Chapter 4A: STA Performance and Compliance

Working in conjunction with the Best Management Practices (BMPs) of the Everglades Agricultural Area (EAA) (discussed in the previous chapter), the Stormwater Treatment Areas (STAs) represent the second stage of a phosphorus removal treatment system for the northern Everglades. Four of the six STAs are fully operational and removing phosphorus that otherwise would have gone into the Everglades Protection Area. During Water Year 2001 (WY2001), STA-1W, STA-5 and STA-6 Section 1 treated over 219 cubic hectometers (177,100 acre feet) and removed over 24 metric tons of phosphorus, for an overall 65 percent removal rate. Two cells of STA-2 were fully operational in WY2001; however, dry conditions eliminated the need for significant flow-through operations. Drought conditions during Water Year 2001 were responsible for lower than anticipated average inflows to the STAs. Supplemental water deliveries were required to three of the STAs to maintain minimum water levels to ensure viability of the treatment vegetation. The composition of the vegetation communities in the STAs varies among the treatment cells, and is generally dominated by either cattail (*Typha sp*.) or submerged aquatic vegetation (SAV) and periphyton.

An overview of the STA operations, vegetation, phosphorus performance, water quality monitoring and permit compliance is presented in this section for each STA. Water quality parameters addressed include nutrients, dissolved oxygen, pesticides and mercury. This information is provided to document compliance with appropriate conditions of the Everglades Forever Act (EFA) and United States Environmental Protection Agency (USEPA) National Pollution Discharge Elimination System (NPDES) permits. Water quality monitoring within and downstream of the STAs demonstrated that the four STAs in operation are in full compliance with the State operating permits. A summary of STA operations and phosphorus removal is presented in **Table 4A-1**. Appendices provide additional details of the monitoring program required by State operating permits.

STA-1 EAST UPDATE

The construction of STA-1 East is being managed by the U.S. Army Corps of Engineers (USACE). Construction on the inflow and outflow pump stations commenced in May 2000, and these are on schedule for completion in July 2002 and February 2003, respectively. Award of the interior earthwork contracts was delayed for approximately nine months and is scheduled by October 2001. Completion of these contracts sufficient for startup operations is scheduled for July 2003. A schematic of STA-1 East is presented in **Figure 4A-1**.

Table 4A-1. Summary of STA Operations

STA	*Operational Status*	*Performance*	*Other Issues*
STA-1 East	Under construction by Corps of Engineers Scheduled for completion in 2003	No performance data yet	None identified
STA-1 West	Fully operational; in stabilization phase; 112 cubic hm (90,900 acre feet) treated in WY2001	10.5 metric tons of TP removed in WY2001; 71% load reduction; flow-weighted mean inflow TP concentration was 148 ppb; outflow concentration was 39 ppb	None identified
STA-2	Fully operational; in stabilization phase	Geometric mean of interior grab samples prior to flow-through was 19.5 ppb	Monitoring elevated mercury in Cell 1
STA-3/4	Under construction; scheduled for completion 10/2003	No performance data yet	None identified
STA-5	Fully operational; in stabilization phase; 71.8 cubic hm (57,300 acre feet) treated in WY2001	8.3 metric tons of TP removed in WY2001; 53% load reduction; flow-weighted mean inflow TP concentration was 231 ppb; outflow concentration was 105 ppb	SAV in Cell 1B is still maturing
STA-6	Fully operational; in post-stabilization phase; 35.7 cubic hm (28,900 acre feet) treated in WY2001	5.6 metric tons of TP removed in WY2001; 83% load reduction; flow-weighted mean inflow TP concentration was 138 ppb; outflow concentration was 31 ppb	None identified

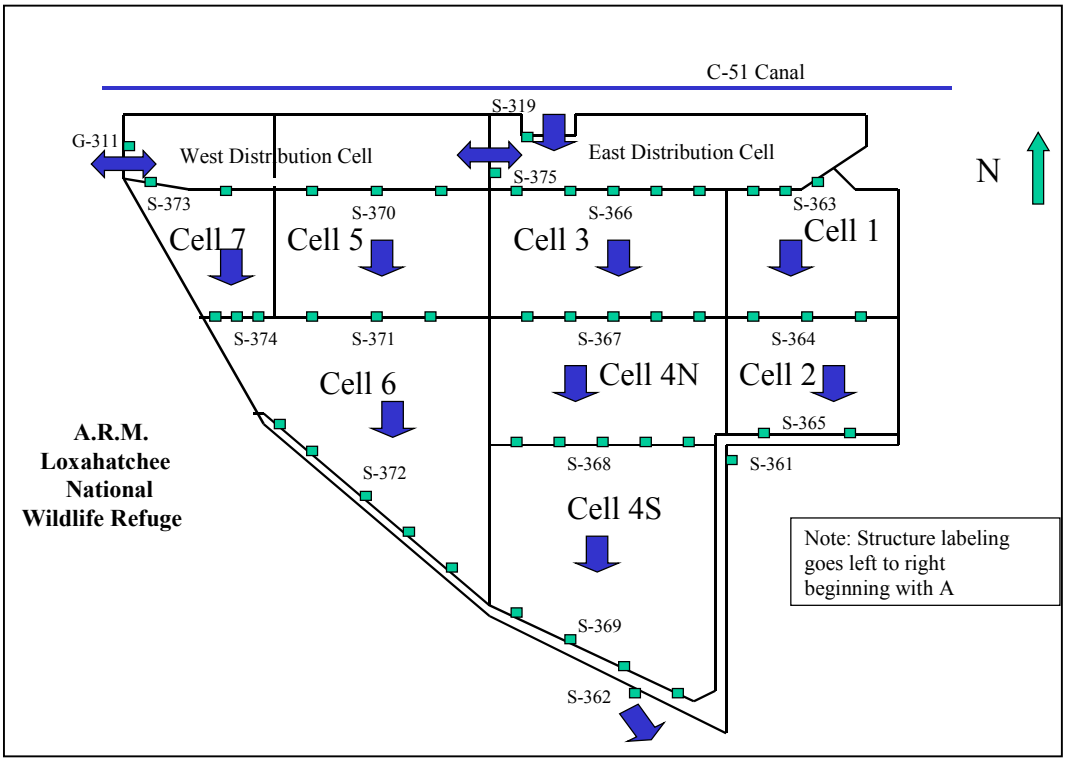


Figure 4A-1. Schematic of STA-1 East (not to scale)

STA-1 WEST

STA-1W OPERATIONS

STA-1W contains approximately 6,670 acres of effective treatment area, arranged in three flow-ways. The eastern flow-way contains Cells 1 and 3, with an effective treatment area of approximately 2516 acres. The western flow-way contains Cells 2 and 4, with an effective treatment area of approximately 1300 acres. The northern flow-way (Cell 5) consists of approximately 2855 acres. In addition, STA-1W includes the STA-1 Inflow Basin, with inflow pump station S-5A, and four gated spillways that allow tremendous operational flexibility. Inflows into STA-1W from the S-5A pump station were directed into STA-1W (Cells 1 through 4) via the G-302 and G-303 structures and into the northern flow way (Cell 5) via the G-302 and G-304A-J structures (**Figure 4A-2**). Full flow-through operations through Cells 1 through 4 as part of STA-1W have occurred since permit issuance in May 1999 and through Cell 5 since July 2000. Cells 1 through 4 had operated from August 1994 to May 1999 when these cells were part of the old Everglades Nutrient Removal Project. Accordingly, treated water from STA-1W has been discharged into the Arthur R. Marshall Loxahatchee National Wildlife Refuge (Refuge) via the G-251 pump station during the reporting period, and only through G-310 since July 2000. Most of the discharge from STA-1W in the past year was directed through Cells 1 through 4.

During the drought, the STA-1 Inflow Basin structures were operated to move water into and out of the Refuge for water supply purposes. For the year, approximately 226 cubic hectometers (183,000 acre feet; 1 cubic hectometer=1,000,000 cubic meters=810.7 acre feet) were pumped by S-5A into the Inflow Basin. A net of approximately 81.4 cubic hectometers (66,000 acre feet) was delivered to the L-8/C-51 canals from the Inflow Basin via S-5AS. In addition, a net of 11.8 cu-

bic hectometers (9,600 acre feet) entered the Inflow Basin via G-300, and a net of 35.8 cubic hm (29,000 acre feet) was delivered to the Refuge via G-301. The cumulative WY2001 discharge to the STA-1W treatment cells via G-302 was approximately 100 cubic hm (81,300 acre feet), equal to an average hydraulic loading rate of 1.02 cm/d over the effective treatment area of the STA.

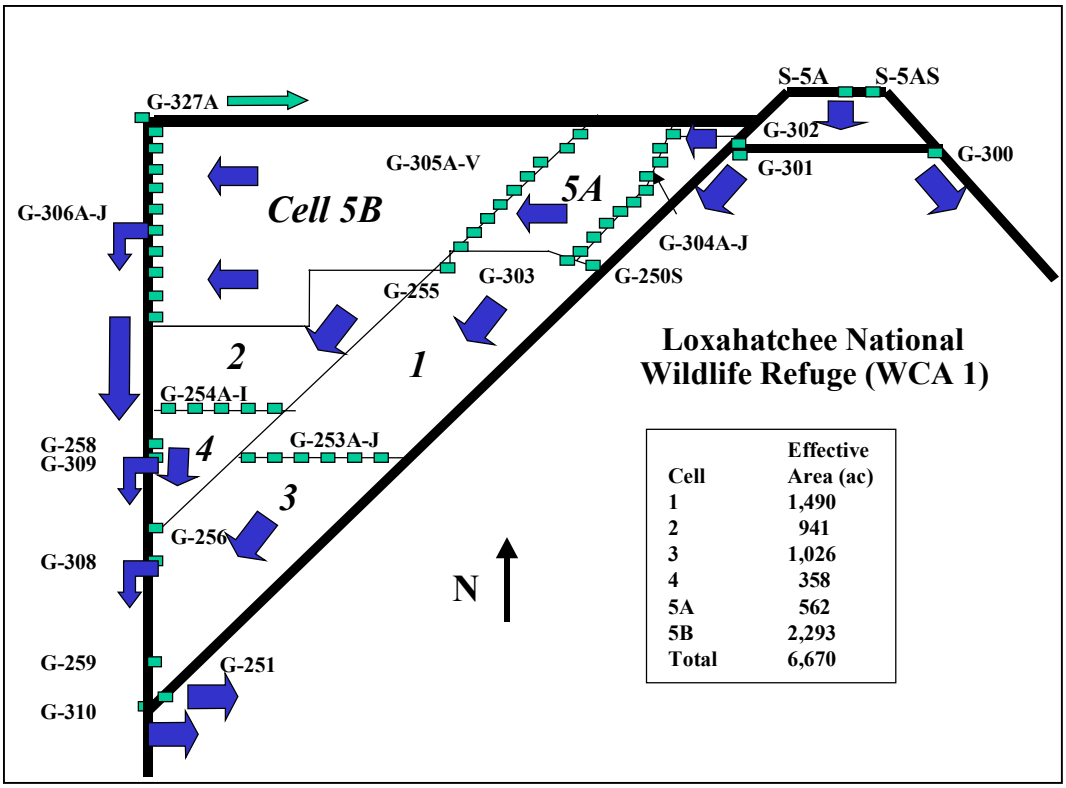
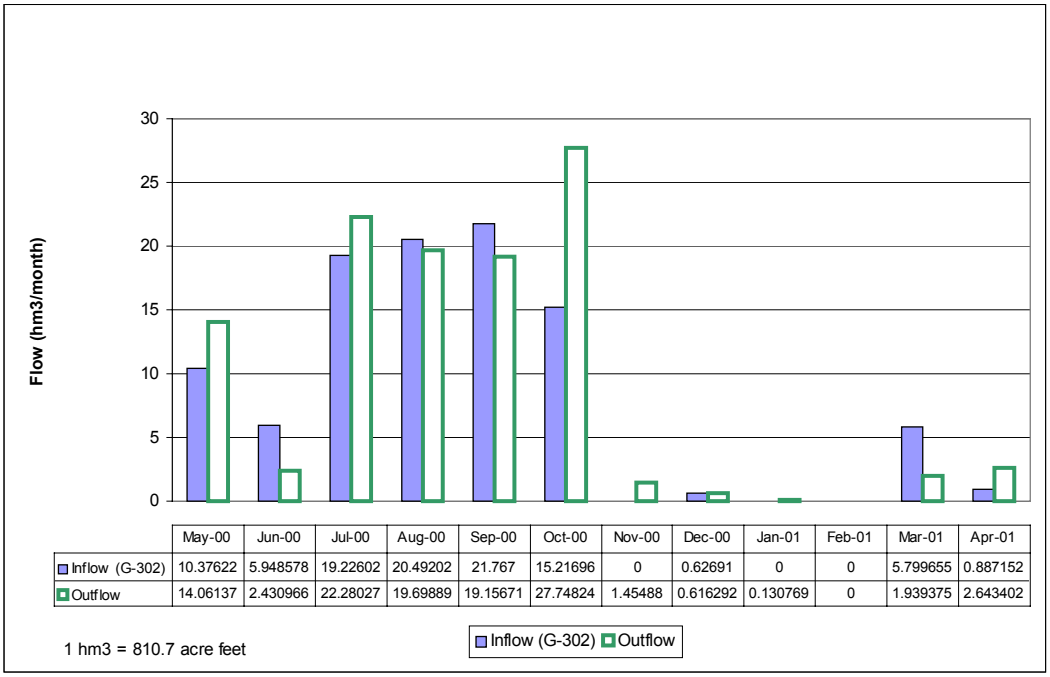


Figure 4A-2. Schematic of STA-1 West (not to scale)

Operations within the treatment area of STA-1W over the past year were also influenced significantly by the drought. With the exception of one storm event and minimal seepage control, both discharge pump stations remained idle for the duration of the dry season, as water levels remained below discharge triggers. The annual volume of treated water discharged to the Refuge was 112 cubic hectometers (90,900 acre feet), or about 50 percent of the anticipated average annual flow for the treatment area. The difference between the inflow and outflow volumes reflects the net contributions of direct rainfall, evapotranspiration (ET), seepage from the Refuge, seepage losses to the adjacent lands and deep percolation. Interior stages were also well below annual averages, although there appear to be no adverse impacts to any of the plant communities. A summary of monthly flows is presented in **Figure 4A-3**.

Cells1 through 4 also experienced markedly lower flow through as a result of the drought and was in a water conservation mode for much of the reporting period. In recognition of their resiliency to dry out, water levels were allowed to drop below ground for brief periods during the drought. Water is conserved in the wetland when deemed necessary to protect the plant communities and help maximize phosphorus removal performance upon returning to flow-through conditions



	May-00	Jun-00	Jul-00	Aug-00	Sep-00	Oct-00	Nov-00	Dec-00	Jan-01	Feb-01	Mar-01	Apr-01
Inflow (G-302)	10.37622	5.948578	19.22602	20.49202	21.767	15.21696	0	0.62691	0	0	5.799655	0.887152
Outflow	14.06137	2.430966	22.28027	19.69889	19.15671	27.74824	1.45488	0.616292	0.130769	0	1.939375	2.643402

Figure 4A-3. STA-1W Monthly Flows

Treatment Cell 5 makes up the northern flow path in STA-1W and is currently within its stabilization period after having demonstrated net improvement in reductions in phosphorus and mercury. Water levels were managed to promote an SAV community by maintaining a minimum depth of 15 cm during the drought. This required emergency water deliveries as authorized by the District's Governing Board during the drought to protect the developing plant community. However, there has been virtually no discharge from this cell during the reporting period.

