









From Science to Solutions™

STA-1E PSTA Field-Scale Demonstration Operations Monitoring Plans

December 1, 2005

Why STAs? Why PSTA?

- "These areas will be designed, operated and managed primarily to purify the water before it enters the WCAs, the Park and the Refuge; in addition, their size and location may allow **significant improvement in the manner in which water is introduced into the natural areas"**
- "The size of each STA is based on the assumption that **the volume of flows experienced during the 1979 to 1988 base period** from each tributary basin would be treated with **no hydraulic bypass**"
- "Inflows to the Refuge must result in compliance with the Class III water quality criteria or long-term concentration levels, whichever are lower by December 31, 2006, as set forth in Appendix B; research and monitoring will be conducted under this Agreement to interpret what phosphorus concentration levels comply with Class III water quality criteria"

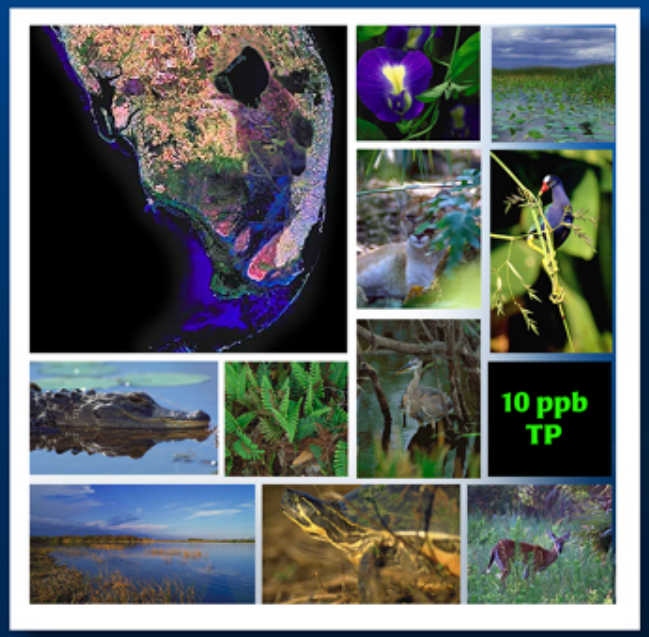
Excerpted from 88-1886-CIV-HOEVELER; emphasis added

Design, Operations, and Monitoring Overview

- Project Objectives
- Design Summary
- Operations Objectives
- Monitoring Objectives
- Project Schedule
- Discussion

Project Objectives

- Evaluate PSTA performance for the POR
- Calibrate concentration-based PSTA model
- Demonstrate cost-effective PSTA substrates
- Determine parameters for optimum PSTA performance



Design Summary

STA-1E PSTA Field-Scale Test Cells Design Background

- Developed PSTA demonstration operational envelope
  - Burns & McDonnell 2000 STA-1E dry out analysis (10-year period of record)
- Configured layouts for PSTA cells
- Specified three substrates (Fort Thompson limerock, IL-6 limerock, lime sludge over Riviera sand)
- Estimated treatment performance for the SAV and PSTA
- Added FAV to achieve the 30 ppb PSTA feed needed for the maximum scenario for 3.5 day/HRT and 2.75 foot depth

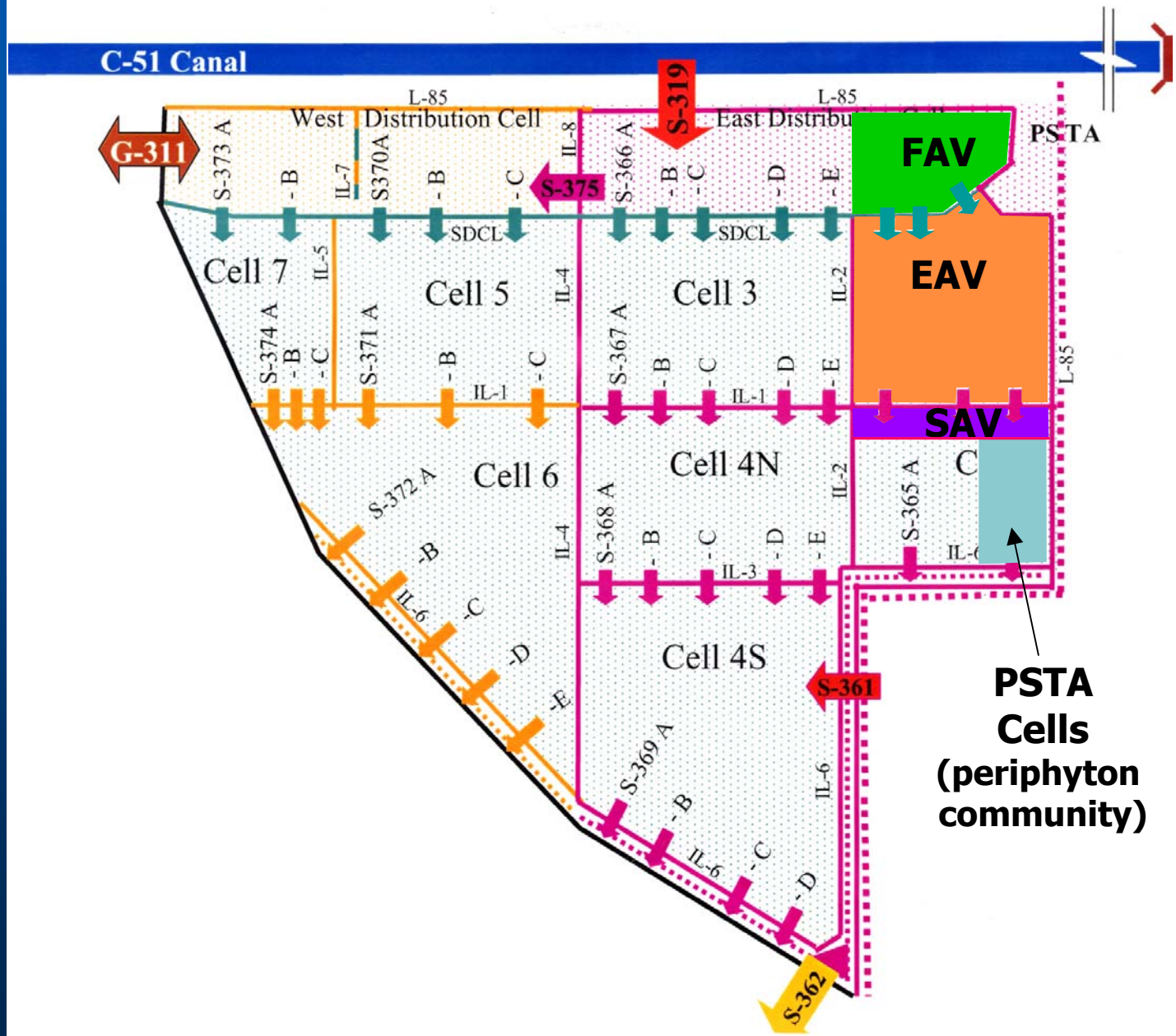
Pre-Treatment Strategy Using FAV, EAV, SAV

