Technical Publication

ERA # 455

Water Budget Analysis for Stormwater Treatment Area 1 East

(May 1, 2005 to April 30, 2006 with data presented since startup in September 2004)

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by

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EXECUTIVE SUMMARY

STA-1E is part of the Everglades Construction Project (ECP) required by the Everglades Forever Act (CH. 373.4592(e), F.S.). The 1994 Everglades Forever Act requested that the United States government, acting through the U.S. Army Corps of Engineers (USACE), construct Stormwater Treatment Area 1 East (STA-1E) as part of the authorized C-51 Flood Control Project.

STA-1E has eight cells with three parallel treatment trains and a total effective treatment area of 2,078 ha (5,133 ac) with an additional 423 ha (1,046 ac) of east and west distribution cells. Since STA-1E start-up in 2004, Cells 1 and 2 have been off-line for the USACE Periphyton-Based Treatment Demonstration Project. The source of water for STA-1E is runoff/drainage from the C-51W Basin consisting of residential and agricultural land uses, L-8 Canal consisting of predominantly agricultural land use, and the STA-1 Inflow Basin also consisting of predominantly agricultural land use. Treated water is discharged into the Loxahatchee National Wildlife Refuge, L-40 Canal.

This report is the first water budget for STA-1E. STA-1E hydrologic and hydraulic monitoring data are used in a water budget analysis from the start-up of the STA to the end of water year 2006 (September 2004 to April 30, 2006). Hydrologic data is summarized from September 20, 2004 to April 30, 2005 for a partial water year, and full water budget is analyzed and summarized for water year 2006 (May 1, 2005 to April 30, 2006).

For water year 2006, the total surface water inflow was 6,431 ha-m (52,134 ac-ft) with 46.4 percent, 34.7 percent and 18.9 percent inflows through G-311, S-319 and S-361, respectively. The total surface water outflow was 6,706 ha-m (54,372 ac-ft) with 75 percent and 25 percent outflows through S-362 and G-311, respectively. The daily mass balance unknowns and errors term (Remainders) has outliers for the period October 29 to November 1, 2005. These outliers correspond to the high outflows from STA-1E into the Inflow Basin through the G-311 structure from October 29 to November 1, 2005. These flows were observed after Hurricane Wilma passed through the area. For water year 2006, rainfall was 111.4 cm (43.8 in) and evapotranspiration was 131.4 cm (51.7 inches). The sum of errors and unknowns was 299 ha-m (2,424 ac-ft), 3.1 percent of total inflows. The 3.1 percent error is acceptable. The mean hydraulic loading rate for water year 2006, based on average flow, was 0.68 cm d^{-1} (0.27 in d^{-1}). The mean hydraulic retention time was computed as the ratio of the estimated mean volume of STA-1E and the average of inflow and outflow rate. The whole area of the STA, including the east and west distribution cell areas, was considered for retention time calculation. The estimated retention time was 41 days. The average depth in each Cell ranged between 19.8 cm (7.8 in) in Cell 1 to 55.5 cm (21.8 in) in Cell 7. Relatively, Cells 4S, 6 and 7 had higher depths.

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LIST OF ABBREVIATIONS AND ACRONYMS

ac	acre
ac-ft	acre-feet
BMP	Best Management Practice
cm	centimeter
cm/d	centimeter per day
cfs	cubic feet per second
EAA	Everglades Agricultural Area
ECP	Everglades Construction Project
EFA	Everglades Forever Act
ENR	Everglades Nutrient Removal
ET	Evapotranspiration
ft	feet
ha	hectare
ha-m	hectare-meter
HW	headwater
$g/m^2/yr$	gram per meter square per year
in	inch
in d^{-1}	inch per day
m	meter
m^3s^{-1}	cubic meter per second
MAX	maximum
MIN	minimum
mm	millimeter
NGVD	National Geodetic Vertical Datum of 1929
P	Phosphorus
Q	discharge
Refuge	Loxahatchee National Wildlife Refuge
rpm	revolution per minute
SAV	Submerged Aquatic Vegetation
SFWMD	South Florida Water Management District
STA	Stormwater Treatment Area
STA-1E	Stormwater Treatment Area 1-East
STA-1W	Stormwater Treatment Area 1-West
TW	tailwater
USACE	US Army Corps of Engineers
WCA-1	Water Conservation Area 1
WY	Water Year

CONVERSION FACTORS

Metric	English
mm	0.03937 in
cm	0.3937 in
m	3.2808 ft
km	0.6215 mile
ha	2.47 ac
$m^3 s^{-1}$	35.2257 cfs
ha-m	8.1068 ac-ft

ACKNOWLEDGEMENTS

The author acknowledges the review of the draft by Pam Lehr, Garth Redfield, Tracey Piccone, Zhao Hongying and Muluneh Imru; Hedy Marshall for editing the draft Technical Publication.

INTRODUCTION

Background

The Everglades Forever Act enacted by the Florida Legislature in April 1994, requested that the United States government, acting through the U.S. Army Corps of Engineers (USACE), construct Stormwater Treatment Area 1 East (STA-1E) as part of the authorized C-51 Flood Control Project by July 1, 2002. Congress authorized Federal participation in the design and construction of STA-1E in Section 315 of Public Law 104-303, dated October 31, 1996, through the Water Resources Development Act of 1996 (Gary Goforth, Inc., 2005). STA-1E is part of the Everglades Construction Project (ECP), construction, operation, and maintenance of which is required by the Everglades Forever Act (EFA- CH. 373.4592(e), F.S.) to restore the Everglades ecosystem (Everglades Forever Act Permit, 2005). All features of STA-1E were built under the direction of USACE except structure G-311, that was constructed by the South Florida Water Management District (SFWMD).

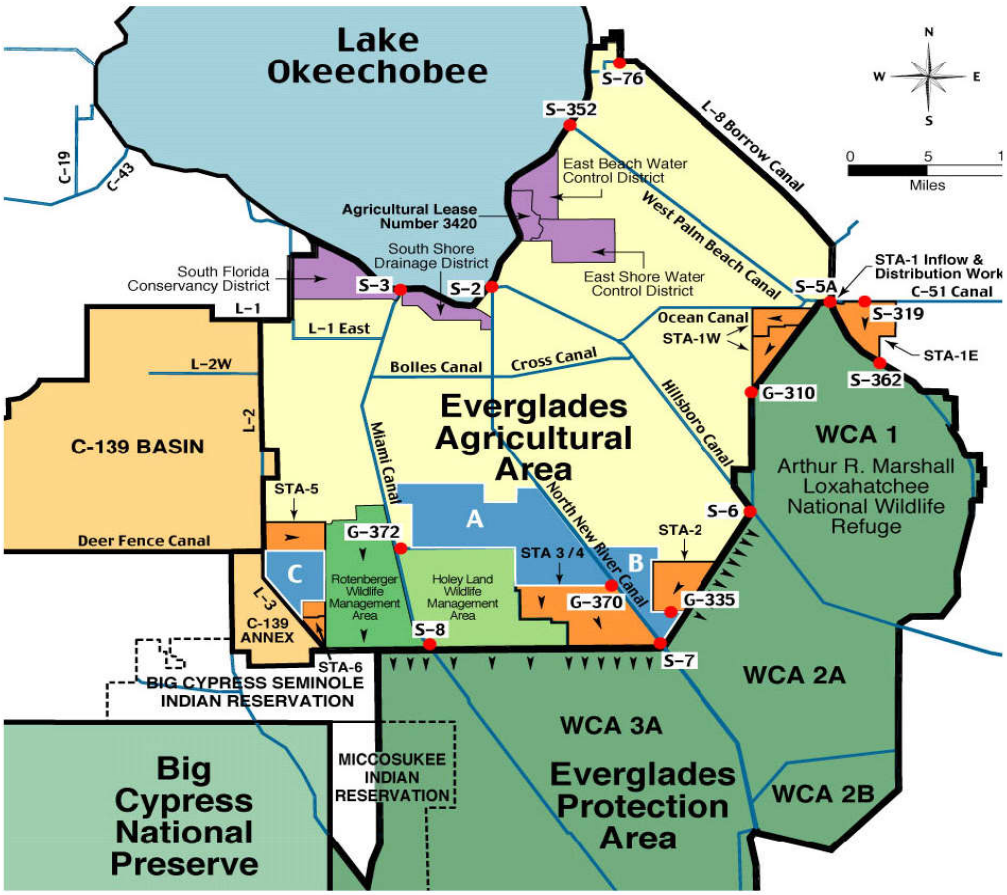

Figure 1. Location of Stormwater Treatment Area 1-East (STA-1E).

Site Description

STA-1E is approximately 32 km (20 miles) west of West Palm Beach, Florida (Latitude 26° 36' 44"; Longitude 80° 18' 6"), located south of State Road 80 and C-51 Canal and east of the S-5A Pump Station. To the southwest is the Arthur R. Marshall Loxahatchee National Wildlife Refuge (Refuge), which includes Water Conservation Area 1 (WCA-1). To the west lies the STA-1 Inflow Basin, which distributes water to STA-1W to the west, STA-1E to the east and WCA-1 to the south (Figure 1).

STA-1E is an eight-cell STA with three parallel treatment trains and a total effective treatment area of 2,078 ha (5,133 ac) with an additional 423 ha (1046 ac) of east and west distribution cells (Figure 2). STA-1E began start-up in 2004. Since operations started, Cells 1 and 2 are off-line for the USACE, Periphyton-Based Treatment Demonstration Project. Inflow into STA-1E is through two pump stations (S-319 and S-361) and a gated spillway (G-311). The source of water for STA-1E is runoff/drainage from the C-51W Basin consisting of residential and agricultural land uses, L-8 Canal consisting of predominantly agricultural land use and the STA-1 Inflow Basin also consisting of predominantly agricultural land use. Treated water is discharged into the Loxahatchee National Wildlife Refuge, L-40 Canal. Outflow of treated water is into the Refuge. The 31-year long-term average annual simulated hydraulic loading rate for this STA is 2.06 cm/d, and the simulated total phosphorus loading rate is 1.33 g/m^2/yr (Pietro et al., 2006). The major vegetation coverage in STA-1E is submerged aquatic vegetation (SAV) and mixed emergent vegetation.

In this report, STA-1E hydrologic and hydraulic monitoring data are analyzed and presented from the start-up of the STA to the end of water year (WY) 2006 (September 2004 to April 30, 2006). The full water year budget is presented for WY2006. The preceding partial water year data is presented in graphic and tabular format as a way of documenting the start-up period hydrology and hydraulics.

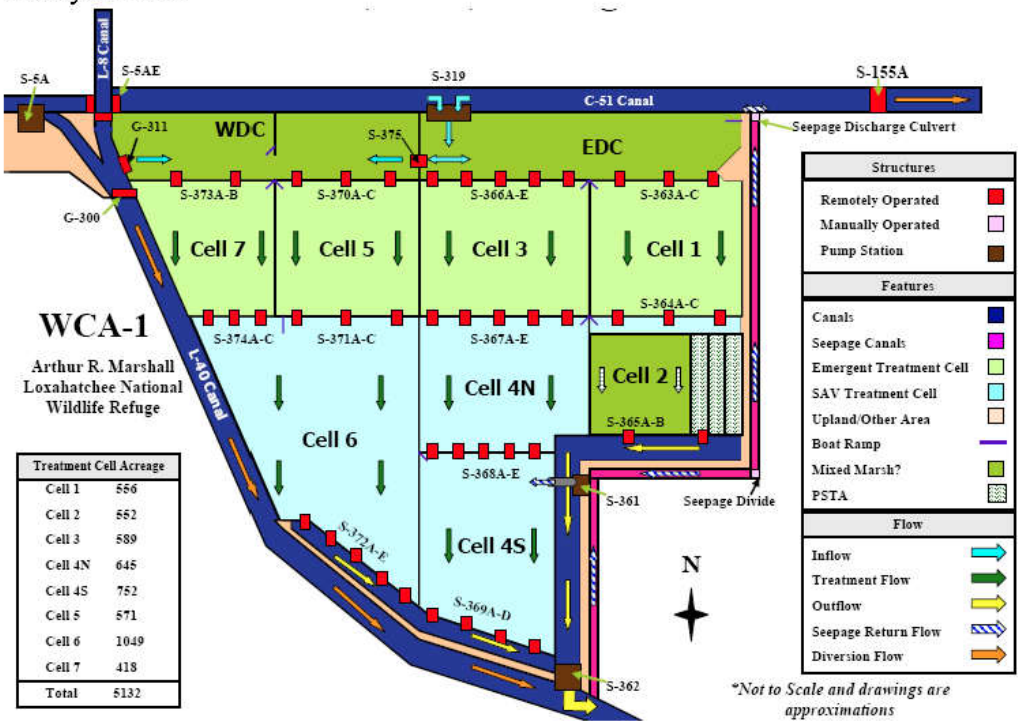

Figure 2. Stormwater Treatment Area 1-East (STA-1E).

