Potential Contribution of Refuge Canals to P Loads

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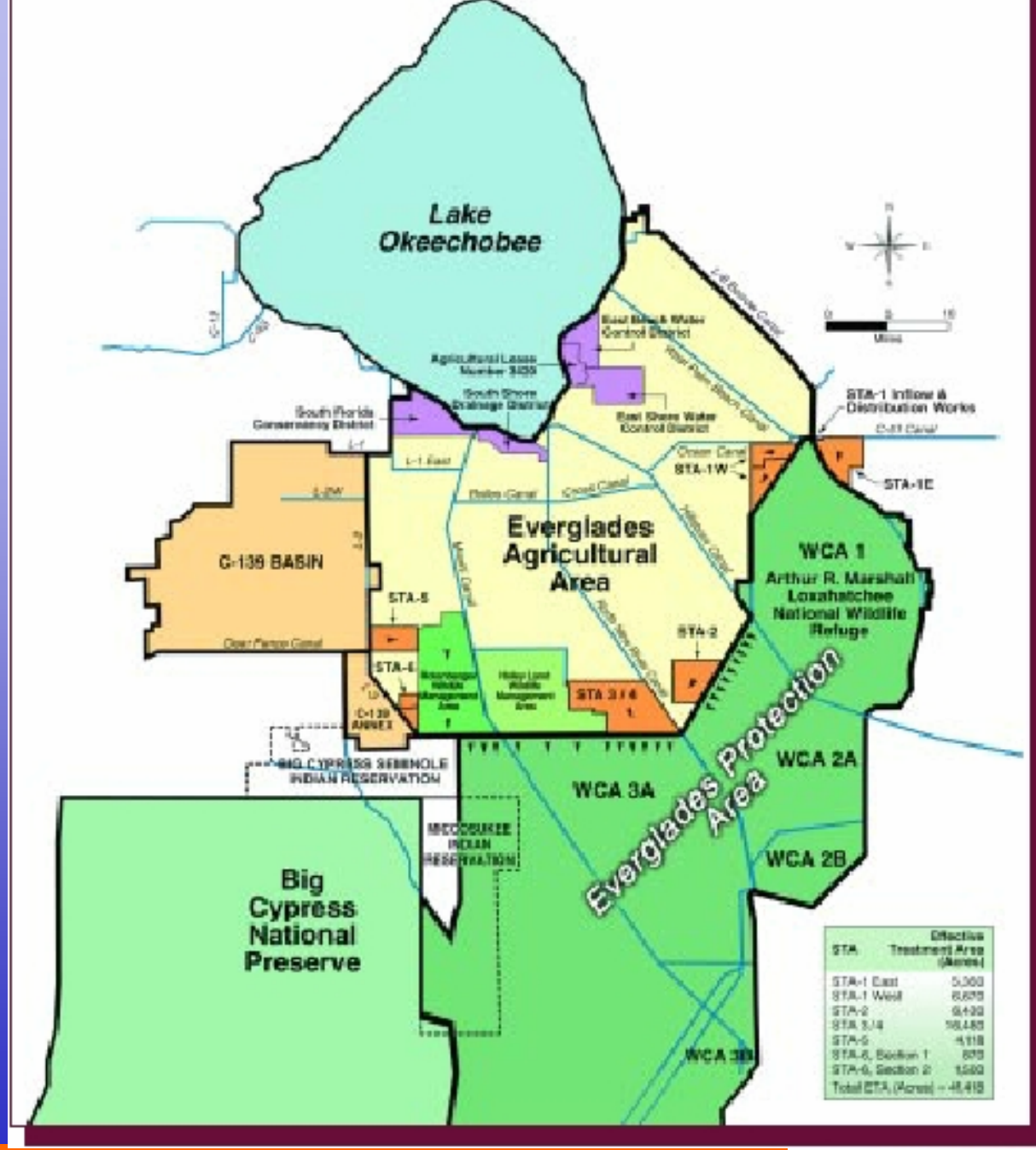
Storm Treatment Areas (STAs)



Background

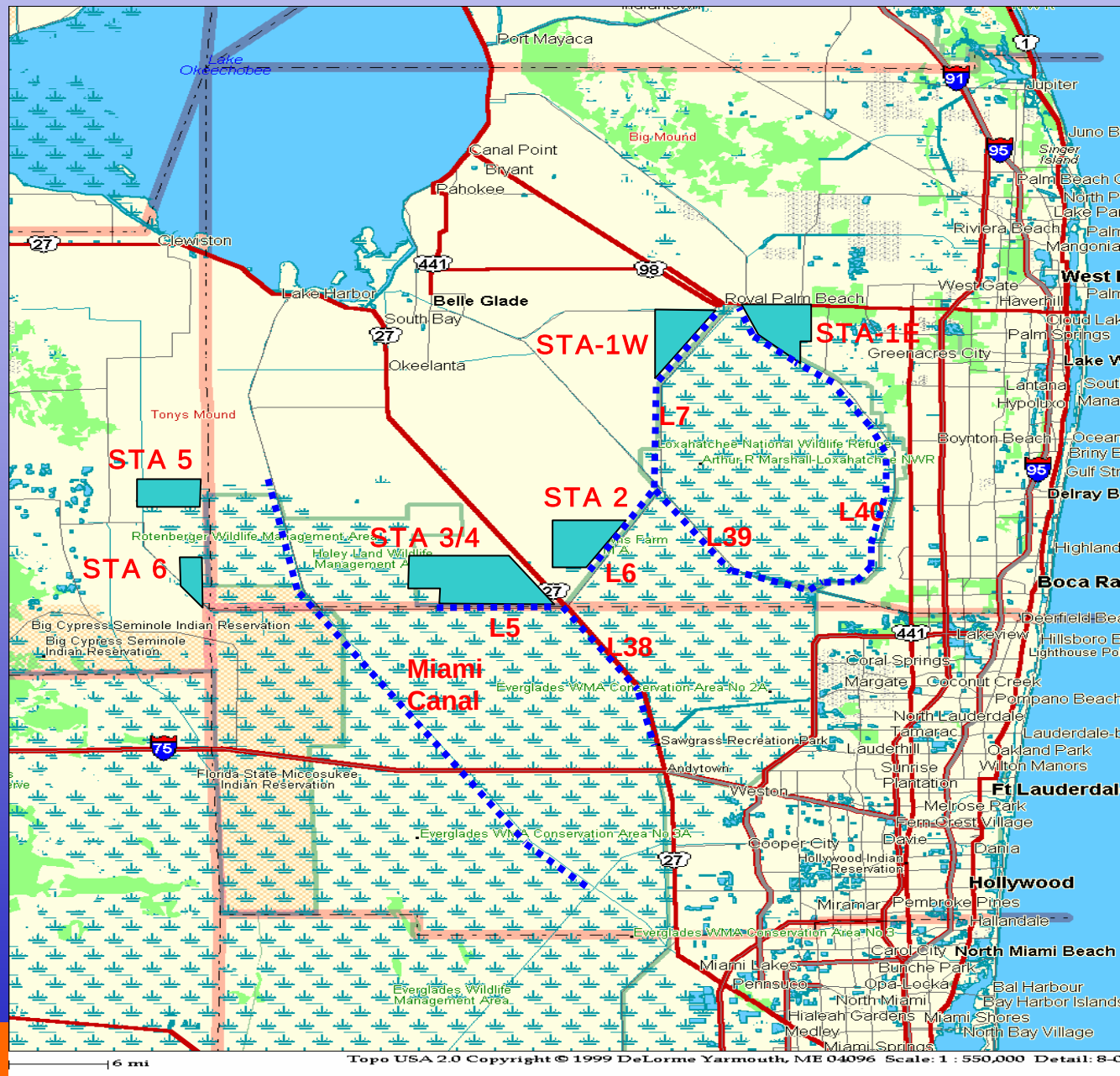
- Goal of the STAs to deliver water of P concentration of 10 ppb or less
- Water from STAs discharge into WCA canals
- Question: How will the WCA canal network impact P concentrations of waters released from STAs?