STA-1W VEGETATION

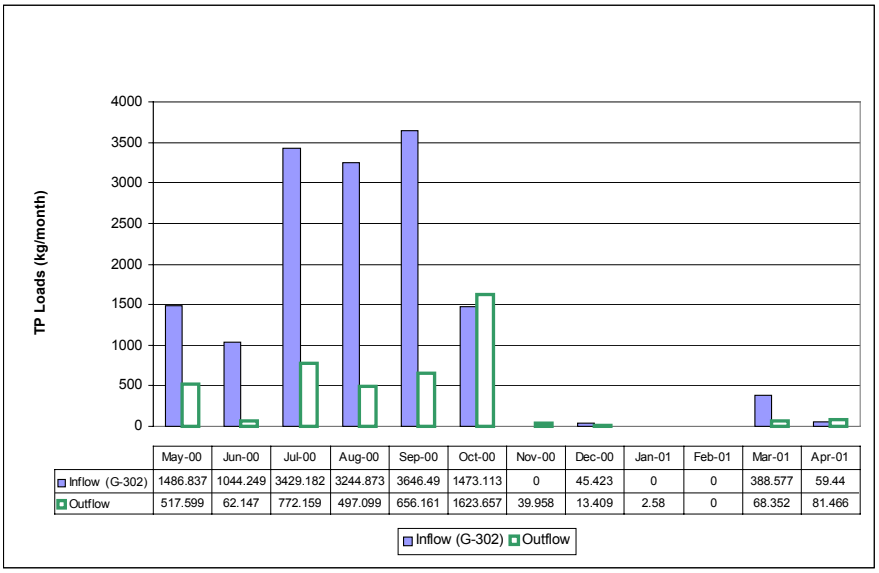
The composition of the plant communities in STA-1W varies among the five treatment cells in the project, but is generally dominated by either cattail (*Typha sp*.) or submerged aquatic vegetation (SAV) and periphyton. Cell 1 is cattail dominated but has significant amounts of SAV and periphyton also. Other notable plant species in Cell 1 include leather fern (*Acrostichum sp*.) and Carolina willow (*Salix caroliniana*). Cell 2 is cattail dominated but also supports a large coverage of SAV and periphyton. Cell 3 is dominated by cattail, but still contains a mosaic of native wetland plant species that were planted during the construction of the ENR Project. Cell 4 is an SAV and periphyton cell by design and any emergent plant species are subject to control methods using appropriate herbicides. Cell 5A is managed as an emergent marsh and is dominated by cattail, while Cell 5B is an SAV and periphyton dominated cell.

Specific condition 27(e) of the EFA permit requires that this annual report include information regarding the application of herbicides to exclude and/or eliminate undesirable vegetation within the treatment cells. For this reporting period, the District applied a total of 633 gallons of

the Herbicide Rodeo, 28.5 gallons of Arsenal, and 79 gallons of various adjuvants (inert liquids) to control various nuisance vegetation. Both aerial and ground-based spray equipment was used to apply these herbicides.

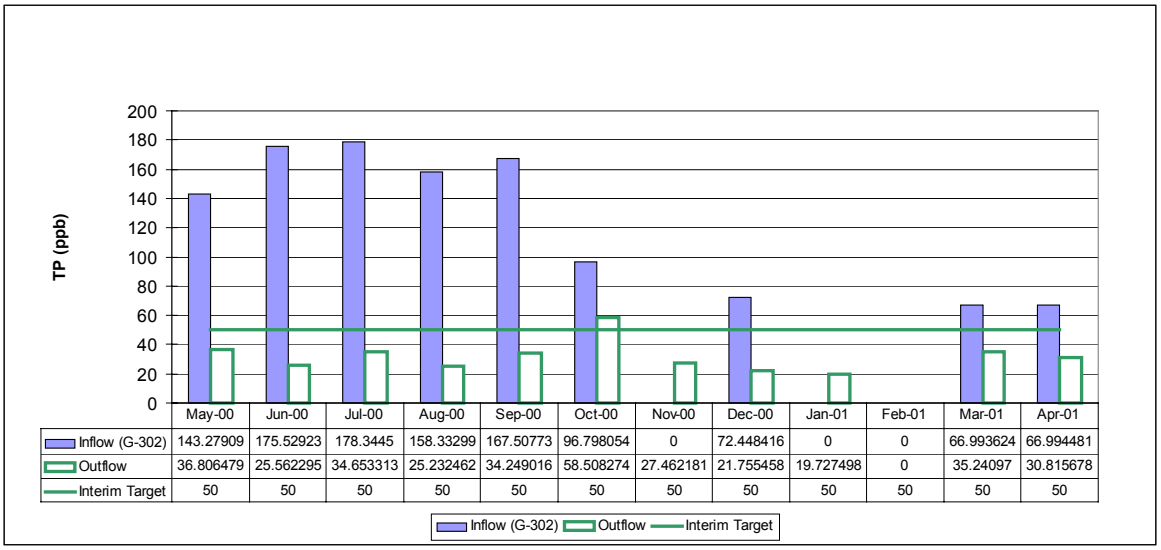
STA-1W PHOSPHORUS REDUCTION

Under the design objectives of the Everglades Forever Act, STA-1W continues to achieve its interim discharge goal of less than 50 parts per billion for total phosphorus. During WY2001, the STA received 14.8 metric tons of phosphorus, equating to a nutrient loading rate of 0.55 grams/square meter. Approximately 10.5 metric tons of TP were removed by STA-1W during WY2001. Monthly discharge concentrations were considerably lower than inflow concentrations, and between May 2000 and April 2001, STA-1W reduced discharge loads of total phosphorus by 71 percent compared to inflow loadings measured at G-302. A summary of monthly TP loads and flow-weighted mean TP concentrations are presented in **Figures 4A-4** and **4A-5**. The flow-weighted mean outflow concentration was 39 ppb, a 74 percent reduction from the inflow concentration of 148 ppb measured at G-302.



	May-00	Jun-00	Jul-00	Aug-00	Sep-00	Oct-00	Nov-00	Dec-00	Jan-01	Feb-01	Mar-01	Apr-01
Inflow (G-302)	1486.837	1044.249	3429.182	3244.873	3646.49	1473.113	0	45.423	0	0	388.577	59.44
Outflow	517.599	62.147	772.159	497.099	656.161	1623.657	39.958	13.409	2.58	0	68.352	81.466

Figure 4A-4. STA-1W Monthly TP Loads



	May-00	Jun-00	Jul-00	Aug-00	Sep-00	Oct-00	Nov-00	Dec-00	Jan-01	Feb-01	Mar-01	Apr-01
Inflow (G-302)	143.27909	175.52923	178.3445	158.33299	167.50773	96.798054	0	72.448416	0	0	66.993624	66.994481
Outflow	36.806479	25.562295	34.653313	25.232462	34.249016	58.508274	27.462181	21.755458	19.727498	0	35.24097	30.815678
Interim Target	50	50	50	50	50	50	50	50	50	50	50	50

Figure 4A-5. STA-1W TP Concentrations Flow-weighted Means

STA-1W Cell 5 began startup operations in March 1999, when it was initially flooded. On February 3, 2000, the District provided the Department with appropriate data that demonstrated Cell 5 had achieved a net reduction in TP, THg and MeHg in accordance with EFA and NPDES permit startup requirements. At that time, Cell 5 began the stabilization phase of operation.

All permit criteria that allow discharges to begin were met by February 3, 2000, but the G-310 outflow pump station was not commissioned until October 2000. Pumping by G-310 prior to October was associated with pump tests. This factor, combined with water conservation needs due to drought conditions, resulted in minimal discharges from Cell 5 during this reporting period. Water levels in Cell 5 were maximized to promote the growth of a submerged aquatic vegetation (SAV) community and discourage the growth of cattails and other emergent plants. This required an emergency water delivery during the drought, which was authorized by the District's Drought Contingency Board.

STA-1 WEST PERMIT COMPLIANCE MONITORING

The data presented in this section demonstrate that STA-1W was in compliance with the EFA and NPDES operating permits for this reporting period and that discharges do not pose any known danger to public health, safety, or welfare. Specific Condition 14(C) of the EFA permit states that STA-1W will remain in the stabilization phase of operation until STA-1E and STA-2 begin flow-through operations. At this time, STA-2 has begun flow-through operations but STA-1E is not expected to begin flow-through operations until 2003.

Total Phosphorus

Samples for Total Phosphorus (TP) have been collected for compliance purposes since the STA-1W Operating and NPDES permits were issued in May 1999. Permit compliance requires that outflow TP concentrations be reported as moving 12-month flow-weighted mean values. As shown in **Figure 4A-6**, TP values have been in compliance with permit conditions at the outflow pump stations for this entire reporting period. The moving 12-month flow-weighted mean TP outflow concentration for STA-1W ranged from 25 to 40 $\mu g\ L^{-1}$.

Non-Phosphorus Parameters With Class III Numeric Criterion

The only non-phosphorus parameter which has a Class III numeric criteria, and for which the outflow concentration did not meet the criterion, was DO. However, the administrative orders associated with the EFA and NPDES permits for STA-1W acknowledged that DO levels fluctuate naturally in marsh environments and routinely fall below the Class III water quality criterion of 5 $mg\ L^{-1}$. The administrative order requires the District to follow a process that will lead to either a revised state criterion for DO in marsh systems, a site specific alternative criterion, or some other form of moderating provision to state criterion and is discussed in the following section.

Non-Phosphorus Parameters Without Class III Numeric Criterion

In addition to TP, the EFA permit requires monitoring and reporting the annual average concentrations of non-phosphorus parameters. The compliance data for non-phosphorus parameters at STA-1W during this reporting period are shown in **Table 4A-2**. Total dissolved solids (TDS), dissolved chloride (Cl), and total dissolved nitrogen (TDN) are identified in **Table 4A-2** as having annual average outflow concentrations greater than their respective annual average inflow concentrations. TDS represents the sum of the concentrations of anions and cations, such as sodium (Na), potassium (K), Ca, magnesium (Mg), Cl, sulfate (SO_4), nitrate (NO_3) and nitrite (NO_2). These ions are common in stormwater and their concentrations are directly related to flow volume. Since dissolved Cl and TDN constituents are components of TDS, their concentrations vary with changes in TDS concentration. The higher discharge concentrations of these parameters observed in **Table 4A-2** is attributed to evaporation, since there was very little discharge from STA-1W from November 2000 through April 2001. Nevertheless, because STA-1W is still in the stabilization phase, there is no net improvement requirement for non-phosphorus parameters, and the STA is in full compliance with the permit.

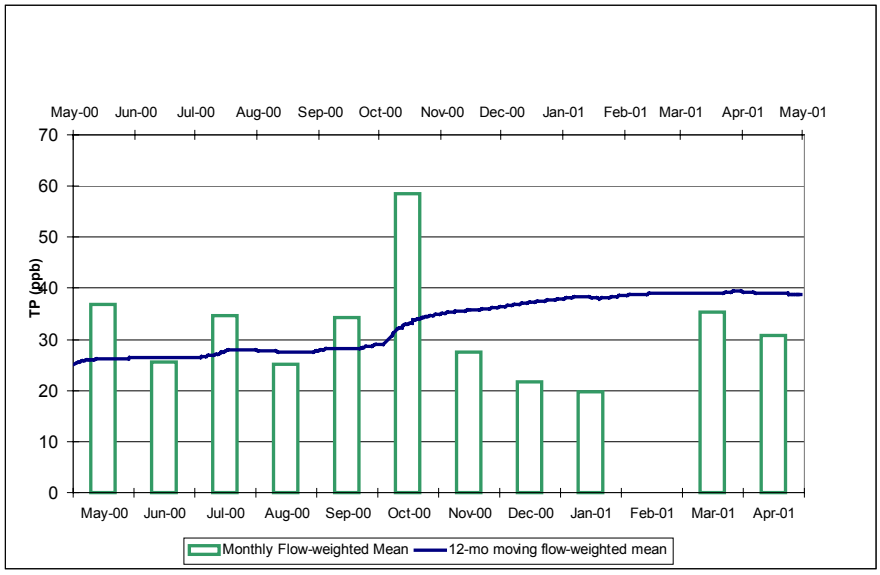


Figure 4A-6. STA-1W Discharge Concentrations Comparison of Monthly with 12-month Moving Average

Ametryn and atrazine concentrations were also greater in the outflows than the inflow (**Table 4A-2**). The quarterly sampling events upon which the ametryn annual average concentration was based indicated that only on May 25, 2000, outflow concentration at G-251 exceeded the inflow concentration. On August 23, 2000, the inflow concentration was greater than the outflow concentrations at G-251 and at G-310. For the November 8, 2000 and February 7, 2001 sampling events, all inflow and outflow concentrations were less than the Practical Quantification Limit (PQL). Quarterly results for atrazine indicated concentrations greater in the outflows than the inflow only on February 7, 2001. On May 25 and August 23, 2000, inflow concentrations were greater than outflow concentrations. Atrazine was not measured on November 8, 2000. Please note that both the frequency of detection and the concentration of ametryn and atrazine at the outflow stations were far below state action levels. Ametryn and atrazine have been measured in rain samples collected at the Atmospheric Deposition Tower located within STA-1W (personal communication from Richard Pfeuffer, Pesticide Program Manager, SFWMD). This information may explain why outflow concentrations periodically exceed inflow concentrations. These herbicides were not used for vegetation management at STA-1W, but are typically detected in areas with nearby intensive agricultural activity, such as in the EAA. STA-1W water quality data for the POR are provided in **Appendix 4A-1**.

