Settlement Agreement
April – June 2006 Report

Prepared for the
Technical Oversight Committee

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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 total phosphorus (TP) concentration levels for the Arthur R. Marshall Loxahatchee National Wildlife Refuge (Refuge) must be met by February 1, 1999, and December 31, 2006, respectively. Both the interim and long-term 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 in National Geodetic Vertical Datum (NGVD29). The monthly TP 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 April, May and June 2006 were 14.9, 20.1 and 21.0 parts per billion (ppb), respectively. The long-term levels were 12.2, 15.9 and 16.5 ppb, respectively. Because the total depth was less than 0.1 meter (m), no water samples were collected at stations LOX3 and LOX5 on April 4, 2006; LOX3, LOX5, LOX9 and LOX 10 on May 1, 2006; LOX3, LOX4, LOX5, LOX7, LOX9, LOX10 on June 12, 2006; and LOX6, LOX11 and LOX13 on June 13, 2006.

Average stages in the Refuge were 16.05, 15.58 and 15.51 feet (NGVD29) in April, May and June 2006, respectively (**Figure 2** and **Table 1)**. The geometric means, calculated from TP concentrations measured in water samples collected in April, May and June 2006 were 8.4, 8.8 and 9.9 ppb, respectively. The geometric means were less than the interim and long-term levels for April, May and June 2006.

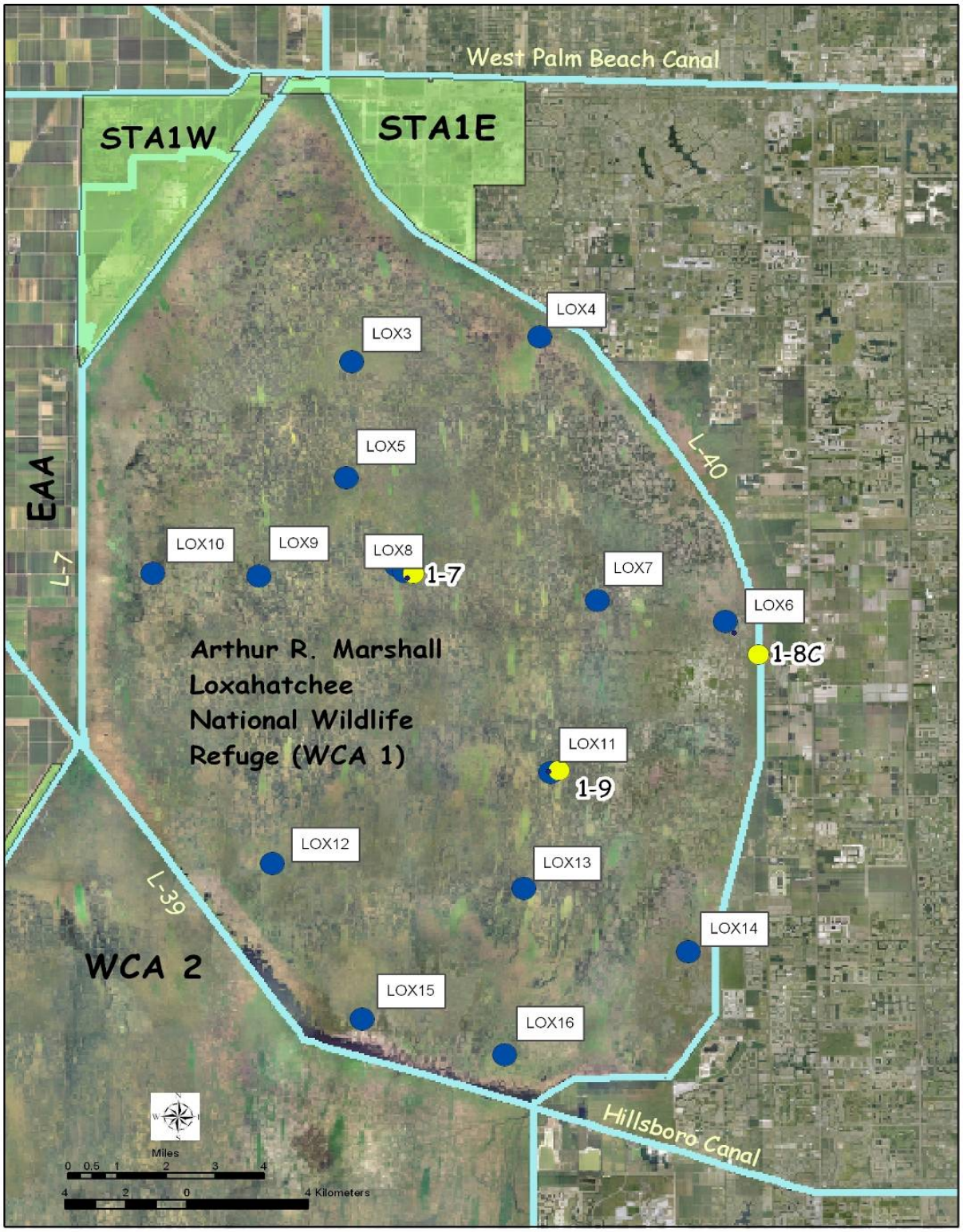

Figure 1. A.R.M. Loxahatchee National Wildlife Refuge Water Quality Sampling and Stage Measurement Sites

