Appendix 3-1: Annual Permit Report for the Everglades Stormwater Treatment Areas

Permit Report (May 1, 2014—April 30, 2015)
Permit Number: 0311207

Seán Sculley

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SUMMARY

Based on Florida Department of Environmental Protection (FDEP) permit reporting guidelines, **Table 1** lists key permit-related information associated with this report. **Table 2** lists the attachments included with this report. **Table A-1** in Attachment A lists specific pages, tables, graphs, and attachments where project status and annual reporting requirements are addressed. This annual report satisfies the reporting requirements specified in the permits listed below.

Table 1. Key permit-related information.[a]

Project Name:	Everglades Construction Project
Permit Numbers:	0311207 (EFA); FL0778451 (NPDES); Consent Order OGC FILE NO. 12-1149 (EFA) and OGC FILE NO. 12-1148 (NPDES)
Issue and Expiration Dates:	Issued 9/10/2012; expires 9/9/2017 (EFA and NPDES)
Project Phases:	Construction and Operation
Permit Specific Condition Requiring Annual Report:	25 (EFA); I.E.6 (NPDES); 13 (EFA CO); 13 (NPDES CO)
Reporting Period:	May 1, 2014–April 30, 2015
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a. Key to abbreviations: CO – Consent Order, EFA – Everglades Forever Act, NPDES – National Pollution Discharge Elimination System, and OGC – Office of General Counsel.

Table 2. Attachments included with this report.

Attachment	Title
A	Specific Conditions and Cross-References
B	Water Quality Data
C	Annual Permit Compliance Monitoring Report for Mercury in the Stormwater Treatment Areas
D	Rotenberger Wildlife Management Area Restoration and STA Downstream Transect Monitoring
E	STA Herbicide Application Summary for Water Year 2015

PROJECT STATUS

The overall total phosphorus (TP) flow-weighted mean outflow concentration for Water Year 2015 (WY2015) (May 1, 2014–April 30, 2015) was 17 micrograms per liter (mg/L), the lowest ever since the Everglades Stormwater Treatment Areas (STAs) were constructed. The STAs treated over 1.3 million acre-feet (ac-ft) of inflows, including an unprecedented volume of 585,300 ac-ft of water released from Lake Okeechobee. All corrective actions described in the Everglades Forever Act (EFA) and National Pollution Discharge Elimination System (NPDES) consent orders (COs) are on schedule.

CONCLUSIONS REGARDING PROJECT SUCCESS

STA TP treatment success can be attributed to collaborative and proactive decision-making regarding STA operations, vegetation management of emergent aquatic vegetation (EAV) and submerged aquatic vegetation (SAV) cells, and the absence of tropical storms and major rainfall events in the Everglades Agricultural Area (EAA) basin.

PROBLEMS ENCOUNTERED

The presence of avian species protected by the Endangered Species Act and the Migratory Bird Treaty Act affected STA operations, but did not require diversions or reduce overall STA TP removal performance. Operation of the STAs was affected, but not impacted or constrained, due to the presence of species protected by the Endangered Species Act or Migratory Bird Treaty Act [Everglade snail kite (*Rostrhamus sociabilis*) and black-necked stilt (*Himantopus mexicanus*)].

ACTIONS TO ADDRESS PROBLEMS

In all situations where protected species were present, alternate flow paths were available within the STAs to allow for continued treatment of inflows. Flow paths within each STA were prioritized on a weekly basis. Specific minimum, maximum, and maintained stages were established for STA cells where protected species or nests were present. Although these species were present within the facility the entire water year except for November and December 2014, no flow-ways had to be taken offline for their protection.

INTRODUCTION

PROJECT OVERVIEW

As part of Everglades restoration, the construction and operation of large freshwater treatment wetlands are mandated by the EFA (Chapter 373.4592, Florida Statutes). These wetlands, known as the Everglades STAs, were constructed south of Lake Okeechobee as part of the Everglades water quality restoration efforts (www.sfwmd.gov/sta) to reduce TP concentrations from surface waters prior to entering the Everglades Protection Area (EPA) (**Figure 1**). The total area of the STAs including infrastructure components is approximately 68,000 acres, with approximately 57,000 acres of effective treatment area (Piccone 2014) currently authorized to operate under EFA Permit Number 0311207, issued by FDEP in September 2012.

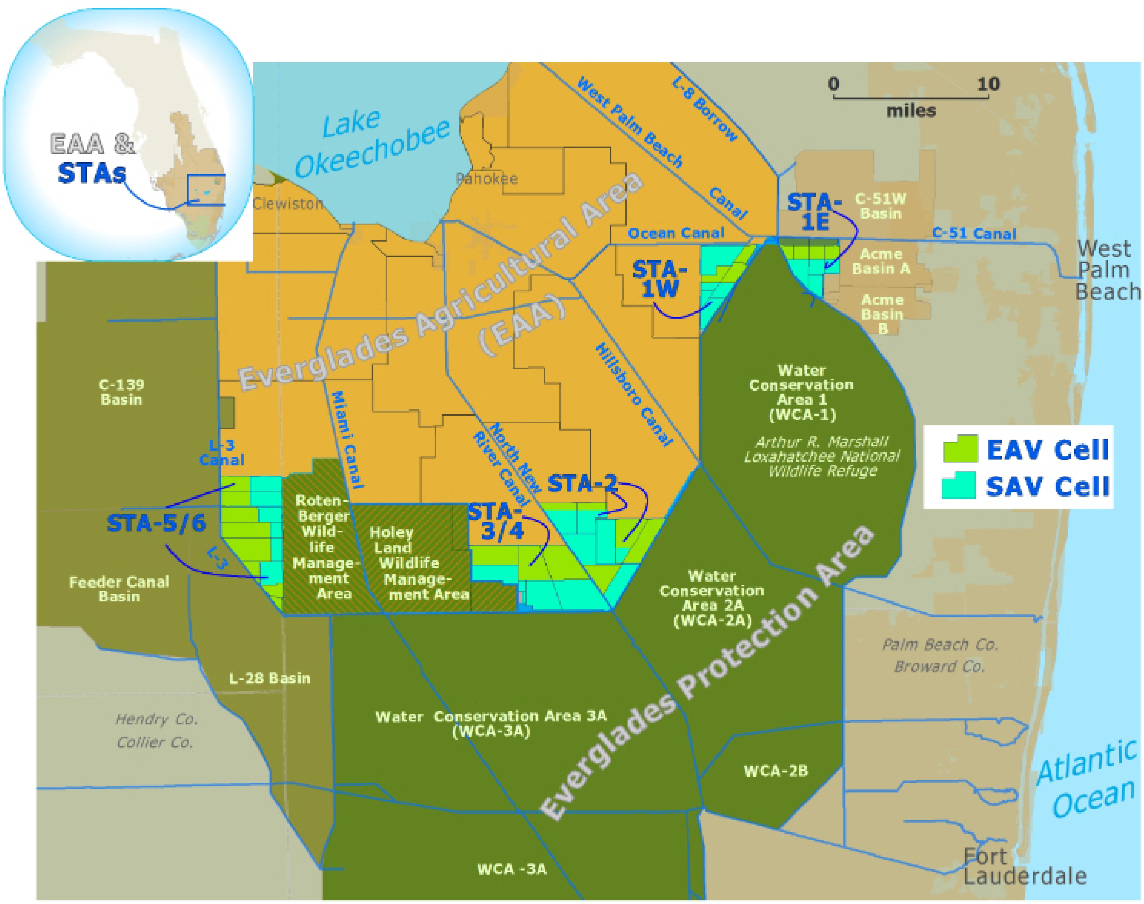

Figure 1. Location of the Everglades STAs.

The Everglades STAs [STA-1 East (STA-1E), STA-1 West (STA-1W), STA-2, STA-3/4, STA-5/6] (**Figure 2**) operate pursuant to EFA and NPDES permits and their associated COs. This appendix serves as the reporting mechanism for requirements contained in those permits and COs for the STAs during WY2015. Attachments A through E provide supplementary information for this report (**Table 2**).

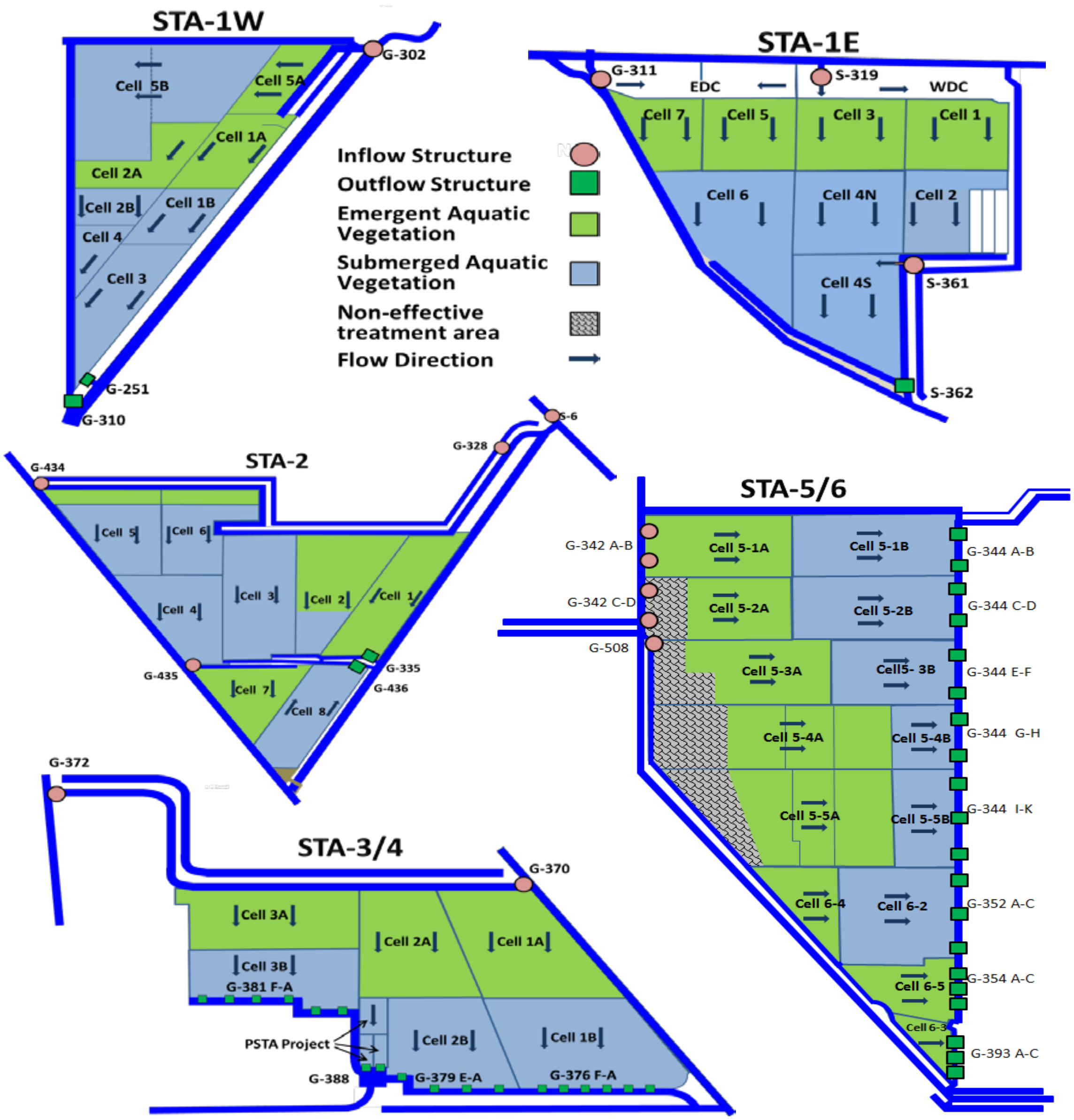

Figure 2. STA schematics showing configuration of treatment cells, flow direction, dominant vegetation type, and locations of inflow and outflow structures.

Varying in size, configuration, and period of operation, the STAs are shallow freshwater marshes divided into treatment cells by interior levees. Water flows through these systems via water control structures, such as pump stations, gated spillways, and culverts. The dominant plant communities in the treatment cells are broadly classified as EAV, SAV, and floating aquatic vegetation (FAV). Both native and nonnative vegetation play a role in phosphorus removal in the STAs. Vegetation management activities include control of undesirable species by herbicide application and mechanical removal as well as planting EAV and inoculations of SAV. The reader is referred to Volume I, Chapter 5B, Performance and Operation of the Everglades Stormwater Treatment Areas, for a discussion of vegetation management in the Everglades STAs and how this affects treatment performance.

PERMIT HISTORY

The current EFA and NPDES permits were issued September 10, 2012. One EFA permit and one NPDES permit were issued for all Everglades STAs. Subsequent modifications issued to the South Florida Water Management District (SFWMD or District) are as follows:

EFA

- 0311207-002, issued March 6, 2013, was an exemption to allow for installation of the S-6 pump station communication tower.
- 0311207-004, issued January 21, 2015, was a modification authorizing construction and operation of the STA-1W Independent Western Flow-way.

NPDES

- FL0778451 (no modifications were issued in WY2015).

STA PERFORMANCE

This section presents the annual data required by STA operating permits, COs, and associated downstream monitoring. A summary table of permit deliverables and reporting requirements is presented in Attachment A. The District performed all sampling and analysis in compliance with Chapter 62-160, Florida Administrative Code (F.A.C.), and the District's Chemistry Laboratory Quality Manual (SFWMD 2015a) and Field Sampling Quality Manual (SFWMD 2015b). Water quality data are provided in Attachment B. The annual permit compliance monitoring report for mercury in the STAs is presented in Attachment C.

PERMIT STATUS AND REPORTING REQUIREMENTS

Permit Compliance for Phosphorus

Upon completion of the specific corrective actions identified in the COs (by December 31, 2025), it is anticipated that the STAs will be discharging consistent with the water quality based effluent limit (WQBEL) for TP established in the EFA and NPDES permits. In the meantime, comparisons of annual flow-weighted mean TP concentrations for each STA with the WQBEL are presented in **Table 3** and **Figure 3**.

The WQBEL was developed to be protective of the EPA and allow for the achievement of the phosphorus criterion established in Rule 62-302.540, F.A.C. The criterion, and therefore the WQBEL, was based on the best available science and the understanding of the biogeochemical processes of the receiving waterbody at the time the criterion was adopted. The WQBEL consists of two components (1) a maximum TP annual flow-weighted mean (AFWM) of 19 parts per billion (ppb) in any water year; and, (2) a TP long-term flow-weighted mean (LTFWM) of 13 ppb, not to be exceeded in more than three out of five water years on a rolling basis. The term AFWM means the annual flow-weighted mean for all of the combined outflow structures for an individual STA. **Table 4** shows the annual flow, load, and flow-weighted mean results for each permitted site by STA.

Table 3. TP AFWM outflow concentrations for WY2011–WY2015.[a]

Water Year[b]	Facility						
	STA-1E	STA-1W	STA-2	STA-3/4	STA-5/6[c]	STA-5	STA-6
WY2011	*22*	*25*	15	16	*31*	*47*	*25*
WY2012	*21*	*22*	12	19	*40*	*32*	*75*
WY2013	*26*	*36*	*22*	14	17		
WY2014	*41*	*24*	19	14	*23*		
WY2015	*21*	19	16	15	*32*		

a. Values 13 ppb or less are in green; values greater than 13 ppb and less than or equal to 19 ppb are in orange; values greater than 19 ppb are in red italics.

b. A water year begins May 1 and ends April 30. For example, WY2015 is from May 1, 2014, through April 30, 2015.

c. With the completion of Compartment C, STAs 5 and 6 are considered one facility (STA-5/6) under the permits issued September 10, 2012. STA-5 and STA-6 data were combined to provide a single tracking value for water year starting with WY2013.

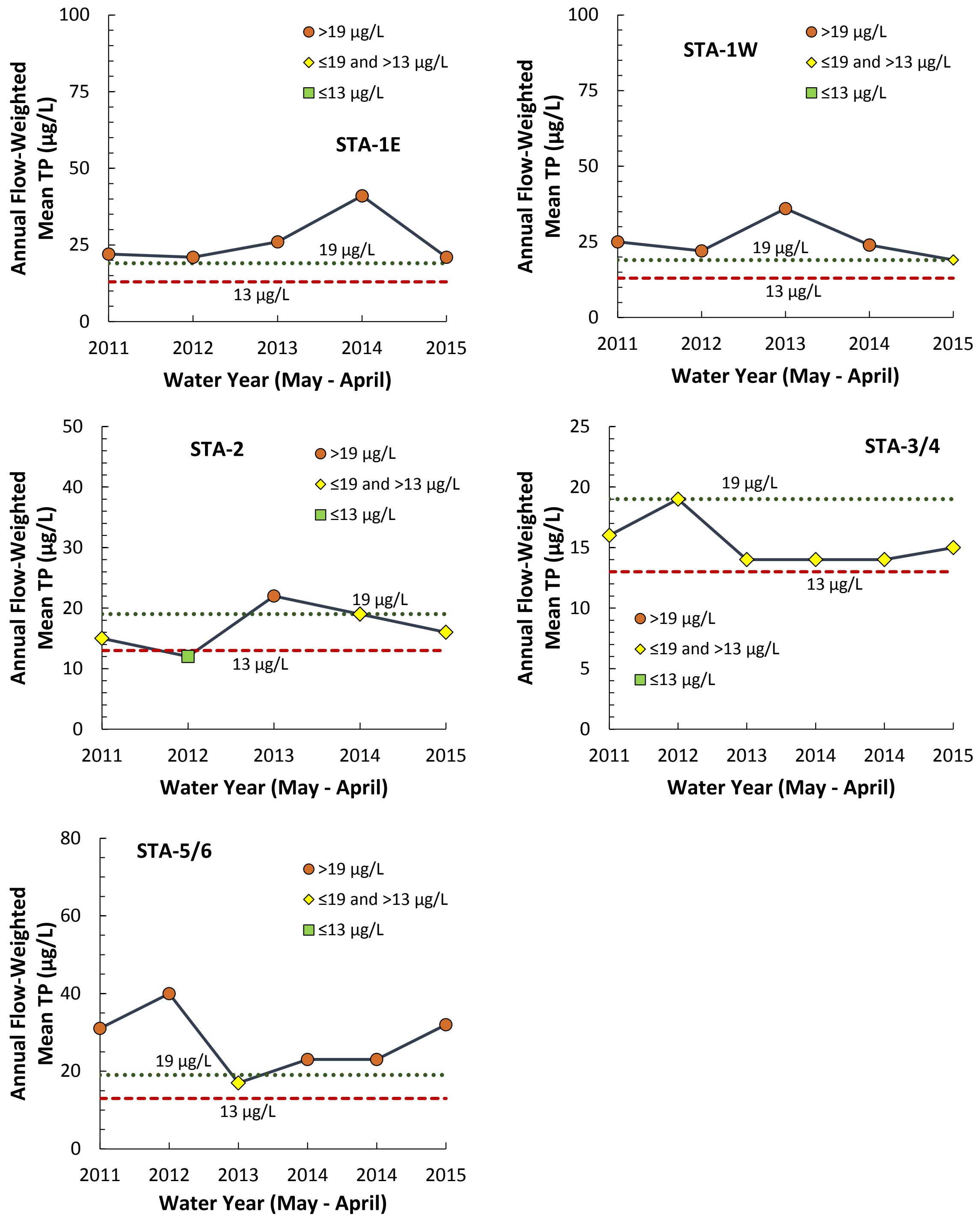

Figure 3. AFWM TP concentrations for combined outflows for each STA compared to the WQBEL two-part criteria. The two reference lines shown on the plots above identify the long-term (13 micrograms per liter [µg/L]) and the annual (19 µg/L) limits of the WQBEL.

Table 4. STA annual performance by station for WY2015.

STA	Flow Structures Represented	Water Quality Station	Annual Flow (ac-ft)	Annual TP Load (metric tons)	AFWM TP (ppb)
STA-1E	S-319 (inflow)	S-319 (inflow)	36,973	7.522	165
	G-311 (inflow)	G-311 (inflow)	78,379	14.781	153
	S-361 (inflow)	S-361 (inflow)	8,903	0.316	29
	S-362 (outflow)	S-362 (outflow)	97,818	2.561	21
STA-1W	G-302 (inflow)	G-302 (inflow)	140,087	27.103	157
	G-251 (outflow)	G-251 (outflow)	44,791	0.865	16
	G-310 (outflow)	G-310 (outflow)	101,962	2.535	20
STA-2	S-6 (inflow)	S-6 (inflow)	367,962	36.214	80
	G-328 (inflow)	G-328 (inflow)	22,183	1.072	39
	G-434 (inflow)	G-434 (inflow)	124,423	9.791	64
	G-435 (inflow)	G-435 (inflow)	20,168	0.669	27
	Additional (Inflows)[a]	Additional (Inflows)[a]	-6,061	-0.498	67
	G-335 (outflow)	G-335 (outflow)	239,078	4.502	15
	G-436 (outflow)	G-436 (outflow)	293,393	5.746	16
STA-3/4	G-370 (inflow)	G-370 (inflow)	67,395	5.599	67
	G-372 (inflow)	G-372 (inflow)	434,258	43.331	81
	G-376A-C (outflow)	G-376B (outflow)	94,870	1.842	16
	G-376D-F (outflow)	G-376E (outflow)	80,122	1.455	15
	G-379A-C (outflow)	G-379B (outflow)	57,106	1.447	21
	G-379D-E, G388 (outflow)	G-379D (outflow)	26,756	0.548	17
	G-381A-B (outflow)	G-381B (outflow)	77,652	1.224	13
	G-381C-F (outflow)	G-381E (outflow)	116,504	1.856	13
STA-5/6	G-342A (inflow)	G-342A (inflow)	8,703	2.313	215
	G-342B (inflow)	G-342B (inflow)	8,834	2.078	191
	G-342C (inflow)	G-342C (inflow)	8,257	2.322	228
	G-342D (inflow)	G-342D (inflow)	6,701	2.443	296
	G-406 (inflow)	G-406 (inflow)	233	0.046	160
	G-508 (inflow)	G-508 (inflow)	49,819	14.283	232
	Additional (Inflows)[b]	Additional (Inflows)[b]	517	0.104	163
	G-344A (outflow)	G-344A (outflow)	6,136	0.188	25
	G-344B (outflow)	G-344B (outflow)	9,320	0.349	30
	G-344C (outflow)	G-344C (outflow)	12,099	0.321	21
	G-344D (outflow)	G-344D (outflow)	7,903	0.216	22
	G-344E (outflow)	G-344E (outflow)	7,060	0.304	35
	G-344F (outflow)	G-344F (outflow)	5,447	0.177	26
	G-344G (outflow)	G-344G (outflow)	4,832	0.176	29
	G-344H (outflow)	G-344H (outflow)	3,904	0.154	32
	G-344I - K (outflow)	G-344I - K (outflow)	8,914	0.273	25
	G-352A-C (outflow)	G-352B (outflow)	15,257	0.740	39
	G-354A-C (outflow)	G-354C (outflow)	3,658	0.400	89
	G-393A-C (outflow)	G-393B (outflow)	1,348	0.081	49

a. Additional inflows G-328I, G-338, and G-339 will be added or subtracted depending on the direction of flow to get the total inflow.

b. Additional inflows G-342O and G-407 will be added or subtracted depending on the direction of flow to get a total inflow.

Water Quality Parameters Other Than Phosphorus

In addition to TP, the District is required to monitor the following water quality parameters at designated STA inflow and outflow locations: alkalinity (STA-1E and STA-1W only), dissolved oxygen (DO) (outflow only), mercury, pH, specific conductance, temperature, total nitrogen (TN), turbidity, nitrate + nitrite (NO_x), and sulfate. Of these parameters, those with Florida Class III standards are shown in **Table 5**. Observations from the STAs during WY2015 for these ten parameters are included in Attachment B.

Table 5. Monitored water quality parameters with Florida Class III criteria specified in Sections 62-302.530 and 62-302.533 (dissolved oxygen), F.A.C.

Parameter	Units[a]	Florida Class III Criteria
Alkalinity	mg $CaCO_3$/L	Shall not be depressed below 20 mg $CaCO_3$/L
Dissolved Oxygen	%	Not more than 10 percent of daily average percent DO saturation values less than 38 percent saturation.
pH		Not less than 6.0 or greater than 8.5
Specific Conductance	µS/cm	Not more than 50 percent of background or 1,275 µS/cm, whichever is greater[b]
Turbidity	NTU	Less than or equal to 29 NTU above background conditions

a. Units: µS/cm – microsiemens per centimeter; mg $CaCO_3$/L – milligrams calcium carbonate per liter; NTU – nephelometric turbidity units.

b. Because this is a freshwater system, the background concentration for specific conductance is assumed to be less than 1,275 µS/cm.

For alkalinity, specific conductance, TN, NO_x, and sulfate, Specific Condition 17 prescribes that the annual average outflow concentration be compared with applicable Class III water quality standards to determine compliance. If the annual outflow concentration exceeds the applicable Class III water quality standard, but is less than the corresponding annual average inflow concentration, the STA is deemed to be in compliance. Since there is no Class III water quality standard for TN, NO_x, or sulfate, only annual average inflow/outflow comparisons for these three parameters are presented. DO at STA outflows is compared with the corresponding Class III standard. Measurements of STA inflow and outflow pH and turbidity are compared with the corresponding Class III standards. Evaluation of mercury in the STAs is discussed in Attachment C. Temperature data are included with all other monitored parameters in Attachment B.

Alkalinity

There were no exceedances of the alkalinity criterion at any of the STA-1E and STA-1W outflow structures during WY2015. The minimum alkalinity value from all structures was 92 milligrams calcium carbonate per liter (mg $CaCO_3$/L), far above the Class III (minimum) standard of 20 milligrams (mg). **Table 9** shows the annual average outflow concentrations of alkalinity for STA-1E and STA-1W are 192 and 191 mg, respectively. These concentrations did not cause or contribute to violations of applicable Class III water quality standards and these STAs are in compliance with Specific Condition 17 with regard to alkalinity.

Table 6. Summary of annual average concentrations of parameters other than TP measured at STA inflows and outflows during WY2015.

Parameters[a]	AFWM[b]			
	Inflow		Outflow	
	Number of Observations[c]	Results	Number of Observations[c]	Results
STA-1E				
Specific Conductance (µS/cm)	83 (153)	769	40 (51)	930
Dissolved Sulfate (mg/L)	84 (126)	55.7	20 (25)	57.3
Total Alkalinity (mg $CaCO_3$/L)	84 (126)	183.88	21 (26)	191.81
Nitrate+Nitrite (mg N/L)	81 (123)	0.583	20 (25)	0.038
Total Nitrogen (mg/L)	83 (125)	2.4	20 (25)	1.59
STA-1W				
Specific Conductance (µS/cm)	27 (51)	833	61 (102)	863
Dissolved Sulfate (mg/L)	26 (41)	67.7	46 (78)	65.8
Total Alkalinity (mg $CaCO_3$/L)	26 (41)	201.13	46 (78)	191.33
Nitrate+Nitrite (mg N/L)	26 (41)	0.738	43 (74)	0.039
Total Nitrogen (mg/L)	26 (41)	2.84	46 (78)	1.84
STA-2				
Specific Conductance (µS/cm)	118 (206)	885	84 (103)	887
Dissolved Sulfate (mg/L)	108 (143)	50.9	45 (56)	45
Nitrate+Nitrite (mg N/L)	107 (141)	0.628	42 (52)	0.015
Total Nitrogen (mg/L)	108 (142)	2.5	45 (56)	1.62
STA-3/4				
Specific Conductance (µS/cm)	52 (104)	715	233 (364)	735
Dissolved Sulfate (mg/L)	52 (73)	48.3	230 (285)	45.9
Nitrate+Nitrite (mg N/L)	52 (73)	1.448	226 (280)	0.017
Total Nitrogen (mg/L)	52 (71)	2.89	226 (279)	1.46
STA-5/6				
Specific Conductance (µS/cm)	104 (311)	494	148 (700)	456
Dissolved Sulfate (mg/L)	100 (146)	10	138 (255)	2.3
Nitrate+Nitrite (mg N/L)	99 (144)	0.036	134 (249)	0.013
Total Nitrogen (mg/L)	100 (146)	1.6	136 (253)	1.39

a. Units: mg $CaCO_3$/L – milligrams calcium carbonate per liter; mg N/L – milligrams nitrogen per liter; mg/L – milligrams per liter; µS/cm – microsiemens per centimeter.

b. Total number of samples collected with flow.

c. Total number of samples collected regardless of flow.

Specific Conductance

The Class III water quality standard for specific conductance is not more than 50 percent of background or 1,275 microsiemens per centimeter (µS/cm), whichever is greater. In this case, the 1,275 µS/cm standard controls. As shown in **Table 6**, although the annual average outflow specific conductance was slightly higher than the corresponding annual average inflow for all STAs except for STA 5/6, the annual average outflow specific conductance for each STA was below the Class III standard. The STAs are therefore in compliance with the permit condition for specific conductance in WY2015.

Total Nitrogen

There is no Class III water quality standard for TN. Nevertheless, **Table 6** shows, for each STA, the annual average TN concentration, expressed in mg/L at the outflow is less than the corresponding inflow concentration. The STAs are in compliance with the permit condition for TN in WY2015.

Nitrate + Nitrite

There is no Class III water quality standard for NO_x. Nevertheless, **Table 6** shows a significant reduction in annual average concentration of NO_x .for each STA in WY2015. The STAs are in compliance with the permit condition for NO_x in WY2015.

Sulfate

There is no Class III water quality standard for sulfate. Nevertheless, **Table 6** shows a reduction in annual average concentration at the outflows for all STAs except for STA-1E. Although the STA-1E annual average sulfate concentration in WY2015 was slightly higher than the corresponding inflow concentration, the increase (1.6 mg/L) was not statistically significant.

Dissolved Oxygen

With respect to DO, the EFA permit (Specific Condition 18) also requires the District to evaluate whether STA discharges may have influenced Everglades marsh sites that were not in compliance with the DO Site Specific Alternative Criteria (SSAC). Compliance with the DO SSAC at marsh stations is analyzed in Volume I, Chapter 3A. The analysis and discussion of marsh stations out of compliance and possibly influenced by STA discharge, using existing and historical facility and marsh data, are presented later in this section.

