Instrumentation		$ -		$ -	
1.5	**Electrical controls**					
1.5.1						
1.5.2	Electrical power distribution	$/mile	$ 80,000	3.00	$ 240,000	Assumed distance
1.6	**Civil Work- water control structures**					
1.6.1	84" culvert open	per structure	$ 20,000		$ -	
1.6.2	84" culvert with gate	per structure	$ 35,000		$ -	
	72" culvert open	per structure	$ 17,500		$ -	
	72" culvert with gate	per structure	$ 32,500		$ -	
	60" culvert open	per structure	$ 15,000		$ -	
	60" culvert with gate	per structure	$ 30,000		$ -	
	48" culvert open	per structure	$ 10,000		$ -	
	48" culvert with gate	per structure	$ 25,000		$ -	
1.6.3	10' x 10' x 53' concrete box culvert - With gates	per structure	$ 300,000		$ -	
1.6.4	10' x 10' x 53' concrete box culvert - Without gates	per structure	$ 150,000			
	5' x 10' x 20' concrete box culvert - without gates	per structure	$ 60,000	12	$ 720,000	3 FPL service road crossings
	5' x 10' x 50' concrete box culvert - without gates	per structure	$ 100,000	4	$ 400,000	95th Street crossing
	Control Structure - large - with gates (2)	per structure	$ 1,500,000		$ -	
	Control Structure - large - without gates	per structure	$ 750,000		$ -	
	Control Structure -small - with gate (1)	per structure	$ 500,000		$ -	
	Control Structure - small - without gates	per structure	$ 250,000		$ -	
	Siphon	lump sum	$ 1,139,000		$ 1,139,000	located at the L-23W canal
1.7.1	**Canals (digging - no blasting)**					
1.7.1.1	Canals- Deep excavation	$/cubic yard	$ 3.5	1,172,627	$ 4,104,193	Assumes placement of excavated material on canal banks
1.7.1.2	Canals- Shallow excavation	$/cubic yard	$ 2.5		$ -	
1.7.2	**Canals (including blasting)**					
1.7.2.1	Canals- Deep excavation	$/cubic yard	$ 5		$ -	
1.7.2.2	Canals- Shallow excavation	$/cubic yard	$ 4		$ -	
1.8.1	**Levees (no blasting)**					
1.8.1.1	Internal- 7' (4.5' SWD)	$/mile	$ 390,000		$ -	
1.8.1.3	External- 8' (4.5' SWD)	$/mile	$ 485,000		$ -	
1.8.1.4	External- 9' (4.5' SWD)	$/mile	$ 562,000		$ -	
1.8.1.5	External-10' (4.5' SWD)	$/mile	$ 703,000		$ -	
	Seepage Control Mound	$/mile	$ 50,000		$ -	
1.9	**Pumping stations**					
1.9.1.1	0-40 cfs	$/cfs	$ 7,600		$ -	
1.9.1.2	41-60 cfs	$/cfs	$ 9,500		$ -	
1.9.1.3	60-500 cfs	$/cfs	$ 9,900	505	$ 4,999,500	Pump station at Ag Reserve Reservoir (high head)
1.9.1.4	500-3,000 cfs	$/cfs	$ 7,500	505	$ 3,787,500	Pump station at ACME Basin B
1.1	**Interior land preparation**					
1.10.1	Disking	$/acre	$ 60		$ -	

APPENDIX A
ACME BASIN B - Alternative 1 Cost Estimate

	Item/Task	Unit		Unit cost	Quantity		Total	Comments/Explanation
	Leveling/Grading	$/acre	$	100		$	-	
	Clearing/Grubbing	$/acre	$	200	176	$	35,200	
	Other Land Preparation							
	Grading/Shaping of excavated material on canal banks	$/yd^2	$	1.00	1,391,517	$	1,391,517	
	Canal bank stabilization	$/yd^2	$	0.20	200,000	$	40,000	seeding/mulching/erosion control
	FPL Service Road Crossings	Lump sum	$	105,000	1	$	105,000	excavating, headwalls, guardrails, seed/sod etc @ 3 road crossings
	95th Street Crossing	Lump sum	$	48,000	1	$	48,000	excavating, road patch, headwalls, guardrails, seed/sod etc
	Easement Crossings/Utility Improvements	Lump sum	$	175,000	1	$	175,000	3 easement crossings
	Antenna site	Lump sum	$	50,000	1	$	50,000	antenna site leased out by the District - provision for working around or relocating antenna
Subtotal						$	17,234,910	
Planning, Engineering and Design - 10%					0.10	$	1,723,491	
Program and Construction Management - 10%					0.10	$	1,723,491	
Subtotal						$	20,681,892	
Capital and Construction Contingency - 30%					0.30	$	6,204,568	
Subtotal Capital and Construction Costs						$	26,886,460	
Land/Right-of-way Acquisition		Lump sum	$	145,040	1	$	145,040	publicly owned lands to be acquired per SFWMD
Land/Right-of-way Acquisition Contingency -25%					0.25	$	36,260	
Land previously acquired - Strazzula		Lump sum	$	185,792	1	$	185,792	portion of Strazzula to be used for diversion per SFWMD
Total Capital Costs						**$**	**27,253,552**	

2	**OPERATING COSTS (per year)**							
2.1	**Labor**							
2.1.1	Engine operator/Maintenance mechanic	each	$	50,000	0.50	$	25,000	
2.1.2	Lead operator	each	$	60,000	0.50	$	30,000	
2.2.1.1	Mechanical maintenance (lubrication, spare parts, etc.)- 500- 3,000 cfs pumps	per unit	$	23,000		$	-	
2.2.1.2	Mechanical maintenance- 0-500 cfs pumps	per unit	$	10,000	4	$	40,000	US and DS pump station
2.2.2	Maintenance (water control structures)	each	$	12,000	1	$	12,000	siphon
	Maintenance - Minor (water control structures)	each	$	6,000		$	-	
	Maintenance - Culverts (water control structures)	each	$	1,000	16	$	16,000	
2.2.3	Maintenance Large building	per unit	$	12,000		$	-	
	Maintenance Small building	per unit	$	6,000	2	$	12,000	
2.2.4	Maintenance- Levees	$/mile	$	1,530	13.42	$	20,533	levees on both sides of the canal
2.2.5	Maintenance (vegetation control)	$/acre	$	22	163	$	3,586	canal maintenance
						$	-	
2.2.8	Maintenance- Sludge treatment		$	-		$	-	
2.3	Chemicals					$	-	
2.3.1	Aluminum sulfate	Dry ton	$	150		$	-	
2.3.2	PAC	lb	$	0		$	-	
2.3.3	Ferric chloride	Dry ton	$	180		$	-	
2.3.4	Ferric sulfate	lb	$	0		$	-	
2.3.5	Lime		$	-		$	-	

APPENDIX A
ACME BASIN B - Alternative 1 Cost Estimate

	Item/Task	Unit	Unit cost	Quantity	Total	Comments/Explanation
2.3.6	Polymer	Tons	$ 4,000		$ -	
2.3.7	Others		$ -		$ -	
2.4	Solids disposal	Tons	$ 50		$ -	
2.5	**Energy**		$ -		$ -	
2.5.1	Electricity	KW/hr	$ 0.08	25,000	$ 2,000	Includes capacity fee
2.5.2	Fuel consumption - upstream pump station	acre-feet	$ 0.50	31,876	$ 15,938	Upstream pump station pumping against normal heads
	Fuel consumption - downstream pump station	acre-feet	$ 0.75	31,876	$ 23,907	Downstream pump station pumping against greater heads
Subtotal Operating Costs					$ 200,964	
Contingency - 30%				0.30	$ 60,289	
Total Operating Costs					**$ 261,253**	

3	**Salvage/Demolition/Replacement costs**					
3.1	Demolition costs				$ -	
3.2	Restoration of levees	$/yard	$ 3		$ -	
3.3	Restoration of FEBs		$ -		$ -	
3.4	Clearing and grubbing		$ -		$ -	
	Light foliage	$/acre	$ 300		$ -	
	Forest/heavy brushes	$/acre	$ 1,500		$ -	
3.5	Replacement items		$ -		$ 946,875	rebuild and refurbish pump stations after 25 years @ 25 percent of the original PS cost

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ACME Basin B Alternative 1

Capital Costs, $	
Total Capital Cost	27,253,552
Present Worth - Capital Cost	25,390,500
O&M Costs, $ /yr	
Total Annual O&M Cost	261,253
Present Worth - Annual O&M Cost	6,484,813
Replacement Costs, $	
Replacement Costs, $	2,196,750
Present Worth - Replacement Costs	958,060
50 - Year Present Worth, $	
Capital Cost	25,390,500
O&M Cost	6,484,813
Replacement Cost	958,060
Total Present Worth - Public Cost,	$32,833,373
Total Phosphorus Removed, kg	118,035
Present worth, $/kg TP removed	$278.17

Assumptions:

1. **Interest rate 6 3/8%**
2. **Inflation 3%**
3. **Capital costs escalated to the year expected to occur**
4. **O & M costs starts on first day of operation**
5. **Permitting and procurement costs are the responsibility of the District**

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APPENDIX A
ACME BASIN B - Alternative 2 Cost Estimate

	Item/Task	Unit	Unit cost	Quantity	Total	Comments/Explanation
1	**Capital costs**					
1.1.1	Equipment	Lump sum	$ -		$ 2,901,902	
1.1.2	Residuals management	$/mgal avg.daily design flow	$ 20,000	25	$ 500,000	B&C Desktop, 1998
1.1.3	Chemical feed system	Lump sum	$ -		$ 72,548	2.5% of equipment cost includes AST, pumps, piping
1.2	Freight		$ -		$ -	
1.3	Installation		$ -		$ -	
1.4	Instrumentation	Lump sum	$ -		$ 435,285	15% of equipment cost
1.5	**Electrical controls**					
1.5.1	Electrical controls					
1.5.2	Electrical power distribution	$/mile	$ 80,000	1.5	$ 120,000	assumes pump station power supply at Flying Cow Rd
1.6	**Civil Work- water control structures**					
1.6.1	84" culvert open	per structure	$ 20,000		$ -	
1.6.2	84" culvert with gate	per structure	$ 35,000		$ -	
	72" culvert open	per structure	$ 17,500		$ -	
	72" culvert with gate	per structure	$ 32,500	4	$ 130,000	4 culverts at Flying Cow Rd
	60" culvert open	per structure	$ 15,000		$ -	
	60" culvert with gate	per structure	$ 30,000		$ -	
	48" culvert open	per structure	$ 10,000		$ -	
	48" culvert with gate	per structure	$ 25,000	4	$ 100,000	connections from seepage canals to inflow and outflow canals
1.6.3	concrete box culvert - With gates	per structure	$ 300,000		$ -	
1.6.4	concrete box culvert - Without gates	per structure	$ 150,000		$ -	
	Control Structure - large - with gates (2)	per structure	$ 1,500,000		$ -	
	Control Structure - large - without gates	per structure	$ 750,000		$ -	
	Control Structure -small - with gate (1)	per structure	$ 500,000		$ -	
	Control Structure - small - without gates	per structure	$ 250,000	1	$ 250,000	FEB overflow to blending basin
1.7.1	**Canals (digging - no blasting)**					
1.7.1.1	Canals- Deep excavation	$/cubic yard	$ 3.5		$ -	
1.7.1.2	Canals- Shallow excavation	$/cubic yard	$ 2.5		$ -	
1.7.2	**Canals (including blasting)**					
1.7.2.1	Canals- Deep excavation	$/cubic yard	$ 5		$ -	
1.7.2.2	Canals- Shallow excavation	$/cubic yard	$ 4		$ -	
1.8.1	**Levees (no blasting)**					
1.8.1.1	Internal- 7' (4.5' SWD)	$/mile	$ 390,000		$ -	
1.8.1.3	External- 8' (4.5' SWD)	$/mile	$ 485,000	4.00	$ 1,940,000	FEB and blending basin; includes inflow, outflow and seepage canals
1.8.1.4	External- 9' (4.5' SWD)	$/mile	$ 562,000		$ -	
1.8.1.5	External-10' (4.5' SWD)	$/mile	$ 703,000		$ -	
	Seepage Control Mound	$/mile	$ 50,000	0.30	$ 15,000	
1.9	**Pumping stations**					
1.9.1.1	0-40 cfs	$/cfs	$ 7,600		$ -	
1.9.1.2	41-60 cfs	$/cfs	$ 9,500	60	$ 570,000	CTSS
1.9.1.3	60-500 cfs	$/cfs	$ 9,900		$ -	

APPENDIX A
ACME BASIN B - Alternative 2 Cost Estimate

	Item/Task	Unit	Unit cost	Quantity	Total	Comments/Explanation
1.9.1.4	500-3,000 cfs	$/cfs	$ 7,500	1010	$ 7,575,000	inflow and outflow pump stations
1.1	**Interior land preparation**					
1.10.1	Disking	$/acre	$ 60		$ -	
	Leveling/Grading	$/acre	$ 100	0	$ -	
	Clearing/Grubbing	$/acre	$ 200	209	$ 41,800	FEB and blending basin
	Other Land Preparation					
	Miscellaneous site work at C-1 canal	lump sum	$ 50,000		$ 50,000	utility relocation, repaving, etc at Flying Cow Rd
	Canal bank stabilization	$/yd^2	$ 0.20	75,000	$ 15,000	seeding/mulching/erosion control for inflow, outflow and seepage canal
Subtotal					$ 14,716,535	
Planning, Engineering and Design - 10%				0.10	$ 1,471,653	
Program and Construction Management - 10%				0.10	$ 1,471,653	
Subtotal					$ 17,659,842	
Capital and Construction Contingency - 30%				0.30	$ 5,297,953	
Subtotal Capital and Construction Costs					$ 22,957,794	
Land previously acquired - 374.53 acres		$/acre	$ 11,000	287	$ 3,157,000	$11,000/acre per SFWMD
Total Capital Costs					**$ 26,114,794**	

2	**OPERATING COSTS (per year)**					
2.1	**Labor**					
2.1.1	Engine operator/Maintenance mechanic	each	$ 50,000		$ -	
2.1.2	Lead operator	each	$ 60,000		$ -	
2.1.3	Treatment plant labor	per hr	$ 30	11,680	$ 350,400	4 8-hr shifts/day
2.2.1.1	Mechanical maintenance (lubrication, spare parts, etc.)- 500- 3,000 cfs pumps	per unit	$ 23,000		$ -	
2.2.1.2	Mechanical maintenance- 0-500 cfs pumps	per unit	$ 10,000	6	$ 60,000	total of 6 pumps - 2 inflow, 2 outflow, and 2 CTSS
2.2.2	Maintenance - Major (water control structures)	each	$ 12,000		$ -	
	Maintenance - Minor (water control structures)	each	$ 6,000	1	$ 6,000	connection to blending basin
	Maintenance - Culverts (water control structures)	each	$ 1,000	8	$ 8,000	Flying Cow and seepage culverts
2.2.3	Maintenance Large building	per unit	$ 12,000		$ -	
	Maintenance Small building	per unit	$ 6,000		$ -	
2.2.4	Maintenance- Levees	$/mile	$ 1,530	4.30	$ 6,579	
2.2.5	Maintenance (vegetation control)	$/acre	$ 22		$ -	
	Maintenance - treatment plant building	per unit	$ 2,400	1	$ 2,400	
	Maintenance - roads, miscellaneous site	Lump sum	$ 5,000		$ 5,000	
					$ -	
2.2.8	Maintenance- residual solids treatment	$/mgal avg.daily design flow	$ 1,200	25	$ 30,000	B&C Desktop, 1998
2.3	Chemicals				$ -	
2.3.1	Aluminum chloride	Dry ton	$ 160	2,236	$ 357,760	
2.3.2	PAC	lb	$ 0		$ -	
2.3.3	Ferric chloride	Dry ton	$ 180		$ -	
2.3.4	Ferric sulfate	lb	$ 0		$ -	
2.3.5	Lime		$ -		$ -	
2.3.6	Polymer	$/mgal treated	$ 8	7,221	$ 57,768	

APPENDIX A
ACME BASIN B - Alternative 2 Cost Estimate

	Item/Task	Unit	Unit cost	Quantity	Total	Comments/Explanation
2.3.7	Others		$ -		$ -	
2.4	Solids disposal	Tons	$ 50		$ -	
2.5	**Energy**		$ -		$ -	
2.5.1	Electricity	KW/hr	$ 0.08	512,418	$ 40,993	treatment plant works, includes capacity fee
2.5.2	Fuel consumption	acre-feet	$ 0.50	85,768	$ 42,884	Inflow, outflow, CTSS pump stations
	Laboratory Expenses					
	In-house expenses (process control)	lump sum	$ 1,000	1	$ 1,000	
Subtotal Operating Costs					$ 968,784	
Contingency - 30%				0.30	$ 290,635	
Total Operating Costs					**$ 1,259,420**	

3	**Salvage/Demolition/Replacement costs**					
3.1	Demolition costs	Lump sum				
3.2	Restoration of levees	$/yard	$ 3			
3.3	Restoration of FEBs		$ -		$ -	
3.4	Clearing and grubbing		$ -		$ -	
	Light foliage	$/acre	$ 300			
	Forest/heavy brushes	$/acre	$ 1,500		$ -	
3.5	Replacement items		$ -		$ 2,036,250	rebuild and refurbish pump stations after 25 years @ 25 percent of the original PS cost
3.5.1	Chemical feed system	Lump sum			43,529	60% of cost replaced every 10 years
3.5.2	Treatment plant equipment	Lump sum			$ 725,476	25% of plant cost replaced at 20th and 40th year

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ACME Basin B Alternative 2

Capital Costs, $	
Total Capital Cost	26,114,795
Present Worth - Capital Cost	25,053,310
O&M Costs, $ /yr	
Total Annual O&M Cost	1,259,419
Present Worth - Annual O&M Cost	27,064,395
Replacement Costs, $	
Replacement Costs, $	2,805,254
Present Worth - Replacement Costs	1,543,434
50 - Year Present Worth, $	
Capital Cost	25,053,310
O&M Cost	27,064,395
Replacement Cost	1,543,434
Total Present Worth - Public Cost,	$53,661,139
Total Phosphorus Removed, kg	85,050
Present worth, $/kg TP removed	$630.94

Assumptions:

1. **Interest rate 6 3/8%**
2. **Inflation 3%**
3. **Capital costs escalated to the year expected to occur**
4. **O & M costs starts on first day of operation**
5. **Permitting and procurement costs are the responsibility of the District**

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APPENDIX A
ACME BASIN B - Alternative 2 Sensitivity Case 1 (50%) Cost Estimate

	Item/Task	Unit	Unit cost	Quantity	Total	Comments/Explanation
1	**Capital costs**					
1.1.1	Equipment	Lump sum	$ -		$ 2,391,490	
1.1.2	Residuals management	$/mgal avg.daily design flow	$ 20,000	20	$ 400,000	B&C Desktop, 1998
1.1.3	Chemical feed system	Lump sum	$ -		$ 59,787	2.5% of equipment cost includes AST, pumps, piping
1.2	Freight		$ -		$ -	
1.3	Installation		$ -		$ -	
1.4	Instrumentation	Lump sum	$ -		$ 358,724	15% of equipment cost
1.5	**Electrical controls**					
1.5.1	Electrical controls					
1.5.2	Electrical power distribution	$/mile	$ 80,000	1.5	$ 120,000	assumes pump station power supply at Flying Cow Rd
1.6	**Civil Work- water control structures**					
1.6.1	84" culvert open	per structure	$ 20,000		$ -	
1.6.2	84" culvert with gate	per structure	$ 35,000		$ -	
	72" culvert open	per structure	$ 17,500		$ -	
	72" culvert with gate	per structure	$ 32,500	4	$ 130,000	4 culverts at Flying Cow Rd
	60" culvert open	per structure	$ 15,000		$ -	
	60" culvert with gate	per structure	$ 30,000		$ -	
	48" culvert open	per structure	$ 10,000		$ -	
	48" culvert with gate	per structure	$ 25,000	4	$ 100,000	connections from seepage canals to inflow and outflow canals
1.6.3	concrete box culvert - With gates	per structure	$ 300,000		$ -	
1.6.4	concrete box culvert - Without gates	per structure	$ 150,000		$ -	
	Control Structure - large - with gates (2)	per structure	$ 1,500,000		$ -	
	Control Structure - large - without gates	per structure	$ 750,000		$ -	
	Control Structure -small - with gate (1)	per structure	$ 500,000		$ -	
	Control Structure - small - without gates	per structure	$ 250,000	1	$ 250,000	FEB overflow to blending basin
1.7.1	**Canals (digging - no blasting)**					
1.7.1.1	Canals- Deep excavation	$/cubic yard	$ 3.5		$ -	
1.7.1.2	Canals- Shallow excavation	$/cubic yard	$ 2.5		$ -	
1.7.2	**Canals (including blasting)**					
1.7.2.1	Canals- Deep excavation	$/cubic yard	$ 5		$ -	
1.7.2.2	Canals- Shallow excavation	$/cubic yard	$ 4		$ -	
1.8.1	**Levees (no blasting)**					
1.8.1.1	Internal- 7' (4.5' SWD)	$/mile	$ 390,000		$ -	
1.8.1.3	External- 8' (4.5' SWD)	$/mile	$ 485,000	3.80	$ 1,843,000	FEB and blending basin; includes inflow, outflow and seepage canals
1.8.1.4	External- 9' (4.5' SWD)	$/mile	$ 562,000		$ -	
1.8.1.5	External-10' (4.5' SWD)	$/mile	$ 703,000		$ -	
	Seepage Control Mound	$/mile	$ 50,000	0.30	$ 15,000	
1.9	**Pumping stations**					
1.9.1.1	0-40 cfs	$/cfs	$ 7,600		$ -	
1.9.1.2	41-60 cfs	$/cfs	$ 9,500	47	$ 446,500	CTSS
1.9.1.3	60-500 cfs	$/cfs	$ 9,900		$ -	

APPENDIX A
ACME BASIN B - Alternative 2 Sensitivity Case 1 (50%) Cost Estimate

	Item/Task	Unit		Unit cost	Quantity		Total	Comments/Explanation
1.9.1.4	500-3,000 cfs	$/cfs	$	7,500	1010	$	7,575,000	inflow and outflow pump stations
1.1	**Interior land preparation**							
1.10.1	Disking	$/acre	$	60		$	-	
	Leveling/Grading	$/acre	$	100		$	-	
	Clearing/Grubbing	$/acre	$	200	208	$	41,600	FEB and blending basin
	Other Land Preparation							
	Miscellaneous site work at C-1 canal	lump sum	$	50,000		$	50,000	utility relocation, repaving, etc at Flying Cow Rd
	Canal bank stabilization	$/yd^2	$	0.20	75,000	$	15,000	seeding/mulching/erosion control for inflow, outflow and seepage canal
Subtotal						$	13,796,101	
Planning, Engineering and Design - 10%					0.10	$	1,379,610	
Program and Construction Management - 10%					0.10	$	1,379,610	
Subtotal						$	16,555,321	
Capital and Construction Contingency - 30%					0.30	$	4,966,596	
Subtotal Capital and Construction Costs						$	21,521,917	
Land previously acquired - 374.53 acres		$/acre	$	11,000	270	$	2,970,000	$11,000/acre per SFWMD
Total Capital Costs						**$**	**24,491,917**	

2	**OPERATING COSTS (per year)**							
2.1	**Labor**							
2.1.1	Engine operator/Maintenance mechanic	each	$	50,000		$	-	
2.1.2	Lead operator	each	$	60,000		$	-	
2.1.3	Treatment plant labor	per hr	$	30	11,680	$	350,400	4 8-hr shifts/day
2.2.1.1	Mechanical maintenance (lubrication, spare parts, etc.)- 500- 3,000 cfs pumps	per unit	$	23,000		$	-	
2.2.1.2	Mechanical maintenance- 0-500 cfs pumps	per unit	$	10,000	6	$	60,000	total of 6 pumps - 2 inflow, 2 outflow, and 2 CTSS
2.2.2	Maintenance - Major (water control structures)	each	$	12,000		$	-	
	Maintenance - Minor (water control structures)	each	$	6,000	1	$	6,000	connection to blending basin
	Maintenance - Culverts (water control structures)	each	$	1,000	8	$	8,000	Flying Cow and seepage culverts
2.2.3	Maintenance Large building	per unit	$	12,000		$	-	
	Maintenance Small building	per unit	$	6,000		$	-	
2.2.4	Maintenance- Levees	$/mile	$	1,530	4.10	$	6,273	
2.2.5	Maintenance (vegetation control)	$/acre	$	22		$	-	
	Maintenance - treatment plant building	per unit	$	2,400	1	$	2,400	
	Maintenance - roads, miscellaneous site	Lump sum	$	5,000		$	5,000	
						$	-	
2.2.8	Maintenance- residual solids treatment	$/mgal avg.daily design flow	$	1,200	20	$	24,000	B&C Desktop, 1998
2.3	Chemicals					$	-	
2.3.1	Aluminum chloride	Dry ton	$	160	2000	$	320,058	
2.3.2	PAC	lb	$	0		$	-	
2.3.3	Ferric chloride	Dry ton	$	180		$	-	
2.3.4	Ferric sulfate	lb	$	0		$	-	
2.3.5	Lime		$	-		$	-	
2.3.6	Polymer	$/mgal treated	$	8	6,460	$	51,680	

APPENDIX A
ACME BASIN B - Alternative 2 Sensitivity Case 1 (50%) Cost Estimate

	Item/Task	Unit	Unit cost	Quantity	Total	Comments/Explanation
2.3.7	Others		$ -		$ -	
2.4	Solids disposal	Tons	$ 50		$ -	
2.5	**Energy**		$ -		$ -	
2.5.1	Electricity	KW/hr	$ 0.08	461050	$ 36,884	treatment plant works, includes capacity fee
2.5.2	Fuel consumption	acre-feet	$ 0.50	83,569	$ 41,784	Inflow, outflow, CTSS pump stations
	Laboratory Expenses					
	In-house expenses (process control)	lump sum	$ 1,000	1	$ 1,000	
Subtotal Operating Costs					$ 913,479	
Contingency - 30%				0.30	$ 274,044	
Total Operating Costs					**$ 1,187,523**	

3	**Salvage/Demolition/Replacement costs**					
3.1	Demolition costs	Lump sum				
3.2	Restoration of levees	$/yard	$ 3			
3.3	Restoration of FEBs		$ -		$ -	
3.4	Clearing and grubbing		$ -		$ -	
	Light foliage	$/acre	$ 300			
	Forest/heavy brushes	$/acre	$ 1,500		$ -	
3.5	Replacement items		$ -		$ 2,005,375	rebuild and refurbish pump stations after 25 years @ 25 percent of the original PS cost
3.5.1	Chemical feed system	Lump sum			35,872	60% of cost replaced every 10 years
3.5.2	Treatment plant equipment	Lump sum			$ 597,873	25% of plant cost replaced at 20th and 40th year

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ACME Basin B Alternative 2 Sensitivity Case 1 (50%)

Capital Costs, $	
Total Capital Cost	24,491,918
Present Worth - Capital Cost	23,496,822
O&M Costs, $ /yr	
Total Annual O&M Cost	1,187,523
Present Worth - Annual O&M Cost	25,519,370
Replacement Costs, $	
Replacement Costs, $	2,639,120
Present Worth - Replacement Costs	1,414,695
50 - Year Present Worth, $	
Capital Cost	23,496,822
O&M Cost	25,519,370
Replacement Cost	1,414,695
Total Present Worth - Public Cost,	$50,430,887
Total Phosphorus Removed, kg	47,000
Present worth, $/kg TP removed	$1,073.00

Assumptions:

1. **Interest rate 6 3/8%**
2. **Inflation 3%**
3. **Capital costs escalated to the year expected to occur**
4. **O & M costs starts on first day of operation**
5. **Permitting and procurement costs are the responsibility of the District**

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APPENDIX A
ACME BASIN B - Alternative 2 Sensitivity Case 2 (8 ppb / 13 ppb) Cost Estimate

	Item/Task	Unit	Unit cost	Quantity	Total	Comments/Explanation
1	**Capital costs**					
1.1.1	Equipment	Lump sum	$ -		$ 5,212,285	
1.1.2	Residuals management	$/mgal avg.daily design flow	$ 20,000	50	$ 1,000,000	B&C Desktop, 1998
1.1.3	Chemical feed system	Lump sum	$ -		$ 130,307	2.5% of equipment cost includes AST, pumps, piping
1.2	Freight		$ -		$ -	
1.3	Installation		$ -		$ -	
1.4	Instrumentation	Lump sum	$ -		$ 781,843	15% of equipment cost
1.5	**Electrical controls**					
1.5.1	Electrical controls					
1.5.2	Electrical power distribution	$/mile	$ 80,000	1.5	$ 120,000	assumes pump station power supply at Flying Cow Rd
1.6	**Civil Work- water control structures**					
1.6.1	84" culvert open	per structure	$ 20,000		$ -	
1.6.2	84" culvert with gate	per structure	$ 35,000		$ -	
	72" culvert open	per structure	$ 17,500		$ -	
	72" culvert with gate	per structure	$ 32,500	4	$ 130,000	4 culverts at Flying Cow Rd
	60" culvert open	per structure	$ 15,000		$ -	
	60" culvert with gate	per structure	$ 30,000		$ -	
	48" culvert open	per structure	$ 10,000		$ -	
	48" culvert with gate	per structure	$ 25,000	4	$ 100,000	connections from seepage canals to inflow and outflow canals
1.6.3	concrete box culvert - With gates	per structure	$ 300,000		$ -	
1.6.4	concrete box culvert - Without gates	per structure	$ 150,000		$ -	
	Control Structure - large - with gates (2)	per structure	$ 1,500,000		$ -	
	Control Structure - large - without gates	per structure	$ 750,000		$ -	
	Control Structure -small - with gate (1)	per structure	$ 500,000		$ -	
	Control Structure - small - without gates	per structure	$ 250,000	1	$ 250,000	FEB overflow to blending basin
1.7.1	**Canals (digging - no blasting)**					
1.7.1.1	Canals- Deep excavation	$/cubic yard	$ 3.5		$ -	
1.7.1.2	Canals- Shallow excavation	$/cubic yard	$ 2.5		$ -	
1.7.2	**Canals (including blasting)**					
1.7.2.1	Canals- Deep excavation	$/cubic yard	$ 5		$ -	
1.7.2.2	Canals- Shallow excavation	$/cubic yard	$ 4		$ -	
1.8.1	**Levees (no blasting)**					
1.8.1.1	Internal- 7' (4.5' SWD)	$/mile	$ 390,000		$ -	
1.8.1.3	External- 8' (4.5' SWD)	$/mile	$ 485,000	4.10	$ 1,988,500	FEB and blending basin; includes inflow, outflow and seepage canals
1.8.1.4	External- 9' (4.5' SWD)	$/mile	$ 562,000		$ -	
1.8.1.5	External-10' (4.5' SWD)	$/mile	$ 703,000		$ -	
	Seepage Control Mound	$/mile	$ 50,000	0.30	$ 15,000	
1.9	**Pumping stations**					
1.9.1.1	0-40 cfs	$/cfs	$ 7,600		$ -	
1.9.1.2	41-60 cfs	$/cfs	$ 9,500			
1.9.1.3	60-500 cfs	$/cfs	$ 9,900	116	$ 1,150,875	CTSS

APPENDIX A
ACME BASIN B - Alternative 2 Sensitivity Case 2 (8 ppb / 13 ppb) Cost Estimate

	Item/Task	Unit		Unit cost	Quantity		Total	Comments/Explanation
1.9.1.4	500-3,000 cfs	$/cfs	$	7,500	1010	$	7,575,000	inflow and outflow pump stations
1.1	**Interior land preparation**							
1.10.1	Disking	$/acre	$	60		$	-	
	Leveling/Grading	$/acre	$	100	0	$	-	
	Clearing/Grubbing	$/acre	$	200	219	$	43,800	FEB and blending basin
	Other Land Preparation							
	Miscellaneous site work at C-1 canal	lump sum	$	50,000		$	50,000	utility relocation, repaving, etc at Flying Cow Rd
	Canal bank stabilization	$/yd^2	$	0.20	75,000	$	15,000	seeding/mulching/erosion control for inflow, outflow and seepage canal
Subtotal						$	18,562,610	
Planning, Engineering and Design - 10%					0.10	$	1,856,261	
Program and Construction Management - 10%					0.10	$	1,856,261	
Subtotal						$	22,275,132	
Capital and Construction Contingency - 30%					0.30	$	6,682,540	
Subtotal Capital and Construction Costs						$	28,957,671	
Land previously acquired - 374.53 acres		$/acre	$	11,000	301	$	3,311,000	$11,000/acre per SFWMD
Total Capital Costs						**$**	**32,268,671**	

2	**OPERATING COSTS (per year)**							
2.1	**Labor**							
2.1.1	Engine operator/Maintenance mechanic	each	$	50,000		$	-	
2.1.2	Lead operator	each	$	60,000		$	-	
2.1.3	Treatment plant labor	per hr	$	30	11,680	$	350,400	4 8-hr shifts/day
2.2.1.1	Mechanical maintenance (lubrication, spare parts, etc.)- 500- 3,000 cfs pumps	per unit	$	23,000		$	-	
2.2.1.2	Mechanical maintenance- 0-500 cfs pumps	per unit	$	10,000	6	$	60,000	total of 6 pumps - 2 inflow, 2 outflow, and 2 CTSS
2.2.2	Maintenance - Major (water control structures)	each	$	12,000		$	-	
	Maintenance - Minor (water control structures)	each	$	6,000	1	$	6,000	connection to blending basin
	Maintenance - Culverts (water control structures)	each	$	1,000	8	$	8,000	Flying Cow and seepage culverts
2.2.3	Maintenance Large building	per unit	$	12,000		$	-	
	Maintenance Small building	per unit	$	6,000		$	-	
2.2.4	Maintenance- Levees	$/mile	$	1,530	4.40	$	6,732	
2.2.5	Maintenance (vegetation control)	$/acre	$	22		$	-	
	Maintenance - treatment plant building	per unit	$	2,400	1	$	2,400	
	Maintenance - roads, miscellaneous site	Lump sum	$	5,000		$	5,000	
						$	-	
2.2.8	Maintenance- residual solids treatment	$/mgal avg.daily design flow	$	1,200	50	$	60,000	B&C Desktop, 1998
2.3	Chemicals					$	-	
2.3.1	Aluminum chloride	Dry ton	$	160	2869	$	458,981	
2.3.2	PAC	lb	$	0		$	-	
2.3.3	Ferric chloride	Dry ton	$	180		$	-	
2.3.4	Ferric sulfate	lb	$	0		$	-	
2.3.5	Lime		$	-		$	-	
2.3.6	Polymer	$/mgal treated	$	8	9,264	$	74,112	

APPENDIX A
ACME BASIN B - Alternative 2 Sensitivity Case 2 (8 ppb / 13 ppb) Cost Estimate

	Item/Task	Unit	Unit cost	Quantity	Total	Comments/Explanation
2.3.7	Others		$ -		$ -	
2.4	Solids disposal	Tons	$ 50		$ -	
2.5	**Energy**		$ -		$ -	
2.5.1	Electricity	KW/hr	$ 0.08	650320	$ 52,026	treatment plant works, includes capacity fee
2.5.2	Fuel consumption	acre-feet	$ 0.50	92,170	$ 46,085	Inflow, outflow, CTSS pump stations
	Laboratory Expenses					
	In-house expenses (process control)	lump sum	$ 1,000	1	$ 1,000	
Subtotal Operating Costs					$ 1,130,735	
Contingency - 30%				0.30	$ 339,221	
Total Operating Costs					**$ 1,469,956**	

3	**Salvage/Demolition/Replacement costs**					
3.1	Demolition costs	Lump sum				
3.2	Restoration of levees	$/yard	$ 3			
3.3	Restoration of FEBs		$ -		$ -	
3.4	Clearing and grubbing		$ -		$ -	
	Light foliage	$/acre	$ 300			
	Forest/heavy brushes	$/acre	$ 1,500		$ -	
3.5	Replacement items		$ -		$ 2,181,469	rebuild and refurbish pump stations after 25 years @ 25 percent of the original PS cost
3.5.1	Chemical feed system	Lump sum			78,184	60% of cost replaced every 10 years
3.5.2	Treatment plant equipment	Lump sum			$ 1,303,071	25% of plant cost replaced at 20th and 40th year

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ACME Basin B Alternative 2 Sensitivity Case 2

Capital Costs, $	
Total Capital Cost	32,268,672
Present Worth - Capital Cost	30,929,775
O&M Costs, $ /yr	
Total Annual O&M Cost	1,469,957
Present Worth - Annual O&M Cost	31,588,761
Replacement Costs, $	
Replacement Costs, $	3,562,724
Present Worth - Replacement Costs	2,128,549
50 - Year Present Worth, $	
Capital Cost	30,929,775
O&M Cost	31,588,761
Replacement Cost	2,128,549
Total Present Worth - Public Cost,	$64,647,085
Total Phosphorus Removed, kg	102,150
Present worth, $/kg TP removed	$632.86

Assumptions:

1. **Interest rate 6 3/8%**
2. **Inflation 3%**
3. **Capital costs escalated to the year expected to occur**
4. **O & M costs starts on first day of operation**
5. **Permitting and procurement costs are the responsibility of the District**

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APPENDIX A
ACME BASIN B - Alternative 3 Cost Estimate

	Item/Task	Unit	Unit cost	Quantity	Total	Comments/Explanation
1	**Capital costs**					
1.1.1	Equipment		$ -		$ -	
1.1.2	Residuals management		$ -		$ -	
1.2	Freight		$ -		$ -	
1.3	Installation		$ -		$ -	
1.4	Instrumentation		$ -		$ -	
1.5	**Electrical controls**					
1.5.1	Electrical controls					
1.5.2	Electrical power distribution	$/mile	$ 80,000	1.50	$ 120,000	assumes pump station power supply at Flying Cow Rd
1.6	**Civil Work- water control structures**					
1.6.1	84" culvert open	per structure	$ 20,000		$ -	
1.6.2	84" culvert with gate	per structure	$ 35,000		$ -	
	72" culvert open	per structure	$ 17,500		$ -	
	72" culvert with gate	per structure	$ 32,500	4	$ 130,000	4 culverts at Flying Cow Rd
	60" culvert open	per structure	$ 15,000	18	$ 270,000	6 culverts for each interior levee (2), outflow levee
	60" culvert with gate	per structure	$ 30,000	6	$ 180,000	6 culverts at inflow canal
	48" culvert open	per structure	$ 10,000		$ -	
	48" culvert with gate	per structure	$ 25,000	4	$ 100,000	connections from seepage canals to inflow and outflow canals
1.6.3	concrete box culvert - With gates	per structure	$ 300,000		$ -	
1.6.4	concrete box culvert - Without gates	per structure	$ 150,000		$ -	
	Control Structure - large - with gates (2)	per structure	$ 1,500,000		$ -	
	Control Structure - large - without gates	per structure	$ 750,000		$ -	
	Control Structure -small - with gate (1)	per structure	$ 500,000		$ -	
	Control Structure - small - without gates	per structure	$ 250,000		$ -	
1.7.1	**Canals (digging - no blasting)**					
1.7.1.1	Canals- Deep excavation	$/cubic yard	$ 3.5		$ -	
1.7.1.2	Canals- Shallow excavation	$/cubic yard	$ 2.5		$ -	
1.7.2	**Canals (including blasting)**					
1.7.2.1	Canals- Deep excavation	$/cubic yard	$ 5		$ -	
1.7.2.2	Canals- Shallow excavation	$/cubic yard	$ 4		$ -	
1.8.1	**Levees (no blasting)**					
1.8.1.1	Internal- 7' (4.5' SWD)	$/mile	$ 390,000	2.34	$ 912,955	Includes internal canals
1.8.1.3	External- 8' (4.5' SWD)	$/mile	$ 485,000	3.39	$ 1,645,785	Includes inflow canal, outflow canal and seepage canals
1.8.1.4	External- 9' (4.5' SWD)	$/mile	$ 562,000		$ -	
1.8.1.5	External-10' (4.5' SWD)	$/mile	$ 703,000		$ -	
	Seepage Control Mound	$/mile	$ 50,000	2.72	$ 136,070	
1.9	**Pumping stations**					
1.9.1.1	0-40 cfs	$/cfs	$ 7,600		$ -	
1.9.1.2	41-60 cfs	$/cfs	$ 9,500		$ -	
1.9.1.3	60-500 cfs	$/cfs	$ 9,900		$ -	
1.9.1.4	500-3,000 cfs	$/cfs	$ 7,500	1010	$ 7,575,000	inflow and outflow pump stations
1.1	**Interior land preparation**					
1.10.1	Disking	$/acre	$ 60		$ -	
	Leveling/Grading	$/acre	$ 100	375	$ 37,500	

APPENDIX A
ACME BASIN B - Alternative 3 Cost Estimate

	Item/Task	Unit		Unit cost	Quantity		Total	Comments/Explanation
	Clearing/Grubbing	$/acre	$	200	297	$	59,400	treatment cells only
	Other Land Preparation							
	Miscellaneous site work at C-1 canal	lump sum	$	50,000		$	50,000	utility relocation, repaving, etc at Flying Cow Rd
	Drainage improvements	lump sum	$	100,000		$	100,000	drainage improvements to the south of the STA
	Canal bank stabilization	$/yd^2	$	0.20	100,000	$	20,000	seeding/mulching/erosion control for inflow, outflow and seepage canals
Subtotal						$	11,336,710	
Planning, Engineering and Design - 10%					0.10	$	1,133,671	
Program and Construction Management - 10%					0.10	$	1,133,671	
Subtotal						$	13,604,052	
Capital and Construction Contingency - 30%					0.30	$	4,081,215	
Subtotal Capital and Construction Costs						$	17,685,267	
Land previously acquired - Section 24		$/acre	$	11,000	374.53	$	4,119,830	per SFWMD
Total Capital Costs						**$**	**21,805,097**	

2	**OPERATING COSTS (per year)**							
2.1	**Labor**							
2.1.1	Engine operator/Maintenance mechanic	each	$	50,000	0.50	$	25,000	
2.1.2	Lead operator	each	$	60,000	0.50	$	30,000	
2.2.1.1	Mechanical maintenance (lubrication, spare parts, etc.)- 500- 3,000 cfs pumps	per unit	$	23,000		$	-	
2.2.1.2	Mechanical maintenance- 0-500 cfs pumps	per unit	$	10,000	4.00	$	40,000	total of 4 pumps - 2 inflow, 2 outflow
2.2.2	Maintenance - Major (water control structures)	each	$	12,000		$	-	
	Maintenance - Minor (water control structures)	each	$	6,000		$	-	
	Maintenance - Culverts (water control structures)	each	$	1,000	32	$	32,000	24 culverts in the STA, 4 culverts on seepage canal, 4 at Flying Cow Road
2.2.3	Maintenance Large building	per unit	$	12,000		$	-	
	Maintenance Small building	per unit	$	6,000	2	$	12,000	
2.2.4	Maintenance- Levees	$/mile	$	1,530	8.46	$	12,937	
2.2.5	Maintenance (vegetation control)	$/acre	$	22	297	$	6,534	treatment cells only
2.2.6	Maintenance - roads, miscellaneous site	Lump sum	$	5,000		$	5,000	
2.2.7						$	-	
2.2.8	Maintenance- Sludge treatment		$	-		$	-	
2.3	Chemicals					$	-	
2.3.1	Aluminum sulfate	Dry ton	$	150		$	-	
2.3.2	PAC	lb	$	0		$	-	
2.3.3	Ferric chloride	Dry ton	$	180		$	-	
2.3.4	Ferric sulfate	lb	$	0		$	-	
2.3.5	Lime		$	-		$	-	
2.3.6	Polymer	Tons	$	4,000		$	-	
2.3.7	Others		$	-		$	-	
2.4	Solids disposal	Tons	$	50		$	-	
2.5	**Energy**		$	-		$	-	
2.5.1	Electricity	KW/hr	$	0.08	25,000	$	2,000	Includes capacity fee

APPENDIX A
ACME BASIN B - Alternative 3 Cost Estimate

	Item/Task	Unit	Unit cost	Quantity	Total	Comments/Explanation
2.5.2	Fuel consumption	acre-feet	$ 0.50	63,753	$ 31,876	Based on the average flow for the 31-yr period of record (44 cfs) @ the inflow and outflow pump stations
Subtotal Operating Costs					$ 197,348	
Contingency - 30%				0.30	$ 59,204	
Total Operating Costs					**$ 256,552**	
3	**Salvage/Demolition/Replacement costs**					
3.1	Demolition costs				$ -	
3.2	Restoration of levees	$/yard	$ 3		$ -	
3.3	Restoration of FEBs		$ -		$ -	
3.4	Clearing and grubbing		$ -		$ -	
	Light foliage	$/acre	$ 300		$ -	
	Forest/heavy brushes	$/acre	$ 1,500		$ -	
3.5	Replacement items		$ -		$ 1,893,750	rebuild and refurbish pump stations after 25 years @ 25 percent of the original PS cost

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ACME Basin B Alternative 3

Capital Costs, $	
Total Capital Cost	21,805,098
Present Worth - Capital Cost	21,038,342
O&M Costs, $ /yr	
Total Annual O&M Cost	256,551
Present Worth - Annual O&M Cost	5,352,599
Replacement Costs, $	
Replacement Costs, $	1,893,750
Present Worth - Replacement Costs	825,914
50 - Year Present Worth, $	
Capital Cost	21,038,342
O&M Cost	5,352,599
Replacement Cost	825,914
Total Present Worth - Public Cost,	$27,216,854
Total Phosphorus Removed, kg	98,970
Present worth, $/kg TP removed	$275.00

Assumptions:

1. **Interest rate 6 3/8%**
2. **Inflation 3%**
3. **Capital costs escalated to the year expected to occur**
4. **O & M costs starts on first day of operation**
5. **Permitting and procurement costs are the responsibility of the District**

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APPENDIX A
ACME BASIN B - Alternative 4 Cost Estimate

	Item/Task	Unit	Unit cost	Quantity	Total	Comments/Explanation
1	**Capital costs**					
1.1.1	Equipment		$ -		$ -	
1.1.2	Residuals management		$ -		$ -	
1.2	Freight		$ -		$ -	
1.3	Installation		$ -		$ -	
1.4	Instrumentation		$ -		$ -	
1.5	**Electrical controls**					
1.5.1	Electrical controls					
1.5.2	Electrical power distribution	$/mile	$ 80,000	1.50	$ 120,000	assumes pump station power supply at Flying Cow Rd
1.6	**Civil Work- water control structures**					
1.6.1	84" culvert open	per structure	$ 20,000		$ -	
1.6.2	84" culvert with gate	per structure	$ 35,000		$ -	
	72" culvert open	per structure	$ 17,500		$ -	
	72" culvert with gate	per structure	$ 32,500	4	$ 130,000	4 culverts at Flying Cow Rd
	60" culvert open	per structure	$ 15,000	18	$ 270,000	6 culverts for each interior levee (2), and outflow levee
	60" culvert with gate	per structure	$ 30,000	6	$ 180,000	6 culverts at inflow canal
	48" culvert open	per structure	$ 10,000		$ -	
	48" culvert with gate	per structure	$ 25,000	4	$ 100,000	connections from seepage canals to inflow and outflow canals
1.6.3	10' x 10' x 53' concrete box culvert - With gates	per structure	$ 300,000		$ -	
1.6.4	10' x 10' x 53' concrete box culvert - Without gates	per structure	$ 150,000		$ -	
	Control Structure - large - with gates (2)	per structure	$ 1,500,000		$ -	
	Control Structure - large - without gates	per structure	$ 750,000		$ -	
	Control Structure -small - with gate (1)	per structure	$ 500,000		$ -	
	Control Structure - small - without gates	per structure	$ 250,000		$ -	
1.7.1	**Canals (digging - no blasting)**					
1.7.1.1	Canals- Deep excavation	$/cubic yard	$ 3.5		$ -	
1.7.1.2	Canals- Shallow excavation	$/cubic yard	$ 2.5		$ -	
1.7.2	**Canals (including blasting)**					
1.7.2.1	Canals- Deep excavation	$/cubic yard	$ 5		$ -	
1.7.2.2	Canals- Shallow excavation	$/cubic yard	$ 4		$ -	
1.8.1	**Levees (no blasting)**					
1.8.1.1	Internal- 7' (4.5' SWD)	$/mile	$ 390,000	2.97	$ 1,158,920	Includes internal canals
1.8.1.3	External- 8' (4.5' SWD)	$/mile	$ 485,000	3.07	$ 1,490,089	Includes inflow canal, outflow canal and seepage canals
1.8.1.4	External- 9' (4.5' SWD)	$/mile	$ 562,000		$ -	
1.8.1.5	External-10' (4.5' SWD)	$/mile	$ 703,000		$ -	
	Seepage Control Mound	$/mile	$ 50,000	2.33	$ 116,383	
1.9	**Pumping stations**					
1.9.1.1	0-40 cfs	$/cfs	$ 7,600		$ -	
1.9.1.2	41-60 cfs	$/cfs	$ 9,500		$ -	
1.9.1.3	60-500 cfs	$/cfs	$ 9,900		$ -	
1.9.1.4	500-3,000 cfs	$/cfs	$ 7,500	1010	$ 7,575,000	inflow and outflow pump stations
1.1	**Interior land preparation**					
1.10.1	Disking	$/acre	$ 60		$ -	
	Leveling/Grading	$/acre	$ 100	415	$ 41,500	

APPENDIX A
ACME BASIN B - Alternative 4 Cost Estimate

	Item/Task	Unit		Unit cost	Quantity		Total	Comments/Explanation
	Clearing/Grubbing	$/acre	$	200	346	$	69,200	treatment cells only
	Other Land Preparation							
	Miscellaneous site work at C-1 canal	lump sum	$	50,000		$	50,000	utility relocation, repaving, etc at Flying Cow Rd
	Canal bank stabilization	$/yd^2	$	0.20	100,000	$	20,000	seeding/mulching/erosion control for inflow, outflow and seepage canals
Subtotal						$	11,321,092	
Planning, Engineering and Design - 10%					0.10	$	1,132,109	
Program and Construction Management - 10%					0.10	$	1,132,109	
Subtotal						$	13,585,310	
Capital and Construction Contingency - 30%					0.30	$	4,075,593	
Subtotal Capital and Construction Costs						$	17,660,904	
Land/Right-of-way Acquisition		$/acre	$	30,000	40.47	$	1,214,100	per SFWMD (additional land to be acquired above the 374.53 acres already owned by SFWMD)
Land/Right-of-way Acquisition Contingency (40%)					0.40	$	485,640	per SFWMD
Land previously acquired - Section 24		$/acre	$	11,000	374.53	$	4,119,830	per SFWMD
Total Capital Costs						**$**	**23,480,474**	

2	**OPERATING COSTS (per year)**							
2.1	**Labor**							
2.1.1	Engine operator/Maintenance mechanic	each	$	50,000	0.50	$	25,000	
2.1.2	Lead operator	each	$	60,000	0.50	$	30,000	
2.2.1.1	Mechanical maintenance (lubrication, spare parts, etc.)- 500- 3,000 cfs pumps	per unit	$	23,000		$	-	
2.2.1.2	Mechanical maintenance- 0-500 cfs pumps	per unit	$	10,000	4.00	$	40,000	total of 4 pumps - 2 inflow, 2 outflow
2.2.2	Maintenance -Major water control structures	each	$	12,000		$	-	
	Maintenance - Minor water control structures	each	$	6,000		$	-	
	Maintenance - Culverts	each	$	1,000	32	$	32,000	24 culverts in the STA, 4 culverts on seepage canals, 4 at Flying Cow Rd
2.2.3	Maintenance Large building	per unit	$	12,000		$	-	
	Maintenance Small building	per unit	$	6,000	2	$	12,000	
2.2.4	Maintenance- Levees	$/mile	$	1,530	8.37	$	12,809	
2.2.5	Maintenance (vegetation control)	$/acre	$	22	346	$	7,612	treatment cells only
2.2.6	Maintenance - roads, miscellaneous site	Lump sum	$	5,000		$	5,000	
2.2.7						$	-	
2.2.8	Maintenance- Sludge treatment		$	-		$	-	
2.3	Chemicals					$	-	
2.3.1	Aluminum sulfate	Dry ton	$	150		$	-	
2.3.2	PAC	lb	$	0.20		$	-	
2.3.3	Ferric chloride	Dry ton	$	180		$	-	
2.3.4	Ferric sulfate	lb	$	0.40		$	-	
2.3.5	Lime		$	-		$	-	
2.3.6	Polymer	Tons	$	4,000		$	-	
2.3.7	Others		$	-		$	-	
2.4	Solids disposal	Tons	$	50		$	-	
2.5	**Energy**		$	-		$	-	

APPENDIX A
ACME BASIN B - Alternative 4 Cost Estimate

	Item/Task	Unit	Unit cost	Quantity	Total	Comments/Explanation
2.5.1	Electricity	KW/hr	$ 0.08	25,000	$ 2,000	Includes capacity fee
2.5.2	Fuel consumption	acre-feet	$ 0.50	63,753	$ 31,876	Based on an average flow of 44 cfs @ the inflow and outflow pump stations
Subtotal Operating Costs					$ 198,297	
Contingency - 30%				0.30	$ 59,489	
Total Operating Costs					**$ 257,786**	

3	**Salvage/Demolition/Replacement costs**					
3.1	Demolition costs				$ -	
3.2	Restoration of levees	$/yard	$ 3		$ -	
3.3	Restoration of FEBs		$ -		$ -	
3.4	Clearing and grubbing		$ -		$ -	
	Light foliage	$/acre	$ 300		$ -	
	Forest/heavy brushes	$/acre	$ 1,500		$ -	rebuild and refurbish pump stations after 25 years @ 25 percent of the original pump cost
3.5	Replacement items		$ -		$ 1,893,750	

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ACME Basin B Alternative 4

Capital Costs, $	
Total Capital Cost	23,480,474
Present Worth - Capital Cost	22,601,769
O&M Costs, $ /yr	
Total Annual O&M Cost	257,786
Present Worth - Annual O&M Cost	5,202,772
Replacement Costs, $	
Replacement Costs, $	1,893,750
Present Worth - Replacement Costs	825,914
50 - Year Present Worth, $	
Capital Cost	22,601,769
O&M Cost	5,202,772
Replacement Cost	825,914
Total Present Worth - Public Cost,	$28,630,454
Total Phosphorus Removed, kg	100,559
Present worth, $/kg TP removed	$284.71

Assumptions:

1. **Interest rate 6 3/8%**
2. **Inflation 3%**
3. **Capital costs escalated to the year expected to occur**
4. **O & M costs starts on first day of operation**
5. **Permitting and procurement costs are the responsibility of the District**

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APPENDIX A
C-11 WEST BASIN - Alternative 1 Cost Estimate

	Item/Task	Unit	Unit cost	Quantity	Total	Comments/Explanation
1	**Capital costs**					
1.1.1	Equipment	Lump sum	$ -		$ 3,937,721	
1.1.2	Residuals management	$/mgal avg.daily design flow	$ 20,000	35	$ 700,000	B&C Desktop, 1998
1.1.3	Chemical feed system	Lump sum	$ -		$ 98,443	2.5% of equipment cost includes AST, pumps, piping
1.2	Freight		$ -		$ -	
1.3	Installation		$ -		$ -	
1.4	Instrumentation	Lump sum	$ -		$ 590,658	15% of equipment cost
1.5	**Electrical controls**					
1.5.1	Electrical controls					
1.5.2	Electrical power distribution	$/mile	$ 80,000	1	$ 80,000	assumed distance - location unknown
1.6	**Civil Work- water control structures**					
1.6.1	84" culvert open	per structure	$ 20,000		$ -	
1.6.2	84" culvert with gate	per structure	$ 35,000		$ -	
	72" culvert open	per structure	$ 17,500		$ -	
	72" culvert with gate	per structure	$ 32,500	4	$ 130,000	4 culverts at the interceptor/seepage canal
	60" culvert open	per structure	$ 15,000		$ -	
	60" culvert with gate	per structure	$ 30,000		$ -	
	48" culvert open	per structure	$ 10,000		$ -	
	48" culvert with gate	per structure	$ 25,000		$ -	
1.6.3	concrete box culvert - With gates	per structure	$ 300,000		$ -	
1.6.4	concrete box culvert - Without gates	per structure	$ 150,000		$ -	
	Control Structure - large - with gates	per structure	$ 1,500,000	1	$ 1,500,000	outflow control structure
	Control Structure - large - without gates	per structure	$ 750,000		$ -	
	Control Structure -small - with gate	per structure	$ 500,000		$ -	
	Control Structure - small - without gates	per structure	$ 250,000	1	$ 250,000	FEB overflow to blending basin
1.7.1	**Canals (digging - no blasting)**					
1.7.1.1	Canals- Deep excavation	$/cubic yard	$ 3.5		$ -	
1.7.1.2	Canals- Shallow excavation	$/cubic yard	$ 2.5	255,000	$ 637,500	interceptor/seepage canal
1.7.2	**Canals (including blasting)**					
1.7.2.1	Canals- Deep excavation	$/cubic yard	$ 5		$ -	
1.7.2.2	Canals- Shallow excavation	$/cubic yard	$ 4		$ -	
1.8.1	**Levees (no blasting)**					
1.8.1.1	Internal- 7' (4.5' SWD)	$/mile	$ 390,000		$ -	
1.8.1.3	External- 8' (4.5' SWD)	$/mile	$ 485,000	3.00	$ 1,455,000	FEB and blending basin
1.8.1.4	External- 9' (4.5' SWD)	$/mile	$ 562,000		$ -	
1.8.1.5	External-10' (4.5' SWD)	$/mile	$ 703,000		$ -	
	Seepage Control Mound	$/mile	$ 50,000		$ -	
1.9	**Pumping stations**					
1.9.1.1	0-40 cfs	$/cfs	$ 7,600		$ -	
1.9.1.2	41-60 cfs	$/cfs	$ 9,500		$ -	
1.9.1.3	60-500 cfs	$/cfs	$ 9,900	81	$ 805,613	CTSS pump station
1.9.1.4	500-3,000 cfs	$/cfs	$ 7,500	2933	$ 21,997,500	Inflow pump station only (existing S-9 pump station used as outflow pump station)
1.1	**Interior land preparation**					

APPENDIX A
C-11 WEST BASIN - Alternative 1 Cost Estimate

	Item/Task	Unit	Unit cost	Quantity	Total	Comments/Explanation
1.10.1	Disking	$/acre	$ 60		$ -	
	Leveling/Grading	$/acre	$ 100		$ -	
	Clearing/Grubbing	$/acre	$ 200	113	$ 22,600	FEB and blending basin
	Other Land Preparation					
	Canal bank stabilization	$/yd^2	$ 0.20	75,000	$ 15,000	seeding/mulching/erosion control for levees and interceptor/seepage canal
Subtotal					$ 32,220,035	
Planning, Engineering and Design - 10%				0.10	$ 3,222,003	
Program and Construction Management - 10%				0.10	$ 3,222,003	
Subtotal					$ 38,664,042	
Capital and Construction Contingency - 30%				0.30	$ 11,599,212	
Subtotal Capital and Construction Costs					$ 50,263,254	
Land/Right-of-way Acquisition		$/acre	$ 300,000	168	$ 50,400,000	
Land/Right-of-way Acquisition associated costs					$ 1,000,000	
Land/Right-of-way Acquisition Contingency -15%				0.15	$ 7,710,000	
Total Capital Costs					**$ 109,373,254**	

2a	**OPERATING COSTS (per year)**					
	2006 through 2036					
2.1	**Labor**					
2.1.1	Engine operator/Maintenance mechanic	each	$ 50,000		$ -	
2.1.2	Lead operator	each	$ 60,000		$ -	
2.1.3	Treatment plant labor	per hr	$ 30	11,680	$ 350,400	4 8-hr shifts/day
2.2.1.1	Mechanical maintenance (lubrication, spare parts, etc.)- 500- 3,000 cfs pumps	per unit	$ 23,000	2	$ 46,000	2 inflow
2.2.1.2	Mechanical maintenance- 0-500 cfs pumps	per unit	$ 10,000	6	$ 60,000	4 inflow and 2 CTSS
2.2.2	Maintenance - Major (water control structures)	each	$ 12,000	1	$ 12,000	
	Maintenance - Minor (water control structures)	each	$ 6,000	1	$ 6,000	FEB overflow to blending basin
	Maintenance - Culverts (water control structures)	each	$ 1,000	4	$ 4,000	4 culverts at the interceptor/seepage canal
2.2.3	Maintenance Large building	per unit	$ 12,000		$ -	
	Maintenance Small building	per unit	$ 6,000		$ -	
2.2.4	Maintenance- Levees	$/mile	$ 1,530	3.00	$ 4,590	
2.2.5	Maintenance (vegetation control)	$/acre	$ 22		$ -	
2.2.6	Maintenance - treatment plant building	per unit	$ 2,400	1	$ 2,400	
2.2.7						
2.2.8	Maintenance- residual solids treatment	$/mgal avg.daily design flow	$ 1,200	35	$ 42,000	B&C Desktop, 1998
2.3	Chemicals				$ -	
2.3.1	Aluminum chloride	Dry ton	$ 160	1080	$ 172,861	
2.3.2	PAC	lb	$ 0		$ -	
2.3.3	Ferric chloride	Dry ton	$ 180		$ -	
2.3.4	Ferric sulfate	lb	$ 0		$ -	
2.3.5	Lime		$ -		$ -	
2.3.6	Polymer	$/mgal treated	$ 8	3489	$ 27,912	
2.3.7	Others		$ -		$ -	
2.4	Solids disposal	Tons	$ 50		$ -	
2.5	**Energy**		$ -		$ -	

APPENDIX A
C-11 WEST BASIN - Alternative 1 Cost Estimate

	Item/Task	Unit	Unit cost	Quantity	Total	Comments/Explanation
2.5.1	Electricity	KW/hr	$ 0.08	260508	$ 20,841	treatment plant works only, includes capacity fee
2.5.2	Fuel consumption	acre-feet	$ 0.50	28,814	$ 14,407	Inflow and CTSS pump stations
	Laboratory Expenses					
	In-house expenses (process control)	lump sum	$ 1,000	1	$ 1,000	
Subtotal Operating Costs - 2006 - 2036 FLOWS					$ 764,411	
Contingency - 30%				0.30	$ 229,323	
Total Operating Costs - 2006 - 2036 FLOWS					**$ 993,734**	

2b	**OPERATING COSTS (per year)**					
	2036 through 2056					
2.1	**Labor**					
2.1.1	Engine operator/Maintenance mechanic	each	$ 50,000		$ -	
2.1.2	Lead operator	each	$ 60,000		$ -	
2.1.3	Treatment plant labor	per hr	$ 30	11,680	$ 350,400	4 8-hr shifts/day
2.2.1.1	Mechanical maintenance (lubrication, spare parts, etc.)- 500- 3,000 cfs pumps	per unit	$ 11,500	2	$ 23,000	unit cost for pump maintenance reduced by 50% since pumps will be used infrequently
2.2.1.2	Mechanical maintenance- 0-500 cfs pumps	per unit	$ 5,000	6	$ 30,000	unit cost for pump maintenance reduced by 50% since pumps will be used infrequently
2.2.2	Maintenance - Major (water control structures)	each	$ 12,000	1	$ 12,000	
	Maintenance - Minor (water control structures)	each	$ 6,000	1	$ 6,000	FEB overflow to blending basin
	Maintenance - Culverts (water control structures)	each	$ 1,000	4	$ 4,000	
2.2.3	Maintenance Large building	per unit	$ 12,000			
	Maintenance Small building	per unit	$ 6,000		$ -	
2.2.4	Maintenance- Levees	$/mile	$ 1,530	3.00	$ 4,590	
2.2.5	Maintenance (vegetation control)	$/acre	$ 22		$ -	
2.2.6	Maintenance - treatment plant building	per unit	$ 2,400	1	$ 2,400	
2.2.7						
2.2.8	Maintenance- residual solids treatment	$/mgal avg.daily design flow	$ 1,200	20	$ 24,000	B&C Desktop, 1998
2.3	Chemicals				$ -	
2.3.1	Aluminum chloride	Dry ton	$ 160	24	$ 3,765	
2.3.2	PAC	lb	$ 0		$ -	
2.3.3	Ferric chloride	Dry ton	$ 180		$ -	
2.3.4	Ferric sulfate	lb	$ 0		$ -	
2.3.5	Lime		$ -		$ -	
2.3.6	Polymer	$/mgal treated	$ 8	76	$ 608	
2.3.7	Others		$ -		$ -	
2.4	Solids disposal	Tons	$ 50		$ -	
2.5	**Energy**		$ -		$ -	

APPENDIX A
C-11 WEST BASIN - Alternative 1 Cost Estimate

	Item/Task	Unit	Unit cost	Quantity	Total	Comments/Explanation
2.5.1	Electricity	KW/hr	$ 0.08	30130	$ 2,410	treatment plant works only, includes capacity fee
2.5.2	Fuel consumption	acre-feet	$ 0.50	1,139	$ 569	Inflow and CTSS pump stations
	Laboratory Expenses					
	In-house expenses (process control)	lump sum	$ 1,000	1	$ 1,000	
Subtotal Operating Costs - 2036 - 2056 FLOWS					$ 464,743	
Contingency - 30%				0.30	$ 139,423	
Total Operating Costs - 2036 - 2056 FLOWS					**$ 604,166**	
3	**Salvage/Demolition/Replacement costs**					
3.1	Demolition costs	Lump sum				
3.2	Restoration of levees	$/yard	$ 3		$ -	
3.3	Restoration of FEBs		$ -		$ -	
3.4	Clearing and grubbing		$ -		$ -	
	Light foliage	$/acre	$ 300		$ -	
	Forest/heavy brushes	$/acre	$ 1,500		$ -	
3.5	Replacement items		$ -		$ 5,700,778	rebuild and refurbishment of pump stations after 25 years @ 25 percent of the original PS cost
3.5.1	Chemical feed system	Lump sum			$ 59,066	60% of cost replaced every 10 years
3.5.2	Treatment plant equipment	Lump sum			$ 984,430	25% of plant cost replaced at 20th and 40th year

C-11 West Basin Alternative 1

Capital Costs, $	
Total Capital Cost	109,373,255
Present Worth - Capital Cost	104,912,009
O&M Costs, $ /yr	
Total Annual O&M Cost	1,597,899
Present Worth - Annual O&M Cost	11,765,356
Replacement Costs, $	
Replacement Costs, $	6,744,274
Present Worth - Replacement Costs	3,375,561
50 - Year Present Worth, $	
Capital Cost	104,912,009
O&M Cost	11,765,356
Replacement Cost	3,375,561
Total Present Worth - Public Cost,	$120,052,926
Total Phosphorus Removed, kg	4,520
Present worth, $/kg TP removed	$26,560.38

Assumptions:

1. **Interest rate 6 3/8%**
2. **Inflation 3%**
3. **Capital costs escalated to the year expected to occur**
4. **O & M costs starts on first day of operation**
5. **Permitting and procurement costs are the responsibility of the District**

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APPENDIX A
C-11 WEST BASIN - Alternative 1 Sensitivity Case (8 ppb / 13 ppb) Cost Estimate

	Item/Task	Unit	Unit cost	Quantity	Total	Comments/Explanation
1	**Capital costs**					
1.1.1	Equipment	Lump sum	$ -		$ 14,073,172	
1.1.2	Residuals management	$/mgal avg.daily design flow	$ 20,000	135	$ 2,700,000	B&C Desktop, 1998
1.1.3	Chemical feed system	Lump sum	$ -		$ 351,829	2.5% of equipment cost includes AST, pumps, piping
1.2	Freight		$ -		$ -	
1.3	Installation		$ -		$ -	
1.4	Instrumentation	Lump sum	$ -		$ 2,110,976	15% of equipment cost
1.5	**Electrical controls**					
1.5.1	Electrical controls					
1.5.2	Electrical power distribution	$/mile	$ 80,000	1	$ 80,000	assumed distance - location unknown
1.6	**Civil Work- water control structures**					
1.6.1	84" culvert open	per structure	$ 20,000		$ -	
1.6.2	84" culvert with gate	per structure	$ 35,000		$ -	
	72" culvert open	per structure	$ 17,500		$ -	
	72" culvert with gate	per structure	$ 32,500	4	$ 130,000	4 culverts at the interceptor/seepage canal
	60" culvert open	per structure	$ 15,000		$ -	
	60" culvert with gate	per structure	$ 30,000		$ -	
	48" culvert open	per structure	$ 10,000		$ -	
	48" culvert with gate	per structure	$ 25,000		$ -	
1.6.3	concrete box culvert - With gates	per structure	$ 300,000		$ -	
1.6.4	concrete box culvert - Without gates	per structure	$ 150,000		$ -	
	Control Structure - large - with gates	per structure	$ 1,500,000	1	$ 1,500,000	outflow control structure
	Control Structure - large - without gates	per structure	$ 750,000		$ -	
	Control Structure -small - with gate	per structure	$ 500,000		$ -	
	Control Structure - small - without gates	per structure	$ 250,000	1	$ 250,000	FEB overflow to blending basin
1.7.1	**Canals (digging - no blasting)**					
1.7.1.1	Canals- Deep excavation	$/cubic yard	$ 3.5		$ -	
1.7.1.2	Canals- Shallow excavation	$/cubic yard	$ 2.5	265,000	$ 662,500	interceptor/seepage canal
1.7.2	**Canals (including blasting)**					
1.7.2.1	Canals- Deep excavation	$/cubic yard	$ 5		$ -	
1.7.2.2	Canals- Shallow excavation	$/cubic yard	$ 4		$ -	
1.8.1	**Levees (no blasting)**					
1.8.1.1	Internal- 7' (4.5' SWD)	$/mile	$ 390,000		$ -	
1.8.1.3	External- 8' (4.5' SWD)	$/mile	$ 485,000	3.10	$ 1,503,500	FEB and blending basin
1.8.1.4	External- 9' (4.5' SWD)	$/mile	$ 562,000		$ -	
1.8.1.5	External-10' (4.5' SWD)	$/mile	$ 703,000		$ -	
	Seepage Control Mound	$/mile	$ 50,000		$ -	
1.9	**Pumping stations**					
1.9.1.1	0-40 cfs	$/cfs	$ 7,600		$ -	
1.9.1.2	41-60 cfs	$/cfs	$ 9,500		$ -	
1.9.1.3	60-500 cfs	$/cfs	$ 9,900	203	$ 2,009,700	CTSS pump station
1.9.1.4	500-3,000 cfs	$/cfs	$ 7,500	2933	$ 21,997,500	Inflow pump station only (existing S-9 pump station used as outflow pump station)
1.1	**Interior land preparation**					

APPENDIX A
C-11 WEST BASIN - Alternative 1 Sensitivity Case (8 ppb / 13 ppb) Cost Estimate

	Item/Task	Unit		Unit cost	Quantity		Total	Comments/Explanation
1.10.1	Disking	$/acre	$	60		$	-	
	Leveling/Grading	$/acre	$	100		$	-	
	Clearing/Grubbing	$/acre	$	200	132	$	26,400	FEB and blending basin
	Other Land Preparation							
	Canal bank stabilization	$/yd^2	$	0.20	75,000	$	15,000	seeding/mulching/erosion control for levees and interceptor/seepage canal
Subtotal						$	47,410,577	
Planning, Engineering and Design - 10%					0.10	$	4,741,058	
Program and Construction Management - 10%					0.10	$	4,741,058	
Subtotal						$	56,892,693	
Capital and Construction Contingency - 30%					0.30	$	17,067,808	
Subtotal Capital and Construction Costs						$	73,960,500	
Land/Right-of-way Acquisition		$/acre	$	300,000	203	$	60,900,000	
Land/Right-of-way Acquisition associated costs						$	1,000,000	
Land/Right-of-way Acquisition Contingency -15%					0.15	$	9,285,000	
Total Capital Costs						**$**	**145,145,500**	

2a	**OPERATING COSTS (per year)**							
	2006 through 2036							
2.1	**Labor**							
2.1.1	Engine operator/Maintenance mechanic	each	$	50,000		$	-	
2.1.2	Lead operator	each	$	60,000		$	-	
2.1.3	Treatment plant labor	per hr	$	30	11,680	$	350,400	4 8-hr shifts/day
2.2.1.1	Mechanical maintenance (lubrication, spare parts, etc.)- 500- 3,000 cfs pumps	per unit	$	23,000	2	$	46,000	2 inflow
2.2.1.2	Mechanical maintenance- 0-500 cfs pumps	per unit	$	10,000	7	$	70,000	4 inflow and 3 CTSS
2.2.2	Maintenance - Major (water control structures)	each	$	12,000	1	$	12,000	
	Maintenance - Minor (water control structures)	each	$	6,000	1	$	6,000	FEB overflow to blending basin
	Maintenance - Culverts (water control structures)	each	$	1,000	4	$	4,000	4 culverts at the interceptor/seepage canal
2.2.3	Maintenance Large building	per unit	$	12,000		$	-	
	Maintenance Small building	per unit	$	6,000		$	-	
2.2.4	Maintenance- Levees	$/mile	$	1,530	3.10	$	4,743	
2.2.5	Maintenance (vegetation control)	$/acre	$	22		$	-	
2.2.6	Maintenance - treatment plant building	per unit	$	2,400	1	$	2,400	
2.2.7								
2.2.8	Maintenance- residual solids treatment	$/mgal avg.daily design flow	$	1,200	135	$	162,000	B&C Desktop, 1998
2.3	Chemicals					$	-	
2.3.1	Aluminum chloride	Dry ton	$	160	1523	$	243,611	
2.3.2	PAC	lb	$	0		$	-	
2.3.3	Ferric chloride	Dry ton	$	180		$	-	
2.3.4	Ferric sulfate	lb	$	0		$	-	
2.3.5	Lime		$	-		$	-	
2.3.6	Polymer	$/mgal treated	$	8	4917	$	39,336	
2.3.7	Others		$	-		$	-	
2.4	Solids disposal	Tons	$	50		$	-	
2.5	**Energy**		$	-		$	-	

APPENDIX A
C-11 WEST BASIN - Alternative 1 Sensitivity Case (8 ppb / 13 ppb) Cost Estimate

	Item/Task	Unit		Unit cost	Quantity		Total	Comments/Explanation
2.5.1	Electricity	KW/hr	$	0.08	356898	$	28,552	treatment plant works only, includes capacity fee
2.5.2	Fuel consumption	acre-feet	$	0.50	33,194	$	16,597	Inflow and CTSS pump stations
	Laboratory Expenses							
	In-house expenses (process control)	lump sum	$	1,000	1	$	1,000	
Subtotal Operating Costs - 2006 - 2036 FLOWS						$	986,639	
Contingency - 30%					0.30	$	295,992	
Total Operating Costs - 2006 - 2036 FLOWS						**$**	**1,282,630**	

2b	**OPERATING COSTS (per year)**							
	2036 through 2056							
2.1	**Labor**							
2.1.1	Engine operator/Maintenance mechanic	each	$	50,000		$	-	
2.1.2	Lead operator	each	$	60,000		$	-	
2.1.3	Treatment plant labor	per hr	$	30	11,680	$	350,400	4 8-hr shifts/day
2.2.1.1	Mechanical maintenance (lubrication, spare parts, etc.)- 500- 3,000 cfs pumps	per unit	$	11,500	2	$	23,000	unit cost for pump maintenance reduced by 50% since pumps will be used infrequently
2.2.1.2	Mechanical maintenance- 0-500 cfs pumps	per unit	$	5,000	7	$	35,000	unit cost for pump maintenance reduced by 50% since pumps will be used infrequently
2.2.2	Maintenance - Major (water control structures)	each	$	12,000	1	$	12,000	
	Maintenance - Minor (water control structures)	each	$	6,000	1	$	6,000	FEB overflow to blending basin
	Maintenance - Culverts (water control structures)	each	$	1,000	4	$	4,000	
2.2.3	Maintenance Large building	per unit	$	12,000				
	Maintenance Small building	per unit	$	6,000		$	-	
2.2.4	Maintenance- Levees	$/mile	$	1,530	3.10	$	4,743	
2.2.5	Maintenance (vegetation control)	$/acre	$	22		$	-	
2.2.6	Maintenance - treatment plant building	per unit	$	2,400	1	$	2,400	
2.2.7								
2.2.8	Maintenance- residual solids treatment	$/mgal avg.daily design flow	$	1,200	50	$	60,000	B&C Desktop, 1998
2.3	Chemicals					$	-	
2.3.1	Aluminum chloride	Dry ton	$	160	29	$	4,707	
2.3.2	PAC	lb	$	0		$	-	
2.3.3	Ferric chloride	Dry ton	$	180		$	-	
2.3.4	Ferric sulfate	lb	$	0		$	-	
2.3.5	Lime		$	-		$	-	
2.3.6	Polymer	$/mgal treated	$	8	95	$	760	
2.3.7	Others		$	-		$	-	
2.4	Solids disposal	Tons	$	50		$	-	
2.5	**Energy**		$	-		$	-	

APPENDIX A
C-11 WEST BASIN - Alternative 1 Sensitivity Case (8 ppb / 13 ppb) Cost Estimate

	Item/Task	Unit	Unit cost	Quantity	Total	Comments/Explanation
2.5.1	Electricity	KW/hr	$ 0.08	31413	$ 2,513	treatment plant works only, includes capacity fee
2.5.2	Fuel consumption	acre-feet	$ 0.50	1,197	$ 598	Inflow and CTSS pump stations
	Laboratory Expenses					
	In-house expenses (process control)	lump sum	$ 1,000	1	$ 1,000	
Subtotal Operating Costs - 2036 - 2056 FLOWS					$ 507,121	
Contingency - 30%				0.30	$ 152,136	
Total Operating Costs - 2036 - 2056 FLOWS					**$ 659,258**	
3	**Salvage/Demolition/Replacement costs**					
3.1	Demolition costs	Lump sum				
3.2	Restoration of levees	$/yard	$ 3		$ -	
3.3	Restoration of FEBs		$ -		$ -	
3.4	Clearing and grubbing		$ -		$ -	
	Light foliage	$/acre	$ 300		$ -	
	Forest/heavy brushes	$/acre	$ 1,500		$ -	
3.5	Replacement items		$ -		$ 6,001,800	rebuild and refurbishment of pump stations after 25 years @ 25 percent of the original PS cost
3.5.1	Chemical feed system	Lump sum			$ 211,098	60% of cost replaced every 10 years
3.5.2	Treatment plant equipment	Lump sum			$ 3,518,293	25% of plant cost replaced at 20th and 40th year

C-11 West Basin Alternative 1 Sensitivity Case

Capital Costs, $	
Total Capital Cost	145,145,500
Present Worth - Capital Cost	139,151,982
O&M Costs, $ /yr	
Total Annual O&M Cost	1,941,888
Present Worth - Annual O&M Cost	14,256,601
Replacement Costs, $	
Replacement Costs, $	9,731,190
Present Worth - Replacement Costs	5,795,857
50 - Year Present Worth, $	
Capital Cost	139,151,982
O&M Cost	14,256,601
Replacement Cost	5,795,857
Total Present Worth - Public Cost,	$159,204,439
Total Phosphorus Removed, kg	7,100
Present worth, $/kg TP removed	$22,423.16

Assumptions:

1. **Interest rate 6 3/8%**
2. **Inflation 3%**
3. **Capital costs escalated to the year expected to occur**
4. **O & M costs starts on first day of operation**
5. **Permitting and procurement costs are the responsibility of the District**

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APPENDIX A
C-11 WEST BASIN - Alternative 2 Cost Estimate