To Feed PSTA Cells at 30 ppb TP

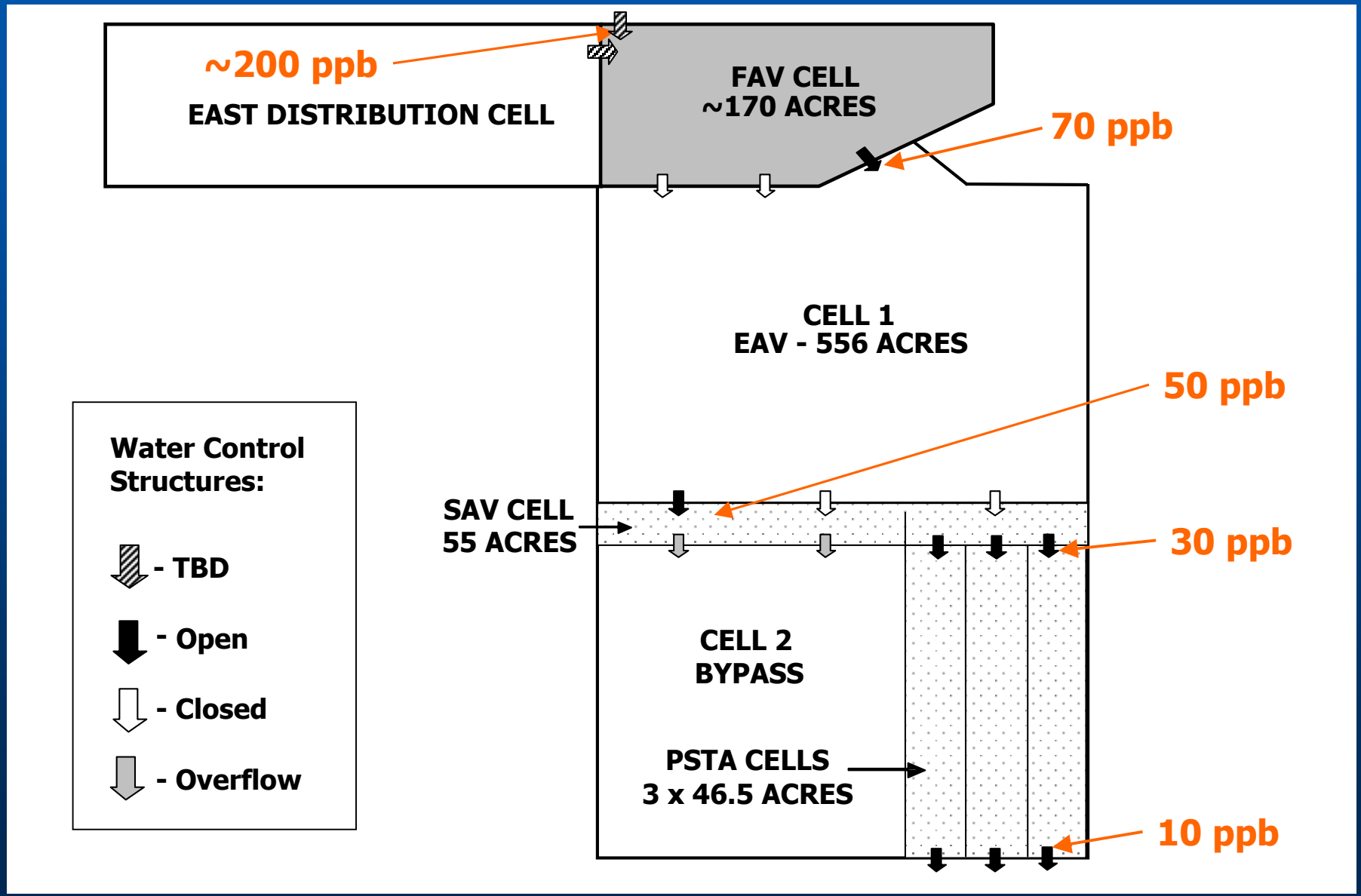
FAV = Floating Aquatic Vegetation

EAV = Emergent Aquatic Vegetation

SAV = Submerged Aquatic Vegetation



Pre-Treatment to Achieve 30 ppb TP Feed to PSTA Cells

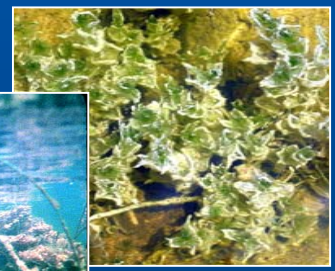


STA-1E

PSTA Demonstration Conceptual Plan to Achieve 10 ppb Phosphorus

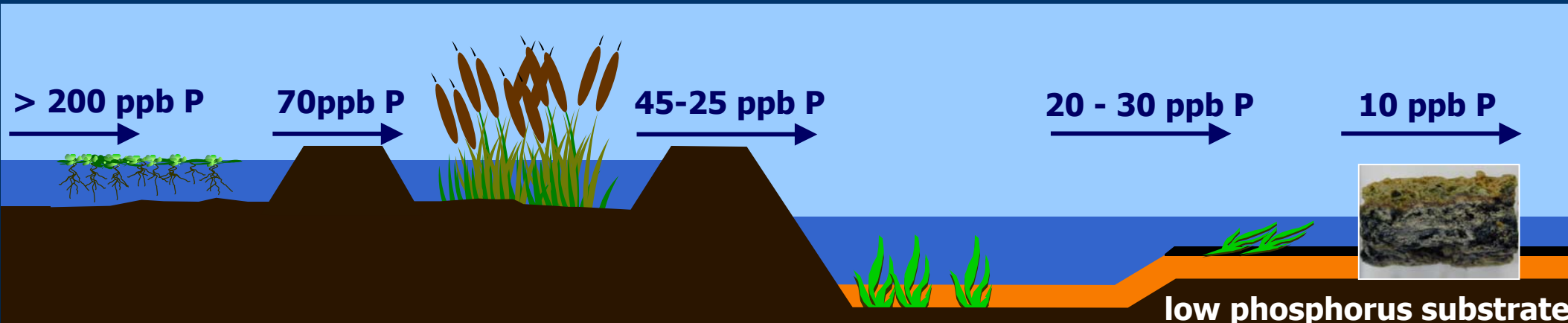
Floating Aquatic Vegetation (FAV)

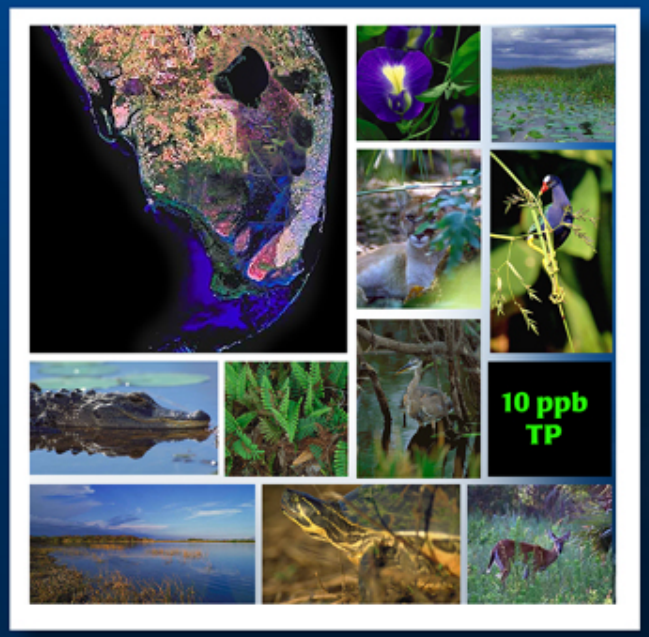
Emergent Growth



SAV w/Periphyton

Calcareous Periphyton (activated)





Operating Objectives

Operating Objectives

- Demonstrate PSTA activation at field-scale
- Demonstrate fixed and pulsed flows for 1979-1988 POR flows
- Demonstrate reactivation after cell failure

