Settlement Agreement
July-September 2002 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 phosphorus concentration levels for the Arthur R. Marshall Loxahatchee National Wildlife Refuge (Refuge) must be met by Feb. 1, 1999, and Dec. 31, 2006, respectively. The concentration levels vary monthly because they are calculated as a function of water stage measured at gaging 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 (mean sea level). The monthly total phosphorus concentrations are determined from water samples collected at 14 interior marsh stations, LOX 3 through LOX 16 (**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.

Average stages in the Refuge were 16.82, 16.22 and 16.66 feet in July, August and September 2002, respectively (**Figure 2, Table 1)**. The geometric means, calculated from total phosphorus concentrations measured in water samples collected in July, August and September were 11.2, 9.0 and 8.2 ppb, respectively (**Table 1**). The July geomean total phosphorus concentration was greater than the interim and long-term levels of 9.7 and 8.3 ppb, respectively. The August and September geomean total phosphorus concentrations were less than the respective interim and long-term levels.

Water samples were collected on July 15 and 16 when the Refuge's average stage was 16.82 feet. This was two days after the highest daily average stage of the quarter was recorded at 16.85 feet. Prior to this peak stage, the Refuge stage had been increasing steadily from a daily average of 15.94 feet during the sampling event on June 17 and 18 due to rainfall and discharges into the Refuge. Although the July total phosphorus geomean of 11.2 ppb was less than the 13.4 ppb geomean in June, the calculated interim and long-term levels in July decreased as a function of the rising stage to the point that both limits were exceeded. This phenomenon has occurred previously under rapidly increasing stage conditions (**Figure 2** and as reported in prior Settlement Agreement Reports for October-December 2001, 2000 and 1999).

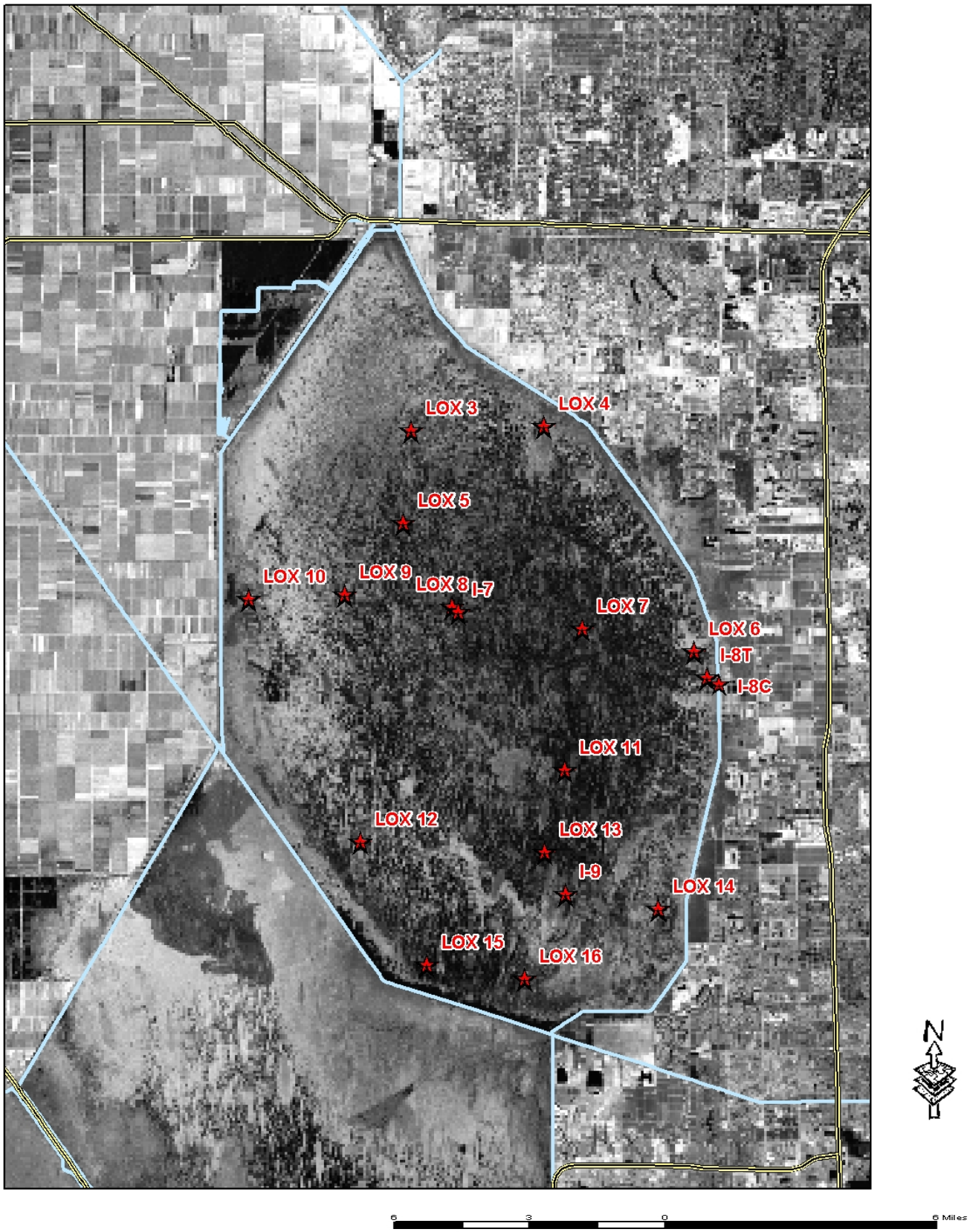

Figure 1. A.R.M. Loxahatchee Refuge Water Quality Sampling and Stage Measurement Sites