Table 4A-2. Summary of annual arithmetic averages for all parameters other than total phosphorus monitored in STA-1W

Parameter	Class III Standards	Sampling Results		
		Inflow S5A	Outflow G251	Outflow G310
Temperature (°C)	N/A	24.6	24.2	25.5
Dissolved Oxygen (mg/L)	Greater than or equal to 5.0 mg/L	4.5	2.6	3.1
Specific Conductivity (µmhos/cm)	Not greater than 50% of background or greater than 1,275 µmhos/cm	963	1,106	1,104
pH	Not less than 6.0 and not greater than 8.5	7.5	7.5	7.4
Turbidity (NTU)	Less than or equal to 29 NTU above background conditions	9.8	3.0	8.8
Total Dissolved Solids (mg/L)	N/A	612	691	678
Unionized Ammonia (mg/L)	Less than or equal to 0.02 mg/L	0.003	0.002	0.006
Orthophosphate as P (µg/L)	N/A	48	7	6
Total Dissolved Phosphorus (µg/L)	N/A	57	12	9
Sulfate (mg/L)	N/A	62.7	53.6	47.5
Alkalinity (mg/L)	Not less than 20 mg/L	123	145	153
Dissolved Chloride (mg/L)	N/A	134	158	155
Total Nitrogen (mg/L)	N/A	2.77	2.53	2.70
Total Dissolved Nitrogen (mg/L)	N/A	2.25	2.32	2.50
Nitrate + Nitrite (mg/L)	N/A	0.329	0.013	0.040
Ametryn (µg/L)	N/A	0.043	0.043	0.048
Atrazine (µg/L)	N/A	0.176	0.181	0.122

Dissolved Oxygen Monitoring

INTRODUCTION

Dissolved oxygen concentrations fluctuate naturally in marsh environments such as the Everglades and routinely fall below the Class III water quality criterion of 5 mg L^{-1}. The STAs also experience natural fluctuations in DO that routinely fall below 5 mg $L^{-1,}$ as was observed in DO data collected in the ENRP (ENR Monitoring Report Appendices, 1995 to 1998). The Department recognized the phenomenon of fluctuating DO concentrations in the EFA permits issued to the District for STA-1W (Administrative Order No. AO-002-EV in Exhibit C of Permit No. 503074709, April 13, 1999) and STA-5 (Administrative Order No. AO-004-EV in Exhibit C of Permit No. 0131842, February 29, 2000). To address DO in STA discharges, Section II of the administrative orders requires the District to provide the Department in an annual report an analysis demonstrating that DO levels in STA discharges do not adversely change the downstream Everglades ecological or downstream water quality based on the following:

- Comparison of DO levels in STA discharges with background conditions in receiving waters
- Evaluation of DO levels at representative interior Everglades marsh stations, demonstrating that STA discharges fully maintain and protect the existing designated uses of the downstream waters and the level of water quality consistent with applicable anti-degradation requirements
- Evaluation of whether discharges are necessary or desirable and otherwise in the public interest
- Depiction of the daily and seasonal diel cycles for STA DO discharges during the period covered by the STA annual report
- Comparison of STA effluent with other historic DO data from the Everglades Protection Area (EPA), including data from interior marsh stations within the Loxahatchee Refuge (STA-1W), the Rotenberger Tract (STA-5) and any other locations downstream of the STA discharges
- Consideration of the influences of temperature, seasonal weather conditions, aquatic community type and hydropattern upon the diel cycle of the STA discharges.

METHODS

To evaluate compliance with the above requirements, the District developed the following plan. When STA-1W begins routine flow-through operations, i.e., discharges occurring through both G-251 and G-310, the District will measure DO concentrations with Hydrolab™ DataSonde® or MiniSonde® probes at 30-minute intervals for four consecutive days on a quarterly basis at the following locations:

- On the south side of the C-51 Canal upstream of S-5A
- Downstream of the G-251 and G-310 discharge structures
- At sites along the X, Y and Z transects in the periphery of the interior Arthur R Marshall Loxahatchee National Wildlife Refuge marshes downstream of the combined discharges (**Figure 4A-7**).

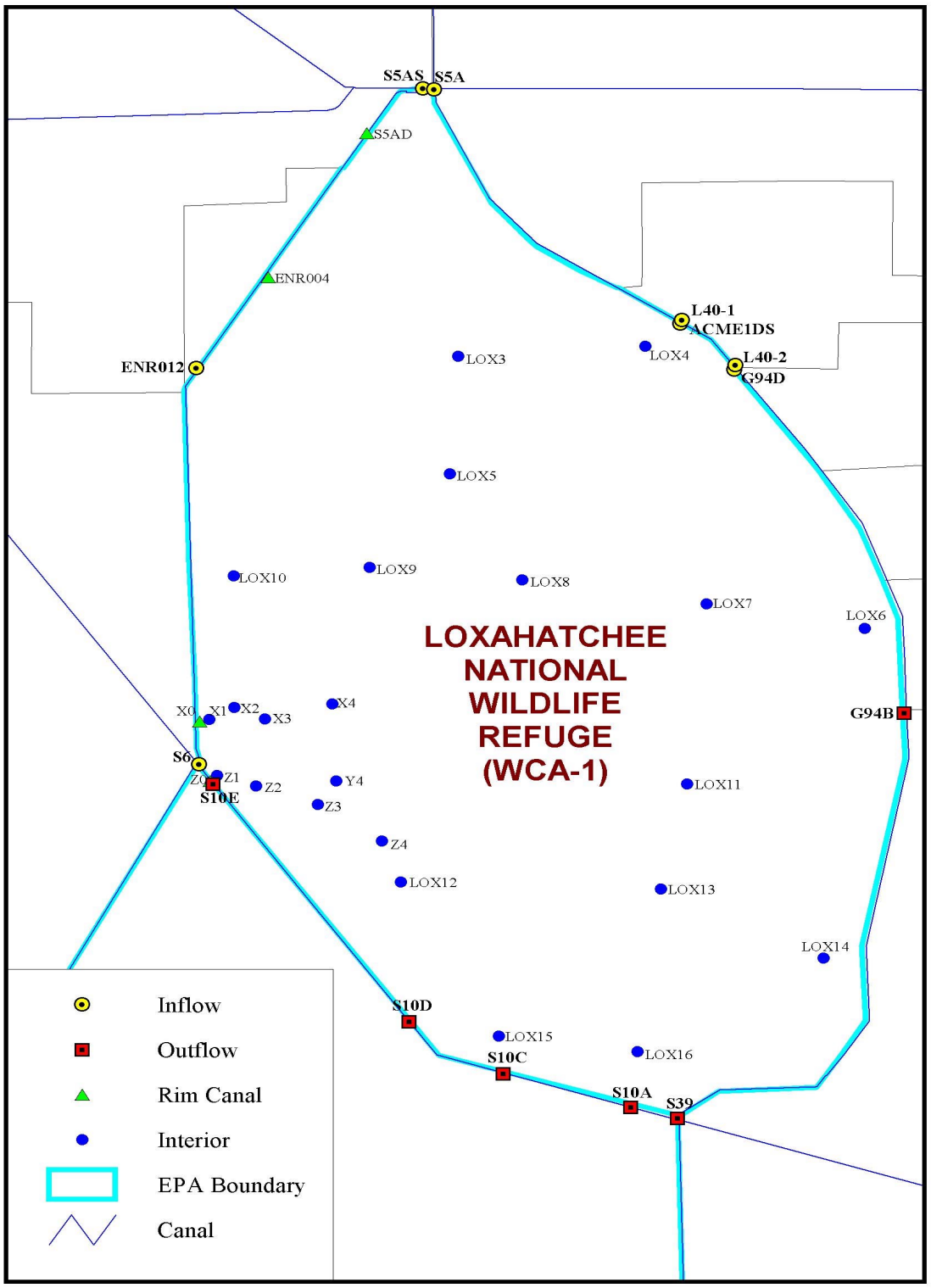


Figure 4A-7. Location and classification of water quality monitoring stations in the Arthur R. Marshall Loxahatchee National Wildlife Refuge

The EFA permit for STA-1W became effective on May 11, 1999. Discharges from STA-1W continued through pump station G-251 while the G-310 pump station was being constructed. Routine flow-through operations began with the startup of G-310 on July 5, 2000. Therefore, only G-251 was used for DO analysis prior to this date. Diel oxygen measurement dates and sites are provided in **Table 4A-3**.

Table 4A-3. Deployment dates for diel oxygen measurements at STA-1W structures and associated downstream marsh sites

Event Dates		Structures		Transect Sites in the Refuge
Start	End	Inflow	Outflow	
08/24/1999	08/31/1999	S5AU	G251D	X1, X2, X3, X4, Z1, Z2, Z3, Z4, Y4
11/29/1999	12/05/1999	S5AU	G251D	X1, X2, X3, X4, Z1, Z2, Z3, Z4, (Y4)
01/31/2000	02/04/2000	S5AU	G251D	X1, X2, X3, X4, Z1, Z2, Z3, Z4, Y4
05/23/2000	05/26/2000	S5AU	G251D	X1*, X2*, X3*, X4*, Z1*, Z2*, Z3*, (Z4), {Y4}
08/25/2000	08/29/2000	S5AU	G251D G310	(X1), X2*, X3*, X4*, (Z1), Z2*, (Z3), Z4*, [Y4]
01/18/2001	01/25/2001	S5AU	G251D G310	----------
01/19/2001	01/26/2001	-------	-------	X1, X2**, X3**, X4**, Z1**, Z2**, Z3, Z4, Y4

Note:

( ) = Site not sampled.

[ ] = Complete data set flagged (i.e., post-calibration of probes out of tolerance).

COMPARISON OF DISSOLVED OXYGEN IN STA-1W DISCHARGES WITH DISSOLVED OXYGEN AT DOWNSTREAM MARSH SITES

Comparisons of DO in STA discharges with downstream marsh sites provides an indication of whether the discharge is affecting the marsh DO concentration or the diel oxygen cycle. Statistical properties of DO and the other parameters measured with the hydrolab selected for comparison for each deployment were mean concentration, minimum concentration and standard deviation. The summary statistics for outflows and the Refuge transects are presented in **Table 4A-3**. Examination of this table shows that no DO data for G-251D were collected during the deployment periods prior to May 23, 2000. This was due to chronic malfunctioning of the DO probes. The same condition of no DO data existed for inflow monitoring station S-5AU through August 2000. In September 2000, a decision was made to remove the continuous monitoring hydrolabs at S-5AU, G-251D and G-310 and only deploy hydrolabs at these sites once per quarter for four days, in conjunction with the marsh transect diel oxygen monitoring program. Complete DO data sets were collected at S-5AU, G-251D and G-310 during the deployment periods thereafter were complete (**Appendix 4A-4**).

A statistical summary of all diel DO data collected at G-251D, G-310 and the marsh transect sites is presented in **Table 4A-4**. Notched box and whisker plots were created from the data in **Table 4A-4** to compare the DO concentrations of the discharges from G-251D and G-310 with the Refuge marsh transect sites (**Figure 4A-8**). The median DO concentrations in the discharges from STA-1W were significantly greater than the median DO concentrations at the Refuge sites, as shown in **Figure 4A-8**. The notched box plots also show that the DO concentrations in the Refuge significantly improve from the impacted sites near the L-7 rim canal (Z1 and X1) to the interior sites. The diel data for S5AU, G-251D, G-310 and the Refuge sites are presented in **Appendix 4A-4**.

Based on the data presented, it appears that the diel DO concentrations in the STA-1W discharges did not affect the low DO concentrations observed at marsh transect stations X1, X2, Z1 and Z2. The diel DO patterns observed at these transect sites are largely due to the long-term effects of TP loading. Ultimately, TP load reductions in STA-1W should improve DO conditions at these transect sites.

The District has included the following documentation to satisfy the remaining requirements of Specific Condition 27:

- District has performed all sampling and analysis under the latest Department-approved CompQAP No. 870166G (June 1999).
- A signed copy of this statement, prepared by Maxine Cheesman, Director of the Water Quality Monitoring Department, Division of Environmental Monitoring and Assessment, SFWMD, the individual responsible for implementation of the sampling program during this period is provided in **Appendix 4A-2**.
- A copy of STA water quality data associated with this POR is provided in **Appendix 4A-3**.

Table 4A-4. Statistical summary of diel dissolved oxygen at the outflow stations (G251D and G310) and transect stations in the Refuge during six deployment periods

Transect	Station	Number of Measurements	Mean	Minimum	Median	Maximum	Standard Deviation
Outflow	G251D	615	5.22	0.60	5.68	8.64	1.77
	G310	284	7.03	5.37	7.10	8.28	0.50
X	X1	1,274	1.31	0.00	0.91	12.51	1.64
	X2	1,138	1.66	0.04	1.22	9.05	1.57
	X3	1,137	2.63	0.09	2.12	8.97	1.84
	X4	1,132	3.85	0.16	4.10	9.44	2.15
Y	Y4	566	3.50	0.39	3.85	7.12	2.07
Z	Z1	879	0.39	0.13	0.17	2.57	0.47
	Z2	1,137	1.58	0.06	1.24	8.18	1.41
	Z3	1,276	3.91	0.09	4.00	8.43	1.90
	Z4	1,330	2.74	0.20	2.41	7.92	1.88

See Appendix 4A-25 for statistical summaries by event and diel parameter.

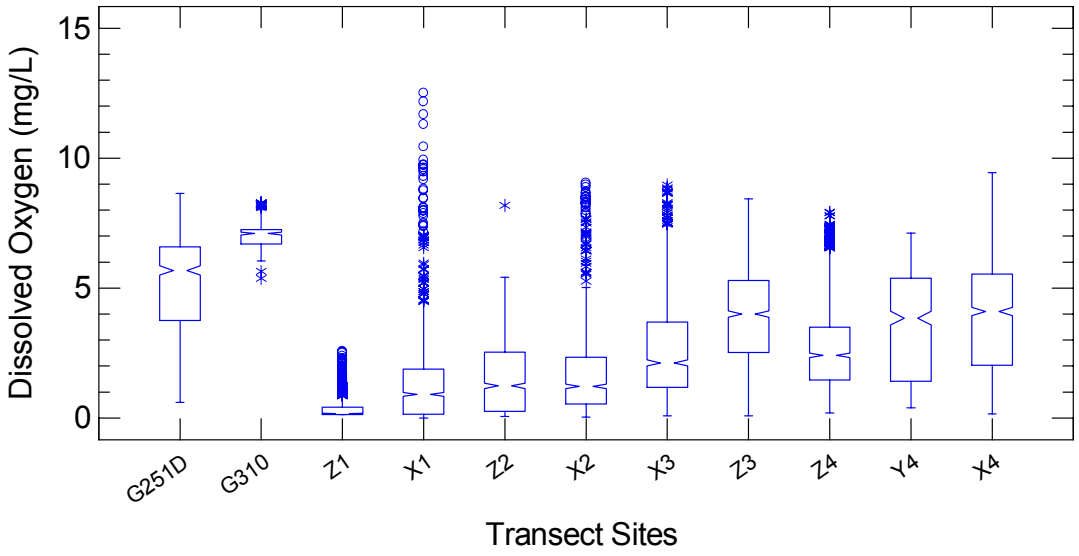


Figure 4A-8. Notched-box and whisker plots of diel dissolved oxygen measurements at STA-1W outflow stations and along transect sites in the Refuge during six monitoring periods The notch on a box plot represents the 95-percent confidence interval about the median, which is represented by the narrowest part of the notch. The top and bottom of the box represent the 75th and 25th percentiles, respectively. The whiskers represent the highest and lowest data values that are within two standard deviations of the median. Values above and below the whiskers are greater than two standard deviations from the median. Notches that do not overlap indicate that the data represented by the boxes being compared are significantly different at the 95-percent confidence level.

STA-2

STA-2 OPERATIONS

STA-2 contains approximately 6,430 acres of effective treatment area, arranged in three parallel flow-ways. The eastern flow-way (Cell 1) consists of approximately 1990 acres of effective treatment area.. The center flow-way (Cell 2) consists of approximately 2220 acres of effective treatment area. The western flow-way (Cell 3) consists of approximately 2220 acres of effective treatment area. A schematic of STA-2 is presented in **Figure 4A-9**. Water enters the STA from the S-6 and G-328 pump stations, is distributed by the inflow canal across the north end of the treatment cells, and flow via gravity south through the three treatment cells. Treated water is collected and discharged to WCA-2A via the G-335 outflow pump station. Discharges are directed to areas within WCA-2A that are already impacted by elevated nutrient levels.