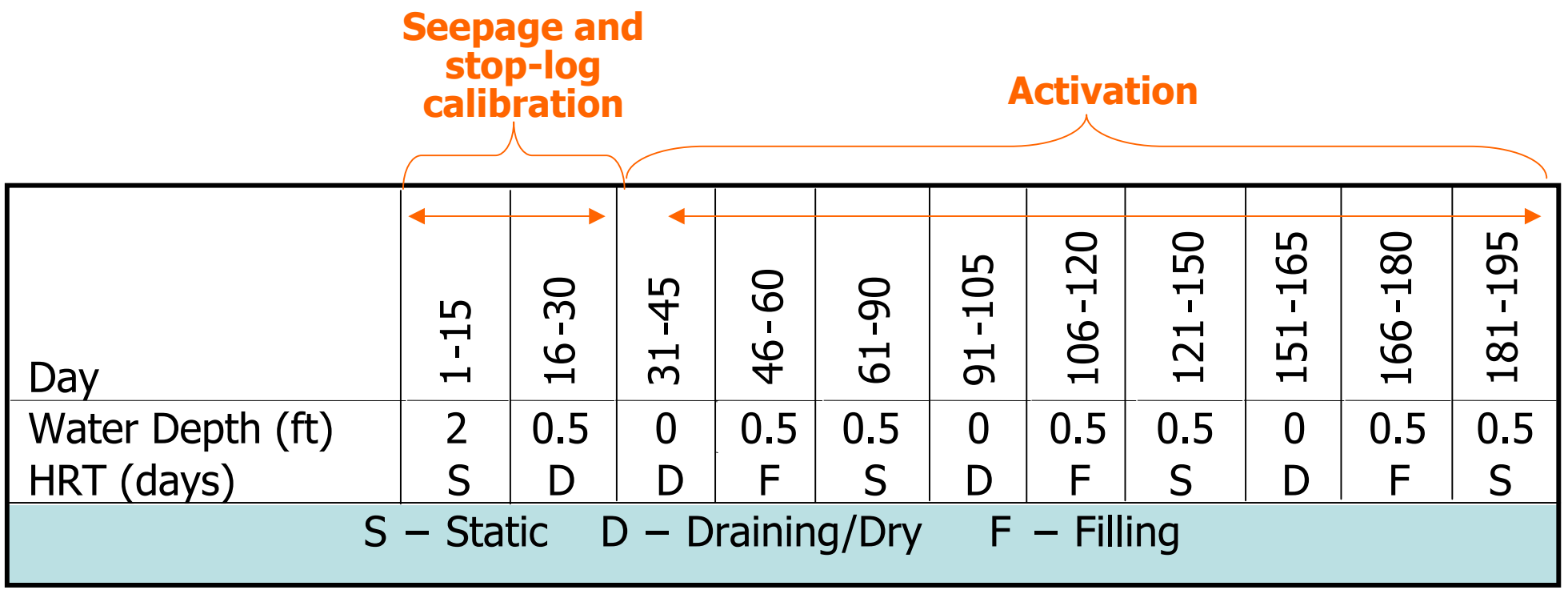
PSTA Operations Overview

- PSTA start-up
  - Seepage Testing
  - Weir Flow Calibration
- Activation

22 weeks

- Fixed flow/depth scenarios (22 weeks)
- POR simulation (52 Weeks)
  (Note: Sequence dependant on start date)
- Extreme loadings to manifest failure and recovery

PSTA Field-Scale Start-up

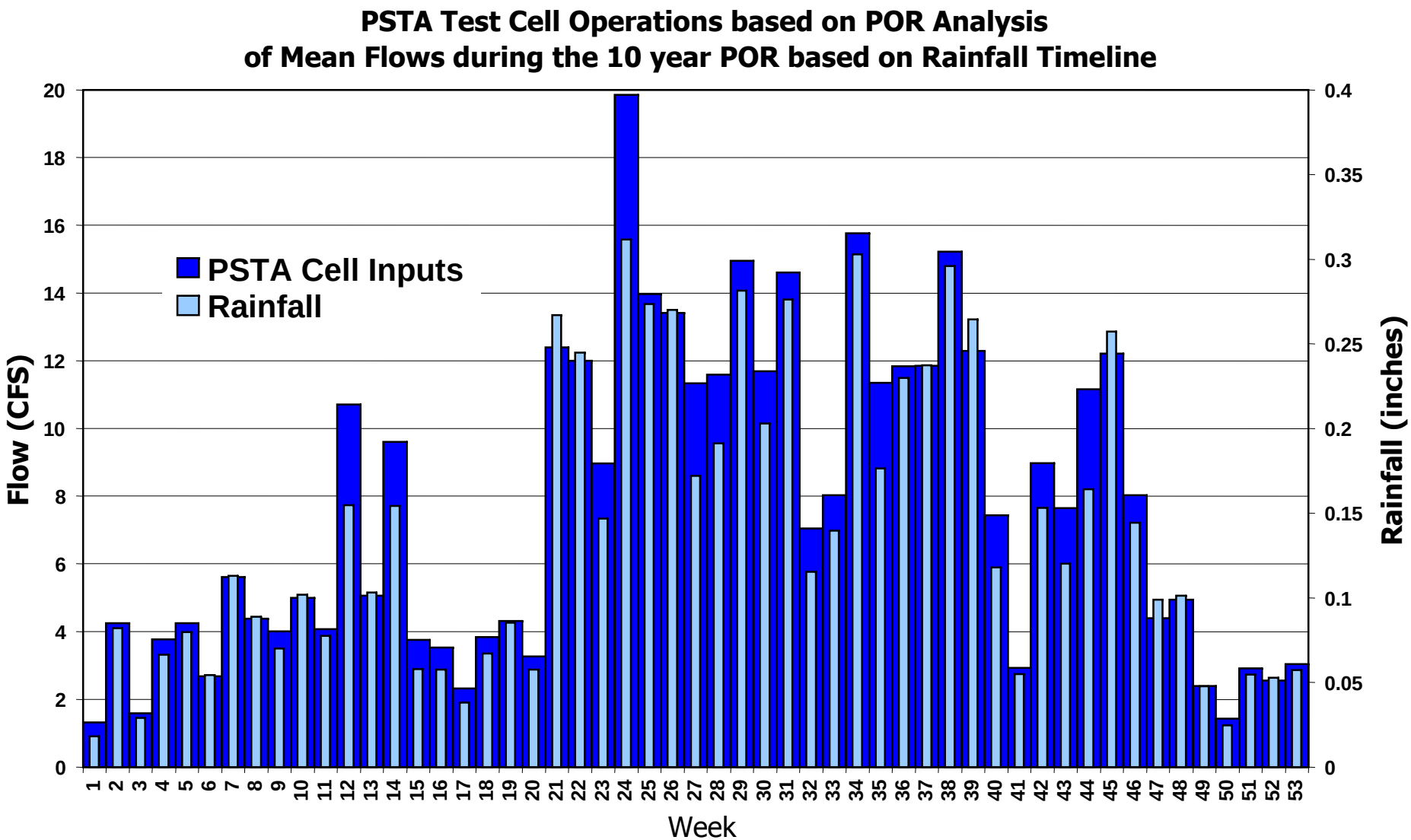


Fixed Flow/Depth Scenarios

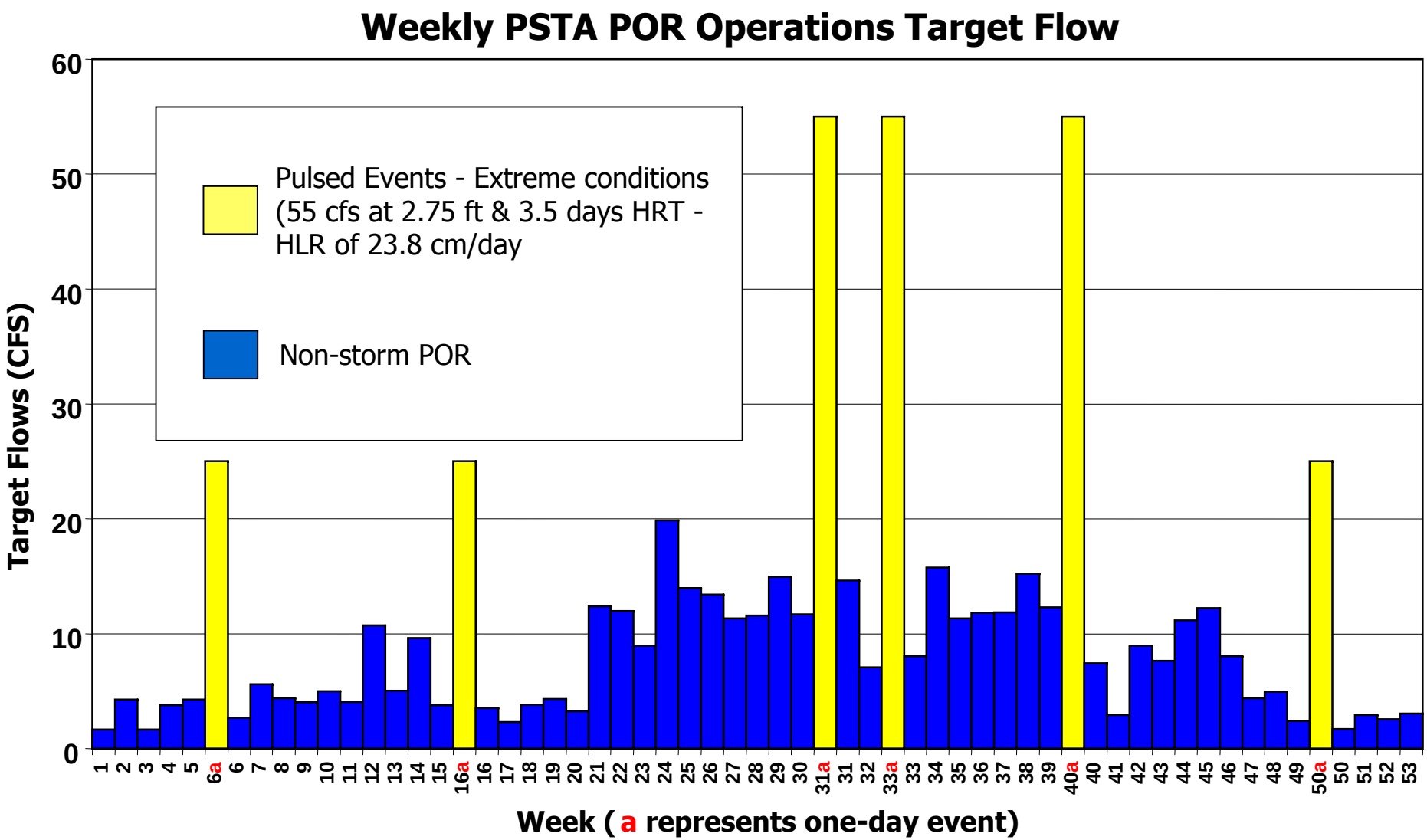
Day	1-15	16-30	31-45	46-60	61-90	91-105	106- 113	113-150
Water Depth (ft)	0.5	1.0	1.0	1.0	1.0	1.0	2.0	2.0
HRT (days)	14	F	14	14	7	7	F	7
F – Filling								