★ Station Location

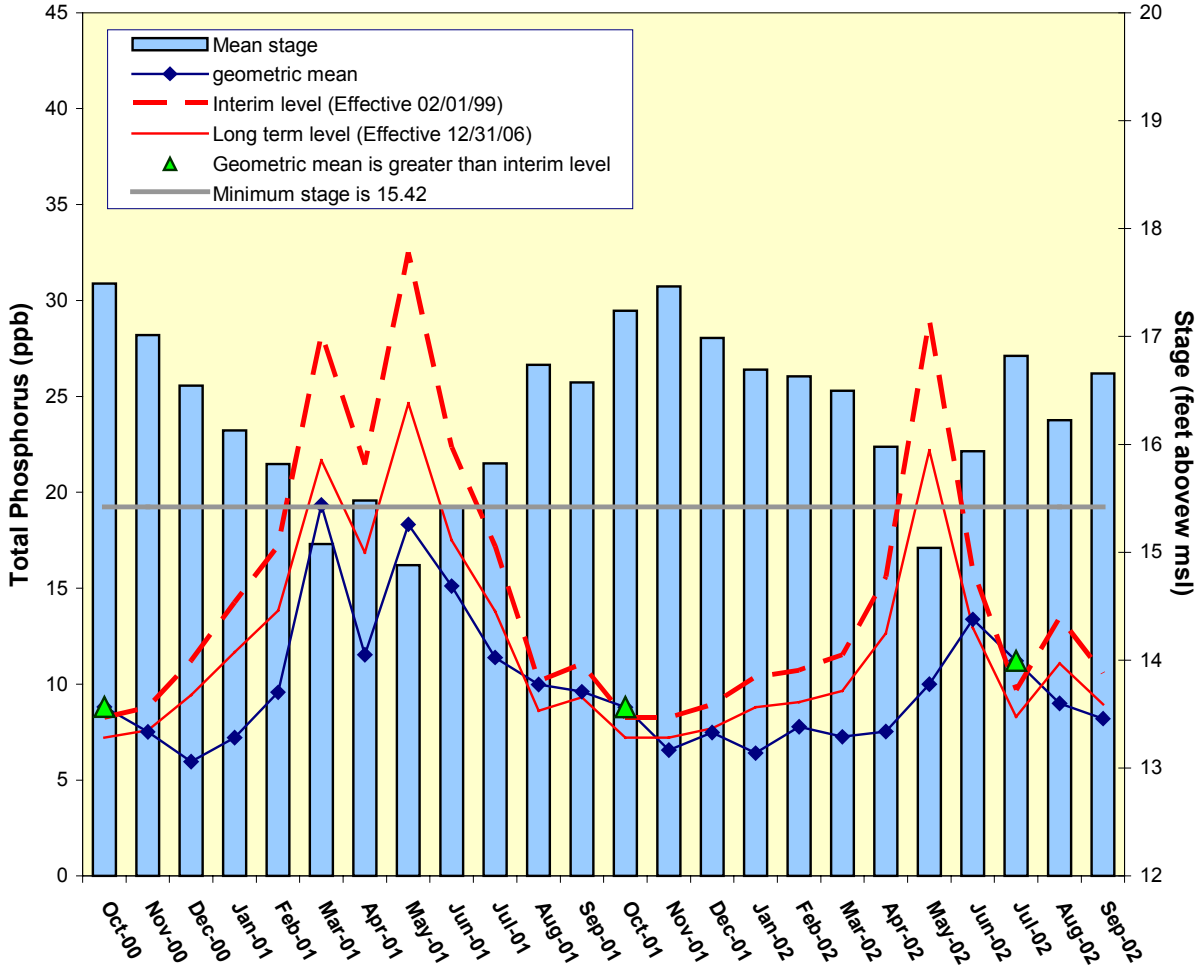

Figure 2. Monthly total phosphorus geometric mean concentrations for the A.R.M. Loxahatchee National Wildlife Refuge compared to the interim and long-term levels. The calculated total phosphorus levels are adjusted for fluctuations in stage.

