Settlement Agreement
July - September 2005 Report

Update, November 30, 2005
On page 11, text was added to explain water quality sampling results for the overflow event at EO2 on August 30, 2005. On page 14, Figure 9 was modified to include TP results for the August overflow event.

Update, December 29, 2005
Figure 2 (page 3) and Table 1 (page 4) are modified to show May and June 2005 TP geometric mean concentration values.

Update, February 16, 2006
Table 1 (page 4) for September 2005: number of TP samples was changed from 10 to 11;
interim level was changed from 13.1 to 13.0 due to the update in stage data;
geometric mean concentration and long term level were not affected.

Prepared for the
Technical Oversight Committee
November 23, 2005

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ARTHUR R. MARSHALL LOXAHATCHEE NATIONAL WILDLIFE REFUGE

The 1991 Settlement Agreement ended the Everglades lawsuit and was entered into by the federal government, the State of Florida and the South Florida Water Management District. The subsequent Consent Decree, as modified in 1995, specified that interim and long-term phosphorus concentration levels for the Arthur R. Marshall Loxahatchee National Wildlife Refuge (Refuge) must be met by February 1, 1999, and December 31, 2006, respectively. The concentration levels vary monthly because they are calculated as a function of water stage measured at gauging stations 1-7, 1-8C and 1-9 within the Refuge. The stage range within which the interim and long-term concentration levels are applicable is 15.42 to 17.14 feet NGVD. The monthly total phosphorus concentrations are determined from water samples collected at 14 interior marsh stations, LOX3 through LOX16 (**Figure 1**). As required in the Consent Decree, the concentrations are converted to a geometric mean, which is compared to the interim and long-term concentration levels.

The interim levels for July, August and September 2005 were 14.9, 13.9 and 13.1 parts per billion (ppb), respectively. The long-term levels were 12.2, 11.4 and 10.8 (ppb), respectively. Because the total depth was less than 0.1 meter (m), no water samples were collected at stations LOX3 and LOX10 for August 2005 and stations LOX3, LOX5 and LOX13 for September 2005.

Average stages in the Refuge were 16.05, 16.17 and 16.28 feet in July, August and September 2005 (**Figure 2** and **Table 1**). The geometric means, calculated from total phosphorus concentrations measured in water samples collected in July, August and September 2005, were 7.4, 6.5 and 7.5 ppb, respectively. The interim levels were 14.9, 13.9 and 13.1 ppb respectively. The geometric means were less than the interim and long-term levels for July, August and September 2005.

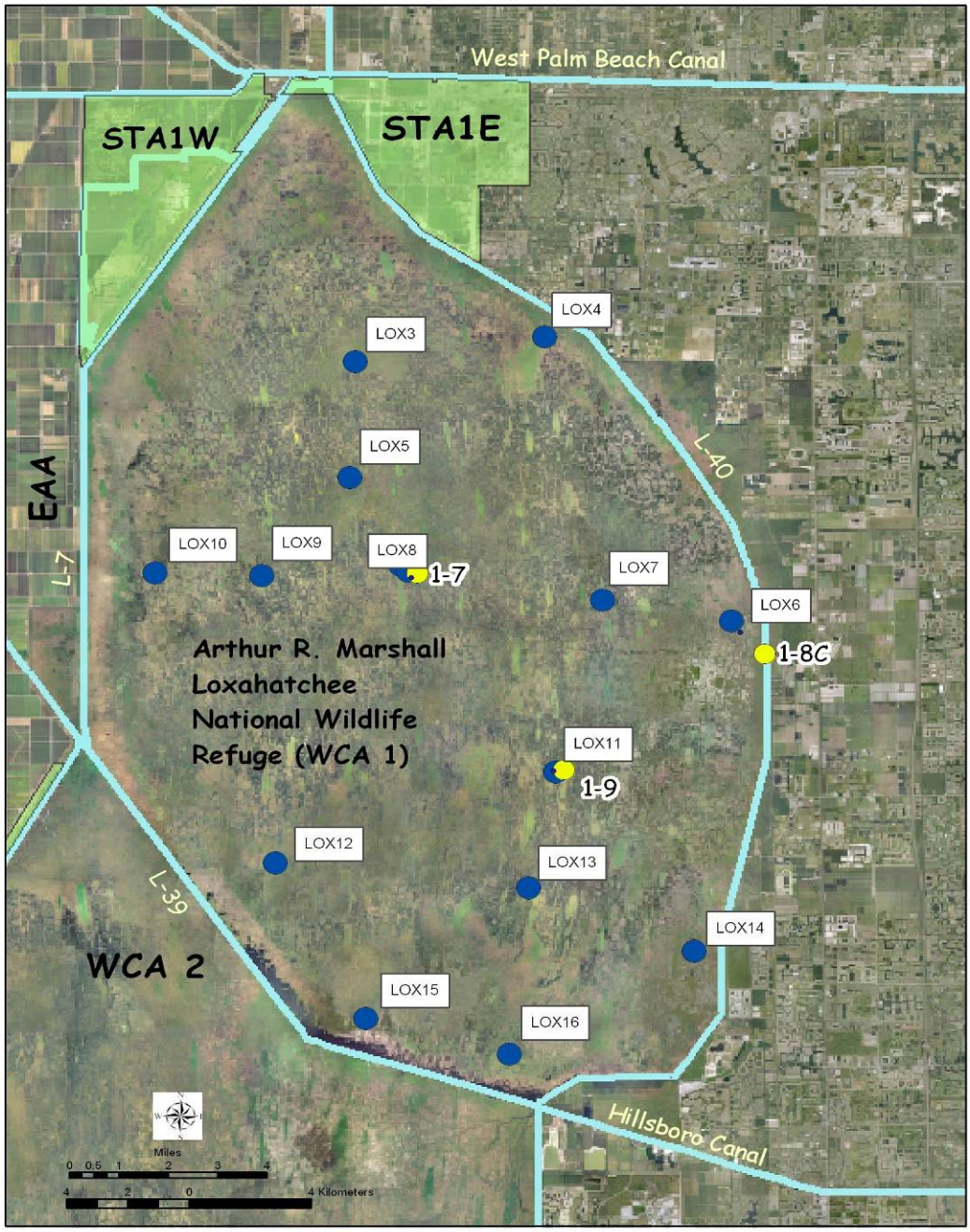

Figure 1. A.R.M. Loxahatchee National Wildlife Refuge Water Quality Sampling and Stage Measurement Sites