Biweekly grab sample DO concentration measurements at STA discharge structures during WY2015 are included in Attachment B. A summary of annual DO concentrations and percent saturation for individual structures and for each STA, the percent saturation criterion, and the percentage of samples exceeding the criterion are shown in **Table 7**.

The method for determination of compliance with the DO water quality standard is as follows: the percent DO saturation is calculated from each sample based on measured DO concentration and temperature (DO observations). An adjustment to the 38 percent saturation value based on the time of day each sample was collected (adjusted criterion values) and pairwise comparisons are made between DO observations and adjusted criteria values. The percentage of DO observations throughout the year less than the corresponding criteria values is then determined for compliance.

The values in the "Calculated Dissolved Oxygen Criteria" column are shown to indicate by how much the DO saturation percentage was adjusted from the standard (38 percent) based on the time of day samples were taken, and cannot be used to directly determine whether an outflow structure was in compliance. The percentage of DO observations less than the DO saturation criterion is shown for each outflow structure and STA in the "Percent Excursion from Criteria" column. Any value in this column greater than 10 percent indicates that the structure or STA is not in compliance with the criteria.

Table 7. Annual DO concentration, percent saturation criteria, and percent excursion from criteria at outflow stations for each STA as well as across the entire STA.

STA	Outflow Structure	No. of Obs.[a]	Dissolved Oxygen		Calculated Dissolved Oxygen Criteria[b]	Percent Excursion from Criteria
			Mean ± Standard Deviation[c]			
			(mg/L)	% Saturation	% Saturation	
STA-1E	S362	51	6.07 ± 1.27	74.4% ± 13.1%	40.7% ± 1.9%	0.0%
STA-1W	ENR012	51	2.96 ± 1.59	35.3% ± 17.6%	35.6% ± 1.3%	56.9%
	G310	51	5.45 ± 1.64	66.1% ± 18.1%	34.5% ± 1.0%	2.0%
	All	102	4.20 ± 2.03	50.7% ± 23.6%	35.1% ± 1.3%	29.4%
STA-2	G335	51	4.14 ± 0.96	49.8% ± 10.2%	35.7% ± 1.0%	7.8%
	G436	48	4.09 ± 1.27	49.2% ± 13.4%	35.9% ± 1.3%	14.6%
	All	99	4.11 ± 1.12	49.5% ± 11.8%	35.8% ± 1.2%	11.1%
STA-3/4	G376B	50	4.92 ± 1.53	59.0% ± 16.4%	36.4% ± 2.8%	14.0%
	G376E	50	4.57 ± 1.39	54.5% ± 13.5%	37.2% ± 2.3%	10.0%
	G379B	50	4.04 ± 1.15	48.4% ± 11.3%	37.9% ± 1.9%	18.0%
	G379D	50	4.57 ± 1.45	55.6% ± 15.8%	38.5% ± 1.6%	14.0%
	G381B	50	4.23 ± 1.41	50.6% ± 15.2%	39.3% ± 1.3%	24.0%
	G381E	50	5.08 ± 2.33	62.3% ± 32.3%	39.9% ± 1.2%	14.0%
	All	300	4.57 ± 1.62	55.1% ± 19.1%	38.2% ± 2.2%	15.7%
STA-5/6	G342A	51	4.73 ± 2.38	56.8% ± 27.3%	40.5% ± 1.7%	33.3%
	G344B	51	3.89 ± 1.54	45.5% ± 15.3%	35.8% ± 0.8%	33.3%
	G344C	51	4.28 ± 1.82	50.6% ± 18.9%	36.3% ± 1.0%	21.6%
	G344D	51	4.50 ± 1.69	53.2% ± 16.8%	36.8% ± 1.0%	19.6%
	G344E	51	3.47 ± 1.29	41.5% ± 13.7%	36.8% ± 1.4%	39.2%
	G344F	51	2.99 ± 1.43	35.3% ± 14.7%	37.4% ± 1.6%	60.8%
	G344G	51	4.35 ± 1.37	52.2% ± 15.4%	38.0% ± 1.7%	25.5%
	G344H	51	3.69 ± 1.40	44.0% ± 15.2%	38.5% ± 1.8%	35.3%
	G344I	47	3.91 ± 1.65	46.8% ± 18.9%	39.0% ± 1.9%	40.4%
	G344J	51	3.95 ± 1.70	47.5% ± 19.0%	39.4% ± 1.9%	37.3%
	G344K	51	4.09 ± 1.94	49.1% ± 22.1%	39.9% ± 2.0%	37.3%
	G352B	43	2.70 ± 1.59	31.6% ± 18.1%	37.0% ± 1.4%	67.4%
	G354C	43	2.37 ± 1.75	26.4% ± 19.0%	37.0% ± 1.4%	74.4%
	G393B	43	2.68 ± 1.89	30.0% ± 20.7%	36.8% ± 1.8%	69.8%
	All	686	3.65 ± 1.74	43.2% ± 19.3%	37.5% ± 2.0%	41.7%

a. No. of Obs. – Number of Observations

b. Florida Class III criteria specified in Sections 62-302.530 and 62-302.533, F.A.C.

c. Arithmetic mean ± standard deviation

As shown in **Table 7** and **Figures 4** and **5**, four of the 25 STA outflow structures were in compliance with the DO standard in WY2015: S-362 (STA-1E), G-310 (STA-1W), G-335 (STA-2), and G-376E (STA-3/4).

As shown in Volume I, Chapter 3A, 11 interior sampling locations within the EPA exceeded the DO SSAC in WY2015: four within the Arthur R. Marshall Loxahatchee National Wildlife Refuge (LNWR; LOXA130, LOXA104.5, Z1, and Z2), three in Water Conservation Area (WCA) 2 (FS1, WCA2F1, and WCA2F2), one in WCA-3 (CA318), and three in Everglades National Park (NE1, P33, and P36). Of these 11 sampling locations, LOXA130, LOXA104.5, and FS1 are considered to be close enough to STA discharge locations to determine whether discharges from the STAs may have influenced their non-compliance.

LNWR marsh station LOXA130 is approximately 6.8 kilometers (km) from STA-1E outflow structure S-362, and approximately 0.6 km from the rim canal. Discharge from STA-1E was not a contributing factor in station LOXA130 being out of compliance with the DO SSAC since no excursion from the DO criterion was observed during WY2015.

LNWR marsh station LOXA104.5 is less than one km from STA-1W outflow structures G-310 and G-251, and approximately 0.3 km from the rim canal. This impacted site failed the DO SSAC limit in four of the past six years. It is unclear whether discharge from STA-1W influenced DO SSAC compliance at this station, taking into consideration that rim canal station LOXA104, located approximately 0.2 km and 1.0 km from G-251 and G-310, respectively, had a mean annual DO concentration of 6.0 mg/L during WY2015.

Exceedance of the DO SSAC at WCA-2A marsh station FS1 was not likely influenced by STA outflow since the Class III DO water quality standard was met at STA-2 outflow structure G-335 and at S-7 during WY2015.

Mercury

For all STAs required to be monitored in WY2015, no violations of the United States Environmental Protection Agency (USEPA) surface water quality standard of 12 nanograms (ng) of total mercury (THg) per liter occurred. All action level requirements listed in A Protocol for Monitoring Mercury and Other Toxicants, referred to as the Protocol (SFWMD and FDEP 2011). THg concentrations in mosquitofish (*Gambusia holbrooki*) and largemouth bass (*Micropterus salmoides*) in STA interior stations for WY2015 did not exceed USEPA predator protection criteria. A detailed report with results and analysis is reported in Attachment C.

pH

No pH readings in STA-1E, STA-1W, or STA-5/6 were outside the Class III standard range of 6.0 to 8.5. One pH value from STA-2 (9.4 from G-335 on July 9, 2014) and one from STA-3/4 (5.6 from G-376B on September 29, 2014) exceeded the Class III standard.

Temperature

There is no Class III water quality standard for temperature. Data are included in Attachment B.

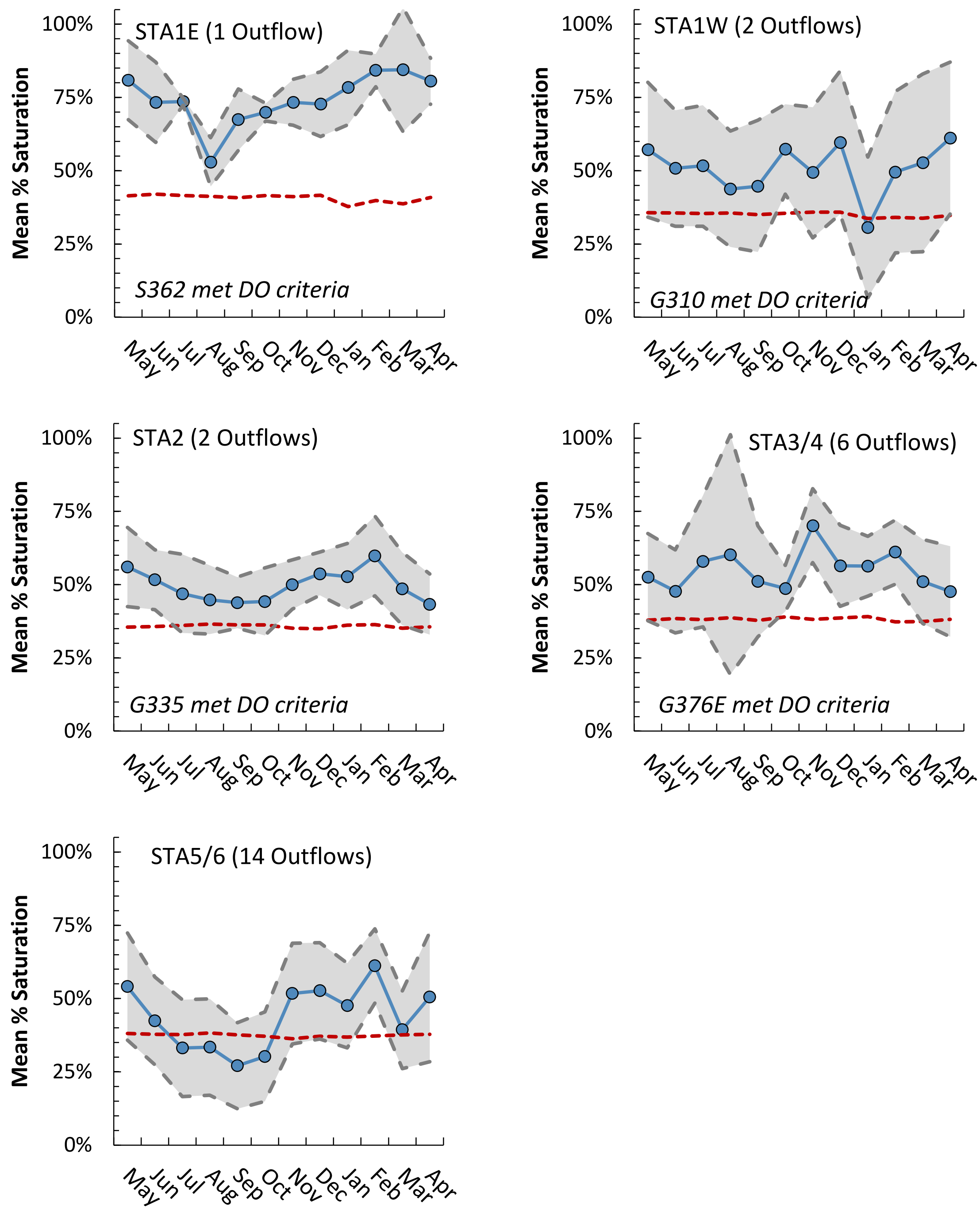

Figure 4. Mean monthly DO concentration during WY2015 for the five permitted STAs referenced to the Class III criterion of 5 mg/L (red dashed line). Shaded region represents one standard deviation around the mean.

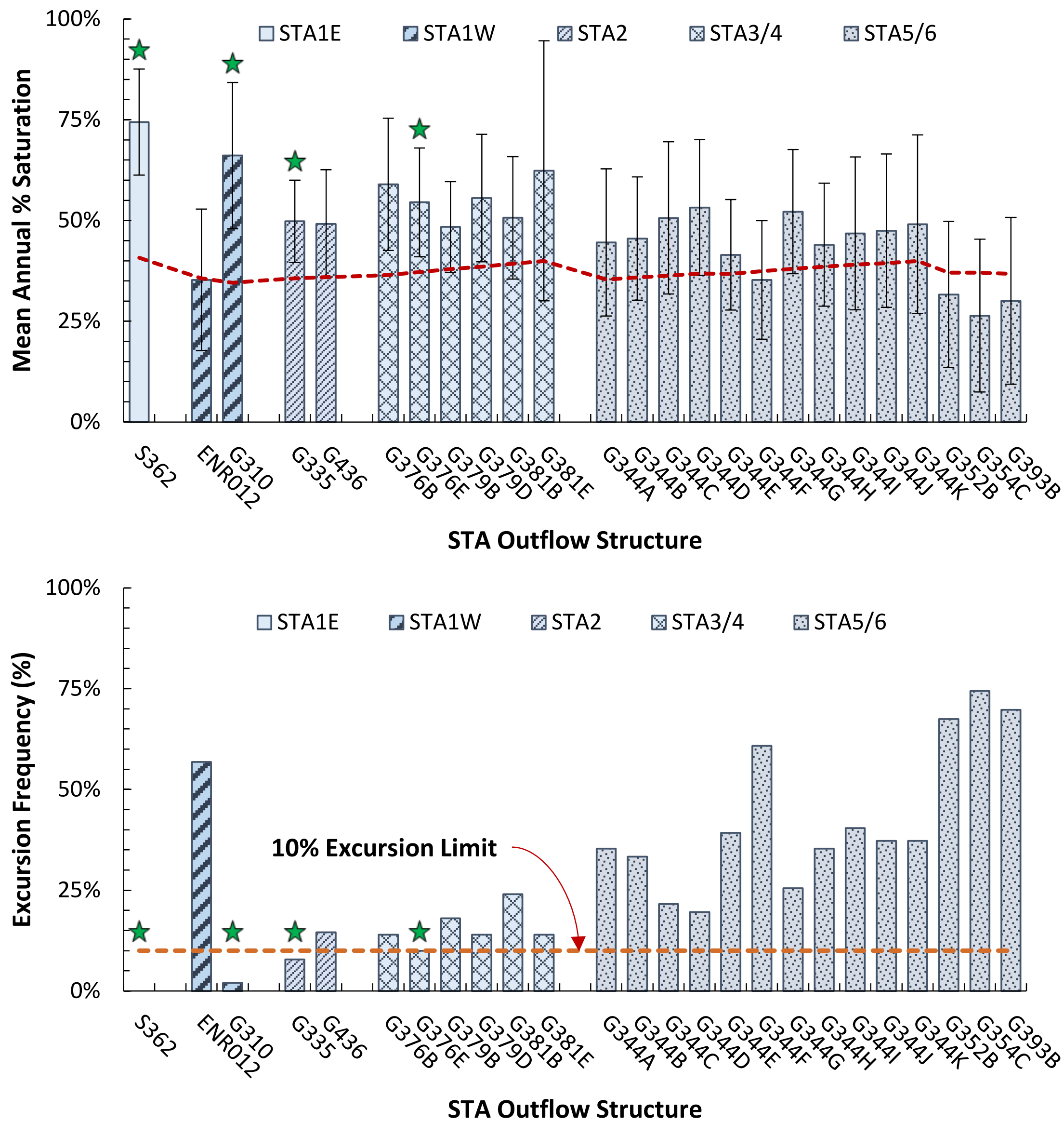

Figure 5. (Top) Bar plot depicting mean annual percent DO saturation (± standard deviation) for each outflow structure at the five permitted STAs with the mean annual DO criterion represented as a red dashed line. (Bottom) Bar plot showing annual excursion limit depicted as a red dashed line. Annual excursion frequencies at structures exceeding the 10 percent limit line indicate that those structures do not meet the DO criterion. Structures in both plots that met the calculated DO criterion are identified with a star.

Rotenberger Wildlife Management Area Restoration and STA Transect Monitoring

The District monitors adjacent wetland areas that receive discharges from the STAs, which include LNWR (adjacent to STA-1E and STA-1W), WCA-2A (adjacent to STA-2), and the Rotenberger Wildlife Management Area (adjacent to STA-5/6) (**Figure 1**). Water and sediment quality, flow, stage, and vegetation data are collected at inflow points and along prescribed transects to assess changes in conditions as water moves south. In accordance with the annual reporting requirements of related permits, these WY2015 data are provided in Attachment D.

LITERATURE CITED

FDEP and SFWMD. 2011. A Protocol for Monitoring Mercury and Other Toxicants. Florida Department of Environmental Protection, Tallahassee, FL, and South Florida Water Management District, West Palm Beach, FL.

Piccone, T., J. McBryan, H. Zhao and Y. Yan. 2012 Updated Everglades Stormwater Treatment Area Average Ground Elevations, Stage-Area/Stage Volume Relationships and Effective Treatment Areas. South Florida Water Management District, West Palm Beach, FL. August 2014 (Revision 2).

SFWMD. 2015a. Chemistry Laboratory Quality Manual. SFWMD-LAB-QM-2015-01, South Florida Water Management District, West Palm Beach, FL.

SFWMD. 2015b. Field Sampling Quality Manual. SFWMD-FIELD-QM-001-08.2, South Florida Water Management District, West Palm Beach, FL.

Attachment A: Specific Conditions and Cross-References

Table A-1. Specific conditions, actions taken, and cross-references presented in this report.

Specific Condition	Description	Applicable Phase	Action Taken	Reported in *2016 South Florida Environmental Report* (Note: V1 – Volume I, V2 – Volume II, and V3 – Volume III)			
				Narrative (page #s)	Figure	Table	Attachment
3	Public Use	All	Recreational facilities were maintained in accordance with permit requirements.				
4	Project Construction	Construction	STA-1E Culvert Repairs, STA-1E S-319 Trash Rake, STA-1E Periphyton Stormwater Treatment Area (PSTA) Decommissioning, STA-1W Independent Flow-way, STA-1W Test Cells, STA-1W Gravity Flow Path				
6	As-Built Certification and Record	Construction	STA-1E Task Order 4 Culvert Repairs and STA-1E PSTA Decommissioning				
7	Pump Station and Structure Maintenance	Maintenance	Documentation of temporary maintenance operations of discharge and diversion structures is kept by SFWMD Operations Control Center staff in logbooks. Corresponding flow and concentration measurements were also taken as required.				
8	Contamination Sites and Residual Agrichemicals	Construction	No contaminated sites discovered.				
9	Vegetation and Operational Enhancements	Operations	STA-1E Cell 2: regraded topography. STA-2: SAV inoculation and planting vegetation strips (cell 8), and inoculation and conversion (cells 2, 5, 6, and 8). STA-5/6: giant bulrush planting (cells 4A and 4B).				
10	STA Operation Plans and Modifications	Operations	There were no updates to STA operation plans in WY2015.				
12	Rotenberger Wildlife Management Area Restoration	Operations/ Maintenance		V3: 16			V3: D
15	Phosphorus Criterion	Operations		V3: 5	V3: 3	V3: 3–4	
16	Diversion	Operations/ Maintenance	After Action Report for STA-3/4 Diversion (low flow water supply) was submitted June 20, 2014.	V3: 2			

Table A-1. Continued.

Specific Condition	Description	Applicable Phase	Action Taken	Reported in *2016 South Florida Environmental Report* (Note: V1 – Volume I, V2 – Volume II, and V3 – Volume III)			
				Narrative (page #'s)	**Figure**	**Table**	**Attachment**
18	Dissolved Oxygen	Operations		V3: 11–13	V3: 4–5	V3: 5–7	
19	Factors Outside Permittee's Control	All	There were no non-compliance events or failures to achieve permit conditions.				
20	Endangered Species/Migratory Bird Treaty Act	All	No non-compliance events occurred.				
21(A-C)	Turbidity Monitoring	Construction/ Maintenance	SFWMD provided turbidity monitoring results to FDEP, as required, for projects that could generate turbidity in receiving waters.				
22	Transect Monitoring	Operations	Monitoring of the Rotenberger Wildlife Management Area was conducted in accordance with the permit.	V3: 16			V3: D
23A	Mercury Monitoring Program	Operations	FDEP approved SFWMD request to terminate other toxicants monitoring in October 2013 after the required monitoring met evaluation criteria.				V3: C
23B	Long Term Monitoring	Operations		V3: All	V3: All	V3: All	V3: All
24 (24A-B)	Annual Levee and Structure Inspections and Reports	Operations	Annual STA Structure & Levee Report was submitted on 2/13/15.				
24B	Periodic (5-Year) Levee and Structure Inspections and Reports	Operations	The 5-Year inspection for STA-3/4 was due in March 2015 and the report was submitted on 5/6/15.				
25	Annual Monitoring Reports	Operations	Annual report completed as required	V3: All	V3: All	V3: All	V3: All
25A	Quality Assurance and Quality Control	Operations	Sampling and analysis were performed according to permit requirements, Chapter 62-160, F.A.C., and the SFWMD water quality monitoring plan.				V3: B
25B	Water Quality Data	Operations					V3: B
25C	Performance Evaluation	Operations		V3: 5–16	V3: 3–5	V3: 3–7	
25D	Herbicide and Pesticide Tracking	Operations					V3: E
25E 1	Implementation Activities; Flow and Load Trends	All		V1: 5B		V1: 5B-1	
25E 2	Facility design modifications	Construction/ Maintenance	Not applicable				

Table A-1. Continued.

Specific Condition	Description	Applicable Phase	Action Taken	Reported in *2016 South Florida Environmental Report* (Note: V1 – Volume I, V2 – Volume II, and V3 – Volume III)			
				Narrative (page #'s)	Figure	Table	Attachment
25E 4	Delays	All	Not applicable.				
25E 5	Facility Recovery Plans	All	No plans being implemented.				
25E 6	Noncompliance	All	None.				
25E 8	Water Quality, Sediment and Vegetation Monitoring of Downstream Transects	Operations					V3: D
25E 9	Recommended Revisions to Facilities	All	None.				
25E 10	Summary of Reports Required in Specific Condition 15	Operations	A Summary of Annual Discharge Performance Report was submitted in July 2014.	V3: 5–8	V3: 3	V3: 3–4	
25E 11	Summary of STA Operations Impacts from Endangered Species Act/ Migratory Bird Treaty Act	Operations	Submitted monthly along with the discharge monitoring report.	V3: 2			V1: App. 5B-5
26	Removal of Parameters	Operations	No parameters were removed during WY2015.				
27	Public Health, Safety, or Welfare	All	No additional parameters requested to be monitored by FDEP.				
28	Temporary Suspension of Sampling	All	Sampling was not suspended during WY2015.				
29	Permit Renewal	All	No renewals were issued.				
30	Permit Modifications	All	Modification 0311207-004 for the STA-1E Independent Flow-way was issued on January 21, 2015.	V3: 5			
32	Reopener Clause	All	Not applicable.				

Attachment B: Water Quality Data

This project information is required by Specific Condition 25 of the Everglades Construction Project Stormwater Treatment Areas permit (0311207), and is available upon request. All sampling and monitoring data referenced in this attachment were collected, analyzed, reported, and retained in accordance with Chapter 62-160, F.A.C.

Attachment C: Annual Permit Compliance Monitoring Report for Mercury in the Everglades Stormwater Treatment Areas

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KEY FINDINGS AND OVERALL ASSESSMENT

This report summarizes data from compliance monitoring of mercury storage, reduction, release, and biomagnification in the Everglades Stormwater Treatment Areas (STAs) for Water Year 2015 (WY2015) (May 1, 2014–April 30, 2015). Key findings are as follows:

- **All STAs under monitoring:** There were no violations of the United States Environmental Protection Agency (USEPA) surface water quality criterion of 12 nanograms (ng) of total mercury (THg) per liter during the reporting year at any of the STAs currently monitored and the projects have met all action level requirements listed in A Protocol for Monitoring Mercury and Other Toxicants, referred to as the Protocol (SFWMD and FDEP 2011). THg concentrations in mosquitofish (*Gambusia holbrooki*) and largemouth bass (*Micropterus salmoides*) in STA interior stations for WY2015 did not exceed USEPA predator protection criteria. In general, THg concentrations in fish for all trophic levels collected from STA interiors are lower than those in fish collected from the Everglades Protection Area (Gu and Howard 2014 2015).
- **STA-1W:** Since WY2009, mercury monitoring in STA-1 West (STA-1W) has been under Phase 3 - Tier 3 (see the *Phase 3: Operational Monitoring* section of this attachment).
- **STA-1E:** During WY2015, STA-1 East (STA-1E) mercury monitoring was under Phase 3 - Tier 1. Collection for surface water THg and methylmercury (MeHg) collections was terminated. Collection for mosquitofish was on a semiannual basis. Collection of large-bodied fishes was on a triennial basis with final sample collection in WY2015. The mercury concentration in mosquitofish from the interior marshes was below the USEPA predator protection trophic level 3 (TL3) fish criterion of 77 nanograms per gram (ng/g). The average THg concentration in the downstream Water Conservation Area (WCA) 1 marsh site slightly exceeded the USEPA predator protection TL3 fish criterion of 77 ng/g. The sunfish (*Lepomis* spp.) THg level exceeded the USEPA predator protection TL3 fish criterion, while

the largemouth bass THg level was below the USEPA predator protection trophic level 4 (TL4) fish criterion.

- **STA-2:** During WY2015, mercury monitoring at STA-2 Cells 1, 2, and 3 was under Phase 3 - Tier 3, which terminates mercury monitoring. Mercury monitoring in the North Buildout (NBO), which includes Cells 4, 5, and 6, and the South Buildout (SBO), which includes Cells 7 and 8, was under Phase 2 - Tier 1. THg concentrations in the NBO and SBO inflow and outflow were considerably lower than the USEPA surface water criterion [12 nanograms per liter (ng/L)]. The average THg concentration in mosquitofish from the STA-2 marsh interior and the downstream site was 18 ng/g and 35 ng/g, respectively, in WY2015. The average THg concentrations in sunfish and largemouth bass were 111 ng/g and 141 ng/g from interior cells. No mosquitofish within or downstream of STA-2 contained mercury concentrations above the USEPA predator protection criteria for TL3 fish. The average THg concentrations in sunfish from interior and downstream and largemouth bass from the downstream were above USEPA criterion for TL3 (77 ng/g) and TL4 (346 ng/g) fish. However, the largemouth bass THg concentration in the interior was well below TL4 fish criterion.
- **STA-3/4:** Consistent with the Protocol, mercury monitoring in STA-3/4 was moved to Phase 3 - Tier 3 on February 20, 2013 after receiving concurrence from the Florida Department of Environmental Protection (FDEP).
- **STA-5/6:** Flow-ways 1 and 2 are under Phase 3 - Tier 3 monitoring. Flow-ways 3, 4, 5, and 6 are under Phase 2 - Tier 1 monitoring. Water column concentrations of both THg and MeHg in these flow-ways were moderate for the inflows and outflows during WY2015 and well below USEPA surface water criterion for THg (12 ng/L). At the outflow, net reductions of THg and loads were approximately 10 percent and net output of MeHg is approximately 18 percent. The average annual mosquitofish composite for WY2015 and each individual mosquitofish composite for all locations within these flow-ways and the downstream site did not exceed the USEPA predator protection criterion for TL3 fish. Sunfish collected from the interior marsh and downstream contained the lowest THg concentrations among the STAs. Largemouth bass collected in the interior site of the flow-ways displayed an annual average level well below the USEPA TL4 fish criterion, while those collected from the downstream site displayed an average concentration above the USEPA TL4 fish criterion.

INTRODUCTION

This attachment contains the annual permit compliance monitoring report for mercury in the Everglades STAs by the South Florida Water Management District (SFWMD or District) and summarizes the mercury-related reporting requirements of FDEP Permit Number 0311207, Specific Condition 23A for STA-1W and STA-1 E, STA-2, STA-3/4, and STA-5/6 under the Everglades Forever Act (EFA) [Chapter 373.4592, Florida Statutes (F.S.)].

This report summarizes results of monitoring in WY2015 for surface water in STA-2 and STA-5/6, and fish of multiple trophic levels in STA-1E, STA-2, and STA-5/6. The results of mercury monitoring downstream of the STAs in accordance with the permit as well as Non-Everglades Construction Project (Non-ECP) discharge structures (permit 06.502590709) are reported separately in Appendix 3-2, Attachment G of this volume.

This report consists of key findings and overall assessment, an introduction and background, and monitoring results. The background section briefly summarizes previously identified and published concerns regarding possible impacts of STA operations on South Florida's mercury problem. The following sections summarize quality assurance (QA)/quality control (QC). The monitoring results section comprises the bulk of new discussion. The last section of this attachment provides updates on mercury monitoring network optimization in each STA.

BACKGROUND

STAs are constructed wetlands designed to remove phosphorus from stormwater runoff originating from upstream agricultural areas and other areas, including Lake Okeechobee releases. The original six STAs, totaling over 65,000 acres and approximately 45,000 acres of effective treatment area, were built as part of the Everglades Construction Project (ECP) authorized under the EFA (Chapter 373.4592, F.S.).

Even before passage of the EFA in 1994, concerns were being raised that attempts to reduce downstream eutrophication could inadvertently aggravate the mercury problem known to be present in the Everglades (Ware et al. 1990, Mercury Technical Committee 1991). These concerns stemmed from studies in other areas that showed flooded soils in new impoundments were sources of inorganic mercury (Cox et al. 1979). Of greater concern, studies also showed wetlands to be a significant site of mercury methylation.

MeHg is more bioaccumulative and toxic than the inorganic or elemental form of mercury (St. Louis et al. 1994, Rudd 1995). Decomposition of flooded terrestrial vegetation and soil carbon in new reservoirs was reported to stimulate the sulfate-reducing bacteria that methylate inorganic mercury (Kelly et al. 1997, Paterson et al. 1998). Environments that favor methylation also drive bioaccumulation. For example, Paterson et al. (1998) found that annual fluxes of MeHg increased 10 to 100 times through a zooplankton community after impoundment.

Newly created reservoirs were also found to contain fish with elevated mercury levels (Abernathy and Cumbie 1977, Bodaly et al. 1984, Bodaly and Fudge 1999). This so-called "reservoir effect" can persist for several decades after initial soil flooding (Bodaly et al. 1984, Verdon et al. 1991, Fink et al. 1999). For instance, Verdon et al. (1991) reported that THg levels in northern pike (*Esox lucius*) increased from 0.61 to 2.99 parts per million (ppm or milligrams per liter) and continued to increase nine years after the initial soil flooding. Given these observations, Kelly et al. (1997) recommended that in siting a new reservoir, total land area flooded should be minimized, and flooding of wetlands, which contain more organic carbon than uplands, should be avoided.

