TECHNICAL MEMORANDUM

SFWMD Data and Documentation Summary for the Eastern Flow Path Water Quality

PREPARED FOR:	South Florida Water Management District (SFWMD)
COPY TO:	File
PREPARED BY:	CH2M HILL Engineers, Inc. (CH2M)
DATE:	March 18, 2016
DISTRICT CONTRACT:	4600003014
DELIVERABLE	2.3 Final Technical Memorandum
	Review and Summary of Documentation and Previous Activities
CH2M PROJECT NUMBER:	666937

1.0 Introduction

CH2M is under contract with the SFWMD to deliver professional services associated with Everglades Restoration Strategy Contract No: 4600003014 entitled "SFWMD Data and Documentation Summary for the Eastern Flow Path Water Quality". The 2012 Restoration Strategies document defines the Eastern Flow Path is comprised of the S5A Sub-basin, the East Beach Water Control District (EBWCD) and the C-51 West basin.

The goal of this contract is to consolidate historic information and existing water quality data in a final deliverable that facilitates development of sub-regional source control projects in the S5A Sub-basin and the EBWCD. Specific contract tasks are described next:

- Task 2: Summarize existing information on historic activities and assessments of water quality data related to tracking phosphorus trends in discharges from the S-5A Sub-basin and the EBWCD. This deliverable (Deliverable 2.1) is the draft technical memorandum to address task.
- Task 3: Evaluate water quality and flow associated with the recent canal cleaning project effort in the EBWCD.
- Task 4: Evaluate water quality and flow data collected along the West Palm Beach Canal (WPB Canal) for characterizing phosphorus forms and transport mechanisms.

Pursuant to the scope of work, Deliverable 2.1 shall: 1) summarize relevant sections of documents; 2) review and describe documentation of historical and existing primary (District) and secondary (Permittee) water control structures and conveyance system (canal and culverts) and water quality monitoring network; 3) review and summarize all relevant historical data for surface water quality and quantity; 4) include detailed description of areas with high relative contributions of phosphorus to the Eastern Flow Path; 5) point out commonalities or differences in content and findings previously documented; and 6) summarize existing documentation of sub-regional water quality improvement measures previously considered for the Eastern Flow Path.

2.0 The S5A Sub-basin and the East Beach Water Control District

The S-5A Sub-basin (Figure 1) of the Everglades Agricultural Area (EAA) is located east of Lake Okeechobee (Lake) and south of the L-8 Canal. The Basin extends 124,532 acres (194.3 square miles) and is served by two project canals: L-10 (5 miles, northwest end) and L-12 (5.5 miles, southeast end), also known as the WPB Canal, and the L-13 borrow, also known as the Ocean Canal. The S-5A Sub-basin also receives irrigation and pass-through flows from Lake Okeechobee. Of all EAA sub-basins, the S5A inflow point from the Lake is not buffered by rim canal or littoral zone areas. The S5A Basin also receives inflows from the EBWCD through structure WP16.8TS (a.k.a, EBPS3). The EBWCD can also discharge (Figure 1) to the Lake via structure C-10.

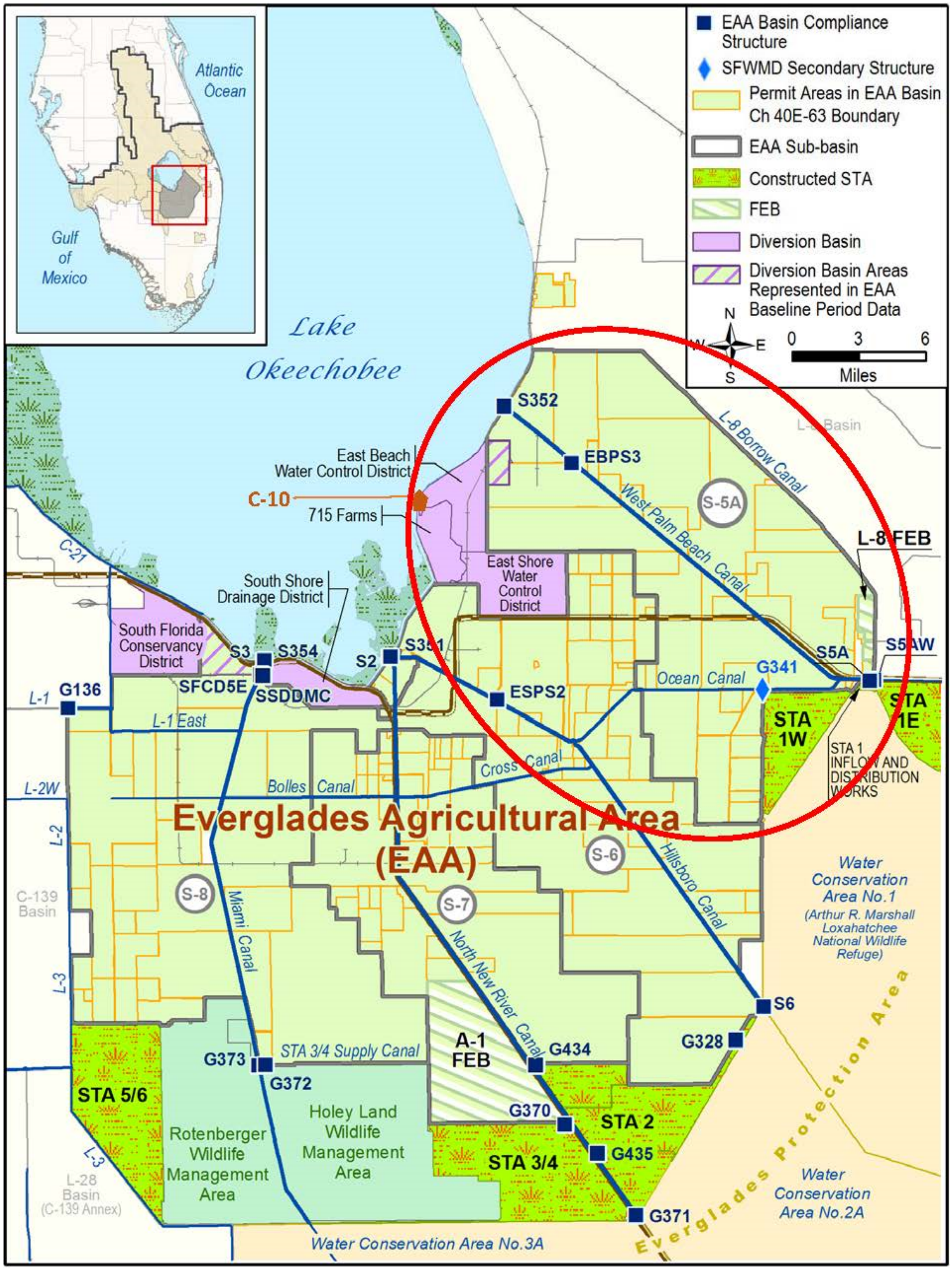
As-built record drawings of the WPB Canal have been documented since 1957 and are available. The southern 1.5 mile of the L-12 Canal was dredged in 1998, and the northern 6.2 miles of the L-10 Canal were dredged in 1999. A bathymetry survey was conducted by MACTEC Engineering & Consulting, Inc. in 2008 which estimate that dredging approximately 10.81 miles of the L-12 Canal would cost approximately $38,101,000, but it was determined to be a low priority because canal conveyance was still appropriate (SFWMD, 2009b).

The S-5A Sub-basin currently consists of thirty (30) hydrology unit or Basin IDs, as described in Works of the District permits issued pursuant to Chapter 40E-63, Florida Administrative Code (F.A.C.). Irrigation needs and water stages at various locations determine the flow direction across the canals. In addition, the G-341 structure on the Ocean Canal separates a portion of the S-5A Sub-basin shown in Figure 1. G-341 structure operation may allow some exchange of water with the S-6 Sub-basin. Basin IDs discharge to the WPB and Ocean canals through pumps. Some Basin IDs discharge to lateral canals with open connections into the WPB Canal. Please refer to Appendix 1 for a compilation of Basin ID structure data reported in prior Everglades Consolidated and South Florida Environmental Reports. A general description of the S-5A Basin was documented in a presentation provided at an April 23, 2008, meeting with FDEP, University of Florida IFAS, and EAA landowner representatives and is included in Appendix 2.

S-5A Basin flows are either routed to Stormwater Treatment Area 1 West/East (STA-1W)/STA-1E, the C-51 Canal, or stored immediately south of the pump station in the distribution cell through the S-5AS structure. The S-5A pump station is used to maintain flood protection for the S-5A Basin and water supply to the STA-1W, the C-51W Basin, and occasionally to STA-1E and the WPB Canal. The S-5A Sub-basin can also discharge to Lake Okeechobee via S-352 under specific conditions.

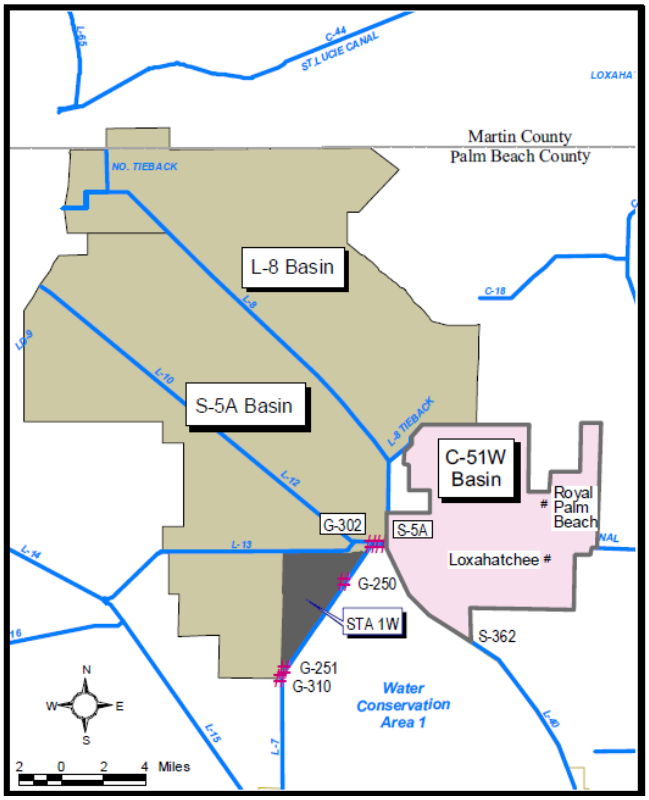
There are six water control structures regulating flow in the S-5A Basin. A schematic of these structures is shown in Figure 3 and the structures are described as follows:

- S-352—gated spillway that controls the flow between WPB Canal and the Lake within the EAA.
- EBPS (WP16.8TS)—diverts S-5A Basin runoff from the EBWCD that previously entered the Lake. This pump station was enlarged as part of the ECP Chapter 298 Districts Diversion project.
- S-5A Pump Station—controls discharges at the southern portion of S-5A Basin. The S-5A Pump Station discharges into the STA-1 Inflow Complex.
- G-250 Pump Station (inactive since July 1999)—controlled discharges into STA-1W.
- S-5AW—gated culvert that enables the transfer of water between S-5A Basin and the L-8 Basin.
- G-341 Divide Structure (active since September 9, 2005)—spillway that divides S-5A Basin and S-6 Basin.



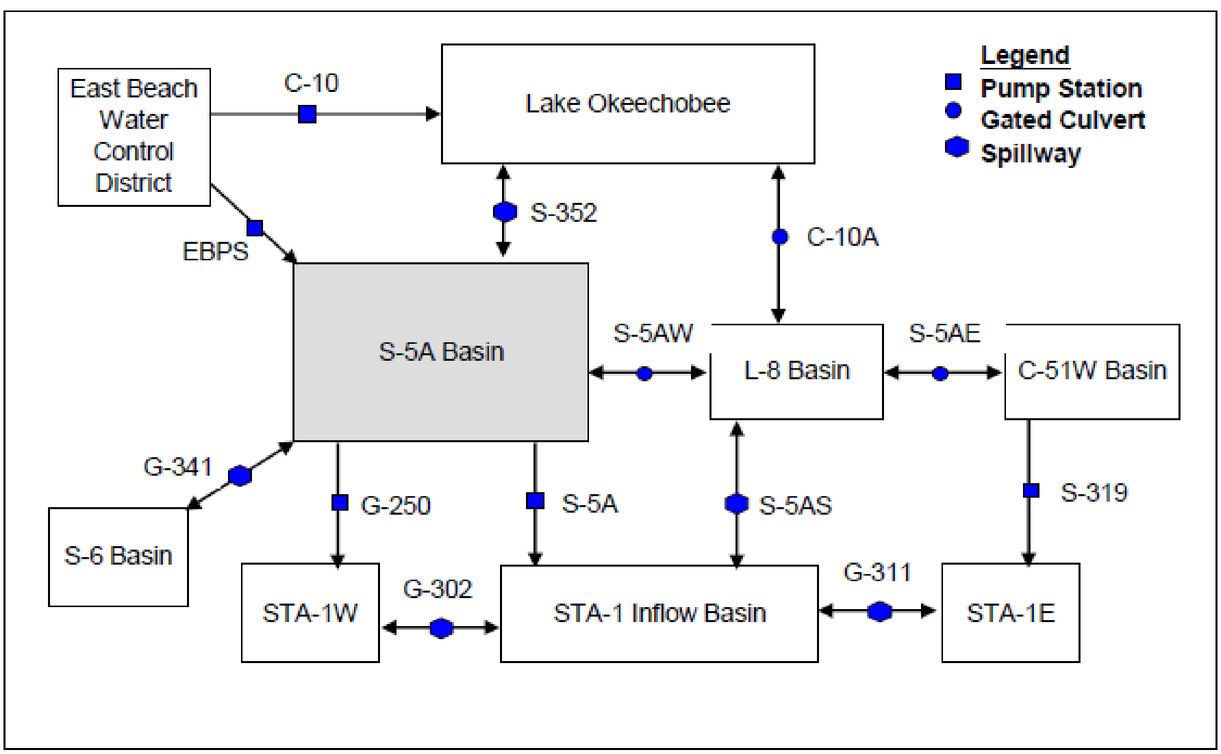
Source: Figure 1. S-5A Sub-basin and EBWCD Location Map, excerpt from SFWMD, 2015.

Figure 1. S-5A Sub-basin Location Map



Source: Figure 5-1. Tributary Basin Map-STA 1 West, excerpt from Goforth and Piccone, 2001.

Figure 2. S-5A Basin Map



Source: Figure 2-1. S-5A Basin Schematic, excerpt from Gary Goforth, Inc., 2009.

Figure 3. S-5A Basin Schematic

3.0 Regional and Sub-regional Projects

3.1 Everglades Construction Project

In 1987, the Florida Legislature passed the Surface Water Improvement and Management (SWIM) Act creating the first Everglades cleanup plan and serving as the state's basis for Everglades restoration. In March of 1992, SFWMD proposed a SWIM Plan, which was challenged by EAA agricultural groups. The Technical Mediation Group was formed to address the issues under contention culminating in a technical plan with mutually acceptable approaches for amending the original SFWMD SWIM Plan. These activities defined the Everglades Construction Project (ECP) and consisted of the construction of Stormwater Treatment Areas (STAs) and Best Management Practices (BMPs) implementation in the EAA. Subsequently, Chapter 40E-63, Florida Administrative Code (F.A.C.) was adopted in 1992 requiring implementation of BMPs to achieve a 25 percent reduction in total phosphorus (TP) load in EAA runoff.

In February 1994, the *Conceptual Design for the Everglades Protection Project* was completed by Burns & McDonnell based on the technical plan agreed through the Technical Mediation Group. This was followed by the Everglades Forever Act (EFA), which was signed into law in May of that same year, setting into action the restoration plan. The Conceptual Design summarized the evaluation of alternate phosphorus reduction technologies which resulted in the selection of STAs as the desirable technology. It also discussed the water quality datasets and assumptions for the initial conceptual design for the six STAs being proposed, as well estimated preliminary capital, and operation and maintenance costs.

The alternate phosphorus reduction technologies were evaluated at the basin, sub-basin (sub-regional), and farm scale by Brown and Caldwell and summarized in the Conceptual Design. In Phase I (Brown and Caldwell, 1993a) the technologies evaluated were chemical treatment, lime rock sorption, sedimentation in limestone borrows, percolation ponds, deep well injection, aquifer storage and recovery, water quality/supply diversion plan, algal turf scribers, nutrient management systems, ozone treatment, sediment dredging, wetlands, managed wetlands, direct filtration, barge treatment and overland flow. Phase I concluded that STAs, managed wetlands and direct filtration were the top rated technologies at the basin and sub-basin scale. Phase II focused on the top three rated technologies identified in Phase I, and detailed evaluations were prepared for the S-5A and the S-7 basins (Brown and Caldwell, 1993b). Additionally, individual analyses incorporating bench scale treatability analyses were conducted for each EAA basin, including the S5A (Brown and Caldwell, 1993c).

After initial considerations and the evaluation of alternate phosphorus reduction technologies, the most relevant features of the plan, as defined in the Conceptual Design, for the S5A Sub-basin and the EBWCD included:

- *"The construction of physical works necessary for the diversion of a part of the S-5A Basin runoff to Pump Station S-6 and STA-2, including increased conveyance capacity in the primary canal system where necessary for the purpose.*
- *The construction of Stormwater Treatment Area No. 1 (STA-1) to serve both the S-5A and the C-51 West basins (less those discharges diverted to Pump Station S-6 and STA-2). This facility will be composed of two separate areas (STA-1W and STA-1E), hydraulically connected by STA-1 Inflow and Distribution Works in the north of WCA-1…*
- *The diversion of discharges from the East Beach Water Control District from Lake Okeechobee to the West Palm Beach Canal and, after treatment in STA-1, to WCA-1."* (Burns & McDonnell, 1994)

The historic discharge data on which the Conceptual Design was based were modified to account for TP reductions due to BMP implementation "*Treatment of all historic discharge from Pump stations S-5A, S-6, S-7, and S-8 during a base period of 1979-1988; those discharges are modified to reflect a 20 percent reduction in the volume of runoff from the Everglades Agricultural Area resulting from the implementation of Best Management Practices, as well as a 25 percent reduction in the total phosphorus load discharged*."

and redirected flows *"S-5A discharges to L-8 and C-51, modified for BMPs, are considered redirected to WCA-1 through Pump Station S-5A*." (Burns & McDonnell, 1994).

In accordance with the EFA, the technical plan also provided for diversions of historic inflows from areas south of the Lake to STAs through the EAA. The EFA states that "*East Beach Water Control District, South Shore Drainage District, South Florida Conservancy District, East Shore Water Control District and the lessee of agricultural lease number 3420 shall complete any system modifications described in the Everglades Construction Project to the extent that funds are available from the Everglades Fund. These entities shall divert the discharges described within the Everglades Construction Project within 60 days of completion of construction of the appropriate STA. Such required modifications shall be deemed to be part of each district's plan of reclamation pursuant to chapter 298.*"

The Conceptual Design clarifies that "*The various 298 District (and the 715 Farms area) considered in this discussion are not included in that part of the Everglades Agricultural Area regulated under Chapter 40E-63 Rule. However, it is assumed for this conceptual design that Best management practices (BMPs)) will be implemented throughout these districts in a fashion generally consistent with that required under Chapter 40E-63 Rule, resulting in a not less than 25 percent reduction in average annual total phosphorus loads and not more than a 20 percent reduction in average annual discharge volumes*." (Burns & McDonnell, 1994).

3.2 Long-term Plan for Achieving Water Quality Goals

In 2003, the *EPA Tributary Basins Long-Term Plan for Achieving Water Quality Goals* (Burns & McDonnell, 2003b) was developed to ensure the SFWMD and the State of Florida would fulfill their obligations under the EFA and the federal Everglades Settlement Agreement, to meet the long-term goal of a geometric mean of 10 parts per billion (ppb) of TP in the EPA. Supplemental measures were developed by technical representatives of the SFWMD, FDEP, EAA Environmental Protection District, and stakeholders. The Long-term Plan document followed the *Conceptual Plan for Achieving Long-Term Water Quality Goals* (Burns & McDonnell, 2003a) and detailed the additional guidance adopted by the Florida Legislature in its 2003 amendment of the EFA, which defines an initial 13-year phase (Fiscal Years 2004 to 2016, inclusive) and responds to the comments received from the stakeholders and the public (Burns & McDonnell, 2003b):

> *"The technical representatives of the various agencies and other stakeholders involved in formulation of this Long-Term Plan consider it to represent the most aggressive approach to achieving the goals of the Everglades Forever Act supportable by the current scientific and technical knowledge base."*

Overall, this plan suggests an optimum combination of source controls, STAs, advanced treatment technologies (ATTs), regulatory programs, and integration with Comprehensive Everglades Restoration Plan (CERP) projects for achieving water quality standards. Part of the plan addressed enhancements and improvements for STA-1W and STA-1E that receive flow from the S-5A Basin, such as canal enlargements and control structure G-341 associated with the partial diversion of runoff from the S-5A Basin, and permit compliance monitoring at S-5A Basin structures S-5A and G-250 (Burns & McDonnell, 2003b).

In particular, the Process Development and Engineering (PDE) component of the Long-term Plan included activities to maintain and improve upon the contribution of source controls to overall water quality goals.

The *EAA Regional Feasibility Study for Period 2010 to 2014* (A.D.A. Engineering, Inc., 2005) was conducted to meet the objectives of the LTP by summarizing the long-term Everglades water quality goal for discharges to the EPA, as established in Rule 62-302.540, F.A.C. This Regional Feasibility Study (RFS) describes the improvements necessary to manage surface water in the EAA before completing CERP projects (A.D.A. Engineering, Inc., 2005). RFS objectives were optimizing flow and load distribution from 2006 to 2009, and developing alternatives to redistribute the flow and TP loads.

3.3 EAA S-5A Water Quality Assessment and Phosphorus Reduction Strategies

The *Everglades Agricultural Area S-5A Basin Water Quality Assessment and Phosphorus Reduction Strategies*, provided an assessment of the S-5A Basin water quality and the potential sub-regional measures for improving water quality discharges for the S-5A Basin and EBWCD. The following four TP reduction measures for the S-5A Basin were reviewed in this study (A.D.A. Engineering, Inc. and Soil and Water Engineering Technology, Inc., 2011):

1. Scenario 1: A combination of Nutrient Binding Technology (NBT or chemical precipitation) and stormwater retention and recycle within EBWCD
2. Scenario 2: A combination of Scenario 1 and a single sub-regional retention and recycle impoundment within the S-5A Basin
3. A sub-regional sediment control measure implemented independently
4. A combination of Scenarios 1, 2, and 3

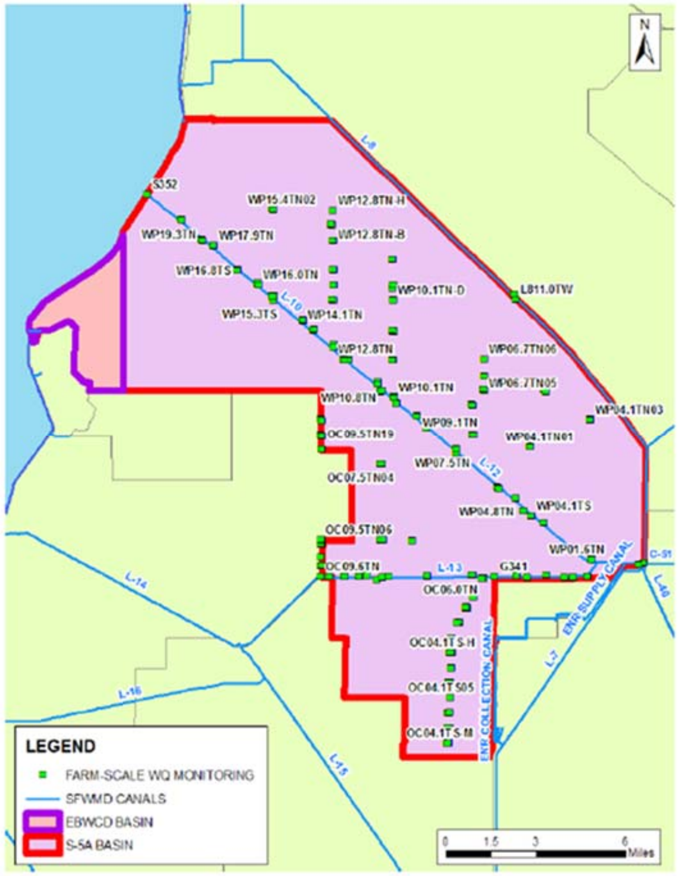
To evaluate these sub-regional measures, the Watershed Assessment Model (WAM) was used in conjunction with a literature review of existing reports, research, studies, data, and regulatory documentation. Specifically, data from the six structures of the S-5A Basin were reviewed for years 1995 through 2009. Table 1 shows the annual flow and TP load data in and out of the S-5A Basin used to develop and calibrate the WAM. Figure 4 shows the monitoring station locations where the data were collected.

Table 1. S-5A Annual Flow and TP Load per Calendar Year In and Out of the S-5A Basin

CALENDAR YEAR	FLOW [AC-FT / DAY]									
	S-5A INPUTS				S-5A OUTPUTS					BASIN FLOW-THRU
	S-352 IN	EBPS	S-5AW IN	G-341 IN	S-5A	G-250	S-5AW OUT	G-341 OUT	S-352 OUT	
1995	242,372	4,757	103,711	-	431,653	138,461	-	-	-	171,149
1996	196,282	3,933	17,296	-	206,600	170,283	-	-	-	119,244
1997	89,137	6,899	10,072	-	285,587	70,031	-	-	-	52,548
1998	181,935	3,129	20,333	-	256,048	95,519	-	-	-	77,592
1999	220,819	3,432	40,449	-	384,415	33,832	-	-	-	130,777
2000	171,489	613	21,720	-	253,476	-	-	-	105	52,929
2001	44,953	10,777	5,892	-	235,215	-	3,123	-	3,049	6,268
2002	348,386	19,646	20,509	-	553,047	-	-	-	-	248,404
2003	160,412	23,860	5,655	-	386,362	-	-	-	-	88,350
2004	141,081	23,308	32,133	-	433,306	-	-	-	-	65,074
2005	80,232	21,231	1,102	2,895	236,812	-	-	24,026	-	19,646
2006	115,983	14,505	5,379	69,375	204,115	-	-	25,502	-	6,063
2007	34,585	6,060	26,404	19,528	105,682	-	2,272	20,290	-	8,902
2008	58,948	17,508	22,411	53,216	249,274	-	-	20,081	-	4,075
2009	78,571	14,522	6,832	65,060	253,486	-	1,495	9,468	2,730	30,536

CALENDAR YEAR	TP LOAD [KG]									
	S-5A INPUTS				S-5A OUTPUTS					BASIN FLOW-THRU
	S-352 IN	EBPS	S-5AW IN	G-341 IN	S-5A	G-250	S-5AW OUT	G-341 OUT	S-352 OUT	
1995	33,657	1,685	12,011	-	78,194	18,873	-	-	-	29,930
1996	39,457	1,190	671	-	44,967	22,689	-	-	-	26,334
1997	22,836	1,833	289	-	64,008	8,469	-	-	-	11,865
1998	36,435	1,174	988	-	53,953	13,711	-	-	-	13,516
1999	56,300	1,162	5,178	-	74,473	3,859	-	-	-	19,142
2000	42,325	374	1,382	-	44,389	-	-	-	32	6,273
2001	13,853	3,235	201	-	27,944	-	791	-	861	396
2002	76,589	7,608	2,025	-	101,286	-	-	-	-	41,052
2003	40,531	8,952	397	-	72,378	-	-	-	-	15,237
2004	35,434	12,727	6,704	-	116,368	-	-	-	-	8,135
2005	29,007	11,983	255	1,214	60,420	-	-	4,684	-	3,635
2006	30,738	6,393	829	18,399	65,337	-	-	3,362	-	991
2007	10,671	3,564	2,187	3,393	18,200	-	198	1,739	-	758
2008	17,550	13,651	2,225	14,477	67,951	-	-	1,618	-	353
2009	23,205	16,863	769	11,604	56,361	-	437	1,799	603	4,175

Source: Tables 3-4 and 3-5, excerpt from: A.D.A. Engineering, Inc. and Soil and Water Engineering Technology, Inc., 2011



Source: Figure 3.4: S-5A Basin Farm-Scale Water Quality Monitoring Locations, excerpt from A.D.A. Engineering, Inc. and Soil and Water Engineering Technology, Inc., 2011.

Figure 4. S-5A Basin Water Quality Monitoring Locations for Annual TP Loads and Flow Data (1995-2009)

The results of the WAM evaluation for each of the TP reduction methods are summarized in Table 2. The scenarios were evaluated for TP load reduction at the S-5A pump station; therefore, the TP load reduction efficiency of the measure itself would actually be greater than shown in Table 2 because the simulations included interactions of the S-5A Basin treated water with other basin waters before it reached the S-5A pump station.

Table 2. TP and Flow Reduction for All Scenarios Evaluated at the S-5A Pump Station

Scenario	Simulated Conditions			Reduction from Base Run		
	Flow (ac-ft)	TP Load (US Tons)	TP Conc. (ppb)	Flow (%)	TP Load (%)	TP Conc. (%)
Base Run	297,005	77.3	192	0	0	0
EBWCD Retention & NBT	295,508	73.1	182	0.5	5.4	4.9
EBWCD Retention & NBT and Single Sub-Regional Retention	274,562	68.7	184	7.6	11	3.9
Regional Sediment Control Measure	297,005	72.3	179	0	6.6	6.6
Combined TP Reduction Measures	274,562	64.3	172	7.6	17	10.0

Source: Table ES-1: TP and Flow Reduction for All Scenarios Evaluated at the S5A Pump Station, excerpt from A.D.A. Engineering, Inc. and Soil and Water Engineering Technology, Inc., 2011.

The cost effectiveness of each scenario was also evaluated in terms of cost per pound of TP removed over a 50-year period from FY 2010 to 2060 and is presented in Table 3. According to this analysis, Scenario 3, the regional sediment control measure at the confluence of the WPB and Ocean Canals upstream of the S-5A pump station, was determined to be the measure of lowest unit cost, while the combination of NBT and stormwater retention and recycle within EBWCD measure (Scenario 1) had the highest unit cost. The study concluded that all scenarios involved "varying levels of complexity for full scale implementation." The overall recommendation was to consider the next steps for implementation and investigate the technical and practical feasibility of long-term implementation of the differing scenarios.

