Hudson River PCBs Site
EPA's Phase I Evaluation

Response to Peer Review Questions

Peer Review Meeting
May 4-6, 2010

EPA Perspective on Phase 1

- Phase 1 was a successful beginning to HR dredging project
- Redistribution
- Fish tissue impacts
- Calculation of Load – Identified in EPS
- Water concentrations returned to baseline after completion of activities
- No measurable impacts to Lower River
- Water concentrations in Lower Hudson same as baseline – important for impacts

Room for Improvement

- Problems are manageable
- Correlations with boat traffic, exposed area, bucket efficiency all indicate capacity for improvements
- Residuals Standard will be streamlined and simplified
  - Quickly identify all non-compliant areas to avoid cap later
- EPA Field Oversight Report identifies areas for improvement
- Extension of schedule, if necessary, would not undermine project benefits

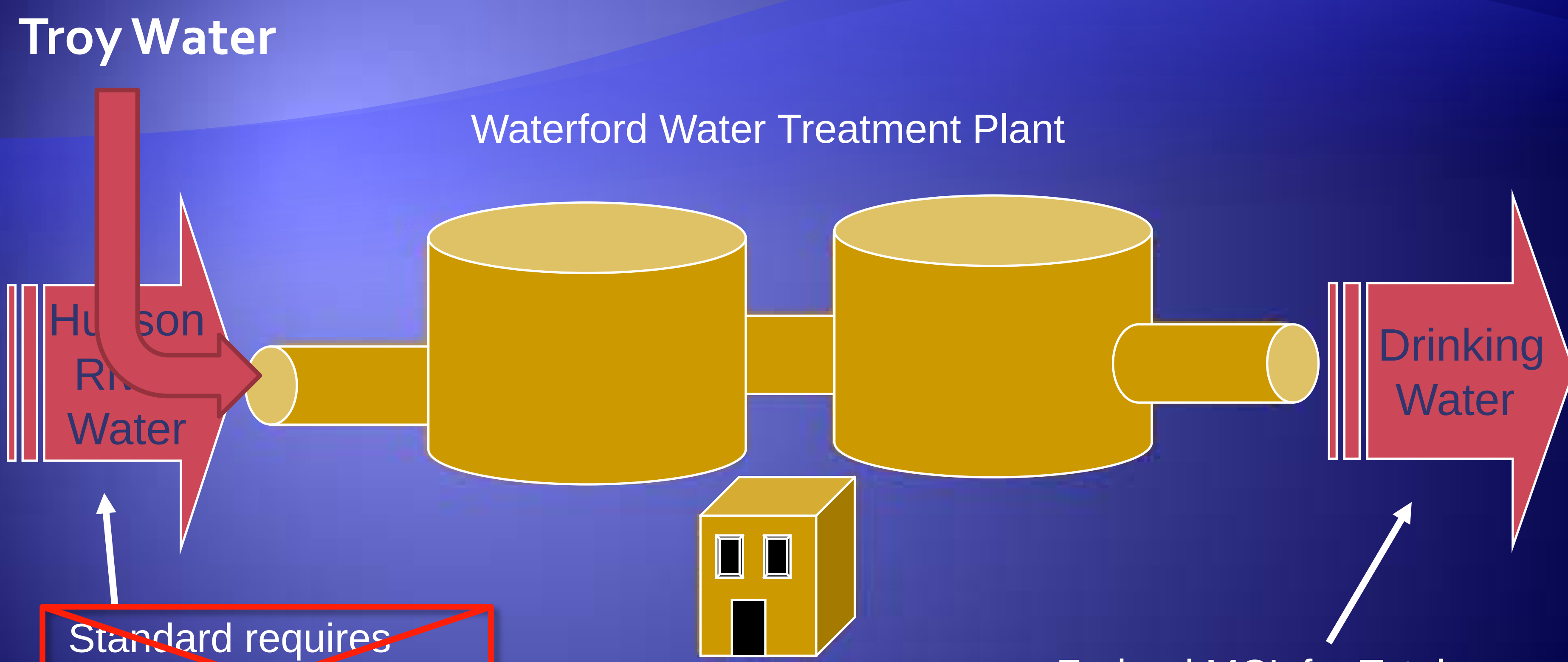
Phase 1 Experiences will inform Phase 2

- Higher than normal flows
- Extent of wood debris – less in Phase 2
- DoC consistently underestimated
  - No overcut allowance in design
- NAPL releases
- Limitations on scow unloading
- Extent of bedrock/clay bottom
- Capping – OM&M Concerns
- Open CUs throughout entire dredging phase
- Multiple River Locations

Changes since February…
Resuspension Standard - Existing *vs.* Proposed

Existing	Proposed Change
Confirmed exceedance of the Federal Drinking Water MCL (500 ng/L) - at any far-field monitoring location. Temporarily halt operations.	Use the 500 ng/L threshold as a trigger to require operational changes, but not necessarily an operational shutdown, at EPA's discretion.
Concern Level - Far-Field Conditions Total PCB Conc > 350 ng/L Total PCB load > 600 g/day Tri+ PCB load > 200 g/day 7-day running average Monitoring contingencies and Engineering evaluation required. No engineering contingencies requirement.	Maintain the water column Control Level of 350 ng/L (7-day running average) for discretionary use by EPA to require (as opposed to merely recommend) appropriate operational changes.

Resuspension Standard Is Protective



~~Standard requires Total PCB < 500 ng/L here.~~

Federal MCL for Total PCB < 500 ng/L no longer a concern. Public water not drawn from Upper Hudson River

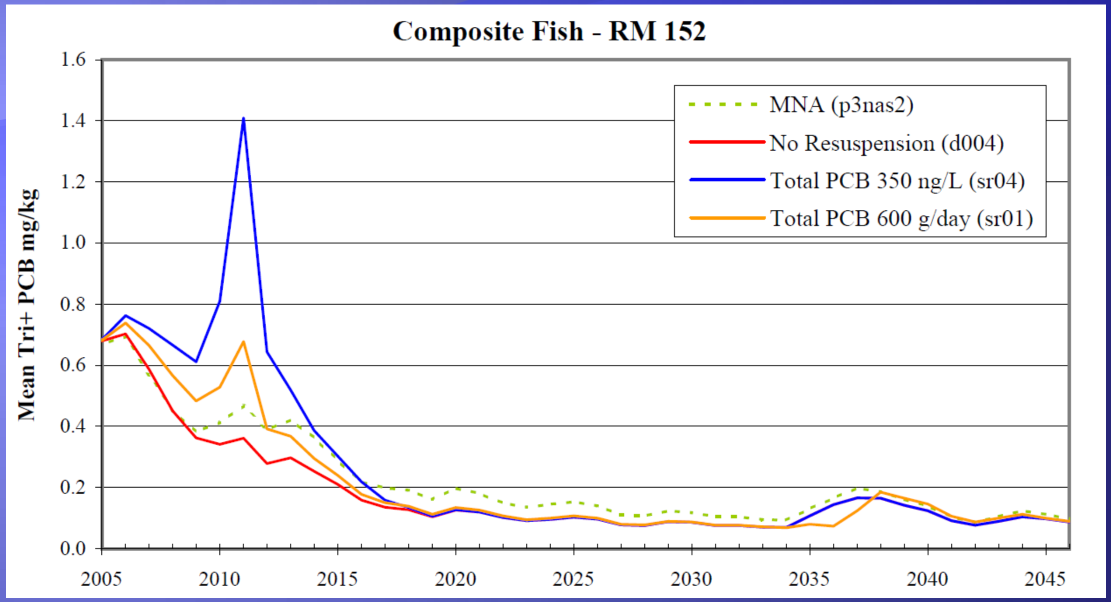
Resuspension Standard - Existing *vs.* Proposed Cont'd

Existing	Proposed Change
Far-field area (>1 mile downstream)	Revise the station of compliance for load to be Waterford, exclusively.
Far-field Net PCB Load: Total PCB – 1080 g/day Tri+ PCB – 360 g/day Annual Load Criteria (Phase 1) Tri+ PCB load : 39 kg/year Total PCB load -:117 kg/year Total load due to the project: 650 kg (Total PCB)	Adjust the far-field net PCB load standard; adjust the seasonal load and corresponding daily evaluation and control level loads upwards. Far-field Net PCB Load: Tri+ PCB load: 122 kg/yr or 680 g/day Total load due to the project: 670 kg (Tri+ PCB)

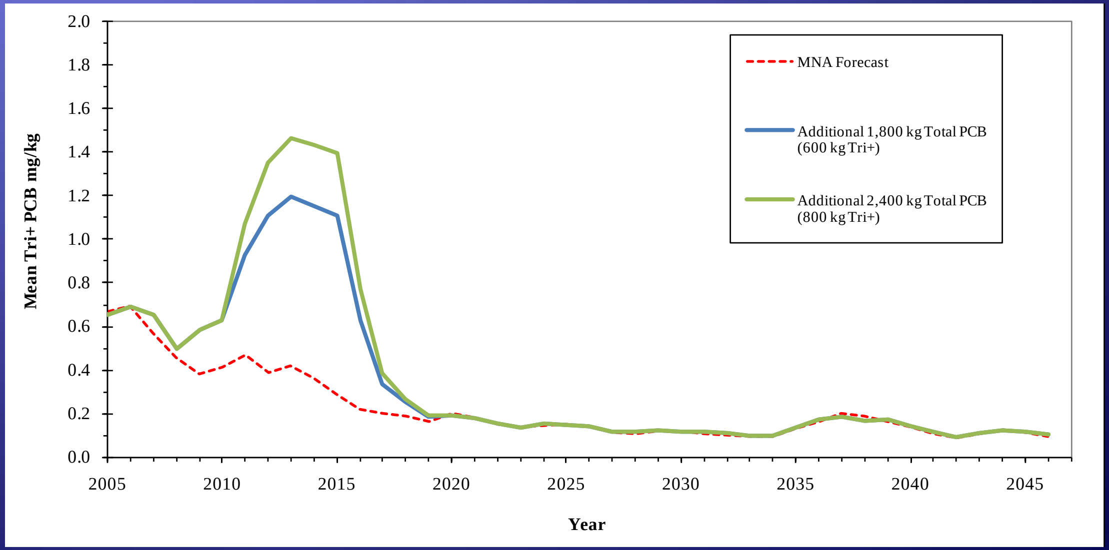
Forecasts of Dredging Related Impacts and Related Risk

Prediction of Impacts on Fish Tissue Concentrations in the Lower Hudson River due to Dredging

Original Standard Basis



Revised Standard Basis



[1]Species-Weighted Average assumes 47% largemouth bass + 44% brown bullhead + 9% Yellow Perch

The Panel Requested Information on:

- "Evidence that supports a description of confidence that experiences and data developed from Phase 1 can be extrapolated to provide confident predictions about conditions relevant to performance standards in Phase 2."

Phase 1 Designed to:

- Represent the range of conditions anticipated in Phase 2, including
  - Bottom conditions
  - Deposit thickness
  - Debris
  - Range of concentrations
  - Sediment characteristics

It will be Practicable to Consistently and Simultaneously Meet EPA's Proposed Performance Standards for Phase 2

- Resuspension shown to be associated with controllable operational factors
- Adjusted load standard more realistic for actual PCB inventory; acceptable risk
- Provision of alternate public water supply alleviates need for automatic shut-downs
- Fixing scow availability issue will increase productivity and reduce resuspension
- Increasing scow loads will reduce vessel traffic and dredging time…and thus resuspension

It will be Practicable to Consistently and Simultaneously Meet EPA's Proposed Performance Standards for Phase 2

- Residuals standard was effective at minimizing residuals and undredged inventory
- Overcut will address DoC uncertainty; result in more efficient dredging (fewer passes)
- Streamlined residuals standard will result in faster CU closure

Supporting Topics Analyses

1) WATER COLUMN LOADS DURING AND AFTER DREDGING
2) CAUSES OF RESUSPENSION DURING PHASE 1 DREDGING
3) REDISTRIBUTION OF CONTAMINANTS DURING DREDGING
4) FORECASTS OF DREDGING RELATED IMPACTS AND RELATED RISK
5) SCOW UNAVAILABILITY AND ITS IMPACT ON PRODUCTIVITY
6) UNDERESTIMATION OF DEPTH OF CONTAMINATION AND ITS IMPACTS ON THE PROJECT

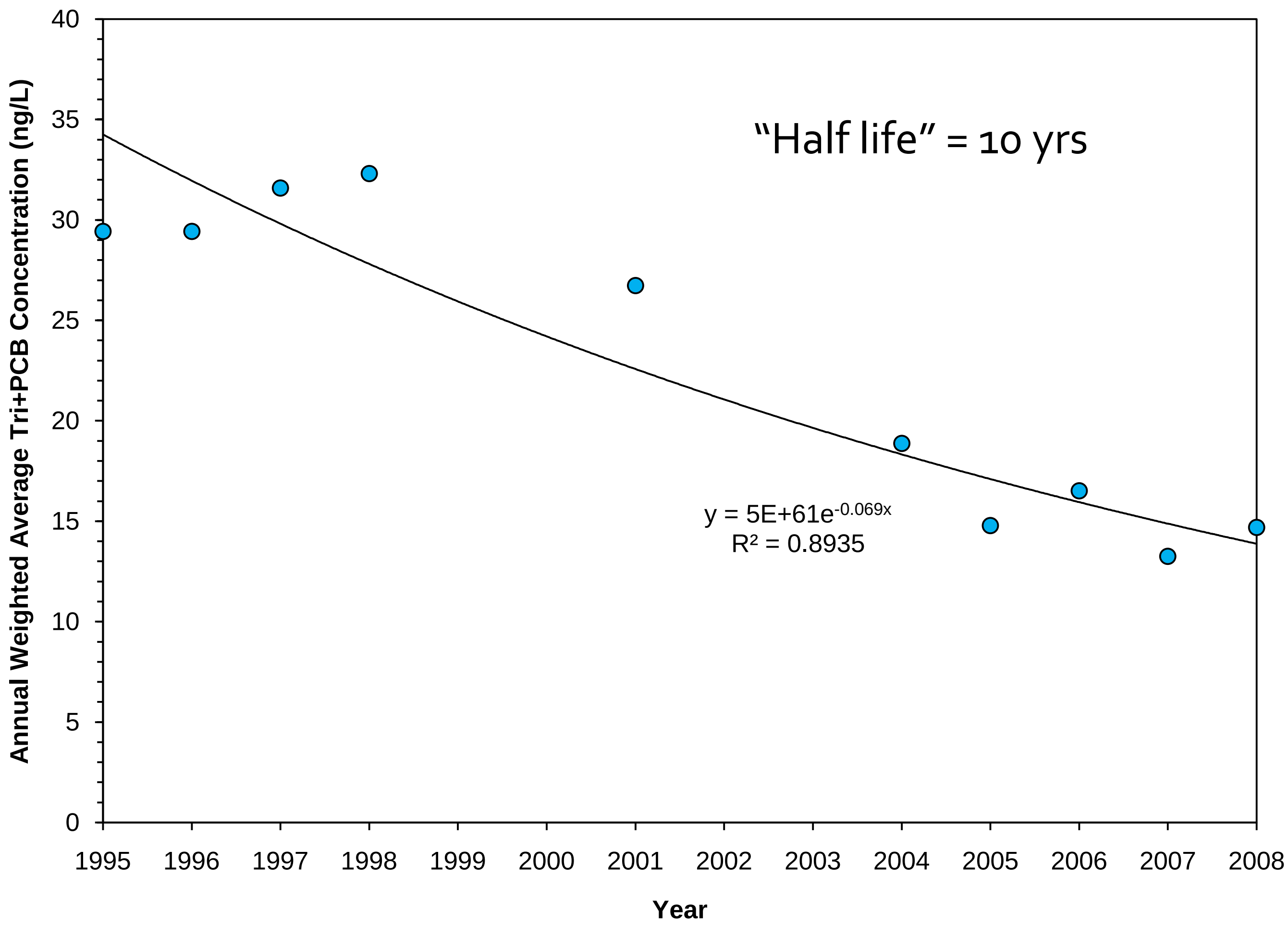
Topic 4

FORECASTS OF DREDGING RELATED IMPACTS AND RELATED RISK

Estimating the Rate of Recovery under MNA

- Objective: estimate current rate of recovery
  - To forecast future recovery rate
  - For comparison to remedy forecast
- MNA subject to uncertain recovery rates
  - **Can be optimistically estimated from weight of evidence from multiple media**
- **Optimistic forecast based on water column Tri+ recovery at 10 year half life**