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-2000	8.8	8.3	7.2	17.49	13	3
Nov-2000	7.5	8.8	7.6	17.01	14	3
Dec-2000	6.0	11.2	9.4	16.55	9	3
Jan-2001	7.2	14.3	11.7	16.13	8	3
Feb-2001	9.6	17.2	13.8	15.82	9	3
Mar-2001	19.3	0.0	0.0	15.08	2	3
Apr-2001	11.5	21.4	16.9	15.48	6	3
May-2001	18.3	0.0	0.0	14.88	2	3
Jun-2001	15.1	0.0	0.0	15.42	9	3
Jul-2001	11.4	17.2	13.8	15.82	11	3
Aug-2001	10.0	10.1	8.6	16.74	14	3
Sep-2001	9.6	11.1	9.3	16.57	14	3
Oct-2001	8.8	8.3	7.2	17.24	14	3
Nov-2001	6.6	8.3	7.2	17.46	14	3
Dec-2001	7.5	8.9	7.7	16.99	14	3
Jan-2002	6.4	10.4	8.8	16.69	14	3
Feb-2002	7.8	10.7	9.1	16.63	14	3
Mar-2002	7.3	11.5	9.7	16.50	14	3
Apr-2002	7.5	15.6	12.7	15.98	11	3
May-2002	10.0	0.0	0.0	15.04	3	3
Jun-2002	13.4	16.0	12.9	15.94	10	3
Jul-2002	11.2	9.7	8.3	16.82	14	3
Aug-2002	9.0	13.5	11.1	16.22	12	3
Sep-2002	8.2	10.6	8.9	16.66	12	3

Notes:
(1) Average Stage is calculated using stage elevations at three stations on the sampling date.
(2) Highlighted values indicate months when exceedances occurred. (The geomean concentration must be greater than the interim level two or more times within a 12-month period to constitute an exeedance.)
(3) Levels do not apply when the stage is less than 15.42 feet.

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) through Shark River Slough be met by October 1, 2003, and December 31, 2006, respectively. The limits apply to the water year ending September 30. 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. In addition, it is required that phosphorus concentrations be presented as 12-month moving flow-weighted means.

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 from 1991 to 2002 (**Figure 3a**). The 12-month moving flow-weighted mean total phosphorus concentration ending September 2002 was 8.8 ppb. Corresponding interim and long-term limits were 9.6 and 7.9 ppb, respectively. This was the first year since 1999 that the interim limit was not exceeded for the water year ending on September 30. This return to lower concentrations observed in the mid-1990s corresponds with increasing flow into Shark River Slough. Both the interim and long-term limits have not been met in the same year since 1997.

Table 2 presents the moving flow-weighted mean concentrations for each 12-month period beginning in October 2000, 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 2002, the flow-weighted mean total phosphorus concentrations were 10.9, 9.1 and 8.8 ppb, respectively.

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 should not exceed a calculated 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 2002, the percent of flow-weighted mean total phosphorus concentrations greater than 10 ppb were 45.8, 39.1 and 30.4, respectively. The July observed percentage was greater than the guideline, but the August and September percentages were lower than their respective guidelines (**Table 2**). The individual sampling events and the 12-month moving averages are presented in **Figure 3b**.