Table 3. Cost Effectiveness for Evaluated Scenarios

	TP MEASURE	50-YR TP LOAD REDUCTION (LB)	ORDER OF MAGNITUDE RANGE OF TOTAL COST ($)	RANGE OF COST EFFECTIVENESS ($ / LB REMOVED)
1	EBWCD RETENTION AND NBT	470,000	$220,225,803*	$469*
			$382,308,249**	$813**
2	SUB-REGIONAL IMPOUNDMENT & SCENARIO 1	860,000	$293,776,403*	$342*
			$492,265,249**	$572**
3	REGIONAL SEDIMENT CONTROL	500,000	$106,345,090*	$213*
			$185,502,432**	$371**
4	COMBINED SCENARIOS 2&3	1,360,000	$400,121,493*	$294*
			$677,767,681**	$498**

** - Assumes landowner approach water control structures, alum used for NBT and all dredged material re-used in another location.*
*** - Assumes civil-works approach water control structures, aluminum chloride used for NBT and all dredged material is disposed of at a landfill.*

Source: Table ES-3: Range of the Cost Effectiveness of Evaluated Scenarios, excerpt from A.D.A. Engineering, Inc. and Soil and Water Engineering Technology, Inc., 2011.

3.4 Restoration Strategies

To address water quality concerns associated with existing inflows into the Everglades Protection Area (EPA), the SFWMD, Florida Department of Environmental Protection (FDEP), and the U.S. Environmental Protection Agency (USEPA) collaboratively developed a plan described in the Restoration Strategies Regional Water Quality Plan (RS-RWQP) (SFWMD, 2012). Three flow paths (Eastern Flow Path [EFP], Central Flow Path, and Western Flow Path) are considered in the plan, each comprised by the sub-basins that discharge to specific STAs.

The projects included in the RS-RWQP consist of Flow Equalization Basins (FEB), STA expansions, and infrastructure and conveyance enhancements. FEBs reduce peak stormwater runoff discharges before reaching the STAs. A Water Quality Based Effluent Limit (WQBEL) was established to achieve phosphorus criterion compliance within the State of Florida's standards in the EPA. Through these projects, the WQBEL is projected to be achieved and meet compliance with water quality standards for the EPA (SFWMD, 2012). The WQBEL would trigger development of additional water quality improvement projects.

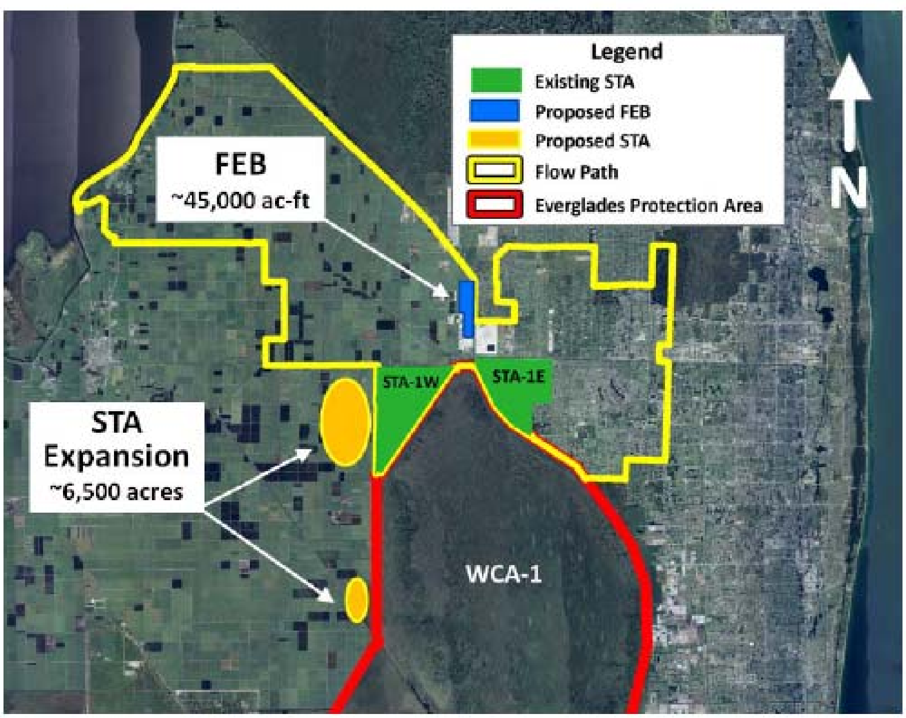
RS-RWQP projects designed for the EFP include a 45,000-acre-foot (ac-ft) storage capacity FEB located in the S-5A Basin, adjacent to the L-8 Canal, and an STA expansion. The FEB is intended to allow optimization of inflow rates to the STAs. The STA expansion will be operated in combination with STA-1W, and will add 6,500 acres of STA (SFWMD, 2012). Conveyance improvements were also designed for structure G-341 to efficiently operate with the previously described project enhancements. Figure 5 shows the EFP project locations.

Section 3.1.4 of the RS-RWQP (SFWMD, 2012) introduces the concept of Sub-regional source control projects as a safety factor to improve water quality through increasing retention/detention of phosphorus in the EFP (S-5A Sub-basin). These projects are intended to be downstream of permittee-implemented best management practices (BMPs) and would result in phosphorus load reductions in flows entering STA-1E and STA-1W.

The RS-RWQP provides funding for the Sub-regional source control projects. Specifically, the RS document explains that *"The modeling inflow datasets in the Eastern Flow Path did not assume additional TP concentration reductions above the TP load reduction already being achieved in accordance with the current BMP regulatory program in the S-5A basin. As part of the Restoration Strategies Water Quality Planning effort, the District proposes to build upon the success of the existing BMP regulatory program by focusing on areas and projects with the greatest potential to further improve water quality. The District's goal is to design projects to increase retention/detention of TP above what is currently required at the basin-ID level in strategic onsite locations or through sub-regional source control projects in series with the onsite BMPs to further reduce TP loads to the STAs.*

The S-5A Sub-basin within the EAA Basin was selected as a priority sub-basin based on the inflow concentrations from Lake Okeechobee into the S-5A, the water quality of the farms discharging within the S-5A, the potential to affect the inflow to the STAs, and potential positive impact to the Refuge. Conceptual projects within the S-5A Sub-basin were considered based on a combination of factors, including water quality of farm discharges, proximity and potential impact to the STA, and having willing participants.

Three conceptual projects and area locations have been identified for sub-regional source controls projects, the Southeast cluster (collective of five separate basin ID's), East Beach Water Control District (298 District) and a District lease property. Collectively, the three project locations contribute an annual average of 24.78 metric tons (WY2006 – 2011) of phosphorus which is 37.4% of the basin load into STA-1E/1W. It is anticipated that these projects have the potential to reduce this load which would be an additional reduction in phosphorus from entering the STA-1E/1W complex that was not taken into account in the model inflow datasets." (SFWMD, 2012)



Source: Figure 3. Eastern Flow Path Projects, excerpt from SFWMD, 2012.

Figure 5. Eastern Flow Path Project Locations

To model EFP scenarios using the Dynamic Model for Stormwater Treatment Areas (DMSTA), simulated basin daily flows and mean monthly TP concentrations were used as model inputs. The RS-RWQP indicates that TP concentrations for the basins tributary to the STAs were based on historical data from the 10-year period of WYs 2000 to 2009. This period was considered reasonably representative of hydrologic and meteorological conditions. District hydrological monitoring network and water quality monitoring programs were used to develop 12 monthly concentration values for each basin. Table 4 and 5 summarize the average monthly TP concentrations by source basin and annual flows and TP loads and concentrations for the EFP, respectively.

Table 4. Source Basin Mean Monthly Total Phosphorus Concentrations

Month	EAA WPB	S5A DIV	EBWCD	C51W	S361	L-8	EAA Hillsboro	EAA NNRC	EAA MIA	ESWCD & 715 Farms
January	116	208	233	94	57	140	70	130	69	64
February	197	296	292	116	53	93	128	132	163	107
March	205	170	366	117	81	141	106	105	70	99
April	160	178	384	195	60	127	130	132	119	121
May	175	116	183	152	72	125	118	139	115	80
June	175	377	329	151	68	91	85	85	85	106
July	126	103	358	139	75	81	91	75	78	123
August	172	303	427	153	94	116	136	81	68	122
September	177	217	445	181	92	119	144	116	85	156
October	166	188	479	273	68	117	130	105	66	224
November	167	79	352	151	52	77	67	46	98	167
December	128	119	221	123	90	121	63	104	54	65

Month	SSDD MIA	SSDD NNRC	SFCD	G136	C139S	Lake NNRC	Lake MIA	Lake WPB	Lake Hillsboro
January	114	71	90	49	80	147	165	258	147
February	130	108	94	472	81	122	176	174	122
March	145	117	94	51	112	158	118	229	158
April	163	97	107	86	165	158	157	240	158
May	136	97	116	43	128	131	120	157	131
June	131	74	115	315	328	144	138	167	144
July	123	60	101	284	269	93	89	174	93
August	141	98	111	233	255	93	151	204	93
September	123	89	114	227	285	115	148	139	115
October	137	97	112	191	233	125	164	145	125
November	135	121	125	128	197	170	148	213	170
December	113	71	80	91	139	164	127	245	164

Source: Table 3. Source Basin Mean Monthly Total Phosphorus Concentrations, excerpt from SFWMD, 2012.

Table 5. Eastern Flow Path Average Annual Flows and TP Loads and Concentrations

Source Basin	Flow (ac-ft per year)	Total Phosphorus Load (metric tons per year)	Total Phosphorus Concentration (ppb)
S-5A	233,700	47.5	165
EBWCD	17,000	7.8	370
C-51 West	141,500	28.2	163
C-51 West (via S361)	9,700	0.9	73
L-8	18,500	2.5	110
Lake Okeechobee (Urban Water Supply via S352)	1,900	0.4	176
Total	422,300	87.3	168

Source: Table 4. Average Annual Flows and Total Phosphorus Loads and Concentrations for the Eastern Flow Path, excerpt from SFWMD, 2012.

Notes: EBWCD flows only include flows at pump station EB#3.

3.5 East Beach Water Control District

As discussed earlier in this document, the EFA provided for diversions of historic inflows into Lake Okeechobee from the East Beach Water Control District, South Shore Drainage District, South Florida Conservancy District, East Shore Water Control District and the lessee of agricultural lease number 3420 (Closter Farms) located south of the Lake to STAs through the EAA. The EFA noted that these areas were an important part of the Everglades Restoration, and therefore must participate in the system modifications specified by the ECP.

Upon amendment of the EFA, these water control districts and Closter Farms entered into a Consent Agreement with FDEP. The Consent Agreement allowed the EBWCD to continue discharges into the Lake if the operating conditions required by the agreement were followed. The operational conditions included specifications such as diversion plans, pumping BMPs, farming BMPs, water quantity and quality monitoring and reporting requirements, pump basin maintenance, canal maintenance, canal right-of-way litter prevention, canal weed control, annual reports, and access allowances. Additional guidelines regarding pumping practices for TP reduction were included in the Consent Agreement's exhibits.

The Consent Agreement authorized FDEP to "implement the provisions of the Everglades Forever Act, Chapter 94-115, Laws of Florida" and stated that it "constitutes final agency action in the 298 Districts' and Closter Farm's application for permit" (FDEP, 1994). Also, consistent with the EFA mandate, the SFWMD entered into an agreement with EBWCD on September 16, 1996, for the creation, funding, and implementation of the Diversion Project.

EBWCD diversion structures into the EAA were completed in July 2001. Before July 2001, an approximate 1,280-acre portion of the east EBWCD was the only portion discharging to the WPB Canal through a 97-cubic-foot-per-second (cfs) pump (East Beach #3 [EB#3]) in combination with a booster pump (EB#2) of similar capacity (97 cfs) located 2.8 miles west of EB#3. The remaining EBWCD area discharged only to the Lake through a 334-cfs pump station known as EB#1. The diversion project completed in July 2001 included the replacement of EB#3 for a new 338-cfs pump station (151,700 gallons per minute [gpm]), known as EBPS or EBPS3; removal of the booster pump EB#2; and improvement to the conveyance system (canals, culverts, and two control structures separating east and west portions) upstream of EBPS3. The November 15, 2001, Environmental Resource Permit (ERP) (No. 50-05179-P) describes the pumping conditions at EBPS3 and EB#1, and the opening and closing elevations for the two internal control structures. Additionally, the District incorporated the lands previously discharging into the Lake through renewal of the source controls Works of the District permit No. 50-00033-E (Application 000428-2 approved December 31, 2001). The permit required the implementation of Best management Practices and a discharge monitoring plan in accordance with Chapter 40E-63, F.A.C., requirements (SFWMD, 2001b):

> *"Chapter 40E-61, F.A.C., (hereinafter referred to as "Rule 40E-61"), establishes a Works of the District Best Management Practice (BMP) permitting program for Lake Okeechobee Drainage Basin which is specifically designed to reduce phosphorus loads to the Lake. Similarly, Chapter 40E-63, F.A.C. (hereinafter referred to as "Rule 40E-63"), establishes a Works of the District BMP permitting program for the Everglades Agricultural Area (EAA). The 40E-61 land added to this permit previously only discharged to the Lake through existing structure C-10 (aka EB #1). Structure C-10 has an authorized discharge capacity of 150,000 GPM. Under the Surface Water Operating permit (a SWM construction permit was not required), the included 40E-61 lands will also discharge to EAA structure WP16.8TS (aka EB#3), and thus the reasons for the modification of this EAA permit. Because the land included in this permit will have the ability to discharge into both Lake Okeechobee and the EAA, it must be permitted under both BMP programs, that is in accordance with 40E-61 existing permit number 50-00001-E (EAA EPD Management Plan Master permit) for structure C-10 discharges, and according to the Rule 40E-63 program under this permit (50-00033-E) for discharges through structure WP16.8TS."*

3.6 Non-agricultural Inquiries

3.6.1 City of Pahokee Sewer Leaks

As discussed earlier in this document, a portion of the City of Pahokee is within the EBWCD. The EBWCD has the ability to discharge into both Lake Okeechobee and the EAA, and has been permitted under a Chapter 40E-61, Florida Administrative Code, EAA Environmental Protection District (EAAEPD) Management Plan Master Permit (LOK MPMP) since 1992. Under the LOK MPMP permit, annual reports have been submitted to verify compliance with permit conditions including implementation of point and nonpoint Phosphorus Reduction Strategies and water quality requirements. One of the Phosphorus Reduction Strategies included in the permit consists of the construction of two deep injection wells to eliminate municipal wastewater effluent discharges tributary to Lake Okeechobee from three Publicly Owned Treatment Works (POTWs). The three POTWs served the cities of Pahokee (within EBWCD), Belle Glade and South Bay. These reports were produced by Hutcheon Engineers for calendar years 1992 to 2001, and by Ed Barber, Technical Advisor to the EAAEPD, from 2002 to date.

While no issues are reported in association with the City of Pahokee and EBWCD for calendar years 1992 to 1999, the 2000 Annual Report (Hutcheon Engineers, 2000) noted indicated that: "*The Total Phosphorus levels as monitored by the District at the East Beach basin were observed by the District to be well in excess of typical farm basins. The EPD performed an investigation within the East Beach basin that include surface and ground water quality monitoring. This basin has several land uses, including urban and agricultural use. The City of Pahokee's wastewater plant is adjacent to the Pelican River, the main drainage within the basin. There is also an abandoned landfill within the basin. A subaqueous sewer force main break was noted within the basin as the force main crossed the Pelican River by the wastewater plant this spring. The force main has since been repaired."*

In follow-up to these concerns, recognizing the observed phosphorus levels in EBWCD discharges and the mix of urban and agricultural land uses within the basin, a coordinated investigative effort between the SFWMD and FDEP was initiated to identify phosphorus sources and the appropriate regulatory program to address them. As a start, the Florida Rural Water Association (FRWA) and the FDEP conducted a dye test in December 2005 to determine if there were any leaks from the City of Pahokee's collection/transmission system. Overall, the dye test did not indicate any leaks in the test sections of the City of Pahokee's wastewater collection/transmission system (FDEP, 2006). Further, the District budgeted for a synoptic upstream surface water monitoring for phosphorus analysis to identify any other potential sources within the EBWCD. This and consecutive upstream synoptic monitoring efforts within EBWCD are presented in section 4.4.

3.6.2 Bryant Mill

Besides the evaluation of potential sewer leaks within the City of Pahokee, the potential effects of the U.S. Sugar Corp. Bryant Mill on EBWCD phosphorus levels were also reviewed by FDEP comparing water quality from the WPB Canal upstream and downstream of the Mill (Nearhoof, 2006, personal communication). E-mail correspondence between the SFWMD and FDEP on February 28th included monthly TP concentration data from the U.S. Sugar Corp. Bryant Mill Wastewater Facility's Discharge Monitoring Report (Facility ID: FLA015034) for the period of record from January 2001 to December 2005 (Nearhoof, 2006, personal communication). Statistical analysis and data plots from the WPB Canal upstream and downstream of Bryant Mill were also included within the email correspondence. The FDEP concluded in this correspondence that from reviewing the data and the plots "there doesn't appear to be a particularly significant influence coming from the mill." The Bryant mill closed in 2007.

3.6.3 City of Pahokee Incinerator and Ash Landfill and the Solid Waste Authority Pahokee Landfill

Coordinated efforts between the District and FDEP continued through 2009, as documented in the presentation given to FDEP, representatives of EAA stakeholders, and University of Florida IFAS (SFWMD, 2008) to review status and follow-up actions in the S5A Basin (See Appendix 2). FDEP reviewed the impact of other potential sources under its jurisdiction and FDEP review of Palm Beach County inventory of waste sites in EBWCD identified two landfills near Bryant Mill. Based on the landfills descriptions combined with available water quality data it was concluded that they were potential sources of phosphorus for investigation (Nearhoof, 2009, personal communication).

3.7 EBWCD Demonstration Project

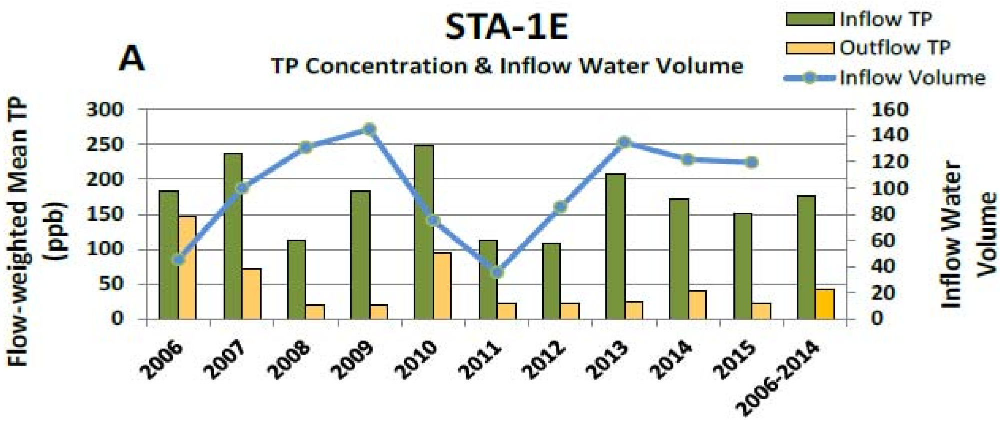
In 2013, a sub-regional voluntary demonstration project to evaluate the water quality benefits of a comprehensive canal management program (SFWMD, 2013a) was conducted in partnership with the EBWCD.

The SFWMD provided funds toward the purchase of a backhoe, and water quality collection, analysis, and validation at representative locations within the EBWCD before, during, and after the canal cleaning effort. EBWCD provided the remaining funds for the backhoe as well as fuel, operation field personnel, and consulting services for progress reporting. Quarterly reports have been submitted to the SFWMD by MacVicar Consulting, Inc., on behalf of the EBWCD. Quarterly reports include a pre- and post-survey of the canal bottom sediment depths from the cleaned canal sections, and quarterly photographs of FAV, estimated percent coverage of FAV, and progress maps (MacVicar Consulting, Inc., 2013a-b, 2014a-e, 2015a-b). An evaluation of this project will be conducted as part of Task 3 of this contract.

4.0 Water Quality Data

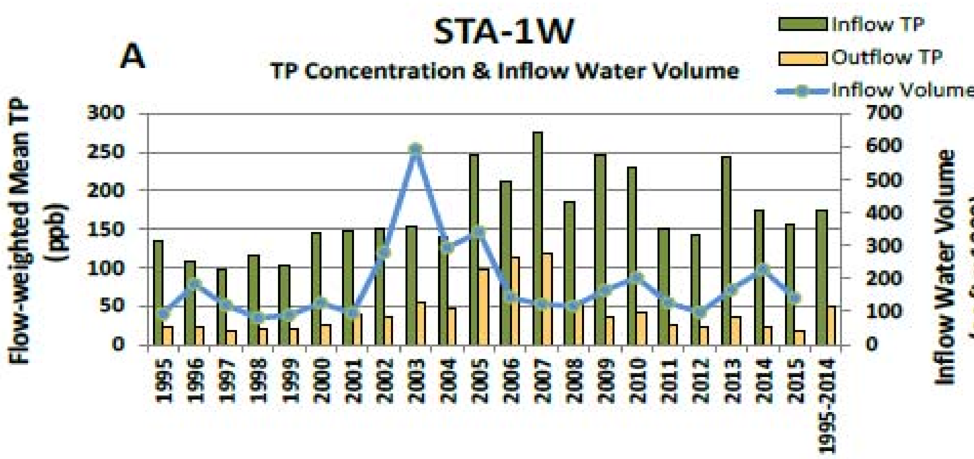
4.1 S-5A Basin Water Quality Data

Water quality is measured at S-5A Basin boundary structures and also at permitted discharge structures from individual Basin IDs pursuant to Chapter 40E-63, F.A.C. As discussed earlier in this document, water quality data at the basin level structures have been used for planning and modeling purposes under the ECP, the Long-term Plan and the Restoration Strategies project. These water quality data are also used for annual compliance determination with Chapter 40E-63, F.A.C., TP load reduction requirements for the EAA basin, as whole (SFER Chapter 4, 2016). Water quality data for the S5A Basin, individually, is presented in Chapter 5b of the South Florida Environmental Report (SFER) entitled Performance and Operation of the Everglades STAs. Flow weighed mean inflow concentrations and flows to STAs 1E and 1W during the life of these works are provided in Figures 6 and 7 (SFER, 2016).



Source: Figure 5B-6 (A). STA-1E TP Concentrations & Inflow Water Volume, excerpt from SFER Chapter 5B, 2016.

Figure 6. STA-1E TP Concentration & Inflow Water Volume

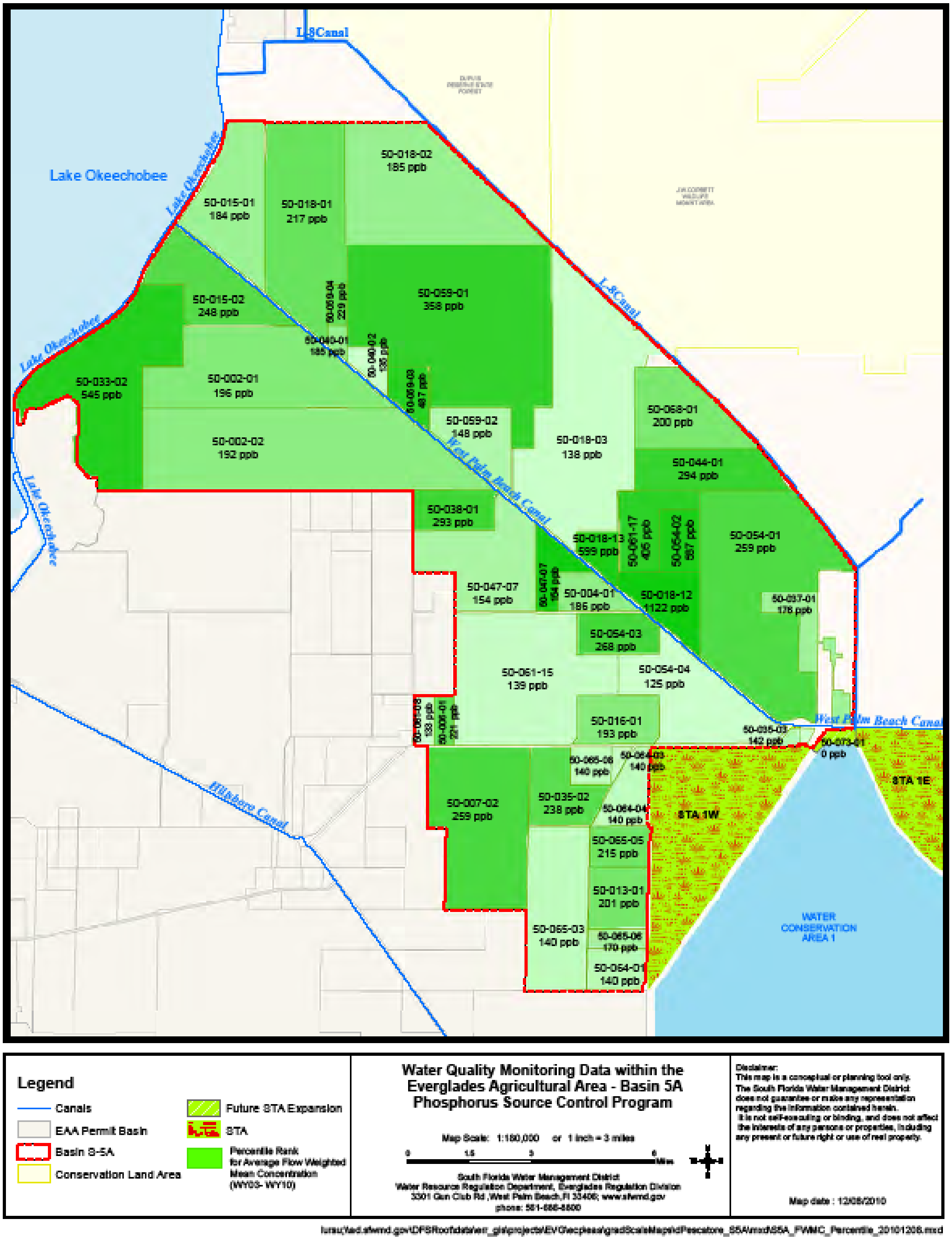


Source: Figure 5B-17 (A). STA-1W TP Concentrations & Inflow Water Volume, excerpt from SFER Chapter 5B, 2016.

Figure 7. STA-1W TP Concentration & Inflow Water Volume

4.2 Permit-level Data

The SFWMD maintains a database of daily flow, load, and rainfall data for each farm structure (pumps and culverts) that discharges into Works of the District within the EAA, including the S-5A Sub-basin and the EBWCD. The period of record of these data extends from 1994. A summary of WY individual Basin ID data, based on the data presented each year in the SFER Chapter 4 on Nutrient Source Control Programs, is presented in Appendix 1. Additionally, S-5A Basin IDs TP flow weighted mean concentrations and loads for WY2003 – 2010 are presented below in Figure 8 (SFWMD, 2011).

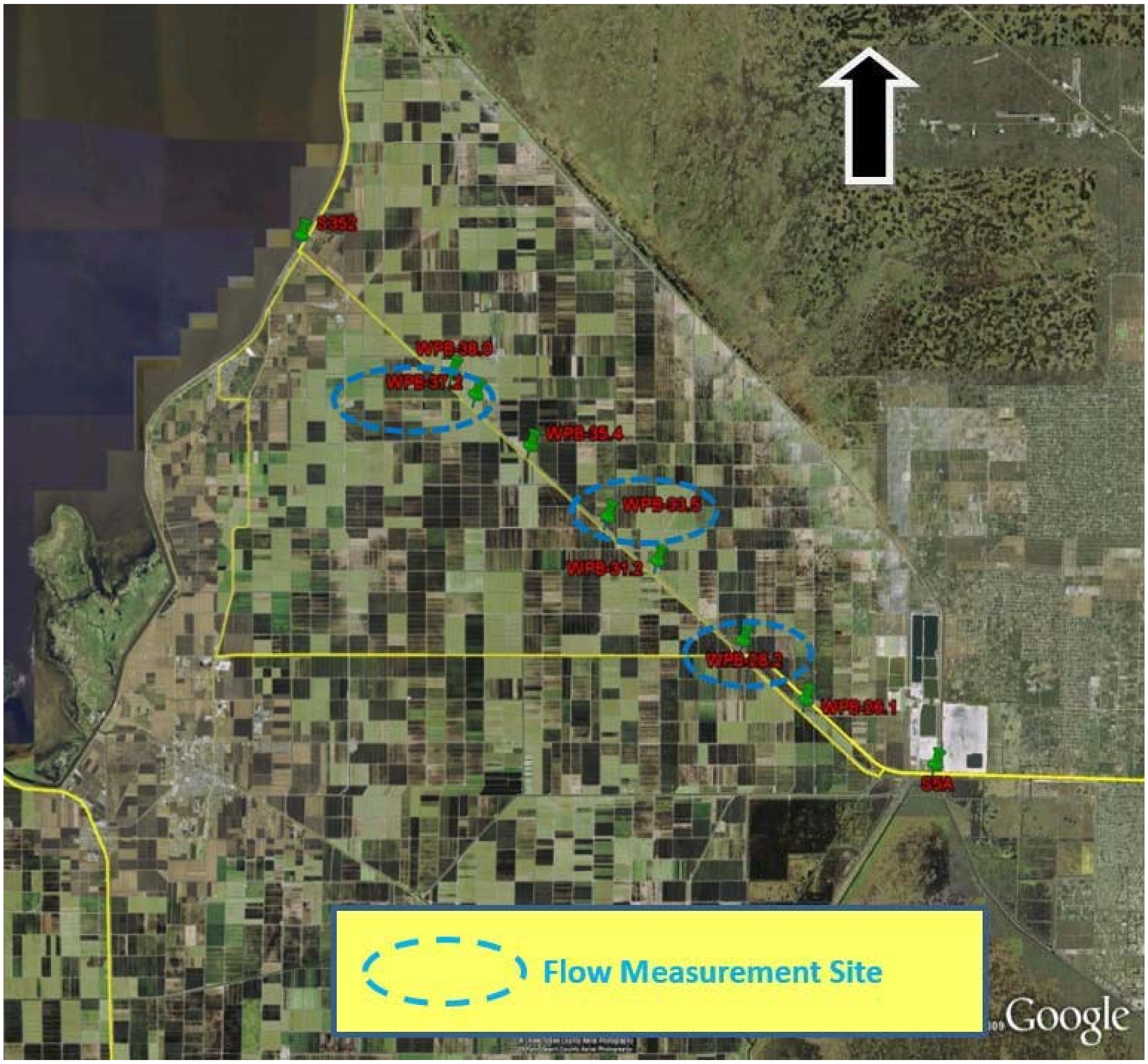


Source: Excerpt from SFWMD, 2011.