	Item/Task	Unit	Unit cost	Quantity	Total	Comments/Explanation
1	**Capital costs**					
1.1.1	Equipment		$ -		$ -	
1.1.2	Residuals management		$ -		$ -	
1.2	Freight		$ -		$ -	
1.3	Installation		$ -		$ -	
1.4	Instrumentation		$ -		$ -	
1.5	**Electrical controls**					
1.5.1	Electrical controls					
1.5.2	Electrical power distribution	$/mile	$ 80,000	1.00	$ 80,000	assumed distance
1.6	**Civil Work- water control structures**					
1.6.1	84" culvert open	per structure	$ 20,000		$ -	
1.6.2	84" culvert with gate	per structure	$ 35,000		$ -	
	72" culvert open	per structure	$ 17,500	15	$ 262,500	15 culverts at outflow levee
	72" culvert with gate	per structure	$ 32,500	19	$ 617,500	15 culverts at inflow levee, 4 culverts at the interceptor/seepage canal
	66" culvert open	per structure	$ 16,250		$ -	
	66" culvert with gate	per structure	$ 31,250		$ -	
	60" culvert open	per structure	$ 15,000		$ -	
	60" culvert with gate	per structure	$ 30,000		$ -	
	48" culvert open	per structure	$ 10,000		$ -	
	48" culvert with gate	per structure	$ 25,000		$ -	
1.6.3	concrete box culvert - With gates	per structure	$ 300,000		$ -	
1.6.4	concrete box culvert - Without gates	per structure	$ 150,000		$ -	
	Control Structure - large - with gates	per structure	$ 1,500,000	1	$ 1,500,000	STA outflow control structure
	Control Structure - large - without gates	per structure	$ 750,000		$ -	
	Control Structure -small - with gate	per structure	$ 500,000		$ -	
	Control Structure - small - without gates	per structure	$ 250,000		$ -	
1.7.1	**Canals (digging - no blasting)**					
1.7.1.1	Canals- Deep excavation	$/cubic yard	$ 3.5		$ -	
1.7.1.2	Canals- Shallow excavation	$/cubic yard	$ 2.5	253,407	$ 633,519	interceptor/seepage canal
1.7.2	**Canals (including blasting)**					
1.7.2.1	Canals- Deep excavation	$/cubic yard	$ 5		$ -	
1.7.2.2	Canals- Shallow excavation	$/cubic yard	$ 4		$ -	
1.8.1	**Levees (no blasting)**					
1.8.1.1	Internal- 7' (4.5' SWD)	$/mile	$ 390,000		$ -	
1.8.1.3	External- 8' (4.5' SWD)	$/mile	$ 485,000		$ -	
	Internal- 7.5' (5.5' SWD)	$/mile	$ 480,000	1.86	$ 894,909	Includes internal canals
	External-8.5' (5.5' SWD)	$/mile	$ 587,000	4.00	$ 2,350,001	Includes inflow canal, outflow canal
1.8.1.4	External- 9' (4.5' SWD)	$/mile	$ 562,000		$ -	
1.8.1.5	External-10' (4.5' SWD)	$/mile	$ 703,000		$ -	
	Seepage Control Mound	$/mile	$ 50,000		$ -	
1.9	**Pumping stations**					
1.9.1.1	0-40 cfs	$/cfs	$ 7,600		$ -	
1.9.1.2	41-60 cfs	$/cfs	$ 9,500		$ -	
1.9.1.3	60-500 cfs	$/cfs	$ 9,900		$ -	
1.9.1.4	500-3,000 cfs	$/cfs	$ 7,500	2933	$ 21,997,500	Inflow pump station only (existing S-9 pump station used as outflow pump station)

APPENDIX A
C-11 WEST BASIN - Alternative 2 Cost Estimate

	Item/Task	Unit	Unit cost	Quantity	Total	Comments/Explanation
1.1	**Interior land preparation**					
1.10.1	Disking	$/acre	$ 60		$ -	
	Leveling/Grading	$/acre	$ 100	730	$ 73,000	
	Clearing/Grubbing	$/acre	$ 200	556	$ 111,200	treatment cells only
	Other Land Preparation					
	Canal bank stabilization	$/yd^2	$ 0.20	150,000	$ 30,000	seeding/mulching/erosion control for inflow, outflow and interceptor/seepage canal
Subtotal					$ 28,550,129	
Planning, Engineering and Design - 10%				0.10	$ 2,855,013	
Program and Construction Management - 10%				0.10	$ 2,855,013	
Subtotal					$ 34,260,154	
Capital and Construction Contingency - 30%				0.30	$ 10,278,046	
Subtotal Capital and Construction Costs					$ 44,538,201	
Land/Right-of-way Acquisition		$/acre	$ 300,000	730	$ 219,000,000	
Land/Right-of-way Acquisition associated costs					$ 1,000,000	
Land/Right-of-way Acquisition Contingency -15%				0.15	$ 33,000,000	
Total Capital Costs					**$ 297,538,201**	
2a	**OPERATING COSTS (per year) for 2006-2036 FLOW**					
2.1	**Labor**					
2.1.1	Engine operator/Maintenance mechanic	each	$ 50,000	0.50	$ 25,000	inflow pump station
2.1.2	Lead operator	each	$ 60,000	0.50	$ 30,000	inflow pump station
2.2.1.1	Mechanical maintenance (lubrication, spare parts, etc.)- 500- 3,000 cfs pumps	per unit	$ 23,000	2	$ 46,000	2 inflow
2.2.1.2	Mechanical maintenance- 0-500 cfs pumps	per unit	$ 10,000	4	$ 40,000	4 inflow
2.2.2	Maintenance - Major (water control structures)	each	$ 12,000	1	$ 12,000	
	Maintenance - Minor (water control structures)	each	$ 6,000		$ -	
	Maintenance - Culverts (water control structures)	each	$ 1,000	34	$ 34,000	30 culverts in the STA, 4 culverts at the interceptor/seepage canal
2.2.3	Maintenance Large building	per unit	$ 12,000	1	$ 12,000	inflow pump station
	Maintenance Small building	per unit	$ 6,000		$ -	
2.2.4	Maintenance- Levees	$/mile	$ 1,530	5.87	$ 8,978	
2.2.5	Maintenance (vegetation control)	$/acre	$ 50	556	$ 27,800	unit cost increased to $50/acre to account for management associated with extensive drydown periods; land area applies to the treatment cells only
2.5	**Energy**		$ -		$ -	
2.5.1	Electricity	KW/hr	$ 0.08	25,000	$ 2,000	Includes capacity fee
2.5.2	Fuel consumption	acre-feet	$ 0.50	18,112	$ 9,056	Based on the average flow for the 31-yr period of record at the inflow pump station
Subtotal Operating Costs - 2006 - 2036 FLOWS					$ 246,834	
Contingency - 30%				0.30	$ 74,050	
Total Operating Costs - 2006 - 2036 FLOWS					**$ 320,884**	
2b	**OPERATING COSTS (per year) for 2036-2056 FLOW**					

APPENDIX A
C-11 WEST BASIN - Alternative 2 Cost Estimate

	Item/Task	Unit		Unit cost	Quantity		Total	Comments/Explanation
2.1	**Labor**							
2.1.1	Engine operator/Maintenance mechanic	each	$	50,000	0.15	$	7,500	inflow pump station
2.1.2	Lead operator	each	$	60,000	0.15	$	9,000	inflow pump station
2.2.1.1	Mechanical maintenance (lubrication, spare parts, etc.)- 500- 3,000 cfs pumps	per unit	$	11,500	2	$	23,000	unit cost for pump maintenance reduced by 50% since pumps will be used infrequently
2.2.1.2	Mechanical maintenance- 0-500 cfs pumps	per unit	$	5,000	4	$	20,000	unit cost for pump maintenance reduced by 50% since pumps will be used infrequently
2.2.2	Maintenance - Major (water control structures)	each	$	6,000	1	$	6,000	unit cost for outflow structure reduced by 50% since operating as a reservoir - outflow structure used only for emergencies
	Maintenance - Minor (water control structures)	each	$	6,000		$	-	
	Maintenance - Culverts (water control structures)	each	$	1,000	4	$	4,000	STA culverts removed
2.2.3	Maintenance Large building	per unit	$	12,000	1	$	12,000	inflow pump station
	Maintenance Small building	per unit	$	6,000		$	-	
2.2.4	Maintenance- Levees	$/mile	$	1,530	4.00	$	6,125	internal levees degraded
2.2.5	Maintenance (vegetation control)	$/acre	$	5	730	$	3,650	debris control in reservoir
2.5	**Energy**		$	-		$	-	
2.5.1	Electricity	KW/hr	$	0.08	25000	$	2,000	Includes capacity fee
2.5.2	Fuel consumption	acre-feet	$	0.50	906	$	453	Based on the average flow for the 31-yr period of record at the inflow pump station
Subtotal Operating Costs - 2036 - 2056 FLOWS						$	93,728	
Contingency - 30%					0.30	$	28,118	
Total Operating Costs - 2036 - 2056 FLOWS						**$**	**121,846**	

3	**Salvage/Demolition/Replacement costs**							
3.1	Demolition costs							
3.2	Restoration of levees	$/yd^3	$	3	100,000	$	300,000	demolition of internal levees and removal of culverts in 2036
3.3	Restoration of FEBs		$	-		$	-	
3.4	Clearing and grubbing		$	-		$	-	
	Light foliage	$/acre	$	300		$	-	
	Forest/heavy brushes	$/acre	$	1,500		$	-	
3.5	Replacement items		$	-		$	5,499,375	rebuild and refurbish inflow pump station after 25 years @ 25 percent of the original PS cost

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C-11 West Basin Alternative 2

Capital Costs, $	
Total Capital Cost	297,538,201
Present Worth - Capital Cost	285,087,182
O&M Costs, $ /yr	
Total Annual O&M Cost	442,731
Present Worth - Annual O&M Cost	3,056,489
Replacement Costs, $	
Replacement Costs, $	5,799,375
Present Worth - Replacement Costs	2,495,470
50 - Year Present Worth, $	
Capital Cost	285,087,182
O&M Cost	3,056,489
Replacement Cost	2,495,470
Total Present Worth - Public Cost,	$290,639,141
Total Phosphorus Removed, kg	6,052
Present worth, $/kg TP removed	$48,023.65

Assumptions:

1. **Interest rate 6 3/8%**
2. **Inflation 3%**
3. **Capital costs escalated to the year expected to occur**
4. **O & M costs starts on first day of operation**
5. **Permitting and procurement costs are the responsibility of the District**

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APPENDIX A
FEEDER CANAL BASIN - Alternative 1 Cost Estimate

	Item/Task	Unit	Unit cost	Quantity	Total	Comments/Explanation
1	**Capital costs**					
1.1.1	Equipment		$ -		$ -	
1.1.2	Residuals management		$ -		$ -	
1.2	Freight		$ -		$ -	
1.3	Installation		$ -		$ -	
1.4	Instrumentation		$ -		$ -	
1.5	**Electrical controls**					
1.5.1	Electrical controls					
1.5.2	Electrical power distribution	$/mile	$ 80,000	2.00	$ 160,000	assumed distance -STA location unknown
1.6	**Civil Work- water control structures**					
1.6.1	84" culvert open	per structure	$ 20,000		$ -	
1.6.2	84" culvert with gate	per structure	$ 35,000		$ -	
	66" culvert open	per structure	$ 16,250		$ -	
	66" culvert with gate	per structure	$ 31,250		$ -	
	60" culvert open	per structure	$ 15,000	42	$ 630,000	14 culverts at each of the interior levees and the outflow levee
	60" culvert with gate	per structure	$ 30,000	14	$ 420,000	14 culverts at the inflow to STA
	48" culvert open	per structure	$ 10,000		$ -	
	48" culvert with gate	per structure	$ 25,000		$ -	
1.6.3	10' x 10' x 53' concrete box culvert - With gates	per structure	$ 300,000		$ -	
1.6.4	10' x 10' x 53' concrete box culvert - Without gates	per structure	$ 150,000		$ -	
	5' x 10' x 20' concrete box culvert - without gates					
	Control Structure - large - with gates	per structure	$ 1,500,000	1	$ 1,500,000	STA outflow structure
	Control Structure - large - without gates	per structure	$ 750,000		$ -	
	Control Structure -small - with gate	per structure	$ 500,000	5	$ 2,500,000	3 connections from reservoir to STA inflow canal,1 on the W. Feeder and 1 on the N. Feeder
	Control Structure - small - without gates	per structure	$ 250,000		$ -	
1.7.1	**Canals (digging - no blasting)**					
1.7.1.1	Canals- Deep excavation	$/cubic yard	$ 3.5		$ -	
1.7.1.2	Canals- Shallow excavation	$/cubic yard	$ 2.5	1,028,000	$ 2,570,000	diversion canal
1.7.2	**Canals (including blasting)**					
1.7.2.1	Canals- Deep excavation	$/cubic yard	$ 5		$ -	
1.7.2.2	Canals- Shallow excavation	$/cubic yard	$ 4		$ -	
1.8.1	**Levees (no blasting)**					
1.8.1.1	Internal- 7' (4.5' SWD)	$/mile	$ 390,000	4.65	$ 1,812,909	Includes internal canals
1.8.1.3	External- 8' (4.5' SWD)	$/mile	$ 485,000	10.02	$ 4,858,818	Includes STA inflow canal, outflow canal and seepage canals and reservoir levees
1.8.1.4	External- 9' (4.5' SWD)	$/mile	$ 562,000		$ -	
1.8.1.5	External-10' (4.5' SWD)	$/mile	$ 703,000		$ -	
	Seepage Control Mound	$/mile	$ 50,000	8.97	$ 448,258	
1.9	**Pumping stations**					
1.9.1.1	0-40 cfs	$/cfs	$ 7,600		$ -	
1.9.1.2	41-60 cfs	$/cfs	$ 9,500		$ -	
1.9.1.3	60-500 cfs	$/cfs	$ 9,900	250	$ 2,475,000	2 seepage pump stations
1.9.1.4	500-3,000 cfs	$/cfs	$ 7,500	5067	$ 38,002,500	Inflow pump station (existing S-190 used as outflow structure)
1.1	**Interior land preparation**					
1.10.1	Disking	$/acre	$ 60		$ -	

APPENDIX A
FEEDER CANAL BASIN - Alternative 1 Cost Estimate

	Item/Task	Unit		Unit cost	Quantity		Total	Comments/Explanation
	Leveling/Grading	$/acre	$	100	2640	$	264,000	
	Clearing/Grubbing	$/acre	$	200	2308	$	461,600	treatment cells only
	Other Land Preparation							
	Canal bank stabilization	$/yd^2	$	0.20	300,000	$	60,000	
Subtotal						$	56,163,085	
Planning, Engineering and Design - 10%					0.10	$	5,616,308	
Program and Construction Management - 10%					0.10	$	5,616,308	
Subtotal						$	67,395,702	
Capital and Construction Contingency - 30%					0.30	$	20,218,711	
Subtotal Capital and Construction Costs						$	87,614,412	
Land/Right-of-way Acquisition		$/acre	$	1,370	2640	$	3,615,890	
Land/Right-of-way Acquisition Contingency -20%					0.20	$	723,178	
Total Capital Costs						**$**	**91,953,480**	
2	**OPERATING COSTS (per year)**							
2.1	**Labor**							
2.1.1	Engine operator/Maintenance mechanic	each	$	50,000	0.75	$	37,500	
2.1.2	Lead operator	each	$	60,000	0.75	$	45,000	
2.2.1.1	Mechanical maintenance (lubrication, spare parts, etc.)- 500- 3,000 cfs pumps	per unit	$	23,000	4	$	92,000	4 inflow
2.2.1.2	Mechanical maintenance- 0-500 cfs pumps	per unit	$	10,000	8	$	80,000	4 inflow, 4 seepage
2.2.2	Maintenance - Major (water control structures)	each	$	12,000	1	$	12,000	
	Maintenance - Minor (water control structures)	each	$	6,000	5	$	30,000	
	Maintenance - Culverts (water control structures)	each	$	1,000	56	$	56,000	56 culverts in the STA
2.2.3	Maintenance Large building	per unit	$	12,000	1	$	12,000	Inflow pump station
	Maintenance Small building	per unit	$	6,000		$	-	
2.2.4	Maintenance- Levees	$/mile	$	1,530	23.63	$	36,157	
2.2.5	Maintenance (vegetation control)	$/acre	$	22	2308	$	50,776	
2.5	**Energy**		$	-		$	-	
2.5.1	Electricity	KW/hr	$	0.08	25000	$	2,000	includes capacity fee
2.5.2	Fuel consumption	acre-feet	$	0.50	113,741	$	56,870	Based on the average flow for the 31-yr period of record (107 cfs) @ the inflow and an average flow of 25 cfs at the seepage pump stations
Subtotal Operating Costs						$	510,303	
Contingency - 30%					0.30	$	153,091	
Total Operating Costs						**$**	**663,394**	
3	**Salvage/Demolition/Replacement costs**							
3.1	Demolition costs					$	-	
3.2	Restoration of levees	$/yard	$	3	0	$	-	
3.3	Restoration of FEBs		$	-		$	-	
3.4	Clearing and grubbing		$	-		$	-	
	Light foliage	$/acre	$	300		$	-	
	Forest/heavy brushes	$/acre	$	1,500		$	-	
3.5	Replacement items		$	-		$	10,119,375	rebuild and refurbishment of pump stations after 25 years @ 25 percent of the original PS cost, Desktop Study pg 3-13
Total Demolition Replacement Costs						**$**	**10,119,375**	

Feeder Canal Basin Alternative 1

Capital Costs, $	
Total Capital Cost	91,953,481
Present Worth - Capital Cost	87,652,036
O&M Costs, $ /yr	
Total Annual O&M Cost	663,394
Present Worth - Annual O&M Cost	13,388,957
Replacement Costs, $	
Replacement Costs, $	10,119,375
Present Worth - Replacement Costs	4,413,322
50 - Year Present Worth, $	
Capital Cost	87,652,036
O&M Cost	13,388,957
Replacement Cost	4,413,322
Total Present Worth - Public Cost,	$105,454,315
Total Phosphorus Removed, kg	151,190
Present worth, $/kg TP removed	$697.50

Assumptions:

1. **Interest rate 6 3/8%**
2. **Inflation 3%**
3. **Capital costs escalated to the year expected to occur**
4. **O & M costs starts on first day of operation**
5. **Permitting and procurement costs are the responsibility of the District**

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APPENDIX A
FEEDER CANAL BASIN - Alternative 1 Sensitivity Case 1 (75 ppb) Cost Estimate

	Item/Task	Unit	Unit cost	Quantity	Total	Comments/Explanation
1	**Capital costs**					
1.1.1	Equipment		$ -		$ -	
1.1.2	Residuals management		$ -		$ -	
1.2	Freight		$ -		$ -	
1.3	Installation		$ -		$ -	
1.4	Instrumentation		$ -		$ -	
1.5	**Electrical controls**					
1.5.1	Electrical controls					
1.5.2	Electrical power distribution	$/mile	$ 80,000	2.00	$ 160,000	assumed distance -STA location unknown
1.6	**Civil Work- water control structures**					
1.6.1	84" culvert open	per structure	$ 20,000		$ -	
1.6.2	84" culvert with gate	per structure	$ 35,000		$ -	
	66" culvert open	per structure	$ 16,250		$ -	
	66" culvert with gate	per structure	$ 31,250		$ -	
	60" culvert open	per structure	$ 15,000	42	$ 630,000	14 culverts at each of the interior levees and the outflow levee
	60" culvert with gate	per structure	$ 30,000	14	$ 420,000	14 culverts at the inflow to STA
	48" culvert open	per structure	$ 10,000		$ -	
	48" culvert with gate	per structure	$ 25,000		$ -	
1.6.3	10' x 10' x 53' concrete box culvert - With gates	per structure	$ 300,000		$ -	
1.6.4	10' x 10' x 53' concrete box culvert - Without gates	per structure	$ 150,000		$ -	
	5' x 10' x 20' concrete box culvert - without gates					
	Control Structure - large - with gates	per structure	$ 1,500,000	1	$ 1,500,000	STA outflow structure
	Control Structure - large - without gates	per structure	$ 750,000		$ -	
	Control Structure -small - with gate	per structure	$ 500,000	5	$ 2,500,000	3 connections from reservoir to STA inflow canal,1 on the W. Feeder and 1 on the N. Feeder
	Control Structure - small - without gates	per structure	$ 250,000		$ -	
1.7.1	**Canals (digging - no blasting)**					
1.7.1.1	Canals- Deep excavation	$/cubic yard	$ 3.5		$ -	
1.7.1.2	Canals- Shallow excavation	$/cubic yard	$ 2.5	1,028,870	$ 2,572,176	diversion canal
1.7.2	**Canals (including blasting)**					
1.7.2.1	Canals- Deep excavation	$/cubic yard	$ 5		$ -	
1.7.2.2	Canals- Shallow excavation	$/cubic yard	$ 4		$ -	
1.8.1	**Levees (no blasting)**					
1.8.1.1	Internal- 7' (4.5' SWD)	$/mile	$ 390,000	5.32	$ 2,074,386	Includes internal canals
1.8.1.3	External- 8' (4.5' SWD)	$/mile	$ 485,000	10.03	$ 4,863,135	Includes STA inflow canal, outflow canal and seepage canals and reservoir levees
1.8.1.4	External- 9' (4.5' SWD)	$/mile	$ 562,000		$ -	
1.8.1.5	External-10' (4.5' SWD)	$/mile	$ 703,000		$ -	
	Seepage Control Mound	$/mile	$ 50,000	8.81	$ 440,322	
1.9	**Pumping stations**					
1.9.1.1	0-40 cfs	$/cfs	$ 7,600		$ -	
1.9.1.2	41-60 cfs	$/cfs	$ 9,500		$ -	
1.9.1.3	60-500 cfs	$/cfs	$ 9,900	250	$ 2,475,000	2 seepage pump stations
1.9.1.4	500-3,000 cfs	$/cfs	$ 7,500	5067	$ 38,002,500	Inflow pump station (existing S-190 used as outflow structure)
1.1	**Interior land preparation**					
1.10.1	Disking	$/acre	$ 60		$ -	

APPENDIX A
FEEDER CANAL BASIN - Alternative 1 Sensitivity Case 1 (75 ppb) Cost Estimate

	Item/Task	Unit		Unit cost	Quantity		Total	Comments/Explanation
	Leveling/Grading	$/acre	$	100	2765	$	276,500	
	Clearing/Grubbing	$/acre	$	200	2432	$	486,400	treatment cells only
	Other Land Preparation							
	Canal bank stabilization	$/yd^2	$	0.20	300,000	$	60,000	
Subtotal						$	56,460,420	
Planning, Engineering and Design - 10%					0.10	$	5,646,042	
Program and Construction Management - 10%					0.10	$	5,646,042	
Subtotal						$	67,752,504	
Capital and Construction Contingency - 30%					0.30	$	20,325,751	
Subtotal Capital and Construction Costs						$	88,078,255	
Land/Right-of-way Acquisition		$/acre	$	1,370	2765	$	3,787,097	
Land/Right-of-way Acquisition Contingency -20%					0.20	$	757,419	
Total Capital Costs						**$**	**92,622,771**	
2	**OPERATING COSTS (per year)**							
2.1	**Labor**							
2.1.1	Engine operator/Maintenance mechanic	each	$	50,000	0.75	$	37,500	
2.1.2	Lead operator	each	$	60,000	0.75	$	45,000	
2.2.1.1	Mechanical maintenance (lubrication, spare parts, etc.)- 500- 3,000 cfs pumps	per unit	$	23,000	4	$	92,000	4 inflow
2.2.1.2	Mechanical maintenance- 0-500 cfs pumps	per unit	$	10,000	8	$	80,000	4 inflow, 4 seepage
2.2.2	Maintenance - Major (water control structures)	each	$	12,000	1	$	12,000	
	Maintenance - Minor (water control structures)	each	$	6,000	5	$	30,000	
	Maintenance - Culverts (water control structures)	each	$	1,000	56	$	56,000	56 culverts in the STA
2.2.3	Maintenance Large building	per unit	$	12,000	1	$	12,000	Inflow pump station
	Maintenance Small building	per unit	$	6,000		$	-	
2.2.4	Maintenance- Levees	$/mile	$	1,530	24.15	$	36,953	
2.2.5	Maintenance (vegetation control)	$/acre	$	22	2432	$	53,504	
2.5	**Energy**		$	-		$	-	
2.5.1	Electricity	KW/hr	$	0.08	25000	$	2,000	includes capacity fee
2.5.2	Fuel consumption	acre-feet	$	0.50	113,741	$	56,870	Based on the average flow for the 31-yr period of record (107 cfs) @ the inflow and an average flow of 25 cfs at the seepage pump stations
Subtotal Operating Costs						$	513,828	
Contingency - 30%					0.30	$	154,148	
Total Operating Costs						**$**	**667,976**	
3	**Salvage/Demolition/Replacement costs**							
3.1	Demolition costs					$	-	
3.2	Restoration of levees	$/yard	$	3		$	-	
3.3	Restoration of FEBs		$	-		$	-	
3.4	Clearing and grubbing		$	-		$	-	
	Light foliage	$/acre	$	300		$	-	
	Forest/heavy brushes	$/acre	$	1,500		$	-	
3.5	Replacement items		$	-		$	10,119,375	rebuild and refurbishment of pump stations after 25 years @ 25 percent of the original PS cost, Desktop Study pg 3-13
Total Demolition Replacement Costs						**$**	**10,119,375**	

Feeder Canal Basin Alternative 1 Sensitivity Case 1 (75 ppb)

Capital Costs, $	
Total Capital Cost	92,622,770
Present Worth - Capital Cost	88,291,956
O&M Costs, $ /yr	
Total Annual O&M Cost	667,975
Present Worth - Annual O&M Cost	13,481,417
Replacement Costs, $	
Replacement Costs, $	10,119,375
Present Worth - Replacement Costs	4,413,322
50 - Year Present Worth, $	
Capital Cost	88,291,956
O&M Cost	13,481,417
Replacement Cost	4,413,322
Total Present Worth - Public Cost,	$106,186,695
Total Phosphorus Removed, kg	282,816
Present worth, $/kg TP removed	$375.46

Assumptions:

1. **Interest rate 6 3/8%**
2. **Inflation 3%**
3. **Capital costs escalated to the year expected to occur**
4. **O & M costs starts on first day of operation**
5. **Permitting and procurement costs are the responsibility of the District**

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APPENDIX A
FEEDER CANAL BASIN - Alternative 1 Sensitivity Case 3 (Hydraulic Bypass) Cost Estimate

	Item/Task	Unit	Unit cost	Quantity	Total	Comments/Explanation
1	**Capital costs**					
1.1.1	Equipment		$ -		$ -	
1.1.2	Residuals management		$ -		$ -	
1.2	Freight		$ -		$ -	
1.3	Installation		$ -		$ -	
1.4	Instrumentation		$ -		$ -	
1.5	**Electrical controls**					
1.5.1	Electrical controls					
1.5.2	Electrical power distribution	$/mile	$ 80,000	2.00	$ 160,000	assumed distance -STA location unknown
1.6	**Civil Work- water control structures**					
1.6.1	84" culvert open	per structure	$ 20,000		$ -	
1.6.2	84" culvert with gate	per structure	$ 35,000		$ -	
	66" culvert open	per structure	$ 16,250		$ -	
	66" culvert with gate	per structure	$ 31,250		$ -	
	60" culvert open	per structure	$ 15,000	33	$ 495,000	11 culverts at each of the interior levees and the outflow levee
	60" culvert with gate	per structure	$ 30,000	11	$ 330,000	11 culverts at the inflow to STA
	48" culvert open	per structure	$ 10,000		$ -	
	48" culvert with gate	per structure	$ 25,000		$ -	
1.6.3	10' x 10' x 53' concrete box culvert - With gates	per structure	$ 300,000		$ -	
1.6.4	10' x 10' x 53' concrete box culvert - Without gates	per structure	$ 150,000		$ -	
	5' x 10' x 20' concrete box culvert - without gates					
	Control Structure - large - with gates	per structure	$ 1,500,000	1	$ 1,500,000	STA outflow structure
	Control Structure - large - without gates	per structure	$ 750,000		$ -	
	Control Structure -small - with gate	per structure	$ 500,000	5	$ 2,500,000	3 connections from reservoir to STA inflow canal,1 on the W. Feeder and 1 on the N. Feeder
	Control Structure - small - without gates	per structure	$ 250,000		$ -	
1.7.1	**Canals (digging - no blasting)**					
1.7.1.1	Canals- Deep excavation	$/cubic yard	$ 3.5		$ -	
1.7.1.2	Canals- Shallow excavation	$/cubic yard	$ 2.5	678,958	$ 1,697,396	diversion canal
1.7.2	**Canals (including blasting)**					
1.7.2.1	Canals- Deep excavation	$/cubic yard	$ 5		$ -	
1.7.2.2	Canals- Shallow excavation	$/cubic yard	$ 4		$ -	
1.8.1	**Levees (no blasting)**					
1.8.1.1	Internal- 7' (4.5' SWD)	$/mile	$ 390,000	4.57	$ 1,783,659	Includes internal canals
1.8.1.3	External- 8' (4.5' SWD)	$/mile	$ 485,000	8.76	$ 4,250,088	Includes STA inflow canal, outflow canal and seepage canals and reservoir levees
1.8.1.4	External- 9' (4.5' SWD)	$/mile	$ 562,000		$ -	
1.8.1.5	External-10' (4.5' SWD)	$/mile	$ 703,000		$ -	
	Seepage Control Mound	$/mile	$ 50,000	7.73	$ 386,439	
1.9	**Pumping stations**					
1.9.1.1	0-40 cfs	$/cfs	$ 7,600		$ -	
1.9.1.2	41-60 cfs	$/cfs	$ 9,500		$ -	
1.9.1.3	60-500 cfs	$/cfs	$ 9,900	150	$ 1,485,000	2 seepage pump stations
1.9.1.4	500-3,000 cfs	$/cfs	$ 7,500	2974	$ 22,305,000	Inflow pump station (existing S-190 used as outflow structure)
1.1	**Interior land preparation**					
1.10.1	Disking	$/acre	$ 60		$ -	

APPENDIX A
FEEDER CANAL BASIN - Alternative 1 Sensitivity Case 3 (Hydraulic Bypass) Cost Estimate

	Item/Task	Unit		Unit cost	Quantity		Total	Comments/Explanation
	Leveling/Grading	$/acre	$	100	2130	$	213,000	
	Clearing/Grubbing	$/acre	$	200	1831	$	366,200	treatment cells only
	Other Land Preparation							
	Canal bank stabilization	$/yd^2	$	0.20	300,000	$	60,000	
Subtotal						$	37,531,782	
Planning, Engineering and Design - 10%					0.10	$	3,753,178	
Program and Construction Management - 10%					0.10	$	3,753,178	
Subtotal						$	45,038,139	
Capital and Construction Contingency - 30%					0.30	$	13,511,442	
Subtotal Capital and Construction Costs						$	58,549,581	
Land/Right-of-way Acquisition		$/acre	$	1,370	2130	$	2,917,366	
Land/Right-of-way Acquisition Contingency -20%					0.20	$	583,473	
Total Capital Costs						**$**	**62,050,419**	
2	**OPERATING COSTS (per year)**							
2.1	**Labor**							
2.1.1	Engine operator/Maintenance mechanic	each	$	50,000	0.50	$	25,000	
2.1.2	Lead operator	each	$	60,000	0.50	$	30,000	
2.2.1.1	Mechanical maintenance (lubrication, spare parts, etc.)- 500- 3,000 cfs pumps	per unit	$	23,000	2	$	46,000	2 inflow
2.2.1.2	Mechanical maintenance- 0-500 cfs pumps	per unit	$	10,000	8	$	80,000	4 inflow, 4 seepage
2.2.2	Maintenance - Major (water control structures)	each	$	12,000	1	$	12,000	
	Maintenance - Minor (water control structures)	each	$	6,000	5	$	30,000	
	Maintenance - Culverts (water control structures)	each	$	1,000	44	$	44,000	44 culverts in the STA
2.2.3	Maintenance Large building	per unit	$	12,000	1	$	12,000	Inflow pump station
	Maintenance Small building	per unit	$	6,000		$	-	
2.2.4	Maintenance- Levees	$/mile	$	1,530	21.07	$	32,230	
2.2.5	Maintenance (vegetation control)	$/acre	$	22	1831	$	40,282	
2.5	**Energy**		$	-		$	-	
2.5.1	Electricity	KW/hr	$	0.08	25000	$	2,000	includes capacity fee
2.5.2	Fuel consumption	acre-feet	$	0.50	113,016	$	56,508	Based on the average flow for the 31-yr period of record (106cfs) @ the inflow and an average flow of 25 cfs at the seepage pump stations
Subtotal Operating Costs						$	410,020	
Contingency - 30%					0.30	$	123,006	
Total Operating Costs						**$**	**533,026**	
3	**Salvage/Demolition/Replacement costs**							
3.1	Demolition costs					$	-	
3.2	Restoration of levees	$/yard	$	3		$	-	
3.3	Restoration of FEBs		$	-		$	-	
3.4	Clearing and grubbing		$	-		$	-	
	Light foliage	$/acre	$	300		$	-	
	Forest/heavy brushes	$/acre	$	1,500		$	-	
3.5	Replacement items		$	-		$	5,947,500	rebuild and refurbishment of pump stations after 25 years @ 25 percent of the original PS cost, Desktop Study pg 3-13
Total Demolition Replacement Costs						**$**	**5,947,500**	

Feeder Canal Alternative 1 Sensitivity Case 3 (Hydraulic Bypass)

Capital Costs, $	
Total Capital Cost	62,050,419
Present Worth - Capital Cost	59,154,180
O&M Costs, $ /yr	
Total Annual O&M Cost	533,026
Present Worth - Annual O&M Cost	10,757,805
Replacement Costs, $	
Replacement Costs, $	5,947,500
Present Worth - Replacement Costs	2,593,859
50 - Year Present Worth, $	
Capital Cost	59,154,180
O&M Cost	10,757,805
Replacement Cost	2,593,859
Total Present Worth - Public Cost,	$72,505,844
Total Phosphorus Removed, kg	146,063
Present worth, $/kg TP removed	$496.40

Assumptions:

1. **Interest rate 6 3/8%**
2. **Inflation 3%**
3. **Capital costs escalated to the year expected to occur**
4. **O & M costs starts on first day of operation**
5. **Permitting and procurement costs are the responsibility of the District**

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APPENDIX A
L-28 BASIN - Alternative 1 Cost Estimate

	Item/Task	Unit	Unit cost	Quantity	Total	Comments/Explanation
1	**Capital costs**					
1.1.1	Equipment		$ -		$ -	
1.1.2	Residuals management		$ -		$ -	
1.2	Freight		$ -		$ -	
1.3	Installation		$ -		$ -	
1.4	Instrumentation		$ -		$ -	
1.5	**Electrical controls**					
1.5.1	Electrical controls					
1.5.2	Electrical power distribution	$/mile	$ 80,000	2.00	$ 160,000	assumed distance- location unknown
1.6	**Civil Work- water control structures**					
1.6.1	84" culvert open	per structure	$ 20,000		$ -	
1.6.2	84" culvert with gate	per structure	$ 35,000		$ -	
	60" culvert open	per structure	$ 15,000	40	$ 600,000	10 culverts for each interior levee (3) and outflow levee
	60" culvert with gate	per structure	$ 30,000	13	$ 390,000	10 culverts at inflow canal, 3 interceptor/seepage canal
	48" culvert open	per structure	$ 10,000		$ -	
	48" culvert with gate	per structure	$ 25,000		$ -	
1.6.3	concrete box culvert - With gates	per structure	$ 300,000		$ -	
1.6.4	concrete box culvert - Without gates	per structure	$ 150,000		$ -	
	Control Structure - large - with gates	per structure	$ 1,500,000	1	$ 1,500,000	STA outflow structure
	Control Structure - large - without gates	per structure	$ 750,000		$ -	
	Control Structure -small - with gate	per structure	$ 500,000	2	$ 1,000,000	divide structures, north and south of S-140
	Control Structure - small - without gates	per structure	$ 250,000		$ -	
1.7.1	**Canals (digging - no blasting)**					
1.7.1.1	Canals- Deep excavation	$/cubic yard	$ 3.5		$ -	
1.7.1.2	Canals- Shallow excavation	$/cubic yard	$ 2.5	336,148	$ 840,370	interceptor/seepage canal
1.7.2	**Canals (including blasting)**					
1.7.2.1	Canals- Deep excavation	$/cubic yard	$ 5		$ -	
1.7.2.2	Canals- Shallow excavation	$/cubic yard	$ 4		$ -	
1.8.1	**Levees (no blasting)**					
1.8.1.1	Internal- 7' (4.5' SWD)	$/mile	$ 390,000	6.52	$ 2,544,602	Includes internal canals
1.8.1.3	External- 8' (4.5' SWD)	$/mile	$ 485,000	5.47	$ 2,650,690	Includes inflow and outflow canal
1.8.1.4	External- 9' (4.5' SWD)	$/mile	$ 562,000		$ -	
1.8.1.5	External-10' (4.5' SWD)	$/mile	$ 703,000		$ -	
	Seepage Control Mound	$/mile	$ 50,000		$ -	
1.9	**Pumping stations**					
1.9.1.1	0-40 cfs	$/cfs	$ 7,600		$ -	
1.9.1.2	41-60 cfs	$/cfs	$ 9,500		$ -	
1.9.1.3	60-500 cfs	$/cfs	$ 9,900		$ -	
1.9.1.4	500-3,000 cfs	$/cfs	$ 7,500	1300	$ 9,750,000	inflow pump station only (existing S-140 pump station used as outflow pump station)
1.1	**Interior land preparation**					
1.10.1	Disking	$/acre	$ 60		$ -	
	Leveling/Grading	$/acre	$ 100	1280	$ 128,000	
	Clearing/Grubbing	$/acre	$ 200	1088	$ 217,600	treatment cells only

APPENDIX A
L-28 BASIN - Alternative 1 Cost Estimate

	Item/Task	Unit		Unit cost	Quantity		Total	Comments/Explanation
	Other Land Preparation							
	Scrape-down peat	$/cubic yard	$	2.5	877,653	$	2,194,133	
	Canal bank stabilization	$/yd^2	$	0.20	200,000	$	40,000	seeding/mulching/erosion control for inflow, outflow and interceptor/seepage canal
Subtotal						$	22,015,396	
Planning, Engineering and Design - 10%					0.10	$	2,201,540	
Program and Construction Management - 10%					0.10	$	2,201,540	
Subtotal						$	26,418,476	
Capital and Construction Contingency - 30%					0.30	$	7,925,543	
Subtotal Capital and Construction Costs						$	34,344,018	
Land/Right-of-way Acquisition		$/acre	$	883	1280	$	1,129,920	
Land/Right-of-way Acquisition Contingency -20%					0.20	$	225,984	
Total Capital Costs						**$**	**35,699,922**	
2	**OPERATING COSTS (per year)**							
2.1	**Labor**							
2.1.1	Engine operator/Maintenance mechanic	each	$	50,000	0.50	$	25,000	
2.1.2	Lead operator	each	$	60,000	0.50	$	30,000	
2.2.1.1	Mechanical maintenance (lubrication, spare parts, etc.)- 500- 3,000 cfs pumps	per unit	$	23,000		$	-	
2.2.1.2	Mechanical maintenance- 0-500 cfs pumps	per unit	$	10,000	4	$	40,000	4 inflow pumps
2.2.2	Maintenance - Major (water control structures)	each	$	12,000	1	$	12,000	
	Maintenance - Minor (water control structures)	each	$	6,000	2	$	12,000	
	Maintenance - Culverts (water control structures)	each	$	1,000	53	$	53,000	50 culverts in the STA, 3 culverts on interceptor/seepage canal
2.2.3	Maintenance Large building	per unit	$	12,000		$	-	
	Maintenance Small building	per unit	$	6,000	1	$	6,000	
2.2.4	Maintenance- Levees	$/mile	$	1,530	11.99	$	18,345	
2.2.5	Maintenance (vegetation control)	$/acre	$	22	1088	$	23,936	
2.2.6								
2.2.7								
2.2.8	Maintenance- Sludge treatment		$	-		$	-	
2.3	Chemicals					$	-	
2.3.1	Aluminum sulfate	Dry ton	$	150		$	-	
2.3.2	PAC	lb	$	0		$	-	
2.3.3	Ferric chloride	Dry ton	$	180		$	-	
2.3.4	Ferric sulfate	lb	$	0		$	-	
2.3.5	Lime		$	-		$	-	
2.3.6	Polymer	Tons	$	4,000		$	-	
2.3.7	Others		$	-		$	-	
2.4	Solids disposal	Tons	$	50		$	-	
2.5	**Energy**							
2.5.1	Electricity	KW/hr	$	0.08	25000	$	2,000	includes capacity fee
2.5.2	Fuel consumption	acre-feet	$	0.50	84,038	$	84,038	Based on the average flow for the 31-yr period of record (116 cfs) @ the inflow pump station
Subtotal Operating Costs						$	306,318	
Contingency - 30%					0.30	$	91,895	
Total Operating Costs						**$**	**398,214**	

APPENDIX A
L-28 BASIN - Alternative 1 Cost Estimate

	Item/Task	Unit	Unit cost	Quantity	Total	Comments/Explanation
3	**Salvage/Demolition/Replacement costs**					
3.1	Demolition costs			$	-	
3.2	Restoration of levees	$/yard	$ 3	$	-	
3.3	Restoration of FEBs		$ -	$	-	
3.4	Clearing and grubbing		$ -	$	-	
	Light foliage	$/acre	$ 300	$	-	
	Forest/heavy brushes	$/acre	$ 1,500	$	-	
3.5	Replacement items		$ -	$	2,437,500	rebuild and refurbishment of pump station after 25 years @ 25 percent of the original PS cost
Total Demolition Replacement Costs				**$**	**2,437,500**	

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L - 28 Alternative 1

Capital Costs, $	
Total Capital Cost	35,699,920
Present Worth - Capital Cost	34,007,372
O&M Costs, $ /yr	
Total Annual O&M Cost	398,215
Present Worth - Annual O&M Cost	8,036,974
Replacement Costs, $	
Replacement Costs, $	2,437,500
Present Worth - Replacement Costs	1,063,057
50 - Year Present Worth, $	
Capital Cost	34,007,372
O&M Cost	8,036,974
Replacement Cost	1,063,057
Total Present Worth - Public Cost,	$43,107,403
Total Phosphorus Removed, kg	131,931
Present worth, $/kg TP removed	$326.74

Assumptions:

1. **Interest rate 6 3/8%**
2. **Inflation 3%**
3. **Capital costs escalated to the year expected to occur**
4. **O & M costs starts on first day of operation**
5. **Permitting and procurement costs are the responsibility of the District**

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APPENDIX A
L-28 BASIN - Alternative 1 Sensitivity Case 1 Cost Estimate

	Item/Task	Unit	Unit cost	Quantity	Total	Comments/Explanation
1	**Capital costs**					
1.1.1	Equipment		$ -		$ -	
1.1.2	Residuals management		$ -		$ -	
1.2	Freight		$ -		$ -	
1.3	Installation		$ -		$ -	
1.4	Instrumentation		$ -		$ -	
1.5	**Electrical controls**					
1.5.1	Electrical controls					
1.5.2	Electrical power distribution	$/mile	$ 80,000	2.00	$ 160,000	assumed distance- location unknown
1.6	**Civil Work- water control structures**					
1.6.1	84" culvert open	per structure	$ 20,000		$ -	
1.6.2	84" culvert with gate	per structure	$ 35,000		$ -	
	60" culvert open	per structure	$ 15,000	40	$ 600,000	10 culverts for each interior levee (3) and outflow levee
	60" culvert with gate	per structure	$ 30,000	13	$ 390,000	10 culverts at inflow canal, 3 interceptor/seepage canal
	48" culvert open	per structure	$ 10,000		$ -	
	48" culvert with gate	per structure	$ 25,000		$ -	
1.6.3	concrete box culvert - With gates	per structure	$ 300,000		$ -	
1.6.4	concrete box culvert - Without gates	per structure	$ 150,000		$ -	
	Control Structure - large - with gates	per structure	$ 1,500,000	1	$ 1,500,000	STA outflow structure
	Control Structure - large - without gates	per structure	$ 750,000		$ -	
	Control Structure -small - with gate	per structure	$ 500,000	2	$ 1,000,000	divide structures, north and south of S-140
	Control Structure - small - without gates	per structure	$ 250,000		$ -	
1.7.1	**Canals (digging - no blasting)**					
1.7.1.1	Canals- Deep excavation	$/cubic yard	$ 3.5		$ -	
1.7.1.2	Canals- Shallow excavation	$/cubic yard	$ 2.5	299,556	$ 748,889	interceptor/seepage canal
1.7.2	**Canals (including blasting)**					
1.7.2.1	Canals- Deep excavation	$/cubic yard	$ 5		$ -	
1.7.2.2	Canals- Shallow excavation	$/cubic yard	$ 4		$ -	
1.8.1	**Levees (no blasting)**					
1.8.1.1	Internal- 7' (4.5' SWD)	$/mile	$ 390,000	5.72	$ 2,229,574	Includes internal canals
1.8.1.3	External- 8' (4.5' SWD)	$/mile	$ 485,000	4.85	$ 2,353,628	Includes inflow and outflow canal
1.8.1.4	External- 9' (4.5' SWD)	$/mile	$ 562,000		$ -	
1.8.1.5	External-10' (4.5' SWD)	$/mile	$ 703,000		$ -	
	Seepage Control Mound	$/mile	$ 50,000		$ -	
1.9	**Pumping stations**					
1.9.1.1	0-40 cfs	$/cfs	$ 7,600		$ -	
1.9.1.2	41-60 cfs	$/cfs	$ 9,500		$ -	
1.9.1.3	60-500 cfs	$/cfs	$ 9,900		$ -	
1.9.1.4	500-3,000 cfs	$/cfs	$ 7,500	1300	$ 9,750,000	inflow pump station only (existing S-140 pump station used as outflow pump station)
1.1	**Interior land preparation**					
1.10.1	Disking	$/acre	$ 60		$ -	
	Leveling/Grading	$/acre	$ 100	1020	$ 102,000	
	Clearing/Grubbing	$/acre	$ 200	840	$ 168,000	treatment cells only

APPENDIX A
L-28 BASIN - Alternative 1 Sensitivity Case 1 Cost Estimate

	Item/Task	Unit		Unit cost	Quantity		Total	Comments/Explanation
	Other Land Preparation							
	Scrape-down peat	$/cubic yard	$	2.5	677,600	$	1,694,000	
	Canal bank stabilization	$/yd^2	$	0.20	200,000	$	40,000	seeding/mulching/erosion control for inflow, outflow and interceptor/seepage canal
Subtotal						$	20,736,091	
Planning, Engineering and Design - 10%					0.10	$	2,073,609	
Program and Construction Management - 10%					0.10	$	2,073,609	
Subtotal						$	24,883,309	
Capital and Construction Contingency - 30%					0.30	$	7,464,993	
Subtotal Capital and Construction Costs						$	32,348,301	
Land/Right-of-way Acquisition		$/acre	$	883	1020	$	900,405	
Land/Right-of-way Acquisition Contingency -20%					0.20	$	180,081	
Total Capital Costs						**$**	**33,428,787**	

2	**OPERATING COSTS (per year)**							
2.1	**Labor**							
2.1.1	Engine operator/Maintenance mechanic	each	$	50,000	0.50	$	25,000	
2.1.2	Lead operator	each	$	60,000	0.50	$	30,000	
2.2.1.1	Mechanical maintenance (lubrication, spare parts, etc.)- 500- 3,000 cfs pumps	per unit	$	23,000		$	-	
2.2.1.2	Mechanical maintenance- 0-500 cfs pumps	per unit	$	10,000	4	$	40,000	4 inflow pumps
2.2.2	Maintenance - Major (water control structures)	each	$	12,000	1	$	12,000	
	Maintenance - Minor (water control structures)	each	$	6,000	2	$	12,000	
	Maintenance - Culverts (water control structures)	each	$	1,000	53	$	53,000	50 culverts in the STA, 3 culverts on interceptor/seepage canal
2.2.3	Maintenance Large building	per unit	$	12,000		$	-	
	Maintenance Small building	per unit	$	6,000	1	$	6,000	
2.2.4	Maintenance- Levees	$/mile	$	1,530	10.57	$	16,172	
2.2.5	Maintenance (vegetation control)	$/acre	$	22	840	$	18,480	
2.2.6								
2.2.7								
2.2.8	Maintenance- Sludge treatment		$	-		$	-	
2.3	Chemicals					$	-	
2.3.1	Aluminum sulfate	Dry ton	$	150		$	-	
2.3.2	PAC	lb	$	0		$	-	
2.3.3	Ferric chloride	Dry ton	$	180		$	-	
2.3.4	Ferric sulfate	lb	$	0		$	-	
2.3.5	Lime		$	-		$	-	
2.3.6	Polymer	Tons	$	4,000		$	-	
2.3.7	Others		$	-		$	-	
2.4	Solids disposal	Tons	$	50		$	-	
2.5	**Energy**		$	-				
2.5.1	Electricity	KW/hr	$	0.08	25000	$	2,000	includes capacity fee
2.5.2	Fuel consumption	acre-feet	$	0.50	84,038	$	84,038	Based on the average flow for the 31-yr period of record (116 cfs) @ the inflow pump station
Subtotal Operating Costs						$	298,689	
Contingency - 30%					0.30	$	89,607	
Total Operating Costs						**$**	**388,296**	

APPENDIX A
L-28 BASIN - Alternative 1 Sensitivity Case 1 Cost Estimate

	Item/Task	Unit	Unit cost	Quantity	Total	Comments/Explanation
3	**Salvage/Demolition/Replacement costs**					
3.1	Demolition costs				$ -	
3.2	Restoration of levees	$/yard	$ 3		$ -	
3.3	Restoration of FEBs		$ -		$ -	
3.4	Clearing and grubbing		$ -		$ -	
	Light foliage	$/acre	$ 300		$ -	
	Forest/heavy brushes	$/acre	$ 1,500		$ -	
3.5	Replacement items		$ -		$ 2,437,500	rebuild and refurbishment of pump station after 25 years @ 25 percent of the original PS cost
Total Demolition Replacement Costs					**$ 2,437,500**	

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L - 28 Alternative 1 Sensitivity Case (25%)

Capital Costs, $	
Total Capital Cost	33,428,788
Present Worth - Capital Cost	31,841,701
O&M Costs, $ /yr	
Total Annual O&M Cost	388,297
Present Worth - Annual O&M Cost	7,836,810
Replacement Costs, $	
Replacement Costs, $	2,437,500
Present Worth - Replacement Costs	1,063,057
50 - Year Present Worth, $	
Capital Cost	31,841,701
O&M Cost	7,836,810
Replacement Cost	1,063,057
Total Present Worth - Public Cost,	$40,741,568
Total Phosphorus Removed, kg	84,439
Present worth, $/kg TP removed	$482.50

Assumptions:

1. **Interest rate 6 3/8%**
2. **Inflation 3%**
3. **Capital costs escalated to the year expected to occur**
4. **O & M costs starts on first day of operation**
5. **Permitting and procurement costs are the responsibility of the District**

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APPENDIX A
NNRC BASIN - Alternative 1 Cost Estimate

	Item/Task	Unit	Unit cost	Quantity	Total	Comments/Explanation
1	**Capital costs**					
1.1.1	Equipment	Lump sum	$ -		$ 1,292,511	
1.1.2	Residuals management	$/mgal avg.daily design flow	$ 20,000	10	$ 200,000	B&C Desktop, 1998
1.1.3	Chemical feed system	Lump sum	$ -		$ 32,313	2.5% of equipment cost includes AST, pumps, piping
1.2	Freight		$ -		$ -	
1.3	Installation		$ -		$ -	
1.4	Instrumentation	Lump sum	$ -		$ 193,877	15% of equipment cost
1.5	**Electrical controls**					
1.5.1	Electrical controls					
1.5.2	Electrical power distribution	$/mile	$ 80,000	2	$ 160,000	assumed distance - location unknown
1.6	**Civil Work- water control structures**					
1.6.1	84" culvert open	per structure	$ 20,000		$ -	
1.6.2	84" culvert with gate	per structure	$ 35,000		$ -	
	60" culvert open	per structure	$ 15,000		$ -	
	60" culvert with gate	per structure	$ 30,000		$ -	
	48" culvert open	per structure	$ 10,000		$ -	
	48" culvert with gate	per structure	$ 25,000	2	$ 50,000	seepage control
1.6.3	concrete box culvert - With gates	per structure	$ 300,000		$ -	
1.6.4	concrete box culvert - Without gates	per structure	$ 150,000		$ -	
	Control Structure - large - with gates (2)	per structure	$ 1,500,000		$ -	
	Control Structure - large - without gates	per structure	$ 750,000		$ -	
	Control Structure -small - with gate (1)	per structure	$ 500,000	2	$ 1,000,000	outflow control and divide structures
	Control Structure - small - without gates	per structure	$ 250,000	1	$ 250,000	FEB control/ overflow
1.7.1	**Canals (digging - no blasting)**					
1.7.1.1	Canals- Deep excavation	$/cubic yard	$ 3.5		$ -	
1.7.1.2	Canals- Shallow excavation	$/cubic yard	$ 2.5		$ -	
1.7.2	**Canals (including blasting)**					
1.7.2.1	Canals- Deep excavation	$/cubic yard	$ 5		$ -	
1.7.2.2	Canals- Shallow excavation	$/cubic yard	$ 4		$ -	
1.8.1	**Levees (no blasting)**					
1.8.1.1	Internal- 7' (4.5' SWD)	$/mile	$ 390,000		$ -	
1.8.1.3	External- 8' (4.5' SWD)	$/mile	$ 485,000	1.40	$ 679,000	
1.8.1.4	External- 9' (4.5' SWD)	$/mile	$ 562,000		$ -	
1.8.1.5	External-10' (4.5' SWD)	$/mile	$ 703,000		$ -	
	Seepage Control Mound	$/mile	$ 50,000	0.90	$ 45,000	
1.9	**Pumping stations**					
1.9.1.1	0-40 cfs	$/cfs	$ 7,600	25	$ 188,480	CTSS pump station
1.9.1.2	41-60 cfs	$/cfs	$ 9,500		$ -	
1.9.1.3	60-500 cfs	$/cfs	$ 9,900	400	$ 3,960,000	inflow pump station (existing G-123 pump station used as outflow pump station)
1.9.1.4	500-3,000 cfs	$/cfs	$ 7,500		$ -	
1.1	**Interior land preparation**					
1.10.1	Disking	$/acre	$ 60		$ -	
	Leveling/Grading	$/acre	$ 100		$ -	

APPENDIX A
NNRC BASIN - Alternative 1 Cost Estimate

	Item/Task	Unit		Unit cost	Quantity		Total	Comments/Explanation
	Clearing/Grubbing	$/acre	$	200	34	$	6,800	FEB and blending basin
	Other Land Preparation							
	Canal bank stabilization	$/yd^2	$	0.20	50,000	$	10,000	seeding/mulching/erosion control for levees and interceptor/seepage canal
Subtotal						$	8,067,980	
Planning, Engineering and Design - 10%					0.10	$	806,798	
Program and Construction Management - 10%					0.10	$	806,798	
Subtotal						$	9,681,577	
Capital and Construction Contingency - 30%					0.30	$	2,904,473	
Subtotal Capital and Construction Costs						$	12,586,049	
Land/Right-of-way Acquisition		$/acre	$	300,000	50	$	15,000,000	
Land/Right-of-way Acquisition associated costs						$	1,000,000	
Land/Right-of-way Acquisition Contingency -15%					0.15	$	2,400,000	
Total Capital Costs						**$**	**30,986,049**	

2	**OPERATING COSTS (per year)**							
2.1	**Labor**							
2.1.1	Engine operator/Maintenance mechanic	each	$	50,000		$	-	
2.1.2	Lead operator	each	$	60,000		$	-	
2.1.3	Treatment plant labor	per hr	$	30	11680	$	350,400	4 8-hr shifts/day
2.2.1.1	Mechanical maintenance (lubrication, spare parts, etc.)- 500- 3,000 cfs pumps	per unit	$	23,000		$	-	
2.2.1.2	Mechanical maintenance- 0-500 cfs pumps	per unit	$	10,000	4	$	40,000	2 inflow and 2 CTSS
2.2.2	Maintenance - Major (water control structures)	each	$	12,000		$	-	
	Maintenance - Minor (water control structures)	each	$	6,000	3	$	18,000	
	Maintenance - Culverts (water control structures)	each	$	1,000	2	$	2,000	2 culverts on seepage canal
2.2.3	Maintenance Large building	per unit	$	12,000		$	-	
	Maintenance Small building	per unit	$	6,000		$	-	
2.2.4	Maintenance- Levees	$/mile	$	1,530	2.30	$	3,519	
2.2.5	Maintenance (vegetation control)	$/acre	$	22		$	-	
2.2.6	Maintenance - treatment plant building	per unit	$	2,400	1	$	2,400	
2.2.7								
2.2.8	Maintenance- residual solids treatment	$/mgal avg.daily design flow	$	1,200	10	$	12,000	B&C Desktop, 1998
2.3	Chemicals					$	-	
2.3.1	Aluminum chloride	Dry ton	$	160	58	$	9,265	
2.3.2	PAC	lb	$	0		$	-	
2.3.3	Ferric chloride	Dry ton	$	180		$	-	
2.3.4	Ferric sulfate	lb	$	0		$	-	
2.3.5	Lime		$	-		$	-	
2.3.6	Polymer	$/mgal treated	$	8	187	$	1,496	
2.3.7	Others		$	-		$	-	
2.4	Solids disposal	Tons	$	50		$	-	
2.5	**Energy**		$	-		$	-	
2.5.1	Electricity	KW/hr	$	0.08	37623	$	3,010	treatment plant works, includes capacity fee
2.5.2	Fuel consumption	acre-feet	$	0.50	2,356	$	1,178	inflow and CTSS pump stations
	Laboratory Expenses							

APPENDIX A
NNRC BASIN - Alternative 1 Cost Estimate

	Item/Task	Unit	Unit cost	Quantity	Total	Comments/Explanation
	In-house expenses (process control)	lump sum	$ 1,000	1	$ 1,000	
Subtotal Operating Costs					$ 444,268	
Contingency - 30%				0.30	$ 133,280	
Total Operating Costs					**$ 577,548**	

3	**Salvage/Demolition/Replacement costs**					
3.1	Demolition costs	Lump sum				
3.2	Restoration of levees	$/yard	$ 3			
3.3	Restoration of FEBs		$ -		$ -	
3.4	Clearing and grubbing		$ -		$ -	
	Light foliage	$/acre	$ 300			
	Forest/heavy brushes	$/acre	$ 1,500		$ -	
3.5	Replacement items		$ -		$ 1,037,120	rebuild and refurbishment of pump stations after 25 years @ 25 percent of the original PS cost
3.5.1	Chemical feed system	Lump sum			19,388	60% of cost replaced every 10 years
3.5.2	Treatment plant equipment	Lump sum			$ 323,128	25% of plant cost replaced at 20th and 40th year

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NNRC Basin Alternative 1

Capital Costs, $	
Total Capital Cost	30,986,050
Present Worth - Capital Cost	29,739,049
O&M Costs, $ /yr	
Total Annual O&M Cost	577,548
Present Worth - Annual O&M Cost	1,380,290
Replacement Costs, $	
Replacement Costs, $	1,379,636
Present Worth - Replacement Costs	744,219
50 - Year Present Worth, $	
Capital Cost	29,739,049
O&M Cost	1,380,290
Replacement Cost	744,219
Total Present Worth - Public Cost,	$31,863,557
Total Phosphorus Removed, kg	84
Present worth, $/kg TP removed	$379,328.06

Assumptions:

1. **Interest rate 6 3/8%**
2. **Inflation 3%**
3. **Capital costs escalated to the year expected to occur**
4. **O & M costs starts on first day of operation**
5. **Permitting and procurement costs are the responsibility of the District**

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APPENDIX A
NNRC BASIN - Alternative 1 Sensitivity Case 1 (8 ppb / 13 ppb) Cost Estimate

	Item/Task	Unit	Unit cost	Quantity	Total	Comments/Explanation
1	**Capital costs**					
1.1.1	Equipment	Lump sum	$ -		$ 4,448,873	
1.1.2	Residuals management	$/mgal avg.daily design flow	$ 20,000	40	$ 800,000	B&C Desktop, 1998
1.1.3	Chemical feed system	Lump sum	$ -		$ 111,222	2.5% of equipment cost includes AST, pumps, piping
1.2	Freight		$ -		$ -	
1.3	Installation		$ -		$ -	
1.4	Instrumentation	Lump sum	$ -		$ 667,331	15% of equipment cost
1.5	**Electrical controls**					
1.5.1	Electrical controls					
1.5.2	Electrical power distribution	$/mile	$ 80,000	2	$ 160,000	assumed distance - location unknown
1.6	**Civil Work- water control structures**					
1.6.1	84" culvert open	per structure	$ 20,000		$ -	
1.6.2	84" culvert with gate	per structure	$ 35,000		$ -	
	60" culvert open	per structure	$ 15,000		$ -	
	60" culvert with gate	per structure	$ 30,000		$ -	
	48" culvert open	per structure	$ 10,000		$ -	
	48" culvert with gate	per structure	$ 25,000	2	$ 50,000	seepage control
1.6.3	concrete box culvert - With gates	per structure	$ 300,000		$ -	
1.6.4	concrete box culvert - Without gates	per structure	$ 150,000		$ -	
	Control Structure - large - with gates (2)	per structure	$ 1,500,000		$ -	
	Control Structure - large - without gates	per structure	$ 750,000		$ -	
	Control Structure -small - with gate (1)	per structure	$ 500,000	2	$ 1,000,000	outflow control and divide structures
	Control Structure - small - without gates	per structure	$ 250,000	1	$ 250,000	FEB control/ overflow
1.7.1	**Canals (digging - no blasting)**					
1.7.1.1	Canals- Deep excavation	$/cubic yard	$ 3.5		$ -	
1.7.1.2	Canals- Shallow excavation	$/cubic yard	$ 2.5		$ -	
1.7.2	**Canals (including blasting)**					
1.7.2.1	Canals- Deep excavation	$/cubic yard	$ 5		$ -	
1.7.2.2	Canals- Shallow excavation	$/cubic yard	$ 4		$ -	
1.8.1	**Levees (no blasting)**					
1.8.1.1	Internal- 7' (4.5' SWD)	$/mile	$ 390,000		$ -	
1.8.1.3	External- 8' (4.5' SWD)	$/mile	$ 485,000	1.60	$ 776,000	
1.8.1.4	External- 9' (4.5' SWD)	$/mile	$ 562,000		$ -	
1.8.1.5	External-10' (4.5' SWD)	$/mile	$ 703,000		$ -	
	Seepage Control Mound	$/mile	$ 50,000	1.00	$ 50,000	
1.9	**Pumping stations**					
1.9.1.1	0-40 cfs	$/cfs	$ 7,600		$ -	
1.9.1.2	41-60 cfs	$/cfs	$ 9,500		$ -	
1.9.1.3	60-500 cfs	$/cfs	$ 9,900	493	$ 4,880,700	inflow pump station (existing G-123 pump station used as outflow pump station) and CTSS pump station
1.9.1.4	500-3,000 cfs	$/cfs	$ 7,500		$ -	
1.1	**Interior land preparation**					
1.10.1	Disking	$/acre	$ 60		$ -	

APPENDIX A
NNRC BASIN - Alternative 1 Sensitivity Case 1 (8 ppb / 13 ppb) Cost Estimate

	Item/Task	Unit		Unit cost	Quantity		Total	Comments/Explanation
	Leveling/Grading	$/acre	$	100		$	-	
	Clearing/Grubbing	$/acre	$	200	44	$	8,800	FEB and blending basin
	Other Land Preparation							
	Canal bank stabilization	$/yd^2	$	0.20	50,000	$	10,000	seeding/mulching/erosion control for levees and interceptor/seepage canal
Subtotal						$	13,212,926	
Planning, Engineering and Design - 10%					0.10	$	1,321,293	
Program and Construction Management - 10%					0.10	$	1,321,293	
Subtotal						$	15,855,511	
Capital and Construction Contingency - 30%					0.30	$	4,756,653	
Subtotal Capital and Construction Costs						$	20,612,164	
Land/Right-of-way Acquisition		$/acre		300,000	56	$	16,800,000	
Land/Right-of-way Acquisition associated costs						$	1,000,000	
Land/Right-of-way Acquisition Contingency -15%					0.15	$	2,670,000	
Total Capital Costs						**$**	**41,082,164**	

2	**OPERATING COSTS (per year)**							
2.1	**Labor**							
2.1.1	Engine operator/Maintenance mechanic	each	$	50,000		$	-	
2.1.2	Lead operator	each	$	60,000		$	-	
2.1.3	Treatment plant labor	per hr	$	30	11680	$	350,400	4 8-hr shifts/day
2.2.1.1	Mechanical maintenance (lubrication, spare parts, etc.)- 500- 3,000 cfs pumps	per unit	$	23,000		$	-	
2.2.1.2	Mechanical maintenance- 0-500 cfs pumps	per unit	$	10,000	4	$	40,000	2 inflow and 2 CTSS
2.2.2	Maintenance - Major (water control structures)	each	$	12,000		$	-	
	Maintenance - Minor (water control structures)	each	$	6,000	3	$	18,000	
	Maintenance - Culverts (water control structures)	each	$	1,000	2	$	2,000	2 culverts on seepage canal
2.2.3	Maintenance Large building	per unit	$	12,000		$	-	
	Maintenance Small building	per unit	$	6,000		$	-	
2.2.4	Maintenance- Levees	$/mile	$	1,530	2.60	$	3,978	
2.2.5	Maintenance (vegetation control)	$/acre	$	22		$	-	
2.2.6	Maintenance - treatment plant building	per unit	$	2,400	1	$	2,400	
2.2.7								
2.2.8	Maintenance- residual solids treatment	$/mgal avg.daily design flow	$	1,200	40	$	48,000	B&C Desktop, 1998
2.3	Chemicals					$	-	
2.3.1	Aluminum chloride	Dry ton	$	160	96	$	15,408	
2.3.2	PAC	lb	$	0		$	-	
2.3.3	Ferric chloride	Dry ton	$	180		$	-	
2.3.4	Ferric sulfate	lb	$	0		$	-	
2.3.5	Lime		$	-		$	-	
2.3.6	Polymer	$/mgal treated	$	8	311	$	2,488	
2.3.7	Others		$	-		$	-	
2.4	Solids disposal	Tons	$	50		$	-	
2.5	**Energy**		$	-		$	-	
2.5.1	Electricity	KW/hr	$	0.08	45993	$	3,679	treatment plant works, includes capacity fee
2.5.2	Fuel consumption	acre-feet	$	0.50	2,736	$	1,368	inflow and CTSS pump stations

APPENDIX A
NNRC BASIN - Alternative 1 Sensitivity Case 1 (8 ppb / 13 ppb) Cost Estimate

	Item/Task	Unit	Unit cost	Quantity	Total	Comments/Explanation
	Laboratory Expenses					
	In-house expenses (process control)	lump sum	$ 1,000	1	$ 1,000	
Subtotal Operating Costs					$ 488,722	
Contingency - 30%				0.30	$ 146,617	
Total Operating Costs					**$ 635,338**	

3	**Salvage/Demolition/Replacement costs**					
3.1	Demolition costs	Lump sum				
3.2	Restoration of levees	$/yard	$ 3			
3.3	Restoration of FEBs		$ -		$ -	
3.4	Clearing and grubbing		$ -		$ -	
	Light foliage	$/acre	$ 300			
	Forest/heavy brushes	$/acre	$ 1,500		$ -	
3.5	Replacement items		$ -		$ 1,220,175	rebuild and refurbishment of pump stations after 25 years @ 25 percent of the original PS cost
3.5.1	Chemical feed system	Lump sum			66,733	60% of cost replaced every 10 years
3.5.2	Treatment plant equipment	Lump sum			$ 1,112,218	25% of plant cost replaced at 20th and 40th year

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NNRC Basin Alternative 1 Sensitivity Case (8 ppb / 13 ppb)

Capital Costs, $	
Total Capital Cost	41,082,165
Present Worth - Capital Cost	39,389,362
O&M Costs, $ /yr	
Total Annual O&M Cost	635,337
Present Worth - Annual O&M Cost	1,518,400
Replacement Costs, $	
Replacement Costs, $	2,399,126
Present Worth - Replacement Costs	1,536,893
50 - Year Present Worth, $	
Capital Cost	39,389,362
O&M Cost	1,518,400
Replacement Cost	1,536,893
Total Present Worth - Public Cost,	$42,444,655
Total Phosphorus Removed, kg	156
Present worth, $/kg TP removed	$272,081.12

Assumptions:

1. **Interest rate 6 3/8%**
2. **Inflation 3%**
3. **Capital costs escalated to the year expected to occur**
4. **O & M costs starts on first day of operation**
5. **Permitting and procurement costs are the responsibility of the District**

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APPENDIX A
NSID BASIN - Alternative 1 Cost Estimate

	Item/Task	Unit	Unit cost	Quantity	Total	Comments/Explanation
1	**Capital costs**					
1.1.1	Equipment		$ -		$ -	
1.1.2	Residuals management		$ -		$ -	
1.2	Freight		$ -		$ -	
1.3	Installation		$ -		$ -	
1.4	Instrumentation		$ -		$ -	
1.5	**Electrical controls**					
1.5.1						
1.5.2	Electrical power distribution	$/mile	$ 80,000	1.00	$ 80,000	Temporary Pump Station @ L-36
1.6	**Civil Work- water control structures**					
1.6.1	84" culvert open	per structure	$ 20,000		$ -	
1.6.2	84" culvert with gate	per structure	$ 35,000		$ -	
	72" culvert open	per structure	$ 17,500		$ -	
	72" culvert with gate	per structure	$ 32,500		$ -	
	60" culvert open	per structure	$ 15,000		$ -	
	60" culvert with gate	per structure	$ 30,000		$ -	
	48" culvert open	per structure	$ 10,000		$ -	
	48" culvert with gate	per structure	$ 25,000		$ -	
1.6.3	10' x 10' x 53' concrete box culvert - With gates	per structure	$ 300,000		$ -	
1.6.4	10' x 10' x 53' concrete box culvert - Without gates	per structure	$ 150,000			
	5' x 10' x 20' concrete box culvert - without gates	per structure	$ 60,000		$ -	
	5' x 10' x 50' concrete box culvert - without gates	per structure	$ 100,000		$ -	
	Control Structure - large - with gates	per structure	$ 1,500,000		$ -	
	Control Structure - large - without gates	per structure	$ 750,000		$ -	
	Control Structure -small - with gate	per structure	$ 500,000	1	$ 500,000	Outflow gravity structure from water storage area
	Control Structure - small - without gates	per structure	$ 250,000		$ -	
1.7.1	**Canals (digging - no blasting)**					
1.7.1.1	Canals- Deep excavation	$/cubic yard	$ 3.5		$ -	
1.7.1.2	Canals- Shallow excavation	$/cubic yard	$ 2.5		$ -	
1.7.2	**Canals (including blasting)**					
1.7.2.1	Canals- Deep excavation	$/cubic yard	$ 5		$ -	
1.7.2.2	Canals- Shallow excavation	$/cubic yard	$ 4		$ -	
1.8.1	**Levees (no blasting)**					
1.8.1.1	Internal- 7' (4.5' SWD)	$/mile	$ 390,000	3.30	$ 1,287,000	Around rock pits only
1.8.1.3	External- 8' (4.5' SWD)	$/mile	$ 485,000		$ -	
1.8.1.4	External- 9' (4.5' SWD)	$/mile	$ 562,000		$ -	
1.8.1.5	External-10' (4.5' SWD)	$/mile	$ 703,000		$ -	
1.8.1.6	External-5' (4.5' SWD)	$/mile	$ 278,572		$ -	
	Seepage Control Mound	$/mile	$ 50,000		$ -	
1.9	**Pumping stations**					
1.9.1.1	0-40 cfs	$/cfs	$ 7,600		$ -	
1.9.1.2	41-60 cfs	$/cfs	$ 9,500		$ -	
1.9.1.3	60-500 cfs	$/cfs	$ 6,000	222	$ 1,332,000	Temporary Pump Station @ L-36 (prefab metal structure)
1.9.1.4	500-3,000 cfs	$/cfs	$ 7,500		$ -	
1.1	**Interior land preparation**					
1.10.1	Disking	$/acre	$ 60		$ -	
	Leveling/Grading	$/acre	$ 100		$ -	
	Clearing/Grubbing	$/acre	$ 200		$ -	

APPENDIX A
NSID BASIN - Alternative 1 Cost Estimate

	Item/Task	Unit		Unit cost	Quantity		Total	Comments/Explanation
	Subtotal					$	3,199,000	
	Planning, Engineering and Design - 10%				0.10	$	319,900	
	Program and Construction Management - 10%				0.10	$	319,900	
	Subtotal					$	3,838,800	
	Capital and Construction Contingency - 30%				0.30	$	1,151,640	
	Subtotal Capital and Construction Costs					$	4,990,440	
	Land/Right-of-way Lease (2 years)	$/year	$	10,996,875	2	$	21,993,750	
	Total Capital Costs					**$**	**26,984,190**	
2	**OPERATING COSTS (per year)**							
2.1	**Labor**							
2.1.1	Engine operator/Maintenance mechanic	each	$	50,000	0.20	$	10,000	Inflow Pump Station @ L-36
2.1.2	Lead operator	each	$	60,000	0.20	$	12,000	Inflow Pump Station @ L-36
2.2.1.1	Mechanical maintenance (lubrication, spare parts, etc.)- 500- 3,000 cfs pumps	per unit	$	23,000		$	-	
2.2.1.2	Mechanical maintenance- 0-500 cfs pumps	per unit	$	10,000	2	$	20,000	Inflow Pump Station @ L-36
2.2.2	Maintenance - Major (water control structures)	each	$	12,000		$	-	
	Maintenance - Minor (water control structures)	each	$	6,000	1.00	$	6,000	
	Maintenance - Culverts (water control structures)	each	$	1,000		$	-	
2.2.3	Maintenance Large building	per unit	$	12,000		$	-	
	Maintenance Small building	per unit	$	6,000	1	$	6,000	Inflow Pump Station @ L-36
2.2.4	Maintenance- Levees	$/mile	$	1,530	3.30	$	5,049	Around rock pits only
2.2.5	Maintenance (vegetation control)	$/acre	$	22		$	-	
						$	-	
2.2.8	Maintenance- Sludge treatment		$	-		$	-	
2.3	Chemicals					$	-	
2.3.1	Aluminum sulfate	Dry ton	$	150		$	-	
2.3.2	PAC	lb	$	0		$	-	
2.3.3	Ferric chloride	Dry ton	$	180		$	-	
2.3.4	Ferric sulfate	lb	$	0		$	-	
2.3.5	Lime		$	-		$	-	
2.3.6	Polymer	Tons	$	4,000		$	-	
2.3.7	Others		$	-		$	-	
2.4	Solids disposal	Tons	$	50		$	-	
2.5	**Energy**		$	-		$	-	
2.5.1	Electricity	KW/hr	$	0.08	25,000	$	2,000	Includes capacity fee
2.5.2	Fuel consumption	acre-feet	$	0.50	3,500	$	1,750	
Subtotal Operating Costs						$	62,799	
Contingency - 30%					0.30	$	18,840	
Total Operating Costs						**$**	**81,639**	
3	**Salvage/Demolition/Replacement costs**							
3.1	Demolition costs	Lump sum	$	350,000	1	$	350,000	Remove temporary pump station
3.2	Restoration of levees	$/yard	$	3		$	-	
3.3	Restoration of FEBs		$	-		$	-	
3.4	Clearing and grubbing		$	-		$	-	
	Light foliage	$/acre	$	300		$	-	
	Forest/heavy brushes	$/acre	$	1,500		$	-	
3.5	Replacement items		$	-		$	-	

NSID Basin Alternative 1

Capital Costs, $	
Total Capital Cost	26,984,190
Present Worth - Capital Cost	25,690,134
O&M Costs, $ /yr	
Total Annual O&M Cost	81,639
Present Worth - Annual O&M Cost	77,552
Demolition Costs, $	
Demolition Costs, $	350,000
Present Worth - Demolition Costs	296,477
50 - Year Present Worth, $	
Capital Cost	25,690,134
O&M Cost	77,552
Demolition Cost	296,477
Total Present Worth - Public Cost,	$26,064,162
Total Phosphorus Removed, kg	293
Present worth, $/kg TP removed	$88,956.18

Assumptions:

1. **Interest rate 6 3/8%**
2. **Inflation 3%**
3. **Capital costs escalated to the year expected to occur**
4. **O & M costs starts on first day of operation**
5. **Permitting and procurement costs are the responsibility of the District**

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APPENDIX A
NSID BASIN - Alternative 2 Cost Estimate

	Item/Task	Unit	Unit cost	Quantity	Total	Comments/Explanation
1	**Capital costs**					
1.1.1	Equipment		$ -		$ -	
1.1.2	Residuals management		$ -		$ -	
1.2	Freight		$ -		$ -	
1.3	Installation		$ -		$ -	
1.4	Instrumentation		$ -		$ -	
1.5	**Electrical controls**					
1.5.1						
1.5.2	Electrical power distribution	$/mile	$ 80,000	0.40	$ 32,000	Inflow/outflow Pump Station and control structures @ L-36
	Electrical power distribution	$/mile	$ 80,000	2.70	$ 216,000	Seepage Pumping Station
1.6	**Civil Work- water control structures**					
1.6.1	84" culvert open	per structure	$ 20,000		$ -	
1.6.2	84" culvert with gate	per structure	$ 35,000		$ -	
	72" culvert open	per structure	$ 17,500		$ -	
	72" culvert with gate	per structure	$ 32,500	24	$ 780,000	Inlet/outlet structures for impoundment cells
	60" culvert open	per structure	$ 15,000		$ -	
	60" culvert with gate	per structure	$ 30,000		$ -	
	48" culvert open	per structure	$ 10,000		$ -	
	48" culvert with gate	per structure	$ 25,000		$ -	
1.6.3	10' x 10' x 53' concrete box culvert - With gates	per structure	$ 300,000		$ -	
1.6.4	10' x 10' x 53' concrete box culvert - Without gates	per structure	$ 150,000			
	5' x 10' x 20' concrete box culvert - without gates	per structure	$ 60,000		$ -	
	5' x 10' x 50' concrete box culvert - without gates	per structure	$ 100,000		$ -	
	Control Structure - large - with gates	per structure	$ 1,500,000		$ -	
	Control Structure - large - without gates	per structure	$ 750,000		$ -	
	Control Structure -small - with gate	per structure	$ 500,000	2	$ 1,000,000	Control Structures @ L-36
	Control Structure - small - without gates	per structure	$ 250,000		$ -	
1.7.1	**Canals (digging - no blasting)**					
1.7.1.1	Canals- Deep excavation	$/cubic yard	$ 3.5		$ -	
1.7.1.2	Canals- Shallow excavation	$/cubic yard	$ 2.5		$ -	
1.7.2	**Canals (including blasting)**					
1.7.2.1	Canals- Deep excavation	$/cubic yard	$ 5		$ -	
1.7.2.2	Canals- Shallow excavation	$/cubic yard	$ 4		$ -	
1.8.1	**Levees (no blasting)**					
1.8.1.1	Internal- 7' (4.5' SWD)	$/mile	$ 390,000		$ -	
1.8.1.3	External- 8' (4.5' SWD)	$/mile	$ 485,000		$ -	
1.8.1.4	External- 9' (4.5' SWD)	$/mile	$ 562,000		$ -	
1.8.1.5	External-10' (4.5' SWD)	$/mile	$ 703,000		$ -	
1.8.1.6	External-10' (8' SWD)	$/mile	$ 900,000	13.00	$ 11,700,000	Includes internal and external levees
	Seepage Control Mound	$/mile	$ 50,000		$ -	
1.9	**Pumping stations**					
1.9.1.1	0-40 cfs	$/cfs	$ 7,600		$ -	
1.9.1.2	41-60 cfs	$/cfs	$ 9,500		$ -	
1.9.1.3	60-500 cfs	$/cfs	$ 9,900	100	$ 990,000	Seepage Pumping Station
1.9.1.4	500-3,000 cfs	$/cfs	$ 7,500	888	$ 6,660,000	Inflow/outflow pump stations
1.9.1.5	Modify Pumping Station				$ 500,000	Reconfigure outflow piping at NSID Pump No 1

APPENDIX A
NSID BASIN - Alternative 2 Cost Estimate

	Item/Task	Unit		Unit cost	Quantity		Total	Comments/Explanation
1.1	**Interior land preparation**							
1.10.1	Disking	$/acre	$	60		$	-	
	Leveling/Grading	$/acre	$	100	800	$	80,000	Impoundment areas only
	Clearing/Grubbing	$/acre	$	200	800	$	160,000	Impoundment areas only
	Other Land Preparation							
	Canal bank stabilization	$/yd^2	$	0.20	250,000	$	50,000	Seeding/mulching
	Initial dredging of L-36 canal	$/yd^3	$	5.00	10,000	$	50,000	Assumes dragline used
Subtotal						$	22,218,000	
Planning, Engineering and Design - 10%					0.10	$	2,221,800	
Program and Construction Management - 10%					0.10	$	2,221,800	
Subtotal						$	26,661,600	
Capital and Construction Contingency - 30%					0.30	$	7,998,480	
Subtotal Capital and Construction Costs						$	34,660,080	
Land/Right-of-way Acquisition		$/acre	$	34,500	1700	$	58,650,000	
Land/Right-of-way Acquisition Contingency - 25%					0.25	$	14,662,500	
Total Capital Costs						**$**	**107,972,580**	

