Appendix 5-3: Annual Permit Report for the C-4 Emergency Detention Basin

Permit Report (May 1, 2011–April 30, 2012)

Rick Householder

Contributors: Shi Kui Xue, Matt Powers, Christopher King, and John Leslie

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 attachments included with this report. **Table A-1** in Attachment A lists the 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 latest modified permit.

Table 1. Key permit-related information.

Project Name:	C-4 Emergency Detention Basin
Permit Numbers:	EI 13-0192729-001 and EI 13-0192729-004
Issue and Expiration Dates:	
EI 13-0192729-001	Issued: 9/10/2002; Expires: 9/9/2007
EI 13-0192729-002	Issued: 2/14/2003
EI 13-0192729-003	Issued: 3/4/2003
EI 13-0192729-004	Issued: 9/26/2003; Expires: 9/25/2008
EI 13-0192729-008	Issued: 2/3/2005
EI 13-0192729-010	Issued: 7/2/2007
EI 13-0192729-011	Issued: 9/25/2008
EI 13-0192729-013	Issued: 2/20/2012
Project Phase:	I & II
Permit Condition Requiring Annual Monitoring Report:	20 (in EI 13-0192729-013)
Relevant Period of Record:	May 1, 2011 – April 30, 2012
Report Lead:	Rick Householder ehouseh@sfwmd.gov 561-682-6582
Permit Coordinator:	John Leslie jleslie@sfwmd.gov 561-682-6476

Table 2. Attachments included with this report.

Attachment	Title
A	Specific Conditions and Cross-References
B	Water Quality Data
C	Hydrological Data
D	Dike and Pump Station Inspection Report

INTRODUCTION

The South Florida Water Management District (SFWMD or District) was issued Environmental Resource Permit 13-0192729-001 and 13-0192729-004 by the Florida Department of Environmental Protection (FDEP) to construct and operate Phases I and II, respectively, of the C-4 Emergency Detention Basin (C-4 EDB) (**Figure 1**). This report provides an estimate of the total phosphorus (TP) mass balance on an event basis and cumulatively for the seven years of operation of the C-4 EDB. This fulfills the TP mass balance reporting requirement in Specific Condition 11 of the permit modification (13-0192729-008) issued on February 3, 2005, for the Water Year 2012 (WY2012) (May 2011–April 2012) annual reporting period.

The C-4 EDB is in the Miami-Dade County Lake Belt Area and includes projects within jurisdictional wetlands in the North Trail Wetland Basin, located adjacent to and immediately north of the C-4 canal and west of the Dade-Broward Levee (Section 4, Township 54 South, Range 39 East). The C-4 EDB provides improved flood protection for the City of Sweetwater and surrounding areas during extreme events by providing 3,264 acre-feet (ac-ft) of aboveground storage for floodwaters. During a major storm event, the C-4 EDB pumps convey floodwaters from the C-4 canal into the storage detention basins (both Phases I and II), which helps reduce flooding of the area further east. After the event and stages in the C-4 canal have returned to normal, the floodwaters discharge from the EDB back to the C-4 canal and eventually to tide. Construction of the water management infrastructure was certified complete in May 2005, and the facility became administratively operational in November 2006 after stage monitoring equipment was relocated and recalibrated to maximize accuracy and minimize siltation.

BACKGROUND

The C-4 EDB is in the North Trail Wetland Basin in southwestern Miami-Dade County between SW 137th Avenue and Krome Avenue and accessible via Tamiami Trail (SW 8th Street, U.S. 41), which runs along the facility's southern border. It was constructed to reduce the magnitude, duration, and frequency of flooding of low-lying areas within the jurisdictions of the cities of Sweetwater, West Miami, and western Miami-Dade County (the "Flagami District"). Such flooding occurred during intense rainfalls accompanying several unnamed (2000) and named tropical storms and Hurricane Irene (1999) in the previous decade. A naturally low-lying, high-seepage area was chosen for the facility between the Dade-Broward Levee and Canal to the west and an abandoned orange grove to the east and between a mining operation to the north and the C-4 canal to the south. On the other side of the Dade-Broward Levee is the Pennsuco Wetlands Area, portions of which are owned by the District.

Figure 1. Overview of the C-4 Emergency Detention Basin (C-4 EDB).

The C-4 EDB was constructed in phases. Phase I includes the northern section and encompasses 415 acres. The remaining 416 acres is Phase II. Together, the two areas total 831 acres. Construction of the Phase I levees, seepage canal, and the G-420 and G-420S pumps was completed in March 2002. Phase II was completed in May 2005. The G-420S pump was replaced in April 2006.

The Phase I and Phase II lands were both owned by private and public entities (**Figure 2**). The District obtained a 50-year easement from the State of Florida for Phase I. Phase II lands were obtained by using funds from the Federal Emergency Management Agency (FEMA) and the Florida Department of Community Affairs (DCA), as well as funds from the Conservation and Recreation Lands Trust Fund (CARL). Phase I will eventually become part of the East Coast Buffer Project. CEMEX, Inc. has mineral extraction rights for a substantial portion of the Phase I parcel for the next 50 years, but the start date and duration of mining are not yet known. During extraction operations, the Phase I section can only be flooded to a maximum depth of 2 feet (ft) rather than the designed 4 ft. The District has been reimbursed for the entire cost of the project by FEMA. Pump and weir construction for Phase I and II were completed in July 2004 and May 2005, respectively.

Figure 2. Phase I and II lands in the C-4 EDB.

PERMIT CONDITIONS

In applying for the permit in 2002, the District agreed to remediate wetlands degraded by construction and remove all exotic trees. Both efforts have been successful. The District also assured the issuing authorities that the risk of adverse impacts to native, short hydroperiod wetland vegetation, and wildlife would be *de minimis* if the facility were operated infrequently and in a manner to minimize the stage-duration by emptying the accumulated rain, groundwater, and inflow water rapidly following a pumping event.

The permits from the U.S. Army Corps of Engineers (USACE) and Miami-Dade County Department of Environmental Resources Management cross-referenced the FDEP permit general and specific conditions, but the USACE permit added a focus on the eradication of primrose willow (*Ludwigia peruviana*), as well as melaleuca (*Melaleuca quinquenervia*). The effectiveness of the exotic plant eradication program is documented annually pursuant to Specific Conditions 8 and 12 of the Phase I and II permits, respectively.

In September 2008, the FDEP issued permit modification #EI 13-012729-011, which amended specific conditions 8 and 11 for the Phase 1 and 2 monitoring in permit modifications

#EI 13-0192729-001 and 13-0192729-004. This allowed biennial vegetation monitoring via aerial photography and quarterly monitoring of wildlife from the levees in conjunction with water quality monitoring. A six-year biennial monitoring program was established to detect, quantify, and report significant changes in vegetation habitat, wildlife utilization, water quality, and periphyton growth within the Phase I (north) and Phase II (south) basins of the C-4 EDB.

On February 20, 2012, the FDEP issued a minor modification to permit # EI 13-0192729-013 to reduce the project's overall monitoring and reporting. The permit modification retains water quality, stage, and flow monitoring, and eliminates all biennial wildlife, periphyton, and vegetation monitoring and reporting. Additionally, the permit modification changed the reporting frequency from biennial to annual.

ACTIVE MANDATES AND PERMIT

The original Environmental Resource Permit (ERP) and all major modifications issued to the SFWMD are:

- #EI 13-0192729-001, issued September 10, 2002, with the expiration of the construction phase on September 9, 2007 (Phase 1)
- #EI 13-0192729-004, issued September 26, 2006, with the expiration of the construction phase on September 25, 2008 (Phase 2)
- #EI 13-0192729-008, issued on February 3, 2005, to modify the project's monitoring requirements by reducing the frequency of monitoring the wetlands within the Phase 1 and Phase 2 Detention Basins.
- #EI 13-012729-010, issued on July 2, 2007, to modify the project's monitoring requirements, which reduced the frequency of wildlife observations from quarterly to semi-annually, periphyton monitoring will coincide with the biennial aerial survey, the Biennial Environmental Impact Evaluation Workshop will be conducted in September instead of July, and the evaluation report is due in November instead of July.
- #EI 13-012729-011, issued on September 25, 2008, to modify the project's monitoring requirements (wildlife observations shall be implemented once every other year incidental to ground-truthing for vegetation monitoring via aerial photography for the period 2005 through 2011).
- #EI 13-012729-013, issued on February 20, 2012, to modify the project monitoring due to a reduction in overall monitoring requirements. Water quality monitoring shall be implemented during periods in which the wetlands within the detention basin are used for stormwater storage.

On November 8, 2006, the FDEP approved the As-Built Certification of the C-4 EDB and concurred that this facility was constructed in accordance with the FDEP permits.

WATER QUALITY MONITORING

This section of the report focuses on the water quality monitoring data from the C-4 EDB.