Figure 8. S-5A Basin IDs TP Flow Weighted Mean Concentrations and Loads for WY2003 – 2010

4.3 West Palm Beach Water Quality Synoptic Monitoring

In November 2012, the SFWMD started a 3-year project for biweekly and event monitoring of water quality at seven intermediate stations along the WPB Canal, and flow monitoring at three of the seven stations through November 2015 (see Figure 9). These data, in combination with long-term flow and phosphorus concentration data collection at the major SFWMD structures in and out of the WPB Canal and data submitted by EAA Works of the District permittees discharging from permit basins to the WPB Canal, will facilitate evaluation of phosphorus speciation and levels. These data will also help to understand the cycling mechanisms affecting the TP loadings levels within the S5A Sub-basin. Data analyses will be conducted under Task 4 of this contract.



Source: Figure 3. S-5A Sub-basin and EBWCD Location Map, excerpt from SFWMD, 2015.

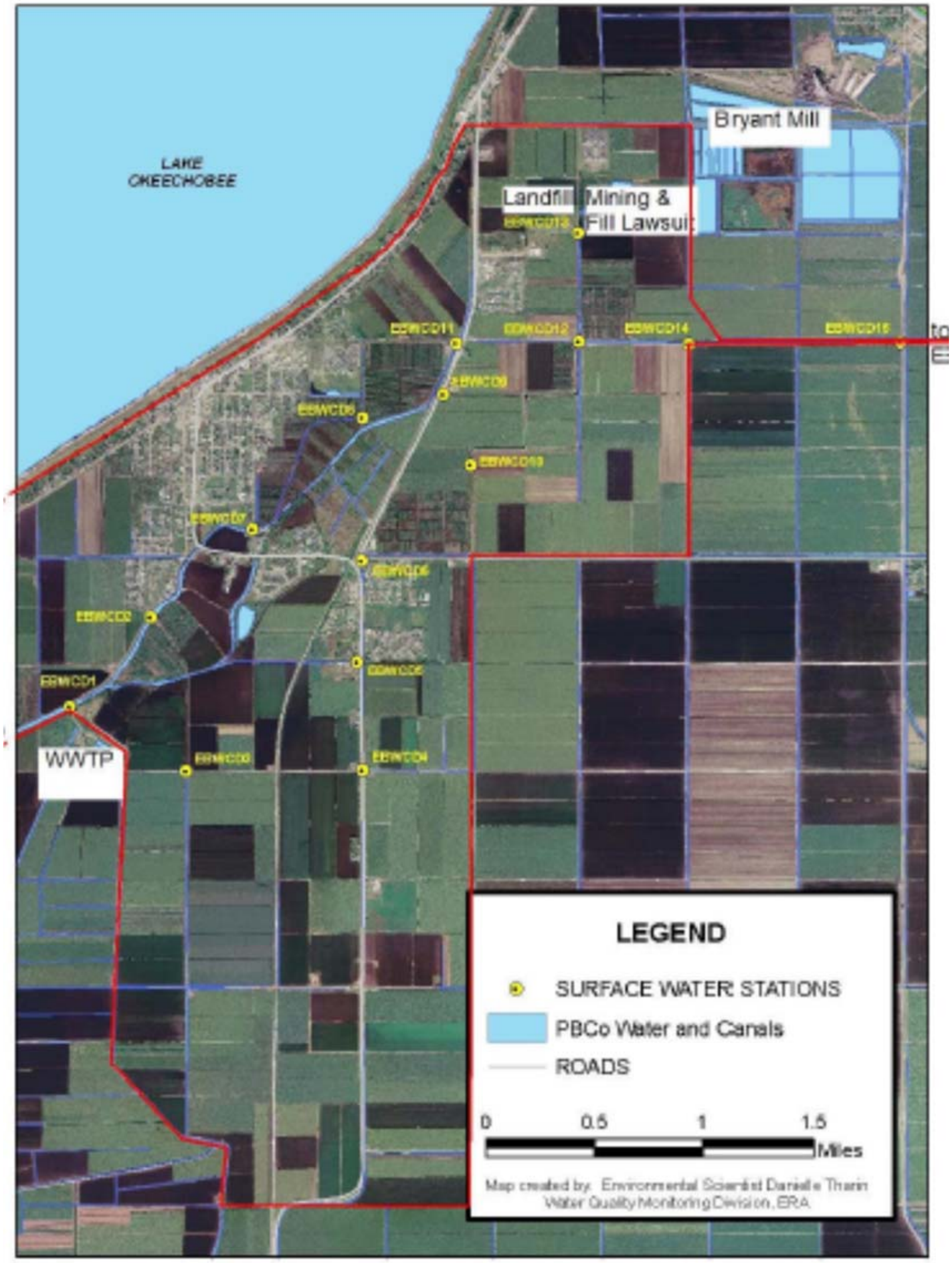
Figure 9. S-5A Sub-basin and EBWCD Location Map

4.4 EBWCD Synoptic Monitoring

As described earlier in this document, synoptic upstream surface water monitoring efforts have been conducted within the EBWCD to address potential phosphorus sources in coordination with FDEP (Section 3.6) and to evaluate the water quality benefits of a comprehensive canal management program in partnership with the EBWCD (Section 3.7).

Between January and September 2007, the SFWMD conducted upstream monitoring at 15 locations (see Figure 10) within EBWCD and data were evaluated by a SFWMD Consultant (Florida Atlantic University,

2008) together with historic water quality data for the EBWCD as a whole. Upstream monitoring resumed between January and September 2009, and these data were summarized by District Everglades Regulation Bureau (EREG) staff (SFWMD, 2009a). Upstream monitoring resumed in May 2013 at 8 of the original 15 stations and is currently ongoing. This latest monitoring effort started in August 2013, as part of the demonstration study to evaluate comprehensive canal management program. The monitored locations are presented in Figure 10, and a summary of the stations and data collected are presented in Table 6.



Source: Figure 4. Monitoring Sites in the EBWCD Synoptic Survey, excerpt from Florida Atlantic University, 2008.

Figure 10. Monitoring Locations in the EBWCD Synoptic Survey

Table 6. Summary of EBWCD Upstream Monitoring Stations for 2007, 2009, 2013, and 2014.

Station Name	Parameters	Period of Record in DBHYDRO	Comment
EBWCD1, EBWCD2, EBWCD3, EBWCD4, EBWCD5, EBWCD6, EBWCD7, EBWCD8, EBWCD9, EBWCD10, EBWCD11, EBWCD12, EBWCD13, EBWCD14, EBWCD15	TP, OPO4, TDPO4, NOX, NH4, SO4, TURB, TEMP, DO, COND, PH	1/18/2007 – 9/27/2007	Grab
EBWCD1, EBWCD2, EBWCD3, EBWCD4, EBWCD5, EBWCD6, EBWCD7, EBWCD8, EBWCD9, EBWCD10, EBWCD11, EBWCD12, EBWCD13, EBWCD14, EBWCD15	TP, OPO4, TDPO4, NOX, NO3, NH4, SO4, TURB, TEMP, DO, COND, PH	1/8/2009 – 9/28/2009	Grab *A one-time sampling event occurred on January 10, 2009 at Station EBWCD13 for the following parameters: Na, K, Ca, Mg, Hardness, Total Cr, NO3, Total Cu, and Total As
EBWCD3, EBWCD4, EBWCD6, EBWCD9, EBWCD10, EBWCD12, EBWCD13, EBWCD14	TP, OPO4, TDPO4, NOX, NH4, TKN	5/6/2013 – 12/1/2014	Grab

Source: Table 2. Summary of EBWCD upstream monitoring stations for 2007, 2009, 2013, and 2014, excerpt from SFWMD, 2015.

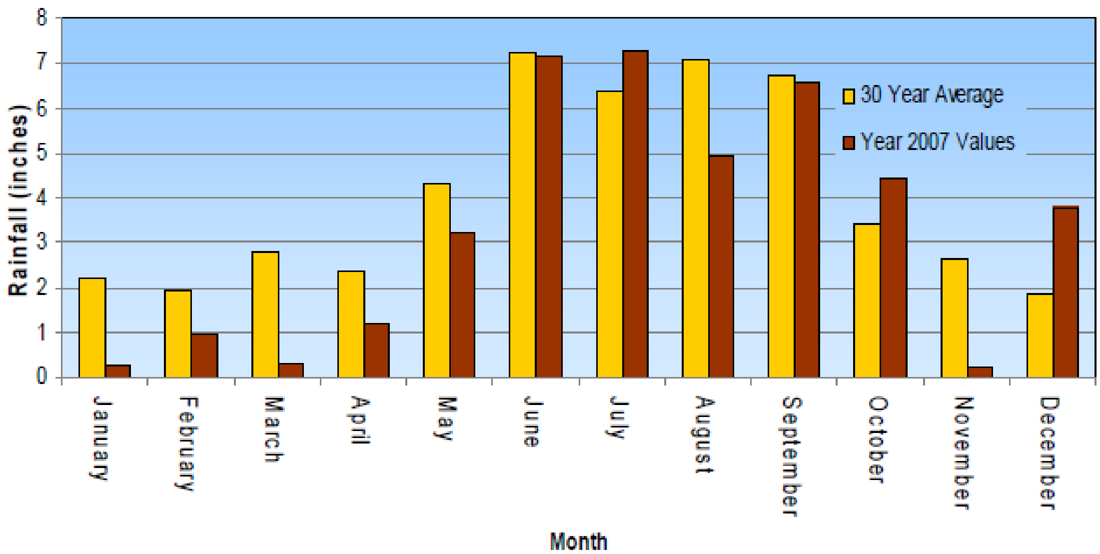
Notes: TDPO4= Total Dissolved Phosphate
NOX= Nitrogen Oxide
SO4= Sulfate
TURB= Turbidity
TEMP= Temperature
DO= Dissolved Oxygen
COND= Conductivity
PH= Measure of the hydrogen ion concentration of a solution
NO3= Nitrate
TKN= Total Kjeldahl Nitrogen
Na= Sodium
K= Potassium
Ca= Calcium
Mg= Magnesium
Total Cr= Total Chromium
NO3= Nitrate
Total Cu= Total Copper
Total As= Total Arsenic

Throughout the 2007 synoptic monitoring period, stations EBWCD 12, 13, 14, and 15, located in the northeast area of the EBWCD, consistently recorded elevated concentrations for almost all the constituents, with EBWCD 13 recording the highest TP concentration. The northeast area of the EBWCD is composed of historical rock-pit mining, landfill operation, agriculture, and Bryant Mill, as depicted in Figure 10. The assessment also noted that the northeast area's low topography made it susceptible to receiving runoff from surrounding areas (Florida Atlantic University, 2008).

During 2007, elevated TP and nitrogen concentrations were also observed from July through September (wet season) at stations EBWCD 4, 5, and 6. These stations are located in the southern area of the EBWCD. The southern area is composed of sugar cane fields (Florida Atlantic University, 2008).

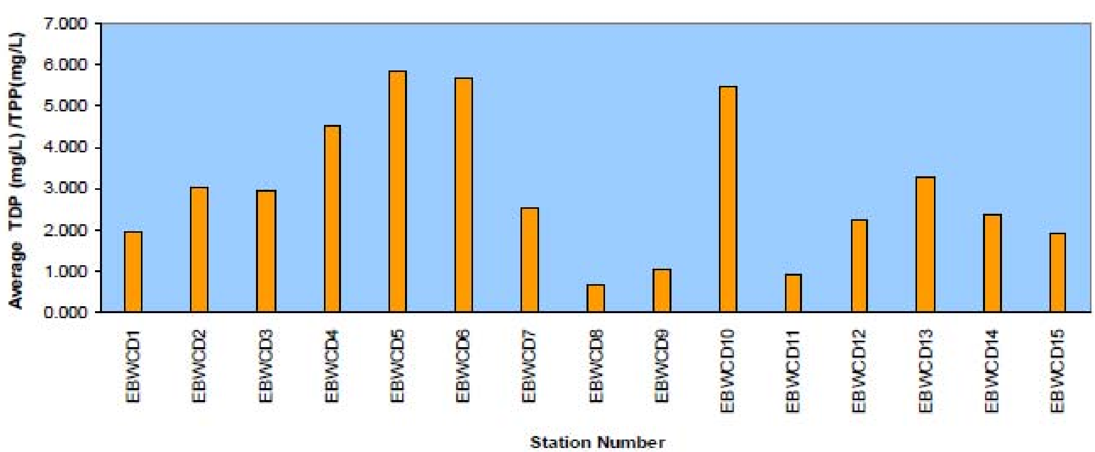
Monthly rainfall levels during the 2007 synoptic period were generally below historic levels, as shown in Figure 11. The cumulative rainfall for WY2007 was 40.25 inches, while the 30-year average annual rainfall was 48.82 inches. Flow monitoring was not conducted at the upstream monitoring stations.

This assessment indicates that dissolved phosphorus is the dominant form of phosphorus. The synoptic study references Daroub, et al. (2002) in suggesting soil mineralization and fertilizer application in the EAA as the primary source for dissolved phosphorus (Florida Atlantic University, 2008). Figure 12 summarizes the ratios of TDP to total particulate phosphorus (TPP) at the 15 monitoring stations.



Source: Figure 15. Monthly Rainfall Depth Values and 30 Year Average Rainfall Amounts, excerpt from Florida Atlantic University, 2008.

Figure 11. Monthly Rainfall Depth Values and 30-Year Average Rainfall Amounts



Source: Figure 19. Average Values of TDP/TPP Ratios, excerpt from Florida Atlantic University, 2008.

Figure 12. Average Values of TDP/TPP Ratio

As part of the 2008 report, Florida Atlantic University also analyzed historic water quality data for EBWCD at their discharge locations to the EAA and the Lake. Table 7 provides a statistical summary for the entire upstream monitoring period. Table 8 summarizes station names, sample parameters, and period of record for the discharge site and upstream monitoring sites.

Table 7. 2007 Mean Concentrations of Constituents Monitoring Frequencies by Site and Parameter

Water Quality Constituent Concentrations and Parameter Values									
Station	TP (mg/L)	TPP (mg/L)	TDP (mg/L)	SRP (mg/L)	NH4 (mg/L)	NOX (mg/L)	Sulfate (mg/L)	Turbidity (NTU)	Specific Conductivity (µS/cm)
EBWCD1	0.148	0.049	0.098	0.083	0.145	0.072	45.442	14.021	610.779
EBWCD2	0.231	0.054	0.178	0.153	0.375	0.032	62.653	8.416	923.474
EBWCD3	0.266	0.063	0.202	0.181	0.285	0.064	46.716	10.126	667.663
EBWCD4	0.347	0.071	0.276	0.252	0.346	0.063	43.653	8.721	644.342
EBWCD5	0.370	0.053	0.317	**0.295**	0.425	0.143	45.126	9.158	639.500
EBWCD6	0.243	0.042	0.213	0.178	0.164	0.014	41.950	5.478	660.833
EBWCD7	0.257	0.073	0.184	0.152	0.507	0.020	79.678	8.061	1286.733
EBWCD8	0.151	0.084	0.057	0.029	0.121	0.076	72.971	16.965	1074.065
EBWCD9	0.177	0.078	0.106	0.069	0.489	0.104	166.505	7.432	2192.000
EBWCD10	0.289	0.047	0.242	0.212	0.276	0.019	53.695	4.353	733.532
EBWCD11	0.167	0.101	0.069	0.041	0.256	0.017	111.253	13.874	1567.947
EBWCD12	0.350	0.133	0.217	0.182	0.565	0.273	252.579	9.584	2742.421
EBWCD13	**0.479**	**0.147**	**0.324**	0.268	**1.209**	0.289	233.353	**18.389**	**3196.611**
EBWCD14	0.320	0.099	0.221	0.188	0.607	**0.308**	271.737	9.032	2790.842
EBWCD15	0.264	0.101	0.157	0.122	0.485	0.226	**273.278**	8.628	2733.167
Maximum	0.479	0.147	0.324	0.295	1.209	0.308	273.278	18.389	3196.611
Minimum	0.148	0.042	0.057	0.029	0.121	0.014	41.950	4.353	610.779

Source: Table 3. Mean Concentrations of Constituents and Parameters from Monitoring Effort, excerpt from Florida Atlantic University, 2008.

Notes: NH4= Ammonium
NOX= Nitrate

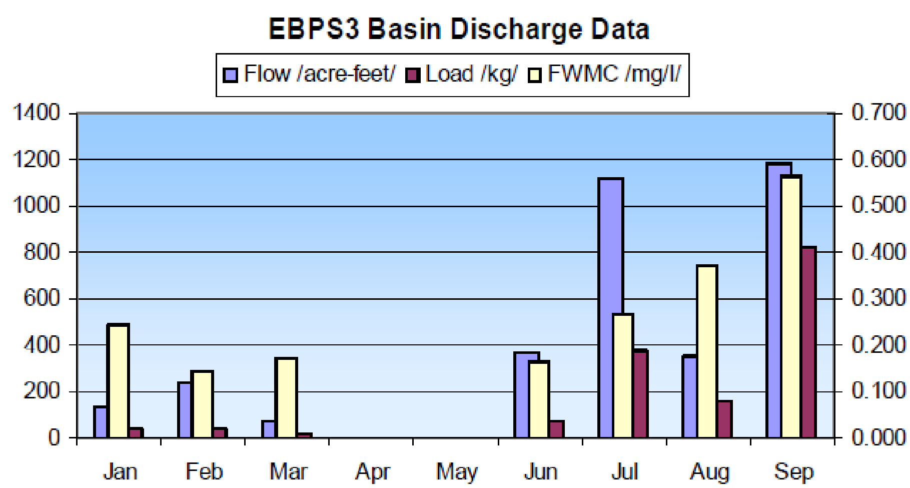
Table 8. Summary of EBWCD Monitoring Stations for WY 1980 through WY 2014.

Station Name	Parameters	Period of Record in DBHYDRO or RegDB	Comment
CULV10 (C-10; EB#1)	TP, OPO4	5/15/1979– 7/11/2012	Grab
EB#3 (WP16.8TS)	TP	1/2/1993 – 7/27/2001	21-day automatic sampler; Data archived in RegDB. Represents historic areas discharging to the EAA prior to the diversion project.
EBPS3 (WP16.8TS; EBPS)	TP	7/25/2001 – 12/31/2014	7-day automatic sampler
		2/13/2002 – 12/31/2014	Grab
	OPO4	01/26/2005 – 02/17/2005 10/23/2014 – Ongoing	Grab
CULV10 (C-10; EB#1)	Flow	3/1/1972– 9/30/2014	
EB#3 (WP16.8TS)	Flow	1/2/1993 – 6/30/2001	Data archived in RegDB
EBPS3 (WP16.8TS; EBPS)	Flow	7/1/2001 – 12/31/2014	

Source: Table 1. Summary of EBWCD monitoring stations for WY 1980 through WY 2014, excerpt from SFWMD, 2015.

Notes: OPO4= Ortho-Phosphate

Flow monitoring was only conducted at EBPS3. Figure 13 summarizes the flow (ac-ft), TP loading (kg), and TP concentrations (mg/L) for the EBPS3 from January to September 2007, in parallel with the synoptic upstream monitoring.



Source: Figure 16. Monthly EBPS3 Flow, TP Load and TP FWMC, excerpt from Florida Atlantic University, 2008.

Figure 13. EBPS3 Basin Discharge Data

The *Year-end Status of FY 2009 EBWCD Upstream Monitoring Program* by the SFWMD (2009) is a follow-up memorandum to the FDEP *Water Quality Synoptic Survey Data Analysis for EBWCD* (Florida Atlantic University, 2008). Because the synoptic upstream surface water monitoring conducted in 2007 identified several potential phosphorus sources, provided future monitoring recommendations, and noted dry conditions during the monitoring period, continued monitoring was approved by the SFWMD for fiscal year (FY) 2009. This additional water quality monitoring would help characterize upstream water quality and flow during more typical (wetter) rainfall conditions.

Preliminary review of the data indicated that elevated TP levels occurred in the same general areas as in 2007. For the southern area, the memorandum indicates that elevated levels of TP, ranging from 800 ppb to 1,400 ppb, were observed at stations EBWCD 4 and 5, coincident with significant discharge through the EBWCD structure EBPS3 to the WPB Canal. Dissolved TP in the form of orthophosphate was the primary phosphorus form observed, which is indicative of runoff from agricultural areas. For the northern areas, TP levels in stations in proximity to Bryant Mill retention ponds, the City of Pahokee Incinerator and Ash Landfill, and the Solid Waste Authority Pahokee Landfill were elevated during dry periods and lowered in wet periods. TP levels in proximity to these areas were elevated during dry conditions and low in wet periods, implying groundwater transport to the conveyance canals being more significant than runoff (SFWMD, 2009).

The memorandum recommends a comprehensive evaluation be conducted from a regional perspective considering all potential sources previously identified, as well as additional factors including: EBWCD pump station flow, concentration and load patterns, timing of upstream results relative to the EBWCD pump stations, spatial distribution and correlation with land use features, parameters indicative of specific land uses, seasonal crop activity, rainfall and flow patterns, Lake Okeechobee irrigation surface inflows, and Lake and/or Groundwater stage patterns.

5.0 Summary

This report summarizes historic efforts to develop regional and sub-regional and water quality improvement projects for the S5A Sub-basin and the EBWCD to facilitate development of future sub-regional source control projects in accordance with the 2012 RS plan collaboratively developed by the SFWMD, FDEP and USEPA. Indicated below are highlights including areas for follow-up:

- Evaluation of regional and sub-regional water quality improvement projects in the S5A basin has been conducted during the past 20+ years. Alternate phosphorus reduction technologies at the regional and sub-regional levels were evaluated by Brown and Caldwell in 1993, as part of the Everglades Construction project design, and most recently in 2011 as part of the S-5A Water Quality Assessment and Phosphorus Reduction Strategies project (A.D.A. Engineering, Inc. and Soil and Water Engineering Technology, Inc., 2011). The 1993 analyses evaluated chemical precipitation, filtration and the use of stormwater treatment areas, and resulted in the selection of STAs as the most appropriate technologies at the regional and sub-regional level. The 2011 analyses used the WAM model to evaluate chemical precipitation, retention and recycle impoundments and a sediment control feature at the sub-regional level. The range of cost effectiveness for these projects ranged from $231 to $813 per pound of TP removed, and ranges of reduction in TP concentration at the S-5A pump station ranging from 3.9% to 4.6%. Completion of all projects was estimated to range from $400M to $678M and with a reduction of TP concentration at the S-5A pump station by 10% (from 192 ppb to 172 ppb).

- In 2001, diversion of the flows from the EBWCD into the EAA were initiated. The EBWCD is a Basin ID that flows into the S5A Basin and that has historically recorded higher TP concentrations than the rest of the S5A Basin. Between 2001 and 2009 various evaluations were conducted, in accordance with the Long-term Plan and in response to agricultural entities inquiries regarding the effects of non-agricultural sources, to develop specific remedies through coordination with FDEP. Review of prior communications between the agencies indicates that there may be an opportunity for follow-up and reassessing the status of some of the potential sources (e.g., City of Pahokee incinerator and Ash landfill and the Solid Waste Authority Pahokee Landfill). In 2013, EBWCD and the District entered into a cooperative agreement to implement a canal cleaning project. Review of the upstream water quality collected to date will be covered under Task 3 of this contract.

- In 2008, an assessment of dredging costs along 10.81 miles of the L-12 Canal (southeast end of the West palm Beach canal) was conducted and resulted in an approximate cost of $38M, however, the project was considered to be a low priority because canal conveyance was still appropriate (SFWMD, 2009b). Re-assessing the project from a water conveyance and water quality perspective may be appropriate. There may also be opportunities within other shared conveyances in the S5A Basin. Basin IDs discharge to the WPB and Ocean canals through pumps. Some Basin IDs discharge to lateral canals with open connections into the WPB Canal. Evaluating the potential of improving storage and water quality features at these lateral canals may be appropriate to pursue.
- In 2012, RS preliminarily identified three conceptual sub-regional source control projects, including the interconnection of five separate Basin IDs, improved detention within the EBWCD and use of an agricultural lease property owned by the District and Palm Beach County which is adjacent to the S-5A pump. The agricultural lease ended on February 2014 (SFWMD, 2013b) and the property is planned for recreational uses with 100% of onsite retention.
- Upcoming is the review of S5A and EBWCD upstream water quality data collected to date, which will be covered under Task 3 and 4 of this contract.

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APPENDIX 1

S-5A Structures and Water Quality Data

Discharge Structures Within the S-5A Basin by Unit Area ID

UNIT_AREA_ID	PERMIT NO	BASIN	TOTAL ACREAGE	STRUCTURE _ID	COMPONENT TYPE	MAXIMUM CALIBRATED	RECEIVING_BODY
50-004-01	50-00031-E	S-5A	908.85	WP07.4TS	2 Constant Speed Pump (Electric)	45,193.00	WEST PALM BEACH CANAL
50-006-01	50-00031-E	S-5A	388.28	OC08.7TN	Constant Speed Pump (Electric)	17,275.00	OCEAN CANAL
50-007-02	50-00031-E	S-5A	5,716.30	OC07.6TS	4 Variable Speed Pump(Diesel)	231,555.00	OCEAN CANAL
50-016-01	50-00031-E	S-5A	1,461.55	OC04.5TN	3 Variable Speed Pump(Diesel)	132,700.00	OCEAN CANAL
50-035-03	50-00031-E	S-5A	107.30	OC00.5TS	Variable Speed Pump(Diesel)	11,918.00	OCEAN CANAL
50-054-03	50-00047-E	S-5A	7,585.98	OC02.0TN	2 Variable Speed Pump(Diesel)	35,125.00	OCEAN CANAL
				OC03.0TN	2 Variable Speed Pump(Diesel)	81,118.00	OCEAN CANAL
				OC06.0TN	3 Variable Speed Pump(Diesel)	125,698.00	OCEAN CANAL
				OC06.0TN	Variable Speed Pump(Diesel)	41,768.00	OCEAN CANAL
				OC06.0TN	Variable Speed Pump(Diesel)	42,320.00	OCEAN CANAL
50-061-08	50-00065-E	S-5A	367.65	OC09.2TN	2 Variable Speed Pump(Diesel)	30,429.00	OCEAN CANAL
50-061-15	50-00061-E	S-5A	4,084.22	OC07.5TN	3 Variable Speed Pump(Diesel)	123,798.00	OCEAN CANAL
50-065-03	50-00083-E	S-5A	3,722.09	OC04.1TS	5 Single Pump/Variable Speed (Diesel)		OCEAN CANAL
50-002-01	50-00002-E	S-5A	5,636.37	WP15.3TS	2 Variable Speed Pump(Diesel)	185,339.00	WEST PALM BEACH CANAL
50-002-02	50-00002-E	S-5A	9,285.40	WP12.1TS	4 Variable Speed Pump(Diesel)	418,840.00	WEST PALM BEACH CANAL
50-015-01	50-00015-E	S-5A	3,339.43	WP19.3TN	2 Variable Speed Pump(Diesel)	113,155.00	WEST PALM BEACH CANAL
50-015-02	50-00015-E	S-5A	2,688.96	WP18.4TS	2 Variable Speed Pump(Diesel)	100,053.00	WEST PALM BEACH CANAL

UNIT_AREA_ID	PERMIT NO	BASIN	TOTAL ACREAGE	STRUCTURE_ID	COMPONENT TYPE	MAXIMUM CALIBRATED	RECEIVING_BODY
50-018-01	50-00018-E	S-5A	5,859.98	WP17.9TN	4 Variable Speed Pump(Diesel)	199,813.00	WEST PALM BEACH CANAL
50-018-02	50-00084-E	S-5A	6,722.07	WP15.4TN02	4 Variable Speed Pump(Diesel)	167,793.00	WEST PALM BEACH CANAL
50-018-03	50-00018-E	S-5A	9,062.31	WP09.1TN	5 Variable Speed Pump(Diesel)	276,963.00	WEST PALM BEACH CANAL
50-018-12	50-00018-E	S-5A	1,577.99	WP04.8TN	3 Variable Speed Pump(Diesel)	117,536.00	WEST PALM BEACH CANAL
50-018-13	50-00018-E	S-5A	594.28	WP07.5TN	Variable Speed Pump(Diesel)	26,268.00	WEST PALM BEACH CANAL
50-025-01	50-00031-E	S-5A	823.73	WP08.7TS	2 Box Pump	24,895.00	WEST PALM BEACH CANAL
50-033-02	50-00033-E	S-5A	6,020.46	WP16.8TS	4 Variable Speed Pump(Diesel)	207,855.00	WEST PALM BEACH CANAL
50-037-01	50-00037-E	S-5A	1,194.20	WP00.7TN	2 Variable Speed Pump(Diesel)	38,787.00	WEST PALM BEACH CANAL
50-038-01	50-00031-E	S-5A	1,285.00	WP10.6TS	3 Variable Speed Pump(Diesel)	111,207.00	WEST PALM BEACH CANAL
50-040-01	50-00031-E	S-5A	216.20	WP15.4TN01	Single Fixed Pump/Variable Speed	15,542.00	WEST PALM BEACH CANAL
50-040-02	50-00031-E	S-5A	494.04	WP15.4TN03	Variable Speed Pump(Diesel)	28,562.00	WEST PALM BEACH CANAL
50-044-01	50-00047-E	S-5A	2,168.80	WP06.7TN04	Variable Speed Pump(Diesel)	34,454.00	WEST PALM BEACH CANAL
				WP06.7TN05	Variable Speed Pump(Diesel)	46,393.00	WEST PALM BEACH CANAL
50-047-07	50-00047-E	S-5A	3,494.20	WP09.9TS	3 Variable Speed Pump(Diesel)	100,780.00	WEST PALM BEACH CANAL
50-054-01	50-00047-E	S-5A	10,360.28	WP00.8TN	Variable Speed Pump(Diesel)	32,358.00	WEST PALM BEACH CANAL
				WP01.6TN	Variable Speed Pump(Diesel)	44,480.00	WEST PALM BEACH CANAL
				WP03.6TN	3 Variable Speed Pump(Diesel)	113,786.00	WEST PALM BEACH CANAL
				WP04.1TN01	Variable Speed Pump(Diesel)	26,281.00	WEST PALM BEACH CANAL
				WP04.1TN03	2 Variable Speed Pump(Diesel)	70,978.00	WEST PALM BEACH CANAL
				WP06.7TN02	Variable Speed Pump(Diesel)	30,135.00	WEST PALM BEACH CANAL