The general topography of the site shows ground elevations decline from the north to the south and from east to the west. Table 1 depicts area and ground elevation of each cell (SFWMD, 2006).

Table 1. Site characteristics of STA-1E.

Flow-way	Cell	Area		Avg.Ground Elevation	
		ha	ac	m NGVD	ft NGVD
Eastern	1	225	556	5.15	16.90
	2	223	552	4.79	15.70
Central	3	238	589	4.63	15.20
	4N	261	645	4.32	14.16
	4S	304	752	3.79	12.43
Western	5	231	571	4.09	13.40
	6	425	1,049	3.61	11.85
	7	169	418	3.57	11.72
Distribution Cells	East	190	470	5.04	16.54
	West	233	576	4.50	14.77
Total		2,501	**6,178**		
Average				4.28	14.04

SYSTEM HYDRAULICS AND OPERATION

System Hydraulics

S-5A Complex

The S-5A Complex is northwest of STA-1E at the confluence of the L-8 Canal and the C-51 Canal. The S-5A Complex (Figure 3) has an open connection to the L-8 Canal and three water control structures (S-5AW, S-5AS and S-5AE). S-5AW is a culvert that controls flow from the West Palm Beach Canal into the Complex and from the Complex into the West Palm Beach Canal. S-5AS is a spillway structure that controls flow from the Complex into the STA-1W Inflow Basin and reverse flows. S-5AE is a culvert structure that controls the flow from the Complex into C-51 Canal and reverse flows. STA-1E receives inflows from C-51 Canal and STA-1W Inflow Basin. L-8 Canal water sources are Lake Okeechobee releases and drainage from the L-8 Basin. Mostly, flows through the S-5AW culvert are from the Complex to the west to the West Palm Beach Canal and S-5A Pump Station. Mostly, flows through the S-5AE culvert are from the Complex to the east into the C-51 Canal.

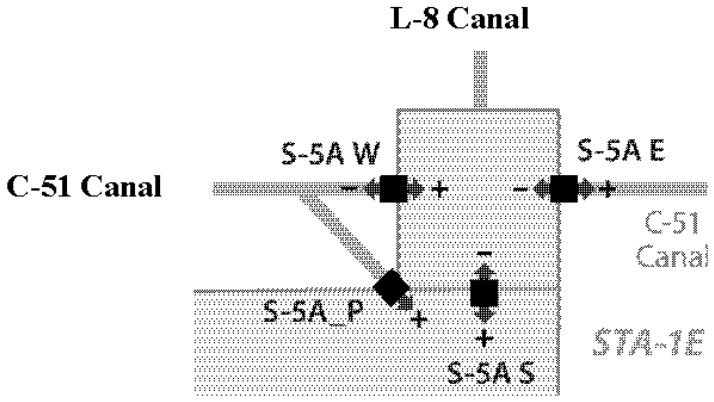

Figure 3. The S-5A Complex.

STA-1 Inflow Basin

Water from the West Palm Beach Canal that previously was pumped into the Refuge (WCA-1) via the S-5A pump station and flowed through the Refuge is presently diverted to STA-1W and STA-1E. A small portion of the area of WCA-1 near the S-5A pump station is levied and forms the STA-1W Inflow Basin that serves as a storage area to divert water into STA-1W and into STA-1E (Figure 4). There are two former and four new water control structures in the STA-1 I&D. The S-5A pump station delivers water from West Palm Beach Canal; the S-5AS spillway controls WCA-1 inflow and outflow at the junction of the L-8 and C-51 canals (S-5A Complex). The six structures in the Inflow Basin are S-5A Pump Station and spillways S-5AS, G-300, G-301, G-302 and G-311.

G-300 is a two-bay, reinforced concrete, U-shaped spillway with vertical lift gates installed on the crest of ogee-shaped weirs. The purpose of this structure is to divert flows from the STA-1 Inflow Basin area into the L-40 borrow canal that runs along the eastern edges of WCA-1. G-301 is a three-bay, reinforced concrete, U-shaped spillway with vertical lift gates on weirs. The purpose of this structure is to divert flow from the STA-1 Inflow Basin area into WCA-1 along the L-7 borrow canal on the western edge of WCA-1. G-302 is a fixed-crest, concrete ogee spillway equipped with two vertical lift gates each of which are 6 m (20 ft) wide. The purpose of this structure is to supply inflow to the five cells of STA-1W from the STA-1 Inflow Basin area. G-302 has a capacity of 92 cubic meters per second ($m^3 s^{-1}$) (3,250 cubic feet per second [cfs]). G-311 is designed as a three-bay, reinforced concrete spillway with lift gates on weirs. The purpose of this structure is to supply water from the STA-1 Inflow Basin area to STA-1E. It can also transfer water from STA-1E to STA -1W via the inflow basin when needed.

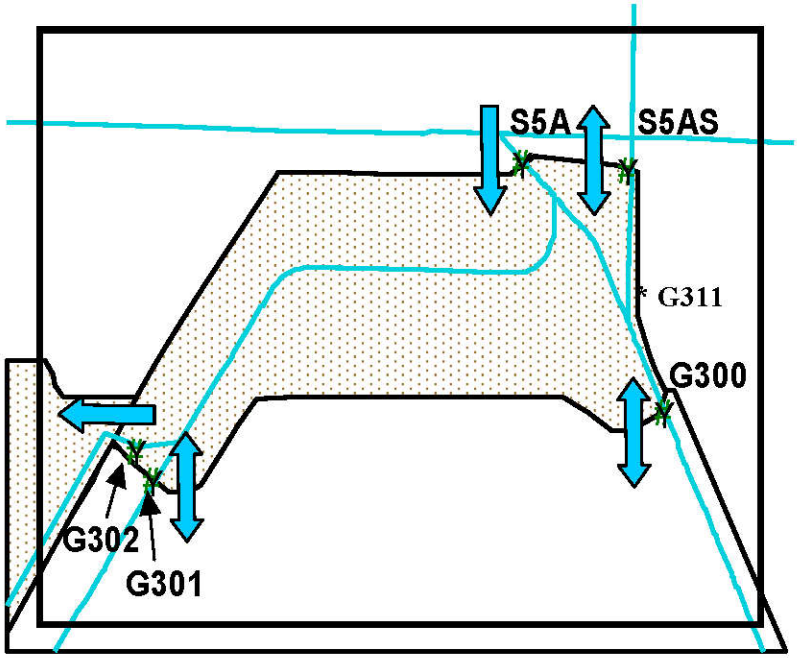

Figure 4. The STA-1 Inflow Basin.

STA-1E Inflow and Outflow Control Structures and Operations

STA-1E has three inflow sources, S-319 and S-361 pump stations and G-311 spillway structure. The major source of inflow is S-319, which pumps from the C-51 Canal into the distribution cells (East and West). S-319 pump station has five diesel engine-driven pumps (three 960 cfs and two 550 cfs), with a total discharge capacity of 3,980 cfs (Goforth, 2005). The East and West Distribution Cells are divided by water control structure S-375, a three-barrel gated culvert controlling flow in both directions. Currently, the main source of water into the C-51 Canal reach is drainage from the C-51W Basin and L-8 runoff. Lake Okeechobee releases through the L-8 Canal is also a source. ACME diversion flow into the C-51 Canal reach will make its way to STA-1E. S-361 pump station pumps in drainage from the Rustic Ranches subdivision and from agricultural areas southeast of STA-1E and seepage from the eastern perimeter of STA-1E. S-361 has a design capacity of 75 cfs, 48 cfs for permitted discharges and 27 cfs for seepage pumping (Goforth, 2005). G-311 is a bidirectional flow three-bay gated spillway with a symmetrical ogee weir that connects the Inflow Basin (I&D) and STA-1E. Discharge from the I&D into STA-1E is made through this structure. The flow sources in the I&D are Lake Okeechobee, Everglades Agricultural Area (EAA), East Beach, L-8 runoff and WCA-1. Flow control structures in STA-1E are shown in Figure 2. STA-1E is anticipated to treat a long-term average of approximately 20,353 ha-m (165,000 ac-ft) annually (Goforth, 2005).

Outflows from STA-1E are through two structures, S-362 pump station and G-311 Spillway. The main outflow point of STA-1E, S-362 pump station, discharges into the L-40 Canal in the Refuge. The S-362 pump station has a total of seven pump units, five diesel-driven engine pumps (three 960 cfs and two 550 cfs) and two electric motor-driven pumps, 110 cfs capacity each. The total discharge capacity of S-362 is 4,200 cfs. G-311 discharges from the western distribution cell

into the I&D by allowing inflows through S-319 to be diverted to STA-1W through the G-302 structure in the I&D (Figure 4). The operation of STA-1E is detailed in the Operation Plan (Goforth, 2005).

STA-1E Internal Flow Control Structures

There are three flow-ways in STA-1E: eastern, central and western. The eastern flow-way comprises Cells 1 and 2. Inflow from the East Distribution Cell flows into Cell 1 through three gated culverts (S-363 A, B and C). Flow from Cell 1 to Cell 2 is through three gated culverts S-364 A, B and C. Cell 2 discharges into a discharge canal through two gated culverts, S-365 A and B. The central flow-way comprises Cells 3, 4N and 4S. Inflow from the East Distribution Cell flows into Cell 3 through five gated culverts, S-366 A, B, C, D, and E. Outflow from Cell 3 is into Cell 4N through five gated culverts S-367 A, B, C, D, and E. Outflow from Cell 4N is into Cell 4S through five gated culverts S-369 A, B, C, D, and E. Additional inflows come to Cell 4S through the S-361 pump station. The sources of water for S-361 are the Rustic Ranches subdivision, agricultural areas southeast of STA-1E, and the seepage canal. Outflow from Cell 4S is into a discharge canal through four gated culverts: S-368 A, B, C, and D. The western flow-way has Cell 5 and Cell 7 in parallel discharging into a common Cell, Cell 6 in series. Inflow from the Western Distribution Cell flows into Cell 5 and Cell 7 through gated culverts: S-370 A, B, and C, and S-373 A and B, respectively. Outflow from Cell 5 is into Cell 6 through three gated culverts: S-371 A, B and C. Outflow from Cell 7 is into Cell 6 through three gated culverts: S-374 A, B and C. Cell 6 discharges into a discharge canal through five gated culverts: S-372 A, B, C, D and E.

HYDROLOGY AND HYDRAULIC MONITORING

Rainfall and Evapotranspiration

Areal rainfall and evapotranspiration over STA-1E were estimated using the data from STA-1W to the west. STA-1W has six rain gauges and areal average daily rainfall from these stations is stored in database key (DBKEY) KN809 in DBHYDRO database (Abtew, 2005). In STA-1W, wetland evapotranspiration or potential evapotranspiration is computed using weather station ENR308 weather parameter observations and the Simple Method (Abtew, 1996). Data is stored under preferred DBKEY KN810 in DBHYDRO. Rainfall for the partial water year, September 20, 2004, to April 30, 2005, was 51.7 cm (20.3 in) and evapotranspiration was 69.3 cm (27.3 in). For water year 2006 (May 1, 2005 to April 30, 2006), rainfall was 111.4 cm (43.8 in) and evapotranspiration was 131.4 cm (51.7 in). Figure 5 depicts daily rainfall and evapotranspiration for the period September 20, 2004 to April 30, 2006.