Experiments

- WCA canal sediment inventories
- P speciation (fractionation) to determine relative availability of P compounds
- P flux studies to determine potential P release into water column (laboratory studies)
- P transport study- evaluate P dynamics under flow conditions (in-situ)

Canal sampling

- Inventory 1-mile longitudinal increments over 120 miles of canals
- 20 Cores sampled for P speciation and flux studies



Average Sediment Properties by Canal

Canal	Bulk Density (g/cm^3)	% Dry Mass	% Organic Matter	Phosphorus Content (mg/kg)
L7S	1.14	18.2	38.8	932
L39	1.21	24.2	34.6	735
L40S	1.24	25.1	33.1	1071
L6	1.31	37.1	23.1	285
L5	1.20	26.7	28.8	583
L38	1.22	29.1	28.5	1123
MC	1.24	28.0	26.6	1477
MCN	1.32	38.7	14.9	1362
L7N	1.07	12.8	48.1	1282
L40N	1.07	12.6	41.8	1168

Average Values for Canal Sediment (Total Depth)

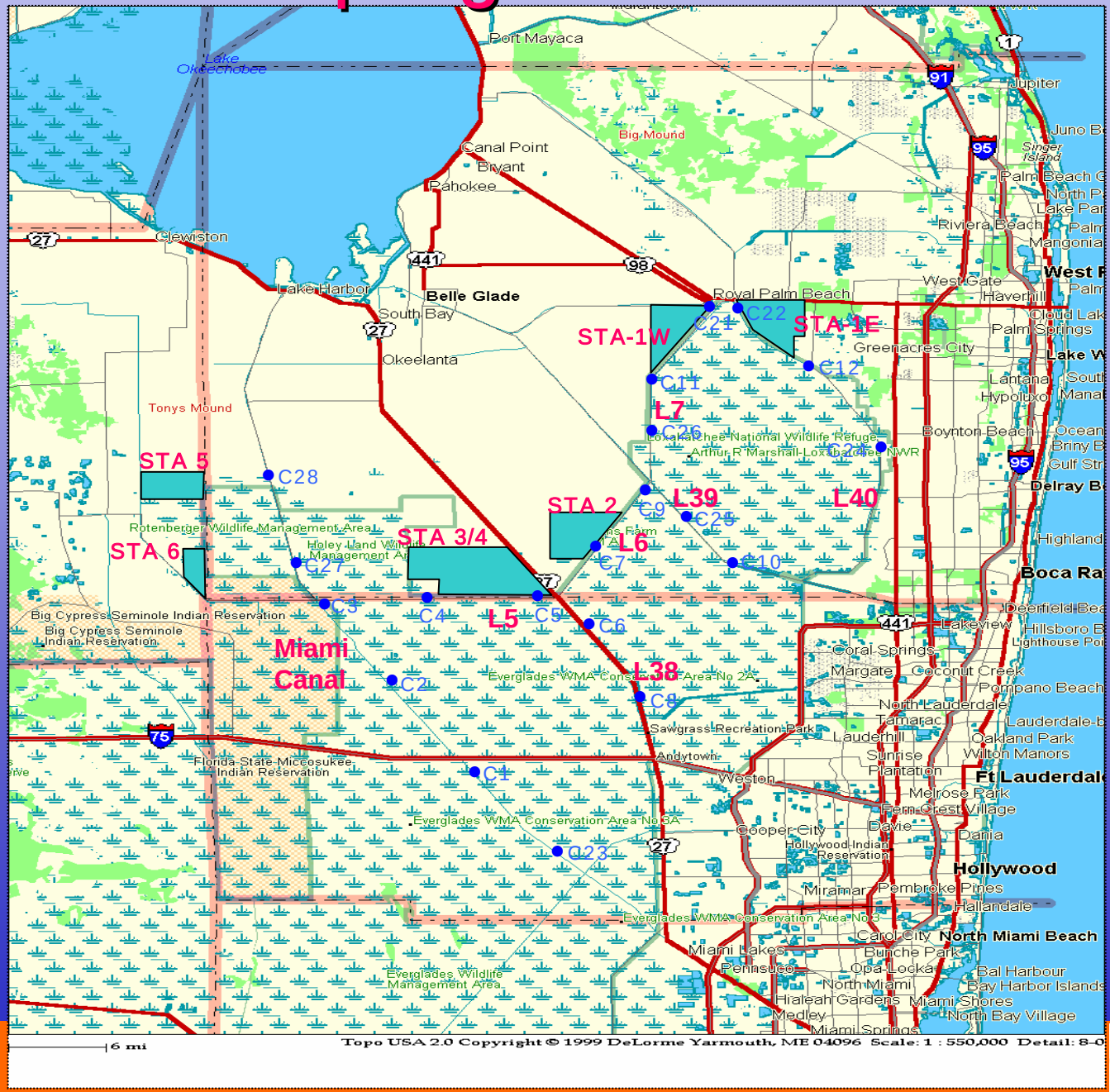
Canal	Average Sediment Depth (m)	Average Width (m)	Length (m)	Canal Bed Area (m^2)	Sediment Volume (m^3)	Estimated P Mass (Kg)
L7S	1.07	55.2	14,725	812,837	869,612	104,353
L39	0.91	42.8	20,921	895,312	813,215	97,586
L40S	0.76	37.4	40,073	1,498,676	1,132,855	260,557
L6	0.54	41.5	11,265	467,412	252,947	32,529
L5	0.82	19.5	8,851	172,666	141,967	21,820
L38	0.64	25.0	20,921	523,541	335,108	100,532
MCN	0.97	31.2	17,220	537,462	520,942	672,016
MC	0.75	22.7	44,901	1,018,903	719,657	79,162
Totals			178,879	5,926,808	4,786,303	1,368,555
L7N	2.45	56.6	10,863	614,865	1,506,782	180,814
L40N	1.78	43.8	6,276	275,098	488,845	112,434
Totals			17,140	889,963	1,995,627	293,248

Phosphorus Fractionation And Release Potential

Objectives

- Evaluate phosphorus storages in canal sediments.
- Estimate potential phosphorus mass release and flux rates from canal sediments using experimental microcosms.

Sampling Locations

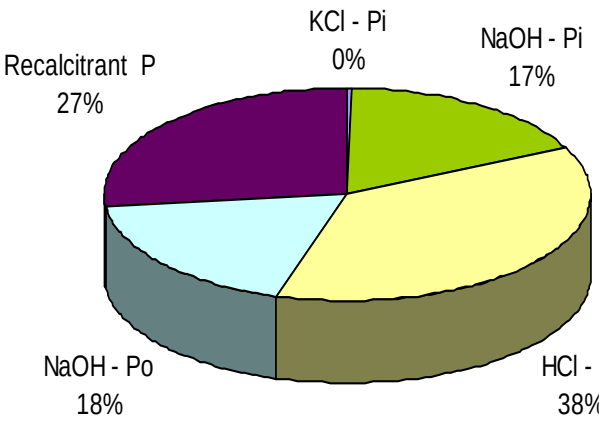


Phosphorus Fractionation Scheme

- Inorganic
  - KCl Pi
    - labile
  - NaOH Pi
    - Fe and Al phosphates – relatively stable; sensitive to sediment redox changes
  - HCl Pi
    - Ca & Mg phosphates- stable with exceptions of changes in pH
- Organic
  - NaOH Po
    - humic and fulvic acids – could be mineralized depending on environmental conditions
  - Recalcitrant P
    - Most stable fraction.