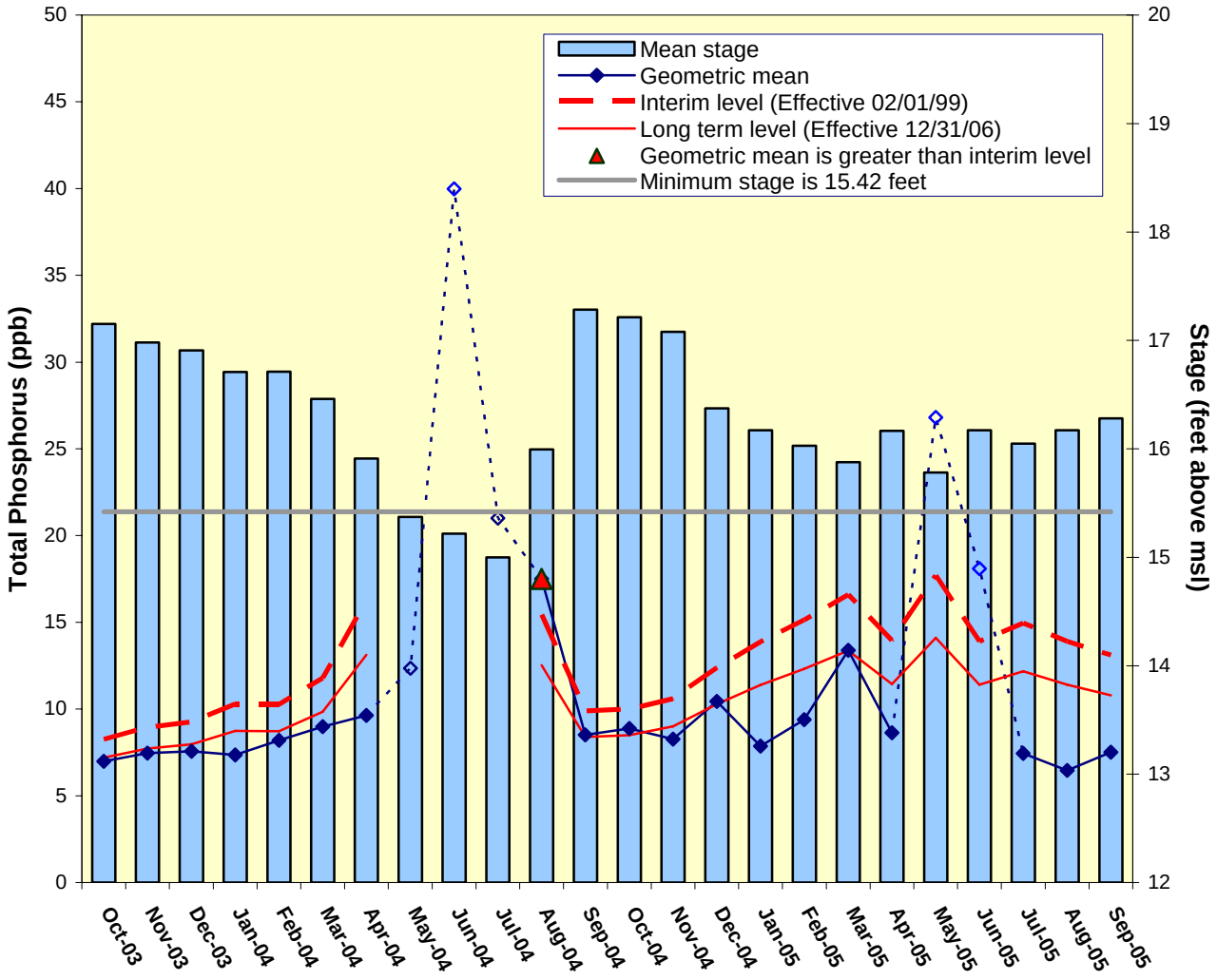

Figure 2. Monthly total phosphorus geometric mean concentrations for the Arthur R. Marshall Loxahatchee National Wildlife Refuge compared to the interim and long-term levels. The calculated level concentrations are adjusted for fluctuations in stage.

Interim and Long-term levels are not shown for May 2004 – July 2004 because the levels do not apply when the mean stage is less than 15.42 feet.

The TP data from May and June, 2005 have been qualified as questionable in accordance with Chapter 62-160 F.A.C. and should not be used. Geometric means for May and June 2005 are shown for reference only and were not considered for compliance purposes.

Table 1. Loxahatchee National Wildlife Refuge Total Phosphorus Compliance Tracking

Month - Year	Geometric Mean Concentration (ppb)	Interim Level (ppb) Effective 2/1/99	Long Term Level (ppb) Effective 12/31/06	Average Stage (ft NGVD)	Number of TP Samples	Number of Stage Measure-ments
Oct-2003	7.0	8.3	7.2	17.15	14	3
Nov-2003	7.5	8.9	7.7	16.98	11	3
Dec-2003	7.6	9.3	8.0	16.91	14	3
Jan-2004	7.4	10.3	8.7	16.71	14	3
Feb-2004	8.2	10.3	8.7	16.71	14	3
Mar-2004	9.0	11.8	9.8	16.46	14	3
Apr-2004	9.6	16.3	13.1	15.91	9	3
May-2004	12.4	N/A	N/A	15.37	9	3
Jun-2004	40.0	N/A	N/A	15.22	2	3
Jul-2004	21.0	N/A	N/A	15.00	1	3
Aug-2004	**17.5**	**15.4**	**12.5**	**16.00**	**12**	**3**
Sep-2004	8.5	9.9	8.4	16.79	14	3
Oct-2004	8.9	10.0	8.5	16.76	13	3
Nov-2004	8.3	10.6	9.0	16.65	14	3
Dec-2004	10.4	12.4	10.3	16.37	13	3
Jan-2005	7.9	13.9	11.4	16.17	12	3
Feb-2005	9.4	15.1	12.3	16.03	11	3
Mar-2005	13.4	16.6	13.4	15.88	11	3
Apr-2005	8.6	13.9	11.4	16.17	11	3
May-2005*	26.8*	17.7	14.1	15.78	10*	3
June-2005*	18.1*	13.9	11.4	16.17	14*	3
Jul-2005	7.4	14.9	12.2	16.05	14	3
Aug-2005	6.5	13.9	11.4	16.17	12	3
Sep-2005	7.5	13.0	10.8	16.28	11	3

Notes:(1) Average Stage is calculated using stage elevations at stations 1-7, 1-8C, and 1-9 on the sampling date.
(2) Highlighted rows indicate months when excursions occurred.
(3) N/A denotes that the concentration values were not applicable because the average stage was less than 15.42 feet.
** The TP data from May and June, 2005 have been qualified as questionable in accordance with Chapter 62-160 F.A.C. and should not be used.*

EVERGLADES NATIONAL PARK

Shark River Slough

The Consent Decree of 1995 specified that interim and long-term total phosphorus concentration limits for discharges into the Everglades National Park (ENP) (**Figure 3**) through Shark River Slough be met by October 1, 2003, and December 31, 2006, respectively. Only the total phosphorus concentrations for the water year ending September 30 are evaluated for compliance with the Consent Decree limits. It was also specified that the total phosphorus concentrations be presented as 12-month moving flow-weighted means. The long-term total phosphorus concentration limit for inflows to Shark River Slough through structures S12A, S12B, S12C, S12D and S333 represents the concentrations delivered during the Outstanding Florida Waters baseline period of March 1, 1978 to March 1, 1979, and is adjusted for variations in flow. Inflow concentrations of total phosphorus through Shark River Slough are compared to the interim and long-term limits at the end of each water year (October 1st through September 30th) from 1991 to 2005 (**Figure 4**). The 12-month moving flow-weighted mean total phosphorus concentration ending September 2005 was 9.4 ppb. Corresponding interim and long-term limits were 9.4 and 7.6 ppb, respectively.

Table 2 presents the moving flow-weighted mean concentrations for each 12-month period beginning in October 2003 as well as the corresponding interim and long-term total phosphorus concentration limits, calculated using the 12-month period flow. For the 12-month periods ending in July, August and September 2005, the flow-weighted mean total phosphorus concentrations were 10.5, 9.8 and 9.4 ppb, respectively. The interim limit was 9.4 ppb for July, August and September 2005. The long-term limits were 7.7 ppb for July and 7.6 ppb for August and September. The July and August 2005 12-month flow-weighted mean concentrations were greater than the interim limits.