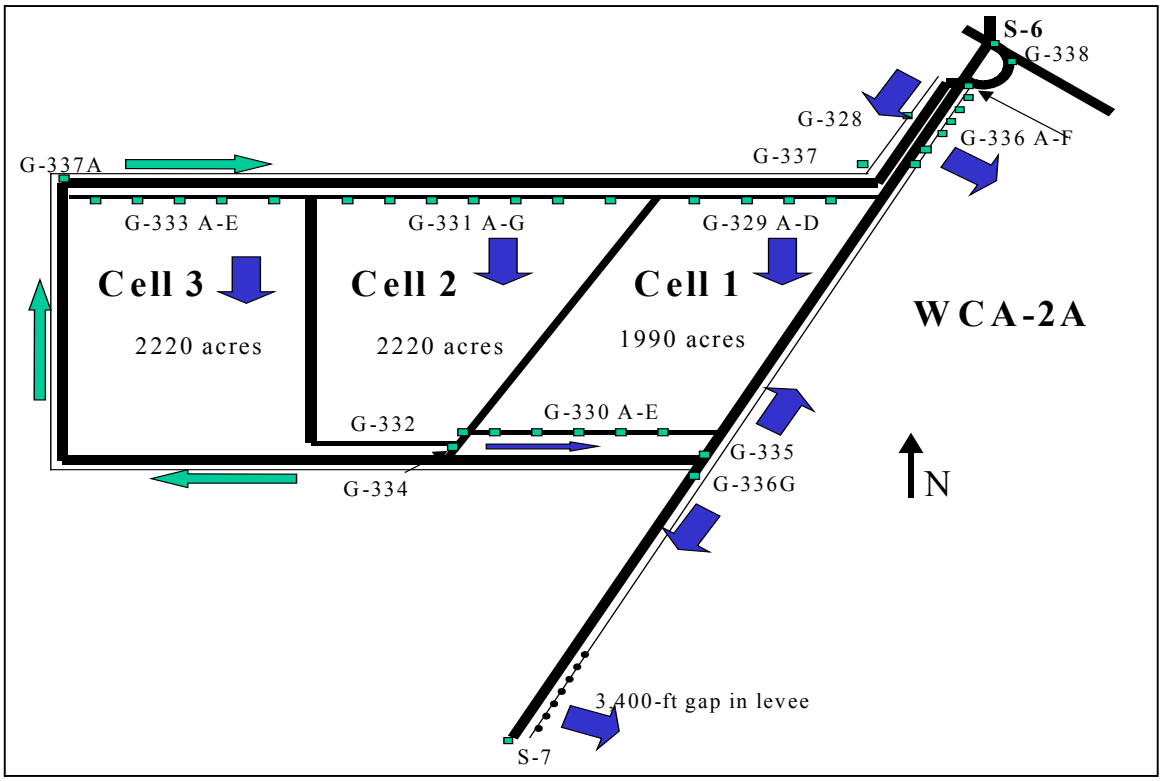


Figure 4A-9. Schematic of STA-2 (not to scale)

Startup operations for STA-2 began upon the completion of the three treatment cells in 1999. Inflow to the STA commenced in June 1999 from the 450-cfs pump station G-328, and water levels were maintained for optimal growth of desired vegetation. Construction of the 3,040-cfs outflow pump station (G-335) was completed in 2000, with final operational testing taking place in October 2000. The final construction component, connection of the S-6 pump station to the Inflow Canal, was completed during the dry season 2001, a schedule that minimized the potential down time of pump station S-6.

Due to drought conditions during this reporting period water levels in the cells were not sufficient to trigger release from any discharge structures. However, during the drought, supplemental water deliveries were made to the STA in order to maintain minimum depth of approximately 15 cm in Cell 3, a level required to ensure the viability of the submerged aquatic vegetation in the cell. Cells 1 and 2 are dominated by sawgrass communities, which are thought to be resilient to drought conditions, and therefore, did not receive supplemental water.

STA-2 VEGETATION

Due to the extreme drought conditions, water levels in STA-2 were managed to protect the established wetland plant community within each treatment cell. Cells 1 and 2 in STA-2 are dominated by emergent vegetation such as sawgrass (Cladium jamaicense) with some cattail (Typha sp.). These species are more tolerant to dryout than the submerged aquatic vegetation (SAV) in Cell 3. Seepage from pump station G-337 was directed primarily to Cell 3 to protect the SAV. As in Cells 4 and 5 of STA-1W, water levels Cell 3 of STA-2 were operated to encourage SAV colonization and discourage the spread of cattail.

Specific Condition 27 of the EFA permit also requires the District to report information regarding the application of herbicides and pesticides used to control undesirable vegetation and pests within the project. For this reporting period, 750 gallons of the Herbicide Rodeo, 1000 gallons of the herbicide Garlon 3A and 216 gallons of various adjuvants (inert liquids) were applied in STA-2 to control old world climbing fern (Lygodium microphyllum), Brazilian Pepper (Schinus terebinthifolius) and other nuisance vegetation. All herbicides were applied using aerial spray equipment.

STA-2 PHOSPHORUS REDUCTION

The EFA and NPDES operating permits were issued for this project on September 29, 2000. Each treatment cell in STA-2 operates independently and the permit authorized discharges when net improvement in TP and mercury is demonstrated for each cell. STA-2 Cells 2 and 3 passed the net improvement startup test for TP and mercury on September 13, and November 9, 2000, respectively. STA-2, Cell 1 passed the startup test for TP but did not pass the startup criteria for Mercury. After review of the Cell 1 mercury situation with FDEP, EPA and other agencies, it was determined that the most effective way to reduce mercury concentrations in Cell 1 was to move as much water through the cell as possible in order to increase the sulfur levels. On August 9, the permit was modified to initiate flow-through operations for Cell 1.

Grab samples at the inflow and outflow sites at STA-2 are shown in **Figure 4A-10** for the water year. The TP concentrations at the downstream end of the cells (geometric mean of 19.5 ppb) was consistently lower than inflow TP concentrations since startup operation began.

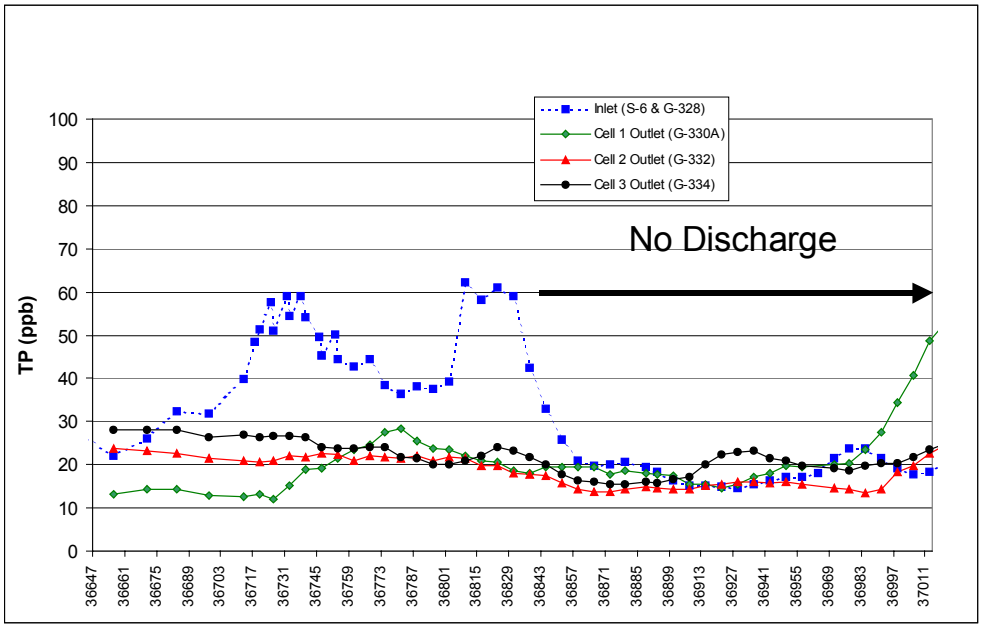


Figure 4A-10. STA-2 TP Concentrations 4-Week Geometric Means

STA-2 PERMIT COMPLIANCE MONITORING

Flow-through operations for STA-2 began in earnest with the onset of the 2001 wet season, subsequent to the reporting period of this *2002 Report*. A complete summary of water quality compliance will be provided in next year's *Report*.

STA-3/4

Construction on STA-3/4 commenced in November 2000 with the award of the inflow pump stations equipment contract. The initial construction contracts (Supply Canal and L-5 enlargement) were awarded in January 2001. In July 2001, the interior works contract and the US 27 bridges contract were awarded. The final construction contract was awarded in August 2001 for the construction of the inflow pump stations. All construction is scheduled to be completed by the October 1, 2003 date mandated by the Everglades Forever Act. STA-3/4 will use the existing S-7 and S-8 pump stations as the outflow facilities, and refurbishment of those stations is underway. Management of all construction dewatering and rainfall is directed at developing vegetation in the interior cells such that startup operations should begin several months before the October construction completion date. A schematic of STA-3/4 is presented in **Figure 4A-11**.

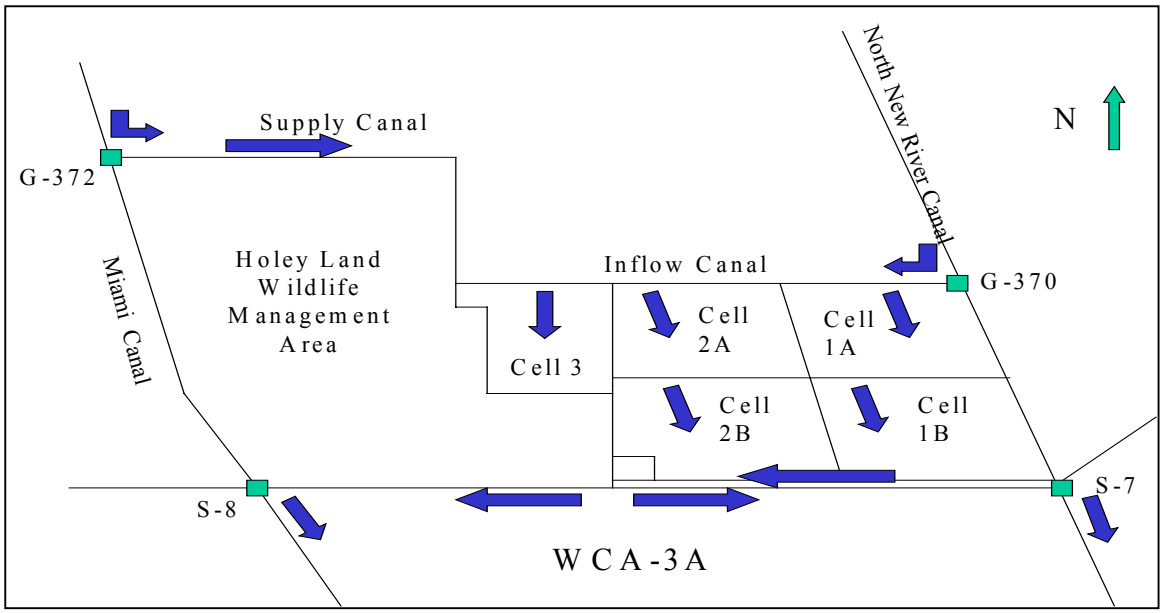


Figure 4A-11. Schematic of STA-3/4 (not to scale)

STA-5

STA-5 OPERATIONS

STA-5 contains approximately 4,110 acres of effective treatment area, arranged in two parallel flow-ways. The northern flow-way (Cells 1A and 1B) consists of approximately 2,055 acres of effective treatment area. The southern flow-way (Cells 2A and 2B) consists of approximately 2,055 acres of effective treatment area. A schematic of STA-5 is presented in **Figure 4A-12.** Water enters the STA from the west and flows by gravity through the treatment area to the east. Treated water is collected and discharged to the Miami Canal, where the majority moves south to the northwest corner of WCA-3A. A complete description of STA-5 is contained in Chapter 6 of the *2000 Everglades Consolidated Report.*

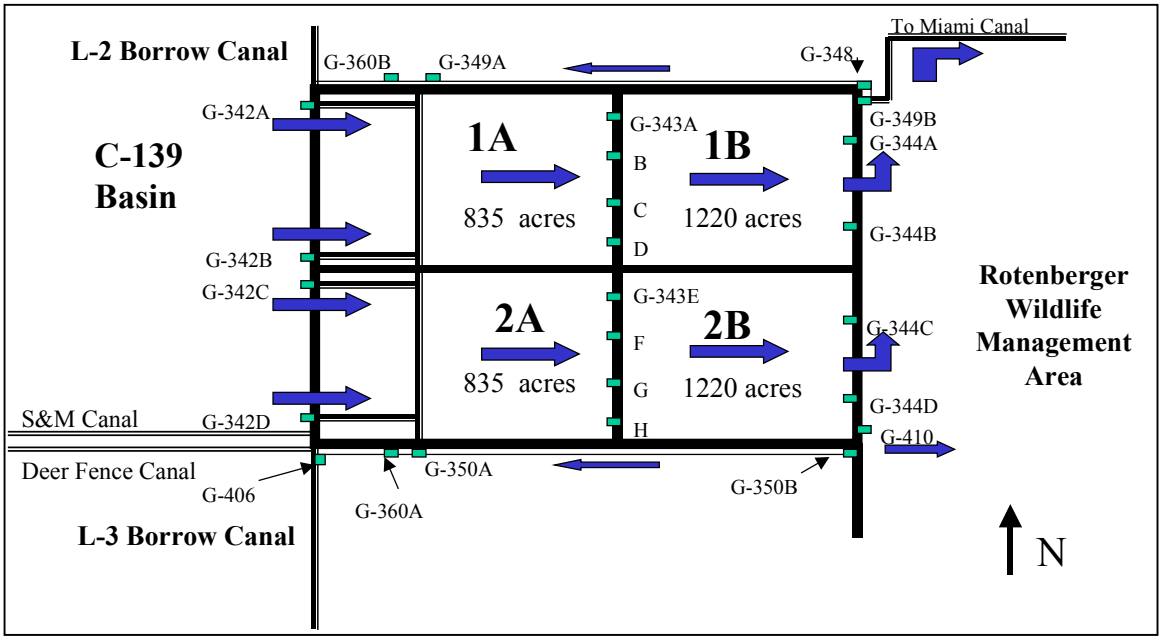
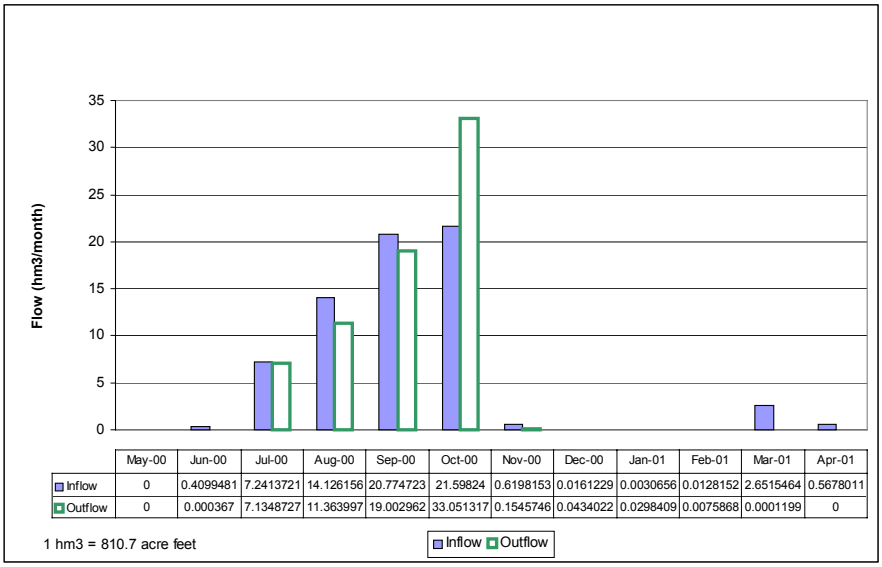


Figure 4A-12. Schematic of STA-5 (not to scale)

Operations at STA-5 over the past year were influenced significantly by a severe drought in South Florida. Three of the four treatment cells experienced two dry out periods where stage receded below average ground surface elevation. One treatment cell, Cell 1B was kept at a depth no less than six inches to protect a growing SAV community. This was accomplished by using a portable diesel pump that delivered an emergency supply of water from the STA-5 discharge canal and authorized by the District's Governing Board. Earlier attempts at directing water pumped into Cell 1A by the seepage return pump G-349A over to Cell 1B did not provide enough water to overcome the effects of evaporation and seepage into underlying soils. The annual volume of treated water discharged from STA-5 was 71.8 cubic hectometers (57,300 acre feet), or about 55 percent of the anticipated average annual flow for the treatment area due to drier than normal conditions. This surface inflow equates to an average hydraulic loading rate of 0.94 cm/d over the effective treatment area of the STA. A summary of monthly flow is presented in **Figure 4A-13**. Despite the severe drought, there appear to be no adverse impacts to any of the plant communities within STA-5.