UNIT_AREA_ID	PERMIT NO	BASIN	TOTAL ACREAGE	STRUCTURE _ID	COMPONENT TYPE	MAXIMUM CALIBRATED	RECEIVING_BODY
50-054-03	50-00047-E	S-5A	7,585.98	WP04.1TS	Constant Speed Pump (Electric)	8,826.00	WEST PALM BEACH CANAL
				WP04.5TS02	Constant Speed Pump (Electric)	21,683.00	WEST PALM BEACH CANAL
				WP04.5TS01	Variable Speed Pump(Diesel)	39,779.00	WEST PALM BEACH CANAL
				WP04.5TS02	Constant Speed Pump (Electric)	21,683.00	WEST PALM BEACH CANAL
50-059-01	50-00047-E	S-5A	11,550.89	WP10.1TN	4 Culvert - Open		WEST PALM BEACH CANAL
				WP10.1TN-A	Variable Speed Pump(Diesel)	19,533.00	WEST PALM BEACH CANAL
				WP10.1TN-C	Variable Speed Pump(Diesel)	23,567.00	WEST PALM BEACH CANAL
				WP10.1TN-D	2 Variable Speed Pump(Diesel)	77,906.00	WEST PALM BEACH CANAL
				WP10.1TN-E	Variable Speed Pump(Diesel)	22,281.00	WEST PALM BEACH CANAL
				WP10.1TN-F	Variable Speed Pump(Diesel)	20,103.00	WEST PALM BEACH CANAL
				WP12.8TN	4 Culvert - Open		WEST PALM BEACH CANAL
				WP12.8TN-C	Variable Speed Pump(Diesel)	18,250.00	WEST PALM BEACH CANAL
				WP12.8TN-D	2 Variable Speed Pump(Diesel)	64,019.00	WEST PALM BEACH CANAL
				WP12.8TN-E	Variable Speed Pump(Diesel)	10,757.00	WEST PALM BEACH CANAL
				WP12.8TN-F	Variable Speed Pump(Diesel)	34,222.00	WEST PALM BEACH CANAL
				WP12.8TN-I	2 Variable Speed Pump(Diesel)	78,051.00	WEST PALM BEACH CANAL
				WP14.1TN	2 Variable Speed Pump(Diesel)	65,270.00	WEST PALM BEACH CANAL
50-059-02	50-00047-E	S-5A	1,782.52	WP10.8TN	2 Variable Speed Pump(Diesel)	69,674.00	WEST PALM BEACH CANAL
				WP12.0TN	Variable Speed Pump(Diesel)	34,098.00	WEST PALM BEACH CANAL

UNIT_AREA_ID	PERMIT NO	BASIN	TOTAL ACREAGE	STRUCTURE _ID	COMPONENT TYPE	MAXIMUM CALIBRATED	RECEIVING_BODY
50-059-03	50-00047-E	S-5A	719.51	WP13.7TN	Variable Speed Pump(Diesel)	30,867.00	WEST PALM BEACH CANAL
50-059-04	50-00047-E	S-5A	306.10	WP16.0TN	Variable Speed Pump(Diesel)	7,489.00	WEST PALM BEACH CANAL
50-061-17	50-00018-E	S-5A	781.18	WP06.7TN01	Variable Speed Pump(Diesel)	29,532.00	WEST PALM BEACH CANAL
50-068-01	50-00047-E	S-5A	2,615.79	WP06.7TN06	3 Variable Speed Pump(Diesel)	111,685.00	WEST PALM BEACH CANAL

Rainfall Adjusted Unit Area Load (RAUL)												
BASIN ID	**UAID**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
50-002-01	166	1.70	0.83	0.54	0.93	0.51	1.32	0.94	1.76	1.11	1.77	0.58
50-002-02	165	1.54	0.60	0.40	0.76	0.60	1.47	0.57	0.74	1.01	1.48	0.75
50-004-01	152	1.95	0.73	0.31	0.41	0.60	0.77	0.57	0.56	0.79	1.17	0.50
50-006-01	134	2.40	0.53	0.94	1.41	0.89	1.03	0.90	0.64	0.62	0.74	0.48
50-007-02	116	8.01	1.93	1.23	2.54	1.06	2.20	1.00	1.91	2.71	3.28	1.45
50-013-01	113	-	-	-	1.58	1.28	1.79	1.23	1.13	1.14	0.96	0.53
50-015-01	188	1.39	0.69	1.21	0.78	-	1.95	1.42	1.03	0.79	1.69	0.72
50-015-02	168	2.80	1.25	1.30	1.32	1.14	1.94	1.36	1.02	0.72	1.44	1.06
50-016-01	129	8.01	1.90	1.58	2.11	2.55	3.81	1.60	2.48	2.00	1.89	0.71
50-018-01	187	1.49	0.45	0.67	0.52	0.82	0.76	0.64	0.76	0.72	1.83	0.54
50-018-02	186	1.87	0.32	0.45	0.68	0.73	0.64	1.01	0.48	0.64	1.04	0.69
50-018-03	179	1.05	0.39	0.74	0.83	0.51	1.02	0.93	0.28	1.23	1.54	0.48
50-018-12	172	0.95	0.50	0.75	1.07	0.59	1.03	0.62	0.87	0.70	1.13	0.39
50-018-13	178	0.21	0.43	0.26	0.76	0.46	2.40	1.14	1.00	1.49	1.67	0.99
50-025-01	153	1.95	0.59	0.34	0.90	0.59	0.71	0.88	1.25	0.95	1.07	0.51
50-033-02	167	6.63	-	1.53	2.98	2.61	2.14	1.71	0.40	1.17	3.49	2.69
50-035-02	113	-	-	-	1.58	1.28	1.79	1.23	1.13	1.14	0.96	0.53
50-035-03	208							6.48	24.14	18.38	14.15	7.31
50-037-01	169	3.55	0.61	0.58	2.20	2.24	2.11	2.83	1.48	0.49	0.53	0.09
50-038-01	160	1.97	1.02	0.45	0.47	0.28	3.49	1.35	0.61	0.75	0.70	1.16
50-040-01	184	-	0.74	-	0.33	0.38	0.38	0.32	6.31	1.59	4.97	0.20
50-040-02	183	-	1.91	0.60	0.53	0.78	1.32	2.14	-	2.80	2.25	0.22
50-044-01	176	-	-	2.66	6.79	2.35	4.38	4.61	1.85	2.18	3.04	1.09
50-047-07	155	-	0.53	0.31	0.86	0.34	0.46	0.45	0.18	0.42	1.09	0.33
50-054-01	170	-	0.94	0.44	0.36	0.67	0.48	0.54	1.43	0.67	0.61	0.17
50-054-03	130	-	0.21	0.19	0.22	0.40	0.18	0.38	0.43	0.46	0.03	0.09
50-059-01	180	-	-	1.16	0.84	1.46	1.68	1.23	0.60	-	1.61	1.21

RAUL												
BASIN ID	UAID	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
50-059-02	181	-	-	-	0.57	0.53	1.43	0.48	0.44	0.51	0.98	0.56
50-059-03	182	-	-	0.88	0.34	0.42	1.06	0.95	-	2.58	2.88	4.33
50-059-04	185	-	1.71	0.61	0.46	0.99	2.05	2.03	0.47	2.53	2.34	1.07
50-061-08	135	-	-	-	-	-	0.93	0.16	0.20	0.28	0.50	0.41
50-061-10	027	-	-	0.26	0.45	0.56	0.17	0.26	0.19	0.39	0.45	0.16
50-061-15	132	-	0.77	0.31	0.48	0.85	1.75	1.08	-	0.36	0.27	0.28
50-061-17	177	-	6.48	5.05	7.38	4.95	3.32	5.59	5.83	4.80	4.19	1.76
50-064-01	113	-	-	-	1.58	1.28	1.79	1.23	1.13	1.14	0.96	0.53
50-064-03	113	-	-	-	1.58	1.28	1.79	1.23	1.13	1.14	0.96	0.53
50-064-04	113	-	-	-	1.58	1.28	1.79	1.23	1.13	1.14	0.96	0.53
50-065-03	113	-	-	-	1.58	1.28	1.79	1.23	1.13	1.14	0.96	0.53
50-065-05	113	-	-	-	1.58	1.28	1.79	1.23	1.13	1.14	0.96	0.53
50-065-08	113	-	-	-	1.58	1.28	1.79	1.23	1.13	1.14	0.96	0.53
50-068-01	175	-	-	0.60	1.31	0.58	0.61	0.59	0.40	0.64	0.74	0.45

RAUL												
BASIN ID	**UAID**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
50-002-01	166	0.69	1.83	0.99	1.10	0.34	0.79	0.68	1.56	0.55	0.87	0.47
50-002-02	165	0.57	0.90	1.14	1.04	0.42	0.89	0.49	0.79	0.44	0.20	0.45
50-004-01	152	0.54	0.48	0.19	2.05	0.31	0.77	0.51	1.65	0.16	-	-
50-006-01	134	0.55	0.78	1.14	1.55	0.69	2.06	0.44	0.42	0.90	-	0.46
50-007-02	116	1.17	5.18	3.15	2.80	0.81	2.99	1.42	1.63	-	-	0.42
50-013-01	113	0.73	1.58	1.07	1.33	0.50	0.76	0.76	1.70	0.89	1.27	0.75
50-015-01	188	0.75	1.68	0.55	1.19	0.43	1.22	1.33	0.55	1.01	0.97	0.42
50-015-02	168	0.57	1.02	0.47	0.90	0.42	0.78	0.65	0.46	0.51	0.49	0.55
50-016-01	129	1.11	1.59	1.67	1.39	0.40	1.06	0.51	0.66	0.95	1.08	1.03
50-018-01	187	1.21	2.30	0.26	2.06	0.73	1.71	1.24	1.32	1.27	0.57	0.54
50-018-02	186	1.23	3.69	0.37	0.70	0.68	0.79	0.66	0.99	0.74	0.69	0.61
50-018-03	179	0.65	1.22	0.69	1.64	0.54	1.25	0.58	1.02	0.81	0.59	0.65
50-018-12	172	1.39	2.40	22.24	14.14	0.15	2.73	0.85	0.70	1.04	1.40	0.42
50-018-13	178	1.28	2.95	9.98	7.86	1.52	3.13	1.31	0.89	1.83	1.52	0.66
50-025-01	153	1.64	1.50	1.84	2.16	0.51	0.69	0.25	0.23	-	-	0.32
50-033-02	214	2.05	5.27	1.97	3.55	2.16	5.13	2.12	1.87	3.10	3.13	1.06
50-035-02	113	0.73	1.58	1.07	1.33	0.50	0.76	0.76	1.70	0.89	1.27	0.75
50-035-03	208	2.80	4.66	5.34	16.53	6.59	6.33	-	6.83	4.38	-	
50-037-01	169	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
50-038-01	160	-	1.81	0.67	1.29	0.20	1.22	0.33	0.37	-	-	-
50-040-01	184	0.48	0.27	0.26	0.84	0.25	1.28	1.26	0.80	0.80	0.56	0.55
50-040-02	183	0.33	0.22	0.39	0.76	0.28	1.26	1.11	0.64	0.73	0.55	0.49
50-044-01	176	1.34	1.71	2.85	2.93	1.15	2.96	0.69	1.10	1.36	1.54	0.54
50-047-07	155	0.56	1.15	0.81	1.07	0.70	0.86	0.29	0.71	0.48	0.77	0.25
50-054-01	170	0.38	0.89	1.77	1.11	0.76	1.91	0.59	0.40	0.94	0.89	0.48
50-054-03	130	0.03	0.08	0.56	0.90	0.55	0.38	0.04	0.02	0.52	0.42	0.22
50-059-01	180	1.61	4.28	1.59	1.41	0.63	1.46	1.16	2.19	0.88	1.02	2.06

RAUL												
BASIN ID	**UAID**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
50-059-02	181	0.78	2.58	0.44	1.18	0.27	0.86	0.58	1.94	0.45	0.44	0.46
50-059-03	182	2.47	3.48	0.69	3.51	0.75	2.16	0.84	0.72	0.55	0.52	0.72
50-059-04	185	1.93	1.74	1.08	0.35	0.55	1.20	1.20	2.21	0.46	0.75	0.88
50-061-08	135	0.53	1.26	0.17	1.25	0.24	0.95	0.65	1.98	0.74	0.62	0.47
50-061-10	027	0.13	0.21	0.53	0.22	0.10	0.24	0.11	0.13	0.17	0.16	0.11
50-061-15	132	3.43	5.64	5.86	6.74	2.84	2.93	1.27	1.96	2.67	1.25	0.46
50-061-17	177	0.73	1.58	1.07	1.33	0.50	0.76	0.76	1.70	0.89	1.27	0.75
50-064-01	113	0.73	1.58	1.07	1.33	0.50	0.76	0.76	1.70	0.89	1.27	0.75
50-064-03	113	0.73	1.58	1.07	1.33	0.50	0.76	0.76	1.70	0.89	1.27	0.75
50-064-04	113	0.73	1.58	1.07	1.33	0.50	0.76	0.76	1.70	0.89	1.27	0.75
50-065-03	113	0.73	1.58	1.07	1.33	0.50	0.76	0.76	1.70	0.89	1.27	0.75
50-065-05	113	0.73	1.58	1.07	1.33	0.50	0.76	0.76	1.70	0.89	1.27	0.75
50-065-06	113	0.73	1.58	1.07	1.33	0.50	0.76	0.76	1.70	0.89	1.27	0.75
50-065-08	113	0.57	1.19	0.92	3.30	0.85	2.01	0.26	1.66	0.53	0.74	0.26
50-068-01	175	0.57	1.19	0.92	3.30	0.85	2.01	0.26	1.66	0.53	0.74	0.26

		Flow (MG)										
BASIN ID	**UAID**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
50-002-01	166	3887	6348	4427	3002	3535	2597	4789	3482	4336	4738	4469
50-002-02	165	9852	11571	8162	5681	8065	4797	6910	3322	5749	5723	6926
50-004-01	152	714	1084	471	588	561	350	568	187	563	622	379
50-006-01	134	437	673	439	542	455	279	528	217	303	214	337
50-007-02	116	7767	10806	6263	5590	5490	5373	5094	5801	10218	7274	6050
50-013-01	113	-	-	-	8166	9873	6378	11417	6144	10423	5307	4760
50-015-01	188	2328	3066	3057	1142	-	1450	3056	1108	1608	2452	2132
50-015-02	168	1860	2070	1868	983	2013	984	2059	580	636	984	1440
50-016-01	129	3067	3530	2146	1552	2606	1731	2071	1272	2038	1525	1053
50-018-01	187	5102	7580	6385	2179	6011	3247	5533	2274	3602	4975	4039
50-018-02	186	7527	9236	8109	3918	9973	3950	8612	3485	6666	6740	6141
50-018-03	179	11490	18349	12295	10156	12514	7246	13043	3430	11774	8884	7577
50-018-12	172	2848	4501	3113	2550	2798	1871	1957	967	2671	1712	1938
50-018-13	178	163	926	431	624	928	958	1040	304	1075	834	782
50-025-01	153	718	1039	511	875	656	414	625	149	669	508	420
50-033-02	167	2211	-	1532	1523	2134	561	1264	276	801	1215	1451
50-035-02	113	-	-	-	8166	9873	6378	11417	6144	10423	5307	4760
50-035-03	208							958	1998	6753	4612	2904
50-037-01	169	1265	2284	1570	2933	2590	2243	2772	879	467	466	170
50-038-01	160	948	1211	584	453	397	673	849	243	766	488	698
50-040-01	184	-	292	-	73	165	102	204	491	458	356	185
50-040-02	183	-	1617	842	259	615	471	842	-	784	595	243
50-044-01	176	-	-	1027	1553	840	628	1491	622	1431	1191	1885
50-047-07	155	-	2355	1488	1762	2904	1869	2799	1225	3694	3300	2605
50-054-01	170	-	9403	6904	6471	7695	3412	6094	4075	6328	2992	2582
50-054-03	130	-	1255	640	654	894	192	532	293	938	48	76
50-059-01	180	-	-	15000	6230	9491	6492	11665	3481	-	7936	7803

		Flow (MG)										
BASIN ID	**UAID**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
50-059-02	181	-	-	-	1161	1546	1329	2014	1024	2208	1894	2061
50-059-03	182	-	-	836	324	487	486	890	-	1057	776	583
50-059-04	185	-	454	273	97	158	181	340	44	271	243	197
50-061-08	135	-	-	-	-	-	241	81	112	344	229	236
50-061-15	132	-	2078	897	661	1540	1396	5457	-	3039	2917	2732
50-061-17	177	-	5328	4813	3149	3832	2012	3882	1525	3048	2727	2228
50-064-01	113	-	-	-	8166	9873	6378	11417	6144	10423	5307	4760
50-064-03	113	-	-	-	8166	9873	6378	11417	6144	10423	5307	4760
50-064-04	113	-	-	-	8166	9873	6378	11417	6144	10423	5307	4760
50-065-03	113	-	-	-	8166	9873	6378	11417	6144	10423	5307	4760
50-065-05	113	-	-	-	8166	9873	6378	11417	6144	10423	5307	4760
50-065-06	113	-	-	-	8166	9873	6378	11417	6144	10423	5307	4760
50-065-08	113	-	-	-	8166	9873	6378	11417	6144	10423	5307	4760
50-068-01	175	-	-	4038	2384	2004	1250	2029	327	2248	1607	1673

		Flow (MG)										
BASIN ID	**UAID**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
50-002-01	166	6255	3959	3382	1403	3042	4039	2606	1057	3406	3450	3673
50-002-02	165	9259	5284	4786	3033	5911	7378	4142	2785	5235	6491	7314
50-004-01	152	579	327	333	550	507	725	279	280	294	-	-
50-006-01	134	493	257	332	206	207	443	96	110	165	-	116
50-007-02	116	9627	6644	6509	4341	6188	15290	7298	4367	-	-	2568
50-013-01	113	8343	7698	9640	6426	10287	10231	5618	6608	11537	14385	10540
50-015-01	188	4156	2699	1312	1169	2190	3502	2108	550	2303	2219	1169
50-015-02	168	1988	1065	825	633	1207	1405	1018	367	1536	1390	1058
50-016-01	129	1950	944	1805	786	1009	1652	708	762	1737	2134	1494
50-018-01	187	8129	5536	2723	2973	5425	8605	3699	1700	5386	4944	2878
50-018-02	186	10390	7970	4083	3847	7549	10032	3499	3035	6705	7475	5996
50-018-03	179	11360	7918	6239	8631	8705	11748	5477	5352	8700	10274	6409
50-018-12	172	3259	2439	2590	2619	658	4540	1778	839	1910	1927	1239
50-018-13	178	930	740	577	819	949	1295	485	319	698	1003	920
50-025-01	153	626	261	164	155	224	428	158	183	-	-	531
50-033-02	214	7055	4815	3320	2330	3954	5236	2819	1404	4678	5061	3089
50-035-02	113	8343	7698	9640	6426	10287	10231	5618	6608	11537	14385	10540
50-035-03	208	1713	1166	1579	620	647	811	-	279	689	-	
50-037-01	169	0	0	0	0	0	0	0	0	0	0	0
50-038-01	160	-	324	567	489	390	1588	564	413	-	-	-
50-040-01	184	296	93	123	92	129	366	178	56	208	153	260
50-040-02	183	397	140	277	188	380	732	430	115	421	319	481
50-044-01	176	2601	1365	1996	1913	3001	3290	1466	1060	2077	3137	1914
50-047-07	155	3651	2799	2383	1864	2400	3931	1388	1908	2906	5140	2865
50-054-01	170	4017	3638	6361	4468	7145	10329	3301	2234	11781	11762	6990
50-054-03	130	186	110	438	333	393	549	78	86	7288	8130	6326
50-059-01	180	16049	7919	4987	5077	6718	10792	5856	5588	7125	8685	6826

		Flow (MG)										
BASIN ID	**UAID**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
50-059-02	181	2923	1506	1095	1294	1108	2068	960	1251	1132	1523	1242
50-059-03	182	903	784	492	316	487	689	298	226	303	541	644
50-059-04	185	600	281	280	51	297	400	303	166	160	237	218
50-061-08	135	544	209	71	233	244	377	124	262	379	284	222
50-061-15	132	5067	3146	4741	2876	3805	6155	1652	3155	4873	4207	2601
50-061-17	177	3605	1521	2227	2520	2345	2866	1372	1126	1040	978	543
50-064-01	113	8343	7698	9640	6426	10287	10231	5618	6608	11537	14385	10540
50-064-03	113	8343	7698	9640	6426	10287	10231	5618	6608	11537	14385	10540
50-064-04	113	8343	7698	9640	6426	10287	10231	5618	6608	11537	14385	10540
50-065-03	113	8343	7698	9640	6426	10287	10231	5618	6608	11537	14385	10540
50-065-05	113	8343	7698	9640	6426	10287	10231	5618	6608	11537	14385	10540
50-065-06	113	8343	7698	9640	6426	10287	10231	5618	6608	11537	14385	10540
50-065-08	113	8343	7698	9640	6426	10287	10231	5618	6608	11537	14385	10540
50-068-01	175	2383	1750	1547	2675	3171	3492	750	968	1235	2392	1641

Concentration (mg/L)												
BASIN ID	UAID	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
50-002-01	166	0.219	0.196	0.149	0.171	0.118	0.272	0.218	0.297	0.203	0.196	0.103
50-002-02	165	0.129	0.130	0.099	0.123	0.100	0.270	0.150	0.215	0.228	0.223	0.143
50-004-01	152	0.228	0.169	0.135	0.065	0.142	0.191	0.178	0.282	0.180	0.158	0.169
50-006-01	134	0.196	0.084	0.188	0.103	0.113	0.141	0.128	0.117	0.109	0.127	0.081
50-007-02	116	0.528	0.276	0.247	0.257	0.161	0.223	0.222	0.197	0.213	0.239	0.193
50-013-01	113	-	-	-	0.170	0.152	0.214	0.170	0.153	0.123	0.110	0.103
50-015-01	188	0.181	0.204	0.293	0.229	-	0.420	0.301	0.317	0.227	0.210	0.157
50-015-02	168	0.347	0.418	0.393	0.341	0.212	0.480	0.334	0.469	0.404	0.347	0.267
50-016-01	129	0.350	0.217	0.242	0.201	0.215	0.316	0.228	0.306	0.207	0.172	0.143
50-018-01	187	0.153	0.094	0.135	0.138	0.117	0.131	0.135	0.205	0.165	0.201	0.112
50-018-02	186	0.146	0.061	0.080	0.113	0.070	0.101	0.152	0.094	0.089	0.094	0.105
50-018-03	179	0.071	0.050	0.115	0.070	0.054	0.122	0.127	0.078	0.133	0.146	0.081
50-018-12	172	0.048	0.049	0.085	0.067	0.051	0.087	0.103	0.155	0.061	0.101	0.047
50-018-13	178	0.069	0.074	0.077	0.071	0.043	0.142	0.129	0.203	0.116	0.110	0.106
50-025-01	153	0.199	0.125	0.120	0.083	0.108	0.134	0.229	0.722	0.164	0.161	0.143
50-033-02	167	0.316	-	0.257	0.228	0.206	0.421	0.309	0.176	0.238	0.309	0.304
50-035-02	113	-	-	-	0.170	0.152	0.214	0.170	0.153	0.123	0.110	0.103
50-035-03	208							0.160	0.184	0.078	0.058	0.073
50-037-01	169	0.577	0.165	0.188	0.170	0.224	0.159	0.357	0.313	0.259	0.187	0.130
50-038-01	160	0.237	0.290	0.215	0.131	0.134	0.635	0.403	0.340	0.176	0.170	0.303
50-040-01	184	-	0.147	-	0.097	0.074	0.077	0.067	0.291	0.106	0.280	0.033
50-040-02	183	-	0.160	0.079	0.102	0.092	0.134	0.250	-	0.250	0.175	0.063
50-044-01	176	-	-	0.723	0.550	0.515	0.839	0.768	0.393	0.270	0.348	0.176
50-047-07	155	-	0.136	0.104	0.109	0.079	0.111	0.151	0.072	0.075	0.107	0.063
50-054-01	170	-	0.201	0.105	0.041	0.095	0.101	0.132	0.276	0.111	0.141	0.069
50-054-03	130	-	0.055	0.078	0.040	0.080	0.112	0.172	0.188	0.085	0.079	0.197
50-059-01	180	-	-	0.199	0.157	0.258	0.284	0.238	0.206	-	0.217	0.253

		Concentration (mg/L)										
BASIN ID	UAID	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
50-059-02	181	-	-	-	0.083	0.088	0.179	0.082	0.078	0.056	0.085	0.068
50-059-03	182	-	-	0.164	0.074	0.090	0.147	0.149	-	0.243	0.244	0.744
50-059-04	185	-	0.308	0.148	0.144	0.279	0.331	0.360	0.343	0.401	0.273	0.234
50-061-08	135	-	-	-	-	-	0.144	0.153	0.072	0.045	0.076	0.091
50-061-15	132	-	0.201	0.153	0.144	0.100	0.149	0.182	-	0.094	0.076	0.087
50-061-17	177	-	0.511	0.360	0.362	0.296	0.247	0.446	0.627	0.347	0.228	0.179
50-064-01	113	-	-	-	0.170	0.152	0.214	0.170	0.153	0.123	0.110	0.103
50-064-03	113	-	-	-	0.170	0.152	0.214	0.170	0.153	0.123	0.110	0.103
50-064-04	113	-	-	-	0.170	0.152	0.214	0.170	0.153	0.123	0.110	0.103
50-065-03	113	-	-	-	0.170	0.152	0.214	0.170	0.153	0.123	0.110	0.103
50-065-05	113	-	-	-	0.170	0.152	0.214	0.170	0.153	0.123	0.110	0.103
50-065-06	113	-	-	-	0.170	0.152	0.214	0.170	0.153	0.123	0.110	0.103
50-065-08	113	-	-	-	0.170	0.152	0.214	0.170	0.153	0.123	0.110	0.103
50-068-01	175	-	-	0.085	0.141	0.110	0.122	0.150	0.332	0.105	0.112	0.098

		Concentration (mg/L)										
BASIN ID	**UAID**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
50-002-01	166	0.188	0.229	0.203	0.298	0.155	0.185	0.165	0.513	0.169	0.246	0.128
50-002-02	165	0.172	0.139	0.272	0.215	0.164	0.187	0.122	0.162	0.147	0.050	0.103
50-004-01	152	0.255	0.117	0.064	0.228	0.137	0.160	0.186	0.331	0.093	-	-
50-006-01	134	0.133	0.105	0.168	0.202	0.325	0.308	0.205	0.093	0.396	-	0.274
50-007-02	116	0.210	0.390	0.341	0.249	0.183	0.186	0.124	0.132	-	-	0.169
50-013-01	113	0.174	0.118	0.150	0.153	0.132	0.136	0.166	0.173	0.156	0.168	0.140
50-015-01	188	0.178	0.179	0.169	0.225	0.158	0.191	0.230	0.201	0.273	0.253	0.217
50-015-02	168	0.221	0.215	0.181	0.245	0.217	0.238	0.183	0.199	0.165	0.165	0.249
50-016-01	129	0.257	0.220	0.171	0.178	0.147	0.160	0.121	0.080	0.149	0.129	0.180
50-018-01	187	0.265	0.215	0.071	0.275	0.196	0.196	0.220	0.281	0.257	0.118	0.199
50-018-02	186	0.236	0.267	0.074	0.081	0.147	0.086	0.140	0.134	0.139	0.108	0.122
50-018-03	179	0.157	0.122	0.123	0.116	0.138	0.160	0.108	0.107	0.157	0.090	0.165
50-018-12	172	0.213	0.142	1.751	0.602	0.096	0.166	0.088	0.085	0.168	0.209	0.101
50-018-13	178	0.247	0.207	1.266	0.384	0.234	0.240	0.179	0.103	0.290	0.156	0.077
50-025-01	153	0.653	0.413	1.139	0.776	0.458	0.221	0.147	0.065	-	-	0.090
50-033-02	167	0.443	0.483	0.368	0.517	0.678	0.823	0.424	0.413	0.620	0.541	0.457
50-033-02	214	0.443	0.483	0.368	0.517	0.678	0.823	0.424	0.413	0.620	0.541	0.457
50-035-02	113	0.174	0.118	0.150	0.153	0.132	0.136	0.166	0.173	0.156	0.168	0.140
50-035-03	208	0.102	0.072	0.086	0.284	0.301	0.156	-	0.181	0.127	-	
50-037-01	169	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
50-038-01	160	-	0.629	0.187	0.229	0.161	0.164	0.083	0.071	-	-	-
50-040-01	184	0.105	0.055	0.056	0.132	0.104	0.126	0.171	0.192	0.154	0.138	0.082
50-040-02	183	0.125	0.069	0.087	0.136	0.091	0.143	0.144	0.172	0.159	0.149	0.090
50-044-01	176	0.338	0.238	0.382	0.224	0.205	0.325	0.114	0.139	0.264	0.185	0.110
50-047-07	155	0.161	0.126	0.147	0.135	0.249	0.128	0.080	0.080	0.107	0.091	0.055
50-054-01	170	0.214	0.200	0.332	0.161	0.253	0.290	0.189	0.103	0.153	0.136	0.128
50-054-03	130	0.066	0.078	0.194	0.223	0.421	0.143	0.062	0.022	0.101	0.068	0.047
50-059-01	180	0.350	0.545	0.451	0.215	0.267	0.260	0.255	0.279	0.265	0.235	0.624

		Concentration (mg/L)										
BASIN ID	**UAID**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
50-059-02	181	0.142	0.265	0.087	0.108	0.104	0.123	0.119	0.169	0.132	0.089	0.120
50-059-03	182	0.587	0.276	0.123	0.530	0.269	0.371	0.223	0.139	0.242	0.120	0.144
50-059-04	185	0.297	0.166	0.145	0.142	0.138	0.153	0.135	0.251	0.163	0.168	0.222
50-061-08	135	0.111	0.197	0.112	0.136	0.090	0.158	0.219	0.175	0.134	0.140	0.138
50-061-15	132	0.190	0.180	0.069	0.078	0.150	0.118	0.075	0.099	0.262	0.118	0.096
50-061-17	177	0.459	0.519	0.518	0.288	0.476	0.273	0.165	0.172	0.374	0.174	0.120
50-064-01	113	0.174	0.118	0.150	0.153	0.132	0.136	0.166	0.173	0.156	0.168	0.140
50-064-03	113	0.174	0.118	0.150	0.153	0.132	0.136	0.166	0.173	0.156	0.168	0.140
50-064-04	113	0.174	0.118	0.150	0.153	0.132	0.136	0.166	0.173	0.156	0.168	0.140
50-065-03	113	0.174	0.118	0.150	0.153	0.132	0.136	0.166	0.173	0.156	0.168	0.140
50-065-05	113	0.174	0.118	0.150	0.153	0.132	0.136	0.166	0.173	0.156	0.168	0.140
50-065-06	113	0.174	0.118	0.150	0.153	0.132	0.136	0.166	0.173	0.156	0.168	0.140
50-065-08	113	0.174	0.118	0.150	0.153	0.132	0.136	0.166	0.173	0.156	0.168	0.140
50-068-01	175	0.189	0.156	0.191	0.218	0.173	0.250	0.103	0.276	0.207	0.140	0.074