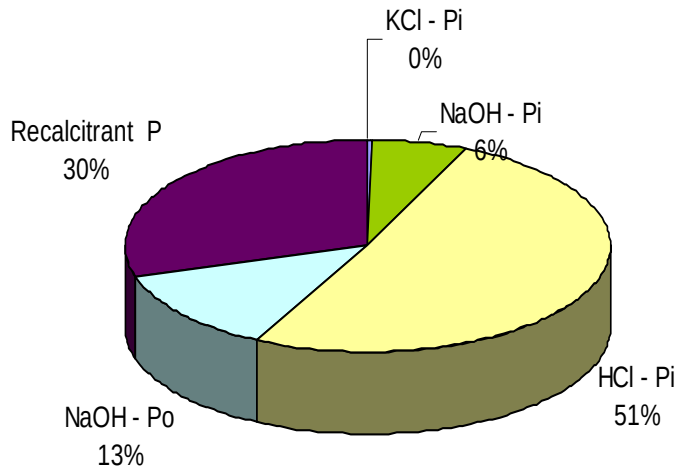
Surface Sediment Phosphorus Storage Near Existing and Proposed STA's

STA - 1E
(L40)



TP = 1092 ± 212 mg kg^{-1}

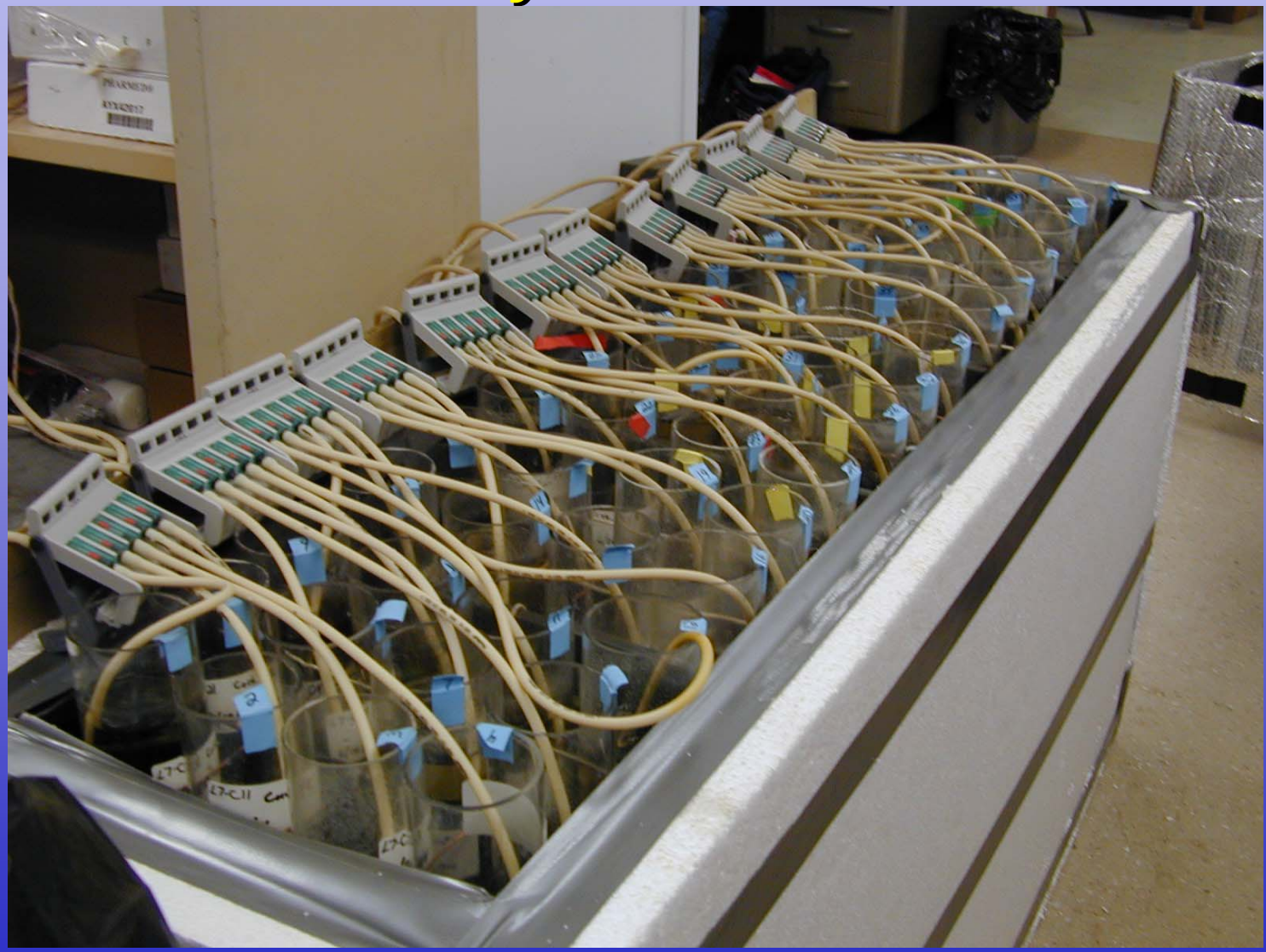
STA - 1W
(L7 and L39)



TP = 790 ± 200 mg kg^{-1}

Phosphorus Release Potential (Flux)