SAMPLING METHODS

All permit mandated project monitoring is outlined in an operational monitoring plan developed by the District's Water Quality Monitoring Section (SFWMD, 2012). This plan assures the consistency and validity of samples and data collected over time. The plan is reviewed annually and revised as needed in response to modifications of the project's operation or

permitted requirements. During the WY2012 reporting period, a minor permit modification was implemented (effective on February 20, 2012) that reduced the number of monitoring stations from three to two locations (see **Tables 3** and **4**). This report covers both permit conditions with EI 13-0192729-012 covering May 1, 2011–February 20, 2012, and EI 13-0192729-013 covering February 20, 2012–April 31, 2012.

From May 1, 2011–February 20, 2012, there were three water quality monitoring stations (G-420, G-421, and G-422) in the C-4 EDB. G-420 and G-422 were located just upstream of the pump stations, and G-421 was located upstream of the structure that allows water out of the C-4 EDB. All three stations were sampled if flow occurred at the station within 72 hours of a flow event and thereafter on a weekly basis. If no flow occurred at the station during the quarter, then a quarterly grab sample was collected at G-420. Samples were analyzed for the following parameters: total phosphate (TPO_4), orthophosphate (OPO_4), total dissolved phosphate ($TDPO_4$) total Kjeldahl nitrogen (TKN), dissolved total Kjeldahl nitrogen (TDKN), nitrate-nitrite (NO_x), and temperature (**Table 3**).

In the modified permit, stations G-420 and G-422 were replaced with a single upstream station (C4IN) located at the mouth of the C-4 inflow canal where it intersects with the C-4 canal. Outfall sampling continues at G-421. Sampling frequency was modified to reflect a more logistically feasible response time (i.e., changed from responding in 72 hours to a flow event to within two weeks to a flow event). Flow events are detected by instrumentation at G-422, G-420, and G-421, each of which measures inflow and outflow from the C-4 EDB. The quarterly requirement to collect samples regardless of flow was eliminated, and above-noted analytical parameters were reduced in which only TPO_4 was measured (**Table 4**).

All samples were collected using the grab method outlined in the SFWMD Field Sampling Quality Manual (FSQM) (SFWMD, 2011a), and in accordance with FDEP SOPs. To satisfy requirements of the FSQM, QC samples were collected along with the sample. Samples were analyzed by the SFWMD water quality laboratory in accordance with the Chemistry Laboratory Quality Manual (SFWMD, 2011b).

Figure 3. Water quality monitoring stations.

Table 3. Stations, parameters, and frequencies, May 11–February 19, 2011.

Station	Parameters	Frequency
G-420	TPO_4, OPO_4, $TDPO_4$, TKN, TDKN, NO_x, TEMP	Within 72 hours if flow, otherwise quarterly
G-421 and G-422	TPO_4, OPO_4, $TDPO_4$, TKN, TDKN, NO_x, TEMP	Weekly when flow

Table 4. Stations, parameter, and frequencies, February 20–April 31, 2012.

Station	Parameters	Frequency
C4IN and G-421	TPO_4	Biweekly if recorded flow

SAMPLING RESULTS

During the reporting period, there were three sampling events at station G-420; one was in response to a flow event on October 21, 2011, and the other sampling events were conducted to meet the conditions of permit EI 13-012729-011 that at least one sample collection be conducted every quarter. The quarterly sampling requirement was eliminated in permit EI 13-012729-013, therefore no samples were collected in the first or second quarters of 2012. **Table 5** summarizes the sampled analytes from these events, and **Table 6** summarizes the water quality statistics. C4IN was not sampled as the permit modification and its inclusion as a sampling point occurred after the flow event.

The elevated TKN and TPO_4 values from the sampling on August 18, 2011, likely reflect a dwindling pool of water as drought conditions during this period continued. Stage data from headwater (G420_H) and tailwater (G420_T), as well as G420_P (pump-cfs), indicate that there was no flow from the G-420 pump station into the C-4 EDB for 28 days prior to the 8/18/2011 sampling event.

In the weeks before and after the sampling event, there were several rain events captured by the nearby rain gauge (S335_R) that are likely responsible for the temporary raises in the tailwater (G420_T). The tailwater stage (G420_T) gauge is located in the detention pond immediately west of the G-420 pump station, which is much deeper than the rest of the C-4 EDB.

As the water levels subsided below the ground elevation of the basin, the remaining water pooled into the detention pond, thereby concentrating TP and TKN. Although subsequent rains kept replenishing the detention pond depth, the extent of the pool was much reduced from its former size, when it covered a large amount of the C-4 EDB.

Table 5. WY2012 water quality sampling results at station G-420.

Date Collected	TDKN mg/L	TKN mg/L	NO_X mg/L	$TDPO_4$ µg/L	OPO_4 µg/L	TPO_4 µg/L	TEMP ºC
6/02/11	1.11	1.11	0.005	2	2	5	25.5
8/18/11	1.13	1.38	0.007	2	2	24	26.6
10/24/11	1.15	1.16	0.005	2	2	6	24.8

Table 6. WY2012 water quality data summary statistics at station G-420.

Test Name	Unit	# of Samples	Mean	STD	Min	Q25	Median	Q75	Max	# Below Detection Limit	# of Excursion
NO_x	mg/L	3	0.006	0.001	0.005	0.005	0.005	0.006	0.007	2	0
TEMP	Cent	3	25.633	0.907	24.800	25.150	25.50	26.050	26.600	0	0
TDKN	mg/L	3	1.130	0.020	1.110	1.120	1.130	1.140	1.150	0	0
TKN	mg/L	3	1.217	0.144	1.110	1.135	1.160	1.270	1.380	0	0
OPO_4	mg/L	3	0.002	0.000	0.002	0.002	0.002	0.002	0.002	2	0
$TDPO_4$	mg/L	3	0.002	0.000	0.002	0.002	0.002	0.002	0.002	1	0
TP	mg/L	3	0.012	0.011	0.005	0.006	0.006	0.015	0.024	0	0

OPERATIONAL EVALUATION

OVERVIEW

Water quality monitoring was used to determine the TP mass balance within the C-4 EDB. The SFWMD has conducted six years (beginning in May 2005) of monitoring to identify water quality changes caused by operation of the C-4 EDB as required by the related permits. The data collected were used to:

- Determine overall nutrient load into and out of the C-4 EDB and document changes that result from operational and management decisions;
- Provide environmental information for management of the C-4 EDB to monitor and document physical and chemical characteristics of the source and receiving environments; and
- Provide the data necessary to identify potential environmental and ecological impact shifts resulting from management decisions.

FACILITY OPERATIONS

The only reportable flood control pumping event during the WY2012 annual reporting period occurred during the no name storm from October 20–22, 2011.

DESCRIPTION OF THE FACILITIES

Water Management Infrastructure

G-420

Structure G-420 pumps are operated remotely following direction from the Miami-Dade County Flood Mitigation Program C-4 EDB Operating Plan. The structure is a three-unit pump station located north of the C-4 canal at the junction of U.S. 41 and S.W. 137th Avenue in Miami-Dade County. The three pumps have a combined rating capacity of 700 cubic feet per second (cfs) and are used to move water from the C-4 canal into the C-4 EDB for flood control.

G-421

Water flows out of Phase I of the C-4 EDB into the supply canal and then to the C-4 canal via the G-421 spillway. The operation of the C-4 EDB is governed by the Interim Seasonal Operation Plan. G-421 pumps are turned on progressively if the T5 (C-4 canal at Tamiami Trail at Coral Gables) stage exceeds 5 ft in relation to the National Geodetic Vertical Datum of 1929 (NGVD 29), and all inflow impellers will be turned on if the T5 stage exceeds 5.2 ft NGVD 29. Pumping ceases when the stage in the C-4 EDB reaches 8 ft NGVD 29 and the T5 begins to recede below 5.9 ft NGVD 29, or the stage in the C-4 EDB exceeds the maximum elevation of 10 ft NGVD 29.

G-422

G-422 consists of a set of seven electric pumps powered by diesel generators. Together, the pumps have a total capacity of 700 cfs and move a maximum of 585 cfs with a 4-ft head difference. Inflow pumps are only operated when the stage in the C-4 canal meets the trigger criterion. Water gravity-flows from Phase I into the supply canal and then to the C-4 canal via the G-421 weir. Discharge occurs only after the flood-stage peak has passed. The structure was registered on March 11, 2006.

G-420S

A 100-cfs submersed electric pump (G-420S) located just to the northeast of G-420 is used to recirculate water collected in the seepage collection canal, which runs north-south along the east levee, back into Phase II.

G-423

Water enters and leaves Phase I through the G-423 weir, which will remain permanently, open until CEMEX, Inc. exercises its mineral extraction option. After the mining operation begins, G-423 will be closed and Phase I will be operated independently of Phase II. The maximum depth of Phase I will be 2 ft, while Phase II will be able to be filled to a maximum of 4 ft. No flow is monitored at this structure.