Observed Decline in Tri+ PCB Concentrations at Waterford under Natural Attenuation



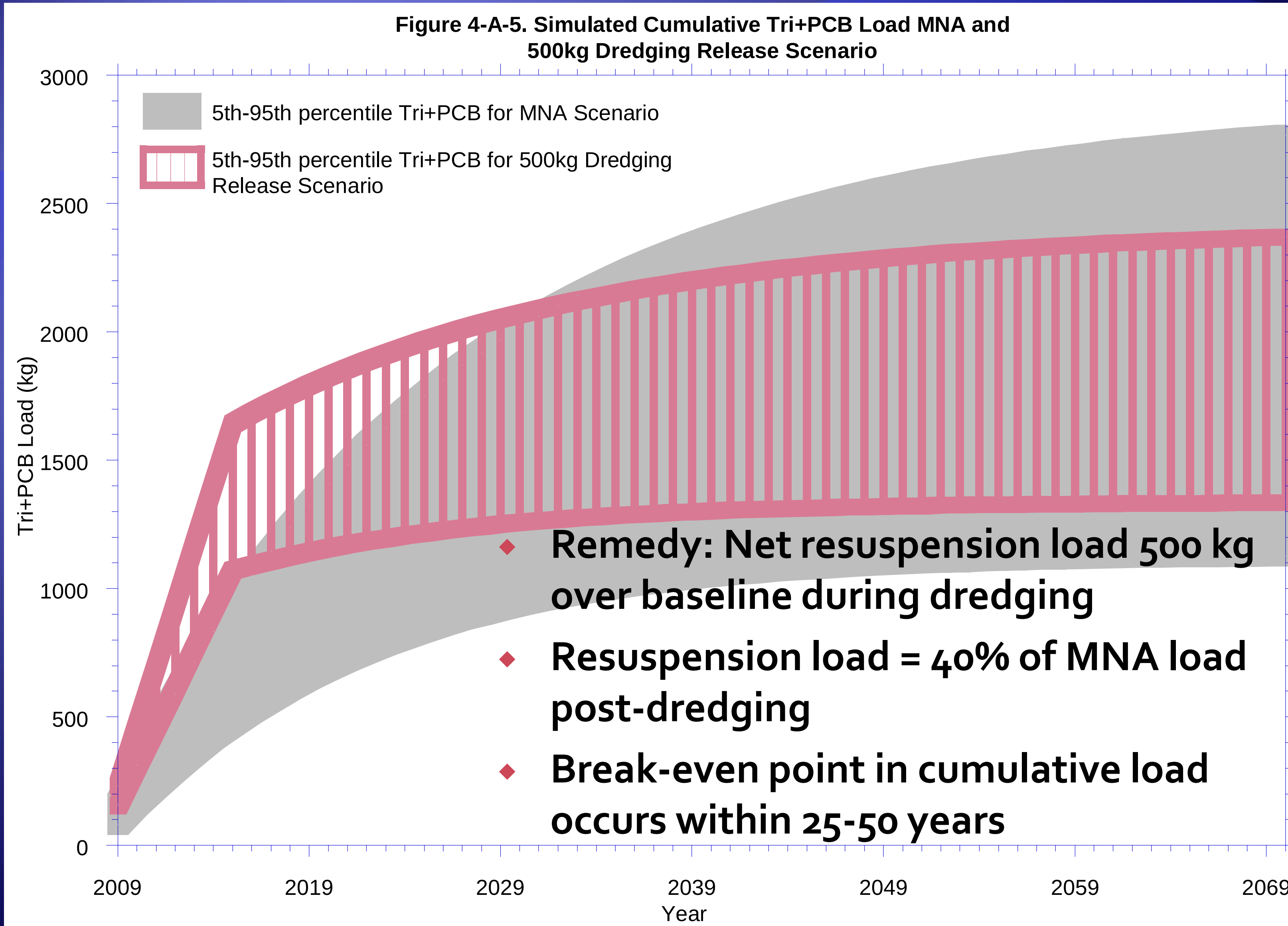
"Half Life" for Sediment SSAP Data 1991 vs. 2005

Table 1. Estimated "half life" in fine sediments estimated from composite samples collected in 1991 and SSAP data from 2003 through 2005

Maximum Pairing Distance	Sediment Type	"Half Life" Years	LCL95	UCL95
30 ft	Fine	**15**	**10**	**32**
50 ft	Fine	34	18	246
100 ft	Fine	90	32	ND

Estimated Cumulative Tri+ PCB Loads to the Lower Hudson

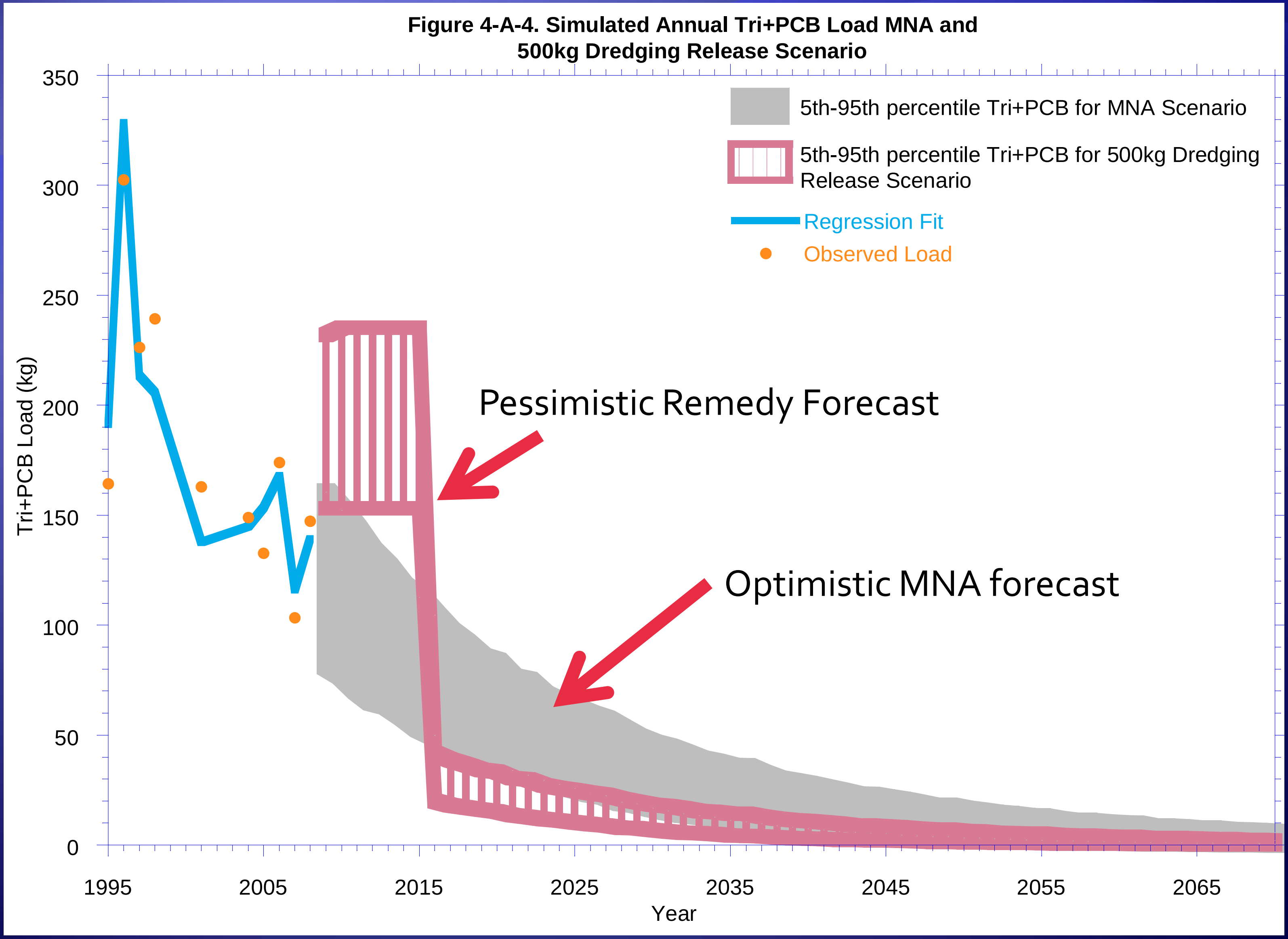
Forecast of PCB Loads Due to Dredging Compared to Natural Attenuation



- Remedy: Net resuspension load 500 kg over baseline during dredging
- Resuspension load = 40% of MNA load post-dredging
- Break-even point in cumulative load occurs within 25-50 years

Estimated AnnualTri+ PCB Loads to the Lower Hudson

Forecast of PCB Loads Due to Dredging Compared to Natural Attenuation



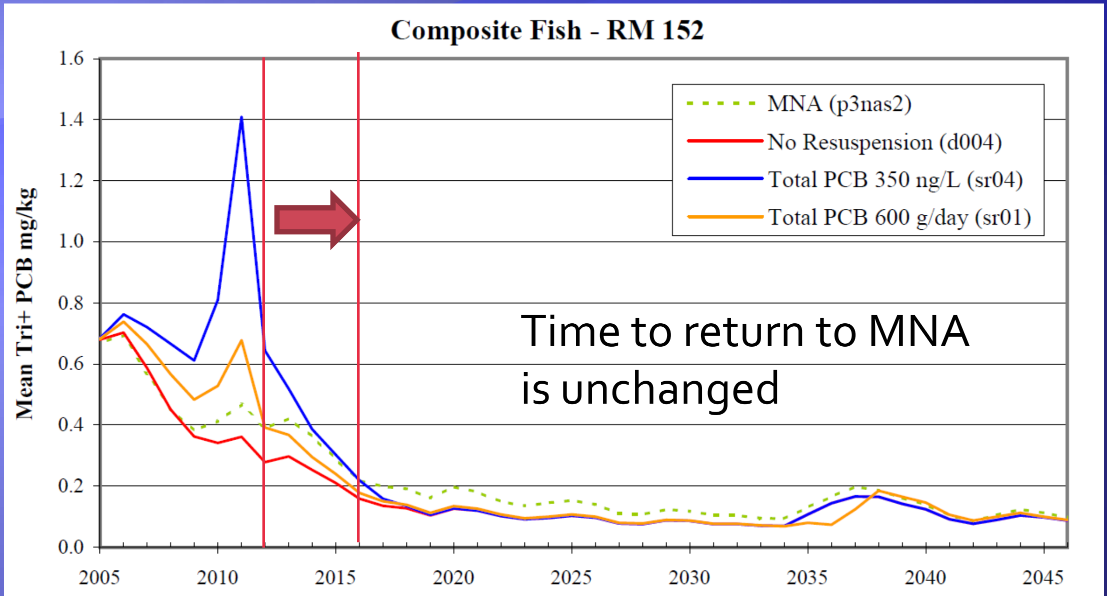
Predicted Fish Tissue Impacts: Lower River

- Farley model/FISHRAND used to compare impacts in Lower River
  - 600 and 800 kg Tri+ load simulations
  - Versus MNA load as forecast by HUDTOX
  - Net impact on fish tissue concentrations **minimal** beyond dredging period

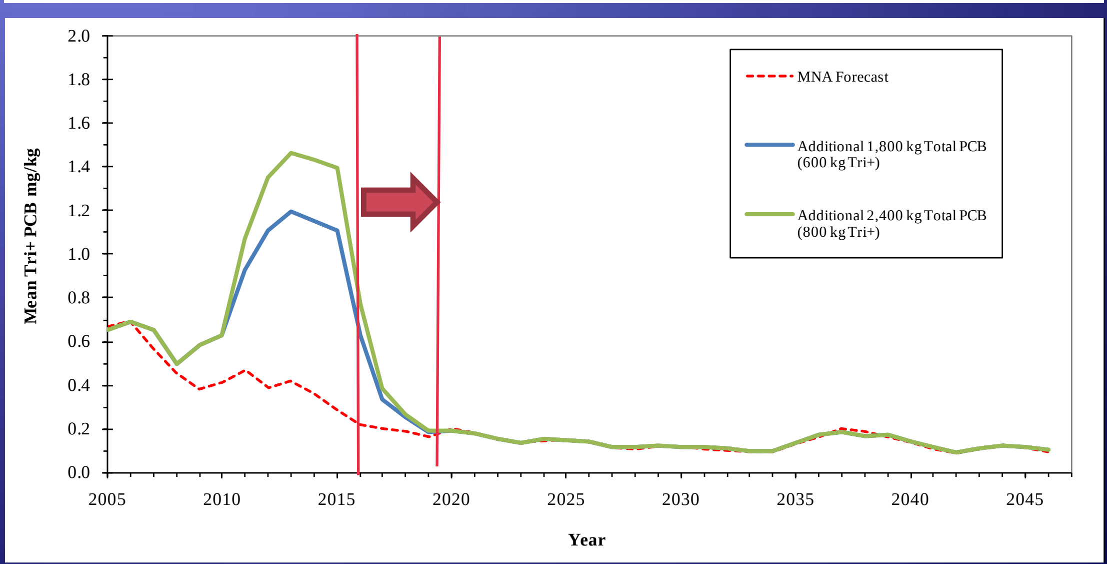
Forecasts of Dredging Related Impacts and Related Risk

Prediction of Impacts on Fish Tissue Concentrations in the Lower Hudson River due to Dredging