Laboratory Microcosms



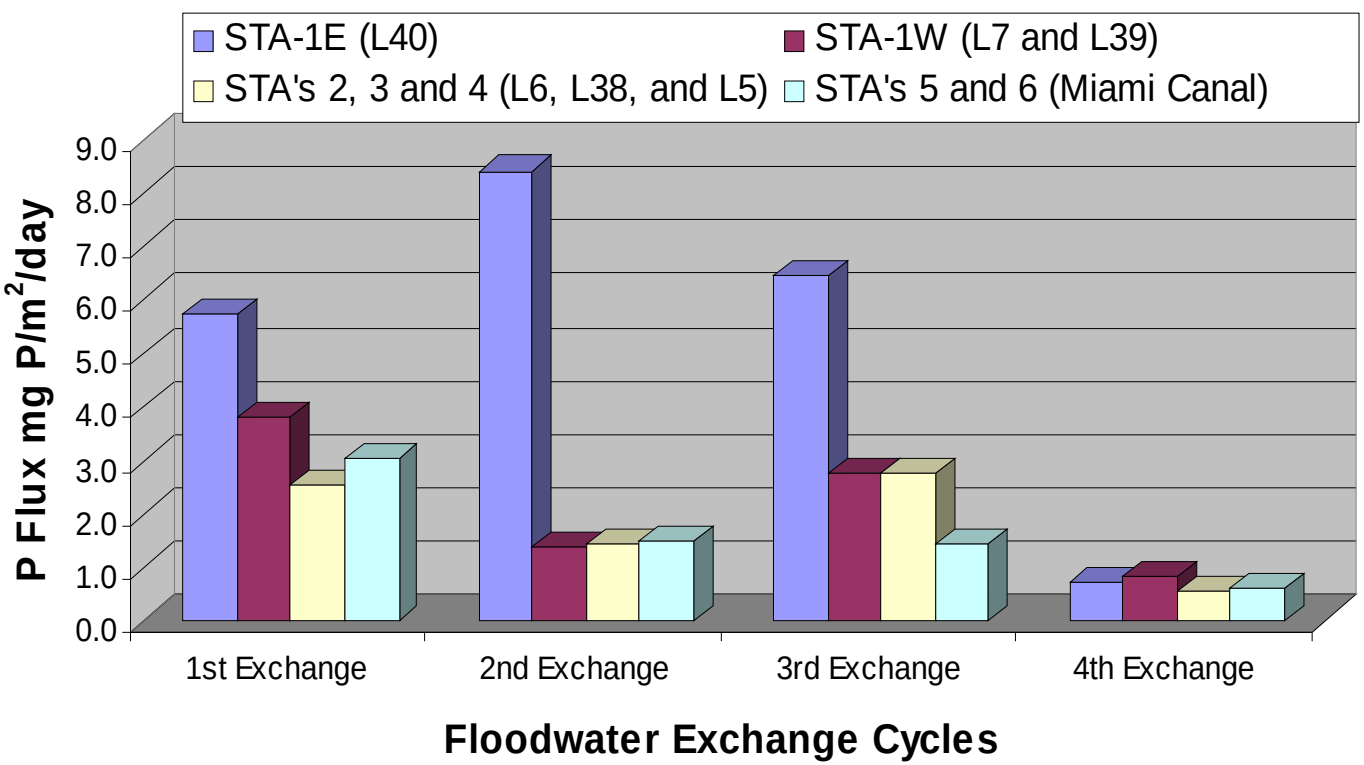
P Flux

- P Flux from sediments was estimated by two methods
  - Maximum Flux= Maximum P release rate per unit area; occurs early on when low-P water is contact with sediments
  - Average Flux= Average P release rate per unit area over a 30-day period

Max and Average Sediment P Flux

	First Floodwater Exchange			
	Maximum Flux		Average Flux	
Site	mean	sd	mean	sd
	----------mg P / m2 / day ----------			
L40-C22	6.04	2.02	0.488	0.115
L40-C12	8.78	1.46	0.619	0.338
L40-C24	*22.02	14.17	*0.453	0.164
L7-C21	3.02	1.65	0.207	0.050
L7-C11	2.41	0.20	0.131	0.021
L7-C26	4.07	1.14	0.396	0.291
L6-C9	2.66	1.25	0.095	0.022
L39-C25	5.30	0.55	0.776	0.221
L39-C10	4.34	1.78	0.309	0.190
L6-C7	2.09	0.58	0.076	0.013
L5-C5	2.30	0.96	0.162	0.016
L38-C6	2.94	0.32	0.138	0.034
L38-C8	2.23	0.55	0.082	0.036
L5-C4	2.91	1.49	*0.292	0.293
MC-C28	2.71	1.06	0.266	0.091
MC-C27	3.40	0.36	0.206	0.051
MC-C3	3.52	1.67	0.188	0.057
MC-C2	4.44	1.74	0.643	0.332
MC-C1	2.30	0.29	0.104	0.007
MC-C23	2.00	0.25	0.086	0.005
* Value from second floodwater exchange				