Hydrologic Monitoring

Flow was monitored at two inflows to the C-4 EDB at G-420 and G-422; outflow was monitored at G-421; seepage flow was monitored at pump G-420S. The wetland stage was monitored at C4SW1, C4SW2, and C4SW3 (**Figure 4**). The standards used to evaluate the accuracy of the rating for flow calculations are consistent with the SFWMD Standard Operating Procedures (SOP) for Flow Data Management in the District Hydrologic Database (Akpoji et al., 2003) and the U.S. Geological Survey approach as outlined by Novak (1985). Four classifications are adopted to assess a rating's accuracy. The rating is classified as (1) "excellent" when about 95 percent of the predicted flow rates are within ±5 percent of the measured discharges, (2) "good" if they are within ±10 percent, (3) "fair" if they are within ±15 percent, and (4) "poor" when they are not within ±15 percent.

WATER BUDGET AND TP MASS BALANCE METHODS

The water budget and TP mass balance were calculated for the entire WY2012, as well as individually for the reportable event during the no name storm (October 20–22, 2011).

Water Budget

The water budget was calculated as follows:

$\Delta S = I+R-ET \pm Se - O-GW(out)$

Where:

- ΔS = change in water storage=$Stage_t$ - $Stage_{t-1}$, $Stage_t$ is the final stage and $Stage_{t-1}$ is the initial stage
- I = inflow structure flows
- R = rainfall
- ET = evapotranspiration loss
- Se = seepage
- O = outflow weir volume
- GW = Groundwater GW(out) = I+R-ET -O- ΔS(when ± Se=0)

TP Mass Balance

The TP mass balance was calculated as:

$$\Delta S_{tp} = I_{tp} + D_{tp} \pm Se_{tp} - O_{tp} - GW_{tp(out)}$$

Where:

- ΔS_{tp} = change in TP storage=TP storage change in soil, water, vegetation, unknown
- I_{tp} = TP coming in through inflow pumps
- O_{tp} = TP leaving out of system through outflow pumps
- Se_{tp} = TP pump into system through seepage pumps, no TP measurements and TP seeping out through seepage
- D_{tp} = Deposition estimate based on literature review (Redfield, 2002)
- GW_{tp}= GW losses or gains, unknown

Retained plus lost through groundwater flow $=\Delta S_{tp} + GW_{tp} = I_{tp} + D_{tp} - O_{tp}$

Daily rainfall measurements were obtained from the nearest station available at S-335, evapotranspiration (ET) was estimated using potential evapotranspiration (ET) data at S-331W (**Figure 5**), and TP load was calculated by multiplying the TP concentration with the corresponding flow. TP inflow and outflow loads were calculated using the SFWMD's Nutrient Load Program. TP atmospheric deposition was calculated by multiplying the area and deposition rate [36 $mg/m^2/yr$ from literature compiled by Redfield (2002)]. The missing outflow TP concentration (auto-sampler was not triggered) at G-421 was conservatively estimated as equal to the inflow concentration at G-420, because both structures represent the same body of water.

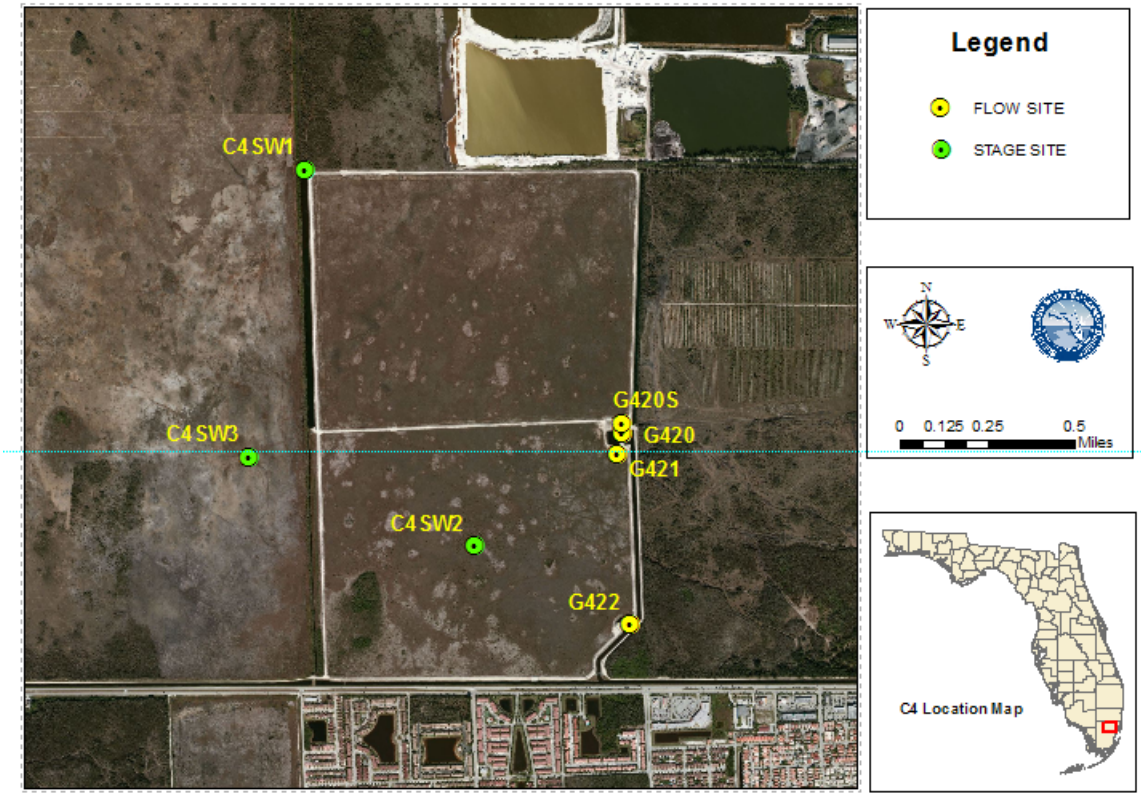

Figure 4. Flow and stage stations for the C-4 EDB.

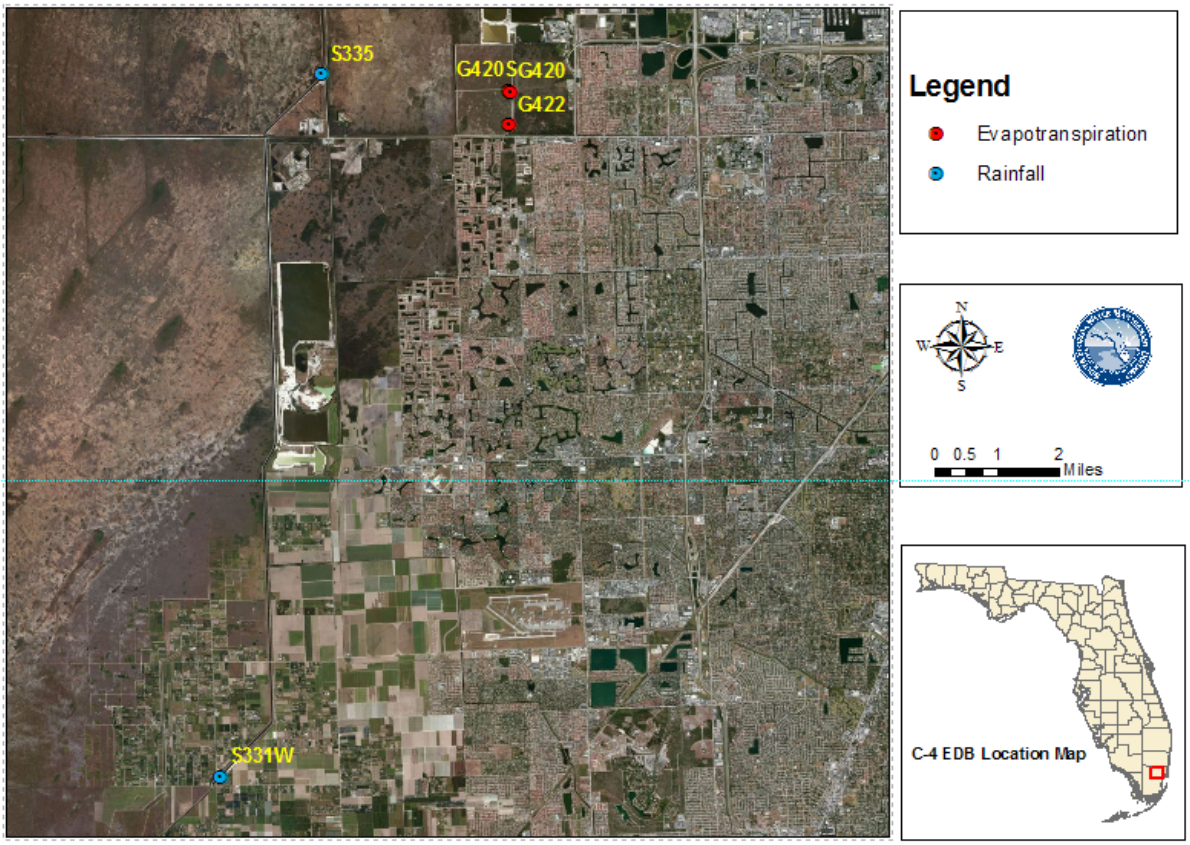

Figure 5. Rainfall and evapotranspiration (ET) stations and detention areas for the C-4 EDB.