Original Standard Basis

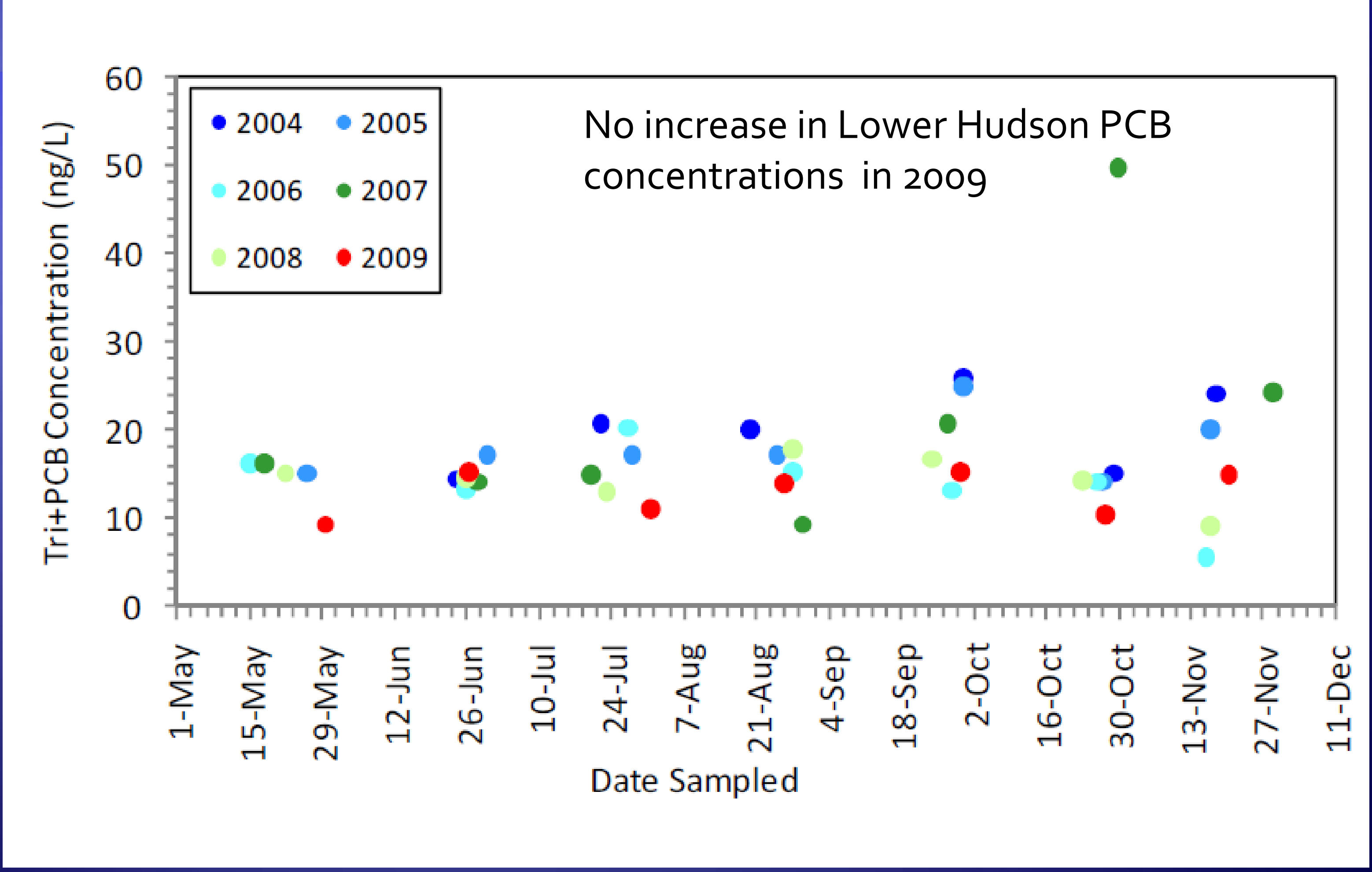


Revised Standard Basis



[1]Species-Weighted Average assumes 47% largemouth bass + 44% brown bullhead + 9% Yellow Perch

Water Column Concentrations
Baseline & During Dredging at Poughkeepsie



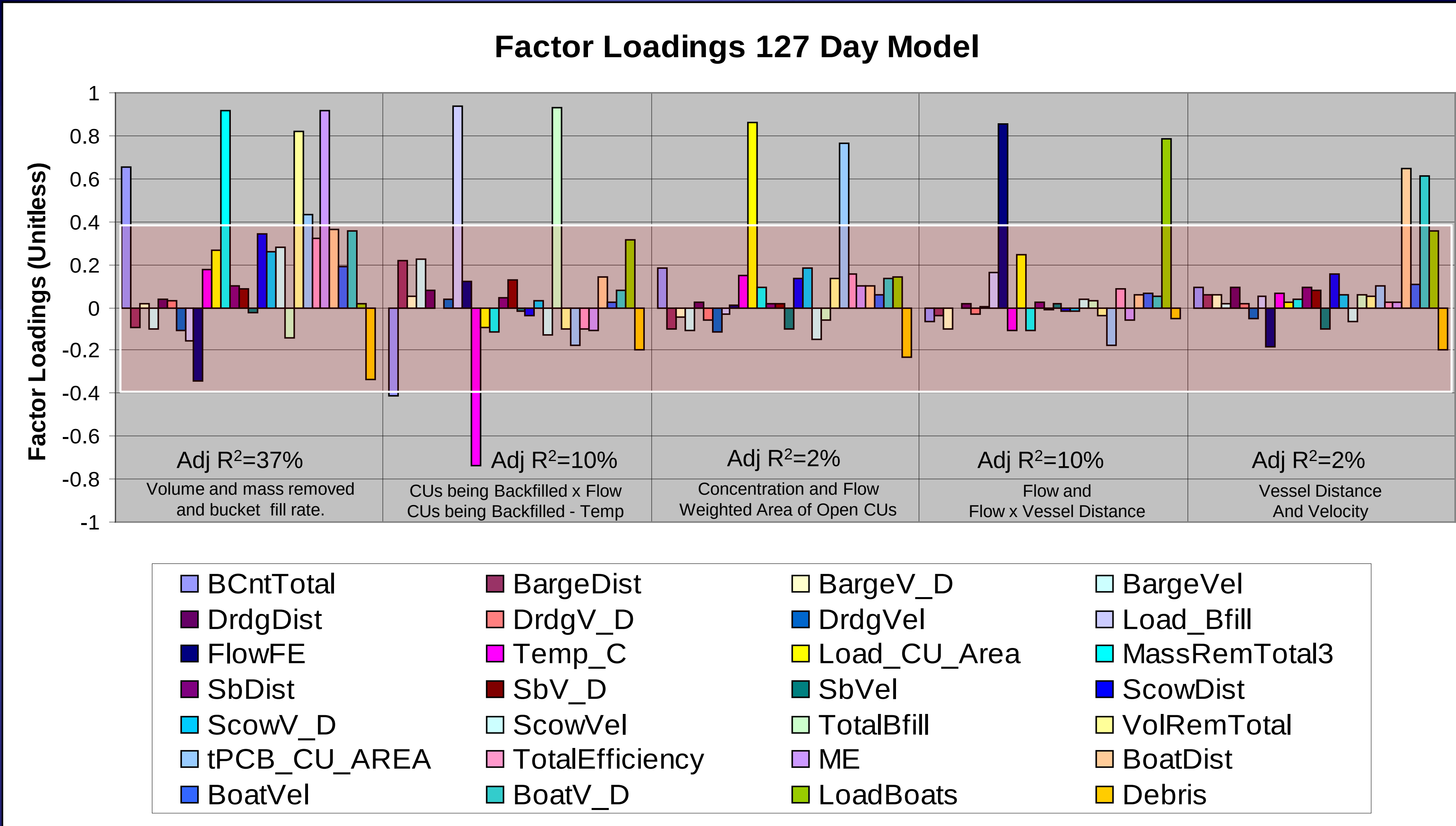
Topic 2

CAUSES OF RESUSPENSION DURING PHASE 1 DREDGING

Multiple Regression Model

$$\ln\left(C_w\right) = C_{baseline} + K_1 C_{source-1} + K_2 C_{source-2} + \ldots\ldots + K_n C_{source-n}$$

- Over 28 dredging-related variables evaluated for association with water column concentrations
- Factor analysis used to identify primary processes
- Regression models developed based on factor scores
- Final models based directly on process variables guided by factor analysis results

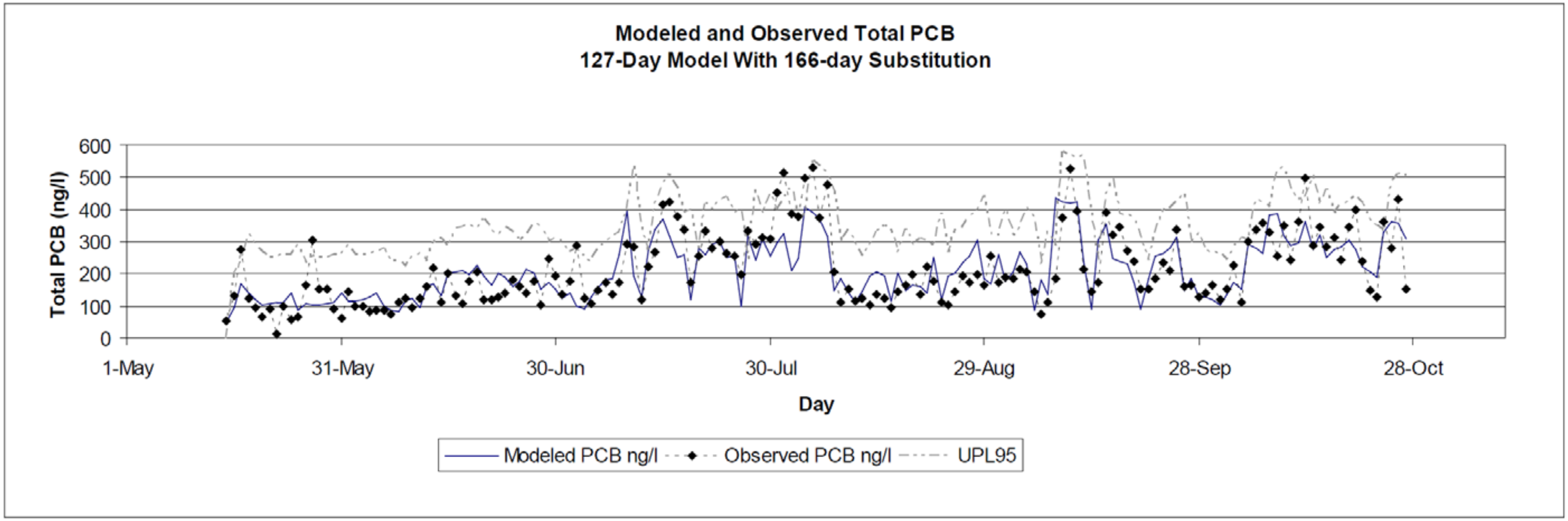


Factor loadings for five factors identified to be important factors for prediction of water column PCB concentrations. R^2 values represent the proportion of variance explained by each factor in multiple regression with water column PCB concentrations at far field stations in Thompson Island Pool. Loadings greater than roughly 0.4 in magnitude are considered meaningful.

Cause of Resuspension During Phase 1 Dredging

Observed and modeled values for water column PCB concentrations at far field station in Thompson Island Pool

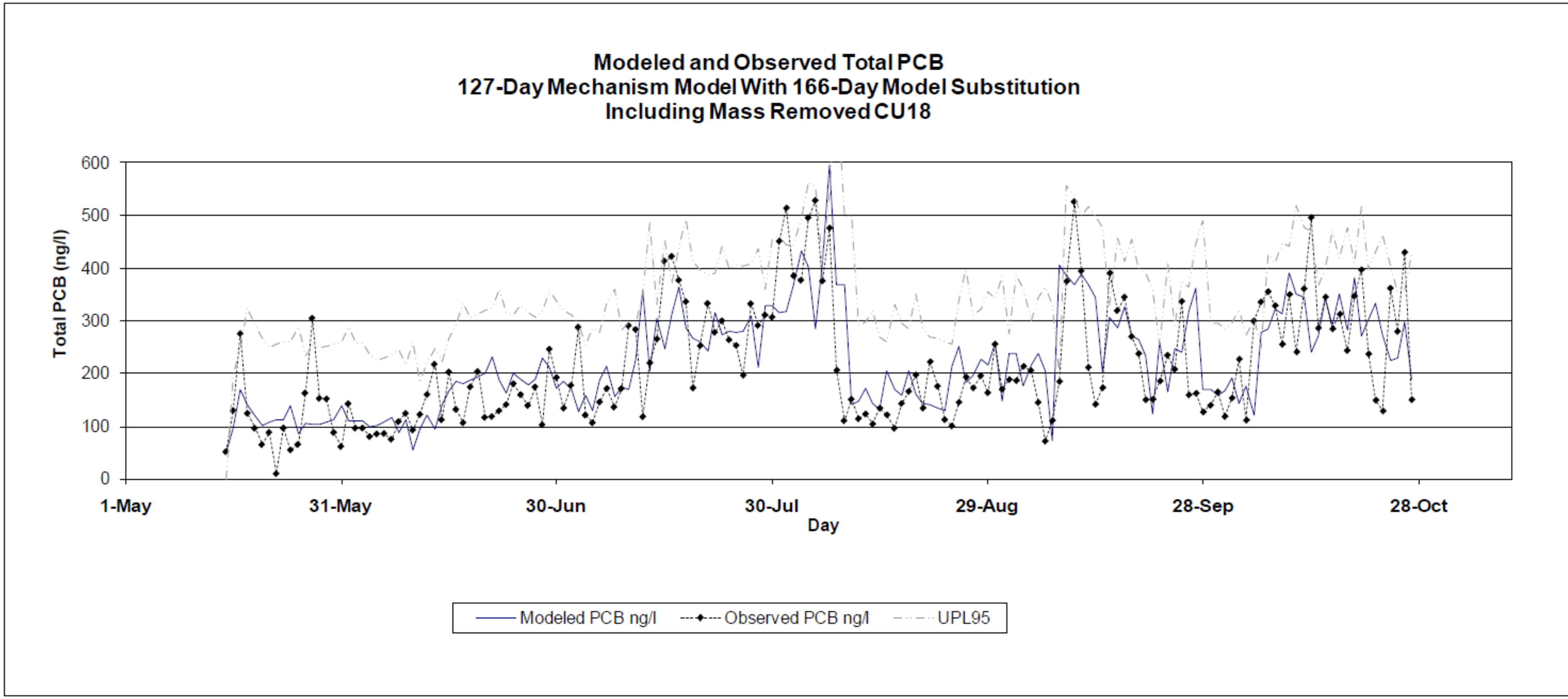
Factor Based Model



Note: The model is based on variables available on 127 of the 166 day season with modeled values from the 166 day model substituted on the remaining days—primarily in May and June.