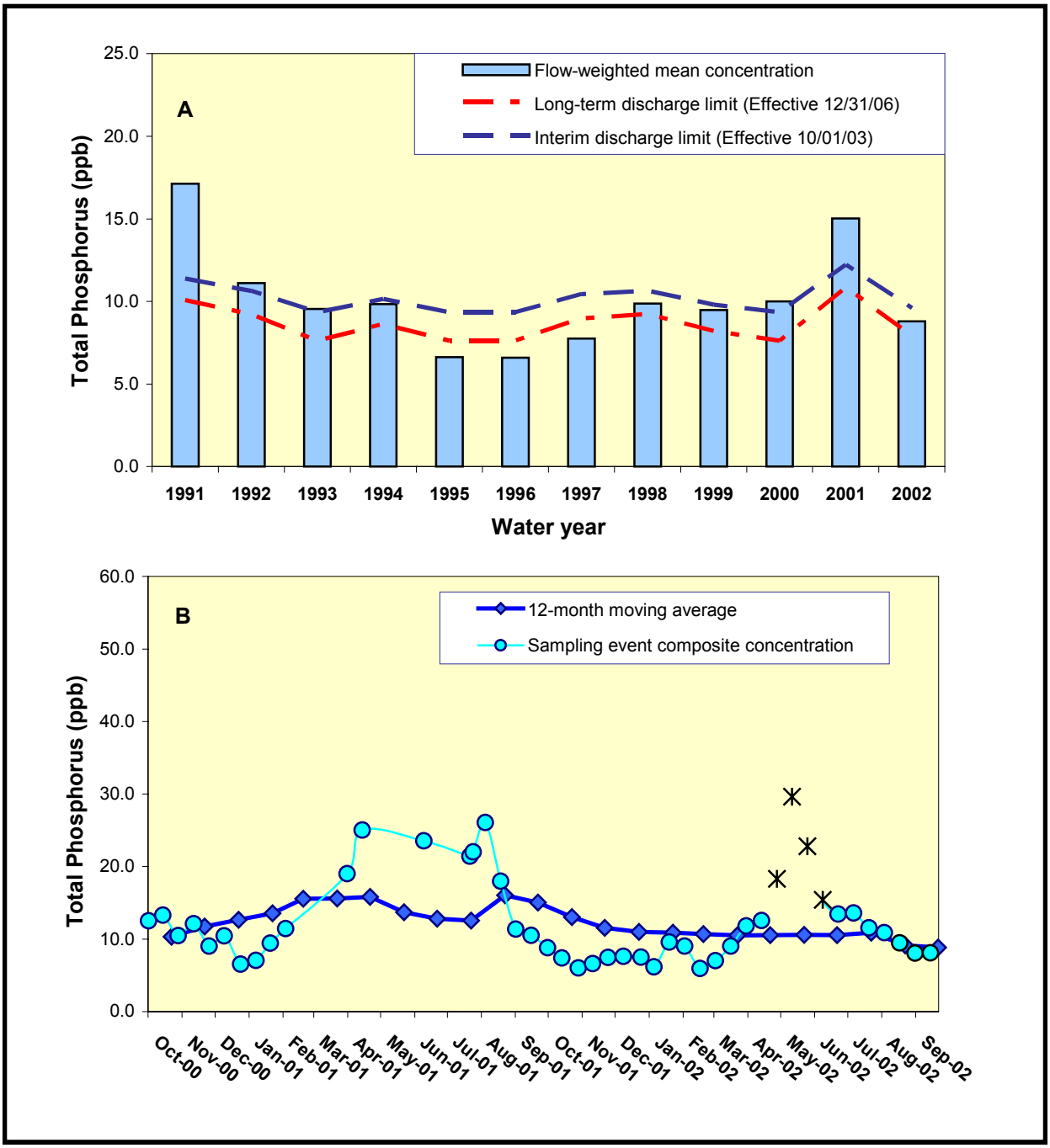

Figure 3. Total phosphorus flow-weighted mean concentrations (fwmc) in inflows to Everglades National Park through Shark River Slough.
A. The 12-month moving average fwmc at the end of each water year compared to the total phosphorus interim and long-term limits.
B. The 12-month moving average fwmc at the end of each month and the composite total phosphorus concentration for each sampling event. *(star): denotes arithmetic average for biweekly samples in May and June 2002 as there was no flow on the sampling dates.

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

12-Month Period Ending On	Total Period Flow	Flow Weighted Mean Total Phosphorus	Interim Limit (ppb)	Long Term Limit (ppb)	Percent of Sampling Events Greater than 10 ppb	
			Effective	Effective	(%)	
	(Kac-ft)	(ppb)	10/1/2003	12/31/2006	Guideline	Observed
31-Oct-00	925.0	10.3	9.9	8.3	43.2	*72.4*
30-Nov-00	642.1	11.7	11.1	9.8	50.8	*79.3*
31-Dec-00	464.0	12.7	12.0	10.8	56.4	*82.8*
31-Jan-01	367.0	13.5	12.5	11.3	59.8	*80.0*
28-Feb-01	298.4	15.5	12.9	11.7	62.2	*85.7*
31-Mar-01	275.9	15.6	13.0	11.9	63.1	*84.6*
30-Apr-01	250.4	15.8	13.2	12.0	64.0	*84.6*
31-May-01	230.9	13.7	13.3	12.1	64.7	*81.8*
30-Jun-01	221.0	12.8	13.3	12.2	65.1	*80.0*
31-Jul-01	212.8	12.5	13.4	12.2	65.4	*78.9*
31-Aug-01	324.0	16.0	12.8	11.6	61.3	*78.9*
30-Sep-01	419.7	15.0	12.2	11.0	57.9	*78.9*
31-Oct-01	502.4	13.0	11.8	10.5	55.2	*68.4*
30-Nov-01	599.2	11.5	11.3	10.0	52.1	*57.9*
31-Dec-01	677.9	11.0	10.9	9.6	49.8	*52.6*
31-Jan-02	695.1	10.9	10.8	9.5	49.3	*52.6*
28-Feb-02	728.3	10.7	10.7	9.3	48.3	45.0
31-Mar-02	779.2	10.5	10.5	9.0	46.9	40.9
30-Apr-02	797.1	10.5	10.4	8.9	46.4	40.9
31-May-02	800.7	10.6	10.4	8.9	46.3	43.5
30-Jun-02	806.8	10.5	10.4	8.9	46.2	40.9
31-Jul-02	925.7	10.9	9.9	8.3	43.2	*45.8*
31-Aug-02	956.7	9.1	9.7	8.1	42.5	39.1
30-Sep-02	996.3	8.8	9.6	7.9	41.6	30.4

Notes: Italicized values exceeded allowed percentage

The daily flows through the individual Shark River Slough structures and S334 from October 2000 through September 2002 are presented in **Figure 4a**. A sharp increase in flow through all structures began in late June 2002. Total daily flows exceeded 2000 cfs from early July through September.

The relationship between the sum of the daily flows at Shark River Slough structures and the corresponding flow-weighted mean total phosphorus concentration for individual sampling events is presented in **Figure 4b.** Higher flows correlate well with lower levels of total phosphorus.