WATER BUDGET AND TP MASS BALANCE RESULTS

WY2012 monitoring data are presented in Attachment B, and water quality data for all parameters monitored at inflow station G-420 is summarized in **Table 6**. The flows at each structure (**Figure 6**) were as follows:

- Peak flow at G-420_P was 232 cfs and total flow was 1,219 ac-ft
- Peak flow at G-422P was 31 cfs and total flow was 165 ac-ft
- Very little outflow, 12 ac-ft, went through G-421_S
- Peak flow at seepage pump G-420S_P was 3.8 cfs

The water budget components including the rainfall (**Figure 7**), evapotranspiration (ET) (**Figure 8**), and storage change (**Figure 9**) are used for the water budget calculations. It should be noted from **Figure 9** that the storage changed very fast during the October no-name storm due to high seepage rates in the C-4 EDB, and little water was continuously stored in the system. The stage time series are shown in **Figure 10**. The stage was high during the wet season around the end of October. The highest water depth reached about 1 ft (stage level 6.3 ft; ground elevation 5.1 ft) during the no name storm event and gradually decreased for over a month.

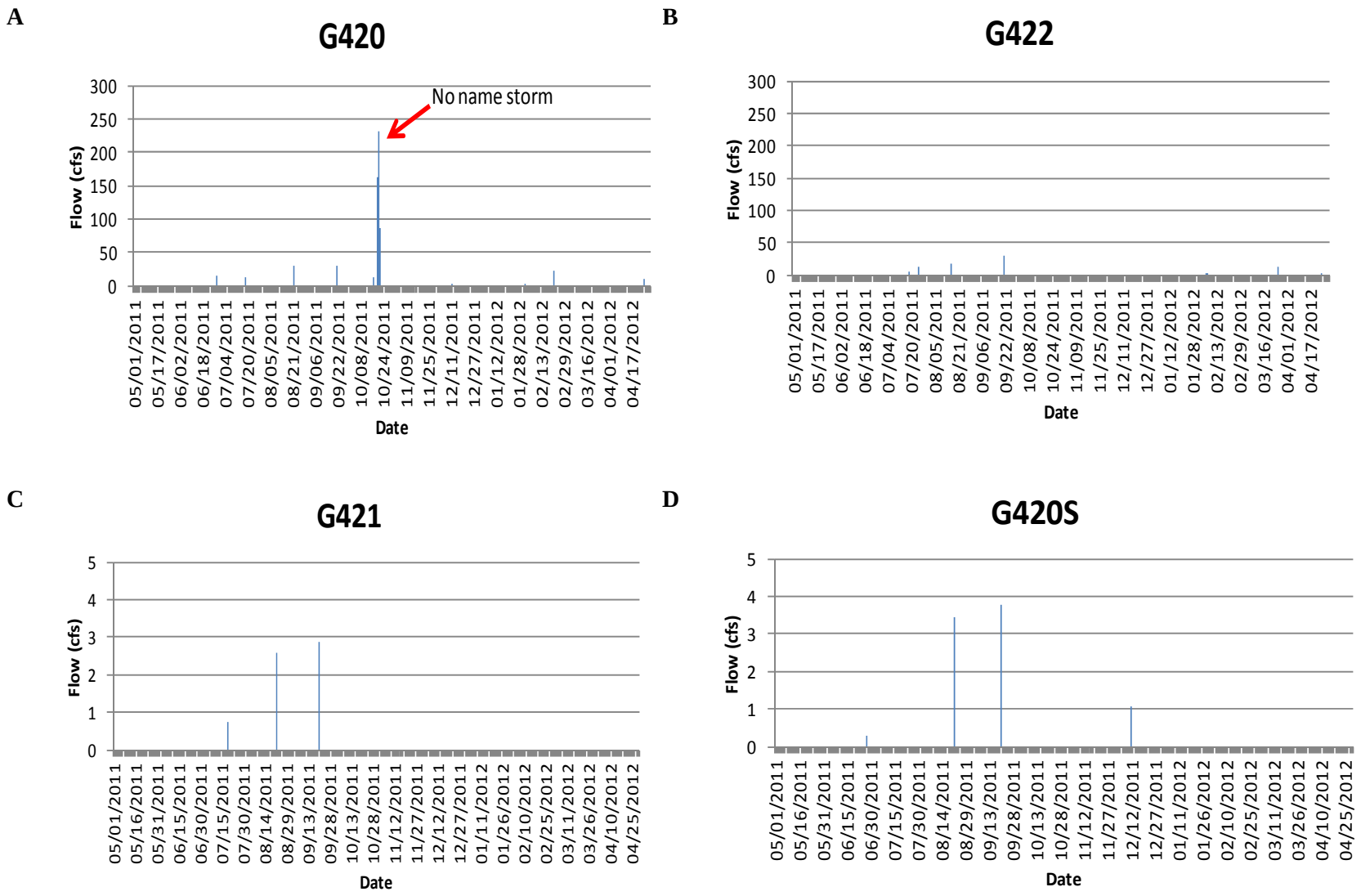

Figure 6. WY2012 flow for the C-4 EDB (A) G-420_O, (B) G-422_P, (C) G-421_S, and (D) G-420S_P.

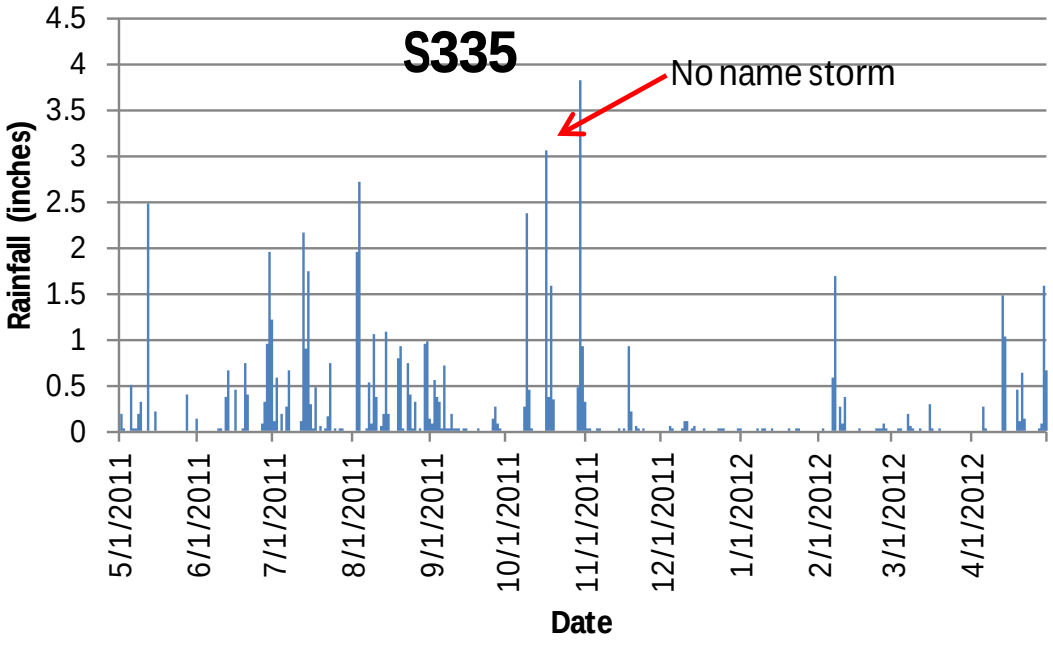

Figure 7. WY2012 rainfall for the C-4 EDB.

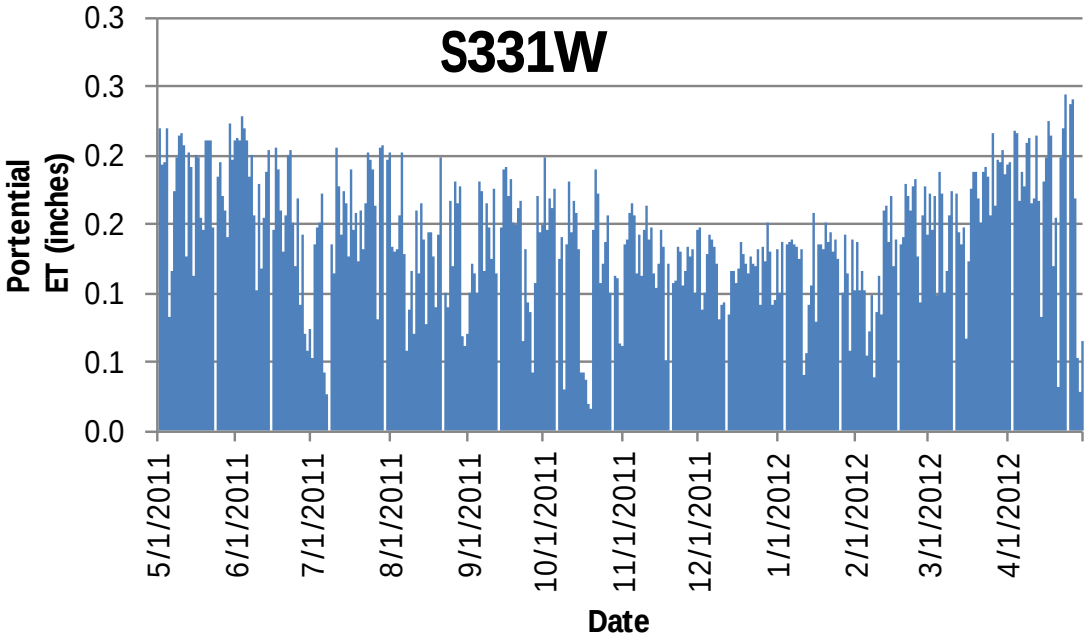

Figure 8. WY2012 ET for the C-4 EDB.