	May-00	Jun-00	Jul-00	Aug-00	Sep-00	Oct-00	Nov-00	Dec-00	Jan-01	Feb-01	Mar-01	Apr-01
Inflow	0	0.4099481	7.2413721	14.126156	20.774723	21.59824	0.6198153	0.0161229	0.0030656	0.0128152	2.6515464	0.5678011
Outflow	0	0.000367	7.1348727	11.363997	19.002962	33.051317	0.1545746	0.0434022	0.0298409	0.0075868	0.0001199	0

Figure 4A-13. STA-5 Monthly Flows

STA-5 VEGETATION

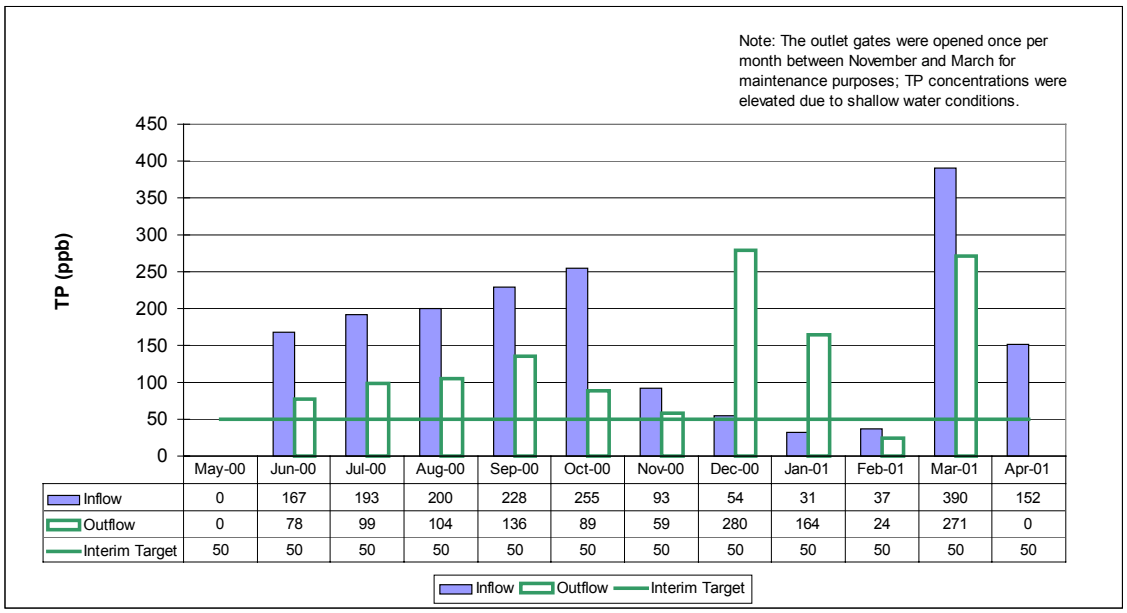
The composition of the plant communities within STA-5 is somewhat variable between the four treatment cells. Cell 1A is dominated by cattail (*Typha* sp.), but also contains significant amounts of primrose willow (*Ludwigia* sp.) and several panic grasses (*Panicum* sp.). The western quarter of Cell 1A has a much higher average ground elevation than the remainder of the cell and supports some notable upland plant species such as wax myrtle (*Myrica cerifera*) and elderberry (*Sambuca canadensis*). Cell 1B is managed as a submerged aquatic vegetation (SAV) and periphyton cell; any emergent plants are eliminated using appropriate herbicides. Cell 2A is dominated by cattail and primrose willow, but contains a significant coverage of smartweed (*Polygo-*

num sp.) and mixed grasses. Cell 2B is also cattail dominated with isolated areas occasionally occupied by water lettuce (*Pistia stratiotes*).

Specific condition 13(b) of the EFA permit requires that this annual report include information regarding the application of herbicides to exclude and/or eliminate undesirable vegetation within the treatment cells. For this reporting period, the District applied a total of 305 gallons of the Herbicide Rodeo and 51 gallons of various adjuvants (inert liquids) to control nuisance vegetation in STA-5. Both aerial and ground-based spray equipment were used to apply these herbicides.

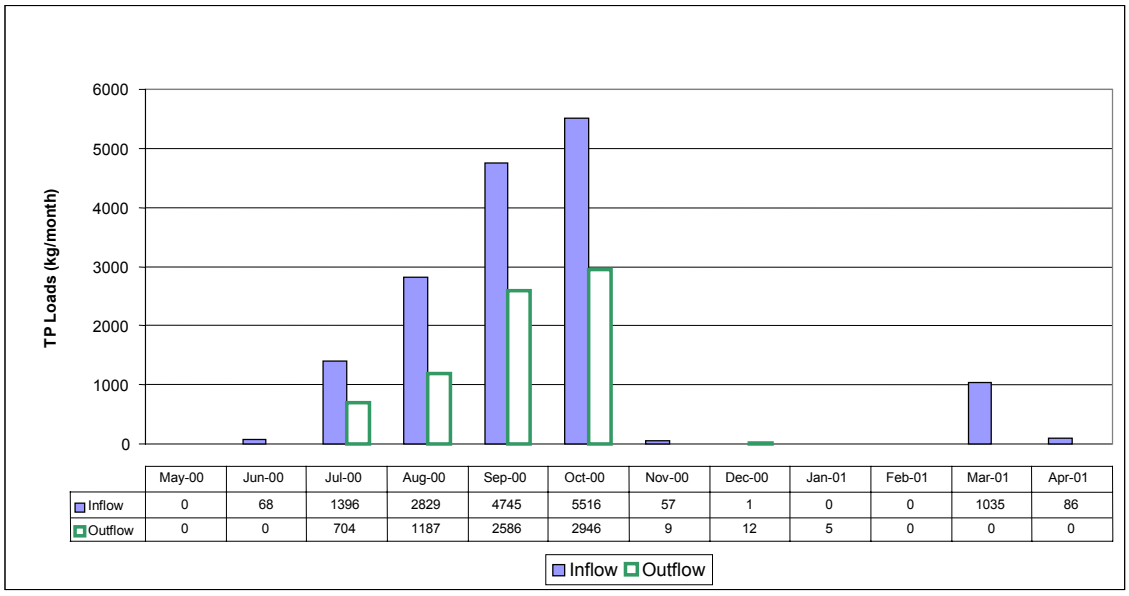
STA-5 PHOSPHORUS REDUCTION

During WY2001, the STA received 15.7 metric tons of phosphorus, equating to a nutrient loading rate of 0.94 grams/square meter. Approximately 8.3 metric tons of TP were removed by STA-5 during WY2001. Monthly discharge TP concentrations were considerably lower than inflow concentrations, and between May 2000 and April 2001, STA-1W reduced discharge loads of total phosphorus by 53 percent compared to inflow loadings. A summary of monthly TP loads and flow-weighted mean TP concentrations are presented in **Figures 4A-14** and **4A-15**. The flow-weighted mean outflow TP concentration was 105 ppb, a 55 percent reduction from the inflow concentration of 231 ppb. While the outflow concentration is above the 50 ppb interim target, the STA is still in the stabilization phase and improved TP reduction is anticipated in the future.



	May-00	Jun-00	Jul-00	Aug-00	Sep-00	Oct-00	Nov-00	Dec-00	Jan-01	Feb-01	Mar-01	Apr-01
Inflow	0	167	193	200	228	255	93	54	31	37	390	152
Outflow	0	78	99	104	136	89	59	280	164	24	271	0
Interim Target	50	50	50	50	50	50	50	50	50	50	50	50

Figure 4A-14. STA-5 Monthly TP Loads



	May-00	Jun-00	Jul-00	Aug-00	Sep-00	Oct-00	Nov-00	Dec-00	Jan-01	Feb-01	Mar-01	Apr-01
Inflow	0	68	1396	2829	4745	5516	57	1	0	0	1035	86
Outflow	0	0	704	1187	2586	2946	9	12	5	0	0	0

Figure 4A-15. STA-5 TP Concentrations Flow-weighted Means

STA-5 PERMIT COMPLIANCE MONITORING

Total Phosphorus

Samples for Total Phosphorus (TP) have been collected for compliance purposes since the operating permits were issued in February 2000. Permit compliance requires that outflow TP concentrations be reported as moving 12-month flow-weighted mean values, and these are shown in **Figure 4A-16**. The moving 12-month flow-weighted mean TP outflow concentration for STA-5 decreased from 150 to 105 µg L^{-1} over the course of WY2001. The 12-month flow-weighted average outflow TP concentration for STA-5 was 105 ppb during WY2001. Since the 12-month average is above 50 ppb, the project remains in the stabilization phase.

Nonphosphorus Parameters

Additionally, compliance analysis for all non-phosphorus parameters were not computed because 12 months of flow-through operational data needed to calculate annual averages for these parameters did not exist due to previously explained circumstances. Although STA-5 experienced limited flow-through operations for this reporting period, discharges from STA-5 do not pose any known danger to public health, safety, or welfare. All available STA-5 data are included in **Appendix 4A-27**.

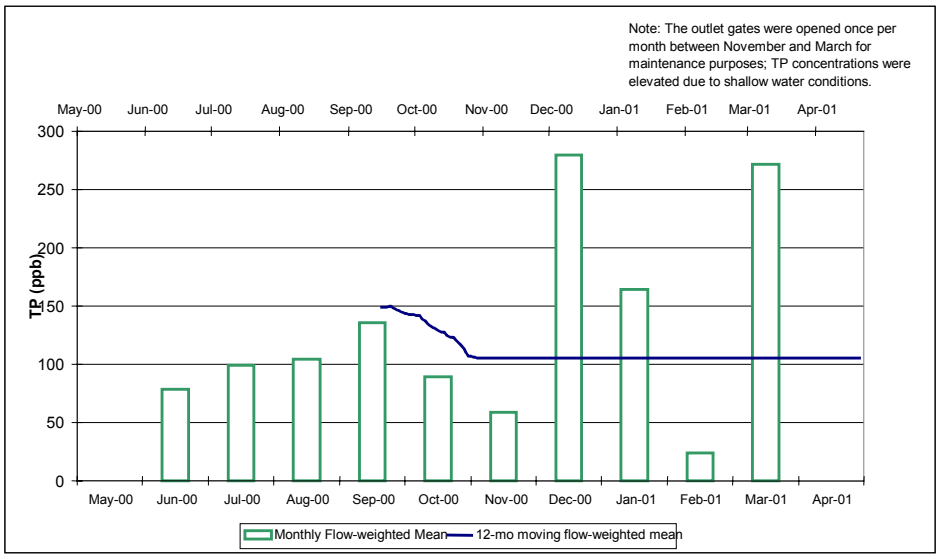


Figure 4A-16. STA-5 Discharge Comparison of Monthly with 12-Month Moving Average

Dissolved Oxygen Monitoring

SAMPLING LOCATIONS

The following plans were developed by the District to comply with the DO requirements of the administrative orders for STA-5. When STA-5 begins routine flow-through operations, i.e. discharge occurs through one or more of the G-344A-D spillway structures, the District will measure DO concentrations with Hydrolab™ DataSonde® or MiniSonde® probes at 30-minute intervals for four consecutive days on a quarterly basis at the following locations:

- Upstream of the four inflow structures G-342A-D
- In the discharge canal near structures G-344A and G-344D, to provide representative data whether the discharge is to the Miami Canal, the Rotenberger Tract through pump station G-410 or to both sites simultaneously (**Figure 4A-12**)
- Background conditions in the Miami Canal will be measured on the west bank upstream of the confluence of the Miami Canal and the STA-5 discharge canal
- Effects of STA-5 discharges to the Miami Canal will be measured on the west bank downstream of the confluence of the Miami Canal and the STA-5 discharge canal
- Effects of STA-5 discharges to the Rotenberger Tract will be measured at sites along the N and S transects within the Rotenberger Tract.

SAMPLING DATES

The STA-5 EFA permit became effective on February 29, 2000. Routine flow-through operations began in June 2000 for the southern flow-way and August 2000 for the northern flow-way. Diel oxygen measurement dates and sites are provided in **Table 4A-5**.

Table 4A-5. Deployment Dates for Diel Oxygen Measurement at STA-5 Structures and Associated Downstream Sites

Structure	Deployment Dates		Miami Canal Sites[1]	
	Start	End	Upstream	Downstream
G344A G344D	05/15/2000	05/18/2000	x	x
G344A G344D	08/14/2000	08/17/2000	x	x
G344A G344D	09/11/2000	09/14/2000	x	x
G344A G344D	10/30/2000	11/03/2000	x	x

[1] Deployment Dates for Diel Oxygen Measurement at STA-5 Structures and Associated Downstream Sites.