APPENDIX 2

Long-term Plan for Achieving Water Quality Goals S5A Sub-Basin Meeting

South Florida Water Management District
Wednesday April 23, 2008

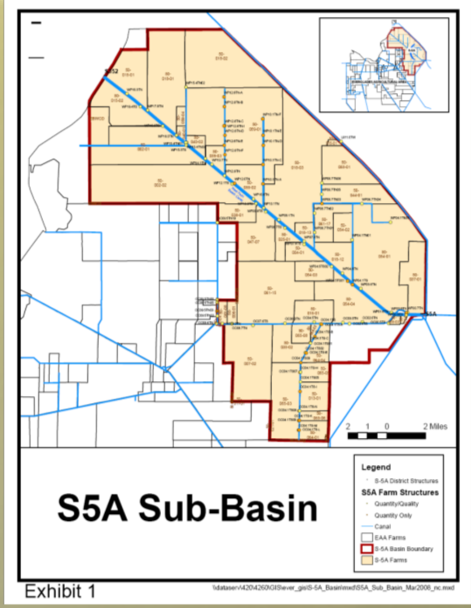
Long-term Plan for Achieving Water Quality Goals S5A Sub-Basin Meeting

South Florida Water Management District
Wednesday April 23, 2008

Agenda

Pam Wade, P.E. Director, Everglades Regulation Division

1. **Background**
2. **Introductions**
   - **Why are we here?**
3. **Basin Conditions**
   a) **Water Quality**
   b) **Source Controls**
   c) **Basin Characteristics**
4. **Past, present, and future projects**
5. **Brainstorming**



Basin Conditions

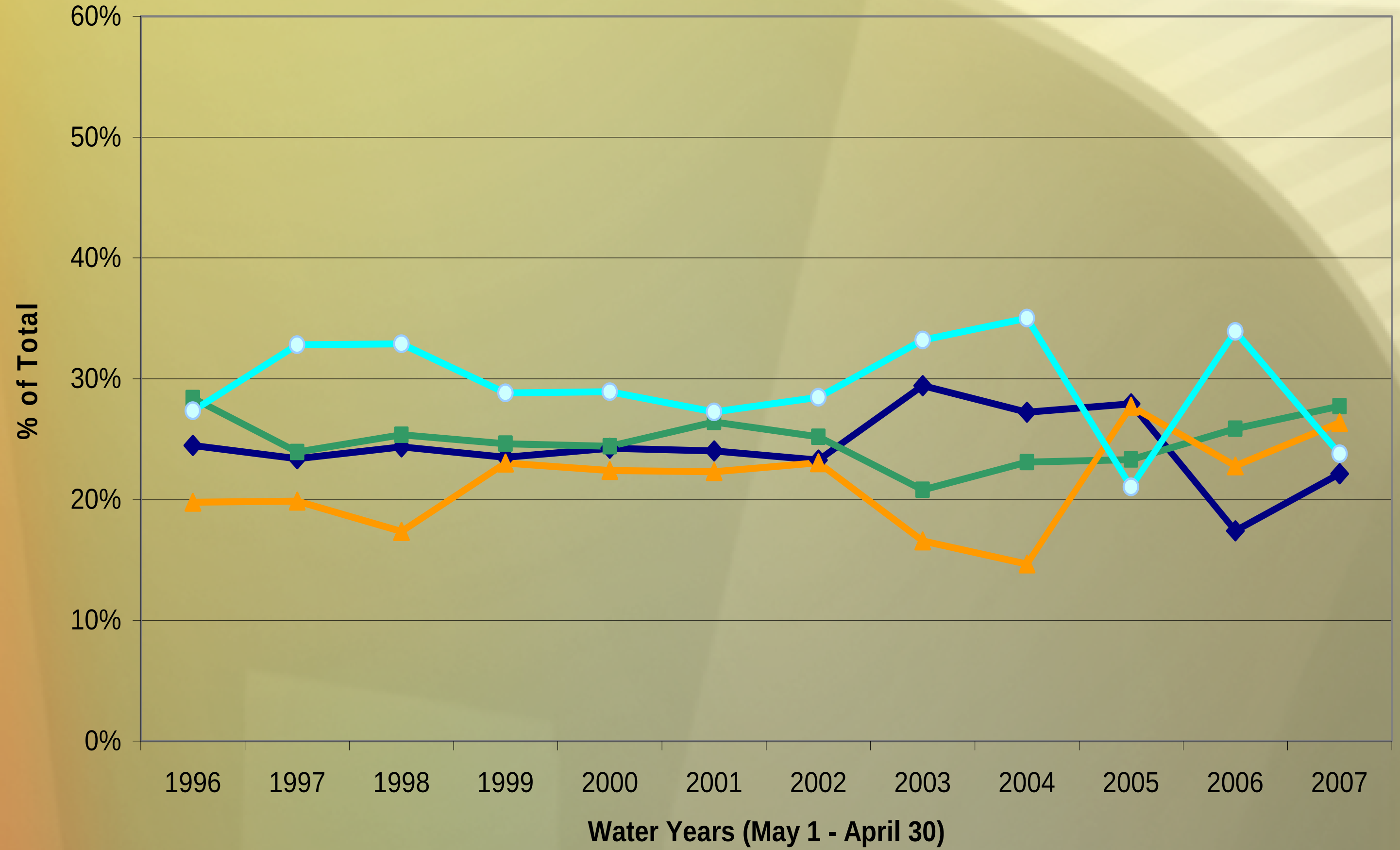
Doug Pescatore, Scientist 4

a) **Water Quality**

1. **S5A Sub-basin level data**
2. **S5A Farm level data**

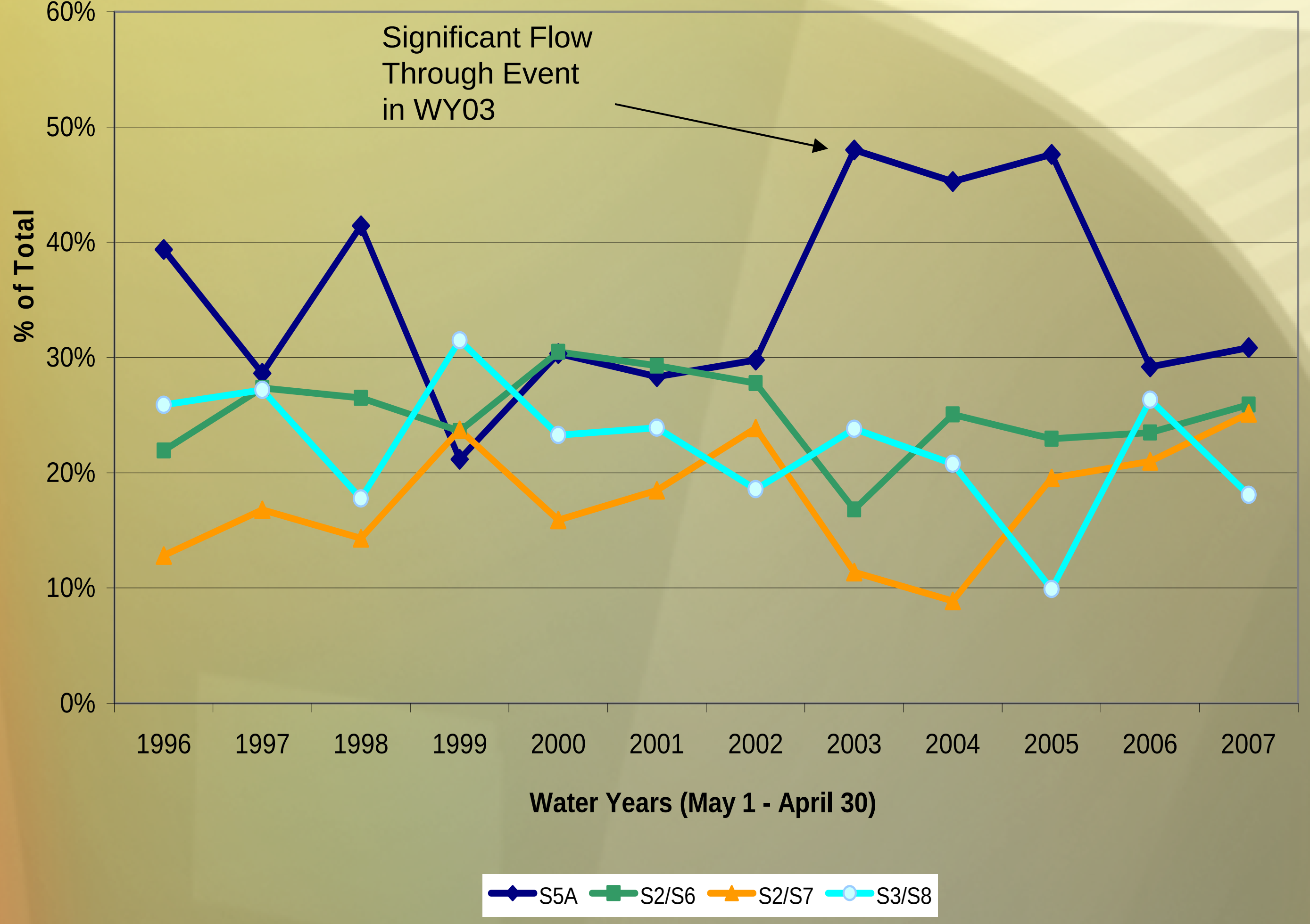
S5A Sub-basin level data

WY1996–WY2007 EAA sub-basin annual runoff volume percent “relative” contribution trend of basin total.

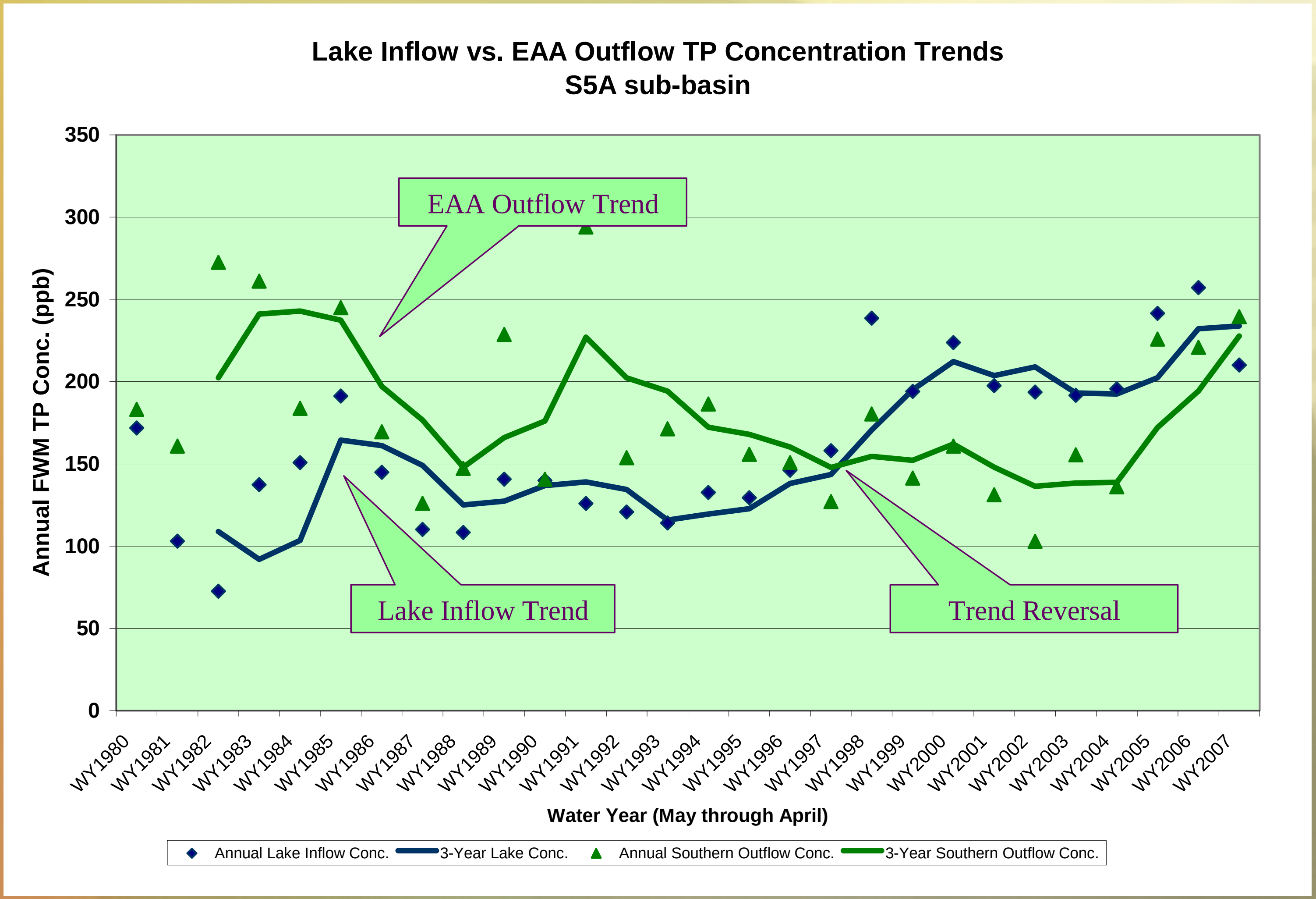


S5A Sub-basin level data

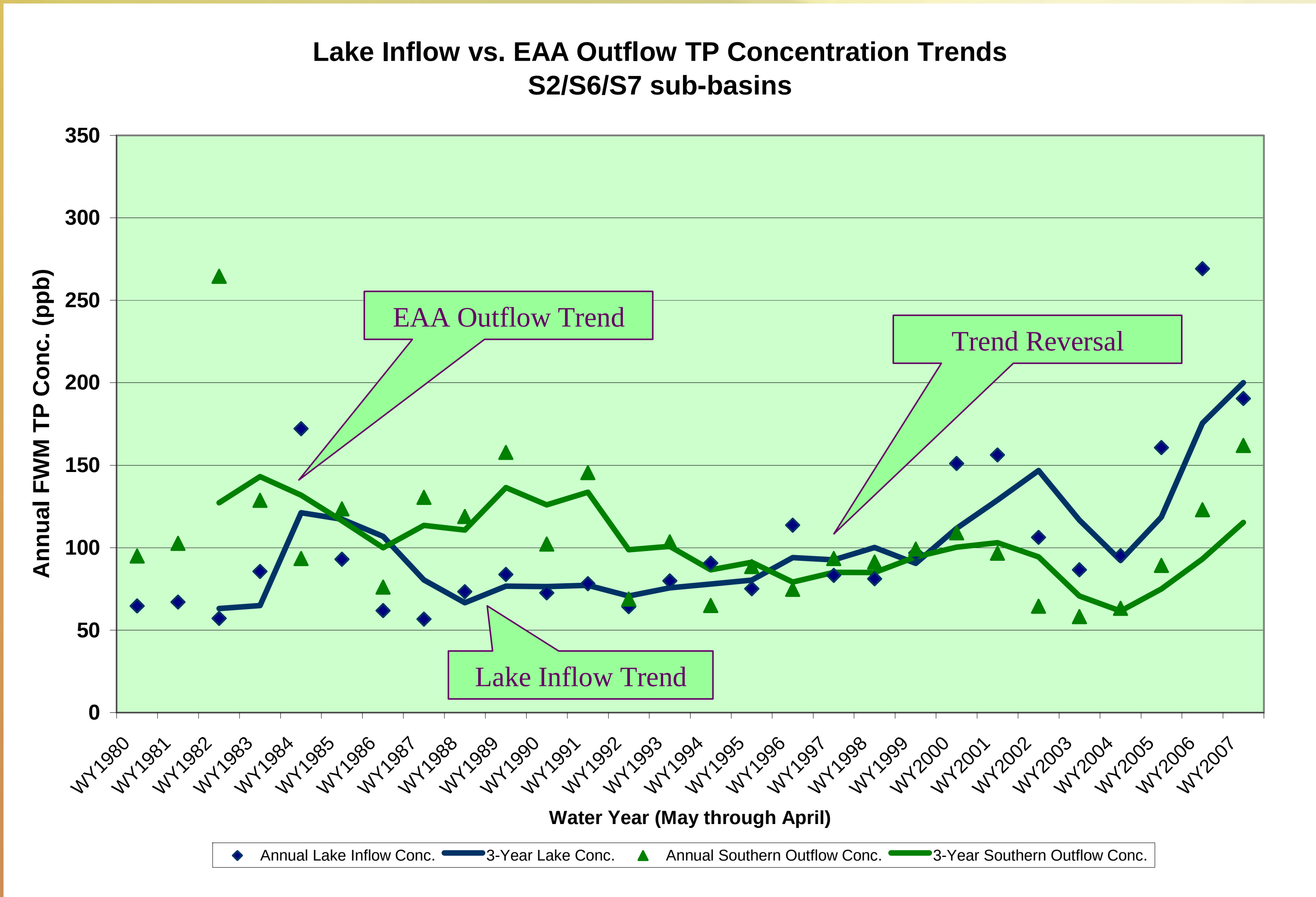
WY1996–WY2007 EAA sub-basin annual TP load percent "relative" contribution trend of basin total.



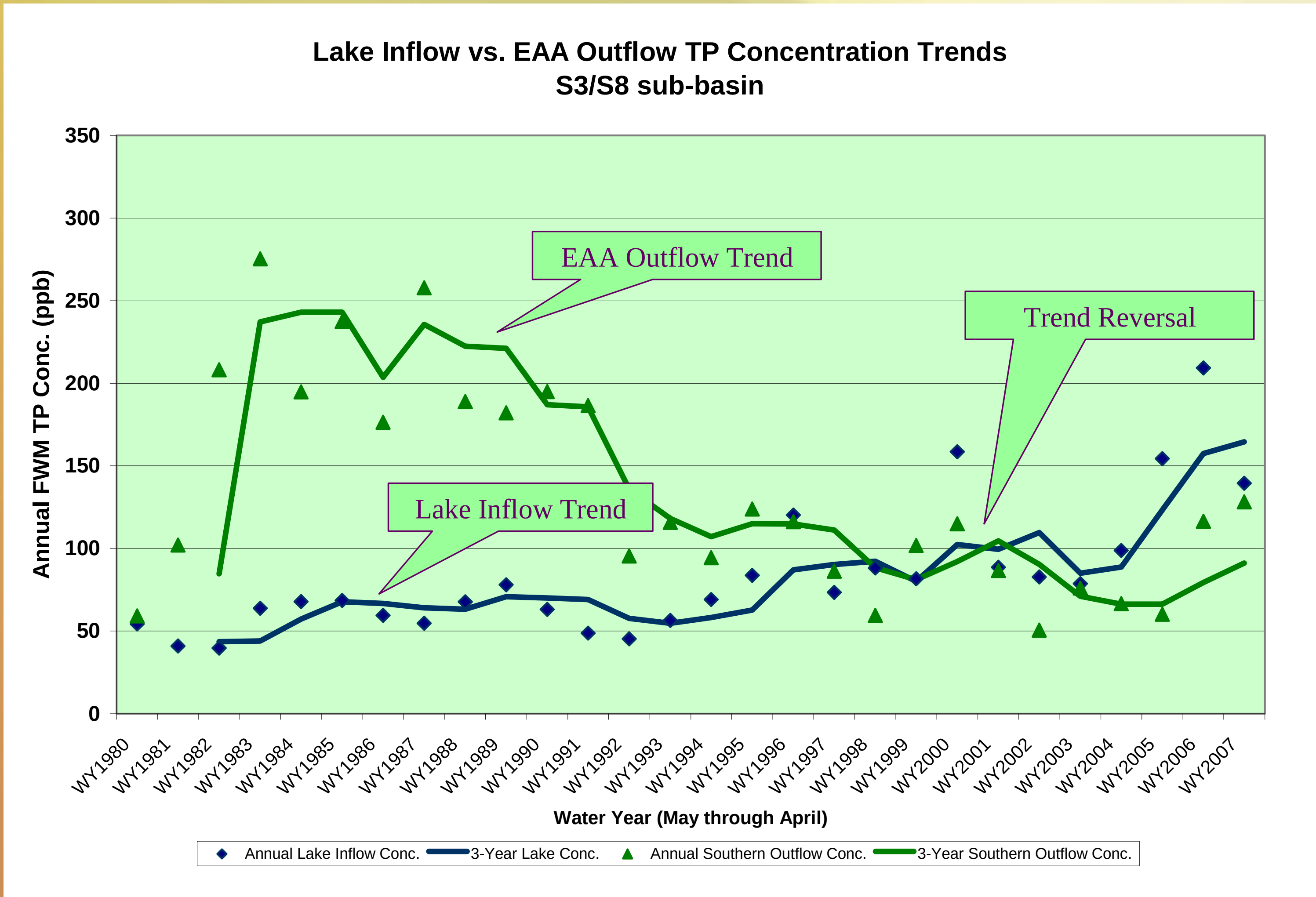
Lake Okeechobee inflows



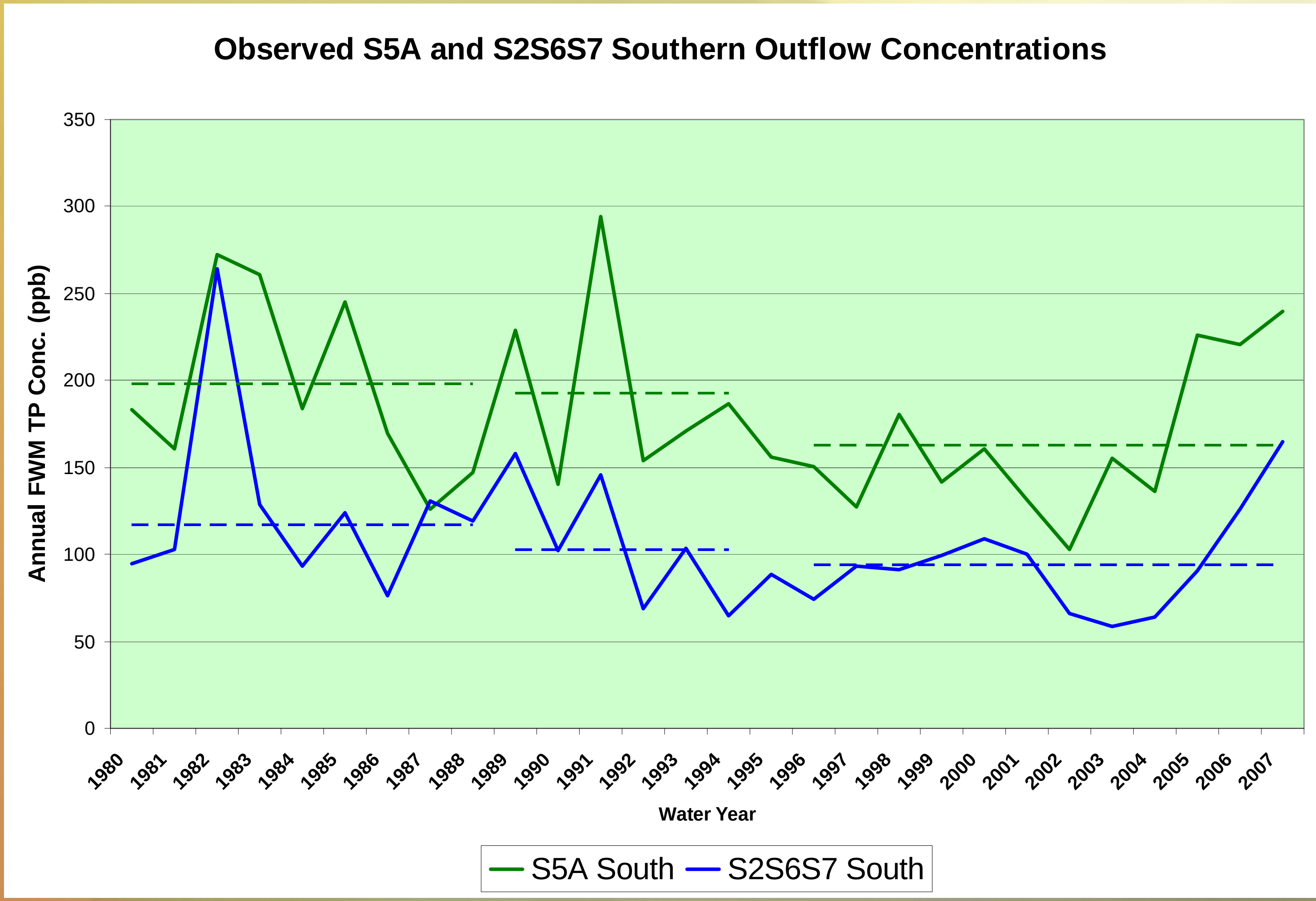
Lake Okeechobee inflows



Lake Okeechobee inflows



S5A Sub-basin level data



S5A Sub-basin level data

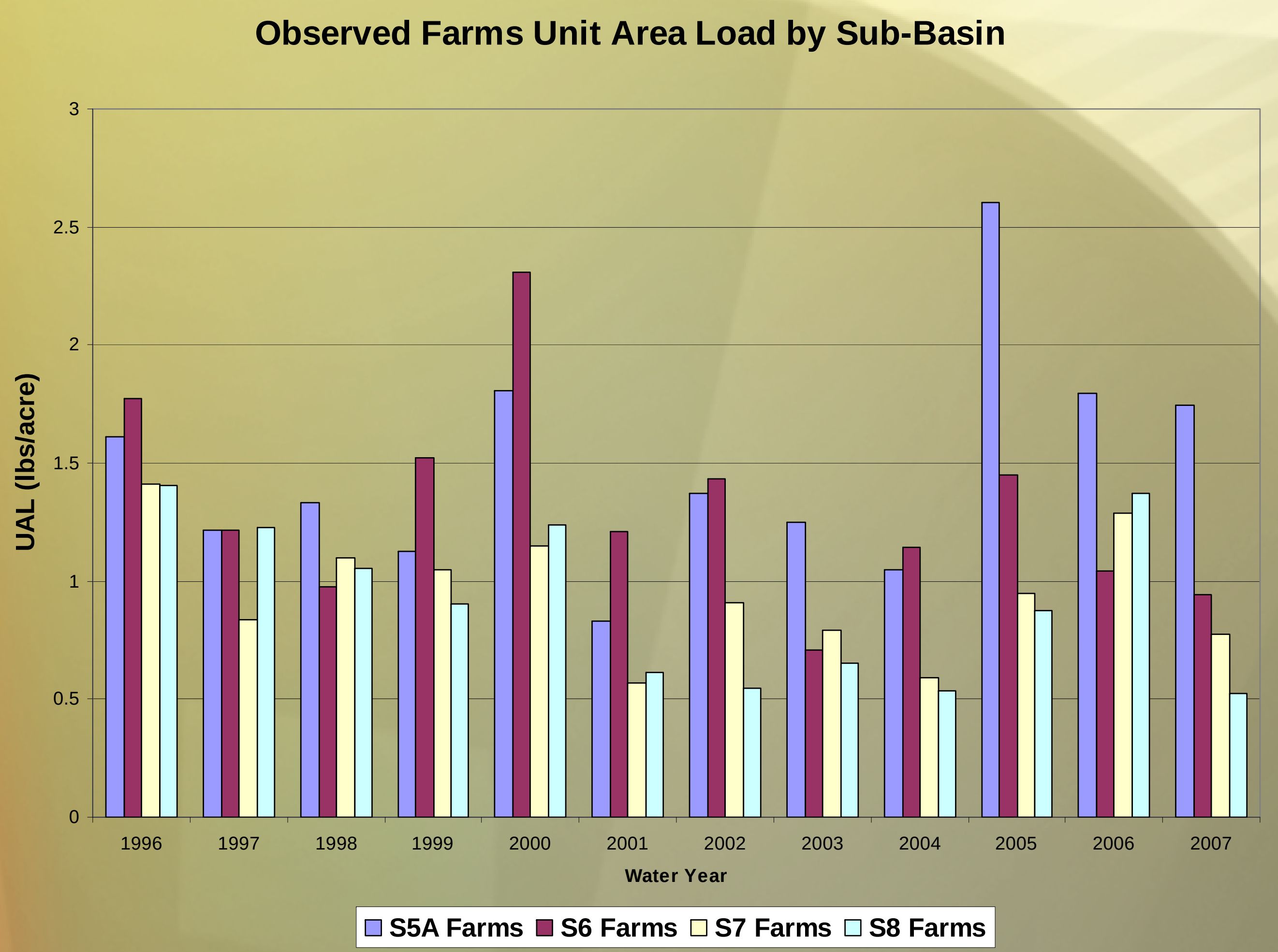
Observed Flow Weighted Mean Concentrations

	S5A Basin Inflow Conc. (ppb)	S5A Basin Outflow Conc. (ppb)
Base Period (WY80-WY88)	126	198
Pre-BMP Period (WY89-WY94)	127	192
Post-BMP Period (WY96-WY07)	204	162

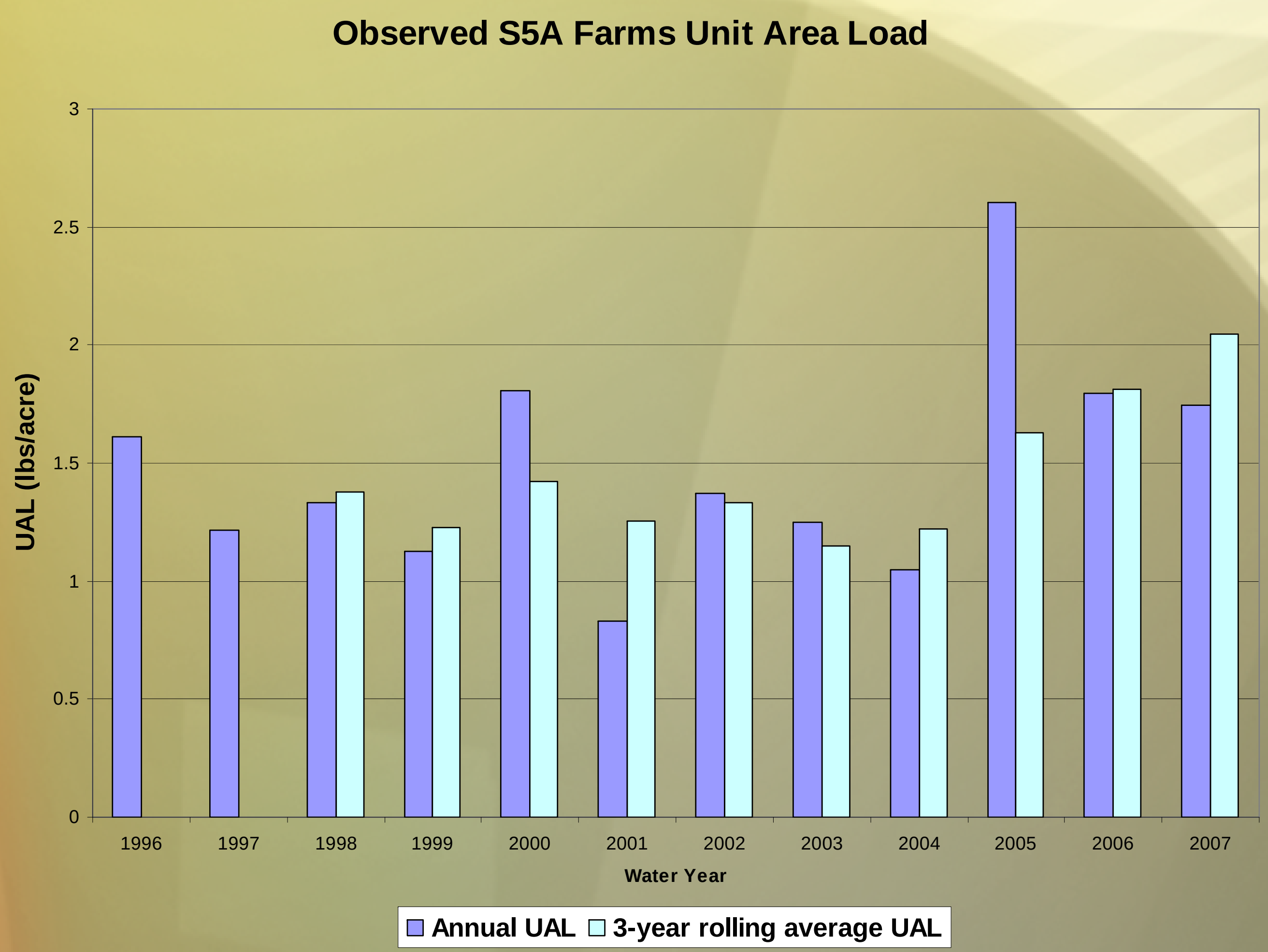
S5A Farm level data

- **Farm Level Data is provided to the District by the Farmers**
- **Only farms with greater than 75% sampled load are presented**
- **Unit Area Loads are presented in pounds per acre and are not adjusted for observed rainfall**
- **Concentrations presented are Flow Weighted Mean Concentrations for all farms within a Sub-Basin**