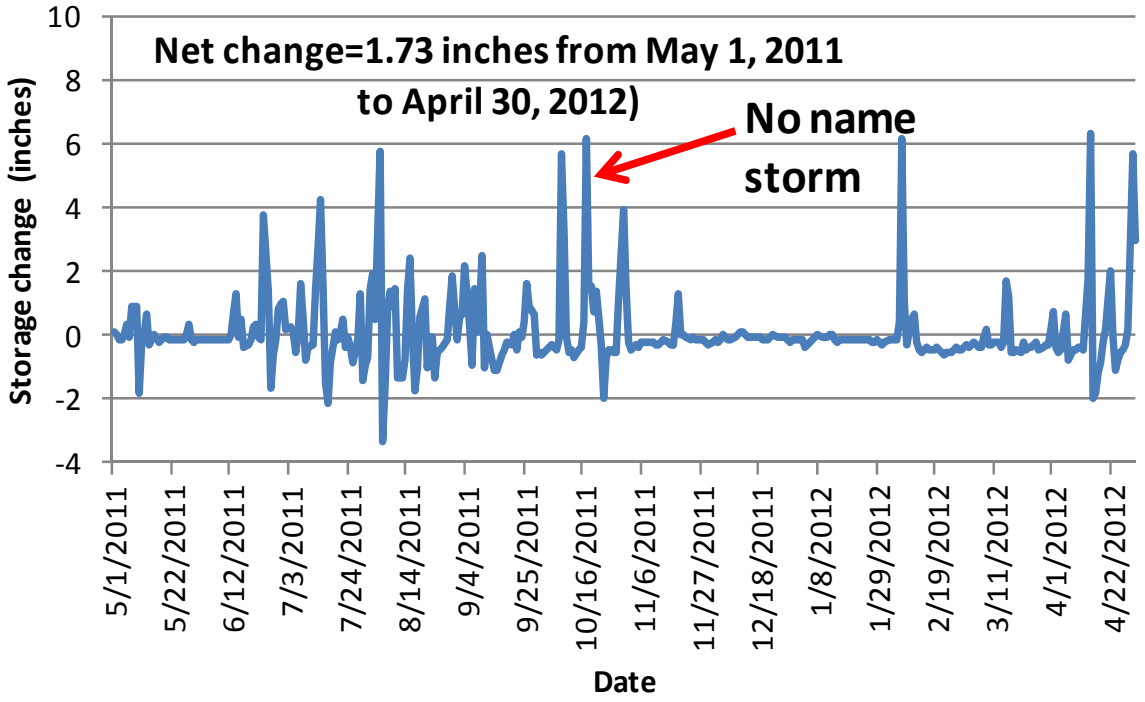

Figure 9. WY2012 storage change for the C-4 EDB.

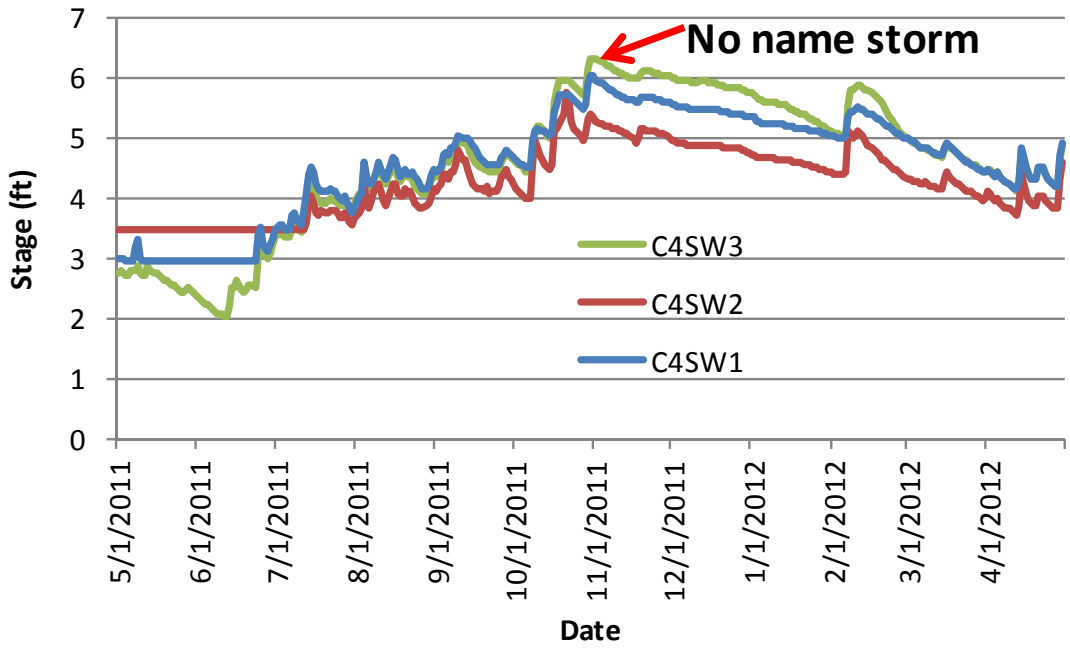

Figure 10. WY2012 stage for the C-4 EDB [Note: ground elevation is about 5.1 ft].

Total flow volumes in the C-4 EDB for the reporting period are summarized in **Table 7**. The water budget is summarized in **Table 8**. The inflow was the highest in October 2011, which was consistent with the rainfall input to the system. As shown in the table, the major inflow component to the water budget is precipitation, and the minor inflow component is surface inflow; the major outflow components are ET and groundwater loss.

Table 7. WY2012 flow volume and flow-weighted mean total phosphorus (TP) concentrations for the C-4 EDB structures.

Area	C-4-EDB Structure	Water Quality Sampling Site	Flow Station	Flow (ac-ft)	Flow Weighted Mean TP (ppb)	TP Load (kg)
Inflow	G-420	G420	G420	1,219	8	12.4
	G-422	G422	G422	165	16	3.2
Outflow	G-421	G421*	G421	12	18	0.3

*Outflow water quality data were not available; G-420 inflow water quality data were used for G-421 outflow concentration.

Table 8. WY2012 water budget for the C-4 EDB.

Component	WY2012 Total (inches)
Precipitation	63.6
Evapotranspiration (ET)	52.2
Inflow[1]	19.98
Outflow[1]	0.18
Seepage Recycle	0.25
Storage Change	1.73
Groundwater (GW)*	29.52

WY2012 is defined as from May 1, 2011–April 30, 2012

*GW(out) =I + R – ET- O - ΔS

[1] Calculated as flow volume divided by total detention area (831 acres)

The TP mass balances are shown in **Table 9**. During WY2012, three grab samples were collected at the inflow detention areas (G-420) (see **Table 6**), and there were no TP samples collected at the outflow structure (G-421). The TP data from inflow structure G-420 were used to estimate the outflow concentration in the mass balance calculation, because no outflow TP concentration data were available at G-421 and both structures represent the same water body.

During WY2012, the mean TP concentration at the G-420 monitoring site was 12 ppb (0.012 mg/L) for grab samples (**Table 6**); no samples were collected at the G-422 site. The TP concentrations varied from 5 to 24 ppb, with a mean TP concentration of 6 ppb. The flow-weighted mean (FWM) TP concentration was 9 ppb for inflow structures G-420 and G422. The TP load to the C-4 EDB was 15.6 kilograms (kg) from inflow structures G-420 and G-422. As TP data were not available at outflow structure G-421, the outflow TP load was calculated using the inflow TP concentration. The estimated outflow TP load was 0.28 kg, although the actual outflow TP load could be slightly less due to plant uptake of TP within the C-4 EDB. As shown in **Table 9**, the estimated atmospheric deposition (121 kg) is much higher than the inflow TP load (15.6 kg). It is assumed that most of the TP was retained (136 kg) in the C-4 EDB or lost through groundwater.

Table 9. WY2012 TP mass balance in the C-4 EDB.

	WY2012 Total (kg)	No-Name Storm Event (Oct. 20-22, 2011) (kg)
Atmospheric Deposition	121*	0.99
Inflow	15.6	8.0*
Outflow	0.28	0
Retained + Lost Through Groundwater Flow	136.32	9.0
*Percentage for Majority**	*89%*	*89%*

*Where retained plus lost through groundwater flow $=\Delta S_{tp+} GW_{tp} = I_{tp} + D_{tp} - O_{tp}$

The TP mass balance for the event-based no name storm is illustrated in **Figure 11** and the WY2012 annual TP mass balance is depicted in **Figure 12**. On an event basis, surface water inflow from G-420 for the October 2011 storm was the major TP contributor (8.0 kg) to the C-4 EDB compared to atmospheric deposition (0.99 kg). The retained TP plus the amount lost through groundwater accounted for 9.0 kg. As shown in **Figure 12**, from May 2011 through April 2012, atmospheric deposition was the major (121 kg) contributor to the TP load compared to the surface water inflow from G-420 and G-422 (15.6 kg) and outflow pump (0.28 kg). The retained TP plus the amount lost through groundwater accounted for 136.3 kg.