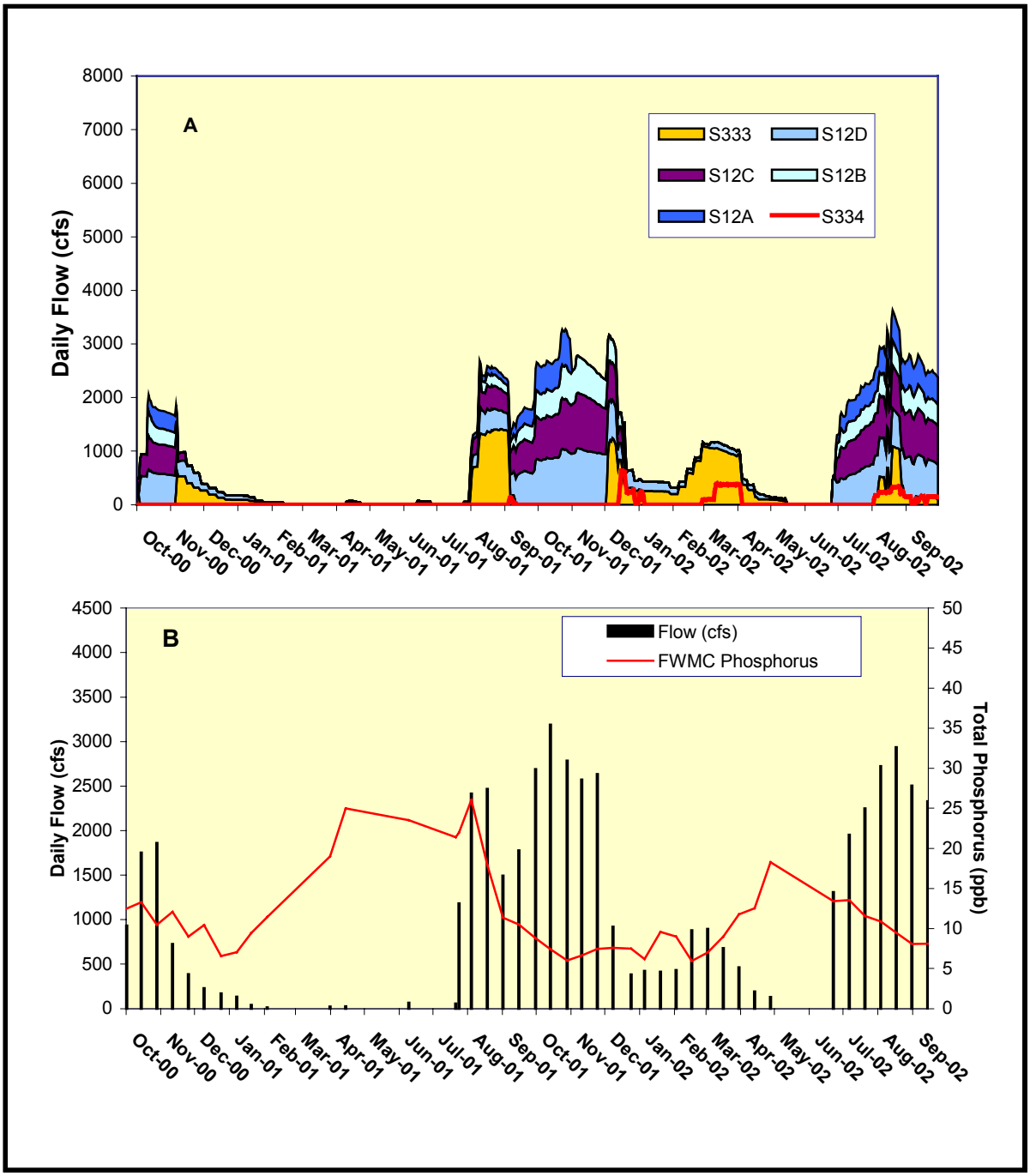

Figure 4. **A**. Daily flows into Shark River Slough by structure. **B**. The relationship between daily flow at Shark River Slough structures and the corresponding flow-weighted mean total phosphorus concentrations for individual sampling events.

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. 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. However, the Settlement Agreement's Technical Oversight Committee requested that data from both the old and new pairs of inflow structures to Taylor Slough be presented for one year. This request was made to determine if the differences between the two data sets observed from August 1999 through March 2000 would continue throughout a complete wet season/dry season cycle and what implications this might have on future compliance with the 11 ppb limit.

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 data for S332D/S174/S18C was consistently greater than flow at S332/S175/S18C. There was also a shift in flow-weighted mean total phosphorus concentration data whereby S332D/S174/S18C concentrations became equal to and then consistently lower than the concentrations at S332/S175/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/S18C data are presented, with the exception of data in **Figure 5a**.

C-111 Project Structures and Detention Areas

The USACE completed construction of the remaining C-111 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 5**). The Flow Way Cell is the only routine surface water discharge location to 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. On July 31, 2002, the Florida Department of Environmental Protection (FDEP) issued Emergency Order #7 to allow the USACE to operate the new and existing facilities in accordance with the IOP.

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. As local sponsor, the District will eventually operate and maintain the project facilities. The USACE has implemented a monitoring plan that was 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 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. Discharges from Emergency Overflows EO1 and EO3 would discharge onto District property and eventually flow 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 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.