Cause of Resuspension During Phase 1 Dredging

Observed and modeled values for water column PCB concentrations at far field station in Thompson Island Pool



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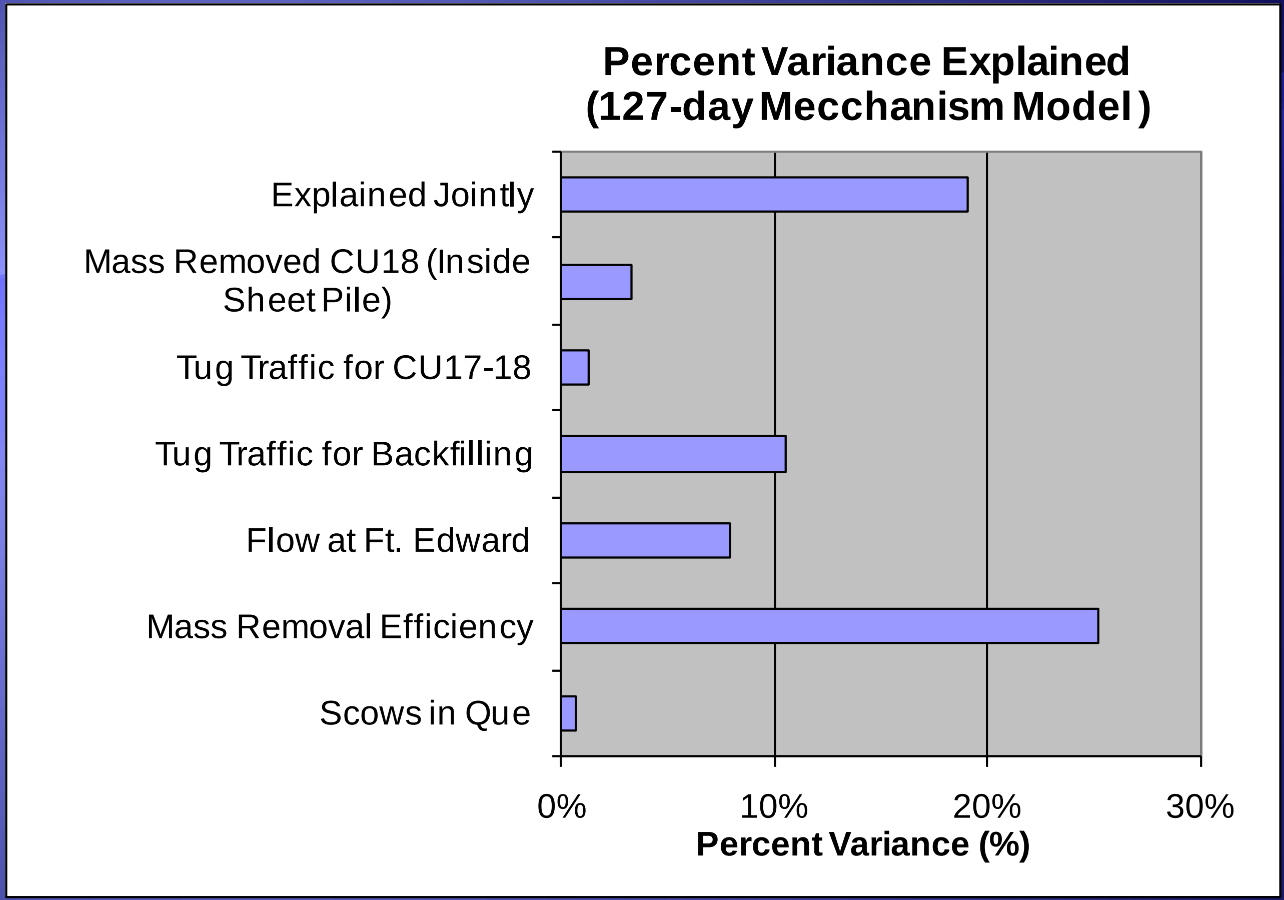
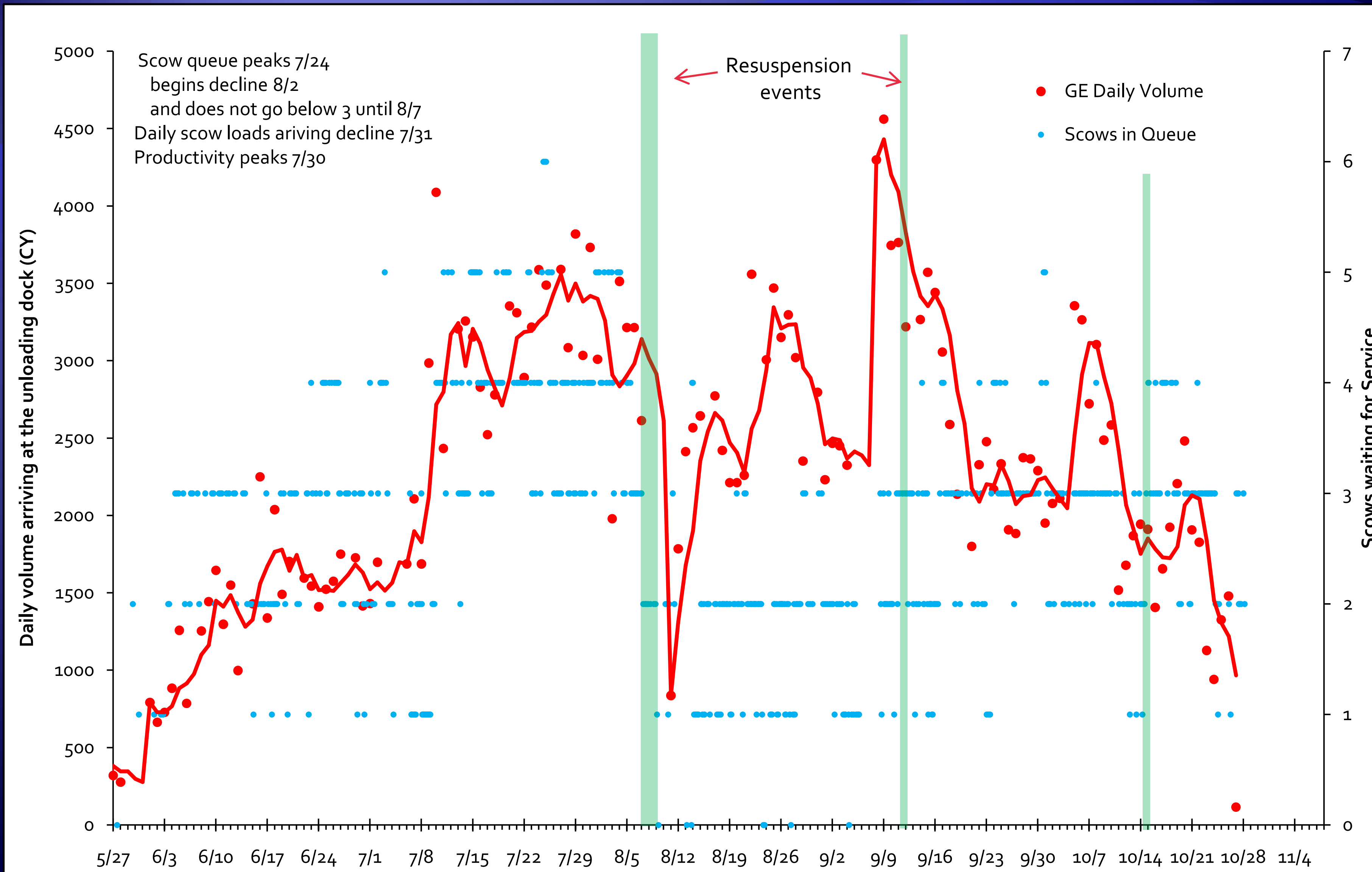


Figure 28. Percent variance explained by individual process variabels in a multiple regression model predicting water column PCB concentration at Thompson Island Dam, Hudson River New York. Overall adjusted R^2=68%. Variance explained jointly cannot be ascribed independently to any particular variable due to inter-correlations among the predictors.

Scow Availability and Its Impacts on Productivity

Scow Queue at Loading Dock and Daily Dredging Productivity



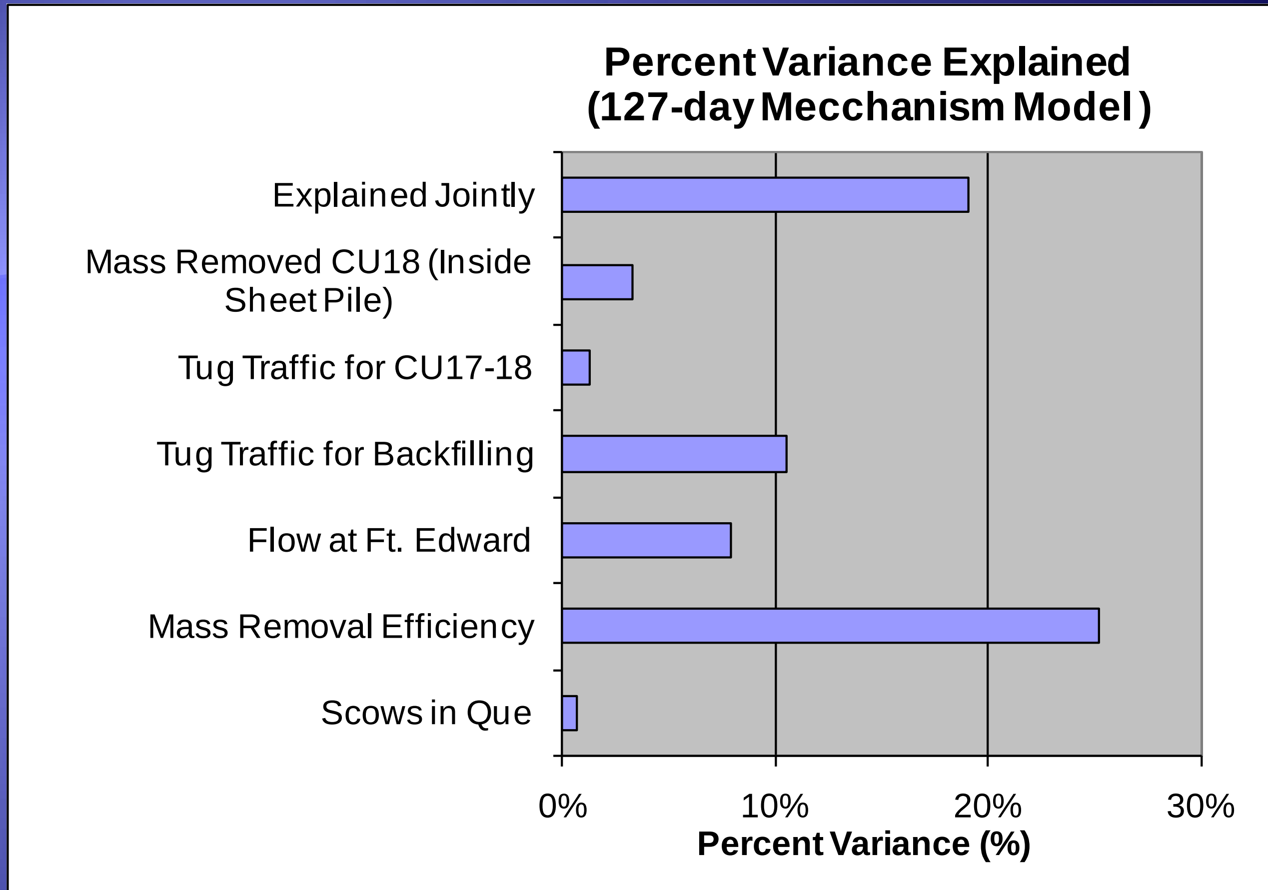
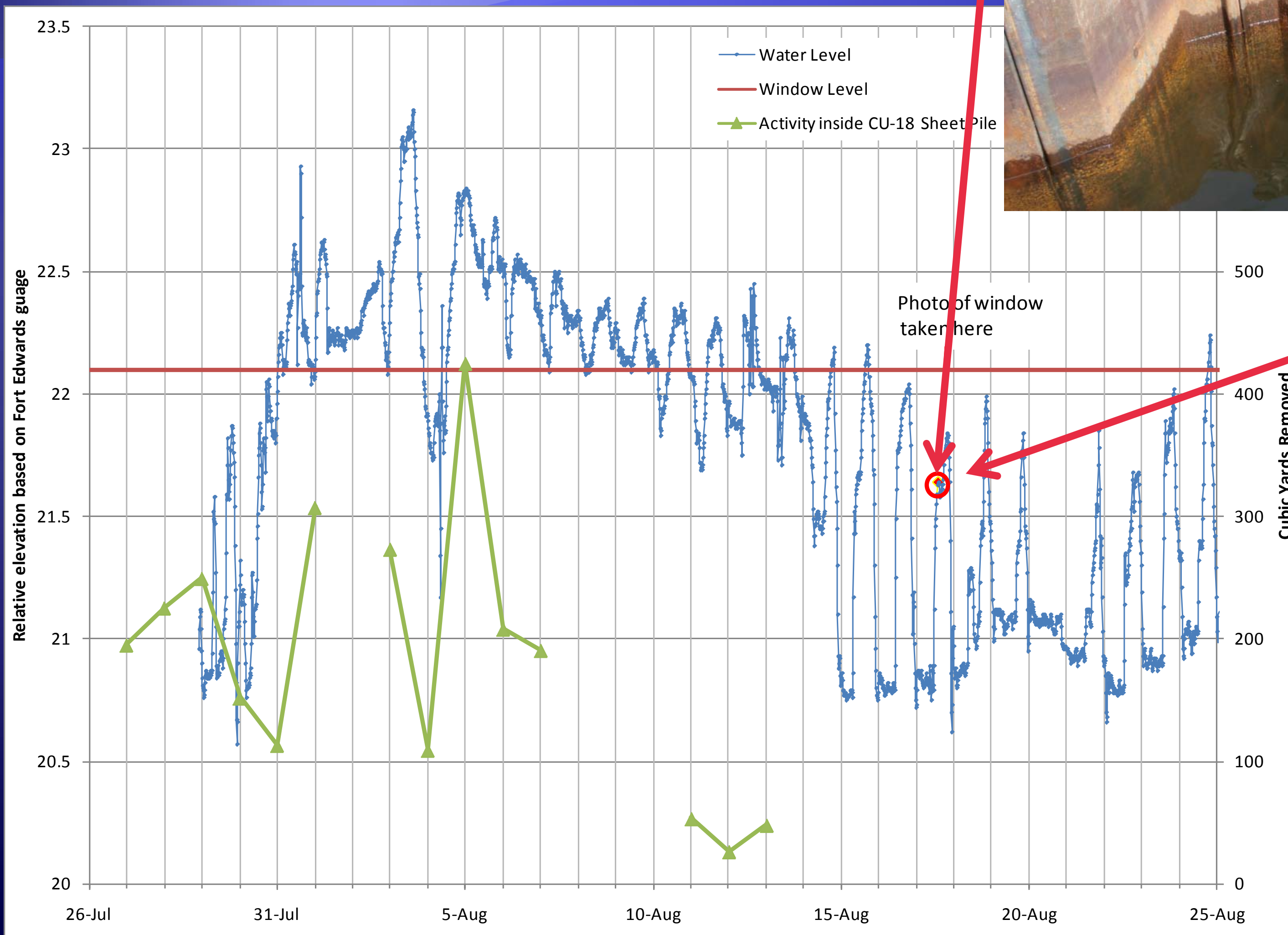
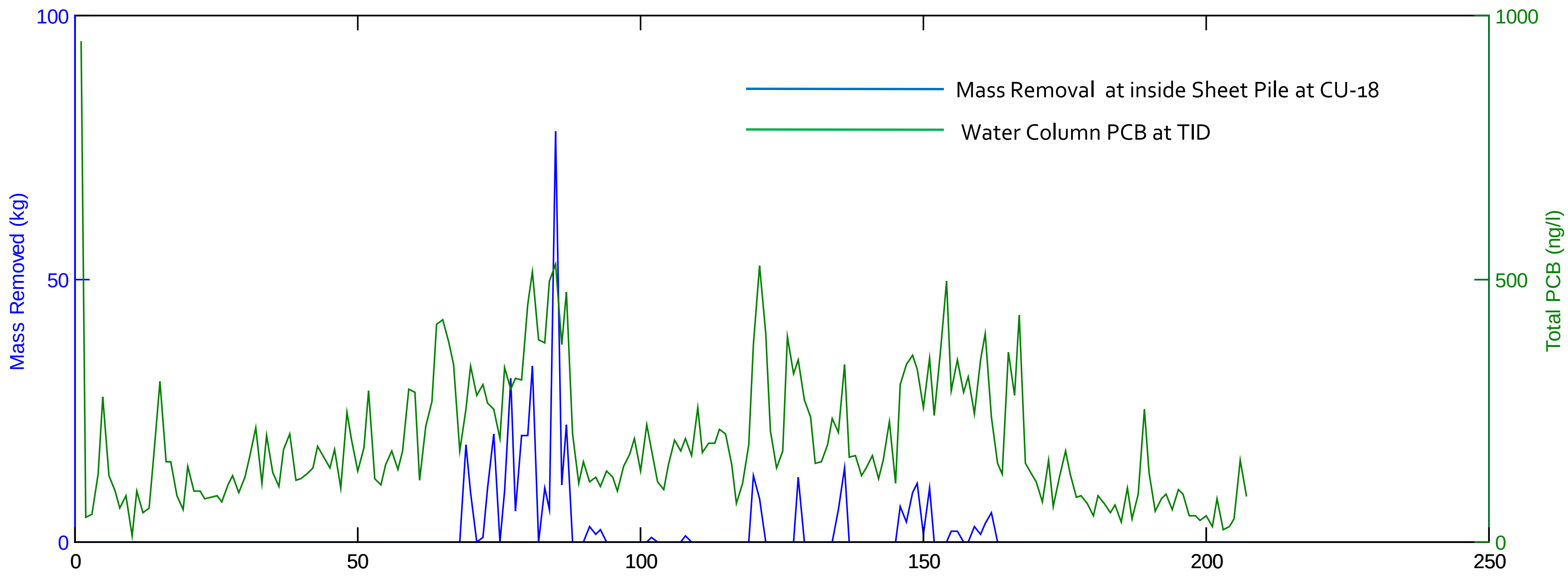