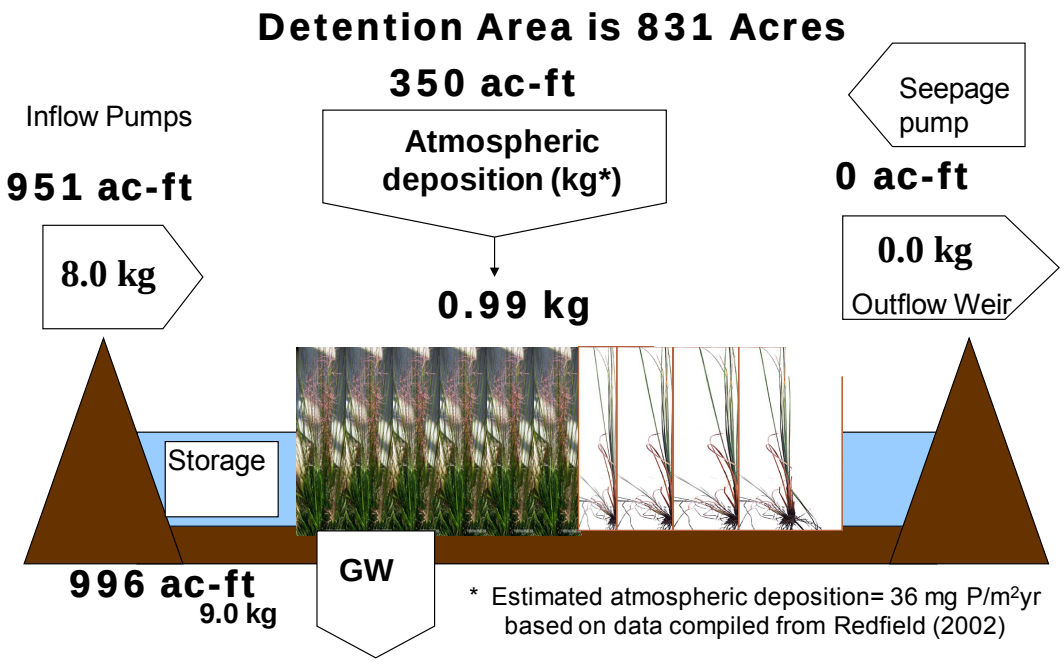

Figure 11. TP mass balance for the no name storm (October 20–22, 2011) flood control pumping event in the C-4 EDB.

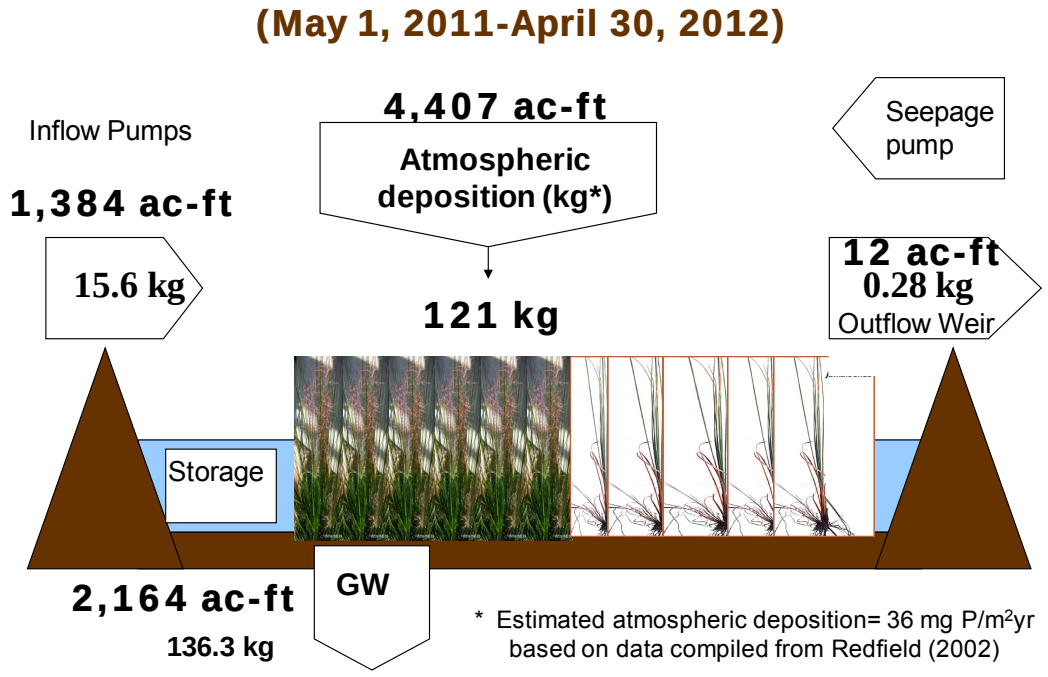

Figure 12. WY2012 TP mass balance in the C-4 EDB.

HIGHLIGHTS

The water budget and TP mass balance calculations indicate that:

- The major inflow component to the water budget was precipitation and the minor inflow component was surface inflow; the major outflow components were ET and groundwater loss.
- The C-4 EDB was a net sink for TP for the one reportable event associated with the no name storm, with 89 percent TP retention plus loss via groundwater seepage loss.
- The C-4 EDB was a net sink for TP during WY2012, with more than 89 percent TP retention plus loss through groundwater seepage loss.
- Surface water inflow loads predominated on an event basis, but atmospheric deposition predominated for the annual reporting period.
- The outflow TP mass load from C-4 EDB was very small (less than 0.28 kg).
- FWM TP concentrations were 9 ppb during WY2012 in the C-4 EDB.

LITERATURE CITED

Akpoji, G.A., E. Damisse, M. Imru, C. James, and N.D. Mtundu. 2003. Standard Operating Procedures for Flow Data Management in the District's Hydrologic Database. South Florida Water Management District, West Palm Beach, FL.

Novak, C.E. 1985. Preparation of Water-Resources Data Reports: U.S. Geological Survey, Open File Report, 85-480.

Redfield, G.W. 2002. Atmospheric Deposition of Phosphorus: Concepts, Constraints, and Published Deposition Rates for Ecosystem Management. Technical Publication #360. South Florida Water Management District, West Palm Beach, FL.

SFWMD. 1999. Comprehensive Quality Assurance Plan No. 870166G. South Florida Water Management District, West Palm Beach, FL.

SFWMD. 2011a. Field Sampling Quality Manual, SFWMD-FIELD-QM-001-07. South Florida Water Management District, West Palm Beach, FL.

SFWMD. 2011b. Chemistry Laboratory Quality Manual, SFWMD-LAB-QM-2010-001. South Florida Water Management District, West Palm Beach, FL.

SFWMD. 2012. Operational Project Monitoring Plan for C-4 Emergency Detention Basin. 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 for the C-4 Emergency Detention Basin Phase I Permit (EI 13-0192729-001) and Phase II Permit (EI 13-0192729-004, Mod -013).

Specific Condition	Description	Applicable Phase	Action & Frequency	Reported in the 2013 SFER in: *(All references are to Volume III, unless noted)*			
				Narrative (page #'s)	**Figure**	**Table**	**Attachment**
3	Addresses: Reports and notices submitted to the Department in accordance with this permit	Operation	Reports and noticed were submitted as required	---	---	---	---
11	Water Quality Monitoring	Operation	Conducted water quality sampling as required. Utilized water quality monitoring data to determine TP mass balance.	5 - 19	3 - 12	3 - 9	B
14	Stage & Flow Monitoring	Operation	Conducted stage and flow monitoring as required	10 - 19	4, 6, 10	7	C
15	Dike and Pump Station Inspection	Operation	Levee inspection and report conducted as required	---	---	---	D
20	Annual Status Report	Operation	Completed report as required	ALL	ALL	ALL	ALL
21	Data Quality	Operation	All monitoring data was collected, analyzed, reported, and retained in accordance with permit requirements	---	---	---	---

Attachment B: Water Quality Data

This project information is required by Specific Condition 11 of the C-4 Emergency Detention Basin Permit (EI 13-0192729), and is available upon request.

Attachment C: Hydrological Data

This project information is required by Specific Condition 14 of the C-4 Emergency Detention Basin Permit (EI 13-0192729), and is available upon request.

Attachment D: Dike and Pump Station Inspection Report

This project information is required by Specific Condition 15 of the C-4 Emergency Detention Basin Permit (EI 13-0192729).