- Similar to Flying Cow Road Test Facility scenarios
- Scenarios follow Start-Up period

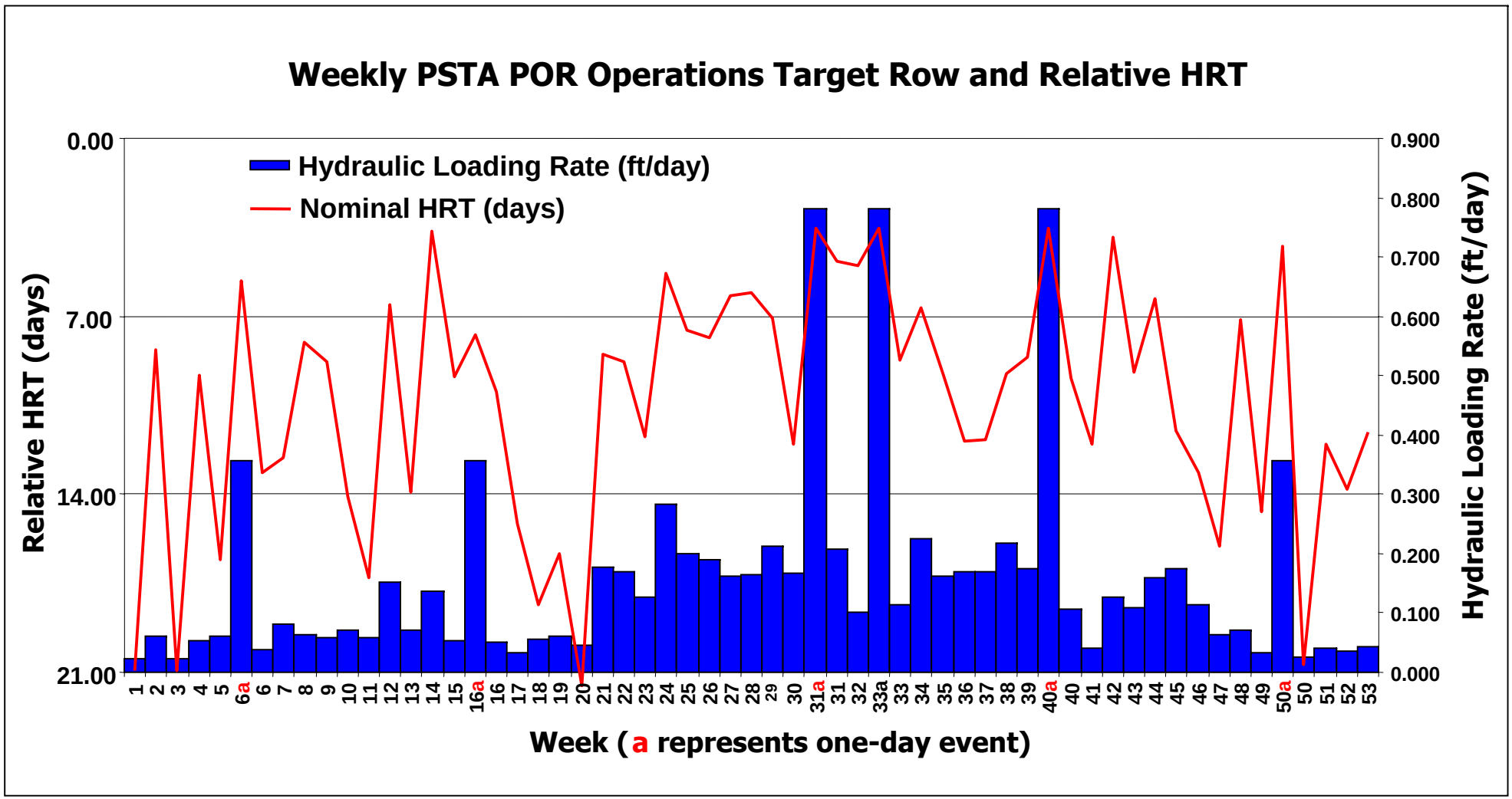
Period of Record (POR) Base Flow Development