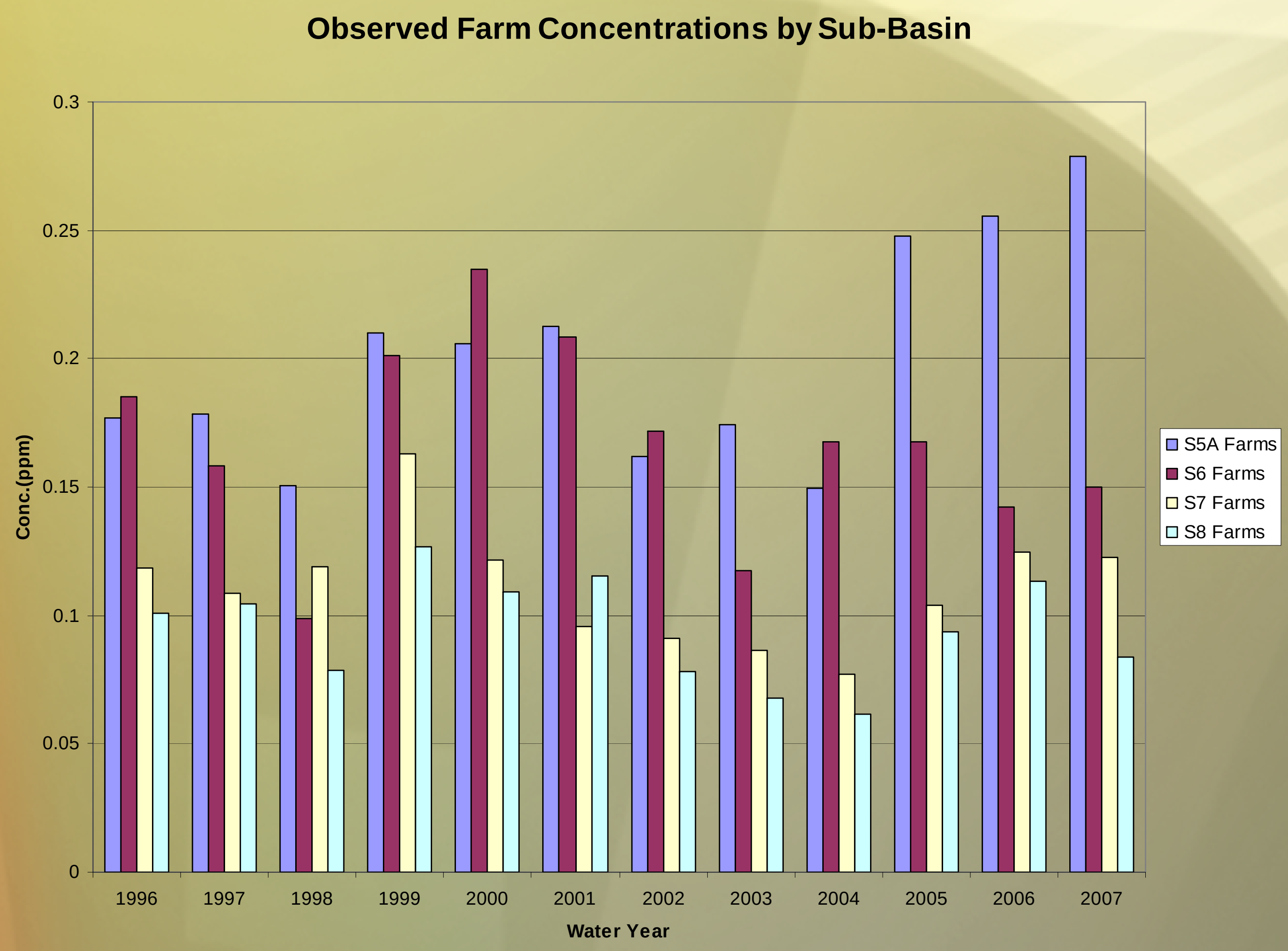
S5A Farm level data



S5A Farm level data



S5A Farm level data



Basin Conditions

Carmela Bedregal, PE, Sr Sup Engineer

b) Source Controls for Phosphorus

1. **BMP Plans per 40E-63 permits**
2. **Phosphorus control strategies per 40E-61 Management Plan Master Permit**
3. **EAA-EPD Master Research Permit**
4. **Other permits (MS4, DEP authorizations for industrial discharges)**

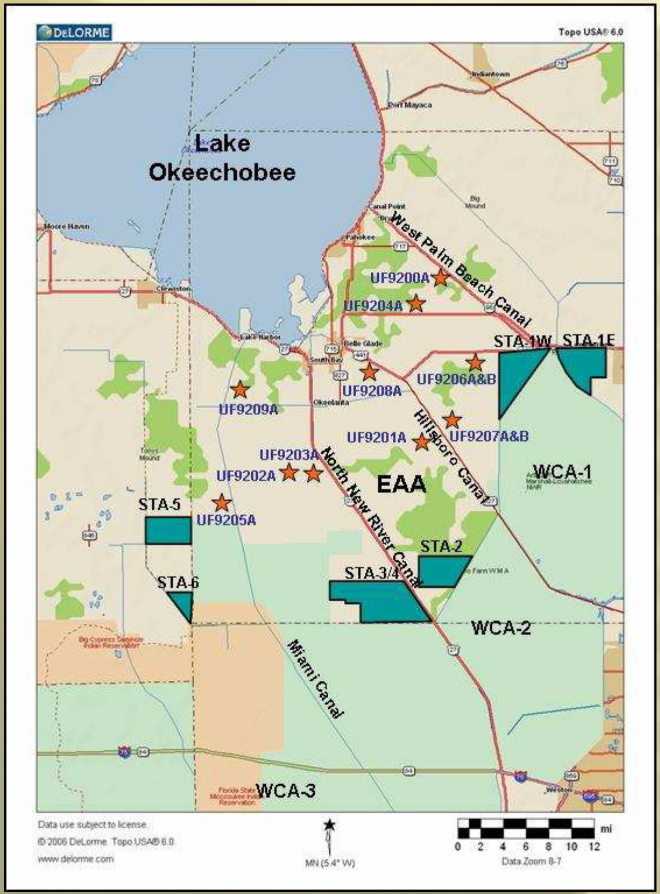
40E-63 and 40E-61 Source Control Programs

- 40E-63 Individual permits issued. Unit level is the farm basin (hydrologic unit)
- Permits were renewed in 2007-2008
- For the entire EAA Basin a BMP Plan generally including:
  - Water Management at the pump (0.5 inch or 1-inch rainfall level)
  - Sediment controls (6 or 4 selected based on detention)
  - Nutrient controls (soil testing, application control methods and spill prevention)
- Individual farm level monitoring.

- 40E-61Lake Okeechobee Master Permit can cover participating farms in the S5A Basin
- Under renewal (application submitted 09/2004)
- For the S5A farms, no source controls in addition to those under 40E-63, F.A.C.
  - Pump BMPs, superseded by Water Management BMP in 40E-63 permits,
  - Diversion of 3 POTW discharges into injection wells (They are in Closter Farms and S-2)
  - Closure of a mill (S4/Industrial Canal basin)

EAA-EPD Master Research Permit

- The EAA-EPD through the University of Florida IFAS conducted one-on-one BMP consultations to optimize BMP implementation on all S5A farms in 2005-2006
- The EAA-EPD conducted a statistical analysis of the data collected on 10 example farms
- S5A 2 farms, S6 4 farms, S-7 2 farms, and S-8 2 farms
- A revised scope of work for continuation of research on BMPs is due on May 8, 2008
- Proposed concept idea for continuing research is on aquatic plant management in EAA farm canals



Source: Management and Environmental Factors that Impact Phosphorus Loading from EAA Farms (Daroub et al, 2008)

Basin Conditions

Ximena Pernett, Engineering Specialist 3

c) Basin Characteristics - Farm regulatory data

1. **Soils**
2. **Farm Types**
3. **BMP Plans**
4. **Farms (types, sizes)**

SOILS IN THE S5A SUB-BASIN

SOIL TYPE	ACREAGE
Pahokee	79,806
Lauderhill	28,728
Terra Ceia/Torry	11,662

Characteristics
- **Moderately deep or deep**
- **Very poorly drained**
- **Rapidly permeable**
- **Organic soils underlain by limestone bedrock**

LAND USES

LAND USES	ACREAGE
AGRICULTURE (Sugar cane, rice, corn, sod, vegetables, nurseries, mixed agriculture)	117,620
URBAN (Residential, Urban, Governmental)	1,548
INDUSTRIAL (Industrial, Rock quarries, Rock pit, Mills)	1,306

BMP PERMITS – 40E-63

Acreage: 87,896; Landuses: Sugar Cane, Vegetables, Sod, Mixed Agriculture, Residential, Urban

BMP	Points
Nutrient Application Control	2.5
Nutrient Spill Prevention	2.5
Soil Testing	5
Particulate Matter and Sediment Control (4)	5
Water Management (1.0 inch)	10

Acreage: 22,330; Landuses: Sugar Cane, Vegetables, Sod, Corn, Industrial

BMP	Points
Nutrient Application Control	2.5
Nutrient Spill Prevention	2.5
Soil Testing	5
Particulate Matter and Sediment Control (6)	10
Water Management (0.5 inch)	5

BMP PERMITS – 40E-63

Acreage: 1,754.33; Landuses: Vegetables

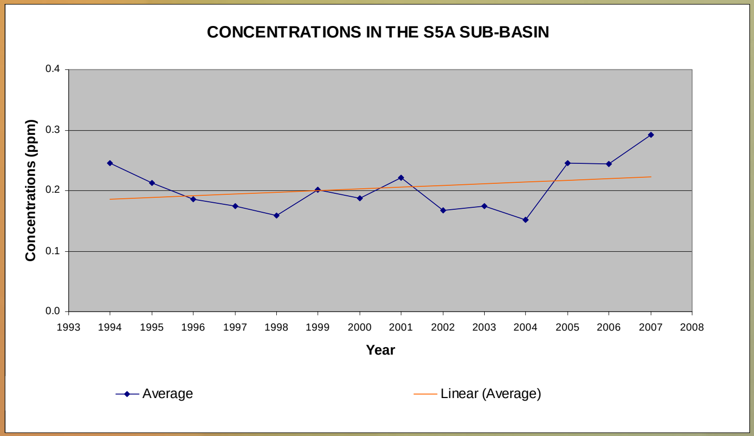
BMP	Points
Nutrient Application Control	2.5
Nutrient Spill Prevention	2.5
Soil Testing	5
Particulate Matter and Sediment Control (4)	5
Water Management (0.5 inch)	5
Reduced flow through water table management	5

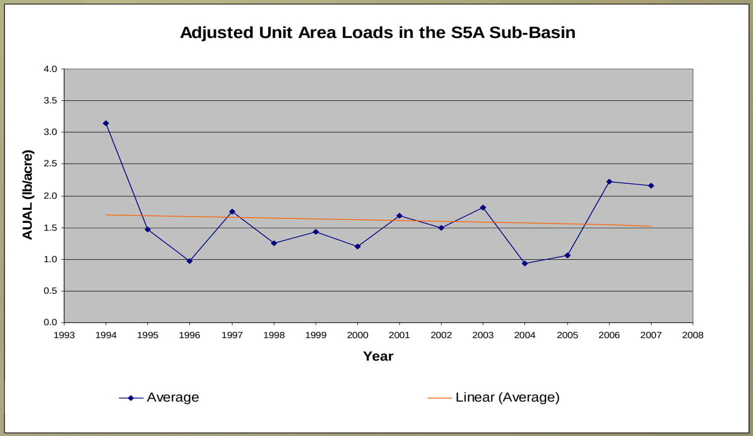
OTHER BMPs:

- **Water Management (1.5 inch) - Acreage: 879; Landuse: Rockpit, Industrial**
- **No Nutrients Imported via Direct Land Application, No Direct Discharge – Acreage: 254; Landuse: Rock quarries**

S5A FARMS

	AVERAGE	MAXIMUM	MINIMUM
SIZE (acres)	2,734	11,551	68
CONCENTRATIONS (ppm)	0.292	1.751 (1615.23 acres, SC+Veg, WY07)	0.033 (216.2 acres, SC+Sod, WY04)
AUAL (lb/acre) Calculated from 1994 - 2007 Adjusted Unit Area Loads	1.614	24.139 (120 acres, vegetables, WY01)	0.033 (1227 acres, SC, WY03)



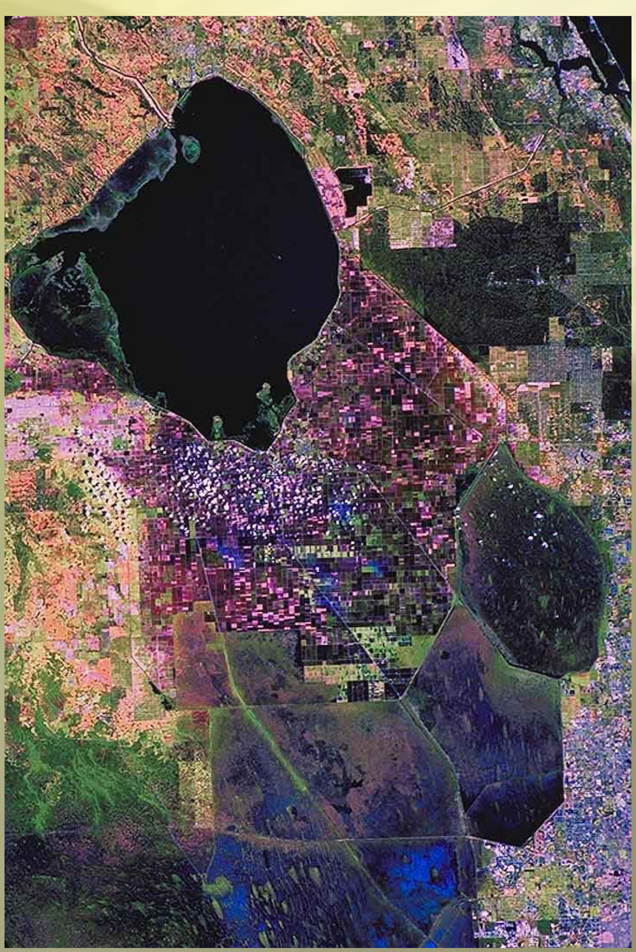


Past, present and future projects

1. **Lake Okeechobee Evaluation**
2. **East Beach Evaluation**
3. **Farm Data Analyses**
4. **S-5A Data Collection and GIS Mapping**

Lake Okeechobee Data Evaluation

The Lake Okeechobee Data Evaluation is intended to determine if there is a statistical relationship between the Lake Okeechobee inflow concentrations to the EAA and the downstream outflow concentrations



Lake Okeechobee Data Evaluation

The analysis is broken into two phases

- **The initial data evaluation**
- **The final analysis**

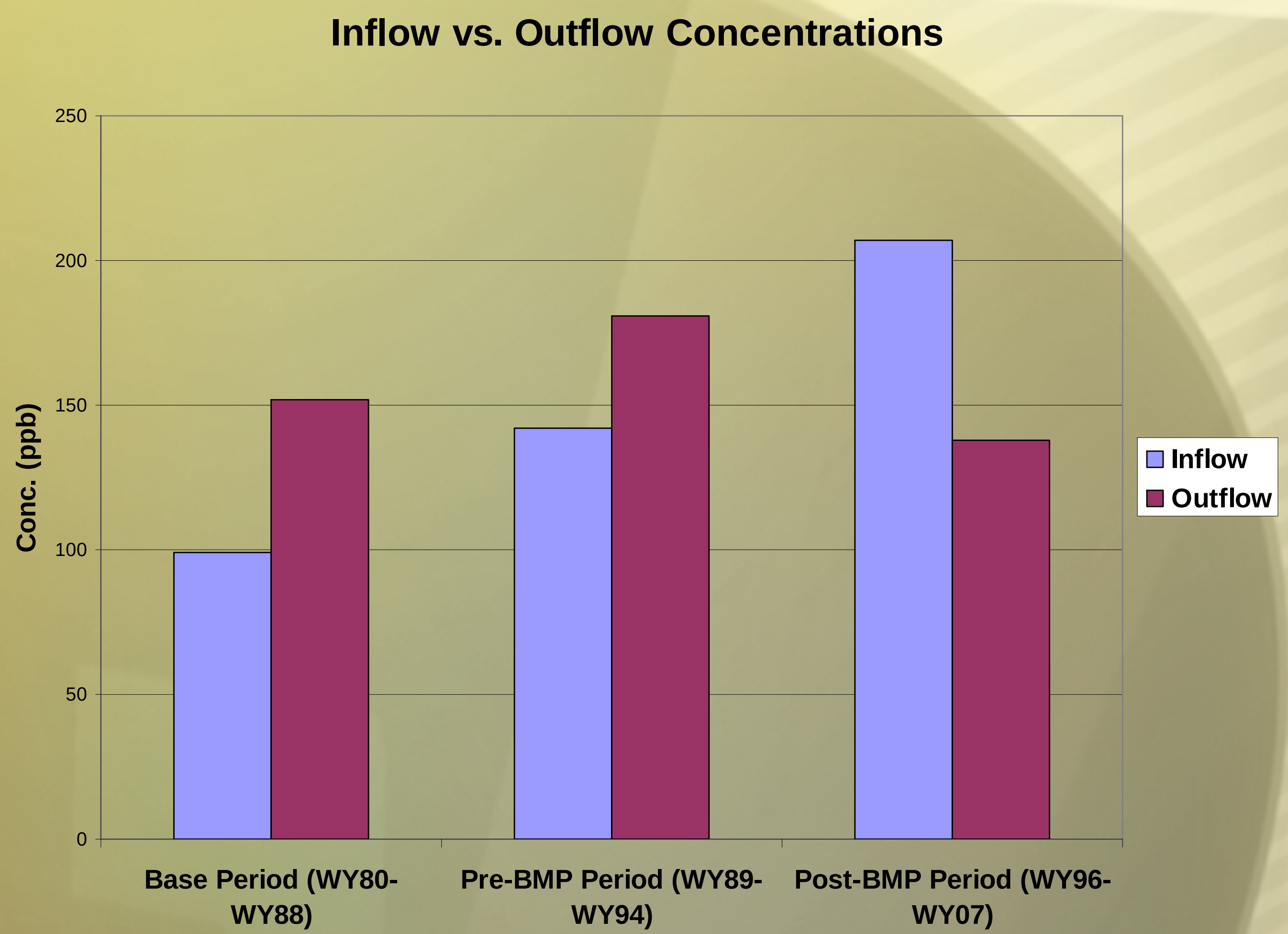
- **The analysis is carried out on 3 hydrologic sub-Basins (S3/S8, S2/S6/S7, and S5A)**
- **The analysis is carried out on 4 time periods (Baseline Period, Pre-BMP, Post-BMP, and the Period of Record)**

Lake Okeechobee Data Evaluation

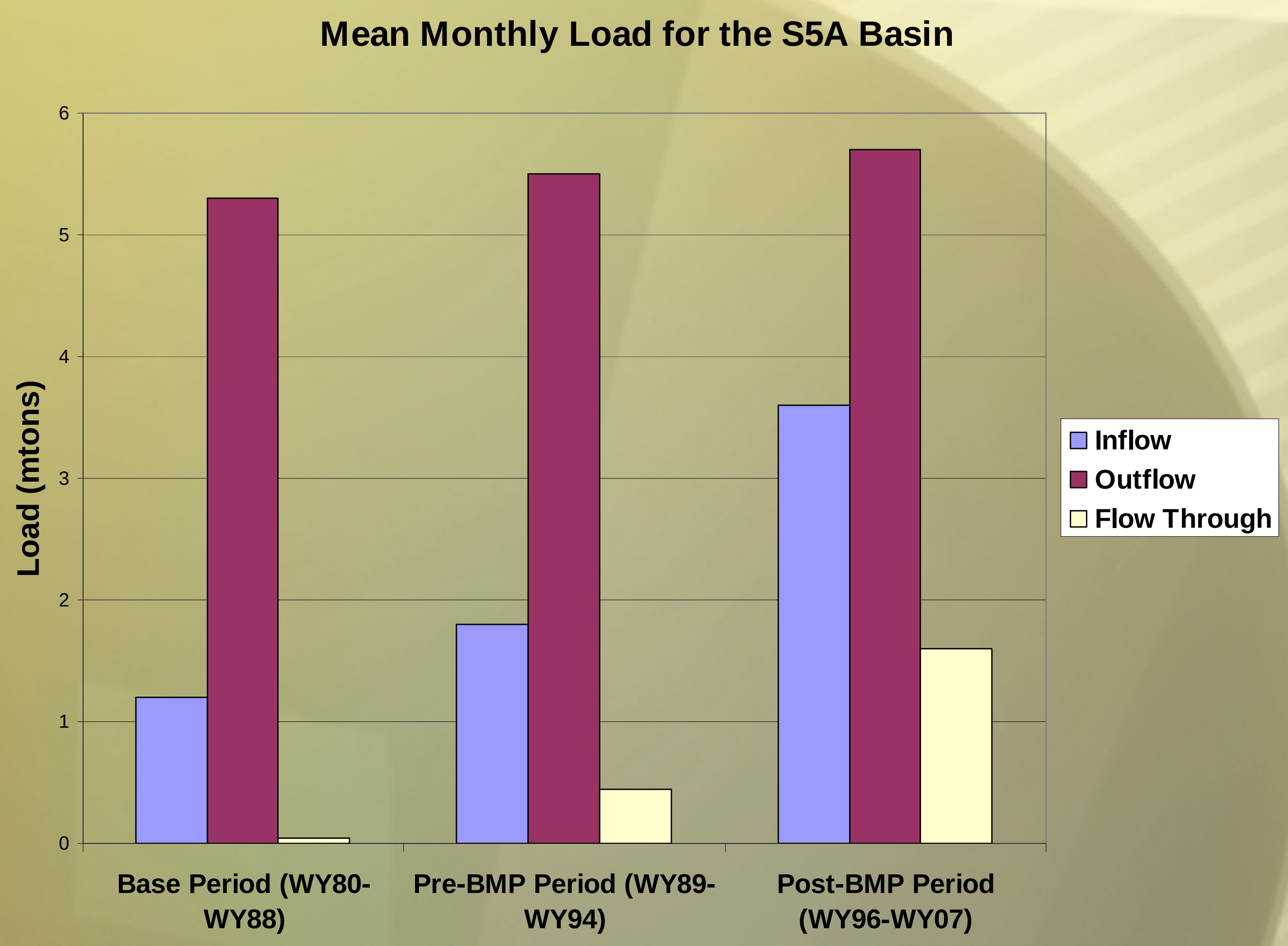
Status of Project

- To date only the Draft of the Initial Data Analysis has been received with the District's comments returned to the Contractor
- Based on the Initial Analysis it was determined that a monthly aggregation of data will provide the most statistically useful information
- It is understood that a lag may exist between inflows and the eventual outflows and that a one month inflow event may translate into several months of affected outflows

Lake Okeechobee Data Evaluation



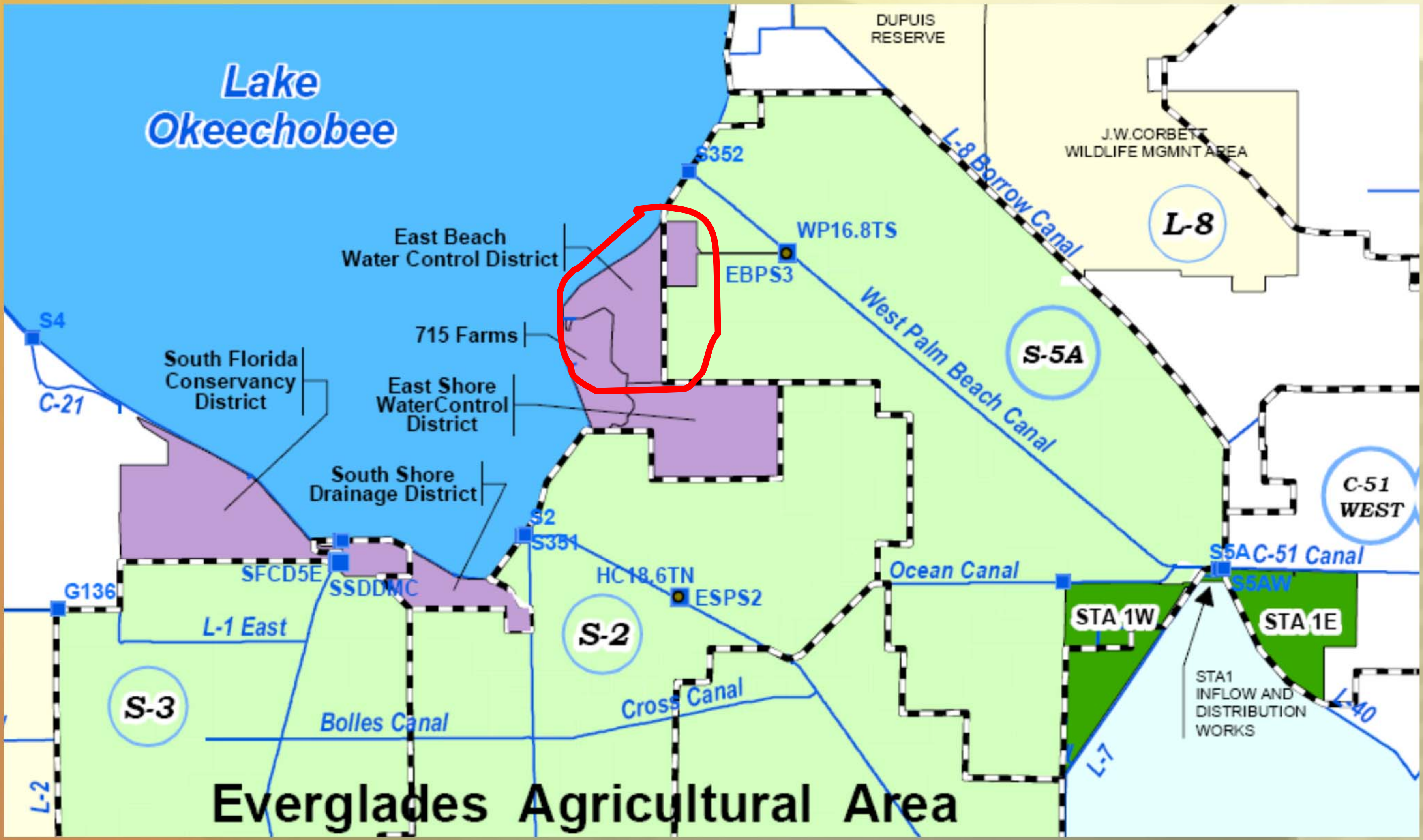
Lake Okeechobee Data Evaluation



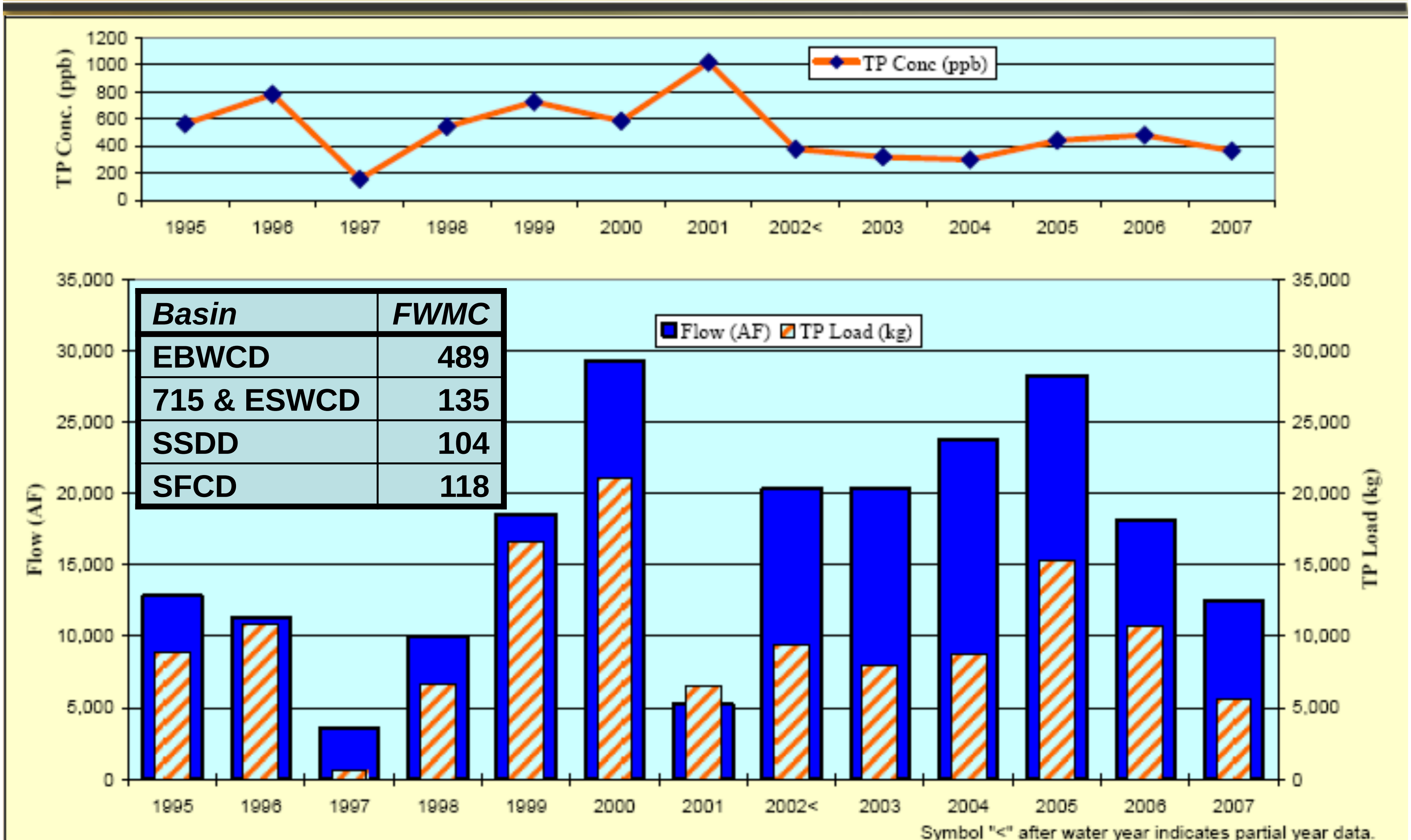
East Beach WCD - Upstream Monitoring Update

Water Quality Synoptic Survey Data Analysis for East Beach Water Control District

East Beach WCD – Inflow to S5A Basin



East Beach WCD – WY1995-2007 Phosphorus Data



Basin	FWMC
EBWCD	489
715 & ESWCD	135
SSDD	104
SFCD	118

Figure 9-3: WY1995-2007 Flows and Phosphorus Levels for EBWCD Runoff.