The Consent Decree stipulates that the percent of flow-weighted mean total phosphorus concentrations greater than 10 ppb from each sampling event in any 12-month period must not exceed a guideline value based on flow into Shark River Slough for the same 12-month period. For the 12-month periods ending July, August and September 2005, the observed percentage of flow-weighted mean total phosphorus concentrations greater than 10 ppb were 55.0, 47.6 and 42.9 percent, respectively. The observed percentage of flow-weighted mean total phosphorus concentrations greater than 10 ppb were less than the guideline for the entire period March 2004 to April 2005 and higher than the guidelines from May to September 2005 (**Table 2**). The individual sampling events and the 12-month moving average are presented in **Figure 5**.

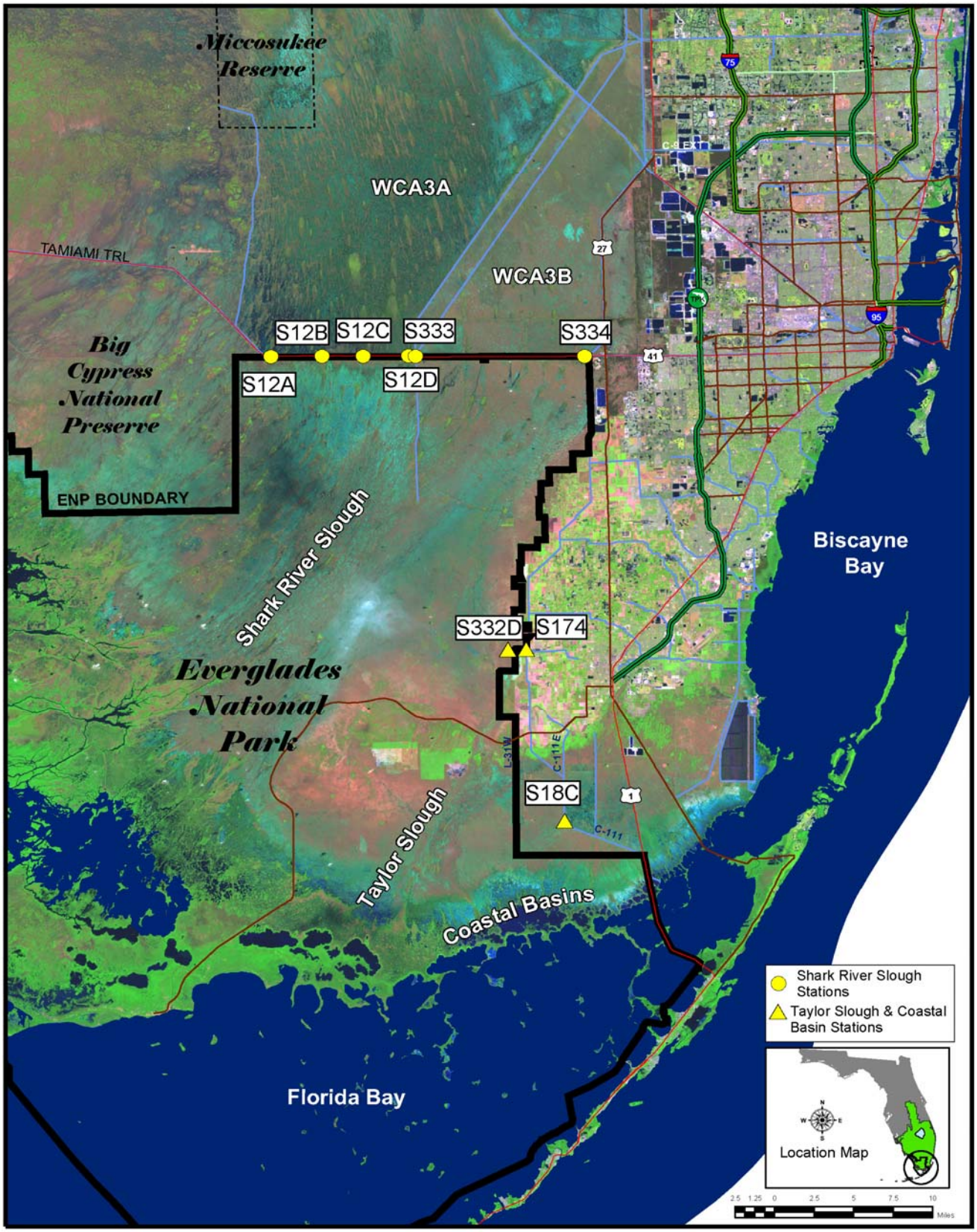

Figure 3. Everglades National Park flow structures

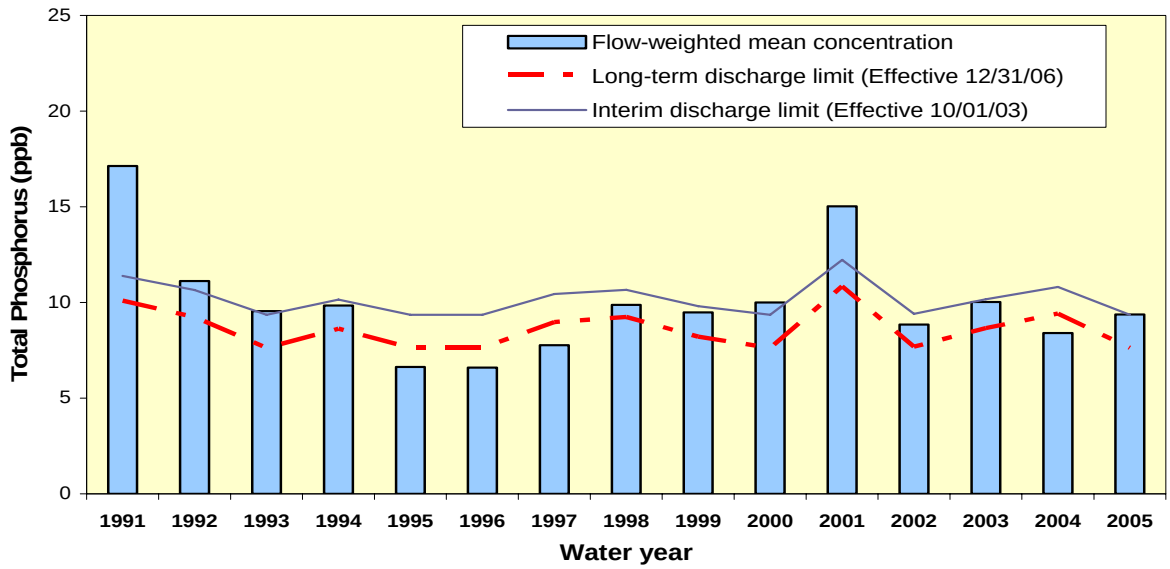

Figure 4. The 12-month moving average total phosphorus flow-weighted mean concentrations (fwmc) in inflows to Everglades National Park through Shark River Slough at the end of each water year compared to the total phosphorus interim and long-term limits. For the second consecutive compliance year, the 12-month fwmc was within the interim limits, which became effective on October 1, 2003.