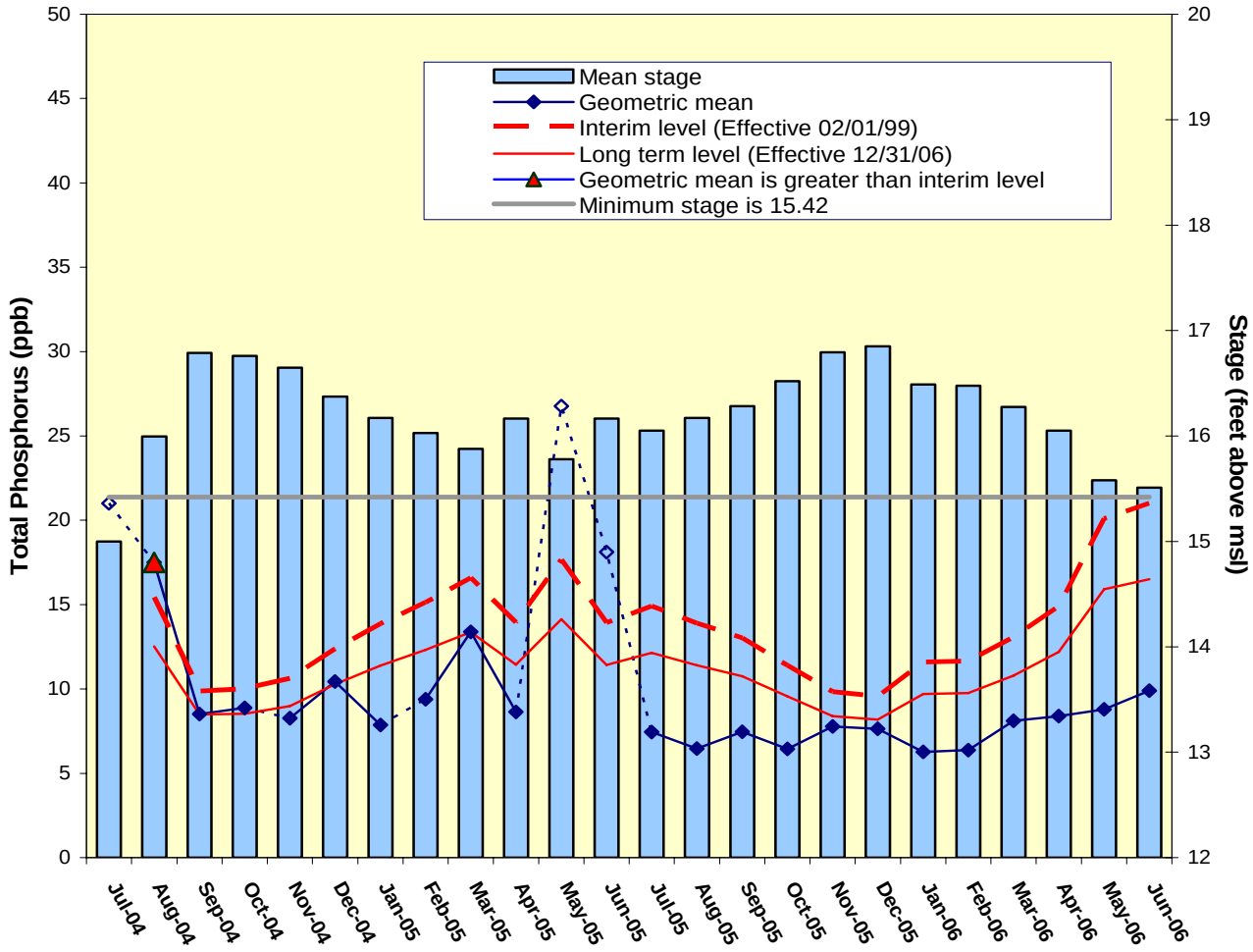

Figure 2. Monthly TP geometric mean concentrations for the Arthur R. Marshall Loxahatchee National Wildlife Refuge compared to the interim and long-term levels. The calculated level concentrations are adjusted for fluctuations in stage.

Interim and Long-term levels are not shown for July 2004 because the level does not apply when the mean stage is less than 15.42 ft.

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 TP 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
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
Jun-2005*	18.1*	13.9	11.4	16.17	14*	3
Jul-2005	7.4	14.9	12.1	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
Oct-2005	6.5	11.4	9.6	16.52	13	3
Nov-2005	7.8	9.8	8.4	16.79	14	3
Dec-2005	7.6	9.6	8.2	16.85	14	3
Jan-2006	6.3	11.6	9.7	16.49	13	3
Feb-2006	6.4	11.7	9.8	16.48	13	3
Mar-2006	8.1	13.1	10.8	16.28	12	3
Apr-2006	8.4	14.9	12.2	16.05	12	3
May-2006	8.8	20.1	15.9	15.58	10	3
Jun-2006	9.9	21.0	16.5	15.51	5	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 (TP) 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. It was specified that the TP concentrations be presented as 12-month flow-weighted means. Only the TP concentrations for the water year ending September 30 are evaluated for compliance with the Consent Decree limits. The long-term TP 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 TP 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 flow-weighted mean TP 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 12-month flow-weighted mean concentrations for each month as well as the corresponding interim and long-term TP concentration limits, calculated using the 12-month period flow. Only the bi-weekly compliance monitoring concentration data were used for the calculations. For the 12-month periods ending in April, May and June 2006, the 12-month flow-weighted mean TP concentration was 9.0, 8.5 and 8.2 ppb. The interim limit was 9.4 ppb and the long-term limit was 7.6 ppb during this period. The April, May and June 2006 12-month flow-weighted mean concentrations were lower than the interim limits.

The Consent Decree stipulates that the percent of flow-weighted mean TP 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 April, May and June 2006, the observed percentage of the sampling event flow-weighted mean TP concentrations greater than 10 ppb were 34.8, 31.8 and 25.0 percent, respectively. The observed percentage of the sampling event flow-weighted mean TP concentrations greater than 10 ppb had been higher than the guidelines from May 2005 to December 2005 but lower since January 2006 (**Table 2**). The individual sampling events flow-weighted mean concentrations and the 12-month flow-weighted mean concentrations are presented in **Figure 5**.