SOUTH FLORIDA WATER MANAGEMENT DISTRICT

Annual Levee Inspection and Report

Project:	C-4 Emergency Detention Basin
Location:	Latitude 25.771743, Longitude -80.440211 Township 53 S, Range 39 E, Section 33 Township 54 S, Range 39 E, Section 04 North of C-4 Canal, 1 mile west of the intersection of SW 137th Avenue and SW 8th Street (Tamiami Trail)(SR41)
Date of Inspection:	February 27, 2012
Permit No.:	Minor Modification No. 0192729-013, Florida Department of Environmental Protection, dated February 20th, 2012
Status:	Competent, capable of operating during the 100 year storm event No water is currently stored
Capacity:	3500 acre-feet
Inspection Findings:	Acceptable Condition

The C-4 Emergency Detention Basin is in an acceptable condition and is capable to safely operate during a storm event. Regular maintenance work and test runs have been performed on the various pump stations and other appurtenant structures. The repairs of the G-420 and G-422 Pump Station roofs were completed in 2011.

Jose D. A. Guardiario, P.E.
P.E. No. 59342
Date: 03/21/2012

1.0 Introduction

The C-4 Emergency Detention Basin is a minor 3,500-acrefoot, above ground impoundment constructed in 2004 by the South Florida Water Management District (District). Financial assistance was provided from the Federal Emergency Management Agency (FEMA) and the State of Florida Department of Community Affairs (DCA) as part of FEMA's Hazard Grant Mitigation Program resulting from Hurricane Irene with the objective of implementing a series of improvements in the C-4 basin to increase the level of flood protection, particularly those communities in the western areas of the C-4 basin, namely the cities of Sweetwater, West Miami and Miami among others. The project is permitted by the Florida Department of Environmental Protection (FDEP) under Minor Modification No. 0192729-013

The C-4 Emergency Detention Basin is located in western Miami Dade County immediately north of the C-4 Canal adjacent to SW 8th Street (Tamiami Trail)(SR41), and 1 mile west of the intersection of SW 137th Avenue and SW 8th Street (Figure 1). It is bounded on the south by the C-4 (Tamiami) Canal, on the east by the Supply Canal, Seepage Canal and wetlands, on the north by the CEMEX mine and wetlands and on the west by wetlands. The C-4 Emergency Detention Basin is hydraulically connected to the District's C-4 Canal (Tamiami) Canal through the Supply Canal and serves to provide relief to the C-4 Canal during storm events. (Figure 1).

2.0 Objective

This report is submitted in order to comply with the requirements of the FDEP Minor Modification No. 0192729-013 Special Condition No. 15, Dike and Pump Station Inspection. Special Condition No. 15 requires annual and periodic levee inspection reports evaluating the integrity and functionality of the above-ground levees and structures, including pump stations. It requires a cover letter summarizing site conditions and work that was completed, or may be completed, in response to inadequacies found during the inspections. A Professional Engineer or the District's Dam Safety Officer is required to review and approve major repair plans associated with the levee system. The District is required to submit Inspection Reports, both annual and periodic, to FDEP in March.

3.0 Methodology

The inspection follows the guidelines of the U.S. Army Corps of Engineers' Levee Owner's Manual For Non-Federal Flood Control Works, The Rehabilitation and Inspection Program, Public Law 84-99, published in March 2006. The inspection is focused towards identifying existing or potential levee safety deficiencies that could adversely impact the operability or stability of the impoundment and appurtenant works. Deficiencies include seepage, piping, cracking, slope instability, sinkholes, animal burrows, uncorrected erosion, and any other sign of deterioration. Reference to the as-built records was made to assure that the constructed project retains the designed performance capability and is ready to operate in a safe manner during storm events.

4.0 Project Features

The C-4 Emergency Detention Basin is an 816-acre impoundment that is accessible through an unpaved road north of the C-4 Canal from SW 137th Avenue. The Basin is divided into two cells, which are the Phase 1 (South) and the Phase 2 (North) Cells that are separated by the Interior Levee. The North Cell contains 418 acres and the South Cell 398 acres, and both are bounded by the Perimeter Levee (Figure 1). Two intake pump stations G-420 and G-422 are located on the east side of the South Cell and are connected to the C-4 Canal through the Supply Canal.

A seepage canal is located on the east side of the North Cell and ties to the G-420S seepage pump which is located at the northeast corner of the South Cell. The G-423 Interbasin Transfer Culvert is located on the east end of the Interior Levee to release water from the South Cell to the North Cell. A discharge spillway (G-421) is located on the south side of the G-422 Intake Pump Station.

5. Findings

The field inspection was conducted by Shawn Gao, Lead Geotechnical Engineer and Jose Guardiario, Principal Engineer of the Design Section, Engineering and Construction Bureau, Operations, Maintenance & Construction Division of the District on February 27, 2012.

At the time of inspection the Basin was dry and did not store water. Vegetation inside the cell consists of Melaleuca trees, saw grass, cattails and weeds.

Access Road:

The unpaved road from SW 137th Avenue is in an acceptable condition. There were no ruts observed and the Melaleuca and Australian Pine trees on the vacant property located on the north side of the road do not impede access to the Basin (Figure 3). The District's Miami Field Station staff regularly graded the access road.

Perimeter Levees:

The top widths of the Perimeter Levees except for the West Perimeter Levee of the North Cell are 14 feet wide with 4H:1V inside slopes and 2H:1V to 3H:1V outside slopes. The top width of the West Perimeter Levee of the North Cell is 25 to 30 feet wide with 5H:1V inside slopes and 1H:1V outside slopes. The majority of the slopes are bare. In some areas, vegetation is present but is withered. Although there is no vegetative cover on the levee banks, it is constructed of crushed limestone, hence it is stable. Refer to Figures 4, 5, 7 to 16, and 19 to 22.

The levee roads do not show ruts and the side slopes do not exhibit evidence of erosion such as gullies. No work has been done on the Perimeter Levees for the past year. Except for lack of vegetation, the Perimeter Levees are acceptable.

Interior Levee:

The top width of the Interior Levee is 10 feet wide with 3H:1V side slopes. The majority of the slopes are bare. In some areas, vegetation is present but is withered (Figure 18). Although there is no vegetative cover on the levee banks, it is constructed of crushed limestone, hence it is stable.

The levee road does not show ruts and the side slopes do not exhibit evidence of erosion such as gullies. No work has been done on the Interior Levee for the past year. Except for lack of vegetation, the Interior Levee is acceptable.

Emergency Spillway:

The Emergency Spillway structure is constructed of a reinforced concrete slab and retaining wall with fabriform concrete matting on the side slopes (Figures 23 and 24). There is no erosion observed at the adjacent embankment and toe and there was no maintenance work performed on the emergency spillway in 2011. Except for the withered vegetation growing in the construction joints, the structure is in an acceptable condition. Future maintenance work is the removal of the vegetation.

Supply Canal:

There are no erosion or slope failures observed on the banks of the Supply Canal. Although there is no vegetative cover on the canal banks, it is in limestone and constructed of crushed limestone, hence it is stable. The Supply Canal is in an acceptable condition.

Pump Stations G-422, G·420 and G·420S, and Discharge Structure G·421:
There are no erosion or cracked concrete surfaces observed on the structures (Figures 25 to 35) that abut the embankment. Minimal iron oxide stains were observed on the walls. Regular preventive maintenance work was performed on these structures. Repairs of the G-422 and G420 roofs were completed in 2011. These structures are in acceptable condition.

Interbasin Transfer Structure G-423
There is no erosion observed at the abutments on this structure and the reinforced concrete surfaces are in good condition. Regular maintenance work was performed on this structure in 2011. This structure is in an acceptable condition.

Summary of Findings
The C4 Emergency Detention Basin is well maintained and fully operational, and is capable of operating safely during a storm event. All levees and structures are in acceptable condition.

Figure 1. Site Location Map.

