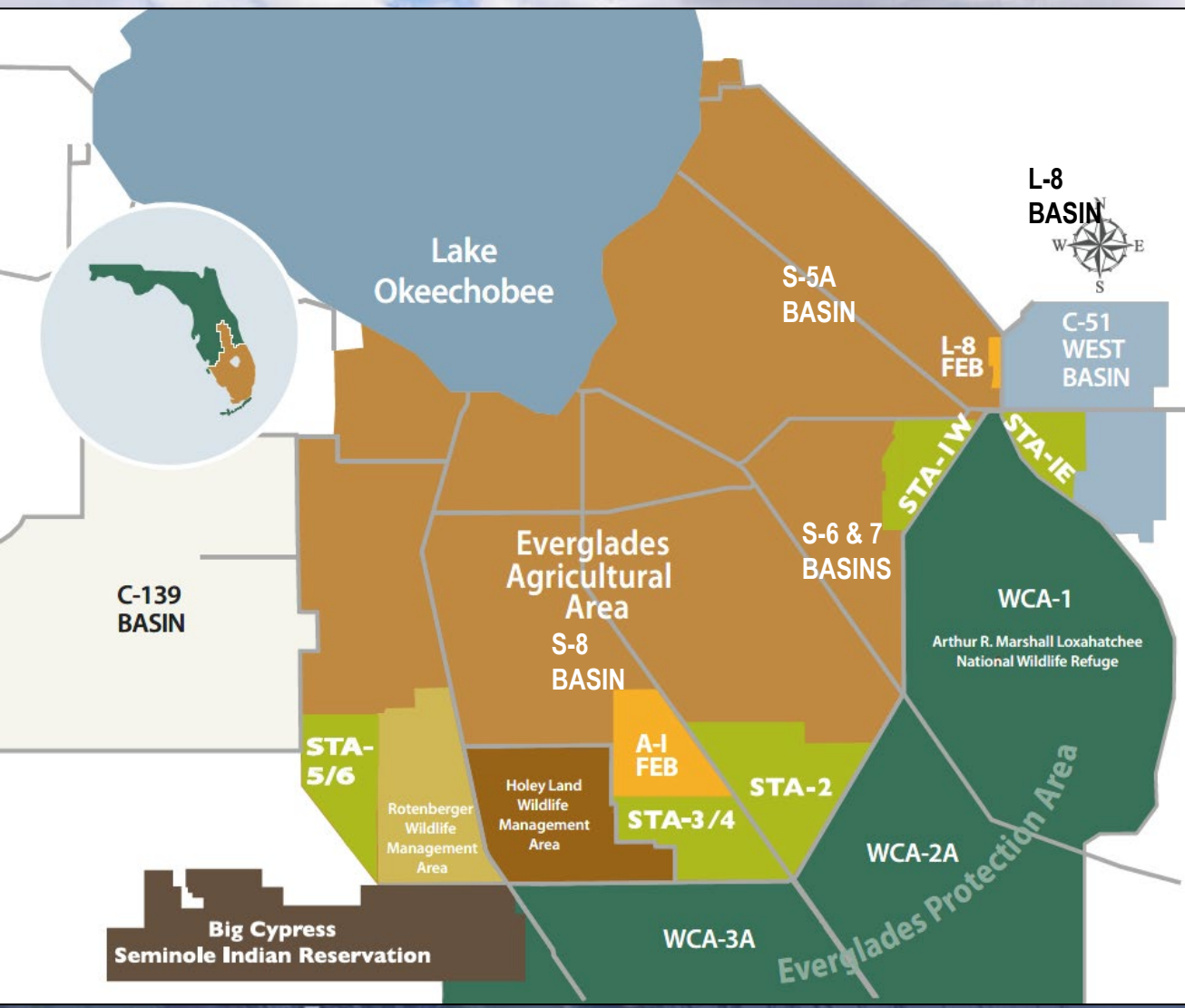


Everglades Stormwater Treatment Areas: The World's Largest Constructed Treatment Wetland Project

9th UF Water Institute Symposium
February 21, 2024

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Everglades STAs



- Reduce phosphorus from basin runoff prior to discharge to Everglades
 - SFWMD currently operates 62,000 acres of STAs and 16,000 acres of Flow Equalization Basins (FEBs) south of Lake Okeechobee
- Restoration Strategies projects to achieve Water Quality Based Effluent Limit (WQBEL) nearing completion
 - Additional ~1,900 STA acres and 2,800 FEB acres

Everglades STA Timeline

1988	Lake Okeechobee Technical Advisory Council commissioned <i>USA v SFWMD et al.</i>	Everglades Nutrient Removal Project	Advanced Treatment Technologies Research Program	STA Optimization Research and Monitoring Program
1991	Everglades Protection Act enacted			
1992	Consent Decree			
1993	ENRP construction completed			
1994	ENRP operating permit issued			
	Everglades Forever Act enacted			
1998	STA-6 construction completed			
1999	STA-5 construction completed			
2000	Comprehensive Everglades Restoration Plan authorized	Long-Term Plan for Achieving Water Quality Goals in the Everglades Protection Area	Restoration Strategies Science Plan	
	STA-1W construction completed			
	STA-2 construction completed			
2003	Long-term Plan enacted			
2004	<i>Tribe & Friends v USEPA</i>			
	STA-3/4 construction completed			
2005	STA-1E construction completed			
2007	STA-2 Compartment B expansion completed			
	STA-5/6 connection and expansion completed			
2008	Judge Gold Order			
2010	Judge Gold Order			
2012	STA discharge permits, Consent Orders, WQBEL establishment			
	Restoration Strategies established			
2013	Restoration Strategies Science Plan implemented			
	STA-2 Compartment B Buildout expansion completed			
	STA-5/6 Compartment C Buildout expansion completed			
2015	A-1 FEB construction completed			
2017	L-8 FEB construction completed			
2018	Restoration Strategies Science Plan updated			
2019	STA-1W Expansion #1 completed			
2020	STA-5/6 earthwork completed			
2023	STA-1W Expansion #2 expected completion			
	C-139 FEB expected completion			
2024	Completion of Restoration Strategies Science Plan			
2025	Completion of Restoration Strategies			
2026	First year of WQBEL implementation (WY27)			