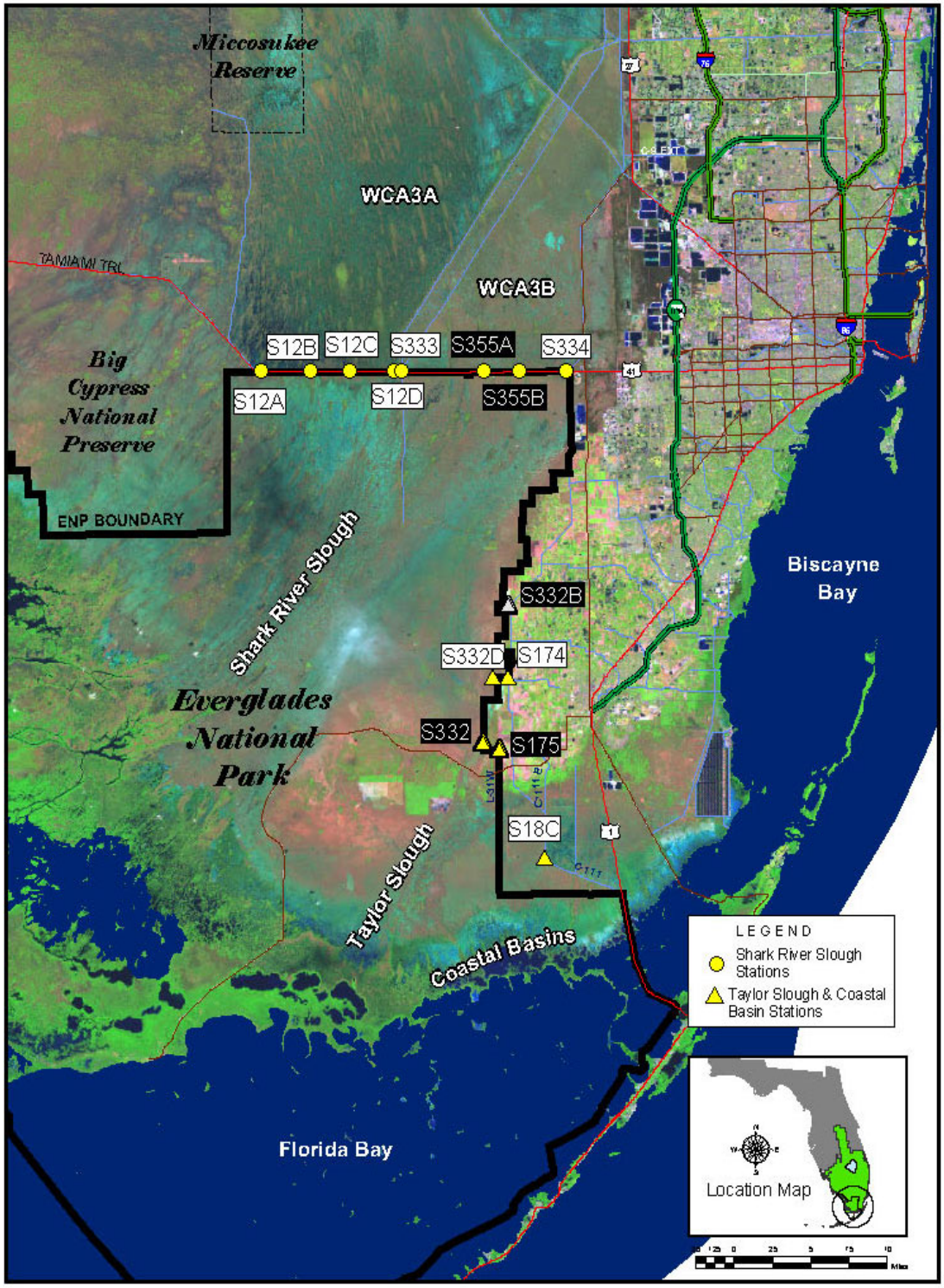

Figure 3. Everglades National Park structures

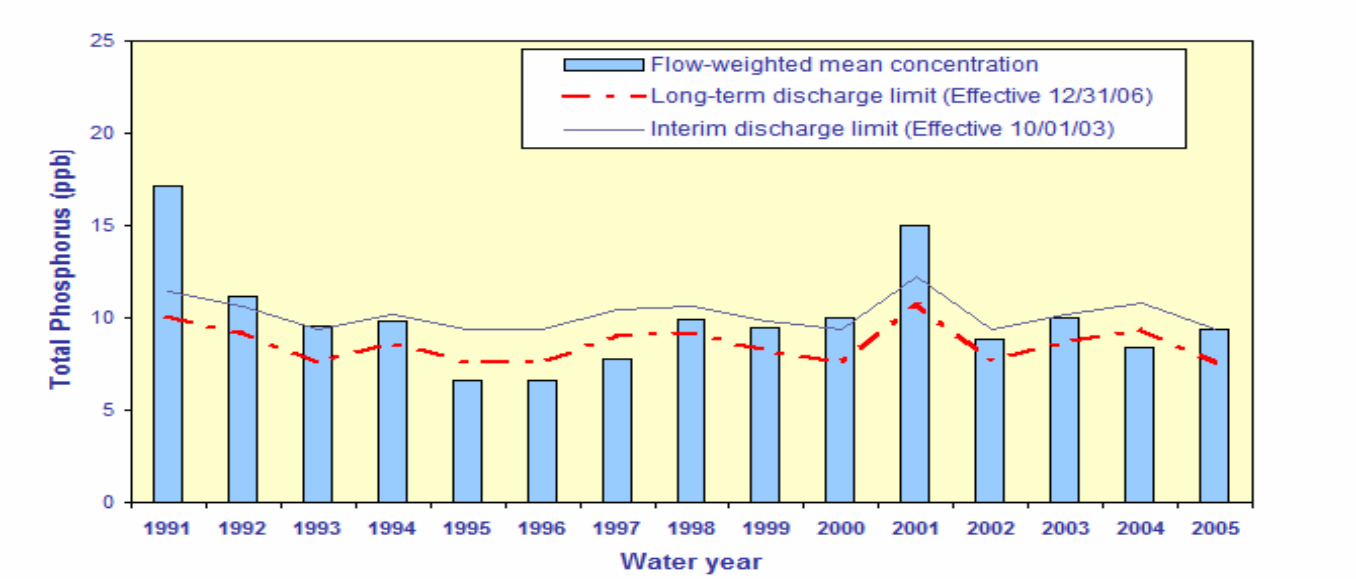

Figure 4. The 12-month flow-weighted mean TP concentrations in inflows to Everglades National Park through Shark River Slough at the end of each water year compared to the TP interim and long-term limits. For the second consecutive compliance year, the 12-month flow-weighted mean concentration was within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