Maximum P Flux Near Existing and Proposed STA's

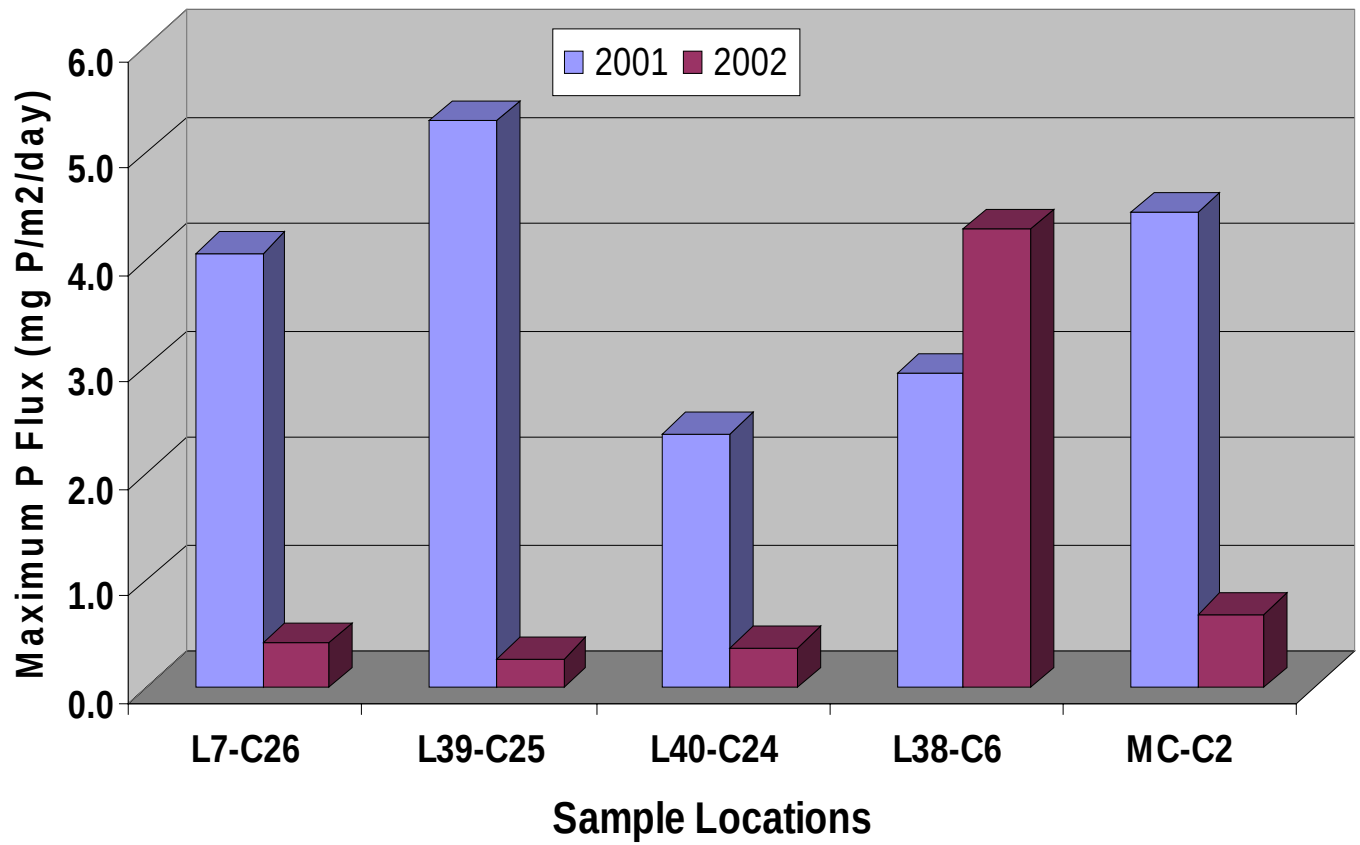


Hypothetical 24-hr P concentration increase

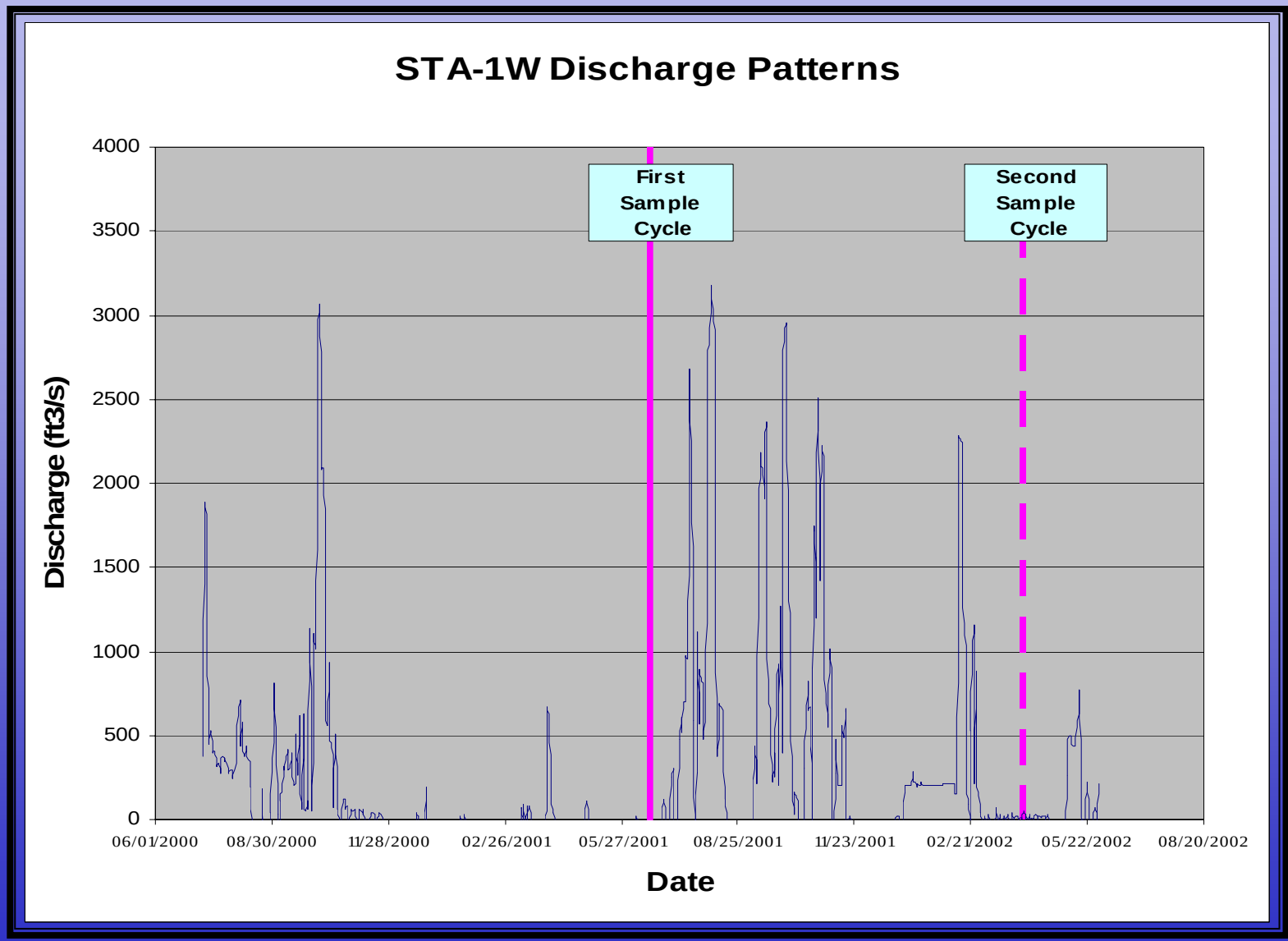
Canal	24 hr- P delta C (ppb) (Max. Flux)		24 hr- P delta C (ppb) (Avg. Flux)	
L7S	1.69		0.20	
L39	1.43		0.17	
L40S	2.92		0.20	

Temporal Effects ?

Maximum P Flux Comparison for 2001 and 2002



STA-1W Flow History for 7/00 Through 5/02



Temporal Effects

- Significant reduction in net P release of core samples from 2001 to 2002 in 4 of the 5 locations.
- Hypothesized causes
  - Seasonal variation in labile P pool
  - Labile P source is susceptible to disturbance and could have been removed or translocated due to flow management.

Summary
sediment inventory, fractions and flux

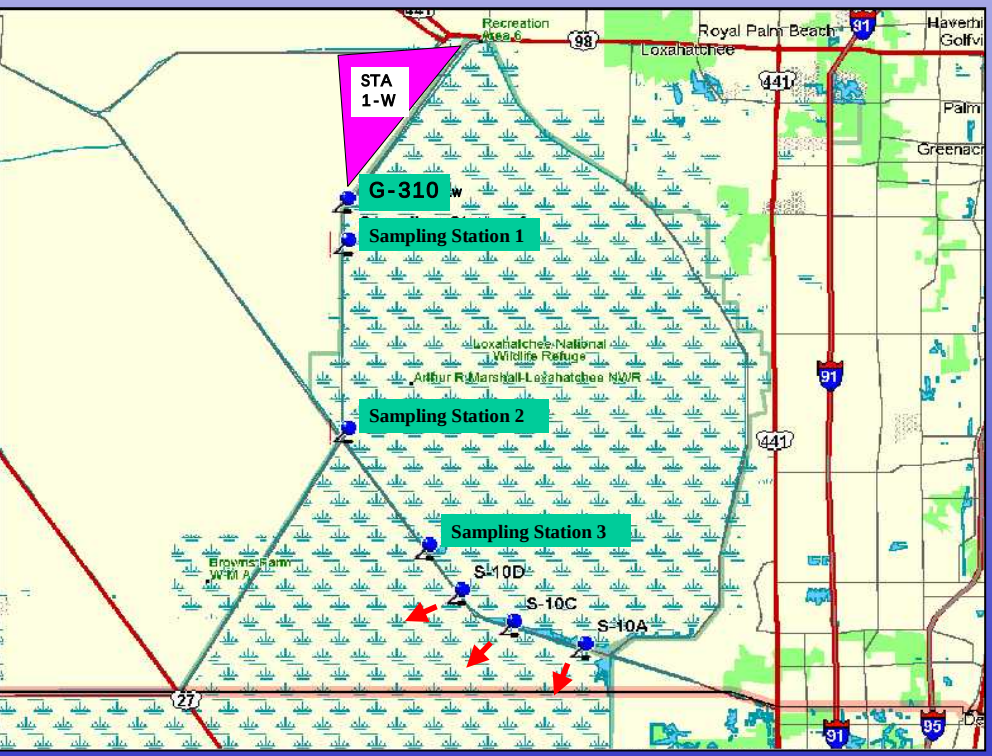
- L7/L39/L40 canals have more organic matter, more readily available P, and higher flux rate.
- Sediment P flux maybe a significant contributor to the elevation of dissolved P in the conveyance system on a periodic basis under the appropriate conditions (quiescent antecedent conditions)
- Compliance sampling schedule- seasonal timing and flow distribution into consideration

Transport studies

- Evaluate P dynamics in L7/L39 under flow conditions
  - Estimate magnitude of particulate P re-suspension and transport
  - Evaluate changes in dissolved P