COMPARISON OF DISSOLVED OXYGEN IN STA-5 DISCHARGES WITH DISSOLVED OXYGEN AT DOWNSTREAM MIAMI CANAL SITES

Hydrolab instruments at STA-5 were deployed at discharge structures G-344A and G-344D and at Miami Canal stations about 100 meters upstream and downstream of the confluence with the STA-5 discharge canal (**Figure 4A-12**). The data collected are presented in **Appendix 4A-26**. Examination of these figures indicates that the discharge DO concentrations from G-344A and G-344D are not exactly the same and that the minimum and mean DO concentrations in water discharged from these structures tend to be less than the minimum and mean concentrations in the Miami Canal. The statistical data for structures and Miami Canal Stations are presented in **Table 4A-6**. Water released from the discharge structures mixes with water in the STA-5 discharge canal while in transit to the Miami Canal. Since the DO of the combined discharge was not measured, its effect on the Miami Canal DO concentrations could only be determined by a statistical comparison of DO at the upstream and downstream stations for each deployment period. The Wilcoxon Rank Sum Test was used for statistical analysis, since the DO data were not normally distributed. Results of the analysis indicate that the mean DO concentration at the downstream station was significantly greater than at the upstream station during the May and September 2000 deployments. During the August 2000 deployment, the downstream station DO concentrations were significantly less than at the upstream station. During the October through November 2000 deployment, there was no significant difference in DO concentrations between the stations (**Table 4A-6**).

Table 4A-6. Statistical summary of diel dissolved oxygen at the outflow stations from STA-5 and stations in the Miami Canal during four deployment periods.

Station	Number of Measurements	Mean	Minimum	Median	Maximum	Standard Deviation
G344A	619	3.45	0.14	2.45	8.94	2.34
G344D	617	2.27	0.03	2.31	7.72	1.55
Miami Canal Upstream	621	3.81	1.57	3.82	8.02	1.34
Miami Canal Downstream	623	3.87	1.74	3.68	8.42	1.35

See Appendix 4A-4, Table 3 for statistical summaries by event and diel parameter.

All DO data collected at the four monitoring sites during the deployments specified in **Table 4A-5** were compared using notched box and whisker plots (**Figure 4A-17**). This analysis indicates that both Miami Canal sites were significantly greater than the discharge sites and that no significant difference in DO concentration existed between G-344A and G-344D or between the upstream and downstream Miami Canal sites. The diel data for G-344A, G-344D and the upstream and downstream Miami Canal sites are presented in **Appendix 4-26.** Although there were only four deployment data sets to evaluate for this report, it appears that the STA discharges have not degraded DO conditions in the Miami Canal.

The District has included the following documentation to satisfy the remaining requirements of Specific Condition 28:

- The District has performed all sampling and analysis under the latest Department-approved CompQAP No. 870166G (June 1999).
- A signed copy of this statement prepared by Maxine Cheesman, Director of the Water Quality Monitoring Department, Division of Environmental Monitoring and Assessment, SFWMD, the individual responsible for implementation of the sampling program during this period is provided in **Appendix 4A-2**.
- A copy of STA water quality data associated with this POR is provided in **Appendix 4A-3**.

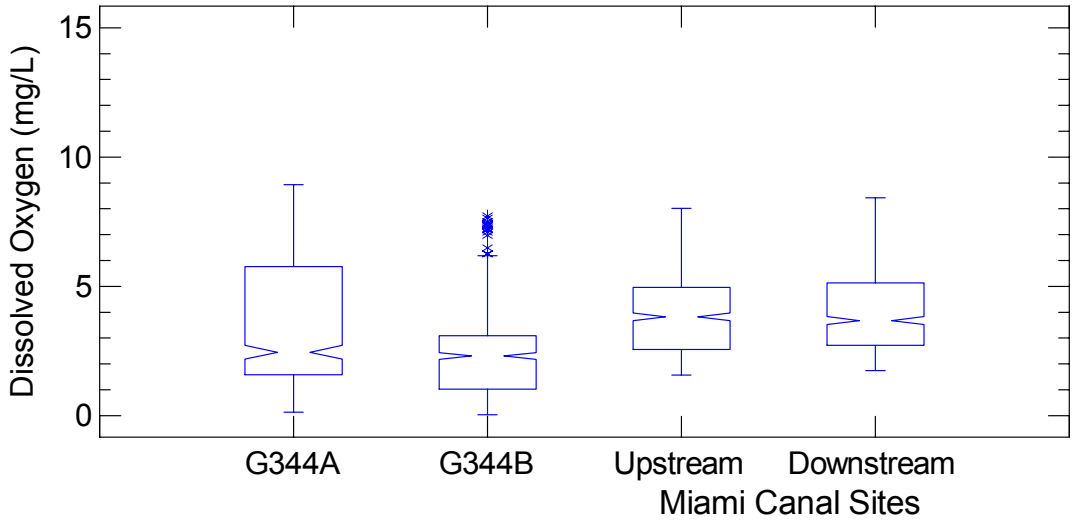


Figure 4A-17. Notched-box and whisker plots of diel dissolved oxygen measurements at STA-5 outflow stations (G344A and G344D) and at sites in the Miami Canal upstream and downstream of the discharge canal from STA-5. See **Figure 4A-8** for an explanation on how to interpret notched box and whisker.

STA-6, SECTION 1 (STA-6)

STA-6 OPERATIONS

The primary objective of this section is to provide an update of operations of STA-6 since last year's report and to document compliance with appropriate conditions of the EFA (FDEP No.262918309). Please refer to Chapter 6 of the 2000 and 2001 *Everglades Consolidated Reports* for a complete description of flow paths and site configuration for STA-6 (Chimney et al, 2000; and Nungesser et al., 2001). The permitted outflow compliance site was officially changed from G-606 to one outflow weir from each treatment cell. These sites are identified as G-354C and G-393B (**Figure 4A-18**). The data from G-606 ended February 2001 and results from the new outflow sites began in March 2001.

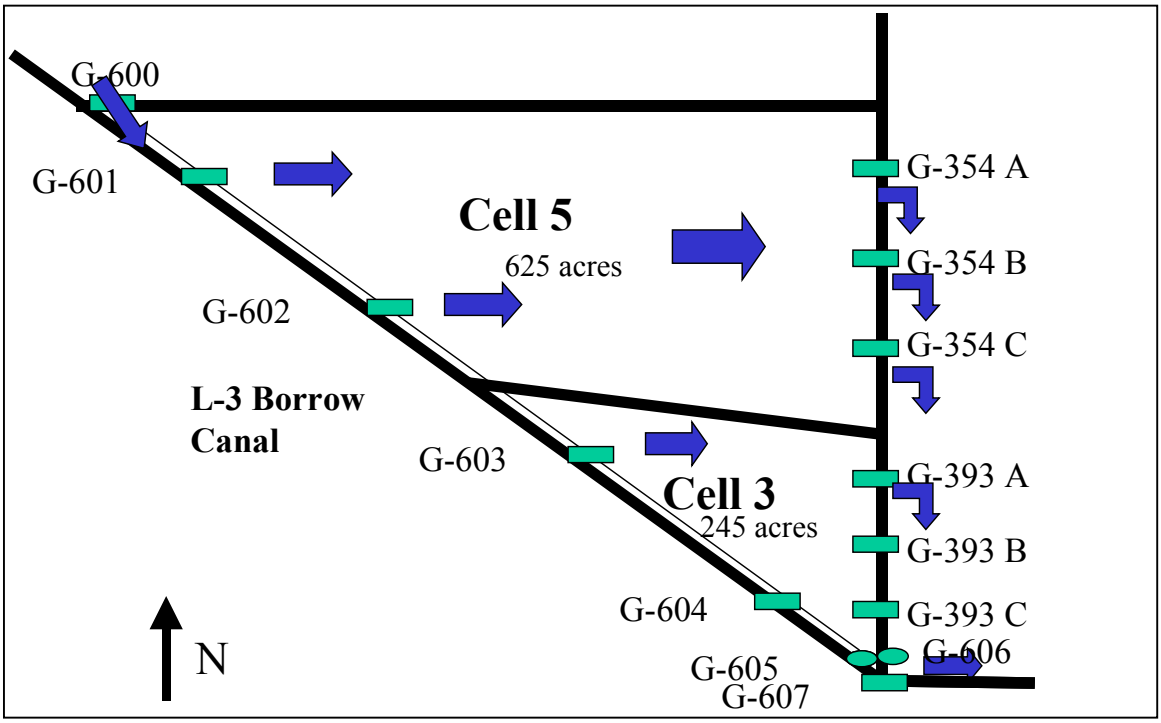
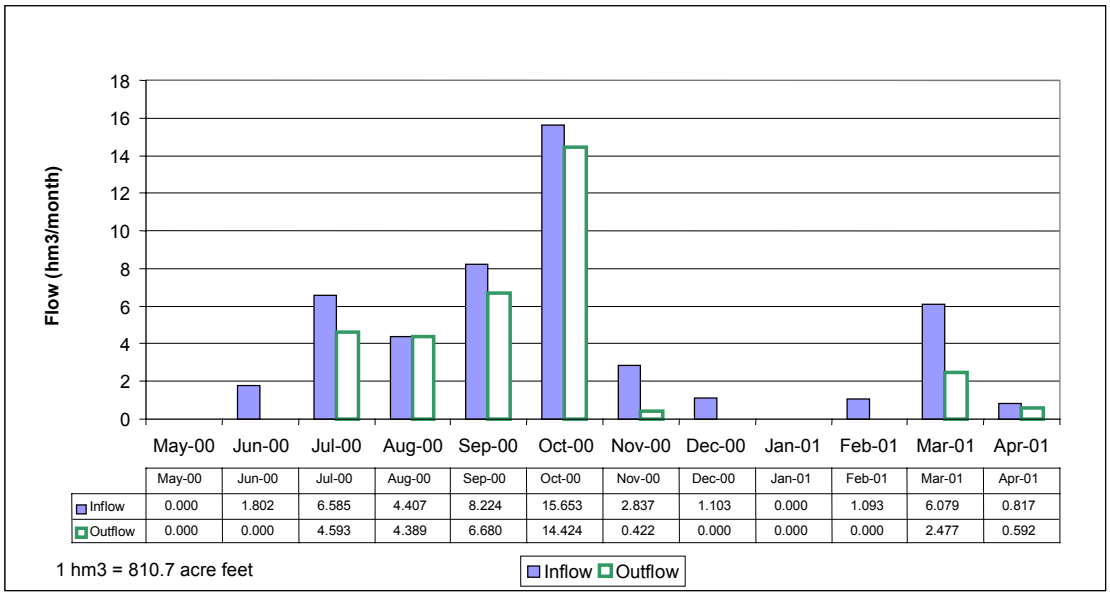


Figure 4A-18. Schematic of STA-6 (not to scale)

Operations at STA-6 over the past year have been influenced significantly by the drought in South Florida. In a typical year, STA-6 experiences an annual winter/spring dry-out. However, in 2001, both treatment cells experienced two dry out events, and subsequently two re-flood periods. The first re-flood occurred shortly after a rainfall event on March 19, 2001. By mid April of the same year, STA-6 dried out again. Coinciding with the start of the wet season, the second re-flood event occurred during the first week of June 2001. No emergency water deliveries were required for STA-6 because the plant community is somewhat drought resistant. For a description of the STA-6 post-drought monitoring plan, please see the STA Optimization section of this chapter. The annual volume of water discharged into STA-6 was 48.6 cubic hectometers (39,400 acre feet), equating to an average hydraulic loading rate of 3.78 cm/day. Due to seepage losses and evapotranspiration, the net volume of treated water discharged from STA-6 during WY2001 was 33.6 cubic hectometers (27,200 acre feet). A summary of monthly flow is presented in **Figure 4A-19**.



	May-00	Jun-00	Jul-00	Aug-00	Sep-00	Oct-00	Nov-00	Dec-00	Jan-01	Feb-01	Mar-01	Apr-01
Inflow	0.000	1.802	6.585	4.407	8.224	15.653	2.837	1.103	0.000	1.093	6.079	0.817
Outflow	0.000	0.000	4.593	4.389	6.680	14.424	0.422	0.000	0.000	0.000	2.477	0.592

Figure 4A-19. STA-6 Monthly Flows

STA-6 VEGETATION

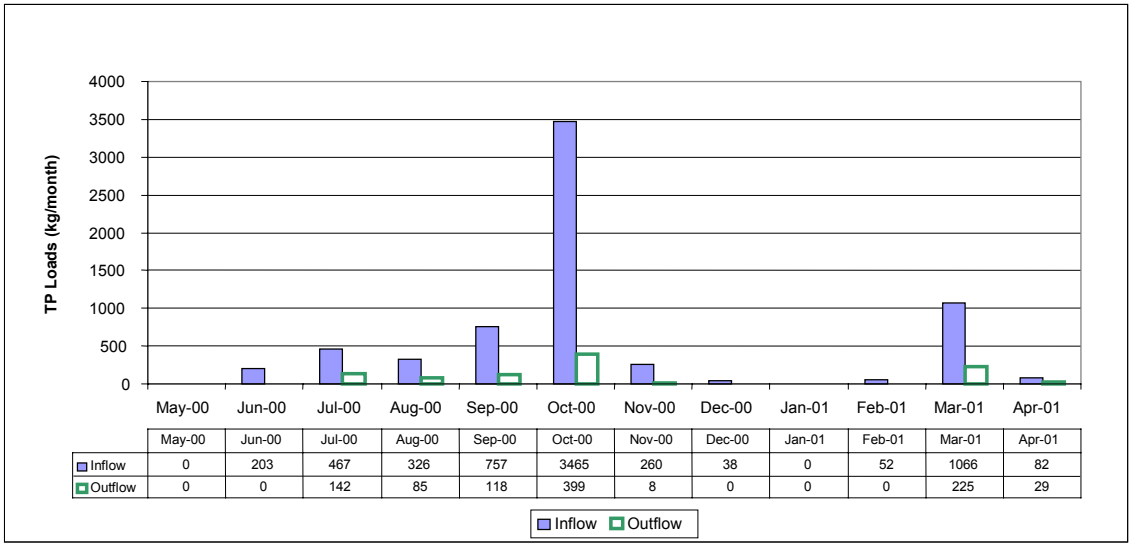
Because of its past and current hydroperiod, the plant community in STA-6 is composed predominately of drought resistant vegetation. A mixed succession of cattail (Typha sp.), primrose willow (*Ludwigia sp.*), and panicum grasses, most notably para grass (*Panicum purpurescens*), define the community in Cell 5 where as Cell 3 is dominated primarily by sawgrass (*Cladium jamaicense*).

Specific Condition 13(b) of the EFA permit requires that the annual report include information regarding the application of herbicides to exclude and/or eliminate undesirable vegetation in the wetted area of the treatment cells. For this reporting period, the district applied a total of 14.26 gallons of the herbicide Garlon 4 and 127.36 gallons of non-toxic carrier oil to control undesirable vegetation in the STA. The herbicide was applied using aerial spray equipment.