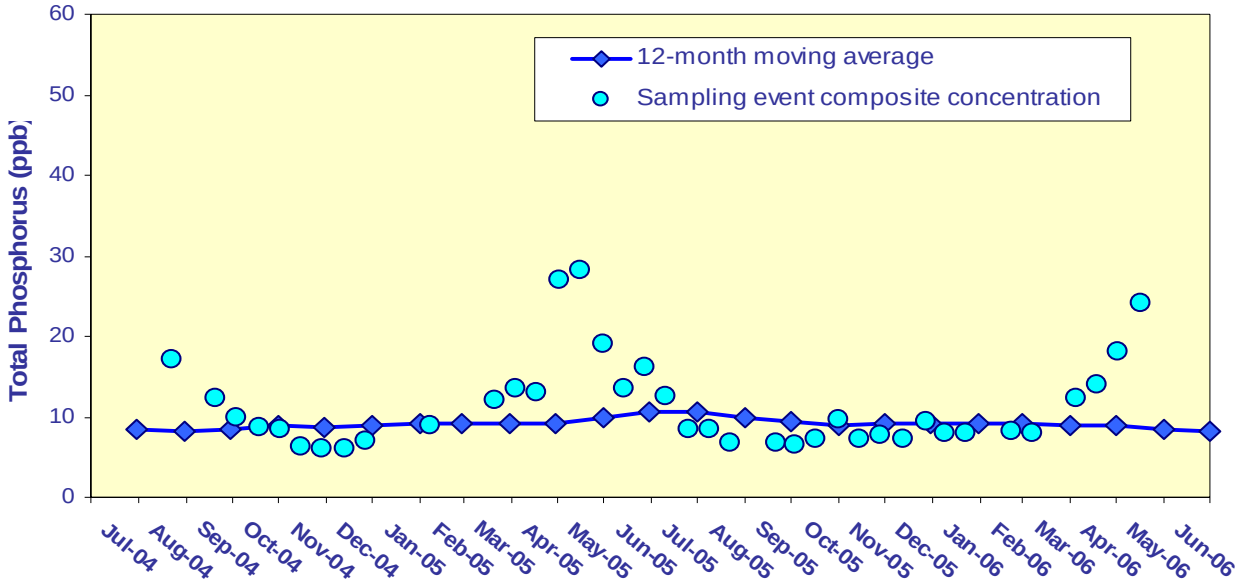

Figure 5. The 12-month flow-weighted mean TP concentrations in inflows to Everglades National Park through Shark River Slough at the end of each month and the flow-weighted mean concentration for each sampling event. There are no sampling event values for July 2004, January 2005, and June 2006 because there was no flow in those periods.

Table 2. Shark River Slough TP 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-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***
31-Oct-05	1338.1	9.0	9.4	7.6	40.1	***40.9***
30-Nov-05	1381.7	9.1	9.4	7.6	40.1	***42.9***
31-Dec-05	1447.6	9.1	9.4	7.6	40.1	***42.9***
31-Jan-06	1507.7	9.0	9.4	7.6	40.1	39.1
28-Feb-06	1497.6*	9.0	9.4	7.6	40.1	39.1
31-Mar-06	1481.0*	9.0	9.4	7.6	40.1	34.8
30-Apr-06	1436.1*	9.0	9.4	7.6	40.1	34.8
31-May-06	1395.5*	8.5	9.4	7.6	40.1	31.8
30-Jun-06	1326.6*	8.2	9.4	7.6	40.1	25.0

Notes: 1)Highlighted rows indicate the end of the water year (October 1 to September 30), which are the compliance points.

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.

** Flow of 1.82 kac-ft in February 2006 at S355A and S355B was included for the 12-month total flows for February – June 2006.*

There was very little inflow to Shark River Slough during this reporting period (total 11.73 kac-ft). Almost all of the flow was through S333 and much of this was discharged through S334.

The daily flows through the individual Shark River Slough structures from July 2004 through June 2006 are presented in **Figure 6**. The S12s are operated to meet target discharges per the Shark River Slough Rainfall Plan which has been in effect since July 1985. All S12s had been utilized from June 22, 2005, through November 15, 2005. S12A has been closed since November 16, 2005; S12B has been closed since December 30, 2005; S12C has been closed since January 19, 2006; S12D has been closed since April 6, 2006 - in accordance with the Interim Operational Plan (IOP) for protection of the Cape Sable Seaside Sparrow.

S334 had been closed most of the time since January 18, 2006. However, a large portion (61 percent) of the flow in the L29 Canal that entered through S333 was released from the system through S334 and, therefore, only 39 percent of the flow through S333 entered Shark River Slough during this reporting period (**Figure 7**).

For additional information on the S12s and S333 structures, please visit:

http://www.sfwmd.gov/org/ema/reports/sharkriver/index.html.

A flow test of S355A (western structure) and S355B (eastern structure), which are located between S333 and S334 (**Figure 3**), was performed from February 2-20, 2006. The estimated daily mean flows were 32 cubic feet per second (cfs) at S355A and 19 cfs at S355B for a total of 1.82 kac-ft for the test period. The flow-weighted mean TP concentration taken on February 16, 2006 was 9 ppb. The flows through S355A and S355B were included in **Table 2**. The 12-month flow-weighted mean concentration was re-calculated to include these TP loads and flow.

The relationship between the sum of the daily flows at Shark River Slough structures and corresponding flow-weighted mean TP concentrations for individual sampling events is presented in **Figure 8.** Values had been following the strong inverse relationship between flow and TP concentration for waters entering the ENP through Shark River Slough. The bi-weekly sampling event flow-weighted mean TP concentrations were elevated (12-24 ppb) reflecting the low flow during this reporting period.