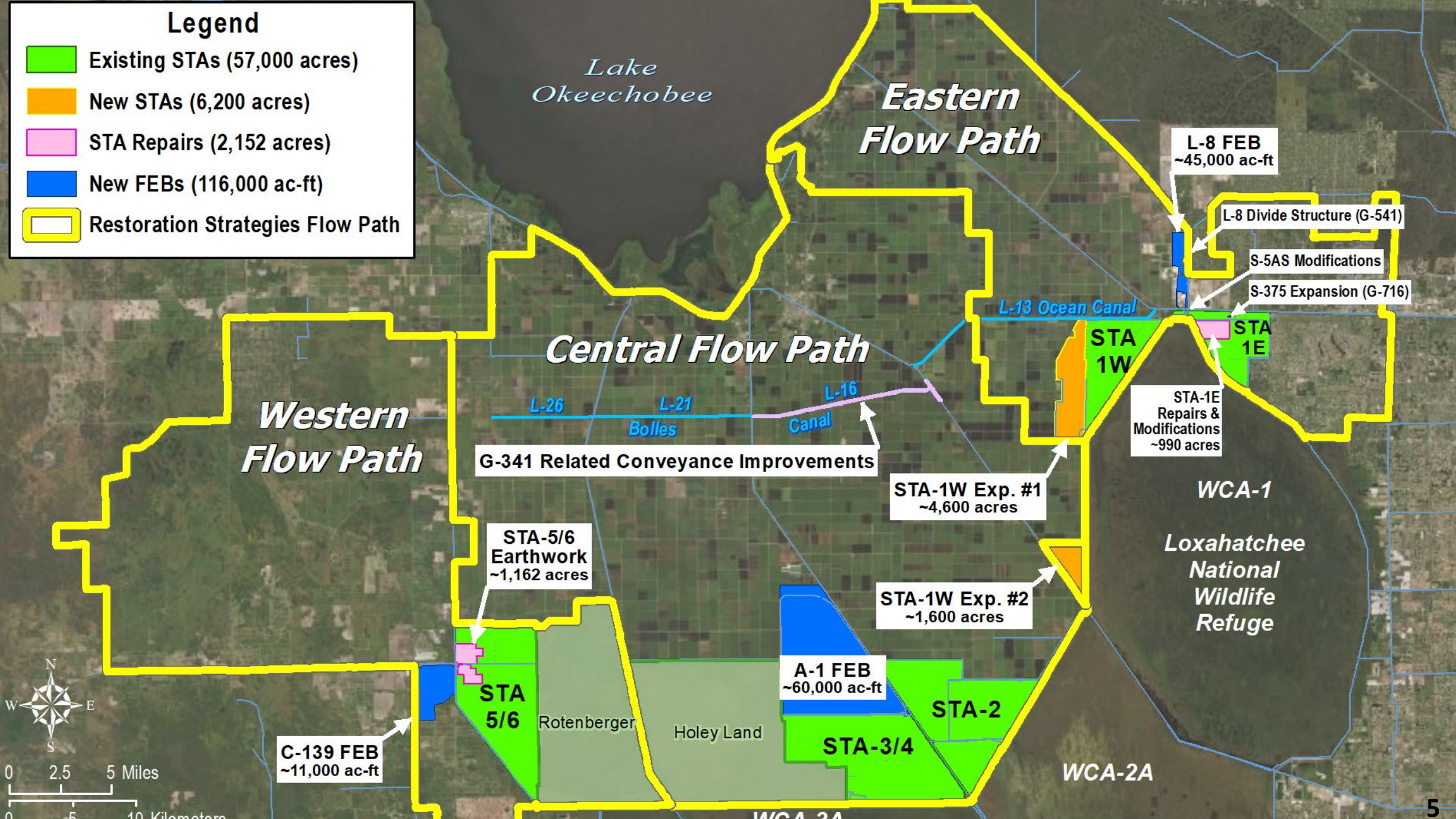
Armstrong, Piccone, Dombrowski, 2023
Ecological Engineering