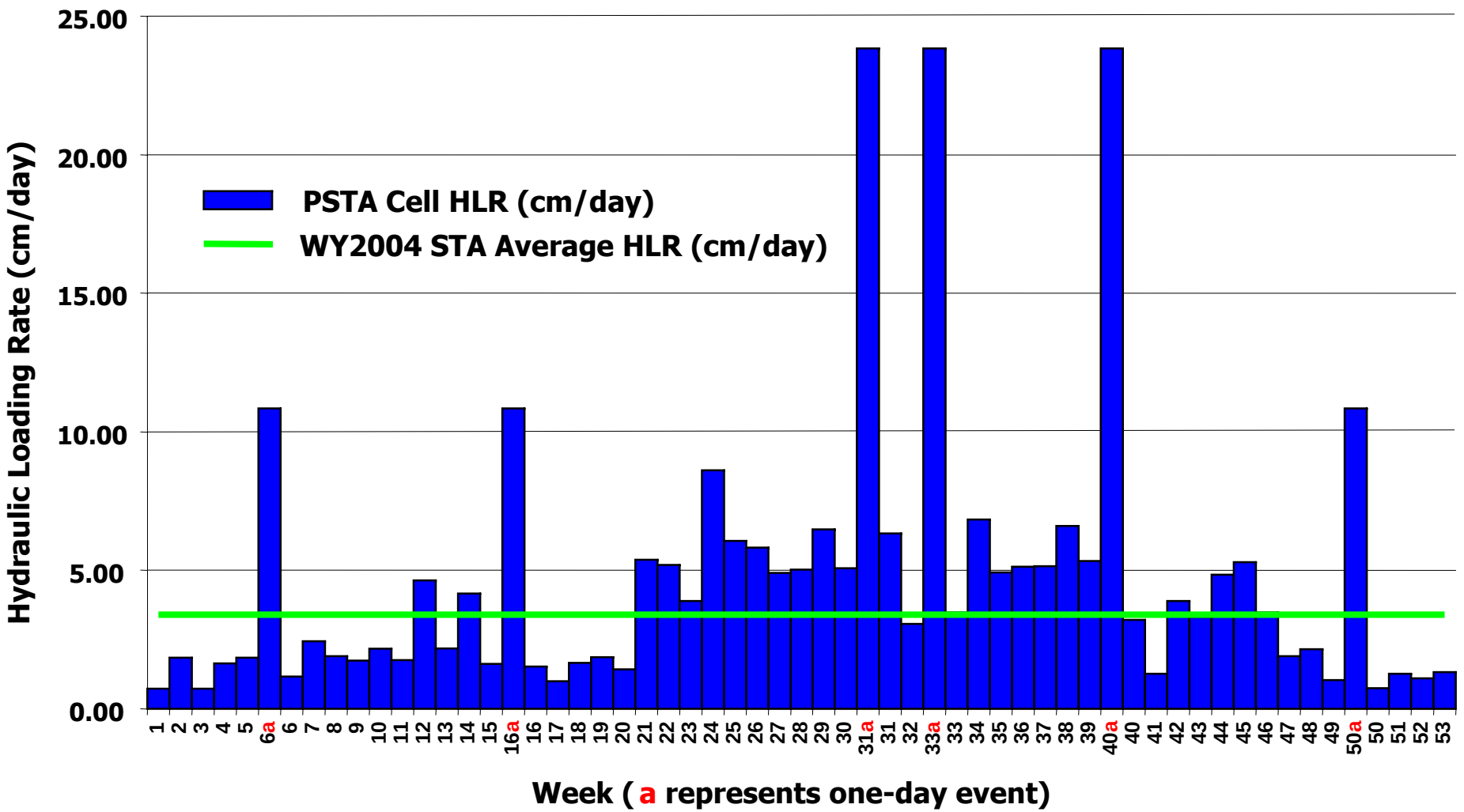
POR Based Flow and Pulsed Events



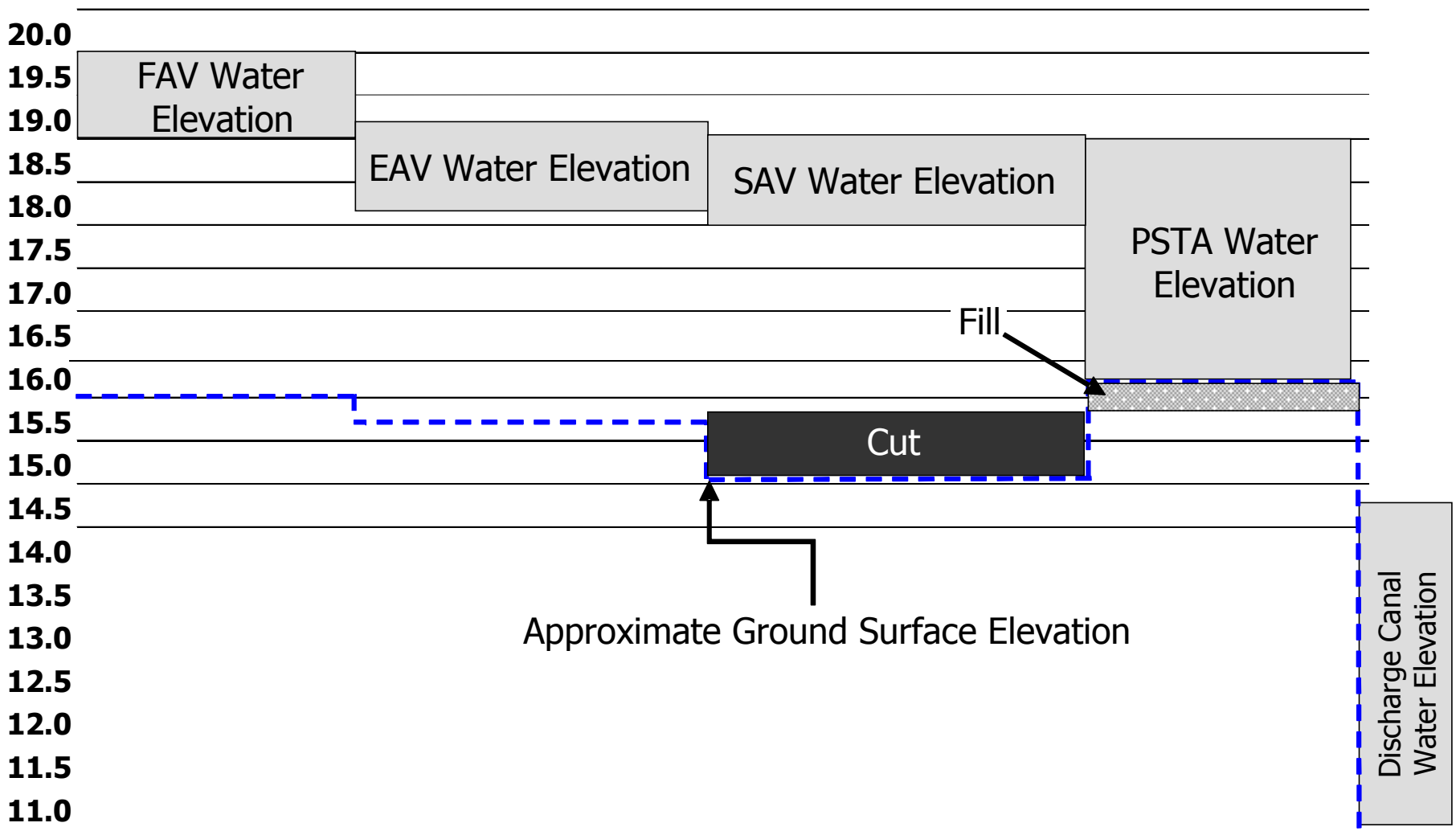
POR Target Flows and HRTs Proposed for 52 Week Demonstration

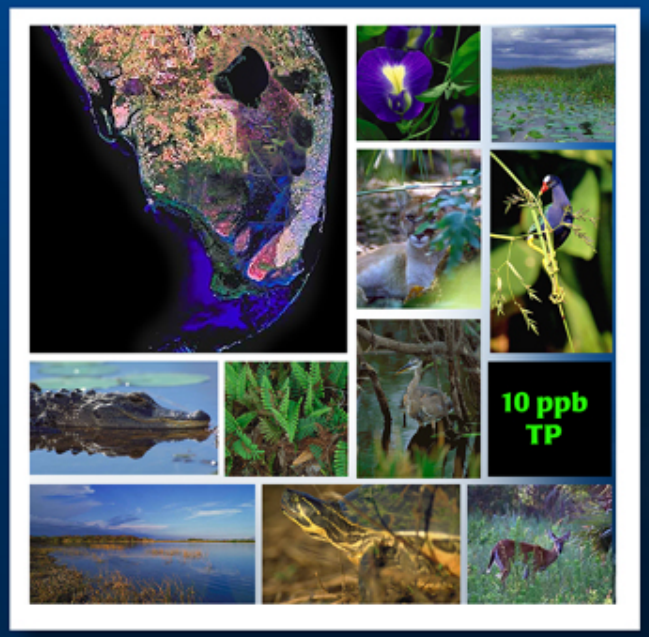


Hydraulic Loading Rates
(Planned HLR based on POR relative to Water Year 2004 STAs)