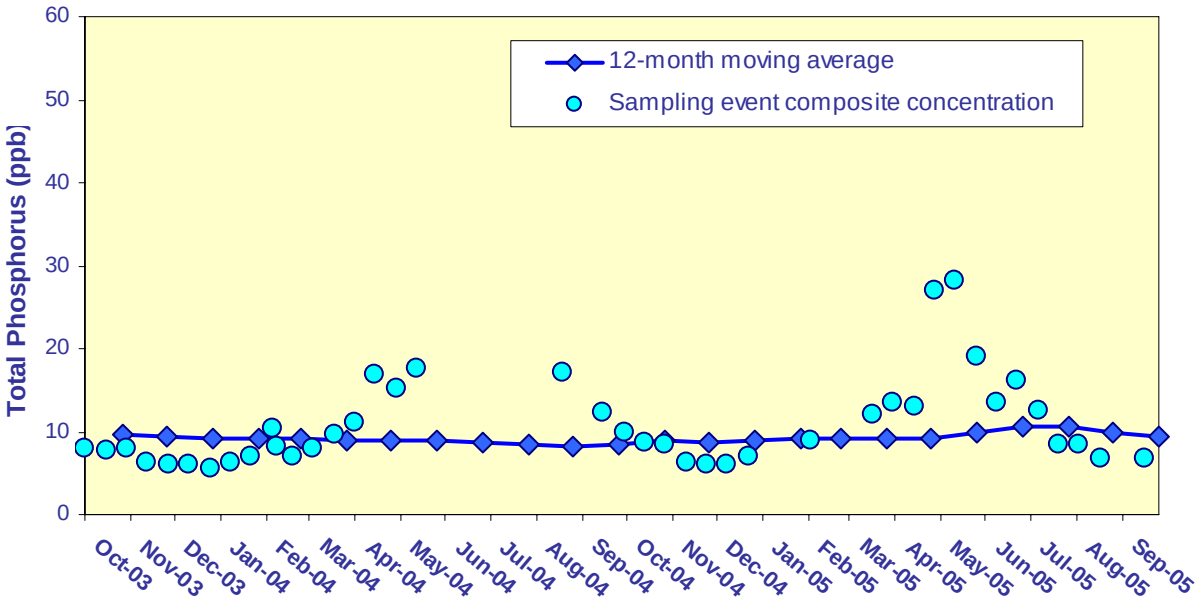

Figure 5. The 12-month moving average total phosphorus flow-weighted mean concentrations (fwmc) in inflows to Everglades National Park through Shark River Slough at the end of each month and the composite total phosphorus concentration for each sampling event. There are no sampling event values for June, July 2004 and January 2005 because there was no flow in those periods.

Table 2. Shark River Slough Total Phosphorus Concentration Compliance Tracking.

12-Month Period Ending On	Total Period Flow (Kac-ft)	Flow Weighted Mean Total Phosphorus (ppb)	Interim Limit (ppb) Effective 10/1/2003	Long Term Limit (ppb) Effective 12/31/2006	Percent of Sampling Events Greater than 10 ppb (%) Guideline	Observed
31-Oct-03	921.8	9.7	9.9	8.3	43.3	***50.0***
30-Nov-03	1001.5	9.5	9.6	7.9	41.4	***46.2***
31-Dec-03	1076.8	9.1	9.4	7.6	40.1	***46.2***
31-Jan-04	1049.0	9.2	9.4	7.7	40.4	***46.2***
29-Feb-04	1033.9	9.1	9.5	7.8	40.7	***44.4***
31-Mar-04	1036.7	8.9	9.4	7.7	40.7	37.0
30-Apr-04	1012.9	9.0	9.5	7.9	41.2	40.7
31-May-04	980.2	9.0	9.7	8.0	41.9	40.7
30-Jun-04	942.5	8.7	9.8	8.2	42.8	36.0
31-Jul-04	832.0	8.4	10.2	8.8	45.5	27.3
31-Aug-04	733.0	8.2	10.7	9.3	48.2	28.6
30-Sep-04*	704.4	8.4	10.8	9.4	49.0	35.0
31-Oct-04	727.8	8.9	10.7	9.3	48.3	35.0
30-Nov-04	760.3	8.7	10.6	9.1	47.4	33.3
31-Dec-04	738.5	9.0	10.7	9.2	48.0	35.0
31-Jan-05	717.3	9.0	10.7	9.3	48.6	38.9
28-Feb-05	709.8	9.1	10.8	9.4	48.8	37.5
31-Mar-05**	698.3	9.2	10.8	9.4	49.2	46.7
30-Apr-05	732.6	9.1	10.7	9.3	48.2	46.7
31-May-05	767.1	10.0	10.5	9.1	47.3	***50.0***
30-Jun-05	836.0	10.5	10.2	8.7	45.4	***55.6***
31-Jul-05	1054.7	10.5	9.4	7.7	40.3	***55.0***
31-Aug-05	1269.2	9.8	9.4	7.6	40.1	***47.6***
30-Sep-05*	1345.9	9.4	9.4	7.6	40.1	***42.9***

Notes: 1) Highlighted rows indicate the end of the water year (Oct 1st to Sept 30th)
2) Bold italicized values exceeded the guideline percentages.
3) When the total flow for Shark River Slough exceeds 1061 Kac-ft/yr, a flow of 1061 Kac-ft/yr is used in calculating the discharge limits.
** September compliance points.*
***Flow data at structure S12A from March 21 to March 23, 2005 were corrected. This affected previously-published Total Period Flow and flow- weighted mean TP values for March-June 2005.*

The daily flows through the individual Shark River Slough structures from October 2003 through September 2005 are presented in **Figure 6**. From mid-December 2004 through June 2005, inflows to Shark River Slough were through S333 and S12D. A large proportion of the flow in the L29 Canal entered through S333 and was released from the system through S334. This condition lasted until mid-June 2005. Structures S12A, S12B and S12C were closed in accordance with Interim Operational Plan (IOP) for protection of the Cape Sable Seaside Sparrow. The S12s are operated to meet target discharges per the Shark River Slough Rainfall Plan which has been in effect since July 1985.

For additional information on the S12s and S333 structures, please visit: http://www.sfwmd.gov/org/ema/reports/sharkriver/index.html.

The relationship between the sum of the daily flows at Shark River Slough structures and corresponding flow-weighted mean total phosphorus concentrations for individual sampling events is presented in **Figure 7.** Values follow the strong inverse relationship between flow and total phosphorus concentration expected for waters entering the ENP through Shark River Slough.

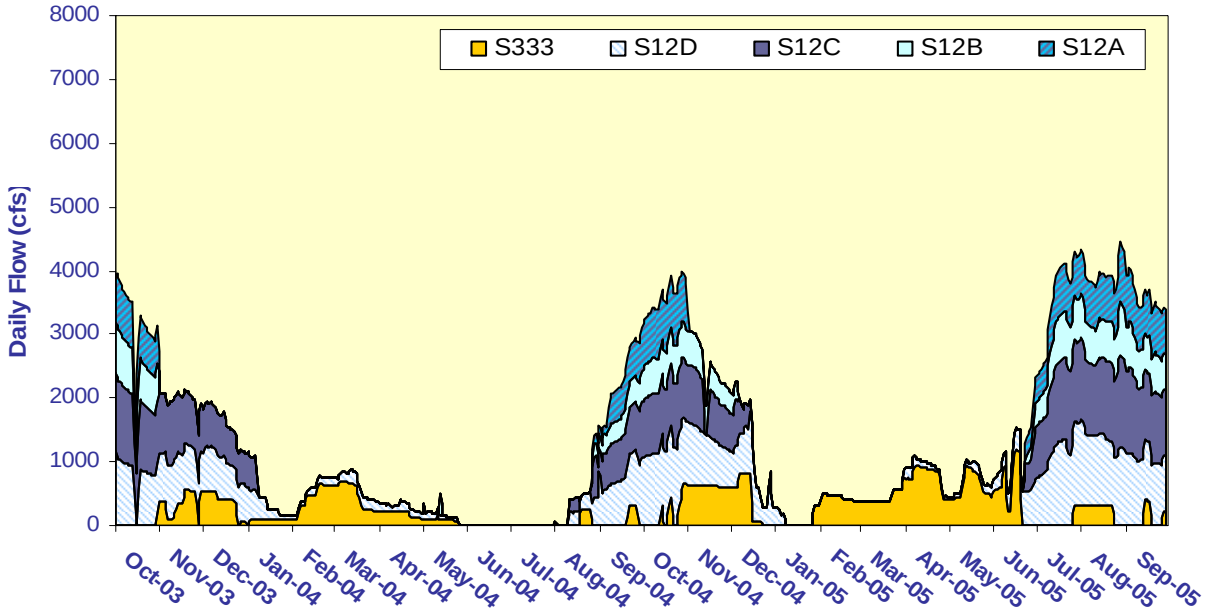

Figure 6. Daily flows into Shark River Slough by structure.