Water Quality Based Effluent Limit

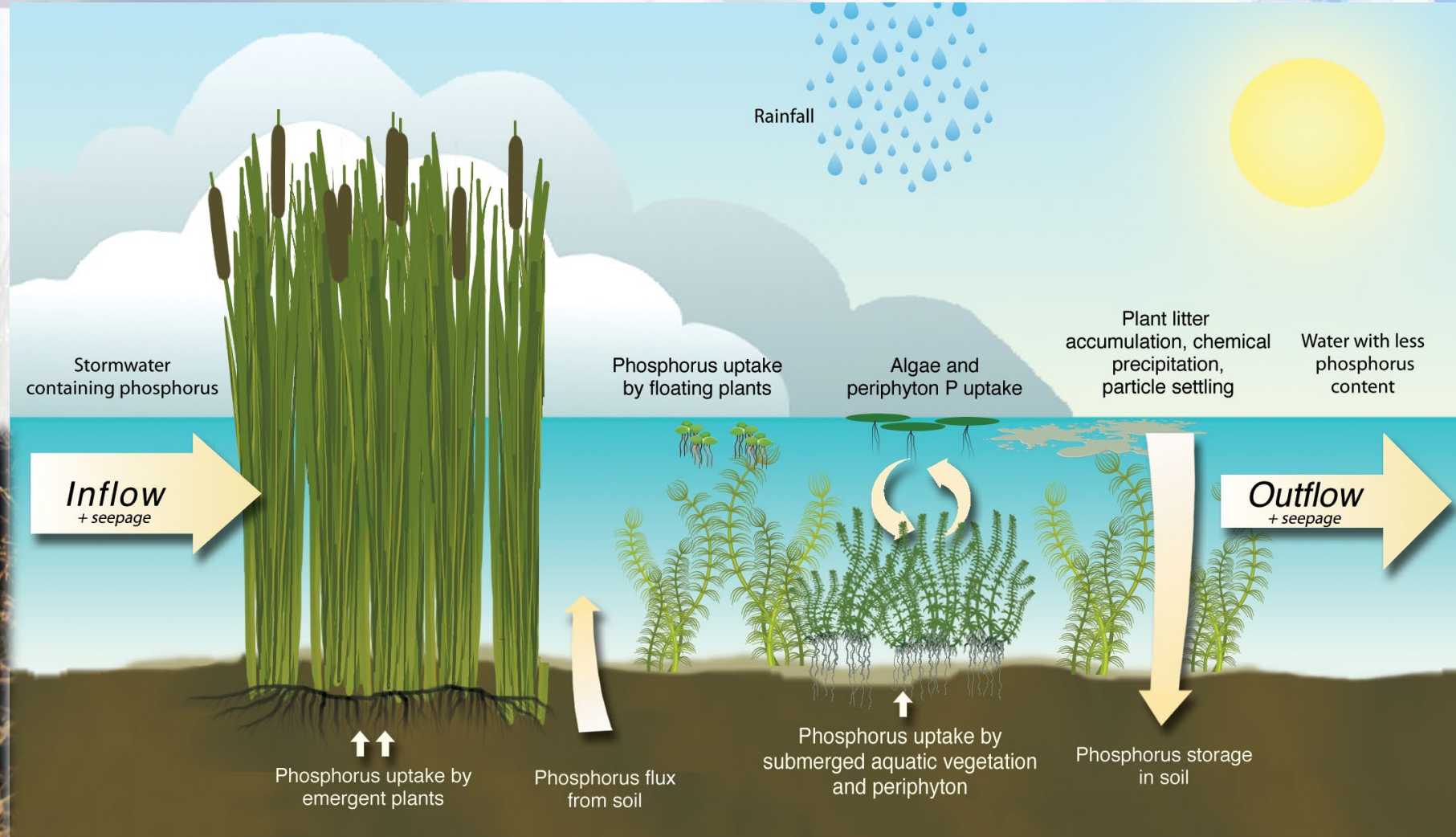
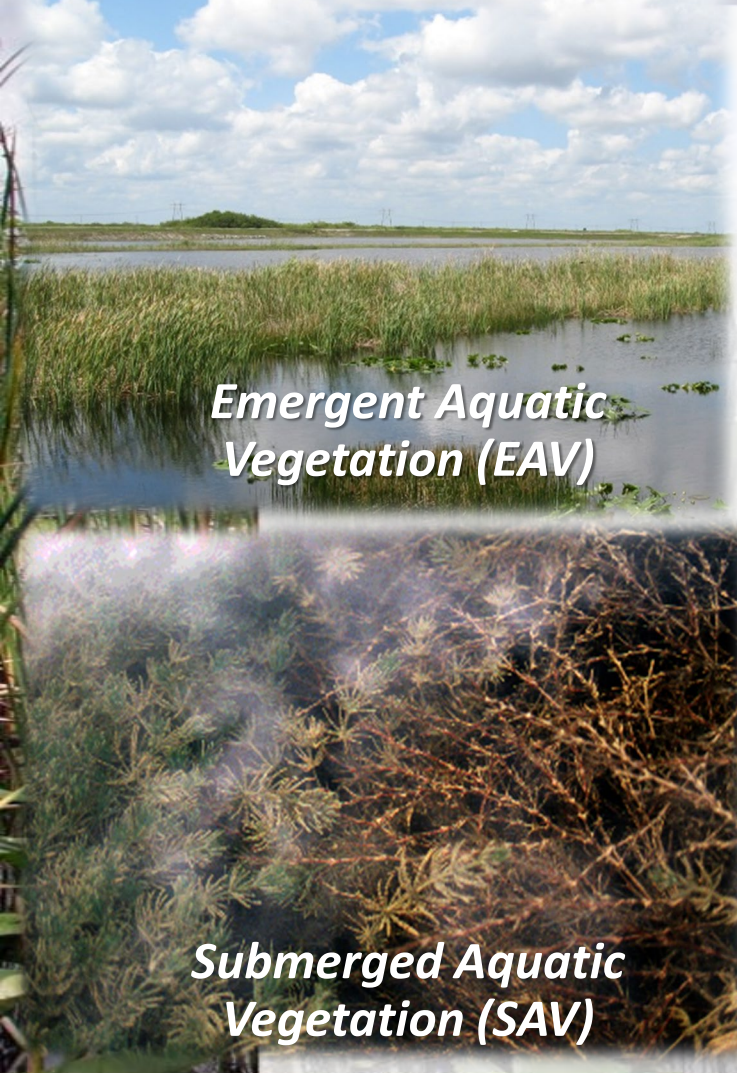
- Established in National Pollutant Discharge Elimination System (NPDES) and Everglades Forever Act (EFA) permits issued by Florida Department of Environmental Protection (FDEP) to SFWMD to operate STAs
- Two-part compliance test:
 - Total Phosphorus (TP) long-term flow weighted mean of 13 ppb, not to be exceeded in more than three out of five water years on rolling basis, and
 - A maximum TP annual flow weighted mean of 19 ppb in any water year
- Ensures STA discharges will not cause or contribute to a violation of water quality standards in Everglades
- Consent Orders for Restoration Strategies projects