Compliance with Consent Decree

Inflow concentrations of total phosphorus to the Everglades National Park 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 6a**). The bars in **Figure 6a** 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 2002 represent the new combination of structures. **Figure 6b** presents the 12-month moving average and individual sampling event flow-weighted mean total phosphorus concentrations at the S174, S332D and S18C structures.

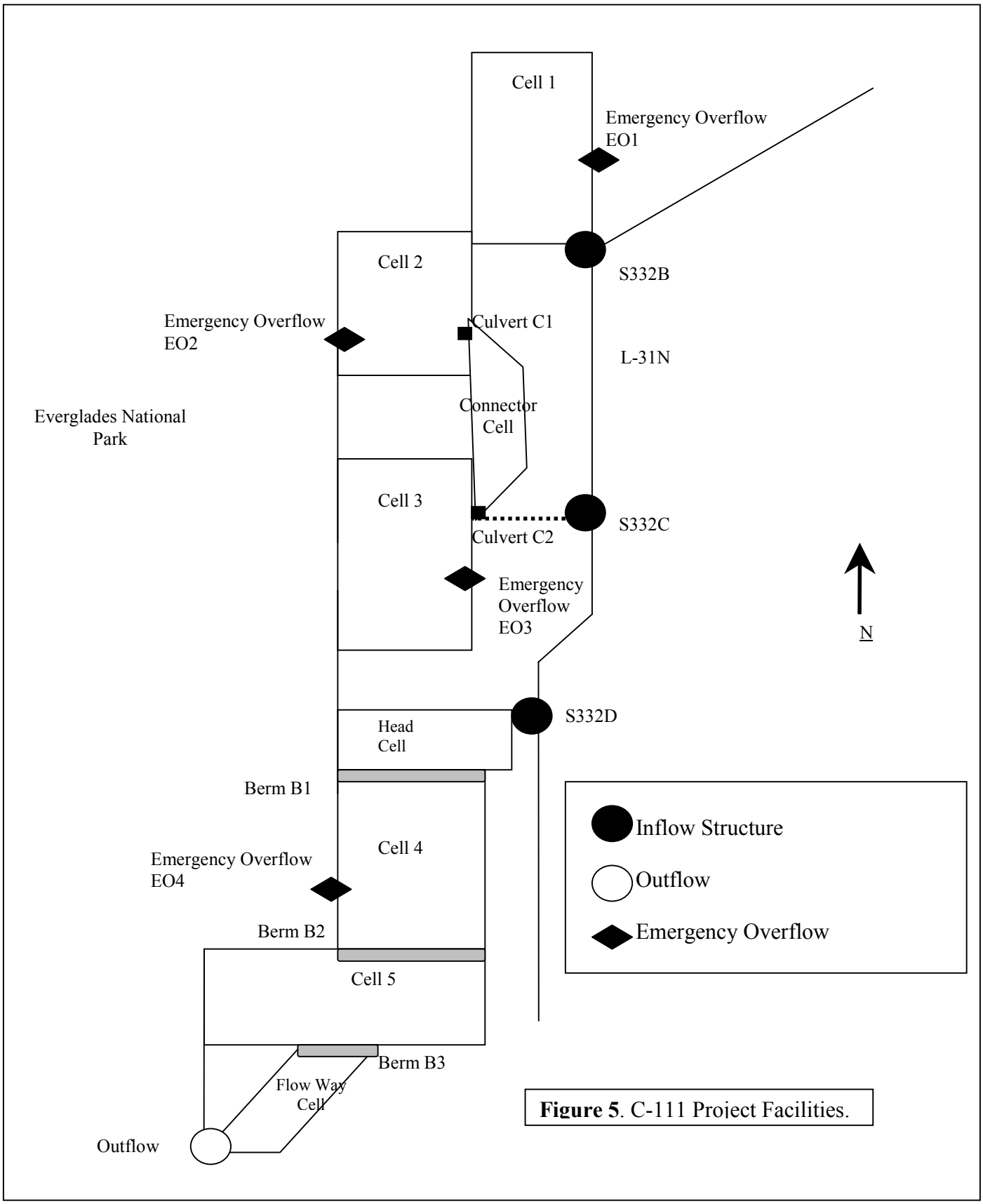

Figure 5. C-111 Project Facilities.