However, applying these recommendations directly to the Everglades is problematic because most of the observations were made in deep water lakes or reservoirs in temperate regions. In a report to the SFWMD on the potential impact of nutrient removal on the Everglades mercury problem, Watras (1993) stated that "the boreal and temperate watersheds, wetlands and reservoirs studied to date are very different geologically, hydrologically, meteorologically, and ecologically from the subtropical systems in the Everglades." Watras recommended monitoring and integrating mass balance and process-oriented studies to understand how this subtropical system would behave. Such studies were initiated in 1994 with the start-up of the prototype STA, the Everglades Nutrient Removal Project (later incorporated within STA-1W). Baseline collections at the project found no evidence of MeHg spikes in either surface water (PTI 1994 attributed to KBN 1994a, Watras 1993, 1994) or resident fish (mosquitofish and largemouth bass) (PTI 1994 attributed to KBN 1994b].

SUMMARY OF THE MERCURY MONITORING AND ASSESSMENT PROGRAM

The following section provides information on current monitoring and reporting activities used for the District's Mercury Monitoring and Assessment Program (SFWMD 1999b). The program was initially developed for the ECP, the Central and Southern Florida Flood Control Project, and the Everglades Protection Area. The SFWMD developed and submitted a plan to FDEP, USEPA, and United States Army Corps of Engineers (USACE) in compliance with the permit requirements (SFWMD 1999a) and was later approved. Details on the procedures for ensuring the quality of and accountability for data generated under this monitoring program were set forth in the SFWMD's Quality Assurance Project Plan for the Mercury Monitoring and Assessment Program (SFWMD 1999b), which was also approved on issuance of the FDEP permit. Revisions to this plan were approved by FDEP on June 7, 1999.

PROTOCOL FOR MONITORING MERCURY AND OTHER TOXICANTS

Phase 1: Baseline Collection and Assessment

Phase 1 baseline collection and assessment is meant to provide information regarding the likelihood that a constructed facility under an EFA project may exacerbate or create a mercury (or other toxicant) problem. Identifying problematic areas will allow managers to avoid sites or areas that may present risk. Phase 1 is operated under three levels: Tier 1 (Compilation and Review of Available Data), Tier 2 (Field Sampling), and Tier 3 (Bioaccumulation Tests and Dynamic Modeling). Under Tier 1, the environmental site assessment is evaluated to determine (1) if any corrective actions were taken during the assessment, (2) there was potential for contamination, or (3) the time interval between the environmental site assessment and project construction. If information data gaps exist, or where the preponderance of baseline data demonstrates a potential problem, then Phase 1 - Tier 2 or Tier 3 is initiated. Under Phase 1 - Tier 2, three representative soil/sediment cores are collected and analyzed from five locations within each operable unit [i.e., Operating Unit (OU), which is each independently operated treatment train] or each 1,000-acre parcel, whichever is smaller, At each location, three cores from the 0-4 centimeter horizon are collected and composited as a single soil sample and analyzed for several constituents that help evaluate MeHg production and mercury bioaccumulation.

Phase 1 - Tier 3 is initiated if at least one of the following occurs: (1) absolute concentrations of MeHg or average percent MeHg in sediments/soils from an OU exceeds the 90 percent upper confidence level of the basin average or, if not available, the 75th percentile concentration (percent MeHg) for all basins; or (2) ambient fish collected with the project boundary demonstrate excessive bioaccumulation that exceeds the 90 percent upper confidence level of the basin-wide average or, if that value is not available, the 75th percentile concentration for all basins. Phase 1 - Tier 3 is used to evaluate extending uncertainties surrounding mercury bioaccumulation. This is accomplished through the use of bioaccumulation testing and modeling.

Phase 2: Monitoring During Three-Year Stabilization Period

If Phase 1 monitoring is not necessary, then Phase 2 - Tier 1 monitoring can occur following OU flow-through. Under Phase 2 - Tier 1, one surface water sample is collected and analyzed for THg and MeHg on a quarterly basis at inflow and outflow structures. Additionally, at least 100 mosquitofish are collected quarterly from multiple locations within each OU to be composited and analyzed for THg. Sunfish and largemouth bass ($n \geq 5$) are collected and analyzed for THg annually.

Six criteria are used to evaluate the performance of each OU with respect to mercury bioaccumulation and enhancement (SFWMD and FDEP 2011). These criteria are related to long-term trends in fish tissue concentrations, surface water THg/MeHg loading, and water quality standards. If any of the action criteria is exceeded, then Phase 2 - Tier 2 is triggered. Tier 2 sequentially involves (1) notifying the permitting authority, (2) resampling the media that triggered Tier 2 monitoring, (3) evaluating the spatial and temporal extent of the mercury bioaccumulation/enhancement accompanied with bioaccumulation modeling, and (4) developing an adaptive management plan.

Phase 3: Operational Monitoring

If after the first three years of monitoring, neither downstream loading nor residue levels in fish have exceeded action levels in the two years prior, then the project can move into Phase 3 - Tier 1 monitoring. Under Phase 3 - Tier 1, (1) surface water sampling is discontinued, (2) the frequency of mosquitofish collection is reduced to semiannually, and (3) the frequency of large-bodied fish collection is reduced to one collection every three years. If the conditions are not met within the first three years, then criteria can be reevaluated annually based on the preceding two-year period.

Phase 3 - Tier 2 is triggered if (1) the annual average THg levels in mosquitofish progressively increase over time, (2) any semiannual mosquitofish composite exceeds the 90 percent upper confidence level of the basin-wide annual average (or, if basin-specific data are lacking, exceeds the 75^{th} percentile concentration for the period of record for all basins), or (3) if triennial monitoring of large-bodied fish (i.e., in years 6 through 9) reveal tissue mercury levels have statistically increased over time (i.e., over two or more years) or have become elevated to the point of exceeding the 90 percent upper confidence level of the basin-wide annual average (or if basin-specific data are lacking, exceeds the 75^{th} percentile for the period of record for all basins).

If fish under Phase 3 operational monitoring have not exceeded action levels by the ninth year, project-specific mercury monitoring can be moved into Phase 3 - Tier 3. Under Phase 3 - Tier 3, all of the project's mercury-related monitoring is discontinued; however, project managers are cautioned that action levels may be revised in the future.

QUALITY ASSURANCE MEASURES

QA/QC are integral to all monitoring programs. A stringent QA/QC program is especially critical when dealing with ultra-trace concentrations of analytes in natural and human-impacted environments. Quality assurance includes design, planning, and management activities conducted prior to implementing the project to ensure that the appropriate types and quantities of data will be collected with the required representativeness, accuracy, precision, reliability, and completeness. The goals of QA are to ensure (1) standard collection, processing, and analysis techniques will be applied consistently and correctly, (2) the number of lost, damaged, and uncollected samples will be minimized, (3) the integrity of the data will be maintained and documented from sample collection to entry into the data record, and (4) data are usable based on project objectives.

QA measures are incorporated during the sample collection and laboratory analysis to evaluate the quality of the data. These measures give an indication of measurement error and bias (or accuracy and precision). Aside from using these results to indicate data quality, an effective QA program must utilize QC results to determine areas of improvement and implement corrective measures. QC measures include both internal and external checks. Typical internal QC checks include replicate measurements, internal test samples, method validation, blanks, and the use of standard reference materials. Typical external QC checks include split and blind studies, independent performance audits, and periodic proficiency examinations. Data comparability is a primary concern because mercury-related degradation of water quality is defined here as relative to baseline data generated by one or more laboratories. It is important to establish and maintain comparability of the performance and results among participating laboratories assessing the reporting units and calculations, database management processes, and interpretative procedures. Comparability of laboratory performance must be ensured if the overall goals of the monitoring program are to be realized.

Laboratory Quality Control

Data for this program was generated by the District and FDEP, both of which are certified by the Florida Department of Health under the National Environmental Laboratory Accreditation Program. The following methods were utilized when analyzing samples for THg and MeHg during WY2012: FDEP–USEPA Method 1631E (Mercury in Water by Oxidation, Purge and Trap, and Cold Vapor Atomic Fluorescence Spectrometry); USEPA Draft Method 1630 (Methylmercury in Water and Tissues by Distillation, Extraction, Aqueous Phase Ethylation, Purge and Trap, Isothermal GC Separation, Cold Vapor Atomic Fluorescence Spectrometry); USEPA Method 245.6 [Mercury in Tissues by Cold Vapor Atomic Absorption Spectrometry (uses liquid digestion)]; EPA 7471A [Mercury in Solids by Cold Vapor Atomic Absorption Spectrometry (uses liquid digestion)]; District–EPA 7473 [Mercury in Solids and Solutions by Thermal Decomposition, Amalgamation, and Atomic Absorption Spectrophotometry (does not incorporate liquid digestion)] (USEPA 1991). All of these methods use performance-based standards employing the appropriate levels of QA/QC required by the National Environmental Laboratory Accreditation Conference, the specific reference method, and the Protocol.

Field Quality Control Samples

For WY2015, 19 field QC samples, including equipment blanks (both laboratory cleaned equipment blanks) and replicate samples were collected for both THg and MeHg surface water samples at STA-2 and STA-5/6. These field QC check samples represented approximately 30 percent of the 61 water samples collected during this reporting period. The results of the field QC blanks are summarized in **Table C-1**. A field kit prep blank is a sample of the deionized distilled water for field QC that remains at the lab to monitor low-level background inorganic mercury contamination of the laboratory deionized distilled water system, which can vary over time. Field kit prep blanks were discontinued effective June 16, 2012, according to the Water Quality Monitoring Division Quality Assurance Team Investigation (QATI) Report QATI 110616-1 (Moorman 2011). An equipment blank is collected at the beginning of every sampling event, and a field clean equipment blank is collected at the end of the event. A trip blank is a blank sample (deionized distilled water) that is used to identify potential contamination during field transport. For this field collection blank, deionized distilled water is carried through the field collection trip, remains sealed in a container, and is then analyzed with all other samples at the FDEP laboratory. Trip blanks were discontinued effective June 16, 2012, according to the Water Quality Monitoring Division Quality Assurance Team Investigation (QATI) Report QATI 033111-1 (Jilek et al. 2011).

The sample corrective action criterion for field cleaned equipment blanks and equipment blanks is currently 10 times the field cleaned equipment blank /equipment blank level. A routine sample associated with field cleaned equipment blanks or equipment blanks is flagged if its value is less than 10 times the method detection limit of 0.1 ng/L for THg, or 0.022 ng/L for MeHg.

Table C-1. Field quality control blanks from STA-2 and STA-5/6 for WY2015. Method detection limits (MDLs) are 0.1 ng/L for THg and 0.022 ng/L for MeHg.

Field QC[a]	THg						MeHg					
	Sample Size (n)[a]	Collection Frequency (%)	Mean (ng/L)[b]	n > MDL	Number Flagged	Percent Flagged[c]	Sample Size (n)[a]	Collection Frequency (%)	Mean (ng/L)[b]	n > MDL	Number Flagged	Percent Flagged[c]
Equipment Blank	4	9.1	-0.1	0	0	0	2	11.8	-0.02	0	0	0
Field Cleaned Equipment Blanks	8	18.2	-0.1	0	0	0	3	17.6	-0.021	0	0	0

a. Total number of respective QA/QC samples

b. Mean concentration of QC samples

c. Percentage of all (QA/QC + monitoring) samples collected for WY2015 (n = 44 for THg and n = 17 for MeHg)

Analytical and Field Sampling Precision

Field replicates samples are collected from the same source as the routine sample using the same sampling equipment. The resulting data are compared to the results of routine samples to evaluate sampling precision.

Laboratory replicates are multiple aliquots of the same sample that are prepared and analyzed within the same run. A replicate consisting of two aliquots of the same sample is referred to as a duplicate. The results of duplicate analyses are used to evaluate analytical precision.

Water Samples

To assess the precision of field collection and analysis, 24 replicate, unfiltered surface water samples (8 THg and 4 MeHg) and mosquitofish composites (12 THg) collected at STA-2 and STA-5/6 were processed during WY2015. **Table C-2** reflects the results of sample analyses. Two replicate samples were matched with one surface water sample. For WY2015, the THg and MeHg relative standard deviations for water samples were below the required 20 percent QA/QC precision level. However, two mosquitofish replicate samples had relative standard deviations that were above 20 percent QA/QC precision.

Table C-2. Relative standard deviations for samples collected within STA-2 and STA-5/6 during WY2015.

Media	Sample Size (n)	% Relative Standard Deviation[a]		
		Minimum	Maximum	Mean
Surface Water THg	8	5.8	8.3	6.8
Surface Water MeHg	4	0.0	4.5	2.3
Mosquitofish THg	12	1.8	25.3	17.3

a. Relative Standard Deviation = standard deviation/average x 100. It is calculated for each sampling event with replicate samples separately (1 sample value + two replicate samples).

Sediment Composite Samples

For WY2015, no sediment samples were collected for mercury analysis.

Inter-laboratory Comparability Studies

To ensure further reproducibility between ongoing mercury sampling initiatives and to evaluate the performance of the District and contract laboratories used for mercury analysis, round robin and performance testing studies for water, fish, and sediment are routinely conducted. These studies are performed by the District and contracted laboratories (Wageningen Evaluating Programmes for Analytical Laboratories 2014–2015).

Surface Water and Fish

As in previous years, inter-laboratory studies were conducted by FDEP to assess the comparability of THg and MeHg analysis in water for several laboratories. Participating laboratories receive nine samples of ambient water from the Everglades for analysis of THg and/or MeHg. In WY2015, the District participated in the Quality Assurance of Information for Marine Environmental Monitoring in Europe studies Round 2014.1 and Round 2014.2, to assess their performance in quantifying mercury in biota.

Sediment

In WY2015, the District laboratory participated in Environmental Resource Associates Soil 88 and Soil 90 performance testing studies to obtain a regular independent assessment of a laboratory's performance and meet requirements for certification for mercury in solid and biological tissue samples. Continued National Environmental Laboratory Accreditation Program certification requires successful participation in performance testing studies every six months.

The District laboratory established permanent participation in soil samples performance evaluation study in WY2015, conducted by the Wageningen Evaluating Programmes for Analytical Laboratories. The District's Chemistry Laboratory participated in four rounds of these studies, at regular time intervals.

SELECTION OF FISH SPECIES AND SIZE RANGE

The proper interpretation of residue levels in tissues can sometimes prove problematic due to the confounding influences of age or species of collected animals. For comparison, special procedures are used to normalize the data (Wren and MacCrimmon 1986, Hakanson 1980). To be consistent with the reporting protocol used by the Florida Fish and Wildlife Conservation Commission (FWC) (Lange et al. 1998, 1999), mercury concentrations in largemouth bass were standardized to an expected mean concentration in three-year-old fish at a given site by regressing mercury against age (EHg3). Currently, the FWC targets largemouth bass between lengths of 307–385 mm, which includes age-3 fish. This length range is targeted to eliminate the need for fish aging. Sunfish were not aged. Instead, arithmetic means were reported. Additionally, the distribution of the different species of sunfish [warmouth (*Lepomis gulosus*), spotted sunfish (*L. punctatus*), bluegill (*L. macrochirus*), and redear sunfish (*L. microlophus*)] that were collected during electroshocking was also qualitatively considered as a potential confounding influence on mercury concentrations prior to each comparison. The target sunfish species is bluegill.

SITE DESCRIPTIONS

Site descriptions and operational plans for STAs are published elsewhere (Piccone et al. 2014). Maps of selected monitoring locations are given with the data for each STA in the *Monitoring Results* section of this attachment.

MONITORING RESULTS

Mercury monitoring in STAs follows the Protocol. For WY2015, surface water samples were collected from STA-2 and STA-5/6 for THg and MeHg analysis, and mosquitofish from STA-1E, STA-2, and STA-5/6. Sunfish and largemouth bass sample were collected from STA-2 and STA-5/6 for THg analysis. Results from each STA will be discussed in the following sections.

STA-1E

STA-1E is currently under Phase 3 - Tier 1 monitoring. Monitoring stations are shown in **Figure C-1**. Mosquitofish composites were collected semiannually in the interior marsh and a downstream site in WY2015. Results showed that average THg concentration of mosquitofish composites was 20 ng/g from three interior sites and 79 ng/g from a downstream site in October 2014 (**Table C-3**). These values were considerably below and slightly above the TL3 fish limit (77 ng/g) for wildlife protection for the interior fish and downstream fish, respectively. Large-bodied fish were collected in WY2015 (**Figure C-2**). The sunfish THg concentration averaged 156 ng/g in the interior site and 153 ng/g at the downstream site, both of which exceeded the TL3 fish limit. The average THg concentration for largemouth bass collected in the STA interior was 314 ng/g, which is below the TL4 fish limit (346 ng/g). No largemouth bass data were available for the downstream station due to lack of samples.

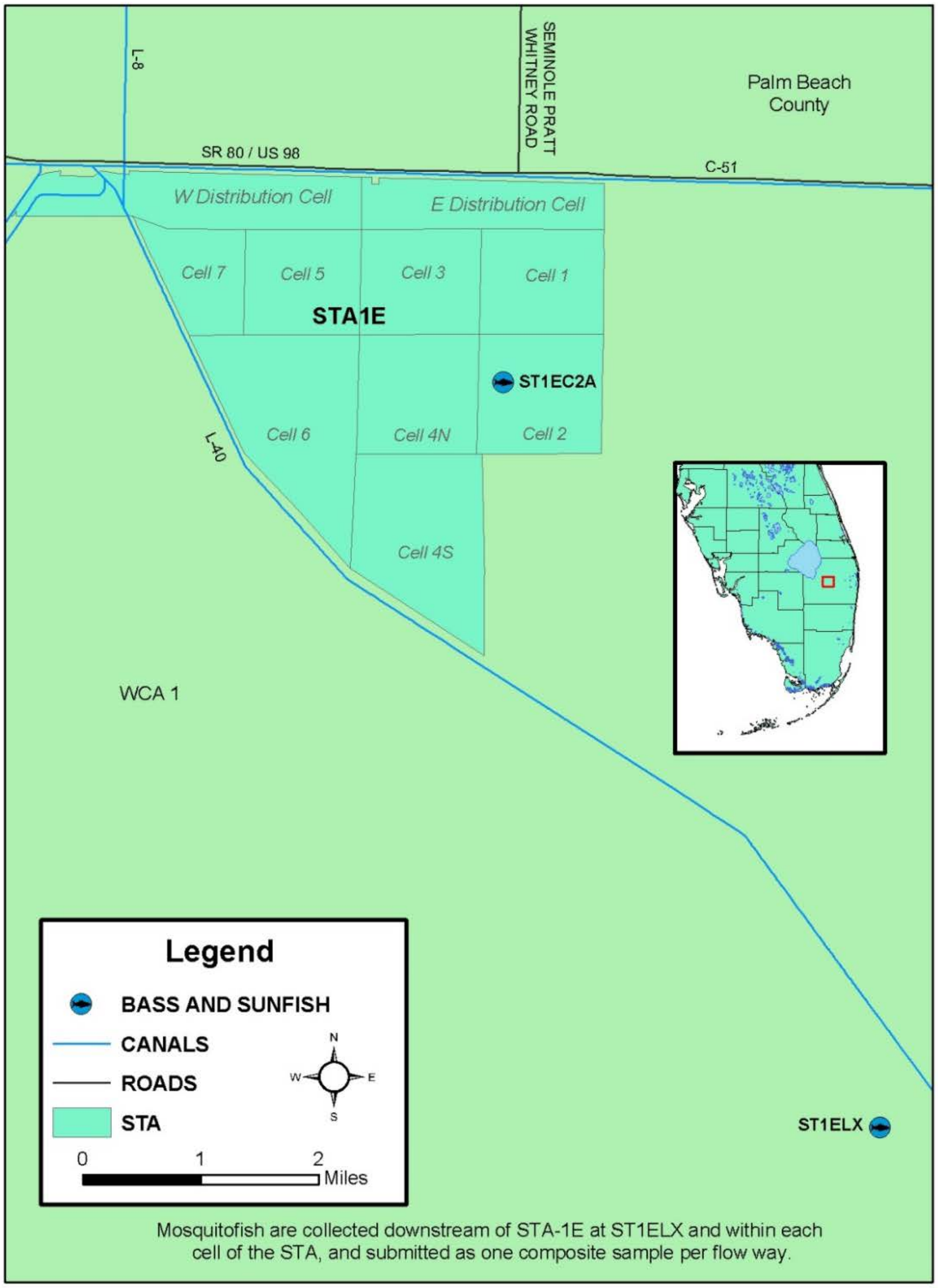

Figure C-1. Map of STA-1E showing mercury monitoring sites. Mosquitofish are collected downstream of STA-1E at ST1ELX and within each cell of the STA, and submitted as one composite sample per flow-way.

Table C-3. Concentration of THg (ng/g, wet weight) in mosquitofish composite samples from STAs during WY2015.

STA	Collection Date	Interior Fish	Collection Date	Outflow/ Downstream Fish
STA-1W		Monitoring Terminated		
STA-1E	16-Oct-14	20	20-Oct-14	79
	Mean	20		79
STA-2 (NBO)	5-May-14	6	05-May-14	18
	7-Aug-14	7	07-Aug-14	25
	30-Oct-14	4	30-Oct-14	18
	29-Jan-15	6	29-Jan-15	15
	22-Apr-15	7	22-Apr-15	ND
	Mean	6		19
STA-2 (SBO)	05-May-14	13	05-May-14	18
	07-Aug-14	24	07-Aug-14	25
	30-Oct-14	20	30-Oct-14	18
	29-Jan-15	10	29-Jan-15	15
	22-Apr-15	11	22-Apr-15	ND
	Mean	16		19
STA-3/4		Monitoring Terminated		
STA-5/6 (Flow-way 3)	01-May-14	12	01-May-14	23
	18-Aug-14	22	18-Aug-14	62
	06-Nov-14	34	06-Nov-14	22
	02-Mar-15	31	02-Mar-15	37
	23-Apr-15	32	23-Apr-15	32
	Mean	26		35
STA-5/6 (Flow-way 4)	01-May-14	16	01-May-14	23
	18-Aug-14	20	18-Aug-14	62
	06-Nov-14	14	06-Nov-14	22
	02-Mar-15	14	02-Mar-15	37
	23-Apr-15	21	23-Apr-15	32
	Mean	17		35
STA-5/6 (Flow-way 5)	01-May-14	13	01-May-14	23
	18-Aug-14	20	18-Aug-14	62
	06-Nov-14	15	06-Nov-14	22
	02-Mar-15	12	02-Mar-15	37
	23-Apr-15	20	23-Apr-15	32
	Mean	16		35
STA-5/6 (Flow-way 6)	01-May-14	17	01-May-14	23
	18-Aug-14	23	18-Aug-14	62
	06-Nov-14	26	06-Nov-14	22
	02-Mar-15	23	02-Mar-15	37
	23-Apr-15	25	23-Apr-15	32
	Mean	18		35

Outflow/Downstream sites are ST1ELX (STA-1E), CA2NF (STA-2), and STA6DC (STA-5/6).

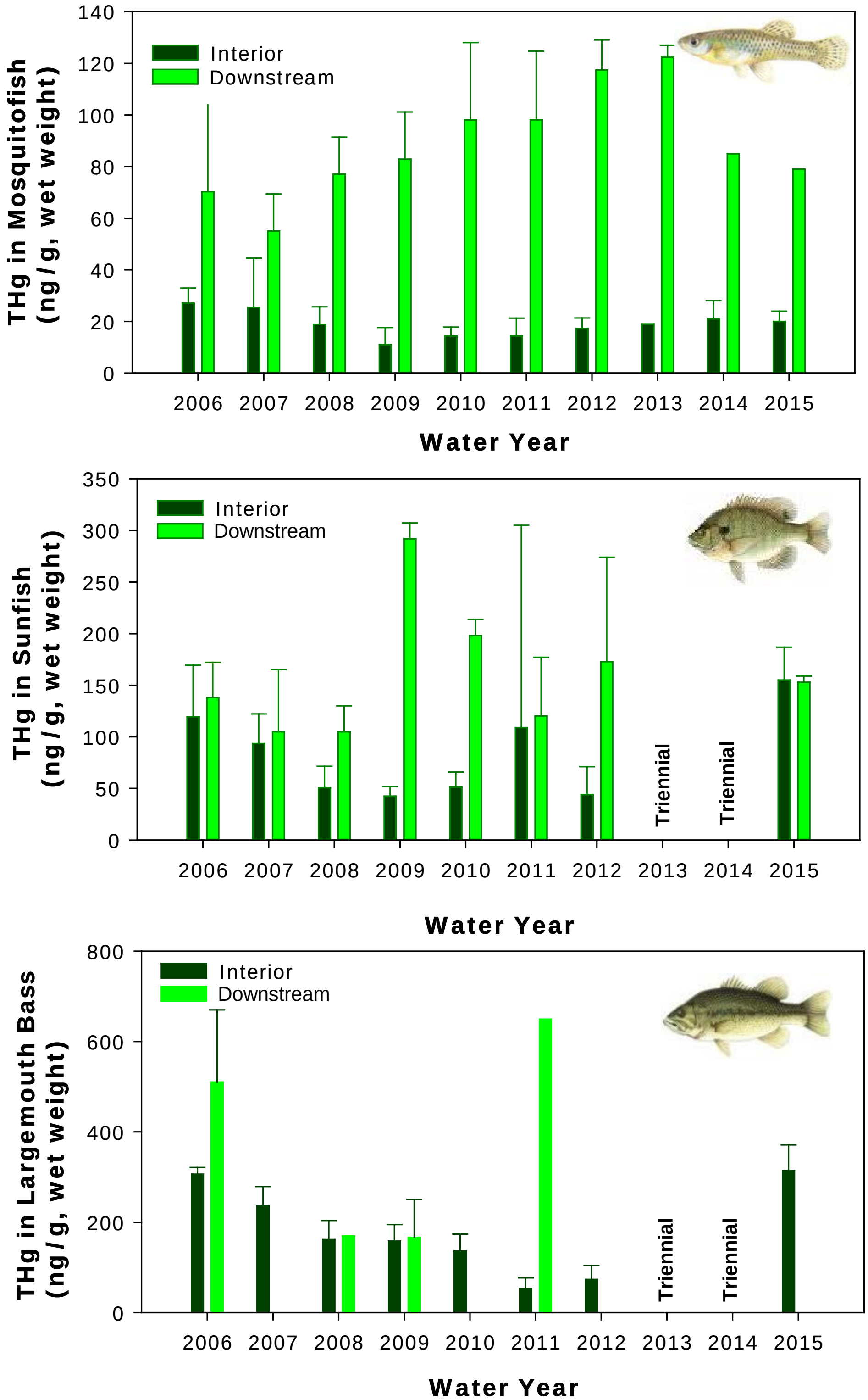

Figure C-2. THg concentrations [ng/g, wet weight, mean ± standard deviation (SD)] in mosquitofish composites (top), whole sunfish (middle), and fillets of largemouth bass (bottom) collected at STA-1E. During Phase 3 - Tier 1, large-bodied fish samples were not taken in WY2015.

STA-2

STA-2 Cells 2 and 3 met mercury start-up criteria in September 2000 and November 2000, respectively. In August 2001, flow-through operation of Cell 1 was approved under a permit modification. Cell 1 met start-up criteria in November 26, 2002. Operational monitoring for mercury at STA-2 began during the third quarter of 2001 after completion of the S-6 connection (Rumbold and Fink, 2002, 2003; Rumbold 2004, 2005; Rumbold et al. 2006). The most recently developed area, Cell 4, passed mercury start-up criteria and flow-through began in 2007. On February 29, 2012, FDEP approved transfer of STA-2 mercury monitoring from Phase 2 – Tier 1: Routine Monitoring during Stabilization Period for STA-2 Cells 1, 2 and 3 to Phase 3 – Tier 3: Routine Operational Monitoring after Year 9 and Phase 3 – Tier 1: Routine Operational Monitoring from Year 4 to Year 9 for STA-2 Cell 4. Phase 3 – Tier 3 implemented the termination of all site specific mercury monitoring at STA-2 Cells 1, 2, and 3 (**Figure C-3**).

The District constructed two new flow-ways in STA-2, known as Everglades Agricultural Area Compartment B Buildout Project (Compartment B). These new flow-ways consist of the NBO, which includes Cells 4, 5, and 6, and the SBO, which includes Cells 7 and 8. Compartment B incorporates the existing Cell 4 (**Figure C-3**). Start-up monitoring (sediment and mosquitofish) in Compartment B began in October 2011. On December 20, 2012, FDEP approved the start-up monitoring be moved to Phase 2 – Tier 1: Routine Monitoring during the Stabilization Period, which requires quarterly collection of surface water samples for THg and MeHg, and quarterly and annual collection of mosquitofish composite and large-bodied fish samples for THg analysis, respectively. Surface water samples were collected at the STA-2 inflow (S6, G328, G434, and G435) and outflow (G335 and G436) stations. Mosquitofish composite samples were collected from NBO, SBO, and a downstream station (CA2NF) in WCA-2. Large-bodied fish samples were collected in Cell 4 (STA2C4A) of NBO, Cell 8 (STA2C8A), and WCA-2 (CA2NF).

Four quarterly sampling events for surface water mercury were taken in WY2015. Results show that THg concentrations at the inflow and outflow did not exceed the USEPA surface water quality criterion of 12 ng/L (**Figure C-4**). The average THg concentration from STA-2 inflow sites (G328, G434, G435, and S6) in WY2015 was slightly higher than the average outflow concentration (G335 and G436). By contrast, the average MeHg concentration at the outflow was higher than that at the inflow (**Figure C-4**).

Because part of the inflow went through other cells that are not currently monitored for mercury, and NBO and SBO shared the same outflow, the mercury reduction for NBO and SBO cannot be evaluated separately. Therefore, mercury load estimates were conducted for the entire STA-2.

The annual mercury loading from all inflow sites was 742 grams of THg and 48 grams of MeHg. The outflow mercury load was 739 grams of THg and 58 grams of MeHg, which represented a net reduction of 0.4 percent of THg and a net output of 21 percent for MeHg (**Table C-4**). The net production of MeHg within STA-2 was likely the result of dryout and rewetting, which facilitated mercury methylation.