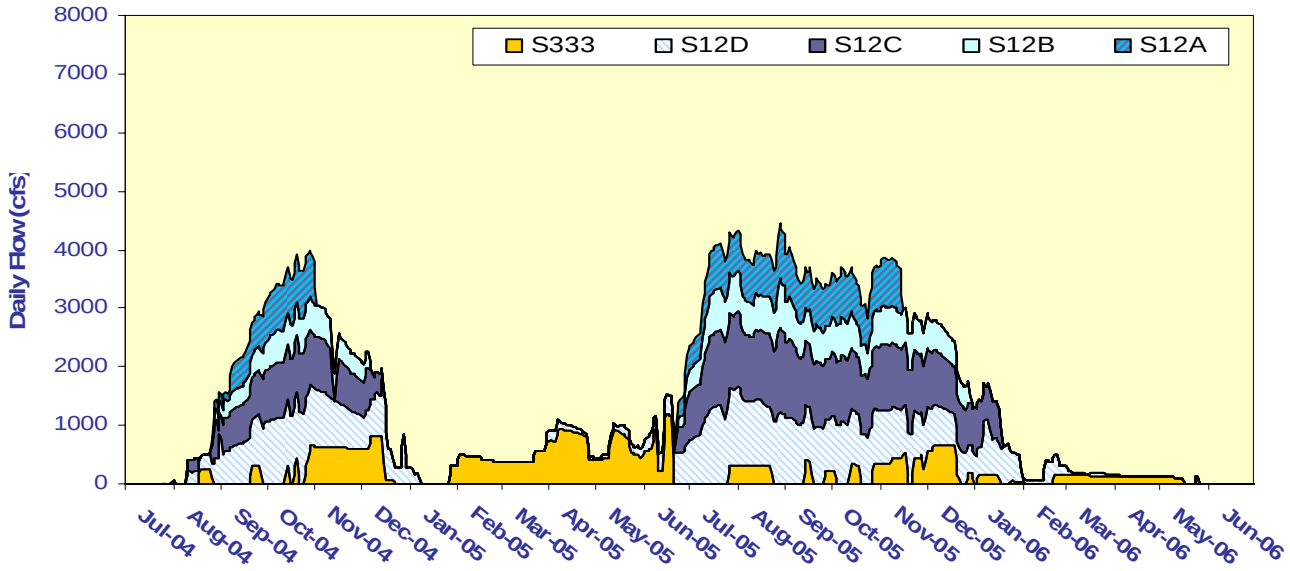

Figure 6. Daily flows into Shark River Slough by structure.