Figure 30. Percent variance explained by individual process variabels in a multiple regression model predicting water column PCB concentration at Thompson Island Dam, Hudson River New York. Overall adjusted R^2=68%. Variance explained jointly cannot be ascribed independently to any particular variable due to inter-correlations among the predictors.

Highly concentrated PCB Contaminated water from CU- 18

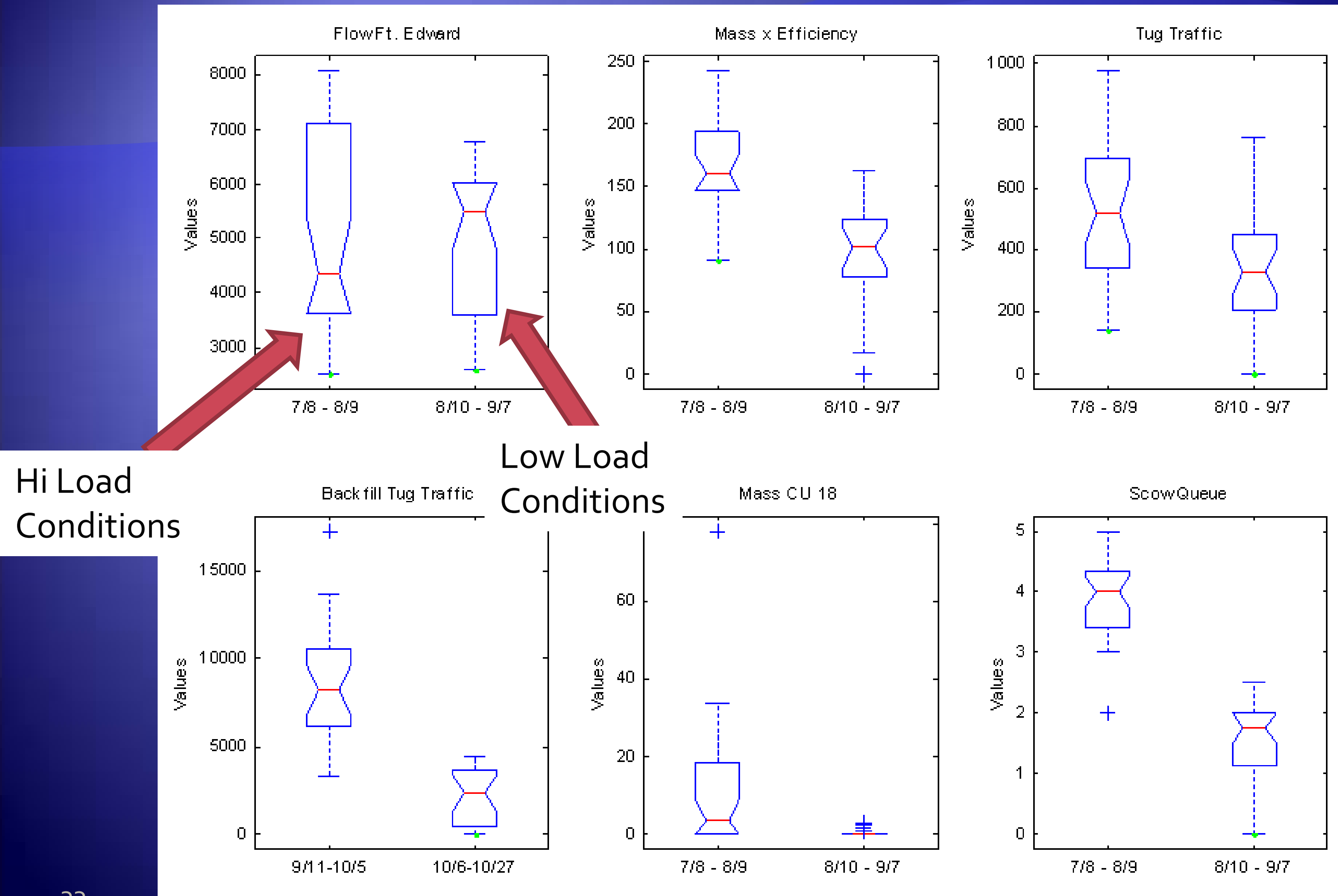




- PCB concentration behind the sheet pile exceeded 100,000 ng/l
- Commonly exceeding 20,000 ng/l
- Small amounts of activity within the sheet pile induced near immediate spikes at TID

Cause of Resuspension During Phase 1 Dredging

Distribution of six key process variables during selected



Summary of Findings

- A set of 6 dredging related variables were identified that in combination with flow explained 68% of variation in water column PCB concentrations at TID
- Tug traffic was important, especially in shallow water over high concentration sediments even during backfilling
- Activities inside CU-18 explained excursions in water column concentrations in late July and early September
- Less than half of the explanatory power was explained by mass removal alone
- Operational data from August 10 to September 7 support the conclusion that Phase 2 dredging can be conducted with reasonable resuspension rates while meeting productivity goals.

Topic 3

REDISTRIBUTION OF CONTAMINANTS DURING DREDGING

Lack of Baseline Information

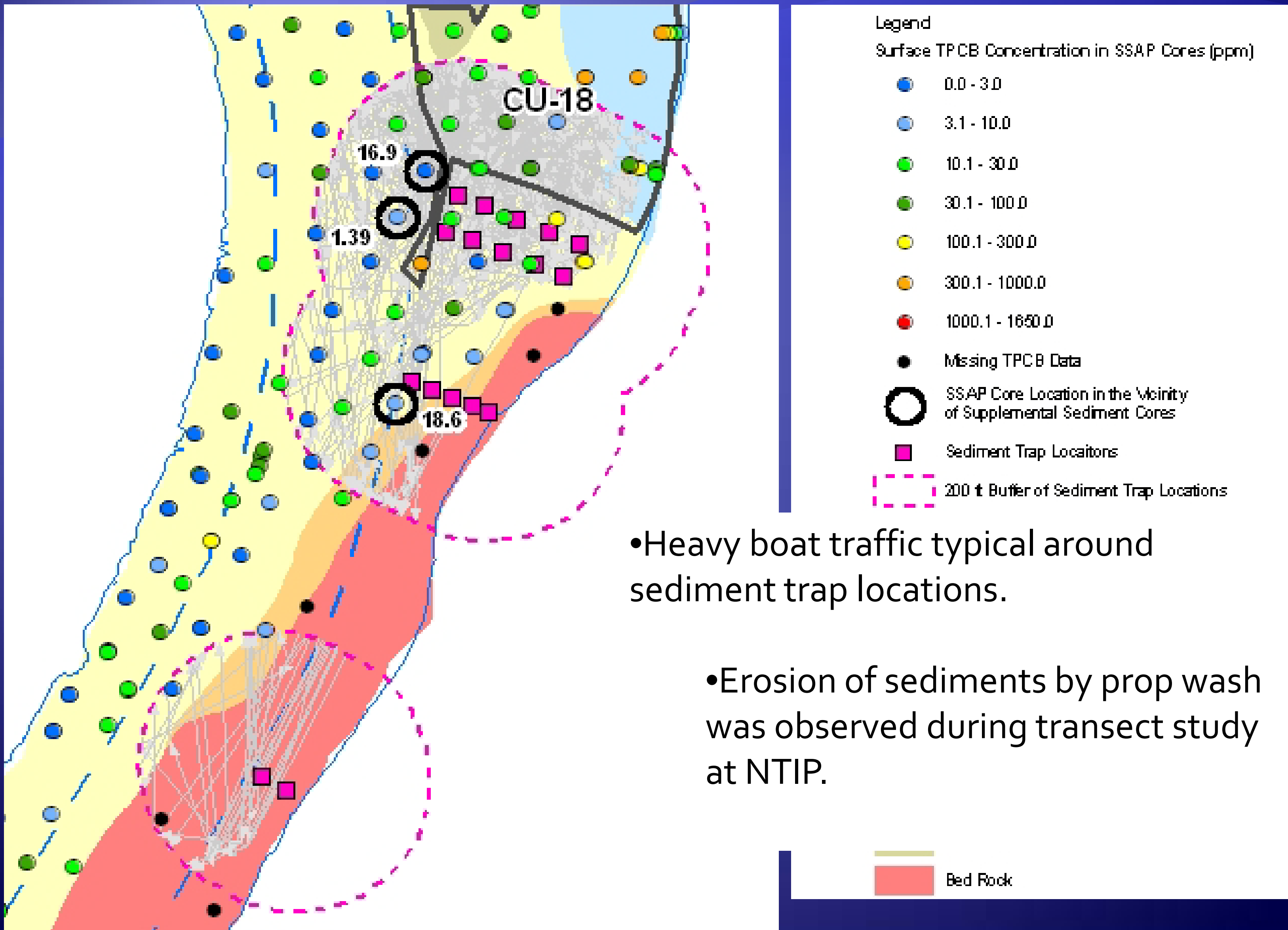
- RAM QAP required collection of baseline sediment traps.
- 34 traps were deployed prior to dredging.
- Traps retrieved May 14
- Baseline trap samples were not analyzed by GE.

Push Cores: GE's attempt to assess sediment redistribution

- GE collected push cores in the vicinity of sediment traps, and adjacent to SSAP core locations.
- Pre-dredging sampling design was flawed—biased toward low concentration sites, making apparent increases likely.
- Originally, 27 cores attempted and sediment was recovered at only 6.
- As noted by GE, five yielded higher values; however results were within the uncertainty of the sampling variance.
- Data are not adequate to support GE's conclusion of sediment redistribution.

Redistribution of Contaminants During Dredging

Boat Traffic and Surface TPCB Concentration in SSAP and Push Cores in the Vicinity of Sediment Trap Locations



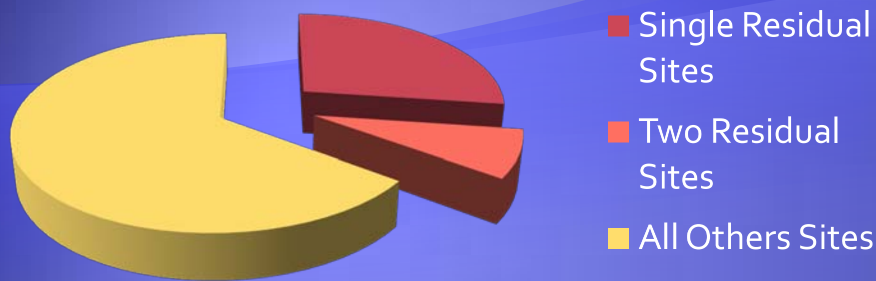
- Heavy boat traffic typical around sediment trap locations.
- Erosion of sediments by prop wash was observed during transect study at NTIP.