2	**OPERATING COSTS (per year)**							
2.1	**Labor**							
2.1.1	Engine operator/Maintenance mechanic	each	$	50,000	0.50	$	25,000	Includes inflow/outflow PS @ L-36 and seepage PS
2.1.2	Lead operator	each	$	60,000	0.50	$	30,000	Includes inflow/outflow PS @ L-36 and seepage PS
2.2.1.1	Mechanical maintenance (lubrication, spare parts, etc.)- 500- 3,000 cfs pumps	per unit	$	23,000		$	-	
2.2.1.2	Mechanical maintenance- 0-500 cfs pumps	per unit	$	10,000	6	$	60,000	Inflow/Outflow PS
	Mechanical maintenance- 0-500 cfs pumps	per unit	$	10,000	2	$	20,000	Seepage Pumping Station
2.2.2	Maintenance - Major (water control structures)	each	$	12,000		$	-	
	Maintenance - Minor (water control structures)	each	$	6,000	2	$	12,000	
	Maintenance - Culverts (water control structures)	each	$	1,000	24	$	24,000	
2.2.3	Maintenance Large building	per unit	$	12,000	1	$	12,000	Inflow/outflow PS @ L-36 and seepage PS
	Maintenance Small building	per unit	$	6,000	1	$	6,000	seepage PS
2.2.4	Maintenance- Levees	$/mile	$	1,530	13.00	$	19,890	All levees internal and external
2.2.5	Maintenance (vegetation control)	$/acre	$	10	800	$	8,000	Impoundment area
						$	-	
2.2.8	Maintenance- Sludge treatment		$	-		$	-	
2.3	Chemicals					$	-	
2.3.1	Aluminum sulfate	Dry ton	$	150		$	-	
2.3.2	PAC	lb	$	0		$	-	
2.3.3	Ferric chloride	Dry ton	$	180		$	-	
2.3.4	Ferric sulfate	lb	$	0		$	-	
2.3.5	Lime		$	-		$	-	
2.3.6	Polymer	Tons	$	4,000		$	-	
2.3.7	Others		$	-		$	-	
2.4	Solids disposal	Tons	$	50		$	-	
2.5	**Energy**		$	-		$	-	
2.5.1	Electricity	KW/hr	$	0.08	25,000	$	2,000	Includes capacity fee
2.5.2	Fuel consumption	acre-feet	$	0.50	14,000	$	7,000	Includes inflow, outflow and seepage pump stations
Subtotal Operating Costs						$	225,890	

APPENDIX A
NSID BASIN - Alternative 2 Cost Estimate

	Item/Task	Unit	Unit cost	Quantity	Total	Comments/Explanation
Contingency - 30%				0.30	$ 67,767	
Total Operating Costs					**$ 293,657**	
3	**Salvage/Demolition/Replacement costs**					
3.1	Demolition costs				$ -	
3.2	Restoration of levees	$/yard	$ 3		$ -	
3.3	Restoration of FEBs		$ -		$ -	
3.4	Clearing and grubbing		$ -		$ -	
	Light foliage	$/acre	$ 300		$ -	
	Forest/heavy brushes	$/acre	$ 1,500		$ -	
3.5	Replacement items	Lump sum			$ 1,912,500	rebuild and refurbish pump stations after 25 years @ 25 percent of the original PS cost

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NSID Basin Alternative 2

Capital Costs, $	
Total Capital Cost	107,972,580
Present Worth - Capital Cost	103,749,949
O&M Costs, $ /yr	
Total Annual O&M Cost	293,657
Present Worth - Annual O&M Cost	5,926,737
Replacement Costs, $	
Replacement Costs, $	1,912,500
Present Worth - Replacement Costs	834,091
50 - Year Present Worth, $	
Capital Cost	103,749,949
O&M Cost	5,926,737
Replacement Cost	834,091
Total Present Worth - Public Cost,	$110,510,777
Total Phosphorus Removed, kg	14,650
Present worth, $/kg TP removed	$7,543.40

Assumptions:

1. **Interest rate 6 3/8%**
2. **Inflation 3%**
3. **Capital costs escalated to the year expected to occur**
4. **O & M costs starts on first day of operation**
5. **Permitting and procurement costs are the responsibility of the District**

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Appendix B
DMSTA Model Output

DMSTA Input Values **ACME Basin B - Alt. 3 basecase**

Input Variable	Units	Value
Design Case Name	-	s100r1
Starting Date for Simulation	-	01/00/00
Ending Date for Simulation	-	01/00/00
Starting Date for Output	-	01/00/00
Steps Per Day	-	8
Number of Iterations	-	2
Output Averaging Interval	days	7
Reservoir H2O Residence Time	days	0
Max Inflow / Mean Inflow	-	0
Max Reservoir Storage	hm3	0
Reservoir P Decay Rate	1/yr/ppb	0
Rainfall P Conc	ppb	20
Atmospheric P Load (Dry)	mg/m2-yr	20

Case Description: 100% SAV at 79 cm and 1.20 km2 with 3 SAV cells **Filename:** acme_final.xls

Output Variable	Units	Value
Water Balance Error	%	0.0%
Mass Balance Error	%	0.0%
Flow-Wtd Conc - With Bypass	ppb	19
Flow-Wtd Conc - Without Bypass	ppb	19
Geometric Mean Conc	ppb	12
95th Percentile Conc	ppb	25
Freq Cell Outflow > 10 ppb	%	66%
Bypass Load	%	0.0%

Cell Number -->		1	2	3	4	5	6
Cell Label	-	SAV1	SAV2	SAV3			
Vegetation Type	------->	SAV_C4	SAV_C4	SAV_C4			
Inflow Fraction	-	1	0	0			
Downstream Cell Number	-	2	3	0			
Surface Area	km2	0.417	0.417	0.366			
Mean Width of Flow Path	km	1.01	1.01	0.66			
Number of Tanks in Series	-	3	3	3			
Outflow Control Depth	cm	79	79	79			
Outflow Coefficient - Exponent	-	3.5	3.5	3.5			
Outflow Coefficient - Intercept	-	0.8	0.8	0.8			
Bypass Depth	cm	140	140	140			
Maximum Inflow	hm3/day	0	0	0			
Maximum Outflow	hm3/day	0	0	0			
Inflow Seepage Rate	(cm/d) / cm	0	0	0			
Inflow Seepage Control Elev	cm	0	0	0			
Inflow Seepage Conc	ppb	0	0	0			
Outflow Seepage Rate	(cm/d) / cm	0.008	0.008	0.008			
Outflow Seepage Control Elev	cm	0	0	0			
Max Outflow Seepage Conc	ppb	20	20	20			
Seepage Recycle Fraction	-	0.5	0.5	0.5			
Seepage Discharge Fraction	-	0	0	0			
Initial Water Column Conc	ppb	30	30	30			
Initial P Storage Per Unit Area	mg/m2	500	500	500			
Initial Water Column Depth	cm	50	50	50			
C0 = WC Conc at 0 g/m2 P Storage	ppb	*4*	*4*	*4*			
C1 = WC Conc at 1 g/m2 P storage	ppb	*22*	*22*	*22*			
K = Net Settling Rate at Steady State	m/yr	*80*	*80*	*80*			
Zx = Depth Scale Factor	cm	*60*	*60*	*60*			
C0 - Periphyton	ppb	*0*	*0*	*0*			
C1 - Periphyton	ppb	*0*	*0*	*0*			
K - Periphyton	1/yr	*0.00*	*0.00*	*0.00*			
Zx - Periphyton	cm	*0*	*0*	*0*			
Sm = Transition Storage Midpoint	mg/m2	*0*	*0*	*0*			
Sb = Transition Storage Bandwidth	mg/m2	*0*	*0*	*0*			

Output Variables	Units	1	2	3	4	5	6	Overall
Execution Time	seconds/yr	3.45	7.36	11.45				11.45
Run Date	-	05/07/02	05/07/02	05/07/02				05/07/02
Starting Date for Simulation	-	01/01/65	01/01/65	01/01/65				01/01/65
Starting Date for Output	-	01/01/65	01/01/65	01/01/65				01/01/65
Ending Date	-	12/31/95	12/31/95	12/31/95				12/31/95
Output Duration	days	11322	11322	11322				11322
Cell Label		SAV1	SAV2	SAV3				Total Outflow
Downstream Cell Label		SAV2	SAV3	Outflow				-
Surface Area	km2	0.417	0.417	0.366				1.2
Mean Water Load	cm/d	25.5	25.2	28.5				8.9
Max Water Load	cm/d	289.0	288.2	327.7				100.4
Inflow Volume	hm3/yr	38.9	38.5	38.1				38.9
Inflow Load	kg/yr	2747.0	1541.1	977.7				2747.0
Inflow Conc	ppb	71	40	26				71
Treated Outflow Volume	hm3/yr	38.5	38.1	37.8				37.8
Treated Outflow Load	kg/yr	1541.1	977.7	724.7				724.7
Treated FWM Outflow Conc	ppb	40	26	19				19
Total Outflow Volume	hm3/yr	38.5	38.1	37.8				37.8

ACME Basin B - Alt. 3 basecase (cont'd)

Total Outflow Load	kg/yr	1541.1	977.7	724.7	724.7
Total FWM Outflow Conc	ppb	40	26	19	19
Bypass Volume	hm3/yr	0.00	0.00	0.00	0.00
Bypass Load	kg/yr	0.00	0.00	0.00	0.00
Bypass Conc	ppb	0	0	0	0
Bypass Load	%	0%	0%	0%	0%
Surface Outflow Load Reduc	%	43.9%	36.6%	25.9%	73.6%
Outflow Geometric Mean - Daily	ppb	33	18	12	12
Outflow Geo Mean - Composites	ppb	33	18	12	12
Frequency Outflow Conc > 10 ppb	%	100%	96%	66%	66%
95th Percentile Outflow Conc	ppb	47	32	25	25
Mean Biomass P Storage	mg/m2	1992	952	504	1177
Max Reservoir Storage	hm3	0.00	0.00	0.00	0.00
Reservoir Load Reduction	%	#N/A	#N/A	#N/A	#N/A
Mean Depth	cm	76.5	75.7	76.3	76.1
Minimum Depth	cm	4.2	4.2	3.5	4.0
Maximum Depth	cm	111.9	111.7	126.2	116.2
Frequency Depth < 5 cm	%	0.0%	0.0%	0.0%	0.0%
Flow/Width	m2/day	104	103	158	120.1
Max 1 Yr Flow-Wtd Conc	ppb	#N/A	#N/A	#N/A	24
Max 5 Yr Flow-Wtd Conc	ppb	#N/A	#N/A	#N/A	21
Max 1 Yr Geometric Mn Conc	ppb	#N/A	#N/A	#N/A	19
Max 5 Yr Geometric Mn Conc	ppb	#N/A	#N/A	#N/A	15
Depth Percentile vs. Calib Set	%	59%	58%	59%	59%
Q/W Percentile vs. Calib Set	%	48%	48%	73%	73%
Cin Percentile vs. Calib Set	%	75%	49%	28%	75%
Cout Percentile vs. Calib Set	%	49%	28%	15%	15%
Depth Range Flag	-	OK	OK	OK	0.0
Q/W Range Flag	-	OK	OK	OK	0.0
Cin Range Flag	-	OK	OK	OK	0.0
Cout Range Flag	-	OK	OK	OK	0.0
Water Balance Error	%	0.00%	0.00%	0.00%	0.00%
Mass Balance Error	%	0.00%	0.02%	0.03%	0.02%

DMSTA Input Values **ACME Basin B - Alt. 3 with 0% Load Reduction (Sensitivity)**

Input Variable	Units	Value
Design Case Name	-	s100r1
Starting Date for Simulation	-	01/00/00
Ending Date for Simulation	-	01/00/00
Starting Date for Output	-	01/00/00
Steps Per Day	-	8
Number of Iterations	-	2
Output Averaging Interval	days	7
Reservoir H2O Residence Time	days	0
Max Inflow / Mean Inflow	-	0
Max Reservoir Storage	hm3	0
Reservoir P Decay Rate	1/yr/ppb	0
Rainfall P Conc	ppb	20
Atmospheric P Load (Dry)	mg/m2-yr	20

Case Description: 100% SAV at 79 cm and 1.20 km2 with 3 SAV cells with 0% load reduction due to source controls

Filename: acme_final_base.xls

Output Variable	Units	Value
Water Balance Error	%	0.0%
Mass Balance Error	%	0.0%
Flow-Wtd Conc - With Bypass	ppb	23
Flow-Wtd Conc - Without Bypass	ppb	23
Geometric Mean Conc	ppb	15
95th Percentile Conc	ppb	29
Freq Cell Outflow > 10 ppb	%	84%
Bypass Load	%	0.0%

Cell Number -->		1	2	3	4	5	6
Cell Label	-	SAV1	SAV2	SAV3			
Vegetation Type	------->	SAV_C4	SAV_C4	SAV_C4			
Inflow Fraction	-	1	0	0			
Downstream Cell Number	-	2	3	0			
Surface Area	km2	0.417	0.417	0.366			
Mean Width of Flow Path	km	1.01	1.01	0.66			
Number of Tanks in Series	-	3	3	3			
Outflow Control Depth	cm	79	79	79			
Outflow Coefficient - Exponent	-	3.5	3.5	3.5			
Outflow Coefficient - Intercept	-	0.8	0.8	0.8			
Bypass Depth	cm	140	140	140			
Maximum Inflow	hm3/day	0	0	0			
Maximum Outflow	hm3/day	0	0	0			
Inflow Seepage Rate	(cm/d) / cm	0	0	0			
Inflow Seepage Control Elev	cm	0	0	0			
Inflow Seepage Conc	ppb	0	0	0			
Outflow Seepage Rate	(cm/d) / cm	0.008	0.008	0.008			
Outflow Seepage Control Elev	cm	0	0	0			
Max Outflow Seepage Conc	ppb	20	20	20			
Seepage Recycle Fraction	-	0.5	0.5	0.5			
Seepage Discharge Fraction	-	0	0	0			
Initial Water Column Conc	ppb	30	30	30			
Initial P Storage Per Unit Area	mg/m2	500	500	500			
Initial Water Column Depth	cm	50	50	50			
C0 = WC Conc at 0 g/m2 P Storage	ppb	*4*	*4*	*4*			
C1 = WC Conc at 1 g/m2 P storage	ppb	*22*	*22*	*22*			
K = Net Settling Rate at Steady State	m/yr	*80*	*80*	*80*			
Zx = Depth Scale Factor	cm	*60*	*60*	*60*			
C0 - Periphyton	ppb	*0*	*0*	*0*			
C1 - Periphyton	ppb	*0*	*0*	*0*			
K - Periphyton	1/yr	*0.00*	*0.00*	*0.00*			
Zx - Periphyton	cm	*0*	*0*	*0*			
Sm = Transition Storage Midpoint	mg/m2	*0*	*0*	*0*			
Sb = Transition Storage Bandwidth	mg/m2	*0*	*0*	*0*			

Output Variables	Units	1	2	3	4	5	6	Overall
Execution Time	seconds/yr	3.74	7.94	12.26				12.26
Run Date	-	05/07/02	05/07/02	05/07/02				05/07/02
Starting Date for Simulation	-	01/01/65	01/01/65	01/01/65				01/01/65
Starting Date for Output	-	01/01/65	01/01/65	01/01/65				01/01/65
Ending Date	-	12/31/95	12/31/95	12/31/95				12/31/95
Output Duration	days	11322	11322	11322				11322
Cell Label		SAV1	SAV2	SAV3				Total Outflow
Downstream Cell Label		SAV2	SAV3	Outflow				-
Surface Area	km2	0.417	0.417	0.366				1.2
Mean Water Load	cm/d	25.5	25.2	28.5				8.9
Max Water Load	cm/d	289.0	288.2	327.7				100.4
Inflow Volume	hm3/yr	38.9	38.5	38.1				38.9
Inflow Load	kg/yr	3662.7	1994.8	1206.4				3662.7
Inflow Conc	ppb	94	52	32				94
Treated Outflow Volume	hm3/yr	38.5	38.1	37.8				37.8
Treated Outflow Load	kg/yr	1994.8	1206.4	853.2				853.2
Treated FWM Outflow Conc	ppb	52	32	23				23
Total Outflow Volume	hm3/yr	38.5	38.1	37.8				37.8

ACME Basin B - Alt. 3 with 0% Load Reduction (Sensitivity) (cont'd)

Total Outflow Load	kg/yr	1994.8	1206.4	853.2	853.2
Total FWM Outflow Conc	ppb	52	32	23	23
Bypass Volume	hm3/yr	0.00	0.00	0.00	0.00
Bypass Load	kg/yr	0.00	0.00	0.00	0.00
Bypass Conc	ppb	0	0	0	0
Bypass Load	%	0%	0%	0%	0%
Surface Outflow Load Reduc	%	45.5%	39.5%	29.3%	76.7%
Outflow Geometric Mean - Daily	ppb	43	23	15	15
Outflow Geo Mean - Composites	ppb	44	24	15	15
Frequency Outflow Conc > 10 ppb	%	100%	100%	100%	84%
95th Percentile Outflow Conc	ppb	49	28	16	29
Mean Biomass P Storage	mg/m2	2739	1317	691	1620
Max Reservoir Storage	hm3	0.00	0.00	0.00	0.00
Reservoir Load Reduction	%	#N/A	#N/A	#N/A	#N/A
Mean Depth	cm	76.5	75.7	76.3	76.1
Minimum Depth	cm	4.2	4.2	3.5	4.0
Maximum Depth	cm	111.9	111.7	126.2	116.2
Frequency Depth < 5 cm	%	0.0%	0.0%	0.0%	0.0%
Flow/Width	m2/day	104	103	158	120.1
Max 1 Yr Flow-Wtd Conc	ppb	#N/A	#N/A	#N/A	29
Max 5 Yr Flow-Wtd Conc	ppb	#N/A	#N/A	#N/A	26
Max 1 Yr Geometric Mn Conc	ppb	#N/A	#N/A	#N/A	25
Max 5 Yr Geometric Mn Conc	ppb	#N/A	#N/A	#N/A	19
Depth Percentile vs. Calib Set	%	59%	58%	59%	59%
Q/W Percentile vs. Calib Set	%	48%	48%	73%	73%
Cin Percentile vs. Calib Set	%	88%	60%	38%	88%
Cout Percentile vs. Calib Set	%	61%	38%	22%	22%
Depth Range Flag	-	OK	OK	OK	0.0
Q/W Range Flag	-	OK	OK	OK	0.0
Cin Range Flag	-	OK	OK	OK	0.0
Cout Range Flag	-	OK	OK	OK	0.0
Water Balance Error	%	0.00%	0.00%	0.00%	0.00%
Mass Balance Error	%	-0.01%	0.01%	0.01%	0.00%

DMSTA Input Values **ACME Basin B - Alt. 3 with 40% Load Reduction (Sensitivity)**

Input Variable	Units	Value
Design Case Name	-	s100r1_40
Starting Date for Simulation	-	01/00/00
Ending Date for Simulation	-	01/00/00
Starting Date for Output	-	01/00/00
Steps Per Day	-	8
Number of Iterations	-	2
Output Averaging Interval	days	7
Reservoir H2O Residence Time	days	0
Max Inflow / Mean Inflow	-	0
Max Reservoir Storage	hm3	0
Reservoir P Decay Rate	1/yr/ppb	0
Rainfall P Conc	ppb	20
Atmospheric P Load (Dry)	mg/m2-yr	20

Case Description: 100% SAV at 79 cm and 1.20 km2 with 3 SAV cells with 40% load reduction due to source controls

Filename: acme_final_40.xls

Output Variable	Units	Value
Water Balance Error	%	0.0%
Mass Balance Error	%	0.0%
Flow-Wtd Conc - With Bypass	ppb	17
Flow-Wtd Conc - Without Bypass	ppb	17
Geometric Mean Conc	ppb	10
95th Percentile Conc	ppb	22
Freq Cell Outflow > 10 ppb	%	53%
Bypass Load	%	0.0%

Cell Number -->		1	2	3	4	5	6
Cell Label	-	SAV1	SAV2	SAV3			
Vegetation Type	------->	SAV_C4	SAV_C4	SAV_C4			
Inflow Fraction	-	1	0	0			
Downstream Cell Number	-	2	3	0			
Surface Area	km2	0.417	0.417	0.366			
Mean Width of Flow Path	km	1.01	1.01	0.66			
Number of Tanks in Series	-	3	3	3			
Outflow Control Depth	cm	79	79	79			
Outflow Coefficient - Exponent	-	3.5	3.5	3.5			
Outflow Coefficient - Intercept	-	0.8	0.8	0.8			
Bypass Depth	cm	140	140	140			
Maximum Inflow	hm3/day	0	0	0			
Maximum Outflow	hm3/day	0	0	0			
Inflow Seepage Rate	(cm/d) / cm	0	0	0			
Inflow Seepage Control Elev	cm	0	0	0			
Inflow Seepage Conc	ppb	0	0	0			
Outflow Seepage Rate	(cm/d) / cm	0.008	0.008	0.008			
Outflow Seepage Control Elev	cm	0	0	0			
Max Outflow Seepage Conc	ppb	20	20	20			
Seepage Recycle Fraction	-	0.5	0.5	0.5			
Seepage Discharge Fraction	-	0	0	0			
Initial Water Column Conc	ppb	30	30	30			
Initial P Storage Per Unit Area	mg/m2	500	500	500			
Initial Water Column Depth	cm	50	50	50			
C0 = WC Conc at 0 g/m2 P Storage	ppb	*4*	*4*	*4*			
C1 = WC Conc at 1 g/m2 P storage	ppb	*22*	*22*	*22*			
K = Net Settling Rate at Steady State	m/yr	*80*	*80*	*80*			
Zx = Depth Scale Factor	cm	*60*	*60*	*60*			
C0 - Periphyton	ppb	*0*	*0*	*0*			
C1 - Periphyton	ppb	*0*	*0*	*0*			
K - Periphyton	1/yr	*0.00*	*0.00*	*0.00*			
Zx - Periphyton	cm	*0*	*0*	*0*			
Sm = Transition Storage Midpoint	mg/m2	*0*	*0*	*0*			
Sb = Transition Storage Bandwidth	mg/m2	*0*	*0*	*0*			

Output Variables	Units	1	2	3	4	5	6	Overall
Execution Time	seconds/yr	5.03	10.10	15.10				15.10
Run Date	-	05/10/02	05/10/02	05/10/02				05/10/02
Starting Date for Simulation	-	01/01/65	01/01/65	01/01/65				01/01/65
Starting Date for Output	-	01/01/65	01/01/65	01/01/65				01/01/65
Ending Date	-	12/31/95	12/31/95	12/31/95				12/31/95
Output Duration	days	11322	11322	11322				11322
Cell Label		SAV1	SAV2	SAV3				Total Outflow
Downstream Cell Label		SAV2	SAV3	Outflow				-
Surface Area	km2	0.417	0.417	0.366				1.2
Mean Water Load	cm/d	25.5	25.2	28.5				8.9
Max Water Load	cm/d	289.0	288.2	327.7				100.4
Inflow Volume	hm3/yr	38.9	38.5	38.1				38.9
Inflow Load	kg/yr	2197.6	1266.6	836.2				2197.6
Inflow Conc	ppb	57	33	22				57
Treated Outflow Volume	hm3/yr	38.5	38.1	37.8				37.8
Treated Outflow Load	kg/yr	1266.6	836.2	642.4				642.4
Treated FWM Outflow Conc	ppb	33	22	17				17
Total Outflow Volume	hm3/yr	38.5	38.1	37.8				37.8

ACME Basin B - Alt. 3 with 40% Load Reduction (Sensitivity) (cont'd)

Total Outflow Load	kg/yr	1266.6	836.2	642.4	642.4
Total FWM Outflow Conc	ppb	33	22	17	17
Bypass Volume	hm3/yr	0.00	0.00	0.00	0.00
Bypass Load	kg/yr	0.00	0.00	0.00	0.00
Bypass Conc	ppb	0	0	0	0
Bypass Load	%	0%	0%	0%	0%
Surface Outflow Load Reduc	%	42.4%	34.0%	23.2%	70.8%
Outflow Geometric Mean - Daily	ppb	26	15	10	10
Outflow Geo Mean - Composites	ppb	27	15	10	10
Frequency Outflow Conc > 10 ppb	%	100%	100%	0%	53%
95th Percentile Outflow Conc	ppb	28	16	10	22
Mean Biomass P Storage	mg/m2	1548	736	394	914
Max Reservoir Storage	hm3	0.00	0.00	0.00	0.00
Reservoir Load Reduction	%	#N/A	#N/A	#N/A	#N/A
Mean Depth	cm	76.5	75.7	76.3	76.1
Minimum Depth	cm	4.2	4.2	3.5	4.0
Maximum Depth	cm	111.9	111.7	126.2	116.2
Frequency Depth < 5 cm	%	0.0%	0.0%	0.0%	0.0%
Flow/Width	m2/day	104	103	158	120.1
Max 1 Yr Flow-Wtd Conc	ppb	#N/A	#N/A	#N/A	21
Max 5 Yr Flow-Wtd Conc	ppb	#N/A	#N/A	#N/A	19
Max 1 Yr Geometric Mn Conc	ppb	#N/A	#N/A	#N/A	16
Max 5 Yr Geometric Mn Conc	ppb	#N/A	#N/A	#N/A	13
Depth Percentile vs. Calib Set	%	59%	58%	59%	59%
Q/W Percentile vs. Calib Set	%	48%	48%	73%	73%
Cin Percentile vs. Calib Set	%	64%	39%	21%	64%
Cout Percentile vs. Calib Set	%	40%	21%	9%	9%
Depth Range Flag	-	OK	OK	OK	0.0
Q/W Range Flag	-	OK	OK	OK	0.0
Cin Range Flag	-	OK	OK	OK	0.0
Cout Range Flag	-	OK	OK	OK	0.0
Water Balance Error	%	0.00%	0.00%	0.00%	0.00%
Mass Balance Error	%	0.01%	0.03%	0.04%	0.04%

DMSTA Input Values **ACME Basin B - Alt. 3 with 50% Load Reduction (Sensitivity)**

Input Variable	Units	Value
Design Case Name	-	s100r1
Starting Date for Simulation	-	01/00/00
Ending Date for Simulation	-	01/00/00
Starting Date for Output	-	01/00/00
Steps Per Day	-	8
Number of Iterations	-	2
Output Averaging Interval	days	7
Reservoir H2O Residence Time	days	0
Max Inflow / Mean Inflow	-	0
Max Reservoir Storage	hm3	0
Reservoir P Decay Rate	1/yr/ppb	0
Rainfall P Conc	ppb	20
Atmospheric P Load (Dry)	mg/m2-yr	20

Case Description: 100% SAV at 79 cm and 1.20 km2 with 3 SAV cells with 50% load reduction due to source controls

Filename: acme_final_50.xls

Output Variable	Units	Value
Water Balance Error	%	0.0%
Mass Balance Error	%	0.0%
Flow-Wtd Conc - With Bypass	ppb	15
Flow-Wtd Conc - Without Bypass	ppb	15
Geometric Mean Conc	ppb	9
95th Percentile Conc	ppb	20
Freq Cell Outflow > 10 ppb	%	42%
Bypass Load	%	0.0%

Cell Number -->		1	2	3	4	5	6
Cell Label	-	SAV1	SAV2	SAV3			
Vegetation Type	------->	SAV_C4	SAV_C4	SAV_C4			
Inflow Fraction	-	1	0	0			
Downstream Cell Number	-	2	3	0			
Surface Area	km2	0.417	0.417	0.366			
Mean Width of Flow Path	km	1.01	1.01	0.66			
Number of Tanks in Series	-	3	3	3			
Outflow Control Depth	cm	79	79	79			
Outflow Coefficient - Exponent	-	3.5	3.5	3.5			
Outflow Coefficient - Intercept	-	0.8	0.8	0.8			
Bypass Depth	cm	140	140	140			
Maximum Inflow	hm3/day	0	0	0			
Maximum Outflow	hm3/day	0	0	0			
Inflow Seepage Rate	(cm/d) / cm	0	0	0			
Inflow Seepage Control Elev	cm	0	0	0			
Inflow Seepage Conc	ppb	0	0	0			
Outflow Seepage Rate	(cm/d) / cm	0.008	0.008	0.008			
Outflow Seepage Control Elev	cm	0	0	0			
Max Outflow Seepage Conc	ppb	20	20	20			
Seepage Recycle Fraction	-	0.5	0.5	0.5			
Seepage Discharge Fraction	-	0	0	0			
Initial Water Column Conc	ppb	30	30	30			
Initial P Storage Per Unit Area	mg/m2	500	500	500			
Initial Water Column Depth	cm	50	50	50			
C0 = WC Conc at 0 g/m2 P Storage	ppb	*4*	*4*	*4*			
C1 = WC Conc at 1 g/m2 P storage	ppb	*22*	*22*	*22*			
K = Net Settling Rate at Steady State	m/yr	*80*	*80*	*80*			
Zx = Depth Scale Factor	cm	*60*	*60*	*60*			
C0 - Periphyton	ppb	*0*	*0*	*0*			
C1 - Periphyton	ppb	*0*	*0*	*0*			
K - Periphyton	1/yr	*0.00*	*0.00*	*0.00*			
Zx - Periphyton	cm	*0*	*0*	*0*			
Sm = Transition Storage Midpoint	mg/m2	*0*	*0*	*0*			
Sb = Transition Storage Bandwidth	mg/m2	*0*	*0*	*0*			

Output Variables	Units	1	2	3	4	5	6	Overall
Execution Time	seconds/yr	3.68	7.65	11.65				11.65
Run Date	-	05/07/02	05/07/02	05/07/02				05/07/02
Starting Date for Simulation	-	01/01/65	01/01/65	01/01/65				01/01/65
Starting Date for Output	-	01/01/65	01/01/65	01/01/65				01/01/65
Ending Date	-	12/31/95	12/31/95	12/31/95				12/31/95
Output Duration	days	11322	11322	11322				11322
Cell Label		SAV1	SAV2	SAV3				Total Outflow
Downstream Cell Label		SAV2	SAV3	Outflow				-
Surface Area	km2	0.417	0.417	0.366				1.2
Mean Water Load	cm/d	25.5	25.2	28.5				8.9
Max Water Load	cm/d	289.0	288.2	327.7				100.4
Inflow Volume	hm3/yr	38.9	38.5	38.1				38.9
Inflow Load	kg/yr	1831.3	1082.1	739.1				1831.3
Inflow Conc	ppb	47	28	19				47
Treated Outflow Volume	hm3/yr	38.5	38.1	37.8				37.8
Treated Outflow Load	kg/yr	1082.1	739.1	584.1				584.1
Treated FWM Outflow Conc	ppb	28	19	15				15
Total Outflow Volume	hm3/yr	38.5	38.1	37.8				37.8

ACME Basin B - Alt. 3 with 50% Load Reduction (Sensitivity) (cont'd)

Total Outflow Load	kg/yr	1082.1	739.1	584.1	584.1
Total FWM Outflow Conc	ppb	28	19	15	15
Bypass Volume	hm3/yr	0.00	0.00	0.00	0.00
Bypass Load	kg/yr	0.00	0.00	0.00	0.00
Bypass Conc	ppb	0	0	0	0
Bypass Load	%	0%	0%	0%	0%
Surface Outflow Load Reduc	%	40.9%	31.7%	21.0%	68.1%
Outflow Geometric Mean - Daily	ppb	22	13	9	9
Outflow Geo Mean - Composites	ppb	22	13	9	9
Frequency Outflow Conc > 10 ppb	%	100%	100%	0%	42%
95th Percentile Outflow Conc	ppb	23	13	8	20
Mean Biomass P Storage	mg/m2	1254	594	321	740
Max Reservoir Storage	hm3	0.00	0.00	0.00	0.00
Reservoir Load Reduction	%	#N/A	#N/A	#N/A	#N/A
Mean Depth	cm	76.5	75.7	76.3	76.1
Minimum Depth	cm	4.2	4.2	3.5	4.0
Maximum Depth	cm	111.9	111.7	126.2	116.2
Frequency Depth < 5 cm	%	0.0%	0.0%	0.0%	0.0%
Flow/Width	m2/day	104	103	158	120.1
Max 1 Yr Flow-Wtd Conc	ppb	#N/A	#N/A	#N/A	19
Max 5 Yr Flow-Wtd Conc	ppb	#N/A	#N/A	#N/A	17
Max 1 Yr Geometric Mn Conc	ppb	#N/A	#N/A	#N/A	14
Max 5 Yr Geometric Mn Conc	ppb	#N/A	#N/A	#N/A	11
Depth Percentile vs. Calib Set	%	59%	58%	59%	59%
Q/W Percentile vs. Calib Set	%	48%	48%	73%	73%
Cin Percentile vs. Calib Set	%	56%	32%	15%	56%
Cout Percentile vs. Calib Set	%	32%	15%	5%	5%
Depth Range Flag	-	OK	OK	OK	0.0
Q/W Range Flag	-	OK	OK	OK	0.0
Cin Range Flag	-	OK	OK	OK	0.0
Cout Range Flag	-	OK	OK	OK	0.0
Water Balance Error	%	0.00%	0.00%	0.00%	0.00%
Mass Balance Error	%	0.01%	0.03%	0.04%	0.05%

DMSTA Input Values **ACME Basin B - Alt. 3 basecase using NEWS (Sensitivity)**

Input Variable	Units	Value
Design Case Name	-	s100r1_NEWS
Starting Date for Simulation	-	01/00/00
Ending Date for Simulation	-	01/00/00
Starting Date for Output	-	01/00/00
Steps Per Day	-	8
Number of Iterations	-	2
Output Averaging Interval	days	7
Reservoir H2O Residence Time	days	0
Max Inflow / Mean Inflow	-	0
Max Reservoir Storage	hm3	0
Reservoir P Decay Rate	1/yr/ppb	0
Rainfall P Conc	ppb	20
Atmospheric P Load (Dry)	mg/m2-yr	20

Case Description: 100% NEWS at 79 cm and 1.20 km2 with 3 NEWS cells

Filename: acme_final_25.xls

Output Variable	Units	Value
Water Balance Error	%	0.0%
Mass Balance Error	%	0.1%
Flow-Wtd Conc - With Bypass	ppb	27
Flow-Wtd Conc - Without Bypass	ppb	27
Geometric Mean Conc	ppb	15
95th Percentile Conc	ppb	38
Freq Cell Outflow > 10 ppb	%	68%
Bypass Load	%	0.0%

Cell Number -->		1	2	3	4	5	6
Cell Label	-	SAV1	SAV2	SAV3			
Vegetation Type	------->	NEWS	NEWS	NEWS			
Inflow Fraction	-	1	0	0			
Downstream Cell Number	-	2	3	0			
Surface Area	km2	0.417	0.417	0.366			
Mean Width of Flow Path	km	1.01	1.01	0.66			
Number of Tanks in Series	-	3	3	3			
Outflow Control Depth	cm	79	79	79			
Outflow Coefficient - Exponent	-	3.5	3.5	3.5			
Outflow Coefficient - Intercept	-	0.8	0.8	0.8			
Bypass Depth	cm	140	140	140			
Maximum Inflow	hm3/day	0	0	0			
Maximum Outflow	hm3/day	0	0	0			
Inflow Seepage Rate	(cm/d) / cm	0	0	0			
Inflow Seepage Control Elev	cm	0	0	0			
Inflow Seepage Conc	ppb	0	0	0			
Outflow Seepage Rate	(cm/d) / cm	0.008	0.008	0.008			
Outflow Seepage Control Elev	cm	0	0	0			
Max Outflow Seepage Conc	ppb	20	20	20			
Seepage Recycle Fraction	-	0.5	0.5	0.5			
Seepage Discharge Fraction	-	0	0	0			
Initial Water Column Conc	ppb	30	30	30			
Initial P Storage Per Unit Area	mg/m2	500	500	500			
Initial Water Column Depth	cm	50	50	50			
C0 = WC Conc at 0 g/m2 P Storage	ppb	*12*	*12*	*12*			
C1 = WC Conc at 1 g/m2 P storage	ppb	*22*	*22*	*22*			
K = Net Settling Rate at Steady State	m/yr	*129*	*129*	*129*			
Zx = Depth Scale Factor	cm	*60*	*60*	*60*			
C0 - Periphyton	ppb	*4*	*4*	*4*			
C1 - Periphyton	ppb	*22*	*22*	*22*			
K - Periphyton	1/yr	*23.80*	*23.80*	*23.80*			
Zx - Periphyton	cm	*0*	*0*	*0*			
Sm = Transition Storage Midpoint	mg/m2	*400*	*400*	*400*			
Sb = Transition Storage Bandwidth	mg/m2	*80*	*80*	*80*			

Output Variables	Units	1	2	3	4	5	6	Overall
Execution Time	seconds/yr	3.42	7.10	10.42				10.42
Run Date	-	07/05/02	07/05/02	07/05/02				07/05/02
Starting Date for Simulation	-	01/01/65	01/01/65	01/01/65				01/01/65
Starting Date for Output	-	01/01/65	01/01/65	01/01/65				01/01/65
Ending Date	-	12/31/95	12/31/95	12/31/95				12/31/95
Output Duration	days	11322	11322	11322				11322
Cell Label		SAV1	SAV2	SAV3				Total Outflow
Downstream Cell Label		SAV2	SAV3	Outflow				-
Surface Area	km2	0.417	0.417	0.366				1.2
Mean Water Load	cm/d	25.5	25.2	28.5				8.9
Max Water Load	cm/d	289.0	288.2	327.7				100.4
Inflow Volume	hm3/yr	38.9	38.5	38.1				38.9
Inflow Load	kg/yr	2747.0	1574.9	1206.2				2747.0
Inflow Conc	ppb	71	41	32				71
Treated Outflow Volume	hm3/yr	38.5	38.1	37.8				37.8
Treated Outflow Load	kg/yr	1574.9	1206.2	1039.0				1039.0
Treated FWM Outflow Conc	ppb	41	32	27				27
Total Outflow Volume	hm3/yr	38.5	38.1	37.8				37.8

ACME Basin B - Alt. 3 basecase using NEWS (Sensitivity) (cont'd)

Total Outflow Load	kg/yr	1574.9	1206.2	1039.0	1039.0
Total FWM Outflow Conc	ppb	41	32	27	27
Bypass Volume	hm3/yr	0.00	0.00	0.00	0.00
Bypass Load	kg/yr	0.00	0.00	0.00	0.00
Bypass Conc	ppb	0	0	0	0
Bypass Load	%	0%	0%	0%	0%
Surface Outflow Load Reduc	%	42.7%	23.4%	13.9%	62.2%
Outflow Geometric Mean - Daily	ppb	27	17	14	14
Outflow Geo Mean - Composites	ppb	27	18	15	15
Frequency Outflow Conc > 10 ppb	%	100%	33%	0%	68%
95th Percentile Outflow Conc	ppb	25	10	7	38
Mean Biomass P Storage	mg/m2	2178	733	471	1156
Max Reservoir Storage	hm3	0.00	0.00	0.00	0.00
Reservoir Load Reduction	%	#N/A	#N/A	#N/A	#N/A
Mean Depth	cm	76.5	75.7	76.3	76.1
Minimum Depth	cm	4.2	4.2	3.5	4.0
Maximum Depth	cm	111.9	111.7	126.2	116.2
Frequency Depth < 5 cm	%	0.0%	0.0%	0.0%	0.0%
Flow/Width	m2/day	104	103	158	120.1
Max 1 Yr Flow-Wtd Conc	ppb	#N/A	#N/A	#N/A	35
Max 5 Yr Flow-Wtd Conc	ppb	#N/A	#N/A	#N/A	30
Max 1 Yr Geometric Mn Conc	ppb	#N/A	#N/A	#N/A	21
Max 5 Yr Geometric Mn Conc	ppb	#N/A	#N/A	#N/A	16
Depth Percentile vs. Calib Set	%	68%	67%	67%	67%
Q/W Percentile vs. Calib Set	%	48%	48%	73%	73%
Cin Percentile vs. Calib Set	%	82%	63%	55%	82%
Cout Percentile vs. Calib Set	%	63%	55%	50%	50%
Depth Range Flag	-	OK	OK	OK	0.0
Q/W Range Flag	-	OK	OK	OK	0.0
Cin Range Flag	-	OK	OK	OK	0.0
Cout Range Flag	-	OK	OK	OK	0.0
Water Balance Error	%	0.00%	0.00%	0.00%	0.00%
Mass Balance Error	%	0.03%	0.06%	0.06%	0.09%

ACME Basin B - Alt. 3 Basecase 25% DMSTA Sensitivity Analysis

Sensitivity Analysis **Case: S100b_r6a** **File: feeder_final_50.xls** **Input Variable Set: All** **Run Date: 05/18/02**

Option	Value	
Select Sensitivity Scale Factor --->	**25%**	*Modify Each Input Variable by +/- This Percentage*
Select Input Parameter Set ------>	**1**	*1 = All, 2 = P Cycling Only, 3 = Design Features Only*
Select Test Option ---------->	**2**	*1 = High Results Only, 2 = High & Low Results*

Number of Model Runs Required = 90 Estimated Run Time = 880.5 minutes

Adjusts Each non-Zero Input Variable, One at a Time, & Re-Runs Simulation

Shows Results for Combined Outflow from Entire Treatment Area

Run

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Input Variable	Cell Number	Input Value - Base	High Results ----> Input Value - High	Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load	Low Results ------> Input Value - Low	Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load	Average Change ----> Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load	Average % Change --> Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load
	-	-	-	ppb	ppb	ppb	kg/yr	-	ppb	ppb	ppb	kg/yr	ppb	ppb	ppb	kg/yr	%	%	%	%
Base Run				26.2	26.2	10.1	2378		26.2	26.2	10.1	2378								
Max Inflow / Mean Inflow	1	16.0	20.0	25.6	27.3	10.0	2469	12.8	25.6	25.7	10.1	2330	0.0	0.8	-0.1	69	0%	3%	-1%	3%
Max Reservoir Storage	1	8.0	10.0	26.2	26.2	10.1	2376	6.4	26.0	26.5	10.1	2400	0.1	-0.1	0.0	-12	0%	0%	0%	0%
Rainfall P Conc	1	20.0	25.0	26.3	26.3	10.3	2379	16.0	26.2	26.2	10.0	2377	0.0	0.0	0.1	1	0%	0%	1%	0%
Atmospheric P Load (Dry)	1	20.0	25.0	26.2	26.2	10.2	2376	16.0	26.3	26.3	10.1	2380	0.0	0.0	0.1	-2	0%	0%	1%	0%
Inflow Fraction	1	1.0	1.3	27.6	29.8	11.5	3410	0.8	23.6	23.6	8.9	1692	2.0	3.1	1.3	859	8%	12%	13%	36%
Surface Area	1	1.2	1.5	25.3	25.3	9.7	2281	0.9	27.1	27.1	10.6	2467	-0.9	-0.9	-0.5	-93	-3.6%	-3.6%	-4.6%	-3.9%
Surface Area	2	1.2	1.5	25.3	25.3	9.7	2279	0.9	27.1	27.2	10.6	2469	-0.9	-1.0	-0.5	-95	-4%	-4%	-5%	-4%
Surface Area	3	1.2	1.5	25.2	25.2	9.7	2278	0.9	27.1	27.2	10.6	2469	-0.9	-1.0	-0.5	-96	-4%	-4%	-5%	-4%
Mean Width of Flow Path	1	1.9	2.3	26.3	26.3	10.1	2381	1.5	24.8	27.0	10.0	2441	0.7	-0.3	0.1	-30	3%	-1%	1%	-1%
Mean Width of Flow Path	2	1.9	2.3	26.3	26.3	10.1	2380	1.5	25.4	26.4	10.1	2388	0.4	-0.1	0.0	-4	2%	0%	0%	0%
Mean Width of Flow Path	3	1.9	2.3	26.3	26.3	10.1	2378	1.5	25.7	26.3	10.1	2379	0.3	0.0	0.0	0	1%	0%	0%	0%
Number of Tanks in Series	1	3.0	3.8	26.1	26.1	10.1	2366	2.4	26.3	26.3	10.2	2383	-0.1	-0.1	0.0	-9	0%	0%	0%	0%
Number of Tanks in Series	2	3.0	3.8	26.1	26.1	10.1	2367	2.4	26.3	26.3	10.2	2383	-0.1	-0.1	0.0	-8	0%	0%	0%	0%
Number of Tanks in Series	3	3.0	3.8	26.1	26.1	10.1	2368	2.4	26.3	26.3	10.2	2382	-0.1	-0.1	0.0	-7	0%	0%	0%	0%
Outflow Control Depth	1	89.0	111.3	26.3	26.3	10.1	2372	71.2	26.2	26.2	10.1	2381	0.0	0.0	0.0	-4	0%	0%	0%	0%
Outflow Control Depth	2	89.0	111.3	26.2	26.2	10.2	2365	71.2	26.3	26.3	10.1	2386	0.0	0.0	0.0	-10	0%	0%	0%	0%
Outflow Control Depth	3	89.0	111.3	26.2	26.2	10.2	2364	71.2	26.3	26.3	10.1	2388	0.0	0.0	0.1	-12	0%	0%	1%	0%
Outflow Coefficient - Intercept	1	0.8	1.0	26.3	26.3	10.1	2381	0.6	24.8	27.0	10.0	2441	0.7	-0.3	0.1	-30	3%	-1%	1%	-1%
Outflow Coefficient - Intercept	2	0.8	1.0	26.3	26.3	10.1	2380	0.6	25.4	26.4	10.1	2388	0.4	-0.1	0.0	-4	2%	0%	0%	0%
Outflow Coefficient - Intercept	3	0.8	1.0	26.3	26.3	10.1	2378	0.6	25.7	26.3	10.1	2379	0.3	0.0	0.0	0	1%	0%	0%	0%
Bypass Depth	1	140.0	175.0	26.2	26.2	10.1	2378	112.0	20.1	30.5	9.3	2762	3.1	-2.1	0.4	-192	12%	-8%	4%	-8%
Bypass Depth	2	140.0	175.0	26.2	26.2	10.1	2378	112.0	21.4	27.4	9.7	2484	2.4	-0.6	0.2	-53	9%	-2%	2%	-2%
Bypass Depth	3	140.0	175.0	26.2	26.2	10.1	2378	112.0	22.6	26.5	10.0	2396	1.8	-0.1	0.1	-9	7%	0%	1%	0%
Outflow Seepage Rate	1	0.0	0.0	26.3	26.3	10.2	2373	0.0	26.2	26.2	10.1	2381	0.0	0.0	0.0	-4	0%	0%	0%	0%
Outflow Seepage Rate	2	0.0	0.0	26.3	26.3	10.2	2374	0.0	26.2	26.2	10.1	2381	0.0	0.0	0.0	-4	0%	0%	0%	0%
Outflow Seepage Rate	3	0.0	0.0	26.3	26.3	10.2	2374	0.0	26.2	26.2	10.1	2381	0.0	0.0	0.0	-3	0%	0%	0%	0%
Max Outflow Seepage Conc	1	20.0	25.0	26.250	26.3	10.1	2378	16.0	26.2	26.2	10.1	2378	0.0	0.0	0.0	0	0%	0%	0%	0%
Max Outflow Seepage Conc	2	20.0	25.0	26.3	26.3	10.1	2378	16.0	26.2	26.2	10.1	2378	0.0	0.0	0.0	0	0%	0%	0%	0%
Max Outflow Seepage Conc	3	20.0	25.0	26.3	26.3	10.1	2378	16.0	26.2	26.2	10.1	2377	0.0	0.0	0.0	0	0%	0%	0%	0%
Seepage Recycle Fraction	1	0.5	0.6	26.2	26.2	10.1	2382	0.4	26.3	26.3	10.2	2375	0.0	0.0	0.0	4	0%	0%	0%	0%
Seepage Recycle Fraction	2	0.5	0.6	26.2	26.2	10.1	2381	0.4	26.3	26.3	10.2	2375	0.0	0.0	0.0	3	0%	0%	0%	0%
Seepage Recycle Fraction	3	0.5	0.6	26.2	26.2	10.1	2381	0.4	26.3	26.3	10.2	2375	0.0	0.0	-0.1	3	0%	0%	-1%	0%
C0 = WC Conc at 0 g/m2 P Storage	1	4.0	5.0	27.2	27.2	10.4	2468	3.2	25.3	25.3	9.9	2293	1.0	1.0	0.3	87	4%	4%	3%	4%

ACME Basin B - Alt. 3 Basecase 25% DMSTA Sensitivity Analysis (cont'd)

Sensitivity Analysis **Case: S100b_r6a** **File: feeder_final_50.xls** **Input Variable Set: All** **Run Date: 05/18/02**

Option	Value	
Select Sensitivity Scale Factor --->	**25%**	*Modify Each Input Variable by +/- This Percentage*
Select Input Parameter Set ------>	**1**	*1 = All, 2 = P Cycling Only, 3 = Design Features Only*
Select Test Option ---------->	**2**	*1 = High Results Only, 2 = High & Low Results*

Number of Model Runs Required = 90 Estimated Run Time = 880.5 minutes

Adjusts Each non-Zero Input Variable, One at a Time, & Re-Runs Simulation

Shows Results for Combined Outflow from Entire Treatment Area

Run

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Input Variable	Cell Number	Input Value - Base	High Results ----> Input Value - High	Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load	Low Results ------> Input Value - Low	Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load	Average Change ----> Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load	Average % Change --> Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load
	-	-	-	ppb	ppb	ppb	kg/yr	-	ppb	ppb	ppb	kg/yr	ppb	ppb	ppb	kg/yr	%	%	%	%
Base Run				26.2	26.2	10.1	2378		26.2	26.2	10.1	2378								
C0 = WC Conc at 0 g/m2 P Storage	2	4.0	5.0	27.3	27.3	10.5	2473	3.2	25.2	25.2	9.9	2284	1.0	1.0	0.3	94	4%	4%	3%	4%
C0 = WC Conc at 0 g/m2 P Storage	3	4.0	5.0	27.4	27.4	10.4	2482	3.2	25.2	25.2	10.0	2280	1.1	1.1	0.2	101	4%	4%	2%	4%
C1 = WC Conc at 1 g/m2 P storage	1	22.0	27.5	26.3	26.3	10.2	2386	17.6	26.2	26.2	10.1	2374	0.1	0.1	0.1	6	0%	0%	1%	0%
C1 = WC Conc at 1 g/m2 P storage	2	22.0	27.5	26.3	26.3	10.2	2382	17.6	26.2	26.2	10.1	2375	0.0	0.0	0.0	3	0%	0%	0%	0%
C1 = WC Conc at 1 g/m2 P storage	3	22.0	27.5	26.3	26.3	10.2	2381	17.6	26.2	26.2	10.1	2376	0.0	0.0	0.1	3	0%	0%	1%	0%
K = Net Settling Rate at Steady State	1	80.1	100.1	25.4	25.4	9.7	2304	64.1	27.0	27.0	10.6	2447	-0.8	-0.8	-0.4	-72	-3%	-3%	-4%	-3%
K = Net Settling Rate at Steady State	2	80.1	100.1	25.4	25.4	9.7	2300	64.1	27.0	27.0	10.6	2450	-0.8	-0.8	-0.5	-75	-3%	-3%	-5%	-3%
K = Net Settling Rate at Steady State	3	80.1	100.1	25.3	25.3	9.5	2295	64.1	27.1	27.1	10.8	2456	-0.9	-0.9	-0.7	-80	-3%	-3%	-7%	-3%
Zx = Depth Scale Factor	1	60.0	75.0	26.2	26.2	10.1	2378	48.0	26.2	26.2	10.1	2378	0.0	0.0	0.0	0	0%	0%	0%	0%
Zx = Depth Scale Factor	2	60.0	75.0	26.3	26.3	10.1	2378	48.0	26.2	26.2	10.1	2378	0.0	0.0	0.0	0	0%	0%	0%	0%
Zx = Depth Scale Factor	3	60.0	75.0	26.3	26.3	10.2	2379	48.0	26.2	26.2	10.1	2377	0.0	0.0	0.0	1	0%	0%	0%	0%

ACME Basin B - Alt. 3 Basecase 50% DMSTA Sensitivity Analysis

Sensitivity Analysis **Case: S100b_r6a** **File: feeder_final_50.xls** **Input Variable Set: All** **Run Date: 05/20/02**

Option	Value	
Select Sensitivity Scale Factor --->	**50%**	*Modify Each Input Variable by +/- This Percentage*
Select Input Parameter Set ------>	**1**	*1 = All, 2 = P Cycling Only, 3 = Design Features Only*
Select Test Option ---------->	**2**	*1 = High Results Only, 2 = High & Low Results*

Number of Model Runs Required = 90 Estimated Run Time = 883.5 minutes

Adjusts Each non-Zero Input Variable, One at a Time, & Re-Runs Simulation

Shows Results for Combined Outflow from Entire Treatment Area

Run

Sort Results

Uncertainty Analysis

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			High Results ---->					Low Results ------>					Average Change ---->				Average % Change -->			
Input Variable	Cell Number	Input Value - Base	Input Value - High	Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load	Input Value - Low	Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load	Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load	Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load
	-	-	-	ppb	ppb	ppb	kg/yr	-	ppb	ppb	ppb	kg/yr	ppb	ppb	ppb	kg/yr	%	%	%	%
Base Run				26.2	26.2	10.1	2378		26.2	26.2	10.1	2378								
Max Inflow / Mean Inflow	1	16.0	24.0	25.1	28.1	9.9	2545	10.7	25.0	25.2	10.1	2284	0.0	1.4	-0.1	130	0%	5%	-1%	5%
Max Reservoir Storage	1	8.0	12.0	26.2	26.2	10.1	2376	5.3	25.9	26.8	10.1	2425	0.2	-0.3	0.0	-24	1%	-1%	0%	-1%
Rainfall P Conc	1	20.0	30.0	26.3	26.3	10.4	2380	13.3	26.2	26.2	10.0	2376	0.0	0.0	0.2	2	0%	0%	2%	0%
Atmospheric P Load (Dry)	1	20.0	30.0	26.2	26.2	10.3	2373	13.3	26.3	26.3	10.0	2381	0.0	0.0	0.2	-4	0%	0%	2%	0%
Inflow Fraction	1	1.0	1.5	28.0	33.0	12.6	4565	0.7	21.8	21.8	8.0	1284	3.1	5.6	2.3	1641	12%	21%	22%	69%
Surface Area	1	1.2	1.8	24.4	24.5	9.3	2196	0.8	27.7	27.9	10.9	2538	-1.6	-1.7	-0.8	-171	-6.2%	-6.5%	-8.2%	-7.2%
Surface Area	2	1.2	1.8	24.4	24.4	9.3	2193	0.8	27.8	27.8	10.9	2536	-1.7	-1.7	-0.8	-172	-6%	-7%	-8%	-7%
Surface Area	3	1.2	1.8	24.4	24.4	9.3	2190	0.8	27.8	27.8	10.9	2537	-1.7	-1.7	-0.8	-173	-7%	-7%	-8%	-7%
Mean Width of Flow Path	1	1.9	2.8	26.3	26.3	10.1	2384	1.2	23.3	27.9	9.8	2531	1.5	-0.8	0.2	-73	6%	-3%	2%	-3%
Mean Width of Flow Path	2	1.9	2.8	26.3	26.3	10.1	2381	1.2	24.2	26.6	10.0	2411	1.1	-0.2	0.1	-15	4%	-1%	1%	-1%
Mean Width of Flow Path	3	1.9	2.8	26.3	26.3	10.1	2379	1.2	24.8	26.3	10.1	2382	0.7	0.0	0.0	-2	3%	0%	0%	0%
Number of Tanks in Series	1	3.0	4.5	26.0	26.0	10.0	2359	2.0	26.5	26.5	10.3	2400	-0.2	-0.2	-0.1	-21	-1%	-1%	-1%	-1%
Number of Tanks in Series	2	3.0	4.5	26.1	26.1	10.0	2361	2.0	26.5	26.5	10.3	2397	-0.2	-0.2	-0.1	-18	-1%	-1%	-1%	-1%
Number of Tanks in Series	3	3.0	4.5	26.1	26.1	10.0	2363	2.0	26.4	26.4	10.3	2396	-0.2	-0.2	-0.1	-16	-1%	-1%	-1%	-1%
Outflow Control Depth	1	89.0	133.5	26.2	26.3	10.1	2367	59.3	26.2	26.2	10.1	2382	0.0	0.1	0.0	-8	0%	0%	0%	0%
Outflow Control Depth	2	89.0	133.5	26.1	26.2	10.1	2352	59.3	26.3	26.3	10.2	2389	-0.1	0.0	0.0	-19	0%	0%	0%	-1%
Outflow Control Depth	3	89.0	133.5	26.1	26.1	10.3	2351	59.3	26.3	26.3	10.2	2394	-0.1	-0.1	0.0	-22	0%	0%	0%	-1%
Outflow Coefficient - Intercept	1	0.8	1.2	26.3	26.3	10.1	2384	0.5	23.3	27.9	9.8	2531	1.5	-0.8	0.2	-73	6%	-3%	2%	-3%
Outflow Coefficient - Intercept	2	0.8	1.2	26.3	26.3	10.1	2381	0.5	24.2	26.6	10.0	2411	1.1	-0.2	0.1	-15	4%	-1%	1%	-1%
Outflow Coefficient - Intercept	3	0.8	1.2	26.3	26.3	10.1	2379	0.5	24.8	26.3	10.1	2382	0.7	0.0	0.0	-2	3%	0%	0%	0%
Bypass Depth	1	140.0	210.0	26.2	26.2	10.1	2378	93.3	13.0	38.5	7.7	3488	6.6	-6.1	1.2	-555	25%	-23%	12%	-23%
Bypass Depth	2	140.0	210.0	26.2	26.2	10.1	2378	93.3	14.6	30.5	8.5	2768	5.8	-2.1	0.8	-195	22%	-8%	8%	-8%
Bypass Depth	3	140.0	210.0	26.2	26.2	10.1	2378	93.3	16.7	27.2	9.4	2466	4.8	-0.5	0.4	-44	18%	-2%	4%	-2%
Outflow Seepage Rate	1	0.0	0.0	26.3	26.3	10.2	2369	0.0	26.2	26.2	10.1	2384	0.1	0.1	0.0	-7	0%	0%	0%	0%
Outflow Seepage Rate	2	0.0	0.0	26.3	26.3	10.2	2369	0.0	26.2	26.2	10.1	2384	0.1	0.1	0.0	-7	0%	0%	0%	0%
Outflow Seepage Rate	3	0.0	0.0	26.3	26.3	10.2	2371	0.0	26.2	26.2	10.1	2383	0.1	0.1	0.1	-6	0%	0%	1%	0%
Max Outflow Seepage Conc	1	20.0	30.0	26.251	26.3	10.1	2378	13.3	26.2	26.2	10.1	2378	0.0	0.0	0.0	0	0%	0%	0%	0%
Max Outflow Seepage Conc	2	20.0	30.0	26.3	26.3	10.1	2378	13.3	26.2	26.2	10.1	2377	0.0	0.0	0.0	0	0%	0%	0%	0%
Max Outflow Seepage Conc	3	20.0	30.0	26.3	26.3	10.1	2378	13.3	26.2	26.2	10.1	2377	0.0	0.0	0.0	1	0%	0%	0%	0%
Seepage Recycle Fraction	1	0.5	0.8	26.2	26.2	10.1	2386	0.3	26.3	26.3	10.2	2373	-0.1	-0.1	0.0	7	0%	0%	0%	0%
Seepage Recycle Fraction	2	0.5	0.8	26.2	26.2	10.1	2385	0.3	26.3	26.3	10.2	2373	-0.1	-0.1	-0.1	6	0%	0%	-1%	0%
Seepage Recycle Fraction	3	0.5	0.8	26.1	26.1	10.0	2384	0.3	26.3	26.3	10.2	2374	-0.1	-0.1	-0.1	5	0%	0%	-1%	0%
C0 = WC Conc at 0 g/m2 P Storage	1	4.0	6.0	28.0	28.0	10.7	2540	2.7	24.6	24.6	9.8	2229	1.7	1.7	0.5	155	7%	7%	5%	7%

ACME Basin B - Alt. 3 Basecase 50% DMSTA Sensitivity Analysis (cont'd)

Sensitivity Analysis **Case: S100b_r6a** **File: feeder_final_50.xls** **Input Variable Set: All** **Run Date: 05/20/02**

Option	Value	
Select Sensitivity Scale Factor --->	**50%**	*Modify Each Input Variable by +/- This Percentage*
Select Input Parameter Set ------>	**1**	*1 = All, 2 = P Cycling Only, 3 = Design Features Only*
Select Test Option ---------->	**2**	*1 = High Results Only, 2 = High & Low Results*

Number of Model Runs Required = 90 Estimated Run Time = 883.5 minutes

Adjusts Each non-Zero Input Variable, One at a Time, & Re-Runs Simulation

Shows Results for Combined Outflow from Entire Treatment Area

Run

Sort Results

Uncertainty Analysis

Menu

Input Variable	Cell Number	Input Value - Base	High Results ----> Input Value - High	Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load	Low Results ------> Input Value - Low	Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load	Average Change ----> Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load	Average % Change --> Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load
	-	-	-	ppb	ppb	ppb	kg/yr	-	ppb	ppb	ppb	kg/yr	ppb	ppb	ppb	kg/yr	%	%	%	%
Base Run				26.2	26.2	10.1	2378		26.2	26.2	10.1	2378								
C0 = WC Conc at 0 g/m2 P Storage	2	4.0	6.0	28.1	28.1	10.8	2548	2.7	24.4	24.4	9.8	2213	1.8	1.8	0.5	167	7%	7%	5%	7%
C0 = WC Conc at 0 g/m2 P Storage	3	4.0	6.0	28.4	28.4	10.8	2570	2.7	24.4	24.4	10.0	2207	2.0	2.0	0.4	182	8%	8%	4%	8%
C1 = WC Conc at 1 g/m2 P storage	1	22.0	33.0	26.4	26.4	10.3	2396	14.7	26.2	26.2	10.1	2373	0.1	0.1	0.1	12	0%	0%	1%	0%
C1 = WC Conc at 1 g/m2 P storage	2	22.0	33.0	26.3	26.3	10.3	2387	14.7	26.2	26.2	10.1	2374	0.1	0.1	0.1	7	0%	0%	1%	0%
C1 = WC Conc at 1 g/m2 P storage	3	22.0	33.0	26.3	26.3	10.3	2386	14.7	26.2	26.2	10.0	2374	0.1	0.1	0.1	6	0%	0%	1%	0%
K = Net Settling Rate at Steady State	1	80.1	120.2	24.7	24.7	9.4	2241	53.4	27.6	27.6	10.9	2500	-1.4	-1.4	-0.8	-129	-5%	-5%	-7%	-5%
K = Net Settling Rate at Steady State	2	80.1	120.2	24.6	24.6	9.3	2233	53.4	27.7	27.7	11.0	2505	-1.5	-1.5	-0.9	-136	-6%	-6%	-9%	-6%
K = Net Settling Rate at Steady State	3	80.1	120.2	24.6	24.6	9.0	2224	53.4	27.8	27.8	11.4	2515	-1.6	-1.6	-1.2	-146	-6%	-6%	-12%	-6%
Zx = Depth Scale Factor	1	60.0	90.0	26.3	26.3	10.2	2379	40.0	26.2	26.2	10.1	2378	0.0	0.0	0.0	1	0%	0%	0%	0%
Zx = Depth Scale Factor	2	60.0	90.0	26.3	26.3	10.2	2381	40.0	26.2	26.2	10.1	2377	0.0	0.0	0.0	2	0%	0%	0%	0%
Zx = Depth Scale Factor	3	60.0	90.0	26.3	26.3	10.3	2385	40.0	26.2	26.2	10.1	2377	0.0	0.0	0.1	4	0%	0%	1%	0%

Uncertainty Analysis

Case: **s100r1 -sens25** **File:** **acme_final_25.xls** 05/11/02

Estimates uncertainty in output variables. Assumes that sensitivity analysis has already been performed. Factors include: (1) uncertainty in p cycling parameters (from calibration); (2) uncertainty in other model inputs (user-specified); (3) inherent model error (from calibration); & (4) sensitivity of model output to each input value. Results are for combined outflows.

Reference: Walker, "A Sensitivity & Error Analysis Framework for Lake Eutrophication Modeling", Wtr Res Bul, Feb 1982

Select Output Variable:

- Treated FWM Outflow Conc
- Total FWM Outflow Conc
- Outflow Geo Mean - Composites
- Total Outflow Load

Treated FWM Outflow Conc (ppb)		Error CV's = Standard Error / Mean	
50th Percentile Est. =	19	Total =	10%
10th Percentile Est. =	17	Model Error =	10%
90th Percentile Est =	22	Parameter Error =	3%
		Input Data Error =	1%

Show Results | Sensitivity Analysis | Menu

Sensitivity Coefficients

% Change in Output Variable / % Change in Input Variable

Enter assumed error CV (standard error, as percent of mean) in col. B (blue cells) to reflect uncertainty in each input value

Case Description: **Filename: acme_final_25.xls**

100% SAV at 79 cm and 1.20 km2 with 3 SAV cells

Output Variable	Units	Value
Water Balance Error	%	0.0%
Mass Balance Error	%	0.0%
Flow-Wtd Conc - With Bypass	ppb	19.2
Flow-Wtd Conc - Without Bypass	ppb	19.2
Geometric Mean Conc	ppb	12.1
95th Percentile Conc	ppb	25.1
Freq Cell Outflow > 10 ppb	%	66%
Bypass Load	%	0.0%

Input Variable	Error CV	Value					
Design Case Name		s100r1					
Starting Date for Simulation							
Ending Date for Simulation							
Starting Date for Output							
Steps Per Day							
Number of Iterations							
Output Averaging Interval							
Reservoir H2O Residence Time							
Max Inflow / Mean Inflow							
Max Reservoir Storage							
Reservoir P Decay Rate							
Rainfall P Conc	30%	0.018					
Atmospheric P Load (Dry)	30%	0.005					
Cell Number -->		1	2	3	4	5	6
Cell Label		SAV1	SAV2	SAV3			
Vegetation Type		SAV_C4	SAV_C4	SAV_C4			
Inflow Fraction	0%	*0.623*					
Downstream Cell Number							
Surface Area		*-0.219*	*-0.216*	*-0.195*			
Mean Width of Flow Path		*0.006*	*0.002*	*0.001*			
Number of Tanks in Series	30%	*-0.019*	*-0.022*	*-0.017*			
Outflow Control Depth		*0.009*	*-0.007*	*-0.007*			
Outflow Coefficient - Exponent							
Outflow Coefficient - Intercept	20%	*0.006*	*0.002*	*0.001*			
Bypass Depth		*0.044*	*0.022*	*0.092*			
Maximum Inflow							
Maximum Outflow							
Inflow Seepage Rate	20%						
Inflow Seepage Control Elev							
Inflow Seepage Conc	20%						
Outflow Seepage Rate	20%	*-0.001*	*0.001*	*0.003*			
Outflow Seepage Control Elev							
Max Outflow Seepage Conc	20%	*0.001*	*0.001*	*0.001*			
Seepage Recycle Fraction	20%	*-0.002*	*-0.002*	*-0.003*			
Seepage Discharge Fraction	20%						
Initial Water Column Conc							
Initial P Storage Per Unit Area							
Initial Water Column Depth							
C0 = WC Conc at 0 g/m2 P Storage		*0.077*	*0.133*	*0.157*			
C1 = WC Conc at 1 g/m2 P storage		*0.015*	*0.014*	*0.011*			
K = Net Settling Rate at Steady State		*-0.203*	*-0.198*	*-0.188*			
Zx = Depth Scale Factor	*retrieved*	*0.000*	*0.000*	*0.001*			
C0 - Periphyton	*from model*						
C1 - Periphyton	*calibration*						
K - Periphyton	*table*						
Zx - Periphyton							
Sm = Transition Storage Midpoint							
Sb = Transition Storage Bandwidth							

Uncertainty Analysis

Case: **s100r1 - sens25** **File:** **acme_final_25.xls** 05/11/02

Estimates uncertainty in output variables. Assumes that sensitivity analysis has already been performed. Factors include: (1) uncertainty in p cycling parameters (from calibration); (2) uncertainty in other model inputs (user-specified); (3) inherent model error (from calibration); & (4) sensitivity of model output to each input value. Results are for combined outflows.

Reference: Walker, "A Sensitivity & Error Analysis Framework for Lake Eutrophication Modeling", Wtr Res Bul, Feb 1982

Select Output Variable:

- Treated FWM Outflow Conc
- Total FWM Outflow Conc
- Outflow Geo Mean - Composites
- Total Outflow Load

Total FWM Outflow Conc (ppb)		Error CV's = Standard Error / Mean	
50th Percentile Est. =	19	Total =	10%
10th Percentile Est. =	17	Model Error =	10%
90th Percentile Est =	22	Parameter Error =	3%
		Input Data Error =	1%

Show Results | Sensitivity Analysis | Menu

Sensitivity Coefficients

% Change in Output Variable / % Change in Input Variable

Enter assumed error CV (standard error, as percent of mean) in col. B (blue cells) to reflect uncertainty in each input value

Case Description: **Filename: acme_final_25.xls**

100% SAV at 79 cm and 1.20 km2 with 3 SAV cells

Output Variable	Units	Value
Water Balance Error	%	0.0%
Mass Balance Error	%	0.0%
Flow-Wtd Conc - With Bypass	ppb	19.2
Flow-Wtd Conc - Without Bypass	ppb	19.2
Geometric Mean Conc	ppb	12.1
95th Percentile Conc	ppb	25.1
Freq Cell Outflow > 10 ppb	%	66%
Bypass Load	%	0.0%

Input Variable	Error CV	Value					
Design Case Name		s100r1					
Starting Date for Simulation							
Ending Date for Simulation							
Starting Date for Output							
Steps Per Day							
Number of Iterations							
Output Averaging Interval							
Reservoir H2O Residence Time							
Max Inflow / Mean Inflow							
Max Reservoir Storage							
Reservoir P Decay Rate							
Rainfall P Conc	30%	0.018					
Atmospheric P Load (Dry)	30%	0.005					
Cell Number -->		1	2	3	4	5	6
Cell Label		SAV1	SAV2	SAV3			
Vegetation Type		SAV_C4	SAV_C4	SAV_C4			
Inflow Fraction	0%	*0.623*					
Downstream Cell Number							
Surface Area		*-0.219*	*-0.216*	*-0.195*			
Mean Width of Flow Path		*0.006*	*0.002*	*0.000*			
Number of Tanks in Series	30%	*-0.019*	*-0.022*	*-0.017*			
Outflow Control Depth		*0.009*	*-0.007*	*-0.007*			
Outflow Coefficient - Exponent							
Outflow Coefficient - Intercept	20%	*0.006*	*0.002*	*0.000*			
Bypass Depth		*-0.019*	*-0.003*	*-0.004*			
Maximum Inflow							
Maximum Outflow							
Inflow Seepage Rate	20%						
Inflow Seepage Control Elev							
Inflow Seepage Conc	20%						
Outflow Seepage Rate	20%	*-0.001*	*0.001*	*0.003*			
Outflow Seepage Control Elev							
Max Outflow Seepage Conc	20%	*0.001*	*0.001*	*0.001*			
Seepage Recycle Fraction	20%	*-0.002*	*-0.002*	*-0.003*			
Seepage Discharge Fraction	20%						
Initial Water Column Conc							
Initial P Storage Per Unit Area							
Initial Water Column Depth							
C0 = WC Conc at 0 g/m2 P Storage		*0.077*	*0.133*	*0.157*			
C1 = WC Conc at 1 g/m2 P storage		*0.015*	*0.014*	*0.011*			
K = Net Settling Rate at Steady State		*-0.203*	*-0.198*	*-0.188*			
Zx = Depth Scale Factor	*retrieved*	*0.000*	*0.000*	*0.001*			
C0 - Periphyton	*from model*						
C1 - Periphyton	*calibration*						
K - Periphyton	*table*						
Zx - Periphyton							
Sm = Transition Storage Midpoint							
Sb = Transition Storage Bandwidth							

Uncertainty Analysis

Case: **s100r1 - sens25** **File:** **acme_final_25.xls** 05/11/02

Estimates uncertainty in output variables. Assumes that sensitivity analysis has already been performed. Factors include: (1) uncertainty in p cycling parameters (from calibration); (2) uncertainty in other model inputs (user-specified); (3) inherent model error (from calibration); & (4) sensitivity of model output to each input value. Results are for combined outflows.

Reference: Walker, "A Sensitivity & Error Analysis Framework for Lake Eutrophication Modeling", Wtr Res Bul, Feb 1982

Select Output Variable:

- Treated FWM Outflow Conc
- Total FWM Outflow Conc
- Outflow Geo Mean - Composites
- Total Outflow Load

Outflow Geo Mean - Composites (ppb)		Error CV's = Standard Error / Mean	
50th Percentile Est. =	12	Total =	11%
10th Percentile Est. =	10	Model Error =	10%
90th Percentile Est =	14	Parameter Error =	3%
		Input Data Error =	2%

Show Results | Sensitivity Analysis | Menu

Sensitivity Coefficients

% Change in Output Variable / % Change in Input Variable

Enter assumed error CV (standard error, as percent of mean) in col. B (blue cells) to reflect uncertainty in each input value

Case Description: **Filename: acme_final_25.xls**

100% SAV at 79 cm and 1.20 km2 with 3 SAV cells

Output Variable	Units	Value
Water Balance Error	%	0.0%
Mass Balance Error	%	0.0%
Flow-Wtd Conc - With Bypass	ppb	19.2
Flow-Wtd Conc - Without Bypass	ppb	19.2
Geometric Mean Conc	ppb	12.1
95th Percentile Conc	ppb	25.1
Freq Cell Outflow > 10 ppb	%	66%
Bypass Load	%	0.0%

Input Variable	Error CV	Value	1	2	3	4	5	6
Design Case Name		s100r1						
Starting Date for Simulation								
Ending Date for Simulation								
Starting Date for Output								
Steps Per Day								
Number of Iterations								
Output Averaging Interval								
Reservoir H2O Residence Time								
Max Inflow / Mean Inflow								
Max Reservoir Storage								
Reservoir P Decay Rate								
Rainfall P Conc	30%	0.032						
Atmospheric P Load (Dry)	30%	0.022						
Cell Number -->			1	2	3	4	5	6
Cell Label			SAV1	SAV2	SAV3			
Vegetation Type			SAV_C4	SAV_C4	SAV_C4			
Inflow Fraction	0%		*0.931*					
Downstream Cell Number								
Surface Area			*-0.317*	*-0.317*	*-0.285*			
Mean Width of Flow Path			*0.002*	*-0.001*	*-0.002*			
Number of Tanks in Series	30%		*-0.034*	*-0.035*	*-0.029*			
Outflow Control Depth			*-0.007*	*-0.014*	*0.007*			
Outflow Coefficient - Exponent								
Outflow Coefficient - Intercept	20%		*0.002*	*-0.001*	*-0.002*			
Bypass Depth			*0.015*	*0.004*	*0.013*			
Maximum Inflow								
Maximum Outflow								
Inflow Seepage Rate	20%							
Inflow Seepage Control Elev								
Inflow Seepage Conc	20%							
Outflow Seepage Rate	20%		*-0.007*	*-0.002*	*0.005*			
Outflow Seepage Control Elev								
Max Outflow Seepage Conc	20%		*0.002*	*0.002*	*0.001*			
Seepage Recycle Fraction	20%		*0.002*	*-0.001*	*-0.003*			
Seepage Discharge Fraction	20%							
Initial Water Column Conc								
Initial P Storage Per Unit Area								
Initial Water Column Depth								
C0 = WC Conc at 0 g/m2 P Storage			*0.078*	*0.113*	*0.025*			
C1 = WC Conc at 1 g/m2 P storage			*0.021*	*0.017*	*0.001*			
K = Net Settling Rate at Steady State			*-0.299*	*-0.313*	*-0.342*			
Zx = Depth Scale Factor	*retrieved*		*0.001*	*0.002*	*0.004*			
C0 - Periphyton	*from model*							
C1 - Periphyton	*calibration*							
K - Periphyton	*table*							
Zx - Periphyton								
Sm = Transition Storage Midpoint								
Sb = Transition Storage Bandwidth								

Uncertainty Analysis

Case: **s100r1 - sens25** **File:** **acme_final_25.xls** 05/11/02

Estimates uncertainty in output variables. Assumes that sensitivity analysis has already been performed. Factors include: (1) uncertainty in p cycling parameters (from calibration); (2) uncertainty in other model inputs (user-specified); (3) inherent model error (from calibration); & (4) sensitivity of model output to each input value. Results are for combined outflows.

Reference: Walker, "A Sensitivity & Error Analysis Framework for Lake Eutrophication Modeling", Wtr Res Bul, Feb 1982

Select Output Variable:

- Treated FWM Outflow Conc
- Total FWM Outflow Conc
- Outflow Geo Mean - Composites
- Total Outflow Load

Total Outflow Load (kg/yr)		Error CV's = Standard Error / Mean	
50th Percentile Est. =	725	Total =	10%
10th Percentile Est. =	628	Model Error =	10%
90th Percentile Est =	821	Parameter Error =	3%
		Input Data Error =	1%

Show Results | Sensitivity Analysis | Menu

Sensitivity Coefficients

% Change in Output Variable / % Change in Input Variable

Enter assumed error CV (standard error, as percent of mean) in col. B (blue cells) to reflect uncertainty in each input value

Case Description: **Filename: acme_final_25.xls**

100% SAV at 79 cm and 1.20 km2 with 3 SAV cells

Output Variable	Units	Value
Water Balance Error	%	0.0%
Mass Balance Error	%	0.0%
Flow-Wtd Conc - With Bypass	ppb	19.2
Flow-Wtd Conc - Without Bypass	ppb	19.2
Geometric Mean Conc	ppb	12.1
95th Percentile Conc	ppb	25.1
Freq Cell Outflow > 10 ppb	%	66%
Bypass Load	%	0.0%

Input Variable	Error CV	Value	1	2	3	4	5	6
Design Case Name		s100r1						
Starting Date for Simulation								
Ending Date for Simulation								
Starting Date for Output								
Steps Per Day								
Number of Iterations								
Output Averaging Interval								
Reservoir H2O Residence Time								
Max Inflow / Mean Inflow								
Max Reservoir Storage								
Reservoir P Decay Rate								
Rainfall P Conc	30%	0.018						
Atmospheric P Load (Dry)	30%	0.005						
Cell Number -->			1	2	3	4	5	6
Cell Label			SAV1	SAV2	SAV3			
Vegetation Type			SAV_C4	SAV_C4	SAV_C4			
Inflow Fraction	0%		*1.579*					
Downstream Cell Number								
Surface Area			*-0.228*	*-0.225*	*-0.203*			
Mean Width of Flow Path			*0.006*	*0.002*	*0.001*			
Number of Tanks in Series	30%		*-0.019*	*-0.022*	*-0.017*			
Outflow Control Depth			*-0.001*	*-0.018*	*-0.016*			
Outflow Coefficient - Exponent								
Outflow Coefficient - Intercept	20%		*0.006*	*0.002*	*0.001*			
Bypass Depth			*-0.020*	*-0.003*	*-0.004*			
Maximum Inflow								
Maximum Outflow								
Inflow Seepage Rate	20%							
Inflow Seepage Control Elev								
Inflow Seepage Conc	20%							
Outflow Seepage Rate	20%		*-0.011*	*-0.009*	*-0.007*			
Outflow Seepage Control Elev								
Max Outflow Seepage Conc	20%		*0.001*	*0.001*	*0.001*			
Seepage Recycle Fraction	20%		*0.009*	*0.008*	*0.006*			
Seepage Discharge Fraction	20%							
Initial Water Column Conc								
Initial P Storage Per Unit Area								
Initial Water Column Depth								
C0 = WC Conc at 0 g/m2 P Storage			*0.077*	*0.133*	*0.157*			
C1 = WC Conc at 1 g/m2 P storage			*0.015*	*0.014*	*0.011*			
K = Net Settling Rate at Steady State			*-0.203*	*-0.198*	*-0.188*			
Zx = Depth Scale Factor	*retrieved*		*0.000*	*0.000*	*0.001*			
C0 - Periphyton	*from model*							
C1 - Periphyton	*calibration*							
K - Periphyton	*table*							
Zx - Periphyton								
Sm = Transition Storage Midpoint								
Sb = Transition Storage Bandwidth								

Uncertainty Analysis

Case: s100r1-sens50 **File: acme_final_25.xls** 05/12/02

Estimates uncertainty in output variables. Assumes that sensitivity analysis has already been performed. Factors include: (1) uncertainty in p cycling parameters (from calibration); (2) uncertainty in other model inputs (user-specified); (3) inherent model error (from calibration); & (4) sensitivity of model output to each input value. Results are for combined outflows.