Water Surface Elevation Operating Ranges



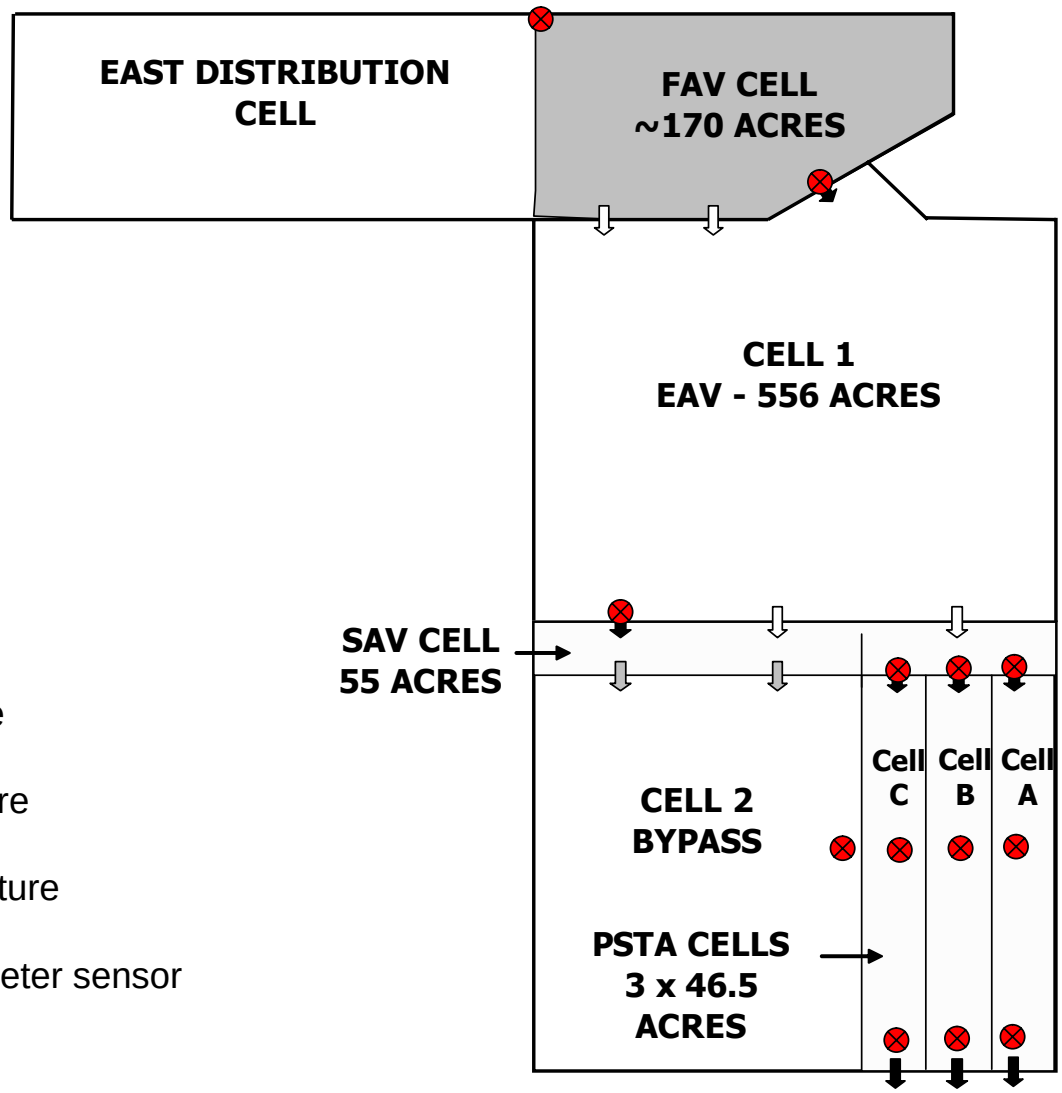


Monitoring Objectives

Monitoring Plan Objectives

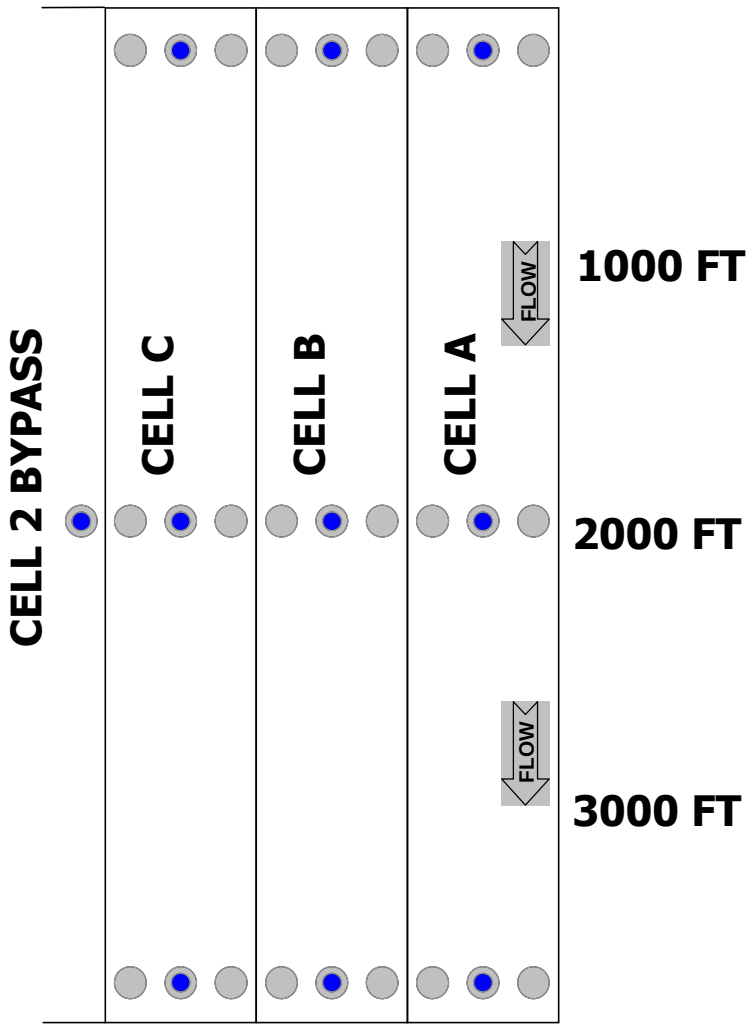
- Establish PSTA operations to achieve 10 ppb TP or better on three substrates
  - limerock 70+ percent calcium
  - limerock 50+ percent calcium
  - lime sludge on Riviera Sand
- Conduct dynamic monitoring to perform mass balance calculations
- Establish scale-up design parameters

Fixed Sampling Stations



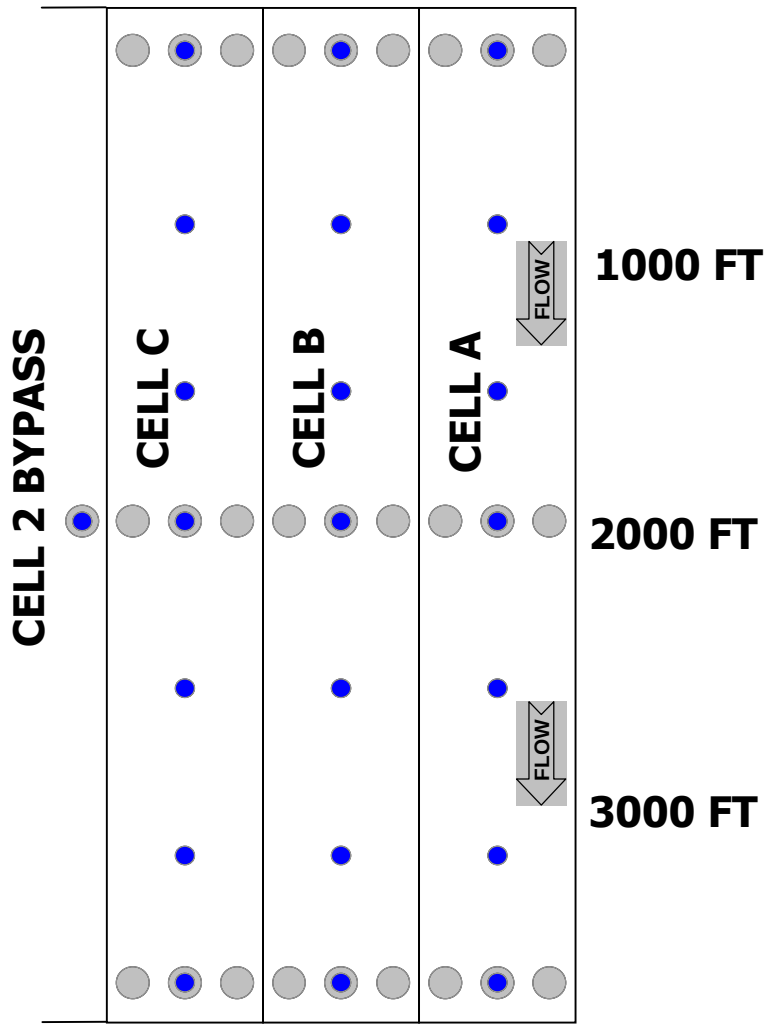
- Open Water Control Structure
- Closed Water Control Structure
- Overflow Water Control Structure
- Autosampler and Multi-parameter sensor