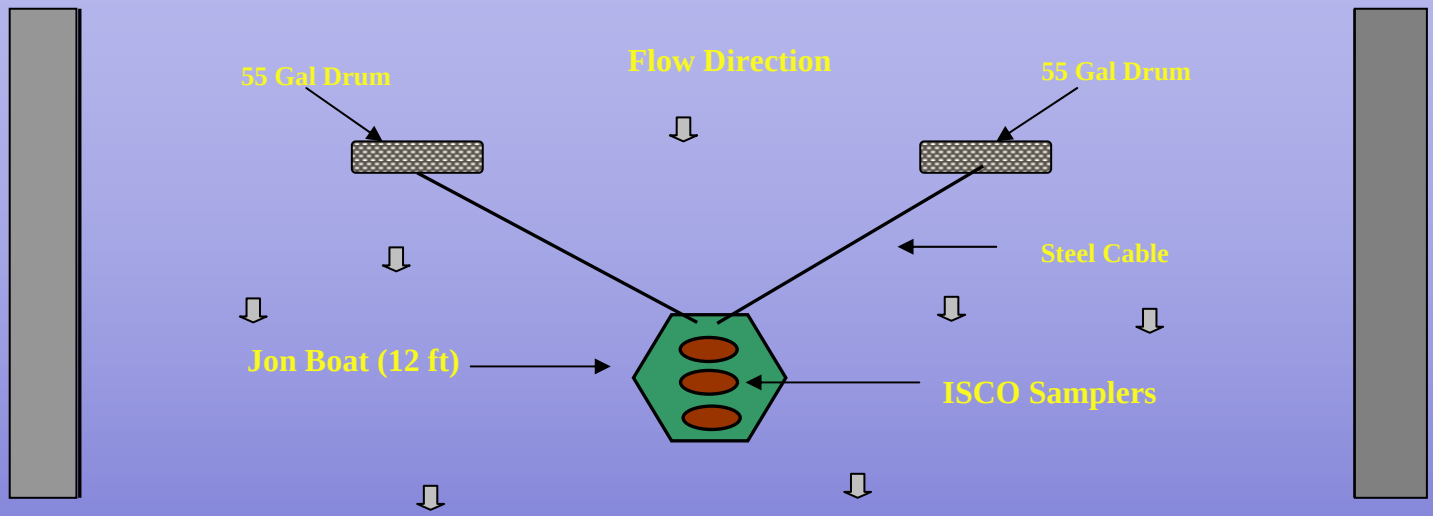
Transport Study sampling locations

L7 and L39 canals downstream of STA-1W

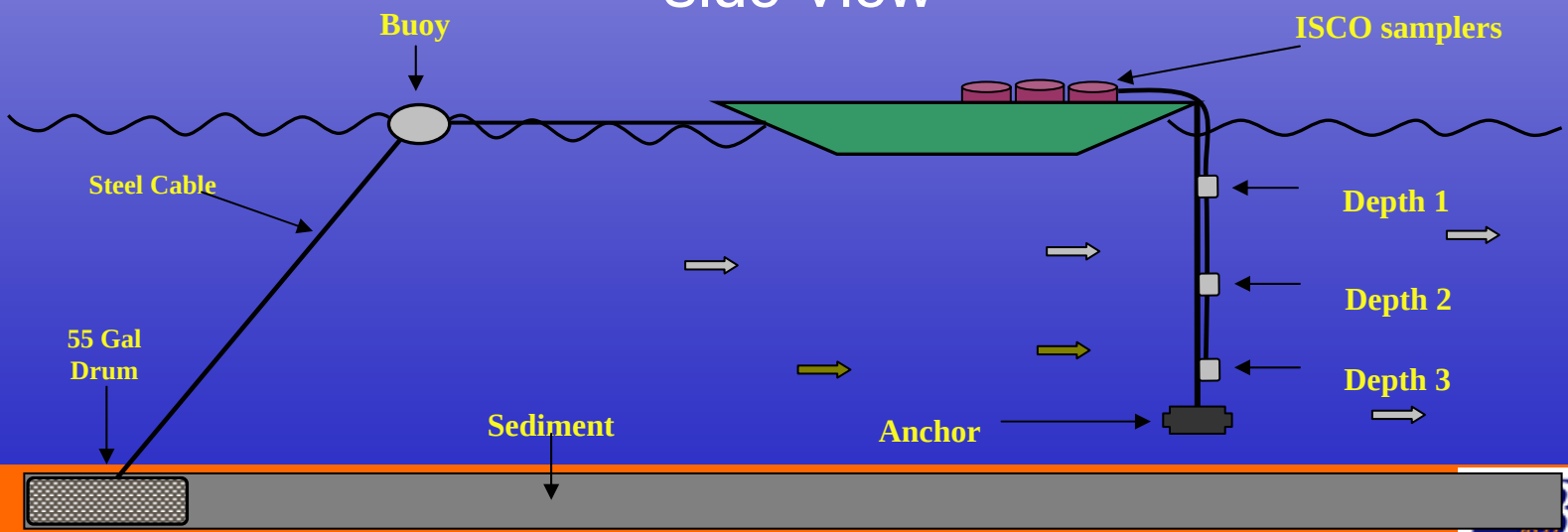


Sampling Platform Set-up

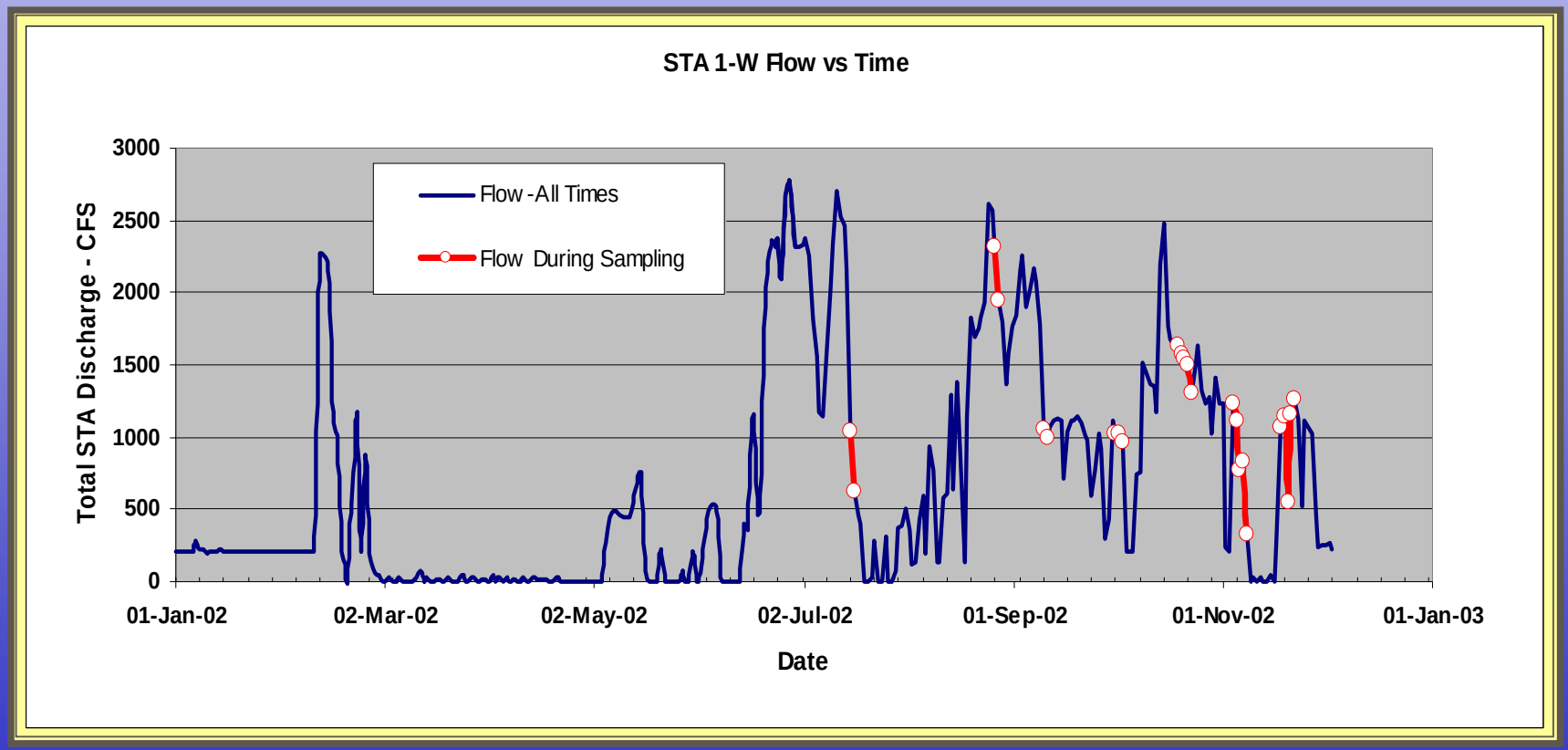