Reference: Walker, "A Sensitivity & Error Analysis Framework for Lake Eutrophication Modeling", Wtr Res Bul, Feb 1982

Select Output Variable:

- Treated FWM Outflow Conc
- Total FWM Outflow Conc
- Outflow Geo Mean - Composites
- Total Outflow Load

Treated FWM Outflow Conc (ppb)		Error CV's = Standard Error / Mean	
50th Percentile Est. =	19	Total =	10%
10th Percentile Est. =	17	Model Error =	10%
90th Percentile Est =	22	Parameter Error =	3%
		Input Data Error =	1%

Show Results | Sensitivity Analysis | Menu

Sensitivity Coefficients

% Change in Output Variable / % Change in Input Variable

Enter assumed error CV (standard error, as percent of mean) in col. B (blue cells) to reflect uncertainty in each input value

Case Description: 100% SAV at 79 cm and 1.20 km2 with 3 SAV cells

Output Variable	Units	Value
Water Balance Error	%	0.0%
Mass Balance Error	%	0.0%
Flow-Wtd Conc - With Bypass	ppb	19.2
Flow-Wtd Conc - Without Bypass	ppb	19.2
Geometric Mean Conc	ppb	12.1
95th Percentile Conc	ppb	25.1
Freq Cell Outflow > 10 ppb	%	66%
Bypass Load	%	0.0%

Input Variable	Error CV	Value	1	2	3	4	5	6
Design Case Name		s100r1						
Starting Date for Simulation								
Ending Date for Simulation								
Starting Date for Output								
Steps Per Day								
Number of Iterations								
Output Averaging Interval								
Reservoir H2O Residence Time								
Max Inflow / Mean Inflow								
Max Reservoir Storage								
Reservoir P Decay Rate								
Rainfall P Conc	30%	0.017						
Atmospheric P Load (Dry)	30%	0.005						
Cell Number -->		1	2	3	4	5	6	
Cell Label		SAV1	SAV2	SAV3				
Vegetation Type		SAV_C4	SAV_C4	SAV_C4				
Inflow Fraction	0%	*0.552*						
Downstream Cell Number								
Surface Area		*-0.197*	*-0.194*	*-0.176*				
Mean Width of Flow Path		*0.006*	*0.002*	*0.011*				
Number of Tanks in Series	30%	*-0.023*	*-0.026*	*-0.021*				
Outflow Control Depth		*0.004*	*-0.011*	*-0.013*				
Outflow Coefficient - Exponent								
Outflow Coefficient - Intercept	20%	*0.006*	*0.002*	*0.011*				
Bypass Depth		*0.136*	*0.107*	*0.125*				
Maximum Inflow								
Maximum Outflow								
Inflow Seepage Rate	20%							
Inflow Seepage Control Elev								
Inflow Seepage Conc	20%							
Outflow Seepage Rate	20%	*-0.001*	*0.001*	*0.003*				
Outflow Seepage Control Elev								
Max Outflow Seepage Conc	20%	*0.001*	*0.001*	*0.001*				
Seepage Recycle Fraction	20%	*-0.002*	*-0.002*	*-0.003*				
Seepage Discharge Fraction	20%							
Initial Water Column Conc								
Initial P Storage Per Unit Area								
Initial Water Column Depth								
C0 = WC Conc at 0 g/m2 P Storage		*0.070*	*0.121*	*0.143*				
C1 = WC Conc at 1 g/m2 P storage		*0.014*	*0.013*	*0.010*				
K = Net Settling Rate at Steady State		*-0.182*	*-0.178*	*-0.169*				
Zx = Depth Scale Factor	*retrieved*	*0.021*	*0.032*	*0.034*				
C0 - Periphyton	*from model*							
C1 - Periphyton	*calibration*							
K - Periphyton	*table*							
Zx - Periphyton								
Sm = Transition Storage Midpoint								
Sb = Transition Storage Bandwidth								

Uncertainty Analysis

Case: s100r1-sens50 **File: acme_final_25.xls** 05/12/02

Estimates uncertainty in output variables. Assumes that sensitivity analysis has already been performed. Factors include: (1) uncertainty in p cycling parameters (from calibration); (2) uncertainty in other model inputs (user-specified); (3) inherent model error (from calibration); & (4) sensitivity of model output to each input value. Results are for combined outflows.

Reference: Walker, "A Sensitivity & Error Analysis Framework for Lake Eutrophication Modeling", Wtr Res Bul, Feb 1982

Select Output Variable:

- Treated FWM Outflow Conc
- Total FWM Outflow Conc
- Outflow Geo Mean - Composites
- Total Outflow Load

Total FWM Outflow Conc (ppb)		Error CV's = Standard Error / Mean	
50th Percentile Est. =	19	Total =	10%
10th Percentile Est. =	17	Model Error =	10%
90th Percentile Est =	22	Parameter Error =	3%
		Input Data Error =	1%

Show Results | Sensitivity Analysis | Menu

Sensitivity Coefficients

% Change in Output Variable / % Change in Input Variable

Enter assumed error CV (standard error, as percent of mean) in col. B (blue cells) to reflect uncertainty in each input value

Case Description: 100% SAV at 79 cm and 1.20 km2 with 3 SAV cells

Output Variable	Units	Value
Water Balance Error	%	0.0%
Mass Balance Error	%	0.0%
Flow-Wtd Conc - With Bypass	ppb	19.2
Flow-Wtd Conc - Without Bypass	ppb	19.2
Geometric Mean Conc	ppb	12.1
95th Percentile Conc	ppb	25.1
Freq Cell Outflow > 10 ppb	%	66%
Bypass Load	%	0.0%

Input Variable	Error CV	Value	1	2	3	4	5	6
Design Case Name		s100r1						
Starting Date for Simulation								
Ending Date for Simulation								
Starting Date for Output								
Steps Per Day								
Number of Iterations								
Output Averaging Interval								
Reservoir H2O Residence Time								
Max Inflow / Mean Inflow								
Max Reservoir Storage								
Reservoir P Decay Rate								
Rainfall P Conc	30%	0.017						
Atmospheric P Load (Dry)	30%	0.005						
Cell Number -->		1	2	3	4	5	6	
Cell Label		SAV1	SAV2	SAV3				
Vegetation Type		SAV_C4	SAV_C4	SAV_C4				
Inflow Fraction	0%	*0.565*						
Downstream Cell Number								
Surface Area		*-0.197*	*-0.194*	*-0.176*				
Mean Width of Flow Path		*0.006*	*0.002*	*0.000*				
Number of Tanks in Series	30%	*-0.023*	*-0.026*	*-0.021*				
Outflow Control Depth		*0.004*	*-0.011*	*-0.013*				
Outflow Coefficient - Exponent								
Outflow Coefficient - Intercept	20%	*0.006*	*0.002*	*0.000*				
Bypass Depth		*-0.091*	*-0.028*	*-0.010*				
Maximum Inflow								
Maximum Outflow								
Inflow Seepage Rate	20%							
Inflow Seepage Control Elev								
Inflow Seepage Conc	20%							
Outflow Seepage Rate	20%	*-0.001*	*0.001*	*0.003*				
Outflow Seepage Control Elev								
Max Outflow Seepage Conc	20%	*0.001*	*0.001*	*0.001*				
Seepage Recycle Fraction	20%	*-0.002*	*-0.002*	*-0.003*				
Seepage Discharge Fraction	20%							
Initial Water Column Conc								
Initial P Storage Per Unit Area								
Initial Water Column Depth								
C0 = WC Conc at 0 g/m2 P Storage		*0.070*	*0.121*	*0.143*				
C1 = WC Conc at 1 g/m2 P storage		*0.014*	*0.013*	*0.010*				
K = Net Settling Rate at Steady State		*-0.182*	*-0.178*	*-0.169*				
Zx = Depth Scale Factor	*retrieved*	*0.021*	*0.032*	*0.034*				
C0 - Periphyton	*from model*							
C1 - Periphyton	*calibration*							
K - Periphyton	*table*							
Zx - Periphyton								
Sm = Transition Storage Midpoint								
Sb = Transition Storage Bandwidth								

Uncertainty Analysis

Case: **s100r1 - sens50** **File:** **acme_final_25.xls** 05/12/02

Estimates uncertainty in output variables. Assumes that sensitivity analysis has already been performed. Factors include: (1) uncertainty in p cycling parameters (from calibration); (2) uncertainty in other model inputs (user-specified); (3) inherent model error (from calibration); & (4) sensitivity of model output to each input value. Results are for combined outflows.

Reference: Walker, "A Sensitivity & Error Analysis Framework for Lake Eutrophication Modeling", Wtr Res Bul, Feb 1982

Select Output Variable:

- Treated FWM Outflow Conc
- Total FWM Outflow Conc
- Outflow Geo Mean - Composites
- Total Outflow Load

Outflow Geo Mean - Composites (ppb)		Error CV's = Standard Error / Mean	
50th Percentile Est. =	12	Total =	11%
10th Percentile Est. =	10	Model Error =	10%
90th Percentile Est =	14	Parameter Error =	3%
		Input Data Error =	2%

Show Results | Sensitivity Analysis | Menu

Sensitivity Coefficients

% Change in Output Variable / % Change in Input Variable

Enter assumed error CV (standard error, as percent of mean) in col. B (blue cells) to reflect uncertainty in each input value

Case Description: **Filename: acme_final_25.xls**

100% SAV at 79 cm and 1.20 km2 with 3 SAV cells

Output Variable	Units	Value
Water Balance Error	%	0.0%
Mass Balance Error	%	0.0%
Flow-Wtd Conc - With Bypass	ppb	19.2
Flow-Wtd Conc - Without Bypass	ppb	19.2
Geometric Mean Conc	ppb	12.1
95th Percentile Conc	ppb	25.1
Freq Cell Outflow > 10 ppb	%	66%
Bypass Load	%	0.0%

Input Variable	Error CV	Value					
Design Case Name		s100r1					
Starting Date for Simulation							
Ending Date for Simulation							
Starting Date for Output							
Steps Per Day							
Number of Iterations							
Output Averaging Interval							
Reservoir H2O Residence Time							
Max Inflow / Mean Inflow							
Max Reservoir Storage							
Reservoir P Decay Rate							
Rainfall P Conc	30%	0.030					
Atmospheric P Load (Dry)	30%	0.021					
Cell Number -->		1	2	3	4	5	6
Cell Label		SAV1	SAV2	SAV3			
Vegetation Type		SAV_C4	SAV_C4	SAV_C4			
Inflow Fraction	0%	*0.839*					
Downstream Cell Number							
Surface Area		*-0.287*	*-0.287*	*-0.257*			
Mean Width of Flow Path		*0.002*	*-0.001*	*-0.001*			
Number of Tanks in Series	30%	*-0.041*	*-0.043*	*-0.036*			
Outflow Control Depth		*-0.016*	*-0.031*	*-0.042*			
Outflow Coefficient - Exponent							
Outflow Coefficient - Intercept	20%	*0.002*	*-0.001*	*-0.001*			
Bypass Depth		*0.065*	*0.037*	*0.031*			
Maximum Inflow							
Maximum Outflow							
Inflow Seepage Rate	20%						
Inflow Seepage Control Elev							
Inflow Seepage Conc	20%						
Outflow Seepage Rate	20%	*-0.003*	*0.001*	*0.005*			
Outflow Seepage Control Elev							
Max Outflow Seepage Conc	20%	*0.001*	*0.002*	*0.001*			
Seepage Recycle Fraction	20%	*0.000*	*-0.003*	*-0.007*			
Seepage Discharge Fraction	20%						
Initial Water Column Conc							
Initial P Storage Per Unit Area							
Initial Water Column Depth							
C0 = WC Conc at 0 g/m2 P Storage		*0.071*	*0.105*	*0.030*			
C1 = WC Conc at 1 g/m2 P storage		*0.020*	*0.016*	*0.001*			
K = Net Settling Rate at Steady State		*-0.269*	*-0.281*	*-0.307*			
Zx = Depth Scale Factor	*retrieved*	*0.045*	*0.061*	*0.067*			
C0 - Periphyton	*from model*						
C1 - Periphyton	*calibration*						
K - Periphyton	*table*						
Zx - Periphyton							
Sm = Transition Storage Midpoint							
Sb = Transition Storage Bandwidth							

Uncertainty Analysis

Case: **s100r1-sens50** **File:** **acme_final_25.xls** 05/12/02

Estimates uncertainty in output variables. Assumes that sensitivity analysis has already been performed. Factors include: (1) uncertainty in p cycling parameters (from calibration); (2) uncertainty in other model inputs (user-specified); (3) inherent model error (from calibration); & (4) sensitivity of model output to each input value. Results are for combined outflows.

Reference: Walker, "A Sensitivity & Error Analysis Framework for Lake Eutrophication Modeling", Wtr Res Bul, Feb 1982

Select Output Variable:

- Treated FWM Outflow Conc
- Total FWM Outflow Conc
- Outflow Geo Mean - Composites
- Total Outflow Load

Total Outflow Load (kg/yr)		Error CV's = Standard Error / Mean	
50th Percentile Est. =	725	Total =	10%
10th Percentile Est. =	628	Model Error =	10%
90th Percentile Est =	821	Parameter Error =	3%
		Input Data Error =	1%

Show Results | Sensitivity Analysis | Menu

Sensitivity Coefficients

% Change in Output Variable / % Change in Input Variable

Enter assumed error CV (standard error, as percent of mean) in col. B (blue cells) to reflect uncertainty in each input value

Case Description: **Filename: acme_final_25.xls**

100% SAV at 79 cm and 1.20 km2 with 3 SAV cells

Output Variable	Units	Value
Water Balance Error	%	0.0%
Mass Balance Error	%	0.0%
Flow-Wtd Conc - With Bypass	ppb	19.2
Flow-Wtd Conc - Without Bypass	ppb	19.2
Geometric Mean Conc	ppb	12.1
95th Percentile Conc	ppb	25.1
Freq Cell Outflow > 10 ppb	%	66%
Bypass Load	%	0.0%

Input Variable	Error CV	Value					
Design Case Name		s100r1					
Starting Date for Simulation							
Ending Date for Simulation							
Starting Date for Output							
Steps Per Day							
Number of Iterations							
Output Averaging Interval							
Reservoir H2O Residence Time							
Max Inflow / Mean Inflow							
Max Reservoir Storage							
Reservoir P Decay Rate							
Rainfall P Conc	30%	0.017					
Atmospheric P Load (Dry)	30%	0.005					
Cell Number -->		1	2	3	4	5	6
Cell Label		SAV1	SAV2	SAV3			
Vegetation Type		SAV_C4	SAV_C4	SAV_C4			
Inflow Fraction	0%	*1.514*					
Downstream Cell Number							
Surface Area		*-0.205*	*-0.203*	*-0.183*			
Mean Width of Flow Path		*0.006*	*0.002*	*0.001*			
Number of Tanks in Series	30%	*-0.023*	*-0.026*	*-0.021*			
Outflow Control Depth		*-0.005*	*-0.020*	*-0.021*			
Outflow Coefficient - Exponent							
Outflow Coefficient - Intercept	20%	*0.006*	*0.002*	*0.001*			
Bypass Depth		*-0.091*	*-0.028*	*-0.010*			
Maximum Inflow							
Maximum Outflow							
Inflow Seepage Rate	20%						
Inflow Seepage Control Elev							
Inflow Seepage Conc	20%						
Outflow Seepage Rate	20%	*-0.011*	*-0.009*	*-0.006*			
Outflow Seepage Control Elev							
Max Outflow Seepage Conc	20%	*0.001*	*0.001*	*0.001*			
Seepage Recycle Fraction	20%	*0.009*	*0.008*	*0.006*			
Seepage Discharge Fraction	20%						
Initial Water Column Conc							
Initial P Storage Per Unit Area							
Initial Water Column Depth							
C0 = WC Conc at 0 g/m2 P Storage		*0.070*	*0.121*	*0.143*			
C1 = WC Conc at 1 g/m2 P storage		*0.014*	*0.013*	*0.010*			
K = Net Settling Rate at Steady State		*-0.182*	*-0.178*	*-0.169*			
Zx = Depth Scale Factor	*retrieved*	*0.021*	*0.032*	*0.034*			
C0 - Periphyton	*from model*						
C1 - Periphyton	*calibration*						
K - Periphyton	*table*						
Zx - Periphyton							
Sm = Transition Storage Midpoint							
Sb = Transition Storage Bandwidth							

DMSTA Input Values **ACME Basin B - Alt. 4 basecase**

Input Variable	Units	Value
Design Case Name	-	s100r1_final
Starting Date for Simulation	-	01/00/00
Ending Date for Simulation	-	01/00/00
Starting Date for Output	-	01/00/00
Steps Per Day	-	8
Number of Iterations	-	2
Output Averaging Interval	days	7
Reservoir H2O Residence Time	days	0
Max Inflow / Mean Inflow	-	0
Max Reservoir Storage	hm3	0
Reservoir P Decay Rate	1/yr/ppb	0
Rainfall P Conc	ppb	20
Atmospheric P Load (Dry)	mg/m2-yr	20

Case Description: 100% SAV at 79 cm and 1.4 km2 with 3 SAV cells **Filename:** acme_final_25.xls

Output Variable	Units	Value
Water Balance Error	%	0.0%
Mass Balance Error	%	0.0%
Flow-Wtd Conc - With Bypass	ppb	17
Flow-Wtd Conc - Without Bypass	ppb	17
Geometric Mean Conc	ppb	10
95th Percentile Conc	ppb	23
Freq Cell Outflow > 10 ppb	%	51%
Bypass Load	%	0.0%

Cell Number -->		1	2	3	4	5	6
Cell Label	-	SAV1	SAV2	SAV3			
Vegetation Type	------->	SAV_C4	SAV_C4	SAV_C4			
Inflow Fraction	-	1	0	0			
Downstream Cell Number	-	2	3	0			
Surface Area	km2	0.467	0.467	0.467			
Mean Width of Flow Path	km	1.18	1.18	1.18			
Number of Tanks in Series	-	3	3	3			
Outflow Control Depth	cm	79	79	79			
Outflow Coefficient - Exponent	-	3.5	3.5	3.5			
Outflow Coefficient - Intercept	-	0.8	0.8	0.8			
Bypass Depth	cm	140	140	140			
Maximum Inflow	hm3/day	0	0	0			
Maximum Outflow	hm3/day	0	0	0			
Inflow Seepage Rate	(cm/d) / cm	0	0	0			
Inflow Seepage Control Elev	cm	0	0	0			
Inflow Seepage Conc	ppb	0	0	0			
Outflow Seepage Rate	(cm/d) / cm	0.008	0.008	0.008			
Outflow Seepage Control Elev	cm	0	0	0			
Max Outflow Seepage Conc	ppb	20	20	20			
Seepage Recycle Fraction	-	0.5	0.5	0.5			
Seepage Discharge Fraction	-	0	0	0			
Initial Water Column Conc	ppb	30	30	30			
Initial P Storage Per Unit Area	mg/m2	500	500	500			
Initial Water Column Depth	cm	50	50	50			
C0 = WC Conc at 0 g/m2 P Storage	ppb	*4*	*4*	*4*			
C1 = WC Conc at 1 g/m2 P storage	ppb	*22*	*22*	*22*			
K = Net Settling Rate at Steady State	m/yr	*80*	*80*	*80*			
Zx = Depth Scale Factor	cm	*60*	*60*	*60*			
C0 - Periphyton	ppb	*0*	*0*	*0*			
C1 - Periphyton	ppb	*0*	*0*	*0*			
K - Periphyton	1/yr	*0.00*	*0.00*	*0.00*			
Zx - Periphyton	cm	*0*	*0*	*0*			
Sm = Transition Storage Midpoint	mg/m2	*0*	*0*	*0*			
Sb = Transition Storage Bandwidth	mg/m2	*0*	*0*	*0*			

Output Variables	Units	1	2	3	4	5	6	Overall
Execution Time	seconds/yr	6.45	12.78	19.07				19.07
Run Date	-	05/14/02	05/14/02	05/14/02				05/14/02
Starting Date for Simulation	-	01/01/65	01/01/65	01/01/65				01/01/65
Starting Date for Output	-	01/01/65	01/01/65	01/01/65				01/01/65
Ending Date	-	12/31/95	12/31/95	12/31/95				12/31/95
Output Duration	days	11322	11322	11322				11322
Cell Label		SAV1	SAV2	SAV3				Total Outflow
Downstream Cell Label		SAV2	SAV3	Outflow				-
Surface Area	km2	0.467	0.467	0.467				1.4
Mean Water Load	cm/d	22.8	22.6	22.3				7.6
Max Water Load	cm/d	258.5	257.9	257.3				86.2
Inflow Volume	hm3/yr	38.9	38.5	38.0				38.9
Inflow Load	kg/yr	2747.0	1462.0	904.5				2747.0
Inflow Conc	ppb	71	38	24				70.6
Treated Outflow Volume	hm3/yr	38.5	38.0	37.6				37.6
Treated Outflow Load	kg/yr	1462.0	904.5	649.5				649.5
Treated FWM Outflow Conc	ppb	38	24	17				17.3
Total Outflow Volume	hm3/yr	38.5	38.0	37.6				37.6

ACME Basin B - Alt. 4 basecase (cont'd)

Total Outflow Load	kg/yr	1462.0	904.5	649.5	649.5
Total FWM Outflow Conc	ppb	38	24	17	17.3
Bypass Volume	hm3/yr	0.00	0.00	0.00	0.00
Bypass Load	kg/yr	0.00	0.00	0.00	0.00
Bypass Conc	ppb	0	0	0	0.0
Bypass Load	%	0%	0%	0%	0%
Surface Outflow Load Reduc	%	46.8%	38.1%	28.2%	76.4%
Outflow Geometric Mean - Daily	ppb	29	15	9	9.0
Outflow Geo Mean - Composites	ppb	31	17	10	10.3
Frequency Outflow Conc > 10 ppb	%	100%	100%	0%	51%
95th Percentile Outflow Conc	ppb	33	18	9	22.8
Mean Biomass P Storage	mg/m2	1901	847	406	1051
Max Reservoir Storage	hm3	0.00	0.00	0.00	0.00
Reservoir Load Reduction	%	#N/A	#N/A	#N/A	#N/A
Mean Depth	cm	76.2	75.4	74.8	75.5
Minimum Depth	cm	4.2	4.0	3.4	3.9
Maximum Depth	cm	106.9	106.9	106.7	106.9
Frequency Depth < 5 cm	%	0.0%	0.0%	0.0%	0.0%
Flow/Width	m2/day	89	88	87	88.0
Max 1 Yr Flow-Wtd Conc	ppb	#N/A	#N/A	#N/A	21.9
Max 5 Yr Flow-Wtd Conc	ppb	#N/A	#N/A	#N/A	19.2
Max 1 Yr Geometric Mn Conc	ppb	#N/A	#N/A	#N/A	16.3
Max 5 Yr Geometric Mn Conc	ppb	#N/A	#N/A	#N/A	12.8
Depth Percentile vs. Calib Set	%	59%	57%	57%	57%
Q/W Percentile vs. Calib Set	%	41%	41%	40%	40%
Cin Percentile vs. Calib Set	%	75%	46%	24%	75%
Cout Percentile vs. Calib Set	%	46%	25%	10%	10%
Depth Range Flag	-	OK	OK	OK	0.0
Q/W Range Flag	-	OK	OK	OK	0.0
Cin Range Flag	-	OK	OK	OK	0.0
Cout Range Flag	-	OK	OK	OK	0.0
Water Balance Error	%	0.00%	0.00%	0.00%	0.00%
Mass Balance Error	%	0.01%	0.03%	0.05%	0.04%

DMSTA Input Values **ACME Basin B - Alt.4 with 0% Load Reduction (Sensitivity)**

Input Variable	Units	Value
Design Case Name	-	s100r1_s2_final
Starting Date for Simulation	-	01/00/00
Ending Date for Simulation	-	01/00/00
Starting Date for Output	-	01/00/00
Steps Per Day	-	8
Number of Iterations	-	2
Output Averaging Interval	days	7
Reservoir H2O Residence Time	days	0
Max Inflow / Mean Inflow	-	0
Max Reservoir Storage	hm3	0
Reservoir P Decay Rate	1/yr/ppb	0
Rainfall P Conc	ppb	20
Atmospheric P Load (Dry)	mg/m2-yr	20

Case Description: 100% SAV at 79 cm and 1.63 km2 with 3 SAV cells
0% load redcction due to source controls

Filename: acme_final_base.xls

Output Variable	Units	Value
Water Balance Error	%	0.0%
Mass Balance Error	%	0.0%
Flow-Wtd Conc - With Bypass	ppb	18
Flow-Wtd Conc - Without Bypass	ppb	18
Geometric Mean Conc	ppb	10
95th Percentile Conc	ppb	24
Freq Cell Outflow > 10 ppb	%	52%
Bypass Load	%	0.0%

Cell Number -->		1	2	3	4	5	6
Cell Label	-	SAV1	SAV2	SAV3			
Vegetation Type	------->	SAV_C4	SAV_C4	SAV_C4			
Inflow Fraction	-	1	0	0			
Downstream Cell Number	-	2	3	0			
Surface Area	km2	0.543	0.543	0.543			
Mean Width of Flow Path	km	1.28	1.28	1.28			
Number of Tanks in Series	-	3	3	3			
Outflow Control Depth	cm	79	79	79			
Outflow Coefficient - Exponent	-	3.5	3.5	3.5			
Outflow Coefficient - Intercept	-	0.8	0.8	0.8			
Bypass Depth	cm	140	140	140			
Maximum Inflow	hm3/day	0	0	0			
Maximum Outflow	hm3/day	0	0	0			
Inflow Seepage Rate	(cm/d) / cm	0	0	0			
Inflow Seepage Control Elev	cm	0	0	0			
Inflow Seepage Conc	ppb	0	0	0			
Outflow Seepage Rate	(cm/d) / cm	0.008	0.008	0.008			
Outflow Seepage Control Elev	cm	0	0	0			
Max Outflow Seepage Conc	ppb	20	20	20			
Seepage Recycle Fraction	-	0.5	0.5	0.5			
Seepage Discharge Fraction	-	0	0	0			
Initial Water Column Conc	ppb	30	30	30			
Initial P Storage Per Unit Area	mg/m2	500	500	500			
Initial Water Column Depth	cm	50	50	50			
C0 = WC Conc at 0 g/m2 P Storage	ppb	*4*	*4*	*4*			
C1 = WC Conc at 1 g/m2 P storage	ppb	*22*	*22*	*22*			
K = Net Settling Rate at Steady State	m/yr	*80*	*80*	*80*			
Zx = Depth Scale Factor	cm	*60*	*60*	*60*			
C0 - Periphyton	ppb	*0*	*0*	*0*			
C1 - Periphyton	ppb	*0*	*0*	*0*			
K - Periphyton	1/yr	*0.00*	*0.00*	*0.00*			
Zx - Periphyton	cm	*0*	*0*	*0*			
Sm = Transition Storage Midpoint	mg/m2	*0*	*0*	*0*			
Sb = Transition Storage Bandwidth	mg/m2	*0*	*0*	*0*			

Output Variables	Units	1	2	3	4	5	6	Overall
Execution Time	seconds/yr	3.87	7.87	11.58				11.58
Run Date	-	07/02/02	07/02/02	07/02/02				07/02/02
Starting Date for Simulation	-	01/01/65	01/01/65	01/01/65				01/01/65
Starting Date for Output	-	01/01/65	01/01/65	01/01/65				01/01/65
Ending Date	-	12/31/95	12/31/95	12/31/95				12/31/95
Output Duration	days	11322	11322	11322				11322
Cell Label		SAV1	SAV2	SAV3				Total Outflow
Downstream Cell Label		SAV2	SAV3	Outflow				-
Surface Area	km2	0.543	0.543	0.543				1.6
Mean Water Load	cm/d	19.6	19.3	19.1				6.5
Max Water Load	cm/d	222.0	221.7	221.3				74.0
Inflow Volume	hm3/yr	38.9	38.4	37.9				38.9
Inflow Load	kg/yr	3662.7	1732.5	974.8				3662.7
Inflow Conc	ppb	94	45	26				94.2
Treated Outflow Volume	hm3/yr	38.4	37.9	37.4				37.4
Treated Outflow Load	kg/yr	1732.5	974.8	663.1				663.1
Treated FWM Outflow Conc	ppb	45	26	18				17.7
Total Outflow Volume	hm3/yr	38.4	37.9	37.4				37.4

ACME Basin B - Alt.4 with 0% Load Reduction (Sensitivity) (cont'd)

Total Outflow Load	kg/yr	1732.5	974.8	663.1	663.1
Total FWM Outflow Conc	ppb	45	26	18	17.7
Bypass Volume	hm3/yr	0.00	0.00	0.00	0.00
Bypass Load	kg/yr	0.00	0.00	0.00	0.00
Bypass Conc	ppb	0	0	0	0.0
Bypass Load	%	0%	0%	0%	0%
Surface Outflow Load Reduc	%	52.7%	43.7%	32.0%	81.9%
Outflow Geometric Mean - Daily	ppb	37	17	10	10.2
Outflow Geo Mean - Composites	ppb	37	18	10	10.4
Frequency Outflow Conc > 10 ppb	%	100%	100%	0%	52%
95th Percentile Outflow Conc	ppb	42	20	9	23.5
Mean Biomass P Storage	mg/m2	2440	983	424	1282
Max Reservoir Storage	hm3	0.00	0.00	0.00	0.00
Reservoir Load Reduction	%	#N/A	#N/A	#N/A	#N/A
Mean Depth	cm	76.1	75.2	74.4	75.2
Minimum Depth	cm	4.2	3.9	2.7	3.6
Maximum Depth	cm	104.7	104.6	104.5	104.6
Frequency Depth < 5 cm	%	0.0%	0.0%	0.0%	0.0%
Flow/Width	m2/day	82	81	80	81.3
Max 1 Yr Flow-Wtd Conc	ppb	#N/A	#N/A	#N/A	22.9
Max 5 Yr Flow-Wtd Conc	ppb	#N/A	#N/A	#N/A	19.8
Max 1 Yr Geometric Mn Conc	ppb	#N/A	#N/A	#N/A	16.9
Max 5 Yr Geometric Mn Conc	ppb	#N/A	#N/A	#N/A	13.2
Depth Percentile vs. Calib Set	%	58%	57%	56%	56%
Q/W Percentile vs. Calib Set	%	38%	38%	37%	37%
Cin Percentile vs. Calib Set	%	88%	54%	28%	88%
Cout Percentile vs. Calib Set	%	54%	28%	11%	11%
Depth Range Flag	-	OK	OK	OK	0.0
Q/W Range Flag	-	OK	OK	OK	0.0
Cin Range Flag	-	OK	OK	OK	0.0
Cout Range Flag	-	OK	OK	OK	0.0
Water Balance Error	%	0.00%	0.00%	0.00%	0.00%
Mass Balance Error	%	-0.01%	0.02%	0.05%	0.01%

DMSTA Input Values **ACME Basin B - Alt. 4 with 50% Load Reduction (Sensitivity)**

Input Variable	Units	Value
Design Case Name	-	s100r1_s3_final
Starting Date for Simulation	-	01/00/00
Ending Date for Simulation	-	01/00/00
Starting Date for Output	-	01/00/00
Steps Per Day	-	8
Number of Iterations	-	2
Output Averaging Interval	days	7
Reservoir H2O Residence Time	days	0
Max Inflow / Mean Inflow	-	0
Max Reservoir Storage	hm3	0
Reservoir P Decay Rate	1/yr/ppb	0
Rainfall P Conc	ppb	20
Atmospheric P Load (Dry)	mg/m2-yr	20

Case Description: 100% SAV at 79 cm and 1.05 km2 with 3 SAV cells with 50% load reduction due to source controls

Filename: acme_final_50.xls

Output Variable	Units	Value
Water Balance Error	%	0.0%
Mass Balance Error	%	0.1%
Flow-Wtd Conc - With Bypass	ppb	17
Flow-Wtd Conc - Without Bypass	ppb	17
Geometric Mean Conc	ppb	10
95th Percentile Conc	ppb	22
Freq Cell Outflow > 10 ppb	%	52%
Bypass Load	%	0.0%

Cell Number -->		1	2	3	4	5	6
Cell Label	-	SAV1	SAV2	SAV3			
Vegetation Type	------->	SAV_C4	SAV_C4	SAV_C4			
Inflow Fraction	-	1	0	0			
Downstream Cell Number	-	2	3	0			
Surface Area	km2	0.350	0.350	0.350			
Mean Width of Flow Path	km	1.02	1.02	1.02			
Number of Tanks in Series	-	3	3	3			
Outflow Control Depth	cm	79	79	79			
Outflow Coefficient - Exponent	-	3.5	3.5	3.5			
Outflow Coefficient - Intercept	-	0.8	0.8	0.8			
Bypass Depth	cm	140	140	140			
Maximum Inflow	hm3/day	0	0	0			
Maximum Outflow	hm3/day	0	0	0			
Inflow Seepage Rate	(cm/d) / cm	0	0	0			
Inflow Seepage Control Elev	cm	0	0	0			
Inflow Seepage Conc	ppb	0	0	0			
Outflow Seepage Rate	(cm/d) / cm	0.008	0.008	0.008			
Outflow Seepage Control Elev	cm	0	0	0			
Max Outflow Seepage Conc	ppb	20	20	20			
Seepage Recycle Fraction	-	0.5	0.5	0.5			
Seepage Discharge Fraction	-	0	0	0			
Initial Water Column Conc	ppb	30	30	30			
Initial P Storage Per Unit Area	mg/m2	500	500	500			
Initial Water Column Depth	cm	50	50	50			
C0 = WC Conc at 0 g/m2 P Storage	ppb	*4*	*4*	*4*			
C1 = WC Conc at 1 g/m2 P storage	ppb	*22*	*22*	*22*			
K = Net Settling Rate at Steady State	m/yr	*80*	*80*	*80*			
Zx = Depth Scale Factor	cm	*60*	*60*	*60*			
C0 - Periphyton	ppb	*0*	*0*	*0*			
C1 - Periphyton	ppb	*0*	*0*	*0*			
K - Periphyton	1/yr	*0.00*	*0.00*	*0.00*			
Zx - Periphyton	cm	*0*	*0*	*0*			
Sm = Transition Storage Midpoint	mg/m2	*0*	*0*	*0*			
Sb = Transition Storage Bandwidth	mg/m2	*0*	*0*	*0*			

Output Variables	Units	1	2	3	4	5	6	Overall
Execution Time	seconds/yr	3.68	7.16	10.68				10.68
Run Date	-	07/02/02	07/02/02	07/02/02				07/02/02
Starting Date for Simulation	-	01/01/65	01/01/65	01/01/65				01/01/65
Starting Date for Output	-	01/01/65	01/01/65	01/01/65				01/01/65
Ending Date	-	12/31/95	12/31/95	12/31/95				12/31/95
Output Duration	days	11322	11322	11322				11322
Cell Label		SAV1	SAV2	SAV3				Total Outflow
Downstream Cell Label		SAV2	SAV3	Outflow				-
Surface Area	km2	0.350	0.350	0.350				1.1
Mean Water Load	cm/d	30.4	30.2	29.9				10.1
Max Water Load	cm/d	344.6	343.9	343.0				114.9
Inflow Volume	hm3/yr	38.9	38.6	38.2				38.9
Inflow Load	kg/yr	1831.3	1157.1	815.1				1831.3
Inflow Conc	ppb	47	30	21				47.1
Treated Outflow Volume	hm3/yr	38.6	38.2	37.9				37.9
Treated Outflow Load	kg/yr	1157.1	815.1	631.4				631.4
Treated FWM Outflow Conc	ppb	30	21	17				16.6
Total Outflow Volume	hm3/yr	38.6	38.2	37.9				37.9

ACME Basin B - Alt. 4 with 50% Load Reduction (Sensitivity) (cont'd)

Total Outflow Load	kg/yr	1157.1	815.1	631.4	631.4
Total FWM Outflow Conc	ppb	30	21	17	16.6
Bypass Volume	hm3/yr	0.00	0.00	0.00	0.00
Bypass Load	kg/yr	0.00	0.00	0.00	0.00
Bypass Conc	ppb	0	0	0	0.0
Bypass Load	%	0%	0%	0%	0%
Surface Outflow Load Reduc	%	36.8%	29.6%	22.5%	65.5%
Outflow Geometric Mean - Daily	ppb	24	15	10	10.2
Outflow Geo Mean - Composites	ppb	24	15	10	10.4
Frequency Outflow Conc > 10 ppb	%	100%	100%	0%	52%
95th Percentile Outflow Conc	ppb	25	15	9	21.7
Mean Biomass P Storage	mg/m2	1342	699	391	811
Max Reservoir Storage	hm3	0.00	0.00	0.00	0.00
Reservoir Load Reduction	%	#N/A	#N/A	#N/A	#N/A
Mean Depth	cm	76.5	75.8	75.4	75.9
Minimum Depth	cm	4.2	4.2	3.8	4.1
Maximum Depth	cm	111.4	111.3	111.2	111.3
Frequency Depth < 5 cm	%	0.0%	0.0%	0.0%	0.0%
Flow/Width	m2/day	103	102	101	102.2
Max 1 Yr Flow-Wtd Conc	ppb	#N/A	#N/A	#N/A	20.3
Max 5 Yr Flow-Wtd Conc	ppb	#N/A	#N/A	#N/A	18.3
Max 1 Yr Geometric Mn Conc	ppb	#N/A	#N/A	#N/A	15.0
Max 5 Yr Geometric Mn Conc	ppb	#N/A	#N/A	#N/A	12.5
Depth Percentile vs. Calib Set	%	59%	58%	57%	57%
Q/W Percentile vs. Calib Set	%	48%	47%	47%	47%
Cin Percentile vs. Calib Set	%	56%	35%	19%	56%
Cout Percentile vs. Calib Set	%	35%	20%	8%	8%
Depth Range Flag	-	OK	OK	OK	0.0
Q/W Range Flag	-	OK	OK	OK	0.0
Cin Range Flag	-	OK	OK	OK	0.0
Cout Range Flag	-	OK	OK	OK	0.0
Water Balance Error	%	0.00%	0.00%	0.00%	0.00%
Mass Balance Error	%	0.02%	0.04%	0.05%	0.06%

DMSTA Input Values **ACME Basin B - Alt. 4 basecase using NEWS (Sensitivity)**

Input Variable	Units	Value
Design Case Name	-	s100r1_NEWS
Starting Date for Simulation	-	01/00/00
Ending Date for Simulation	-	01/00/00
Starting Date for Output	-	01/00/00
Steps Per Day	-	8
Number of Iterations	-	2
Output Averaging Interval	days	7
Reservoir H2O Residence Time	days	0
Max Inflow / Mean Inflow	-	0
Max Reservoir Storage	hm3	0
Reservoir P Decay Rate	1/yr/ppb	0
Rainfall P Conc	ppb	20
Atmospheric P Load (Dry)	mg/m2-yr	20

Case Description: 100% NEWS at 79 cm and 1.4 km2 with 3 NEWS cells
ACME Alt. 4 basecase

Filename: acme_final_25.xls

Output Variable	Units	Value
Water Balance Error	%	0.0%
Mass Balance Error	%	0.1%
Flow-Wtd Conc - With Bypass	ppb	26
Flow-Wtd Conc - Without Bypass	ppb	26
Geometric Mean Conc	ppb	14
95th Percentile Conc	ppb	36
Freq Cell Outflow > 10 ppb	%	65%
Bypass Load	%	0.0%

Cell Number -->		1	2	3	4	5	6
Cell Label	-	SAV1	SAV2	SAV3			
Vegetation Type	------->	NEWS	NEWS	NEWS			
Inflow Fraction	-	1	0	0			
Downstream Cell Number	-	2	3	0			
Surface Area	km2	0.467	0.467	0.467			
Mean Width of Flow Path	km	1.18	1.18	1.18			
Number of Tanks in Series	-	3	3	3			
Outflow Control Depth	cm	79	79	79			
Outflow Coefficient - Exponent	-	3.5	3.5	3.5			
Outflow Coefficient - Intercept	-	0.8	0.8	0.8			
Bypass Depth	cm	140	140	140			
Maximum Inflow	hm3/day	0	0	0			
Maximum Outflow	hm3/day	0	0	0			
Inflow Seepage Rate	(cm/d) / cm	0	0	0			
Inflow Seepage Control Elev	cm	0	0	0			
Inflow Seepage Conc	ppb	0	0	0			
Outflow Seepage Rate	(cm/d) / cm	0.008	0.008	0.008			
Outflow Seepage Control Elev	cm	0	0	0			
Max Outflow Seepage Conc	ppb	20	20	20			
Seepage Recycle Fraction	-	0.5	0.5	0.5			
Seepage Discharge Fraction	-	0	0	0			
Initial Water Column Conc	ppb	30	30	30			
Initial P Storage Per Unit Area	mg/m2	500	500	500			
Initial Water Column Depth	cm	50	50	50			
C0 = WC Conc at 0 g/m2 P Storage	ppb	*12*	*12*	*12*			
C1 = WC Conc at 1 g/m2 P storage	ppb	*22*	*22*	*22*			
K = Net Settling Rate at Steady State	m/yr	*129*	*129*	*129*			
Zx = Depth Scale Factor	cm	*60*	*60*	*60*			
C0 - Periphyton	ppb	*4*	*4*	*4*			
C1 - Periphyton	ppb	*22*	*22*	*22*			
K - Periphyton	1/yr	*23.80*	*23.80*	*23.80*			
Zx - Periphyton	cm	*0*	*0*	*0*			
Sm = Transition Storage Midpoint	mg/m2	*400*	*400*	*400*			
Sb = Transition Storage Bandwidth	mg/m2	*80*	*80*	*80*			

Output Variables	Units	1	2	3	4	5	6	Overall
Execution Time	seconds/yr	3.45	6.81	10.19				10.19
Run Date	-	07/05/02	07/05/02	07/05/02				07/05/02
Starting Date for Simulation	-	01/01/65	01/01/65	01/01/65				01/01/65
Starting Date for Output	-	01/01/65	01/01/65	01/01/65				01/01/65
Ending Date	-	12/31/95	12/31/95	12/31/95				12/31/95
Output Duration	days	11322	11322	11322				11322
Cell Label		SAV1	SAV2	SAV3				Total Outflow
Downstream Cell Label		SAV2	SAV3	Outflow				-
Surface Area	km2	0.467	0.467	0.467				1.4
Mean Water Load	cm/d	22.8	22.6	22.3				7.6
Max Water Load	cm/d	258.5	257.9	257.3				86.2
Inflow Volume	hm3/yr	38.9	38.5	38.0				38.9
Inflow Load	kg/yr	2747.0	1520.4	1160.4				2747.0
Inflow Conc	ppb	71	40	31				70.6
Treated Outflow Volume	hm3/yr	38.5	38.0	37.6				37.6
Treated Outflow Load	kg/yr	1520.4	1160.4	978.1				978.1
Treated FWM Outflow Conc	ppb	40	31	26				26.0
Total Outflow Volume	hm3/yr	38.5	38.0	37.6				37.6

ACME Basin B - Alt. 4 basecase using NEWS (Sensitivity) (cont'd)

Total Outflow Load	kg/yr	1520.4	1160.4	978.1	978.1
Total FWM Outflow Conc	ppb	40	31	26	26.0
Bypass Volume	hm3/yr	0.00	0.00	0.00	0.00
Bypass Load	kg/yr	0.00	0.00	0.00	0.00
Bypass Conc	ppb	0	0	0	0.0
Bypass Load	%	0%	0%	0%	0%
Surface Outflow Load Reduc	%	44.7%	23.7%	15.7%	64.4%
Outflow Geometric Mean - Daily	ppb	22	14	12	11.6
Outflow Geo Mean - Composites	ppb	26	17	14	13.8
Frequency Outflow Conc > 10 ppb	%	100%	0%	0%	65%
95th Percentile Outflow Conc	ppb	23	9	7	36.3
Mean Biomass P Storage	mg/m2	2041	659	437	1046
Max Reservoir Storage	hm3	0.00	0.00	0.00	0.00
Reservoir Load Reduction	%	#N/A	#N/A	#N/A	#N/A
Mean Depth	cm	76.2	75.4	74.8	75.5
Minimum Depth	cm	4.2	4.0	3.4	3.9
Maximum Depth	cm	106.9	106.9	106.7	106.9
Frequency Depth < 5 cm	%	0.0%	0.0%	0.0%	0.0%
Flow/Width	m2/day	89	88	87	88.0
Max 1 Yr Flow-Wtd Conc	ppb	#N/A	#N/A	#N/A	34.0
Max 5 Yr Flow-Wtd Conc	ppb	#N/A	#N/A	#N/A	28.0
Max 1 Yr Geometric Mn Conc	ppb	#N/A	#N/A	#N/A	19.9
Max 5 Yr Geometric Mn Conc	ppb	#N/A	#N/A	#N/A	15.0
Depth Percentile vs. Calib Set	%	67%	66%	66%	66%
Q/W Percentile vs. Calib Set	%	41%	41%	40%	40%
Cin Percentile vs. Calib Set	%	82%	62%	53%	82%
Cout Percentile vs. Calib Set	%	62%	54%	48%	48%
Depth Range Flag	-	OK	OK	OK	0.0
Q/W Range Flag	-	OK	OK	OK	0.0
Cin Range Flag	-	OK	OK	OK	0.0
Cout Range Flag	-	OK	OK	OK	0.0
Water Balance Error	%	0.00%	0.00%	0.00%	0.00%
Mass Balance Error	%	0.03%	0.07%	0.07%	0.10%

ACME Basin B - Alt. 4 basecase 25% DMSTA Sensitivity Analysis

Sensitivity Analysis **Case: s100r1_final** **File: acme_final_25.xls** **Input Variable Set: All** **Run Date: 05/14/02**

Option	Value	
Select Sensitivity Scale Factor --->	**25%**	*Modify Each Input Variable by +/- This Percentage*
Select Input Parameter Set ------>	**1**	*1 = All, 2 = P Cycling Only, 3 = Design Features Only*
Select Test Option ---------->	**2**	*1 = High Results Only, 2 = High & Low Results*

Number of Model Runs Required = 86 Estimated Run Time = 850.0 minutes

Adjusts Each non-Zero Input Variable, One at a Time, & Re-Runs Simulation

Shows Results for Combined Outflow from Entire Treatment Area

Run

Sort Results

Uncertainty Analysis

Menu

Input Variable	Cell Number	Input Value - Base	High Results ----> Input Value - High	Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load	Low Results ------> Input Value - Low	Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load	Average Change ----> Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load	Average % Change --> Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load
	-	-	-	ppb	ppb	ppb	kg/yr	-	ppb	ppb	ppb	kg/yr	ppb	ppb	ppb	kg/yr	%	%	%	%
Base Run				17.3	17.3	10.3	649		17.3	17.3	10.3	649								
Rainfall P Conc	1	20.0	25.0	17.4	17.4	10.5	653	16.0	17.2	17.2	10.2	646	0.1	0.1	0.1	3	1%	1%	1%	1%
Atmospheric P Load (Dry)	1	20.0	25.0	17.3	17.3	10.4	650	16.0	17.2	17.2	10.3	649	0.0	0.0	0.1	1	0%	0%	1%	0%
Inflow Fraction	1	1.0	1.3	20.1	20.1	13.0	953	0.8	15.0	15.0	8.4	448	2.6	2.6	2.3	253	15%	15%	23%	39%
Surface Area	1	0.5	0.6	16.4	16.4	9.6	615	0.4	18.1	18.1	11.1	683	-0.9	-0.9	-0.8	-34	-5%	-5%	-8%	-5%
Surface Area	2	0.5	0.6	16.4	16.4	9.6	615	0.4	18.1	18.1	11.1	683	-0.9	-0.9	-0.8	-34	-5%	-5%	-8%	-5%
Surface Area	3	0.5	0.6	16.4	16.4	9.6	615	0.4	18.1	18.1	11.1	683	-0.9	-0.9	-0.8	-34	-5.0%	-5.0%	-7.5%	-5.2%
Mean Width of Flow Path	1	1.2	1.5	17.3	17.3	10.3	650	0.9	17.2	17.2	10.3	648	0.0	0.0	0.0	1	0%	0%	0%	0%
Mean Width of Flow Path	2	1.2	1.5	17.3	17.3	10.3	650	0.9	17.3	17.3	10.3	649	0.0	0.0	0.0	0	0%	0%	0%	0%
Mean Width of Flow Path	3	1.2	1.5	17.3	17.3	10.3	649	0.9	17.3	17.3	10.3	649	0.0	0.0	0.0	0	0%	0%	0%	0%
Number of Tanks in Series	1	3.0	3.8	17.1	17.1	10.2	645	2.4	17.3	17.3	10.4	651	-0.1	-0.1	-0.1	-3	0%	0%	-1%	0%
Number of Tanks in Series	2	3.0	3.8	17.1	17.1	10.2	645	2.4	17.3	17.3	10.4	652	-0.1	-0.1	-0.1	-4	-1%	-1%	-1%	-1%
Number of Tanks in Series	3	3.0	3.8	17.1	17.1	10.2	645	2.4	17.3	17.3	10.4	652	-0.1	-0.1	-0.1	-3	-1%	-1%	-1%	-1%
Outflow Control Depth	1	79.0	98.8	17.3	17.3	10.3	648	63.2	17.2	17.2	10.3	648	0.0	0.0	0.0	0	0%	0%	0%	0%
Outflow Control Depth	2	79.0	98.8	17.2	17.2	10.3	645	63.2	17.3	17.3	10.4	652	0.0	0.0	0.0	-4	0%	0%	0%	-1%
Outflow Control Depth	3	79.0	98.8	17.2	17.2	10.4	645	63.2	17.3	17.3	10.3	653	-0.1	-0.1	0.0	-4	0%	0%	0%	-1%
Outflow Coefficient - Intercept	1	0.8	1.0	17.3	17.3	10.3	650	0.6	17.2	17.2	10.3	648	0.0	0.0	0.0	1	0%	0%	0%	0%
Outflow Coefficient - Intercept	2	0.8	1.0	17.3	17.3	10.3	650	0.6	17.3	17.3	10.3	649	0.0	0.0	0.0	0	0%	0%	0%	0%
Outflow Coefficient - Intercept	3	0.8	1.0	17.3	17.3	10.3	649	0.6	17.3	17.3	10.3	649	0.0	0.0	0.0	0	0%	0%	0%	0%
Bypass Depth	1	140.0	175.0	17.3	17.3	10.3	649	112.0	17.3	17.3	10.3	649	0.0	0.0	0.0	0	0%	0%	0%	0%
Bypass Depth	2	140.0	175.0	17.3	17.3	10.3	649	112.0	17.3	17.3	10.3	649	0.0	0.0	0.0	0	0%	0%	0%	0%
Bypass Depth	3	140.0	175.0	17.3	17.3	10.3	649	112.0	17.3	17.3	10.3	649	0.0	0.0	0.0	0	0%	0%	0%	0%
Outflow Seepage Rate	1	0.0	0.0	17.3	17.3	10.3	647	0.0	17.3	17.3	10.4	651	0.0	0.0	0.0	-2	0%	0%	0%	0%
Outflow Seepage Rate	2	0.0	0.0	17.3	17.3	10.3	648	0.0	17.3	17.3	10.3	651	0.0	0.0	0.0	-2	0%	0%	0%	0%
Outflow Seepage Rate	3	0.0	0.0	17.3	17.3	10.4	648	0.0	17.2	17.2	10.3	651	0.0	0.0	0.0	-1	0%	0%	0%	0%
Max Outflow Seepage Conc	1	20.0	25.0	17.3	17.3	10.3	650	16.0	17.3	17.3	10.3	649	0.0	0.0	0.0	0	0%	0%	0%	0%
Max Outflow Seepage Conc	2	20.0	25.0	17.3	17.3	10.3	650	16.0	17.3	17.3	10.3	649	0.0	0.0	0.0	0	0%	0%	0%	0%
Max Outflow Seepage Conc	3	20.0	25.0	17.267	17.3	10.3	650	16.0	17.3	17.3	10.3	649	0.0	0.0	0.0	0	0%	0%	0%	0%
Seepage Recycle Fraction	1	0.5	0.6	17.3	17.3	10.3	651	0.4	17.3	17.3	10.3	648	0.0	0.0	0.0	2	0%	0%	0%	0%
Seepage Recycle Fraction	2	0.5	0.6	17.2	17.2	10.3	651	0.4	17.3	17.3	10.3	648	0.0	0.0	0.0	1	0%	0%	0%	0%
Seepage Recycle Fraction	3	0.5	0.6	17.2	17.2	10.3	651	0.4	17.3	17.3	10.3	648	0.0	0.0	0.0	1	0%	0%	0%	0%
C0 = WC Conc at 0 g/m2 P Storage	1	4.0	5.0	17.6	17.6	10.6	663	3.2	16.9	16.9	10.2	637	0.4	0.4	0.2	13	2%	2%	2%	2%
C0 = WC Conc at 0 g/m2 P Storage	2	4.0	5.0	17.9	17.9	10.7	673	3.2	16.7	16.7	10.1	627	0.6	0.6	0.3	23	4%	4%	3%	4%

ACME Basin B - Alt. 4 basecase 25% DMSTA Sensitivity Analysis

Sensitivity Analysis **Case: s100r1_final** **File: acme_final_25.xls** **Input Variable Set: All** **Run Date: 05/14/02**

Option	Value	
Select Sensitivity Scale Factor --->	**25%**	*Modify Each Input Variable by +/- This Percentage*
Select Input Parameter Set ------>	**1**	*1 = All, 2 = P Cycling Only, 3 = Design Features Only*
Select Test Option ---------->	**2**	*1 = High Results Only, 2 = High & Low Results*

Number of Model Runs Required = 86 Estimated Run Time = 850.0 minutes

Adjusts Each non-Zero Input Variable, One at a Time, & Re-Runs Simulation

Shows Results for Combined Outflow from Entire Treatment Area

Run

Sort Results

Uncertainty Analysis

Menu

			High Results ---->					Low Results ------>					Average Change ---->				Average % Change -->			
Input Variable	Cell Number	Input Value - Base	Input Value - High	Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load	Input Value - Low	Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load	Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load	Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load
	-	-	-	ppb	ppb	ppb	kg/yr	-	ppb	ppb	ppb	kg/yr	ppb	ppb	ppb	kg/yr	%	%	%	%
Base Run				17.3	17.3	10.3	649		17.3	17.3	10.3	649								
C0 = WC Conc at 0 g/m2 P Storage	3	4.0	5.0	18.2	18.2	10.6	684	3.2	16.4	16.4	10.2	619	0.9	0.9	0.2	33	5%	5%	2%	5%
C1 = WC Conc at 1 g/m2 P storage	1	22.0	27.5	17.3	17.3	10.4	652	17.6	17.2	17.2	10.3	648	0.1	0.1	0.1	2	0%	0%	0%	0%
C1 = WC Conc at 1 g/m2 P storage	2	22.0	27.5	17.3	17.3	10.4	652	17.6	17.2	17.2	10.3	648	0.1	0.1	0.0	2	0%	0%	0%	0%
C1 = WC Conc at 1 g/m2 P storage	3	22.0	27.5	17.3	17.3	10.4	651	17.6	17.2	17.2	10.3	648	0.0	0.0	0.0	1	0%	0%	0%	0%
K = Net Settling Rate at Steady State	1	80.1	100.1	16.4	16.4	9.6	619	64.1	18.1	18.1	11.1	680	-0.8	-0.8	-0.7	-31	-5%	-5%	-7%	-5%
K = Net Settling Rate at Steady State	2	80.1	100.1	16.5	16.5	9.6	620	64.1	18.0	18.0	11.1	678	-0.8	-0.8	-0.8	-29	-4%	-4%	-7%	-4%
K = Net Settling Rate at Steady State	3	80.1	100.1	16.4	16.4	9.4	619	64.1	18.1	18.1	11.3	680	-0.8	-0.8	-0.9	-31	-5%	-5%	-9%	-5%
Zx = Depth Scale Factor	1	60.0	75.0	17.3	17.3	10.3	649	48.0	17.3	17.3	10.3	649	0.0	0.0	0.0	0	0%	0%	0%	0%
Zx = Depth Scale Factor	2	60.0	75.0	17.3	17.3	10.3	650	48.0	17.3	17.3	10.3	649	0.0	0.0	0.0	0	0%	0%	0%	0%
Zx = Depth Scale Factor	3	60.0	75.0	17.3	17.3	10.4	650	48.0	17.3	17.3	10.3	649	0.0	0.0	0.0	0	0%	0%	0%	0%

ACME Basin B - Alt. 4 basecase 50% DMSTA Sensitivity Analysis

Sensitivity Analysis **Case: s100r1_final** **File: acme_final_25.xls** **Input Variable Set: All** **Run Date: 05/15/02**

Option	Value	
Select Sensitivity Scale Factor --->	**50%**	*Modify Each Input Variable by +/- This Percentage*
Select Input Parameter Set ------>	**1**	*1 = All, 2 = P Cycling Only, 3 = Design Features Only*
Select Test Option ---------->	**2**	*1 = High Results Only, 2 = High & Low Results*

Number of Model Runs Required = 86 Estimated Run Time = 847.1 minutes

Adjusts Each non-Zero Input Variable, One at a Time, & Re-Runs Simulation

Shows Results for Combined Outflow from Entire Treatment Area

Run

Sort Results

Uncertainty Analysis

Menu

			High Results ---->					Low Results ------>					Average Change ---->				Average % Change -->			
Input Variable	Cell Number	Input Value - Base	Input Value - High	Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load	Input Value - Low	Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load	Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load	Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load
	-	-	-	ppb	ppb	ppb	kg/yr	-	ppb	ppb	ppb	kg/yr	ppb	ppb	ppb	kg/yr	%	%	%	%
Base Run				17.3	17.3	10.3	649		17.3	17.3	10.3	649								
Rainfall P Conc	1	20.0	30.0	17.5	17.5	10.6	657	13.3	17.1	17.1	10.2	645	0.2	0.2	0.2	6	1%	1%	2%	1%
Atmospheric P Load (Dry)	1	20.0	30.0	17.3	17.3	10.5	651	13.3	17.2	17.2	10.2	648	0.0	0.0	0.1	2	0%	0%	1%	0%
Inflow Fraction	1	1.0	1.5	23.0	23.0	15.8	1309	0.7	13.5	13.5	7.2	334	4.7	4.7	4.3	487	27%	27%	41%	75%
Surface Area	1	0.5	0.7	15.7	15.7	8.9	586	0.3	18.8	18.8	11.7	709	-1.6	-1.6	-1.4	-62	-9%	-9%	-14%	-10%
Surface Area	2	0.5	0.7	15.7	15.7	8.9	586	0.3	18.8	18.8	11.7	708	-1.5	-1.5	-1.4	-61	-9%	-9%	-14%	-9%
Surface Area	3	0.5	0.7	15.7	15.7	8.9	586	0.3	18.8	18.8	11.7	708	-1.5	-1.5	-1.4	-61	-9.0%	-9.0%	-13.4%	-9.4%
Mean Width of Flow Path	1	1.2	1.8	17.3	17.3	10.3	651	0.8	17.2	17.2	10.3	647	0.1	0.1	0.0	2	0%	0%	0%	0%
Mean Width of Flow Path	2	1.2	1.8	17.3	17.3	10.3	650	0.8	17.2	17.2	10.3	649	0.0	0.0	0.0	1	0%	0%	0%	0%
Mean Width of Flow Path	3	1.2	1.8	17.3	17.3	10.3	649	0.8	17.3	17.3	10.3	649	0.0	0.0	0.0	0	0%	0%	0%	0%
Number of Tanks in Series	1	3.0	4.5	17.1	17.1	10.1	643	2.0	17.5	17.5	10.6	658	-0.2	-0.2	-0.2	-8	-1%	-1%	-2%	-1%
Number of Tanks in Series	2	3.0	4.5	17.1	17.1	10.1	642	2.0	17.5	17.5	10.6	659	-0.2	-0.2	-0.2	-9	-1%	-1%	-2%	-1%
Number of Tanks in Series	3	3.0	4.5	17.1	17.1	10.1	642	2.0	17.5	17.5	10.6	659	-0.2	-0.2	-0.2	-8	-1%	-1%	-2%	-1%
Outflow Control Depth	1	79.0	118.5	17.3	17.3	10.3	645	52.7	17.2	17.2	10.5	648	0.0	0.1	-0.1	-2	0%	0%	-1%	0%
Outflow Control Depth	2	79.0	118.5	17.1	17.1	10.3	640	52.7	17.4	17.4	10.7	655	-0.1	-0.1	-0.2	-8	-1%	-1%	-2%	-1%
Outflow Control Depth	3	79.0	118.5	17.1	17.1	10.5	640	52.7	17.6	17.6	11.0	665	-0.2	-0.2	-0.3	-13	-1%	-1%	-3%	-2%
Outflow Coefficient - Intercept	1	0.8	1.2	17.3	17.3	10.3	651	0.5	17.2	17.2	10.3	647	0.1	0.1	0.0	2	0%	0%	0%	0%
Outflow Coefficient - Intercept	2	0.8	1.2	17.3	17.3	10.3	650	0.5	17.2	17.2	10.3	649	0.0	0.0	0.0	1	0%	0%	0%	0%
Outflow Coefficient - Intercept	3	0.8	1.2	17.3	17.3	10.3	649	0.5	17.3	17.3	10.3	649	0.0	0.0	0.0	0	0%	0%	0%	0%
Bypass Depth	1	140.0	210.0	17.3	17.3	10.3	649	93.3	15.1	18.8	9.8	709	1.1	-0.8	0.3	-30	6%	-5%	3%	-5%
Bypass Depth	2	140.0	210.0	17.3	17.3	10.3	649	93.3	15.6	17.7	10.0	667	0.8	-0.2	0.2	-9	5%	-1%	1%	-1%
Bypass Depth	3	140.0	210.0	17.3	17.3	10.3	649	93.3	16.1	17.3	10.2	652	0.6	0.0	0.1	-1	3%	0%	1%	0%
Outflow Seepage Rate	1	0.0	0.0	17.3	17.3	10.3	645	0.0	17.3	17.3	10.4	652	0.0	0.0	0.0	-3	0%	0%	0%	-1%
Outflow Seepage Rate	2	0.0	0.0	17.3	17.3	10.3	646	0.0	17.2	17.2	10.3	652	0.0	0.0	0.0	-3	0%	0%	0%	0%
Outflow Seepage Rate	3	0.0	0.0	17.3	17.3	10.4	647	0.0	17.2	17.2	10.3	651	0.0	0.0	0.0	-2	0%	0%	0%	0%
Max Outflow Seepage Conc	1	20.0	30.0	17.3	17.3	10.3	650	13.3	17.3	17.3	10.3	649	0.0	0.0	0.0	0	0%	0%	0%	0%
Max Outflow Seepage Conc	2	20.0	30.0	17.3	17.3	10.3	650	13.3	17.3	17.3	10.3	649	0.0	0.0	0.0	0	0%	0%	0%	0%
Max Outflow Seepage Conc	3	20.0	30.0	17.268	17.3	10.3	650	13.3	17.3	17.3	10.3	649	0.0	0.0	0.0	0	0%	0%	0%	0%
Seepage Recycle Fraction	1	0.5	0.8	17.2	17.2	10.4	653	0.3	17.3	17.3	10.3	647	0.0	0.0	0.0	3	0%	0%	0%	0%
Seepage Recycle Fraction	2	0.5	0.8	17.2	17.2	10.3	653	0.3	17.3	17.3	10.3	647	0.0	0.0	0.0	3	0%	0%	0%	0%
Seepage Recycle Fraction	3	0.5	0.8	17.2	17.2	10.3	652	0.3	17.3	17.3	10.3	648	0.0	0.0	0.0	2	0%	0%	0%	0%
C0 = WC Conc at 0 g/m2 P Storage	1	4.0	6.0	17.9	17.9	10.8	675	2.7	16.7	16.7	10.0	627	0.6	0.6	0.4	24	4%	4%	4%	4%
C0 = WC Conc at 0 g/m2 P Storage	2	4.0	6.0	18.4	18.4	11.1	694	2.7	16.2	16.2	9.9	610	1.1	1.1	0.6	42	6%	6%	6%	6%

ACME Basin B - Alt. 4 basecase 50% DMSTA Sensitivity Analysis (cont'd)

Sensitivity Analysis

Case: s100r1_final **File: acme_final_25.xls** **Input Variable Set: All** **Run Date: 05/15/02**

Option	Value	
Select Sensitivity Scale Factor --->	**50%**	*Modify Each Input Variable by +/- This Percentage*
Select Input Parameter Set ------>	**1**	*1 = All, 2 = P Cycling Only, 3 = Design Features Only*
Select Test Option ---------->	**2**	*1 = High Results Only, 2 = High & Low Results*

Number of Model Runs Required = 86 Estimated Run Time = 847.1 minutes

Adjusts Each non-Zero Input Variable, One at a Time, & Re-Runs Simulation

Shows Results for Combined Outflow from Entire Treatment Area

Run

Sort Results

Uncertainty Analysis

Menu

			High Results ---->					Low Results ------>					Average Change ---->				Average % Change -->			
Input Variable	Cell Number	Input Value - Base	Input Value - High	Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load	Input Value - Low	Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load	Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load	Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load
	-	-	-	ppb	ppb	ppb	kg/yr	-	ppb	ppb	ppb	kg/yr	ppb	ppb	ppb	kg/yr	%	%	%	%
Base Run				17.3	17.3	10.3	649		17.3	17.3	10.3	649								
C0 = WC Conc at 0 g/m2 P Storage	3	4.0	6.0	19.0	19.0	11.0	715	2.7	15.9	15.9	10.2	596	1.6	1.6	0.4	59	9%	9%	4%	9%
C1 = WC Conc at 1 g/m2 P storage	1	22.0	33.0	17.4	17.4	10.5	654	14.7	17.2	17.2	10.3	646	0.1	0.1	0.1	4	1%	1%	1%	1%
C1 = WC Conc at 1 g/m2 P storage	2	22.0	33.0	17.4	17.4	10.4	654	14.7	17.2	17.2	10.3	647	0.1	0.1	0.1	4	1%	1%	1%	1%
C1 = WC Conc at 1 g/m2 P storage	3	22.0	33.0	17.3	17.3	10.4	653	14.7	17.2	17.2	10.3	647	0.1	0.1	0.0	3	0%	0%	0%	0%
K = Net Settling Rate at Steady State	1	80.1	120.2	15.8	15.8	9.0	594	53.4	18.7	18.7	11.6	704	-1.5	-1.5	-1.3	-55	-8%	-8%	-13%	-8%
K = Net Settling Rate at Steady State	2	80.1	120.2	15.9	15.9	9.0	597	53.4	18.6	18.6	11.7	701	-1.4	-1.4	-1.4	-52	-8%	-8%	-13%	-8%
K = Net Settling Rate at Steady State	3	80.1	120.2	15.8	15.8	8.7	594	53.4	18.7	18.7	12.1	705	-1.5	-1.5	-1.7	-56	-9%	-9%	-16%	-9%
Zx = Depth Scale Factor	1	60.0	90.0	17.6	17.6	10.8	663	40.0	17.3	17.3	10.3	649	0.2	0.2	0.2	7	1%	1%	2%	1%
Zx = Depth Scale Factor	2	60.0	90.0	17.8	17.8	11.0	670	40.0	17.3	17.3	10.3	649	0.3	0.3	0.3	11	2%	2%	3%	2%
Zx = Depth Scale Factor	3	60.0	90.0	18.1	18.1	11.1	680	40.0	17.3	17.3	10.3	649	0.4	0.4	0.4	15	2%	2%	4%	2%

Uncertainty Analysis

Case: **s100r1 - sens25** **File:** **acme_final_25.xls** 05/14/02

Estimates uncertainty in output variables. Assumes that sensitivity analysis has already been performed. Factors include: (1) uncertainty in p cycling parameters (from calibration); (2) uncertainty in other model inputs (user-specified); (3) inherent model error (from calibration); & (4) sensitivity of model output to each input value. Results are for combined outflows.

Reference: Walker, "A Sensitivity & Error Analysis Framework for Lake Eutrophication Modeling", Wtr Res Bul, Feb 1982

Select Output Variable:

- Treated FWM Outflow Conc
- Total FWM Outflow Conc
- Outflow Geo Mean - Composites
- Total Outflow Load

Treated FWM Outflow Conc (ppb)		Error CV's = Standard Error / Mean	
50th Percentile Est. =	17	Total =	10%
10th Percentile Est. =	15	Model Error =	10%
90th Percentile Est =	20	Parameter Error =	3%
		Input Data Error =	1%

Show Results | Sensitivity Analysis | Menu

Sensitivity Coefficients

% Change in Output Variable / % Change in Input Variable

Enter assumed error CV (standard error, as percent of mean) in col. B (blue cells) to reflect uncertainty in each input value

Case Description: **Filename: acme_final_25.xls**

100% SAV at 79 cm and 1.4 km2 with 3 SAV cells
ACME Alt. 4 basecase
no reservoir

Output Variable	Units	Value
Water Balance Error	%	0.0%
Mass Balance Error	%	0.0%
Flow-Wtd Conc - With Bypass	ppb	17.3
Flow-Wtd Conc - Without Bypass	ppb	17.3
Geometric Mean Conc	ppb	10.3
95th Percentile Conc	ppb	22.8
Freq Cell Outflow > 10 ppb	%	51%
Bypass Load	%	0.0%

Input Variable	Error CV	Value	1	2	3	4	5	6
Design Case Name		s100r1_final						
Starting Date for Simulation								
Ending Date for Simulation								
Starting Date for Output								
Steps Per Day								
Number of Iterations								
Output Averaging Interval								
Reservoir H2O Residence Time								
Max Inflow / Mean Inflow								
Max Reservoir Storage								
Reservoir P Decay Rate								
Rainfall P Conc	30%	0.021						
Atmospheric P Load (Dry)	30%	0.005						
Cell Number -->		1	2	3	4	5	6	
Cell Label		SAV1	SAV2	SAV3				
Vegetation Type		SAV_C4	SAV_C4	SAV_C4				
Inflow Fraction	0%	*0.596*						
Downstream Cell Number								
Surface Area		*-0.201*	*-0.199*	*-0.199*				
Mean Width of Flow Path		*0.006*	*0.002*	*-0.001*				
Number of Tanks in Series	30%	*-0.019*	*-0.022*	*-0.021*				
Outflow Control Depth		*0.011*	*-0.010*	*-0.014*				
Outflow Coefficient - Exponent								
Outflow Coefficient - Intercept	20%	*0.006*	*0.002*	*-0.001*				
Bypass Depth		*0.000*	*0.000*	*0.000*				
Maximum Inflow								
Maximum Outflow								
Inflow Seepage Rate	20%							
Inflow Seepage Control Elev								
Inflow Seepage Conc	20%							
Outflow Seepage Rate	20%	*0.001*	*0.002*	*0.004*				
Outflow Seepage Control Elev								
Max Outflow Seepage Conc	20%	*0.001*	*0.001*	*0.001*				
Seepage Recycle Fraction	20%	*-0.003*	*-0.003*	*-0.005*				
Seepage Discharge Fraction	20%							
Initial Water Column Conc								
Initial P Storage Per Unit Area								
Initial Water Column Depth								
C0 = WC Conc at 0 g/m2 P Storage		*0.082*	*0.143*	*0.200*				
C1 = WC Conc at 1 g/m2 P storage		*0.014*	*0.012*	*0.009*				
K = Net Settling Rate at Steady State		*-0.188*	*-0.179*	*-0.190*				
Zx = Depth Scale Factor	*retrieved*	*0.000*	*0.000*	*0.001*				
C0 - Periphyton	*from model*							
C1 - Periphyton	*calibration*							
K - Periphyton	*table*							
Zx - Periphyton								
Sm = Transition Storage Midpoint								
Sb = Transition Storage Bandwidth								

Uncertainty Analysis

Case: **s100r1 - sens25** **File:** **acme_final_25.xls** 05/14/02

Estimates uncertainty in output variables. Assumes that sensitivity analysis has already been performed. Factors include: (1) uncertainty in p cycling parameters (from calibration); (2) uncertainty in other model inputs (user-specified); (3) inherent model error (from calibration); & (4) sensitivity of model output to each input value. Results are for combined outflows.

Reference: Walker, "A Sensitivity & Error Analysis Framework for Lake Eutrophication Modeling", Wtr Res Bul, Feb 1982

Select Output Variable:

- Treated FWM Outflow Conc
- Total FWM Outflow Conc
- Outflow Geo Mean - Composites
- Total Outflow Load

Total FWM Outflow Conc (ppb)		Error CV's = Standard Error / Mean	
50th Percentile Est. =	17	Total =	10%
10th Percentile Est. =	15	Model Error =	10%
90th Percentile Est =	20	Parameter Error =	3%
		Input Data Error =	1%

Show Results | Sensitivity Analysis | Menu

Sensitivity Coefficients

% Change in Output Variable / % Change in Input Variable

Enter assumed error CV (standard error, as percent of mean) in col. B (blue cells) to reflect uncertainty in each input value

Case Description: **Filename: acme_final_25.xls**

100% SAV at 79 cm and 1.4 km2 with 3 SAV cells
ACME Alt. 4 basecase
no reservoir

Output Variable	Units	Value
Water Balance Error	%	0.0%
Mass Balance Error	%	0.0%
Flow-Wtd Conc - With Bypass	ppb	17.3
Flow-Wtd Conc - Without Bypass	ppb	17.3
Geometric Mean Conc	ppb	10.3
95th Percentile Conc	ppb	22.8
Freq Cell Outflow > 10 ppb	%	51%
Bypass Load	%	0.0%

Input Variable	Error CV	Value	1	2	3	4	5	6
Design Case Name		s100r1_final						
Starting Date for Simulation								
Ending Date for Simulation								
Starting Date for Output								
Steps Per Day								
Number of Iterations								
Output Averaging Interval								
Reservoir H2O Residence Time								
Max Inflow / Mean Inflow								
Max Reservoir Storage								
Reservoir P Decay Rate								
Rainfall P Conc	30%	0.021						
Atmospheric P Load (Dry)	30%	0.005						
Cell Number -->		1	2	3	4	5	6	
Cell Label		SAV1	SAV2	SAV3				
Vegetation Type		SAV_C4	SAV_C4	SAV_C4				
Inflow Fraction	0%	*0.596*						
Downstream Cell Number								
Surface Area		*-0.201*	*-0.199*	*-0.199*				
Mean Width of Flow Path		*0.006*	*0.002*	*-0.001*				
Number of Tanks in Series	30%	*-0.019*	*-0.022*	*-0.021*				
Outflow Control Depth		*0.011*	*-0.010*	*-0.014*				
Outflow Coefficient - Exponent								
Outflow Coefficient - Intercept	20%	*0.006*	*0.002*	*-0.001*				
Bypass Depth		*0.000*	*0.000*	*0.000*				
Maximum Inflow								
Maximum Outflow								
Inflow Seepage Rate	20%							
Inflow Seepage Control Elev								
Inflow Seepage Conc	20%							
Outflow Seepage Rate	20%	*0.001*	*0.002*	*0.004*				
Outflow Seepage Control Elev								
Max Outflow Seepage Conc	20%	*0.001*	*0.001*	*0.001*				
Seepage Recycle Fraction	20%	*-0.003*	*-0.003*	*-0.005*				
Seepage Discharge Fraction	20%							
Initial Water Column Conc								
Initial P Storage Per Unit Area								
Initial Water Column Depth								
C0 = WC Conc at 0 g/m2 P Storage		*0.082*	*0.143*	*0.200*				
C1 = WC Conc at 1 g/m2 P storage		*0.014*	*0.012*	*0.009*				
K = Net Settling Rate at Steady State		*-0.188*	*-0.179*	*-0.190*				
Zx = Depth Scale Factor	*retrieved*	*0.000*	*0.000*	*0.001*				
C0 - Periphyton	*from model*							
C1 - Periphyton	*calibration*							
K - Periphyton	*table*							
Zx - Periphyton								
Sm = Transition Storage Midpoint								
Sb = Transition Storage Bandwidth								

Uncertainty Analysis

Case: **s100r1 - sens25** **File:** **acme_final_25.xls** 05/14/02

Estimates uncertainty in output variables. Assumes that sensitivity analysis has already been performed. Factors include: (1) uncertainty in p cycling parameters (from calibration); (2) uncertainty in other model inputs (user-specified); (3) inherent model error (from calibration); & (4) sensitivity of model output to each input value. Results are for combined outflows.

Reference: Walker, "A Sensitivity & Error Analysis Framework for Lake Eutrophication Modeling", Wtr Res Bul, Feb 1982

Select Output Variable:

- Treated FWM Outflow Conc
- Total FWM Outflow Conc
- Outflow Geo Mean - Composites
- Total Outflow Load

Outflow Geo Mean - Composites (ppb)		Error CV's = Standard Error / Mean	
50th Percentile Est. =	10	Total =	11%
10th Percentile Est. =	9	Model Error =	10%
90th Percentile Est =	12	Parameter Error =	3%
		Input Data Error =	2%

Show Results | Sensitivity Analysis | Menu

Sensitivity Coefficients

% Change in Output Variable / % Change in Input Variable

Enter assumed error CV (standard error, as percent of mean) in col. B (blue cells) to reflect uncertainty in each input value

Case Description: **Filename: acme_final_25.xls**

100% SAV at 79 cm and 1.4 km2 with 3 SAV cells
ACME Alt. 4 basecase
no reservoir

Output Variable	Units	Value
Water Balance Error	%	0.0%
Mass Balance Error	%	0.0%
Flow-Wtd Conc - With Bypass	ppb	17.3
Flow-Wtd Conc - Without Bypass	ppb	17.3
Geometric Mean Conc	ppb	10.3
95th Percentile Conc	ppb	22.8
Freq Cell Outflow > 10 ppb	%	51%
Bypass Load	%	0.0%

Input Variable	Error CV	Value	1	2	3	4	5	6
Design Case Name		s100r1_final						
Starting Date for Simulation								
Ending Date for Simulation								
Starting Date for Output								
Steps Per Day								
Number of Iterations								
Output Averaging Interval								
Reservoir H2O Residence Time								
Max Inflow / Mean Inflow								
Max Reservoir Storage								
Reservoir P Decay Rate								
Rainfall P Conc	30%	0.040						
Atmospheric P Load (Dry)	30%	0.028						
Cell Number -->		1	2	3	4	5	6	
Cell Label		SAV1	SAV2	SAV3				
Vegetation Type		SAV_C4	SAV_C4	SAV_C4				
Inflow Fraction	0%	*0.901*						
Downstream Cell Number								
Surface Area		*-0.301*	*-0.301*	*-0.300*				
Mean Width of Flow Path		*0.003*	*-0.001*	*0.000*				
Number of Tanks in Series	30%	*-0.035*	*-0.036*	*-0.037*				
Outflow Control Depth		*-0.007*	*-0.013*	*0.013*				
Outflow Coefficient - Exponent								
Outflow Coefficient - Intercept	20%	*0.003*	*-0.001*	*0.000*				
Bypass Depth		*0.000*	*0.000*	*0.000*				
Maximum Inflow								
Maximum Outflow								
Inflow Seepage Rate	20%							
Inflow Seepage Control Elev								
Inflow Seepage Conc	20%							
Outflow Seepage Rate	20%	*-0.008*	*-0.003*	*0.004*				
Outflow Seepage Control Elev								
Max Outflow Seepage Conc	20%	*0.002*	*0.002*	*0.001*				
Seepage Recycle Fraction	20%	*0.003*	*0.000*	*-0.005*				
Seepage Discharge Fraction	20%							
Initial Water Column Conc								
Initial P Storage Per Unit Area								
Initial Water Column Depth								
C0 = WC Conc at 0 g/m2 P Storage		*0.079*	*0.124*	*0.077*				
C1 = WC Conc at 1 g/m2 P storage		*0.020*	*0.016*	*0.007*				
K = Net Settling Rate at Steady State		*-0.282*	*-0.295*	*-0.367*				
Zx = Depth Scale Factor	*retrieved*	*0.001*	*0.002*	*0.005*				
C0 - Periphyton	*from model*							
C1 - Periphyton	*calibration*							
K - Periphyton	*table*							
Zx - Periphyton								
Sm = Transition Storage Midpoint								
Sb = Transition Storage Bandwidth								

Uncertainty Analysis

Case: **s100r1 - sens25** **File:** **acme_final_25.xls** 05/14/02

Estimates uncertainty in output variables. Assumes that sensitivity analysis has already been performed. Factors include: (1) uncertainty in p cycling parameters (from calibration); (2) uncertainty in other model inputs (user-specified); (3) inherent model error (from calibration); & (4) sensitivity of model output to each input value. Results are for combined outflows.