Legend

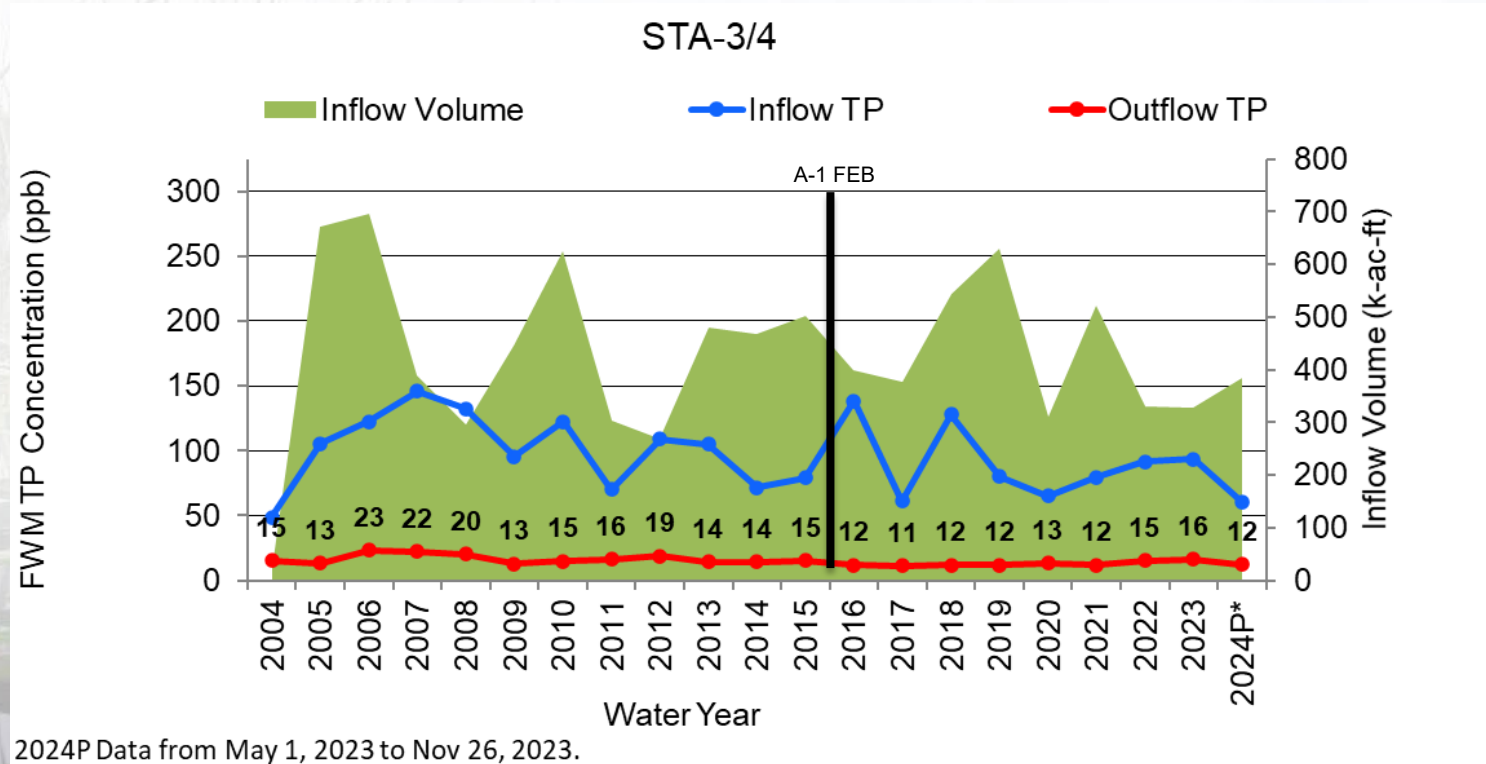
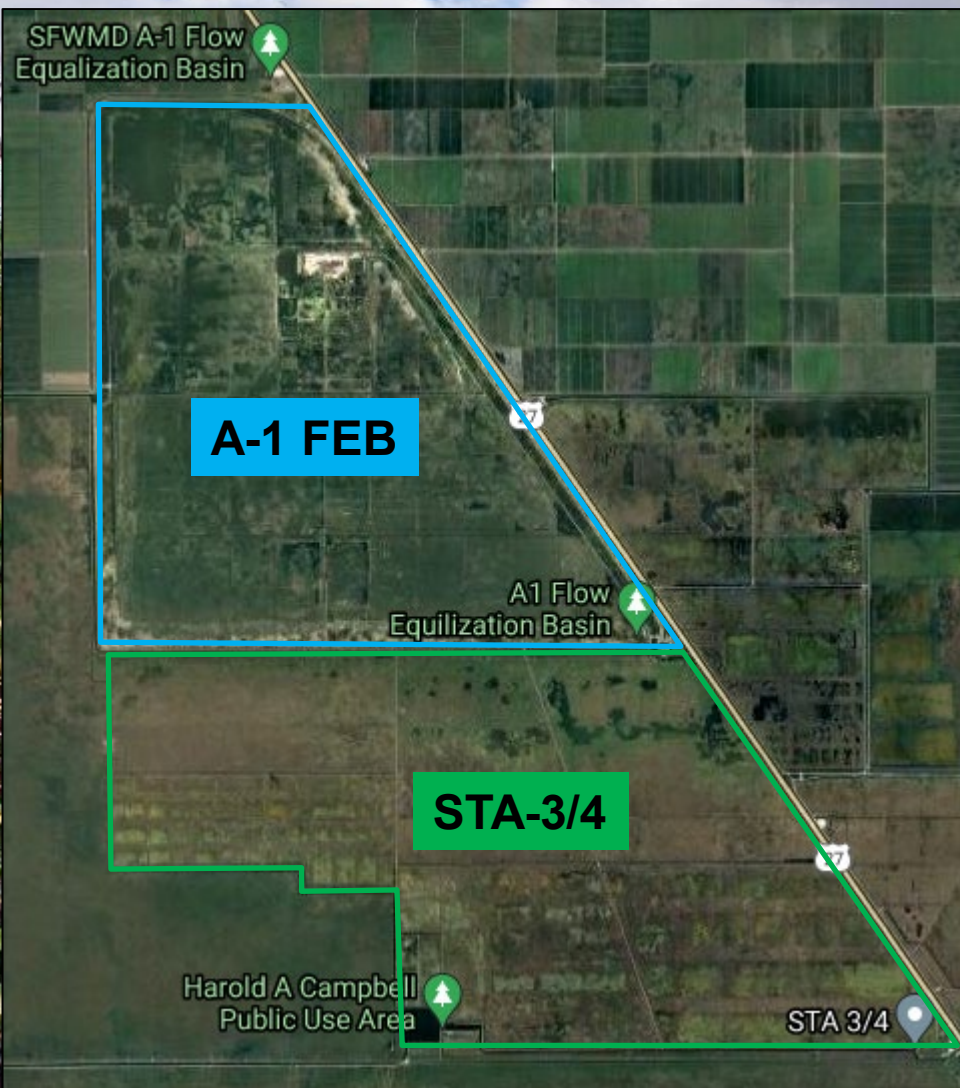
- Existing STAs (57,000 acres)
- New STAs (6,200 acres)
- STA Repairs (2,152 acres)
- New FEBs (116,000 ac-ft)
- Restoration Strategies Flow Path