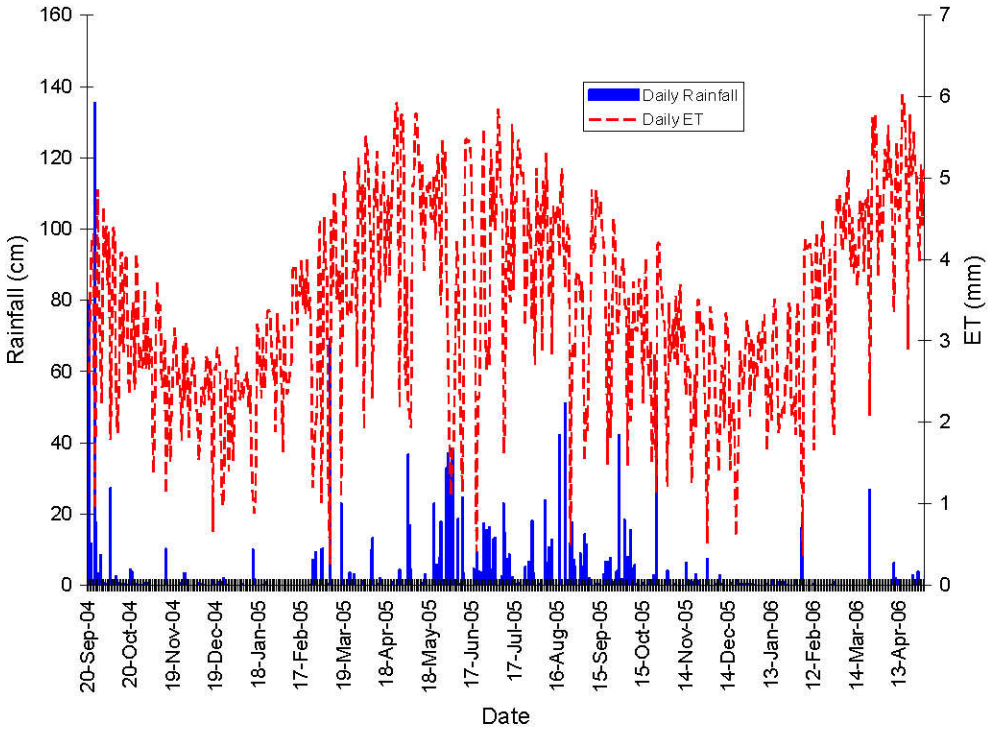

Figure 5. Daily distribution of rainfall and evapotranspiration.

Table 2. STA-1E monthly flows, rainfall and evapotranspiration (ET).

Water Year	Year	Month	Inflow	Outflow	Rainfall	ET
			S319+S361#+G311	S362+G311		
			ha-m	ha-m	cm	cm
WY2005	2004	Sep*	772.234	1104.066	26.09	3.48
	2004	Oct	141.800	839.305	4.60	10.26
	2004	Nov	140.324	25.319	1.55	7.74
	2004	Dec	296.282	9.209	0.61	6.84
	2005	Jan	228.046	0.000	1.30	7.69
	2005	Feb	169.271	45.071	2.31	8.32
	2005	Mar	347.761	60.128	12.07	11.18
	2005	Apr	293.919	81.759	3.15	13.80
WY2006	2005	May	245.175	0.000	18.64	13.62
	2005	Jun	257.213	347.604	23.85	10.02
	2005	Jul	342.471	249.026	13.11	13.43
	2005	Aug	182.236	190.398	19.05	12.41
	2005	Sep	224.163	320.671	12.90	10.57
	2005	Oct	1389.052	2515.826	11.68	9.41
	2005	Nov	1113.146	1359.297	2.46	8.06
	2005	Dec	394.131	121.090	0.84	7.59
	2006	Jan	349.295	168.928	0.58	8.15
	2006	Feb	1514.385	1326.866	3.68	9.56
	2006	Mar	272.057	93.205	2.67	13.82
	2006	Apr	147.539	14.078	1.88	14.74

* partial month September 20-30.

1 ha-m = 8.1068 ac-ft

S-361 flow source is Rustic Ranches drainage and STA-1E seepage recirculation

Flows

DBKEYs for STA-1E flow control structures and stage gauges are listed in Appendix I. For the partial water year 2005 (September 20, 2004 to April 30, 2005), total surface water inflows were 2,390 ha-m (19,372 ac-ft) and total outflows were 2,165 ha-m (17,550 ac-ft). For the full water year 2006, total surface water inflows were 6,431 ha-m (52,134 ac-ft) and outflows were 6,707 ha-m (54,372 ac-ft). Monthly inflows and outflows are shown in Table 2. Figure 6 depicts daily inflows and outflows for the period of reporting. Inflows through S-319, G-311 and S-361 were 46.4 percent, 34.7 percent and 18.9 percent, respectively. S-361 inflows are a mixture of drainage from Rustic Ranches and seepage from STA-1E seepage canal to the east. The contribution from each source is not known. Outflows through S-362 and G-311 were 80.8 percent and 19.2 percent, respectively.

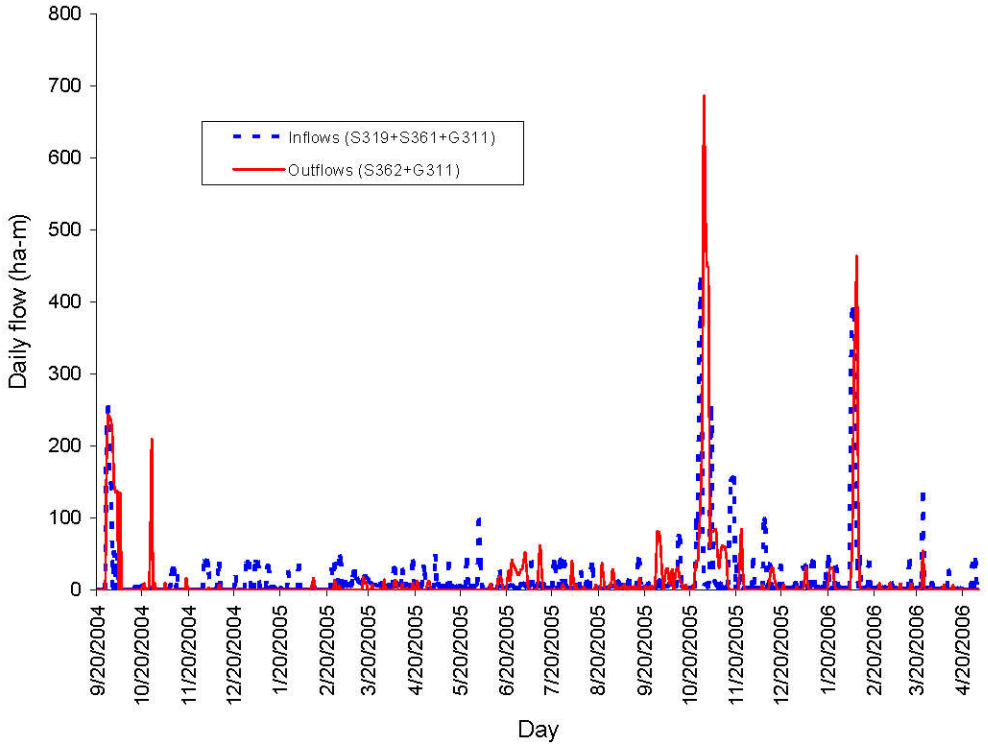

Figure 6. STA-1E daily inflows and outflows

Water Levels

Daily water surface elevations (stages) in each cell of STA-1E are dependent upon rainfall, evapotranspiration, seepage and daily operational decisions. Water levels are regulated based on target water depths, water availability, maintenance, treatment capacity and other operational criteria. The minimum, maximum and mean of daily average stage observations for the study period are shown in Table 3. The mean stage in Cell 1 was 5.35 m (17.55 ft) with average water depth of 19.8 cm (7.8 in). Since Cell 2 has been under construction for a Periphyton-based Treatment Demonstration Project, stage data is not available. The mean stage in Cell 3 was 5.03 m (16.5 ft) with average

water depth of 39.6 cm (15.6 in). The mean stage in Cell 4N was 4.67 m (15.3 ft) with average water depth of 35.4 cm (13.9 in). The mean stage in Cell 4S was 4.28 m (14.0 ft) with average water depth of 48.8 cm (19.2 in). The mean stage in Cell 5 was 4.39 m (14.4 ft) with average water depth of 30.8 cm (12.1 in). The mean stage in Cell 6 was 4.06 m (13.3 ft) with average water depth of 44.8 cm (17.6 in). The mean stage in Cell 7 was 4.13 m (13.5 ft) with average water depth of 55.5 cm (21.8 in). Daily water level fluctuations in Cells 1-7 are is depicted in Figure 7-13.

Table 3. Water surface elevations and depths in each cell of STA-1E.

Cell	Water Surface Elevation						Depth	
	Min		Max		Mean		Mean	
	m	ft	m	ft	m	ft	cm	in
Cell 1	4.71	15.46	5.54	18.16	5.35	17.55	19.81	7.8
Cell 2	-	-	-	-	-	-	-	-
Cell 3	4.32	14.18	5.32	17.45	5.03	16.5	39.62	15.6
Cell 4N	4.39	14.39	4.85	15.9	4.67	15.32	35.36	13.92
Cell 4S	4.02	13.18	4.80	15.74	4.28	14.03	48.77	19.2
Cell 5	4.05	13.29	5.05	16.57	4.39	14.41	30.78	12.12
Cell 6	3.78	12.41	4.66	15.3	4.06	13.32	44.81	17.64
Cell 7	3.82	12.52	4.88	15.99	4.13	13.54	55.47	21.84

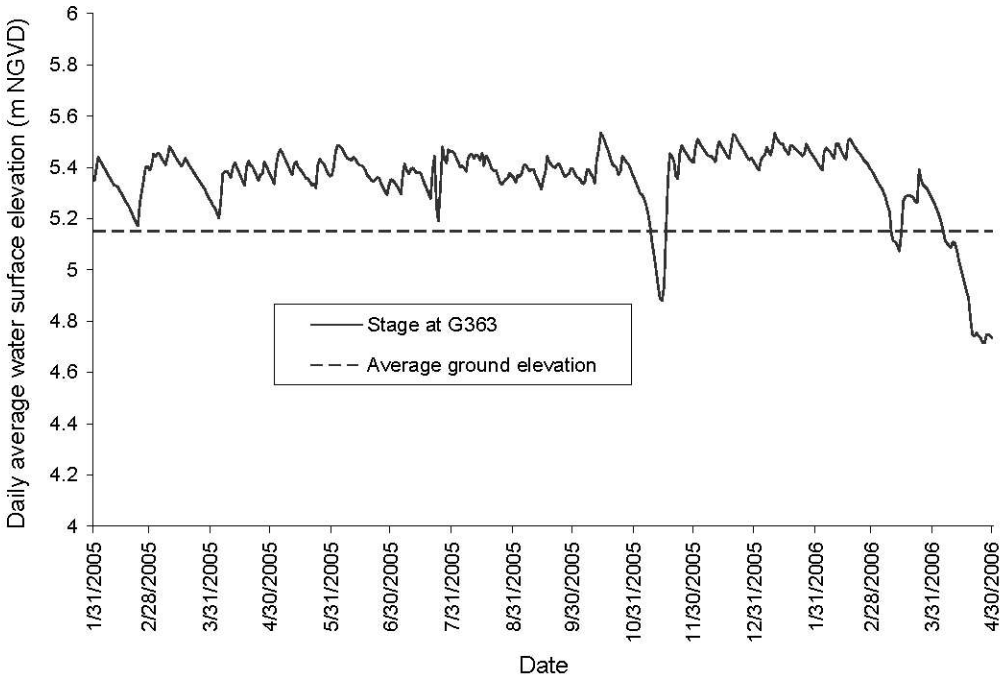

Figure 7. Daily water level fluctuation in Cell 1 of STA-1E.