Reference: Walker, "A Sensitivity & Error Analysis Framework for Lake Eutrophication Modeling", Wtr Res Bul, Feb 1982

Select Output Variable:

- Treated FWM Outflow Conc
- Total FWM Outflow Conc
- Outflow Geo Mean - Composites
- Total Outflow Load

Total Outflow Load (kg/yr)		Error CV's = Standard Error / Mean	
50th Percentile Est. =	649	Total =	11%
10th Percentile Est. =	562	Model Error =	10%
90th Percentile Est =	737	Parameter Error =	3%
		Input Data Error =	1%

Show Results | Sensitivity Analysis | Menu

Sensitivity Coefficients

% Change in Output Variable / % Change in Input Variable

Enter assumed error CV (standard error, as percent of mean) in col. B (blue cells) to reflect uncertainty in each input value

Case Description: **Filename: acme_final_25.xls**

100% SAV at 79 cm and 1.4 km2 with 3 SAV cells
ACME Alt. 4 basecase
no reservoir

Output Variable	Units	Value
Water Balance Error	%	0.0%
Mass Balance Error	%	0.0%
Flow-Wtd Conc - With Bypass	ppb	17.3
Flow-Wtd Conc - Without Bypass	ppb	17.3
Geometric Mean Conc	ppb	10.3
95th Percentile Conc	ppb	22.8
Freq Cell Outflow > 10 ppb	%	51%
Bypass Load	%	0.0%

Input Variable	Error CV	Value	1	2	3	4	5	6
Design Case Name		s100r1_final						
Starting Date for Simulation								
Ending Date for Simulation								
Starting Date for Output								
Steps Per Day								
Number of Iterations								
Output Averaging Interval								
Reservoir H2O Residence Time								
Max Inflow / Mean Inflow								
Max Reservoir Storage								
Reservoir P Decay Rate								
Rainfall P Conc	30%	0.021						
Atmospheric P Load (Dry)	30%	0.005						
Cell Number -->		1	2	3	4	5	6	
Cell Label		SAV1	SAV2	SAV3				
Vegetation Type		SAV_C4	SAV_C4	SAV_C4				
Inflow Fraction	0%	*1.557*						
Downstream Cell Number								
Surface Area		*-0.211*	*-0.209*	*-0.209*				
Mean Width of Flow Path		*0.007*	*0.002*	*0.000*				
Number of Tanks in Series	30%	*-0.019*	*-0.022*	*-0.021*				
Outflow Control Depth		*-0.001*	*-0.022*	*-0.026*				
Outflow Coefficient - Exponent								
Outflow Coefficient - Intercept	20%	*0.007*	*0.002*	*0.000*				
Bypass Depth		*0.000*	*0.000*	*0.000*				
Maximum Inflow								
Maximum Outflow								
Inflow Seepage Rate	20%							
Inflow Seepage Control Elev								
Inflow Seepage Conc	20%							
Outflow Seepage Rate	20%	*-0.011*	*-0.009*	*-0.008*				
Outflow Seepage Control Elev								
Max Outflow Seepage Conc	20%	*0.001*	*0.001*	*0.001*				
Seepage Recycle Fraction	20%	*0.009*	*0.009*	*0.007*				
Seepage Discharge Fraction	20%							
Initial Water Column Conc								
Initial P Storage Per Unit Area								
Initial Water Column Depth								
C0 = WC Conc at 0 g/m2 P Storage		*0.082*	*0.143*	*0.200*				
C1 = WC Conc at 1 g/m2 P storage		*0.014*	*0.012*	*0.009*				
K = Net Settling Rate at Steady State		*-0.188*	*-0.179*	*-0.190*				
Zx = Depth Scale Factor	*retrieved*	*0.000*	*0.000*	*0.001*				
C0 - Periphyton	*from model*							
C1 - Periphyton	*calibration*							
K - Periphyton	*table*							
Zx - Periphyton								
Sm = Transition Storage Midpoint								
Sb = Transition Storage Bandwidth								

Uncertainty Analysis

Case: **s100r1 - sens50** **File:** **acme_final_25.xls** 05/15/02

Estimates uncertainty in output variables. Assumes that sensitivity analysis has already been performed. Factors include: (1) uncertainty in p cycling parameters (from calibration); (2) uncertainty in other model inputs (user-specified); (3) inherent model error (from calibration); & (4) sensitivity of model output to each input value. Results are for combined outflows.

Reference: Walker, "A Sensitivity & Error Analysis Framework for Lake Eutrophication Modeling", Wtr Res Bul, Feb 1982

Select Output Variable:

- Treated FWM Outflow Conc
- Total FWM Outflow Conc
- Outflow Geo Mean - Composites
- Total Outflow Load

Treated FWM Outflow Conc (ppb)		Error CV's = Standard Error / Mean	
50th Percentile Est. =	17	Total =	11%
10th Percentile Est. =	15	Model Error =	10%
90th Percentile Est =	20	Parameter Error =	3%
		Input Data Error =	1%

Show Results | Sensitivity Analysis | Menu

Sensitivity Coefficients

% Change in Output Variable / % Change in Input Variable

Enter assumed error CV (standard error, as percent of mean) in col. B (blue cells) to reflect uncertainty in each input value

Case Description: **Filename: acme_final_25.xls**

100% SAV at 79 cm and 1.4 km2 with 3 SAV cells
ACME Alt. 4 basecase
no reservoir

Output Variable	Units	Value
Water Balance Error	%	0.0%
Mass Balance Error	%	0.0%
Flow-Wtd Conc - With Bypass	ppb	17.3
Flow-Wtd Conc - Without Bypass	ppb	17.3
Geometric Mean Conc	ppb	10.3
95th Percentile Conc	ppb	22.8
Freq Cell Outflow > 10 ppb	%	51%
Bypass Load	%	0.0%

Input Variable	Error CV	Value	1	2	3	4	5	6
Design Case Name		s100r1_final						
Starting Date for Simulation								
Ending Date for Simulation								
Starting Date for Output								
Steps Per Day								
Number of Iterations								
Output Averaging Interval								
Reservoir H2O Residence Time								
Max Inflow / Mean Inflow								
Max Reservoir Storage								
Reservoir P Decay Rate								
Rainfall P Conc	30%	0.019						
Atmospheric P Load (Dry)	30%	0.005						
Cell Number -->		1	2	3	4	5	6	
Cell Label		SAV1	SAV2	SAV3				
Vegetation Type		SAV_C4	SAV_C4	SAV_C4				
Inflow Fraction	0%	*0.545*						
Downstream Cell Number								
Surface Area		*-0.181*	*-0.179*	*-0.179*				
Mean Width of Flow Path		*0.006*	*0.002*	*0.000*				
Number of Tanks in Series	30%	*-0.023*	*-0.026*	*-0.026*				
Outflow Control Depth		*0.006*	*-0.014*	*-0.028*				
Outflow Coefficient - Exponent								
Outflow Coefficient - Intercept	20%	*0.006*	*0.002*	*0.000*				
Bypass Depth		*0.125*	*0.098*	*0.068*				
Maximum Inflow								
Maximum Outflow								
Inflow Seepage Rate	20%							
Inflow Seepage Control Elev								
Inflow Seepage Conc	20%							
Outflow Seepage Rate	20%	*0.001*	*0.002*	*0.004*				
Outflow Seepage Control Elev								
Max Outflow Seepage Conc	20%	*0.001*	*0.001*	*0.001*				
Seepage Recycle Fraction	20%	*-0.002*	*-0.003*	*-0.004*				
Seepage Discharge Fraction	20%							
Initial Water Column Conc								
Initial P Storage Per Unit Area								
Initial Water Column Depth								
C0 = WC Conc at 0 g/m2 P Storage		*0.074*	*0.129*	*0.182*				
C1 = WC Conc at 1 g/m2 P storage		*0.013*	*0.011*	*0.008*				
K = Net Settling Rate at Steady State		*-0.169*	*-0.161*	*-0.171*				
Zx = Depth Scale Factor	*retrieved*	*0.021*	*0.032*	*0.047*				
C0 - Periphyton	*from model*							
C1 - Periphyton	*calibration*							
K - Periphyton	*table*							
Zx - Periphyton								
Sm = Transition Storage Midpoint								
Sb = Transition Storage Bandwidth								

Uncertainty Analysis

Case: **s100r1 - sens50** **File:** **acme_final_25.xls** 05/15/02

Estimates uncertainty in output variables. Assumes that sensitivity analysis has already been performed. Factors include: (1) uncertainty in p cycling parameters (from calibration); (2) uncertainty in other model inputs (user-specified); (3) inherent model error (from calibration); & (4) sensitivity of model output to each input value. Results are for combined outflows.

Reference: Walker, "A Sensitivity & Error Analysis Framework for Lake Eutrophication Modeling", Wtr Res Bul, Feb 1982

Select Output Variable:

- Treated FWM Outflow Conc
- Total FWM Outflow Conc
- Outflow Geo Mean - Composites
- Total Outflow Load

Total FWM Outflow Conc (ppb)		Error CV's = Standard Error / Mean	
50th Percentile Est. =	17	Total =	11%
10th Percentile Est. =	15	Model Error =	10%
90th Percentile Est =	20	Parameter Error =	3%
		Input Data Error =	1%

Show Results | Sensitivity Analysis | Menu

Sensitivity Coefficients

% Change in Output Variable / % Change in Input Variable

Enter assumed error CV (standard error, as percent of mean) in col. B (blue cells) to reflect uncertainty in each input value

Case Description: **Filename: acme_final_25.xls**

100% SAV at 79 cm and 1.4 km2 with 3 SAV cells
ACME Alt. 4 basecase
no reservoir

Output Variable	Units	Value
Water Balance Error	%	0.0%
Mass Balance Error	%	0.0%
Flow-Wtd Conc - With Bypass	ppb	17.3
Flow-Wtd Conc - Without Bypass	ppb	17.3
Geometric Mean Conc	ppb	10.3
95th Percentile Conc	ppb	22.8
Freq Cell Outflow > 10 ppb	%	51%
Bypass Load	%	0.0%

Input Variable	Error CV	Value	1	2	3	4	5	6
Design Case Name		s100r1_final						
Starting Date for Simulation								
Ending Date for Simulation								
Starting Date for Output								
Steps Per Day								
Number of Iterations								
Output Averaging Interval								
Reservoir H2O Residence Time								
Max Inflow / Mean Inflow								
Max Reservoir Storage								
Reservoir P Decay Rate								
Rainfall P Conc	30%	0.019						
Atmospheric P Load (Dry)	30%	0.005						
Cell Number -->		1	2	3	4	5	6	
Cell Label		SAV1	SAV2	SAV3				
Vegetation Type		SAV_C4	SAV_C4	SAV_C4				
Inflow Fraction	0%	*0.545*						
Downstream Cell Number								
Surface Area		*-0.181*	*-0.179*	*-0.179*				
Mean Width of Flow Path		*0.006*	*0.002*	*0.000*				
Number of Tanks in Series	30%	*-0.023*	*-0.026*	*-0.026*				
Outflow Control Depth		*0.006*	*-0.013*	*-0.028*				
Outflow Coefficient - Exponent								
Outflow Coefficient - Intercept	20%	*0.006*	*0.002*	*0.000*				
Bypass Depth		*-0.091*	*-0.027*	*-0.004*				
Maximum Inflow								
Maximum Outflow								
Inflow Seepage Rate	20%							
Inflow Seepage Control Elev								
Inflow Seepage Conc	20%							
Outflow Seepage Rate	20%	*0.001*	*0.002*	*0.004*				
Outflow Seepage Control Elev								
Max Outflow Seepage Conc	20%	*0.001*	*0.001*	*0.001*				
Seepage Recycle Fraction	20%	*-0.002*	*-0.003*	*-0.004*				
Seepage Discharge Fraction	20%							
Initial Water Column Conc								
Initial P Storage Per Unit Area								
Initial Water Column Depth								
C0 = WC Conc at 0 g/m2 P Storage		*0.074*	*0.129*	*0.182*				
C1 = WC Conc at 1 g/m2 P storage		*0.013*	*0.011*	*0.008*				
K = Net Settling Rate at Steady State		*-0.169*	*-0.161*	*-0.171*				
Zx = Depth Scale Factor	*retrieved*	*0.021*	*0.032*	*0.047*				
C0 - Periphyton	*from model*							
C1 - Periphyton	*calibration*							
K - Periphyton	*table*							
Zx - Periphyton								
Sm = Transition Storage Midpoint								
Sb = Transition Storage Bandwidth								

Uncertainty Analysis

Case: **s100r1 - sens50** **File:** **acme_final_25.xls** 05/15/02

Estimates uncertainty in output variables. Assumes that sensitivity analysis has already been performed. Factors include: (1) uncertainty in p cycling parameters (from calibration); (2) uncertainty in other model inputs (user-specified); (3) inherent model error (from calibration); & (4) sensitivity of model output to each input value. Results are for combined outflows.

Reference: Walker, "A Sensitivity & Error Analysis Framework for Lake Eutrophication Modeling", Wtr Res Bul, Feb 1982

Select Output Variable:

- Treated FWM Outflow Conc
- Total FWM Outflow Conc
- Outflow Geo Mean - Composites
- Total Outflow Load

Outflow Geo Mean - Composites (ppb)		Error CV's = Standard Error / Mean	
50th Percentile Est. =	10	Total =	11%
10th Percentile Est. =	9	Model Error =	10%
90th Percentile Est =	12	Parameter Error =	3%
		Input Data Error =	3%

Show Results | Sensitivity Analysis | Menu

Sensitivity Coefficients

% Change in Output Variable / % Change in Input Variable

Enter assumed error CV (standard error, as percent of mean) in col. B (blue cells) to reflect uncertainty in each input value

Case Description: **Filename: acme_final_25.xls**

100% SAV at 79 cm and 1.4 km2 with 3 SAV cells
ACME Alt. 4 basecase
no reservoir

Output Variable	Units	Value
Water Balance Error	%	0.0%
Mass Balance Error	%	0.0%
Flow-Wtd Conc - With Bypass	ppb	17.3
Flow-Wtd Conc - Without Bypass	ppb	17.3
Geometric Mean Conc	ppb	10.3
95th Percentile Conc	ppb	22.8
Freq Cell Outflow > 10 ppb	%	51%
Bypass Load	%	0.0%

Input Variable	Error CV	Value	1	2	3	4	5	6
Design Case Name		s100r1_final						
Starting Date for Simulation								
Ending Date for Simulation								
Starting Date for Output								
Steps Per Day								
Number of Iterations								
Output Averaging Interval								
Reservoir H2O Residence Time								
Max Inflow / Mean Inflow								
Max Reservoir Storage								
Reservoir P Decay Rate								
Rainfall P Conc	30%	0.037						
Atmospheric P Load (Dry)	30%	0.026						
Cell Number -->		1	2	3	4	5	6	
Cell Label		SAV1	SAV2	SAV3				
Vegetation Type		SAV_C4	SAV_C4	SAV_C4				
Inflow Fraction	0%	*0.823*						
Downstream Cell Number								
Surface Area		*-0.272*	*-0.271*	*-0.269*				
Mean Width of Flow Path		*0.002*	*0.000*	*0.000*				
Number of Tanks in Series	30%	*-0.043*	*-0.044*	*-0.046*				
Outflow Control Depth		*-0.018*	*-0.035*	*-0.054*				
Outflow Coefficient - Exponent								
Outflow Coefficient - Intercept	20%	*0.002*	*0.000*	*0.000*				
Bypass Depth		*0.051*	*0.029*	*0.011*				
Maximum Inflow								
Maximum Outflow								
Inflow Seepage Rate								
Inflow Seepage Control Elev								
Inflow Seepage Conc								
Outflow Seepage Rate	20%	*-0.004*	*0.000*	*0.006*				
Outflow Seepage Control Elev								
Max Outflow Seepage Conc	20%	*0.001*	*0.001*	*0.001*				
Seepage Recycle Fraction		*0.004*	*0.001*	*-0.003*				
Seepage Discharge Fraction								
Initial Water Column Conc								
Initial P Storage Per Unit Area								
Initial Water Column Depth								
C0 = WC Conc at 0 g/m2 P Storage		*0.073*	*0.115*	*0.079*				
C1 = WC Conc at 1 g/m2 P storage		*0.018*	*0.015*	*0.006*				
K = Net Settling Rate at Steady State		*-0.253*	*-0.265*	*-0.330*				
Zx = Depth Scale Factor	*retrieved*	*0.045*	*0.060*	*0.075*				
C0 - Periphyton	*from model*							
C1 - Periphyton	*calibration*							
K - Periphyton	*table*							
Zx - Periphyton								
Sm = Transition Storage Midpoint								
Sb = Transition Storage Bandwidth								

Uncertainty Analysis

Case: **s100r1 - sens50** **File:** **acme_final_25.xls** 05/15/02

Estimates uncertainty in output variables. Assumes that sensitivity analysis has already been performed. Factors include: (1) uncertainty in p cycling parameters (from calibration); (2) uncertainty in other model inputs (user-specified); (3) inherent model error (from calibration); & (4) sensitivity of model output to each input value. Results are for combined outflows.

Reference: Walker, "A Sensitivity & Error Analysis Framework for Lake Eutrophication Modeling", Wtr Res Bul, Feb 1982

Select Output Variable:

- Treated FWM Outflow Conc
- Total FWM Outflow Conc
- Outflow Geo Mean - Composites
- Total Outflow Load

Total Outflow Load (kg/yr)		Error CV's = Standard Error / Mean	
50th Percentile Est. =	649	Total =	11%
10th Percentile Est. =	562	Model Error =	10%
90th Percentile Est =	737	Parameter Error =	3%
		Input Data Error =	1%

Show Results | Sensitivity Analysis | Menu

Sensitivity Coefficients

% Change in Output Variable / % Change in Input Variable

Enter assumed error CV (standard error, as percent of mean) in col. B (blue cells) to reflect uncertainty in each input value

Case Description: **Filename: acme_final_25.xls**

100% SAV at 79 cm and 1.4 km2 with 3 SAV cells
ACME Alt. 4 basecase
no reservoir

Output Variable	Units	Value
Water Balance Error	%	0.0%
Mass Balance Error	%	0.0%
Flow-Wtd Conc - With Bypass	ppb	17.3
Flow-Wtd Conc - Without Bypass	ppb	17.3
Geometric Mean Conc	ppb	10.3
95th Percentile Conc	ppb	22.8
Freq Cell Outflow > 10 ppb	%	51%
Bypass Load	%	0.0%

Input Variable	Error CV	Value	1	2	3	4	5	6
Design Case Name		s100r1_final						
Starting Date for Simulation								
Ending Date for Simulation								
Starting Date for Output								
Steps Per Day								
Number of Iterations								
Output Averaging Interval								
Reservoir H2O Residence Time								
Max Inflow / Mean Inflow								
Max Reservoir Storage								
Reservoir P Decay Rate								
Rainfall P Conc	30%	0.019						
Atmospheric P Load (Dry)	30%	0.005						
Cell Number -->		1	2	3	4	5	6	
Cell Label		SAV1	SAV2	SAV3				
Vegetation Type		SAV_C4	SAV_C4	SAV_C4				
Inflow Fraction	0%	*1.501*						
Downstream Cell Number								
Surface Area		*-0.190*	*-0.188*	*-0.188*				
Mean Width of Flow Path		*0.006*	*0.002*	*0.000*				
Number of Tanks in Series	30%	*-0.023*	*-0.026*	*-0.026*				
Outflow Control Depth		*-0.005*	*-0.024*	*-0.039*				
Outflow Coefficient - Exponent								
Outflow Coefficient - Intercept	20%	*0.006*	*0.002*	*0.000*				
Bypass Depth		*-0.092*	*-0.027*	*-0.004*				
Maximum Inflow								
Maximum Outflow								
Inflow Seepage Rate								
Inflow Seepage Control Elev								
Inflow Seepage Conc								
Outflow Seepage Rate	20%	*-0.011*	*-0.009*	*-0.007*				
Outflow Seepage Control Elev								
Max Outflow Seepage Conc	20%	*0.001*	*0.001*	*0.001*				
Seepage Recycle Fraction		*0.009*	*0.008*	*0.007*				
Seepage Discharge Fraction								
Initial Water Column Conc								
Initial P Storage Per Unit Area								
Initial Water Column Depth								
C0 = WC Conc at 0 g/m2 P Storage		*0.074*	*0.129*	*0.182*				
C1 = WC Conc at 1 g/m2 P storage		*0.013*	*0.011*	*0.008*				
K = Net Settling Rate at Steady State		*-0.169*	*-0.161*	*-0.171*				
Zx = Depth Scale Factor	*retrieved*	*0.021*	*0.032*	*0.047*				
C0 - Periphyton	*from model*							
C1 - Periphyton	*calibration*							
K - Periphyton	*table*							
Zx - Periphyton								
Sm = Transition Storage Midpoint								
Sb = Transition Storage Bandwidth								

DMSTA Input Values **C-11 West Basin - Alt. 2 basecase**

Input Variable	Units	Value
Design Case Name	-	SC4_final
Starting Date for Simulation	-	01/00/00
Ending Date for Simulation	-	01/00/00
Starting Date for Output	-	01/00/00
Steps Per Day	-	8
Number of Iterations	-	2
Output Averaging Interval	days	7
Reservoir H2O Residence Time	days	0
Max Inflow / Mean Inflow	-	0
Max Reservoir Storage	hm3	0
Reservoir P Decay Rate	1/yr/ppb	0
Rainfall P Conc	ppb	20
Atmospheric P Load (Dry)	mg/m2-yr	20

Case Description: **Filename:** **C11w_base_final.xls**

100% SAV_C4
Max Depth = 170 cm
2006-2036 flows
Base case (50 ppb)

Output Variable	Units	Value
Water Balance Error	%	0.0%
Mass Balance Error	%	0.0%
Flow-Wtd Conc - With Bypass	ppb	14
Flow-Wtd Conc - Without Bypass	ppb	14
Geometric Mean Conc	ppb	10
95th Percentile Conc	ppb	19
Freq Cell Outflow > 10 ppb	%	54%
Bypass Load	%	0.0%

Cell Number -->		1	2	3	4	5	6
Cell Label	-	S1					
Vegetation Type	------->	SAV_C4					
Inflow Fraction	-	1					
Downstream Cell Number	-	0					
Surface Area	km2	2.250					
Mean Width of Flow Path	km	1.50					
Number of Tanks in Series	-	3					
Outflow Control Depth	cm	109					
Outflow Coefficient - Exponent	-	3.5					
Outflow Coefficient - Intercept	-	0.8					
Bypass Depth	cm	170					
Maximum Inflow	hm3/day	0					
Maximum Outflow	hm3/day	0					
Inflow Seepage Rate	(cm/d) / cm	0					
Inflow Seepage Control Elev	cm	0					
Inflow Seepage Conc	ppb	0					
Outflow Seepage Rate	(cm/d) / cm	0.008					
Outflow Seepage Control Elev	cm	0					
Max Outflow Seepage Conc	ppb	20					
Seepage Recycle Fraction	-	0.5					
Seepage Discharge Fraction	-	0					
Initial Water Column Conc	ppb	30					
Initial P Storage Per Unit Area	mg/m2	500					
Initial Water Column Depth	cm	50					
C0 = WC Conc at 0 g/m2 P Storage	ppb	*4*					
C1 = WC Conc at 1 g/m2 P storage	ppb	*22*					
K = Net Settling Rate at Steady State	m/yr	*80*					
Zx = Depth Scale Factor	cm	*60*					
C0 - Periphyton	ppb	*0*					
C1 - Periphyton	ppb	*0*					
K - Periphyton	1/yr	*0.00*					
Zx - Periphyton	cm	*0*					
Sm = Transition Storage Midpoint	mg/m2	*0*					
Sb = Transition Storage Bandwidth	mg/m2	*0*					

Output Variables	Units	1	2	3	4	5	6	Overall
Execution Time	seconds/yr	5.16						5.16
Run Date	-	05/20/02						05/20/02
Starting Date for Simulation	-	01/01/65						01/01/65
Starting Date for Output	-	01/01/65						01/01/65
Ending Date	-	12/31/95						12/31/95
Output Duration	days	11322						11322
Cell Label		S1						Total Outflow
Downstream Cell Label		Outflow						-
Surface Area	km2	2.250						2.3
Mean Water Load	cm/d	2.7						2.7
Max Water Load	cm/d	76.8						76.8
Inflow Volume	hm3/yr	22.6						22.6
Inflow Load	kg/yr	493.8						493.8
Inflow Conc	ppb	22						22
Treated Outflow Volume	hm3/yr	19.9						19.9
Treated Outflow Load	kg/yr	277.3						277.3
Treated FWM Outflow Conc	ppb	14						14
Total Outflow Volume	hm3/yr	19.9						19.9
Total Outflow Load	kg/yr	277.3						277.3

C-11 West Basin - Alt. 2 basecase (cont'd)

Total FWM Outflow Conc	ppb	14	14
Bypass Volume	hm3/yr	0.00	0.00
Bypass Load	kg/yr	0.00	0.00
Bypass Conc	ppb	0.0	0.0
Bypass Load	%	0.0%	0.0%
Surface Outflow Load Reduc	%	43.9%	43.9%
Outflow Geometric Mean - Daily	ppb	11	11
Outflow Geo Mean - Composites	ppb	10	10
Frequency Outflow Conc > 10 ppb	%	54%	54%
95th Percentile Outflow Conc	ppb	19	19
Mean Biomass P Storage	mg/m2	92	92
Max Reservoir Storage	hm3	0.00	0.00
Reservoir Load Reduction	%	#N/A	#N/A
Mean Depth	cm	64.3	64.3
Minimum Depth	cm	1.0	1.0
Maximum Depth	cm	115.6	115.6
Frequency Depth < 5 cm	%	0.0%	0.0%
Flow/Width	m2/day	36	36.4
Max 1 Yr Flow-Wtd Conc	ppb	#N/A	29
Max 5 Yr Flow-Wtd Conc	ppb	#N/A	19
Max 1 Yr Geometric Mn Conc	ppb	#N/A	23
Max 5 Yr Geometric Mn Conc	ppb	#N/A	12
Depth Percentile vs. Calib Set	%	43%	43%
Q/W Percentile vs. Calib Set	%	17%	17%
Cin Percentile vs. Calib Set	%	#N/A	#N/A
Cout Percentile vs. Calib Set	%	#N/A	#N/A
Depth Range Flag	-	OK	0.0
Q/W Range Flag	-	OK	0.0
Cin Range Flag	-		0.0
Cout Range Flag	-		0.0
Water Balance Error	%	0.00%	0.00%
Mass Balance Error	%	0.02%	0.02%

DMSTA Input Values **C-11 West Basin - Alt. 2 with 25% Load Reduction (Sensitivity)**

Input Variable	Units	Value
Design Case Name	-	SC4_25per_fina
Starting Date for Simulation	-	01/00/00
Ending Date for Simulation	-	01/00/00
Starting Date for Output	-	01/00/00
Steps Per Day	-	8
Number of Iterations	-	2
Output Averaging Interval	days	7
Reservoir H2O Residence Time	days	0
Max Inflow / Mean Inflow	-	0
Max Reservoir Storage	hm3	0
Reservoir P Decay Rate	1/yr/ppb	0
Rainfall P Conc	ppb	20
Atmospheric P Load (Dry)	mg/m2-yr	20

Case Description: 100% SAV_C4
with 25% reduction in TP from source controls
2006-2036 flows

Filename: C11w_25per_final.xls

Output Variable	Units	Value
Water Balance Error	%	0.0%
Mass Balance Error	%	0.0%
Flow-Wtd Conc - With Bypass	ppb	12
Flow-Wtd Conc - Without Bypass	ppb	12
Geometric Mean Conc	ppb	9
95th Percentile Conc	ppb	15
Freq Cell Outflow > 10 ppb	%	41%
Bypass Load	%	0.0%

Cell Number -->		1	2	3	4	5	6
Cell Label	-	S1					
Vegetation Type	------->	SAV_C4					
Inflow Fraction	-	1					
Downstream Cell Number	-	0					
Surface Area	km2	2.200					
Mean Width of Flow Path	km	1.48					
Number of Tanks in Series	-	3					
Outflow Control Depth	cm	109					
Outflow Coefficient - Exponent	-	3.5					
Outflow Coefficient - Intercept	-	0.8					
Bypass Depth	cm	170					
Maximum Inflow	hm3/day	0					
Maximum Outflow	hm3/day	0					
Inflow Seepage Rate	(cm/d) / cm	0					
Inflow Seepage Control Elev	cm	0					
Inflow Seepage Conc	ppb	0					
Outflow Seepage Rate	(cm/d) / cm	0.008					
Outflow Seepage Control Elev	cm	0					
Max Outflow Seepage Conc	ppb	20					
Seepage Recycle Fraction	-	0.5					
Seepage Discharge Fraction	-	0					
Initial Water Column Conc	ppb	30					
Initial P Storage Per Unit Area	mg/m2	500					
Initial Water Column Depth	cm	50					
C0 = WC Conc at 0 g/m2 P Storage	ppb	*4*					
C1 = WC Conc at 1 g/m2 P storage	ppb	*22*					
K = Net Settling Rate at Steady State	m/yr	*80*					
Zx = Depth Scale Factor	cm	*60*					
C0 - Periphyton	ppb	*0*					
C1 - Periphyton	ppb	*0*					
K - Periphyton	1/yr	*0.00*					
Zx - Periphyton	cm	*0*					
Sm = Transition Storage Midpoint	mg/m2	*0*					
Sb = Transition Storage Bandwidth	mg/m2	*0*					

Output Variables	Units	1	2	3	4	5	6	Overall
Execution Time	seconds/yr	4.87						4.87
Run Date	-	05/20/02						05/20/02
Starting Date for Simulation	-	01/01/65						01/01/65
Starting Date for Output	-	01/01/65						01/01/65
Ending Date	-	12/31/95						12/31/95
Output Duration	days	11322						11322
Cell Label		S1						Total Outflow
Downstream Cell Label		Outflow						-
Surface Area	km2	2.200						2.2
Mean Water Load	cm/d	2.8						2.8
Max Water Load	cm/d	78.6						78.6
Inflow Volume	hm3/yr	22.6						22.6
Inflow Load	kg/yr	370.3						370.3
Inflow Conc	ppb	16						16
Treated Outflow Volume	hm3/yr	20.0						20.0
Treated Outflow Load	kg/yr	236.8						236.8
Treated FWM Outflow Conc	ppb	12						12
Total Outflow Volume	hm3/yr	20.0						20.0
Total Outflow Load	kg/yr	236.8						236.8

C-11 West Basin - Alt. 2 w/ 25% Load Reduction (Sensitivity) (cont'd)

Total FWM Outflow Conc	ppb	12	12
Bypass Volume	hm3/yr	0.00	0.00
Bypass Load	kg/yr	0.00	0.00
Bypass Conc	ppb	0.0	0.0
Bypass Load	%	0.0%	0.0%
Surface Outflow Load Reduc	%	36.0%	36.0%
Outflow Geometric Mean - Daily	ppb	10	10
Outflow Geo Mean - Composites	ppb	9	9
Frequency Outflow Conc > 10 ppb	%	41%	41%
95th Percentile Outflow Conc	ppb	15	15
Mean Biomass P Storage	mg/m2	68	68
Max Reservoir Storage	hm3	0.00	0.00
Reservoir Load Reduction	%	#N/A	#N/A
Mean Depth	cm	64.3	64.3
Minimum Depth	cm	1.0	1.0
Maximum Depth	cm	115.7	115.7
Frequency Depth < 5 cm	%	0.8%	0.8%
Flow/Width	m2/day	37	36.9
Max 1 Yr Flow-Wtd Conc	ppb	#N/A	22.5
Max 5 Yr Flow-Wtd Conc	ppb	#N/A	15.6
Max 1 Yr Geometric Mn Conc	ppb	#N/A	19.7
Max 5 Yr Geometric Mn Conc	ppb	#N/A	10.8
Depth Percentile vs. Calib Set	%	43%	43%
Q/W Percentile vs. Calib Set	%	17%	17%
Cin Percentile vs. Calib Set	%	5%	5%
Cout Percentile vs. Calib Set	%	-8%	-8%
Depth Range Flag	-	OK	0.0
Q/W Range Flag	-	OK	0.0
Cin Range Flag	-	OK	0.0
Cout Range Flag	-	FLAG	1.0
Water Balance Error	%	0.00%	0.00%
Mass Balance Error	%	0.02%	0.02%

DMSTA Input Values **C-11 West Basin - Alt. 2 basecase using NEWS (Sensitivity)**

Input Variable	Units	Value
Design Case Name	-	NEWS_final
Starting Date for Simulation	-	01/00/00
Ending Date for Simulation	-	01/00/00
Starting Date for Output	-	01/00/00
Steps Per Day	-	8
Number of Iterations	-	2
Output Averaging Interval	days	7
Reservoir H2O Residence Time	days	0
Max Inflow / Mean Inflow	-	0
Max Reservoir Storage	hm3	0
Reservoir P Decay Rate	1/yr/ppb	0
Rainfall P Conc	ppb	20
Atmospheric P Load (Dry)	mg/m2-yr	20

Case Description: 100% NEWS
Max Depth = 170 cm
2006-2036 flows
Base case (50 ppb)

Filename: C11w_base_final.xls

Output Variable	Units	Value
Water Balance Error	%	0.0%
Mass Balance Error	%	0.1%
Flow-Wtd Conc - With Bypass	ppb	16
Flow-Wtd Conc - Without Bypass	ppb	16
Geometric Mean Conc	ppb	14
95th Percentile Conc	ppb	20
Freq Cell Outflow > 10 ppb	%	91%
Bypass Load	%	0.0%

Cell Number -->		1	2	3	4	5	6
Cell Label	-	S1					
Vegetation Type	------->	NEWS					
Inflow Fraction	-	1					
Downstream Cell Number	-	0					
Surface Area	km2	2.250					
Mean Width of Flow Path	km	1.50					
Number of Tanks in Series	-	3					
Outflow Control Depth	cm	109					
Outflow Coefficient - Exponent	-	3.5					
Outflow Coefficient - Intercept	-	0.8					
Bypass Depth	cm	170					
Maximum Inflow	hm3/day	0					
Maximum Outflow	hm3/day	0					
Inflow Seepage Rate	(cm/d) / cm	0					
Inflow Seepage Control Elev	cm	0					
Inflow Seepage Conc	ppb	0					
Outflow Seepage Rate	(cm/d) / cm	0.008					
Outflow Seepage Control Elev	cm	0					
Max Outflow Seepage Conc	ppb	20					
Seepage Recycle Fraction	-	0.5					
Seepage Discharge Fraction	-	0					
Initial Water Column Conc	ppb	30					
Initial P Storage Per Unit Area	mg/m2	500					
Initial Water Column Depth	cm	50					
C0 = WC Conc at 0 g/m2 P Storage	ppb	*12*					
C1 = WC Conc at 1 g/m2 P storage	ppb	*22*					
K = Net Settling Rate at Steady State	m/yr	*129*					
Zx = Depth Scale Factor	cm	*60*					
C0 - Periphyton	ppb	*4*					
C1 - Periphyton	ppb	*22*					
K - Periphyton	1/yr	*23.80*					
Zx - Periphyton	cm	*0*					
Sm = Transition Storage Midpoint	mg/m2	*400*					
Sb = Transition Storage Bandwidth	mg/m2	*80*					

Output Variables	Units	1	2	3	4	5	6	Overall
Execution Time	seconds/yr	3.42						3.42
Run Date	-	07/05/02						07/05/02
Starting Date for Simulation	-	01/01/65						01/01/65
Starting Date for Output	-	01/01/65						01/01/65
Ending Date	-	12/31/95						12/31/95
Output Duration	days	11322						11322
Cell Label		S1						Total Outflow
Downstream Cell Label		Outflow						-
Surface Area	km2	2.250						2.3
Mean Water Load	cm/d	2.7						2.7
Max Water Load	cm/d	76.8						76.8
Inflow Volume	hm3/yr	22.6						22.6
Inflow Load	kg/yr	493.8						493.8
Inflow Conc	ppb	22						21.9
Treated Outflow Volume	hm3/yr	19.9						19.9
Treated Outflow Load	kg/yr	327.7						327.7
Treated FWM Outflow Conc	ppb	16						16.4
Total Outflow Volume	hm3/yr	19.9						19.9

C-11 West Basin - Alt. 2 basecase using NEWS (Sensitivity) (cont'd)

Total Outflow Load	kg/yr	327.7	327.7
Total FWM Outflow Conc	ppb	16	16.4
Bypass Volume	hm3/yr	0.00	0.00
Bypass Load	kg/yr	0.00	0.00
Bypass Conc	ppb	0	0.0
Bypass Load	%	0.0%	0.0%
Surface Outflow Load Reduc	%	33.6%	33.6%
Outflow Geometric Mean - Daily	ppb	14	14.2
Outflow Geo Mean - Composites	ppb	14	14
Frequency Outflow Conc > 10 ppb	%	#DIV/0!	91%
95th Percentile Outflow Conc	ppb	#NUM!	20.5
Mean Biomass P Storage	mg/m2	210	210
Max Reservoir Storage	hm3	0.00	0.00
Reservoir Load Reduction	%	#N/A	#N/A
Mean Depth	cm	64.3	64.3
Minimum Depth	cm	1.0	1.0
Maximum Depth	cm	115.6	115.6
Frequency Depth < 5 cm	%	0.0%	0.0%
Flow/Width	m2/day	36	36.4
Max 1 Yr Flow-Wtd Conc	ppb	#N/A	29.5
Max 5 Yr Flow-Wtd Conc	ppb	#N/A	20.4
Max 1 Yr Geometric Mn Conc	ppb	#N/A	18.3
Max 5 Yr Geometric Mn Conc	ppb	#N/A	14.7
Depth Percentile vs. Calib Set	%	55%	55%
Q/W Percentile vs. Calib Set	%	17%	17%
Cin Percentile vs. Calib Set	%	#N/A	#N/A
Cout Percentile vs. Calib Set	%	#N/A	#N/A
Depth Range Flag	-	OK	0.0
Q/W Range Flag	-	OK	0.0
Cin Range Flag	-		0.0
Cout Range Flag	-		0.0
Water Balance Error	%	0.00%	0.00%
Mass Balance Error	%	0.05%	0.05%

C-11 West Basin - Alt. 2 Basecase 25% DMSTA Sensitivity Analysis

Sensitivity Analysis **Case: SC4_final** **File: C11w_base_final.xls** **Input Variable Set: All** **Run Date: 06/07/02**

Option	Value			
Select Sensitivity Scale Factor --->	**25%**	*Modify Each Input Variable by +/- This Percentage*	Number of Model Runs Required = 34	Estimated Run Time = 112.2 minutes
Select Input Parameter Set ------>	**1**	*1 = All, 2 = P Cycling Only, 3 = Design Features Only*	*Adjusts Each non-Zero Input Variable, One at a Time, & Re-Runs Simulation*	
Select Test Option ---------->	**2**	*1 = High Results Only, 2 = High & Low Results*	*Shows Results for Combined Outflow from Entire Treatment Area*	

Run

Sort Results

Uncertainty Analysis

Menu

			High Results ---->					Low Results ------>					Average Change ---->				Average % Change -->			
Input Variable	Cell Number	Input Value - Base	Input Value - High	Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load	Input Value - Low	Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load	Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load	Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load
	-	-	-	ppb	ppb	ppb	kg/yr	-	ppb	ppb	ppb	kg/yr	ppb	ppb	ppb	kg/yr	%	%	%	%
Base Run				13.9	13.9	10.5	277		13.9	13.9	10.5	277								
Rainfall P Conc	1	20.0	25.0	13.9	13.9	10.4	277	16.0	13.9	13.9	10.5	278	0.0	0.0	0.0	-1	0%	0%	0%	0%
Atmospheric P Load (Dry)	1	20.0	25.0	13.8	13.8	10.4	275	16.0	14.0	14.0	10.6	279	-0.1	-0.1	-0.1	-2	-1%	-1%	-1%	-1%
Inflow Fraction	1	1.0	1.3	14.5	14.6	11.1	373	0.8	13.2	13.2	9.9	204	0.6	0.7	0.6	85	5%	5%	6%	30%
Surface Area	1	2.3	2.8	13.2	13.2	9.9	255	1.8	14.6	14.6	11.1	298	-0.7	-0.7	-0.6	-22	-5%	-5%	-6%	-8%
Mean Width of Flow Path	1	1.5	1.9	13.9	13.9	10.5	277	1.2	13.9	13.9	10.5	277	0.0	0.0	0.0	0	0%	0%	0%	0%
Number of Tanks in Series	1	3.0	3.8	13.7	13.7	10.3	273	2.4	14.0	14.0	10.6	279	-0.1	-0.1	-0.2	-3	-1.0%	-1.0%	-1.6%	-1.0%
Outflow Control Depth	1	109.0	136.3	13.6	13.6	10.3	262	87.2	14.2	14.2	10.6	292	-0.3	-0.3	-0.2	-15	-2%	-2%	-2%	-5%
Outflow Coefficient - Intercept	1	0.8	1.0	13.9	13.9	10.5	277	0.6	13.9	13.9	10.5	277	0.0	0.0	0.0	0	0%	0%	0%	0%
Bypass Depth	1	170.0	212.5	13.9	13.9	10.5	277	136.0	13.5	13.9	10.5	278	0.2	0.0	0.0	0	1%	0%	0%	0%
Outflow Seepage Rate	1	0.0	0.0	14.0	14.0	10.6	274	0.0	13.8	13.8	10.4	280	0.1	0.1	0.1	-3	1%	1%	1%	-1%
Max Outflow Seepage Conc	1	20.0	25.0	13.9	13.9	10.5	277	16.0	13.9	13.9	10.5	277	0.0	0.0	0.0	0	0%	0%	0%	0%
Seepage Recycle Fraction	1	0.5	0.6	13.8	13.8	10.4	280	0.4	14.0	14.0	10.5	275	-0.1	-0.1	-0.1	3	-1%	-1%	-1%	1%
C0 = WC Conc at 0 g/m2 P Storage	1	4.0	5.0	15.5	15.5	12.3	309	3.2	12.4	12.4	8.9	248	1.5	1.5	1.7	30	11%	11%	16%	11%
C1 = WC Conc at 1 g/m2 P storage	1	22.0	27.5	13.8	13.8	10.4	275	17.6	14.0	14.0	10.6	279	-0.1	-0.1	-0.1	-2	-1%	-1%	-1%	-1%
K = Net Settling Rate at Steady State	1	80.1	100.1	13.6	13.6	10.1	270	64.1	14.3	14.3	10.9	284	-0.4	-0.4	-0.4	-7	-3%	-3%	-4%	-3%
Zx = Depth Scale Factor	1	60.0	75.0	14.0	14.0	10.6	279	48.0	13.8	13.8	10.4	276	0.1	0.1	0.1	2	1%	1%	1%	1%

C-11 West Basin - Alt. 2 Basecase 50% DMSTA Sensitivity Analysis

Sensitivity Analysis **Case: SC4_final** **File: C11w_base_final.xls** **Input Variable Set: All** **Run Date: 06/19/02**

Option	Value	
Select Sensitivity Scale Factor --->	**50%**	*Modify Each Input Variable by +/- This Percentage*
Select Input Parameter Set ------>	**1**	*1 = All, 2 = P Cycling Only, 3 = Design Features Only*
Select Test Option ---------->	**2**	*1 = High Results Only, 2 = High & Low Results*

Number of Model Runs Required = 34 Estimated Run Time = 113.3 minutes

Adjusts Each non-Zero Input Variable, One at a Time, & Re-Runs Simulation

Shows Results for Combined Outflow from Entire Treatment Area

Run

Sort Results

Uncertainty Analysis

Menu

			High Results ---->					Low Results ------>					Average Change ---->				Average % Change -->			
Input Variable	Cell Number	Input Value - Base	Input Value - High	Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load	Input Value - Low	Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load	Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load	Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load
	-	-	-	ppb	ppb	ppb	kg/yr	-	ppb	ppb	ppb	kg/yr	ppb	ppb	ppb	kg/yr	%	%	%	%
Base Run				13.9	13.9	10.5	277		13.9	13.9	10.5	277								
Rainfall P Conc	1	20.0	30.0	13.9	13.9	10.4	276	13.3	14.0	14.0	10.6	278	-0.1	-0.1	-0.1	-1	0%	0%	-1%	0%
Atmospheric P Load (Dry)	1	20.0	30.0	13.7	13.7	10.3	273	13.3	14.1	14.1	10.7	281	-0.2	-0.2	-0.2	-4	-1%	-1%	-2%	-1%
Inflow Fraction	1	1.0	1.5	15.0	15.1	11.5	472	0.7	12.7	12.7	9.5	157	1.2	1.2	1.0	157	8%	9%	10%	57%
Surface Area	1	2.3	3.4	12.7	12.7	9.5	236	1.5	15.1	15.1	11.6	315	-1.2	-1.2	-1.0	-39	-9%	-9%	-10%	-14%
Mean Width of Flow Path	1	1.5	2.3	13.9	13.9	10.5	277	1.0	13.8	13.9	10.5	278	0.1	0.0	0.0	0	1%	0%	0%	0%
Number of Tanks in Series	1	3.0	4.5	13.6	13.6	10.1	271	2.0	14.3	14.3	10.9	285	-0.3	-0.3	-0.4	-7	-2.4%	-2.4%	-4.0%	-2.4%
Outflow Control Depth	1	109.0	163.5	13.3	13.3	10.3	248	72.7	14.5	14.5	10.8	302	-0.6	-0.6	-0.3	-27	-4%	-4%	-3%	-10%
Outflow Coefficient - Intercept	1	0.8	1.2	13.9	13.9	10.5	277	0.5	13.8	13.9	10.5	278	0.1	0.0	0.0	0	1%	0%	0%	0%
Bypass Depth	1	170.0	255.0	13.9	13.9	10.5	277	113.3	12.8	14.0	10.4	280	0.6	-0.1	0.0	-1	4%	0%	0%	0%
Outflow Seepage Rate	1	0.0	0.0	14.1	14.1	10.6	272	0.0	13.8	13.8	10.3	281	0.2	0.2	0.2	-5	1%	1%	1%	-2%
Max Outflow Seepage Conc	1	20.0	30.0	13.9	13.9	10.5	277	13.3	13.9	13.9	10.5	277	0.0	0.0	0.0	0	0%	0%	0%	0%
Seepage Recycle Fraction	1	0.5	0.8	13.7	13.7	10.2	284	0.3	14.0	14.0	10.6	273	-0.2	-0.2	-0.2	5	-1%	-1%	-1%	2%
C0 = WC Conc at 0 g/m2 P Storage	1	4.0	6.0	16.8	16.8	13.9	335	2.7	11.3	11.3	7.8	225	2.7	2.7	3.0	55	20%	20%	29%	20%
C1 = WC Conc at 1 g/m2 P storage	1	22.0	33.0	13.7	13.7	10.3	273	14.7	14.1	14.1	10.6	280	-0.2	-0.2	-0.2	-4	-1%	-1%	-2%	-1%
K = Net Settling Rate at Steady State	1	80.1	120.2	13.3	13.3	9.7	265	53.4	14.6	14.6	11.3	291	-0.6	-0.6	-0.8	-13	-5%	-5%	-8%	-5%
Zx = Depth Scale Factor	1	60.0	90.0	14.1	14.1	10.7	281	40.0	13.8	13.8	10.4	275	0.1	0.1	0.1	3	1%	1%	1%	1%

Uncertainty Analysis

Case: **SC4_final** **sens25** **File:** **C11w_base_final.xls** 06/07/02

Estimates uncertainty in output variables. Assumes that sensitivity analysis has already been performed. Factors include: (1) uncertainty in p cycling parameters (from calibration); (2) uncertainty in other model inputs (user-specified); (3) inherent model error (from calibration); & (4) sensitivity of model output to each input value. Results are for combined outflows.

Reference: Walker, "A Sensitivity & Error Analysis Framework for Lake Eutrophication Modeling", Wtr Res Bul, Feb 1982

Select Output Variable:

- Treated FWM Outflow Conc
- Total FWM Outflow Conc
- Outflow Geo Mean - Composites
- Total Outflow Load

Treated FWM Outflow Conc (ppb)		Error CV's = Standard Error / Mean	
50th Percentile Est. =	14	Total =	11%
10th Percentile Est. =	12	Model Error =	10%
90th Percentile Est =	16	Parameter Error =	4%
		Input Data Error =	2%

Show Results | Sensitivity Analysis | Menu

Sensitivity Coefficients

% Change in Output Variable / % Change in Input Variable

Enter assumed error CV (standard error, as percent of mean) in col. B (blue cells) to reflect uncertainty in each input value

Input Variable	**Error CV**	**Value**
Design Case Name		SC4_final
Starting Date for Simulation		
Ending Date for Simulation		
Starting Date for Output		
Steps Per Day		
Number of Iterations		
Output Averaging Interval		
Reservoir H2O Residence Time		
Max Inflow / Mean Inflow		
Max Reservoir Storage		
Reservoir P Decay Rate		
Rainfall P Conc	30%	-0.009
Atmospheric P Load (Dry)	30%	-0.033
Cell Number -->		1
Cell Label		S1
Vegetation Type		SAV_C4
Inflow Fraction	0%	*0.185*
Downstream Cell Number		
Surface Area		*-0.195*
Mean Width of Flow Path		*0.008*
Number of Tanks in Series	30%	*-0.040*
Outflow Control Depth		*-0.096*
Outflow Coefficient - Exponent		
Outflow Coefficient - Intercept	20%	*0.008*
Bypass Depth		*0.057*
Maximum Inflow		
Maximum Outflow		
Inflow Seepage Rate	20%	
Inflow Seepage Control Elev		
Inflow Seepage Conc	20%	
Outflow Seepage Rate	20%	*0.027*
Outflow Seepage Control Elev		
Max Outflow Seepage Conc	20%	*0.001*
Seepage Recycle Fraction	20%	*-0.027*
Seepage Discharge Fraction	20%	
Initial Water Column Conc		
Initial P Storage Per Unit Area		
Initial Water Column Depth		
C0 = WC Conc at 0 g/m2 P Storage		*0.440*
C1 = WC Conc at 1 g/m2 P storage		*-0.027*
K = Net Settling Rate at Steady State		*-0.101*
Zx = Depth Scale Factor	*retrieved*	*0.022*
C0 - Periphyton	*from model*	
C1 - Periphyton	*calibration*	
K - Periphyton	*table*	
Zx - Periphyton		
Sm = Transition Storage Midpoint		
Sb = Transition Storage Bandwidth		

Case Description: **Filename: C11w_base_final.xls**

100% SAV_C4
Max Depth = 170 cm
2006-2036 flows
Base case (50 ppb)

Output Variable	**Units**	**Value**
Water Balance Error	%	0.0%
Mass Balance Error	%	0.0%
Flow-Wtd Conc - With Bypass	ppb	13.9
Flow-Wtd Conc - Without Bypass	ppb	13.9
Geometric Mean Conc	ppb	10.5
95th Percentile Conc	ppb	18.6
Freq Cell Outflow > 10 ppb	%	54%
Bypass Load	%	0.0%

2	**3**	**4**	**5**	**6**

Uncertainty Analysis

Case: **SC4_final** **sens25** **File:** **C11w_base_final.xls** 06/07/02

Estimates uncertainty in output variables. Assumes that sensitivity analysis has already been performed. Factors include: (1) uncertainty in p cycling parameters (from calibration); (2) uncertainty in other model inputs (user-specified); (3) inherent model error (from calibration); & (4) sensitivity of model output to each input value. Results are for combined outflows.

Reference: Walker, "A Sensitivity & Error Analysis Framework for Lake Eutrophication Modeling", Wtr Res Bul, Feb 1982

Select Output Variable:

- Treated FWM Outflow Conc
- Total FWM Outflow Conc
- Outflow Geo Mean - Composites
- Total Outflow Load

Total FWM Outflow Conc (ppb)		Error CV's = Standard Error / Mean	
50th Percentile Est. =	14	Total =	11%
10th Percentile Est. =	12	Model Error =	10%
90th Percentile Est =	16	Parameter Error =	4%
		Input Data Error =	2%

Show Results | Sensitivity Analysis | Menu

Sensitivity Coefficients

% Change in Output Variable / % Change in Input Variable

Enter assumed error CV (standard error, as percent of mean) in col. B (blue cells) to reflect uncertainty in each input value

Input Variable	**Error CV**	**Value**	**Case Description:**	**Filename: C11w_base_final.xls**			
Design Case Name		SC4_final	100% SAV_C4				
Starting Date for Simulation			Max Depth = 170 cm				
Ending Date for Simulation			2006-2036 flows				
Starting Date for Output			Base case (50 ppb)				
Steps Per Day			**Output Variable**			**Units**	**Value**
Number of Iterations			Water Balance Error			%	0.0%
Output Averaging Interval			Mass Balance Error			%	0.0%
Reservoir H2O Residence Time			Flow-Wtd Conc - With Bypass			ppb	13.9
Max Inflow / Mean Inflow			Flow-Wtd Conc - Without Bypass			ppb	13.9
Max Reservoir Storage			Geometric Mean Conc			ppb	10.5
Reservoir P Decay Rate			95th Percentile Conc			ppb	18.6
Rainfall P Conc	30%	-0.009	Freq Cell Outflow > 10 ppb			%	54%
Atmospheric P Load (Dry)	30%	-0.033	Bypass Load			%	0.0%
Cell Number -->		**1**	**2**	**3**	**4**	**5**	**6**
Cell Label		S1					
Vegetation Type		SAV_C4					
Inflow Fraction	0%	*0.197*					
Downstream Cell Number							
Surface Area		*-0.195*					
Mean Width of Flow Path		*-0.002*					
Number of Tanks in Series	30%	*-0.040*					
Outflow Control Depth		*-0.096*					
Outflow Coefficient - Exponent							
Outflow Coefficient - Intercept	20%	*-0.002*					
Bypass Depth		*-0.003*					
Maximum Inflow							
Maximum Outflow							
Inflow Seepage Rate	20%						
Inflow Seepage Control Elev							
Inflow Seepage Conc	20%						
Outflow Seepage Rate	20%	*0.027*					
Outflow Seepage Control Elev							
Max Outflow Seepage Conc	20%	*0.001*					
Seepage Recycle Fraction	20%	*-0.027*					
Seepage Discharge Fraction	20%						
Initial Water Column Conc							
Initial P Storage Per Unit Area							
Initial Water Column Depth							
C0 = WC Conc at 0 g/m2 P Storage		*0.440*					
C1 = WC Conc at 1 g/m2 P storage		*-0.027*					
K = Net Settling Rate at Steady State		*-0.101*					
Zx = Depth Scale Factor	*retrieved*	*0.022*					
C0 - Periphyton	*from model*						
C1 - Periphyton	*calibration*						
K - Periphyton	*table*						
Zx - Periphyton							
Sm = Transition Storage Midpoint							
Sb = Transition Storage Bandwidth							

Uncertainty Analysis

Case: **SC4_final** **sens25** **File:** **C11w_base_final.xls** 06/07/02

Estimates uncertainty in output variables. Assumes that sensitivity analysis has already been performed. Factors include: (1) uncertainty in p cycling parameters (from calibration); (2) uncertainty in other model inputs (user-specified); (3) inherent model error (from calibration); & (4) sensitivity of model output to each input value. Results are for combined outflows.

Reference: Walker, "A Sensitivity & Error Analysis Framework for Lake Eutrophication Modeling", Wtr Res Bul, Feb 1982

Select Output Variable:

- Treated FWM Outflow Conc
- Total FWM Outflow Conc
- Outflow Geo Mean - Composites
- Total Outflow Load

Outflow Geo Mean - Composites (ppb)		Error CV's = Standard Error / Mean	
50th Percentile Est. =	10	Total =	12%
10th Percentile Est. =	9	Model Error =	10%
90th Percentile Est =	12	Parameter Error =	7%
		Input Data Error =	2%

Show Results | Sensitivity Analysis | Menu

Sensitivity Coefficients

% Change in Output Variable / % Change in Input Variable

Enter assumed error CV (standard error, as percent of mean) in col. B (blue cells) to reflect uncertainty in each input value

Case Description: **Filename: C11w_base_final.xls**

100% SAV_C4
Max Depth = 170 cm
2006-2036 flows
Base case (50 ppb)

Output Variable	Units	Value
Water Balance Error	%	0.0%
Mass Balance Error	%	0.0%
Flow-Wtd Conc - With Bypass	ppb	13.9
Flow-Wtd Conc - Without Bypass	ppb	13.9
Geometric Mean Conc	ppb	10.5
95th Percentile Conc	ppb	18.6
Freq Cell Outflow > 10 ppb	%	54%
Bypass Load	%	0.0%

Input Variable	Error CV	Value
Design Case Name		SC4_final
Starting Date for Simulation		
Ending Date for Simulation		
Starting Date for Output		
Steps Per Day		
Number of Iterations		
Output Averaging Interval		
Reservoir H2O Residence Time		
Max Inflow / Mean Inflow		
Max Reservoir Storage		
Reservoir P Decay Rate		
Rainfall P Conc	30%	-0.019
Atmospheric P Load (Dry)	30%	-0.042

Cell Number -->		1	2	3	4	5	6
Cell Label		S1					
Vegetation Type		SAV_C4					
Inflow Fraction	0%	*0.220*					
Downstream Cell Number							
Surface Area		*-0.220*					
Mean Width of Flow Path		*0.000*					
Number of Tanks in Series	30%	*-0.063*					
Outflow Control Depth		*-0.060*					
Outflow Coefficient - Exponent							
Outflow Coefficient - Intercept	20%	*0.000*					
Bypass Depth		*0.003*					
Maximum Inflow							
Maximum Outflow							
Inflow Seepage Rate	20%						
Inflow Seepage Control Elev							
Inflow Seepage Conc	20%						
Outflow Seepage Rate	20%	*0.035*					
Outflow Seepage Control Elev							
Max Outflow Seepage Conc	20%	*0.000*					
Seepage Recycle Fraction	20%	*-0.025*					
Seepage Discharge Fraction	20%						
Initial Water Column Conc							
Initial P Storage Per Unit Area							
Initial Water Column Depth							
C0 = WC Conc at 0 g/m2 P Storage		*0.647*					
C1 = WC Conc at 1 g/m2 P storage		*-0.038*					
K = Net Settling Rate at Steady State		*-0.163*					
Zx = Depth Scale Factor	*retrieved*	*0.029*					
C0 - Periphyton	*from model*						
C1 - Periphyton	*calibration*						
K - Periphyton	*table*						
Zx - Periphyton							
Sm = Transition Storage Midpoint							
Sb = Transition Storage Bandwidth							

Uncertainty Analysis

Case: **SC4_final** **sens25** **File:** **C11w_base_final.xls** 06/07/02

Estimates uncertainty in output variables. Assumes that sensitivity analysis has already been performed. Factors include: (1) uncertainty in p cycling parameters (from calibration); (2) uncertainty in other model inputs (user-specified); (3) inherent model error (from calibration); & (4) sensitivity of model output to each input value. Results are for combined outflows.

Reference: Walker, "A Sensitivity & Error Analysis Framework for Lake Eutrophication Modeling", Wtr Res Bul, Feb 1982

Select Output Variable:

- Treated FWM Outflow Conc
- Total FWM Outflow Conc
- Outflow Geo Mean - Composites
- Total Outflow Load

Total Outflow Load (kg/yr)		Error CV's = Standard Error / Mean	
50th Percentile Est. =	277	Total =	11%
10th Percentile Est. =	238	Model Error =	10%
90th Percentile Est =	317	Parameter Error =	4%
		Input Data Error =	2%

Show Results | Sensitivity Analysis | Menu

Sensitivity Coefficients

% Change in Output Variable / % Change in Input Variable

Enter assumed error CV (standard error, as percent of mean) in col. B (blue cells) to reflect uncertainty in each input value

Input Variable	**Error CV**	**Value**
Design Case Name		SC4_final
Starting Date for Simulation		
Ending Date for Simulation		
Starting Date for Output		
Steps Per Day		
Number of Iterations		
Output Averaging Interval		
Reservoir H2O Residence Time		
Max Inflow / Mean Inflow		
Max Reservoir Storage		
Reservoir P Decay Rate		
Rainfall P Conc	30%	-0.009
Atmospheric P Load (Dry)	30%	-0.033
Cell Number -->		1
Cell Label		S1
Vegetation Type		SAV_C4
Inflow Fraction	0%	*1.219*
Downstream Cell Number		
Surface Area		*-0.311*
Mean Width of Flow Path		*-0.002*
Number of Tanks in Series	30%	*-0.040*
Outflow Control Depth		*-0.216*
Outflow Coefficient - Exponent		
Outflow Coefficient - Intercept	20%	*-0.002*
Bypass Depth		*-0.003*
Maximum Inflow		
Maximum Outflow		
Inflow Seepage Rate	20%	
Inflow Seepage Control Elev		
Inflow Seepage Conc	20%	
Outflow Seepage Rate	20%	*-0.038*
Outflow Seepage Control Elev		
Max Outflow Seepage Conc	20%	*0.001*
Seepage Recycle Fraction	20%	*0.040*
Seepage Discharge Fraction	20%	
Initial Water Column Conc		
Initial P Storage Per Unit Area		
Initial Water Column Depth		
C0 = WC Conc at 0 g/m2 P Storage		*0.440*
C1 = WC Conc at 1 g/m2 P storage		*-0.027*
K = Net Settling Rate at Steady State		*-0.101*
Zx = Depth Scale Factor	*retrieved*	*0.022*
C0 - Periphyton	*from model*	
C1 - Periphyton	*calibration*	
K - Periphyton	*table*	
Zx - Periphyton		
Sm = Transition Storage Midpoint		
Sb = Transition Storage Bandwidth		

Case Description: **Filename: C11w_base_final.xls**

100% SAV_C4
Max Depth = 170 cm
2006-2036 flows
Base case (50 ppb)

Output Variable	**Units**	**Value**
Water Balance Error	%	0.0%
Mass Balance Error	%	0.0%
Flow-Wtd Conc - With Bypass	ppb	13.9
Flow-Wtd Conc - Without Bypass	ppb	13.9
Geometric Mean Conc	ppb	10.5
95th Percentile Conc	ppb	18.6
Freq Cell Outflow > 10 ppb	%	54%
Bypass Load	%	0.0%

Cell Number -->	2	3	4	5	6
Cell Label					
Vegetation Type					
Inflow Fraction					
Downstream Cell Number					
Surface Area					
Mean Width of Flow Path					
Number of Tanks in Series					
Outflow Control Depth					
Outflow Coefficient - Exponent					
Outflow Coefficient - Intercept					
Bypass Depth					
Maximum Inflow					
Maximum Outflow					
Inflow Seepage Rate					
Inflow Seepage Control Elev					
Inflow Seepage Conc					
Outflow Seepage Rate					
Outflow Seepage Control Elev					
Max Outflow Seepage Conc					
Seepage Recycle Fraction					
Seepage Discharge Fraction					
Initial Water Column Conc					
Initial P Storage Per Unit Area					
Initial Water Column Depth					
C0 = WC Conc at 0 g/m2 P Storage					
C1 = WC Conc at 1 g/m2 P storage					
K = Net Settling Rate at Steady State					
Zx = Depth Scale Factor					
C0 - Periphyton					
C1 - Periphyton					
K - Periphyton					
Zx - Periphyton					
Sm = Transition Storage Midpoint					
Sb = Transition Storage Bandwidth					

Uncertainty Analysis

Case: **SC4_final** **sens50** **File:** **C11w_base_final.xls** 06/19/02

Estimates uncertainty in output variables. Assumes that sensitivity analysis has already been performed. Factors include: (1) uncertainty in p cycling parameters (from calibration); (2) uncertainty in other model inputs (user-specified); (3) inherent model error (from calibration); & (4) sensitivity of model output to each input value. Results are for combined outflows.

Reference: Walker, "A Sensitivity & Error Analysis Framework for Lake Eutrophication Modeling", Wtr Res Bul, Feb 1982

Select Output Variable:

- Treated FWM Outflow Conc
- Total FWM Outflow Conc
- Outflow Geo Mean - Composites
- Total Outflow Load

Treated FWM Outflow Conc (ppb)		Error CV's = Standard Error / Mean	
50th Percentile Est. =	14	Total =	11%
10th Percentile Est. =	12	Model Error =	10%
90th Percentile Est =	16	Parameter Error =	4%
		Input Data Error =	2%

Show Results | Sensitivity Analysis | Menu

Sensitivity Coefficients

% Change in Output Variable / % Change in Input Variable

Enter assumed error CV (standard error, as percent of mean) in col. B (blue cells) to reflect uncertainty in each input value

Case Description: **Filename: C11w_base_final.xls**

100% SAV_C4
Max Depth = 170 cm
2006-2036 flows
Base case (50 ppb)

Output Variable	Units	Value
Water Balance Error	%	0.0%
Mass Balance Error	%	0.0%
Flow-Wtd Conc - With Bypass	ppb	13.9
Flow-Wtd Conc - Without Bypass	ppb	13.9
Geometric Mean Conc	ppb	10.5
95th Percentile Conc	ppb	18.6
Freq Cell Outflow > 10 ppb	%	54%
Bypass Load	%	0.0%

Input Variable	Error CV	Value
Design Case Name		SC4_final
Starting Date for Simulation		
Ending Date for Simulation		
Starting Date for Output		
Steps Per Day		
Number of Iterations		
Output Averaging Interval		
Reservoir H2O Residence Time		
Max Inflow / Mean Inflow		
Max Reservoir Storage		
Reservoir P Decay Rate		
Rainfall P Conc	30%	-0.008
Atmospheric P Load (Dry)	30%	-0.030
Cell Number -->		1
Cell Label		S1
Vegetation Type		SAV_C4
Inflow Fraction	0%	*0.166*
Downstream Cell Number		
Surface Area		*-0.177*
Mean Width of Flow Path		*0.010*
Number of Tanks in Series	30%	*-0.048*
Outflow Control Depth		*-0.088*
Outflow Coefficient - Exponent		
Outflow Coefficient - Intercept	20%	*0.010*
Bypass Depth		*0.079*
Maximum Inflow		
Maximum Outflow		
Inflow Seepage Rate	20%	
Inflow Seepage Control Elev		
Inflow Seepage Conc	20%	
Outflow Seepage Rate	20%	*0.024*
Outflow Seepage Control Elev		
Max Outflow Seepage Conc	20%	*0.001*
Seepage Recycle Fraction	20%	*-0.027*
Seepage Discharge Fraction	20%	
Initial Water Column Conc		
Initial P Storage Per Unit Area		
Initial Water Column Depth		
C0 = WC Conc at 0 g/m2 P Storage		*0.394*
C1 = WC Conc at 1 g/m2 P storage		*-0.026*
K = Net Settling Rate at Steady State		*-0.093*
Zx = Depth Scale Factor	*retrieved*	*0.021*
C0 - Periphyton	*from model*	
C1 - Periphyton	*calibration*	
K - Periphyton	*table*	
Zx - Periphyton		
Sm = Transition Storage Midpoint		
Sb = Transition Storage Bandwidth		

Cell Number -->	2	3	4	5	6
Cell Label					
Vegetation Type					
Inflow Fraction					
Downstream Cell Number					
Surface Area					
Mean Width of Flow Path					
Number of Tanks in Series					
Outflow Control Depth					
Outflow Coefficient - Exponent					
Outflow Coefficient - Intercept					
Bypass Depth					
Maximum Inflow					
Maximum Outflow					
Inflow Seepage Rate					
Inflow Seepage Control Elev					
Inflow Seepage Conc					
Outflow Seepage Rate					
Outflow Seepage Control Elev					
Max Outflow Seepage Conc					
Seepage Recycle Fraction					
Seepage Discharge Fraction					
Initial Water Column Conc					
Initial P Storage Per Unit Area					
Initial Water Column Depth					
C0 = WC Conc at 0 g/m2 P Storage					
C1 = WC Conc at 1 g/m2 P storage					
K = Net Settling Rate at Steady State					
Zx = Depth Scale Factor					
C0 - Periphyton					
C1 - Periphyton					
K - Periphyton					
Zx - Periphyton					
Sm = Transition Storage Midpoint					
Sb = Transition Storage Bandwidth					

Uncertainty Analysis

Case: SC4_final **sens50** **File:** C11w_base_final.xls 06/19/02

Estimates uncertainty in output variables. Assumes that sensitivity analysis has already been performed. Factors include: (1) uncertainty in p cycling parameters (from calibration); (2) uncertainty in other model inputs (user-specified); (3) inherent model error (from calibration); & (4) sensitivity of model output to each input value. Results are for combined outflows.

Reference: Walker, "A Sensitivity & Error Analysis Framework for Lake Eutrophication Modeling", Wtr Res Bul, Feb 1982

Select Output Variable:

- Treated FWM Outflow Conc
- Total FWM Outflow Conc
- Outflow Geo Mean - Composites
- Total Outflow Load

Total FWM Outflow Conc (ppb)		Error CV's = Standard Error / Mean	
50th Percentile Est. =	14	Total =	11%
10th Percentile Est. =	12	Model Error =	10%
90th Percentile Est =	16	Parameter Error =	4%
		Input Data Error =	2%

Show Results | Sensitivity Analysis | Menu

Sensitivity Coefficients

% Change in Output Variable / % Change in Input Variable

Enter assumed error CV (standard error, as percent of mean) in col. B (blue cells) to reflect uncertainty in each input value

Input Variable	Error CV	Value	Case Description:	Filename: C11w_base_final.xls
Design Case Name		SC4_final	100% SAV_C4	
Starting Date for Simulation			Max Depth = 170 cm	
Ending Date for Simulation			2006-2036 flows	
Starting Date for Output			Base case (50 ppb)	
Steps Per Day			**Output Variable**	**Units** / **Value**
Number of Iterations			Water Balance Error	% 0.0%
Output Averaging Interval			Mass Balance Error	% 0.0%
Reservoir H2O Residence Time			Flow-Wtd Conc - With Bypass	ppb 13.9
Max Inflow / Mean Inflow			Flow-Wtd Conc - Without Bypass	ppb 13.9
Max Reservoir Storage			Geometric Mean Conc	ppb 10.5
Reservoir P Decay Rate			95th Percentile Conc	ppb 18.6
Rainfall P Conc	30%	-0.008	Freq Cell Outflow > 10 ppb	% 54%
Atmospheric P Load (Dry)	30%	-0.030	Bypass Load	% 0.0%

Cell Number -->		1	2	3	4	5	6
Cell Label		S1					
Vegetation Type		SAV_C4					
Inflow Fraction	0%	*0.179*					
Downstream Cell Number							
Surface Area		*-0.177*					
Mean Width of Flow Path		*-0.002*					
Number of Tanks in Series	30%	*-0.048*					
Outflow Control Depth		*-0.086*					
Outflow Coefficient - Exponent							
Outflow Coefficient - Intercept	20%	*-0.002*					
Bypass Depth		*-0.009*					
Maximum Inflow							
Maximum Outflow							
Inflow Seepage Rate	20%						
Inflow Seepage Control Elev							
Inflow Seepage Conc	20%						
Outflow Seepage Rate	20%	*0.024*					
Outflow Seepage Control Elev							
Max Outflow Seepage Conc	20%	*0.001*					
Seepage Recycle Fraction	20%	*-0.027*					
Seepage Discharge Fraction	20%						
Initial Water Column Conc							
Initial P Storage Per Unit Area							
Initial Water Column Depth							
C0 = WC Conc at 0 g/m2 P Storage		*0.394*					
C1 = WC Conc at 1 g/m2 P storage		*-0.026*					
K = Net Settling Rate at Steady State		*-0.093*					
Zx = Depth Scale Factor	*retrieved*	*0.021*					
C0 - Periphyton	*from model*						
C1 - Periphyton	*calibration*						
K - Periphyton	*table*						
Zx - Periphyton							
Sm = Transition Storage Midpoint							
Sb = Transition Storage Bandwidth							

Uncertainty Analysis

Case: SC4_final **sens50** **File:** C11w_base_final.xls 06/19/02

Estimates uncertainty in output variables. Assumes that sensitivity analysis has already been performed. Factors include: (1) uncertainty in p cycling parameters (from calibration); (2) uncertainty in other model inputs (user-specified); (3) inherent model error (from calibration); & (4) sensitivity of model output to each input value. Results are for combined outflows.

Reference: Walker, "A Sensitivity & Error Analysis Framework for Lake Eutrophication Modeling", Wtr Res Bul, Feb 1982

Select Output Variable:

- Treated FWM Outflow Conc
- Total FWM Outflow Conc
- Outflow Geo Mean - Composites
- Total Outflow Load

Outflow Geo Mean - Composites (ppb)		Error CV's = Standard Error / Mean	
50th Percentile Est. =	10	Total =	12%
10th Percentile Est. =	9	Model Error =	10%
90th Percentile Est =	12	Parameter Error =	6%
		Input Data Error =	3%

Show Results | Sensitivity Analysis | Menu

Sensitivity Coefficients

% Change in Output Variable / % Change in Input Variable

Enter assumed error CV (standard error, as percent of mean) in col. B (blue cells) to reflect uncertainty in each input value

Case Description: **Filename: C11w_base_final.xls**

100% SAV_C4
Max Depth = 170 cm
2006-2036 flows
Base case (50 ppb)

Output Variable	Units	Value
Water Balance Error	%	0.0%
Mass Balance Error	%	0.0%
Flow-Wtd Conc - With Bypass	ppb	13.9
Flow-Wtd Conc - Without Bypass	ppb	13.9
Geometric Mean Conc	ppb	10.5
95th Percentile Conc	ppb	18.6
Freq Cell Outflow > 10 ppb	%	54%
Bypass Load	%	0.0%

Input Variable	Error CV	Value
Design Case Name		SC4_final
Starting Date for Simulation		
Ending Date for Simulation		
Starting Date for Output		
Steps Per Day		
Number of Iterations		
Output Averaging Interval		
Reservoir H2O Residence Time		
Max Inflow / Mean Inflow		
Max Reservoir Storage		
Reservoir P Decay Rate		
Rainfall P Conc	30%	-0.017
Atmospheric P Load (Dry)	30%	-0.038
Cell Number -->		1
Cell Label		S1
Vegetation Type		SAV_C4
Inflow Fraction	0%	*0.197*
Downstream Cell Number		
Surface Area		*-0.197*
Mean Width of Flow Path		*0.000*
Number of Tanks in Series	30%	*-0.079*
Outflow Control Depth		*-0.051*
Outflow Coefficient - Exponent		
Outflow Coefficient - Intercept	20%	*0.000*
Bypass Depth		*0.007*
Maximum Inflow		
Maximum Outflow		
Inflow Seepage Rate	20%	
Inflow Seepage Control Elev		
Inflow Seepage Conc	20%	
Outflow Seepage Rate	20%	*0.029*
Outflow Seepage Control Elev		
Max Outflow Seepage Conc	20%	*0.000*
Seepage Recycle Fraction	20%	*-0.030*
Seepage Discharge Fraction	20%	
Initial Water Column Conc		
Initial P Storage Per Unit Area		
Initial Water Column Depth		
C0 = WC Conc at 0 g/m2 P Storage		*0.579*
C1 = WC Conc at 1 g/m2 P storage		*-0.035*
K = Net Settling Rate at Steady State		*-0.150*
Zx = Depth Scale Factor	*retrieved*	*0.028*
C0 - Periphyton	*from model*	
C1 - Periphyton	*calibration*	
K - Periphyton	*table*	
Zx - Periphyton		
Sm = Transition Storage Midpoint		
Sb = Transition Storage Bandwidth		

Cell Number -->	2	3	4	5	6
Cell Label					
Vegetation Type					
Inflow Fraction					
Downstream Cell Number					
Surface Area					
Mean Width of Flow Path					
Number of Tanks in Series					
Outflow Control Depth					
Outflow Coefficient - Exponent					
Outflow Coefficient - Intercept					
Bypass Depth					
Maximum Inflow					
Maximum Outflow					
Inflow Seepage Rate					
Inflow Seepage Control Elev					
Inflow Seepage Conc					
Outflow Seepage Rate					
Outflow Seepage Control Elev					
Max Outflow Seepage Conc					
Seepage Recycle Fraction					
Seepage Discharge Fraction					
Initial Water Column Conc					
Initial P Storage Per Unit Area					
Initial Water Column Depth					
C0 = WC Conc at 0 g/m2 P Storage					
C1 = WC Conc at 1 g/m2 P storage					
K = Net Settling Rate at Steady State					
Zx = Depth Scale Factor					
C0 - Periphyton					
C1 - Periphyton					
K - Periphyton					
Zx - Periphyton					
Sm = Transition Storage Midpoint					
Sb = Transition Storage Bandwidth					

Uncertainty Analysis

Case: SC4_final **sens50** **File:** C11w_base_final.xls 06/19/02

Estimates uncertainty in output variables. Assumes that sensitivity analysis has already been performed. Factors include: (1) uncertainty in p cycling parameters (from calibration); (2) uncertainty in other model inputs (user-specified); (3) inherent model error (from calibration); & (4) sensitivity of model output to each input value. Results are for combined outflows.