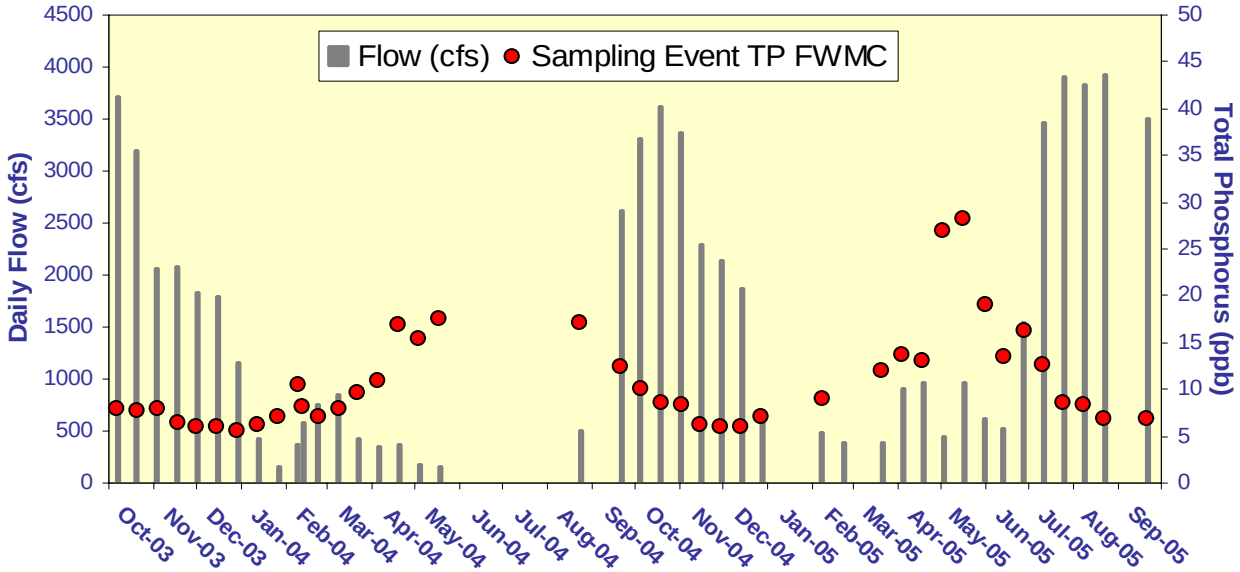

Figure 7. The relationship between daily flow at Shark River Slough structures and the corresponding flow-weighted mean total phosphorus concentrations for individual sampling events. There was no sampling event flow-weighted mean concentration for the months of June through July 2004 and January 2005 because there was no flow in those months.

Taylor Slough and the Coastal Basins

Under the Consent Decree, a single total phosphorus long-term limit of 11 ppb, to be met by December 31, 2006, was set for the two points of inflow to Taylor Slough (S332 and S175) and the inflow point to the Coastal Basins (S18C). The 11 ppb limit applies to the water year ending September 30. For the Water Year ending September 2005, the total phosphorus value was much lower than the long-term limit.

C-111 Project Structures and Detention Areas

Beginning in August 1999, structure S332D, a new pump station constructed by the U.S. Army Corps of Engineers (USACE), began operation. The structure is adjacent to spillway S174 and pumps water from the L31N canal into the L31W canal. The S332D and S174 structures became the new inflow compliance monitoring sites for Taylor Slough on October 1, 1999, replacing S332 and S175.

The USACE completed construction of the remaining C-111 project structures and detention areas along the eastern boundary of the ENP in June 2002. The project was authorized by the USACE in 1995 to restore more natural hydrologic conditions in Taylor Slough and to maintain flood protection to the east of the L31N and C-111 canals. Project facilities consist of pump stations S332B, S332C and S332D, Detention Cells 1 through 5, a Connector Cell between cells 2 and 3, a Flow Way Cell originating at Berm 3 of Cell 5, and four emergency overflow structures (**Figure 8**). The Flow Way Cell is the only location to routinely discharge surface water into the ENP from this project.

The construction of these facilities was accelerated to respond to U.S. Fish and Wildlife requirements to give immediate relief to water conditions that threaten the Cape Sable Seaside Sparrow, an endangered species. The USACE signed a Record of Decision on July 2, 2002 that authorizes the implementation of an Interim Operational Plan (IOP) to govern the operation of the new facilities. Since July 31, 2002, the USACE has been operating the project under Emergency Orders issued by the Florida Department of Environmental Protection (FDEP).

The USACE and the South Florida Water Management District (District) will monitor the implementation of the IOP under the terms and conditions of the C-111 Project Cooperation Agreement executed in 1995. The District, on behalf of the USACE, is implementing a monitoring plan approved by FDEP that assesses the hydrologic, environmental, and surface and ground water quality changes that may occur as a result of the IOP. The District started the routine sampling in September 2003.

The monitoring plan treats the detention areas as a single project with five cells, three inflows and a single outflow to ENP. Only Emergency Overflows EO2 and EO4 would discharge into ENP if utilized. Overflows have periodically occurred at EO2 between September 2001 and September 2003. Data from these overflows were presented graphically in previous reports. There were no overflows during the period from October 2003 through June 2005. After this period, overflow events occured at the S332B west detention area for: three days in July 2005 (7/1-7/2 and 7/10), seven days in August 2005 (8/25-8/31), and eight days in September 2005 (9/1-9/6) and 9/20-9/21). Water Quality sample was collected on August 30, 2005 during the overflow event. The TP concentration of the August 30, 2005 sample was 14 ppb

(Figure 9). Discharges from Emergency Overflows EO1 and EO3 would flow onto District property and eventually into the L31N Canal. The majority of the water pumped into the detention cells, as well as rainfall, is expected to seep into the Biscayne Aquifer directly below the project site and provide a hydrologic “curtain” to reduce ground water seepage in an easterly direction from ENP.

Until FDEP issues an operating permit to the District and approves the District’s related monitoring plan, the District will continue to report data from S332D and S174 to determine compliance with the Consent Decree requirements as described in the following section.