Tiered Sampling Locations – Fixed and Random Locations



STATION TYPE
Groundwater Station
Multi-Media Station

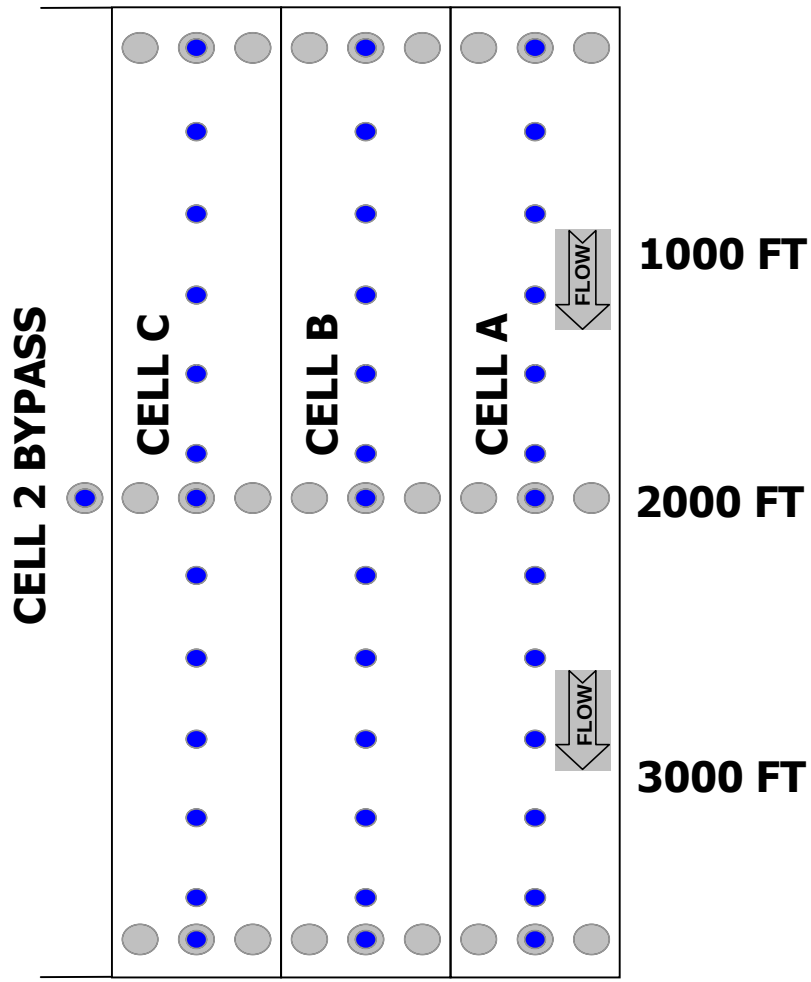
TIER I



STATION TYPE
Groundwater Station
Multi-Media Station

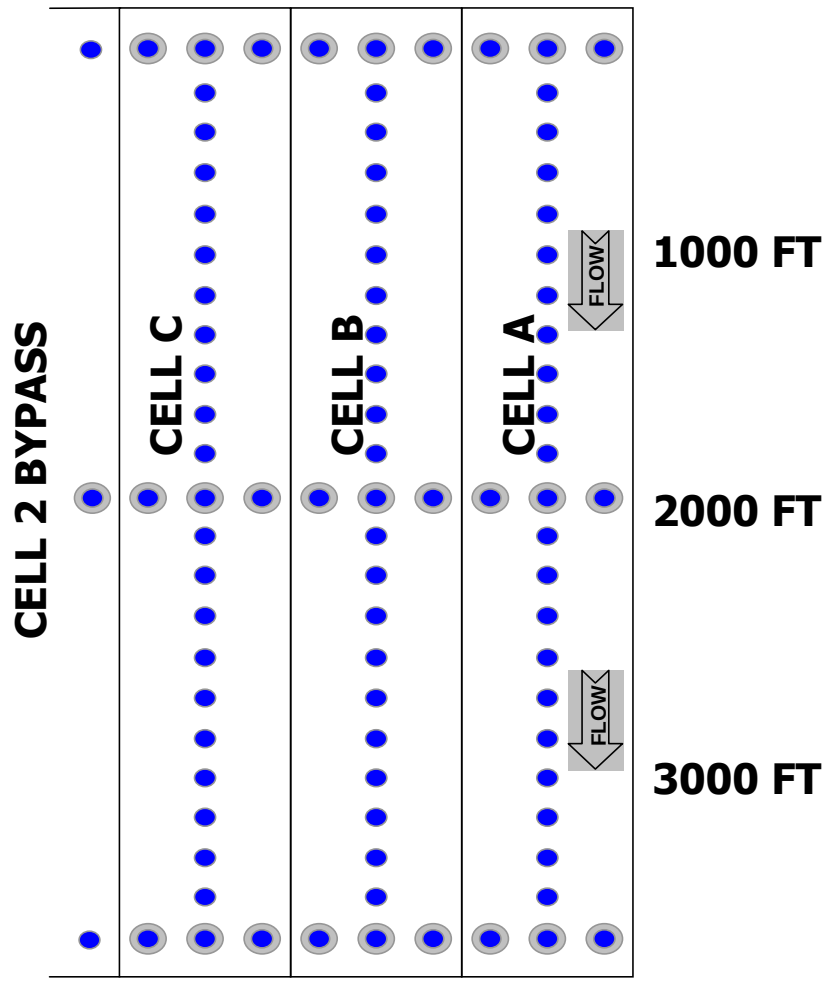
TIER II

Tiered Sampling Locations – Fixed and Random Locations



TIER III

STATION TYPE
Groundwater Station
Multi-Media Station



TIER IV

STATION TYPE
Groundwater Station
Multi-Media Station

Laboratory Sampling Frequencies

Parameter	Tier 1	Tier 2	Tier 3	Tier 4
Alkaline Phosphatase	BW	Transect	Transect	Transect
Alkalinity	M	Q	A	
Ammonia	BW	M	Q	
Calcium	M	Q		
Chloride	M	Q		
Color	BW	M	Q	
Dissolved Organic Carbon	BW	M	Q	
Iron	M	Q		
Magnesium	M	Q		
Mercury	A			
Nitrite	BW	M	Q	
Nitrite + Nitrate	BW	M	Q	
Ortho Phosphorus	BW	M	Q	
Potassium	M	Q		
Silica	M	Q		
BW – Biweekly M – Monthly Q – Quarterly A – Annually				

Note: Transect frequency consists of approximately monthly

Laboratory Sampling Frequencies continued

Parameter	Tier 1	Tier 2	Tier 3	Tier 4
Silica	M	Q		
Sodium	M	Q		
Sulfate	M	Q		
Total Dissolved Kjeldahl Nitrogen	M	Q	A	
Total Dissolved Phosphorus	M	Q	A	
Total Dissolved Solids	BW	M	Q	
Total Kjeldahl Nitrogen	M	Q	A	
Total Nitrogen	BW	Transect	Transect	Transect
Total Organic Carbon	BW	M	Q	
Total Phosphorus	Composite	Transect	Transect	Transect
Total Suspended Solids	BW	M	Q	
Turbidity	M	Q	A	
BW – Biweekly M – Monthly Q – Quarterly A – Annually				

Note: Transect frequency consists of approximately monthly

Field Monitoring Frequencies

Parameter	Tier 1	Tier 2	Tier 3	Tier 4
Flow Rate	Continuous*			
Dissolved Oxygen	Continuous	Transect	Transect	Transect
pH	Continuous	Transect	Transect	Transect
Photo Documentation		Transect	Transect	Transect
Redox Potential	Continuous	Transect	Transect	Transect
Specific Conductance	Continuous	Transect	Transect	Transect
Turbidity	Continuous	Transect	Transect	Transect
Water Depth	Continuous	Transect	Transect	Transect
Water Temperature	Continuous	Transect	Transect	Transect
* weir settings will be calibrated				

Note: Transect frequency consists of approximately monthly

Periphyton Mat Monitoring Frequencies

Parameter	Tier 1	Tier 2	Tier 3	Tier 4
Alkaline Phosphatase	BW	Q	A	
Ash-Free Dry Weight	BW	Q	A	A*
Bulk Density	BW	Q	A	
Calcium (as $CaCO_3$)	BW	Q	A	A*
Chlorophyll a	BW	Q	A	
Mat Thickness	BW	Q	A	
Percent Water	BW	Q	A	
Periphyton Species Composition	BW*	Q	A	A*
Photo Documentation	BW	Q	A	
Total Carbon	BW	Q	A	A*
Total Nitrogen	BW	Q	A	A*
Total Organic Carbon	BW	Q	A	A*
Total Phosphorus	BW	Q	A	A*
BW - Biweekly Q - Quarterly A - Annually				
* samples will be collected, preserved and analyzed as necessary				