Reference: Walker, "A Sensitivity & Error Analysis Framework for Lake Eutrophication Modeling", Wtr Res Bul, Feb 1982

Select Output Variable:

- Treated FWM Outflow Conc
- Total FWM Outflow Conc
- Outflow Geo Mean - Composites
- Total Outflow Load

Total Outflow Load (kg/yr)		Error CV's = Standard Error / Mean	
50th Percentile Est. =	277	Total =	11%
10th Percentile Est. =	238	Model Error =	10%
90th Percentile Est =	316	Parameter Error =	4%
		Input Data Error =	2%

Show Results | Sensitivity Analysis | Menu

Sensitivity Coefficients

% Change in Output Variable / % Change in Input Variable

Enter assumed error CV (standard error, as percent of mean) in col. B (blue cells) to reflect uncertainty in each input value

Input Variable	**Error CV**	**Value**
Design Case Name		SC4_final
Starting Date for Simulation		
Ending Date for Simulation		
Starting Date for Output		
Steps Per Day		
Number of Iterations		
Output Averaging Interval		
Reservoir H2O Residence Time		
Max Inflow / Mean Inflow		
Max Reservoir Storage		
Reservoir P Decay Rate		
Rainfall P Conc	30%	-0.008
Atmospheric P Load (Dry)	30%	-0.030
Cell Number -->		1
Cell Label		S1
Vegetation Type		SAV_C4
Inflow Fraction	0%	*1.136*
Downstream Cell Number		
Surface Area		*-0.283*
Mean Width of Flow Path		*-0.002*
Number of Tanks in Series	30%	*-0.048*
Outflow Control Depth		*-0.195*
Outflow Coefficient - Exponent		
Outflow Coefficient - Intercept	20%	*-0.002*
Bypass Depth		*-0.009*
Maximum Inflow		
Maximum Outflow		
Inflow Seepage Rate	20%	
Inflow Seepage Control Elev		
Inflow Seepage Conc	20%	
Outflow Seepage Rate	20%	*-0.035*
Outflow Seepage Control Elev		
Max Outflow Seepage Conc	20%	*0.001*
Seepage Recycle Fraction	20%	*0.038*
Seepage Discharge Fraction	20%	
Initial Water Column Conc		
Initial P Storage Per Unit Area		
Initial Water Column Depth		
C0 = WC Conc at 0 g/m2 P Storage		*0.394*
C1 = WC Conc at 1 g/m2 P storage		*-0.026*
K = Net Settling Rate at Steady State		*-0.093*
Zx = Depth Scale Factor	*retrieved*	*0.021*
C0 - Periphyton	*from model*	
C1 - Periphyton	*calibration*	
K - Periphyton	*table*	
Zx - Periphyton		
Sm = Transition Storage Midpoint		
Sb = Transition Storage Bandwidth		

Case Description: **Filename: C11w_base_final.xls**

100% SAV_C4
Max Depth = 170 cm
2006-2036 flows
Base case (50 ppb)

Output Variable	**Units**	**Value**
Water Balance Error	%	0.0%
Mass Balance Error	%	0.0%
Flow-Wtd Conc - With Bypass	ppb	13.9
Flow-Wtd Conc - Without Bypass	ppb	13.9
Geometric Mean Conc	ppb	10.5
95th Percentile Conc	ppb	18.6
Freq Cell Outflow > 10 ppb	%	54%
Bypass Load	%	0.0%

Cell Number -->	2	3	4	5	6
Cell Label					
Vegetation Type					
Inflow Fraction					
Downstream Cell Number					
Surface Area					
Mean Width of Flow Path					
Number of Tanks in Series					
Outflow Control Depth					
Outflow Coefficient - Exponent					
Outflow Coefficient - Intercept					
Bypass Depth					
Maximum Inflow					
Maximum Outflow					
Inflow Seepage Rate					
Inflow Seepage Control Elev					
Inflow Seepage Conc					
Outflow Seepage Rate					
Outflow Seepage Control Elev					
Max Outflow Seepage Conc					
Seepage Recycle Fraction					
Seepage Discharge Fraction					
Initial Water Column Conc					
Initial P Storage Per Unit Area					
Initial Water Column Depth					
C0 = WC Conc at 0 g/m2 P Storage					
C1 = WC Conc at 1 g/m2 P storage					
K = Net Settling Rate at Steady State					
Zx = Depth Scale Factor					
C0 - Periphyton					
C1 - Periphyton					
K - Periphyton					
Zx - Periphyton					
Sm = Transition Storage Midpoint					
Sb = Transition Storage Bandwidth					

DMSTA Input Values **Feeder Basin - Alt. 1 basecase**

Input Variable	Units	Value
Design Case Name	-	S100b_r6a
Starting Date for Simulation	-	01/00/00
Ending Date for Simulation	-	01/00/00
Starting Date for Output	-	01/00/00
Steps Per Day	-	8
Number of Iterations	-	2
Output Averaging Interval	days	7
Reservoir H2O Residence Time	days	0
Max Inflow / Mean Inflow	-	16
Max Reservoir Storage	hm3	8
Reservoir P Decay Rate	1/yr/ppb	0
Rainfall P Conc	ppb	20
Atmospheric P Load (Dry)	mg/m2-yr	20

Case Description: 100% SAV at 89 cm and 3.5 km2 (3 cells of SAV) with reservoir

Filename: feeder_final_50.xls

Output Variable	Units	Value
Water Balance Error	%	0.0%
Mass Balance Error	%	-0.1%
Flow-Wtd Conc - With Bypass	ppb	26
Flow-Wtd Conc - Without Bypass	ppb	26
Geometric Mean Conc	ppb	10
95th Percentile Conc	ppb	36
Freq Cell Outflow > 10 ppb	%	48%
Bypass Load	%	0.0%

Cell Number -->		1	2	3	4	5	6
Cell Label	-	SAV1	SAV1	SAV1			
Vegetation Type	------->	SAV_C4	SAV_C4	SAV_C4			
Inflow Fraction	-	1	0	0			
Downstream Cell Number	-	2	3	0			
Surface Area	km2	1.167	1.167	1.167			
Mean Width of Flow Path	km	1.87	1.87	1.87			
Number of Tanks in Series	-	3	3	3			
Outflow Control Depth	cm	89	89	89			
Outflow Coefficient - Exponent	-	3.5	3.5	3.5			
Outflow Coefficient - Intercept	-	0.8	0.8	0.8			
Bypass Depth	cm	140	140	140			
Maximum Inflow	hm3/day	0	0	0			
Maximum Outflow	hm3/day	0	0	0			
Inflow Seepage Rate	(cm/d) / cm	0	0	0			
Inflow Seepage Control Elev	cm	0	0	0			
Inflow Seepage Conc	ppb	0	0	0			
Outflow Seepage Rate	(cm/d) / cm	0.008	0.008	0.008			
Outflow Seepage Control Elev	cm	0	0	0			
Max Outflow Seepage Conc	ppb	20	20	20			
Seepage Recycle Fraction	-	0.5	0.5	0.5			
Seepage Discharge Fraction	-	0	0	0			
Initial Water Column Conc	ppb	30	30	30			
Initial P Storage Per Unit Area	mg/m2	500	500	500			
Initial Water Column Depth	cm	50	50	50			
C0 = WC Conc at 0 g/m2 P Storage	ppb	*4*	*4*	*4*			
C1 = WC Conc at 1 g/m2 P storage	ppb	*22*	*22*	*22*			
K = Net Settling Rate at Steady State	m/yr	*80*	*80*	*80*			
Zx = Depth Scale Factor	cm	*60*	*60*	*60*			
C0 - Periphyton	ppb	*0*	*0*	*0*			
C1 - Periphyton	ppb	*0*	*0*	*0*			
K - Periphyton	1/yr	*0.00*	*0.00*	*0.00*			
Zx - Periphyton	cm	*0*	*0*	*0*			
Sm = Transition Storage Midpoint	mg/m2	*0*	*0*	*0*			
Sb = Transition Storage Bandwidth	mg/m2	*0*	*0*	*0*			

Output Variables	Units	1	2	3	4	5	6	Overall
Execution Time	seconds/yr	3.55	7.16	10.90				10.90
Run Date	-	05/09/02	05/09/02	05/09/02				05/09/02
Starting Date for Simulation	-	01/01/65	01/01/65	01/01/65				01/01/65
Starting Date for Output	-	01/01/65	01/01/65	01/01/65				01/01/65
Ending Date	-	12/31/95	12/31/95	12/31/95				12/31/95
Output Duration	days	11322	11322	11322				11322
Cell Label		SAV1	SAV1	SAV1				Total Outflow
Downstream Cell Label		SAV1	SAV1	Outflow				-
Surface Area	km2	1.167	1.167	1.167				3.5
Mean Water Load	cm/d	22.4	22.0	21.6				7.5
Max Water Load	cm/d	296.8	295.2	292.7				98.9
Inflow Volume	hm3/yr	95.3	93.7	92.1				95.3
Inflow Load	kg/yr	5562.7	3983.3	2983.7				5562.7
Inflow Conc	ppb	58	43	32				58.4
Treated Outflow Volume	hm3/yr	93.7	92.1	90.6				90.6
Treated Outflow Load	kg/yr	3983.3	2983.7	2377.8				2377.8
Treated FWM Outflow Conc	ppb	43	32	26				26.2
Total Outflow Volume	hm3/yr	93.7	92.1	90.6				90.6

Feeder Canal Basin - Alt. 1 basecase (cont'd)

Total Outflow Load	kg/yr	3983.3	2983.7	2377.8	2377.8
Total FWM Outflow Conc	ppb	43	32	26	26.2
Bypass Volume	hm3/yr	0.00	0.00	0.00	0.00
Bypass Load	kg/yr	0.00	0.00	0.00	0.00
Bypass Conc	ppb	0	0	0	0.0
Bypass Load	%	0%	0%	0%	0%
Surface Outflow Load Reduc	%	28.4%	25.1%	20.3%	57.3%
Outflow Geometric Mean - Daily	ppb	20	14	11	10.7
Outflow Geo Mean - Composites	ppb	19	13	10	10.1
Frequency Outflow Conc > 10 ppb	%	#DIV/0!	#DIV/0!	#DIV/0!	48%
95th Percentile Outflow Conc	ppb	#NUM!	#NUM!	#NUM!	36.2
Mean Biomass P Storage	mg/m2	947	609	379	645
Max Reservoir Storage	hm3	2.73	2.73	2.73	2.73
Reservoir Load Reduction	%	0%	0%	0%	0%
Mean Depth	cm	78.9	76.7	75.6	77.1
Minimum Depth	cm	1.0	1.0	1.0	1.0
Maximum Depth	cm	126.4	126.2	125.9	126.1
Frequency Depth < 5 cm	%	0.0%	0.0%	0.0%	0.0%
Flow/Width	m2/day	137	135	133	134.8
Max 1 Yr Flow-Wtd Conc	ppb	#N/A	#N/A	#N/A	51.0
Max 5 Yr Flow-Wtd Conc	ppb	#N/A	#N/A	#N/A	38.0
Max 1 Yr Geometric Mn Conc	ppb	#N/A	#N/A	#N/A	32.7
Max 5 Yr Geometric Mn Conc	ppb	#N/A	#N/A	#N/A	22.8
Depth Percentile vs. Calib Set	%	62%	59%	58%	58%
Q/W Percentile vs. Calib Set	%	63%	62%	61%	61%
Cin Percentile vs. Calib Set	%	66%	#N/A	#N/A	66%
Cout Percentile vs. Calib Set	%	#N/A	#N/A	#N/A	#N/A
Depth Range Flag	-	OK	OK	OK	0.0
Q/W Range Flag	-	OK	OK	OK	0.0
Cin Range Flag	-	OK			0.0
Cout Range Flag	-				0.0
Water Balance Error	%	0.00%	0.00%	0.00%	0.00%
Mass Balance Error	%	-0.08%	-0.02%	0.01%	-0.08%

DMSTA Input Values **Feeder Basin - Alt. 1 with 75 ppb max TP (Sensitivity)**

Input Variable	Units	Value
Design Case Name	-	SC4_75final
Starting Date for Simulation	-	01/00/00
Ending Date for Simulation	-	01/00/00
Starting Date for Output	-	01/00/00
Steps Per Day	-	8
Number of Iterations	-	2
Output Averaging Interval	days	7
Reservoir H2O Residence Time	days	0
Max Inflow / Mean Inflow	-	16
Max Reservoir Storage	hm3	7.2
Reservoir P Decay Rate	1/yr/ppb	0
Rainfall P Conc	ppb	20
Atmospheric P Load (Dry)	mg/m2-yr	20

Case Description: **Filename:** **feeder_final_75.xls**

100% SAV at 89 cm and 4.6 km2 (3 cells of SAV)
with reservoir
SC4_75f
GM10 - back out reservoir rqrd

Output Variable	Units	Value
Water Balance Error	%	0.0%
Mass Balance Error	%	-0.2%
Flow-Wtd Conc - With Bypass	ppb	27
Flow-Wtd Conc - Without Bypass	ppb	27
Geometric Mean Conc	ppb	10
95th Percentile Conc	ppb	36
Freq Cell Outflow > 10 ppb	%	51%
Bypass Load	%	0.0%

Cell Number -->		1	2	3	4	5	6
Cell Label	-	SAV1	SAV2	SAV3			
Vegetation Type	------->	SAV_C4	SAV_C4	SAV_C4			
Inflow Fraction	-	1	0	0			
Downstream Cell Number	-	2	3	0			
Surface Area	km2	1.533	1.533	1.533			
Mean Width of Flow Path	km	2.14	2.14	2.14			
Number of Tanks in Series	-	3	3	3			
Outflow Control Depth	cm	89	89	89			
Outflow Coefficient - Exponent	-	3.5	3.5	3.5			
Outflow Coefficient - Intercept	-	0.8	0.8	0.8			
Bypass Depth	cm	140	140	140			
Maximum Inflow	hm3/day	0	0	0			
Maximum Outflow	hm3/day	0	0	0			
Inflow Seepage Rate	(cm/d) / cm	0	0	0			
Inflow Seepage Control Elev	cm	0	0	0			
Inflow Seepage Conc	ppb	0	0	0			
Outflow Seepage Rate	(cm/d) / cm	0.008	0.008	0.008			
Outflow Seepage Control Elev	cm	0	0	0			
Max Outflow Seepage Conc	ppb	20	20	20			
Seepage Recycle Fraction	-	0.5	0.5	0.5			
Seepage Discharge Fraction	-	0	0	0			
Initial Water Column Conc	ppb	30	30	30			
Initial P Storage Per Unit Area	mg/m2	500	500	500			
Initial Water Column Depth	cm	50	50	50			
C0 = WC Conc at 0 g/m2 P Storage	ppb	*4*	*4*	*4*			
C1 = WC Conc at 1 g/m2 P storage	ppb	*22*	*22*	*22*			
K = Net Settling Rate at Steady State	m/yr	*80*	*80*	*80.10*			
Zx = Depth Scale Factor	cm	*60*	*60*	*60*			
C0 - Periphyton	ppb	*0*	*0*	*0*			
C1 - Periphyton	ppb	*0*	*0*	*0*			
K - Periphyton	1/yr	*0.00*	*0.00*	*0.00*			
Zx - Periphyton	cm	*0*	*0*	*0*			
Sm = Transition Storage Midpoint	mg/m2	*0*	*0*	*0*			
Sb = Transition Storage Bandwidth	mg/m2	*0*	*0*	*0*			

Output Variables	Units	1	2	3	4	5	6	Overall
Execution Time	seconds/yr	4.97	10.36	15.71				15.71
Run Date	-	05/15/02	05/15/02	05/15/02				05/15/02
Starting Date for Simulation	-	01/01/65	01/01/65	01/01/65				01/01/65
Starting Date for Output	-	01/01/65	01/01/65	01/01/65				01/01/65
Ending Date	-	12/31/95	12/31/95	12/31/95				12/31/95
Output Duration	days	11322	11322	11322				11322
Cell Label		SAV1	SAV1	SAV1				Total Outflow
Downstream Cell Label		SAV1	SAV1	Outflow				-
Surface Area	km2	1.533	1.533	1.533				4.6
Mean Water Load	cm/d	17.0	16.6	16.3				5.7
Max Water Load	cm/d	225.9	224.2	221.7				75.3
Inflow Volume	hm3/yr	95.3	93.2	91.2				95.3
Inflow Load	kg/yr	8344.0	5034.6	3268.2				8344.0
Inflow Conc	ppb	88	54	36				87.6
Treated Outflow Volume	hm3/yr	93.2	91.2	89.2				89.2
Treated Outflow Load	kg/yr	5034.6	3268.2	2385.9				2385.9
Treated FWM Outflow Conc	ppb	54	36	27				26.8
Total Outflow Volume	hm3/yr	93.2	91.2	89.2				89.2

Feeder Basin - Alt. 1 with 75 ppb max TP (Sensitivity) (cont'd)

Total Outflow Load	kg/yr	5034.6	3268.2	2385.9	2385.9
Total FWM Outflow Conc	ppb	54	36	27	26.8
Bypass Volume	hm3/yr	0.00	0.00	0.00	0.00
Bypass Load	kg/yr	0.00	0.00	0.00	0.00
Bypass Conc	ppb	0	0	0	0.0
Bypass Load	%	0%	0%	0%	0%
Surface Outflow Load Reduc	%	39.7%	35.1%	27.0%	71.4%
Outflow Geometric Mean - Daily	ppb	26	16	11	10.9
Outflow Geo Mean - Composites	ppb	25	15	10	10.4
Frequency Outflow Conc > 10 ppb	%	#DIV/0!	#DIV/0!	#DIV/0!	51%
95th Percentile Outflow Conc	ppb	#NUM!	#NUM!	#NUM!	36.2
Mean Biomass P Storage	mg/m2	1495	809	418	907
Max Reservoir Storage	hm3	2.73	2.73	2.73	2.73
Reservoir Load Reduction	%	0%	0%	0%	0%
Mean Depth	cm	78.2	75.9	74.5	76.2
Minimum Depth	cm	1.0	1.0	1.0	1.0
Maximum Depth	cm	121.5	121.2	120.8	121.2
Frequency Depth < 5 cm	%	0.0%	0.0%	0.0%	0.0%
Flow/Width	m2/day	119	116	114	116.3
Max 1 Yr Flow-Wtd Conc	ppb	#N/A	#N/A	#N/A	54.6
Max 5 Yr Flow-Wtd Conc	ppb	#N/A	#N/A	#N/A	37.4
Max 1 Yr Geometric Mn Conc	ppb	#N/A	#N/A	#N/A	33.9
Max 5 Yr Geometric Mn Conc	ppb	#N/A	#N/A	#N/A	24.2
Depth Percentile vs. Calib Set	%	61%	58%	56%	56%
Q/W Percentile vs. Calib Set	%	55%	54%	53%	53%
Cin Percentile vs. Calib Set	%	85%	#N/A	#N/A	85%
Cout Percentile vs. Calib Set	%	#N/A	#N/A	#N/A	#N/A
Depth Range Flag	-	OK	OK	OK	0.0
Q/W Range Flag	-	OK	OK	OK	0.0
Cin Range Flag	-	OK			0.0
Cout Range Flag	-				0.0
Water Balance Error	%	0.00%	0.00%	0.00%	0.00%
Mass Balance Error	%	-0.19%	-0.05%	0.00%	-0.21%

DMSTA Input Values **Feeder Basin - Alt. 1 with 100 ppb max TP (Sensitivity)**

Input Variable	Units	Value
Design Case Name	-	SC4_100final
Starting Date for Simulation	-	01/00/00
Ending Date for Simulation	-	01/00/00
Starting Date for Output	-	01/00/00
Steps Per Day	-	8
Number of Iterations	-	2
Output Averaging Interval	days	7
Reservoir H2O Residence Time	days	0
Max Inflow / Mean Inflow	-	16
Max Reservoir Storage	hm3	6.6
Reservoir P Decay Rate	1/yr/ppb	0
Rainfall P Conc	ppb	20
Atmospheric P Load (Dry)	mg/m2-yr	20

Case Description: **Filename: feeder_final_100.xls**

100% SAV at 89 cm and 5.4 km2 (3 cells of SAV)
with reservoir
SC4_100d
find GM 10

Output Variable	Units	Value
Water Balance Error	%	0.0%
Mass Balance Error	%	-0.3%
Flow-Wtd Conc - With Bypass	ppb	27
Flow-Wtd Conc - Without Bypass	ppb	27
Geometric Mean Conc	ppb	10
95th Percentile Conc	ppb	36
Freq Cell Outflow > 10 ppb	%	51%
Bypass Load	%	0.0%

Cell Number -->		1	2	3	4	5	6
Cell Label	-	SAV1	SAV1	SAV1			
Vegetation Type	------->	SAV_C4	SAV_C4	SAV_C4			
Inflow Fraction	-	1	0	0			
Downstream Cell Number	-	2	3	0			
Surface Area	km2	1.800	1.800	1.800			
Mean Width of Flow Path	km	2.32	2.32	2.32			
Number of Tanks in Series	-	3	3	3			
Outflow Control Depth	cm	89	89	89			
Outflow Coefficient - Exponent	-	3.5	3.5	3.5			
Outflow Coefficient - Intercept	-	0.8	0.8	0.8			
Bypass Depth	cm	140	140	140			
Maximum Inflow	hm3/day	0	0	0			
Maximum Outflow	hm3/day	0	0	0			
Inflow Seepage Rate	(cm/d) / cm	0	0	0			
Inflow Seepage Control Elev	cm	0	0	0			
Inflow Seepage Conc	ppb	0	0	0			
Outflow Seepage Rate	(cm/d) / cm	0.008	0.008	0.008			
Outflow Seepage Control Elev	cm	0	0	0			
Max Outflow Seepage Conc	ppb	20	20	20			
Seepage Recycle Fraction	-	0.5	0.5	0.5			
Seepage Discharge Fraction	-	0	0	0			
Initial Water Column Conc	ppb	30	30	30			
Initial P Storage Per Unit Area	mg/m2	500	500	500			
Initial Water Column Depth	cm	50	50	50			
C0 = WC Conc at 0 g/m2 P Storage	ppb	*4*	*4*	*4*			
C1 = WC Conc at 1 g/m2 P storage	ppb	*22*	*22*	*22*			
K = Net Settling Rate at Steady State	m/yr	*80*	*80*	*80*			
Zx = Depth Scale Factor	cm	*60*	*60*	*60*			
C0 - Periphyton	ppb	*0*	*0*	*0*			
C1 - Periphyton	ppb	*0*	*0*	*0*			
K - Periphyton	1/yr	*0.00*	*0.00*	*0.00*			
Zx - Periphyton	cm	*0*	*0*	*0*			
Sm = Transition Storage Midpoint	mg/m2	*0*	*0*	*0*			
Sb = Transition Storage Bandwidth	mg/m2	*0*	*0*	*0*			

Output Variables	Units	1	2	3	4	5	6	Overall
Execution Time	seconds/yr	5.00	10.13	15.52				15.52
Run Date	-	05/15/02	05/15/02	05/15/02				05/15/02
Starting Date for Simulation	-	01/01/65	01/01/65	01/01/65				01/01/65
Starting Date for Output	-	01/01/65	01/01/65	01/01/65				01/01/65
Ending Date	-	12/31/95	12/31/95	12/31/95				12/31/95
Output Duration	days	11322	11322	11322				11322
Cell Label		SAV1	SAV1	SAV1				Total Outflow
Downstream Cell Label		SAV1	SAV1	Outflow				-
Surface Area	km2	1.800	1.800	1.800				5.4
Mean Water Load	cm/d	14.5	14.1	13.8				4.8
Max Water Load	cm/d	192.4	190.8	188.3				64.1
Inflow Volume	hm3/yr	95.3	92.8	90.5				95.3
Inflow Load	kg/yr	11125.3	5881.5	3422.1				11125.3
Inflow Conc	ppb	117	63	38				116.8
Treated Outflow Volume	hm3/yr	92.8	90.5	88.2				88.2
Treated Outflow Load	kg/yr	5881.5	3422.1	2355.0				2355.0
Treated FWM Outflow Conc	ppb	63	38	27				26.7
Total Outflow Volume	hm3/yr	92.8	90.5	88.2				88.2

Feeder Basin - Alt. 1 with 100 ppb max TP (Sensitivity) (cont'd)

Total Outflow Load	kg/yr	5881.5	3422.1	2355.0	2355.0
Total FWM Outflow Conc	ppb	63	38	27	26.7
Bypass Volume	hm3/yr	0.00	0.00	0.00	0.00
Bypass Load	kg/yr	0.00	0.00	0.00	0.00
Bypass Conc	ppb	0	0	0	0.0
Bypass Load	%	0%	0%	0%	0%
Surface Outflow Load Reduc	%	47.1%	41.8%	31.2%	78.8%
Outflow Geometric Mean - Daily	ppb	26	14	9	8.9
Outflow Geo Mean - Composites	ppb	30	16	10	10.4
Frequency Outflow Conc > 10 ppb	%	#DIV/0!	#DIV/0!	#DIV/0!	51%
95th Percentile Outflow Conc	ppb	#NUM!	#NUM!	#NUM!	35.9
Mean Biomass P Storage	mg/m2	2008	955	430	1131
Max Reservoir Storage	hm3	2.73	2.73	2.73	2.73
Reservoir Load Reduction	%	0%	0%	0%	0%
Mean Depth	cm	77.8	75.4	73.6	75.6
Minimum Depth	cm	1.0	1.0	1.0	1.0
Maximum Depth	cm	118.7	118.4	118.4	118.5
Frequency Depth < 5 cm	%	0.0%	0.0%	0.0%	0.0%
Flow/Width	m2/day	109	107	104	106.6
Max 1 Yr Flow-Wtd Conc	ppb	#N/A	#N/A	#N/A	58.7
Max 5 Yr Flow-Wtd Conc	ppb	#N/A	#N/A	#N/A	36.5
Max 1 Yr Geometric Mn Conc	ppb	#N/A	#N/A	#N/A	33.8
Max 5 Yr Geometric Mn Conc	ppb	#N/A	#N/A	#N/A	24.3
Depth Percentile vs. Calib Set	%	61%	58%	55%	55%
Q/W Percentile vs. Calib Set	%	51%	49%	48%	48%
Cin Percentile vs. Calib Set	%	98%	#N/A	#N/A	98%
Cout Percentile vs. Calib Set	%	#N/A	#N/A	#N/A	#N/A
Depth Range Flag	-	OK	OK	OK	0.0
Q/W Range Flag	-	OK	OK	OK	0.0
Cin Range Flag	-	OK			0.0
Cout Range Flag	-				0.0
Water Balance Error	%	0.00%	0.00%	0.00%	0.00%
Mass Balance Error	%	-0.28%	-0.07%	-0.01%	-0.31%

DMSTA Input Values **Feeder Basin - Alt. 1 basecase with Bypass of 10-yr flows**

Input Variable	Units	Value
Design Case Name	-	S100b_r6a_b11
Starting Date for Simulation	-	01/00/00
Ending Date for Simulation	-	01/00/00
Starting Date for Output	-	01/00/00
Steps Per Day	-	8
Number of Iterations	-	2
Output Averaging Interval	days	7
Reservoir H2O Residence Time	days	0
Max Inflow / Mean Inflow	-	16
Max Reservoir Storage	hm3	5.5
Reservoir P Decay Rate	1/yr/ppb	0
Rainfall P Conc	ppb	20
Atmospheric P Load (Dry)	mg/m2-yr	20

Case Description: **Filename:** **feeder_bypass_50.xls**

100% SAV at 89 cm and 3.4 km2 (3 cells of SAV)
with reservoir
with bypass 10 yr storm event flows (2974 cfs)
Feeder 50 ppb case

Output Variable	Units	Value
Water Balance Error	%	0.0%
Mass Balance Error	%	-0.1%
Flow-Wtd Conc - With Bypass	ppb	26
Flow-Wtd Conc - Without Bypass	ppb	26
Geometric Mean Conc	ppb	10
95th Percentile Conc	ppb	36
Freq Cell Outflow > 10 ppb	%	49%
Bypass Load	%	0.0%

Cell Number -->		1	2	3	4	5	6
Cell Label	-	SAV1	SAV2	SAV3			
Vegetation Type	------->	SAV_C4	SAV_C4	SAV_C4			
Inflow Fraction	-	1	0	0			
Downstream Cell Number	-	2	3	0			
Surface Area	km2	1.133	1.133	1.133			
Mean Width of Flow Path	km	1.84	1.84	1.84			
Number of Tanks in Series	-	3	3	3			
Outflow Control Depth	cm	89	89	89			
Outflow Coefficient - Exponent	-	3.5	3.5	3.5			
Outflow Coefficient - Intercept	-	0.8	0.8	0.8			
Bypass Depth	cm	140	140	140			
Maximum Inflow	hm3/day	0	0	0			
Maximum Outflow	hm3/day	0	0	0			
Inflow Seepage Rate	(cm/d) / cm	0	0	0			
Inflow Seepage Control Elev	cm	0	0	0			
Inflow Seepage Conc	ppb	0	0	0			
Outflow Seepage Rate	(cm/d) / cm	0.008	0.008	0.008			
Outflow Seepage Control Elev	cm	0	0	0			
Max Outflow Seepage Conc	ppb	20	20	20			
Seepage Recycle Fraction	-	0.5	0.5	0.5			
Seepage Discharge Fraction	-	0	0	0			
Initial Water Column Conc	ppb	30	30	30			
Initial P Storage Per Unit Area	mg/m2	500	500	500			
Initial Water Column Depth	cm	50	50	50			
C0 = WC Conc at 0 g/m2 P Storage	ppb	*4*	*4*	*4*			
C1 = WC Conc at 1 g/m2 P storage	ppb	*22*	*22*	*22*			
K = Net Settling Rate at Steady State	m/yr	*80*	*80*	*80*			
Zx = Depth Scale Factor	cm	*60*	*60*	*60*			
C0 - Periphyton	ppb	*0*	*0*	*0*			
C1 - Periphyton	ppb	*0*	*0*	*0*			
K - Periphyton	1/yr	*0.00*	*0.00*	*0.00*			
Zx - Periphyton	cm	*0*	*0*	*0*			
Sm = Transition Storage Midpoint	mg/m2	*0*	*0*	*0*			
Sb = Transition Storage Bandwidth	mg/m2	*0*	*0*	*0*			

Output Variables	Units	1	2	3	4	5	6	Overall
Execution Time	seconds/yr	7.42	14.55	21.55				21.55
Run Date	-	05/16/02	05/16/02	05/16/02				05/16/02
Starting Date for Simulation	-	01/01/65	01/01/65	01/01/65				01/01/65
Starting Date for Output	-	01/01/65	01/01/65	01/01/65				01/01/65
Ending Date	-	12/31/95	12/31/95	12/31/95				12/31/95
Output Duration	days	11322	11322	11322				11322
Cell Label		SAV1	SAV2	SAV3				Total Outflow
Downstream Cell Label		SAV2	SAV3	Outflow				-
Surface Area	km2	1.133	1.133	1.133				3.4
Mean Water Load	cm/d	22.9	22.5	22.2				7.6
Max Water Load	cm/d	305.6	303.9	301.4				101.9
Inflow Volume	hm3/yr	94.8	93.3	91.7				94.8
Inflow Load	kg/yr	5420.1	3899.1	2934.2				5420.1
Inflow Conc	ppb	57	42	32				57.2
Treated Outflow Volume	hm3/yr	93.3	91.7	90.3				90.3
Treated Outflow Load	kg/yr	3899.1	2934.2	2346.1				2346.1
Treated FWM Outflow Conc	ppb	42	32	26				26.0
Total Outflow Volume	hm3/yr	93.3	91.7	90.3				90.3

Feeder Basin - Alt. 1 basecase with Bypass of 10-yr flows (cont'd)

Total Outflow Load	kg/yr	3899.1	2934.2	2346.1	2346.1
Total FWM Outflow Conc	ppb	42	32	26	26.0
Bypass Volume	hm3/yr	0.00	0.00	0.00	0.00
Bypass Load	kg/yr	0.00	0.00	0.00	0.00
Bypass Conc	ppb	0	0	0	0.0
Bypass Load	%	0%	0%	0%	0%
Surface Outflow Load Reduc	%	28.1%	24.7%	20.0%	56.7%
Outflow Geometric Mean - Daily	ppb	20	14	11	10.8
Outflow Geo Mean - Composites	ppb	19	13	10	10.2
Frequency Outflow Conc > 10 ppb	%	83%	64%	49%	49%
95th Percentile Outflow Conc	ppb	59	45	36	36.3
Mean Biomass P Storage	mg/m2	939	605	379	641
Max Reservoir Storage	hm3	2.75	2.75	2.75	2.75
Reservoir Load Reduction	%	0%	0%	0%	0%
Mean Depth	cm	78.9	76.8	75.7	77.1
Minimum Depth	cm	1.0	1.0	1.0	1.0
Maximum Depth	cm	126.9	126.7	126.4	126.7
Frequency Depth < 5 cm	%	0.2%	0.3%	0.4%	0.3%
Flow/Width	m2/day	138	136	134	136.2
Max 1 Yr Flow-Wtd Conc	ppb	#N/A	#N/A	#N/A	51.6
Max 5 Yr Flow-Wtd Conc	ppb	#N/A	#N/A	#N/A	36.4
Max 1 Yr Geometric Mn Conc	ppb	#N/A	#N/A	#N/A	29.1
Max 5 Yr Geometric Mn Conc	ppb	#N/A	#N/A	#N/A	22.2
Depth Percentile vs. Calib Set	%	62%	59%	58%	58%
Q/W Percentile vs. Calib Set	%	64%	63%	62%	62%
Cin Percentile vs. Calib Set	%	65%	50%	38%	65%
Cout Percentile vs. Calib Set	%	51%	38%	29%	29%
Depth Range Flag	-	OK	OK	OK	0.0
Q/W Range Flag	-	OK	OK	OK	0.0
Cin Range Flag	-	OK	OK	OK	0.0
Cout Range Flag	-	OK	OK	OK	0.0
Water Balance Error	%	0.00%	0.00%	0.00%	0.00%
Mass Balance Error	%	-0.06%	-0.01%	0.02%	-0.06%

DMSTA Input Values **Feeder Basin - Alt. 1 basecase using NEWS (Sensitivity)**

Input Variable	Units	Value
Design Case Name	-	NEWS
Starting Date for Simulation	-	01/00/00
Ending Date for Simulation	-	01/00/00
Starting Date for Output	-	01/00/00
Steps Per Day	-	8
Number of Iterations	-	2
Output Averaging Interval	days	7
Reservoir H2O Residence Time	days	0
Max Inflow / Mean Inflow	-	16
Max Reservoir Storage	hm3	8
Reservoir P Decay Rate	1/yr/ppb	0
Rainfall P Conc	ppb	20
Atmospheric P Load (Dry)	mg/m2-yr	20

Case Description: **Filename:** **feeder_final_50.xls**

100% NEWS at 89 cm and 3.5 km2 (3 cells of NEWS)
with reservoir

Output Variable	Units	Value
Water Balance Error	%	0.0%
Mass Balance Error	%	0.2%
Flow-Wtd Conc - With Bypass	ppb	40
Flow-Wtd Conc - Without Bypass	ppb	40
Geometric Mean Conc	ppb	13
95th Percentile Conc	ppb	59
Freq Cell Outflow > 10 ppb	%	54%
Bypass Load	%	0.0%

Cell Number -->		1	2	3	4	5	6
Cell Label	-	SAV1	SAV1	SAV1			
Vegetation Type	------->	NEWS	NEWS	NEWS			
Inflow Fraction	-	1	0	0			
Downstream Cell Number	-	2	3	0			
Surface Area	km2	1.167	1.167	1.167			
Mean Width of Flow Path	km	1.87	1.87	1.87			
Number of Tanks in Series	-	3	3	3			
Outflow Control Depth	cm	89	89	89			
Outflow Coefficient - Exponent	-	3.5	3.5	3.5			
Outflow Coefficient - Intercept	-	0.8	0.8	0.8			
Bypass Depth	cm	140	140	140			
Maximum Inflow	hm3/day	0	0	0			
Maximum Outflow	hm3/day	0	0	0			
Inflow Seepage Rate	(cm/d) / cm	0	0	0			
Inflow Seepage Control Elev	cm	0	0	0			
Inflow Seepage Conc	ppb	0	0	0			
Outflow Seepage Rate	(cm/d) / cm	0.008	0.008	0.008			
Outflow Seepage Control Elev	cm	0	0	0			
Max Outflow Seepage Conc	ppb	20	20	20			
Seepage Recycle Fraction	-	0.5	0.5	0.5			
Seepage Discharge Fraction	-	0	0	0			
Initial Water Column Conc	ppb	30	30	30			
Initial P Storage Per Unit Area	mg/m2	500	500	500			
Initial Water Column Depth	cm	50	50	50			
C0 = WC Conc at 0 g/m2 P Storage	ppb	*12*	*12*	*12*			
C1 = WC Conc at 1 g/m2 P storage	ppb	*22*	*22*	*22*			
K = Net Settling Rate at Steady State	m/yr	*129*	*129*	*129*			
Zx = Depth Scale Factor	cm	*60*	*60*	*60*			
C0 - Periphyton	ppb	*4*	*4*	*4*			
C1 - Periphyton	ppb	*22*	*22*	*22*			
K - Periphyton	1/yr	*23.80*	*23.80*	*23.80*			
Zx - Periphyton	cm	*0*	*0*	*0*			
Sm = Transition Storage Midpoint	mg/m2	*400*	*400*	*400*			
Sb = Transition Storage Bandwidth	mg/m2	*80*	*80*	*80*			

Output Variables	Units	1	2	3	4	5	6	Overall
Execution Time	seconds/yr	3.84	7.61	11.36				11.36
Run Date	-	07/05/02	07/05/02	07/05/02				07/05/02
Starting Date for Simulation	-	01/01/65	01/01/65	01/01/65				01/01/65
Starting Date for Output	-	01/01/65	01/01/65	01/01/65				01/01/65
Ending Date	-	12/31/95	12/31/95	12/31/95				12/31/95
Output Duration	days	11322	11322	11322				11322
Cell Label		SAV1	SAV1	SAV1				Total Outflow
Downstream Cell Label		SAV1	SAV1	Outflow				-
Surface Area	km2	1.167	1.167	1.167				3.5
Mean Water Load	cm/d	22.4	22.0	21.6				7.5
Max Water Load	cm/d	296.8	295.2	292.7				98.9
Inflow Volume	hm3/yr	95.3	93.7	92.1				95.3
Inflow Load	kg/yr	5562.7	4627.0	4045.5				5562.7
Inflow Conc	ppb	58	49	44				58.4
Treated Outflow Volume	hm3/yr	93.7	92.1	90.6				90.6
Treated Outflow Load	kg/yr	4627.0	4045.5	3627.4				3627.4
Treated FWM Outflow Conc	ppb	49	44	40				40.0
Total Outflow Volume	hm3/yr	93.7	92.1	90.6				90.6

Feeder Basin - Alt. 1 basecase using NEWS (Sensitivity) (cont'd)

Total Outflow Load	kg/yr	4627.0	4045.5	3627.4	3627.4
Total FWM Outflow Conc	ppb	49	44	40	40.0
Bypass Volume	hm3/yr	0.00	0.00	0.00	0.00
Bypass Load	kg/yr	0.00	0.00	0.00	0.00
Bypass Conc	ppb	0	0	0	0.0
Bypass Load	%	0%	0%	0%	0%
Surface Outflow Load Reduc	%	16.8%	12.6%	10.3%	34.8%
Outflow Geometric Mean - Daily	ppb	20	16	15	14.6
Outflow Geo Mean - Composites	ppb	18	15	13	13.3
Frequency Outflow Conc > 10 ppb	%	#DIV/0!	#DIV/0!	#DIV/0!	54%
95th Percentile Outflow Conc	ppb	#NUM!	#NUM!	#NUM!	59.5
Mean Biomass P Storage	mg/m2	696	497	406	533
Max Reservoir Storage	hm3	2.73	2.73	2.73	2.73
Reservoir Load Reduction	%	0%	0%	0%	0%
Mean Depth	cm	78.9	76.7	75.6	77.1
Minimum Depth	cm	1.0	1.0	1.0	1.0
Maximum Depth	cm	126.4	126.2	125.9	126.1
Frequency Depth < 5 cm	%	0.0%	0.0%	0.0%	0.0%
Flow/Width	m2/day	137	135	133	134.8
Max 1 Yr Flow-Wtd Conc	ppb	#N/A	#N/A	#N/A	85.1
Max 5 Yr Flow-Wtd Conc	ppb	#N/A	#N/A	#N/A	58.7
Max 1 Yr Geometric Mn Conc	ppb	#N/A	#N/A	#N/A	32.6
Max 5 Yr Geometric Mn Conc	ppb	#N/A	#N/A	#N/A	19.4
Depth Percentile vs. Calib Set	%	70%	68%	67%	67%
Q/W Percentile vs. Calib Set	%	63%	62%	61%	61%
Cin Percentile vs. Calib Set	%	75%	#N/A	#N/A	75%
Cout Percentile vs. Calib Set	%	#N/A	#N/A	#N/A	#N/A
Depth Range Flag	-	OK	OK	OK	0.0
Q/W Range Flag	-	OK	OK	OK	0.0
Cin Range Flag	-	OK			0.0
Cout Range Flag	-				0.0
Water Balance Error	%	0.00%	0.00%	0.00%	0.00%
Mass Balance Error	%	0.06%	0.06%	0.06%	0.15%

Feeder Canal Basin - Alt. 1 Basecase 25% DMSTA Sensitivity Analysis

Sensitivity Analysis **Case: S100b_r6a** **File: feeder_final_50.xls** **Input Variable Set: All** **Run Date: 05/18/02**

Option	Value	
Select Sensitivity Scale Factor --->	**25%**	*Modify Each Input Variable by +/- This Percentage*
Select Input Parameter Set ------>	**1**	*1 = All, 2 = P Cycling Only, 3 = Design Features Only*
Select Test Option ---------->	**2**	*1 = High Results Only, 2 = High & Low Results*

Number of Model Runs Required = 90 Estimated Run Time = 880.5 minutes

Adjusts Each non-Zero Input Variable, One at a Time, & Re-Runs Simulation

Shows Results for Combined Outflow from Entire Treatment Area

Run

Sort Results

Uncertainty Analysis

Menu

Input Variable	Cell Number	Input Value - Base	High Results ----> Input Value - High	Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load	Low Results ------> Input Value - Low	Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load	Average Change ----> Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load	Average % Change --> Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load
	-	-	-	ppb	ppb	ppb	kg/yr	-	ppb	ppb	ppb	kg/yr	ppb	ppb	ppb	kg/yr	%	%	%	%
Base Run				26.2	26.2	10.1	2378		26.2	26.2	10.1	2378								
Max Inflow / Mean Inflow	1	16.0	20.0	25.6	27.3	10.0	2469	12.8	25.6	25.7	10.1	2330	0.0	0.8	-0.1	69	0%	3%	-1%	3%
Max Reservoir Storage	1	8.0	10.0	26.2	26.2	10.1	2376	6.4	26.0	26.5	10.1	2400	0.1	-0.1	0.0	-12	0%	0%	0%	0%
Rainfall P Conc	1	20.0	25.0	26.3	26.3	10.3	2379	16.0	26.2	26.2	10.0	2377	0.0	0.0	0.1	1	0%	0%	1%	0%
Atmospheric P Load (Dry)	1	20.0	25.0	26.2	26.2	10.2	2376	16.0	26.3	26.3	10.1	2380	0.0	0.0	0.1	-2	0%	0%	1%	0%
Inflow Fraction	1	1.0	1.3	27.6	29.8	11.5	3410	0.8	23.6	23.6	8.9	1692	2.0	3.1	1.3	859	8%	12%	13%	36%
Surface Area	1	1.2	1.5	25.3	25.3	9.7	2281	0.9	27.1	27.1	10.6	2467	-0.9	-0.9	-0.5	-93	-3.6%	-3.6%	-4.6%	-3.9%
Surface Area	2	1.2	1.5	25.3	25.3	9.7	2279	0.9	27.1	27.2	10.6	2469	-0.9	-1.0	-0.5	-95	-4%	-4%	-5%	-4%
Surface Area	3	1.2	1.5	25.2	25.2	9.7	2278	0.9	27.1	27.2	10.6	2469	-0.9	-1.0	-0.5	-96	-4%	-4%	-5%	-4%
Mean Width of Flow Path	1	1.9	2.3	26.3	26.3	10.1	2381	1.5	24.8	27.0	10.0	2441	0.7	-0.3	0.1	-30	3%	-1%	1%	-1%
Mean Width of Flow Path	2	1.9	2.3	26.3	26.3	10.1	2380	1.5	25.4	26.4	10.1	2388	0.4	-0.1	0.0	-4	2%	0%	0%	0%
Mean Width of Flow Path	3	1.9	2.3	26.3	26.3	10.1	2378	1.5	25.7	26.3	10.1	2379	0.3	0.0	0.0	0	1%	0%	0%	0%
Number of Tanks in Series	1	3.0	3.8	26.1	26.1	10.1	2366	2.4	26.3	26.3	10.2	2383	-0.1	-0.1	0.0	-9	0%	0%	0%	0%
Number of Tanks in Series	2	3.0	3.8	26.1	26.1	10.1	2367	2.4	26.3	26.3	10.2	2383	-0.1	-0.1	0.0	-8	0%	0%	0%	0%
Number of Tanks in Series	3	3.0	3.8	26.1	26.1	10.1	2368	2.4	26.3	26.3	10.2	2382	-0.1	-0.1	0.0	-7	0%	0%	0%	0%
Outflow Control Depth	1	89.0	111.3	26.3	26.3	10.1	2372	71.2	26.2	26.2	10.1	2381	0.0	0.0	0.0	-4	0%	0%	0%	0%
Outflow Control Depth	2	89.0	111.3	26.2	26.2	10.2	2365	71.2	26.3	26.3	10.1	2386	0.0	0.0	0.0	-10	0%	0%	0%	0%
Outflow Control Depth	3	89.0	111.3	26.2	26.2	10.2	2364	71.2	26.3	26.3	10.1	2388	0.0	0.0	0.1	-12	0%	0%	1%	0%
Outflow Coefficient - Intercept	1	0.8	1.0	26.3	26.3	10.1	2381	0.6	24.8	27.0	10.0	2441	0.7	-0.3	0.1	-30	3%	-1%	1%	-1%
Outflow Coefficient - Intercept	2	0.8	1.0	26.3	26.3	10.1	2380	0.6	25.4	26.4	10.1	2388	0.4	-0.1	0.0	-4	2%	0%	0%	0%
Outflow Coefficient - Intercept	3	0.8	1.0	26.3	26.3	10.1	2378	0.6	25.7	26.3	10.1	2379	0.3	0.0	0.0	0	1%	0%	0%	0%
Bypass Depth	1	140.0	175.0	26.2	26.2	10.1	2378	112.0	20.1	30.5	9.3	2762	3.1	-2.1	0.4	-192	12%	-8%	4%	-8%
Bypass Depth	2	140.0	175.0	26.2	26.2	10.1	2378	112.0	21.4	27.4	9.7	2484	2.4	-0.6	0.2	-53	9%	-2%	2%	-2%
Bypass Depth	3	140.0	175.0	26.2	26.2	10.1	2378	112.0	22.6	26.5	10.0	2396	1.8	-0.1	0.1	-9	7%	0%	1%	0%
Outflow Seepage Rate	1	0.0	0.0	26.3	26.3	10.2	2373	0.0	26.2	26.2	10.1	2381	0.0	0.0	0.0	-4	0%	0%	0%	0%
Outflow Seepage Rate	2	0.0	0.0	26.3	26.3	10.2	2374	0.0	26.2	26.2	10.1	2381	0.0	0.0	0.0	-4	0%	0%	0%	0%
Outflow Seepage Rate	3	0.0	0.0	26.3	26.3	10.2	2374	0.0	26.2	26.2	10.1	2381	0.0	0.0	0.0	-3	0%	0%	0%	0%
Max Outflow Seepage Conc	1	20.0	25.0	26.250	26.3	10.1	2378	16.0	26.2	26.2	10.1	2378	0.0	0.0	0.0	0	0%	0%	0%	0%
Max Outflow Seepage Conc	2	20.0	25.0	26.3	26.3	10.1	2378	16.0	26.2	26.2	10.1	2378	0.0	0.0	0.0	0	0%	0%	0%	0%
Max Outflow Seepage Conc	3	20.0	25.0	26.3	26.3	10.1	2378	16.0	26.2	26.2	10.1	2377	0.0	0.0	0.0	0	0%	0%	0%	0%
Seepage Recycle Fraction	1	0.5	0.6	26.2	26.2	10.1	2382	0.4	26.3	26.3	10.2	2375	0.0	0.0	0.0	4	0%	0%	0%	0%
Seepage Recycle Fraction	2	0.5	0.6	26.2	26.2	10.1	2381	0.4	26.3	26.3	10.2	2375	0.0	0.0	0.0	3	0%	0%	0%	0%
Seepage Recycle Fraction	3	0.5	0.6	26.2	26.2	10.1	2381	0.4	26.3	26.3	10.2	2375	0.0	0.0	-0.1	3	0%	0%	-1%	0%
C0 = WC Conc at 0 g/m2 P Storage	1	4.0	5.0	27.2	27.2	10.4	2468	3.2	25.3	25.3	9.9	2293	1.0	1.0	0.3	87	4%	4%	3%	4%

Feeder Canal Basin - Alt. 1 Basecase 25% DMSTA Sensitivity Analysis (cont'd)

Sensitivity Analysis **Case: S100b_r6a** **File: feeder_final_50.xls** **Input Variable Set: All** **Run Date: 05/18/02**

Option	Value	
Select Sensitivity Scale Factor --->	**25%**	*Modify Each Input Variable by +/- This Percentage*
Select Input Parameter Set ------>	**1**	*1 = All, 2 = P Cycling Only, 3 = Design Features Only*
Select Test Option ---------->	**2**	*1 = High Results Only, 2 = High & Low Results*

Number of Model Runs Required = 90 Estimated Run Time = 880.5 minutes

Adjusts Each non-Zero Input Variable, One at a Time, & Re-Runs Simulation

Shows Results for Combined Outflow from Entire Treatment Area

Run

Sort Results

Uncertainty Analysis

Menu

Input Variable	Cell Number	Input Value - Base	High Results ----> Input Value - High	Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load	Low Results ------> Input Value - Low	Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load	Average Change ----> Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load	Average % Change --> Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load
	-	-	-	ppb	ppb	ppb	kg/yr	-	ppb	ppb	ppb	kg/yr	ppb	ppb	ppb	kg/yr	%	%	%	%
Base Run				26.2	26.2	10.1	2378		26.2	26.2	10.1	2378								
C0 = WC Conc at 0 g/m2 P Storage	2	4.0	5.0	27.3	27.3	10.5	2473	3.2	25.2	25.2	9.9	2284	1.0	1.0	0.3	94	4%	4%	3%	4%
C0 = WC Conc at 0 g/m2 P Storage	3	4.0	5.0	27.4	27.4	10.4	2482	3.2	25.2	25.2	10.0	2280	1.1	1.1	0.2	101	4%	4%	2%	4%
C1 = WC Conc at 1 g/m2 P storage	1	22.0	27.5	26.3	26.3	10.2	2386	17.6	26.2	26.2	10.1	2374	0.1	0.1	0.1	6	0%	0%	1%	0%
C1 = WC Conc at 1 g/m2 P storage	2	22.0	27.5	26.3	26.3	10.2	2382	17.6	26.2	26.2	10.1	2375	0.0	0.0	0.0	3	0%	0%	0%	0%
C1 = WC Conc at 1 g/m2 P storage	3	22.0	27.5	26.3	26.3	10.2	2381	17.6	26.2	26.2	10.1	2376	0.0	0.0	0.1	3	0%	0%	1%	0%
K = Net Settling Rate at Steady State	1	80.1	100.1	25.4	25.4	9.7	2304	64.1	27.0	27.0	10.6	2447	-0.8	-0.8	-0.4	-72	-3%	-3%	-4%	-3%
K = Net Settling Rate at Steady State	2	80.1	100.1	25.4	25.4	9.7	2300	64.1	27.0	27.0	10.6	2450	-0.8	-0.8	-0.5	-75	-3%	-3%	-5%	-3%
K = Net Settling Rate at Steady State	3	80.1	100.1	25.3	25.3	9.5	2295	64.1	27.1	27.1	10.8	2456	-0.9	-0.9	-0.7	-80	-3%	-3%	-7%	-3%
Zx = Depth Scale Factor	1	60.0	75.0	26.2	26.2	10.1	2378	48.0	26.2	26.2	10.1	2378	0.0	0.0	0.0	0	0%	0%	0%	0%
Zx = Depth Scale Factor	2	60.0	75.0	26.3	26.3	10.1	2378	48.0	26.2	26.2	10.1	2378	0.0	0.0	0.0	0	0%	0%	0%	0%
Zx = Depth Scale Factor	3	60.0	75.0	26.3	26.3	10.2	2379	48.0	26.2	26.2	10.1	2377	0.0	0.0	0.0	1	0%	0%	0%	0%

Feeder Canal Basin - Alt. 1 Basecase 50% DMSTA Sensitivity Analysis

Sensitivity Analysis **Case: S100b_r6a** **File: feeder_final_50.xls** **Input Variable Set: All** **Run Date: 05/20/02**

Option	Value	
Select Sensitivity Scale Factor --->	**50%**	*Modify Each Input Variable by +/- This Percentage*
Select Input Parameter Set ------>	**1**	*1 = All, 2 = P Cycling Only, 3 = Design Features Only*
Select Test Option ---------->	**2**	*1 = High Results Only, 2 = High & Low Results*

Number of Model Runs Required = 90 Estimated Run Time = 883.5 minutes

Adjusts Each non-Zero Input Variable, One at a Time, & Re-Runs Simulation

Shows Results for Combined Outflow from Entire Treatment Area

Run

Sort Results

Uncertainty Analysis

Menu

Input Variable	Cell Number	Input Value - Base	High Results ----> Input Value - High	Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load	Low Results ------> Input Value - Low	Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load	Average Change ----> Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load	Average % Change --> Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load
	-	-	-	ppb	ppb	ppb	kg/yr	-	ppb	ppb	ppb	kg/yr	ppb	ppb	ppb	kg/yr	%	%	%	%
Base Run				26.2	26.2	10.1	2378		26.2	26.2	10.1	2378								
Max Inflow / Mean Inflow	1	16.0	24.0	25.1	28.1	9.9	2545	10.7	25.0	25.2	10.1	2284	0.0	1.4	-0.1	130	0%	5%	-1%	5%
Max Reservoir Storage	1	8.0	12.0	26.2	26.2	10.1	2376	5.3	25.9	26.8	10.1	2425	0.2	-0.3	0.0	-24	1%	-1%	0%	-1%
Rainfall P Conc	1	20.0	30.0	26.3	26.3	10.4	2380	13.3	26.2	26.2	10.0	2376	0.0	0.0	0.2	2	0%	0%	2%	0%
Atmospheric P Load (Dry)	1	20.0	30.0	26.2	26.2	10.3	2373	13.3	26.3	26.3	10.0	2381	0.0	0.0	0.2	-4	0%	0%	2%	0%
Inflow Fraction	1	1.0	1.5	28.0	33.0	12.6	4565	0.7	21.8	21.8	8.0	1284	3.1	5.6	2.3	1641	12%	21%	22%	69%
Surface Area	1	1.2	1.8	24.4	24.5	9.3	2196	0.8	27.7	27.9	10.9	2538	-1.6	-1.7	-0.8	-171	-6.2%	-6.5%	-8.2%	-7.2%
Surface Area	2	1.2	1.8	24.4	24.4	9.3	2193	0.8	27.8	27.8	10.9	2536	-1.7	-1.7	-0.8	-172	-6%	-7%	-8%	-7%
Surface Area	3	1.2	1.8	24.4	24.4	9.3	2190	0.8	27.8	27.8	10.9	2537	-1.7	-1.7	-0.8	-173	-7%	-7%	-8%	-7%
Mean Width of Flow Path	1	1.9	2.8	26.3	26.3	10.1	2384	1.2	23.3	27.9	9.8	2531	1.5	-0.8	0.2	-73	6%	-3%	2%	-3%
Mean Width of Flow Path	2	1.9	2.8	26.3	26.3	10.1	2381	1.2	24.2	26.6	10.0	2411	1.1	-0.2	0.1	-15	4%	-1%	1%	-1%
Mean Width of Flow Path	3	1.9	2.8	26.3	26.3	10.1	2379	1.2	24.8	26.3	10.1	2382	0.7	0.0	0.0	-2	3%	0%	0%	0%
Number of Tanks in Series	1	3.0	4.5	26.0	26.0	10.0	2359	2.0	26.5	26.5	10.3	2400	-0.2	-0.2	-0.1	-21	-1%	-1%	-1%	-1%
Number of Tanks in Series	2	3.0	4.5	26.1	26.1	10.0	2361	2.0	26.5	26.5	10.3	2397	-0.2	-0.2	-0.1	-18	-1%	-1%	-1%	-1%
Number of Tanks in Series	3	3.0	4.5	26.1	26.1	10.0	2363	2.0	26.4	26.4	10.3	2396	-0.2	-0.2	-0.1	-16	-1%	-1%	-1%	-1%
Outflow Control Depth	1	89.0	133.5	26.2	26.3	10.1	2367	59.3	26.2	26.2	10.1	2382	0.0	0.1	0.0	-8	0%	0%	0%	0%
Outflow Control Depth	2	89.0	133.5	26.1	26.2	10.1	2352	59.3	26.3	26.3	10.2	2389	-0.1	0.0	0.0	-19	0%	0%	0%	-1%
Outflow Control Depth	3	89.0	133.5	26.1	26.1	10.3	2351	59.3	26.3	26.3	10.2	2394	-0.1	-0.1	0.0	-22	0%	0%	0%	-1%
Outflow Coefficient - Intercept	1	0.8	1.2	26.3	26.3	10.1	2384	0.5	23.3	27.9	9.8	2531	1.5	-0.8	0.2	-73	6%	-3%	2%	-3%
Outflow Coefficient - Intercept	2	0.8	1.2	26.3	26.3	10.1	2381	0.5	24.2	26.6	10.0	2411	1.1	-0.2	0.1	-15	4%	-1%	1%	-1%
Outflow Coefficient - Intercept	3	0.8	1.2	26.3	26.3	10.1	2379	0.5	24.8	26.3	10.1	2382	0.7	0.0	0.0	-2	3%	0%	0%	0%
Bypass Depth	1	140.0	210.0	26.2	26.2	10.1	2378	93.3	13.0	38.5	7.7	3488	6.6	-6.1	1.2	-555	25%	-23%	12%	-23%
Bypass Depth	2	140.0	210.0	26.2	26.2	10.1	2378	93.3	14.6	30.5	8.5	2768	5.8	-2.1	0.8	-195	22%	-8%	8%	-8%
Bypass Depth	3	140.0	210.0	26.2	26.2	10.1	2378	93.3	16.7	27.2	9.4	2466	4.8	-0.5	0.4	-44	18%	-2%	4%	-2%
Outflow Seepage Rate	1	0.0	0.0	26.3	26.3	10.2	2369	0.0	26.2	26.2	10.1	2384	0.1	0.1	0.0	-7	0%	0%	0%	0%
Outflow Seepage Rate	2	0.0	0.0	26.3	26.3	10.2	2369	0.0	26.2	26.2	10.1	2384	0.1	0.1	0.0	-7	0%	0%	0%	0%
Outflow Seepage Rate	3	0.0	0.0	26.3	26.3	10.2	2371	0.0	26.2	26.2	10.1	2383	0.1	0.1	0.1	-6	0%	0%	1%	0%
Max Outflow Seepage Conc	1	20.0	30.0	26.251	26.3	10.1	2378	13.3	26.2	26.2	10.1	2378	0.0	0.0	0.0	0	0%	0%	0%	0%
Max Outflow Seepage Conc	2	20.0	30.0	26.3	26.3	10.1	2378	13.3	26.2	26.2	10.1	2377	0.0	0.0	0.0	0	0%	0%	0%	0%
Max Outflow Seepage Conc	3	20.0	30.0	26.3	26.3	10.1	2378	13.3	26.2	26.2	10.1	2377	0.0	0.0	0.0	1	0%	0%	0%	0%
Seepage Recycle Fraction	1	0.5	0.8	26.2	26.2	10.1	2386	0.3	26.3	26.3	10.2	2373	-0.1	-0.1	0.0	7	0%	0%	0%	0%
Seepage Recycle Fraction	2	0.5	0.8	26.2	26.2	10.1	2385	0.3	26.3	26.3	10.2	2373	-0.1	-0.1	-0.1	6	0%	0%	-1%	0%
Seepage Recycle Fraction	3	0.5	0.8	26.1	26.1	10.0	2384	0.3	26.3	26.3	10.2	2374	-0.1	-0.1	-0.1	5	0%	0%	-1%	0%
C0 = WC Conc at 0 g/m2 P Storage	1	4.0	6.0	28.0	28.0	10.7	2540	2.7	24.6	24.6	9.8	2229	1.7	1.7	0.5	155	7%	7%	5%	7%

Feeder Canal Basin - Alt. 1 Basecase 50% DMSTA Sensitivity Analysis (cont'd)

Sensitivity Analysis **Case: S100b_r6a** **File: feeder_final_50.xls** **Input Variable Set: All** **Run Date: 05/20/02**

Option	Value	
Select Sensitivity Scale Factor --->	**50%**	*Modify Each Input Variable by +/- This Percentage*
Select Input Parameter Set ------>	**1**	*1 = All, 2 = P Cycling Only, 3 = Design Features Only*
Select Test Option ---------->	**2**	*1 = High Results Only, 2 = High & Low Results*

Number of Model Runs Required = 90 Estimated Run Time = 883.5 minutes

Adjusts Each non-Zero Input Variable, One at a Time, & Re-Runs Simulation

Shows Results for Combined Outflow from Entire Treatment Area

Run

Sort Results

Uncertainty Analysis

Menu

			High Results ---->					Low Results ------>					Average Change ---->				Average % Change -->			
	Cell Number	Input Value - Base	Input Value - High	Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load	Input Value - Low	Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load	Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load	Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load
Input Variable	-	-	-	ppb	ppb	ppb	kg/yr	-	ppb	ppb	ppb	kg/yr	ppb	ppb	ppb	kg/yr	%	%	%	%
Base Run				26.2	26.2	10.1	2378		26.2	26.2	10.1	2378								
C0 = WC Conc at 0 g/m2 P Storage	2	4.0	6.0	28.1	28.1	10.8	2548	2.7	24.4	24.4	9.8	2213	1.8	1.8	0.5	167	7%	7%	5%	7%
C0 = WC Conc at 0 g/m2 P Storage	3	4.0	6.0	28.4	28.4	10.8	2570	2.7	24.4	24.4	10.0	2207	2.0	2.0	0.4	182	8%	8%	4%	8%
C1 = WC Conc at 1 g/m2 P storage	1	22.0	33.0	26.4	26.4	10.3	2396	14.7	26.2	26.2	10.1	2373	0.1	0.1	0.1	12	0%	0%	1%	0%
C1 = WC Conc at 1 g/m2 P storage	2	22.0	33.0	26.3	26.3	10.3	2387	14.7	26.2	26.2	10.1	2374	0.1	0.1	0.1	7	0%	0%	1%	0%
C1 = WC Conc at 1 g/m2 P storage	3	22.0	33.0	26.3	26.3	10.3	2386	14.7	26.2	26.2	10.0	2374	0.1	0.1	0.1	6	0%	0%	1%	0%
K = Net Settling Rate at Steady State	1	80.1	120.2	24.7	24.7	9.4	2241	53.4	27.6	27.6	10.9	2500	-1.4	-1.4	-0.8	-129	-5%	-5%	-7%	-5%
K = Net Settling Rate at Steady State	2	80.1	120.2	24.6	24.6	9.3	2233	53.4	27.7	27.7	11.0	2505	-1.5	-1.5	-0.9	-136	-6%	-6%	-9%	-6%
K = Net Settling Rate at Steady State	3	80.1	120.2	24.6	24.6	9.0	2224	53.4	27.8	27.8	11.4	2515	-1.6	-1.6	-1.2	-146	-6%	-6%	-12%	-6%
Zx = Depth Scale Factor	1	60.0	90.0	26.3	26.3	10.2	2379	40.0	26.2	26.2	10.1	2378	0.0	0.0	0.0	1	0%	0%	0%	0%
Zx = Depth Scale Factor	2	60.0	90.0	26.3	26.3	10.2	2381	40.0	26.2	26.2	10.1	2377	0.0	0.0	0.0	2	0%	0%	0%	0%
Zx = Depth Scale Factor	3	60.0	90.0	26.3	26.3	10.3	2385	40.0	26.2	26.2	10.1	2377	0.0	0.0	0.1	4	0%	0%	1%	0%

Uncertainty Analysis

Case: **S100b_r6a - sens25** **File: feeder_final_50.xls** 05/18/02

Estimates uncertainty in output variables. Assumes that sensitivity analysis has already been performed. Factors include: (1) uncertainty in p cycling parameters (from calibration); (2) uncertainty in other model inputs (user-specified); (3) inherent model error (from calibration); & (4) sensitivity of model output to each input value. Results are for combined outflows.

Reference: Walker, "A Sensitivity & Error Analysis Framework for Lake Eutrophication Modeling", Wtr Res Bul, Feb 1982

Select Output Variable:

- Treated FWM Outflow Conc
- Total FWM Outflow Conc
- Outflow Geo Mean - Composites
- Total Outflow Load

Treated FWM Outflow Conc (ppb)		Error CV's = Standard Error / Mean	
50th Percentile Est. =	26	Total =	11%
10th Percentile Est. =	23	Model Error =	10%
90th Percentile Est =	30	Parameter Error =	3%
		Input Data Error =	3%

Show Results | Sensitivity Analysis | Menu

Sensitivity Coefficients

% Change in Output Variable / % Change in Input Variable

Enter assumed error CV (standard error, as percent of mean) in col. B (blue cells) to reflect uncertainty in each input value

Case Description: 100% SAV at 89 cm and 3.5 km2 (3 cells of SAV) with reservoir

Output Variable	Units	Value
Water Balance Error	%	0.0%
Mass Balance Error	%	-0.1%
Flow-Wtd Conc - With Bypass	ppb	26.2
Flow-Wtd Conc - Without Bypass	ppb	26.2
Geometric Mean Conc	ppb	10.1
95th Percentile Conc	ppb	36.2
Freq Cell Outflow > 10 ppb	%	48%
Bypass Load	%	0.0%

Input Variable	Error CV	Value	1	2	3	4	5	6
Design Case Name		S100b_r6a						
Starting Date for Simulation								
Ending Date for Simulation								
Starting Date for Output								
Steps Per Day								
Number of Iterations								
Output Averaging Interval								
Reservoir H2O Residence Time								
Max Inflow / Mean Inflow		0.005						
Max Reservoir Storage		0.015						
Reservoir P Decay Rate								
Rainfall P Conc	30%	0.002						
Atmospheric P Load (Dry)	30%	-0.004						
Cell Number -->			1	2	3	4	5	6
Cell Label			SAV1	SAV1	SAV1			
Vegetation Type			SAV_C4	SAV_C4	SAV_C4			
Inflow Fraction	0%		*0.301*					
Downstream Cell Number								
Surface Area			*-0.142*	*-0.142*	*-0.143*			
Mean Width of Flow Path			*0.110*	*0.065*	*0.045*			
Number of Tanks in Series	30%		*-0.015*	*-0.013*	*-0.012*			
Outflow Control Depth			*0.004*	*-0.005*	*-0.007*			
Outflow Coefficient - Exponent								
Outflow Coefficient - Intercept	20%		*0.110*	*0.065*	*0.045*			
Bypass Depth			*0.472*	*0.370*	*0.280*			
Maximum Inflow								
Maximum Outflow								
Inflow Seepage Rate	20%							
Inflow Seepage Control Elev								
Inflow Seepage Conc	20%							
Outflow Seepage Rate	20%		*0.005*	*0.005*	*0.006*			
Outflow Seepage Control Elev								
Max Outflow Seepage Conc	20%		*0.000*	*0.000*	*0.001*			
Seepage Recycle Fraction	20%		*-0.006*	*-0.006*	*-0.007*			
Seepage Discharge Fraction	20%							
Initial Water Column Conc								
Initial P Storage Per Unit Area								
Initial Water Column Depth								
C0 = WC Conc at 0 g/m2 P Storage			*0.147*	*0.159*	*0.170*			
C1 = WC Conc at 1 g/m2 P storage			*0.010*	*0.005*	*0.005*			
K = Net Settling Rate at Steady State			*-0.121*	*-0.127*	*-0.135*			
Zx = Depth Scale Factor	*retrieved*		*0.000*	*0.001*	*0.002*			
C0 - Periphyton	*from model*							
C1 - Periphyton	*calibration*							
K - Periphyton	*table*							
Zx - Periphyton								
Sm = Transition Storage Midpoint								
Sb = Transition Storage Bandwidth								

Uncertainty Analysis

Case: **S100b_r6a - sens25** **File:** **feeder_final_50.xls** 05/18/02

Estimates uncertainty in output variables. Assumes that sensitivity analysis has already been performed. Factors include: (1) uncertainty in p cycling parameters (from calibration); (2) uncertainty in other model inputs (user-specified); (3) inherent model error (from calibration); & (4) sensitivity of model output to each input value. Results are for combined outflows.

Reference: Walker, "A Sensitivity & Error Analysis Framework for Lake Eutrophication Modeling", Wtr Res Bul, Feb 1982

Select Output Variable:

- Treated FWM Outflow Conc
- Total FWM Outflow Conc
- Outflow Geo Mean - Composites
- Total Outflow Load

Total FWM Outflow Conc (ppb)		Error CV's = Standard Error / Mean	
50th Percentile Est. =	26	Total =	10%
10th Percentile Est. =	23	Model Error =	10%
90th Percentile Est =	30	Parameter Error =	3%
		Input Data Error =	1%

Show Results | Sensitivity Analysis | Menu

Sensitivity Coefficients

% Change in Output Variable / % Change in Input Variable

Enter assumed error CV (standard error, as percent of mean) in col. B (blue cells) to reflect uncertainty in each input value

Case Description: 100% SAV at 89 cm and 3.5 km2 (3 cells of SAV) with reservoir

Filename: **feeder_final_50.xls**

Output Variable	Units	Value
Water Balance Error	%	0.0%
Mass Balance Error	%	-0.1%
Flow-Wtd Conc - With Bypass	ppb	26.2
Flow-Wtd Conc - Without Bypass	ppb	26.2
Geometric Mean Conc	ppb	10.1
95th Percentile Conc	ppb	36.2
Freq Cell Outflow > 10 ppb	%	48%
Bypass Load	%	0.0%

Input Variable	Error CV	Value	1	2	3	4	5	6
Design Case Name		S100b_r6a						
Starting Date for Simulation								
Ending Date for Simulation								
Starting Date for Output								
Steps Per Day								
Number of Iterations								
Output Averaging Interval								
Reservoir H2O Residence Time								
Max Inflow / Mean Inflow		0.117						
Max Reservoir Storage		-0.020						
Reservoir P Decay Rate								
Rainfall P Conc	30%	0.002						
Atmospheric P Load (Dry)	30%	-0.004						
Cell Number -->			1	2	3	4	5	6
Cell Label			SAV1	SAV1	SAV1			
Vegetation Type			SAV_C4	SAV_C4	SAV_C4			
Inflow Fraction	0%		*0.471*					
Downstream Cell Number								
Surface Area			*-0.142*	*-0.145*	*-0.146*			
Mean Width of Flow Path			*-0.051*	*-0.008*	*-0.001*			
Number of Tanks in Series	30%		*-0.015*	*-0.013*	*-0.012*			
Outflow Control Depth			*0.005*	*-0.004*	*-0.007*			
Outflow Coefficient - Exponent								
Outflow Coefficient - Intercept	20%		*-0.051*	*-0.008*	*-0.001*			
Bypass Depth			*-0.323*	*-0.089*	*-0.016*			
Maximum Inflow								
Maximum Outflow								
Inflow Seepage Rate	20%							
Inflow Seepage Control Elev								
Inflow Seepage Conc	20%							
Outflow Seepage Rate	20%		*0.005*	*0.005*	*0.006*			
Outflow Seepage Control Elev								
Max Outflow Seepage Conc	20%		*0.000*	*0.000*	*0.001*			
Seepage Recycle Fraction	20%		*-0.006*	*-0.006*	*-0.007*			
Seepage Discharge Fraction	20%							
Initial Water Column Conc								
Initial P Storage Per Unit Area								
Initial Water Column Depth								
C0 = WC Conc at 0 g/m2 P Storage			*0.147*	*0.159*	*0.170*			
C1 = WC Conc at 1 g/m2 P storage			*0.010*	*0.005*	*0.005*			
K = Net Settling Rate at Steady State			*-0.121*	*-0.127*	*-0.135*			
Zx = Depth Scale Factor	*retrieved*		*0.000*	*0.001*	*0.002*			
C0 - Periphyton	*from model*							
C1 - Periphyton	*calibration*							
K - Periphyton	*table*							
Zx - Periphyton								
Sm = Transition Storage Midpoint								
Sb = Transition Storage Bandwidth								

Uncertainty Analysis

Case: **S100b_r6a - sens25** **File:** **feeder_final_50.xls** 05/18/02

Estimates uncertainty in output variables. Assumes that sensitivity analysis has already been performed. Factors include: (1) uncertainty in p cycling parameters (from calibration); (2) uncertainty in other model inputs (user-specified); (3) inherent model error (from calibration); & (4) sensitivity of model output to each input value. Results are for combined outflows.

Reference: Walker, "A Sensitivity & Error Analysis Framework for Lake Eutrophication Modeling", Wtr Res Bul, Feb 1982

Select Output Variable:

- Treated FWM Outflow Conc
- Total FWM Outflow Conc
- Outflow Geo Mean - Composites
- Total Outflow Load

Outflow Geo Mean - Composites (ppb)		Error CV's = Standard Error / Mean	
50th Percentile Est. =	10	Total =	11%
10th Percentile Est. =	9	Model Error =	10%
90th Percentile Est =	12	Parameter Error =	2%
		Input Data Error =	2%

Show Results | Sensitivity Analysis | Menu

Sensitivity Coefficients

% Change in Output Variable / % Change in Input Variable

Enter assumed error CV (standard error, as percent of mean) in col. B (blue cells) to reflect uncertainty in each input value

Case Description: **Filename: feeder_final_50.xls**

100% SAV at 89 cm and 3.5 km2 (3 cells of SAV) with reservoir

Output Variable	Units	Value
Water Balance Error	%	0.0%
Mass Balance Error	%	-0.1%
Flow-Wtd Conc - With Bypass	ppb	26.2
Flow-Wtd Conc - Without Bypass	ppb	26.2
Geometric Mean Conc	ppb	10.1
95th Percentile Conc	ppb	36.2
Freq Cell Outflow > 10 ppb	%	48%
Bypass Load	%	0.0%

Input Variable	Error CV	Value	1	2	3	4	5	6
Design Case Name		S100b_r6a						
Starting Date for Simulation								
Ending Date for Simulation								
Starting Date for Output								
Steps Per Day								
Number of Iterations								
Output Averaging Interval								
Reservoir H2O Residence Time								
Max Inflow / Mean Inflow		-0.024						
Max Reservoir Storage		0.006						
Reservoir P Decay Rate								
Rainfall P Conc	30%	0.044						
Atmospheric P Load (Dry)	30%	0.036						
Cell Number -->			1	2	3	4	5	6
Cell Label			SAV1	SAV1	SAV1			
Vegetation Type			SAV_C4	SAV_C4	SAV_C4			
Inflow Fraction	0%		*0.507*					
Downstream Cell Number								
Surface Area			*-0.183*	*-0.183*	*-0.185*			
Mean Width of Flow Path			*0.032*	*0.009*	*0.002*			
Number of Tanks in Series	30%		*-0.018*	*-0.017*	*-0.018*			
Outflow Control Depth			*0.000*	*0.002*	*0.022*			
Outflow Coefficient - Exponent								
Outflow Coefficient - Intercept	20%		*0.032*	*0.009*	*0.002*			
Bypass Depth			*0.175*	*0.087*	*0.032*			
Maximum Inflow								
Maximum Outflow								
Inflow Seepage Rate	20%							
Inflow Seepage Control Elev								
Inflow Seepage Conc	20%							
Outflow Seepage Rate	20%		*0.009*	*0.012*	*0.019*			
Outflow Seepage Control Elev								
Max Outflow Seepage Conc	20%		*0.001*	*0.001*	*0.001*			
Seepage Recycle Fraction	20%		*-0.009*	*-0.011*	*-0.020*			
Seepage Discharge Fraction	20%							
Initial Water Column Conc								
Initial P Storage Per Unit Area								
Initial Water Column Depth								
C0 = WC Conc at 0 g/m2 P Storage			*0.106*	*0.113*	*0.076*			
C1 = WC Conc at 1 g/m2 P storage			*0.025*	*0.017*	*0.027*			
K = Net Settling Rate at Steady State			*-0.165*	*-0.190*	*-0.261*			
Zx = Depth Scale Factor	*retrieved*		*0.001*	*0.002*	*0.008*			
C0 - Periphyton	*from model*							
C1 - Periphyton	*calibration*							
K - Periphyton	*table*							
Zx - Periphyton								
Sm = Transition Storage Midpoint								
Sb = Transition Storage Bandwidth								

Uncertainty Analysis

Case: **S100b_r6a - sens25** **File:** **feeder_final_50.xls** 05/18/02

Estimates uncertainty in output variables. Assumes that sensitivity analysis has already been performed. Factors include: (1) uncertainty in p cycling parameters (from calibration); (2) uncertainty in other model inputs (user-specified); (3) inherent model error (from calibration); & (4) sensitivity of model output to each input value. Results are for combined outflows.

Reference: Walker, "A Sensitivity & Error Analysis Framework for Lake Eutrophication Modeling", Wtr Res Bul, Feb 1982

Select Output Variable:

- Treated FWM Outflow Conc
- Total FWM Outflow Conc
- Outflow Geo Mean - Composites
- Total Outflow Load

Total Outflow Load (kg/yr)		Error CV's = Standard Error / Mean	
50th Percentile Est. =	2378	Total =	10%
10th Percentile Est. =	2058	Model Error =	10%
90th Percentile Est =	2697	Parameter Error =	3%
		Input Data Error =	1%

Show Results | Sensitivity Analysis | Menu

Sensitivity Coefficients

% Change in Output Variable / % Change in Input Variable

Enter assumed error CV (standard error, as percent of mean) in col. B (blue cells) to reflect uncertainty in each input value

Case Description: **Filename: feeder_final_50.xls**

100% SAV at 89 cm and 3.5 km2 (3 cells of SAV) with reservoir

Output Variable	Units	Value
Water Balance Error	%	0.0%
Mass Balance Error	%	-0.1%
Flow-Wtd Conc - With Bypass	ppb	26.2
Flow-Wtd Conc - Without Bypass	ppb	26.2
Geometric Mean Conc	ppb	10.1
95th Percentile Conc	ppb	36.2
Freq Cell Outflow > 10 ppb	%	48%
Bypass Load	%	0.0%

Input Variable	Error CV	Value	1	2	3	4	5	6
Design Case Name		S100b_r6a						
Starting Date for Simulation								
Ending Date for Simulation								
Starting Date for Output								
Steps Per Day								
Number of Iterations								
Output Averaging Interval								
Reservoir H2O Residence Time								
Max Inflow / Mean Inflow		0.117						
Max Reservoir Storage		-0.020						
Reservoir P Decay Rate								
Rainfall P Conc	30%	0.002						
Atmospheric P Load (Dry)	30%	-0.004						
Cell Number -->			1	2	3	4	5	6
Cell Label			SAV1	SAV1	SAV1			
Vegetation Type			SAV_C4	SAV_C4	SAV_C4			
Inflow Fraction	0%		*1.445*					
Downstream Cell Number								
Surface Area			*-0.157*	*-0.160*	*-0.161*			
Mean Width of Flow Path			*-0.051*	*-0.007*	*-0.001*			
Number of Tanks in Series	30%		*-0.015*	*-0.013*	*-0.012*			
Outflow Control Depth			*-0.007*	*-0.017*	*-0.020*			
Outflow Coefficient - Exponent								
Outflow Coefficient - Intercept	20%		*-0.051*	*-0.007*	*-0.001*			
Bypass Depth			*-0.323*	*-0.089*	*-0.016*			
Maximum Inflow								
Maximum Outflow								
Inflow Seepage Rate	20%							
Inflow Seepage Control Elev								
Inflow Seepage Conc	20%							
Outflow Seepage Rate	20%		*-0.007*	*-0.006*	*-0.006*			
Outflow Seepage Control Elev								
Max Outflow Seepage Conc	20%		*0.000*	*0.000*	*0.001*			
Seepage Recycle Fraction	20%		*0.006*	*0.005*	*0.004*			
Seepage Discharge Fraction	20%							
Initial Water Column Conc								
Initial P Storage Per Unit Area								
Initial Water Column Depth								
C0 = WC Conc at 0 g/m2 P Storage			*0.147*	*0.159*	*0.170*			
C1 = WC Conc at 1 g/m2 P storage			*0.010*	*0.005*	*0.005*			
K = Net Settling Rate at Steady State			*-0.121*	*-0.127*	*-0.135*			
Zx = Depth Scale Factor	*retrieved*		*0.000*	*0.001*	*0.002*			
C0 - Periphyton	*from model*							
C1 - Periphyton	*calibration*							
K - Periphyton	*table*							
Zx - Periphyton								
Sm = Transition Storage Midpoint								
Sb = Transition Storage Bandwidth								

Uncertainty Analysis

Case: **S100b_r6a - sens50** **File:** **feeder_final_50.xls** 05/20/02

Estimates uncertainty in output variables. Assumes that sensitivity analysis has already been performed. Factors include: (1) uncertainty in p cycling parameters (from calibration); (2) uncertainty in other model inputs (user-specified); (3) inherent model error (from calibration); & (4) sensitivity of model output to each input value. Results are for combined outflows.

Reference: Walker, "A Sensitivity & Error Analysis Framework for Lake Eutrophication Modeling", Wtr Res Bul, Feb 1982

Select Output Variable:

- Treated FWM Outflow Conc
- Total FWM Outflow Conc
- Outflow Geo Mean - Composites
- Total Outflow Load

Treated FWM Outflow Conc (ppb)		Error CV's = Standard Error / Mean	
50th Percentile Est. =	26	Total =	11%
10th Percentile Est. =	23	Model Error =	10%
90th Percentile Est =	30	Parameter Error =	3%
		Input Data Error =	3%

Show Results | Sensitivity Analysis | Menu

Sensitivity Coefficients

% Change in Output Variable / % Change in Input Variable

Enter assumed error CV (standard error, as percent of mean) in col. B (blue cells) to reflect uncertainty in each input value

Case Description: **Filename: feeder_final_50.xls**

100% SAV at 89 cm and 3.5 km2 (3 cells of SAV) with reservoir

Output Variable	Units	Value
Water Balance Error	%	0.0%
Mass Balance Error	%	-0.1%
Flow-Wtd Conc - With Bypass	ppb	26.2
Flow-Wtd Conc - Without Bypass	ppb	26.2
Geometric Mean Conc	ppb	10.1
95th Percentile Conc	ppb	36.2
Freq Cell Outflow > 10 ppb	%	48%
Bypass Load	%	0.0%

Input Variable	Error CV	Value	1	2	3	4	5	6
Design Case Name		S100b_r6a						
Starting Date for Simulation								
Ending Date for Simulation								
Starting Date for Output								
Steps Per Day								
Number of Iterations								
Output Averaging Interval								
Reservoir H2O Residence Time								
Max Inflow / Mean Inflow		0.002						
Max Reservoir Storage		0.013						
Reservoir P Decay Rate								
Rainfall P Conc	30%	0.002						
Atmospheric P Load (Dry)	30%	-0.003						
Cell Number -->			1	2	3	4	5	6
Cell Label			SAV1	SAV1	SAV1			
Vegetation Type			SAV_C4	SAV_C4	SAV_C4			
Inflow Fraction	0%		*0.238*					
Downstream Cell Number								
Surface Area			*-0.125*	*-0.129*	*-0.131*			
Mean Width of Flow Path			*0.116*	*0.081*	*0.055*			
Number of Tanks in Series	30%		*-0.017*	*-0.015*	*-0.014*			
Outflow Control Depth			*0.001*	*-0.007*	*-0.009*			
Outflow Coefficient - Exponent								
Outflow Coefficient - Intercept	20%		*0.116*	*0.081*	*0.055*			
Bypass Depth			*0.506*	*0.444*	*0.365*			
Maximum Inflow								
Maximum Outflow								
Inflow Seepage Rate	20%							
Inflow Seepage Control Elev								
Inflow Seepage Conc	20%							
Outflow Seepage Rate	20%		*0.005*	*0.005*	*0.006*			
Outflow Seepage Control Elev								
Max Outflow Seepage Conc	20%		*0.000*	*0.000*	*0.001*			
Seepage Recycle Fraction	20%		*-0.006*	*-0.006*	*-0.007*			
Seepage Discharge Fraction	20%							
Initial Water Column Conc								
Initial P Storage Per Unit Area								
Initial Water Column Depth								
C0 = WC Conc at 0 g/m2 P Storage			*0.131*	*0.141*	*0.153*			
C1 = WC Conc at 1 g/m2 P storage			*0.010*	*0.006*	*0.005*			
K = Net Settling Rate at Steady State			*-0.109*	*-0.114*	*-0.122*			
Zx = Depth Scale Factor	*retrieved*		*0.001*	*0.002*	*0.004*			
C0 - Periphyton	*from model*							
C1 - Periphyton	*calibration*							
K - Periphyton	*table*							
Zx - Periphyton								
Sm = Transition Storage Midpoint								
Sb = Transition Storage Bandwidth								

Uncertainty Analysis

Case: **S100b_r6a - sens50** **File:** **feeder_final_50.xls** 05/20/02

Estimates uncertainty in output variables. Assumes that sensitivity analysis has already been performed. Factors include: (1) uncertainty in p cycling parameters (from calibration); (2) uncertainty in other model inputs (user-specified); (3) inherent model error (from calibration); & (4) sensitivity of model output to each input value. Results are for combined outflows.