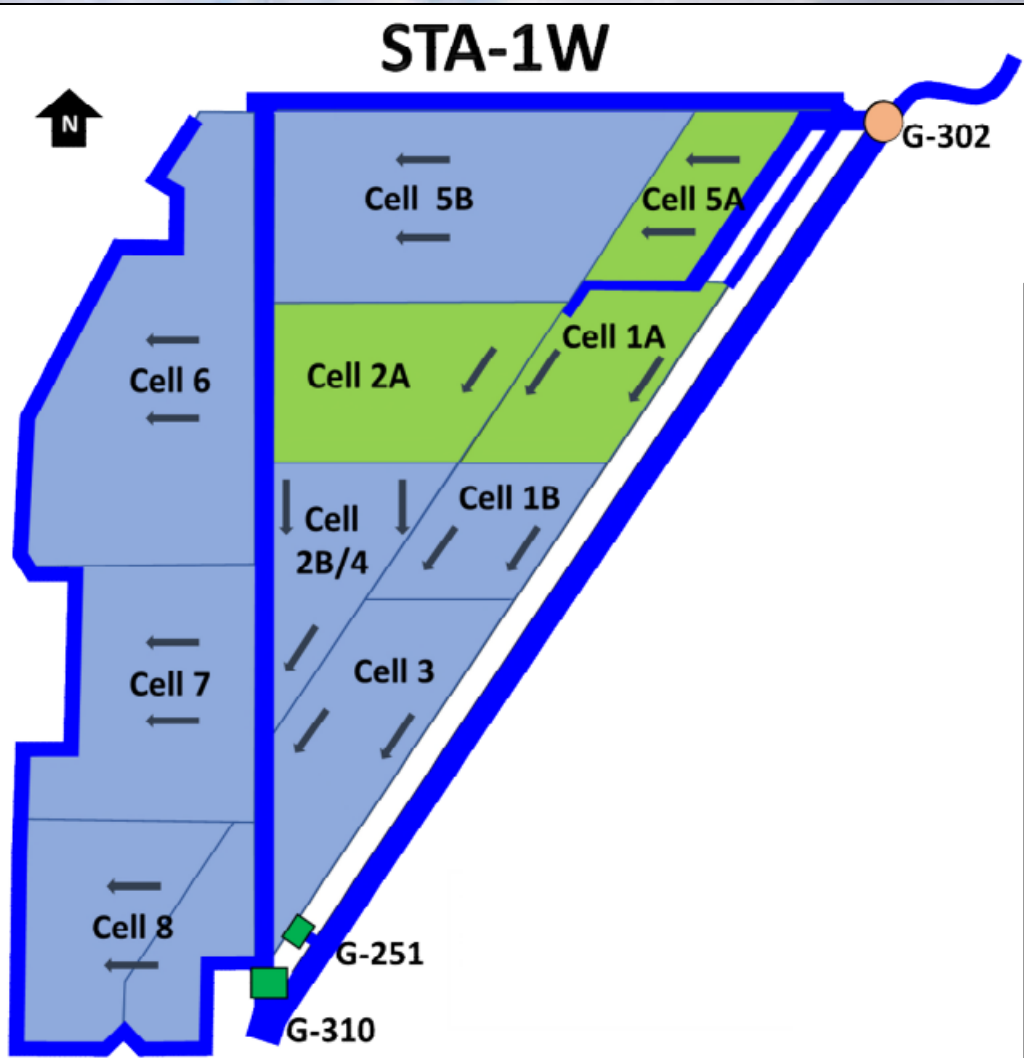
STA Treatment System



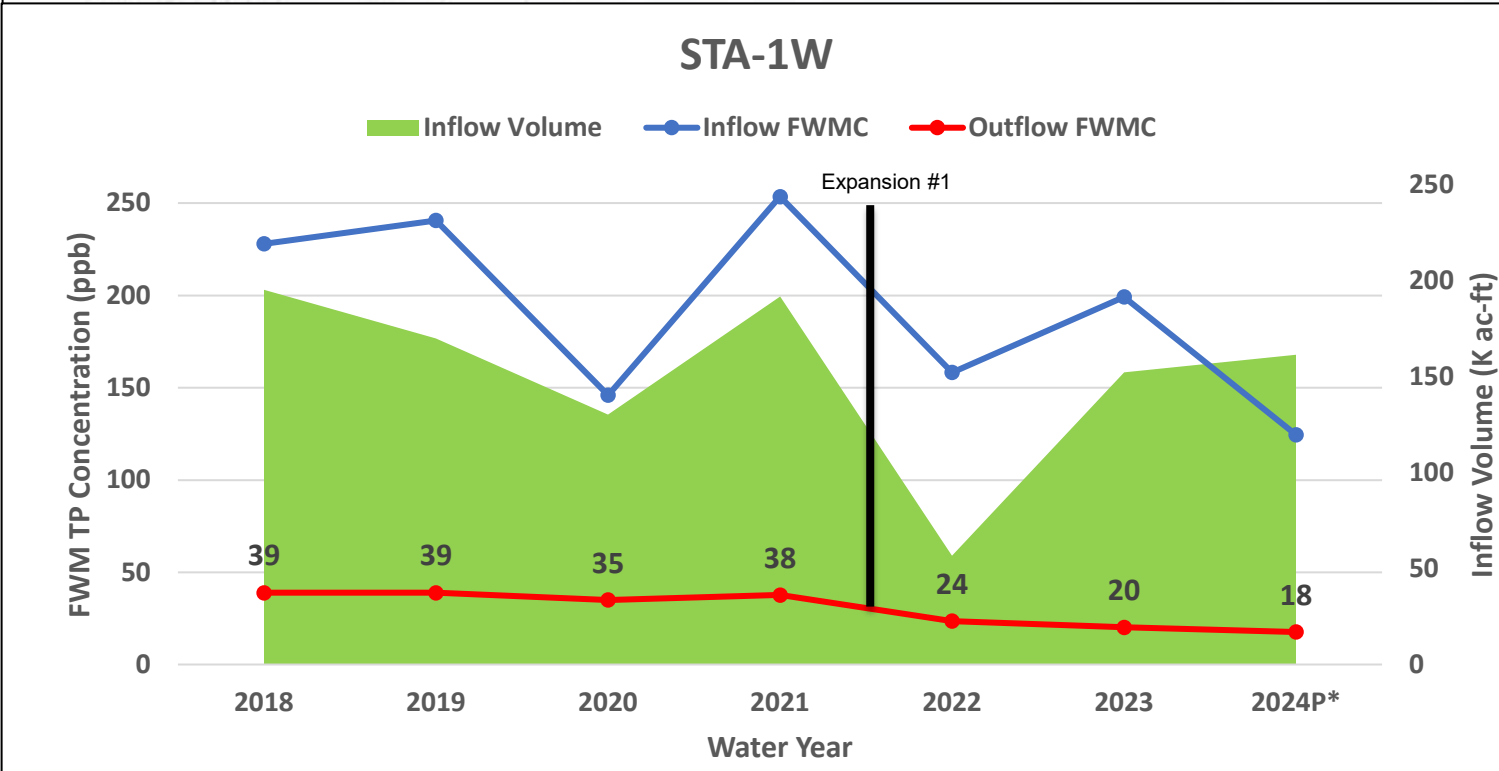
STA-3/4 & A-1 FEB



STA-1W and Expansion #1



- Declining trend in outflow TP FWMC following completion of Expansion #1



Everglades STA Operations & Performance

STA-1E S-319 Inflow Pump Station

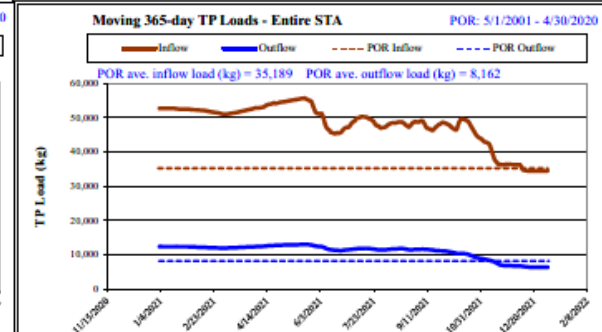
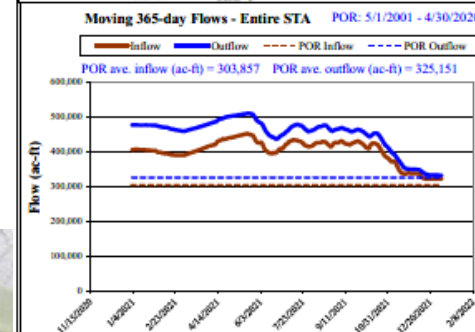
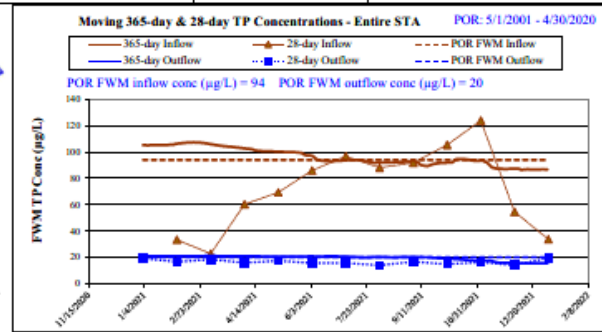
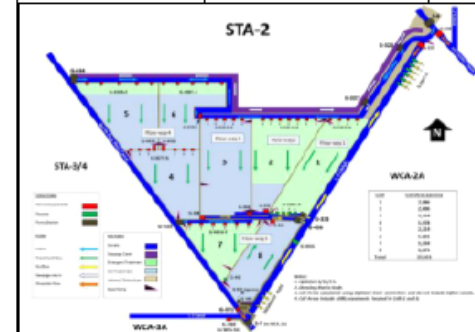
- STAs operate in regional water management system
 - Inflow pump stations provide flood protection
 - FEBs help reduce effects of peak flows on STAs
- Maintain optimal water depth for vegetation
 - 1.25 feet (0.38 m) depth between flow events
 - Avoid too deep for too long especially in EAV cells
 - Avoid dryout and subsequent phosphorus “flux” to water column
- Balance STA flows and phosphorus loading rates (PLR)