Topic 6

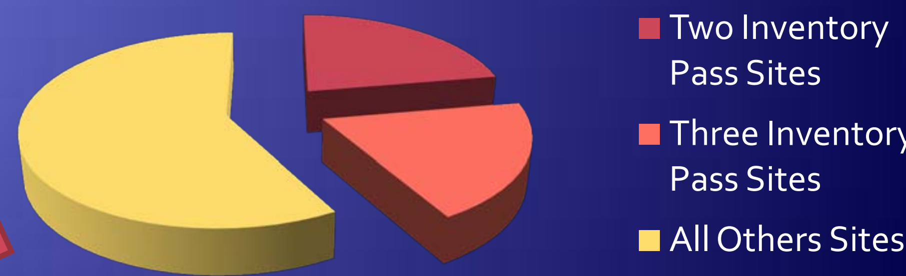
UNDERESTIMATION OF DEPTH OF CONTAMINATION AND ITS IMPACTS ON THE PROJECT

HISTORY OF POST-DREDGING CORE SITES

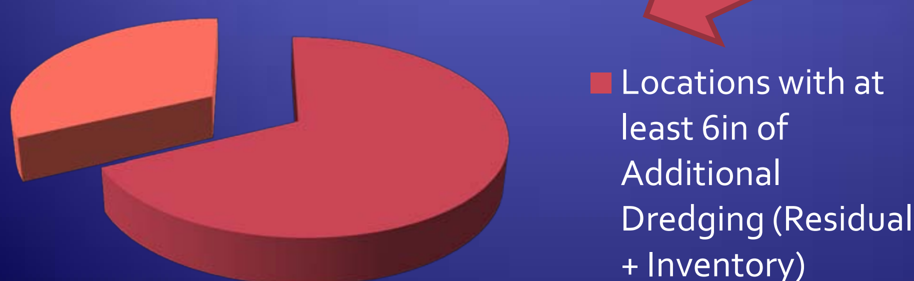
Only 35 Percent of Locations Required a Residual Layer Removal



42 Percent of Locations Required 2 Inventory Passes; 20 Percent required 3



68 Percent of Locations Required at least 6 in of Additional Dredging

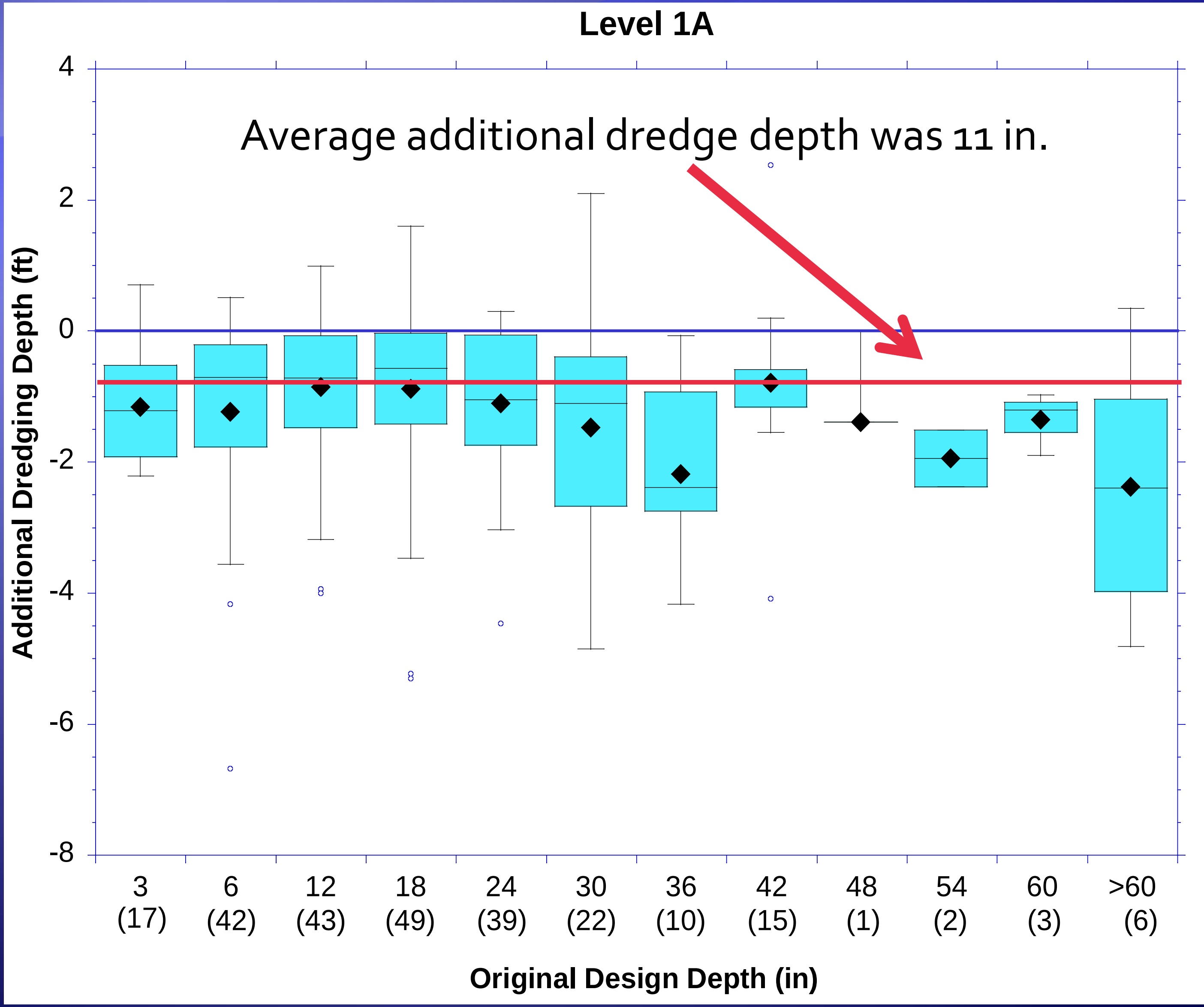


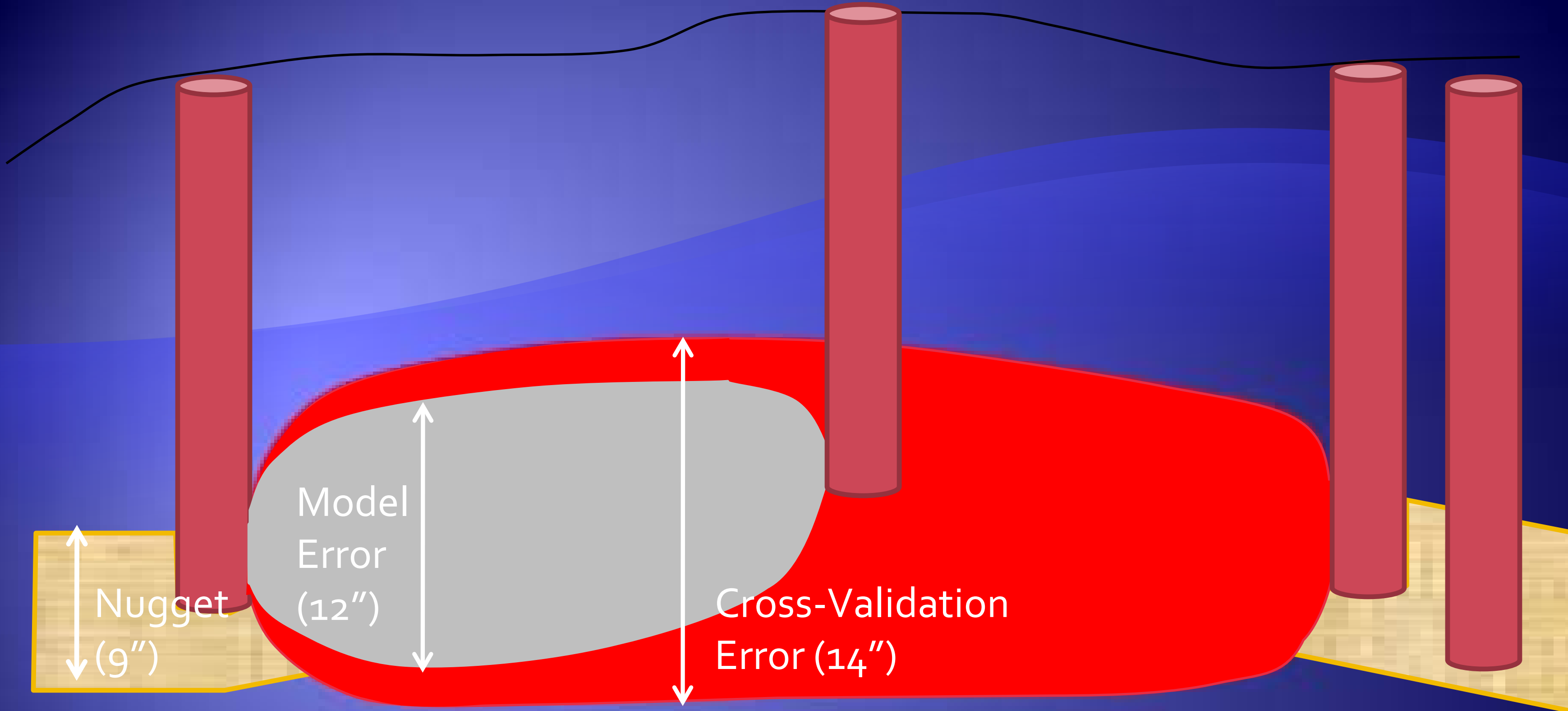
Directly supports EPA's overcut proposal

Depth of Contamination Components of Uncertainty

- Extensive discussions of DoC uncertainty
- DoC estimates were inaccurate and imprecise
- Underestimating DoC led to additional re-dredging to remove inventory.
- DoC uncertainty impacted all three standards
- This is correctable in Phase 2

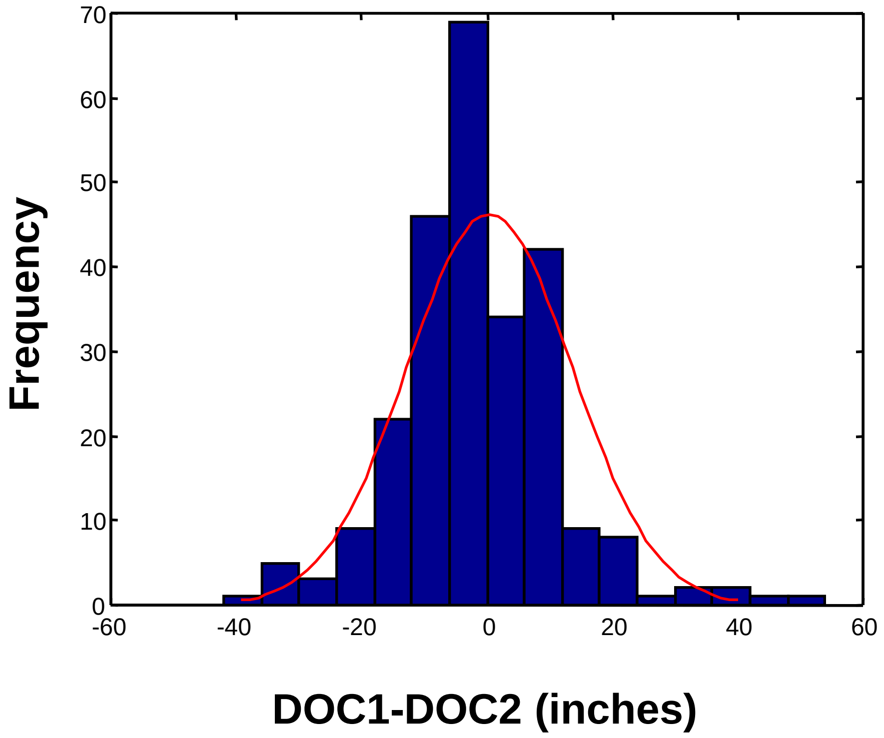
Relevance and Consequences of Uncertainty in Measurements of the Depth of Contamination

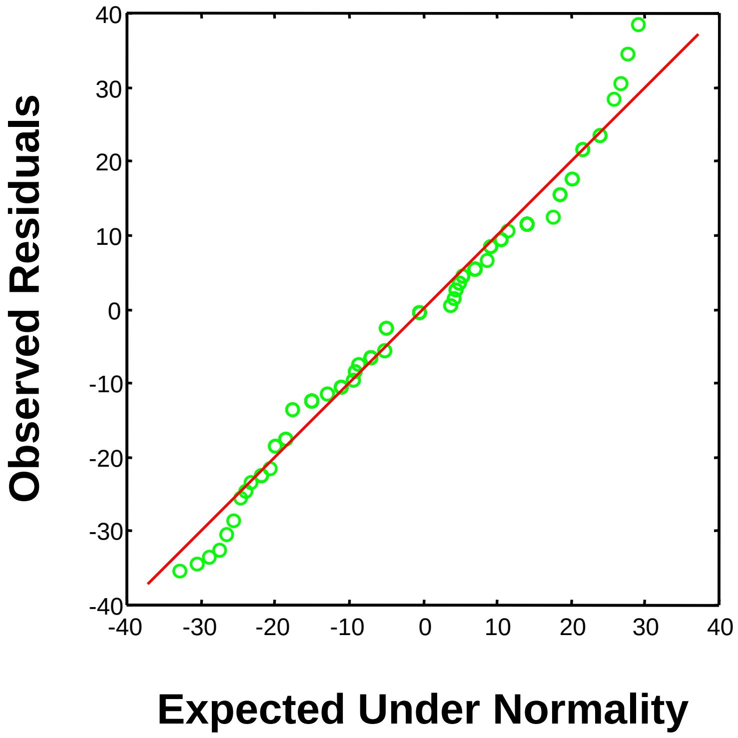




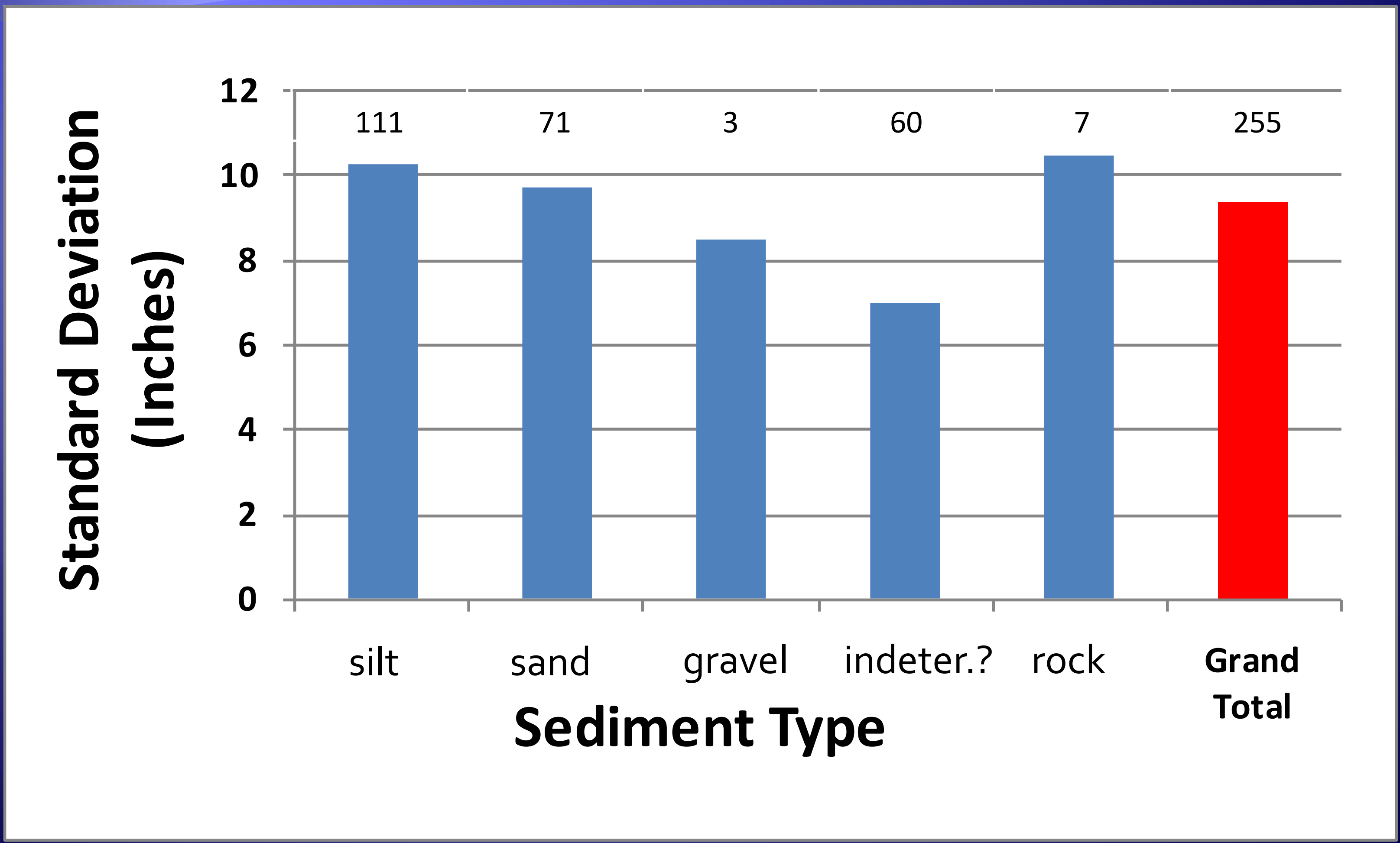
Depth of Contamination Components of Uncertainty