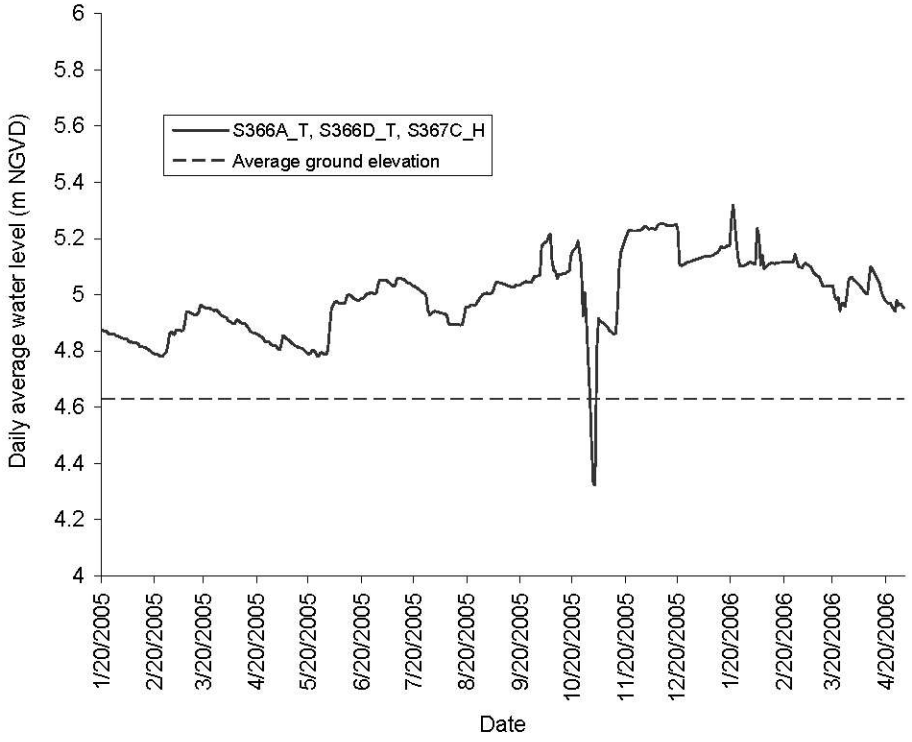

Figure 8. Daily water level fluctuation in Cell 3 of STA-1E.

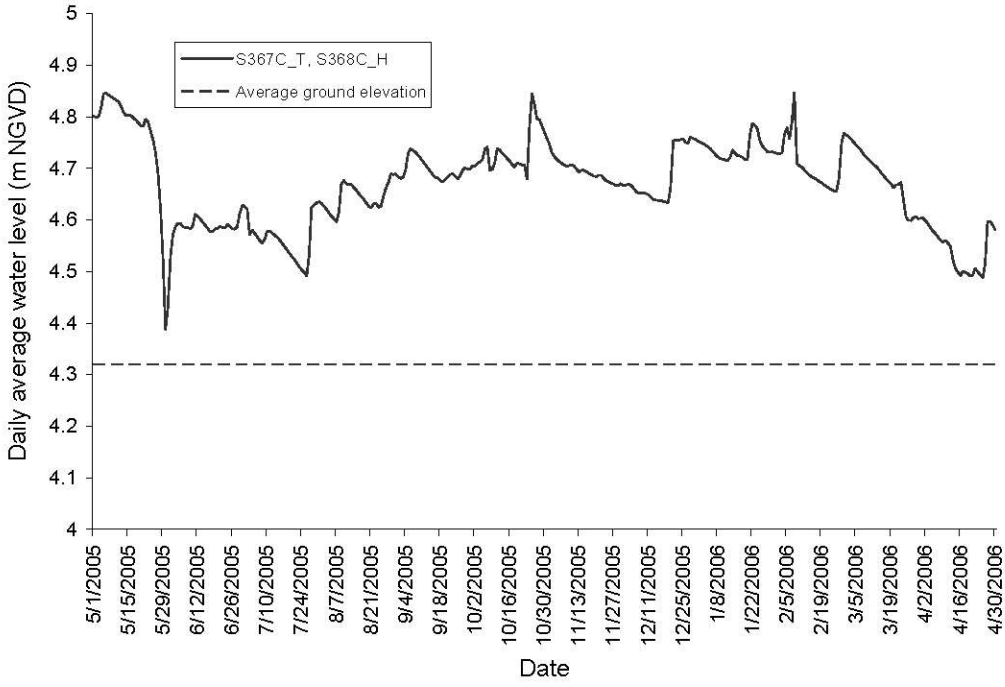

Figure 9. Daily water level fluctuation in Cell 4N of STA-1E.

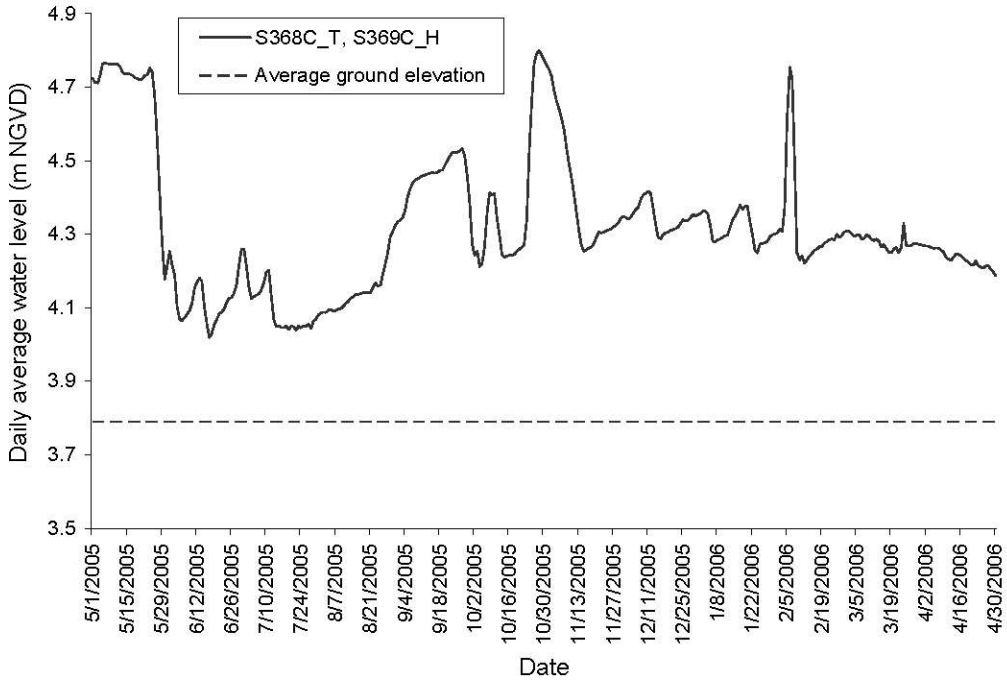

Figure 10. Daily water level fluctuation in Cell 4S of STA-1E.

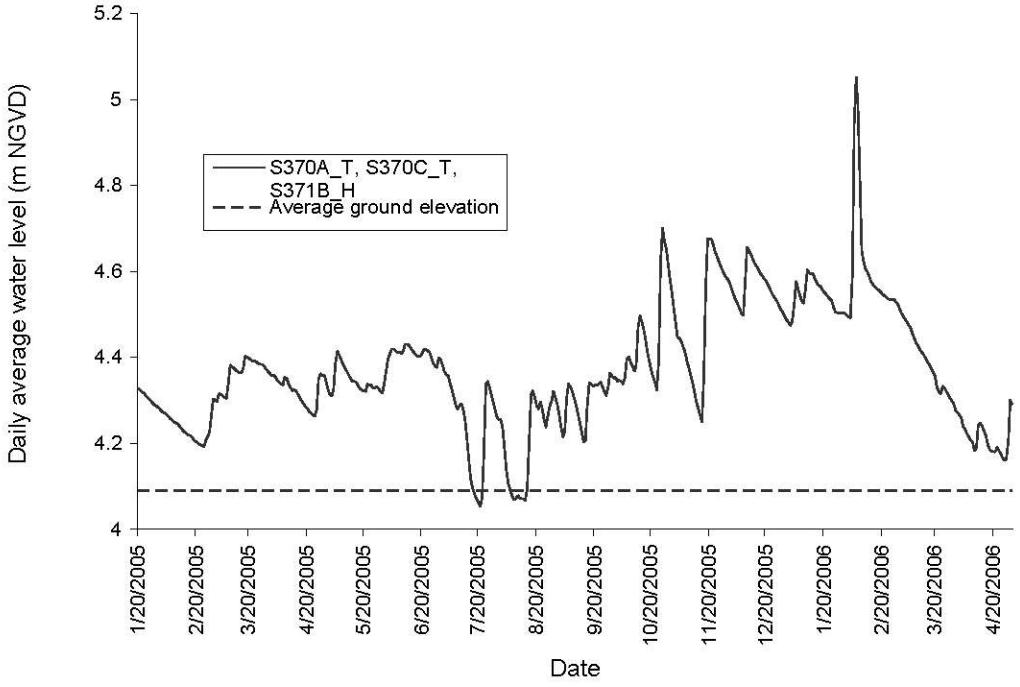

Figure 11. Daily water level fluctuation in Cell 5 of STA-1E.

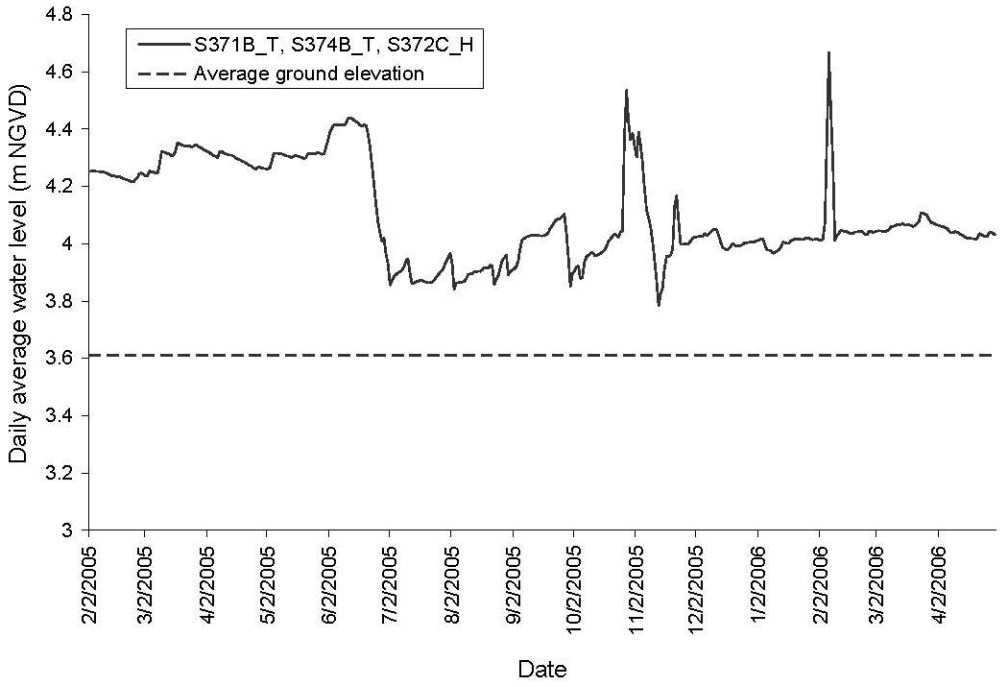

Figure 12. Daily water level fluctuation in Cell 6 of STA-1E.