Top View



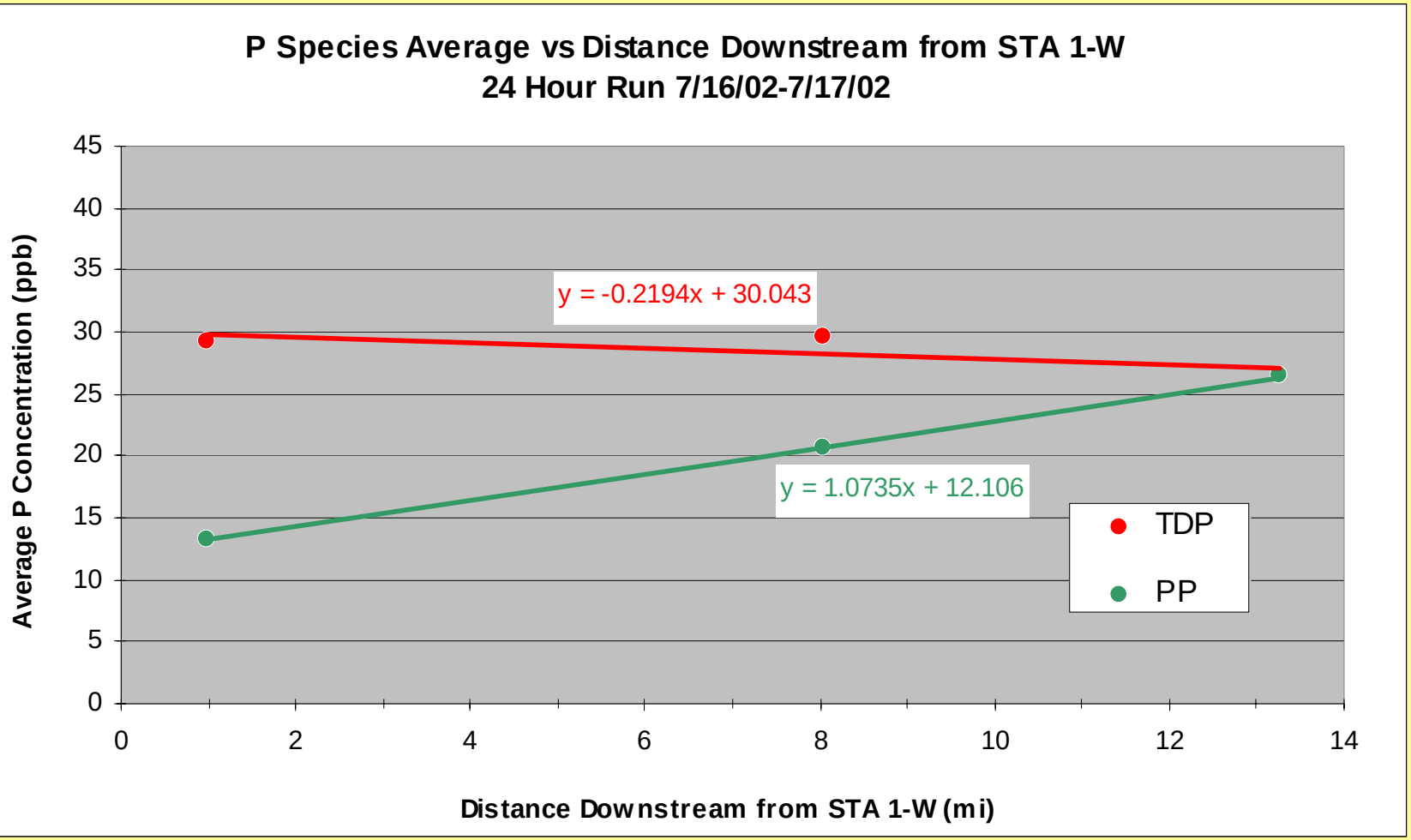
Side View



STA-1 W Discharge Flow Jan-Nov. 2002



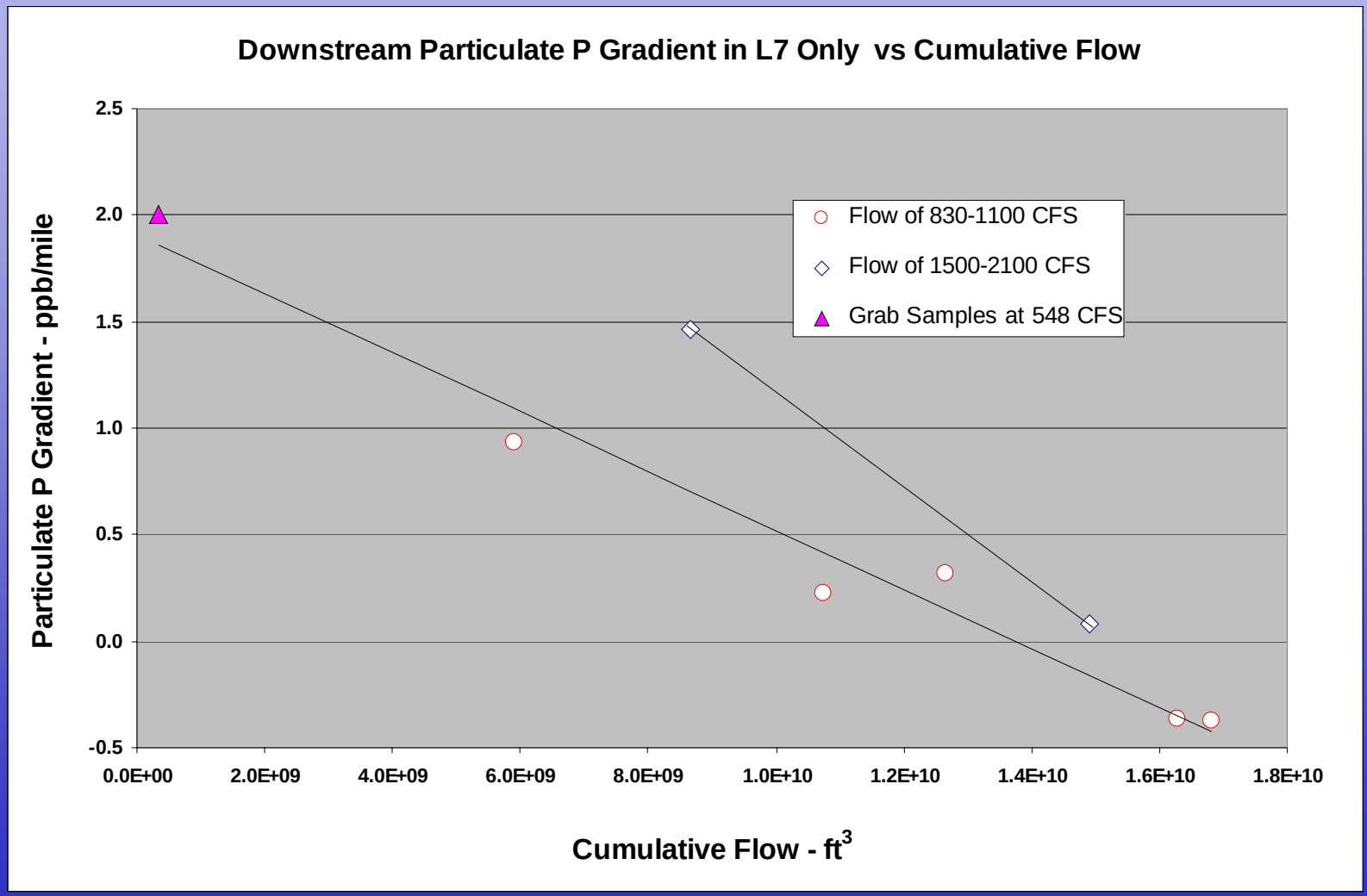
Downstream P Gradient Sampling Event Starting 7/16/02