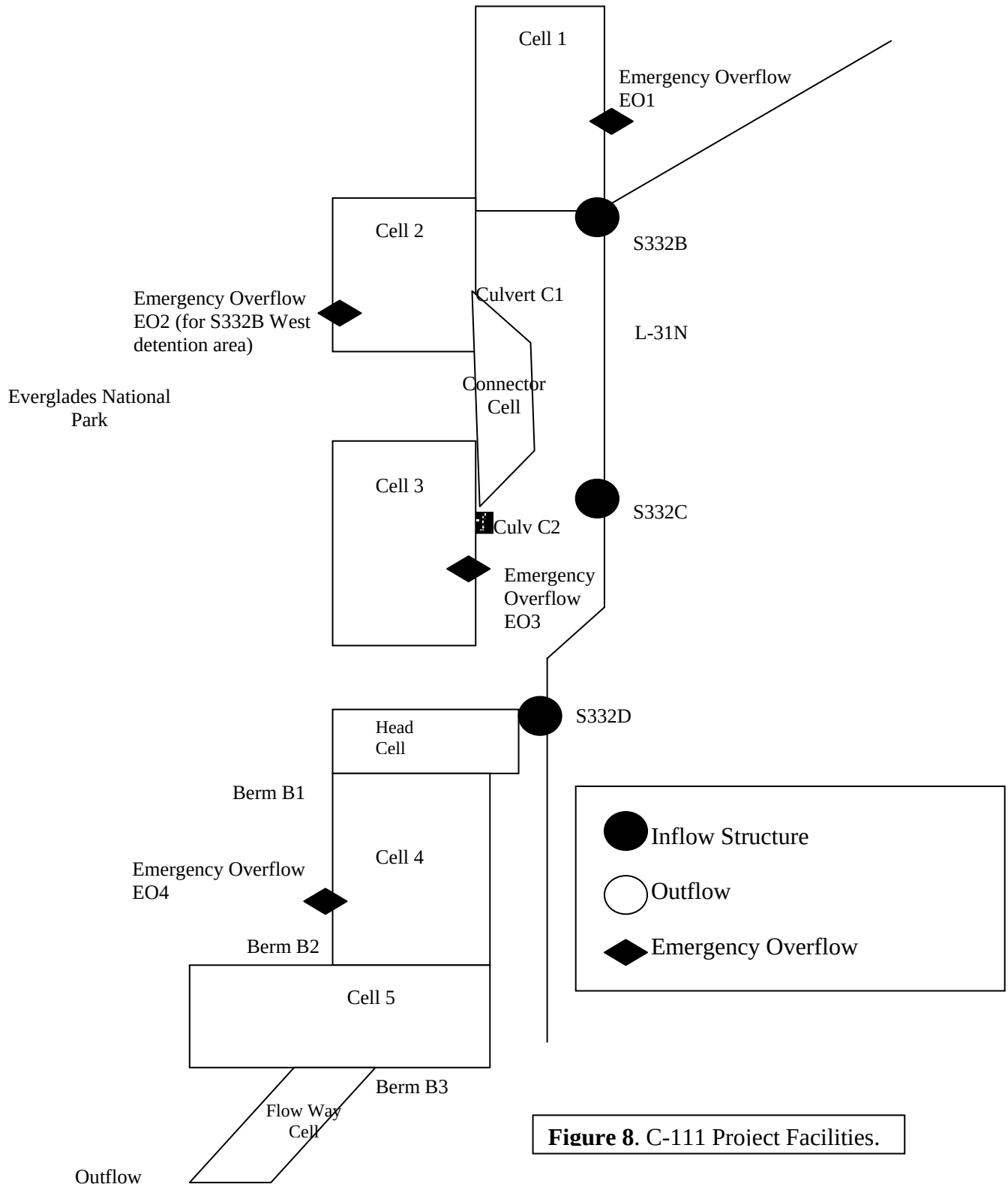

Figure 8. C-111 Project Facilities.

Overflow Events 2005 at S332B Pump

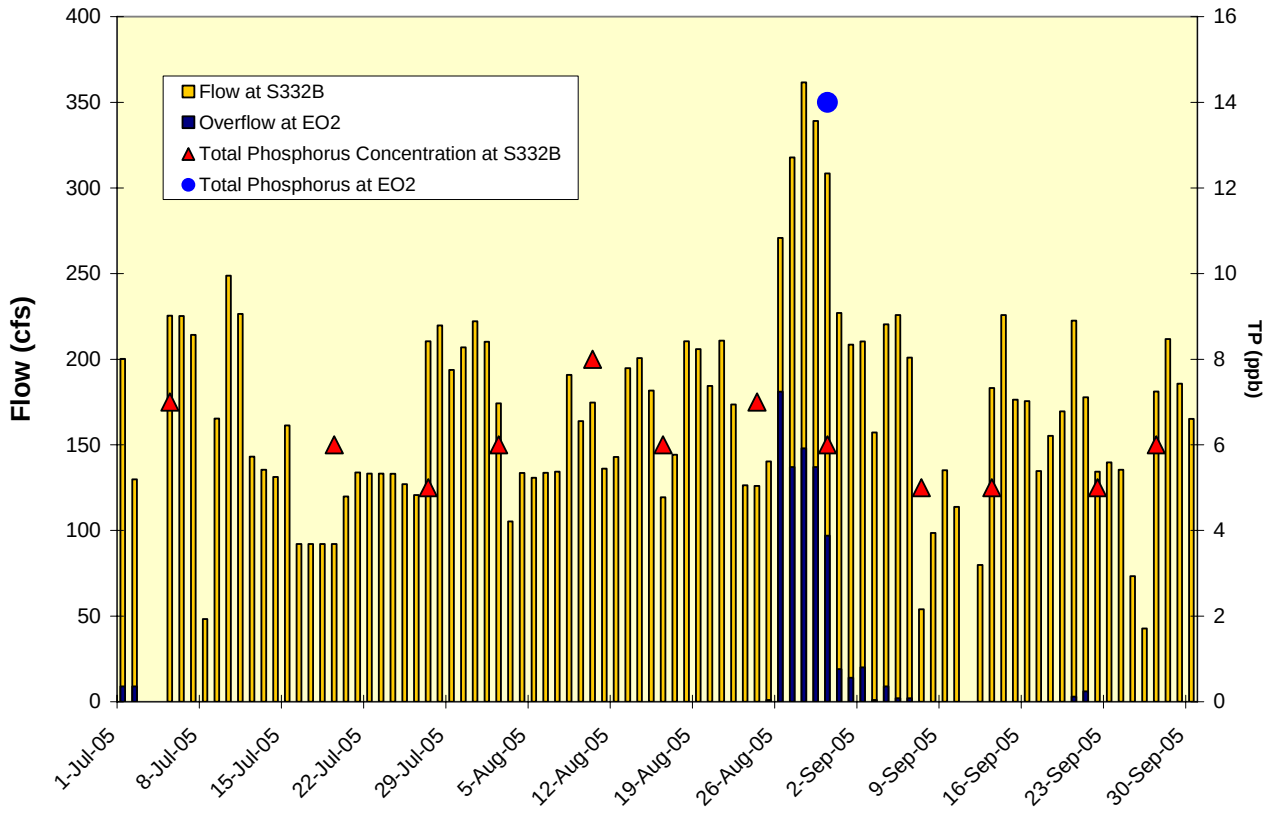

Figure 9. Flows through pump S332B and total phosphorus concentrations during overflow events at EO2 west pond.

Compliance with Consent Decree

Inflow concentrations of total phosphorus to the ENP through Taylor Slough and the Coastal Basins are compared to the 11 ppb limit at the end of each water year using data from both the old (S175, S332, S18C) and new (S174, S332D, S18C) combinations of structures (**Figure 10)**. The bars in **Figure 10** represent the flow-weighted mean total phosphorus concentrations from S332, S175 and S18C for water years 1989 through 2002. The diamond point values for water years 1999 through 2005 represent the new combination of structures. S175, located on the Levee 31W borrow canal, is closed under IOP. It was opened briefly on August 26 and 27, 2005 for the flood protection of the area after Hurricane Katrina (total flow: 2,066 acre-feet; TP concentration: 6 ppb; TP load: 15 kg). However, flow through S175 is not considered an input to the ENP but a flow within it.