STA-6 PHOSPHORUS REDUCTION

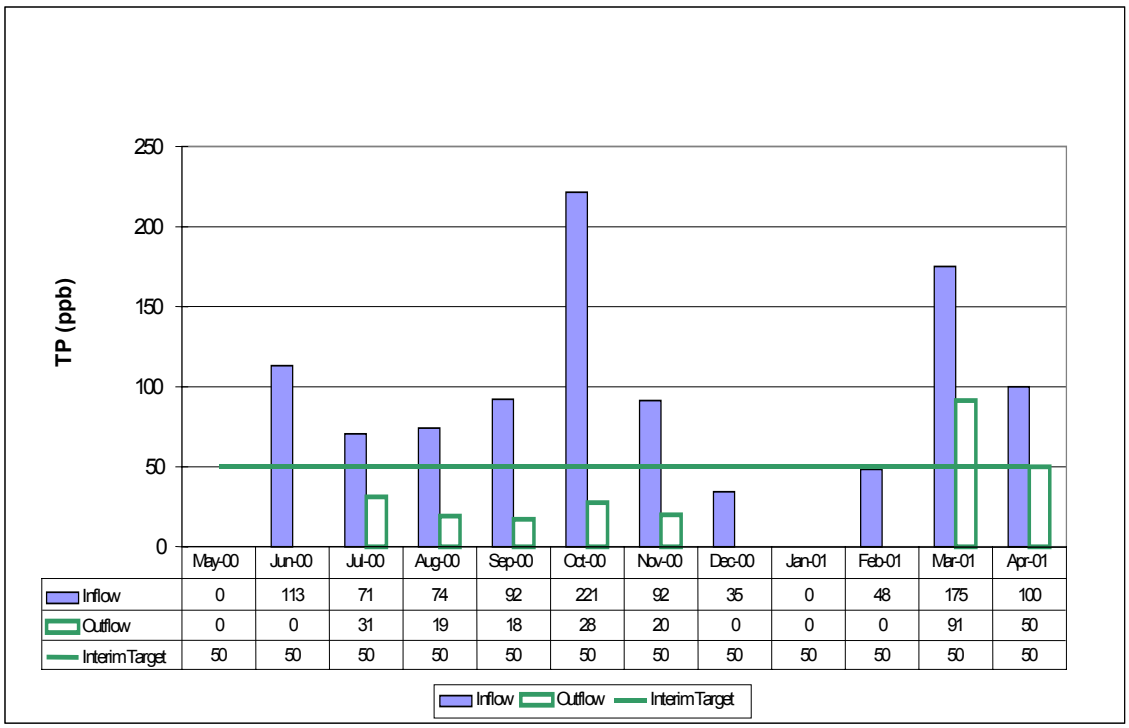
Under the design objectives of the Everglades Forever Act, STA-6 continues to achieve its interim discharge goal of less than 50 ppb for TP. During WY2001, the STA received 6.7 metric tons of phosphorus, equating to a nutrient loading rate of 1.91 grams/square meter. By comparison, this loading rate is roughly 3.5 times the loading rate of STA-1W, and twice the loading rate of STA-5. Approximately 5.6 metric tons of TP were removed by STA-6 during WY2001. Between May 2000 and April 2001, STA-6 experienced an 83 percent load reduction in total phosphorus (**Figure 4A-20**). Furthermore, monthly discharge concentrations were considerably lower than inflow concentrations (**Figure 4A-21**). The flow-weighted mean outflow concentration was 31 ppb, a 77 percent reduction from the inflow concentration of 138 ppb.

In 2001, both treatment cells experienced two dry-out events and, subsequently, two reflood periods. The first reflooding occurred shortly after a rainfall event on March 19, 2001. By mid-April of the same year, STA-6 dried out again. Coinciding with the start of the wet season, the second reflood event occurred during the first week of June 2001. No emergency water deliveries were required for STA-6 because the plant community is somewhat drought resistant. For a detailed description of the STA-6 drought-monitoring plan, see the STA Optimization section of this chapter.



	May-00	Jun-00	Jul-00	Aug-00	Sep-00	Oct-00	Nov-00	Dec-00	Jan-01	Feb-01	Mar-01	Apr-01
Inflow	0	203	467	326	757	3465	260	38	0	52	1066	82
Outflow	0	0	142	85	118	399	8	0	0	0	225	29

Figure 4A-20. STA-6 Monthly TP Loads



	May-00	Jun-00	Jul-00	Aug-00	Sep-00	Oct-00	Nov-00	Dec-00	Jan-01	Feb-01	Mar-01	Apr-01
Inflow	0	113	71	74	92	221	92	35	0	48	175	100
Outflow	0	0	31	19	18	28	20	0	0	0	91	50
Interim Target	50	50	50	50	50	50	50	50	50	50	50	50

Figure 4A-21. STA-6 TP Concentrations Flow-weighted Means

STA-6, SECTION 1 PERMIT COMPLIANCE MONITORING

The District initiated a water quality monitoring program in STA-6 in December 1997 for the purpose of demonstrating compliance with the above mentioned conditions of the operating permit. At that time STA-6 began its stabilization period. Presently, STA-6 is in a post-stabilization phase. **Tables 4A-7 and 4A-8** summarize all water quality parameters, data, sampling frequencies and analytical methodologies that are part of this program. STA-6 discharges do not pose any known danger to public health, safety or welfare. Since compliance with specific conditions 7(a)(i) and 7(a)(ii) was achieved, information required in specific condition 7(a)(iii) is not required at this time.

Table 4A-7. Water Quality Parameters Monitored in STA-6, Section 1

Parameters Sampled	STORET Code	Water Quality Parameters	Unit of Measure
	10	Temperature	°C
	300	Dissolved Oxygen	mg/L
	94	Specific Conductance	µmhos/cm
Physical Parameters	400	pH	STD units
	82078	Turbidity	NTU
	80	Color	PCU
	530	Total Suspended Solids	mg/L
Nutrients			
(Flow proportional samples)	665	Total Phosphorus	µg P/L
	612	Ammonia – unionized	mg N/L
(Grab samples)	625	Total Kjeldahl Nitrogen	mg N/L
	660	Orthophosphate	µg P/L
Major Ions	74010	Iron - total	mg/L
	956	Silica	mg/L
	945	Sulfate	mg/L
	410	Alkalinity	mg $CaCO_3$/L
	940	Chloride - dissolved	mg/L
	929	Sodium - dissolved	mg/L
	937	Potassium - dissolved	mg/L
	916	Calcium - dissolved	mg/L
	927	Magnesium - dissolved	mg/L
Pesticides	82184	Ametryn	µg/L
	39033	Atrazine	µg/L

Table 4A-8. Sample locations, sampling frequencies, and sample type for flow and water quality parameters monitored in STA-6, Section 1.

Sample Location	Parameters	Sampling Frequency	Sample Type
Inflow Pump Station (G600)	Flow	DAV	PR
	Physical Characteristics	Bi-W	G
	Nutrients - Flow-proportioned	W	FPC
	Nutrient - Grabs	Bi-W	G
	Major Ions	QTR	G
	Pesticides	QTR	G
Outflow Site (G606)	Flow	DAV	UVM
	Physical Characteristics	Bi-W	G
	Nutrients - Flow-proportioned	W	FPC
	Nutrient - Grabs	Bi-W	G
	Major Ions	QTR	G
	Pesticides	QTR	G

Bi-W = biweekly (26 sample/yr)
DAV = daily average of continuous sampling
QTR = quarterly (4 samples/yr)
W = weekly (52 sample/yr)
FPC = flow-proportioned composite sample
G = grab sample
PR = based on pump records
UVM = ultrasonic velocity meter

Total Phosphorus

Specific condition 7(b) of the STA-6 operating permit states that the project will be considered stabilized and operations will move to the post-stabilization phase when the rolling 12-month flow-weighted average TP concentration at the outflow is less than or equal to 50 µg L^{-1} for 12 consecutive periods. As was reported in the 2001 ECR, this criterion has been met. In accordance with this permit condition, the project has been in the Post Stabilization Period of operation. The permit requires that the flow-weighted average annual outflow concentration remains below 76 ppb, and STA-6 exhibited an annual value of 30 ppb during WY2001. The moving 12-month flow-weighted average increased from 15 to 30 ppb during the course of WY2001, due primarily to elevated concentrations leaving the project after reflooding in March (**Figure 4A-22**).

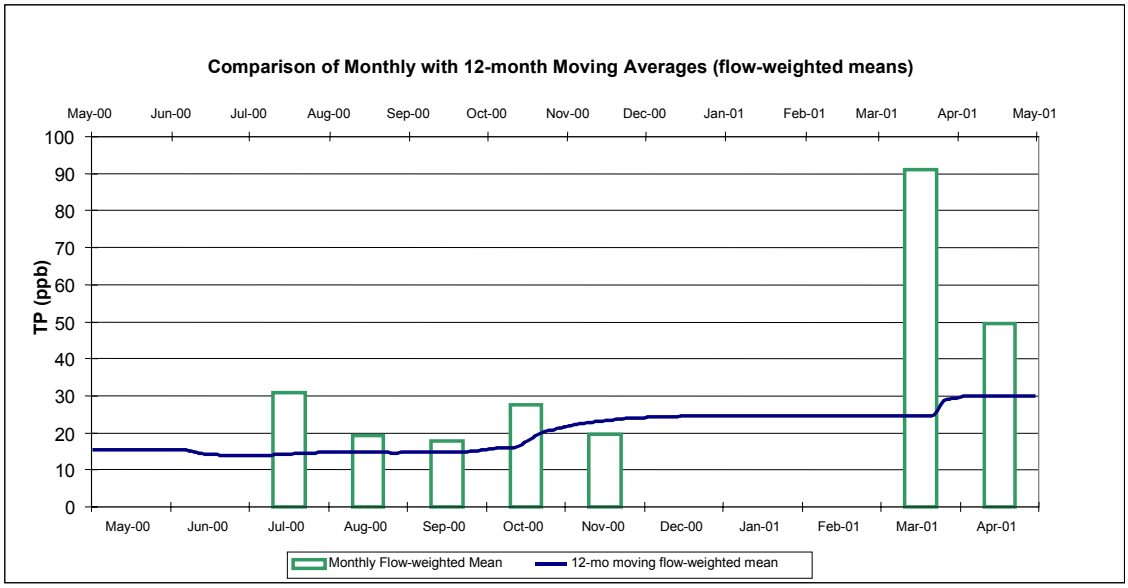


Figure 4A-22. STA-6 Discharge Concentrations

Nonphosphorus Parameters With Class III Numeric Criterion

The four-quarter average discharge concentrations for all non-phosphorus parameters with Class III numeric criteria were all in compliance with numeric criteria (**Table 4A-9**).

Nonphosphorus Parameters Without Class III Numeric Criterion

Color and dissolved potassium were the only parameters that had higher average annual outflow concentrations than inflow concentrations (**Table 4A-9**) at STA-6. However, since these parameters have no applicable numeric State water quality standards, STA-6 is deemed to be in full compliance with the permit. The most likely reason for these elevated results is that the treatment cells had two discrete dry-out periods during the 2000 through 2001 dry season. As water levels decreased, concentrations of water quality constituents increased. Under dry conditions, these constituents concentrated in the sediment or in subsurface water. During the March

2001 reflooding event, color and K concentrations increased in the outflows. Greater outflow than inflow concentrations of orthophosphate, SO_4, Cl and Mg also occurred during this period, but the average quarterly discharged concentrations were not great enough to cause the average annual values to exceed the inflow values.

The District has performed all sampling and analysis under the latest Department-approved CompQAP No. 870166G (June 1999).

- Specific Condition 14(d) of the permit requires a statement by the individual responsible for implementation of the sampling program concerning the authenticity, precision and accuracy of the data as well as minimum detection limits. A signed copy of this statement prepared by Maxine Cheesman, Director of the Water Quality Monitoring Department, Division of Environmental Monitoring and Assessment, SFWMD, during this period is provided in **Appendix 4A-2**.

- The District has performed all sampling and analysis under the latest Department-approved CompQAP No. 870166G (June 1999).

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- The District has performed all sampling and analysis under the latest Department-approved CompQAP No. 870166G (June 1999).

Table 4A-9 lists the herbicides that were analyzed in surface waters from STA-6. The four-quarter average outflow concentration for all compounds was lower than or equal to corresponding inflow concentrations. Although not a permit requirement, it is important to note that during each quarter, herbicide concentrations at the outflow were less than at the inflow. The herbicides detected are not used for vegetation management at STA-6, but are typical of areas with nearby intensive agricultural activity.

The District has included the following documentation to satisfy the remaining requirements of Specific Condition 14:

- A copy of STA water quality data associated with this POR is provided in **Appendix 4A-3**.

Table 4A-9. Summary of quarterly results for all water quality parameters other than total phosphorus monitored at STA-6, Section 1.

Parameter	Sampling Episode	Class III Standard	Sampling Results		
			Inflow G600	Outflow G606	Outflow Compliance
Temperature (°C)	1st Quarter of WY2001	N/A	28.1	28.7	
	2nd Quarter of WY2001		27.1	28.4	
	3rd Quarter of WY2001		20.3	19.8	
	4th Quarter of WY2001		23.8	23.0	
	Four Quarter Mean		***24.8***	***25.0***	***N/A***
Dissolved Oxygen (mg/L)	1st Quarter of WY2001	Greater than or equal to 5.0 mg/L	4.0	5.3	
	2nd Quarter of WY2001		2.5	4.2	
	3rd Quarter of WY2001		3.4	6.7	
	4th Quarter of WY2001		4.6	6.1	
	Four Quarter Mean		***3.6***	***5.5***	***N/A***
Specific Conductivity (µmhos/cm)	1st Quarter of WY2001	Not greater than 50% of background or greater than 1,275 µmhos/cm	627	584	
	2nd Quarter of WY2001		642	554	
	3rd Quarter of WY2001		764	638	
	4th Quarter of WY2001		811	705	
	Four Quarter Mean		***711***	***620***	***Yes***
pH	1st Quarter of WY2001	Not less than 6.0 and not greater than 8.5	7.5	7.7	
	2nd Quarter of WY2001		7.2	7.4	
	3rd Quarter of WY2001		7.3	7.7	
	4th Quarter of WY2001		7.3	7.6	
	Four Quarter Mean		***7.4***	***7.6***	***Yes***
Turbidity (NTU)	1st Quarter of WY2001	Less than or equal to 29 NTU above background conditions	6.4	4.0	
	2nd Quarter of WY2001		2.3	1.3	
	3rd Quarter of WY2001		3.5	2.0	
	4th Quarter of WY2001		4.6	1.8	
	Four Quarter Mean		***4.2***	***2.3***	***Yes***
Color (PCU)	1st Quarter of WY2001	N/A	74.1	86.0	
	2nd Quarter of WY2001		93.7	105.0	
	3rd Quarter of WY2001		70.9	77.4	
	4th Quarter of WY2001		74.3	94.8	
	Four Quarter Mean		***78.3***	***90.8***	***N/A***
Total Suspended Solids (mg/L)	1st Quarter of WY2001	N/A	7	5	
	2nd Quarter of WY2001		5	2	
	3rd Quarter of WY2001		7	2	
	4th Quarter of WY2001		7	2	
	Four Quarter Mean		***6***	***3***	***N/A***
Unionized Ammonia (mg/L)	1st Quarter of WY2001	Less than or equal to 0.02 mg/L	0.003	0.001	
	2nd Quarter of WY2001		0.003	0.001	
	3rd Quarter of WY2001		0.002	0.003	
	4th Quarter of WY2001		0.002	0.001	
	Four Quarter Mean		***0.002***	***0.001***	***Yes***
Total Kjeldahl Nitrogen (mg/L)	1st Quarter of WY2001	N/A	1.8	1.5	
	2nd Quarter of WY2001		1.8	1.3	
	3rd Quarter of WY2001		1.6	1.5	
	4th Quarter of WY2001		1.9	1.8	
	Four Quarter Mean		***1.8***	***1.5***	***N/A***
Orthophosphate as P (µg/L)	1st Quarter of WY2001	N/A	16	21	
	2nd Quarter of WY2001		45	6	
	3rd Quarter of WY2001		7	3	
	4th Quarter of WY2001		9	2	
	Four Quarter Mean		***19***	***10***	***N/A***
Total Iron (µg/L)	1st Quarter of WY2001	Less than or equal to 1,000 µg/L	144	173	
	2nd Quarter of WY2001		309	189	
	3rd Quarter of WY2001		173	261	
	4th Quarter of WY2001		144	82	
	Four Quarter Mean		***192***	***176***	***Yes***

Table 4A-9 (Continued). Summary of quarterly results for all water quality parameters other than total phosphorus monitored at STA-6, Section 1.