Distribution of DoC for N = 255 Co-located Cores
Maximum distance 20 feet
Skewness = 0.31





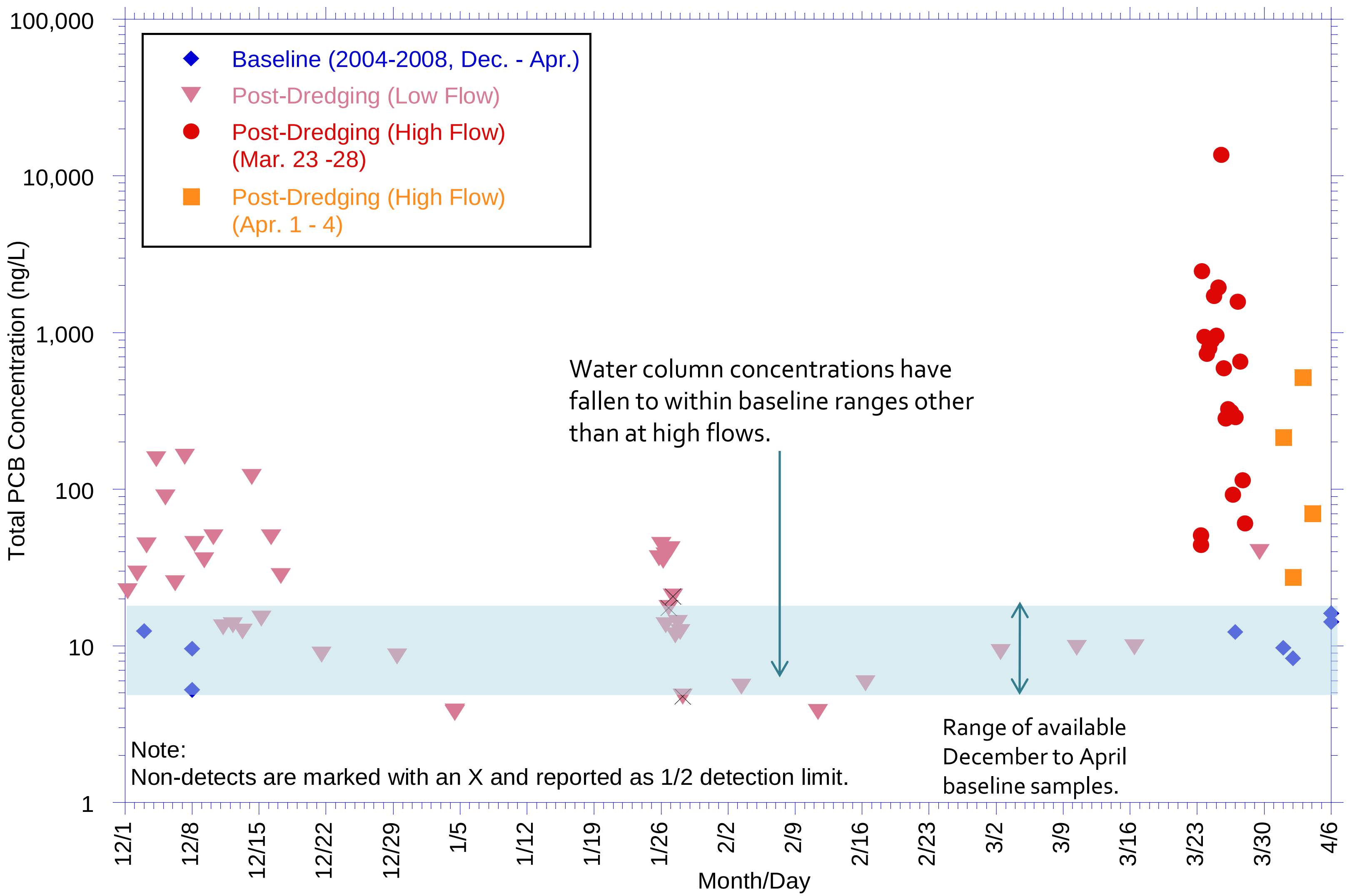
Phase I Nugget Effect at Type 1A Co-located Cores Maximum Distance 20 Feet N=255