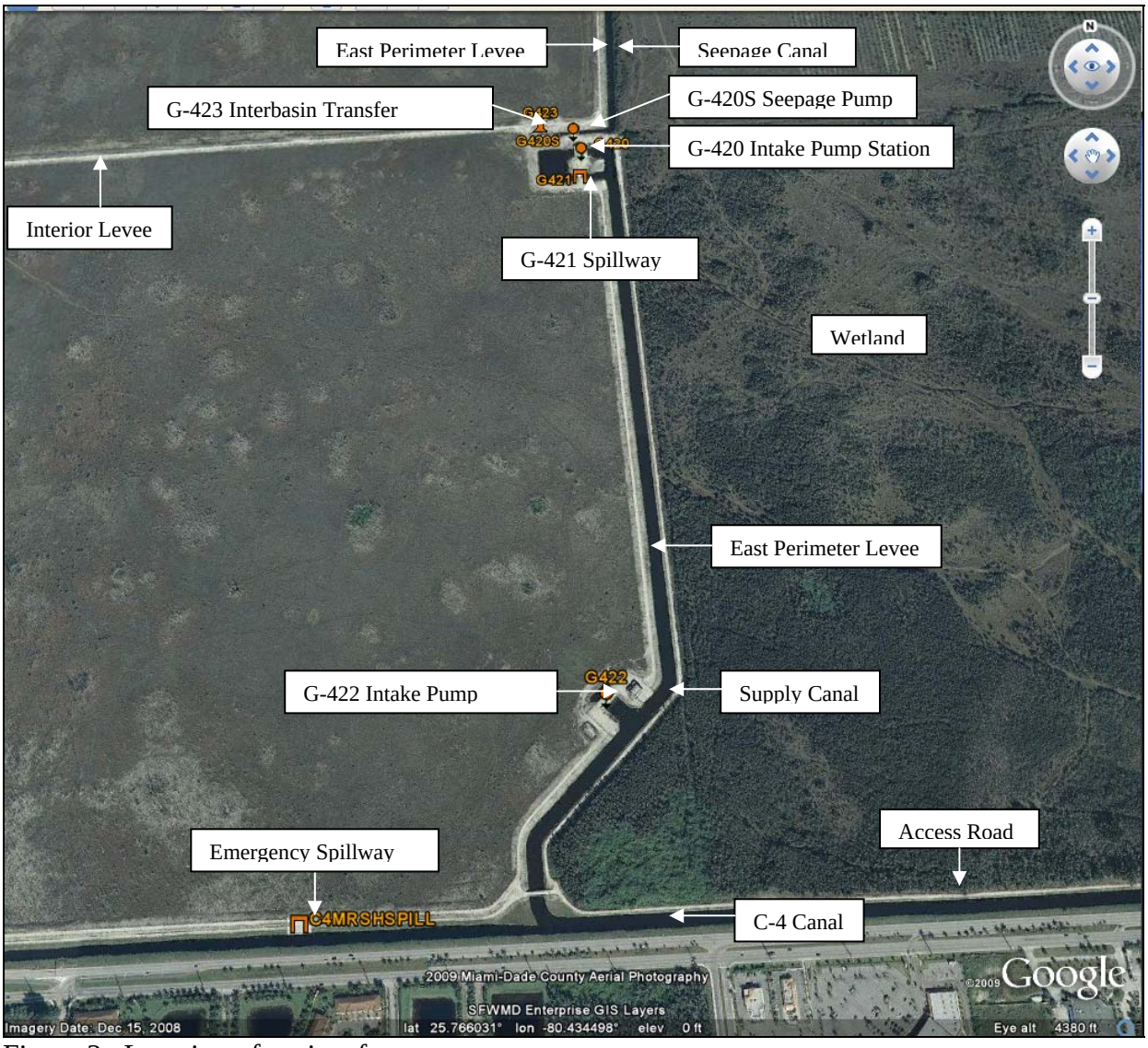

Figure 2. Location of project features.

Figure 3. Westerly view of the unpaved access road from SW 137th Avenue.

Figure 4. Northerly view of the 14-foot wide East Perimeter Levee and the Supply Canal from the southeast corner of the South Cell. The inside and outside slopes are 4H:1V and 2.5H:1V, respectively. The majority of the side slopes are bare of vegetation. The weeds on the slopes are withered. No ruts or erosion was observed.

Figure 5. Southerly view of the 14-foot wide East Perimeter Levee 0.28 miles north of the G-422 Pump Station. The inside and outside slopes are 4H:1V and 2.5H:1V, respectively. Majority of the side slopes are bare of vegetation. The weeds on the slopes are withered. No ruts or erosion was observed.

Figure 6. Northerly view of the South Cell interior, 0.28 miles north of the G-422 Pump Station.

Figure 7. Southerly view of the North Cell Perimeter Levee inside slope 0.2 miles north of the intersection of the Interior Levee and the North Perimeter Levee. The 4H:1V inside slope has a mixture of 6" muck and limestone gravel and boulders with withered vegetation cover. No ruts or erosion was observed.

Figure 8. Southerly view of the North Cell Perimeter Levee as seen from the northeast corner of the North Cell. The inside and outside slopes are 4H:1V and 2H:1V, respectively. Vegetation on the slopes is withered. No ruts and erosion observed.

Figure 9. Northeasterly view of the 3-foot boulders installed at the northeast corner of the North Cell to prevent motorized vehicles from entering the C-4 Emergency Detention Basin.

Figure 10. Northwesterly view of the northeast corner of the North Cell Perimeter Levee. The levee width is approximately 30- feet wide at this corner with the inside slopes at 0.75H:1V which will require flattening. Sparse vegetation on the slopes is withered. No ruts and erosion observed.

Figure 11. Westerly view of the North Cell North Perimeter Levee as seen from the northeast corner. The inside and outside slopes are 4H:1V and 2.5H:1V, respectively. Sparse vegetation noted and is withered. No ruts or erosion was observed.

Figure 12. Westerly view of the North Cell North Perimeter Levee and the CEMEX Mines, 0.4 miles west of the northeast corner of the Basin. The inside and outside slopes are 4H:1V and 2.5H:1V, respectively. Sparse withered vegetation noted. No ruts or erosion was observed.

Figure 13. Easterly view of the North Cell North Perimeter Levee as seen from the northwest corner of the Basin. At this corner the levee top transitions into a 25 to 30-foot wide West Perimeter levee. The inside and outside slopes are 4H:1V and 2.5H:1V, respectively. Sparse withered vegetation noted. No ruts or erosion was observed.

Figure 14. Southerly view of the North Cell West Perimeter Levee as seen from the northwest corner. The inside and outside slopes are 4H:1V and 1H:1V, respectively. Sparse withered vegetation noted. No ruts or erosion was observed.

Figure 15. Southerly view of the North Cell West Perimeter Levee and Borrow Pit as seen from the northwest corner. The outside slope is 1H:1V. Sparse withered vegetation noted. No ruts or erosion was observed.

Figure 16. Northerly view of the 25-foot wide North Cell West Perimeter Levee as seen from its junction with the Interior Levee. The inside and outside slopes are 4H:1V and 1H:1V, respectively. Sparse withered vegetation noted. No ruts or erosion was observed.

Figure 17. Southeasterly view of the North Cell interior as seen from the northwest corner.

Figure 18. Easterly view of the 10-foot wide Interior Levee between the North and South Cells. The levee slope is 4H:1V. Sparse withered vegetation noted. No ruts or erosion was observed.

Figure 19. Southerly view of the 14-foot wide South Cell West Perimeter Levee as seen from its junction with the Interior Levee. The inside and outside slopes are 4H:1V and 2H:1V, respectively. Sparse withered vegetation noted. No ruts or erosion was observed.

Figure 20. Northerly view of the 14-foot wide South Cell West Perimeter Levee as seen from the southwest corner. The inside and outside slopes are 4H:1V and 2H:1V, respectively. Sparse withered vegetation noted. No ruts or erosion was observed.

Figure 21. Eastherly view of the 14-foot wide South Cell South Perimeter Levee as seen from southwest corner. The inside and outside slopes are 4H:1V and 2H:1V, respectively. Sparse withered vegetation noted. No ruts or erosion was observed.

Figure 22. Easterly view of the 14-foot wide South Cell South Perimeter Levee and 25-foot wide berm approximately 200 feet east of the southwest corner. The inside and outside slopes are 4H:1V and 2H:1V, respectively. Sparse withered vegetation noted. No ruts or erosion was observed.

Figure 23. Westerly view of the Emergency Spillway. The concrete surface is in good condition. Some vegetation growth along the construction joints.

Figure 24. Closer view of the Emergency Spillway showing some vegetation growing along construction joints and fabriform joints.

Figure 25 . Northerly view of the G-422 Intake Pump Station.

Figure 26. Westerly view of the G-422 Intake Pump Station showing the trash rake system and seven pump bays with 89cfs electric pumps. The concrete abutments and steel sheet pile walls are in good condition.

Figure 27. Northeasterly view of the G-422 Intake Pump Station Emergency Generator Building. The roof was repaired in 2011.

Figure 28. Southwesterly view of the G-421 Gated Spillway Structure Wingwall. Iron oxide stains from minor corrosion of fence posts. No cracks were observed on the concrete surfaces.

Figure 29. View of the G-421 Gated Spillway Structure vertical roller gate and weir crest.

Figure 30. View of the G-421 Gated Spillway Structure service bridge. No cracks observed on the concrete surfaces.

Figure 31. Westerly view of the G-420 Intake Pump Station showing the trash rake system and three pump bays with 223cfs electric pumps. The concrete abutments and steel sheet pile walls are in good condition.

Figure 32. Northeasterly view of the G-420 Intake Pump Station showing the discharge bays. The concrete abutments and steel sheet pile walls are in good condition.

Figure 33. Southerly view of the G-420 Intake Pump Station showing the aboveground fuel storage tanks.

Figure 34. Westerly view of the G-420S Seepage Pump Station showing the trash rack and Jersey barrier wall.

Figure 35. G-420S Seepage Pump discharge showing the flap gate.

Figure 36. Northerly view of the G-423 Interbasin Transfer Structure with six 5-foot high by 10-foot wide gated culverts.

Figure 37. Westerly view of the G-423 Interbasin Transfer Structure discharge.

Figure 38. Northerly view of the Supply Canal as seen from the access bridge. There are no erosion or slope failure observed on the canal banks.