Parameter	Sampling Episode	Class III Standard	Sampling Results		
			Inflow G600	Outflow G606	Outflow Compliance
Silica (mg/L)	1st Quarter of WY2001	N/A	3.5	5.7	
	2nd Quarter of WY2001		9.2	9.8	
	3rd Quarter of WY2001		8.3	6.2	
	4th Quarter of WY2001		6.1	3.3	
	Four Quarter Mean		***6.8***	***6.3***	***N/A***
Sulfate (mg/L)	1st Quarter of WY2001	N/A	24.4	18.5	
	2nd Quarter of WY2001		29.2	14.7	
	3rd Quarter of WY2001		23.5	11.6	
	4th Quarter of WY2001		32.0	56.7	
	Four Quarter Mean		***27.3***	***25.3***	***N/A***
Alkalinity (mg/L)	1st Quarter of WY2001	Not less than 20 mg/L	77.8	85.2	
	2nd Quarter of WY2001		122.5	101.9	
	3rd Quarter of WY2001		142.2	123.5	
	4th Quarter of WY2001		306.5	177.6	
	Four Quarter Mean		***162.2***	***122.1***	***Yes***
Dissolved Chloride (mg/L)	1st Quarter of WY2001	N/A	56.2	55.7	
	2nd Quarter of WY2001		54.9	41.7	
	3rd Quarter of WY2001		60.8	52.7	
	4th Quarter of WY2001		93.4	108.5	
	Four Quarter Mean		***66.3***	***64.6***	***N/A***
Dissolved Sodium (mg/L)	1st Quarter of WY2001	N/A	32.5	34.4	
	2nd Quarter of WY2001		36.3	27.9	
	3rd Quarter of WY2001		46.6	36.1	
	4th Quarter of WY2001		70.3	70.2	
	Four Quarter Mean		***46.4***	***42.2***	***N/A***
Dissolved Potassium (mg/L)	1st Quarter of WY2001	N/A	4.6	4.7	
	2nd Quarter of WY2001		5.4	3.6	
	3rd Quarter of WY2001		3.2	3.9	
	4th Quarter of WY2001		4.2	8.4	
	Four Quarter Mean		***4.4***	***5.2***	***N/A***
Dissolved Calcium (mg/L)	1st Quarter of WY2001	N/A	51.4	56.5	
	2nd Quarter of WY2001		99.2	75.7	
	3rd Quarter of WY2001		102.3	85.5	
	4th Quarter of WY2001		116.4	77.7	
	Four Quarter Mean		***92.3***	***73.9***	***N/A***
Dissolved Magnesium (mg/L)	1st Quarter of WY2001	N/A	9.5	8.6	
	2nd Quarter of WY2001		7.3	5.8	
	3rd Quarter of WY2001		8.3	7.2	
	4th Quarter of WY2001		8.6	10.9	
	Four Quarter Mean		***8.4***	***8.1***	***N/A***
Ametryn (µg/L)	1st Quarter of WY2001	N/A	0.014	0.018	
	2nd Quarter of WY2001		0.024	0.031	
	3rd Quarter of WY2001		0.012	0.017	
	4th Quarter of WY2001		0.140	ND	
	Four Quarter Mean		***0.048***	***0.022***	***N/A***
Atrazine (µg/L)	1st Quarter of WY2001	N/A	0.410	0.520	
	2nd Quarter of WY2001		0.120	0.031	
	3rd Quarter of WY2001		0.630	0.005	
	4th Quarter of WY2001		1.600	ND	
	Four Quarter Mean		***0.690***	***0.185***	***N/A***

MERCURY COMPLIANCE

The entire Everglades still remains under Department of Health advisories, recommending no or limited consumption of select fish species due to the high Hg levels in their flesh. This has impaired the use of the Everglades as a sport fishery, and two areas within the Everglades have been listed as having impaired waters requiring the calculation of total maximum daily loads (TMDLs) pursuant to Section 303(d)(1)(C) of the Federal Clean Water Act (Letter from J. Brooks, Department, to F. Finch, SFWMD, June 9, 2000). The governor's Mercury in Fish and Wildlife Task Force identified the reflooding of former agricultural soils as a potential source of inorganic Hg and MeHg to the Everglades in December 1991.

As a consequence of the preceding, the permits issued to the District for the operation of STAs by the Department have special conditions dealing specifically with Hg. To detect a long-term increase in soil Hg levels, six 10-cm cores are collected prior to flooding and triennially thereafter for THg and MeHg analysis using ultratrace methods. To detect a "first-flush" effect following flooding, samples of unfiltered water are collected biweekly at the inflow and a representative interior site in each treatment cell during startup and are analyzed for unfiltered inorganic Hg and MeHg using ultratrace analytical methods. When the interior concentrations are not significantly greater than corresponding inflow concentrations, flow-through operation may commence and the STA enters a stabilization period expected to last two to three years. Upon initiation of flow-through operation, unfiltered samples of inflow and outflow water are collected quarterly and analyzed for both Hg species, while mosquitofish are collected semiannually and sunfish and largemouth bass are collected annually at the inflows and interior cell outflows and analyzed for THg.

It is MeHg, not inorganic Hg, that bioaccumulates in aquatic organisms up to 10,000,000 times the concentration in the surrounding water (Lange et al., 1999) and is a potent neurotoxic substance (Clarkson, 1994). According to Gilmour et al. (1998a, b), MeHg is synthesized primarily in the top 4 cm of surficial peat soils by SO_4-reducing bacteria in the presence of inorganic mercuric ion, $Hg(II)^{+2}$ and SO_4, but in the absence of DO. However, under the right conditions MeHg can also be synthesized by these same bacteria in decaying periphyton mats (Cleckner et al., 1999). The inorganic Hg, from which MeHg is synthesized, is introduced into the Everglades primarily by direct or indirect wet and dry atmospheric deposition of naturally occurring inorganic Hg augmented by local, regional and global sources. These sources have increased airborne Hg concentrations and deposition rates over natural background values by about three to five times in the last century (Delfino et al., 1993). For the Everglades as a whole, more than 95 percent of the flux of new Hg is coming from atmospheric deposition (USEPA, 1998). These air sources are nonabatable in the context of Florida water law. However, immediately downstream of District structures the inorganic Hg and MeHg in Lake Okeechobee releases and EAA runoff may make a substantial contribution to the flux of new Hg into the Everglades. While the prototype STA – the ENRP – had the lowest average concentrations of Hg in fish anywhere in the Everglades and removed between 50 percent and 75 percent of the inflow inorganic Hg and MeHg (Miles and Fink, 1998; SFWMD, 1999; Fink and Rawlik, 2000), other STAs have performed differently.

The Hg operational performance of STA-6, STA-5, STA-1W and the Hg startup status of STA-2 are summarized in the following paragraphs. The detailed Hg compliance report for each STA is presented in **Appendix 4A-30**. For a detailed description of Hg research in the STAs and EPA, please refer to Chapter 7 of the 2000 and 2001 ECR (Fink and Rawlik, 2000; Atkeson et al., 2001).

STA-1 WEST

The permit to operate STA-1W was issued by the Department to the District in April 1999; startup monitoring of STA-1W began in May 1999. Following the production of a "first-flush" pulse of MeHg that lasted about six months, STA-1W met its Hg startup criteria in January 2000 (Rawlik, 2001). In reporting year 2000 to 2001, for STA-1W as a whole THg decreased and MeHg increased from inflow to outflow, but outflow concentrations of THg and MeHg averaged about 50 percent and 75 percent of their inflow concentrations, respectively, when the ENRP portion of STA-1W is considered individually, and about 75 percent and 150 percent of the inflow when Cell 5 is considered individually. The cause of the differences in performance between these two treatment trains is unknown, though differences in land preparation and vegetation type cannot be ruled out. This pattern is not followed by fish, with the average concentrations of THg in interior and outflow mosquitofish, sunfish and largemouth bass being less than their corresponding inflow concentrations in both treatment trains. Cell-5 fish are consistently higher than their Cell 3 or 4 counterparts, taking into account differences in the size and age distributions of the fish in these distinct systems. However, these concentrations were somewhat elevated when compared to the corresponding averages in the ENRP in the period 1995 through 1999, though not significantly so. They are less than the USEPA and U.S. Fish and Wildlife Service (USFWS) levels of concern for wildlife and are statistically significantly lower than the concentrations in fish collected from interior marsh sites. Thus, the concentrations of MeHg in mosquitofish from STA-1W should not present a risk of toxic effects to fish-eating birds feeding there preferentially.

STA-2

STA-2 consists of three parallel treatment cells that can be operated independently. The 1,990-acre Cell 1 land was remnant Everglades that had been partially drained, but never cultivated; about 25 percent of the 2,220-acre Cell 2 land was under cultivation, with the remainder being partially drained remnant Everglades; and all the 2,220-acre Cell 3 was former agricultural soil. STA-2 startup monitoring began in July 2000. Cells 3 and 2 met their Hg startup criteria in September 2000 and November 2000, respectively, but Cell 1 still had not as of April 30, 2001. In September 2000, 4.8 ng L^{-1} of MeHg were detected in the unfiltered water sample collected from the interior of Cell 1. The District reported this anomalously high Hg concentration to the Department in October 2000 following completion of quality assurance review. STA-2, Cell 1 water column concentration continued to oscillate to lower concentrations over the next two months, reaching a low of about 0.1 ng L^{-1} in January 2001. In October 2000, the District began monthly monitoring of mosquitofish collected at three sites in Cell 1. The average concentration of THg in Cell 1 mosquitofish continued to increase through the last collection in March 2001 to 320 μg Kg^{-1} wet weight. By comparison, the average THg concentration in mosquitofish collected in the period 1998 through 2000 from WCA-3A-15, the Everglades "hot spot," was about 200 μg Kg^{-1} wet weight. Cell 1 dried out in mid-April 2001. Just prior to dry-out, when the water depth was roughly 10 cm, the unfiltered MeHg concentration in water reached 4.2 ng L^{-1}. A detailed report on the STA-2 Cell 1 Hg anomaly is contained in **Appendix 4A-28**.

The District determined that the high concentrations of MeHg bioaccumulating in the Cell 1 food chain could represent an unacceptable risk to sensitive members of some fish-eating wildlife species foraging in Cell 1. As a consequence of Everglades-like biogeochemical conditions occurring in Cell 1, it was assumed that this Hg anomaly would continue following post-drought reflooding. An extended period of standing water in Cell 1 during the wet season is likely to be the worst case for MeHg production, bioaccumulation and risk. After discussions with FDEP, USEPA and other agencies, it was determined that the most effective way to minimize risks to foraging wildlife would be to initiate flow-through with EAA canal water as soon as possible, in

an attempt to increase the sulfur loading and therefore slow down the mercury methylation process. On August 9, 2001, the Department issued the District a modification to the EFA permit for STA-2 to allow flow-through operation in Cell 1. This will prevent an extended period of standing water and substantially reduce the likelihood of MeHg buildup to anomalously high levels in water, soil and aquatic biota. The report in **Appendix 4A-29** was prepared to support this permit modification request using technical information available on Hg sources, transport, storage, transformation and effects in the Everglades and elsewhere.

STA-5

STA-5 outflow concentrations of unfiltered THg and MeHg were less than influent concentrations in the first and second quarters of the reporting year, but higher than the influent during the second half of the reporting year. The concentrations of MeHg and THg in mosquitofish, sunfish and largemouth bass were highly variable at all sites, showed differences between treatment trains and were higher than their STA-1W counterparts. Moreover, the concentrations of MeHg in mosquitofish and sunfish exceeded their respective USEPA levels of concern, but largemouth bass did not. However, the concentrations in mosquitofish, sunfish and bass were less than WCA-3A-15, the Everglades "hot spot," which is generally considered to be the benchmark above which the risks to sensitive members of fish-eating bird populations are at an unacceptable risk of long-term toxic effects when feeding there preferentially (Rumbold, 2000).

STA-6, SECTION 1

STA-6 receives stormwater runoff releases from the U.S. Sugar Corporation that cannot be regulated by the District. Consequently, unlike the other STAs, STA-6 dries out and hydrates frequently. STA-6 met the Hg startup criteria in December 1997. STA-6 completed its two-year stabilization period in December 1999. As required by its Section 404(a) dredge and fill permit for the ECP, the District provided the USACE with a status report on STA-6 Hg performance in the 2001 ECR (Atkeson and Parks, 2001; **Appendix 4A-30**). Based on calculations contained in **Appendix 4A-30** of this report, STA-6 appears to be removing less than 25 percent of the inflow inorganic Hg and MeHg, and on several occasions quarterly sampling indicated the outflow concentrations were significantly higher than inflow concentrations. In addition, while mosquitofish collected at the outflow culverts were not significantly more contaminated than those collected at the inflow, this was not the case for sunfish and largemouth bass. The interior fish were collected in treatment Cell 3, but not Cell 5. However, the concentrations in mosquitofish, sunfish and bass are less than at WCA-3A-15.

MERCURY SUMMARY

- Unfiltered water concentrations of MeHg and THg (= inorganic Hg + MeHg) in the inflows and outflows of STA-1W, STA-5 and STA-6 were highly variable. Occasionally, THg, MeHg or both were at greater concentration at the outflow than at one or more of the inflows to the STAs. STA-6, which has completed its stabilization period, appears to be removing roughly 25 percent of the THg and MeHg present in the inflow on an annual average basis.
- While STA-2, Cells 2 and 3, met their startup criteria in September and November 2000, respectively, Cell 1 still had not at the end of this reporting year. The District reported anomalously high levels of MeHg in interior water in STA-2 Cell 1 in October 2000. A follow-up study detected anomalously high levels of

THg in mosquitofish, but Cell 1 dried out before sunfish sampling could commence. Nevertheless, the District inferred from the mosquitofish data that these concentrations could represent an unacceptable risk of toxic effects to fish-eating birds preferentially foraging in Cell 1. In August 2001 the District was issued a permit modification to allow Cell 1 to operate in a flow-through mode, which is expected to reduce the MeHg production and bioaccumulation rates by altering cell hydrology and surficial soil chemistry. Expanded monitoring will ensure that performance relative to this expectation is properly addressed.

- In STA-5, which is still in its stabilization period, THg concentrations in mosquitofish, sunfish and largemouth bass were highly variable at all sites and showed differences between treatment trains, but were less than those at the Everglades "hot spot" in WCA-3A. Nevertheless, levels of Hg in STA-5 fish remain at or above guidance levels developed by the USEPA and the USFWS for the protection of fish-eating wildlife.