Table C-3 and **Figure C-5** summarize the results from the operational monitoring of mosquitofish mercury concentrations in STA-2 Compartment B (ST2NBO and ST2SBO) for WY2015. The average mosquitofish composite for the NBO was 6 ng/g, while the average THg concentration for SBO was 16 ng/g, both of which were well below USEPA TL3 fish criterion (77 ng/g). The average THg concentration of mosquitofish at the downstream site was 19 ng/g, which was also well below USEPA TL3 fish criterion.

Table C-5 and **Figure C-5** summarize the results from the operational monitoring of large-bodied fish mercury concentrations in STA-2 Compartment B (ST2C4A and ST2C8A) for WY2015. The average THg concentration of sunfish was 111 ng/g in the interior and 101 ng/g in the downstream site, which are above the TL3 fish criterion. The average THg concentration of largemouth bass was 141 ng/g and 117 ng/g for the interior and the downstream site, respectively. These values are below the USEPA TL4 fish criterion (346 ng/g).

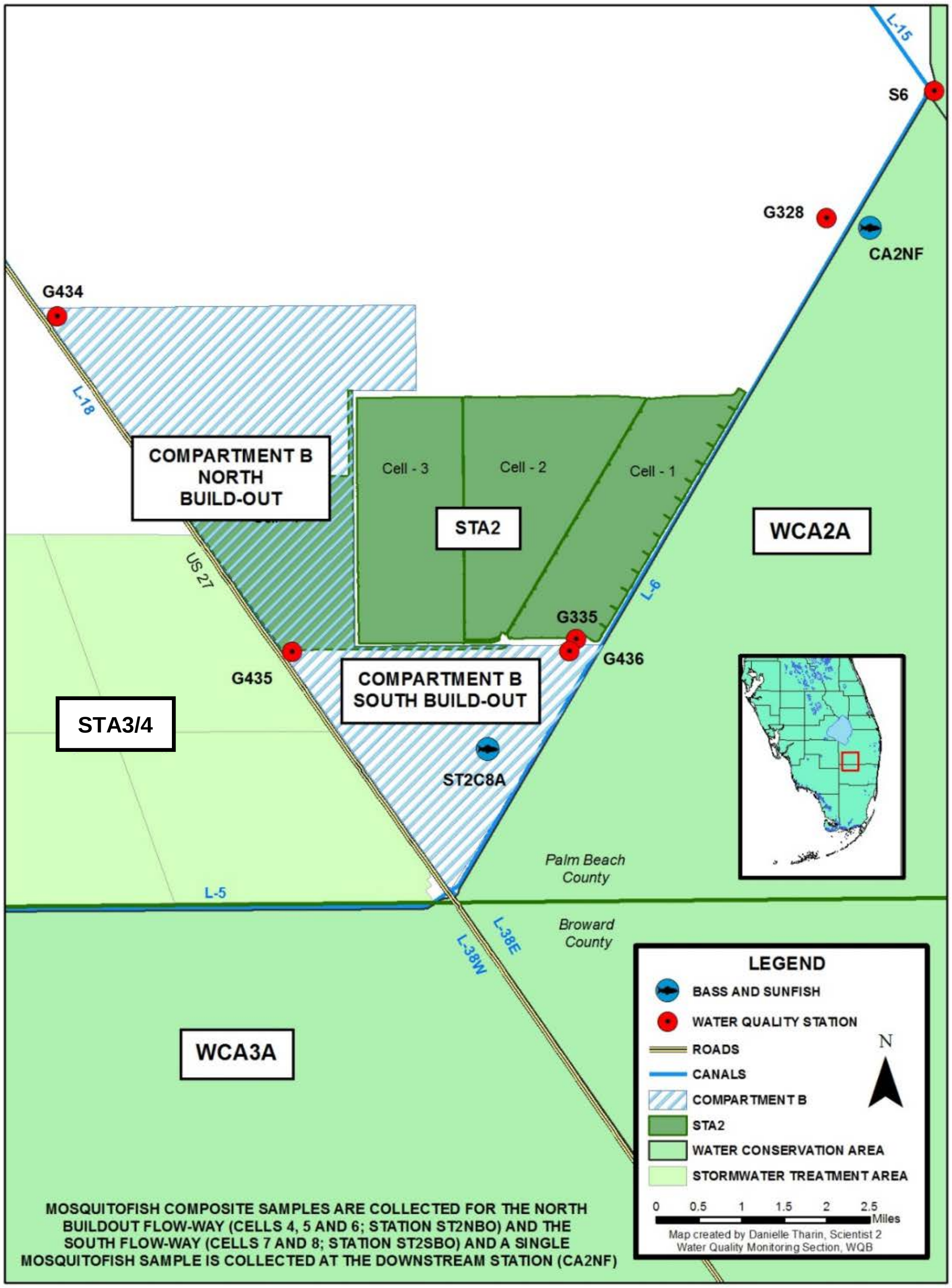

Figure C-3. Map of STA-2 showing current mercury monitoring sites. Mosquitofish samples are collected from downstream station CA2NF and in each cell, and then submitted as a composite for each flow-way.

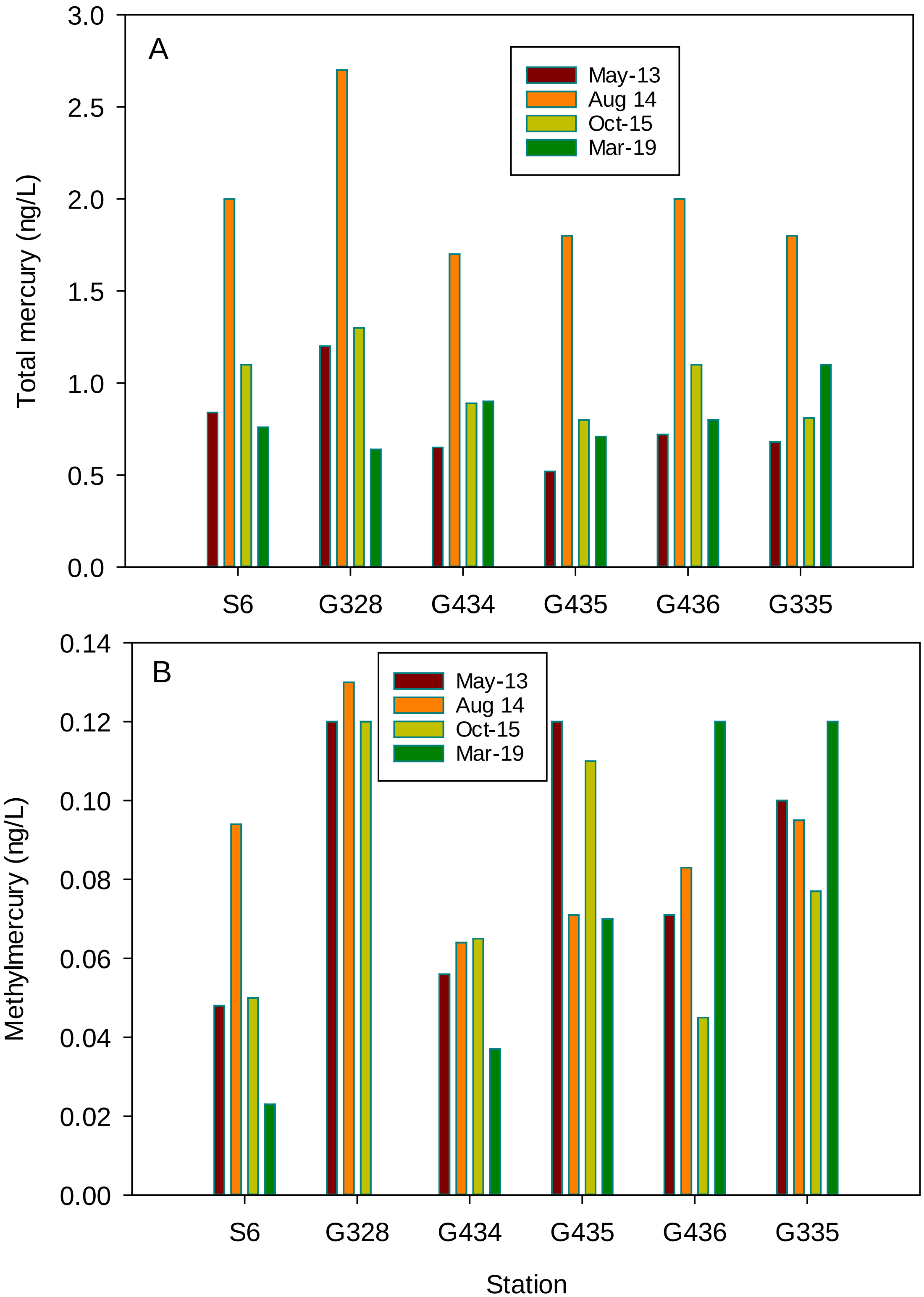

Figure C-4. Concentrations of THg (A) and MeHg (B) in unfiltered surface water collected at inflow (S6, G328, G434, and G435) and outflow stations (G436 and G335) from STA-2 during WY2015.

Table C-4. THg and MeHg inflow and outflow loads[a] in grams for WY2015.

STA	Inflow Load		Outflow Load		% Reduction[b]	
	THg	MeHg	THg	MeHg	THg	MeHg
STA-1W	Terminated					
STA-1E	Terminated					
STA-2 NBO/SBO	742	48.0	739	58.0	0.4%	-21.0%
STA-5/6 Flow-way 3,4,5,6	151	8.5	133	10.8	12.8%	-21.5%

a. Calculated as total flow volume for water year (in cubic meters) x average THg or MeHg concentration (grams per cubic meter)

b. (inflow - outflow/inflow)*100

Table C-5. Concentration of THg (ng/g, wet weight) in sunfish collected from STAs in WY2015 [mean ± standard deviation (SD)]. Sample size is in parentheses. Cumulative mean includes all data for the period of record.

STA	Interior Fish	Outflow/Downstream Fish
STA-1W	*No results; monitoring terminated in 2009*	
STA-1E	156 ± 32 (5)	153 ± 6 (3)
Cumulative Mean	67	161
STA-2	111 ± 45 (5)	101 ± 117 (20)
Cumulative Mean	95	119
STA-3/4	*No results; monitoring terminated in 2012*	
STA-5/6 Flow-ways 3, 4, 5 and 6	30 ± 6 (5)	63 ± 34 (5)
Cumulative Mean	44	60

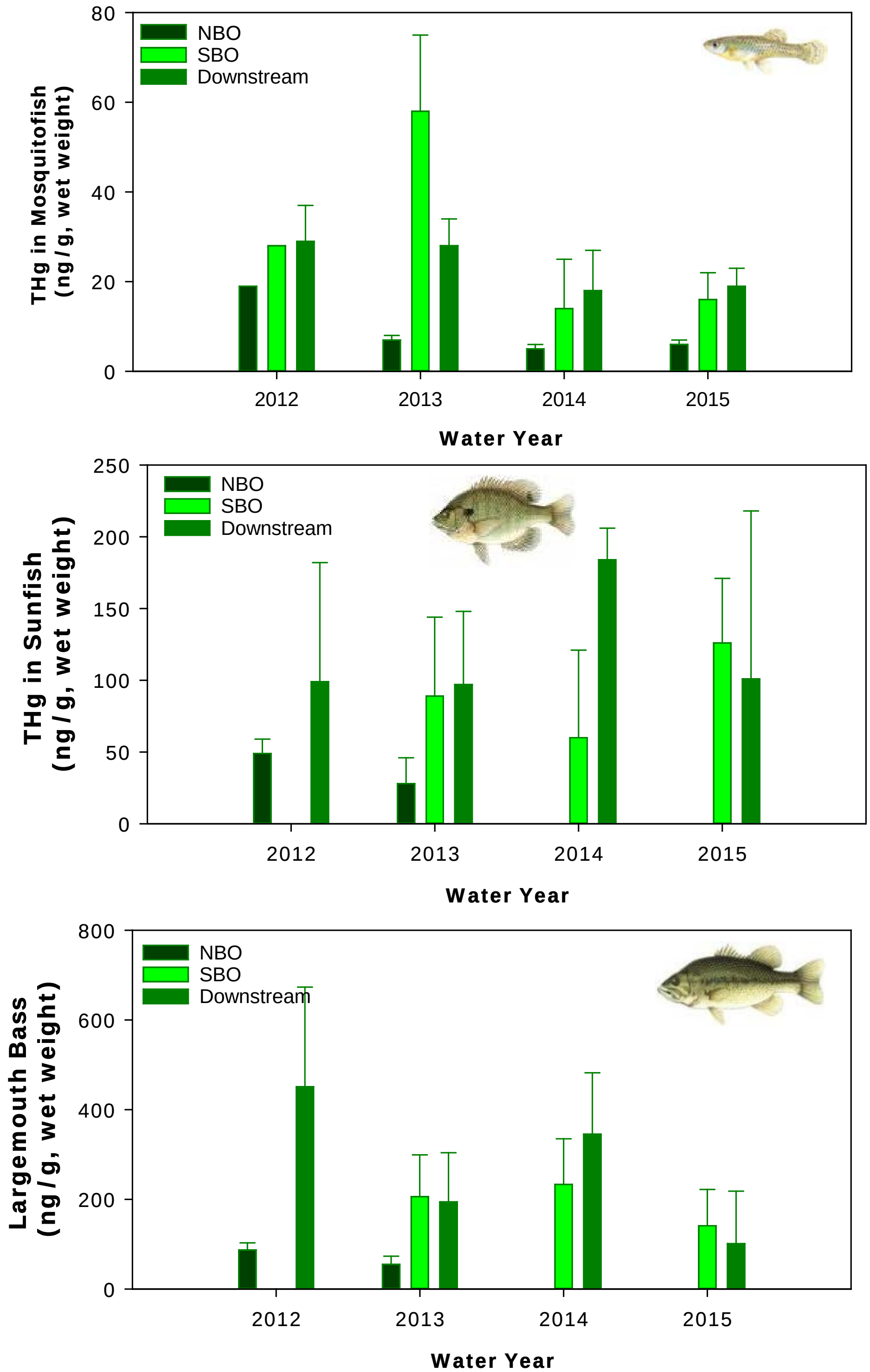

Figure C-5. Mercury concentrations (ng/g, wet weight, mean ± SD) in mosquitofish composites (top), whole sunfish (middle), and fillets of largemouth bass (bottom) collected at STA2C4A (NBO), STA2C8A (SBO), and the downstream site at WCA-2 (CA2NF) from WY2012 to WY2015.

STA-3/4

On February 20, 2013, FDEP approved the transfer of STA-3/4 mercury monitoring from Phase 3 - Tier 1: Routine Operational Monitoring from Year 4 to Year 9 to Phase 3 - Tier 3: Routine Operational Monitoring after Year 9. This implemented the termination of all site-specific mercury monitoring at STA-3/4. Prior to this approval, THg level in mosquitofish composite samples collected on October 22, 2012, was 10 ng/g for the interior marshes (an average of three cells) and 22 ng/g for a downstream site, respectively (**Table C-3**), which were well below USEPA predator protection criteria for TL3 fish.

STA-5/6

On December 31, 2009, FDEP approved the District's request to move mercury monitoring in Flow-ways 1 and 2 from Phase 3 - Tier 1 to Phase 3 - Tier 3. This implemented termination of all site-specific mercury monitoring in those flow-ways. Flow-way 3 is under Phase 2 - Tier 1 Monitoring: Routine Monitoring during the Stabilization Period. In September 2012, the District completed construction of the Everglades Agricultural Area Compartment C Buildout Project (Compartment C). Compartment C includes the G-508 pump station, STA-5 Flow-way 4 (consisting of Cells 5-4A and 5-4B), STA-5 Flow-way 5 (consisting of Cells 5-5A and 5-5B), and STA-6 Cell 6-4. STA-6 Cell 6-4, combined with the existing Cell 6-2, forms Flow-way 6. The entire STA-5, STA-6, and Compartment C Buildout complex is now referred to as STA-5/6. Compartment C, which passed the start-up monitoring in 2012 and is currently under Phase 2 - Tier 1 monitoring (**Figure C-6**).

In July 2013, the District completed one year (i.e., four quarterly sampling events) of Phase 2 – Tier 1: Routine Monitoring during Stabilization Period. Based on guidance contained in the Protocol, after one year of monitoring, project managers may elect to reduce the number of OUs sampled for large-bodied fish to one OU with the highest observed concentration of mercury and one downstream station and assess results as "worst case". Consistent with this guidance and with concurrence of FDEP, the District terminated large-bodied fish monitoring at downstream station RA1 and STA-5/6 Flow-way 3 (station STA5C3B1), Flow-way 4 (station STA5C4B1), and Flow-way 6 (station STA6S2), and retained monitoring Flow-way 5 (station STA5C5B1) as "worst case", effective October 2, 2013. Based on an evaluation submitted to FDEP on October 1, 2013, it was determined that Flow-way 6 has slightly higher concentrations of mercury than Flow-way 5; however, Flow-way 6 is maintained at a lower operational priority for receiving inflow water for treatment and tends to dry-out. Large-bodied fish were monitored in Flow-way 5 since it was determined to have the second highest concentrations of mercury, a higher operational priority than Flow-way 6, and there is a greater likelihood of obtaining bass, sunfish, and mosquitofish samples from that flow-way.

The Protocol requires fish monitoring at one downstream station per project. In September 2012, Compartment C combined with the former STA-5 and STA-6 to form STA-5/6. Because the STA-5/6 complex now operates as one project, the number of downstream stations was reduced from two (i.e., stations RA1 in Rotenberger Wildlife Management Area and STA6DC in the STA-5/6 discharge canal) to one (i.e., STA6DC). Downstream mosquitofish THg concentrations were significantly higher at STA6DC than RA1. Furthermore, the Rotenberger Wildlife Management Area does not provide hydrological conditions favorable for recruitment of large-bodied fish, and the District was frequently unable to obtain a full quota (n = 5) of largemouth bass at station RA1. For these reasons, and with concurrence of FDEP, station STA6DC was retained as the STA-5/6 downstream monitoring station, and all monitoring was terminated at station RA1, effective October 2, 2013.

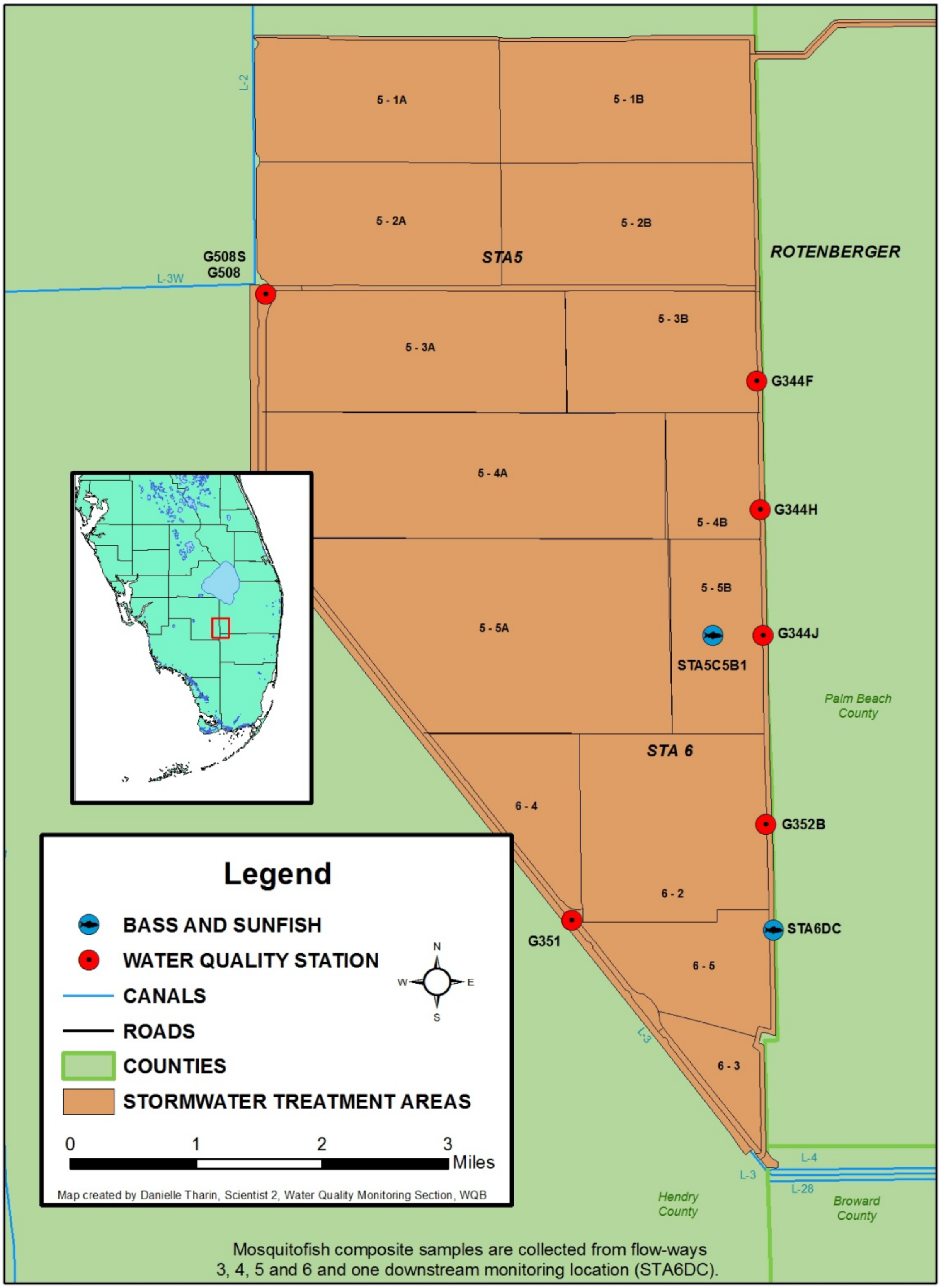

Figure C-6. Map of STA-5/6 showing current mercury monitoring sites. Mosquitofish composite samples are collected for each flow-way and composited, and collected at two downstream sites (RA1, first quarter only) and (STA6DC). Large-bodied fish are collected at one interior station (STA5CB1) and a downstream site (STA6DC).

Four quarterly samples for THg and MeHg in surface water were collected from an inflow station (G508) and each of the 4 flow-way outflows (Flow-ways 3, 4, 5, and 6) in WY2015 (**Figure C-7**). Water column concentrations of THg and MeHg from Flow-way 3 in WY2015 displayed some of the lowest values, compared to other flow-ways. This is consistent with previous results. No THg sample was above the 12 ng/L USEPA surface water criterion. For WY2015, the inflow and outflow THg load were 151 and 133 grams per year, reflecting a 12 percent reduction for the outflow. The inflow and outflow MeHg loads were 8.5 and 10.8 grams per year, reflecting a -21.5 percent net output (**Table C-4**).

Mosquitofish composites collected from Flow-ways 3, 4, 5, and 6 in WY2015 (**Figure C-6**) contained low annual mean mercury concentrations (**Figure C-8**) compared to other STAs (**Table C-3**). The average annual mosquitofish composite for WY2015 was 18 ng/g for the interior sites and 35 ng/g for the downstream site (ST6DC). Each individual mosquitofish composite (12 to 34 ng/g) for all locations within STA-5/6 Flow-ways 3 to 6 and the downstream site (22 to 62 ng/g) did not exceed the period of record 75th percentile for all downstream Everglades sampling locations.

Large-bodied fish samples were collected at one interior station (STA5C5B) and one downstream station (STA6DC) during WY2015 (**Figure C-6**). Sunfish collected from the interior marsh and the downstream stations in WY2015 contained an average THg level of 30 ng/g and 63 ng/g, respectively (**Table C-5**), which is below the TL3 fish standard (77 ng/g and 100 ng/g) by the USEPA and United States Fish and Wildlife Service, respectively (**Figure C-8**).

For WY2015, 10 individual largemouth bass were caught at the interior station and the downstream station. Among these, four individuals from the interior marsh and two individuals form the downstream station fell into the range of total length (307 to 385 millimeters) required by the Protocol. The average THg concentration was 124 ng/g for the interior (**Table C-6**), which is below the USEPA TL4 fish standard (346 ng/g). The average THg concentration for the downstream station was 756 ng/g, which is higher than the previous two water years (**Figure C-8**).

Regarding the risk to fish-eating wildlife, the resident mosquitofish within and downstream from STA-5/6 contained average mercury levels below the USEPA criterion of 77 ng/g for TL3 fish species. No bluegills from Flow-ways 3, 4, 5, and 6 and the downstream site exceeded the USEPA criterion (77 ng/g) of TL3 fish. No largemouth bass from the interior marsh and all five individuals from the downstream site were above the USEPA criterion of TL4 fish (346 ng/g). Therefore, the risk of mercury exposure to fish-eating wildlife foraging preferentially at interior is low within STA-5/6 and high at downstream locations.

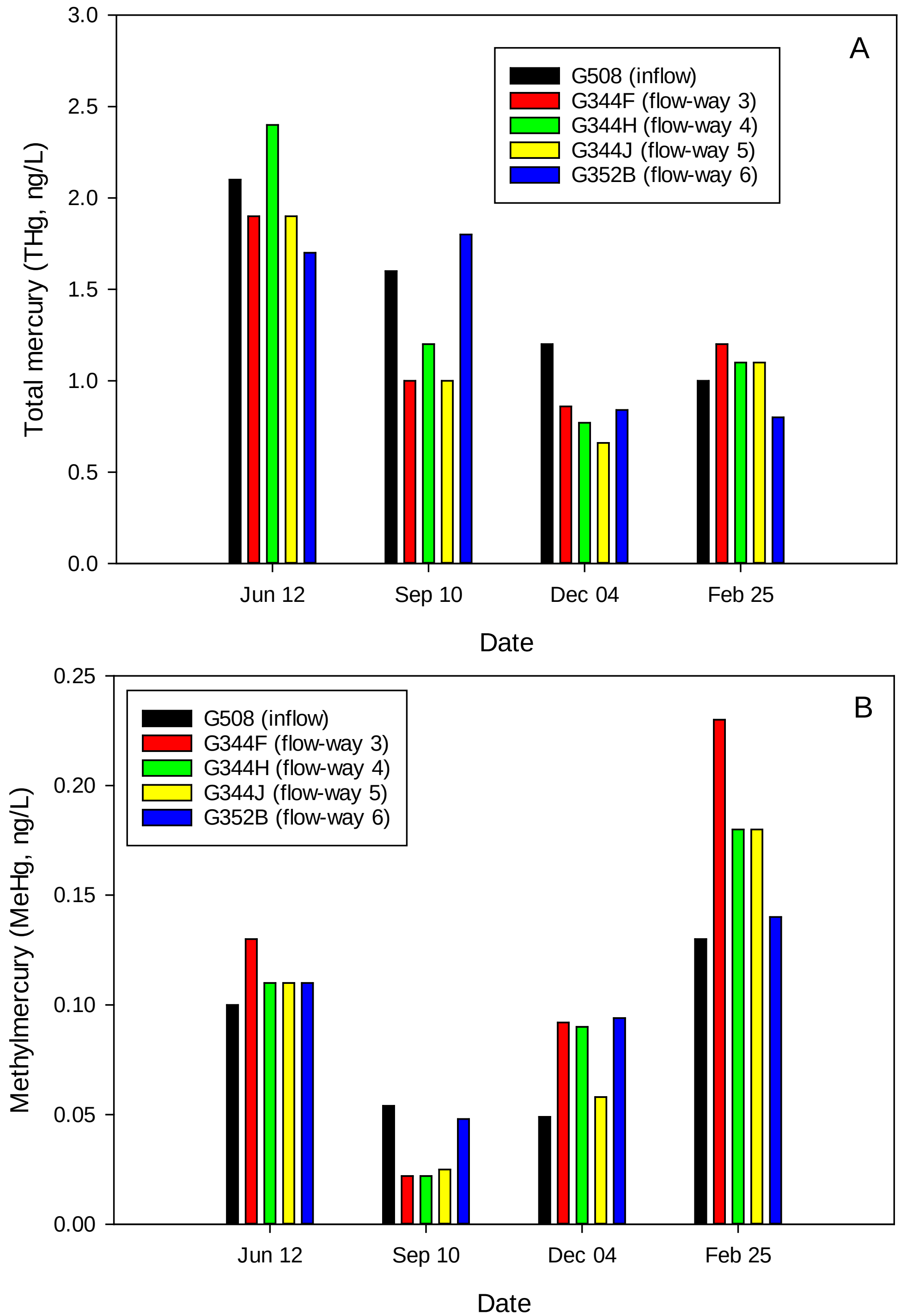

Figure C-7. Concentrations of THg (A) and MeHg (B) in unfiltered surface water collected at inflow and outflow(G508) of Flow-way 3 (G344F), Flow-way 4 (G344H), Flow-way 5 (G344J), and Flow-way 6 (G352B) of STA-5/6.