East Beach WCD – Comparison with S5A TP data

	EBWCD UAL (lbs/acre)	EBWCD FWMC (ppb)	EAA UAL (lbs/acre)	EAA FWMC (ppb)
1996	3.66	782	0.679	98
1997	0.23	155	0.515	100
1998	2.26	542	0.679	102
1999	5.61	726	0.533	123
2000	7.10	583	0.828	119
2001	2.21	1015	0.227	64
2002	3.18	376	0.445	77
2003	2.70	319	0.355	66
2004	2.93	297	0.362	69
2005	5.15	439	0.822	124
2006	3.63	481	0.711	119
2007	1.87	362	0.696	166
Min.	0.23	155	0.227	64
Max.	7.10	1,015	0.828	166
Ave.	3.35	506	0.571	102

EBWCD FWMC 1996–2001: Mean 634 ppb
EBWCD FWMC 2002–2007: Mean 379 ppb
EAA FWMC 1996–2001: Mean 101 ppb
EAA FWMC 2002–2007: Mean 104 ppb

East Beach WCD - Background

- **TP concentrations are historically higher than other Diversion Project basins and S5A**
- **DEP requested additional regulatory action**
- **The urban contribution of Pahokee's sewer collection system has been perceived to contribute significantly to basin TP levels**
- **DEP investigated potential sanitary sewer collection system leaks to surface water**
- **SFWMD initiated surface water monitoring project "EAA298" for source determination**
- **SFWMD contracted with FAU for source assessment reporting of the monitoring data**

East Beach WCD Upstream – Monitoring Plan

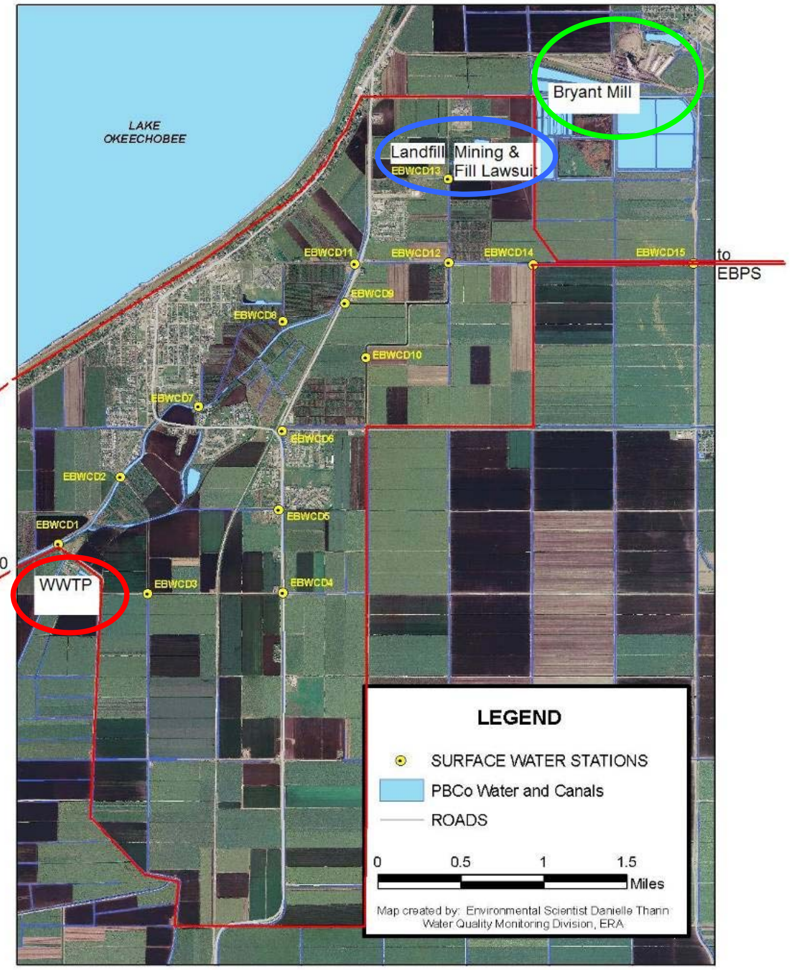
- **15 surface water sampling locations**
- **Bi-weekly January 18 - September 30**
- **Parameters/constituents collected:**
  - **Total, particulate and soluble reactive P**
  - **Ammonia-N, Sulfate, Nitrate+Nitrite**
  - **Turbidity, Specific Conductivity, Temperature, pH, Dissolved Oxygen**
- **Upstream flow measurement was unsuccessful due to infrequent flow**

East Beach WCD Upstream – Monitoring Sites

Site selection considered:

- **Accessibility**
- **Basin coverage**
- **Relation to potential point and non-point sources**
- **Anticipated flow direction**
- **Estimated contributing area**

EAST BEACH WATER CONTROL DISTRICT SYNOPTIC SURVEY



East Beach WCD Upstream – Parameters

Parameter selection considered:

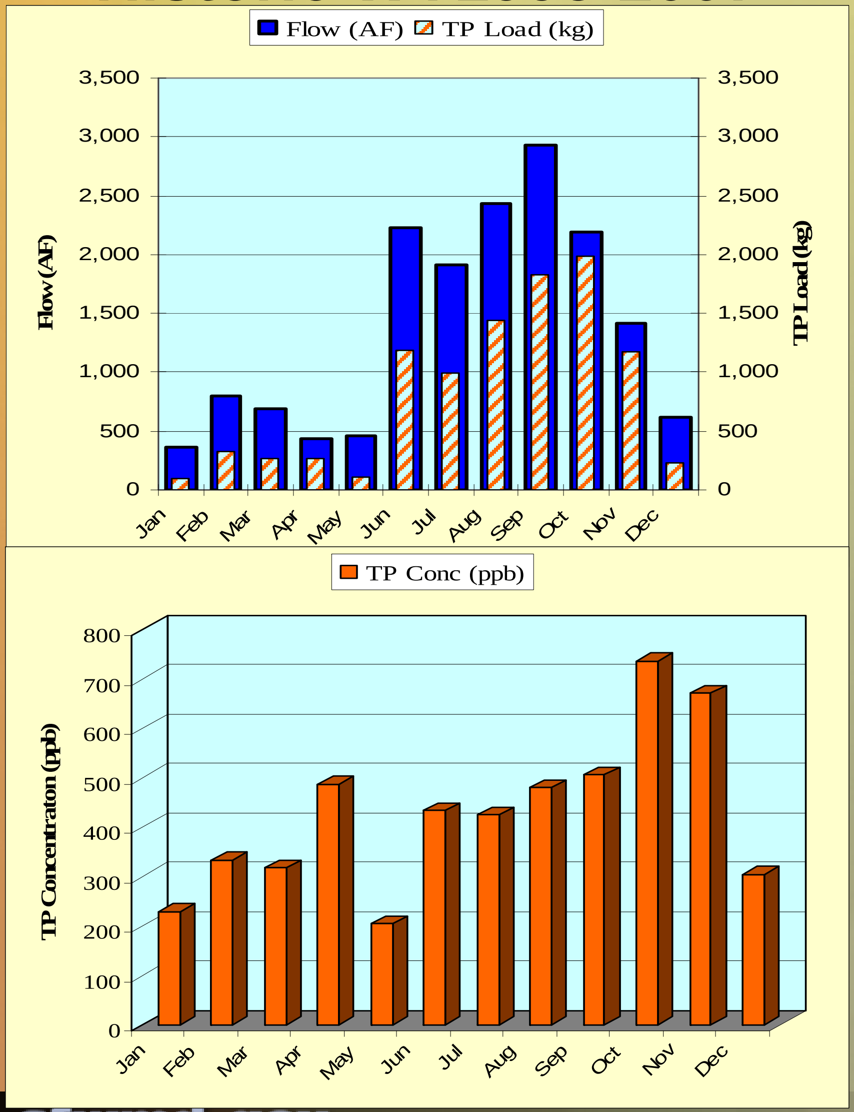
- **Dissolved and particulate phosphorus as indicators for fertilizer vs. sediment runoff**
- **Elevated nitrates and ammonia in runoff can indicate agricultural**
- **Specific Conductivity as conservative "tracer" and indicative of groundwater source**
- **Turbidity, Temperature, pH, Dissolved Oxygen used to assess general water quality**
- **Limitation of parameters based on goal of initial screening level synoptic survey**

East Beach WCD Upstream – Spatial Analysis

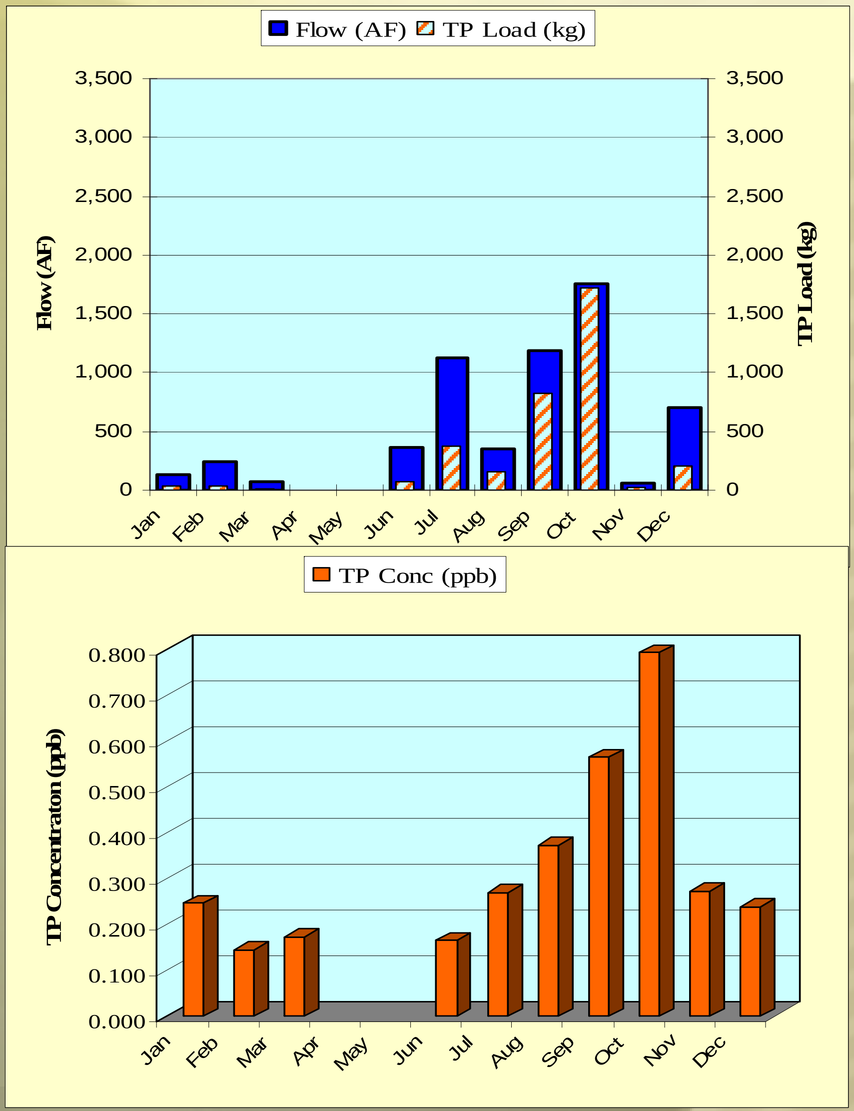
Station	TP04 (mg/L)	TPP (mg/L)	TDP (mg/L)	OPO4 (mg/L)	NH4 (mg/L)	NOX (mg/L)
EBWCD1	0.148	0.049	0.098	0.083	0.145	0.072
EBWCD2	0.231	0.054	0.178	0.153	0.375	0.032
EBWCD3	0.266	0.063	0.202	0.181	0.285	0.064
EBWCD4	0.347	0.071	0.276	0.252	0.346	0.063
EBWCD5	0.370	0.053	0.317	**0.295**	0.425	0.143
EBWCD6	0.243	0.042	0.213	0.178	0.164	0.014
EBWCD7	0.257	0.073	0.184	0.152	0.507	0.020
EBWCD8	0.151	0.084	0.057	0.029	0.121	0.076
EBWCD9	0.177	0.078	0.106	0.069	0.489	0.104
EBWCD10	0.289	0.047	0.242	0.212	0.276	0.019
EBWCD11	0.167	0.101	0.069	0.041	0.256	0.017
EBWCD12	0.350	0.133	0.217	0.182	0.565	0.273
EBWCD13	**0.479**	**0.147**	**0.324**	0.268	**1.209**	0.289
EBWCD14	0.320	0.099	0.221	0.188	0.607	**0.308**
EBWCD15	0.264	0.101	0.157	0.122	0.485	0.226

East Beach WCD – Historic Discharge Patterns

Historic WY1995-2007



Calendar Year 2007



East Beach WCD – Temporal Analysis

Station	TP04 (mg/L)	TPP (mg/L)	TDP (mg/L)	OPO4 (mg/L)	NH4 (mg/L)	NOX (mg/L)	Sulfate (mg/L)	Turbidity (NTU)	Specific Conductivity (µS/cm)
	Water Quality Constituent Concentrations and Parameter Values								
EBWCD4									
	0.080	0.029	0.051	0.040	0.029	0.036	36.350	9.163	497.625
	0.541	0.101	0.440	0.405	0.548	0.086	48.964	8.400	751.045
EBWCD13									
	0.346	0.153	0.193	0.156	0.675	0.229	252.571	14.100	3316.375
	0.639	0.141	0.483	0.400	1.792	0.310	212.636	20.500	3030.455

These example sites represent two unique sources:

EBWCD4 (south) has much higher wet season levels than dry, indicating surface water contributions are most likely.

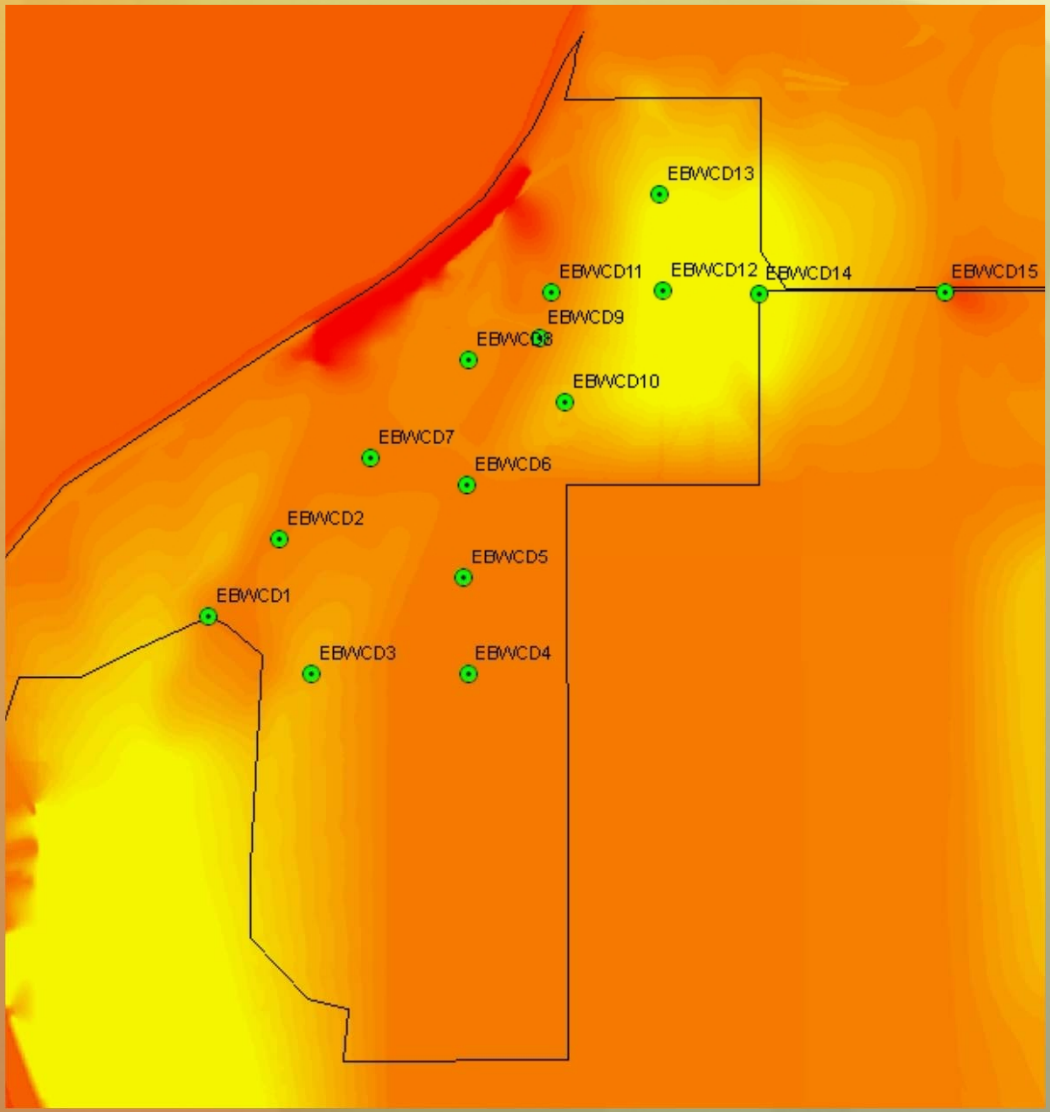
EBWCD13 (north) has more consistent levels with high salt content indicating likely groundwater contribution.

East Beach WCD – Upstream Data Assessment

For the sampling January – September 2007:

- **Very high specific conductivity and sulfate levels throughout the sampling period at northern sites indicates groundwater influence**
- **Very high phosphorus and ammonia levels coincident with rainfall and flow in the south indicate of surface water runoff contribution**
- **Phosphorus levels were lower in the dry than wet period adjacent to urban and WWTP, indicating point source is likely not a significant contributor to TP load**

East Beach WCD – Topography



Topography is lowest surrounding sites EBWCD12-EBWCD14, supporting the idea that groundwater influence to the surface water quality could be strong.

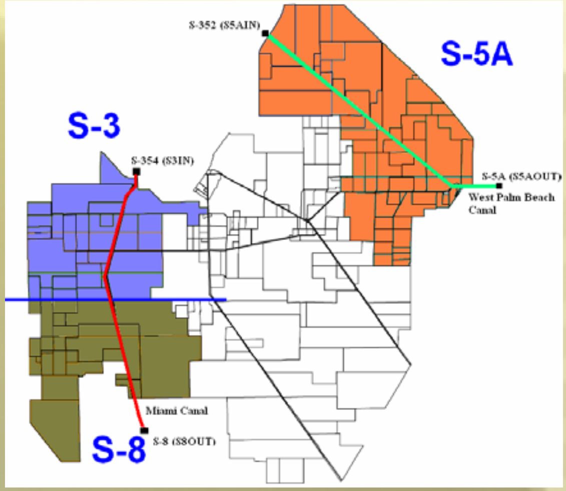
East Beach WCD – Upstream Assessment Report

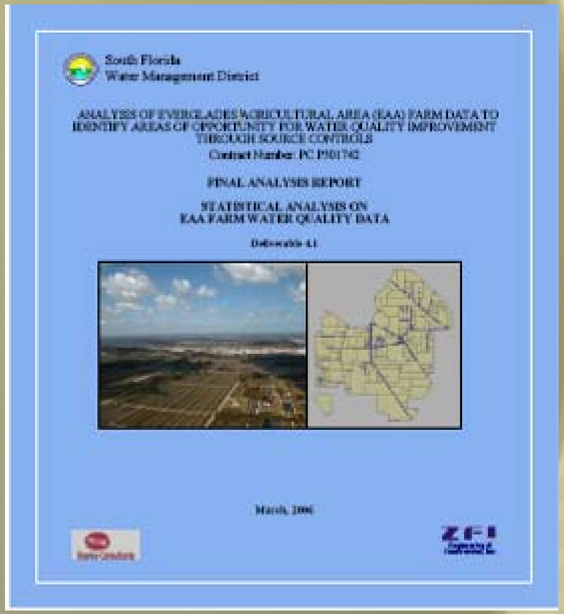
- **Detailed findings and explanations will be presented within the Data Analysis Report prepared by FAU investigators Dr. Ramesh Teegavarapu and Dr. Daniel Meeroff**
- **Findings should be qualified by the short term monitoring during drought conditions, but the annual pattern at the basin outfall is typical**
- **Additional monitoring and assessment techniques will be discussed in the report per SFWMD request**

Farm Data Analyses - Overview

Carmela Bedregal, PE, Sr Supervising Engineer

- **What does the farm regulatory data say on the differences on TP concentration and load between farms and sub-basins?**
- **EAA sub-basins covered: S3, S8, and S5A (WY95 to 03)**
- **Describe the seasonal and long term variations based on sub-basin and farm characteristics**
- **Final Report: March 2006 and is available at the District Long-term Plan website**

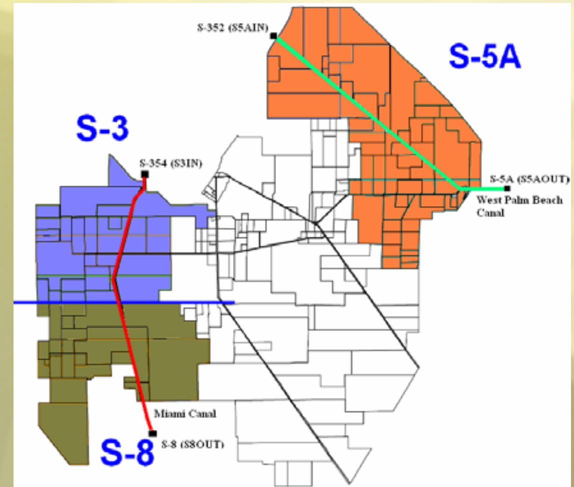




Farm Data Analyses – Farm Characteristics

Table 2-2: Farm Categories and Characteristic Groups Assigned to Farms

Category	Characteristic Groups
Location	S3, S8, or S5A
Soil Type	Sands, Dania, Lauderhill, Pahokee, or Terra ceia
Water Detention Level	0.5", 1.0", or ≥ 1.5"
Land uses	A: Sugarcane with minimal rotation or other uses B: Sugarcane in rotation with corn, or some parcels dedicated to corn C: If the farm is either: (1) a sugarcane field in rotation with rice or fallow flooded parcels, (2) an area containing sugarcane fields and urban land, or (3) an area containing sugarcane and pasture lands. D: Areas with sugarcane and sod, or primarily sod E: Citrus groves, tree farms, fruit tree, or combinations appear to prevail F: Sugarcane and vegetables, vegetables, or areas where vegetables appear to prevail G: Agricultural lands with industrial uses in it (e.g., mills)



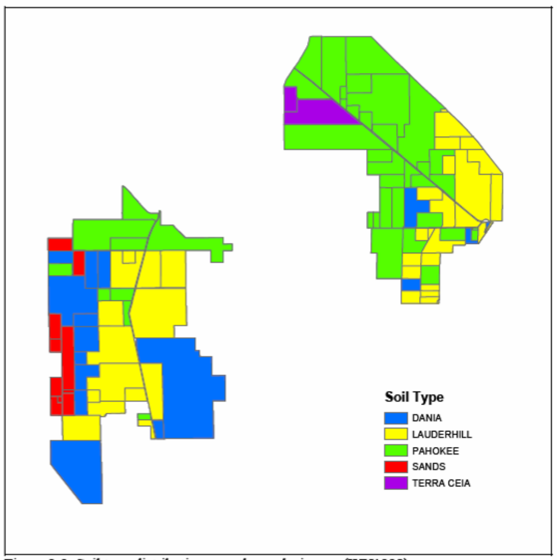


Figure 2-3: Soil type distribution over the analysis area (WY1998)

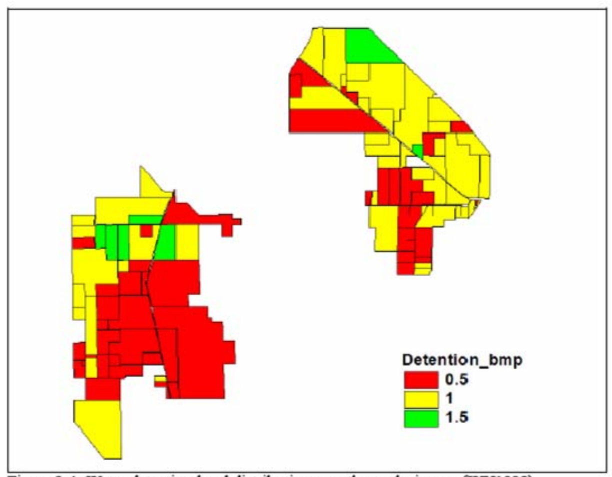


Figure 2-4: Water detention level distribution over the analysis area (WY1998)

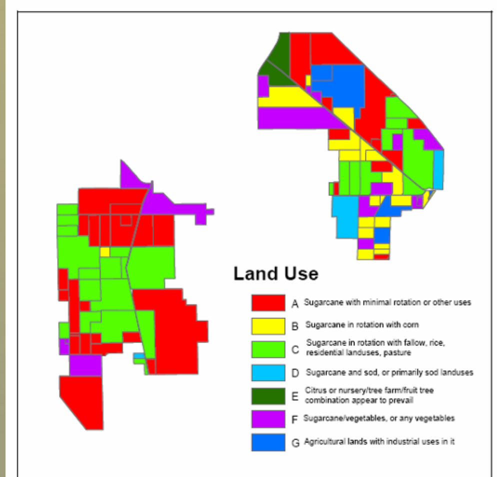
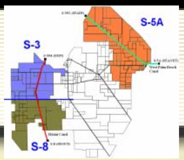
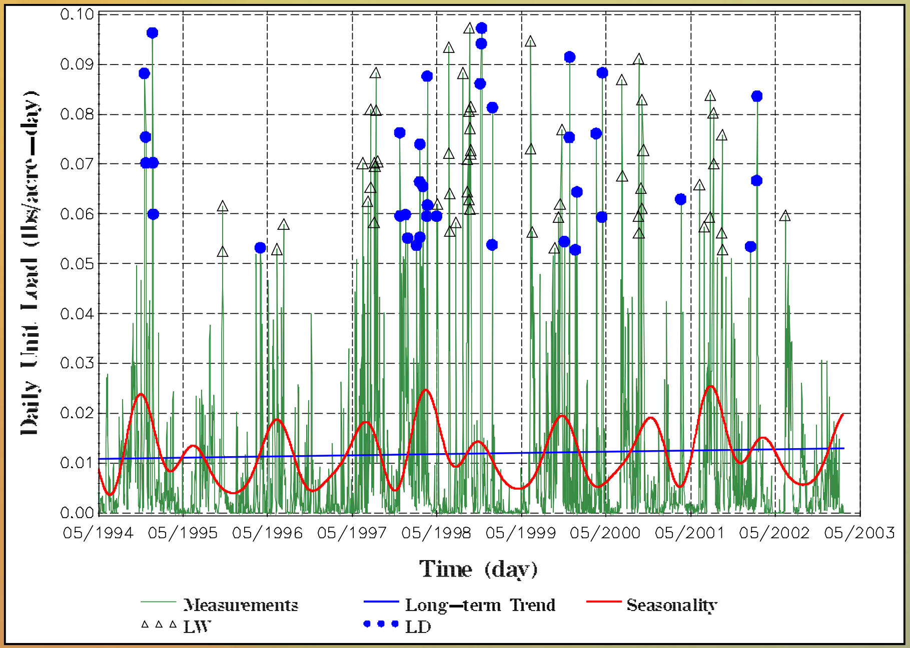


Figure 2-2: Land use distribution over the analysis area (WY1998)

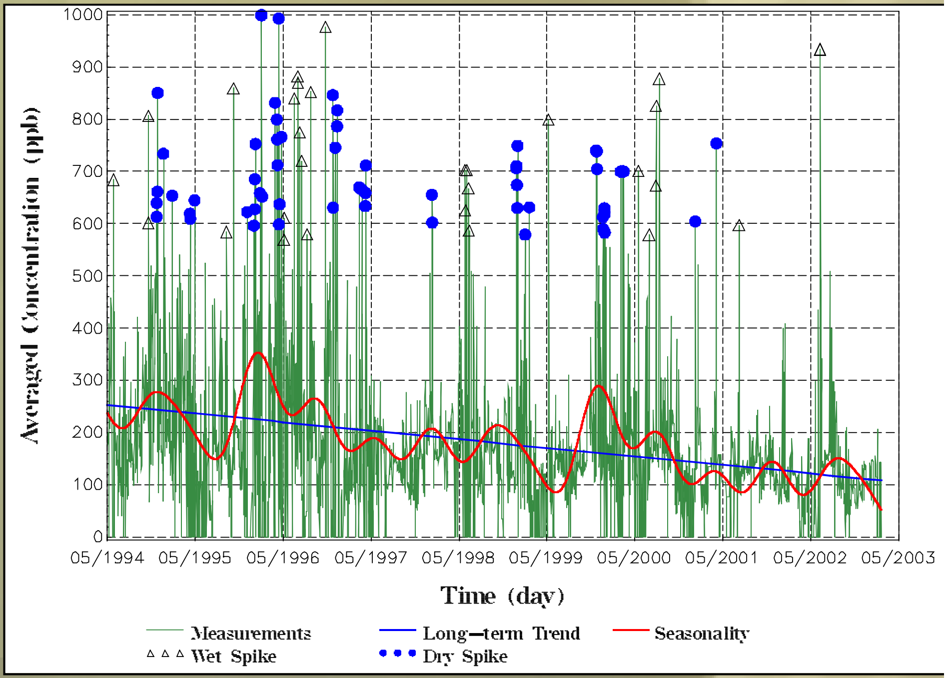
Farm Data Analyses – Long-term Trends



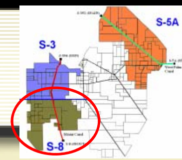
What were the long term trends in TP load and concentration from S5A Farms on average?