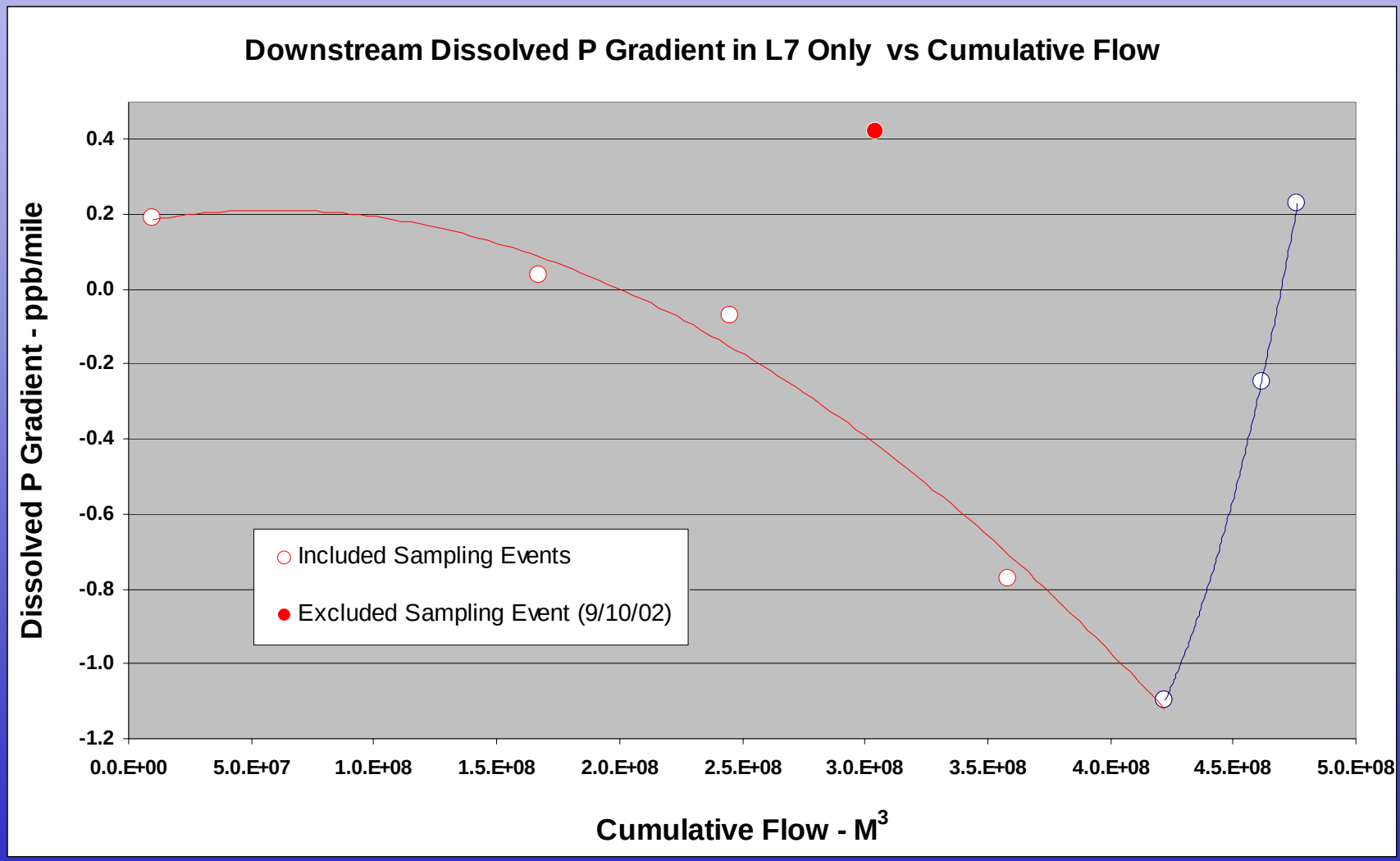
Slopes and Intercepts of Regression Equations

Date	TDP Slope ppb/mile	TDP Intercept ppb	PP Slope ppb/mile	PP Intercept ppb
7/16/02	-0.219	30.0	1.074	12.1
8/27/02	-0.367	26.7	0.892	13.2
9/10/02	0.257	31.4	-0.108	13.1
10/1/02	-1.295	39.6	0.047	8.9
10/19/02	-0.909	39.8	0.350	9.5
11/4/02	-0.426	43.7	-0.196	14.8
11/18/02	-0.253	36.6	-0.311	14.8
Average	-0.459	35.4	0.250	12.4

Particulate P Gradients in L7 as a Function of Cumulative Flow



Dissolved P Gradients in L7 as Function of Cumulative Flow



Summary – Transport Studies

- The conveyance systems appeared to affect a net reduction of dissolved P and a net contribution of particulate P downstream of STA-1W.
- The net reduction of dissolved P - results from biological activity in the canals and their floodplains, and appeared to be a function of time-in-season, higher in the summer and lower during spring and autumn.

Summary – Transport Studies (cont'd)

- The net contribution of particulate P - results from the remobilization of biological generated particulate matter that had accumulated in the canal system during the quiescent dry season.
- As the pumping season progressed, the particulate matter accumulation was subject to washout, so early in the period mobilization was high, and low at the end of pumping period.

Recommendations for Future Work

- Interaction between canal/floodplain sediments and aquatic systems and water column is important to understand especially during the dry season.
- Evaluation of the dissolved P removal and contribution mechanisms, and seasonal responses.
- Expand the P transport study to include L40 downstream of STA-1E.