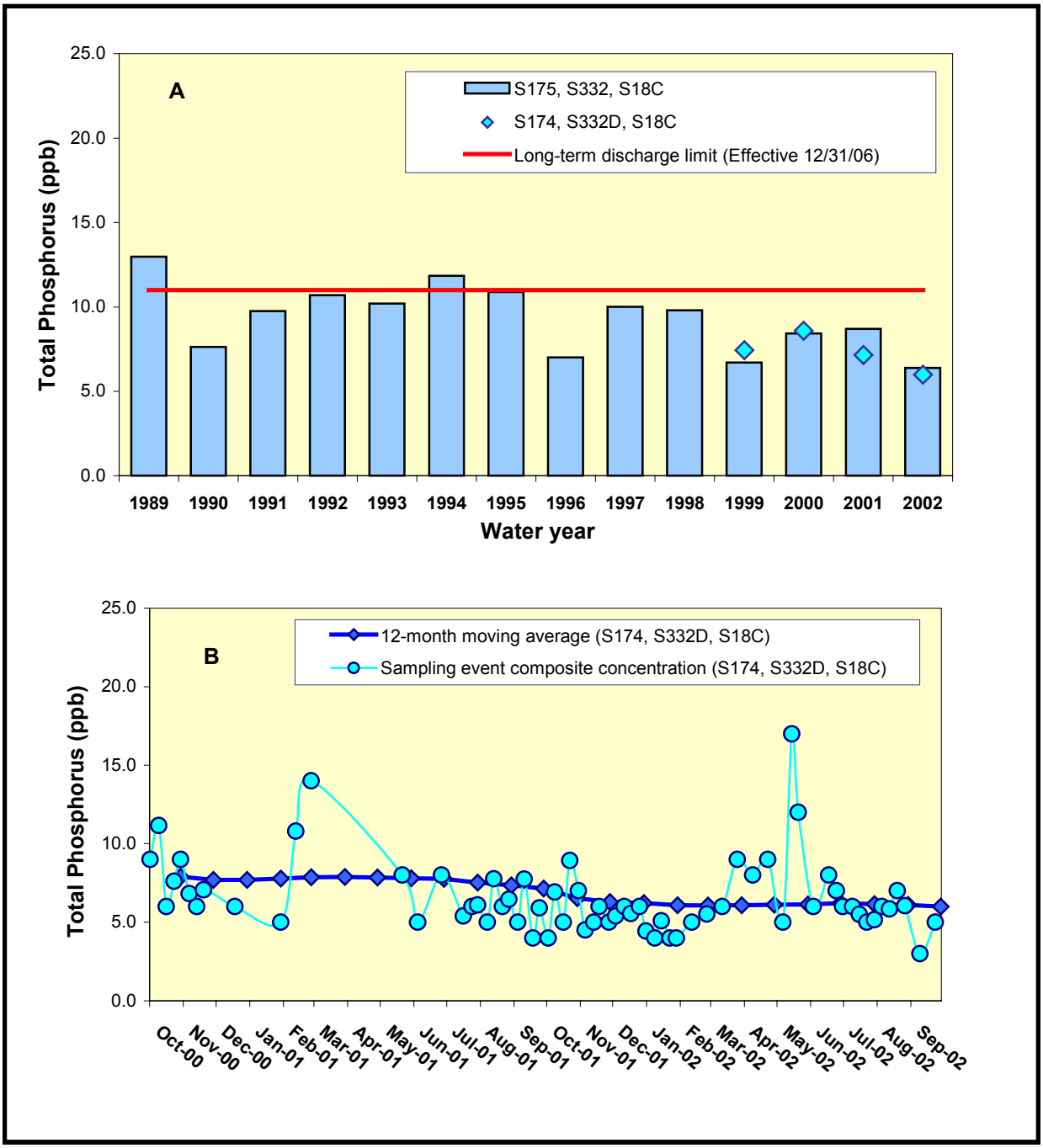

Figure 6. Total phosphorus flow-weighted mean concentrations (fwmc) in inflows to Everglades National Park through Taylor Slough and the Coastal Basins. **A.** The 12-month moving average fwmc at the end of each water year compared to the 11 ppb long-term total phosphorus limit. **B**. The 12-month moving average fwmc 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	Flow Weighted Mean Total Phosphorus	Limit (Effective 12/31/06)	Percent of Sampling Events Greater than 10 ppb	
			(ppb)	(%)	
	(Kac-ft)	(ppb)	Long Term	Guideline	Observed
31-Oct-00	399.0	7.9	11.0	53.1	16.3
30-Nov-00	375.0	7.7	11.0	53.1	14.6
31-Dec-00	351.0	7.7	11.0	53.1	15.0
31-Jan-01	307.9	7.8	11.0	53.1	15.4
28-Feb-01	281.6	7.9	11.0	53.1	21.6
31-Mar-01	269.5	7.9	11.0	53.1	22.9
30-Apr-01	260.1	7.9	11.0	53.1	20.6
31-May-01	254.1	7.8	11.0	53.1	12.9
30-Jun-01	249.0	7.8	11.0	53.1	10.0
31-Jul-01	243.0	7.5	11.0	53.1	10.7
31-Aug-01	237.1	7.3	11.0	53.1	11.5
30-Sep-01	235.1	7.2	11.0	53.1	11.5
31-Oct-01	235.2	6.5	11.0	53.1	8.0
30-Nov-01	269.7	6.3	11.0	53.1	7.4
31-Dec-01	296.5	6.2	11.0	53.1	6.7
31-Jan-02	316.0	6.1	11.0	53.1	5.9
28-Feb-02	320.6	6.1	11.0	53.1	0.0
31-Mar-02	325.9	6.1	11.0	53.1	0.0
30-Apr-02	331.1	6.1	11.0	53.1	0.0
31-May-02	336.4	6.1	11.0	53.1	5.0
30-Jun-02	364.3	6.2	11.0	53.1	4.9
31-Jul-02	392.1	6.1	11.0	53.1	4.7
31-Aug-02	388.3	6.1	11.0	53.1	4.7
30-Sep-02	357.1	6.0	11.0	53.1	4.9

The 12-month flow-weighted mean concentrations for July, August and September 2002 were 6.1, 6.1 and 6.0 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 value of 53.1 percent. The percentage of flow-weighted mean total phosphorus concentrations greater than 10 ppb for the combined flow through S174, S332D and S18C was, 4.7, 4.7 and 4.9 for the periods ending, July, August and September, respectively, (**Table 3**).