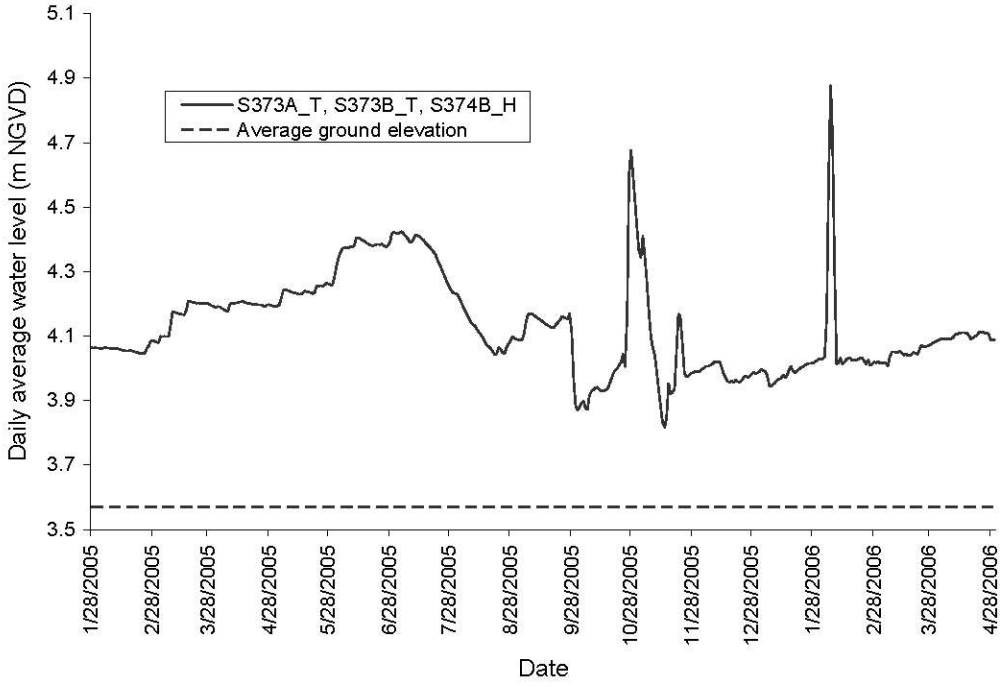

Figure 13. Daily water level fluctuation in Cell 7 of STA-1E.

WATER BUDGET COMPUTATIONS

STA-1E Water Balance Model

A general mass balance model is expressed by Equation 1. Inflows terms include surface water inflows and rainfall. Outflow terms include surface water outflows and evapotranspiration. The change in storage volume is reflected by the daily water level fluctuation. Errors account for measurement errors and model errors. Model errors include unknown inflows and outflows of the system that are associated with model assumptions or model formulations (Equation 2). Seepage outflow that is recirculated into the STA and not monitored and accounted for will result in under calculation of outflows. Unmonitored seepage inflows into the STA will result in under calculation of inflows. In STA-1E, part of the seepage outflow into the seepage canal on the east is pumped back through S-361. The portion of seepage that is diverted to the C-51 Canal is not monitored.

$$\mathbf{INFLOWS - OUTFLOWS} = \Delta S + \varepsilon_T \qquad (1)$$

Where INFLOW is the amount of water that enters the system from external sources, and OUTFLOW is water that leaves the system boundary and is not recirculated. ΔS is the change in storage in the system during the time interval of interest. The sum of all errors is represented by ε_T. Because each inflow and outflow may not be quantified, the term UNKNOWNS is included. The term REMAINDERS is the sum of errors and unknowns computed as follows:

$$\mathbf{REMAINDERS} = \mathbf{INFLOWS - OUTFLOWS} - \Delta S \qquad (2)$$

$$\mathbf{REMAINDERS} = \mathbf{S\text{-}319+S\text{-}361+G\text{-}311+RAIN\text{-}S\text{-}362\text{-}G\text{-}311\text{-}ET} - \Delta S \qquad (3)$$

Since ΔS, change in storage (equation 4), is computed as follows, the only unknown in Equation 3 is the REMAINDERS.

$$\Delta S = (Stg_i - Stg_{i-1}) * AREA \qquad (4)$$

where Stg_i is average stage on day I; Stg_{i-1} is average stage on previous day; and AREA is the area under consideration. The daily change in storage for STA-1E was computed as the sum of storage changes in each of the seven cells (Cells 1, 3, 4N, 4S, 5, 6 and 7). The change in storage volume in each cell was computed based on the area of the cell and change in stage in the cell. The remainders in the computation of daily water balances are the sum of all errors and unknowns in the system. Distribution of daily remainders is depicted in Figure 14. The daily mass balance unknowns and errors (Remainders) term (Figure 14 and Appendix II) has outliers for the period October 29 to November 1, 2005. These outliers correspond to the high outflows from STA-1E into the Inflow Basin through the G-311 structure.

Water budget analysis is done for the full water year 2006. Daily water budget parameters are shown in Appendix II. Summary of the water budget is shown in Table 4. The inflow supplied through the S-319 and S-361 pump stations and G-311 spillway accounts for about 68 percent of the inflow to the system. Rainfall accounts for 29 percent. Outflows through S-362 and G-311 account for 67 percent of the outflows, with evapotranspiration constituting 33 percent of the total

outflows. The unknowns in the system are ungauged subsurface inflows, outflows and errors that account for 3 percent of the total inflows.

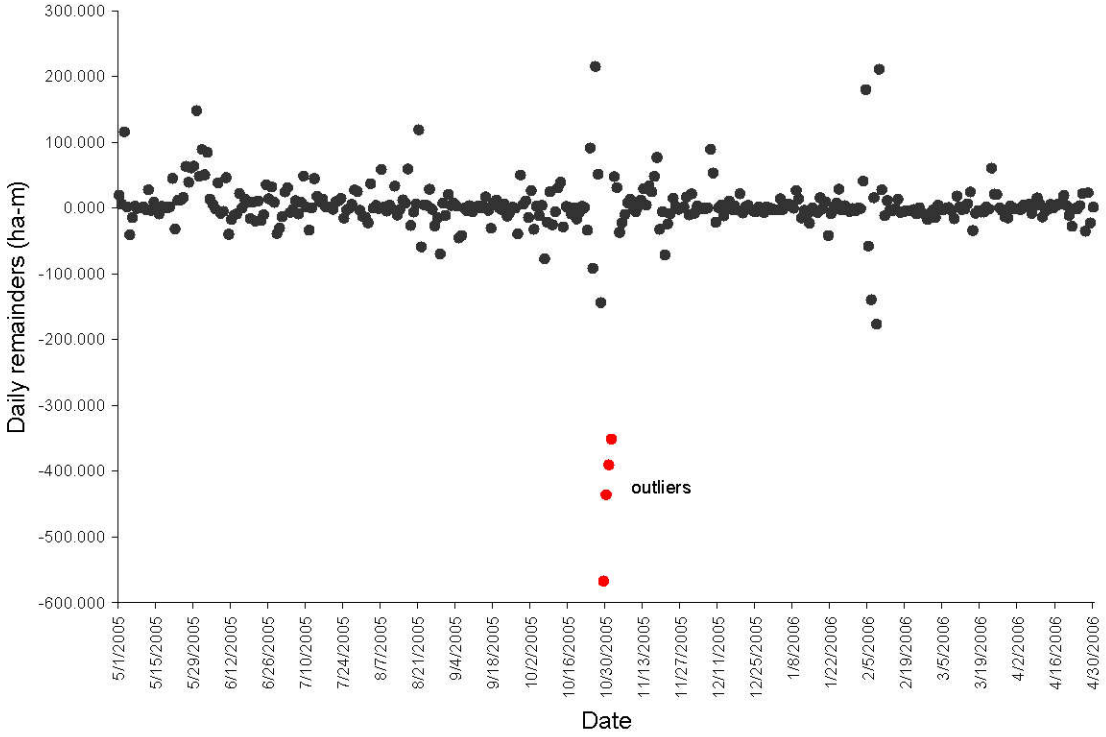

Figure 14. Distribution of daily remainders (errors and unknowns) from STA-1E water balance.

Mean hydraulic loading is computed by dividing daily average daily inflow by the area of the STA. Mean hydraulic retention time is computed by dividing the average volume of the STA with the average of total inflows and outflows.

Table 4. Summary of water budget for STA-1E (May 1, 2005 to April 30, 2006).

Inflows	ha-m	Percent of total	Ouflows	ha-m	Percent of total
Inflows	6,431	67.6	Outflows	6,706	67.1
Rain	2,783	29.3	ET	3,283	32.9
Remainders	299	3.1			
Total	9,513	100.0		9,989	100.0

Change in storage	-477
Hydraulic loading rate (cm/d)	0.68
Average depth (cm)	29.2
Retention time (days)	41

"1 ha-m = 8.1068 ac-ft"

SUMMARY

This report is the first water budget for STA-1E. STA-1E hydrologic and hydraulic monitoring data are used in a water budget analysis from the start-up of the STA to the end of water year 2006 (September 20, 2004 to April 30, 2006). Hydrologic data is summarized from September 20, 2004 to April 30, 2005 for a partial water year, and full water budget is analyzed and summarized for water year 2006 (May 1, 2005 to April 30, 2006).

For water year 2006, the total surface water inflow was 6,431 ha-m (52,134 ac-ft) with 47.6 percent, 34.6 percent and 17.8 percent inflows through G-311, S-319 and S-361, respectively. The total surface water outflow was 6,706 ha-m (54,372 ac-ft) with 75 percent and 25 percent outflows through S-362 and G-311, respectively. The daily mass balance unknowns and errors term (Remainders) has outliers for the period October 29 to November 1, 2005. These outliers correspond to the high outflows from STA-1E into the Inflow Basin through the G-311 structure from October 29 to November 1, 2005. These flows were observed after Hurricane Wilma passed through the area. For water year 2006, rainfall was 111.4 cm (43.8 in) and evapotranspiration was 131.4 cm (51.7 inches). The sum of errors and unknowns was 299 ha-m (2,424 ac-ft), 3.1 percent of total inflows. A 3.1 percent error is acceptable. The mean hydraulic loading rate for water year 2006, based on average flow, was 0.68 cm d^{-1} (0.27 in d^{-1}). The mean hydraulic retention time was computed as the ratio of the estimated mean volume of STA-1E and the average of inflow and outflow rate. The whole area of the STA, including the east and west distribution cell areas, was considered for retention time calculation. The estimated retention time was 41 days. The average depth in each Cell ranged between 19.8 cm (7.8 in) in Cell 1 to 55.5 cm (21.8 in) in Cell 7. Relatively, Cells 4S, 6 and 7 had higher depths.

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Appendix I. Flow control structures, stage recorders and database retrieval keys for STA-1E.