Substrate Monitoring Frequencies

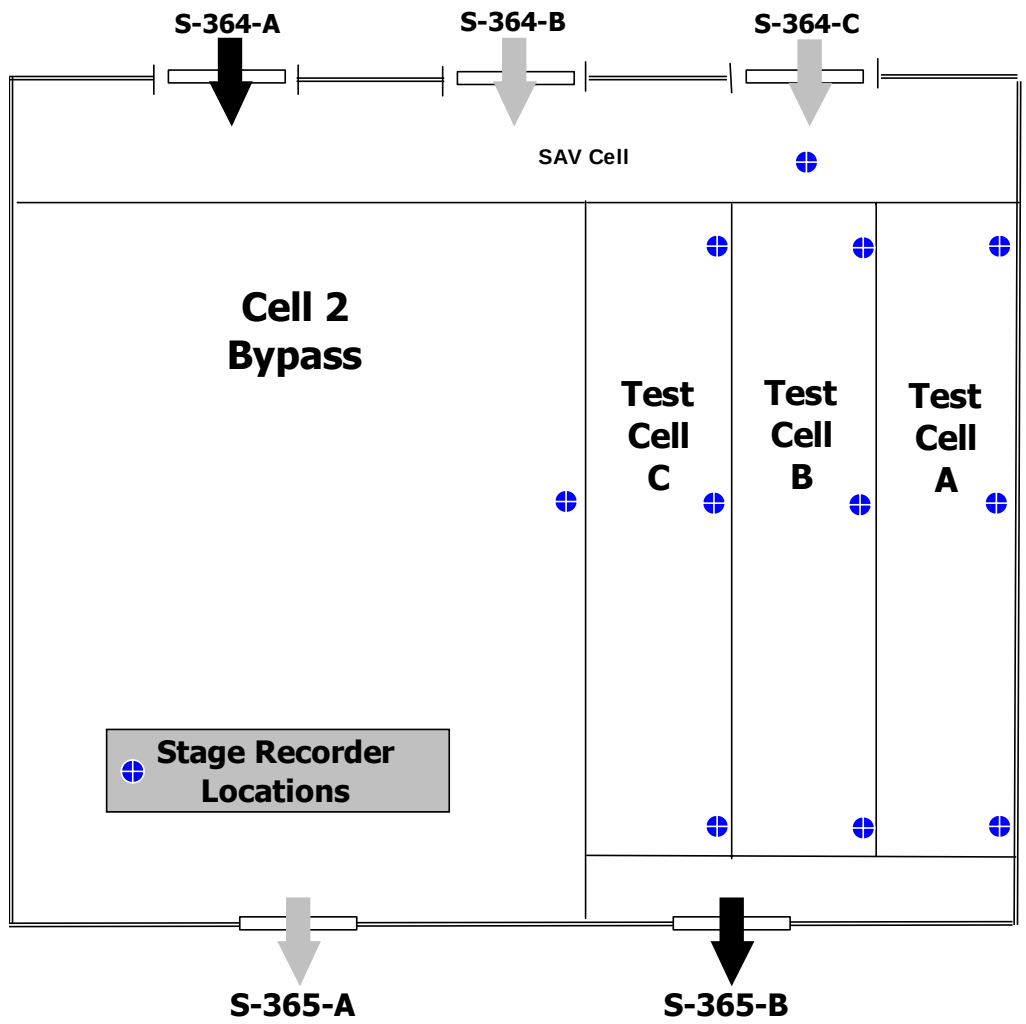
Parameter	Tier 1	Tier 2	Tier 3	Tier 4
Total Phosphorus	Q	A	A*	A*
Bulk Density	Q	A		
Calcium (as $CaCO_3$)	Q	A	A*	A*
Non-Reactive Phosphorus	Q	A		
Organic Matter	Q	A	A*	A*
Percent Solids	Q	A	A*	A*
Soluble Reactive Phosphorus	Q	A		
Total Nitrogen	Q	A	A*	A*
Total Organic Carbon	Q	A	A*	A*
Q - Quarterly A - Annually				
* samples will be collected, preserved and analyzed as necessary				

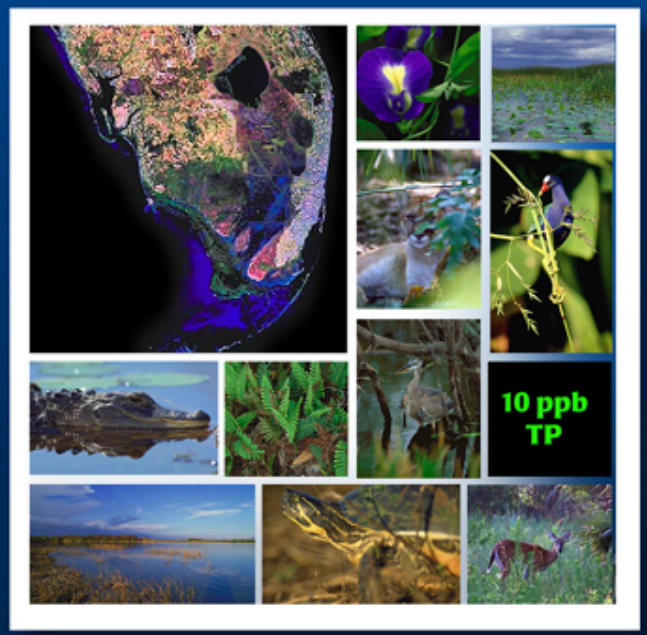
Stage Recorder Locations for Hydrological Parameters

- Water Depth
- Input Flow
- Output Flow

Meteorological Parameters

- Rainfall
- Evapotranspiration
- Photosynthetic Active Radiation
- Wind Speed and Direction

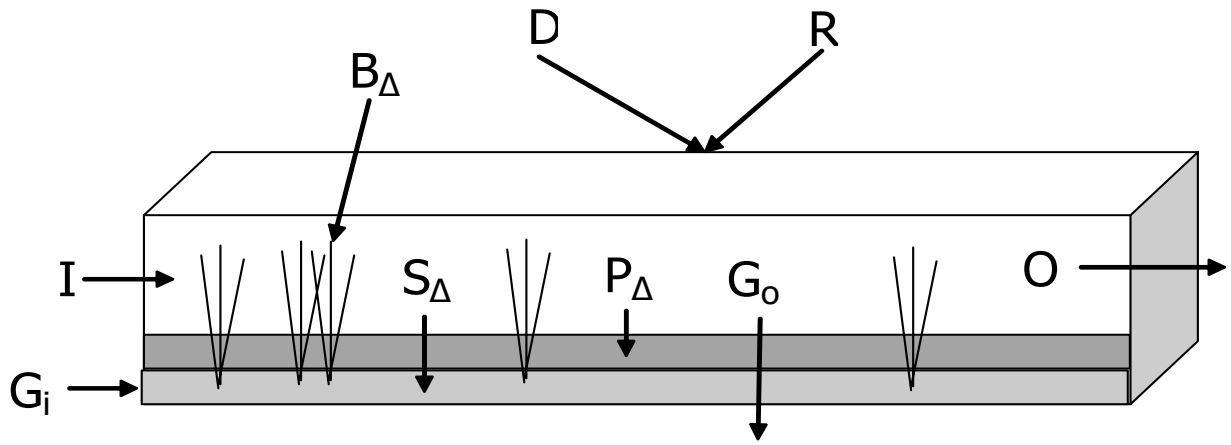




Mass Balance Calculations

Phosphorus Budget

G_i	Seepage Inflow	Segment
G_o	Seepage Outflow	Segment
I	Inflow	Segment
O	Outflow	Segment
B_Δ	Change in Non-Periphyton Mat	Segment
P_Δ	Change in Periphyton Mat	Segment
D	Dry Deposition	Cell
R	Rainfall	Cell
S_Δ	Change in Substrate	Segment



Water Budget Volume

$$V_{\Delta} = V_i - V_o + V_r - V_e + V_b - V_s$$

V_{Δ}	Change of water volume within PSTA cells
V_b	Infiltration from Cell 2 bypass
V_e	Evaporated
V_i	Input
V_o	Output
V_r	Rainfall
V_s	Seepage loss (levee and groundwater)

Project Schedule