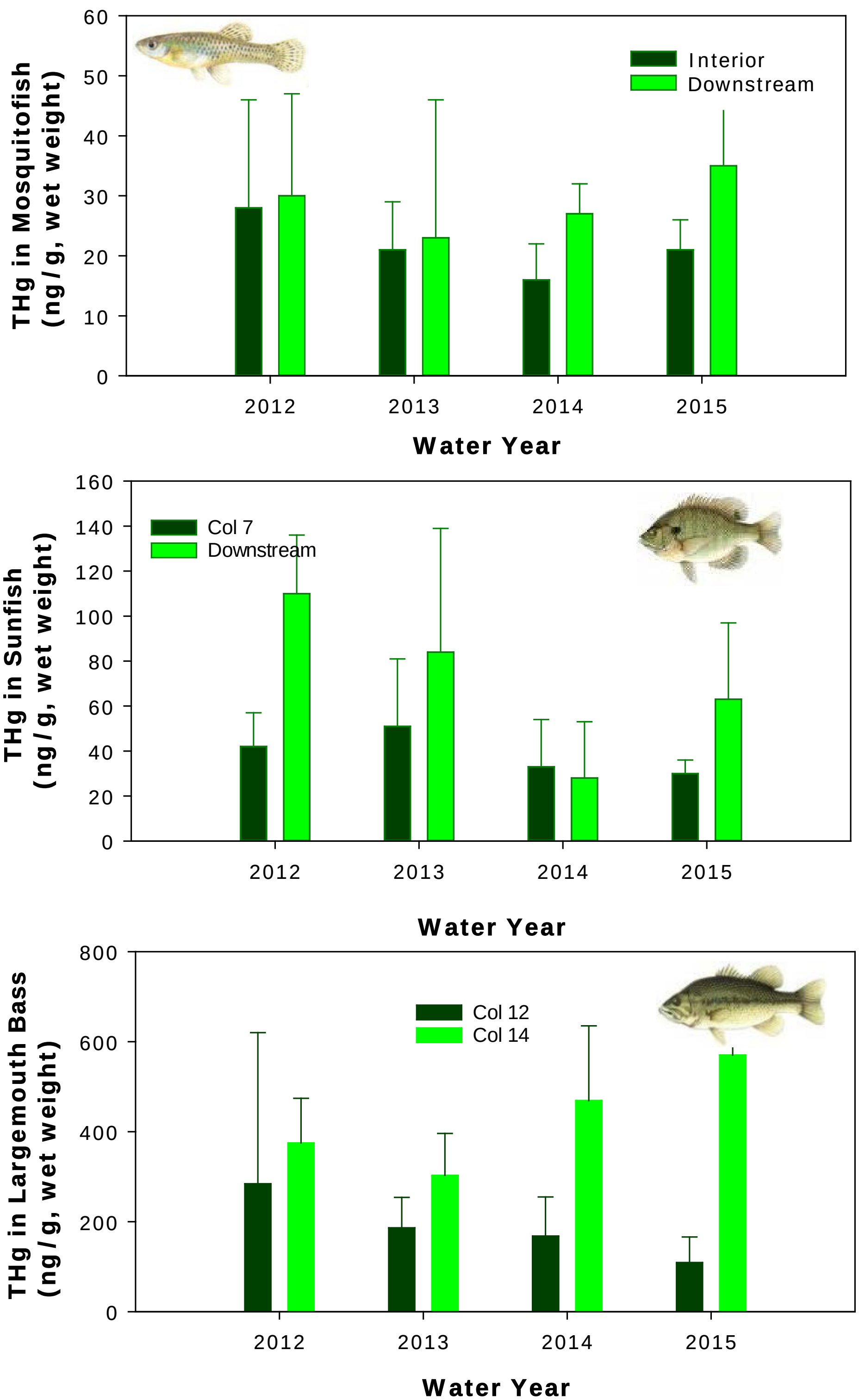

Figure C-8. THg concentrations (ng/g, wet weight, mean ± SD) in mosquitofish composites (top), whole sunfish (middle), and fillets of largemouth bass (bottom) collected at Flow-ways 3, 4, and 5 (mosquitofish and sunfish) and all sites (largemouth bass) of STA-5/6.

Table C-6. Largemouth bass THg concentrations (ng/g, wet weight) collected in the STAs between 307 and 385 millimeters for WY2015 (mean ± SD, sample size). In parentheses all data is presented, which includes data within and outside of the 307–385 millimeter range. Cumulative mean includes all fish for the period of record.

STA	Interior Fish	Outflow/Downstream Fish
STA-1W	*No results, monitoring terminated in 2009*	
STA-1E	316 ± 65 ,4 (314 ± 57 ,5)	No samples
Cumulative mean	164	300
STA-2[a]	86 ± 131, 3 (141 ± 81, 5)	1143 ± 386, 4 (509 ± 307, 20)
Cumulative mean	147	330
STA-3/4	*No results, monitoring terminated in 2013*	
STA-5/6 Flow-way 3, 4, 5, 6	124 ± 54, 4 (109 ± 57, 5)	756, 2 (570 ± 129, 5)
Cumulative mean	202	377

a. Data are from Compartment B (STA2C4A and STA2C8A).

MERCURY MONITORING NETWORK OPTIMIZATIONS

The summaries below provide information on the current mercury monitoring phase for each STA. These phases are concurrent with guidance contained in the Protocol.

STA-1W

The permit modification for moving from Phase 3 - Tier 1 to Phase 3 - Tier 3 was issued August 21, 2009. Phase 3 - Tier 3 terminated all mercury monitoring in STA-1W (mosquitofish stations ST1W13COM, ST1W24COM, ST1WC5COM, ENR012, G310, and ST1WLX; bass and sunfish stations ST1W51, ENR012, G310, and ST1WLX).

STA-1E

Mercury monitoring in STA-1E is currently in Phase 3 - Tier 1. On February 29, 2012, FDEP approved transfer of STA-1E mercury monitoring from Phase 2 - Tier 1: Routine Monitoring during Stabilization Period to Phase 3 - Tier 1: Routine Operational Monitoring from Year 4 to Year 9 for all flow-ways (Western, Central, and Eastern), which include Cells 1, 2, 3, 4N, 4S, 5, 6, and 7 of STA-1E. Phase 3 - Tier 1 terminated all mercury surface water monitoring at STA-1E (stations G-311, S-362, S-361, and S-319), reduced the mosquitofish monitoring frequency from quarterly to semiannually, bass and sunfish monitoring frequency from annually to triennially, and reduced the number of bass and sunfish monitoring stations from all flow-ways to one flow-way with the historically highest mercury concentrations (station ST1EC2A in Cell 2 of the eastern flow-way) and one downstream station (ST1ELX). Bass and sunfish monitoring were terminated in the Central (station ST1EC4SA in Cell 4S) and Western (station ST1EC6A in Cell 6) flow-ways.

STA-2

Mercury monitoring in STA-2 is currently in Phase 3 - Tier 3: Routine Operational Monitoring after Year 9 for Cells 1, 2, and 3 and Phase 2 - Tier 1: Routine Monitoring During Stabilization Period for Compartment B Cells 4, 5, 6, 7, and 8.

On February 29, 2012, FDEP approved transfer of STA-2 mercury monitoring from Phase 2 - Tier 1: Routine Monitoring during Stabilization Period for Cells 1, 2, and 3 of STA-2 to Phase 3 - Tier 3: Routine Operational Monitoring after Year 9 and Phase 3 - Tier 1: Routine Operational Monitoring From Year 4 to Year 9 for Cell 4 of STA-2. Phase 3 - Tier 3 implemented the termination of all site specific mercury monitoring at STA-2 Cells 1, 2, and 3 (mosquitofish stations ST2C1COM, ST2C2COM, and ST2C3COM).

In August 2012, the District completed construction of the Everglades Agricultural Area Compartment B Buildout Project (Compartment B). Compartment B includes three pump stations (G-434, G-435, and G-436) and two flow-ways: the NBO, which includes Cells 4, 5, and 6 and the SBO, which includes Cells 7 and 8. Compartment B incorporated the existing Cell 4. Startup monitoring for mercury and other toxicants was performed for Compartment B in September (mosquitofish) and October (sediment) 2011 to capture the "first-flush effect" when the NBO and SBO were initially inundated. Compartment B met the mercury and other toxicant startup criteria specified in Specific Condition 23 of EFA Permit Number 0311207 in October 2011 (see data summary provided in correspondence from H. Andreotta, SFWMD, dated December 14, 2012). On December 20, 2012, FDEP approved transfer of monitoring from Phase 1 - Tier 2: Field Sampling for Initial Startup Monitoring prior to Discharge to Phase 2 - Tier 1: Routine Monitoring during Stabilization Period for Compartment B (Cells 4, 5, 6, 7, and 8).

In July 2013, the District completed one year (i.e., four quarterly sampling events) of Phase 2 - Tier 1: Routine Monitoring during Stabilization Period. Based on guidance contained in the Protocol (page 14, 2nd paragraph), after one year of monitoring, project managers may elect to reduce the number of OUs sampled for large-bodied fish to one OU with the highest observed concentration of mercury and one downstream station, and assess results as "worst case". Consistent with this guidance (see data summary provided in correspondence from H. Andreotta, SFWMD, dated October 1, 2013) and with concurrence of FDEP, the District terminated large-bodied fish monitoring at the Compartment B NBO station ST2C4A and will monitor SBO station ST2C8A as "worst case", effective October 2, 2013.

The Protocol also states that if, after one year of monitoring, action level criteria are met, surface water sampling for other toxicants would be discontinued. If levels of other toxicants in tissues do not exceed recognized background tissue concentrations or benchmarks established in ecological risk assessments completed as part of the environmental site assessment, then sampling would be discontinued. Compartment B met these criteria (see data summary provided in correspondence from H. Andreotta, SFWMD, dated October 1, 2013) and on October 2, 2013, FDEP approved termination of monitoring for other toxicants.

STA-3/4

Mercury monitoring in STA-3/4 is currently in Phase 3 - Tier 3. In October 2012, all Phase 3 - Tier 1 mercury monitoring criteria were met (see correspondence from H. Andreotta, SFWMD, dated January 17, 2013). On February 20, 2013, FDEP approved transfer of STA-3/4 mercury monitoring from Phase 3 - Tier 1: Routine Operational Monitoring from Year 4 to Year 9 to Phase 3 - Tier 3: Routine Operational Monitoring after Year 9. This implemented termination of all site specific mercury monitoring at STA-3/4 (semiannual mosquitofish monitoring at stations STA34C1COM, STA34C2COM, and STA34C3COM and triennial bass and sunfish monitoring at stations STA34C22 and L5F1.)

STA-5/6

Mercury monitoring at STA-5/6 is currently in Phase 3 - Tier 3: Routine Operational Monitoring after Year 9 for STA-5/6 Flow-ways 1, 2, 7, and 8 and Phase 2 - Tier 1: Routine Monitoring during Stabilization for STA-5/6 Flow-ways 3, 4, 5, and 6. STA-5 Flow-ways 1 and 2 met Phase 3 - Tier 3: Routine Operational Monitoring after Year 9 conditions in November 2008 (see data summary provided in correspondence from G. Vince, SFWMD, dated October 12, 2009, and data for the final November 2009 fish collection submitted to FDEP in December 2009 by H. Andreotta, SFWMD).

FDEP issued minor permit modification 0236905-001 on June 6, 2008, approving transfer of mercury monitoring from Phase 2 - Tier 1: Routine Monitoring during Stabilization Period to Phase 3 - Tier 3: Routine Operational Monitoring from Year 4 to Year 9 for STA-6 Section 1. Phase 3 - Tier 3 implemented the termination of all site specific mercury monitoring at STA-6 Section 1.

In September 2012, the District completed construction of the Everglades Agricultural Area Compartment C Buildout Project (Compartment C). Compartment C includes the G-508 pump station, STA-5 Flow-way 4 (consisting of Cells 5-4A and 5-4B), STA-5 Flow-way 5 (consisting of Cells 5-5A and 5-5B), and STA-6 Cell 6-4. STA-6 Cell 6-4 combined with the existing Cell 6-2 formed Flow-way 6. The entire STA-5, STA-6, and Compartment C Buildout complex is now referred to as STA-5/6.

Startup monitoring for mercury and other toxicants was performed for Compartment C in September (mosquitofish) and October (sediment) 2011 to capture the "first-flush effect" when the project was initially inundated. Compartment C met the mercury and other toxicant startup criteria as specified in Specific Condition 23 of EFA Permit Number 0311207 in October 2011 (see data summary provided in correspondence from H. Andreotta, SFWMD, dated December 14, 2012). On December 20, 2012, FDEP approved transfer of monitoring from Phase 1 - Tier 2: Field Sampling for Initial Startup Monitoring prior to Discharge to Phase 2 - Tier 1: Routine Monitoring during Stabilization Period for Compartment C (Flow-ways 4, 5, and 6).

In July 2013, the District completed one year (i.e., four quarterly sampling events) of Phase 2 - Tier 1: Routine Monitoring during Stabilization Period. Based on guidance contained in the Protocol, after one year of monitoring project managers may elect to reduce the number of OUs sampled for large-bodied fish to one OU with the highest observed concentration of mercury and one downstream station and assess results as "worst case". Consistent with this guidance and with concurrence of FDEP, the District terminated large-bodied fish monitoring at STA-5/6 Flow-way 3 (station STA5C3B1), Flow-way 4 (station STA5C4B1), and Flow-way 6 (station STA6S2), and will monitor Flow-way 5 (station STA5C5B1) as "worst case", effective October 2, 2013. Based on an evaluation submitted to FDEP on October 1, 2013, it was determined that Flow-way 6 has slightly higher concentrations of mercury than Flow-way 5, however, Flow-way 6 is maintained at lower operational priority for receiving inflow water for treatment and tends to dry-out. Large-bodied fish will be monitored in Flow-way 5 since it was determined to have the second highest concentrations of mercury, a higher operational priority than Flow-way 6, and there is a greater likelihood of obtaining bass, sunfish, and mosquitofish samples from that flow-way.

The Protocol requires fish monitoring at one downstream station per project. In September 2012, Compartment C combined with the former STA-5 and STA-6 to form STA-5/6. Because the STA-5/6 complex now operates as one project, the number of downstream stations was reduced from two (i.e., stations RA1 in Rotenberger Wildlife Management Area and STA6DC in the STA-5/6 discharge canal) to one (i.e., STA6DC). Downstream mosquitofish THg concentrations were significantly higher at STA6DC than RA1. Furthermore, Rotenberger Wildlife Management Area does not provide hydrological conditions favorable for recruitment of large-bodied fish, and the District was frequently unable to obtain a full quota (n = 5) of largemouth bass at station RA1. For these reasons, and with concurrence of FDEP, station STA6DC was retained as the STA-5/6 downstream monitoring station and all monitoring was terminated at station RA1, effective October 2, 2013.

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Attachment D: Rotenberger Wildlife Management Area Restoration and Stormwater Treatment Area Downstream Transect Monitoring

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In addition to the information provided in this attachment, additional supplemental information is required by Specific Conditions 12(a), 12(b), and 25(b) of the Everglades Forever Act (EFA) permit (0311207). This supporting information is available upon request.

HYDROPATTERN RESTORATION AND STA DISCHARGE MONITORING ON THE DOWNSTREAM AREAS

This section presents Water Year 2015 (WY2015) (May 1, 2014–April 30, 2015) results for monitoring conducted in the areas downstream of the Everglades Stormwater Treatment Areas (STAs), including the Arthur R. Marshall Loxahatchee National Wildlife Refuge [LNWR, or Water Conservation Area (WCA-1)], WCA-2A, and the Rotenberger Wildlife Management Area (RWMA). EFA Permit 0311207, EFA Consent Order Office of General Counsel (OGC) File Number 12-1149, and National Pollutant Discharge Elimination System (NPDES) Consent Order OGC File Number 12-1148 require characterization of the effects of STA discharges on adjacent marsh areas. This characterization is based on monthly samples collected for specific conductance (conductivity) and total phosphorus (TP). Water quality monitoring stations in the marsh areas were chosen along a transect from the discharge points and are categorized as "impacted" or "unimpacted" based on sediment TP levels. Transect stations in areas where sediment TP levels are greater than 500 milligrams per kilogram (mg/kg) are identified as impacted.

This year, soil parameters included as part of the permit monitoring requirements are not reported because they are only to be monitored once every two years. The soil parameters are TP, total nitrogen, total carbon, percent ash content, bulk density, and total calcium. Soils at all 28 marsh stations continue to be collected every odd year. Soil parameters from the 3 canal stations (Z-0, LOXA104, and LOXA135) are not required to be monitored.

Monitoring data for each transect are provided in Attachment B. A summary of specific conductance and TP collected for these transects is provided in **Tables D-1** and **D-2**, respectively. These water quality data are also graphically presented as notched box-and-whisker plots, along with the results of the monitoring conducted as part of the hydropattern restoration monitoring, which includes vegetation and water level.

[1] Florida Fish and Wildlife Conservation Commission, Miami/Fort Lauderdale area

Table D-1. Summary statistics for specific conductance in microsiemens per centimeter (µS/cm) at transect stations from STA outflows during WY2015.[a]

STA (Transects)		Station Information: Station	Station Information: Category[b]	Distance (km)[c]	No. of Obs.	Mean ± SD	Min	Percentiles[d] 25th	Percentiles[d] 50th	Percentiles[d] 75th	Max	Geometric Mean
STA-1E[e]	(1)	LOXA135	Rim Canal	0.00	12	1,029 ± 168	745	908	1,034	1,159	1,279	1,016
		LOXA136	Impacted	0.56	9	719 ± 174	333	664	719	853	930	695
		LOXA137	Impacted	1.07	9	529 ± 153	249	462	552	639	719	504
		LOXA138	Unimpacted	2.11	8	345 ± 127	169	267	325	417	573	325
		LOXA139	Unimpacted	3.93	8	148 ± 26	123	129	138	165	197	146
STA-1W[f]	(1)	LOXA104	Rim Canal	0.00	12	827 ± 157	624	721	788	920	1,192	815
		LOXA104.5	Impacted	0.31	8	538 ± 184	367	397	474	668	864	514
		LOXA105	Impacted	0.77	8	321 ± 86	223	268	294	366	487	312
		LOXA106	Impacted	1.09	8	220 ± 58	149	186	201	258	325	214
		LOXA107	Impacted	2.21	8	145 ± 18	127	131	141	154	179	144
		LOXA107U	Unimpacted	3.38	8	116 ± 26	87	98	110	129	169	114
		LOXA108	Unimpacted	4.07	8	109 ± 36	77	87	98	120	187	105
	(2)	LOXAZ0	Rim Canal	0.00	11	767 ± 99	626	676	805	844	891	761
		LOXAZ1	Impacted	0.25	9	569 ± 128	370	476	587	652	763	556
		LOXAZ2	Impacted	1.44	8	348 ± 40	292	318	347	373	416	346
		LOXAZ3	Impacted	3.48	10	145 ± 48	98	120	131	146	261	139
		LOXAZ4	Unimpacted	5.82	10	156 ± 39	123	134	141	163	253	153

Table D-1. (Continued).

STA (Transects)		Station Information: Station	Station Information: Category[b]	Distance (km)[c]	No. of Obs.	Mean ± SD	Min	Percentiles[d]: 25th	Percentiles[d]: 50th	Percentiles[d]: 75th	Max	Geometric Mean
STA-2	(1)	2AN.25	Impacted	0.25	12	930 ± 170	649	789	975	1,047	1,194	915
		2AN1	Impacted	0.98	10	911 ± 187	627	753	923	1,056	1,192	893
		2AN2	Impacted	1.98	10	916 ± 200	657	750	911	1,022	1240	897
		2AN4	Impacted	3.77	11	953 ± 211	667	763	920	1,143	1,278	932
		2AN5	Unimpacted	4.83	10	905 ± 192	678	747	862	1,114	1,185	887
		2AN6	Unimpacted	5.82	9	870 ± 148	650	757	890	995	1,090	859
	(2)	2AC.25	Impacted	0.25	11	934 ± 185	666	769	974	1,085	1,194	917
		2AC2	Impacted	1.88	9	903 ± 207	687	703	870	1,080	1,203	883
		2AC4	Unimpacted	3.77	9	897 ± 177	723	741	853	1,046	1,209	883
		2AC5	Unimpacted	4.80	9	914 ± 149	744	776	934	1,019	1,130	903
	(3)	2AFS.25	Impacted	0.34	10	927 ± 171	682	787	912	1,072	1,189	912
		FS1	Impacted	1.02	10	944 ± 184	643	757	972	1,104	1,205	927
		FS3	Impacted	3.09	12	1,075 ± 288	802	869	1,002	1,162	1,804	1046
		CA29	Unimpacted	6.17	11	933 ± 196	710	764	932	1,013	1,377	915
STA-5/6	(1)	ROTC1	Impacted	0.23	10	583 ± 157	358	418	653	721	748	562
		ROTC2	Impacted	2.30	9	525 ± 233	260	290	666	722	793	474
		ROTC3	Impacted	4.20	8	441 ± 231	217	234	366	695	726	389

a. Abbreviations in headings: km – kilometers, Max – Maximum, Min – Minimum, No. of Obs. – Number of Observations, SD – Standard Deviation, STA – Stormwater Treatment Area.

b. Categories of “impacted” and “unimpacted” refer to station identification based on sediment phosphorus concentrations. Impacted stations have sediment TP concentrations of 500 mg/kg. This categorization of sampling stations is presented in the EFA Consent Order OGC File Number 12-1149 and NPDES Consent Order OGC File Number 12-1148

c. Distance along transect from canal in kilometers (km)

d. 50^{th} Percentile – Median

e. STA-1E – Stormwater Treatment Area 1 East

f. STA-1W – Stormwater Treatment Area 1 West

Table D-2. Summary statistics for TP in micrograms per liter (µg/L) at transect stations from STA outflows during WY2015.[a]

STA (Transects)		Station Information		Distance (km)[c]	No. of Obs.	Mean ± SD	Min	Percentiles[d]			Max	Geometric Mean
		Station	Category[b]					25th	50th	75th		
STA-1E[e]	(1)	LOXA135	Rim Canal	0.00	12	25 ± 7	17	19	23	30	38	24
		LOXA136	Impacted	0.56	9	18 ± 7	10	12	18	22	31	17
		LOXA137	Impacted	1.07	9	11 ± 3	8	9	9	13	17	10
		LOXA138	Unimpacted	2.11	8	7 ± 2	5	6	6	8	9	7
		LOXA139	Unimpacted	3.93	8	9 ± 3	6	8	9	10	17	9
STA-1W[f]	(1)	LOXA104	Rim Canal	0.00	12	22 ± 7	15	16	19	26	38	21
		LOXA104.5	Impacted	0.31	8	25 ± 19	14	16	19	24	72	22
		LOXA105	Impacted	0.77	8	14 ± 5	7	11	13	18	23	13
		LOXA106	Impacted	1.09	8	11 ± 2	8	9	12	13	13	11
		LOXA107	Impacted	2.21	8	10 ± 2	8	9	10	11	13	10
		LOXA107U	Unimpacted	3.38	8	8 ± 2	5	7	8	10	11	8
		LOXA108	Unimpacted	4.07	8	10 ± 2	7	8	10	11	12	9
	(2)	LOXAZ0	Rim Canal	0.00	12	17 ± 2	13	16	16	18	22	17
		LOXAZ1	Impacted	0.25	10	25 ± 10	15	17	23	30	49	24
		LOXAZ2	Impacted	1.44	9	13 ± 4	8	11	11	15	22	13
		LOXAZ3	Impacted	3.48	12	8 ± 3	5	7	8	9	17	8
		LOXAZ4	Unimpacted	5.82	12	7 ± 2	6	7	7	7	14	7

Table D-2. (Continued)

STA (Transects)		Station Information: Station	Station Information: Category[b]	Distance (km)[c]	No. of Obs.	Mean ± SD	Min	Percentiles[d]: 25th	Percentiles[d]: 50th	Percentiles[d]: 75th	Max	Geometric Mean
STA-2	(1)	2AN.25	Impacted	0.25	12	17 ± 5	12	13	16	21	25	16
		2AN1	Impacted	0.98	10	17 ± 9	9	10	15	18	40	15
		2AN2	Impacted	1.98	10	9 ± 2	7	7	9	10	14	9
		2AN4	Impacted	3.77	11	7 ± 1	4	6	7	7	9	6
		2AN5	Unimpacted	4.83	10	7 ± 3	5	5	6	7	16	6
		2AN6	Unimpacted	5.82	9	5 ± 1	4	5	5	6	7	5
	(2)	2AC.25	Impacted	0.25	12	14 ± 5	5	11	12	18	21	13
		2AC2	Impacted	1.88	10	7 ± 3	5	5	7	7	14	7
		2AC4	Unimpacted	3.77	10	6 ± 3	4	5	6	6	15	6
		2AC5	Unimpacted	4.80	10	6 ± 2	4	5	5	7	9	6
	(3)	2AFS.25	Impacted	0.34	10	17 ± 5	11	16	17	18	27	17
		FS1	Impacted	1.02	10	16 ± 5	11	12	16	21	23	16
		FS3	Impacted	3.09	11	7 ± 3	3	5	6	8	13	6
		CA29	Unimpacted	6.17	11	5 ± 2	3	4	4	5	10	5
STA-5/6	(1)	ROTC1	Impacted	0.23	10	18 ± 6	9	14	17	20	27	17
		ROTC2	Impacted	2.30	9	14 ± 4	9	12	13	18	20	14
		ROTC3	Impacted	4.20	8	16 ± 5	11	12	14	18	26	15

a. Abbreviations in headings: km – kilometers, Max – Maximum, Min – Minimum, No. of Obs. – Number of Observations, SD – Standard Deviation, STA – Stormwater Treatment Area.

b. Categories of “impacted” and “unimpacted” refer to station identification based on sediment phosphorus concentrations. Impacted stations have sediment TP concentrations of 500 mg/kg. This categorization of sampling stations is presented in the EFA Consent Order OGC File Number 12-1149 and NPDES Consent Order OGC File Number 12-1148

c. Distance along transect from canal in kilometers (km)

d. 50th Percentile – Median

e. STA-1E – Stormwater Treatment Area 1 East

f. STA-1W – Stormwater Treatment Area 1 West

ARTHUR R. MARSHALL LOXAHATCHEE NATIONAL WILDLIFE REFUGE

Specific conductance levels and TP concentrations measured along transects in the LNWR (**Figure D-1**) exhibited decreases within 1 to 3 kilometers (km) from the rim canal during WY2015 (**Figures D-2** and **D-3**). Within the first kilometer from the rim canal, geometric mean specific conductance values measured in the western transect [downstream of Stormwater Treatment Area 1 West (STA-1W) outflows] decreased to approximately 200 microsiemens per centimeter (µS/cm) or by 58 percent (300 µS/cm). Geometric mean TP concentrations for this transect decreased by approximately 50 percent or 11 micrograms per liter [µg/L or parts per billion (ppb)] within 1 km of the rim canal station. Specific conductance measured along the eastern transect [downstream of the Stormwater Treatment Area 1 East (STA-1E) outflow] exhibited a decrease of approximately 50 percent, or 512 µS/cm (as an annual geometric mean), within 1 km distance from the rim canal. Geometric mean TP concentrations for this transect exhibited a 56 percent (or 13 µg/L) decrease within 1 km of the rim canal. An additional transect (LOXAZ0 to LOXAZ4, located in the southwestern portion of the LNWR) was added to the monitoring requirement. Geometric mean specific conductance for this transect decreased by 55 percent, or 415 µS/cm, within approximately 1.5 km from the rim canal. Additionally, geometric mean TP concentrations decreased by 46 percent, or 11 micrograms per liter (µg/L). Stations located more than 1 km from the rim canal for all three transects had geometric mean TP concentrations ranging from 7 to 13 ppb, with geometric mean specific conductance values ranging from 105 to 346 µS/cm (**Tables D-1** and **D-2**). Typical specific conductance values for rain-fed marshes in the Everglades are less than 200 µS/cm (McCormick et al., 2011). Only one specific conductance measurement for the three transects during WY2015 in the LNWR exceeded the Class III criterion of 1,275 µS/cm. A value of 1,279 µS/cm was recorded in May 2014 at LOXA135 (rim canal station of the STA-E transect).

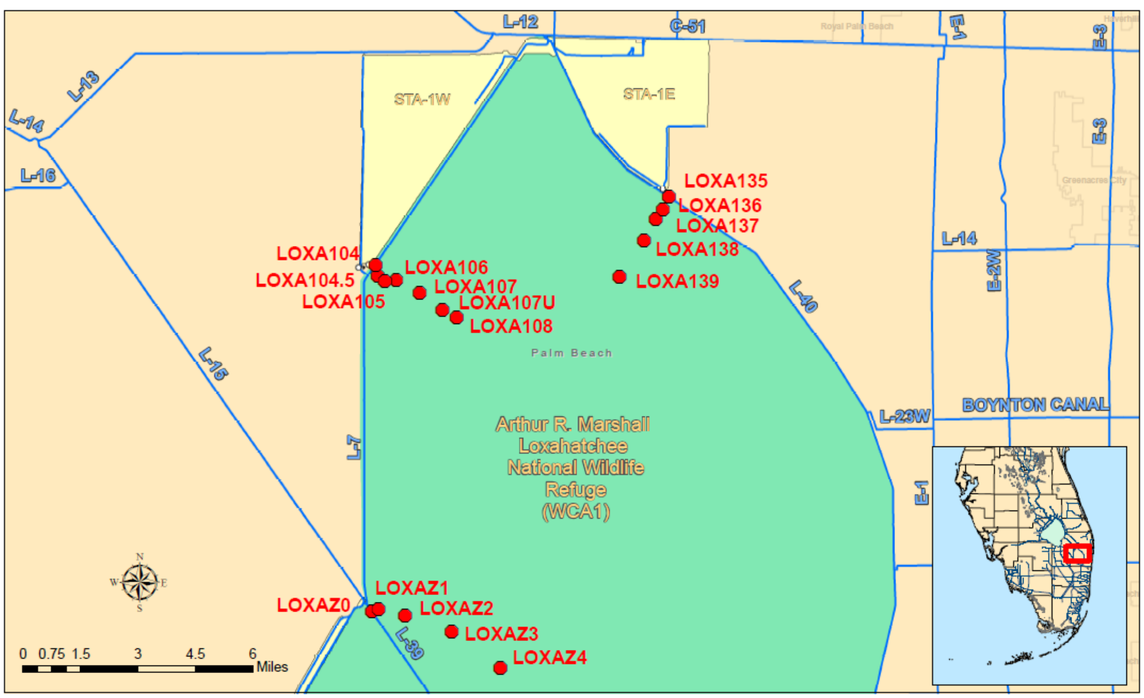


Figure D-1. Locations of marsh transect stations in the LNWR and outflow structures from STA-1W and STA-1E.