Reference: Walker, "A Sensitivity & Error Analysis Framework for Lake Eutrophication Modeling", Wtr Res Bul, Feb 1982

Select Output Variable:

- Treated FWM Outflow Conc
- Total FWM Outflow Conc
- Outflow Geo Mean - Composites
- Total Outflow Load

Total FWM Outflow Conc (ppb)		Error CV's = Standard Error / Mean	
50th Percentile Est. =	26	Total =	10%
10th Percentile Est. =	23	Model Error =	10%
90th Percentile Est =	30	Parameter Error =	3%
		Input Data Error =	2%

Show Results | Sensitivity Analysis | Menu

Sensitivity Coefficients

% Change in Output Variable / % Change in Input Variable

Enter assumed error CV (standard error, as percent of mean) in col. B (blue cells) to reflect uncertainty in each input value

Case Description: **Filename: feeder_final_50.xls**

100% SAV at 89 cm and 3.5 km2 (3 cells of SAV) with reservoir

Output Variable	Units	Value
Water Balance Error	%	0.0%
Mass Balance Error	%	-0.1%
Flow-Wtd Conc - With Bypass	ppb	26.2
Flow-Wtd Conc - Without Bypass	ppb	26.2
Geometric Mean Conc	ppb	10.1
95th Percentile Conc	ppb	36.2
Freq Cell Outflow > 10 ppb	%	48%
Bypass Load	%	0.0%

Input Variable	Error CV	Value	1	2	3	4	5	6
Design Case Name		S100b_r6a						
Starting Date for Simulation								
Ending Date for Simulation								
Starting Date for Output								
Steps Per Day								
Number of Iterations								
Output Averaging Interval								
Reservoir H2O Residence Time								
Max Inflow / Mean Inflow		0.109						
Max Reservoir Storage		-0.020						
Reservoir P Decay Rate								
Rainfall P Conc	30%	0.002						
Atmospheric P Load (Dry)	30%	-0.003						
Cell Number -->			1	2	3	4	5	6
Cell Label			SAV1	SAV1	SAV1			
Vegetation Type			SAV_C4	SAV_C4	SAV_C4			
Inflow Fraction	0%		*0.429*					
Downstream Cell Number								
Surface Area			*-0.130*	*-0.131*	*-0.132*			
Mean Width of Flow Path			*-0.062*	*-0.013*	*-0.002*			
Number of Tanks in Series	30%		*-0.017*	*-0.015*	*-0.014*			
Outflow Control Depth			*0.005*	*-0.004*	*-0.007*			
Outflow Coefficient - Exponent								
Outflow Coefficient - Intercept	20%		*-0.062*	*-0.013*	*-0.002*			
Bypass Depth			*-0.466*	*-0.164*	*-0.037*			
Maximum Inflow								
Maximum Outflow								
Inflow Seepage Rate	20%							
Inflow Seepage Control Elev								
Inflow Seepage Conc	20%							
Outflow Seepage Rate	20%		*0.005*	*0.005*	*0.006*			
Outflow Seepage Control Elev								
Max Outflow Seepage Conc	20%		*0.000*	*0.000*	*0.001*			
Seepage Recycle Fraction	20%		*-0.006*	*-0.006*	*-0.007*			
Seepage Discharge Fraction	20%							
Initial Water Column Conc								
Initial P Storage Per Unit Area								
Initial Water Column Depth								
C0 = WC Conc at 0 g/m2 P Storage			*0.131*	*0.141*	*0.153*			
C1 = WC Conc at 1 g/m2 P storage			*0.010*	*0.006*	*0.005*			
K = Net Settling Rate at Steady State			*-0.109*	*-0.114*	*-0.122*			
Zx = Depth Scale Factor	*retrieved*		*0.001*	*0.002*	*0.004*			
C0 - Periphyton	*from model*							
C1 - Periphyton	*calibration*							
K - Periphyton	*table*							
Zx - Periphyton								
Sm = Transition Storage Midpoint								
Sb = Transition Storage Bandwidth								

Uncertainty Analysis

Case: **S100b_r6a -sens50** **File:** **feeder_final_50.xls** 05/20/02

Estimates uncertainty in output variables. Assumes that sensitivity analysis has already been performed. Factors include: (1) uncertainty in p cycling parameters (from calibration); (2) uncertainty in other model inputs (user-specified); (3) inherent model error (from calibration); & (4) sensitivity of model output to each input value. Results are for combined outflows.

Reference: Walker, "A Sensitivity & Error Analysis Framework for Lake Eutrophication Modeling", Wtr Res Bul, Feb 1982

Select Output Variable:

- Treated FWM Outflow Conc
- Total FWM Outflow Conc
- Outflow Geo Mean - Composites
- Total Outflow Load

Outflow Geo Mean - Composites (ppb)		Error CV's = Standard Error / Mean	
50th Percentile Est. =	10	Total =	10%
10th Percentile Est. =	9	Model Error =	10%
90th Percentile Est =	12	Parameter Error =	2%
		Input Data Error =	2%

Show Results | Sensitivity Analysis | Menu

Sensitivity Coefficients

% Change in Output Variable / % Change in Input Variable

Enter assumed error CV (standard error, as percent of mean) in col. B (blue cells) to reflect uncertainty in each input value

Case Description: 100% SAV at 89 cm and 3.5 km2 (3 cells of SAV) with reservoir

Output Variable	Units	Value
Water Balance Error	%	0.0%
Mass Balance Error	%	-0.1%
Flow-Wtd Conc - With Bypass	ppb	26.2
Flow-Wtd Conc - Without Bypass	ppb	26.2
Geometric Mean Conc	ppb	10.1
95th Percentile Conc	ppb	36.2
Freq Cell Outflow > 10 ppb	%	48%
Bypass Load	%	0.0%

Input Variable	Error CV	Value	1	2	3	4	5	6
Design Case Name		S100b_r6a						
Starting Date for Simulation								
Ending Date for Simulation								
Starting Date for Output								
Steps Per Day								
Number of Iterations								
Output Averaging Interval								
Reservoir H2O Residence Time								
Max Inflow / Mean Inflow		-0.023						
Max Reservoir Storage		0.006						
Reservoir P Decay Rate								
Rainfall P Conc	30%	0.040						
Atmospheric P Load (Dry)	30%	0.033						
Cell Number -->			1	2	3	4	5	6
Cell Label			SAV1	SAV1	SAV1			
Vegetation Type			SAV_C4	SAV_C4	SAV_C4			
Inflow Fraction	0%		*0.448*					
Downstream Cell Number								
Surface Area			*-0.165*	*-0.166*	*-0.165*			
Mean Width of Flow Path			*0.038*	*0.014*	*0.004*			
Number of Tanks in Series	30%		*-0.021*	*-0.021*	*-0.023*			
Outflow Control Depth			*-0.004*	*-0.002*	*0.009*			
Outflow Coefficient - Exponent								
Outflow Coefficient - Intercept	20%		*0.038*	*0.014*	*0.004*			
Bypass Depth			*0.244*	*0.159*	*0.076*			
Maximum Inflow								
Maximum Outflow								
Inflow Seepage Rate	20%							
Inflow Seepage Control Elev								
Inflow Seepage Conc	20%							
Outflow Seepage Rate	20%		*0.008*	*0.008*	*0.012*			
Outflow Seepage Control Elev								
Max Outflow Seepage Conc	20%		*0.001*	*0.001*	*0.001*			
Seepage Recycle Fraction	20%		*-0.009*	*-0.011*	*-0.015*			
Seepage Discharge Fraction	20%							
Initial Water Column Conc								
Initial P Storage Per Unit Area								
Initial Water Column Depth								
C0 = WC Conc at 0 g/m2 P Storage			*0.097*	*0.105*	*0.084*			
C1 = WC Conc at 1 g/m2 P storage			*0.023*	*0.016*	*0.022*			
K = Net Settling Rate at Steady State			*-0.148*	*-0.171*	*-0.236*			
Zx = Depth Scale Factor	*retrieved*		*0.003*	*0.006*	*0.018*			
C0 - Periphyton	*from model*							
C1 - Periphyton	*calibration*							
K - Periphyton	*table*							
Zx - Periphyton								
Sm = Transition Storage Midpoint								
Sb = Transition Storage Bandwidth								

Uncertainty Analysis

Case: **S100b_r6a - sens50** **File:** **feeder_final_50.xls** 05/20/02

Estimates uncertainty in output variables. Assumes that sensitivity analysis has already been performed. Factors include: (1) uncertainty in p cycling parameters (from calibration); (2) uncertainty in other model inputs (user-specified); (3) inherent model error (from calibration); & (4) sensitivity of model output to each input value. Results are for combined outflows.

Reference: Walker, "A Sensitivity & Error Analysis Framework for Lake Eutrophication Modeling", Wtr Res Bul, Feb 1982

Select Output Variable:

- Treated FWM Outflow Conc
- Total FWM Outflow Conc
- Outflow Geo Mean - Composites
- Total Outflow Load

Total Outflow Load (kg/yr)		Error CV's = Standard Error / Mean	
50th Percentile Est. =	2378	Total =	10%
10th Percentile Est. =	2060	Model Error =	10%
90th Percentile Est =	2696	Parameter Error =	3%
		Input Data Error =	2%

Show Results | Sensitivity Analysis | Menu

Sensitivity Coefficients

% Change in Output Variable / % Change in Input Variable

Enter assumed error CV (standard error, as percent of mean) in col. B (blue cells) to reflect uncertainty in each input value

Case Description: **Filename: feeder_final_50.xls**

100% SAV at 89 cm and 3.5 km2 (3 cells of SAV) with reservoir

Output Variable	Units	Value
Water Balance Error	%	0.0%
Mass Balance Error	%	-0.1%
Flow-Wtd Conc - With Bypass	ppb	26.2
Flow-Wtd Conc - Without Bypass	ppb	26.2
Geometric Mean Conc	ppb	10.1
95th Percentile Conc	ppb	36.2
Freq Cell Outflow > 10 ppb	%	48%
Bypass Load	%	0.0%

Input Variable	Error CV	Value	1	2	3	4	5	6
Design Case Name		S100b_r6a						
Starting Date for Simulation								
Ending Date for Simulation								
Starting Date for Output								
Steps Per Day								
Number of Iterations								
Output Averaging Interval								
Reservoir H2O Residence Time								
Max Inflow / Mean Inflow		0.110						
Max Reservoir Storage		-0.020						
Reservoir P Decay Rate								
Rainfall P Conc	30%	0.002						
Atmospheric P Load (Dry)	30%	-0.003						
Cell Number -->			1	2	3	4	5	6
Cell Label			SAV1	SAV1	SAV1			
Vegetation Type			SAV_C4	SAV_C4	SAV_C4			
Inflow Fraction	0%		*1.380*					
Downstream Cell Number								
Surface Area			*-0.143*	*-0.144*	*-0.146*			
Mean Width of Flow Path			*-0.062*	*-0.013*	*-0.002*			
Number of Tanks in Series	30%		*-0.017*	*-0.015*	*-0.014*			
Outflow Control Depth			*-0.006*	*-0.016*	*-0.018*			
Outflow Coefficient - Exponent								
Outflow Coefficient - Intercept	20%		*-0.062*	*-0.013*	*-0.002*			
Bypass Depth			*-0.467*	*-0.164*	*-0.037*			
Maximum Inflow								
Maximum Outflow								
Inflow Seepage Rate	20%							
Inflow Seepage Control Elev								
Inflow Seepage Conc	20%							
Outflow Seepage Rate	20%		*-0.006*	*-0.006*	*-0.005*			
Outflow Seepage Control Elev								
Max Outflow Seepage Conc	20%		*0.000*	*0.000*	*0.001*			
Seepage Recycle Fraction	20%		*0.006*	*0.005*	*0.004*			
Seepage Discharge Fraction	20%							
Initial Water Column Conc								
Initial P Storage Per Unit Area								
Initial Water Column Depth								
C0 = WC Conc at 0 g/m2 P Storage			*0.131*	*0.141*	*0.153*			
C1 = WC Conc at 1 g/m2 P storage			*0.010*	*0.006*	*0.005*			
K = Net Settling Rate at Steady State			*-0.109*	*-0.114*	*-0.122*			
Zx = Depth Scale Factor	*retrieved*		*0.001*	*0.002*	*0.004*			
C0 - Periphyton	*from model*							
C1 - Periphyton	*calibration*							
K - Periphyton	*table*							
Zx - Periphyton								
Sm = Transition Storage Midpoint								
Sb = Transition Storage Bandwidth								

DMSTA Input Values **L-28 Basin - Alt. 1 basecase**

Input Variable	Units	Value
Design Case Name	-	S50P50d
Starting Date for Simulation	-	01/00/00
Ending Date for Simulation	-	01/00/00
Starting Date for Output	-	01/00/00
Steps Per Day	-	8
Number of Iterations	-	2
Output Averaging Interval	days	7
Reservoir H2O Residence Time	days	0
Max Inflow / Mean Inflow	-	0
Max Reservoir Storage	hm3	0
Reservoir P Decay Rate	1/yr/ppb	0
Rainfall P Conc	ppb	20
Atmospheric P Load (Dry)	mg/m2-yr	20

Case Description: **Filename:** **L-28_final_base.xls**

50% SAV 50% PSTA at 79,69 cm at 4.4 km2
2 cells of SAV, 2 cells of PSTA
no reservoir
L-28 basecase

Output Variable	Units	Value
Water Balance Error	%	0.0%
Mass Balance Error	%	0.0%
Flow-Wtd Conc - With Bypass	ppb	12
Flow-Wtd Conc - Without Bypass	ppb	12
Geometric Mean Conc	ppb	10
95th Percentile Conc	ppb	15
Freq Cell Outflow > 10 ppb	%	52%
Bypass Load	%	0.0%

Cell Number -->		1	2	3	4	5	6
Cell Label	-	Cell1	Cell2	Cell3	Cell4		
Vegetation Type	------->	SAV_C4	SAV_C4	PSTA	PSTA		
Inflow Fraction	-	1	0	0	0		
Downstream Cell Number	-	2	3	4	0		
Surface Area	km2	1.100	1.100	1.100	1.100		
Mean Width of Flow Path	km	2.10	2.10	2.10	2.10		
Number of Tanks in Series	-	3	3	3	3		
Outflow Control Depth	cm	79	79	69	69		
Outflow Coefficient - Exponent	-	3.5	3.5	3.5	3.5		
Outflow Coefficient - Intercept	-	0.8	0.8	0.8	0.8		
Bypass Depth	cm	140	140	140	140		
Maximum Inflow	hm3/day	0	0	0	0		
Maximum Outflow	hm3/day	0	0	0	0		
Inflow Seepage Rate	(cm/d) / cm	0	0	0	0		
Inflow Seepage Control Elev	cm	0	0	0	0		
Inflow Seepage Conc	ppb	0	0	0	0		
Outflow Seepage Rate	(cm/d) / cm	0.008	0.008	0.008	0.008		
Outflow Seepage Control Elev	cm	0	0	0	0		
Max Outflow Seepage Conc	ppb	20	20	20	20		
Seepage Recycle Fraction	-	0.5	0.5	0.5	0.5		
Seepage Discharge Fraction	-	0	0	0	0		
Initial Water Column Conc	ppb	30	30	30	30		
Initial P Storage Per Unit Area	mg/m2	500	500	500	500		
Initial Water Column Depth	cm	50	50	50	50		
C0 = WC Conc at 0 g/m2 P Storage	ppb	*4*	*4*	*4*	*4*		
C1 = WC Conc at 1 g/m2 P storage	ppb	*22*	*22*	*22*	*22*		
K = Net Settling Rate at Steady State	m/yr	*80*	*80*	*24*	*24*		
Zx = Depth Scale Factor	cm	*60*	*60*	*0*	*0*		
C0 - Periphyton	ppb	*0*	*0*	*0*	*0*		
C1 - Periphyton	ppb	*0*	*0*	*0*	*0*		
K - Periphyton	1/yr	*0.00*	*0.00*	*0.00*	*0.00*		
Zx - Periphyton	cm	*0*	*0*	*0*	*0*		
Sm = Transition Storage Midpoint	mg/m2	*0*	*0*	*0*	*0*		
Sb = Transition Storage Bandwidth	mg/m2	*0*	*0*	*0*	*0*		

Output Variables	Units	1	2	3	4	5	6	Overall
Execution Time	seconds/yr	10.23	15.03	18.10	21.13			21.13
Run Date	-	05/10/02	05/10/02	05/10/02	05/10/02			05/10/02
Starting Date for Simulation	-	01/01/65	01/01/65	01/01/65	01/01/65			01/01/65
Starting Date for Output	-	01/01/65	01/01/65	01/01/65	01/01/65			01/01/65
Ending Date	-	12/31/95	12/31/95	12/31/95	12/31/95			12/31/95
Output Duration	days	11322	11322	11322	11322			11322
Cell Label		Cell1	Cell2	Cell3	Cell4			Total Outflow
Downstream Cell Label		Cell2	Cell3	Cell4	Outflow			-
Surface Area	km2	1.100	1.100	1.100	1.100			4.4
Mean Water Load	cm/d	25.7	25.4	25.0	24.7			6.4
Max Water Load	cm/d	194.9	197.9	200.8	203.5			48.7
Inflow Volume	hm3/yr	103.5	102.0	100.4	99.1			103.5
Inflow Load	kg/yr	3984.9	2265.8	1449.8	1297.8			3984.9
Inflow Conc	ppb	39	22	14	13			38.5
Treated Outflow Volume	hm3/yr	102.0	100.4	99.1	97.7			97.7
Treated Outflow Load	kg/yr	2265.8	1449.8	1297.8	1174.8			1174.8
Treated FWM Outflow Conc	ppb	22	14	13	12			12.0
Total Outflow Volume	hm3/yr	102.0	100.4	99.1	97.7			97.7

L-28 Basin - Alt. 1 basecase (cont'd)

Total Outflow Load	kg/yr	2265.8	1449.8	1297.8	1174.8	1174.8
Total FWM Outflow Conc	ppb	22	14	13	12	12.0
Bypass Volume	hm3/yr	0.00	0.00	0.00	0.00	0.00
Bypass Load	kg/yr	0.00	0.00	0.00	0.00	0.00
Bypass Conc	ppb	0	0	0	0	0.0
Bypass Load	%	0%	0%	0%	0%	0%
Surface Outflow Load Reduc	%	43.1%	36.0%	10.5%	9.5%	70.5%
Outflow Geometric Mean - Daily	ppb	21	13	11	10	10.4
Outflow Geo Mean - Composites	ppb	21	13	11	10	10.3
Frequency Outflow Conc > 10 ppb	%	100%	86%	72%	52%	52%
95th Percentile Outflow Conc	ppb	26	18	16	15	15.1
Mean Biomass P Storage	mg/m2	1091	533	396	338	590
Max Reservoir Storage	hm3	0.00	0.00	0.00	0.00	0.00
Reservoir Load Reduction	%	#N/A	#N/A	#N/A	#N/A	#N/A
Mean Depth	cm	74.4	74.2	65.4	64.9	69.7
Minimum Depth	cm	1.6	1.6	1.2	1.2	1.4
Maximum Depth	cm	106.3	106.9	107.4	107.9	107.1
Frequency Depth < 5 cm	%	0.0%	0.0%	0.1%	0.1%	0.0%
Flow/Width	m2/day	133	131	129	128	130.2
Max 1 Yr Flow-Wtd Conc	ppb	#N/A	#N/A	#N/A	#N/A	14.7
Max 5 Yr Flow-Wtd Conc	ppb	#N/A	#N/A	#N/A	#N/A	12.9
Max 1 Yr Geometric Mn Conc	ppb	#N/A	#N/A	#N/A	#N/A	13.1
Max 5 Yr Geometric Mn Conc	ppb	#N/A	#N/A	#N/A	#N/A	11.3
Depth Percentile vs. Calib Set	%	56%	56%	92%	92%	92%
Q/W Percentile vs. Calib Set	%	62%	61%	77%	76%	76%
Cin Percentile vs. Calib Set	%	47%	21%	59%	52%	47%
Cout Percentile vs. Calib Set	%	21%	1%	52%	46%	46%
Depth Range Flag	-	OK	OK	OK	OK	0.0
Q/W Range Flag	-	OK	OK	OK	OK	0.0
Cin Range Flag	-	OK	OK	OK	OK	0.0
Cout Range Flag	-	OK	OK	OK	OK	0.0
Water Balance Error	%	0.00%	0.00%	0.00%	0.00%	0.00%
Mass Balance Error	%	0.00%	0.00%	0.01%	0.01%	0.00%

DMSTA Input Values **L-28 Basin - Alt. 1 with 25% Load Reduction (Sensitivity)**

Input Variable	Units	Value
Design Case Name	-	S50P50_s4
Starting Date for Simulation	-	01/00/00
Ending Date for Simulation	-	01/00/00
Starting Date for Output	-	01/00/00
Steps Per Day	-	8
Number of Iterations	-	2
Output Averaging Interval	days	7
Reservoir H2O Residence Time	days	0
Max Inflow / Mean Inflow	-	0
Max Reservoir Storage	hm3	0
Reservoir P Decay Rate	1/yr/ppb	0
Rainfall P Conc	ppb	20
Atmospheric P Load (Dry)	mg/m2-yr	20

Case Description: **Filename:** **L-28_final_25.xls**

50% SAV 50% PSTA at 79,69 cm at 3.4 km2
2 cells of SAV, 2 cells of PSTA
no reservoir
L-28 w/ 25% source controls

Output Variable	Units	Value
Water Balance Error	%	0.0%
Mass Balance Error	%	0.0%
Flow-Wtd Conc - With Bypass	ppb	12
Flow-Wtd Conc - Without Bypass	ppb	12
Geometric Mean Conc	ppb	10
95th Percentile Conc	ppb	15
Freq Cell Outflow > 10 ppb	%	55%
Bypass Load	%	0.0%

Cell Number -->		1	2	3	4	5	6
Cell Label	-	Cell1	Cell2	Cell3	Cell4		
Vegetation Type	------->	SAV_C4	SAV_C4	PSTA	PSTA		
Inflow Fraction	-	1	0	0	0		
Downstream Cell Number	-	2	3	4	0		
Surface Area	km2	0.850	0.850	0.850	0.850		
Mean Width of Flow Path	km	1.84	1.84	1.84	1.84		
Number of Tanks in Series	-	3	3	3	3		
Outflow Control Depth	cm	79	79	69	69		
Outflow Coefficient - Exponent	-	3.5	3.5	3.5	3.5		
Outflow Coefficient - Intercept	-	0.8	0.8	0.8	0.8		
Bypass Depth	cm	140	140	140	140		
Maximum Inflow	hm3/day	0	0	0	0		
Maximum Outflow	hm3/day	0	0	0	0		
Inflow Seepage Rate	(cm/d) / cm	0	0	0	0		
Inflow Seepage Control Elev	cm	0	0	0	0		
Inflow Seepage Conc	ppb	0	0	0	0		
Outflow Seepage Rate	(cm/d) / cm	0.008	0.008	0.008	0.008		
Outflow Seepage Control Elev	cm	0	0	0	0		
Max Outflow Seepage Conc	ppb	20	20	20	20		
Seepage Recycle Fraction	-	0.5	0.5	0.5	0.5		
Seepage Discharge Fraction	-	0	0	0	0		
Initial Water Column Conc	ppb	30	30	30	30		
Initial P Storage Per Unit Area	mg/m2	500	500	500	500		
Initial Water Column Depth	cm	50	50	50	50		
C0 = WC Conc at 0 g/m2 P Storage	ppb	*4*	*4*	*4*	*4*		
C1 = WC Conc at 1 g/m2 P storage	ppb	*22*	*22*	*22*	*22*		
K = Net Settling Rate at Steady State	m/yr	*80*	*80*	*23.80*	*24*		
Zx = Depth Scale Factor	cm	*60*	*60*	*0*	*0*		
C0 - Periphyton	ppb	*0*	*0*	*0*	*0*		
C1 - Periphyton	ppb	*0*	*0*	*0*	*0*		
K - Periphyton	1/yr	*0.00*	*0.00*	*0.00*	*0.00*		
Zx - Periphyton	cm	*0*	*0*	*0*	*0*		
Sm = Transition Storage Midpoint	mg/m2	*0*	*0*	*0*	*0*		
Sb = Transition Storage Bandwidth	mg/m2	*0*	*0*	*0*	*0*		

Output Variables	Units	1	2	3	4	5	6	Overall
Execution Time	seconds/yr	3.52	7.29	10.03	12.74			12.74
Run Date	-	06/26/02	06/26/02	06/26/02	06/26/02			06/26/02
Starting Date for Simulation	-	01/01/65	01/01/65	01/01/65	01/01/65			01/01/65
Starting Date for Output	-	01/01/65	01/01/65	01/01/65	01/01/65			01/01/65
Ending Date	-	12/31/95	12/31/95	12/31/95	12/31/95			12/31/95
Output Duration	days	11322	11322	11322	11322			11322
Cell Label		Cell1	Cell2	Cell3	Cell4			Total Outflow
Downstream Cell Label		Cell2	Cell3	Cell4	Outflow			-
Surface Area	km2	0.850	0.850	0.850	0.850			3.4
Mean Water Load	cm/d	33.3	32.9	32.6	32.2			8.3
Max Water Load	cm/d	252.2	255.2	258.1	260.9			63.0
Inflow Volume	hm3/yr	103.5	102.3	101.1	100.1			103.5
Inflow Load	kg/yr	2988.7	1959.9	1396.7	1283.6			2988.7
Inflow Conc	ppb	29	19	14	13			28.9
Treated Outflow Volume	hm3/yr	102.3	101.1	100.1	99.0			99.0
Treated Outflow Load	kg/yr	1959.9	1396.7	1283.6	1187.5			1187.5
Treated FWM Outflow Conc	ppb	19	14	13	12			12.0
Total Outflow Volume	hm3/yr	102.3	101.1	100.1	99.0			99.0

L-28 Basin - Alt. 1 with 25% Load Reduction (Sensitivity) (cont'd)

Total Outflow Load	kg/yr	1959.9	1396.7	1283.6	1187.5	1187.5
Total FWM Outflow Conc	ppb	19	14	13	12	12.0
Bypass Volume	hm3/yr	0.00	0.00	0.00	0.00	0.00
Bypass Load	kg/yr	0.00	0.00	0.00	0.00	0.00
Bypass Conc	ppb	0	0	0	0	0.0
Bypass Load	%	0%	0%	0%	0%	0%
Surface Outflow Load Reduc	%	34.4%	28.7%	8.1%	7.5%	60.3%
Outflow Geometric Mean - Daily	ppb	18	12	11	11	10.5
Outflow Geo Mean - Composites	ppb	18	12	11	10	10.4
Frequency Outflow Conc > 10 ppb	%	100%	84%	71%	55%	55%
95th Percentile Outflow Conc	ppb	22	17	16	15	14.9
Mean Biomass P Storage	mg/m2	853	479	385	340	514
Max Reservoir Storage	hm3	0.00	0.00	0.00	0.00	0.00
Reservoir Load Reduction	%	#N/A	#N/A	#N/A	#N/A	#N/A
Mean Depth	cm	74.5	74.4	66.1	66.0	70.3
Minimum Depth	cm	1.6	1.6	1.2	1.2	1.4
Maximum Depth	cm	110.2	110.6	111.1	111.5	110.8
Frequency Depth < 5 cm	%	0.0%	0.0%	0.1%	0.1%	0.0%
Flow/Width	m2/day	152	150	149	147	149.4
Max 1 Yr Flow-Wtd Conc	ppb	#N/A	#N/A	#N/A	#N/A	14.2
Max 5 Yr Flow-Wtd Conc	ppb	#N/A	#N/A	#N/A	#N/A	12.7
Max 1 Yr Geometric Mn Conc	ppb	#N/A	#N/A	#N/A	#N/A	12.8
Max 5 Yr Geometric Mn Conc	ppb	#N/A	#N/A	#N/A	#N/A	11.3
Depth Percentile vs. Calib Set	%	56%	56%	93%	93%	93%
Q/W Percentile vs. Calib Set	%	70%	70%	88%	88%	88%
Cin Percentile vs. Calib Set	%	34%	14%	56%	51%	34%
Cout Percentile vs. Calib Set	%	15%	-1%	51%	46%	46%
Depth Range Flag	-	OK	OK	OK	OK	0.0
Q/W Range Flag	-	OK	OK	OK	OK	0.0
Cin Range Flag	-	OK	OK	OK	OK	0.0
Cout Range Flag	-	OK	FLAG	OK	OK	1.0
Water Balance Error	%	0.00%	0.00%	0.00%	0.00%	0.00%
Mass Balance Error	%	0.00%	0.00%	0.01%	0.01%	0.01%

DMSTA Input Values **L-28 Basin - Alt. 1 basecase using NEWS (Sensitivity)**

Input Variable	Units	Value
Design Case Name	-	NEWS
Starting Date for Simulation	-	01/00/00
Ending Date for Simulation	-	01/00/00
Starting Date for Output	-	01/00/00
Steps Per Day	-	8
Number of Iterations	-	2
Output Averaging Interval	days	7
Reservoir H2O Residence Time	days	0
Max Inflow / Mean Inflow	-	0
Max Reservoir Storage	hm3	0
Reservoir P Decay Rate	1/yr/ppb	0
Rainfall P Conc	ppb	20
Atmospheric P Load (Dry)	mg/m2-yr	20

Case Description: **Filename:** **L-28_final_base.xls**

100% NEWS at 79,69 cm at 4.4 km2
4 cells of NEWS
no reservoir
L-28 basecase with NEWS

Output Variable	Units	Value
Water Balance Error	%	0.0%
Mass Balance Error	%	0.0%
Flow-Wtd Conc - With Bypass	ppb	15
Flow-Wtd Conc - Without Bypass	ppb	15
Geometric Mean Conc	ppb	11
95th Percentile Conc	ppb	20
Freq Cell Outflow > 10 ppb	%	60%
Bypass Load	%	0.0%

Cell Number -->		1	2	3	4	5	6
Cell Label	-	Cell1	Cell2	Cell3	Cell4		
Vegetation Type	------->	NEWS	NEWS	NEWS	NEWS		
Inflow Fraction	-	1	0	0	0		
Downstream Cell Number	-	2	3	4	0		
Surface Area	km2	1.100	1.100	1.100	1.100		
Mean Width of Flow Path	km	2.10	2.10	2.10	2.10		
Number of Tanks in Series	-	3	3	3	3		
Outflow Control Depth	cm	79	79	69	69		
Outflow Coefficient - Exponent	-	3.5	3.5	3.5	3.5		
Outflow Coefficient - Intercept	-	0.8	0.8	0.8	0.8		
Bypass Depth	cm	140	140	140	140		
Maximum Inflow	hm3/day	0	0	0	0		
Maximum Outflow	hm3/day	0	0	0	0		
Inflow Seepage Rate	(cm/d) / cm	0	0	0	0		
Inflow Seepage Control Elev	cm	0	0	0	0		
Inflow Seepage Conc	ppb	0	0	0	0		
Outflow Seepage Rate	(cm/d) / cm	0.008	0.008	0.008	0.008		
Outflow Seepage Control Elev	cm	0	0	0	0		
Max Outflow Seepage Conc	ppb	20	20	20	20		
Seepage Recycle Fraction	-	0.5	0.5	0.5	0.5		
Seepage Discharge Fraction	-	0	0	0	0		
Initial Water Column Conc	ppb	30	30	30	30		
Initial P Storage Per Unit Area	mg/m2	500	500	500	500		
Initial Water Column Depth	cm	50	50	50	50		
C0 = WC Conc at 0 g/m2 P Storage	ppb	*12*	*12*	*12*	*12*		
C1 = WC Conc at 1 g/m2 P storage	ppb	*22*	*22*	*22*	*22*		
K = Net Settling Rate at Steady State	m/yr	*129*	*129*	*129*	*129*		
Zx = Depth Scale Factor	cm	*60*	*60*	*60*	*60*		
C0 - Periphyton	ppb	*4*	*4*	*4*	*4*		
C1 - Periphyton	ppb	*22*	*22*	*22*	*22*		
K - Periphyton	1/yr	*23.80*	*23.80*	*23.80*	*23.80*		
Zx - Periphyton	cm	*0*	*0*	*0*	*0*		
Sm = Transition Storage Midpoint	mg/m2	*400*	*400*	*400*	*400*		
Sb = Transition Storage Bandwidth	mg/m2	*80*	*80*	*80*	*80*		

Output Variables	Units	1	2	3	4	5	6	Overall
Execution Time	seconds/yr	3.42	7.13	10.84	14.55			14.55
Run Date	-	07/05/02	07/05/02	07/05/02	07/05/02			07/05/02
Starting Date for Simulation	-	01/01/65	01/01/65	01/01/65	01/01/65			01/01/65
Starting Date for Output	-	01/01/65	01/01/65	01/01/65	01/01/65			01/01/65
Ending Date	-	12/31/95	12/31/95	12/31/95	12/31/95			12/31/95
Output Duration	days	11322	11322	11322	11322			11322
Cell Label		Cell1	Cell2	Cell3	Cell4			Total Outflow
Downstream Cell Label		Cell2	Cell3	Cell4	Outflow			-
Surface Area	km2	1.100	1.100	1.100	1.100			4.4
Mean Water Load	cm/d	25.7	25.4	25.0	24.7			6.4
Max Water Load	cm/d	194.9	197.9	200.8	203.5			48.7
Inflow Volume	hm3/yr	103.5	102.0	100.4	99.1			103.5
Inflow Load	kg/yr	3984.9	2492.3	1933.7	1627.5			3984.9
Inflow Conc	ppb	39	24	19	16			38.5
Treated Outflow Volume	hm3/yr	102.0	100.4	99.1	97.7			97.7
Treated Outflow Load	kg/yr	2492.3	1933.7	1627.5	1423.7			1423.7
Treated FWM Outflow Conc	ppb	24	19	16	15			14.6
Total Outflow Volume	hm3/yr	102.0	100.4	99.1	97.7			97.7

L-28 Basin - Alt. 1 basecase using NEWS (Sensitivity) (cont'd)

Total Outflow Load	kg/yr	2492.3	1933.7	1627.5	1423.7	1423.7
Total FWM Outflow Conc	ppb	24	19	16	15	14.6
Bypass Volume	hm3/yr	0.00	0.00	0.00	0.00	0.00
Bypass Load	kg/yr	0.00	0.00	0.00	0.00	0.00
Bypass Conc	ppb	0	0	0	0	0.0
Bypass Load	%	0%	0%	0%	0%	0%
Surface Outflow Load Reduc	%	37.5%	22.4%	15.8%	12.5%	64.3%
Outflow Geometric Mean - Daily	ppb	22	16	13	12	11.6
Outflow Geo Mean - Composites	ppb	21	16	13	11	11.4
Frequency Outflow Conc > 10 ppb	%	100%	100%	0%	0%	60%
95th Percentile Outflow Conc	ppb	19	12	9	8	20.1
Mean Biomass P Storage	mg/m2	1071	496	377	320	566
Max Reservoir Storage	hm3	0.00	0.00	0.00	0.00	0.00
Reservoir Load Reduction	%	#N/A	#N/A	#N/A	#N/A	#N/A
Mean Depth	cm	74.4	74.2	65.4	64.9	69.7
Minimum Depth	cm	1.6	1.6	1.2	1.2	1.4
Maximum Depth	cm	106.3	106.9	107.4	107.9	107.1
Frequency Depth < 5 cm	%	0.0%	0.0%	0.0%	0.0%	0.0%
Flow/Width	m2/day	133	131	129	128	130.2
Max 1 Yr Flow-Wtd Conc	ppb	#N/A	#N/A	#N/A	#N/A	19.6
Max 5 Yr Flow-Wtd Conc	ppb	#N/A	#N/A	#N/A	#N/A	16.2
Max 1 Yr Geometric Mn Conc	ppb	#N/A	#N/A	#N/A	#N/A	14.4
Max 5 Yr Geometric Mn Conc	ppb	#N/A	#N/A	#N/A	#N/A	12.5
Depth Percentile vs. Calib Set	%	65%	65%	56%	56%	56%
Q/W Percentile vs. Calib Set	%	62%	61%	60%	59%	59%
Cin Percentile vs. Calib Set	%	61%	46%	38%	32%	61%
Cout Percentile vs. Calib Set	%	46%	38%	33%	28%	28%
Depth Range Flag	-	OK	OK	OK	OK	0.0
Q/W Range Flag	-	OK	OK	OK	OK	0.0
Cin Range Flag	-	OK	OK	OK	OK	0.0
Cout Range Flag	-	OK	OK	OK	OK	0.0
Water Balance Error	%	0.00%	0.00%	0.00%	0.00%	0.00%
Mass Balance Error	%	0.00%	0.01%	0.01%	0.01%	0.01%

L-28 Basin - Alt. 1 Basecase 25% DMSTA Sensitivity Analysis

Sensitivity Analysis **Case: S50P50d** **File: L-28_final_base.xls** **Input Variable Set: All** **Run Date: 05/16/02**

Option	Value	
Select Sensitivity Scale Factor --->	**25%**	*Modify Each Input Variable by +/- This Percentage*
Select Input Parameter Set ------>	**1**	*1 = All, 2 = P Cycling Only, 3 = Design Features Only*
Select Test Option ---------->	**2**	*1 = High Results Only, 2 = High & Low Results*

Number of Model Runs Required = 108 Estimated Run Time = 1134.0 minutes

Adjusts Each non-Zero Input Variable, One at a Time, & Re-Runs Simulation

Shows Results for Combined Outflow from Entire Treatment Area

Run

Sort Results

Uncertainty Analysis

Menu

			High Results ---->					Low Results ------>					Average Change ---->				Average % Change -->			
Input Variable	Cell Number	Input Value - Base	Input Value - High	Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load	Input Value - Low	Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load	Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load	Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load
	-	-	-	ppb	ppb	ppb	kg/yr	-	ppb	ppb	ppb	kg/yr	ppb	ppb	ppb	kg/yr	%	%	%	%
Base Run				12.0	12.0	10.3	1175		12.0	12.0	10.3	1175								
Rainfall P Conc	1	20.0	25.0	12.2	12.2	10.4	1188	16.0	11.9	11.9	10.2	1164	0.1	0.1	0.1	12	1%	1%	1%	1%
Atmospheric P Load (Dry)	1	20.0	25.0	12.1	12.1	10.4	1183	16.0	12.0	12.0	10.2	1168	0.1	0.1	0.1	7	1%	1%	1%	1%
Inflow Fraction	1	1.0	1.3	13.9	13.9	12.2	1719	0.8	10.5	10.5	8.8	807	1.7	1.7	1.7	456	14%	14%	17%	39%
Surface Area	1	1.1	1.4	11.4	11.4	9.6	1105	0.9	12.7	12.7	11.0	1242	-0.7	-0.7	-0.7	-68	-5%	-5%	-6%	-6%
Surface Area	2	1.1	1.4	11.4	11.4	9.6	1105	0.9	12.7	12.7	11.0	1241	-0.7	-0.7	-0.7	-68	-5%	-5%	-6%	-6%
Surface Area	3	1.1	1.4	11.8	11.8	10.1	1149	0.9	12.2	12.2	10.5	1197	-0.2	-0.2	-0.2	-24	-1.7%	-1.7%	-2.0%	-2.0%
Surface Area	4	1.1	1.4	11.8	11.8	10.1	1149	0.9	12.2	12.2	10.5	1197	-0.2	-0.2	-0.2	-24	-2%	-2%	-2%	-2%
Mean Width of Flow Path	1	2.1	2.6	12.0	12.0	10.3	1175	1.7	12.0	12.0	10.3	1174	0.0	0.0	0.0	0	0%	0%	0%	0%
Mean Width of Flow Path	2	2.1	2.6	12.0	12.0	10.3	1175	1.7	12.0	12.0	10.3	1175	0.0	0.0	0.0	0	0%	0%	0%	0%
Mean Width of Flow Path	3	2.1	2.6	12.0	12.0	10.3	1175	1.7	12.0	12.0	10.3	1175	0.0	0.0	0.0	0	0%	0%	0%	0%
Mean Width of Flow Path	4	2.1	2.6	12.0	12.0	10.3	1175	1.7	12.0	12.0	10.3	1175	0.0	0.0	0.0	0	0%	0%	0%	0%
Number of Tanks in Series	1	3.0	3.8	11.9	11.9	10.2	1166	2.4	12.1	12.1	10.4	1178	-0.1	-0.1	-0.1	-6	-1%	-1%	-1%	-1%
Number of Tanks in Series	2	3.0	3.8	11.9	11.9	10.2	1166	2.4	12.1	12.1	10.4	1179	-0.1	-0.1	-0.1	-6	-1%	-1%	-1%	-1%
Number of Tanks in Series	3	3.0	3.8	12.0	12.0	10.3	1174	2.4	12.0	12.0	10.3	1175	0.0	0.0	0.0	-1	0%	0%	0%	0%
Number of Tanks in Series	4	3.0	3.8	12.0	12.0	10.3	1174	2.4	12.0	12.0	10.3	1175	0.0	0.0	0.0	-1	0%	0%	0%	0%
Outflow Control Depth	1	79.0	98.8	12.0	12.0	10.3	1170	63.2	12.0	12.0	10.3	1178	0.0	0.0	0.0	-4	0%	0%	0%	0%
Outflow Control Depth	2	79.0	98.8	12.0	12.0	10.3	1169	63.2	12.0	12.0	10.3	1179	0.0	0.0	0.0	-5	0%	0%	0%	0%
Outflow Control Depth	3	69.0	86.3	12.0	12.0	10.3	1171	55.2	12.0	12.0	10.3	1177	0.0	0.0	0.0	-3	0%	0%	0%	0%
Outflow Control Depth	4	69.0	86.3	12.0	12.0	10.3	1172	55.2	12.0	12.0	10.3	1176	0.0	0.0	0.0	-2	0%	0%	0%	0%
Outflow Coefficient - Intercept	1	0.8	1.0	12.0	12.0	10.3	1175	0.6	12.0	12.0	10.3	1174	0.0	0.0	0.0	0	0%	0%	0%	0%
Outflow Coefficient - Intercept	2	0.8	1.0	12.0	12.0	10.3	1175	0.6	12.0	12.0	10.3	1175	0.0	0.0	0.0	0	0%	0%	0%	0%
Outflow Coefficient - Intercept	3	0.8	1.0	12.0	12.0	10.3	1175	0.6	12.0	12.0	10.3	1175	0.0	0.0	0.0	0	0%	0%	0%	0%
Outflow Coefficient - Intercept	4	0.8	1.0	12.0	12.0	10.3	1175	0.6	12.0	12.0	10.3	1175	0.0	0.0	0.0	0	0%	0%	0%	0%
Bypass Depth	1	140.0	175.0	12.0	12.0	10.3	1175	112.0	12.0	12.0	10.3	1175	0.0	0.0	0.0	0	0%	0%	0%	0%
Bypass Depth	2	140.0	175.0	12.0	12.0	10.3	1175	112.0	12.0	12.0	10.3	1175	0.0	0.0	0.0	0	0%	0%	0%	0%
Bypass Depth	3	140.0	175.0	12.0	12.0	10.3	1175	112.0	12.0	12.0	10.3	1175	0.0	0.0	0.0	0	0%	0%	0%	0%
Bypass Depth	4	140.0	175.0	12.021	12.0	10.3	1175	112.0	12.0	12.0	10.3	1175	0.0	0.0	0.0	0	0%	0%	0%	0%
Outflow Seepage Rate	1	0.0	0.0	12.0	12.0	10.3	1170	0.0	12.0	12.0	10.3	1178	0.0	0.0	0.0	-4	0%	0%	0%	0%
Outflow Seepage Rate	2	0.0	0.0	12.0	12.0	10.3	1171	0.0	12.0	12.0	10.3	1178	0.0	0.0	0.0	-3	0%	0%	0%	0%
Outflow Seepage Rate	3	0.0	0.0	12.0	12.0	10.3	1172	0.0	12.0	12.0	10.3	1177	0.0	0.0	0.0	-3	0%	0%	0%	0%
Outflow Seepage Rate	4	0.0	0.0	12.0	12.0	10.3	1172	0.0	12.0	12.0	10.3	1177	0.0	0.0	0.0	-2	0%	0%	0%	0%
Max Outflow Seepage Conc	1	20.0	25.0	12.0	12.0	10.3	1175	16.0	12.0	12.0	10.3	1174	0.0	0.0	0.0	0	0%	0%	0%	0%
Max Outflow Seepage Conc	2	20.0	25.0	12.0	12.0	10.3	1175	16.0	12.0	12.0	10.3	1174	0.0	0.0	0.0	0	0%	0%	0%	0%
Max Outflow Seepage Conc	3	20.0	25.0	12.0	12.0	10.3	1175	16.0	12.0	12.0	10.3	1175	0.0	0.0	0.0	0	0%	0%	0%	0%
Max Outflow Seepage Conc	4	20.0	25.0	12.0	12.0	10.3	1175	16.0	12.0	12.0	10.3	1175	0.0	0.0	0.0	0	0%	0%	0%	0%
Seepage Recycle Fraction	1	0.5	0.6	12.0	12.0	10.3	1179	0.4	12.0	12.0	10.3	1171	0.0	0.0	0.0	4	0%	0%	0%	0%
Seepage Recycle Fraction	2	0.5	0.6	12.0	12.0	10.3	1178	0.4	12.0	12.0	10.3	1172	0.0	0.0	0.0	3	0%	0%	0%	0%
Seepage Recycle Fraction	3	0.5	0.6	12.0	12.0	10.3	1178	0.4	12.0	12.0	10.3	1172	0.0	0.0	0.0	3	0%	0%	0%	0%
Seepage Recycle Fraction	4	0.5	0.6	12.0	12.0	10.3	1177	0.4	12.0	12.0	10.3	1173	0.0	0.0	0.0	2	0%	0%	0%	0%

L-28 Basin - Alt. 1 Basecase 25% DMSTA Sensitivity Analysis (cont'd)

Sensitivity Analysis **Case: S50P50d** **File: L-28_final_base.xls** **Input Variable Set: All** **Run Date: 05/16/02**

Option	Value	
Select Sensitivity Scale Factor --->	**25%**	*Modify Each Input Variable by +/- This Percentage*
Select Input Parameter Set ------>	**1**	*1 = All, 2 = P Cycling Only, 3 = Design Features Only*
Select Test Option ---------->	**2**	*1 = High Results Only, 2 = High & Low Results*

Number of Model Runs Required = 108 Estimated Run Time = 1134.0 minutes

Adjusts Each non-Zero Input Variable, One at a Time, & Re-Runs Simulation

Shows Results for Combined Outflow from Entire Treatment Area

Run

Sort Results

Uncertainty Analysis

Menu

			High Results ---->					Low Results ------>					Average Change ---->				Average % Change -->			
	Cell Number	Input Value - Base	Input Value - High	Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load	Input Value - Low	Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load	Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load	Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load
Input Variable	-	-	-	ppb	ppb	ppb	kg/yr	-	ppb	ppb	ppb	kg/yr	ppb	ppb	ppb	kg/yr	%	%	%	%
Base Run				12.0	12.0	10.3	1175		12.0	12.0	10.3	1175								
C0 = WC Conc at 0 g/m2 P Storage	1	4.0	5.0	12.3	12.3	10.5	1200	3.2	11.8	11.8	10.1	1154	0.2	0.2	0.2	23	2%	2%	2%	2%
C0 = WC Conc at 0 g/m2 P Storage	2	4.0	5.0	12.5	12.5	10.7	1222	3.2	11.6	11.6	10.0	1135	0.4	0.4	0.3	43	4%	4%	3%	4%
C0 = WC Conc at 0 g/m2 P Storage	3	4.0	5.0	12.2	12.2	10.5	1195	3.2	11.8	11.8	10.2	1157	0.2	0.2	0.1	19	2%	2%	1%	2%
C0 = WC Conc at 0 g/m2 P Storage	4	4.0	5.0	12.3	12.3	10.5	1199	3.2	11.8	11.8	10.2	1154	0.2	0.2	0.1	22	2%	2%	1%	2%
C1 = WC Conc at 1 g/m2 P storage	1	22.0	27.5	12.1	12.1	10.3	1179	17.6	12.0	12.0	10.3	1172	0.0	0.0	0.0	3	0%	0%	0%	0%
C1 = WC Conc at 1 g/m2 P storage	2	22.0	27.5	12.1	12.1	10.3	1178	17.6	12.0	12.0	10.3	1172	0.0	0.0	0.0	3	0%	0%	0%	0%
C1 = WC Conc at 1 g/m2 P storage	3	22.0	27.5	12.0	12.0	10.3	1175	17.6	12.0	12.0	10.3	1174	0.0	0.0	0.0	0	0%	0%	0%	0%
C1 = WC Conc at 1 g/m2 P storage	4	22.0	27.5	12.0	12.0	10.3	1175	17.6	12.0	12.0	10.3	1174	0.0	0.0	0.0	0	0%	0%	0%	0%
K = Net Settling Rate at Steady State	1	80.1	100.1	11.4	11.4	9.7	1112	64.1	12.7	12.7	10.9	1236	-0.6	-0.6	-0.6	-62	-5%	-5%	-6%	-5%
K = Net Settling Rate at Steady State	2	80.1	100.1	11.4	11.4	9.6	1111	64.1	12.7	12.7	11.0	1238	-0.6	-0.6	-0.7	-63	-5%	-5%	-6%	-5%
K = Net Settling Rate at Steady State	3	23.8	29.8	11.7	11.7	10.0	1148	19.0	12.3	12.3	10.6	1198	-0.3	-0.3	-0.3	-25	-2%	-2%	-3%	-2%
K = Net Settling Rate at Steady State	4	23.8	29.8	11.7	11.7	10.0	1145	19.0	12.3	12.3	10.6	1201	-0.3	-0.3	-0.3	-28	-2%	-2%	-3%	-2%
Zx = Depth Scale Factor	1	60.0	75.0	12.0	12.0	10.3	1175	48.0	12.0	12.0	10.3	1175	0.0	0.0	0.0	0	0%	0%	0%	0%
Zx = Depth Scale Factor	2	60.0	75.0	12.0	12.0	10.3	1175	48.0	12.0	12.0	10.3	1175	0.0	0.0	0.0	0	0%	0%	0%	0%

L-28 Basin - Alt. 1 Basecase 50% DMSTA Sensitivity Analysis

Sensitivity Analysis **Case: S50P50d** **File: L-28_final_base.xls** **Input Variable Set: All** **Run Date: 05/17/02**

Option	Value	
Select Sensitivity Scale Factor --->	**50%**	*Modify Each Input Variable by +/- This Percentage*
Select Input Parameter Set ------>	**1**	*1 = All, 2 = P Cycling Only, 3 = Design Features Only*
Select Test Option ---------->	**2**	*1 = High Results Only, 2 = High & Low Results*

Number of Model Runs Required = 108 Estimated Run Time = 1134.0 minutes

Adjusts Each non-Zero Input Variable, One at a Time, & Re-Runs Simulation

Shows Results for Combined Outflow from Entire Treatment Area

Run

Sort Results

Uncertainty Analysis

Menu

			High Results ---->					Low Results ------>					Average Change ---->				Average % Change -->			
Input Variable	Cell Number	Input Value - Base	Input Value - High	Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load	Input Value - Low	Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load	Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load	Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load
	-	-	-	ppb	ppb	ppb	kg/yr	-	ppb	ppb	ppb	kg/yr	ppb	ppb	ppb	kg/yr	%	%	%	%
Base Run				12.0	12.0	10.3	1175		12.0	12.0	10.3	1175								
Rainfall P Conc	1	20.0	30.0	12.3	12.3	10.6	1201	13.3	11.8	11.8	10.1	1157	0.2	0.2	0.2	22	2%	2%	2%	2%
Atmospheric P Load (Dry)	1	20.0	30.0	12.2	12.2	10.6	1191	13.3	11.9	11.9	10.1	1164	0.1	0.1	0.2	14	1%	1%	2%	1%
Inflow Fraction	1	1.0	1.5	15.7	15.7	14.0	2339	0.7	9.5	9.5	7.8	600	3.1	3.1	3.1	870	26%	26%	30%	74%
Surface Area	1	1.1	1.7	10.8	10.8	9.1	1047	0.7	13.2	13.2	11.5	1293	-1.2	-1.2	-1.2	-123	-10%	-10%	-11%	-10%
Surface Area	2	1.1	1.7	10.8	10.8	9.1	1048	0.7	13.2	13.2	11.5	1293	-1.2	-1.2	-1.2	-122	-10%	-10%	-11%	-10%
Surface Area	3	1.1	1.7	11.6	11.6	9.9	1125	0.7	12.3	12.3	10.6	1212	-0.4	-0.4	-0.4	-44	-3.1%	-3.1%	-3.6%	-3.7%
Surface Area	4	1.1	1.7	11.6	11.6	9.9	1125	0.7	12.3	12.3	10.6	1212	-0.4	-0.4	-0.4	-44	-3%	-3%	-4%	-4%
Mean Width of Flow Path	1	2.1	3.1	12.0	12.0	10.3	1175	1.4	12.0	12.0	10.3	1174	0.0	0.0	0.0	0	0%	0%	0%	0%
Mean Width of Flow Path	2	2.1	3.1	12.0	12.0	10.3	1175	1.4	12.0	12.0	10.3	1175	0.0	0.0	0.0	0	0%	0%	0%	0%
Mean Width of Flow Path	3	2.1	3.1	12.0	12.0	10.3	1175	1.4	12.0	12.0	10.3	1174	0.0	0.0	0.0	0	0%	0%	0%	0%
Mean Width of Flow Path	4	2.1	3.1	12.0	12.0	10.3	1175	1.4	12.0	12.0	10.3	1174	0.0	0.0	0.0	0	0%	0%	0%	0%
Number of Tanks in Series	1	3.0	4.5	11.9	11.9	10.2	1161	2.0	12.2	12.2	10.5	1191	-0.2	-0.2	-0.2	-15	-1%	-1%	-2%	-1%
Number of Tanks in Series	2	3.0	4.5	11.9	11.9	10.2	1161	2.0	12.2	12.2	10.5	1192	-0.2	-0.2	-0.2	-16	-1%	-1%	-2%	-1%
Number of Tanks in Series	3	3.0	4.5	12.0	12.0	10.3	1173	2.0	12.0	12.0	10.3	1177	0.0	0.0	0.0	-2	0%	0%	0%	0%
Number of Tanks in Series	4	3.0	4.5	12.0	12.0	10.3	1173	2.0	12.0	12.0	10.3	1177	0.0	0.0	0.0	-2	0%	0%	0%	0%
Outflow Control Depth	1	79.0	118.5	12.0	12.0	10.3	1164	52.7	12.0	12.0	10.4	1180	0.0	0.0	-0.1	-8	0%	0%	-1%	-1%
Outflow Control Depth	2	79.0	118.5	12.0	12.0	10.3	1164	52.7	12.1	12.1	10.5	1186	-0.1	-0.1	-0.1	-11	0%	0%	-1%	-1%
Outflow Control Depth	3	69.0	103.5	12.0	12.0	10.3	1167	46.0	12.0	12.0	10.3	1177	0.0	0.0	0.0	-5	0%	0%	0%	0%
Outflow Control Depth	4	69.0	103.5	12.0	12.0	10.3	1168	46.0	12.0	12.0	10.3	1177	0.0	0.0	0.0	-4	0%	0%	0%	0%
Outflow Coefficient - Intercept	1	0.8	1.2	12.0	12.0	10.3	1175	0.5	12.0	12.0	10.3	1174	0.0	0.0	0.0	0	0%	0%	0%	0%
Outflow Coefficient - Intercept	2	0.8	1.2	12.0	12.0	10.3	1175	0.5	12.0	12.0	10.3	1175	0.0	0.0	0.0	0	0%	0%	0%	0%
Outflow Coefficient - Intercept	3	0.8	1.2	12.0	12.0	10.3	1175	0.5	12.0	12.0	10.3	1174	0.0	0.0	0.0	0	0%	0%	0%	0%
Outflow Coefficient - Intercept	4	0.8	1.2	12.0	12.0	10.3	1175	0.5	12.0	12.0	10.3	1174	0.0	0.0	0.0	0	0%	0%	0%	0%
Bypass Depth	1	140.0	210.0	12.0	12.0	10.3	1175	93.3	11.9	12.1	10.3	1180	0.1	0.0	0.0	-3	1%	0%	0%	0%
Bypass Depth	2	140.0	210.0	12.0	12.0	10.3	1175	93.3	11.9	12.0	10.3	1176	0.1	0.0	0.0	-1	0%	0%	0%	0%
Bypass Depth	3	140.0	210.0	12.0	12.0	10.3	1175	93.3	11.9	12.0	10.3	1175	0.0	0.0	0.0	0	0%	0%	0%	0%
Bypass Depth	4	140.0	210.0	12.021	12.0	10.3	1175	93.3	12.0	12.0	10.3	1175	0.0	0.0	0.0	0	0%	0%	0%	0%
Outflow Seepage Rate	1	0.0	0.0	12.0	12.0	10.3	1166	0.0	12.0	12.0	10.3	1181	0.0	0.0	0.0	-7	0%	0%	0%	-1%
Outflow Seepage Rate	2	0.0	0.0	12.0	12.0	10.3	1168	0.0	12.0	12.0	10.3	1179	0.0	0.0	0.0	-6	0%	0%	0%	0%
Outflow Seepage Rate	3	0.0	0.0	12.0	12.0	10.3	1169	0.0	12.0	12.0	10.3	1179	0.0	0.0	0.0	-5	0%	0%	0%	0%
Outflow Seepage Rate	4	0.0	0.0	12.0	12.0	10.3	1169	0.0	12.0	12.0	10.3	1178	0.0	0.0	0.0	-4	0%	0%	0%	0%
Max Outflow Seepage Conc	1	20.0	30.0	12.0	12.0	10.3	1176	13.3	12.0	12.0	10.3	1174	0.0	0.0	0.0	1	0%	0%	0%	0%
Max Outflow Seepage Conc	2	20.0	30.0	12.0	12.0	10.3	1175	13.3	12.0	12.0	10.3	1174	0.0	0.0	0.0	0	0%	0%	0%	0%
Max Outflow Seepage Conc	3	20.0	30.0	12.0	12.0	10.3	1175	13.3	12.0	12.0	10.3	1174	0.0	0.0	0.0	0	0%	0%	0%	0%
Max Outflow Seepage Conc	4	20.0	30.0	12.0	12.0	10.3	1175	13.3	12.0	12.0	10.3	1174	0.0	0.0	0.0	0	0%	0%	0%	0%
Seepage Recycle Fraction	1	0.5	0.8	12.0	12.0	10.3	1183	0.3	12.0	12.0	10.3	1169	0.0	0.0	0.0	7	0%	0%	0%	1%
Seepage Recycle Fraction	2	0.5	0.8	12.0	12.0	10.3	1182	0.3	12.0	12.0	10.3	1170	0.0	0.0	0.0	6	0%	0%	0%	1%
Seepage Recycle Fraction	3	0.5	0.8	12.0	12.0	10.3	1181	0.3	12.0	12.0	10.3	1171	0.0	0.0	0.0	5	0%	0%	0%	0%
Seepage Recycle Fraction	4	0.5	0.8	12.0	12.0	10.3	1180	0.3	12.0	12.0	10.3	1171	0.0	0.0	0.0	4	0%	0%	0%	0%

L-28 Basin - Alt. 1 Basecase 50% DMSTA Sensitivity Analysis (cont'd)

Sensitivity Analysis **Case: S50P50d** **File: L-28_final_base.xls** **Input Variable Set: All** **Run Date: 05/17/02**

Option	Value	
Select Sensitivity Scale Factor --->	**50%**	*Modify Each Input Variable by +/- This Percentage*
Select Input Parameter Set ------>	**1**	*1 = All, 2 = P Cycling Only, 3 = Design Features Only*
Select Test Option ---------->	**2**	*1 = High Results Only, 2 = High & Low Results*

Number of Model Runs Required = 108 Estimated Run Time = 1134.0 minutes

Adjusts Each non-Zero Input Variable, One at a Time, & Re-Runs Simulation

Shows Results for Combined Outflow from Entire Treatment Area

Run

Sort Results

Uncertainty Analysis

Menu

			High Results ---->					Low Results ------>					Average Change ---->				Average % Change -->			
Input Variable	Cell Number	Input Value - Base	Input Value - High	Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load	Input Value - Low	Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load	Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load	Treated FWM Outflow Conc	Total FWM Outflow Conc	Outflow Geo Mean - Composites	Total Outflow Load
	-	-	-	ppb	ppb	ppb	kg/yr	-	ppb	ppb	ppb	kg/yr	ppb	ppb	ppb	kg/yr	%	%	%	%
Base Run				12.0	12.0	10.3	1175		12.0	12.0	10.3	1175								
C0 = WC Conc at 0 g/m2 P Storage	1	4.0	6.0	12.5	12.5	10.7	1223	2.7	11.7	11.7	10.0	1139	0.4	0.4	0.4	42	4%	4%	3%	4%
C0 = WC Conc at 0 g/m2 P Storage	2	4.0	6.0	12.9	12.9	11.1	1266	2.7	11.3	11.3	9.8	1107	0.8	0.8	0.6	79	7%	7%	6%	7%
C0 = WC Conc at 0 g/m2 P Storage	3	4.0	6.0	12.4	12.4	10.6	1214	2.7	11.7	11.7	10.1	1144	0.4	0.4	0.3	35	3%	3%	2%	3%
C0 = WC Conc at 0 g/m2 P Storage	4	4.0	6.0	12.5	12.5	10.7	1222	2.7	11.7	11.7	10.2	1140	0.4	0.4	0.3	41	3%	3%	3%	3%
C1 = WC Conc at 1 g/m2 P storage	1	22.0	33.0	12.1	12.1	10.4	1183	14.7	12.0	12.0	10.3	1170	0.1	0.1	0.1	6	1%	1%	1%	1%
C1 = WC Conc at 1 g/m2 P storage	2	22.0	33.0	12.1	12.1	10.4	1182	14.7	12.0	12.0	10.3	1170	0.1	0.1	0.1	6	1%	1%	1%	1%
C1 = WC Conc at 1 g/m2 P storage	3	22.0	33.0	12.0	12.0	10.3	1176	14.7	12.0	12.0	10.3	1174	0.0	0.0	0.0	1	0%	0%	0%	0%
C1 = WC Conc at 1 g/m2 P storage	4	22.0	33.0	12.0	12.0	10.3	1176	14.7	12.0	12.0	10.3	1174	0.0	0.0	0.0	1	0%	0%	0%	0%
K = Net Settling Rate at Steady State	1	80.1	120.2	10.9	10.9	9.2	1060	53.4	13.1	13.1	11.4	1284	-1.1	-1.1	-1.1	-112	-10%	-10%	-11%	-10%
K = Net Settling Rate at Steady State	2	80.1	120.2	10.8	10.8	9.1	1058	53.4	13.2	13.2	11.5	1286	-1.2	-1.2	-1.2	-114	-10%	-10%	-11%	-10%
K = Net Settling Rate at Steady State	3	23.8	35.7	11.5	11.5	9.7	1122	15.9	12.4	12.4	10.8	1215	-0.5	-0.5	-0.5	-46	-4%	-4%	-5%	-4%
K = Net Settling Rate at Steady State	4	23.8	35.7	11.4	11.4	9.7	1118	15.9	12.5	12.5	10.8	1219	-0.5	-0.5	-0.6	-50	-4%	-4%	-6%	-4%
Zx = Depth Scale Factor	1	60.0	90.0	12.5	12.5	10.8	1220	40.0	12.0	12.0	10.3	1175	0.2	0.2	0.2	22	2%	2%	2%	2%
Zx = Depth Scale Factor	2	60.0	90.0	12.6	12.6	10.9	1233	40.0	12.0	12.0	10.3	1175	0.3	0.3	0.3	29	2%	2%	3%	2%

Uncertainty Analysis

Case: **S50P50d** **sens25** **File:** **L-28_final_base.xls** 05/16/02

Estimates uncertainty in output variables. Assumes that sensitivity analysis has already been performed. Factors include: (1) uncertainty in p cycling parameters (from calibration); (2) uncertainty in other model inputs (user-specified); (3) inherent model error (from calibration); & (4) sensitivity of model output to each input value. Results are for combined outflows.

Reference: Walker, "A Sensitivity & Error Analysis Framework for Lake Eutrophication Modeling", Wtr Res Bul, Feb 1982

Select Output Variable:

- Treated FWM Outflow Conc
- Total FWM Outflow Conc
- Outflow Geo Mean - Composites
- Total Outflow Load

Treated FWM Outflow Conc (ppb)		Error CV's = Standard Error / Mean	
50th Percentile Est. =	12	Total =	10%
10th Percentile Est. =	10	Model Error =	10%
90th Percentile Est =	14	Parameter Error =	3%
		Input Data Error =	2%

Show Results | Sensitivity Analysis | Menu

Sensitivity Coefficients

% Change in Output Variable / % Change in Input Variable

Enter assumed error CV (standard error, as percent of mean) in col. B (blue cells) to reflect uncertainty in each input value

Case Description: **Filename: L-28_final_base.xls**

50% SAV 50% PSTA at 79,69 cm at 4.4 km2
2 cells of SAV, 2 cells of PSTA
no reservoir
L-28 basecase

Output Variable	Units	Value
Water Balance Error	%	0.0%
Mass Balance Error	%	0.0%
Flow-Wtd Conc - With Bypass	ppb	12.0
Flow-Wtd Conc - Without Bypass	ppb	12.0
Geometric Mean Conc	ppb	10.3
95th Percentile Conc	ppb	15.1
Freq Cell Outflow > 10 ppb	%	52%
Bypass Load	%	0.0%

Input Variable	Error CV	Value	1	2	3	4	5	6
Design Case Name		S50P50d						
Starting Date for Simulation								
Ending Date for Simulation								
Starting Date for Output								
Steps Per Day								
Number of Iterations								
Output Averaging Interval								
Reservoir H2O Residence Time								
Max Inflow / Mean Inflow								
Max Reservoir Storage								
Reservoir P Decay Rate								
Rainfall P Conc	30%	0.041						
Atmospheric P Load (Dry)	30%	0.025						
Cell Number -->		1	2	3	4	5	6	
Cell Label		Cell1	Cell2	Cell3	Cell4			
Vegetation Type		SAV_C4	SAV_C4	PSTA	PSTA			
Inflow Fraction	0%	*0.573*						
Downstream Cell Number								
Surface Area		*-0.219*	*-0.218*	*-0.069*	*-0.069*			
Mean Width of Flow Path		*0.001*	*0.000*	*0.000*	*0.000*			
Number of Tanks in Series	30%	*-0.021*	*-0.022*	*-0.002*	*-0.002*			
Outflow Control Depth		*-0.003*	*-0.005*	*-0.002*	*0.000*			
Outflow Coefficient - Exponent								
Outflow Coefficient - Intercept	20%	*0.001*	*0.000*	*0.000*	*0.000*			
Bypass Depth		*0.005*	*0.004*	*0.003*	*0.002*			
Maximum Inflow								
Maximum Outflow								
Inflow Seepage Rate	20%							
Inflow Seepage Control Elev								
Inflow Seepage Conc	20%							
Outflow Seepage Rate	20%	*-0.003*	*0.000*	*0.000*	*0.001*			
Outflow Seepage Control Elev								
Max Outflow Seepage Conc	20%	*0.002*	*0.001*	*0.000*	*0.000*			
Seepage Recycle Fraction	20%	*0.002*	*0.000*	*-0.001*	*-0.001*			
Seepage Discharge Fraction	20%							
Initial Water Column Conc								
Initial P Storage Per Unit Area								
Initial Water Column Depth								
C0 = WC Conc at 0 g/m2 P Storage		*0.079*	*0.148*	*0.066*	*0.076*			
C1 = WC Conc at 1 g/m2 P storage		*0.012*	*0.012*	*0.002*	*0.001*			
K = Net Settling Rate at Steady State		*-0.212*	*-0.216*	*-0.087*	*-0.094*			
Zx = Depth Scale Factor	*retrieved*	*0.000*	*0.001*					
C0 - Periphyton	*from model*							
C1 - Periphyton	*calibration*							
K - Periphyton	*table*							
Zx - Periphyton								
Sm = Transition Storage Midpoint								
Sb = Transition Storage Bandwidth								

Uncertainty Analysis

Case: **S50P50d** **sens25** **File:** **L-28_final_base.xls** 05/16/02

Estimates uncertainty in output variables. Assumes that sensitivity analysis has already been performed. Factors include: (1) uncertainty in p cycling parameters (from calibration); (2) uncertainty in other model inputs (user-specified); (3) inherent model error (from calibration); & (4) sensitivity of model output to each input value. Results are for combined outflows.

Reference: Walker, "A Sensitivity & Error Analysis Framework for Lake Eutrophication Modeling", Wtr Res Bul, Feb 1982

Select Output Variable:

- Treated FWM Outflow Conc
- Total FWM Outflow Conc
- Outflow Geo Mean - Composites
- Total Outflow Load

Total FWM Outflow Conc (ppb)		Error CV's = Standard Error / Mean	
50th Percentile Est. =	12	Total =	10%
10th Percentile Est. =	10	Model Error =	10%
90th Percentile Est =	14	Parameter Error =	3%
		Input Data Error =	2%

Show Results | Sensitivity Analysis | Menu

Sensitivity Coefficients

% Change in Output Variable / % Change in Input Variable

Enter assumed error CV (standard error, as percent of mean) in col. B (blue cells) to reflect uncertainty in each input value

Case Description: **Filename: L-28_final_base.xls**

50% SAV 50% PSTA at 79,69 cm at 4.4 km2
2 cells of SAV, 2 cells of PSTA
no reservoir
L-28 basecase

Output Variable	Units	Value
Water Balance Error	%	0.0%
Mass Balance Error	%	0.0%
Flow-Wtd Conc - With Bypass	ppb	12.0
Flow-Wtd Conc - Without Bypass	ppb	12.0
Geometric Mean Conc	ppb	10.3
95th Percentile Conc	ppb	15.1
Freq Cell Outflow > 10 ppb	%	52%
Bypass Load	%	0.0%

Input Variable	Error CV	Value	1	2	3	4	5	6
Design Case Name		S50P50d						
Starting Date for Simulation								
Ending Date for Simulation								
Starting Date for Output								
Steps Per Day								
Number of Iterations								
Output Averaging Interval								
Reservoir H2O Residence Time								
Max Inflow / Mean Inflow								
Max Reservoir Storage								
Reservoir P Decay Rate								
Rainfall P Conc	30%	0.041						
Atmospheric P Load (Dry)	30%	0.025						
Cell Number -->		1	2	3	4	5	6	
Cell Label		Cell1	Cell2	Cell3	Cell4			
Vegetation Type		SAV_C4	SAV_C4	PSTA	PSTA			
Inflow Fraction	0%	*0.573*						
Downstream Cell Number								
Surface Area		*-0.219*	*-0.218*	*-0.069*	*-0.069*			
Mean Width of Flow Path		*0.001*	*0.000*	*0.000*	*0.000*			
Number of Tanks in Series	30%	*-0.021*	*-0.022*	*-0.002*	*-0.002*			
Outflow Control Depth		*-0.003*	*-0.005*	*-0.002*	*0.000*			
Outflow Coefficient - Exponent								
Outflow Coefficient - Intercept	20%	*0.001*	*0.000*	*0.000*	*0.000*			
Bypass Depth		*-0.001*	*0.000*	*0.000*	*0.000*			
Maximum Inflow								
Maximum Outflow								
Inflow Seepage Rate	20%							
Inflow Seepage Control Elev								
Inflow Seepage Conc	20%							
Outflow Seepage Rate	20%	*-0.003*	*0.000*	*0.000*	*0.001*			
Outflow Seepage Control Elev								
Max Outflow Seepage Conc	20%	*0.002*	*0.001*	*0.000*	*0.000*			
Seepage Recycle Fraction	20%	*0.002*	*0.000*	*-0.001*	*-0.001*			
Seepage Discharge Fraction	20%							
Initial Water Column Conc								
Initial P Storage Per Unit Area								
Initial Water Column Depth								
C0 = WC Conc at 0 g/m2 P Storage		*0.079*	*0.148*	*0.066*	*0.076*			
C1 = WC Conc at 1 g/m2 P storage		*0.012*	*0.012*	*0.002*	*0.001*			
K = Net Settling Rate at Steady State		*-0.212*	*-0.216*	*-0.087*	*-0.094*			
Zx = Depth Scale Factor	*retrieved*	*0.000*	*0.001*					
C0 - Periphyton	*from model*							
C1 - Periphyton	*calibration*							
K - Periphyton	*table*							
Zx - Periphyton								
Sm = Transition Storage Midpoint								
Sb = Transition Storage Bandwidth								

Uncertainty Analysis

Case: **S50P50d** **sens25** **File:** **L-28_final_base.xls** 05/16/02

Estimates uncertainty in output variables. Assumes that sensitivity analysis has already been performed. Factors include: (1) uncertainty in p cycling parameters (from calibration); (2) uncertainty in other model inputs (user-specified); (3) inherent model error (from calibration); & (4) sensitivity of model output to each input value. Results are for combined outflows.

Reference: Walker, "A Sensitivity & Error Analysis Framework for Lake Eutrophication Modeling", Wtr Res Bul, Feb 1982

Select Output Variable:

- Treated FWM Outflow Conc
- Total FWM Outflow Conc
- Outflow Geo Mean - Composites
- Total Outflow Load

Outflow Geo Mean - Composites (ppb)		Error CV's = Standard Error / Mean	
50th Percentile Est. =	10	Total =	11%
10th Percentile Est. =	9	Model Error =	10%
90th Percentile Est =	12	Parameter Error =	3%
		Input Data Error =	2%

Show Results | Sensitivity Analysis | Menu

Sensitivity Coefficients

% Change in Output Variable / % Change in Input Variable

Enter assumed error CV (standard error, as percent of mean) in col. B (blue cells) to reflect uncertainty in each input value

Case Description: **Filename: L-28_final_base.xls**

50% SAV 50% PSTA at 79,69 cm at 4.4 km2
2 cells of SAV, 2 cells of PSTA
no reservoir
L-28 basecase

Output Variable	Units	Value
Water Balance Error	%	0.0%
Mass Balance Error	%	0.0%
Flow-Wtd Conc - With Bypass	ppb	12.0
Flow-Wtd Conc - Without Bypass	ppb	12.0
Geometric Mean Conc	ppb	10.3
95th Percentile Conc	ppb	15.1
Freq Cell Outflow > 10 ppb	%	52%
Bypass Load	%	0.0%

Input Variable	Error CV	Value	1	2	3	4	5	6
Design Case Name		S50P50d						
Starting Date for Simulation								
Ending Date for Simulation								
Starting Date for Output								
Steps Per Day								
Number of Iterations								
Output Averaging Interval								
Reservoir H2O Residence Time								
Max Inflow / Mean Inflow								
Max Reservoir Storage								
Reservoir P Decay Rate								
Rainfall P Conc	30%	0.043						
Atmospheric P Load (Dry)	30%	0.044						
Cell Number -->		1	2	3	4	5	6	
Cell Label		Cell1	Cell2	Cell3	Cell4			
Vegetation Type		SAV_C4	SAV_C4	PSTA	PSTA			
Inflow Fraction	0%	*0.664*						
Downstream Cell Number								
Surface Area		*-0.257*	*-0.256*	*-0.078*	*-0.078*			
Mean Width of Flow Path		*0.001*	*0.000*	*0.000*	*0.000*			
Number of Tanks in Series	30%	*-0.026*	*-0.027*	*-0.003*	*-0.003*			
Outflow Control Depth		*-0.008*	*-0.005*	*0.001*	*0.004*			
Outflow Coefficient - Exponent								
Outflow Coefficient - Intercept	20%	*0.001*	*0.000*	*0.000*	*0.000*			
Bypass Depth		*0.001*	*0.000*	*0.000*	*0.000*			
Maximum Inflow								
Maximum Outflow								
Inflow Seepage Rate	20%							
Inflow Seepage Control Elev								
Inflow Seepage Conc	20%							
Outflow Seepage Rate	20%	*-0.006*	*-0.002*	*-0.001*	*0.000*			
Outflow Seepage Control Elev								
Max Outflow Seepage Conc	20%	*0.002*	*0.001*	*0.000*	*0.000*			
Seepage Recycle Fraction	20%	*0.005*	*0.003*	*0.001*	*0.000*			
Seepage Discharge Fraction	20%							
Initial Water Column Conc								
Initial P Storage Per Unit Area								
Initial Water Column Depth								
C0 = WC Conc at 0 g/m2 P Storage		*0.075*	*0.131*	*0.053*	*0.058*			
C1 = WC Conc at 1 g/m2 P storage		*0.013*	*0.013*	*0.001*	*0.001*			
K = Net Settling Rate at Steady State		*-0.244*	*-0.255*	*-0.107*	*-0.125*			
Zx = Depth Scale Factor	*retrieved*	*0.001*	*0.002*					
C0 - Periphyton	*from model*							
C1 - Periphyton	*calibration*							
K - Periphyton	*table*							
Zx - Periphyton								
Sm = Transition Storage Midpoint								
Sb = Transition Storage Bandwidth								

Uncertainty Analysis

Case: **S50P50d** **sens25** **File:** **L-28_final_base.xls** 05/16/02

Estimates uncertainty in output variables. Assumes that sensitivity analysis has already been performed. Factors include: (1) uncertainty in p cycling parameters (from calibration); (2) uncertainty in other model inputs (user-specified); (3) inherent model error (from calibration); & (4) sensitivity of model output to each input value. Results are for combined outflows.

Reference: Walker, "A Sensitivity & Error Analysis Framework for Lake Eutrophication Modeling", Wtr Res Bul, Feb 1982

Select Output Variable:

- Treated FWM Outflow Conc
- Total FWM Outflow Conc
- Outflow Geo Mean - Composites
- Total Outflow Load

Total Outflow Load (kg/yr)		Error CV's = Standard Error / Mean	
50th Percentile Est. =	1175	Total =	11%
10th Percentile Est. =	1017	Model Error =	10%
90th Percentile Est =	1333	Parameter Error =	3%
		Input Data Error =	2%

Show Results | Sensitivity Analysis | Menu

Sensitivity Coefficients

% Change in Output Variable / % Change in Input Variable

Enter assumed error CV (standard error, as percent of mean) in col. B (blue cells) to reflect uncertainty in each input value

Case Description: **Filename: L-28_final_base.xls**

50% SAV 50% PSTA at 79,69 cm at 4.4 km2
2 cells of SAV, 2 cells of PSTA
no reservoir
L-28 basecase

Output Variable	Units	Value
Water Balance Error	%	0.0%
Mass Balance Error	%	0.0%
Flow-Wtd Conc - With Bypass	ppb	12.0
Flow-Wtd Conc - Without Bypass	ppb	12.0
Geometric Mean Conc	ppb	10.3
95th Percentile Conc	ppb	15.1
Freq Cell Outflow > 10 ppb	%	52%
Bypass Load	%	0.0%

Input Variable	Error CV	Value	1	2	3	4	5	6
Design Case Name		S50P50d						
Starting Date for Simulation								
Ending Date for Simulation								
Starting Date for Output								
Steps Per Day								
Number of Iterations								
Output Averaging Interval								
Reservoir H2O Residence Time								
Max Inflow / Mean Inflow								
Max Reservoir Storage								
Reservoir P Decay Rate								
Rainfall P Conc	30%	0.041						
Atmospheric P Load (Dry)	30%	0.025						
Cell Number -->		1	2	3	4	5	6	
Cell Label		Cell1	Cell2	Cell3	Cell4			
Vegetation Type		SAV_C4	SAV_C4	PSTA	PSTA			
Inflow Fraction	0%	*1.553*						
Downstream Cell Number								
Surface Area		*-0.233*	*-0.232*	*-0.081*	*-0.081*			
Mean Width of Flow Path		*0.001*	*0.000*	*0.001*	*0.001*			
Number of Tanks in Series	30%	*-0.021*	*-0.022*	*-0.002*	*-0.002*			
Outflow Control Depth		*-0.014*	*-0.016*	*-0.010*	*-0.008*			
Outflow Coefficient - Exponent								
Outflow Coefficient - Intercept	20%	*0.001*	*0.000*	*0.001*	*0.001*			
Bypass Depth		*-0.001*	*0.000*	*0.000*	*0.000*			
Maximum Inflow								
Maximum Outflow								
Inflow Seepage Rate	20%							
Inflow Seepage Control Elev								
Inflow Seepage Conc	20%							
Outflow Seepage Rate	20%	*-0.014*	*-0.011*	*-0.009*	*-0.008*			
Outflow Seepage Control Elev								
Max Outflow Seepage Conc	20%	*0.002*	*0.001*	*0.000*	*0.000*			
Seepage Recycle Fraction	20%	*0.013*	*0.011*	*0.009*	*0.008*			
Seepage Discharge Fraction	20%							
Initial Water Column Conc								
Initial P Storage Per Unit Area								
Initial Water Column Depth								
C0 = WC Conc at 0 g/m2 P Storage		*0.079*	*0.148*	*0.066*	*0.076*			
C1 = WC Conc at 1 g/m2 P storage		*0.012*	*0.012*	*0.002*	*0.001*			
K = Net Settling Rate at Steady State		*-0.212*	*-0.216*	*-0.087*	*-0.094*			
Zx = Depth Scale Factor	*retrieved*	*0.000*	*0.001*					
C0 - Periphyton	*from model*							
C1 - Periphyton	*calibration*							
K - Periphyton	*table*							
Zx - Periphyton								
Sm = Transition Storage Midpoint								
Sb = Transition Storage Bandwidth								

Uncertainty Analysis

Case: **S50P50d** **sens50** **File:** **L-28_final_base.xls** 05/17/02

Estimates uncertainty in output variables. Assumes that sensitivity analysis has already been performed. Factors include: (1) uncertainty in p cycling parameters (from calibration); (2) uncertainty in other model inputs (user-specified); (3) inherent model error (from calibration); & (4) sensitivity of model output to each input value. Results are for combined outflows.