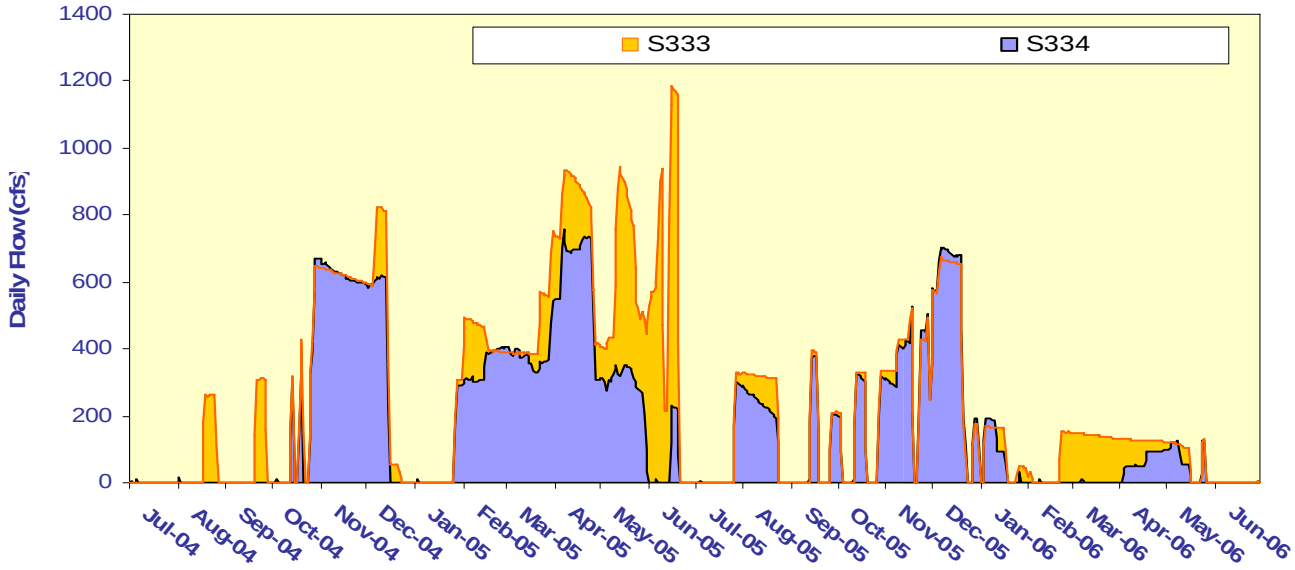

Figure 7. Daily flows comparison between S333 and S334

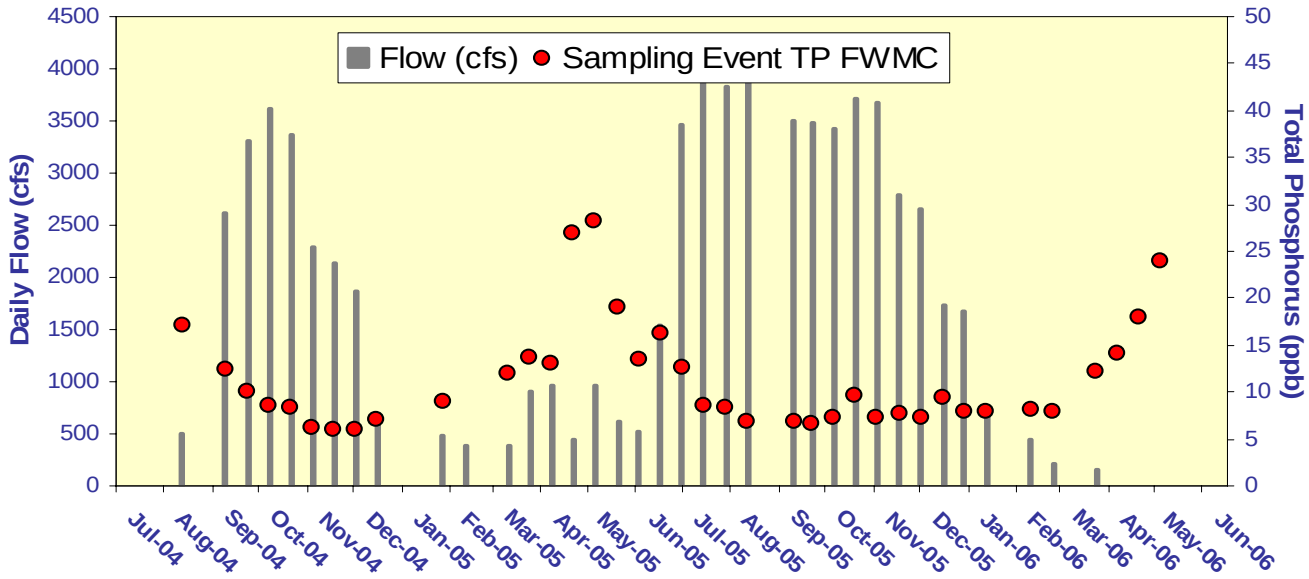

Figure 8. The relationship between daily flow at Shark River Slough structures and the corresponding flow-weighted mean TP concentrations for individual sampling events.

Taylor Slough and the Coastal Basins

Under the Consent Decree, a single total phosphorus (TP) 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 TP 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, Cell 1 through Cell 5, a connector cell between Cell 2 and Cell 3, a flow way cell originating at Berm 3 of Cell 5, and four diversion structures, DS1 through DS4 (**Figure 9**). 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. The diversion structures DS1 through DS4, previously referred to as EO1 through EO4, would discharge into the ENP if utilized. Overflows have periodically occurred at DS2. Data from these overflows were presented graphically in previous reports. There was no overflow during this reporting period. Discharges from the diversion

structures DS1 and DS3 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.

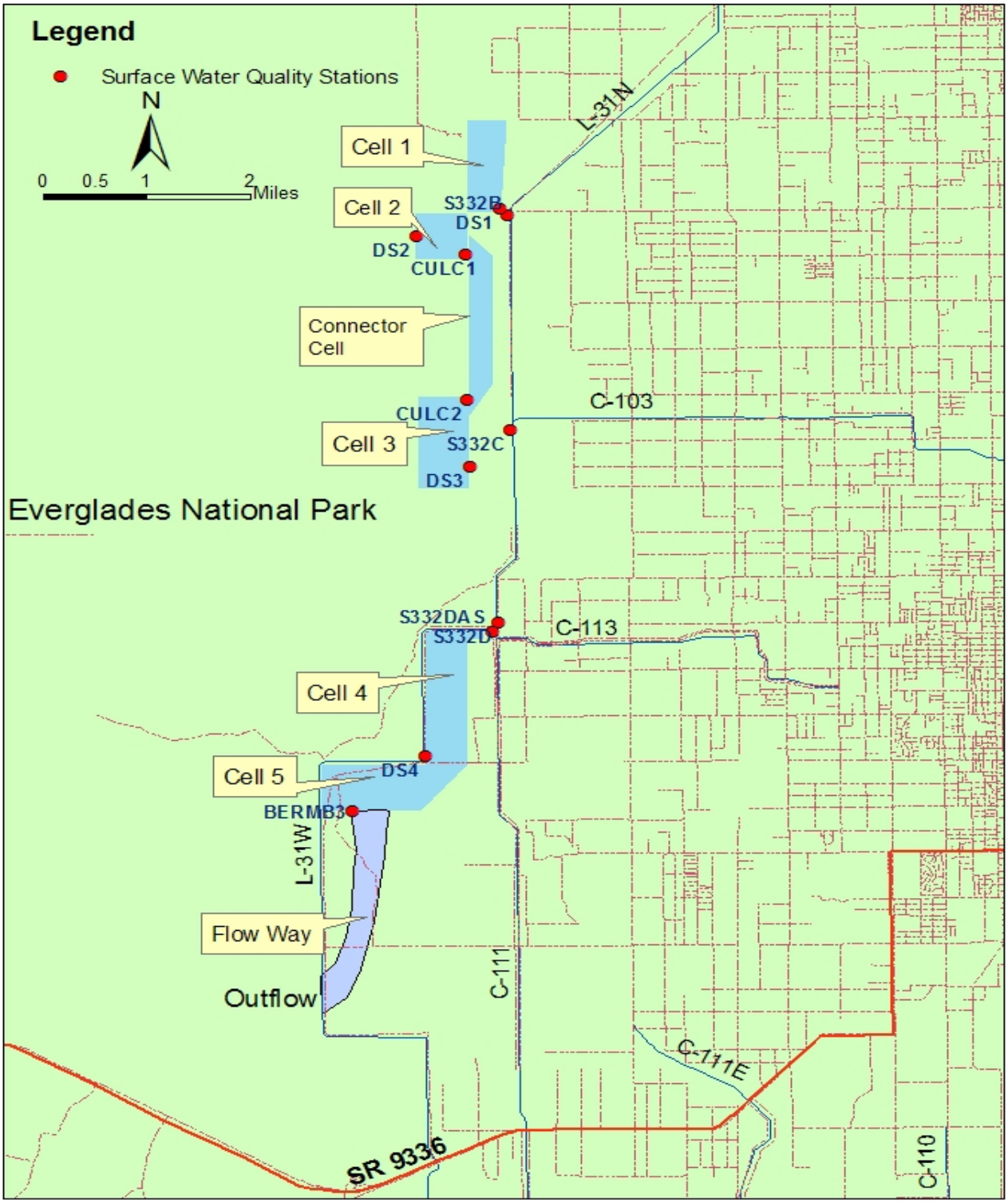

Figure 9. C-111 Project facilities.

Compliance with Consent Decree

Inflow concentrations of TP 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 12-month flow-weighted mean TP 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.

TP 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 TP 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 S332 to 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 10** .

Figure 11 presents the 12-month and individual sampling date flow-weighted mean TP concentrations at the S174, S332D and S18C structures. All TP grab sample concentrations taken on positive flow days reported for surface water monitoring at the 3 sites were used for the compliance calculations.