Station	Description	Location	Dbkey	Remark	Note
S-319_P	Pump	Off C-51 Canal	TP366	Inflow pump station	
G311_S	Spillway	Eastern Levee of I&D	TP367	Inflow and outflow from I&D to STA-1E	
S361_P	Pump	Eastern Levee of Cell 4S	TP368	Inflow to STA-1E (drainage and seepage)	
S362_P	Pump	Outflow from STA-1E	TP369	Discharge from STA-1E	
S364A_C	Culvert	Levee between Cell 1 and EDC	SD004	Inflow into Cell 1	
S363B_C	Culvert	Levee between Cell 1 and EDC	SD005	Inflow into Cell 1	
S363C_C	Culvert	Levee between Cell 1 and EDC	SD006	Inflow into Cell 1	
S364A_C	Culvert	Levee between Cell 1 and Cell 2	SG557	Inflow into Cell 2	
S364B_C	Culvert	Levee between Cell 1 and Cell 2	SG558	Inflow into Cell 2	
S364C_C	Culvert	Levee between Cell 1 and Cell 2	SG559	Inflow into Cell 2	
S365A_C	Culvert	Southern Levee of Cell 2	SG561	Discharge to discharge canal	
S365B_C	Culvert	Southern Levee of Cell 2	SG563	Discharge to discharge canal	
S366A_C	Culvert	Levee between Cell 3and EDC	SD001	Inflow into Cell 3	
S366B_C	Culvert	Levee between Cell 3and EDC	SD002	Inflow into Cell 3	
S366C_C	Culvert	Levee between Cell 3and EDC	SD007	Inflow into Cell 3	
S366D_C	Culvert	Levee between Cell 3and EDC	SD003	Inflow into Cell 3	
S366E_C	Culvert	Levee between Cell 3and EDC	SD008	Inflow into Cell 3	
S367A_C	Culvert	Levee between Cell 3 and Cell 4N	TA349	Discharge from Cell 3 into Cell 4N	
S367B_C	Culvert	Levee between Cell 3 and Cell 4N	TA350	Discharge from Cell 3 into Cell 4N	
S367C_C	Culvert	Levee between Cell 3 and Cell 4N	TA312	Discharge from Cell 3 into Cell 4N	
S367D_C	Culvert	Levee between Cell 3 and Cell 4N	TA351	Discharge from Cell 3 into Cell 4N	
S367E_C	Culvert	Levee between Cell 3 and Cell 4N	TA352	Discharge from Cell 3 into Cell 4N	
S368A_C	Culvert	Levee between Cell 4N and Cell 4S	SG581	Discharge from Cell 4N to Cell 4S	
S368B_C	Culvert	Levee between Cell 4N and Cell 4S	SG583	Discharge from Cell 4N to Cell 4S	
S368C_C	Culvert	Levee between Cell 4N and Cell 4S	SG585	Discharge from Cell 4N to Cell 4S	
S368D_C	Culvert	Levee between Cell 4N and Cell 4S	SG591	Discharge from Cell 4N to Cell 4S	
S368E_C	Culvert	Levee between Cell 4N and Cell 4S	SG593	Discharge from Cell 4N to Cell 4S	
S369A_C	Culvert	Southern Levee of Cell 4S	TA355	Discharge to discharge canal	
S369B_C	Culvert	Southern Levee of Cell 4S	TA356	Discharge to discharge canal	
S369C_C	Culvert	Southern Levee of Cell 4S	TA318	Discharge to discharge canal	
S369D_C	Culvert	Southern Levee of Cell 4S	TA357	Discharge to discharge canal	
S375_C	Culvert	Divide between EDC and WDC	TN551	Controls flow between EDC and WDC	
S370A_C	Culvert	Northern Levee of Cell 5	SG921	Inflow into Cell 5	
S370B_C	Culvert	Northern Levee of Cell 5	Sg927	Inflow into Cell 5	
S370C_C	Culvert	Northern Levee of Cell 5	SG929	Inflow into Cell 5	
S371A_C	Culvert	Levee between Cell 5 and Cell 6	TA324	Discharge from Cell 5 into Cell 6	
S371B_C	Culvert	Levee between Cell 5 and Cell 6		Discharge from Cell 5 into Cell 6	no dbkey
S371C_C	Culvert	Levee between Cell 5 and Cell 6		Discharge from Cell 5 into Cell 6	no dbkey
S372A_C	Culvert	Southern Levee of Cell 6	TN560	Discharge to discharge canal	
S372B_C	Culvert	Southern Levee of Cell 6	TY236	Discharge to discharge canal	no flow data
S372C_C	Culvert	Southern Levee of Cell 6	TA330	Discharge to discharge canal	
S372D_C	Culvert	Southern Levee of Cell 6	TN561	Discharge to discharge canal	
S372E_C	Culvert	Southern Levee of Cell 6	TY238	Discharge to discharge canal	no flow data
S373A_C	Culvert	Northern Levee of Cell 7	SG931	Inflow into Cell 7	
S373B_C	Culvert	Northern Levee of Cell 7	SG937	Inflow into Cell 7	
S374A_C	Culvert	Levee between Cell 7 and Cell 6	TB006	Discharge from Cell 7 into Cell 6	
S374B_C	Culvert	Levee between Cell 7 and Cell 6	TA336	Discharge from Cell 7 into Cell 6	
S374C_C	Culvert	Levee between Cell 7 and Cell 6	TB008	Discharge from Cell 7 into Cell 6	
S363A_T	Stage	Cell 1 North	SC965	Stage in Cell 1	
S363C_T	Stage	Cell 1 North	SC970	Stage in Cell 1	
S364B_H	Stage	Cell 1 South	SG551	Stage in Cell 1	
S364B_T	Stage	Cell 2 North	SG553	Stage in Cell 2	
S365B_T	Stage	Cell 2 South	SG556	Stage in Cell 2	
S366B_T	Stage	Cell 3 North	SC977	Stage in Cell 3	
S366D_T	Stage	Cell 3 North	SC984	Stage in Cell 3	
S367C_H	Stage	Cell 3 South	TA313	Stage in Cell 3	
S367C_T	Stage	Cell 4N North	TA315	Stage in Cell 4N	
S368C_H	Stage	Cell 4N South	SG586	Stage in Cell 4N	
S368C_T	Stage	Cell 4N South	SG588	Stage in Cell 4S	
S369C_H	Stage	Cell 4S South	TA319	Stage in Cell 4S	
S370A_T	Stage	Cell 5 North	SG924	Stage in Cell 5	
S370C_T	Stage	Cell 5 North	TF248	Stage in Cell 5	
S371B_H	Stage	Cell 5 South	TA325	Stage in Cell 5	
S371B_T	Stage	Cell 6 North	TA327	Stage in Cell 6	
S374B_T	Stage	Cell 6 North	TA339	Stage in Cell 6	
S372C_H	Stage	Cell 6 South	TA331	Stage in Cell 6	
S373A_T	Stage	Cell 7North	SG934	Stage in Cell 7	
S373B_T	Stage	Cell 7 North	SG940	Stage in Cell 7	
S374B_H	Stage	Cell 7 South	TA337	Stage in Cell 7	

Appendix II. Water balance terms with calculated remainders.

Date	Change in storage	Inflow surface water	Outflow surface water	Rain	ET	Remainders
	ha-m	ha-m	ha-m	ha-m	ha-m	ha-m
1-May-05	-25.675	0.000	0.000	0.000	6.123	19.552
2-May-05	-14.317	0.000	0.000	1.269	9.446	6.140
3-May-05	19.232	49.443	0.000	91.403	5.698	115.917
4-May-05	41.065	6.031	0.000	41.893	5.198	1.662
5-May-05	56.724	10.093	0.000	10.791	4.823	-40.663
6-May-05	4.965	2.640	0.000	0.000	12.245	-14.570
7-May-05	-9.527	5.708	0.000	0.000	12.320	2.915
8-May-05	-9.093	4.974	0.000	0.000	14.469	-0.402
9-May-05	-9.907	4.950	0.000	0.000	14.444	0.412
10-May-05	-8.854	6.229	0.000	0.000	13.370	1.714
11-May-05	-9.433	1.050	0.000	0.000	12.745	-2.262
12-May-05	0.135	38.900	0.000	0.000	10.971	27.794
13-May-05	-7.745	0.000	0.000	1.269	12.895	-3.880
14-May-05	-13.222	5.273	0.000	0.000	9.671	8.824
15-May-05	2.203	4.274	0.000	7.617	11.221	-1.532
16-May-05	-1.909	1.311	0.000	0.000	12.245	-9.025
17-May-05	-8.835	5.461	0.000	0.000	12.045	2.251
18-May-05	-10.986	3.565	0.000	0.000	12.370	2.180
19-May-05	-5.669	5.950	0.000	0.000	11.295	0.324
20-May-05	-8.544	4.859	0.000	0.000	11.221	2.183
21-May-05	-0.310	0.132	0.000	57.127	12.570	45.000
22-May-05	23.651	2.638	0.000	0.000	10.596	-31.609
23-May-05	-5.634	4.088	0.000	14.599	12.420	11.902
24-May-05	18.449	43.882	0.000	0.000	13.220	12.213
25-May-05	-7.269	1.703	0.000	19.042	11.770	16.244
26-May-05	-24.063	3.435	0.000	44.432	8.597	63.334
27-May-05	-45.593	5.412	0.000	1.904	13.695	39.215
28-May-05	-69.807	3.824	0.000	0.000	12.570	61.061
29-May-05	-73.150	3.971	0.000	0.000	13.270	63.851
30-May-05	-69.036	6.880	0.000	81.882	9.821	147.977
31-May-05	45.961	8.497	0.000	92.673	7.097	48.112
1-Jun-05	86.081	97.900	0.000	81.247	4.198	88.868
2-Jun-05	53.454	36.779	0.000	69.822	2.749	50.399
3-Jun-05	16.180	8.955	0.000	95.847	4.098	84.523
4-Jun-05	-13.957	0.000	0.000	3.808	4.398	13.367
5-Jun-05	-11.655	0.000	0.000	1.269	7.097	5.828
6-Jun-05	-9.080	0.000	0.000	0.000	10.546	-1.465
7-Jun-05	-1.776	0.000	0.000	46.336	9.721	38.391
8-Jun-05	2.154	0.000	0.000	0.635	6.672	-8.192
9-Jun-05	-1.508	6.506	8.356	0.000	4.573	-4.915
10-Jun-05	12.482	0.000	0.000	61.570	2.849	46.239
11-Jun-05	42.368	0.000	0.000	8.252	5.973	-40.089
12-Jun-05	3.541	0.000	0.000	0.000	13.645	-17.186
13-Jun-05	-2.783	0.000	0.000	0.000	13.695	-10.912

1 ha-m = 8.1068 ac-ft

Appendix II. Water balance terms with calculated remainders (continued).

Date	Change in storage	Inflow surface water	Outflow surface water	Rain	ET	Remainders
	ha-m	ha-m	ha-m	ha-m	ha-m	ha-m
14-Jun-05	-13.045	10.220	18.245	0.000	13.595	-8.575
15-Jun-05	-27.841	27.112	19.141	0.000	13.645	22.168
16-Jun-05	-21.724	7.842	16.092	0.000	13.170	0.304
17-Jun-05	-22.919	2.121	0.000	0.000	11.345	13.695
18-Jun-05	-3.884	3.504	0.000	11.425	9.996	8.817
19-Jun-05	11.123	2.936	0.000	0.635	8.597	-16.148
20-Jun-05	2.335	3.673	14.908	23.486	1.025	8.890
21-Jun-05	-3.892	4.996	26.026	3.174	5.798	-19.761
22-Jun-05	-14.958	4.663	12.762	9.521	5.748	10.633
23-Jun-05	-22.702	6.954	40.302	0.635	8.871	-18.883
24-Jun-05	-23.098	3.998	34.205	8.886	12.145	-10.368
25-Jun-05	-33.828	3.261	30.885	43.163	14.019	35.348
26-Jun-05	-35.587	3.592	27.063	10.156	8.222	14.049
27-Jun-05	-17.521	3.345	20.729	38.720	6.597	32.259
28-Jun-05	-3.828	3.181	21.538	30.468	7.322	8.616
29-Jun-05	52.311	7.842	28.132	40.624	6.772	-38.750
30-Jun-05	2.184	7.834	29.221	6.347	13.370	-30.593
1-Jul-05	-20.519	9.620	42.839	10.791	11.171	-13.080
2-Jul-05	-51.514	4.074	51.078	32.372	12.520	24.362
3-Jul-05	-29.793	4.076	25.091	33.007	10.896	30.889
4-Jul-05	-1.508	4.079	0.000	0.000	11.995	-6.409
5-Jul-05	-8.339	4.076	0.000	0.000	14.619	-2.204
6-Jul-05	14.600	40.180	0.000	0.000	14.194	11.386
7-Jul-05	2.094	4.972	0.000	0.000	11.970	-9.092
8-Jul-05	-8.969	5.270	0.000	6.347	11.720	8.867
9-Jul-05	8.349	3.969	0.000	57.127	4.023	48.723
10-Jul-05	35.454	5.512	0.000	36.181	4.773	1.465
11-Jul-05	9.803	10.648	40.549	17.773	11.545	-33.477
12-Jul-05	-49.875	3.893	61.021	18.408	10.921	0.233
13-Jul-05	-45.489	5.745	19.119	21.581	8.971	44.726
14-Jul-05	-16.930	9.572	0.000	0.000	8.697	17.805
15-Jul-05	-13.624	4.294	0.000	5.713	14.144	9.486
16-Jul-05	-19.261	3.484	0.000	0.000	9.071	13.673
17-Jul-05	-11.515	2.836	0.000	0.000	11.920	2.430
18-Jul-05	-10.138	2.674	0.000	0.635	11.670	1.776
19-Jul-05	-15.529	0.000	0.000	0.000	13.645	1.884
20-Jul-05	-7.339	2.997	0.000	1.269	13.495	-1.889
21-Jul-05	16.942	39.475	0.213	0.000	12.695	9.626
22-Jul-05	9.431	32.796	0.000	0.000	12.520	10.845
23-Jul-05	-23.653	2.349	0.000	1.269	12.670	14.602
24-Jul-05	21.911	1.864	0.000	12.695	7.947	-15.298
25-Jul-05	33.245	38.521	0.000	0.635	9.196	-3.285
26-Jul-05	30.166	41.920	0.149	0.000	11.870	-0.266
27-Jul-05	-3.660	3.239	7.416	16.503	10.646	5.341

1 ha-m = 8.1068 ac-ft

Appendix II. Water balance terms with calculated remainders (continued).