Weekly Performance Report

- Dashboard for each STA
- Entire STA & individual flow-ways
- Annual, monthly & weekly summaries
- Near real-time flow & phosphorus data
- Support operational recommendations
 - Balance flows and 365-day PLRs among flow-ways and STAs

WEEKLY STA PERFORMANCE SUMMARY									
PROJECT	STA-2	DATE	1/5/2022						
		LATEST DATA		1/2/2022					
365-day Values	WY2022 to Date Flow-weighted Mean Conc (µg/L)	Inflow: 96	Outflow: 15	Entire STA	Flow-way 5	Flow-way 4	Flow-way 3	Flow-way 2	Flow-way 1
	Inflow Volume (ac-ft)			321,905	30,157	119,459	131,809	5,173	56,456
	Inflow Load (kg)			34,466	1,751	11,066	11,775	458	4,133
	Inflow Flow-weighted Mean Conc (µg/L)			87	47	75	72	72	59
	Outflow Volume (ac-ft)			331,564	23,018	106,950	135,894	37,465	57,944
	Outflow Load (kg)			6,367	278	1,577	2,777	1,237	955
	Outflow Flow-weighted Mean Conc (µg/L)			16	10	12	17	27	13
365-day load reduction (kg)				28,099	1,474	9,490	8,997	-779	3,178
28-day Values	Inflow Volume (ac-ft)			2,505	1,477	6,121	12	no flow	no flow
	Inflow Load (kg)			104	84	211	0	no flow	no flow
	Inflow Flow-weighted Mean Conc (µg/L)			34	46	28	28	no flow	no flow
	Outflow Volume (ac-ft)			2,452	58	622	no flow	8,051	no flow
	Outflow Load (kg)			59	1	13	no flow	339	no flow
	Outflow Flow-weighted Mean Conc (µg/L)			20	14	17	no flow	34	no flow
7-day Values	Inflow Volume (ac-ft)			1,138	1,138	372	no flow	no flow	no flow
	Inflow Flow-weighted Mean Conc (µg/L)			50	50	28	no flow	no flow	no flow
	Outflow Volume (ac-ft)			305	no flow	no flow	no flow	2,104	no flow
	Outflow Flow-weighted Mean Conc (µg/L)			19	no flow	no flow	no flow	47	no flow
365-day phosphorus loading rate (g/m ² /yr)				0.6	0.1	0.5	1.3	N/A	0.6
6-month trend in outflow TP concentration (- means decrease; µg/L)				-4	0	-1	0	-16	1