The 12-month flow-weighted mean concentrations for April, May, and June 2006 were 6.5, 6.4, and 6.7 ppb, respectively, for the combined flow through S174, S332D and S18C (**Table 3**). The Consent Decree stipulates that the percent of flow-weighted mean TP 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 percentages of the sampling event flow-weighted mean TP concentrations greater than 10 ppb for the combined flow through S174, S332D and S18C were 10,4, 4.6, and 4.9 percent, respectively, for the periods ending April, May, and June 2006.

The daily flows into the 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 TP concentrations for each sampling event. From 1984 to 1990, there was no observable relationship between daily mean flow and flow-weighted mean TP concentrations at S332 and S18C structures. Some higher concentrations were observed during low flow periods during 2004 and 2005 at S332D, S174 and S18C. However, flow-weighted mean TP concentrations for all sampling dates have been less than or equal to 9 ppb since September 2005 except for May 17, 2006, sampling at S332D (13 ppb).

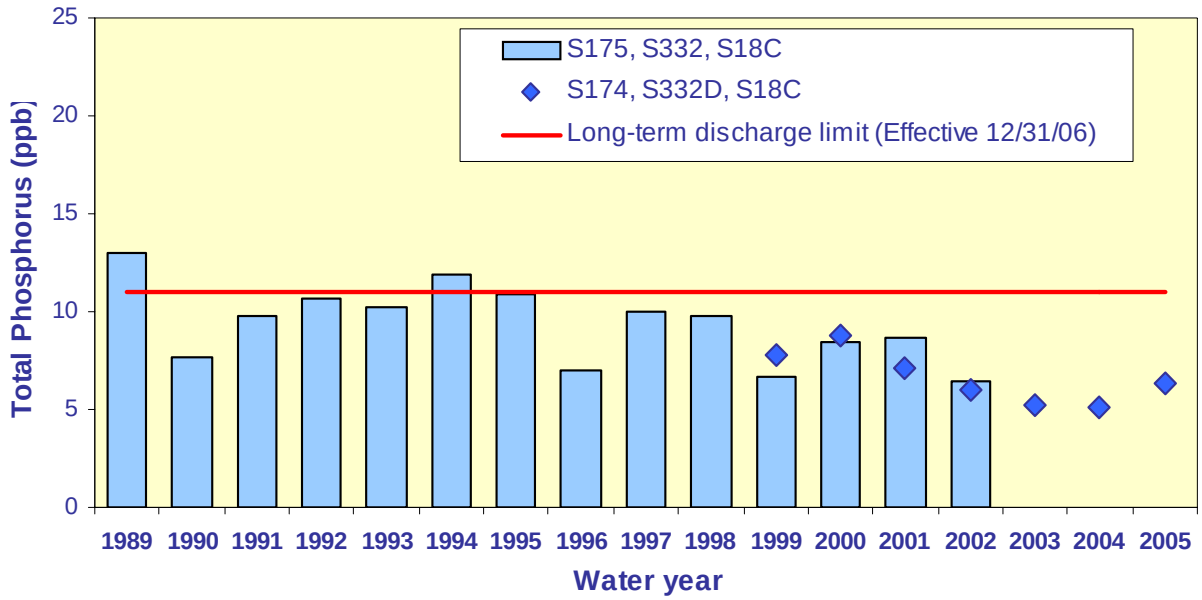

Figure 10. The 12-month flow-weighted mean TP concentrations in inflows to Everglades National Park through Taylor Slough and the Coastal Basins at the end of each water year compared to the 11 ppb long-term TP limit.

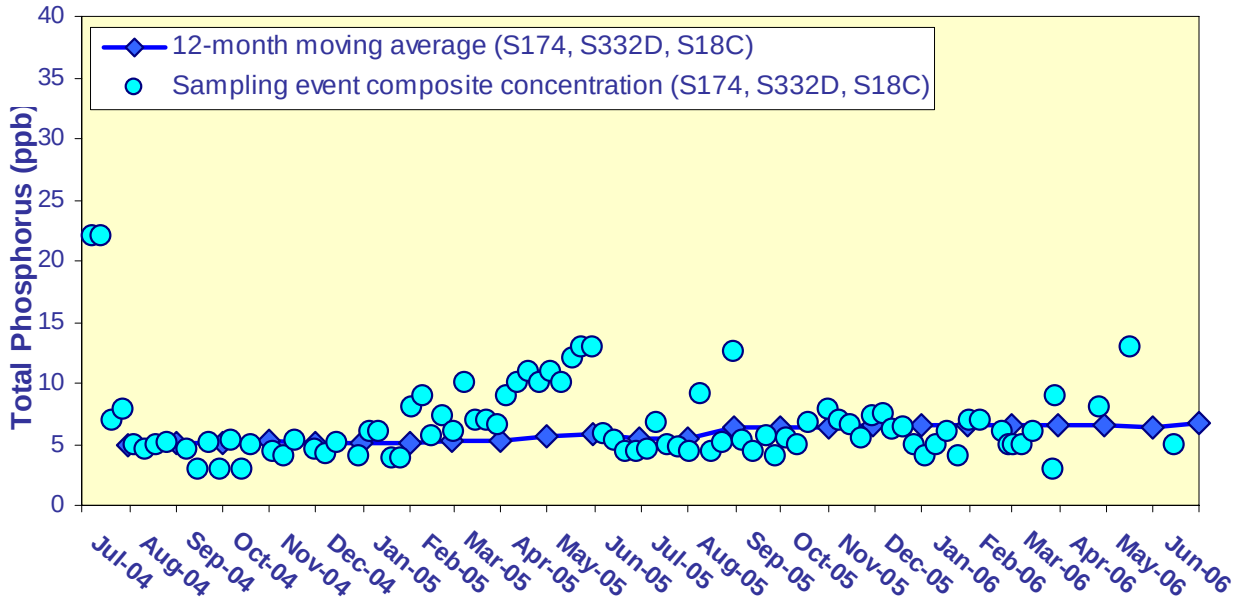

Figure 11. 12-month flow-weighted mean TP concentrations in inflows to Everglades National Park through Taylor Slough and the Coastal Basins at the end of each month and the flow-weighted mean TP concentration for each sampling event.