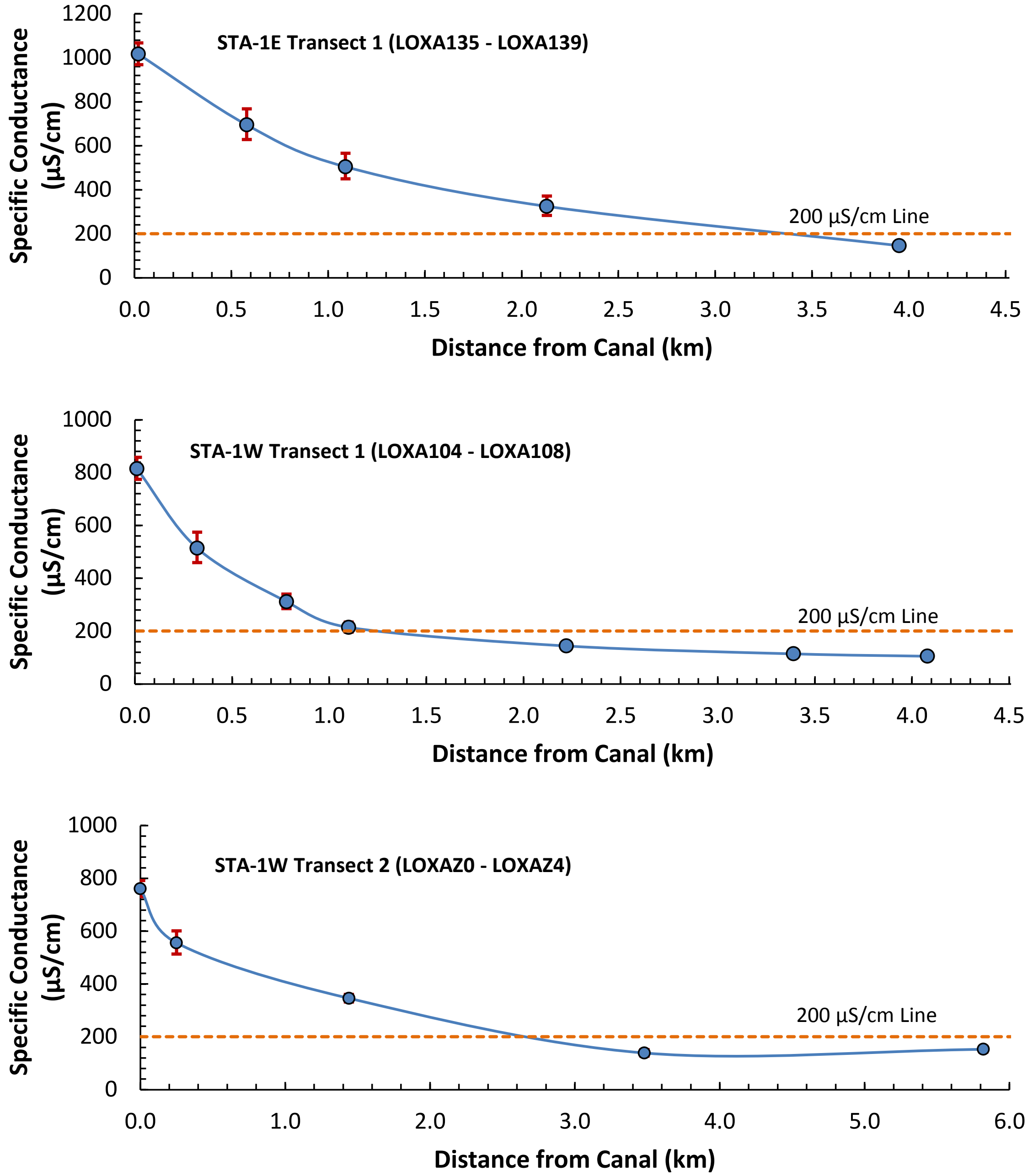


Figure D-2. Geometric mean specific conductance measured at transect stations downstream of STA-1W and STA-1E during WY2015. Error bars represent the standard error around the calculated geometric mean. The 200 µS/cm reference line indicates the upper limit of specific conductance observed in “rain-driven” portions of the LNWR.

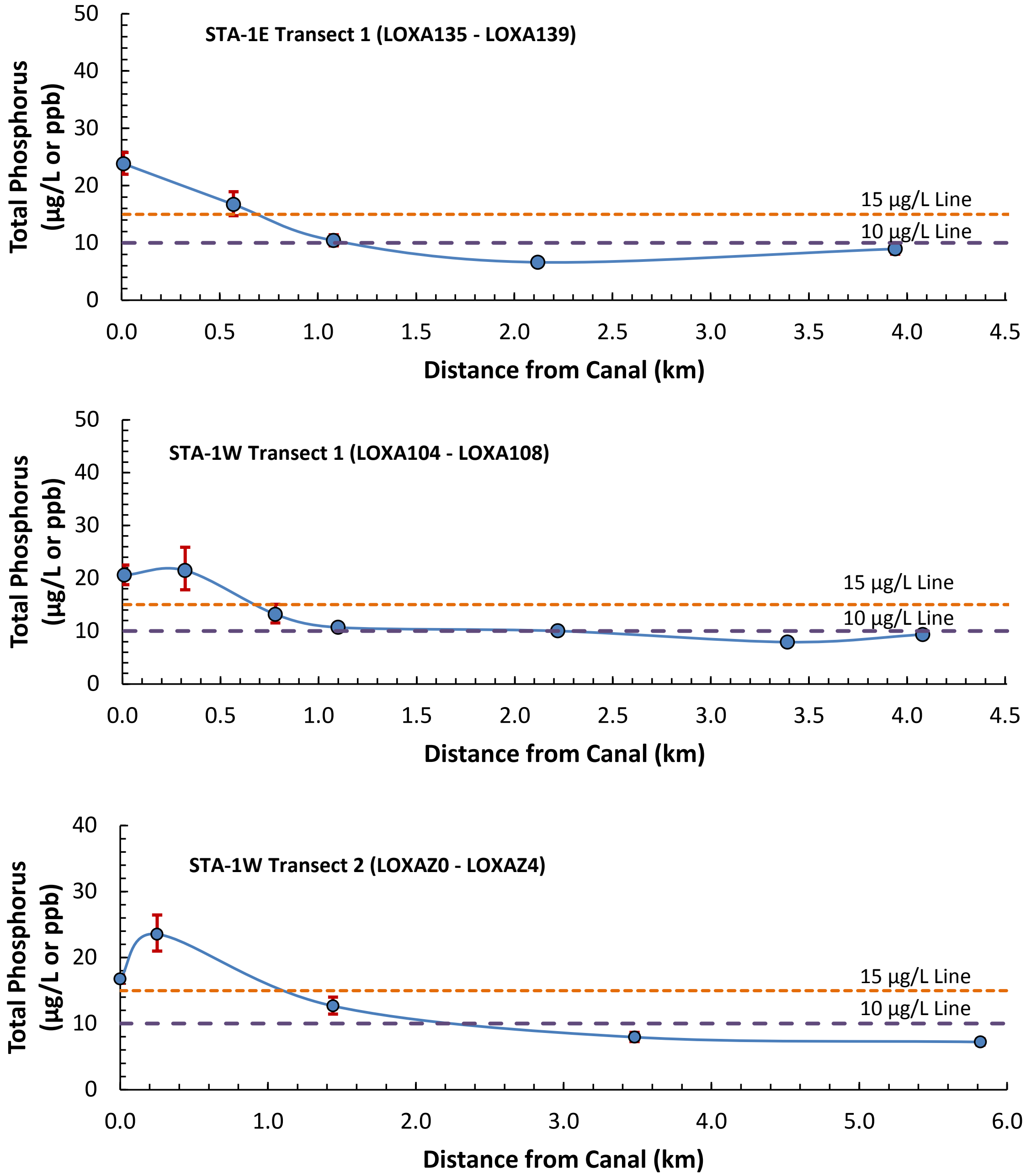


Figure D-3. Geometric TP concentrations measured at transect stations downstream of STA-1W and STA-1E during WY2015. Error bars represent the standard error around the calculated geometric mean. Reference lines (at 10 and 15 µg/L) indicate the long-term and annual limit used in the Phosphorus Rule.

A statistical summary comparing specific conductance and TP values for WY2014 and WY2015 at transects associated with STA-1E and STA-1W outflows is provided in **Tables D-3** and **D-4.** The average specific conductance levels for the STA-1E transect were 483 ± 346 µS/cm (geometric mean = 358; median = 341) and 589 ± 346 µS/cm (geometric mean = 481; median = 603) for WY2014 and WY2015, respectively. A Mann-Whitney test indicated that the observed increase in specific conductance from WY2014 to WY2015 was not statistically significant at a significance level (α) of 0.05 (Mann-Whitney test, p-value = 0.184). The average TP concentration for this transect was 17 ± 14 µg/L (geometric mean = 13; median = 11) for WY2014, and 15 ± 8 µg/L (geometric mean = 13; median =12) for WY2015, with no statistical difference observed between the two years (Mann-Whitney test, p-value = 0.713). Transect 1 of STA-1W had specific conductance averaging 522 ± 322 µS/cm (geometric mean = 397; median = 560) for WY2014 and 359 ± 291 µS/cm (geometric mean = 262; median = 358) for WY2015. Based on the specific conductance data for these two years, WY2015 had statistically lower levels than WY2014 (Mann-Whitney test, p-value = 0.005). A comparison of TP concentration between these two water years for Transect 1 (STA-1W) shows that no statistical difference in TP concentrations was observed (p-value = 0.582), with concentrations averaging of 22 ± 35 µg/L (geometric mean = 15; median = 13) for WY2014, and 15 ± 10 µg/L (geometric mean = 13; median = 12) for WY2015. No statistical difference was observed between WY2014 and WY2015 with respect to specific conductance (p-value = 0.900) and TP concentrations (p-value = 0.984) measured at STA-1W Transect 2. Specific conductance measured during WY2014 averaged 420 ± 314 µS/cm (geometric mean = 302; median = 261) compared to 403 ± 264 µS/cm (geometric mean = 316; median = 347) for WY2015. During WY2014, TP concentrations averaged 15 ± 12 µg/L (geometric mean = 12; median = 12) compared to 14 ± 8 µg/L (geometric mean = 12; median 13) for WY2015.

Table D-3. Comparison of surface water specific conductance collected at permit compliance stations in the LNWR during WY2014 and WY2015.

STA (Transect)	Station	Specific Conductance (µS/cm)[a]					
		WY2014			WY2015		
		Number of Samples	Mean ± SD[b]	Geometric Mean	Number of Samples	Mean ± SD[b]	Geometric Mean
STA-1E (Transect 1)	LOXA135	12	968 ± 208	946	12	1,029 ± 168	1,016
	LOXA136	12	563 ± 248	499	9	719 ± 174	695
	LOXA137	12	432 ± 230	367	9	529 ± 153	504
	LOXA138	12	242 ± 113	220	8	345 ± 127	324
	LOXA139	9	121 ± 36	116	8	148 ± 26	146
STA-1W (Transect 1)	LOXA104	12	802 ± 164	786	12	827 ± 157	815
	LOXA104.5	10	777 ± 174	751	8	538 ± 184	514
	LOXA105	10	668 ± 260	609	8	321 ± 86	312
	LOXA106	9	613 ± 240	556	8	220 ± 58	214
	LOXA107	6	266 ± 96	251	8	145 ± 18	144
	LOXA107U	10	146 ± 31	143	8	116 ± 26	114
	LOXA108	7	114 ± 30	110	8	109 ± 36	105
STA-1W (Transect 2)	LOXAZ0	12	808 ± 165	792	11	767 ± 99	761
	LOXAZ1	11	641 ± 278	545	9	569 ± 128	556
	LOXAZ2	12	369 ± 200	309	8	348 ± 40	346
	LOXAZ3	12	149 ± 42	144	10	145 ± 48	139
	LOXAZ4	12	151 ± 72	138	10	156 ± 39	153

a. SD – standard deviation.

b. µS/cm – microsiemens per centimeter.

Table D-4. Comparison of TP concentrations collected at permit compliance stations in the LNWR during WY2014 and WY2015.

STA (Transect)	Station	Total Phosphorus (µg/L)					
		WY2014			WY2015		
		Number of Samples	Mean ± SD[a]	Geometric Mean	Number of Samples	Mean ± SD[a]	Geometric Mean
STA-1E (Transect 1)	LOXA135	12	42 ± 11	40	12	25 ± 7	24
	LOXA136	12	15 ± 4	15	9	18 ± 7	17
	LOXA137	12	9 ± 2	9	9	11 ± 3	10
	LOXA138	11	8 ± 2	7	8	7 ± 2	7
	LOXA139	9	8 ± 2	8	8	9 ± 3	9
STA-1W (Transect 1)	LOXA104	12	50 ± 67	36	12	22 ± 7	21
	LOXA104.5	10	32 ± 35	24	8	25 ± 19	21
	LOXA105	10	20 ± 15	17	8	14 ± 5	13
	LOXA106	9	10 ± 3	10	8	11 ± 2	11
	LOXA107	6	9 ± 2	9	8	10 ± 2	10
	LOXA107U	10	7 ± 3	7	8	8 ± 2	8
	LOXA108	7	9 ± 5	8	8	10 ± 2	9
STA-1W (Transect 2)	LOXAZ0	12	28 ± 18	25	12	17 ± 2	17
	LOXAZ1	11	24 ± 8	23	10	25 ± 10	24
	LOXAZ2	12	12 ± 2	12	9	13 ± 4	13
	LOXAZ3	12	7 ± 2	7	12	8 ± 3	8
	LOXAZ4	12	6 ± 1	6	12	7 ± 2	7

a. SD – standard deviation

Macrophyte Composition along the Permit Compliance Transects

Macrophyte surveys in WCA-1 were initiated in 2012. There are three transects in WCA-1: LOXA104.5 to LOXA108 is located in the west central region of WCA-1, and is closest to the discharge from STA-1W; LOXA136 to LOXA139 is located in the east central region nearest the discharge from STA-1E; and LOXAZ1-LOXAZ4 is located in the southwest region downstream of the future STA-1W expansion. All marsh sites along the three transects in WCA-1 are Glades Marshes, as defined by Florida Natural Areas Inventory (2010). This natural community is characterized by sawgrass (*Cladium jamaicense*), spikerushes (*Eleocharis spp.*), maidencane (*Panicum hemitomon*), and beaksedges (*Rhynchospora spp.*).

The frequency of occurrence of several dominant macrophyte species was measured along fixed transects biannually from 2012 through 2014. Using point-intercept survey methodology, the presence of sawgrass and cattail (*Typha* spp.) at one-meter intervals along 10 meter transects was recorded. Only data from the permit compliance sites are presented in this report. **Tables D-5**, **D-6,** and **D-7** show the frequency of occurrence of cattail and sawgrass along each transect. At the western transect, site LOXA104.5 (0.31 km from the nearest discharge point) was dominated by cattail. At LOXA105, approximately 0.77 km from the discharge point, sawgrass was the dominant plant species. Sawgrass was dominant at the remainder of the sites (LOXA106, LOXA107, and LOXA107U) on the western transect, except at LOXA108. LOXA108 has been dominated by Tracy's beaksedge (*Rhynchospora tracyi*) and slim spikerush (*Eleocharis elongata*) since 2012, when the vegetation surveys were initiated. The east central transect consisted of four marsh sites (LOXA139, LOXA138, LOXA137, and LOXA136) and one canal site (LOXA135). LOXA136 is approximately 0.5 km from the inflow point, and is the only station where cattail was present. Cattail was not present at any of the other sites on the east central transect. Sawgrass was present at LOXA137, LOXA138, and LOXA139, but was not dominant at any site. At LOXA136, cattail and duck potato (*Sagittaria lancifolia*) were most prevalent. Cattail is to be expected in a Glades Marsh at sites closest to the canal, where nutrient levels in the water are highest (**Table D-4**). LOXA137 was dominated by a mix of emergent species including maidencane, pickerelweed (*Pontedaria cordata*), and slim spikerush. LOXA138 was dominated by slim spikerush and LOXA139 was dominated by Tracy's beaksedge.

Table D-5. Number of points (out of 10 possible points at one-meter intervals along each line transect) of WCA-1 at monitoring locations in WY2015 where sawgrass (SAW) or cattail (CAT) was present in WY2015.

Date	LOXA104.5		LOXA105		LOXA106		LOXA107		LOXA107U		LOXA108	
	CAT	SAW	CAT	SAW	CAT	SAW	CAT	SAW	CAT	SAW	CAT	SAW
July 2014	10	0	0	9	0	10	0	10	0	10	0	9
October 2014	10	0	0	9	0	10	0	10	0	10	0	7

Table D-6. Number of points (out of 10 possible points at one-meter intervals along each line transect) of WCA-1 at monitoring locations in WY2015 where sawgrass (SAW) or cattail (CAT) was present in WY2015.

Date	LOXA136		LOXA137		LOXA138		LOXA139	
	CAT	SAW	CAT	SAW	CAT	SAW	CAT	SAW
May 2014	9	0	0	2	0	3		
July 2014							0	2
November 2014	5	0	0	3	0	3	0	3

Table D-7. Number of points (out of 10 possible points at one-meter intervals along each line transect) of WCA-1 at monitoring locations in WY2015 where sawgrass (SAW) or cattail (CAT) was present in WY2015.

Date	LOXAZ1		LOXAZ2		LOXAZ3		LOXAZ4	
	CAT	SAW	CAT	SAW	CAT	SAW	CAT	SAW
May 2014	8	0	7	8	0	3	0	3
Oct 2014	9	0	6	4	0	2	0	2

At the southwest transect, LOXAZ1 was 0.25 km from the inflow point. Cattail, giant leather fern (*Acrostichum danaeifolium*), and Peruvian water primrose (*Ludwigia peruviana*) were co-dominant at LOXAZ1. Sawgrass and cattail were co-dominant at LOXAZ2, which is roughly 1.5 km from the inflow point. No cattail was present at sites LOXAZ3 and LOXAZ4, which are approximately 3.5 and 6 km from the inflow point, respectively. Sawgrass was present at LOXAZ3 and LOXAZ4, but was not a dominant species (**Table D-7**). LOXAZ3 and LOXAZ4 were characterized by a slough natural community co-dominated by fragrant waterlily (*Nymphaea odorata*) and eastern purple bladderwort (*Utricularia purpurea*).

NORTHWESTERN WATER CONSERVATION AREA 2A

Monitoring Objectives

In accordance with the EFA, the South Florida Water Management District (SFWMD or District) has been monitoring the effect of water discharged from Stormwater Treatment Area (STA) 2 into the northwestern region of WCA-2A. These releases are intended to restore the hydropattern and ecological functionality of the marshes downstream of STA-2. The STA-2 EFA permit requires that the District implement a monitoring and assessment program to monitor and evaluate ecological changes associated with STA-2 discharges into the area. This annual report addresses the (1) beneficial environmental effects, including changes in water quality, soil, vegetative conditions, inundation, and timing of discharges, and (2) any adverse environmental effects, including imbalances in natural populations of flora or fauna, changes in periphyton communities, or other undesirable consequences of the hydropattern restoration.

Configuration

STA-2 primarily discharges into WCA-2A through six culverts (G-336A–F structures) (**Figure D-4**). STA-2 discharges are also released through G-336G into the discharge canal south of STA-2. Approximately 1 km northeast of the S-7 pump station, the levee separating this discharge canal from WCA-2A is degraded, allowing discharge passing through G-336G to passively enter WCA-2A. Three transects (N-, C-, and S-transects) were established in 1998 to monitor environmental and ecological changes in the area. In 2005, a new transect (FS-transect) was established to monitor the STA-2 discharges through the degraded levee northeast of S-7. The FS-transect includes locations at 0.25, 1, 2, and 3 km from the degraded levee. There are two EFA permit compliance monitoring transects that consist of selected stations from the N-, C-, and FS-transects, and also include station CA29.

Hydropattern Restoration

Hydropattern improvements resulting from STA-2 discharges are presented in Pietro et al. (2009) and Garrett and Ivanoff (2008). Permanent stage recorders were installed at WC2AN1 and WC2AS1 (**Figure D-4**) stations in WY2009, and both gauges began recording data in June 2009. Stage data were available for WY2010–WY2015 for sites WC2AN1 and WC2AS1. Water depths were determined by subtracting estimated ground elevation from the stages. Results showed that in WY2015, both the north and south stations were inundated throughout the water year (**Figure D-5**). Mean water depth was 26.6 inches at WC2AN1 and 11.6 inches at WC2AS1. Compared to WY2014, mean depths were higher by 2 inches. Water depths at the north station fluctuated between 10 and 44 inches. Water depths at the south station fluctuated between 3 and 27 inches.

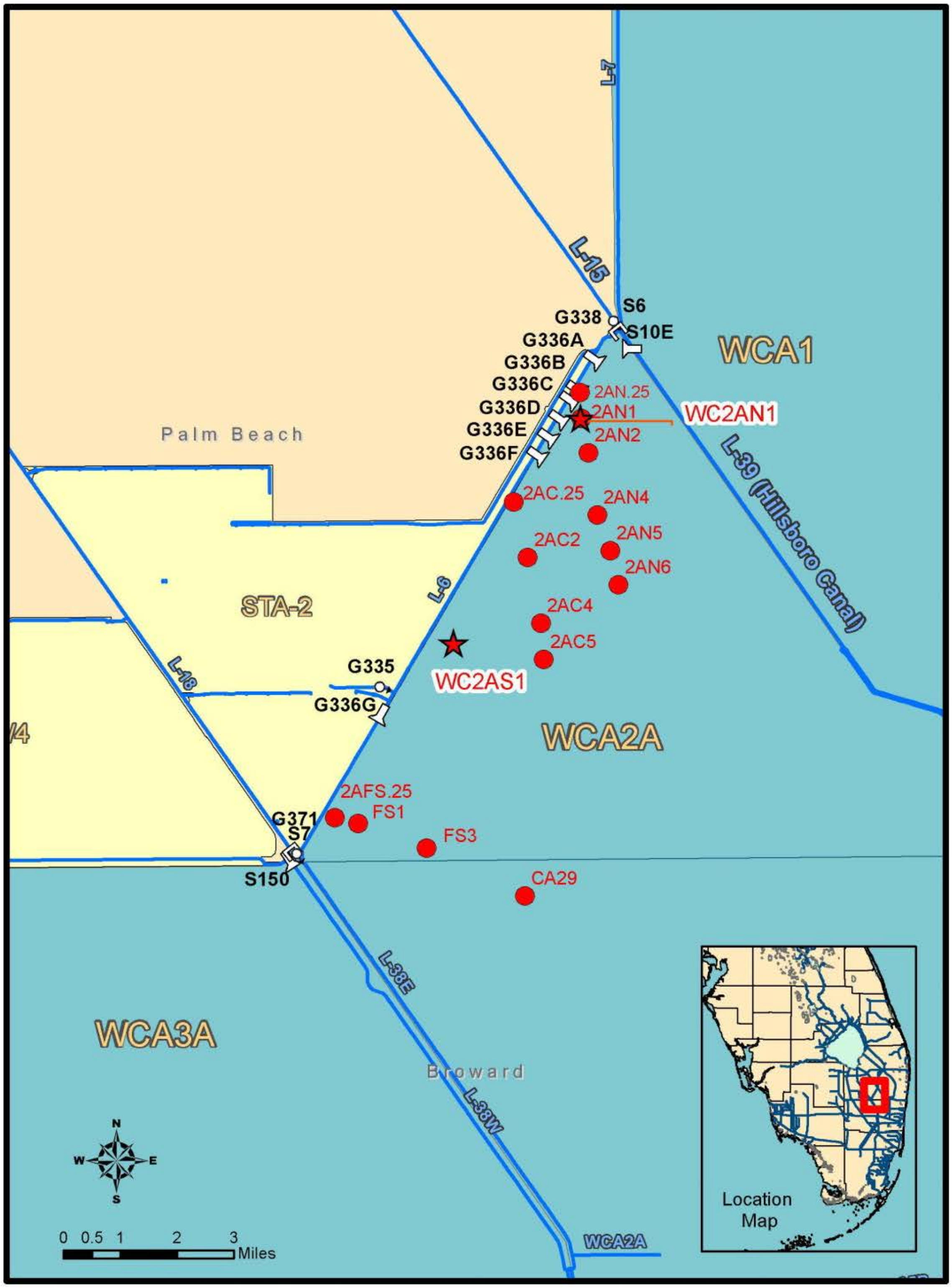


Figure D-4. Location of STA-2 discharge structures, including the G-336A–G discharge culverts, in relation to sampling stations along transects in the northwestern section of WCA-2A.

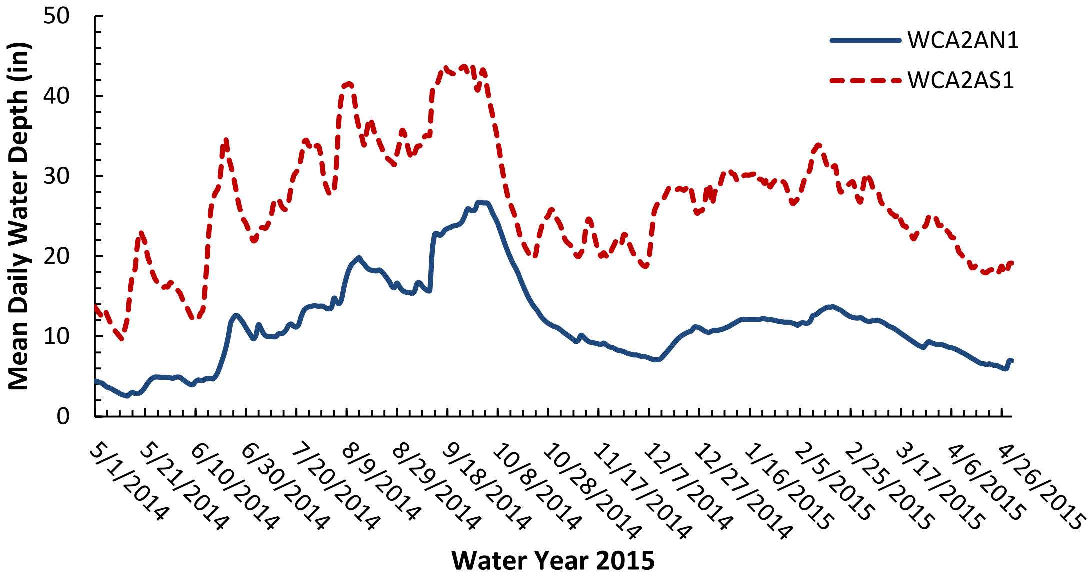


Figure D-5. Mean daily water depths for WY2015 derived from two stage recorders deployed along the northwestern region of WCA-2A. See **Figure D-4** for the location of these stations.

EFA Permit Compliance Transect Total Phosphorus and Specific Conductance at STA-2 Downstream Area (WCA-2A)

Three EFA permit compliance transects are downstream of the STA-2 discharge. These transects are monitored to characterize the effects of STA-2 discharges on the marsh. They are in the western part of WCA-2A, with Transect 1 in the northern portion, Transect 2 in the central portion, and Transect 3 in the southern portion (**Figure D-4**). Transect 1 is near the G-336A-G structure and consists of six marsh monitoring stations (2AN.25, 2AN1, 2AN2, 2AN4, 2AN5, and 2AN6) extending approximately 5 km into the WCA. Transect 2 is located 4 km south of Transect 1 and consists of four marsh monitoring stations (2AC.25, 2AC2, 2AC4, and 2AC5). The third transect is downstream of the G-336G structure and consists of four marsh monitoring stations (2AFS.25, FS1, FS3, and CA29) extending approximately 6 km into WCA-2A.

Geometric mean specific conductance during WY2015 ranged from 859 to 1,046 microsiemens per centimeter (µS/cm) for the three transects (**Table D-8**). Specific conductance levels along the northern transect between 0.25 and 4 km from the L-6 canal ranged from 893 to 932 µS/cm and decreased to 859 µS/cm at 5 km into the marsh (**Figure D-6**). Geometric mean specific conductance levels changed little along the central transect during WY2015, going from 883 to 917 µS/cm (**Figure D-6**). The southern transect showed a slight increase in specific conductance through approximately 3 km from the L-6 canal (912 to 1,046 µS/cm). Beyond this distance, specific conductance decreased to 915 µS/cm (**Table D-8**). Four specific conductance measurements, one along the northern transect and three along the southern transect, exceeded the Class III criterion of 1,275 µS/cm. These higher specific conductance values (1,278 to 1,804 µS/cm) were recorded at the beginning of the water year (May and June). A statistical comparison of specific conductance for WY2014 and WY2015 is provided in **Table D-8**. A statistically significant decrease was observed for specific conductance between WY2014 and WY2015 measured at the northern and central transects (Mann-Whitney p-values < 0.001 and 0.017, respectively). No statistical difference was observed between WY2014 and WY2015 specific conductance levels for the southern transect (p-value = 0.170).

Table D-8. Comparisons of surface water specific conductance between WY2014 and WY2015 at the permit compliance transect stations in WCA-2.

STA (Transect)	Station	Specific Conductance (µS/cm)					
		WY2014			WY2015		
		Number of Samples	Mean ± SD[a]	Geometric Mean	Number of Samples	Mean ± SD[a]	Geometric Mean
STA-2 (Transect 1)	2AN.25	12	1,102 ± 101	1,098	12	930 ± 170	915
	2AN1	12	1,086 ± 103	1,082	10	911 ± 187	893
	2AN2	11	1,073 ± 133	1,065	10	916 ± 200	897
	2AN4	12	1,038 ± 151	1,028	11	953 ± 211	932
	2AN5	10	990 ± 144	981	10	905 ± 192	887
	2AN6	10	948 ± 164	936	9	870 ± 148	859
STA-2 (Transect 2)	2AC.25	11	1,073 ± 99	1,069	11	934 ± 185	917
	2AC2	11	1,046 ± 144	1,037	9	903 ± 207	883
	2AC4	9	962 ± 142	953	9	897 ± 177	883
	2AC5	8	895 ± 82	892	9	914 ± 149	903
STA-2 (Transect 3)	2AFS.25	11	1,036 ± 64	1,034	10	927 ± 171	912
	FS1	9	1,045 ± 80	1,042	10	944 ± 184	927
	FS3	12	986 ± 121	979	12	1,075 ± 288	1,046
	CA29	12	951 ± 145	940	11	933 ± 196	915

a. SD – standard deviation.