Figure 11 presents the 12-month moving average and individual sampling event flow-weighted mean total phosphorus concentrations at the S174, S332D and S18C structures.

Total phosphorus and flow data from both sets of structures presented in prior editions of this report through December 2001 (April 2002 report) showed that, beginning October 2000, the 12-month moving total flow for S332D, S174 and S18C was consistently greater than flow at S332, S175 and S18C. There was also a shift in flow-weighted mean total phosphorus concentration data whereby S332D, S174 and S18C concentrations became equal to and then consistently lower than the concentrations at S332, S175 and S18C. These changes reflected the switch made from S175, S332 to S174, S332D for water delivery to Taylor Slough between July 3 and July 5, 2000. Consequently, as of the July 2002 report, only S332D, S174 and S18C data are presented for monthly tracking of data in **Figure 11**.

The 12-month flow-weighted mean concentrations for July, August and September 2005 were 5.4, 6.4 and 6.3 ppb, respectively, for the combined flow through S174, S332D and S18C (**Table 3**). The Consent Decree stipulates that the percent of flow-weighted mean total phosphorus concentrations greater than 10 ppb from each sampling event in any 12-month period must not exceed a fixed guideline of 53.1 percent. The observed percentage of flow-weighted mean total phosphorus concentrations greater than 10 ppb for the combined flow through S174, S332D and S18C was 10.4, 12.2 and 12.2 percent for the periods ending July, August and September 2005.

The daily flows into ENP through S332D, S174 and S18C are presented in **Figure 12**. **Figure 13** shows the relationship between the daily inflows and the corresponding flow-weighted mean total phosphorus concentrations for each sampling event. There used to be no observable relationship between daily mean flow and flow-weighted mean total phosphorus concentrations at S332, S175 and S18C structures. However, the data for October 2003 through September 2005 at S332D, S174 and S18C structures indicate that all of the higher flow-weighted mean concentrations occurred on lower flow days except for August 2005.

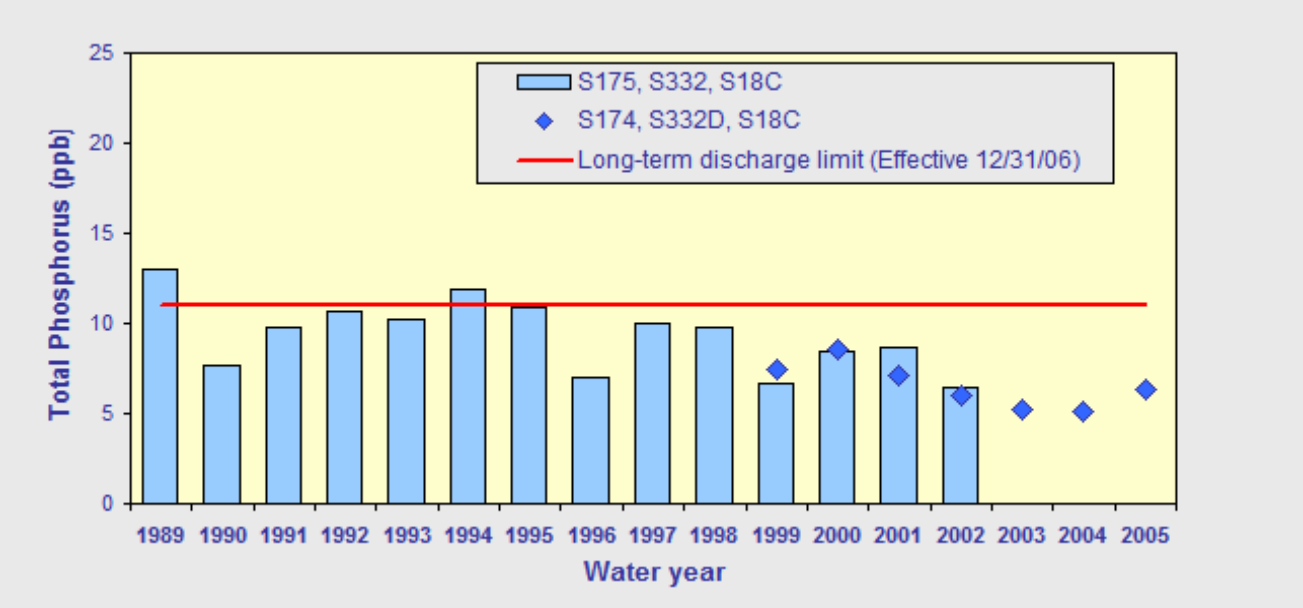

Figure 10. The 12-month moving average total phosphorus flow-weighted mean concentrations (fwmc) in inflows to Everglades National Park through Taylor Slough and the Coastal Basins at the end of each water year compared to the 11 ppb long-term total phosphorus limit.

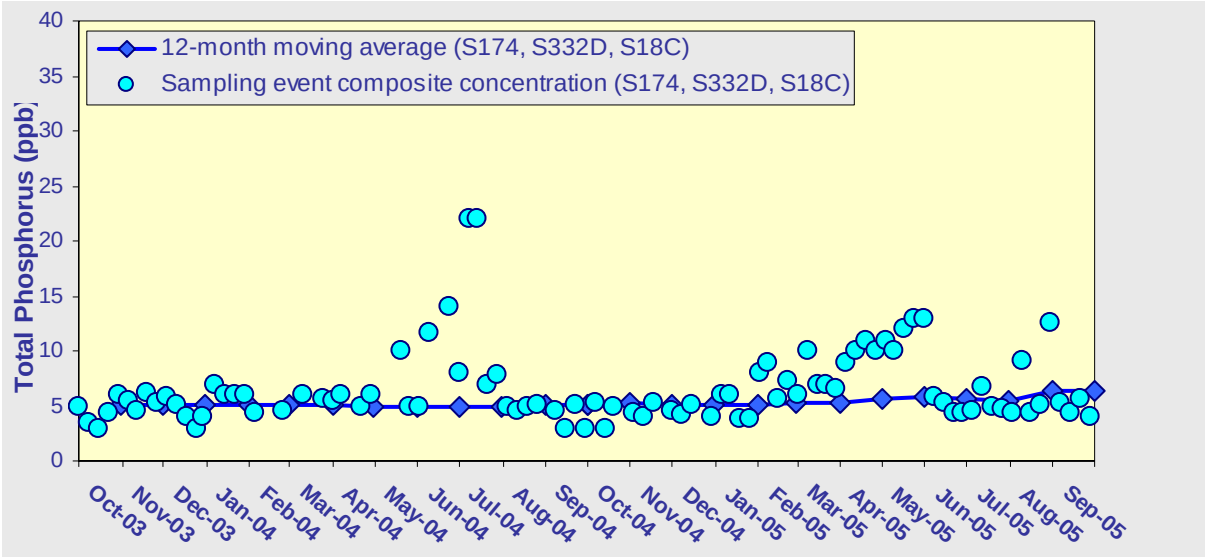

Figure 11. 12-month moving average total phosphorus flow-weighted mean concentrations (fwmc) in inflows to Everglades National Park through Taylor Slough and the Coastal Basins at the end of each month and the composite total phosphorus concentration for each sampling event.