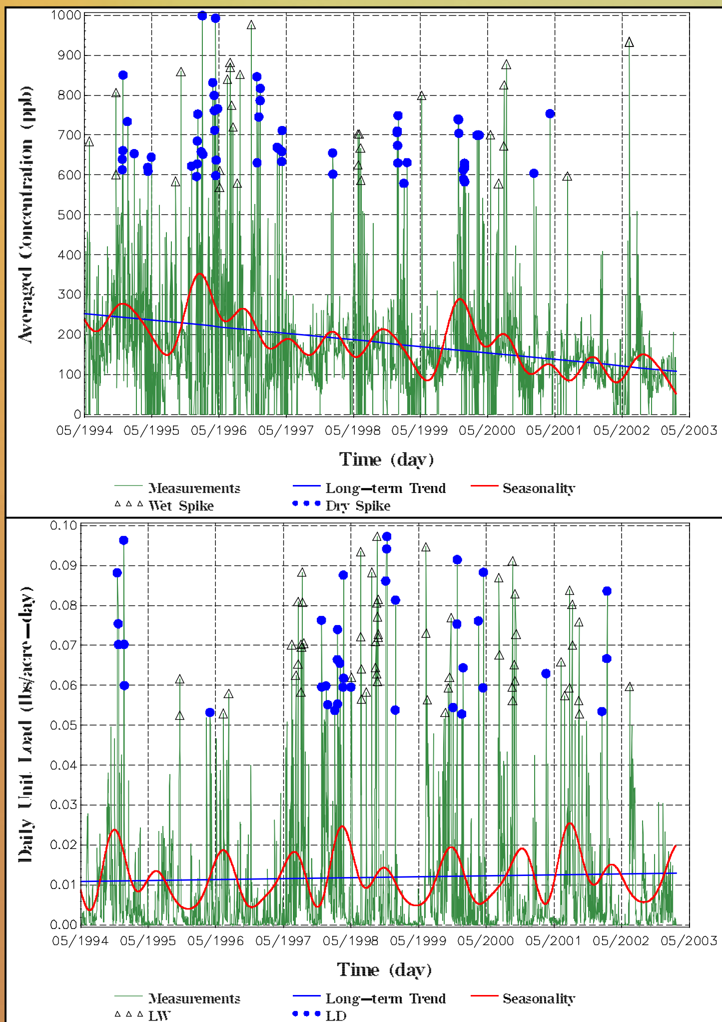
0.01 lbs/acre-day = 3.65 lbs/acre-year

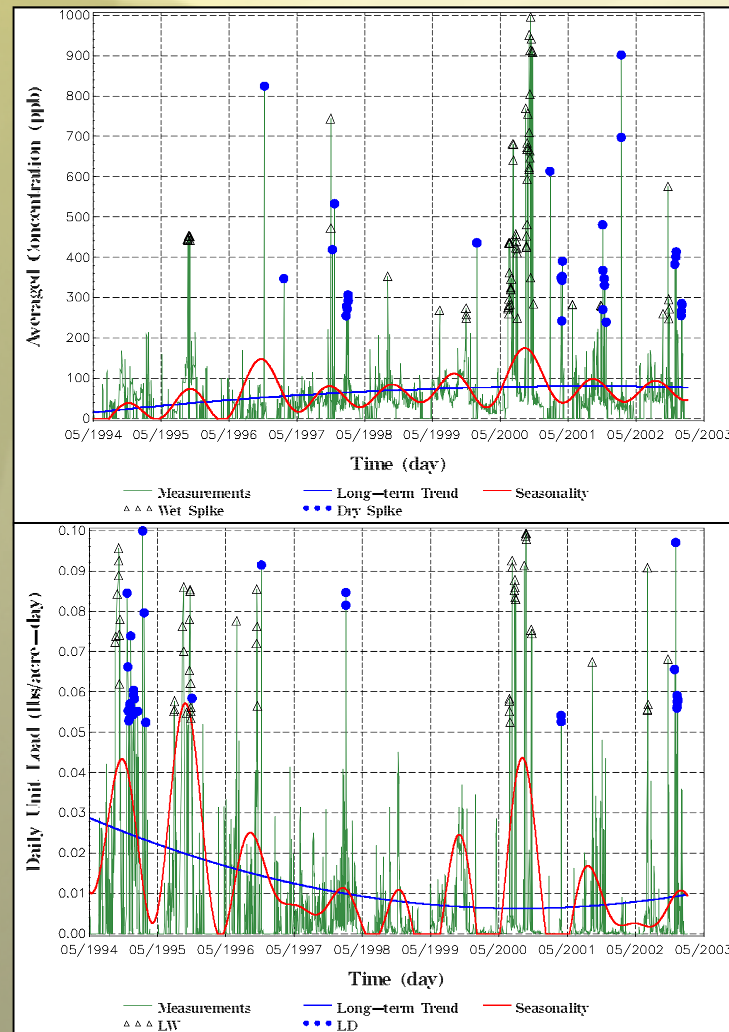


Farm Data Analyses – S5A vs. S8

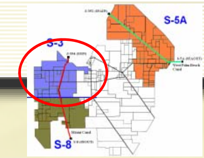


How did the farms in the S5A compare with those in other sub-basins? (S5A vs. S8)

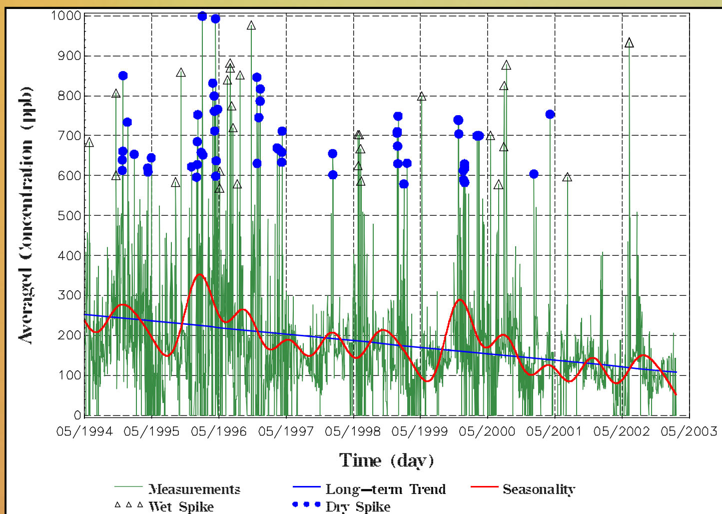


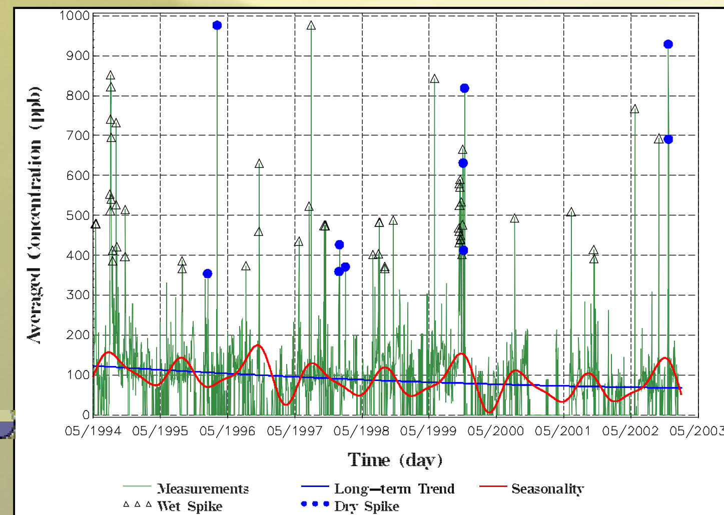


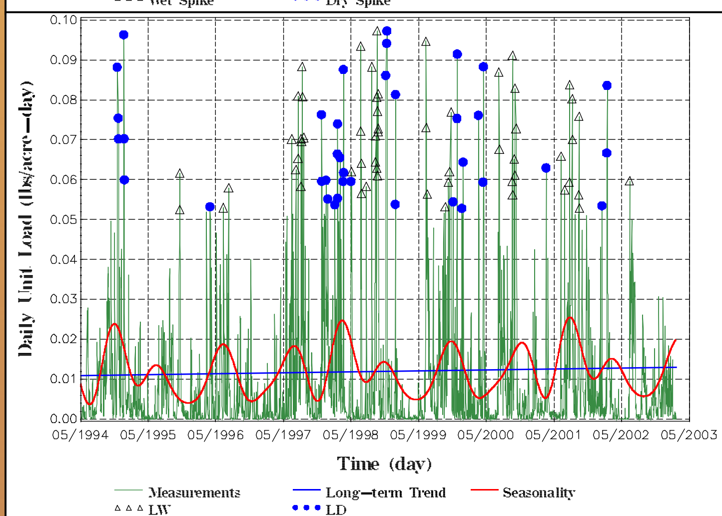
Farm Data Analyses – S5A vs. S3

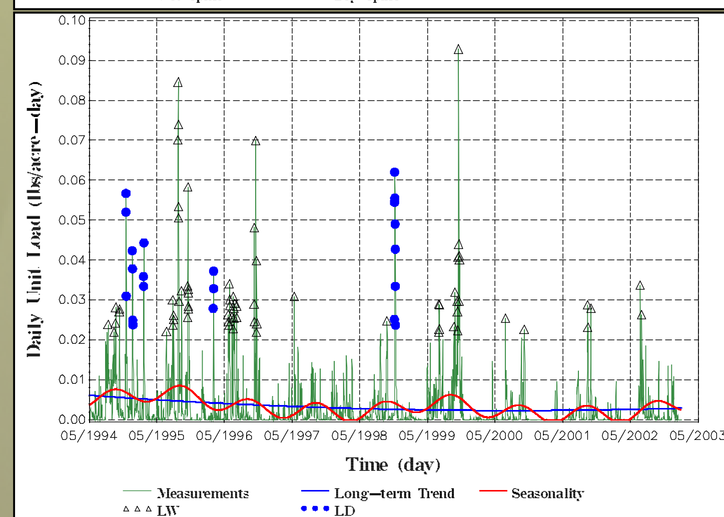


How did the farms compare with those in other sub-basins? (S5A vs. S3)





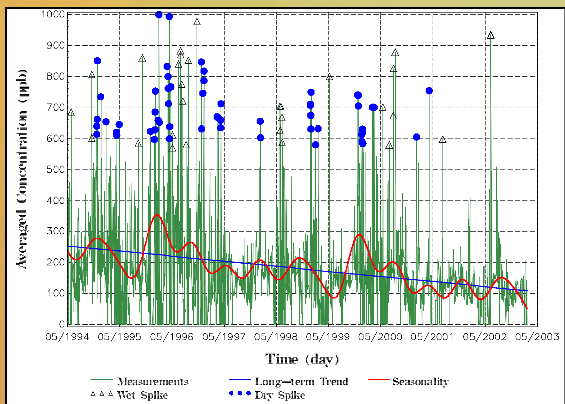




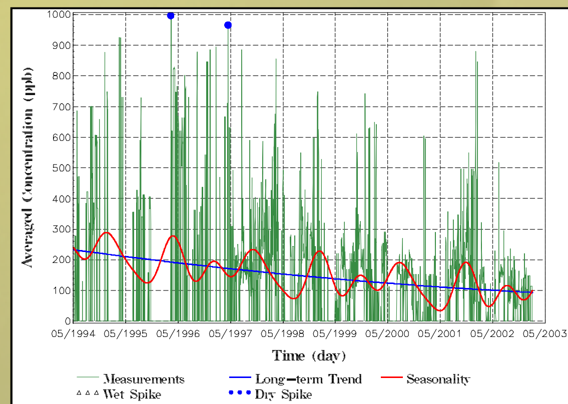
Farm Data Analyses – Types of Farms

Did all the farms groups in the S5A follow the average sub-basin performance? (concentration)

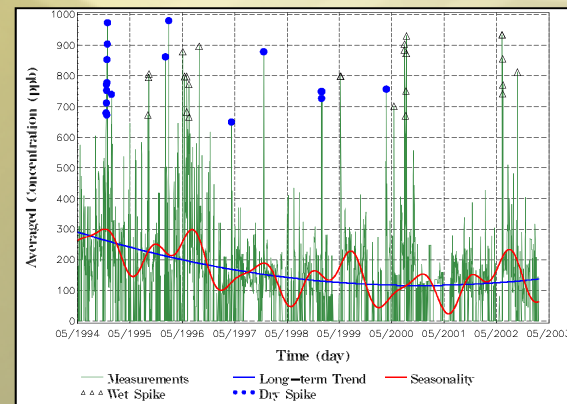
Sub-Basin Average



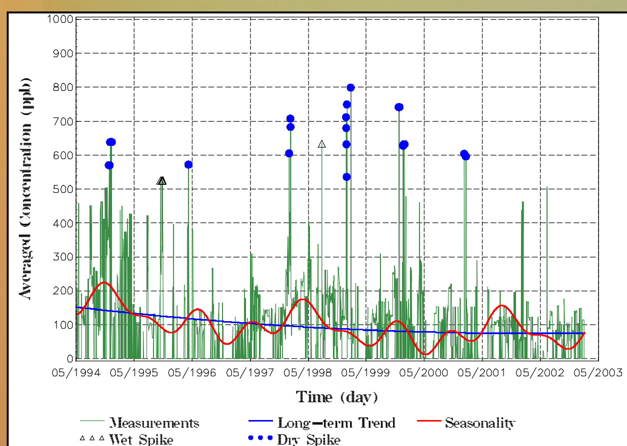
w/ Industrial (mills)



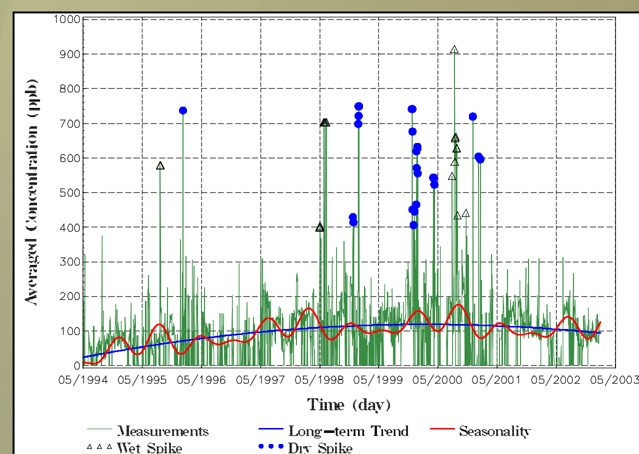
Vegetable



Sugarcane with corn



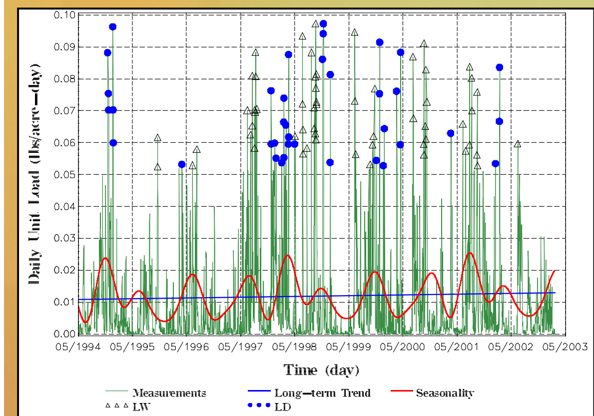
Sugarcane



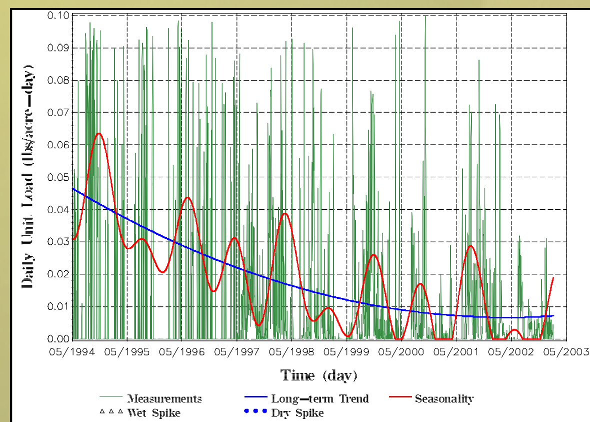
Farm Data Analyses – Types of Farms

What about daily unit load?

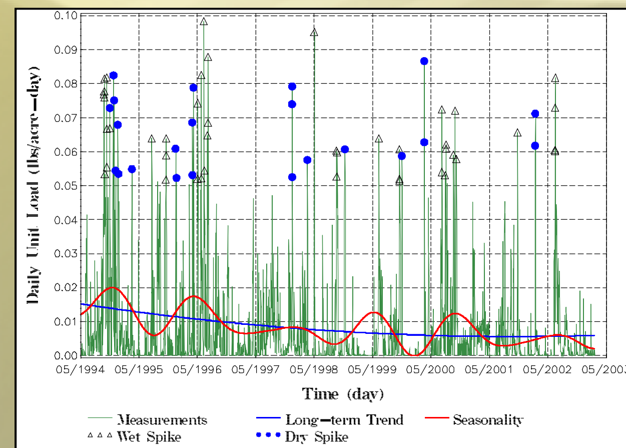
S5A Sub-Basin Average

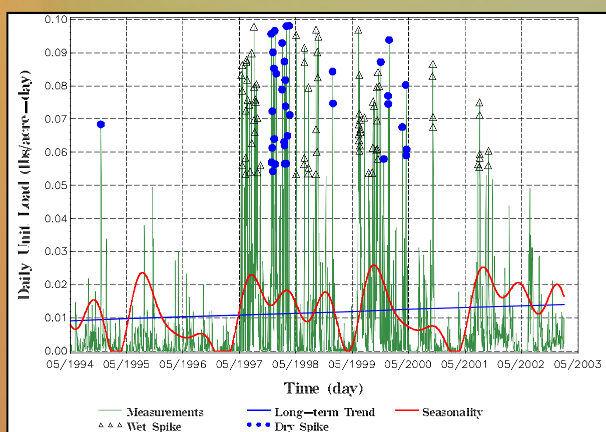


w/ Industrial (mills)

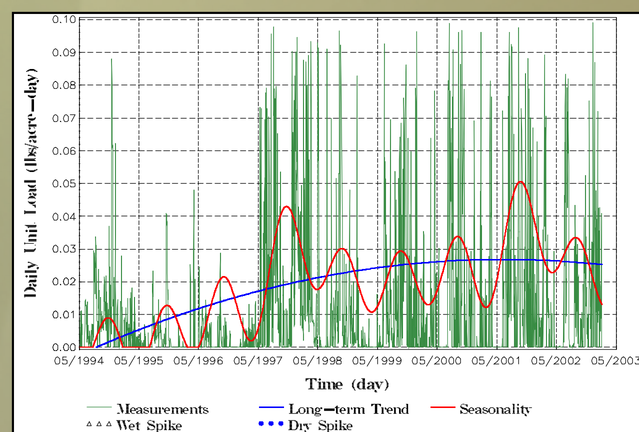


Vegetable





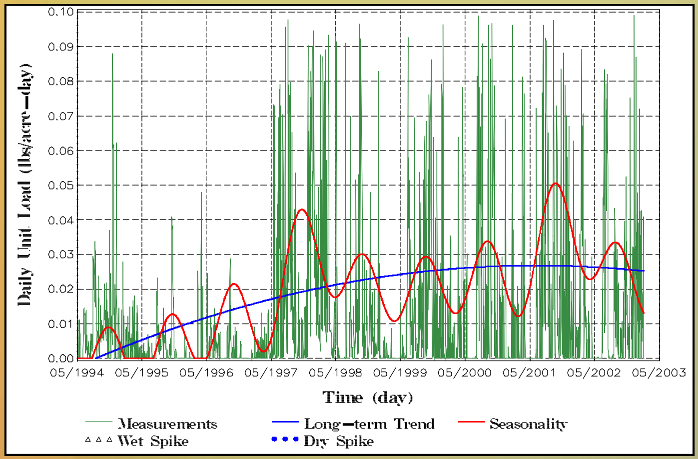
Sugarcane



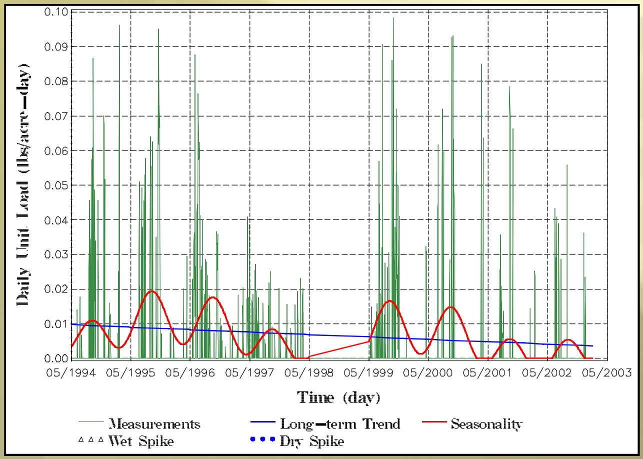
Sugarcane in rotation with corn

Farm Data Analyses – Farm Types across Sub-basins

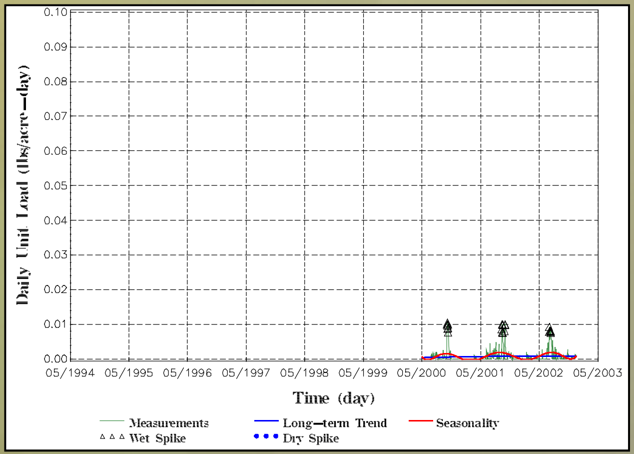
How did the sugarcane in rotation with corn compare with other sub-basins?



S5



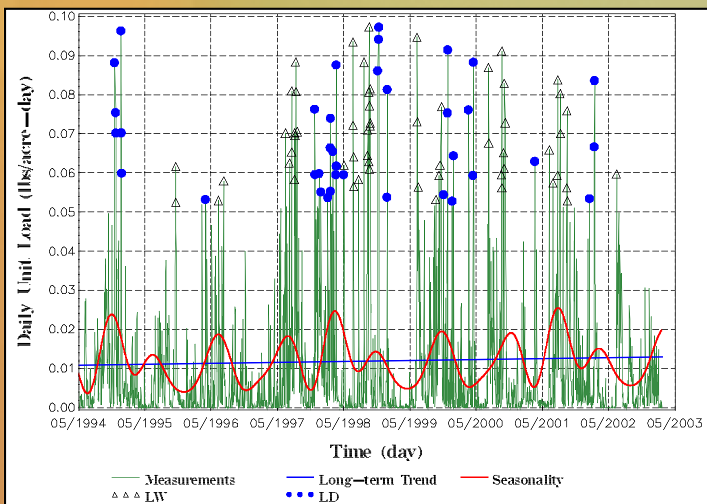
S3

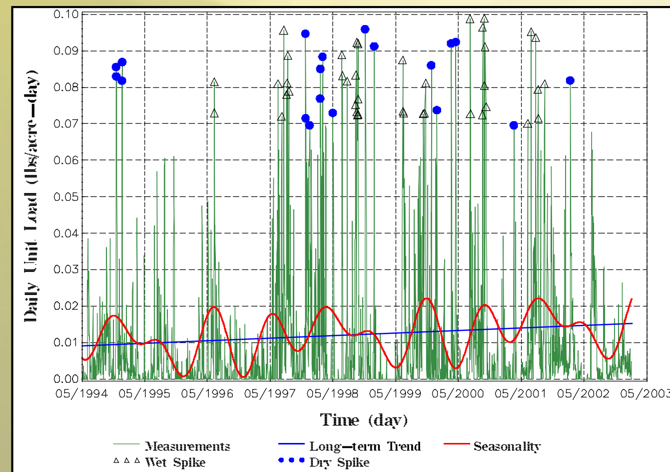


S8 (smaller sample)

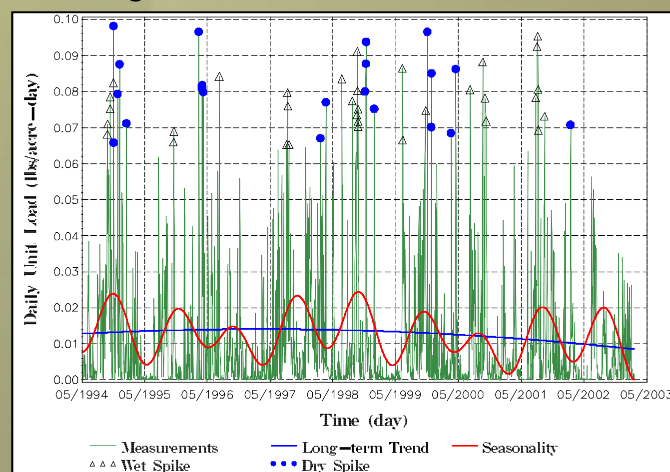
Farm Data Analyses – BMPs

S5A:
Was performance among S5A farms different based on the BMP plans? (load)





S5A 0.5-inch detention, nutrient management and 4 sediment controls



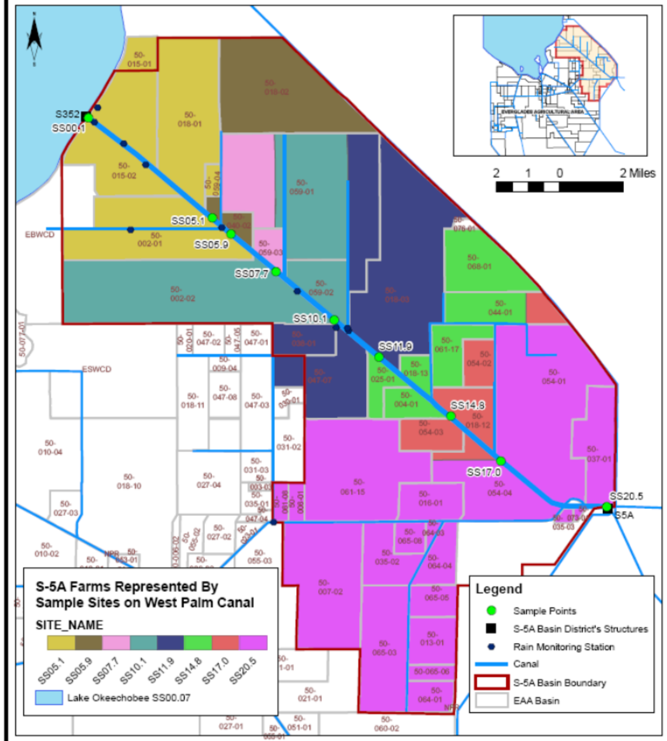
S5A 1-inch detention, nutrient management and 6 sediment controls

Farm Data Analyses – Wrap it up

1. **The graphs depict for S5A Basin Farms for WY95 to WY03 that TP:**
   - **A substantial decreasing trend for concentration,**
   - **A higher unit load level (>0.01 lbs-acre-day) and slight increasing trend for load**
2. **The expectedly higher contributors (vegetable farms, and agricultural lands with industrial uses) exhibited decreasing trends in concentration and load.**
3. **Sugarcane farms --and those that grow corn in rotation– show increasing trends in unit load (corn acreage is not tracked).**
4. **Farms with BMP Plans that provide higher detention showed decreasing trends.**

S5A Data Collection and GIS Mapping

- Previous evaluations were to analyze available data collected for other purposes.
- Used statistical tools for evaluation
- Proposed: gather the needed data for a full picture
- Phosphorus speciation and cycling mechanisms in the West Palm Beach Canal
- Three years of flow and phosphorus speciation collection and use of GIS tools for interpretation
- Supplement Lake Okeechobee and East Beach efforts
- Status: scope of work under development



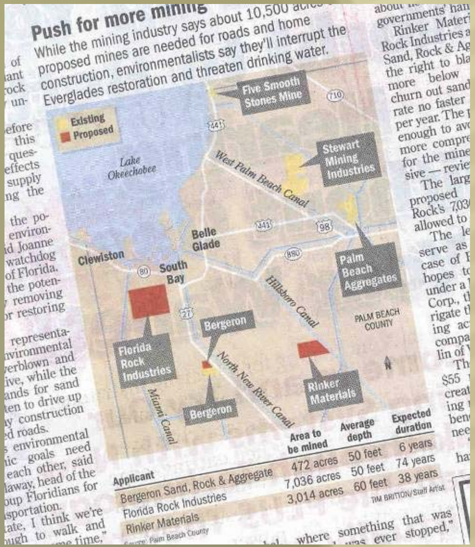
S-5A Sub-Basin Sample Sites

Exhibit 2A

Chronology of Basin Changes and Factors

Historical water quality and projects were discussed. Basin changes and factors may influence water quality from the Basin in the future. A list of past and future are:

- **2002 East Beach Water Control District starts diversion to S5A**
- **2004 the District divide structure (G-341) is installed on the Ocean Canal, thus reducing total farm runoff from S5A to STA1W (est. 15-20% less)**
- **2004 and 2005 hurricanes hit S5A increasing nutrients in sub-basin levels**
- **2005 the Gladeview Canal Water Control District structure is installed, facilitating recycle and reuse of runoff within the GCWCD boundaries**
- **2005 increased rock mining and conversion from sugarcane land to rock mining, retention onsite**
- **Market conditions may bring new or more TP-intensive crops**
- **Mill closures (Bryant Mill)**
- **Future rock mining operations to expand into other areas of the EAA and S5A, further reducing land from agriculture.**



Brainstorming

- Input on presentation
- Investigation versus action
- Needs and ideas: Causes and Strategies
- Open discussion
- Partnership and roles