The daily flows into Everglades National Park through S332D, S174 and S18C are presented in **Figure 7a**. **Figure 7b** shows the relationship between the daily inflows and the corresponding flow-weighted mean total phosphorus concentrations for each sampling event. As the data indicate, there is no linear relationship between daily mean flow and flow-weighted mean total phosphorus concentrations at these structures.

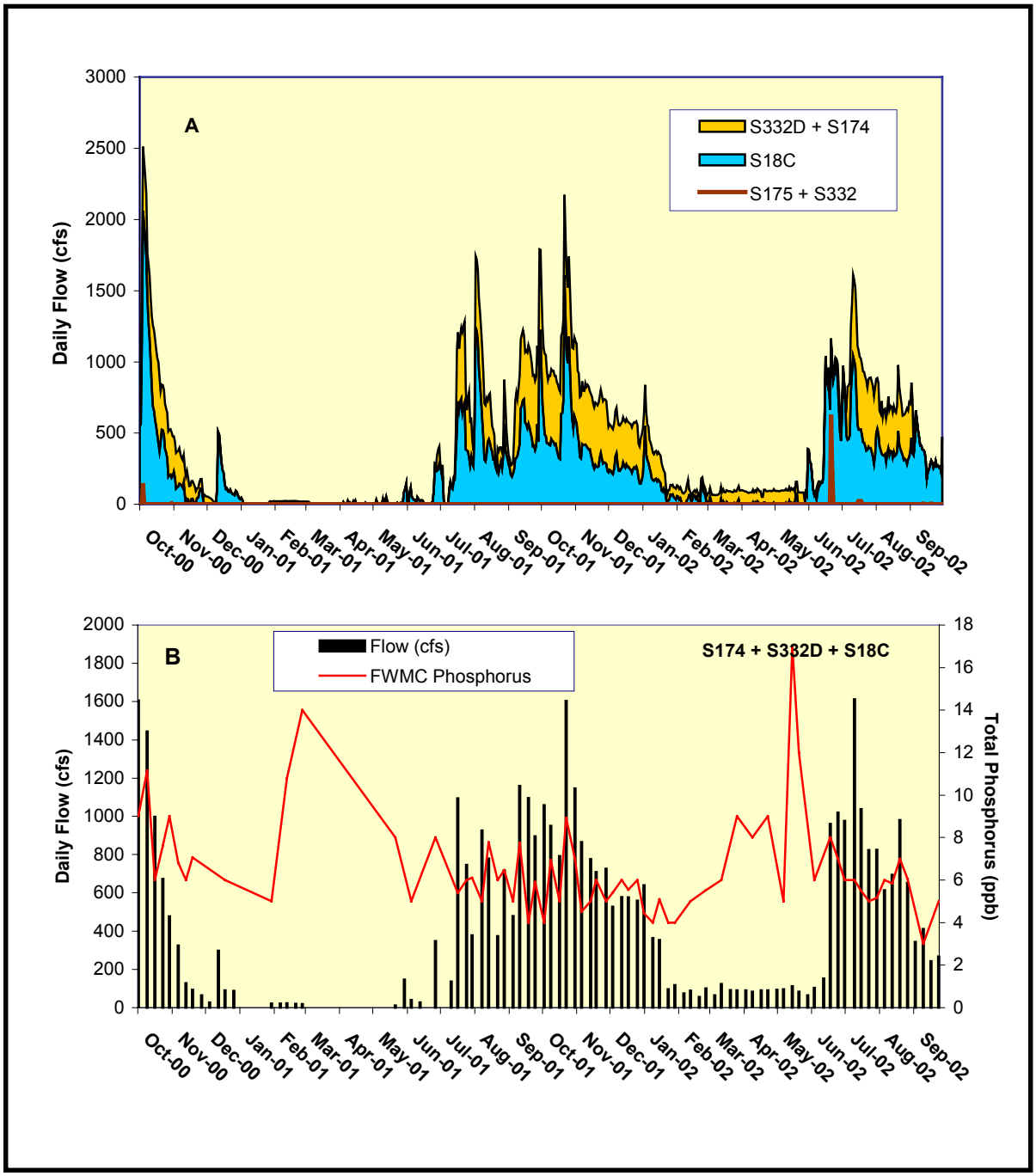

Figure 7. **A.** Daily flows into Everglades National Park through Taylor Slough and S18C. **B**. The relationship between daily flows at Taylor Slough structures and S18C and the corresponding flow-weighted mean total phosphorus concentrations for individual sampling events.