Date	Change in storage	Inflow surface water	Outflow surface water	Rain	ET	Remainders
	ha-m	ha-m	ha-m	ha-m	ha-m	ha-m
28-Jul-05	2.024	41.506	1.551	0.635	11.071	27.495
29-Jul-05	14.976	3.239	0.000	45.067	8.172	25.159
30-Jul-05	4.114	2.432	0.000	8.252	9.996	-3.427
31-Jul-05	10.354	3.159	0.000	1.269	6.772	-12.699
1-Aug-05	4.441	3.369	0.000	0.000	12.795	-13.867
2-Aug-05	-25.305	2.425	39.735	0.000	10.546	-22.550
3-Aug-05	-59.446	2.104	14.507	0.000	10.146	36.898
4-Aug-05	-8.148	2.080	0.000	1.269	11.695	-0.198
5-Aug-05	-9.511	7.803	6.337	0.000	7.197	3.779
6-Aug-05	-9.466	2.278	0.000	0.000	12.395	-0.651
7-Aug-05	-8.732	0.969	0.000	59.666	10.946	58.422
8-Aug-05	12.113	26.371	0.000	0.000	13.245	1.013
9-Aug-05	14.903	4.847	0.000	15.869	10.546	-4.733
10-Aug-05	9.403	0.020	3.851	26.659	8.821	4.603
11-Aug-05	-4.875	3.469	0.000	1.904	11.270	-1.022
12-Aug-05	4.034	12.598	0.000	31.737	7.097	33.205
13-Aug-05	2.609	3.257	0.000	0.000	11.620	-10.973
14-Aug-05	-6.294	2.461	0.000	0.000	10.996	-2.240
15-Aug-05	11.349	35.184	0.000	0.000	11.370	12.464
16-Aug-05	7.836	26.659	0.000	0.000	11.620	7.203
17-Aug-05	38.049	2.246	0.000	105.368	10.071	59.494
18-Aug-05	8.422	1.431	7.409	0.000	11.995	-26.394
19-Aug-05	-4.003	2.616	0.000	0.000	12.795	-6.176
20-Aug-05	-13.899	2.635	0.000	0.000	10.496	6.038
21-Aug-05	1.881	2.256	0.000	127.584	9.096	118.863
22-Aug-05	14.093	0.636	36.583	1.269	10.346	-59.116
23-Aug-05	-32.576	2.564	19.275	0.000	11.121	4.744
24-Aug-05	-12.107	2.479	0.000	0.000	10.621	3.965
25-Aug-05	1.419	2.050	0.869	29.833	1.250	28.346
26-Aug-05	40.720	2.121	0.000	43.797	7.072	-1.874
27-Aug-05	35.590	3.501	5.720	17.773	7.447	-27.483
28-Aug-05	22.158	6.259	5.065	13.330	6.947	-14.581
29-Aug-05	37.036	4.906	27.998	0.000	9.546	-69.674
30-Aug-05	-32.550	6.405	22.133	0.000	9.646	7.177
31-Aug-05	4.955	4.238	0.918	0.000	9.371	-11.006
1-Sep-05	-6.718	5.982	5.532	22.216	8.747	20.638
2-Sep-05	1.024	11.710	0.000	2.539	9.296	3.929
3-Sep-05	1.706	2.628	0.000	13.330	7.022	7.230
4-Sep-05	29.090	4.250	3.944	35.546	3.798	2.963
5-Sep-05	74.414	7.384	1.581	28.564	5.448	-45.494
6-Sep-05	35.030	5.811	7.751	0.000	4.748	-41.718
7-Sep-05	2.429	5.486	0.000	5.078	8.322	-0.187
8-Sep-05	-2.850	4.681	3.959	0.000	7.697	-4.125
9-Sep-05	-1.915	13.768	0.000	0.000	12.145	3.538

1 ha-m = 8.1068 ac-ft

Appendix II. Water balance terms with calculated remainders (continued).

Date	Change in storage	Inflow surface water	Outflow surface water	Rain	ET	Remainders
	ha-m	ha-m	ha-m	ha-m	ha-m	ha-m
10-Sep-05	-5.064	3.215	3.606	0.000	10.196	-5.524
11-Sep-05	-10.272	3.220	3.271	0.000	10.371	-0.151
12-Sep-05	-10.933	2.907	0.000	0.635	12.095	2.379
13-Sep-05	-11.424	3.912	5.187	1.269	11.595	-0.177
14-Sep-05	-12.338	2.679	0.000	0.000	11.320	3.696
15-Sep-05	6.416	35.189	0.000	0.000	11.770	17.003
16-Sep-05	20.592	43.801	15.617	0.000	10.946	-3.354
17-Sep-05	30.217	2.244	0.000	7.617	10.546	-30.902
18-Sep-05	-5.375	3.731	0.000	7.617	9.846	6.877
19-Sep-05	-0.232	3.276	0.000	16.503	7.722	12.289
20-Sep-05	12.443	4.744	5.026	16.503	3.724	0.056
21-Sep-05	11.032	5.314	0.000	12.060	8.672	-2.329
22-Sep-05	14.370	10.102	3.795	19.042	4.523	6.457
23-Sep-05	11.461	3.330	0.000	2.539	6.822	-12.414
24-Sep-05	-7.253	2.748	5.273	0.000	11.270	-6.543
25-Sep-05	-8.862	1.879	0.000	1.269	10.771	1.240
26-Sep-05	1.154	3.685	2.165	8.886	9.296	-0.045
27-Sep-05	19.219	4.120	26.586	10.156	7.722	-39.251
28-Sep-05	-29.999	3.695	80.387	105.368	8.422	50.253
29-Sep-05	-79.573	14.604	80.098	1.269	9.571	5.778
30-Sep-05	-78.566	4.069	66.893	4.443	9.696	10.489
1-Oct-05	-16.910	3.555	26.334	1.269	10.021	-14.621
2-Oct-05	13.596	2.806	0.000	45.702	8.647	26.265
3-Oct-05	16.124	5.084	19.177	6.347	8.472	-32.342
4-Oct-05	-11.811	4.191	28.925	19.677	3.674	3.081
5-Oct-05	-21.555	4.715	29.532	0.635	8.821	-11.449
6-Oct-05	27.984	8.177	9.638	38.720	5.023	4.252
7-Oct-05	84.434	18.698	17.230	11.425	5.748	-77.288
8-Oct-05	-7.546	8.287	28.056	0.000	9.296	-21.520
9-Oct-05	-12.806	5.782	0.000	13.964	7.822	24.730
10-Oct-05	2.832	5.620	20.359	0.000	7.897	-25.468
11-Oct-05	-26.152	4.774	29.933	1.269	7.797	-5.535
12-Oct-05	4.991	74.940	29.855	0.000	9.396	30.699
13-Oct-05	11.598	72.890	12.747	0.000	9.246	39.298
14-Oct-05	19.882	7.064	10.438	1.904	7.372	-28.724
15-Oct-05	-3.663	3.643	0.000	0.635	5.598	2.343
16-Oct-05	-6.490	3.998	0.000	0.000	9.246	1.242
17-Oct-05	-5.071	2.894	7.042	0.000	10.046	-9.123
18-Oct-05	-4.348	3.195	0.000	0.000	7.272	0.272
19-Oct-05	16.891	3.428	0.000	3.174	6.347	-16.637
20-Oct-05	2.527	3.443	0.000	0.000	7.472	-6.556
21-Oct-05	1.003	3.604	0.000	3.808	3.749	2.661
22-Oct-05	5.273	3.893	0.000	6.982	4.723	0.879
23-Oct-05	7.574	3.259	24.673	2.539	7.072	-33.521

1 ha-m = 8.1068 ac-ft

Appendix II. Water balance terms with calculated remainders (continued).

Date	Change in storage	Inflow surface water	Outflow surface water	Rain	ET	Remainders
	ha-m	ha-m	ha-m	ha-m	ha-m	ha-m
24-Oct-05	96.670	97.798	39.461	132.662	2.849	91.480
25-Oct-05	112.229	71.512	41.814	1.269	10.421	-91.682
26-Oct-05	26.352	336.797	84.500	0.000	10.521	215.424
27-Oct-05	225.324	433.875	147.625	0.000	9.571	51.356
28-Oct-05	50.402	167.950	252.131	0.000	9.021	-143.605
29-Oct-05	-111.186	7.768	677.947	0.000	8.097	-567.089
30-Oct-05	-92.360	7.727	527.831	0.000	8.097	-435.842
31-Oct-05	-58.346	7.685	450.579	0.000	5.898	-390.446
1-Nov-05	-84.625	2.498	445.764	10.156	3.024	-351.509
2-Nov-05	-42.963	75.050	61.562	0.000	8.672	47.780
3-Nov-05	135.548	255.092	81.564	0.000	6.872	31.108
4-Nov-05	-13.697	37.838	81.270	0.000	7.322	-37.056
5-Nov-05	-53.292	14.091	81.791	0.000	8.172	-22.580
6-Nov-05	-73.137	7.729	84.282	0.635	6.947	-9.728
7-Nov-05	-66.812	4.656	54.244	0.000	8.896	8.328
8-Nov-05	-50.591	0.000	30.395	0.000	6.747	13.449
9-Nov-05	-49.388	9.253	47.478	0.000	8.672	2.491
10-Nov-05	-60.519	3.416	60.431	0.000	9.221	-5.718
11-Nov-05	-68.795	1.607	60.184	0.000	7.172	3.046
12-Nov-05	-75.760	3.939	59.820	0.000	7.972	11.908
13-Nov-05	-79.553	1.338	43.488	0.000	7.647	29.756
14-Nov-05	-0.355	4.756	10.790	15.869	5.823	4.367
15-Nov-05	39.083	79.927	0.000	0.000	7.072	33.771
16-Nov-05	121.769	149.986	0.000	3.174	6.622	24.769
17-Nov-05	100.995	155.569	0.000	0.000	6.472	48.102
18-Nov-05	75.415	155.486	0.000	0.000	3.124	76.948
19-Nov-05	32.908	3.362	0.000	1.904	4.548	-32.190
20-Nov-05	33.382	34.114	0.000	0.000	6.472	-5.740
21-Nov-05	79.640	6.090	0.399	7.617	4.848	-71.180
22-Nov-05	9.178	36.843	46.179	3.174	8.697	-24.037
23-Nov-05	-34.878	47.872	83.396	0.635	8.747	-8.758
24-Nov-05	-45.755	3.154	26.261	0.000	7.797	14.852
25-Nov-05	-7.681	3.154	0.000	0.000	8.147	2.688
26-Nov-05	-3.792	2.395	0.000	0.000	7.997	-1.809
27-Nov-05	-2.683	3.146	0.000	0.000	5.998	-0.169
28-Nov-05	-3.496	3.279	0.000	0.000	4.998	1.776
29-Nov-05	3.554	3.193	0.000	18.408	1.274	16.772
30-Nov-05	9.393	4.311	0.000	0.000	5.473	-10.555
1-Dec-05	13.932	44.065	0.000	0.000	8.547	21.587
2-Dec-05	2.710	3.142	0.000	0.000	8.222	-7.790
3-Dec-05	-6.835	3.098	0.000	0.000	7.072	2.860
4-Dec-05	-3.604	2.263	0.000	0.000	7.622	-1.755
5-Dec-05	-1.211	3.115	0.000	0.635	5.148	-0.188
6-Dec-05	-0.069	2.554	0.000	0.635	4.448	-1.190

1 ha-m = 8.1068 ac-ft

Appendix II. Water balance terms with calculated remainders (continued).