Table 3. Taylor Slough and the Coastal Basins TP 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-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
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
31-Oct-05	373.4	6.3	11.0	53.1	12.2
30-Nov-05	358.6	6.6	11.0	53.1	12.0
31-Dec-05	366.9	6.6	11.0	53.1	11.8
31-Jan-06	369.5	6.6	11.0	53.1	11.8
28-Feb-06	364.6	6.6	11.0	53.1	11.8
31-Mar-06	359.7	6.6	11.0	53.1	11.8
30-Apr-06	351.5	6.5	11.0	53.1	10.4
31-May-06	343.7	6.4	11.0	53.1	4.6
30-Jun-06	295.5	6.7	11.0	53.1	4.9

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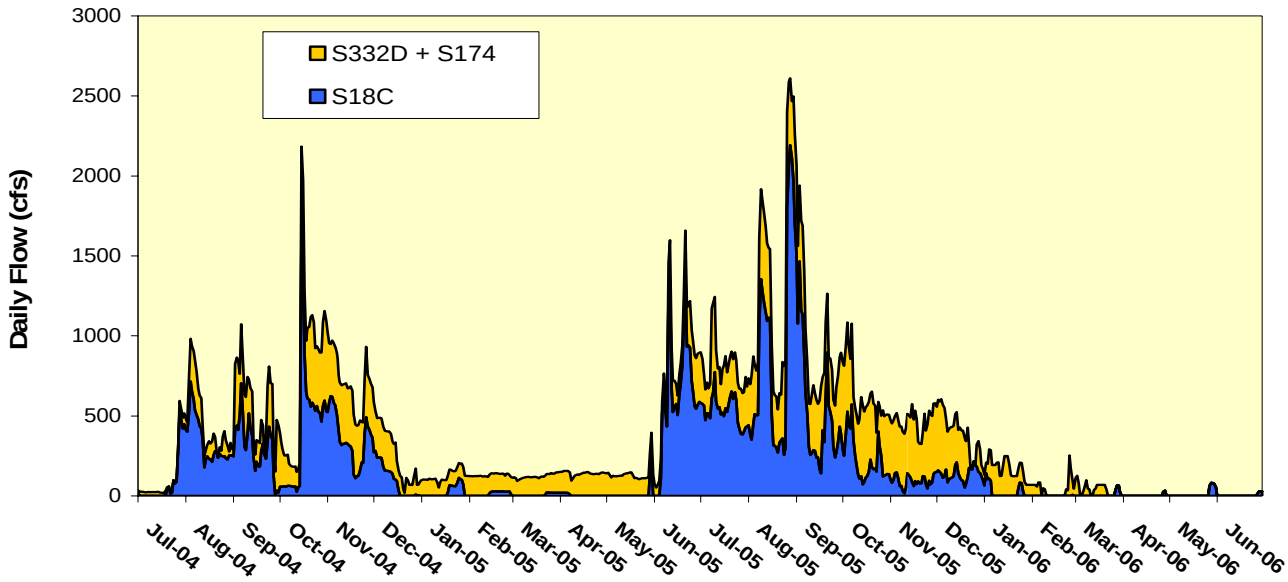

Figure 12. Daily flows into Everglades National Park through Taylor Slough (S332D+S174) and S18C.

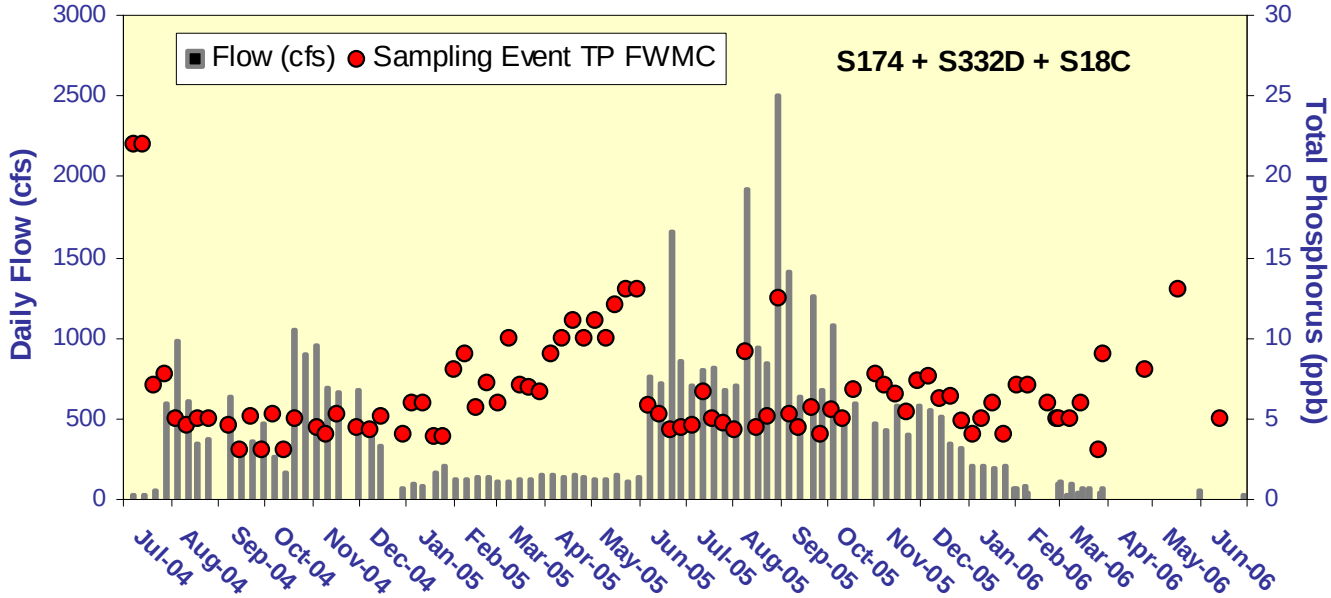

Figure 13. The relationship between daily flows at Taylor Slough structures (S332D + S174) and S18C and the corresponding flow-weighted mean TP concentrations for individual sampling events.