Table 3. Taylor Slough and the Coastal Basins Total Phosphorus Concentration Compliance Tracking.

12-Month Period Ending On	Total Period Flow (Kac-ft)	Flow Weighted Mean Total Phosphorus (ppb)	Long Term Limit (Effective 12/31/06) (ppb)	Percent of Sampling Events Greater than 10 ppb (%)	
				Guideline	Observed
31-Oct-03	233.8	5.0	11.0	53.1	0.0
30-Nov-03	276.6	5.1	11.0	53.1	0.0
31-Dec-03	293.9	5.0	11.0	53.1	0.0
31-Jan-04	295.9	5.1	11.0	53.1	0.0
29-Feb-04	301.4	5.0	11.0	53.1	0.0
31-Mar-04	297.9	5.0	11.0	53.1	0.0
30-Apr-04	292.3	5.0	11.0	53.1	0.0
31-May-04	274.8	4.9	11.0	53.1	2.2
30-Jun-04	238.0	4.9	11.0	53.1	6.8
31-Jul-04	224.3	5.0	11.0	53.1	11.4
31-Aug-04	202.7	5.1	11.0	53.1	11.4
30-Sep-04	192.6	5.2	11.0	53.1	11.4
30-Sep-04	192.6	5.2	11.0	53.1	11.4
31-Oct-04	210.1	5.3	11.0	53.1	11.9
30-Nov-04	206.7	5.1	11.0	53.1	11.9
31-Dec-04	193.0	5.2	11.0	53.1	12.5
31-Jan-05	194.4	5.1	11.0	53.1	12.5
28-Feb-05	194.7	5.2	11.0	53.1	11.9
31-Mar-05	199.6	5.3	11.0	53.1	11.4
30-Apr-05	207.2	5.6	11.0	53.1	13.3
31-May-05	214.1	5.9	11.0	53.1	18.8
30-Jun-05	261.0	5.5	11.0	53.1	14.6
31-Jul-05	304.6	5.4	11.0	53.1	10.4
31-Aug-05	357.1	6.4	11.0	53.1	12.2
30-Sep-05	380.0	6.3	11.0	53.1	12.2

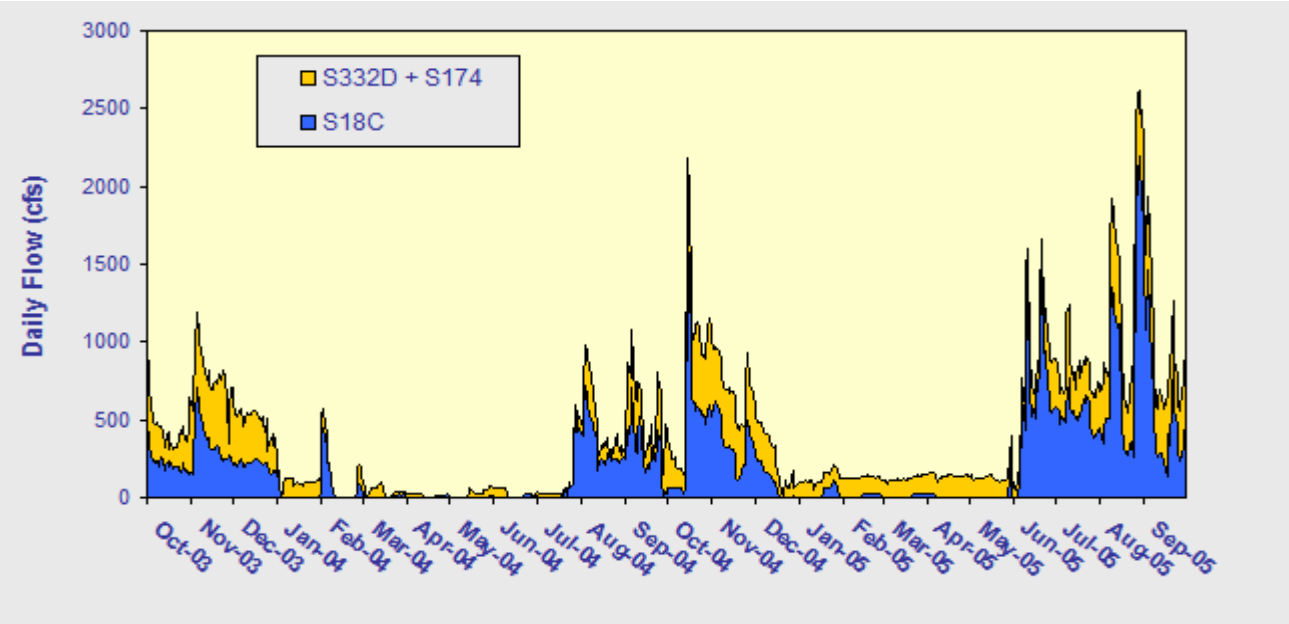

Figure 12. Daily flows into Everglades National Park through Taylor Slough (S332D+S174) and S18C.

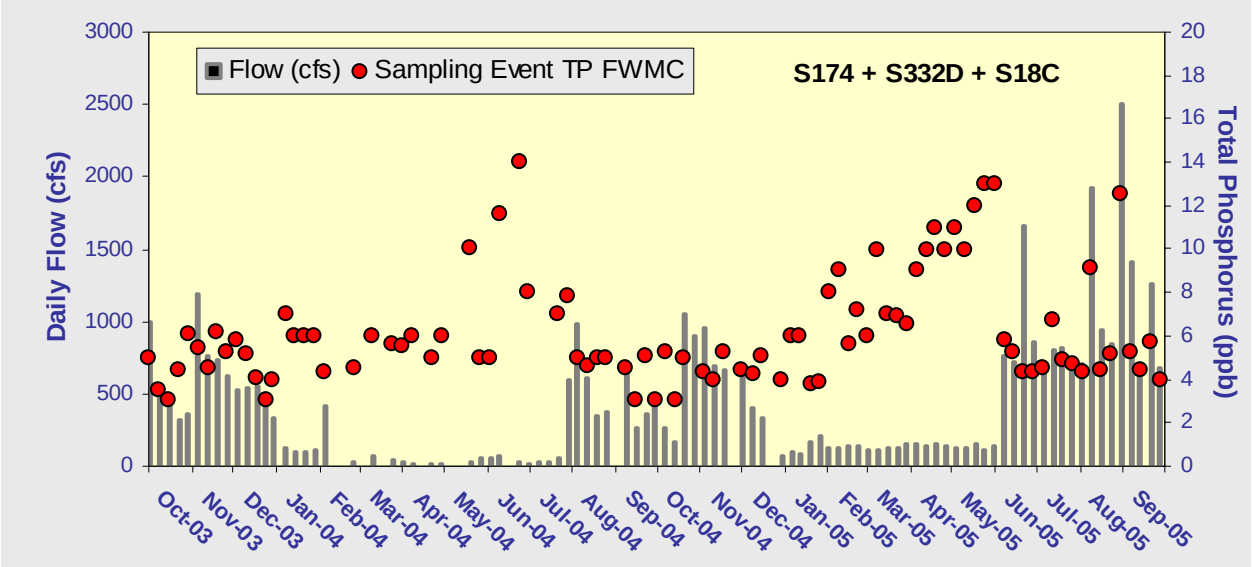

Figure 13. The relationship between daily flows at Taylor Slough structures (S332D + S174) and S18C and the corresponding flow-weighted mean total phosphorus concentrations for individual sampling events.