Date	Change in storage	Inflow surface water	Outflow surface water	Rain	ET	Remainders
	ha-m	ha-m	ha-m	ha-m	ha-m	ha-m
7-Dec-05	-7.156	3.134	7.653	1.269	3.474	0.433
8-Dec-05	10.399	97.766	0.000	6.982	5.198	89.151
9-Dec-05	28.391	87.742	0.000	0.635	6.747	53.238
10-Dec-05	19.589	4.524	0.000	0.000	6.647	-21.712
11-Dec-05	-1.585	3.780	0.000	0.000	4.823	0.542
12-Dec-05	6.176	37.425	18.213	0.000	8.347	4.689
13-Dec-05	-24.296	1.984	30.351	0.000	7.847	-11.918
14-Dec-05	-34.052	3.785	30.300	0.000	7.422	0.115
15-Dec-05	-24.538	2.890	15.077	1.904	3.549	10.707
16-Dec-05	-8.492	3.117	7.971	0.000	5.448	-1.810
17-Dec-05	-4.428	4.570	0.000	0.000	5.598	3.400
18-Dec-05	0.260	2.324	0.000	0.000	4.798	-2.734
19-Dec-05	13.362	35.340	0.000	1.269	1.474	21.774
20-Dec-05	18.838	10.232	0.000	3.808	2.749	-7.546
21-Dec-05	-10.820	2.576	7.113	0.000	4.473	1.811
22-Dec-05	-7.924	2.924	0.000	0.635	7.172	4.310
23-Dec-05	-2.552	2.486	0.000	0.000	6.647	-1.610
24-Dec-05	1.668	2.094	0.000	0.635	5.998	-4.937
25-Dec-05	3.241	3.124	0.000	1.269	6.447	-5.295
26-Dec-05	-5.841	3.303	0.000	0.000	7.672	1.472
27-Dec-05	-3.575	1.926	0.000	0.000	8.147	-2.646
28-Dec-05	2.273	2.914	0.000	0.000	7.622	-6.981
29-Dec-05	4.721	10.406	0.000	1.269	5.173	1.782
30-Dec-05	-6.189	2.912	4.411	0.000	7.522	-2.833
31-Dec-05	-4.106	2.616	0.000	0.000	7.547	-0.826
1-Jan-06	-0.905	2.777	0.000	0.000	5.948	-2.265
2-Jan-06	-0.242	3.022	0.000	0.635	6.822	-2.924
3-Jan-06	11.652	32.233	0.000	0.000	6.422	14.159
4-Jan-06	9.171	28.414	13.760	0.000	7.747	-2.264
5-Jan-06	-8.007	34.056	30.420	0.000	7.697	3.946
6-Jan-06	-22.874	1.226	10.959	0.000	6.847	6.293
7-Jan-06	-10.684	2.219	0.000	0.000	8.197	4.706
8-Jan-06	-4.363	3.565	0.000	0.000	8.297	-0.369
9-Jan-06	2.966	36.620	0.000	0.000	6.647	27.007
10-Jan-06	22.636	39.977	0.000	0.635	4.098	13.877
11-Jan-06	10.253	1.612	0.000	0.000	6.622	-15.263
12-Jan-06	-0.352	2.427	0.000	0.000	6.272	-3.493
13-Jan-06	12.939	4.018	0.000	3.808	5.073	-10.186
14-Jan-06	19.855	3.939	0.000	0.635	7.697	-22.978
15-Jan-06	-6.430	2.542	0.000	0.000	8.771	0.201
16-Jan-06	-0.131	4.578	0.000	0.000	8.322	-3.613
17-Jan-06	3.412	3.469	0.000	0.000	6.772	-6.715
18-Jan-06	5.465	23.819	0.000	1.904	4.673	15.585
19-Jan-06	-0.182	4.213	0.081	0.000	4.998	-0.683

1 ha-m = 8.1068 ac-ft

Appendix II. Water balance terms with calculated remainders (continued).

Date	Change in storage	Inflow surface water	Outflow surface water	Rain	ET	Remainders
	ha-m	ha-m	ha-m	ha-m	ha-m	ha-m
20-Jan-06	20.980	48.313	13.021	0.000	5.198	9.113
21-Jan-06	9.629	0.678	29.923	2.539	5.448	-41.783
22-Jan-06	-23.128	2.410	29.713	0.635	5.248	-8.788
23-Jan-06	-30.225	3.758	30.102	0.635	6.747	-2.232
24-Jan-06	-21.025	3.374	10.949	0.000	6.248	7.202
25-Jan-06	-4.124	33.336	0.000	0.000	8.647	28.814
26-Jan-06	4.800	10.416	0.000	0.000	8.497	-2.881
27-Jan-06	-5.850	2.987	0.000	0.000	5.123	3.714
28-Jan-06	-4.793	1.260	0.000	0.000	5.473	0.580
29-Jan-06	1.636	2.014	0.000	0.000	5.798	-5.420
30-Jan-06	2.215	3.012	0.000	3.174	4.623	-0.653
31-Jan-06	-1.193	3.012	0.000	0.000	8.697	-4.491
1-Feb-06	-5.421	2.787	0.000	0.000	8.322	-0.114
2-Feb-06	-0.998	3.264	0.000	0.000	4.898	-0.636
3-Feb-06	-2.866	2.523	0.000	39.989	4.348	41.030
4-Feb-06	144.187	297.297	20.362	48.241	0.925	180.065
5-Feb-06	362.300	389.516	74.786	0.000	10.146	-57.715
6-Feb-06	201.597	382.042	309.401	0.000	10.596	-139.553
7-Feb-06	-128.756	257.233	359.808	0.000	10.321	15.860
8-Feb-06	-250.141	37.141	453.268	0.000	10.421	-176.406
9-Feb-06	-313.848	3.120	95.517	0.000	10.471	210.980
10-Feb-06	9.609	47.464	0.000	0.000	10.171	27.684
11-Feb-06	5.528	2.214	0.000	0.000	8.597	-11.911
12-Feb-06	-10.872	3.318	0.000	1.269	4.148	11.311
13-Feb-06	-4.936	2.701	0.000	0.000	10.271	-2.633
14-Feb-06	-4.267	2.743	0.000	0.000	10.846	-3.836
15-Feb-06	-2.081	4.661	0.000	0.000	7.622	-0.880
16-Feb-06	15.321	40.133	2.050	0.000	9.396	13.366
17-Feb-06	-0.367	2.914	0.000	0.000	10.221	-6.939
18-Feb-06	-1.544	3.650	0.000	0.000	11.171	-5.976
19-Feb-06	-3.328	2.716	0.000	0.000	9.996	-3.952
20-Feb-06	-1.425	2.983	0.000	0.000	8.771	-4.364
21-Feb-06	-1.927	2.616	0.000	0.000	8.697	-4.154
22-Feb-06	-0.359	4.578	0.000	0.000	7.297	-2.360
23-Feb-06	-8.180	2.420	8.913	0.000	10.321	-8.635
24-Feb-06	-8.873	2.694	2.589	0.000	8.447	0.531
25-Feb-06	4.732	1.767	0.000	0.635	4.823	-7.154
26-Feb-06	11.747	4.553	0.000	1.904	4.623	-9.913
27-Feb-06	9.078	2.892	0.064	0.000	11.071	-17.321
28-Feb-06	-1.293	2.447	0.108	0.000	11.870	-8.238
1-Mar-06	-5.572	2.819	0.254	0.000	11.395	-3.259
2-Mar-06	-5.791	1.725	9.863	0.000	11.995	-14.342
3-Mar-06	-6.479	10.208	1.473	0.000	10.646	4.568
4-Mar-06	-6.728	1.255	0.000	0.000	10.271	-2.288

1 ha-m = 8.1068 ac-ft

Appendix II. Water balance terms with calculated remainders (continued).

Date	Change in storage	Inflow surface water	Outflow surface water	Rain	ET	Remainders
	ha-m	ha-m	ha-m	ha-m	ha-m	ha-m
5-Mar-06	-6.166	3.105	0.000	0.000	11.720	-2.450
6-Mar-06	-7.406	2.816	0.000	0.000	10.546	-0.324
7-Mar-06	-12.821	0.000	0.000	0.000	12.145	0.676
8-Mar-06	-7.828	1.270	0.000	0.000	12.745	-3.647
9-Mar-06	-1.273	1.563	8.786	0.000	10.521	-16.471
10-Mar-06	-25.612	2.549	0.000	0.000	9.771	18.390
11-Mar-06	-12.550	0.631	0.000	0.000	11.295	1.885
12-Mar-06	-4.617	2.312	0.000	0.000	9.571	-2.642
13-Mar-06	-7.211	1.884	0.000	0.000	10.471	-1.376
14-Mar-06	-13.438	2.143	0.000	0.000	9.146	6.435
15-Mar-06	7.677	41.856	0.000	0.000	9.721	24.458
16-Mar-06	23.544	9.853	8.639	0.000	11.870	-34.200
17-Mar-06	-2.335	1.174	0.000	0.000	11.171	-7.661
18-Mar-06	-5.487	2.430	0.000	0.000	11.720	-3.803
19-Mar-06	-3.382	0.000	0.000	0.000	9.621	-6.239
20-Mar-06	-1.959	3.555	0.000	0.000	11.820	-6.307
21-Mar-06	-11.829	1.637	0.000	0.000	11.495	1.971
22-Mar-06	-11.052	0.803	1.414	0.000	12.145	-1.704
23-Mar-06	11.316	15.965	5.393	66.648	5.223	60.681
24-Mar-06	48.254	134.464	54.417	0.000	10.596	21.197
25-Mar-06	-31.890	3.139	0.000	0.000	14.344	20.685
26-Mar-06	-10.286	3.142	0.000	0.000	13.120	0.308
27-Mar-06	-7.720	2.229	0.000	0.000	14.444	-4.495
28-Mar-06	3.010	3.144	0.000	0.000	13.120	-12.986
29-Mar-06	4.385	1.700	2.965	0.000	9.521	-15.172
30-Mar-06	-4.378	10.553	0.000	0.000	12.045	2.886
31-Mar-06	-8.157	2.134	0.000	0.000	11.171	-0.880
1-Apr-06	-7.857	1.776	0.000	0.000	10.471	-0.838
2-Apr-06	-8.661	2.290	0.000	0.000	12.570	-1.619
3-Apr-06	-10.187	1.050	0.000	0.000	13.370	-2.134
4-Apr-06	-15.526	1.830	0.000	0.000	12.420	4.936
5-Apr-06	-14.043	2.229	0.000	0.000	14.094	2.177
6-Apr-06	-15.729	2.718	0.000	0.000	12.520	5.927
7-Apr-06	-11.820	0.000	6.826	0.000	13.070	-8.076
8-Apr-06	-11.636	2.209	0.000	0.000	10.696	3.150
9-Apr-06	-5.718	2.630	0.000	15.234	8.372	15.210
10-Apr-06	15.992	28.480	0.064	5.078	12.145	5.357
11-Apr-06	5.293	2.794	0.000	2.539	13.595	-13.554
12-Apr-06	-0.933	1.424	0.000	3.808	11.595	-5.430
13-Apr-06	-15.221	0.000	6.293	0.635	11.171	-1.607
14-Apr-06	-16.290	1.940	0.000	0.000	12.745	5.486
15-Apr-06	-15.386	0.000	0.000	0.000	15.044	0.342
16-Apr-06	-17.371	2.652	0.000	0.000	14.844	5.180
17-Apr-06	-19.660	0.000	0.000	0.000	14.194	5.466

1 ha-m = 8.1068 ac-ft

Appendix II. Water balance terms with calculated remainders (continued).

Date	Change in storage	Inflow surface water	Outflow surface water	Rain	ET	Remainders
	ha-m	ha-m	ha-m	ha-m	ha-m	ha-m
18-Apr-06	-17.629	2.527	0.895	0.000	11.770	7.491
19-Apr-06	-25.227	1.130	0.000	0.000	7.247	19.110
20-Apr-06	-17.668	0.710	0.000	0.000	14.444	3.934
21-Apr-06	-1.527	0.000	0.000	0.000	12.570	-11.043
22-Apr-06	21.922	0.000	0.000	6.982	12.695	-27.635
23-Apr-06	-12.590	0.000	0.000	0.635	13.919	-0.695
24-Apr-06	-11.377	0.000	0.000	0.000	12.845	-1.468
25-Apr-06	-12.838	3.149	0.000	0.000	12.470	3.516
26-Apr-06	15.983	39.035	0.000	9.521	10.721	21.852
27-Apr-06	31.208	3.156	0.000	2.539	9.946	-35.459
28-Apr-06	7.822	43.808	0.000	0.000	12.920	23.066
29-Apr-06	11.399	0.000	0.000	0.000	11.046	-22.445
30-Apr-06	-14.275	0.000	0.000	0.000	12.770	1.505

1 ha-m = 8.1068 ac-ft