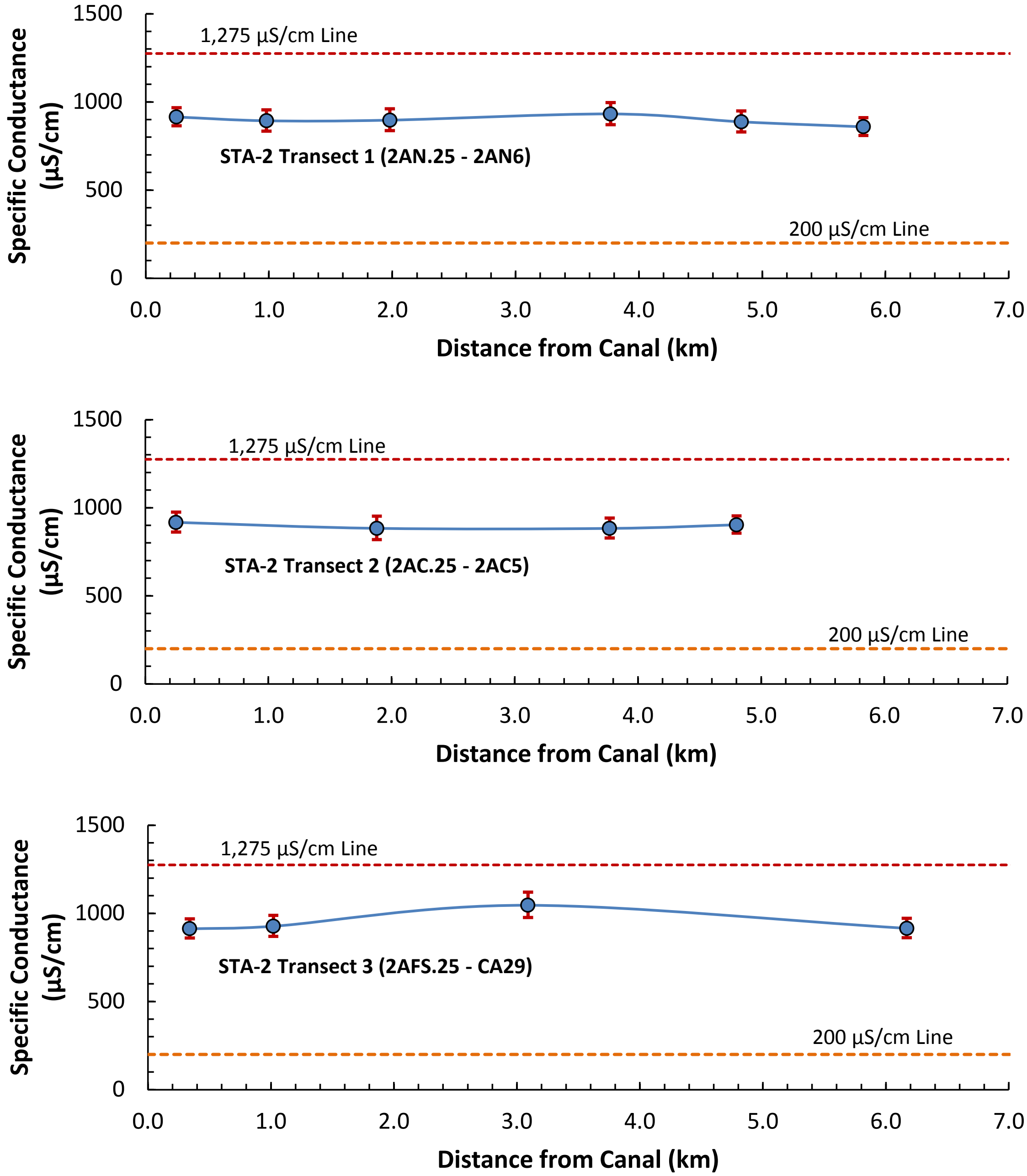


Figure D-6. Geometric mean specific conductance measured at transect stations in WCA-2 downstream of STA-2 during WY2015. Error bars represent the standard error around the calculated geometric mean. The 1,275 µS/cm reference line indicates the Class III freshwater criterion.

Geometric mean TP concentrations in WY2015 ranged from 5 to 16 µg/L across the three transects, with stations located closer to the canal exhibiting higher TP concentrations (**Table D-9**). By approximately 4 km from the L-6 canal, TP concentrations for all three transects were below 7 µg/L (**Figure D-7**). TP concentrations in the northern transect decreased from a geometric mean concentration of 16 µg/L at 2AN.25 to 5 µg/L at 5 km from the discharge point. In the central transect, geometric mean TP concentrations decreased from 13 µg/L at the station closest to the discharge canal to 6 µg/L, approximately 5 km into the marsh. Along the southern transect, the geometric mean TP concentration near the inflow was 17 µg/L and decreased to 5 µg/L approximately 6 km into the marsh. All transects exhibited a substantial reduction in TP concentrations at 1 to 2 km from the inflow.

The Mann-Whitney test was used to determine statistically significant differences for TP data between WY2014 and WY2015. Based on the analysis, no statistically significant differences were observed for the northern, central, and southern transects (p-values 0.319, 0.890, and 0.634, respectively) between the two water years. The observed difference between geometric mean TP concentrations for these two years was < 1 µg/L, with WY2015 having lower concentrations.

Table D-9. Comparisons of surface water TP concentrations between WY2014 and WY2015 at the permit compliance transect stations in WCA-2.

STA (Transect)	Station	Total Phosphorus (µg/L)					
		WY2014			WY2015		
		Number of Samples	Mean ± SD[a]	Geometric Mean	Number of Samples	Mean ± SD[a]	Geometric Mean
STA-2 (Transect 1)	2AN.25	12	20 ± 5	20	12	17 ± 5	16
	2AN1	12	16 ± 4	16	10	17 ± 9	15
	2AN2	11	11 ± 2	11	10	9 ± 2	9
	2AN4	12	7 ± 2	7	11	7 ± 1	6
	2AN5	10	6 ± 1	6	10	7 ± 3	6
	2AN6	10	6 ± 1	6	9	5 ± 1	5
STA-2 (Transect 2)	2AC.25	11	13 ± 2	13	12	14 ± 5	13
	2AC2	11	7 ± 1	6	10	7 ± 3	7
	2AC4	9	6 ± 1	6	10	6 ± 3	6
	2AC5	8	6 ± 1	6	10	6 ± 2	6
STA-2 (Transect 3)	2AFS.25	11	20 ± 2	19	10	17 ± 5	17
	FS1	9	16 ± 2	16	10	16 ± 5	16
	FS3	12	7 ± 1	7	11	7 ± 3	6
	CA29	12	5 ± 1	4	11	5 ± 2	5

a. SD – standard deviation.

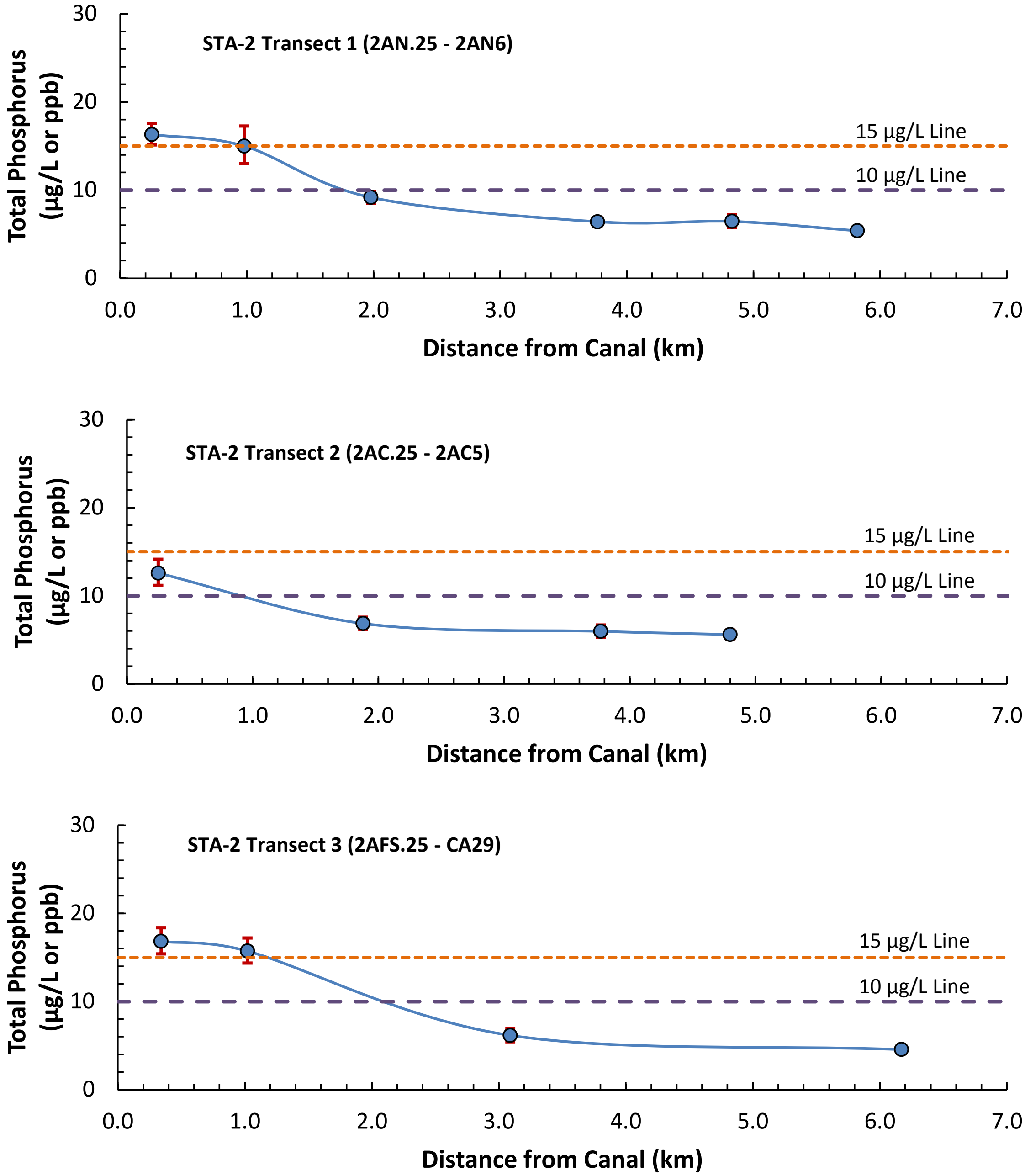


Figure D-7. Geometric TP concentrations measured at transect stations in WCA-2 downstream of STA-2 during WY2015. Error bars represent the standard error around the calculated geometric mean. Two reference lines (10 and 15 µg/L) indicate the long-term and annual limit used in the Phosphorus Rule.

Macrophyte Composition Along the Permit Compliance Transects

The frequency of occurrence of several dominant macrophyte species was measured along fixed transects each year from 2005 through 2014 for most sites in WCA-2A. In 2010, four additional sites (2AN5, 2AN6, 2AC5, and CA29) were added to the transects in WCA-2A. Using a point-intercept survey methodology, the presence of sawgrass and cattail at one-meter intervals along 10 meter transects was recorded. Only data from the permit compliance sites are presented in this report. **Tables D-10**, **D-11,** and **D-12** show the frequency of cattail and sawgrass along each transect. The northern transect, site 2AN.25 (0.25 km from the nearest G-336 discharge point), was dominated by cattail, with little sawgrass present. At 2AN1, approximately 1 km from the discharge point on the northern transect, cattail and sawgrass were co-dominant. Sawgrass was dominant and no cattail was present over the survey period at sites 2AN2, 2AN4, 2AN5, and 2AN6, located between 2 and 6 km from the inflow point (**Table D-10**).

Table D-10. Number of points (out of 10 possible points at one-meter intervals along each transect) at the northern transect locations of WCA-2A where sawgrass (SAW) or cattail (CAT) was present in WY2015.

Date	2AN.25		2AN1		2AN2		2AN4		2AN5		2AN6	
	CAT	SAW	CAT	SAW	CAT	SAW	CAT	SAW	CAT	SAW	CAT	SAW
May 2014	10	2	10	10	0	10	0	10	0	10	0	10
November 2014	10	3	10	4	0	10	0	10	0	10	0	10

Table D-11. Number of points (out of 10 possible points at one-meter intervals along each transect) at the central transect locations of WCA-2A where sawgrass (SAW) or cattail (CAT) was present in WY2015.

Date	2AC.25		2AC2		2AC4		2AC5	
	CAT	SAW	CAT	SAW	CAT	SAW	CAT	SAW
May 2014	0	10	0	10	0	10	0	10
October 2014	0	10	0	10	0	10	0	10

Table D-12. Number of points (out of 10 possible points at one-meter intervals along each transect) at the southern transect locations of WCA-2A where sawgrass (SAW) or cattail (CAT) was present in WY2015.

Date	2AFS.25		CA29		FS1		FS3	
	CAT	SAW	CAT	SAW	CAT	SAW	CAT	SAW
May 2014			0	7			0	10
July 2014	10	9			10	10		
November 2014	10	6	0	7	10	10	0	10

The C transect is located between the northern and southern transects. Site 2AC.25 is closest to the L6 canal and 2AC5 is the farthest away. Although only 0.1 km from the L-6 canal, 2AC.25 is approximately 1.5 km from the nearest inflow point, G336F. Sawgrass and willow (*Salix caroliniana*) are co-dominate at 2AC.25, and cattail is conspicuously absent from the site. Sawgrass is dominant at 2AC2, 2AC4, and 2AC5 (**Table D-11**).

At the southern transect, sites 2AFS.25 and FS1 are located approximately 0.25 km and 1 km from the inflow point, respectively. Both sawgrass and cattail were co-dominant at 2AFS.25 and FS1. No noteworthy change in the frequency of occurrence for either sawgrass or cattail was recorded at 2AFS.25 or FS1 since 2010. Sawgrass was dominant at sites FS3 and CA29 (**Table D-12**). Sawgrass has maintained a constant frequency of occurrence at FS3 since 2005, when monitoring was initiated at this site. The 10-meter transect at CA29 runs through a sawgrass ridge and the slightly deeper slough habitat bordering it. There has been slight variation year to year with the frequency of occurrence of sawgrass at this site, but overall, since 2010 when vegetation surveys began, there has been little change in the vegetation community at this site.

ROTENBERGER WILDLIFE MANAGEMENT AREA

Restoration and Monitoring Objectives

The Rotenberger Hydropattern Restoration Project is a component of the District's Everglades restoration efforts. The project goal is to slow, halt, and eventually reverse the ecosystem degradation within the RWMA (**Figure D-8**), primarily by restoring a more natural hydropattern. The degradation has been caused by overly dry conditions that have resulted in repeated peat fires, soil oxidation, and compaction, nutrient release from surface soils, and conversion of obligate wetland vegetative communities to upland-type communities. Anticipated benefits of the restoration efforts include the preservation and encouragement of additional desirable wetland vegetation species and the initiation of peat formation.

Configuration

Project features include a 240-cubic foot per second electric pump station (G-410) to withdraw treated water from the STA-5/6 discharge canal for release into the RWMA. This pump station distributes water through a 10-mile spreader canal located parallel to the west perimeter levee of the area. Surface water released from the RWMA goes into the Miami Canal (L-28 canal) through four gated culverts (G-402A through G-402D) along the eastern boundary of the RWMA. There is a quarter-mile collection canal upstream of each outlet structure.

The ROTC1, ROTC2, and ROTC3 stations are EFA permit compliance locations within the RWMA. Monitoring data for the stations downstream of STA-5/6 can be found within two District databases, Everglades Research Database Production and DBHYDRO. Water levels have historically been monitored at the Rott.N and Rott.S stage gauges.

Water Budget

Water budgets for WY2003 through WY2015 are presented in **Table D-13**. Historically, eighty percent of the inflows in the water budget are attributed to rainfall, and eighty-six percent of the outflows are attributed to evapotranspiration (ET). Inflow through G410 was less than average, but rainfall was higher than average, and both were higher than WY2014. Surface water outflow was about average and lower than WY2014. ET was above average, but lower than WY2014. Seepage values were not accounted for in these calculations. Errors include seepage losses or gains and measurement errors. Water levels were above ground throughout the water year. Daily average head and tail water fluctuations at the G410 pump is shown in **Figure D-9a**. Daily average head and tail water fluctuations at the G402 A, B, and C culverts are shown in **Figure D-9b**.

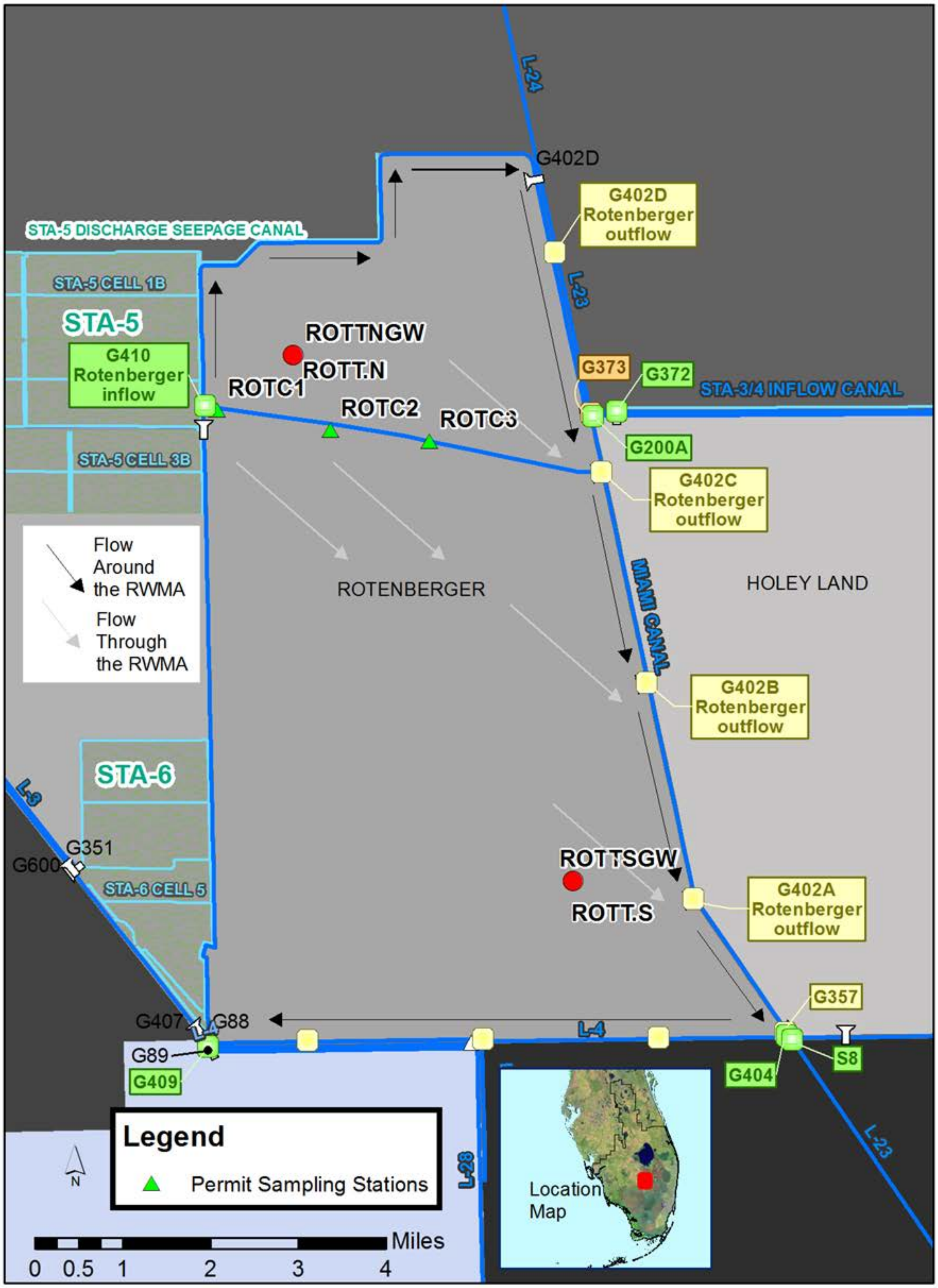
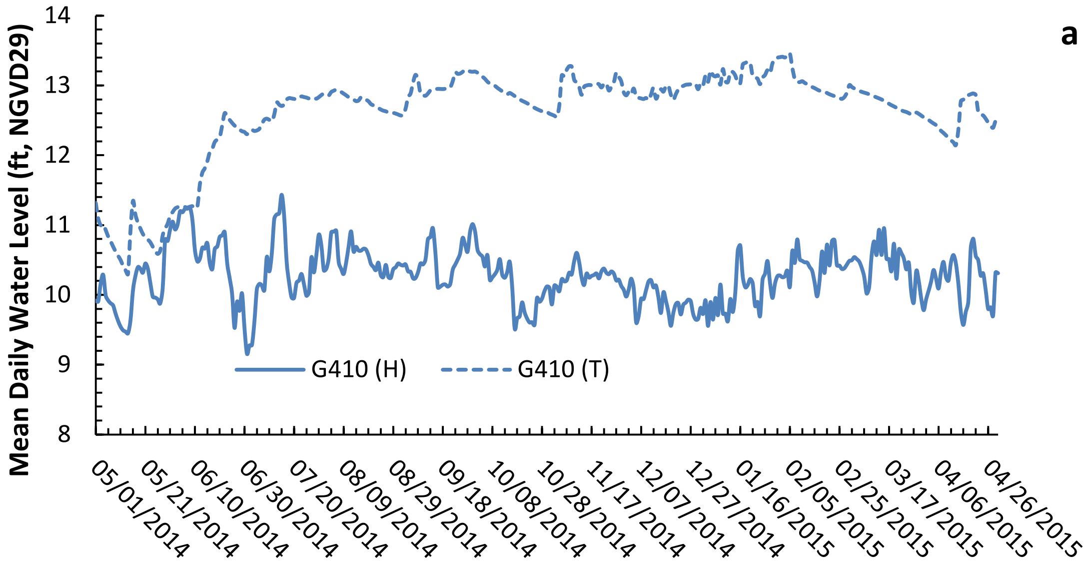


Figure D-8. Map of the RWMA showing major structures and monitoring transect ROTC (permit compliance monitoring transect). Rott.N and Rott.S are the locations of the permanent stage recorders and newly installed groundwater wells.

Table D-13. RWMA water budgets calculated for WY2003–WY2015. Inflows in acre-feet (ac-ft) represent discharges into the RWMA from the G-410 structure, and outflows represent water releases from the G-402A–C structures.

Water Year	Inflow	Rainfall	Total Inflow	Outflow	ET	Total Outflow	Change in Storage	Error %
	(ac-ft)							
2003	54,306	111,179	165,485	25,312	125,410	150,722	70	-9.3
2004	16,849	11,4620	131,469	352	123,546	123,898	-20	-5.9
2005	44,414	113,868	158,282	33,788	123,847	157,635	33	-0.4
2006	29,886	114,605	144,491	54,648	124,451	179,099	-792	20.9
2007	16,195	85,538	101,733	4,630	123,403	128,033	-731	22.3
2008	11,646	108,725	120,371	0	124,900	124,900	11,431	13.0
2009	32,297	102,125	134,422	25,126	128,177	153,303	-11,187	5.3
2010	40,582	152,423	193,005	21,295	125,578	146,873	1,018	-26.5
2011	17,922	116,675	134,597	21,622	138,200	159,822	-13,365	8.1
2012	32,472	135,025	167,497	5,192	137,575	142,767	16,050	-5.6
2013	37,055	146,325	183,380	11,009	134,125	145,134	13,200	-15.2
2014	20,934	119,325	140,259	41,092	133,825	174,917	-13,200	13.6
2015	29,564	141,325	170889	21,506	130,300	151806	3,600	-9.6
Total	**384,122**	**1,561,758**	**1,945,880**	**265,572**	**1,673,337**	**1,938,909**	**6,107**	**10.6**
	G-410 Inflow	**Rainfall**					**G-402 Outflow**	**ET**
% of inflow	20%	80%				% of Outflow	14%	86%



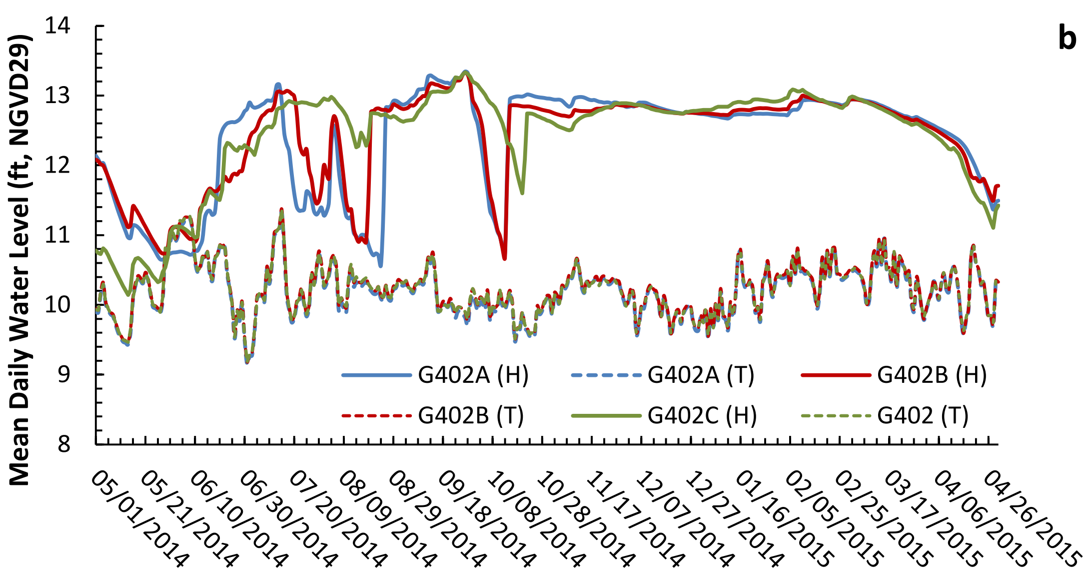


Figure D-9. (a) Daily head (H) and tailwater (T) fluctuation in feet National Geodetic Vertical Datum of 1929 (feet, NGVD29) at the G410 pump station. (b) Daily head and tailwater fluctuation at G402A, B, C culverts.

Hydrologic and Total Phosphorus Loads

A total of 29,563 acre-feet (ac-ft) of STA-5/6 water was conveyed into the RWMA through the G-410 pump station in WY2015 (**Table D-13**). This volume is approximately 8,600 ac-ft more than reported for the WY2014 discharge (**Table D-13**). An estimated 0.60 metric tons (mt) of phosphorus was imported to the RWMA during WY2015, resulting in an inflow flow-weighted mean (FWM) TP concentration of 17 µg/L. While flow and TP load to the RWMA were lower during WY2014, the annual FWM TP concentration was the same as in WY2015 (flow = 21,506 ac-ft; TP load = 0.45 mt; and TP FWM = 17 µg/L for WY2014). A Spearman correlation analysis of FWM TP concentrations with time exhibited a statistically significant decreasing trend for WY2015 ($r = -0.73$, p-value = 0.007) at a significance level (α) of 0.05. The slope of the regression was shown to be statistically different from zero. A similar analysis for TP load into RWMA indicated that while loads exhibited an increasing trend for WY2015, the slope of the line was also not statistically different from zero ($r = 0.35$; p-value = 0.27). Monthly flow volumes and TP loads into and from the RWMA for WY2009 to WY2015 are presented in **Figure D-10**.

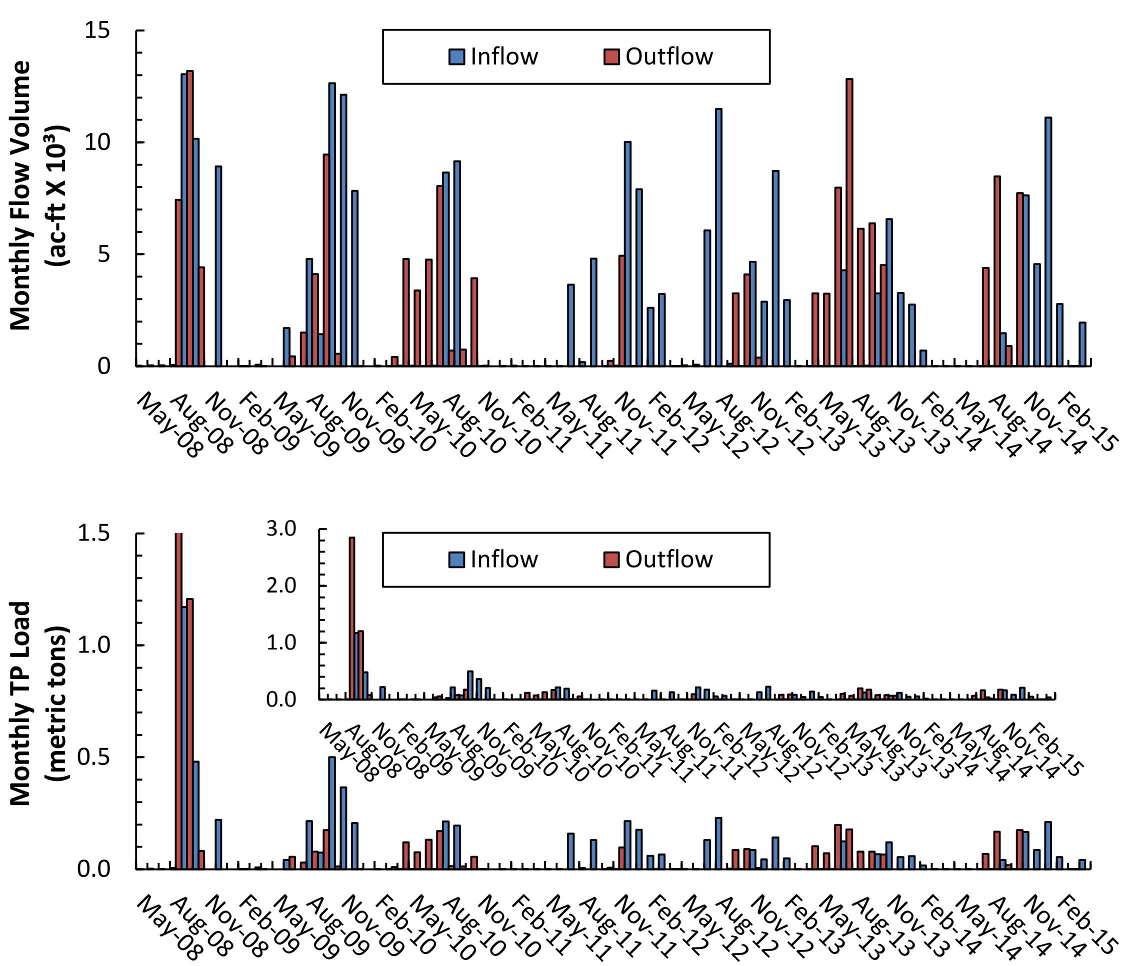
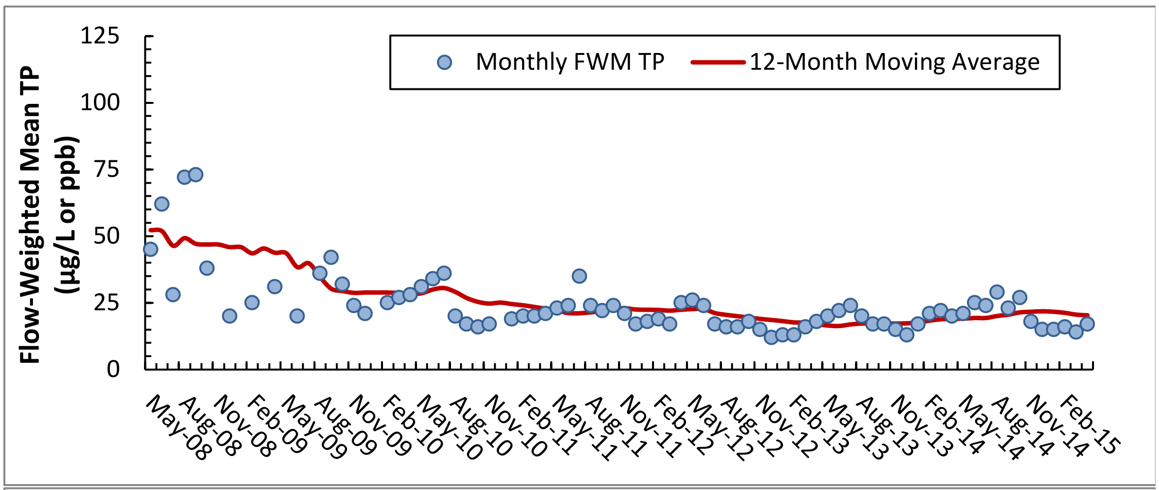


Figure D-10. Monthly flow volumes (top) and TP loads (bottom) for inflow and outflow structures at the RWMA for WY2009–WY2015. Inset graph in the bottom plot shows the full scale of data set.