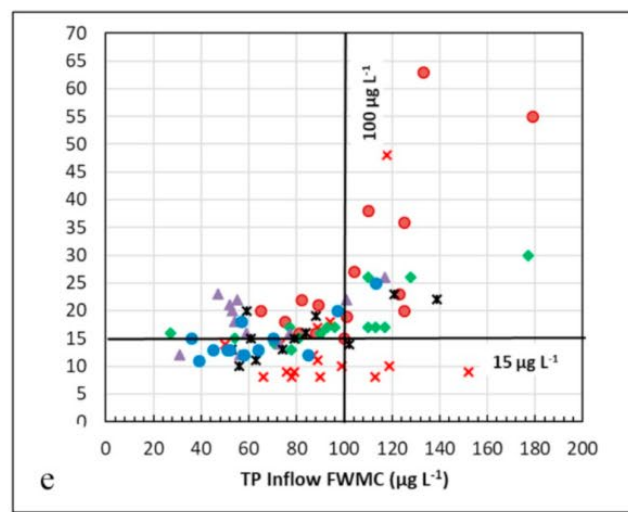
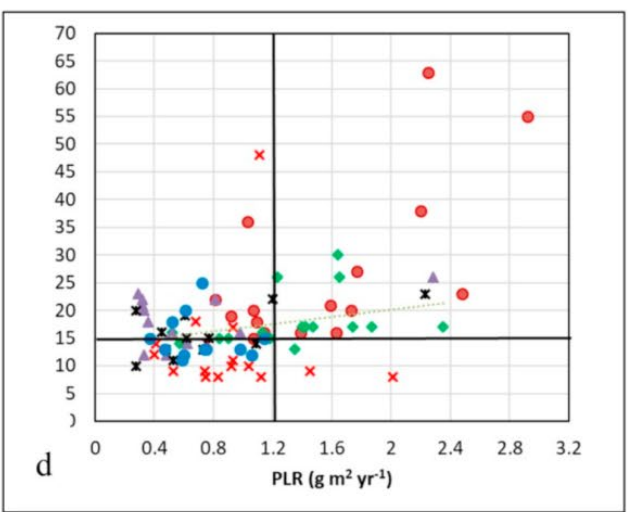
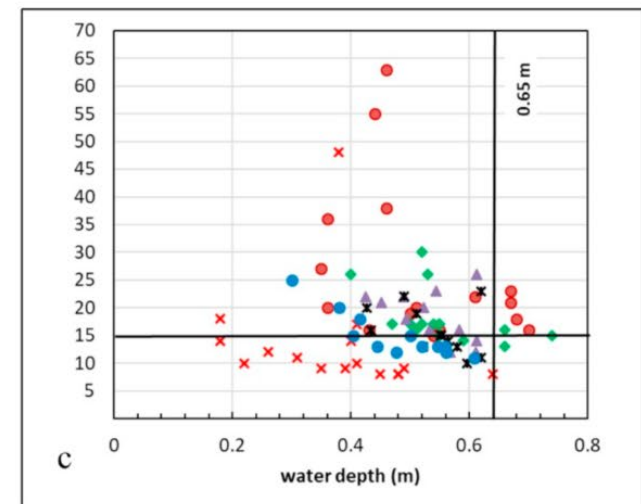
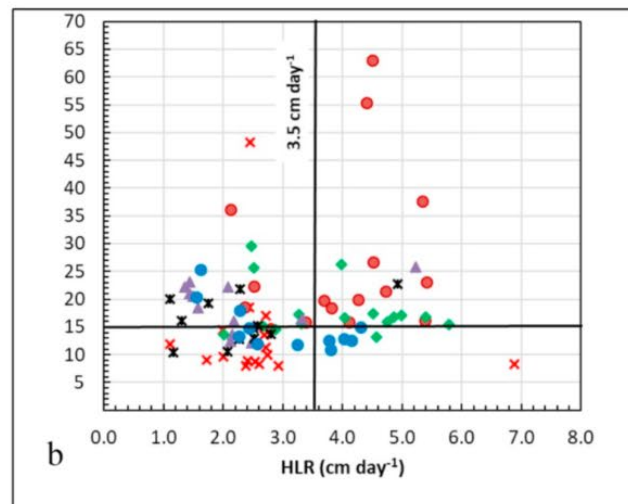
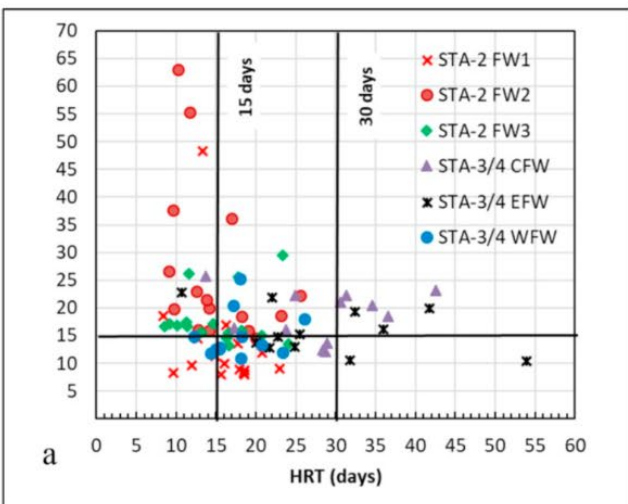
Flow-Way Information (Research projects, stage-duration, vegetation, etc.)				
Flow-way 5	Flow-way 4	Flow-way 3	Flow-way 2	Flow-way 1
On-line	On-line	On-line	Off-line	On-line
	On-line with restrictions for vegetation managements activities starting on 10/28/2019.	On-line with restrictions for vegetation rehabilitation activities starting on 05/21/2019.	Off-line for construction activities starting on 9/7/2021.	



The data provided in this summary report were developed using a combination of provisional and quality-assured flow and water quality data. In some cases, best professional judgment was used to estimate missing data or revise questionable data. Values provided are not considered final, but are appropriate for use in STA operational decision-making. The PLRs being reported on the weekly sheets are adjusted to account for length of time and/or treatment area offline.

Factors Affecting STA Treatment Performance

Outflow TP FWMC ($\mu\text{g L}^{-1}$)



Partition Analysis from:
 Zhao and Piccone 2020,
 Ecological Engineering

Restoration Strategies Science Plan

- Developed in 2013 and updated in 2018
- Required by STA permits and consent orders
- Studies evaluating key factors and processes that affect phosphorus removal in STAs
 - Studying vegetation, internal phosphorus loads, biogeochemical and physical mechanisms, fauna
 - Support design, operation and management of STAs to achieve WQBEL

SOUTH FLORIDA WATER MANAGEMENT DISTRICT

RESTORATION STRATEGIES REGIONAL WATER QUALITY PLAN

Science Plan for the Everglades Stormwater Treatment Areas



South Florida Water Management District
3301 Gun Club Road, West Palm Beach, Florida 33406
July 2018

Science Plan Major Findings to Date

- No flow (stagnant) conditions result in increased water column TP in SAV areas especially after high flow events
- Water depths greater than ~3 feet for more than 8 weeks result in reduced density of adult and juvenile cattail and higher risk of tussock formation
- Canal TP export related to high flow events and increased particulate P
- FEBs reduce frequency and duration of peak flows
 - Promote low steady flows, reduce effects of extended deep-water conditions on cattail health and sustainability, and reduce potential canal TP export
- PSTA cell muck removal and low inflow TP concentrations/loads resulted in annual flow weighted mean discharge TP ≤ 13 ppb for 14 years
- Fauna are abundant in the STAs and play an important role in phosphorus cycling through bioturbation, herbivory, and excretion



Questions

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