Reference: Walker, "A Sensitivity & Error Analysis Framework for Lake Eutrophication Modeling", Wtr Res Bul, Feb 1982

Select Output Variable:

- Treated FWM Outflow Conc
- Total FWM Outflow Conc
- Outflow Geo Mean - Composites
- Total Outflow Load

Treated FWM Outflow Conc (ppb)		Error CV's = Standard Error / Mean	
50th Percentile Est. =	12	Total =	11%
10th Percentile Est. =	10	Model Error =	10%
90th Percentile Est =	14	Parameter Error =	3%
		Input Data Error =	2%

Show Results | Sensitivity Analysis | Menu

Sensitivity Coefficients

% Change in Output Variable / % Change in Input Variable

Enter assumed error CV (standard error, as percent of mean) in col. B (blue cells) to reflect uncertainty in each input value

Input Variable	**Error CV**	**Value**	**Case Description:**	**Filename: L-28_final_base.xls**			
Design Case Name		S50P50d	50% SAV 50% PSTA at 79,69 cm at 4.4 km2				
Starting Date for Simulation			2 cells of SAV, 2 cells of PSTA				
Ending Date for Simulation			no reservoir				
Starting Date for Output			L-28 basecase				
Steps Per Day			**Output Variable**			**Units**	**Value**
Number of Iterations			Water Balance Error			%	0.0%
Output Averaging Interval			Mass Balance Error			%	0.0%
Reservoir H2O Residence Time			Flow-Wtd Conc - With Bypass			ppb	12.0
Max Inflow / Mean Inflow			Flow-Wtd Conc - Without Bypass			ppb	12.0
Max Reservoir Storage			Geometric Mean Conc			ppb	10.3
Reservoir P Decay Rate			95th Percentile Conc			ppb	15.1
Rainfall P Conc	30%	0.038	Freq Cell Outflow > 10 ppb			%	52%
Atmospheric P Load (Dry)	30%	0.024	Bypass Load			%	0.0%
Cell Number -->		**1**	**2**	**3**	**4**	**5**	**6**
Cell Label		Cell1	Cell2	Cell3	Cell4		
Vegetation Type		SAV_C4	SAV_C4	PSTA	PSTA		
Inflow Fraction	0%	*0.515*					
Downstream Cell Number							
Surface Area		*-0.197*	*-0.196*	*-0.063*	*-0.063*		
Mean Width of Flow Path		*0.001*	*0.000*	*0.000*	*0.000*		
Number of Tanks in Series	30%	*-0.025*	*-0.027*	*-0.003*	*-0.003*		
Outflow Control Depth		*-0.004*	*-0.009*	*-0.001*	*0.000*		
Outflow Coefficient - Exponent							
Outflow Coefficient - Intercept	20%	*0.001*	*0.000*	*0.000*	*0.000*		
Bypass Depth		*0.011*	*0.008*	*0.006*	*0.005*		
Maximum Inflow							
Maximum Outflow							
Inflow Seepage Rate	20%						
Inflow Seepage Control Elev							
Inflow Seepage Conc	20%						
Outflow Seepage Rate	20%	*-0.003*	*0.000*	*0.000*	*0.001*		
Outflow Seepage Control Elev							
Max Outflow Seepage Conc	20%	*0.001*	*0.001*	*0.000*	*0.000*		
Seepage Recycle Fraction	20%	*0.002*	*0.000*	*0.000*	*-0.001*		
Seepage Discharge Fraction	20%						
Initial Water Column Conc							
Initial P Storage Per Unit Area							
Initial Water Column Depth							
C0 = WC Conc at 0 g/m2 P Storage		*0.072*	*0.135*	*0.060*	*0.070*		
C1 = WC Conc at 1 g/m2 P storage		*0.011*	*0.011*	*0.001*	*0.001*		
K = Net Settling Rate at Steady State		*-0.190*	*-0.194*	*-0.079*	*-0.086*		
Zx = Depth Scale Factor	*retrieved*	*0.038*	*0.050*				
C0 - Periphyton	*from model*						
C1 - Periphyton	*calibration*						
K - Periphyton	*table*						
Zx - Periphyton							
Sm = Transition Storage Midpoint							
Sb = Transition Storage Bandwidth							

Uncertainty Analysis

Case: **S50P50d** **sens50** **File:** **L-28_final_base.xls** 05/17/02

Estimates uncertainty in output variables. Assumes that sensitivity analysis has already been performed. Factors include: (1) uncertainty in p cycling parameters (from calibration); (2) uncertainty in other model inputs (user-specified); (3) inherent model error (from calibration); & (4) sensitivity of model output to each input value. Results are for combined outflows.

Reference: Walker, "A Sensitivity & Error Analysis Framework for Lake Eutrophication Modeling", Wtr Res Bul, Feb 1982

Select Output Variable:

- Treated FWM Outflow Conc
- Total FWM Outflow Conc
- Outflow Geo Mean - Composites
- Total Outflow Load

Total FWM Outflow Conc (ppb)		Error CV's = Standard Error / Mean	
50th Percentile Est. =	12	Total =	11%
10th Percentile Est. =	10	Model Error =	10%
90th Percentile Est =	14	Parameter Error =	3%
		Input Data Error =	2%

Show Results | Sensitivity Analysis | Menu

Sensitivity Coefficients

% Change in Output Variable / % Change in Input Variable

Enter assumed error CV (standard error, as percent of mean) in col. B (blue cells) to reflect uncertainty in each input value

Case Description: **Filename: L-28_final_base.xls**

50% SAV 50% PSTA at 79,69 cm at 4.4 km2
2 cells of SAV, 2 cells of PSTA
no reservoir
L-28 basecase

Output Variable	Units	Value
Water Balance Error	%	0.0%
Mass Balance Error	%	0.0%
Flow-Wtd Conc - With Bypass	ppb	12.0
Flow-Wtd Conc - Without Bypass	ppb	12.0
Geometric Mean Conc	ppb	10.3
95th Percentile Conc	ppb	15.1
Freq Cell Outflow > 10 ppb	%	52%
Bypass Load	%	0.0%

Input Variable	Error CV	Value	1	2	3	4	5	6
Design Case Name		S50P50d						
Starting Date for Simulation								
Ending Date for Simulation								
Starting Date for Output								
Steps Per Day								
Number of Iterations								
Output Averaging Interval								
Reservoir H2O Residence Time								
Max Inflow / Mean Inflow								
Max Reservoir Storage								
Reservoir P Decay Rate								
Rainfall P Conc	30%	0.038						
Atmospheric P Load (Dry)	30%	0.024						
Cell Number -->		1	2	3	4	5	6	
Cell Label		Cell1	Cell2	Cell3	Cell4			
Vegetation Type		SAV_C4	SAV_C4	PSTA	PSTA			
Inflow Fraction	0%	*0.515*						
Downstream Cell Number								
Surface Area		*-0.197*	*-0.196*	*-0.063*	*-0.063*			
Mean Width of Flow Path		*0.001*	*0.000*	*0.000*	*0.000*			
Number of Tanks in Series	30%	*-0.025*	*-0.027*	*-0.003*	*-0.003*			
Outflow Control Depth		*-0.004*	*-0.009*	*-0.001*	*0.000*			
Outflow Coefficient - Exponent								
Outflow Coefficient - Intercept	20%	*0.001*	*0.000*	*0.000*	*0.000*			
Bypass Depth		*-0.004*	*-0.001*	*0.000*	*0.000*			
Maximum Inflow								
Maximum Outflow								
Inflow Seepage Rate	20%							
Inflow Seepage Control Elev								
Inflow Seepage Conc	20%							
Outflow Seepage Rate	20%	*-0.003*	*0.000*	*0.000*	*0.001*			
Outflow Seepage Control Elev								
Max Outflow Seepage Conc	20%	*0.001*	*0.001*	*0.000*	*0.000*			
Seepage Recycle Fraction	20%	*0.002*	*0.000*	*0.000*	*-0.001*			
Seepage Discharge Fraction	20%							
Initial Water Column Conc								
Initial P Storage Per Unit Area								
Initial Water Column Depth								
C0 = WC Conc at 0 g/m2 P Storage		*0.072*	*0.135*	*0.060*	*0.070*			
C1 = WC Conc at 1 g/m2 P storage		*0.011*	*0.011*	*0.001*	*0.001*			
K = Net Settling Rate at Steady State		*-0.190*	*-0.194*	*-0.079*	*-0.086*			
Zx = Depth Scale Factor	*retrieved*	*0.038*	*0.050*					
C0 - Periphyton	*from model*							
C1 - Periphyton	*calibration*							
K - Periphyton	*table*							
Zx - Periphyton								
Sm = Transition Storage Midpoint								
Sb = Transition Storage Bandwidth								

Uncertainty Analysis

Case: **S50P50d** **sens50** **File:** **L-28_final_base.xls** 05/17/02

Estimates uncertainty in output variables. Assumes that sensitivity analysis has already been performed. Factors include: (1) uncertainty in p cycling parameters (from calibration); (2) uncertainty in other model inputs (user-specified); (3) inherent model error (from calibration); & (4) sensitivity of model output to each input value. Results are for combined outflows.

Reference: Walker, "A Sensitivity & Error Analysis Framework for Lake Eutrophication Modeling", Wtr Res Bul, Feb 1982

Select Output Variable:

- Treated FWM Outflow Conc
- Total FWM Outflow Conc
- Outflow Geo Mean - Composites
- Total Outflow Load

Outflow Geo Mean - Composites (ppb)		Error CV's = Standard Error / Mean	
50th Percentile Est. =	10	Total =	11%
10th Percentile Est. =	9	Model Error =	10%
90th Percentile Est =	12	Parameter Error =	3%
		Input Data Error =	2%

Show Results | Sensitivity Analysis | Menu

Sensitivity Coefficients

% Change in Output Variable / % Change in Input Variable

Enter assumed error CV (standard error, as percent of mean) in col. B (blue cells) to reflect uncertainty in each input value

Case Description: **Filename: L-28_final_base.xls**

50% SAV 50% PSTA at 79,69 cm at 4.4 km2
2 cells of SAV, 2 cells of PSTA
no reservoir
L-28 basecase

Output Variable	**Units**	**Value**
Water Balance Error	%	0.0%
Mass Balance Error	%	0.0%
Flow-Wtd Conc - With Bypass	ppb	12.0
Flow-Wtd Conc - Without Bypass	ppb	12.0
Geometric Mean Conc	ppb	10.3
95th Percentile Conc	ppb	15.1
Freq Cell Outflow > 10 ppb	%	52%
Bypass Load	%	0.0%

Input Variable	**Error CV**	**Value**					
Design Case Name		S50P50d					
Starting Date for Simulation							
Ending Date for Simulation							
Starting Date for Output							
Steps Per Day							
Number of Iterations							
Output Averaging Interval							
Reservoir H2O Residence Time							
Max Inflow / Mean Inflow							
Max Reservoir Storage							
Reservoir P Decay Rate							
Rainfall P Conc	30%	0.040					
Atmospheric P Load (Dry)	30%	0.041					
Cell Number -->		**1**	**2**	**3**	**4**	**5**	**6**
Cell Label		Cell1	Cell2	Cell3	Cell4		
Vegetation Type		SAV_C4	SAV_C4	PSTA	PSTA		
Inflow Fraction	0%	*0.596*					
Downstream Cell Number							
Surface Area		*-0.230*	*-0.229*	*-0.071*	*-0.071*		
Mean Width of Flow Path		*0.000*	*0.000*	*0.000*	*0.000*		
Number of Tanks in Series	30%	*-0.031*	*-0.032*	*-0.003*	*-0.003*		
Outflow Control Depth		*-0.012*	*-0.019*	*0.001*	*0.004*		
Outflow Coefficient - Exponent							
Outflow Coefficient - Intercept	20%	*0.000*	*0.000*	*0.000*	*0.000*		
Bypass Depth		*0.003*	*0.002*	*0.001*	*0.000*		
Maximum Inflow							
Maximum Outflow							
Inflow Seepage Rate	20%						
Inflow Seepage Control Elev							
Inflow Seepage Conc	20%						
Outflow Seepage Rate	20%	*-0.006*	*-0.002*	*-0.001*	*0.000*		
Outflow Seepage Control Elev							
Max Outflow Seepage Conc	20%	*0.002*	*0.001*	*0.000*	*0.000*		
Seepage Recycle Fraction	20%	*0.005*	*0.002*	*0.001*	*0.000*		
Seepage Discharge Fraction	20%						
Initial Water Column Conc							
Initial P Storage Per Unit Area							
Initial Water Column Depth							
C0 = WC Conc at 0 g/m2 P Storage		*0.069*	*0.122*	*0.049*	*0.055*		
C1 = WC Conc at 1 g/m2 P storage		*0.012*	*0.011*	*0.001*	*0.001*		
K = Net Settling Rate at Steady State		*-0.219*	*-0.229*	*-0.098*	*-0.114*		
Zx = Depth Scale Factor	*retrieved*	*0.046*	*0.058*				
C0 - Periphyton	*from model*						
C1 - Periphyton	*calibration*						
K - Periphyton	*table*						
Zx - Periphyton							
Sm = Transition Storage Midpoint							
Sb = Transition Storage Bandwidth							

Uncertainty Analysis

Case: **S50P50d** **sens50** **File:** **L-28_final_base.xls** 05/17/02

Estimates uncertainty in output variables. Assumes that sensitivity analysis has already been performed. Factors include: (1) uncertainty in p cycling parameters (from calibration); (2) uncertainty in other model inputs (user-specified); (3) inherent model error (from calibration); & (4) sensitivity of model output to each input value. Results are for combined outflows.

Reference: Walker, "A Sensitivity & Error Analysis Framework for Lake Eutrophication Modeling", Wtr Res Bul, Feb 1982

Select Output Variable:

- Treated FWM Outflow Conc
- Total FWM Outflow Conc
- Outflow Geo Mean - Composites
- Total Outflow Load

Total Outflow Load (kg/yr)		Error CV's = Standard Error / Mean	
50th Percentile Est. =	1175	Total =	11%
10th Percentile Est. =	1016	Model Error =	10%
90th Percentile Est =	1333	Parameter Error =	3%
		Input Data Error =	2%

Show Results | Sensitivity Analysis | Menu

Sensitivity Coefficients

% Change in Output Variable / % Change in Input Variable

Enter assumed error CV (standard error, as percent of mean) in col. B (blue cells) to reflect uncertainty in each input value

Case Description: **Filename: L-28_final_base.xls**

50% SAV 50% PSTA at 79,69 cm at 4.4 km2
2 cells of SAV, 2 cells of PSTA
no reservoir
L-28 basecase

Output Variable	Units	Value
Water Balance Error	%	0.0%
Mass Balance Error	%	0.0%
Flow-Wtd Conc - With Bypass	ppb	12.0
Flow-Wtd Conc - Without Bypass	ppb	12.0
Geometric Mean Conc	ppb	10.3
95th Percentile Conc	ppb	15.1
Freq Cell Outflow > 10 ppb	%	52%
Bypass Load	%	0.0%

Input Variable	Error CV	Value	1	2	3	4	5	6
Design Case Name		S50P50d						
Starting Date for Simulation								
Ending Date for Simulation								
Starting Date for Output								
Steps Per Day								
Number of Iterations								
Output Averaging Interval								
Reservoir H2O Residence Time								
Max Inflow / Mean Inflow								
Max Reservoir Storage								
Reservoir P Decay Rate								
Rainfall P Conc	30%	0.038						
Atmospheric P Load (Dry)	30%	0.024						
Cell Number -->		1	2	3	4	5	6	
Cell Label		Cell1	Cell2	Cell3	Cell4			
Vegetation Type		SAV_C4	SAV_C4	PSTA	PSTA			
Inflow Fraction	0%	*1.481*						
Downstream Cell Number								
Surface Area		*-0.209*	*-0.208*	*-0.074*	*-0.074*			
Mean Width of Flow Path		*0.001*	*0.000*	*0.001*	*0.001*			
Number of Tanks in Series	30%	*-0.025*	*-0.027*	*-0.003*	*-0.003*			
Outflow Control Depth		*-0.014*	*-0.018*	*-0.008*	*-0.007*			
Outflow Coefficient - Exponent								
Outflow Coefficient - Intercept	20%	*0.001*	*0.000*	*0.001*	*0.001*			
Bypass Depth		*-0.004*	*-0.001*	*0.000*	*0.000*			
Maximum Inflow								
Maximum Outflow								
Inflow Seepage Rate	20%							
Inflow Seepage Control Elev								
Inflow Seepage Conc	20%							
Outflow Seepage Rate	20%	*-0.012*	*-0.010*	*-0.008*	*-0.008*			
Outflow Seepage Control Elev								
Max Outflow Seepage Conc	20%	*0.001*	*0.001*	*0.000*	*0.000*			
Seepage Recycle Fraction	20%	*0.012*	*0.010*	*0.008*	*0.008*			
Seepage Discharge Fraction	20%							
Initial Water Column Conc								
Initial P Storage Per Unit Area								
Initial Water Column Depth								
C0 = WC Conc at 0 g/m2 P Storage		*0.072*	*0.135*	*0.060*	*0.070*			
C1 = WC Conc at 1 g/m2 P storage		*0.011*	*0.011*	*0.001*	*0.001*			
K = Net Settling Rate at Steady State		*-0.190*	*-0.194*	*-0.079*	*-0.086*			
Zx = Depth Scale Factor	*retrieved*	*0.038*	*0.050*					
C0 - Periphyton	*from model*							
C1 - Periphyton	*calibration*							
K - Periphyton	*table*							
Zx - Periphyton								
Sm = Transition Storage Midpoint								
Sb = Transition Storage Bandwidth								

Appendix C
CTSS Model Output

ACME BASIN B
CTSS/FEB DESIGN
BASE CASE

Background:

This approach is used to size a chemical treatment followed by solids separation (CTSS) treatment plant and a flow-equalization-basin (FEB) to provide for a blended effluent concentration.

Effluent Concentrations:

CTSS effluent phosphorus concentration at average flow =	6	ppb
CTSS effluent phosphorus concentration at peak flow=	10	ppb

First-cut Assumptions:

1.) Used SFWMD flow data for ACME Basin (71-ppb 25% reduction in TP load) for period 1965 to 1995.
2.) By-pass occurs when FEB volume > capacity.
3.) No seepage loss has been accounted for in the FEB.
4.) Using 0% phosphorus removal within the FEB.
5.) Once FEB = 3.5 feet, treatment plant operates at 1.5*average design flow until FEB< 3.5 feet.
6.) Treatment start when one day of flow has been stored in FEB.
7.) There is always at least 0.5 feet in equlaization basin.
8.) FEB has 6.5 feet of equalization capacity (0.5 to 4.5 feet).

Procedure:

1.)	Use SFWMD flow data for ACME for period 1965 to 1995.				
3.)	Perform first iteration using a CTSS size =	25	mgd		
4.)	Perform first iteration using a FEB size =	200	acre	4	feet equalization (0.5 to 4.5 feet)
		261	mgal	195	mgal (ramp-up point, 3.5-ft in FEB)

Results:

1.)	Total Qin =	318327	mgal	10269	mgal /yr
	Total Qin phosphorus load =	85094	kg	2745	kg /yr
2.)	Total by-pass volume =	94487	mgal	3048	mgal /yr
	Total by-pass phosphorus load =	25264	kg	815	kg /yr
3.)	Total CTSS treatment =	223840	mgal	7221	mgal /yr
	CTSS effluent =	7110	kg	229	kg /yr
4.)	Blended effluent concentration =	27	ppb		
	((Total by-pass load + CTSS effluent load)/Total flow)				

days in operation =	8208
% of 31-year flow event =	72%
number of days at peak =	3570
% of time operating at peak =	43%
Consecutive days at peak =	169

FEB Data

Average FEB height =	2.0	feet
Days FEB operating > 3.5 feet =	3083	days
Days FEB operating > 4.0 feet =	2698	days

Blending Basin size

	3-day HRT at peak flow and FEB depth	
	8.2	acres
+ 10%	9	acres

P removed

31-yr total	=	52720	kg
	=	115983	lb

Residual solids disposal area

	48	acres
+ 10%	52	acres

Long term (31-yr) geometric mean of the weekly flow-weigthed means

GM = 10 ppb

ACME BASIN B
CTSS/FEB DESIGN
SENSITIVITY CASE (8 ppb / 13 ppb)

Background:

This approach is used to size a chemical treatment followed by solids separation (CTSS) treatment plant and a flow-equalization-basin (FEB) to provide for a blended effluent concentration.

Effluent Concentrations:

CTSS effluent phosphorus concentration at average flow =	8	ppb
CTSS effluent phosphorus concentration at peak flow=	13	ppb

First-cut Assumptions:

1.) Used SFWMD flow data for ACME Basin (71-ppb 25% reduction in TP load) for period 1965 to 1995.
2.) By-pass occurs when FEB volume > capacity.
3.) No seepage loss has been accounted for in the FEB.
4.) Using 0% phosphorus removal within the FEB.
5.) Once FEB = 3.5 feet, treatment plant operates at 1.5*average design flow until FEB< 3.5 feet.
6.) Treatment start when one day of flow has been stored in FEB.
7.) There is always at least 0.5 feet in equlaization basin.
8.) FEB has 6.5 feet of equalization capacity (0.5 to 4.5 feet).

Procedure:

1.)	Use SFWMD flow data for ACME for period 1965 to 1995.				
3.)	Perform first iteration using a CTSS size =	53	mgd		
4.)	Perform first iteration using a FEB size =	200	acre	4	feet equalization (0.5 to 4.5 feet)
		261	mgal	195	mgal (ramp-up point, 3.5-ft in FEB)

Results:

1.)	Total Qin =	318327	mgal	10269	mgal /yr
	Total Qin phosphorus load =	85094	kg	2745	kg /yr
2.)	Total by-pass volume =	31132	mgal	1004	mgal /yr
	Total by-pass phosphorus load =	8324	kg	269	kg /yr
3.)	Total CTSS treatment =	287195	mgal	9264	mgal /yr
	CTSS effluent =	12523	kg	404	kg /yr
4.)	Blended effluent concentration =	17	ppb		
	((Total by-pass load + CTSS effluent load)/Total flow)				

days in operation =	6898
% of 31-year flow event =	61%
number of days at peak =	3208
% of time operating at peak =	47%
Consecutive days at peak =	52

FEB Data

Average FEB height =	1.1	feet
Days FEB operating > 3.5 feet =	878	days
Days FEB operating > 4.0 feet =	700	days

Blending Basin size

3-day HRT at peak flow and FEB depth
17.3 acres

P removed

31-yr total	=	64247	kg
	=	141344	lb

Residual solids disposal area

61 acres

Long term (31-yr) geometric mean

GM = 10 ppb

ACME BASIN B
CTSS/FEB DESIGN
SENSITIVITY CASE (50% TP Load Reduction)

Background:

This approach is used to size a chemical treatment followed by solids separation (CTSS) treatment plant and a flow-equalization-basin (FEB) to provide for a blended effluent concentration.

Effluent Concentrations:

CTSS effluent phosphorus concentration at average flow =	6	ppb
CTSS effluent phosphorus concentration at peak flow=	10	ppb

First-cut Assumptions:

1.) Used SFWMD flow data for ACME Basin (47-ppb 50% reduction in TP load) for period 1965 to 1995.
2.) By-pass occurs when FEB volume > capacity.
3.) No seepage loss has been accounted for in the FEB.
4.) Using 0% phosphorus removal within the FEB.
5.) Once FEB = 3.5 feet, treatment plant operates at 1.5*average design flow until FEB< 3.5 feet.
6.) Treatment start when one day of flow has been stored in FEB.
7.) There is always at least 0.5 feet in equlaization basin.
8.) FEB has 6.5 feet of equalization capacity (0.5 to 4.5 feet).

Procedure:

1.) Use SFWMD flow data for ACME for period 1965 to 1995.

3.)	Perform first iteration using a CTSS size =	20	mgd		
4.)	Perform first iteration using a FEB size =	200	acre	4	feet equalization (0.5 to 4.5 feet)
		261	mgal	195	mgal (ramp-up point, 3.5-ft in FEB

Results:

1.)	Total Qin =	318327	mgal	10269	mgal /yr
	Total Qin phosphorus load =	56729	kg	1830	kg /yr
2.)	Total by-pass volume =	118081	mgal	3809	mgal /yr
	Total by-pass phosphorus load =	21051	kg	679	kg /yr
3.)	Total CTSS treatment =	200247	mgal	6460	mgal /yr
	CTSS effluent =	6548	kg	211	kg /yr
4.)	Blended effluent concentration =	23	ppb		
	((Total by-pass load + CTSS effluent load)/Total flow)				

days in operation =	8576
% of 31-year flow event =	76%
number of days at peak =	4405
% of time operating at peak =	51%
Consecutive days at peak =	172

FEB Data

Average FEB height =	2.4	feet
Days FEB operating > 3.5 feet =	3932	days
Days FEB operating > 4.0 feet =	3462	days

Blending Basin size

3-day HRT at peak flow and FEB depth
7 acres

P removed

31-yr total	=	29130	kg
	=	64087	lb

Residual solids disposal area

43 acres

Long term (31-yr) geometric mean of the weekly flow-weighted means

GM = 10 ppb

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C-11 WEST BASIN (2006 thru 2036)
CTSS/FEB DESIGN
BASE CASE

Background:

This approach is used to size a chemical treatment followed by solids separation (CTSS) treatment plant and a flow-equalization-basin (FEB) to provide for a blended effluent concentration.

Effluent Concentrations:

CTSS effluent phosphorus concentration at average flow =	6	ppb
CTSS effluent phosphorus concentration at peak flow=	10	ppb

First-cut Assumptions:

1.) Used SFWMD flow data for C-11 West Basin (22-ppb) for period 1965 to 1995.
2.) By-pass occurs when FEB volume > capacity.
3.) No seepage loss has been accounted for in the FEB.
4.) Using 0% phosphorus removal within the FEB.
5.) Once FEB = 3.5 feet, treatment plant operates at 1.5*average design flow until FEB< 3.5 feet.
6.) Treatment start when one day of flow has been stored in FEB.
7.) There is always at least 0.5 feet in equlaization basin.
8.) FEB has4 feet of equalization capacity (0.5 to 4.5 feet).

Procedure:

1.) Use SFWMD flow data for C-11 West for period 1965 to 1995.

3.)	Perform first iteration using a CTSS size =	35	mgd		
4.)	Perform first iteration using a FEB size =	100	acre	4	feet equalization (0.5 to 4.5 feet)
		130	mgal	98	mgal (ramp-up point, 3.5-ft in FEE

Results:

1.)	Total Qin =	184773	mgal	5960	mgal /yr
	Total Qin phosphorus load =	15296	kg	493	kg /yr
2.)	Total by-pass volume =	76625	mgal	2472	mgal /yr
	Total by-pass phosphorus load =	6987	kg	225	kg /yr
3.)	Total CTSS treatment =	108148	mgal	3489	mgal /yr
	CTSS effluent =	3715	kg	120	kg /yr
4.)	Blended effluent concentration =	15	ppb		
	((Total by-pass load + CTSS effluent load)/Total flow)				

days in operation =	2388
% of 31-year flow event =	21%
number of days at peak =	1584
% of time operating at peak =	66%
Consecutive days at peak =	25

FEB Data

Average FEB height =	1.0	feet
Days FEB operating > 3.5 feet =	812	days
Days FEB operating > 4.0 feet =	722	days

Blending Basin size

	3-day HRT at peak flow and FEB depth	
	11.4	acres
+ 10%	13	acres

P removed

31-yr total	=	4594	kg
	=	10106	lb

Residual solids disposal area

	23	acres
+ 10%	25	acres

Long term (31-yr) geometric mean of the weekly flow-weighted means

GM = 10 ppb

C-11 WEST BASIN (2036 thru 2056)
CTSS/FEB DESIGN
BASE CASE

Background:

This approach is used to size a chemical treatment followed by solids separation (CTSS) treatment plant and a flow-equalization-basin (FEB) to provide for a blended effluent concentration.

Effluent Concentrations:

CTSS effluent phosphorus concentration at average flow =	6	ppb
CTSS effluent phosphorus concentration at peak flow=	10	ppb

First-cut Assumptions:

1.) Used SFWMD flow data for C-11 West Basin (28-ppb) for period 1965 to 1995.
2.) By-pass occurs when FEB volume > capacity.
3.) No seepage loss has been accounted for in the FEB.
4.) Using 0% phosphorus removal within the FEB.
5.) Once FEB = 3.5 feet, treatment plant operates at 1.5*average design flow until FEB< 3.5 feet.
6.) Treatment start when one day of flow has been stored in FEB.
7.) There is always at least 0.5 feet in equlaization basin.
8.) FEB has4 feet of equalization capacity (0.5 to 4.5 feet).

Procedure:

1.)	Use SFWMD flow data for C-11 West for period 1965 to 1995.				
3.)	Perform first iteration using a CTSS size =	20	mgd		
4.)	Perform first iteration using a FEB size =	100	acre	4	feet equalization (0.5 to 4.5 feet)
		130	mgal	98	mgal (ramp-up point, 3.5-ft in FEB)

Results:

1.)	Total Qin =	8947	mgal	289	mgal /yr
	Total Qin phosphorus load =	960	kg	31	kg /yr
2.)	Total by-pass volume =	6603	mgal	213	mgal /yr
	Total by-pass phosphorus load =	774	kg	25	kg /yr
3.)	Total CTSS treatment =	2344	mgal	76	mgal /yr
	CTSS effluent =	73	kg	2	kg /yr
4.)	Blended effluent concentration =	25	ppb		
	((Total by-pass load + CTSS effluent load)/Total flow)				
				846	
	days in operation =	104			
	% of 31-year flow event =	1%			
	number of days at peak =	43			
	% of time operating at peak =	41%			
	Consecutive days at peak =	9			

FEB Data

Average FEB height =	0.5	feet
Days FEB operating > 3.5 feet =	30	days
Days FEB operating > 4.0 feet =	17	days

Blending Basin size

	3-day HRT at peak flow and FEB depth	
	6.5	acres
+ 10%	7	acres

P removed

31-yr total	=	114	kg
	=	250	lb

Residual solids disposal area

	0	acres
+ 10%	1	acres

Long term (31-yr) geometric mean of the weekly flow-weighted means

GM = 10 ppb

C-11 WEST BASIN (2006 thru 2036)
CTSS/FEB DESIGN
SENSITIVITY CASE (8 ppb / 13 ppb)

Background:

This approach is used to size a chemical treatment followed by solids separation (CTSS) treatment plant and a flow-equalization-basin (FEB) to provide for a blended effluent concentration.

Effluent Concentrations:

CTSS effluent phosphorus concentration at average flow =	8	ppb
CTSS effluent phosphorus concentration at peak flow=	13	ppb

First-cut Assumptions:

1.) Used SFWMD flow data for C-11 West Basin (22-ppb) for period 1965 to 1995.
2.) By-pass occurs when FEB volume > capacity.
3.) No seepage loss has been accounted for in the FEB.
4.) Using 0% phosphorus removal within the FEB.
5.) Once FEB = 3.5 feet, treatment plant operates at 1.5*average design flow until FEB< 3.5 feet.
6.) Treatment start when one day of flow has been stored in FEB.
7.) There is always at least 0.5 feet in equlaization basin.
8.) FEB has4 feet of equalization capacity (0.5 to 4.5 feet).

Procedure:

1.)	Use SFWMD flow data for C-11 West for period 1965 to 1995.				
3.)	Perform first iteration using a CTSS size =	135	mgd		
4.)	Perform first iteration using a FEB size =	100	acre	4	feet equalization (0.5 to 4.5 feet)
		130	mgal	98	mgal (ramp-up point, 3.5-ft in FEB)

Results:

1.)	Total Qin =	184773	mgal	5960	mgal /yr
	Total Qin phosphorus load =	15296	kg	493	kg /yr
2.)	Total by-pass volume =	32344	mgal	1043	mgal /yr
	Total by-pass phosphorus load =	3415	kg	110	kg /yr
3.)	Total CTSS treatment =	152428	mgal	4917	mgal /yr
	CTSS effluent =	4615	kg	149	kg /yr
4.)	Blended effluent concentration =	11	ppb		
	((Total by-pass load + CTSS effluent load)/Total flow)				

days in operation =	1437
% of 31-year flow event =	13%
number of days at peak =	0
% of time operating at peak =	0%
Consecutive days at peak =	0

FEB Data

Average FEB height =	0.9	feet
Days FEB operating > 3.5 feet =	308	days
Days FEB operating > 4.0 feet =	250	days

Blending Basin size

	3-day HRT at average flow and FEB depth	
	29.3	acres
+ 10%	32	acres

P removed

31-yr total	=	7267	kg
	=	15986	lb

Residual solids disposal area

	32	acres
+ 10%	36	acres

Long term (31-yr) geometric mean of the weekly flow-weighted means

GM = 9 ppb

C-11 WEST BASIN (2036 thru 2056)
CTSS/FEB DESIGN
SENSITIVITY CASE (8 ppb / 13 ppb)

Background:

This approach is used to size a chemical treatment followed by solids separation (CTSS) treatment plant and a flow-equalization-basin (FEB) to provide for a blended effluent concentration.

Effluent Concentrations:

CTSS effluent phosphorus concentration at average flow =	8	ppb
CTSS effluent phosphorus concentration at peak flow=	13	ppb

First-cut Assumptions:

1.) Used SFWMD flow data for C-11 West Basin (28-ppb) for period 1965 to 1995.
2.) By-pass occurs when FEB volume > capacity.
3.) No seepage loss has been accounted for in the FEB.
4.) Using 0% phosphorus removal within the FEB.
5.) Once FEB = 3.5 feet, treatment plant operates at 1.5*average design flow until FEB< 3.5 feet.
6.) Treatment start when one day of flow has been stored in FEB.
7.) There is always at least 0.5 feet in equlaization basin.
8.) FEB has4 feet of equalization capacity (0.5 to 4.5 feet).

Procedure:

1.)	Use SFWMD flow data for C-11 West for period 1965 to 1995.				
3.)	Perform first iteration using a CTSS size =	50	mgd		
4.)	Perform first iteration using a FEB size =	100	acre	4	feet equalization (0.5 to 4.5 feet)
		130	mgal	98	mgal (ramp-up point, 3.5-ft in FEB)

Results:

1.)	Total Qin =	8947	mgal	289	mgal /yr
	Total Qin phosphorus load =	960	kg	31	kg /yr
2.)	Total by-pass volume =	6005	mgal	194	mgal /yr
	Total by-pass phosphorus load =	713	kg	23	kg /yr
3.)	Total CTSS treatment =	2943	mgal	95	mgal /yr
	CTSS effluent =	126	kg	4	kg /yr
4.)	Blended effluent concentration =	25	ppb		
	((Total by-pass load + CTSS effluent load)/Total flow)				
				839	
	days in operation =	51			
	% of 31-year flow event =	0%			
	number of days at peak =	51			
	% of time operating at peak =	100%			
	Consecutive days at peak =	5			

FEB Data

Average FEB height =	0.6	feet
Days FEB operating > 3.5 feet =	11	days
Days FEB operating > 4.0 feet =	11	days

Blending Basin size

	3-day HRT at peak flow and FEB depth	
	16.3	acres
+ 10%	18	acres

P removed

31-yr total	=	121	kg
	=	267	lb

Residual solids disposal area

	1	acres
+ 10%	1	acres

Long term (31-yr) geometric mean

GM 12 ppb

NNRC BASIN
CTSS/FEB DESIGN
BASE CASE

Background:

This approach is used to size a chemical treatment followed by solids separation (CTSS) treatment plant and a flow-equalization-basin (FEB) to provide for a blended effluent concentration.

Effluent Concentrations:

CTSS effluent phosphorus concentration at average flow =	6	ppb
CTSS effluent phosphorus concentration at peak flow=	10	ppb

First-cut Assumptions:

1.) Used SFWMD flow data for NNRC Basin (18-ppb) for period 1965 to 1995.
2.) By-pass occurs when FEB volume > capacity.
3.) No seepage loss has been accounted for in the FEB.
4.) Using 0% phosphorus removal within the FEB.
5.) Once FEB = 3.5 feet, treatment plant operates at 1.5*average design flow until FEB< 3.5 feet.
6.) Treatment start when one day of flow has been stored in FEB.
7.) There is always at least 0.5 feet in equlaization basin.
8.) FEB has4 feet of equalization capacity (0.5 to 4.5 feet).

Procedure:

1.) Use SFWMD flow data for NNRC for period 1965 to 1995.

3.)	Perform first iteration using a CTSS size =	8	mgd		
4.)	Perform first iteration using a FEB size =	30	acre	4	feet equalization (0.5 to 4.5 feet)
		39	mgal	29	mgal (ramp-up point, 3.5-ft in FEB

Results:

1.)	Total Qin =	18003	mgal	581	mgal /yr
	Total Qin phosphorus load =	1226	kg	40	kg /yr
2.)	Total by-pass volume =	12834	mgal	414	mgal /yr
	Total by-pass phosphorus load =	874	kg	28	kg /yr
3.)	Total CTSS treatment =	5169	mgal	167	mgal /yr
	CTSS effluent =	172	kg	6	kg /yr
4.)	Blended effluent concentration =	15	ppb		
	((Total by-pass load + CTSS effluent load)/Total flow)				

days in operation =	524
% of 31-year flow event =	5%
number of days at peak =	482
% of time operating at peak =	92%
Consecutive days at peak =	34

FEB Data

Average FEB height =	0.6	feet
Days FEB operating > 3.5 feet =	238	days
Days FEB operating > 4.0 feet =	214	days

Blending Basin size

	3-day HRT at peak flow and FEB depth	
	2.6	acres
+ 10%	3	acres

P removed

31-yr total	=	180	kg
	=	396	lb

Residual solids disposal area

	1	acres
+ 10%	1	acres

Long term (31-yr) geometric mean of the weekly flow-weighted means

GM = 10 ppb

NNRC BASIN
CTSS/FEB DESIGN
SENSITIVITY CASE (8 ppb / 13 ppb)

Background:

This approach is used to size a chemical treatment followed by solids separation (CTSS) treatment plant and a flow-equalization-basin (FEB) to provide for a blended effluent concentration.

Effluent Concentrations:

CTSS effluent phosphorus concentration at average flow =	8	ppb
CTSS effluent phosphorus concentration at peak flow=	13	ppb

First-cut Assumptions:

1.) Used SFWMD flow data for NNRC Basin (18-ppb) for period 1965 to 1995.
2.) By-pass occurs when FEB volume > capacity.
3.) No seepage loss has been accounted for in the FEB.
4.) Using 0% phosphorus removal within the FEB.
5.) Once FEB = 3.5 feet, treatment plant operates at 1.5*average design flow until FEB< 3.5 feet.
6.) Treatment start when one day of flow has been stored in FEB.
7.) There is always at least 0.5 feet in equlaization basin.
8.) FEB has4 feet of equalization capacity (0.5 to 4.5 feet).

Procedure:

1.) Use SFWMD flow data for NNRC for period 1965 to 1995.

3.)	Perform first iteration using a CTSS size =	40	mgd		
4.)	Perform first iteration using a FEB size =	30	acre	4	feet equalization (0.5 to 4.5 feet)
		39	mgal	29	mgal (ramp-up point, 3.5-ft in FEI

Results:

1.)	Total Qin =	18003	mgal	581	mgal /yr
	Total Qin phosphorus load =	1226	kg	40	kg /yr
2.)	Total by-pass volume =	8347	mgal	269	mgal /yr
	Total by-pass phosphorus load =	569	kg	18	kg /yr
3.)	Total CTSS treatment =	9656	mgal	311	mgal /yr
	CTSS effluent =	292	kg	9	kg /yr
4.)	Blended effluent concentration =	13	ppb		
	((Total by-pass load + CTSS effluent load)/Total flow)				

days in operation =	285
% of 31-year flow event =	3%
number of days at peak =	0
% of time operating at peak =	0%
Consecutive days at peak =	0

FEB Data

Average FEB height =	0.7	feet
Days FEB operating > 3.5 feet =	122	days
Days FEB operating > 4.0 feet =	110	days

Blending Basin size

	3-day HRT at peak flow and FEB depth	
	13.0	acres
+ 10%	14	acres

P removed

31-yr total	=	365	kg
	=	803	lb

Residual solids disposal area

	2	acres
+ 10%	2	acres

Long term (31-yr) geometric mean

GM = 10 ppb

Appendix D
Evaluation of ACME Basin B Alternative 5
by Burns & McDonnell

The following document was prepared by Burns & McDonnell as part of the Basin Specific Feasibility Studies for the Everglades Construction Project basins under Contract C-E023 with the South Florida Water Management District. It is included in this document for reference purposes only.

Preamble

This *Part 2 Acme Report* presents the information modified from STA-1E Alternative 2 in the Part 2 Report of Burns & McDonnell's August 16, 2002 Draft Submittal *Basin-Specific Feasibility Studies Preliminary Alternative Combinations for the ECP Basins: Evaluation of Alternatives*, related to the incremental phosphorus loading, costs, and evaluation assessment associated with Acme Basin B. The document presented herein duplicates the original STA-1E Alternative 2 information in addition to presenting the incremental numbers related to Acme Basin B without any changes to the original information related to STA-1E Alternative 2.

2.3 STA-1E Alternative No. 2

Alternative No. 2 for STA-1E contemplates the introduction of all discharges from Acme Basin B to an enhanced or optimized STA-1E.

A schematic of STA-1E under Alternative 1, is presented in Figure 2.4.

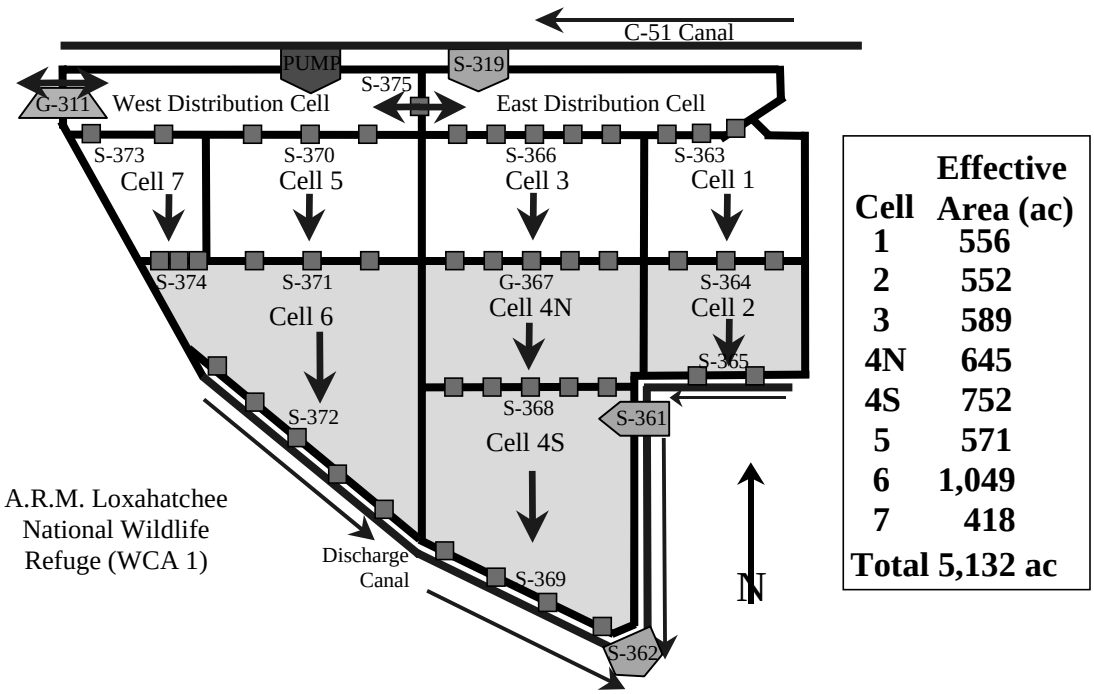

Figure 2.4. Schematic of STA-1E under Alternative 1

The Acme Improvement District Basin B presently discharges directly to WCA-1 at two locations immediately southeast of STA-1E (see Figure 2.5).

Average annual discharge from Acme Basin B to WCA-a, as reported in the District's May, 2001 Baseline Data for the Basin-Specific Feasibility Studies, are estimated to be 31,499 acre-feet at a flow-weighted mean TP concentration of 94 ppb (ave. annual TP load of 3.66 metric tonnes). The Village of Wellington has adopted an ordinance requiring

implementation of BMPs in Basins B, with a targetted reduction of 25% in total phosphorus discharges. Accordingly, the diversion of Basin B to STA-1E can be projected to add an average annual volume of 31,499 acre-feet at a flow-weighted mean TP of 71 ppb to the STA-1E baseline inflows.

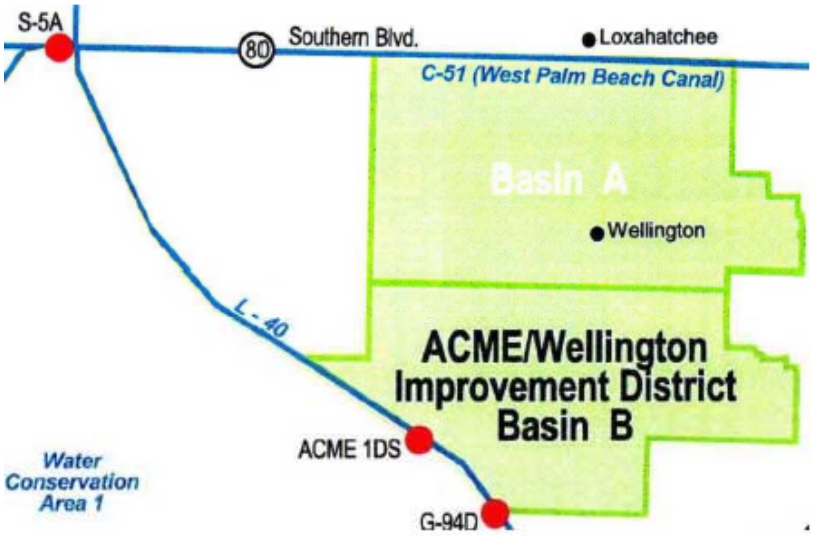

Figure 2.5. Schematic of Acme Basin B Discharge to WCA1

STA-1E inflows modified to include Acme Basin B are summarized in Table 2.12.

Under Alternative No. 2, STA-1E, receiving additional inflows from the ACME Basin, would be modified to optimize its performance, with completion of all modifications and placement into service of the modified treatment area occurring in 2006. For this analysis, that optimization is considered to consist of the conversion of Cells 2, 4NS and 6 from emergent vegetation to Submerged Aquatic Vegetation (SAV_C4) and further includes the redistribution of 3% of the total inflow from Cells 5,7 to Cell 3.

Table 2.12 Estimated Inflows, STA-1E Alternative 2, 1965-1995

Inflow Source and Description	Average Annual Inflow		Flow-Weighted Mean TP Conc. (ppb)
	Volume (ac-ft)	TP Load (1,000 kg)	
C-51 Basin	105,202	24.01	185
L-101/EAA WPB Basin (S-5A)	22,552	3.70	133
Lake Okeechobee			
Water Supply	631	0.11	141
Rustic Ranches	4,946	1.13	185
ACME Basin*	31,499	2.74	71
Total Average Annual Inflows	**164,830**	**31.69**	**156**

* Assumes 25% reduction due to BMPs in Acme Basin B

2.1.1 Treatment Analysis Input Data Summary

The District's Excel file "acme-simulated-flow-tp.xls" provided simulated inflow volumes and TP concentrations for the ACME Basin B. The same file renamed "sta1E Alt2 inflow tp.xls", was used as a data file for inflow rates and TP concentrations for Alternative 2. Inflow rates, TP concentrations, rainfall, and evapotranspiration employed in the DMSTA analysis of Alternative 2 were taken from this file and these input variables are defined in the Excel worksheet "1E ALT 2 SAVC4" included in workbooks "1E_Alt2_p1_Data.xls" and "1E_Alt2_ p2_Data.xls". Two worksheets are again used because STA-1E has more than 6 cells, the limit for the DMSTA model.

2.1.2 Summary of Input Variables for Treatment Analysis

As previously discussed above, input variables employed in the analysis of Alternative 2 for STA-1E are identical to those included in the Alternative 1 analysis. The only variations in Alternative 2 are listed below.

- 3% of the Total Inflow to Cells 5,7 was redirected to Cell 3 by modifying the inflow fractions, (e.g., inflow fraction to Cells 5,7 was reduced from 0.44 to 0.41).

2.1.3 Results of DMSTA Analysis for Alternative 2

A detailed listing of input variables employed in the analysis of Alternative 2 for STA-1E, together with a detailed listing of computed output variables resulting from that analysis, is presented in Tables 2.14 and 2.15 (which consists of screen information taken directly from the DMSTA output file).

A condensed summary of the results of the analysis is presented in Table 2.13, which is considered reflective of the long-term treatment performance of STA-1E following full implementation of Alternative 2. STA-1E would operate under Alternative 2 from 2007-2056.

Table 2.13 Discharge Summary, STA-1E Alternative 2

Parameter	Units	Value
Average Annual Outflow Volume	Hm^3/yr	215.8
Average Annual Outflow Volume	Ac-ft/yr	175,000
Average Annual Outflow TP Load	Kg/yr	3,310.4
Flow-weighted Mean TP Concentration	ppb	15
Geometric Mean TP Concentration, weekly composites	ppb	10**

**Computed GeoMean Conc. Less than LSC assigned as 10 ppb.

From Table 2.13, the STA-1E outflow concentration of 15 ppb applied to Acme Basin B flows of 31,499 ac-ft yields an average annual outflow TP Load of 583 Kg/yr.

Table 2.14 Results of Distribution Cell DMSTA Analysis, STA-1E Alternative 2

Case Description: Alternative 2 Includes ACME inflows with 25% BMP controls

Filename: 1E_Baseline_ACME_p1_Data.xls

Input Variable	Units	Value
Design Case Name	-	_Baseline_Acm
Starting Date for Simulation	-	01/01/65
Ending Date for Simulation	-	12/31/95
Starting Date for Output	-	01/01/65
Steps Per Day	-	3
Number of Iterations	-	2
Output Averaging Interval	days	1
Reservoir H2O Residence Time	days	0
Max Inflow / Mean Inflow	-	0
Max Reservoir Storage	hm3	0
Reservoir P Decay Rate	1/yr/ppb	0
Rainfall P Conc	ppb	10
Atmospheric P Load (Dry)	mg/m2-yr	20

Output Variable	Units	Value
Water Balance Error	%	0.0%
Mass Balance Error	%	-0.1%
Flow-Wtd Conc - With Bypass	ppb	113.2
Flow-Wtd Conc - Without Bypass	ppb	113.2
Geometric Mean Conc	ppb	105.4
95th Percentile Conc	ppb	120.7
Freq Cell Outflow > 10 ppb	%	100%
Bypass Load	%	0.0%

Cell Number -->		1	2	3	4	5	6
Cell Label	-	1					
Vegetation Type	------->	EMERG					
Inflow Fraction	-	1					
Downstream Cell Number	-	0					
Surface Area	km2	4.233					
Mean Width of Flow Path	km	2.78					
Number of Tanks in Series	-	1					
Outflow Control Depth	cm	60					
Outflow Coefficient - Exponent	-	2.26					
Outflow Coefficient - Intercept	-	1.35					
Bypass Depth	cm	0					
Maximum Inflow	hm3/day	0					
Maximum Outflow	hm3/day	0					
Inflow Seepage Rate	(cm/d) / cm	0					
Inflow Seepage Control Elev	cm	0					
Inflow Seepage Conc	ppb	20					
Outflow Seepage Rate	(cm/d) / cm	0.00856					
Outflow Seepage Control Elev	cm	-128					
Max Outflow Seepage Conc	ppb	20					
Seepage Recycle Fraction	-	1					
Seepage Discharge Fraction	-	0					
Initial Water Column Conc	ppb	30					
Initial P Storage Per Unit Area	mg/m2	500					
Initial Water Column Depth	cm	50					
C0 = WC Conc at 0 g/m2 P Storage	ppb	*4*					
C1 = WC Conc at 1 g/m2 P storage	ppb	*22*					
K = Net Settling Rate at Steady State	m/yr	*16*					
Zx = Depth Scale Factor	cm	*60*					
C0 - Periphyton	ppb	*0*					
C1 - Periphyton	ppb	*0*					
K - Periphyton	1/yr	*0.00*					
Zx - Periphyton	cm	*0*					
Sm = Transition Storage Midpoint	mg/m2	*0*					
Sb = Transition Storage Bandwidth	mg/m2	*0*					

Output Variables	Units	1	2	3	4	5	6	Overall
Execution Time	seconds/yr	0.61						0.61
Run Date	-	07/23/02						07/23/02
Starting Date for Simulation	-	01/01/65						01/01/65
Starting Date for Output	-	01/01/65						01/01/65
Ending Date	-	12/31/95						12/31/95
Output Duration	days	11322						11322
Cell Label		1						Total Outflow
Downstream Cell Label		Outflow						-
Surface Area	km2	4.233						4.2
Mean Water Load	cm/d	13.2						13.2
Max Water Load	cm/d	363.5						363.5
Inflow Volume	hm3/yr	203.5						203.5
Inflow Load	kg/yr	31718.4						31718.4
Inflow Conc	ppb	155.9						155.9
Treated Outflow Volume	hm3/yr	203.9						203.9
Treated Outflow Load	kg/yr	23085.9						23085.9
Treated FWM Outflow Conc	ppb	113.2						113.2
Total FWM Outflow Conc	ppb	113.2						113.2
Surface Outflow Load Reduc	%	27.2%						27.2%
Outflow Geometric Mean - Daily	ppb	105.4						105.4
Outflow Geo Mean - Composites	ppb	105.4						105.4
Frequency Outflow Conc > 10 ppb	%	100%						100%

Table 2.15 Results of DMSTA Analysis, STA-1E Alternative 2

Input Variable	Units	Value
Design Case Name	-	E Alt 2 SAV_C4
Starting Date for Simulation	-	01/01/65
Ending Date for Simulation	-	12/31/95
Starting Date for Output	-	01/01/65
Steps Per Day	-	2
Number of Iterations	-	1
Output Averaging Interval	days	7
Reservoir H2O Residence Time	days	0
Max Inflow / Mean Inflow	-	0
Max Reservoir Storage	hm3	0
Reservoir P Decay Rate	1/yr/ppb	0
Rainfall P Conc	ppb	10
Atmospheric P Load (Dry)	mg/m2-yr	20

Case Description: ACME inflow and concentrations added to original inflows
Redistributed flows for cells 3 and 5
SAV_C4 in cells 2, 4, and 6
25% BMP controls

Filename: 1E_Alt2_SAV_C4_p2_Data.xls

Output Variable	Units	Value
Water Balance Error	%	0.0%
Mass Balance Error	%	0.0%
Flow-Wtd Conc - With Bypass	ppb	15.3
Flow-Wtd Conc - Without Bypass	ppb	15.3
Geometric Mean Conc	ppb	8.2
95th Percentile Conc	ppb	18.3
Freq Cell Outflow > 10 ppb	%	39%
Bypass Load	%	0.0%

Cell Number -->		1	2	3	4	5	6
Cell Label	-	1	2	3	4NS	5,7	6
Vegetation Type	------->	EMERG	SAV_C4	EMERG	SAV_C4	EMERG	SAV_C4
Inflow Fraction	-	0.2	0	0.39	0	0.41	0
Downstream Cell Number	-	2	0	4	0	6	0
Surface Area	km2	2.250	2.233	2.384	5.653	4.002	4.245
Mean Width of Flow Path	km	1.55	1.46	1.56	1.55	2.50	1.99
Number of Tanks in Series	-	3	3	3	8	3	3
Outflow Control Depth	cm	40	60	40	60	40	60
Outflow Coefficient - Exponent	-	2.36	2.31	2.29	2.33	2.32	2.34
Outflow Coefficient - Intercept	-	2.44	2.94	1.12	1.41	0.79	1.15
Bypass Depth	cm	0	0	0	0	0	0
Maximum Inflow	hm3/day	0	0	0	0	0	0
Maximum Outflow	hm3/day	0	0	0	0	0	0
Inflow Seepage Rate	(cm/d) / cm	0	0	0.00361	0.00335	0.00443	0.01121
Inflow Seepage Control Elev	cm	0	0	122	100	87	129
Inflow Seepage Conc	ppb	20	20	20	20	20	20
Outflow Seepage Rate	(cm/d) / cm	0.00765	0.01537	0.00361	0.00539	0	0
Outflow Seepage Control Elev	cm	-69	-38	30	-17	0	0
Max Outflow Seepage Conc	ppb	20	20	20	20	20	20
Seepage Recycle Fraction	-	0.77	0.81	0	0.31	0	0
Seepage Discharge Fraction	-	0	0	0	0	0	0
Initial Water Column Conc	ppb	30	30	30	30	30	30
Initial P Storage Per Unit Area	mg/m2	500	500	500	500	500	500
Initial Water Column Depth	cm	50	50	50	50	50	50
C0 = WC Conc at 0 g/m2 P Storage	ppb	*4*	*4*	*4*	*4*	*4*	*4*
C1 = WC Conc at 1 g/m2 P storage	ppb	*22*	*22*	*22*	*22*	*22*	*22*
K = Net Settling Rate at Steady State	m/yr	*16*	*80*	*15.66*	*80.10*	*15.66*	*80.10*
Zx = Depth Scale Factor	cm	*60*	*60*	*60*	*60*	*60*	*60*
C0 - Periphyton	ppb	*0*	*0*	*0*	*0*	*0*	*0*
C1 - Periphyton	ppb	*0*	*0*	*0*	*0*	*0*	*0*
K - Periphyton	1/yr	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
Zx - Periphyton	cm	*0*	*0*	*0*	*0*	*0*	*0*
Sm = Transition Storage Midpoint	mg/m2	*0*	*0*	*0*	*0*	*0*	*0*
Sb = Transition Storage Bandwidth	mg/m2	*0*	*0*	*0*	*0*	*0*	*0*

Output Variables	Units	1	2	3	4	5	6	Overall
Execution Time	seconds/yr	0.52	0.90	1.32	2.26	2.65	3.06	3.06
Run Date	-	07/24/02	07/24/02	07/24/02	07/24/02	07/24/02	07/24/02	07/24/02
Starting Date for Simulation	-	01/01/65	01/01/65	01/01/65	01/01/65	01/01/65	01/01/65	01/01/65
Starting Date for Output	-	01/01/65	01/01/65	01/01/65	01/01/65	01/01/65	01/01/65	01/01/65
Ending Date	-	12/31/95	12/31/95	12/31/95	12/31/95	12/31/95	12/31/95	12/31/95
Output Duration	days	11322	11322	11322	11322	11322	11322	11322
Cell Label		1	2	3	4NS	5,7	6	Total Outflow
Downstream Cell Label		2	Outflow	4NS	Outflow	6	Outflow	-
Surface Area	km2	2.250	2.233	2.384	5.653	4.002	4.245	20.8
Mean Water Load	cm/d	5.0	4.8	9.1	4.0	5.7	5.6	2.7
Max Water Load	cm/d	63.8	64.8	117.5	47.7	73.6	65.1	34.6
Inflow Volume	hm3/yr	40.8	39.5	79.6	81.7	83.7	86.8	204.0
Inflow Load	kg/yr	4620.7	2670.9	9010.4	6542.0	9472.5	5878.0	23103.6
Inflow Conc	ppb	113.2	67.6	113.2	80.0	113.2	67.7	113.2
Treated Outflow Volume	hm3/yr	39.5	37.6	81.7	79.3	86.8	99.0	215.8
Treated Outflow Load	kg/yr	2670.9	686.9	6542.0	1036.7	5878.0	1586.8	3310.4
Treated FWM Outflow Conc	ppb	67.6	18.3	80.0	13.1	67.7	16.0	15.3
Total FWM Outflow Conc	ppb	67.6	18.3	80.0	13.1	67.7	16.0	15.3
Surface Outflow Load Reduc	%	42.2%	74.3%	27.4%	84.2%	37.9%	73.0%	85.7%
Outflow Geometric Mean - Daily	ppb	59.5	9.5	79.3	6.1	66.5	8.9	8.0
Outflow Geo Mean - Composites	ppb	59.8	9.7	79.0	6.1	66.3	9.2	8.2
Frequency Outflow Conc > 10 ppb	%	100%	100%	100%	0%	100%	40%	25%

2.1.4 ACME Basin B Diversion, Description of Physical Works

Alternative 2 require the diversion of flows from Acme Basin B to STA-1E. Acme Basin B presently discharges to the Loxahatchee National Wildlife Refuge (WCA-1) through two pumping stations situated on Levee L-40. Pumping Station No. 1 is located approximately one mile southeasterly along L-40 from its intersection with Flying Cow Road (extended). This station has a permitted capacity of 100,000 gpm, and is also equipped with 75,000 gpm of standby pumping capacity. Pumping Station No. 2 is located approximately 1.4 miles southeasterly along L-40 from Pumping Station No. 1. The permitted capacity of this station is 120,000 gpm; it is also equipped for an irrigation withdrawal rate (from WCA-1) of 60,000 gpm. These stations are reportedly in need of major rehabilitation, which has been deferred pending determination of the long-term water management strategies for Basin B.

Two basic options are available for diversion of discharges from those present pumping station locations to the headworks (e.g., distribution cells) of STA-1E:

> **Option 1:** The first option would consist of enlargement of approximately 4.5 miles of the Acme C-1 Canal and the Acme C-27 Canal (approximately one mile in length). It might also be necessary to enlarge approximately one mile each of the Acme C-25 and C-4 canals, leading from Pumping Station No. 2 to Pumping Station No. 1. Determination of the required extent and magnitude of the enlargement would require specific analysis of the existing canals.
>
> Those canal enlargements would extend northerly to a point north of the existing FPL transmission lines, which would require an extension of the C-1 Canal beyond a major electrical substation immediately east of Flying Cow Road. Discharges would then be carried across Flying Cow Road through a new culvert, and then conveyed west to the vicinity of the east line of the East Distribution Cell with a new canal. It should be noted that the new canal would

intersect the seepage collection canal now being constructed along the east line of STA-1E, potentially requiring the construction of a control structure on that seepage canal immediately south of its confluence with the new Acme canal. A new pumping station would then lift those discharges into the East Distribution Cell. For this analysis, the capacity of the pumping station has been assigned at 491 cfs, equal to the presently permitted discharge capacity of Pumping Stations 1 and 2 combined.

Option 2: It has been reported (personal communication with Mock Ross & Associates, engineer for the Village of Wellington, dated May 31, 2001) that a preliminary hydraulic analysis has been prepared that suggests it may be possible to convey Basin B runoff north through Basin A using the existing canal system. That diversion could be accomplished through operation (opening) of existing culverts beneath Pierson Road (the divide between Basins A and B).

Discharges from Basin A to the C-51 West Canal are presently effected through two pumping stations (total permitted discharge capacity of 120,000 gpm in the pumping stations; 60,000 gpm of standby capacity is also present in one station) and four gravity outfalls. Two of the gravity outfalls are collocated with the pumping stations (at the north ends of the C-2 and C-9 canals). The other two gravity outfalls are located at the north ends of the C-8 and C-14 canals. The Village of Wellington is also pursuing authority to construct an additional 75,000 gpm of pumping capacity from Basin A to the C-51 West Canal.

Once introduced to the C-51 Canal, the Basin B discharges would be lifted to the East Distribution Cell of STA-1E by a new pumping station constructed on the south bank of the C-51 Canal. As was the case for Option 1, that pumping station is assumed to have a capacity of 491 cfs.

The nominal capacities of Inflow Pumping Station S-319 and Outflow Pumping Station S-362 are 3,980 cfs and 4,200 cfs, respectively. The District's *Baseline Data* includes mean daily inflows at S-319 equal to its nominal capacity. Following addition of Acme Basin B discharges to the STA-1E baseline inflows, the modified peak daily inflow to STA-1E would be 6,285 cfs. It is therefore considered appropriate to consider an additional inflow pumping capacity equal to the presently permitted capacities of the Acme Basin B pumping stations (491 cfs).

The maximum simulated discharge from STA-1E over the 31-year period 1965-1995 with Acme Basin B discharges added to STA-1E, is 4,090 cfs, as compared to the nominal capacity at S-362 of 4,200 cfs. As the peak daily outflow for the 31-year period is less than the capacity of S-362, it is concluded that no bypass would have been required, and that there would not be a need for additional outflow pumping capacity.

For this analysis, it has been assumed Option 2 would be selected, and no costs have been included for the diversion of Acme Basin B to the C-51 West Canal. The only capital construction necessary for further directing those discharges to STA-1E would be the new 491-cfs inflow pumping station.

2.1.5 Opinion of Probable Capital Cost

The following is a summary listing of the anticipated physical works necessary for implementation of Alternative 2:

- Basin B discharges would be lifted to the East Distribution Cell of STA-1E by a new pumping station constructed on the south bank of the C-51 Canal.
- Herbicide treatment of Cells 2, 4NS and 6 for removal of emergent macrophyte vegetation to permit development of SAV_C4.

An opinion of the probable capital cost for Alternative 2 is presented in Table 2.16.

Table 2.16 Opinion of Probable Capital Cost, STA-1E Alternative 2

Item No.	Description	Estimated Quantity	Unit	Estimated Unit Cost	Estimated Total Cost	Remarks
1	Pumping Station, Cell	491	cfs	$9,900	$4,860,900	Unit cost from Evaluation Methodology
2	Eradication of Existing Vegetation	2998	ac	$200	$599,600	Unit cost from 02/2002 STSOC for SAV/LR
Subtotal, Estimated Construction Costs					**$5,460,500**	**$5,470,000**
Planning, Engineering & Design		10 %			$546,050	**$550,000**
Program & Construction Management		10 %			$546,050	**$550,000**
Total Estimated Cost, Without Contingency					**$6,552,600**	**$6,570,000**
Contingency		30 %			$1,965,780	**$1,970,000**
TOTAL ESTIMATED CAPITAL COST					**$8,518,380**	**$8,520,000**

The opinions of probable capital costs presented herein are considered suitable for the development and evaluation of alternatives at the feasibility study level, but should not be taken as firm estimates of the cost for implementation of any given alternative. All estimated costs are stated at current (2002) pricing levels.

From Table 2.16, the opinion of probable incremental capital cost related to Acme Basin B is the following: $4,860,000 for direct Capital Cost, $490,000 for each of the Planning, Engineer & Design and Program & Construction Management costs, and $1,740,000 for Contingency. The total combined incremental Capital Cost for Acme B Basin B flows is $7,580,000.

2.1.6 Opinion of Probable Annual Costs for Operation & Maintenance

The following is a summary listing of the anticipated incremental operation and maintenance requirements for Alternatives 3 (e.g., requirements in addition to those for operation of maintenance of STA-1E as presently designed):

- Additional herbicide treatment of Cells 2, 4NS and 6 for control of invasive species and emergent macrophyte vegetation including:
    - Operation and maintenance of one pumping station to handle Basin B discharges to the East Distribution Cell constructed on the south bank of the C-51 Canal. The pumps in this station are anticipated to be diesel driven.

- Annual costs to spray for invasive species.
- Additional costs for post-drought eradication of undesirable species.

The February 22, 2002 Draft *Supplemental Technology Standard of Comparison (STSOC) Analysis for Submerged Aquatic Macrophyte/Limerock Technology*, D.B Environmental, presents an estimated cost of $25/acre/year for regular herbicide treatment for control of invasive species, and an additional $10/acre/year for post-drought eradication spraying. The opinion of probable incremental operation and maintenance cost includes a substantially reduced allowance of $10/acre/year for both those items, as was discussed for Alternative 1.

An opinion of the probable incremental operation and maintenance cost for Alternative 3 is presented in Table 2.17.

Table 2.17 Opinion of Probable Incremental O&M Cost, STA-1E Alternative 2

Item No.	Description	Estimated Quantity	Unit	Estimated Unit Cost	Estimated Total Cost	Remarks
1	Mech. Maintenance, Pumping Station	2	Ea.	$10,000	$20,000	Unit cost from Evaluation Methodology
2	Engine Operator/Maintenance Mechanic	3	Ea.	$50,000	$150,000	Unit cost from Evaluation Methodology
3	Fuel Costs	38,654	ac-ft	$0.50	$19,327	Avg. Annual Provided by SFWMD "ACME_SUM.xls"
4	Incremental Cost forAnnual Vegetation Control	2,998	ac	$10	$29,980	
Subtotal, Estimated Incremental Operation & Maintenance Costs					**$219,307**	
Contingency		30 %			$65,792	
TOTAL INCREMENTAL O&M COST					**$285,099**	**$285,000**

The opinions of probable incremental operation and maintenance costs presented herein are considered suitable for the development and evaluation of alternatives at the feasibility study level, but should not be taken as firm estimates of the cost for implementation of any given alternative. All estimated costs are stated at current (2002) pricing levels, and do not include any allowance for cost escalation over the life of the project.

From Table 2.17, the opinion of probable total incremental O&M cost related to Acme Basin B is $245,000.

2.1.7 Total Present Worth

The total present cost of Alternative 3 is presented in Table 2.18, and is computed as of December 31, 2006. It is based on a 50-year project life extending from January 1, 2007 through December 31, 2056 (period of analysis), a discount rate of 6-3/8%, and includes escalation at an annual rate of 3%.

Table 2.18 Total Present Worth, STA-1E Alternative 2

Annual Discount Rate		**6.375%**		**Date of Pricing Data**		**12/31/02**
Present Cost as of		**12/31/2002**				
Annual Escalation Rate		**3.000%**		**Convenience Rate**		**3.277%**
Capital Costs						**Present**
Year		**PED**	**P&CM**	**Const.**	**Total**	**Worth**
2003		$566,500			$566,500	$532,550
2004			$291,748	$3,935,939	$4,227,687	$3,736,144
2005			$300,500	$4,054,017	$4,354,517	$3,617,606
Total Capital Cost					$4,354,517	$7,886,300
Incremental Costs for Operation and Maintenance						**Present**
From	**To**			**Total O&M Cost**		**Worth**
2007	2056			$37,267,308		5,877,768
Total Present Worth of Alternative						**$13,764,069**

From Table 2.18, the opinion of probable total incremental present worth related to Acme Basin B is $12,069,065.

2.5 Summary of Evaluation Criteria Scoring

The following tables present summaries of the evaluation criteria scoring for the alternative water quality improvement strategies for STA-1E. The information presented therein will subsequently be employed by the District and others in further evaluation of the alternatives, and identification of that alternative or alternative(s) to be carried forward to the conceptual design phase. In Table 2.20, the 489kg load represented is the 50-yr baseline load (from Table 2.6) plus the Acme Basin B load. This baseline load is calculated in the same manner as information presented in Table 2.13. Table 2.20a presents the incremental cost and load information related to Acme Basin B only.

Table 2.20 Summary Evaluation Criteria Scores, STA-1E Alternative 2

Criteria			Unit	Value	Source of Data
Technical Performance Evaluation:				**ENTER**	**ENTER**
1,2	Level of Phosphorus Reduction				
	1	50-Year TP Load Disc. - Baseline#	tonnes	489	Table 2.6 + ACME B (2.74 tpy)
		50-Year TP Load Disc. - Alternative 2	tonnes	166	Table 2.13
		Phosphorus Load Reduction	%	66.1	Computed
	2a	Long-term flow-weighted mean TP concentration	ppb	15	Table 2.13
	2b	Long-term geometric mean of 7-day composite TP concentrations	ppb	10**	Table 2.13
3	Implementation Schedule		years	4	2006 Specified Completion, from 01/03
4	Operational Flexibility, including adaptive management		-3 (worst) +3 (best)	0	BPJ, based on review of information presented in STSOC (see Part 1)
5	Resiliency to extreme conditions		-4 (worst) +4 (best)	1	BPJ, based on review of information presented in STSOC (see Part 1)
6	Assessment of full-scale construction and operation		-3 (worst) +3 (best)	1	BPJ, based on review of information presented in STSOC (see Part 1)
7	Management of side streams		-3 (worst) +3 (best)	-1	BPJ, based on review of information presented in STSOC (see Part 1)
Environmental Evaluation:					
1	Level of improvement in non-phosphorus parameters		-19 (worst) +19 (best)	2	Table 1.5
Economic Evaluation:					
1,2	Costs				
	1	50-yr Present Worth Cost	$	$13,764,069	Table 2.20
	2	Total 50-Year TP Removal	kg	323,010	Difference Between 50-Year TP Discharges
	2	Cost-effectiveness	$/kg	$42.61	Computed

BPJ = Best Professional Judgment
STSOC = Supplemental Technology Standard of Comparison
TP = Total Phoshphorus

Long-Term TP Concentrations are for fully implemented alternative

Present Worth Cost for 50-Year Life (2007-2056)

- Worth as of 12/31/2002
- 3% Escalation Rate from 12/31/2002
- Discount Rate of 6-3/8%

Baseline discharge consists of the sum of baseline discharge of 7.03 tonnes per year from Table 2.6, and the baseline discharge from Acme Basin B to WCA-1 (2.74 tonnes per year, see Table 2.12)

** Computed Geo.Mean Conc. Less than LSC assigned as 10 ppb.

Table 2.20a Summary Evaluation Criteria Scores, Acme Basin B

Criteria			Unit	Value	Source of Data
Technical Performance Evaluation:				**ENTER**	**ENTER**
1,2	Level of Phosphorus Reduction				
	1	50-Year TP Load Disc. - Baseline#	tonnes	137	ACME B (2.74 tpy) * 50 years
		50-Year TP Load Disc. - Alternative 2	tonnes	29	0.583 tpy * 50 years
		Phosphorus Load Reduction	%	78.7	Computed
	2a	Long-term flow-weighted mean TP concentration	ppb	15	Table 2.13
	2b	Long-term geometric mean of 7-day composite TP concentrations	ppb	10**	Table 2.13
3	Implementation Schedule		years	4	2006 Specified Completion, from 01/03
4	Operational Flexibility, including adaptive management		-3 (worst) +3 (best)	0	BPJ, based on review of information presented in STSOC (see Part 1)
5	Resiliency to extreme conditions		-4 (worst) +4 (best)	1	BPJ, based on review of information presented in STSOC (see Part 1)
6	Assessment of full-scale construction and operation		-3 (worst) +3 (best)	1	BPJ, based on review of information presented in STSOC (see Part 1)
7	Management of side streams		-3 (worst) +3 (best)	-1	BPJ, based on review of information presented in STSOC (see Part 1)
Environmental Evaluation:					
1	Level of improvement in non-phosphorus parameters		-19 (worst) +19 (best)	2	Table 1.5
Economic Evaluation:					
1,2	Costs				
	1	50-yr Present Worth Cost	$	$12,069,065	Table 2.20
	2	Total 50-Year TP Removal	kg	107,850	Difference Between 50-Year TP Discharges
	2	Cost-effectiveness	$/kg	$111.91	Computed

BPJ = Best Professional Judgment
STSOC = Supplemental Technology Standard of Comparison
TP = Total Phoshphorus

Long-Term TP Concentrations are for fully implemented alternative

Present Worth Cost for 50-Year Life (2007-2056)

- Worth as of 12/31/2002
- 3% Escalation Rate from 12/31/2002
- Discount Rate of 6-3/8%

Baseline discharge consists of the sum of baseline discharge of 7.03 tonnes per year from Table 2.6, and the baseline discharge from Acme Basin B to WCA-1 (2.74 tonnes per year, see Table 2.12)

** Computed Geo.Mean Conc. Less than LSC assigned as 10 ppb.

2.6 Sensitivity Analyses of Phosphorus Reduction Parameters

The effectiveness of phosphorus reduction in the alternatives considered are examined with respect to the change in the following three input parameters presented in the sensitivity analyses:

- Varying BMP Performance
- Different SAV Communities
- All Input Parameters
    - Uncertainty Analysis

The third analysis (all input parameters) also employs an uncertainty analysis. The information presented therein will assist the District in further analyses of the alternatives presented in the future evaluation of the parameters.

2.6.1 Variation in BMP Performance

The alternatives performed in the BMP sensitivity analysis for STA-1E involved the following variations in inflow loads:

- Sensitivity Normal (existing conditions – no reductions necessary)
    - C-51 Basin – 0% reduction in TP loads
    - L-101/EAA WPB Basin – 50% reduction in TP loads
    - L.O. Water Supply – 0% reduction in TP loads
    - Rustic Ranch – 0% reduction in TP loads
    - ACME Basin B– 25% reduction in TP loads
- Sensitivity Analysis #1
    - C-51 Basin – 25% reduction in TP loads
    - L-101/EAA WPB Basin – 75% reduction in TP loads
    - L.O. Water Supply – 0% reduction in TP loads
    - Rustic Ranch – 25% reduction in TP loads

- ACME Basin B– 50% reduction in TP loads

- Sensitivity Analysis #2
  - C-51 Basin – 0% reduction in TP loads
  - L-101/EAA WPB Basin – 25% reduction in TP loads
  - L.O. Water Supply – 0% reduction in TP loads
  - Rustic Ranch – 0% reduction in TP loads
  - ACME Basin B– 0% reduction in TP loads

A summary of the results of those analyses is presented in Table 2.21.

Table 2.21 Variation in BMP Performance

Condition	Location	TP Conc. For BMP Load Reduction					
		Normal		Sens. #1		Sens. #2	
		F.W.	Geo.	F.W.	Geo.	F.W.	Geo.
Baseline, Existing	STA-1E Inflows	176	--	127	--	187	--
	STA-1E Outflows	38	34	31	27	38	35
Alternative 1	STA-1E Inflows	176	--	127	--	187	--
	STA-1E Outflows	15	10**	14*	10**	14*	10**
Alternative 2 (with ACME)	STA-1E Inflows	156	--	111	--	170	--
	STA-1E Outflows	15	10**	14*	10**	15	10**

*Computed F.W.M. Conc. Less than LSC assigned as 14 ppb.
**Computed GeoMean Conc. Less than LSC assigned as 10 ppb.

2.6.2 Variation in SAV Performance

The current vegetative community (SAV_C4) was changed to the vegetative community (NEWS) to determine the effects of different vegetative communities on the phosphorus reduction parameters. Table 2.22 summarizes, for Alternatives 1 and 3, the outcome of the phosphorus reduction performance due to different SAV communities.

Table 2.22 Variation in SAV Performance

Condition	Location	TP Conc. For Different SAV Communities			
		SAV_C4		NEWS	
		F.W.	Geo.	F.W.	Geo.
Alternative 1	STA-1E Inflows	176	--	176	--
	STA-1E Outflows	15	10**	24	11
Alternative 2 (with ACME)	STA-1E Inflows	156	--	156	--
	STA-1E Outflows	15	10**	24	11

**Computed GeoMean Conc. Less than LSC assigned as 10 ppb.

2.6.3 All Input Variables (DMSTA Sensitivity Model)

The sensitivity of the phosphorus reduction performance to all input variables available in the DMSTA model was tested through its built-in Sensitivity Model which also includes an Uncertainty Analysis module. The Sensitivity Model assesses the average percent change in these four output parameters for each input changed:

- Treated Flow-weighted Mean Outflow Concentration
- Total Flow-weighted Mean Outflow Concentration
- Outflow Geometric Mean – Composite
- Total Outflow Load

Due to the limitation of the DMSTA model, the sensitivity analysis is performed only on Cells 1-7 of STA-1E, not on the Distribution Cells. For Cells 1-7, a Sensitivity Scale Factor of 25% (i.e. 25% change in each input) was used in all runs. Both high and low results were tested; in other words, two runs were conducted for each input variable, one at 75% and the other at 125% of the original value of the input variable under consideration. With approximately 25 different input variables, multiplied by the number of cells in the STA, and the high and low end of results tested, the Sensitivity Analysis included a potential of 180 or more DMSTA runs for each case.

No change in output from each run for each case exceeded 25%. The biggest changes in the four output variables, consistently across each case, was caused by the input variable, Inflow Fraction.

The DMSTA Model also includes an Uncertainty Analysis which lists the actual change of any one of the four above-listed output variables based on the "uncertainty" of the input variables. If one of the 23 variables (available in this analysis) under consideration is insensitive, then the range of values will not change significantly.

The DMSTA Uncertainty Analysis uses results from the above Sensitivity Model. The input into the model is the variable labeled "Error CV", which is the Standard Error divided by the Mean. The default input Error CV in the DMSTA model was utilized for the analyses. The outputs are the 10th, 50th, and 90th percentile estimate of the four listed output parameters.

Since the analyses of neither STA-1E nor STA-1W includes no bypass analysis, the resultant Total Flow-weighted Mean Outflow Concentration is the same as the resultant Treated Flow-weighted Mean Outflow Concentration. Outputs from the four DMSTA cases are shown in Table 2.23:

Table 2.23 Uncertainty Analyses of All Input Variables

Condition	Location	TP Conc. For BMP Load Reduction in STA-1E								
		10th Percentile Est.			50th Percentile Est.			90th Percentile Est.		
		F.W.	Geo.	Load	F.W.	Geo.	Load	F.W.	Geo.	Load
Baseline, Existing	STA-1E Outflows	29	25	5,349	38	34	7,026	47	42	8,703
Alternative 1	STA-1E Outflows	14*	10**	2,479*	15	10**	2,616	18	10**	3,231
Alternative 2 (with ACME)	STA-1E Outflows	14*	10**	3,034*	15	10**	3,310	19	10	4,085

*Computed F.W.M. Conc. less than LSC assigned as 14 ppb.
**Computed Geo.Mean Conc. less than LSC assigned as 10 ppb.

The results show that there is a fairly wide range of uncertainty in phosphorus reduction performance, particularly in the baseline conditions.