Approximately 21,506 ac-ft of water was released through the G-402A–C structures during WY2015, approximately 19,585 ac-ft less than in WY2014 (**Table D-13**). Total TP load released from the RWMA through the G-402A-C structures during WY2015 was 0.44 mt or 0.24 mt less than discharged from the RWMA in WY2014. The resulting annual FWM TP concentration for WY2015, based on annual flow and load at the RWMA outflow, was 16 µg/L (**Figure D-11**). In contrast, the higher outflow volume and TP load from RWMA reported for WY2014 resulted in a lower annual FWM concentration (flow = 41,091 ac-ft; TP Load = 0.67 mt, and FWM TP = 13 µg/L). Additionally, outflow loads decreased during WY2015. Based on trend analysis with time using the Spearman correlation, TP loads did not exhibit a statistically significant decrease (r = -0.25, p-value = 0.43) at a significance level (α) of 0.05. In contrast, outflow FWM TP concentrations during WY2015 did exhibit a statistically significant increase (r = 0.97, p-value = 0.005). However, it is important to note half of the monitoring months during WY2015 did not have any recorded flow from the RWMA; therefore, any trends derived from this data set are questionable.



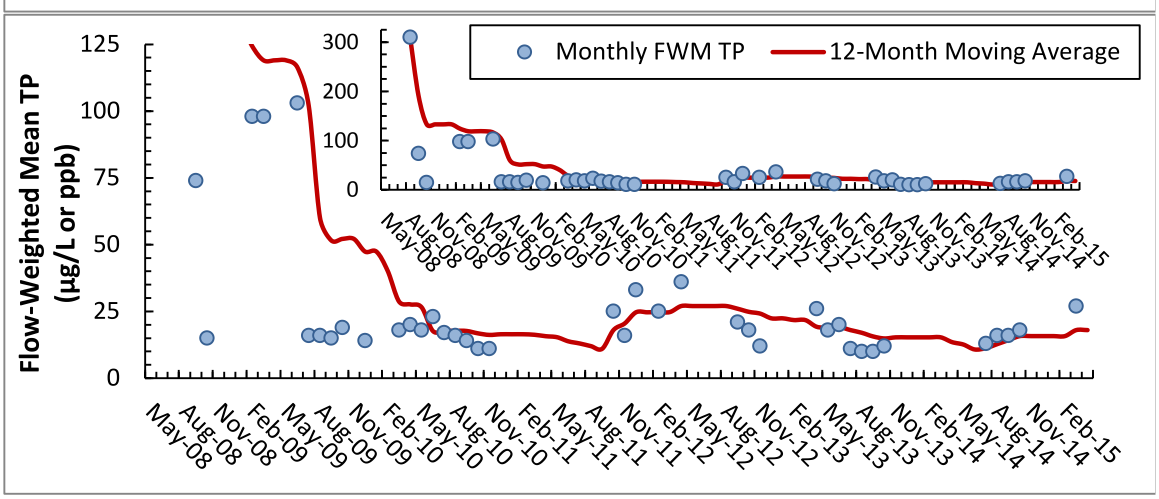


Figure D-11. Comparison of monthly flow-weighted mean TP concentrations with the 12-month moving average of the flow-weighted means for the RWMA inflow (top) and outflow (bottom) structures during WY2009 through WY2015. Inset graph in the bottom plot shows the full scale of data set.

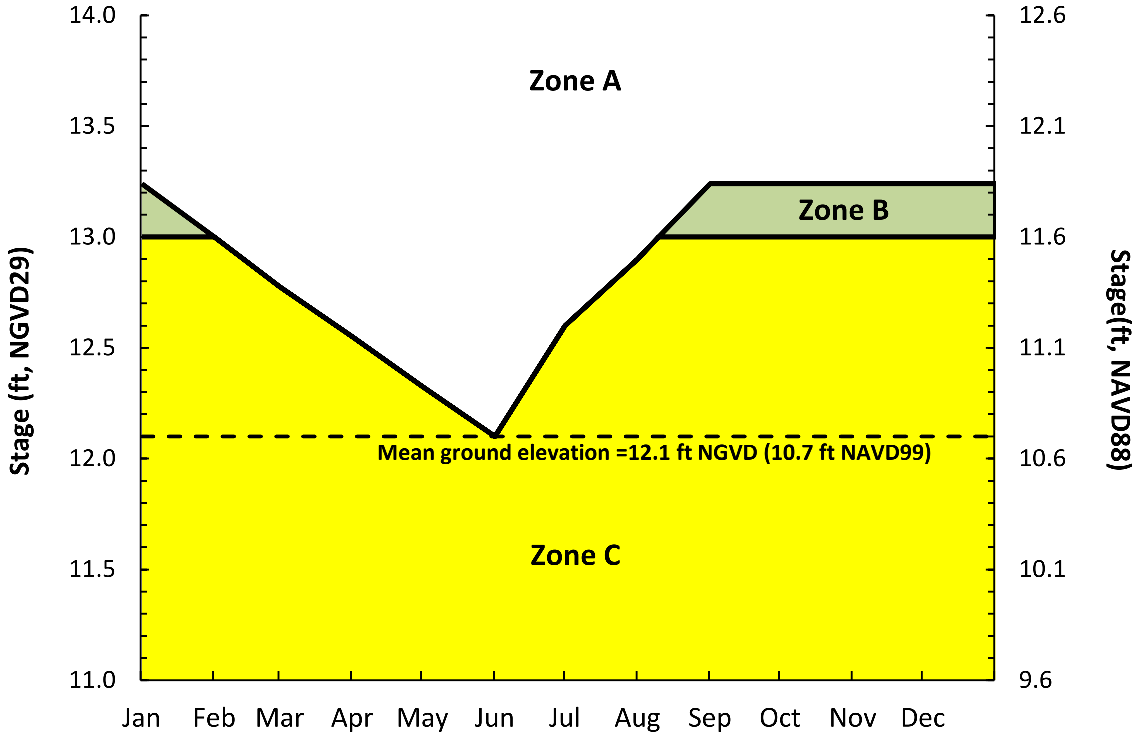
Annual TP loads into and from RWMA exhibited a decreasing trend using a Spearman correlation (r_{in} = -0.61 and r_{out} = -0.43). However, the observed trends were not statistically significant (p-value$_{in}$ = 0.148 and pvalue$_{out}$ = 0.337) at a significance level (α) of 0.05. Annual FWM TP concentrations at inflow and outflow structures for RWMA exhibited decreasing trends for WY2009 through WY2015 with inflow TP concentrations having a statistically significant decrease (r_{in} = -0.86 and p-value$_{in}$ = 0.014; and r_{out} = -0.75 and p-value$_{out}$ = 0.052).

Hydropattern Restoration

Starting in June 2008, the District began meeting with the Florida Fish and Wildlife Conservation Commission (FWC) and Florida Department of Environmental Protection (FDEP) to review the RWMA Operation Plan (SFWMD 2004) and to revise and improve the interim regulation schedule in an effort to better achieve the hydropattern restoration goals for the RWMA. An initial step in the process was to obtain an updated survey of the RWMA, which was completed in December 2008. The RWMA was surveyed in 2004 and 2008. The calculated ground elevation from the 2008 survey was 12.14 feet (ft) National Geodetic Vertical Datum 1929 (NGVD29).

The daily target stages for the RWMA in previous years were set based on the District's Natural System Model (NSM) values plus 0.25 feet. The 0.25 feet was added to minimize the potential for excessive dry-out during the dry season. In April 2009, consensus was reached on a modified interim regulation schedule that attempts to maintain the hydropattern restoration goals while also addressing the diverse biological needs of the RWMA and minimizing the risk of muck and/or peat fires. The biological needs considered were those of tree islands, native open-marsh vegetation (e.g., sawgrass and maidencane), periphyton, wading birds, aquatic macrofauna [e.g., crayfish (*Procambarus alleni*)], and upland faunal species (e.g., mammals). It is recognized that during severe droughts when no supplemental water is available, the RWMA will dry out.

In the modified regulation schedule (**Figure D-12**), when water levels are within either Zone A or Zone C and regional water conditions allow, Rotenberger inflow and outflow structures will be managed in an effort to return water levels to the regulation schedule or Zone B. The District will continue to communicate all water management actions with the FWC (SFWMD, 2010).



Zone	Operational Direction
A	Manage inflows (G410) and/or outflows (G402A, G402B, G402C, and G402D) to return to regulation schedule of Zone B.
B	Discretionary Zone: manage inflows and/or outflows to maintain water levels within Zone B, if possible, based on an assessment of historical, climatic, and regional water conditions. Coordination with FWC required.
C	If regional water conditions allow, manage inflows and/or outflows to return to regulation schedule or Zone B.

Figure D-12. Modified interim regulation schedule for RWMA.

Monitoring has stopped at ROTT.N (ROTTN-L) and ROTT.S (ROTTS-L) surface water monitoring sites, but the substitute monitoring sites, ROTTNGW and ROTTSGW, are replaced respectively (**Figure D-8**). WY2014 and WY2015 daily average RWMA stages, average ground elevation, and the interim operation plan target stages are depicted in **Figure D-13**. Water level was below ground at the beginning of WY2015; otherwise, water levels were relatively close to the operation plan target.

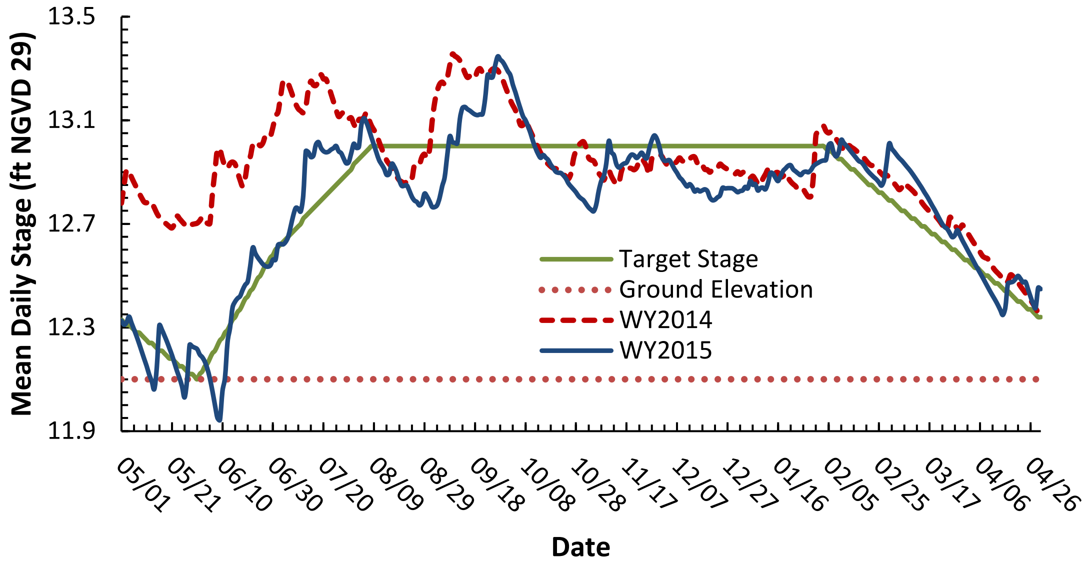


Figure D-13. Daily mean RWMA stages, average ground elevation, and interim operation plan target stages.

EFA Permit Compliance Transect Total Phosphorus and Specific Conductance at STA-5/6 Downstream Area

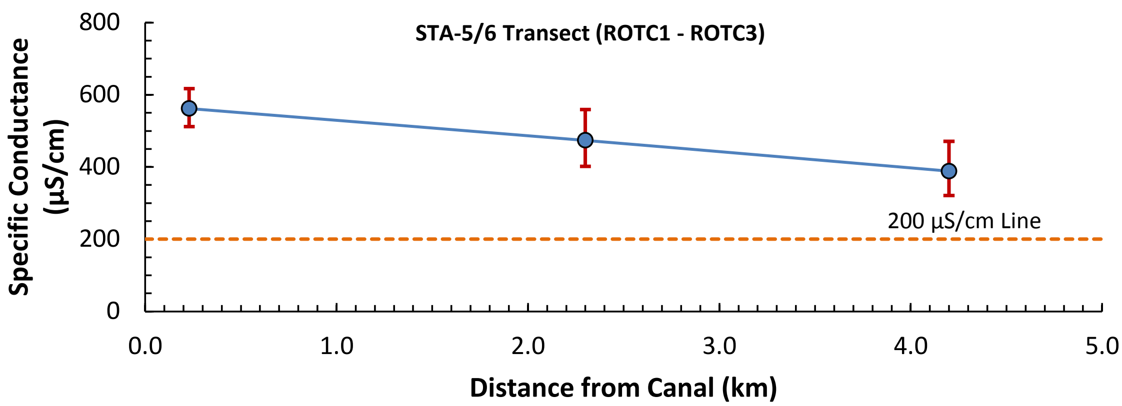
As previously mentioned, the RWMA EFA permit compliance transect comprises three monitoring stations (ROTC-1, ROTC-2, and ROTC-3) that extend approximately 4 km downstream of pump station G-410 (**Figure D-8**). All stations along this transect are identified as impacted.

During WY2015, specific conductance levels measured along the RWMA transect were well below the 1,275 µS/cm for Class III waters (**Table D-14**). Geometric mean specific conductance levels in WY2015 decreased by approximately 31 percent along the RWMA transect. Geometric mean TP concentrations exhibited a decrease of approximately 12 percent from 17 µg/L, at the marsh station closest to the inflow, to 15 µg/L, at a distance of 4 km from the canal (**Figure D-14**).

A comparison of specific conductance and TP concentrations for WY2014 and WY2015 is provided in **Table D-14**. A statistically significant difference was observed between specific conductance data from WY2014 and WY2015 (Mann-Whitney p-value = 0.027). Specific conductance in WY2014 (geometric mean = 386 µS/cm; median = 431 µS/cm) was lower than in WY2015 (geometric mean = 476 µS/cm; median = 627 µS/cm). A statistically significant increase in TP concentrations was observed between data for WY2014 and WY2015 (p-value < 0.001), with concentrations for WY2015 being higher by 5 µg/L (geometric mean and median = 15 µg/L) compared to WY2014 (geometric mean and median = 10 µg/L)

Table D-14. Comparison of surface water mean [± 1 standard deviation (SD)] specific conductance and TP concentrations between WY2014 and WY2015 at permit compliance stations in the RWMA.

STA (Transect)	Station	WY2014			WY2015		
		Number of Samples	Mean ± SD	Geometric Mean	Number of Samples	Mean ± SD	Geometric Mean
		Specific Conductance (µS/cm)					
STA-5/6 (Transect 1)	ROTC1	11	477 ± 156	452	10	583 ± 157	562
	ROTC2	11	410 ± 181	371	9	525 ± 233	474
	ROTC3	8	359 ± 153	327	8	441 ± 231	389
		Total Phosphorus (µg/L)					
	ROTC1	10	13 ± 3	12	10	18 ± 6	17
	ROTC2	11	8 ± 2	8	9	14 ± 4	14
	ROTC3	8	10 ± 2	9	8	16 ± 5	15



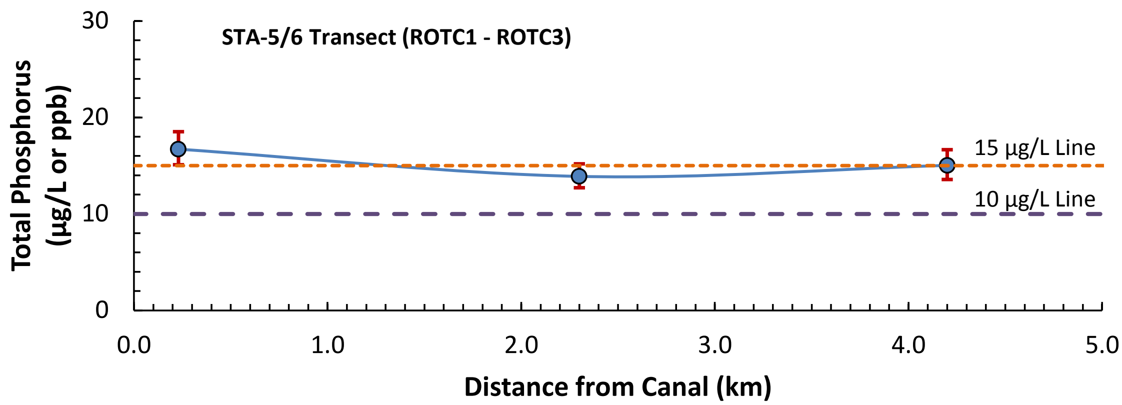


Figure D-14. Geometric mean specific conductance and TP concentrations at transect stations in RWMA, downstream of STA-5/6, during WY2015. Error bars represent the standard error around the calculated geometric mean. The 1,275 µS/cm reference line on specific conductance plot indicates the Class III freshwater criterion. The Phosphorus Rule does not apply to the RWMA; 10 and 15 µg/L lines on the TP plot are for reference only.

Macrophyte Coverage

Using a point intercept survey methodology, the areal coverage of dominant macrophyte species has been surveyed at the three permit-mandated stations along fixed 10-meter transects twice a year (dry and wet seasons) since 2004. The presence of sawgrass and cattail at 1-meter intervals was recorded (**Table D-15**). Sawgrass and cattail coverage remained relatively unchanged at the ROTC1 station from previous years. Cattail was the dominant species, present at every survey point at ROTC1. This is not unexpected, since ROTC1 is the closest station to the Rotenberger inflow, where TP concentrations were highest (**Table D-14**). Both sawgrass and cattail were present at ROTC2 and ROTC3, where surface water TP concentrations were low (**Table D-14**). ROTC3 has exhibited very little variation in vegetation community, remaining consistently sawgrass dominant during the survey period, 2004–2014. ROTC2 is a mixed cattail sawgrass marsh. Although there has been some variation in the frequency of occurrence of cattail throughout the history of this station, ROTC2 remains a sawgrass dominated marsh for the time being.

Table D-15. Number of points (out of 10 possible points at one-meter intervals along each transect) where sawgrass (SAW) or cattail (CAT) was present in WY2015/WY2014.

Date	ROTC1		ROTC2		ROTC3	
	CAT	SAW	CAT	SAW	CAT	SAW
March 2014	10	3	3	10	3	10
September 2014	10	1	3	9	8	10

Restoration Activities

In 2009, the District, in cooperation with the FWC, began the restoration of 19 acres of tree islands in the southwest corner of the RWMA. Restoration began with the treatment and removal of exotic species, including Brazilian pepper (*Schinus terebinthifolius*) and primrose willow. These tree islands were initially planted with 3,000 native tree and shrub species, which are protected from wildlife damage with metal exclosures. The FWC planted an additional 384 trees and shrubs on these islands in 2010–2011. In 2013, in order to meet the survival rate established for the initial planting, an additional 1,028 plants were planted by the District, in coordination with the FWC. These islands are cooperatively maintained on an annual basis for both exotic plants and metal exclosure upkeep.

The FWC conducts various other restoration activities in RWMA each year. For 2014–2015, approximately 316 acres were treated for exotic plants, including tree islands, levee, and marsh habitats. Metal exclosure maintenance occurred on all planted tree islands in RWMA (5,987 exclosures on 21 tree islands). Additionally, annual aerial cattail surveys are conducted to monitor cattail expansion within RWMA.

The FWC completed restoration of the old farms located within RWMA in 2011. This multi-year project included the mechanical removal or degradation of 10.7 miles of berms and canals. These features altered surface flow throughout 1,758 acres along the eastern boundary of the area. Photo monitoring is performed periodically to document the effects of the restoration activities. Cattail has continued to be a dominant invasive, and in September 2014, FWC chemically treated 100 acres of cattail in a section of the northernmost farm. This work was funded by the FWC Aquatic Habitat Restoration and Enhancement Program at a cost of $10,000. With positive results from the treatment, the FWC plans to chemically treat an additional 500 acres in the old farm areas in 2015–2016. In addition to photo monitoring, vegetation surveys are performed periodically to monitor the effects of the treatment.

The FWC completed the removal of an unimproved road leading to an abandoned drill pad island in 2013–2014 in order to restore hydrologic flow. The drill pad island was retained as it has undergone several restoration efforts, including exotic plant control and native tree and shrub planting, and because it provides habitat similar to a natural tree island. Photo-monitoring and vegetation surveys are performed periodically to document the effects of the restoration activities. Cattail and primrose willow, dominant undesirable species documented during surveys, were chemically treated in May 2015 in the area where the road was removed.

Collaborative restoration work in Rotenberger between the FWC and the District continues.

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Attachment E: Everglades Stormwater Treatment Area Herbicide and Pesticide Application Summary for Water Year 2015

Louis Toth

Table E-1 summarizes herbicide treatments (acres treated and gallons of herbicides used) in the Everglades Stormwater Treatment Areas (STAs) during Water Year 2015 (Water Year 2015) (May 1, 2014–April 30, 2015). No pesticides were applied within the Everglades STAs during WY2015.

CONTROL EFFORTS

Herbicides were used to control three species of floating plants: water lettuce (*Pistia stratiotes*), water hyacinth (*Eichhornia crassipes*), and crested floating heart (*Nymphoides cristata*); five species of emergents: cattail (*Typha domingensis* and *Typha latifolia*), alligator weed (*Alternanthera philoxeroides*), and pennywort (*Hydrocotyle umbellata* and *Hydrocotyle ranuculoides*); three species of grasses: torpedo grass (*Panicum repens*), common reed (*Phragmites australis*), and Napier grass (*Pennisetum purpureum*); three species of shrubs: Brazilian pepper (*Schinus terebinthifolius*), primrose willow (*Ludwigia peruviana*), and Carolina willow (*Salix caroliniana*); and the submerged exotic: hydrilla (*Hydrilla verticillata*).

Large aerial herbicide treatments were used to reduce cover of willow and primrose willow in Cell 1 of Stormwater Treatment Area 1 East (STA-1E; 250 acres) and Cells 1A and 2A of STA-5 (270 acres), floating mats of pennywort and primrose willow in Cell 1A (250 acres) of Stormwater Treatment Area 1 West (STA-1W), cattail encroachment in submerged aquatic vegetation (SAV) Cells 2 and 4 of STA-2 (275 acres) and Cell 1B of STA-3/4 (150 acres), water lettuce in Cell 4A of STA-5 (350 acres), and to eliminate cattail for the second phase of incremental conversion of Cells 6 (250 acres) and 8 (450 acres) of STA-2 to SAV. Herbicide applications also were used regularly to control floating plants near the inflow and outflow structures of all cells, and in SAV cells. Frequent ground (i.e., airboat) treatments were needed for water lettuce, water hyacinth, and pennywort in Cells 4N (200 acres) and 6 (620 acres) of STA-1E, Cells 5A (320 acres) and 5B (750 acres) of STA-1W, and Cells 1B (225 acres), 2B (320 acres), and 4A (700 acres) of STA-5/6. Large ground treatments also were used to facilitate rehabilitation and enhancement efforts in Cell 1A (550 acres) of STA-1W and Cell 2A (138 acres) of STA-3/4, and to eliminate cattail encroachment in Cell 3B (207 acres) of STA-3/4.

APPLICATION RATE

Water lettuce, water hyacinth, and crested floating heart were treated with either diquat dibromide (37.3% solution) at a rate of 1 quart per acre, (46.3%) at 2 quarts per acre, or with a mix of diquat and 2,4D. New growth-regulating herbicides (flumioxazin and penoxsulam) also were used to treat floating plants, particularly in locations where giant bulrush was planted. Flumioxazin

(51%) was particularly effective in eliminating water lettuce at 6 ounces per acre. Penoxsulam (21.7%) was applied at 4 to 6 ounces per acre, alone, and in a mix with flumioxazin at 6 to 10 ounces per acre, to treat water hyacinth and pennywort. Another relatively new herbicide, imazamox (12.1%), was applied at 38.4 ounces per acre to treat cattail. Applications of triclopyr (44.4%) at a rate of 1 to 2 gallons per acre, or a mix of glyphosate (53.8%) at 7.5 pints per acre, and imazapyr (28.7%) at 2 quarts per acre, were applied to willow, primrose willow, and Brazilian pepper. Cattails were treated with glyphosate or with a mix of glyphosate and imazapyr. Glyphosate or the glyphosate/imazapyr mix also were used to treat torpedograss, Napier grass, common reed, and pennywort. Endothall (40.3%) was used at a rate of 2.6 gallons per acre-foot to treat hydrilla.

APPLICATION CERTIFICATION STATEMENT

The South Florida Water Management District ensures that all herbicide applications were carried out in accordance with label specifications and in compliance with National Pollution Discharge Elimination System (NPDES) regulations.

Table E-1. Herbicide use and acres of vegetation treated during WY2015.

Cell	Acres	Diquat (gallons)	Imazapyr (gallons)	Glyphosate (gallons)	2,4 D (gallons)	Triclopyr (gallons)	Flumioxazin (pounds)	Imazamox (gallons)	Penoxsulam (gallons)	Endothall (gallons)
STA 1E										
1	267.28	0.75	241.25	109.5	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	147.24	10	15	49.5	2.5	0	3.75	0	0	0
4N	227.26	28.5	4.5	16.88	0	0	10.25	0	0	0
4S	166.5	2	16	60.28	0	0	12.75	0	0	0
5	215.55	22	17.5	27.38	21	12	1.5	0	0	0
6	674.62	41.25	17.5	50	1	1	55.25	0	0	0
7	279.9	15	5	18.76	0	0	32.75	0	0	0
STA 1W										
1A	816.03	28.75	59.73	236.65	21.5	0	40.25	0	0	0
1B	86.94	5	5	7.5	0	0	9.5	0	0	0
2A	61.26	3.5	10.13	21.94	1	0	0	0	0	0
2B	17.04	1	0	0	1	0	3.75	0	0	0
3	95.33	0	9.38	70.32	0	0	0	0	0	0
4	54.87	0	2.51	59	0	0	0	0	0	0
5A	360.34	31.75	12	45.02	5	0	26	0	0	0
5B	749.24	104.13	0	0	10	0	24.25	0	0	0
STA 2										
1	32.76	5.13	1.25	4.69	0	0	0	0	0	0
2	257.29	6.38	16.63	112.54	0	0	2	30	0	0
3	139.18	25.63	1.75	6.56	0	0	1.75	0	0	0
4	75	0	37.5	70.25	0	0	0	0	0	0
5	228.51	17.26	10.82	75.01	0	0	15.75	0	0.53	0
6	318.92	0.5	90.75	244.24	0	0	11.63	0	0.57	0
7	0	0	0	0	0	0	0	0	0	0
8	564.58	1.13	118.3	506.66	0	0	0	0	0	0

Table E-1. Continued.

Cell	Acres	Diquat (gallons)	Imazapyr (gallons)	Glyphosate (gallons)	2,4 D (gallons)	Triclopyr (gallons)	Flumioxazin (pounds)	Imazamox (gallons)	Penoxsulam (gallons)	Endothall (gallons)
STA 3/4										
1A	34.5	3.63	0	0	0	0	5.88	0	0.26	0
1B	150	0	75	140.5	0	0	0	0	0	0
2A	138.52	1.13	0	2.81	0	0	41.77	0	2.95	0
2B	0	0	0	0	0	0	0	0	0	0
3A	80.14	12.51	0.13	0.47	0	0	9.01	0	0.16	0
3B	212.59	1.25	27.62	206.74	0	0	0	0	0	0
PSTA	36.41	0	9.88	0	0	0	0	0	0	0
STA 5/6										
5-1A	219.11	9.38	85	159.25	0	0	4.75	0	0	0
5-1B	226.09	21.39	0.12	2.58	1	0	36.75	0	2.24	0
5-2A	135.92	7.38	50	94.69	0	0	1.75	0	0	0
5-2B	320.06	26.01	0.06	2.34	0	0	60.03	0	1.73	0
5-3A	76.15	18.5	0	0	0.5	0	0.75	0	0	0
5-3B	11.16	0	0	0	0	0	3	0	0	0
5-4A	1060.15	294.66	10.89	43.64	0	0	52.51	0	0	0
5-4B	63.58	0	6.25	27.37	0	1.25	14.83	0	0	0
5-5A	75.32	9.01	8.26	32.35	5.5	0	0.88	0	0	0
5-5B	0	0	0	0	0	0	0	0	0	0
6-3	0.92	0	0	1.03	0	0	0	0	0	0.54
6-5	7.2	1.25	0	0.94	0	0	0.5	0	0	0.54
6-2	0	0	0	0	0	0	0	0	0	0
6-4	5.9	2.38	0	0	1.25	0	0	0	0	0