Topic 1

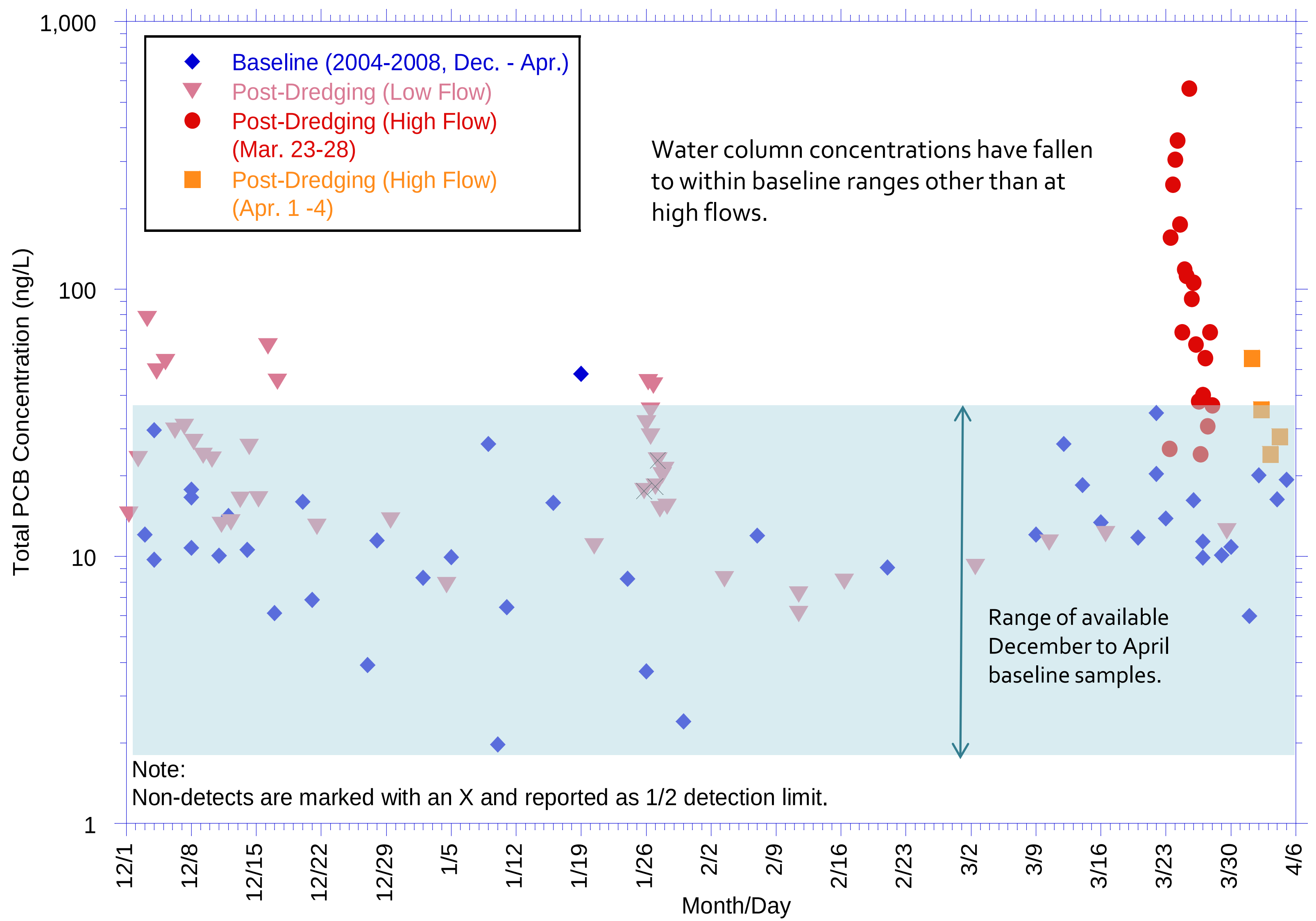
WATER COLUMN LOADS DURING AND AFTER DREDGING

WATER COLUMN LOADS DURING AND AFTER DREDGING
Thompson Island

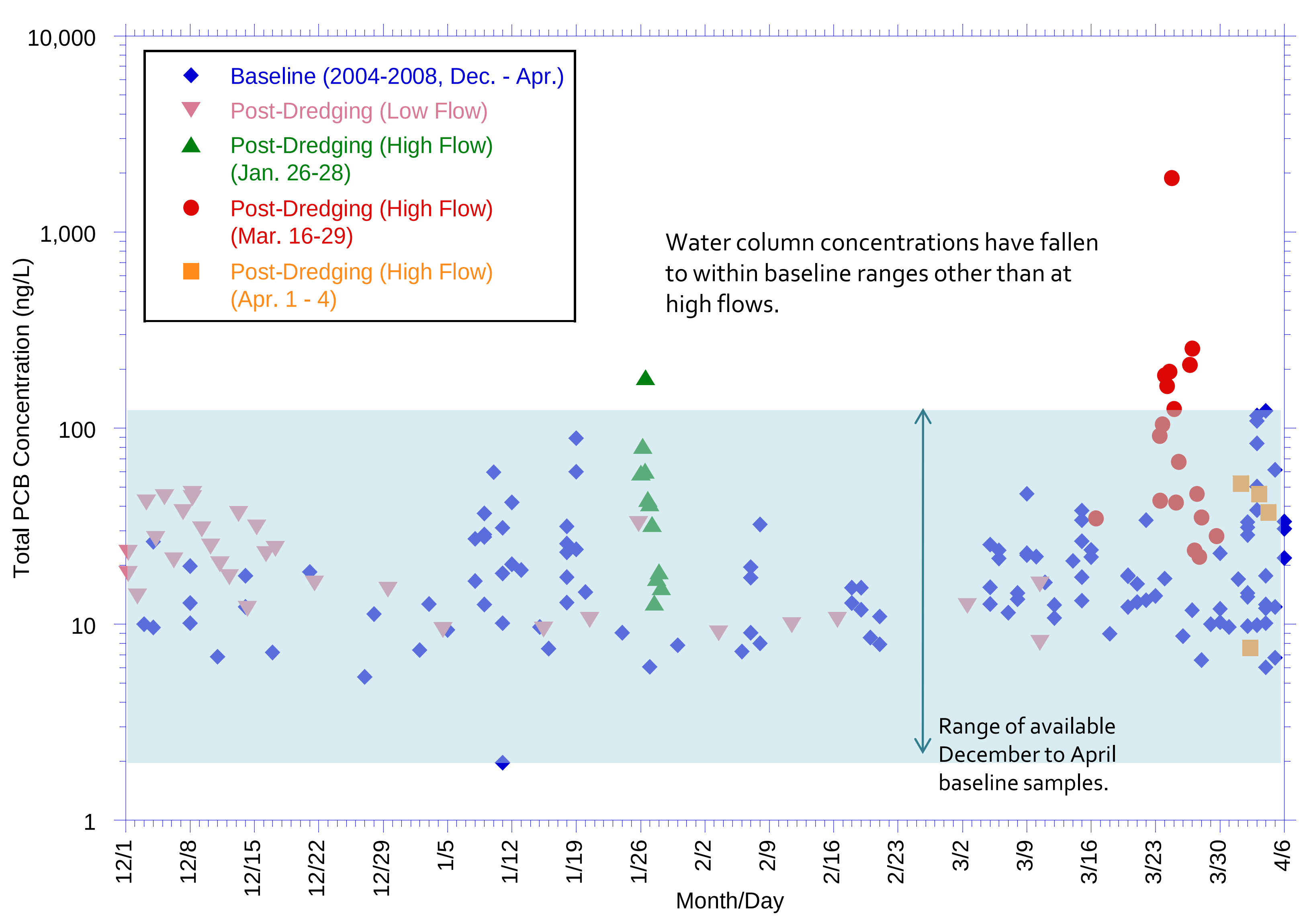


WATER COLUMN LOADS DURING AND AFTER DREDGING

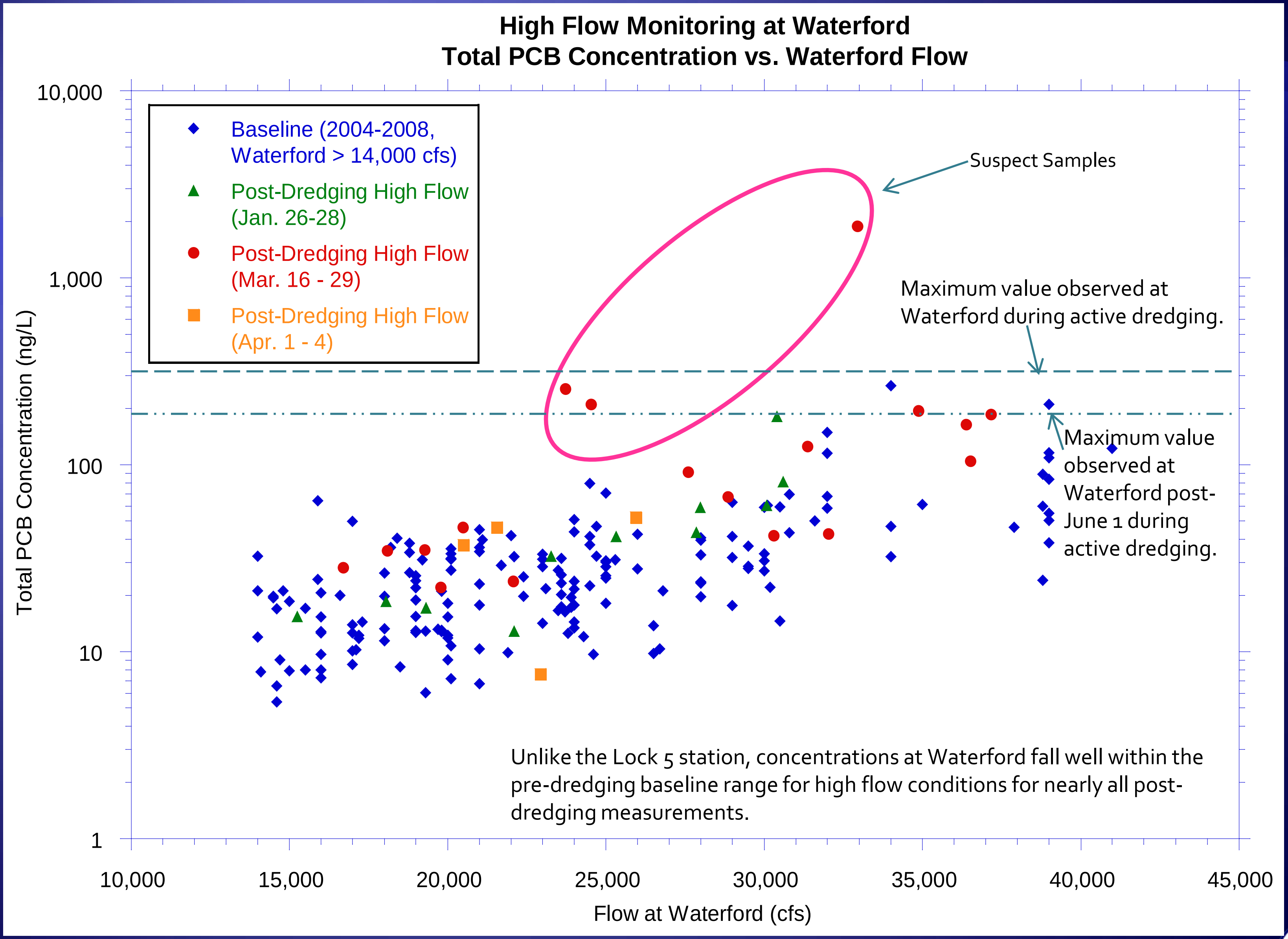
Lock 5



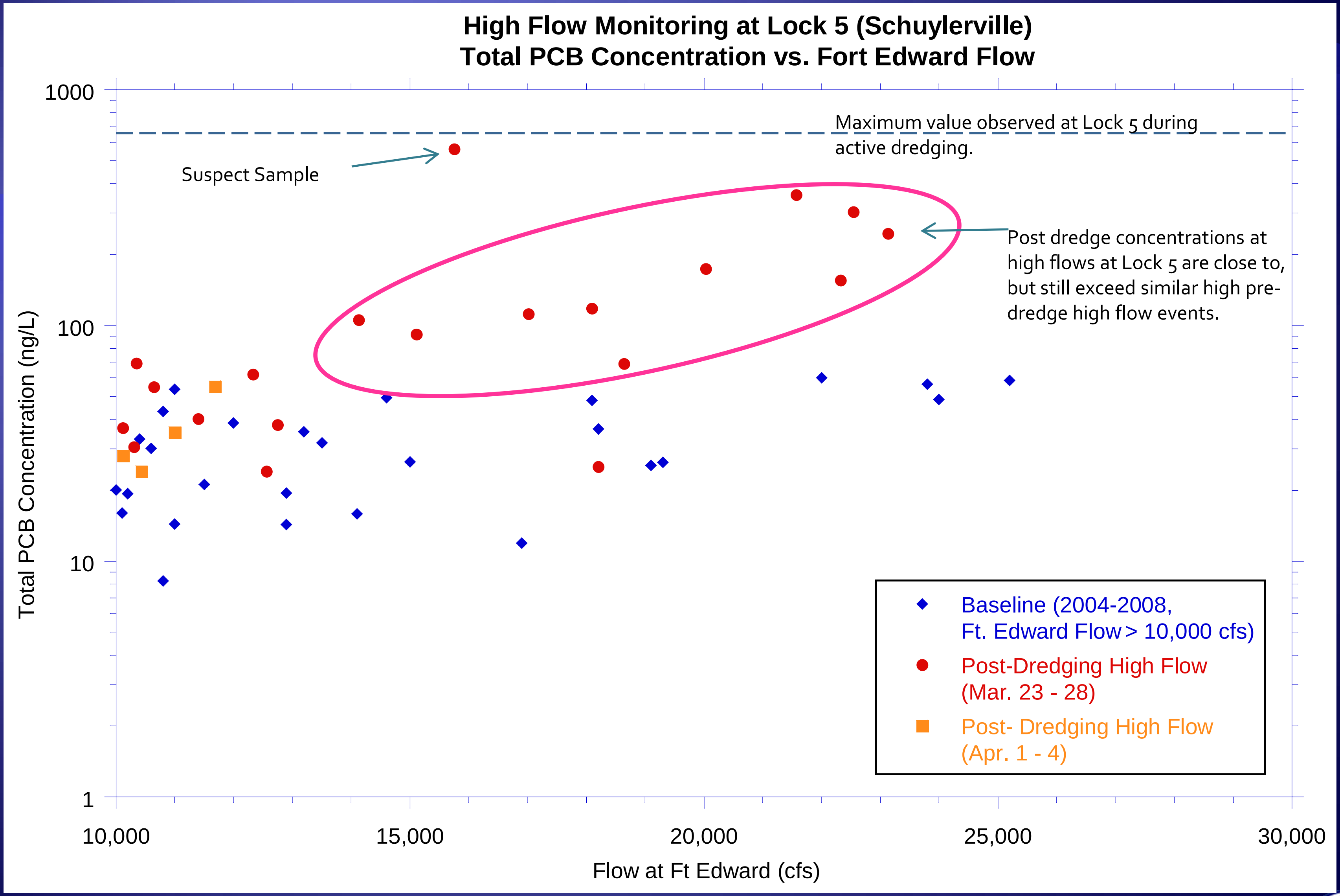
WATER COLUMN LOADS DURING AND AFTER DREDGING
Waterford



WATER COLUMN LOADS DURING AND AFTER DREDGING



WATER COLUMN LOADS DURING AND AFTER DREDGING



Thompson Island Intake No.1

TID Intake #1 covered with weeds and mud

Thompson Island Intake No.3

TID Intake Screen #3 being pulled from river and covered with weeds and mud

Thompson Island Intake No.3

TID Intake Screen #3 being pulled from river and covered with weeds and mud

Thompson Island Intake No.4

TID Intake Screen #4 being pulled to surface and covered with weeds and mud.

Lock 5 Intake No.4

Lost intake screen and clogged with mud and vegetation

Lock 5 Intake No. 2

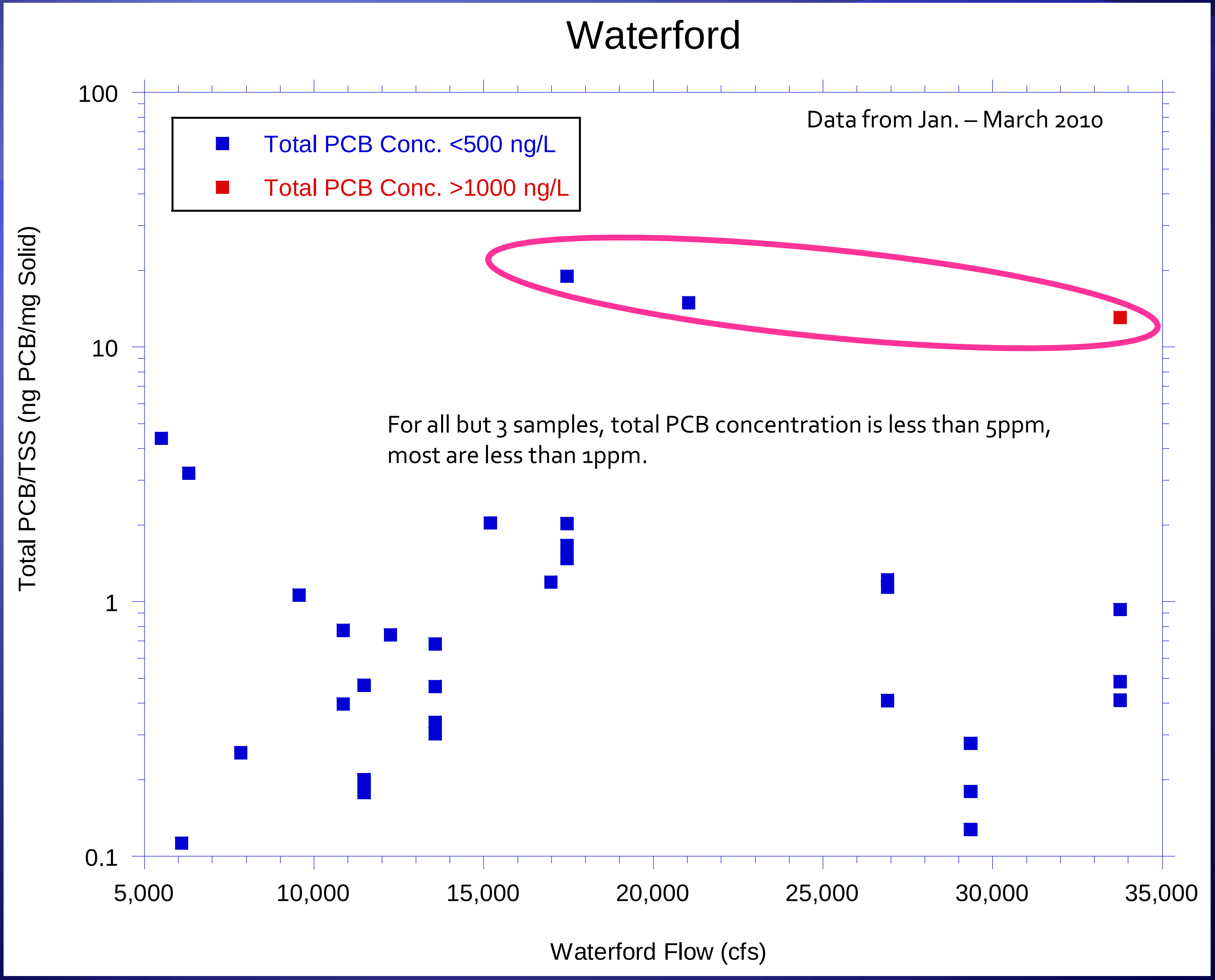
Muddy water flow from intake during backflush

Lock 5 Intake No.3

Muddy water flow from intake during backflush

WATER COLUMN LOADS DURING AND AFTER DREDGING

Total PCB Concentrations Normalized to TSS



WATER COLUMN LOADS DURING AND AFTER DREDGING

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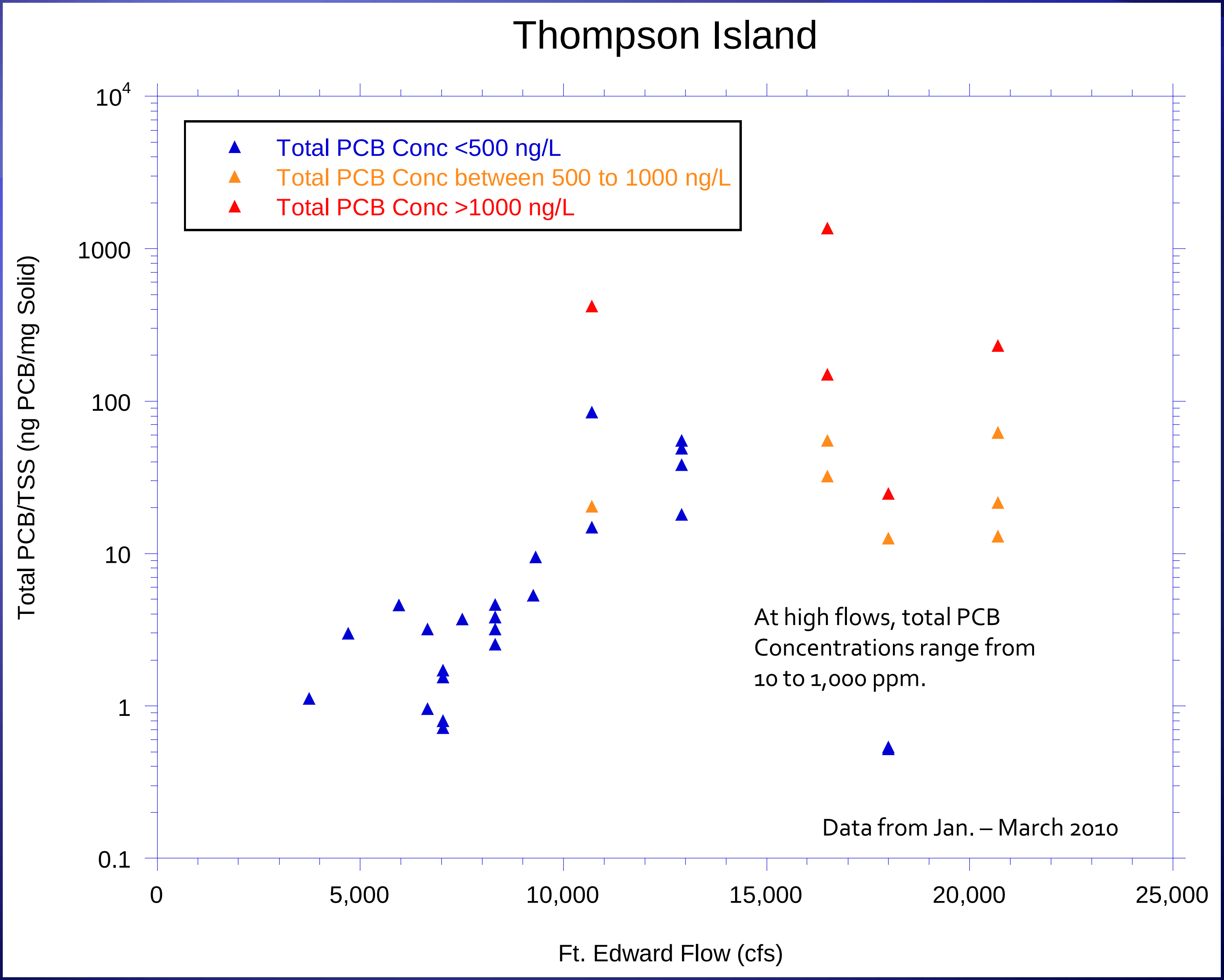
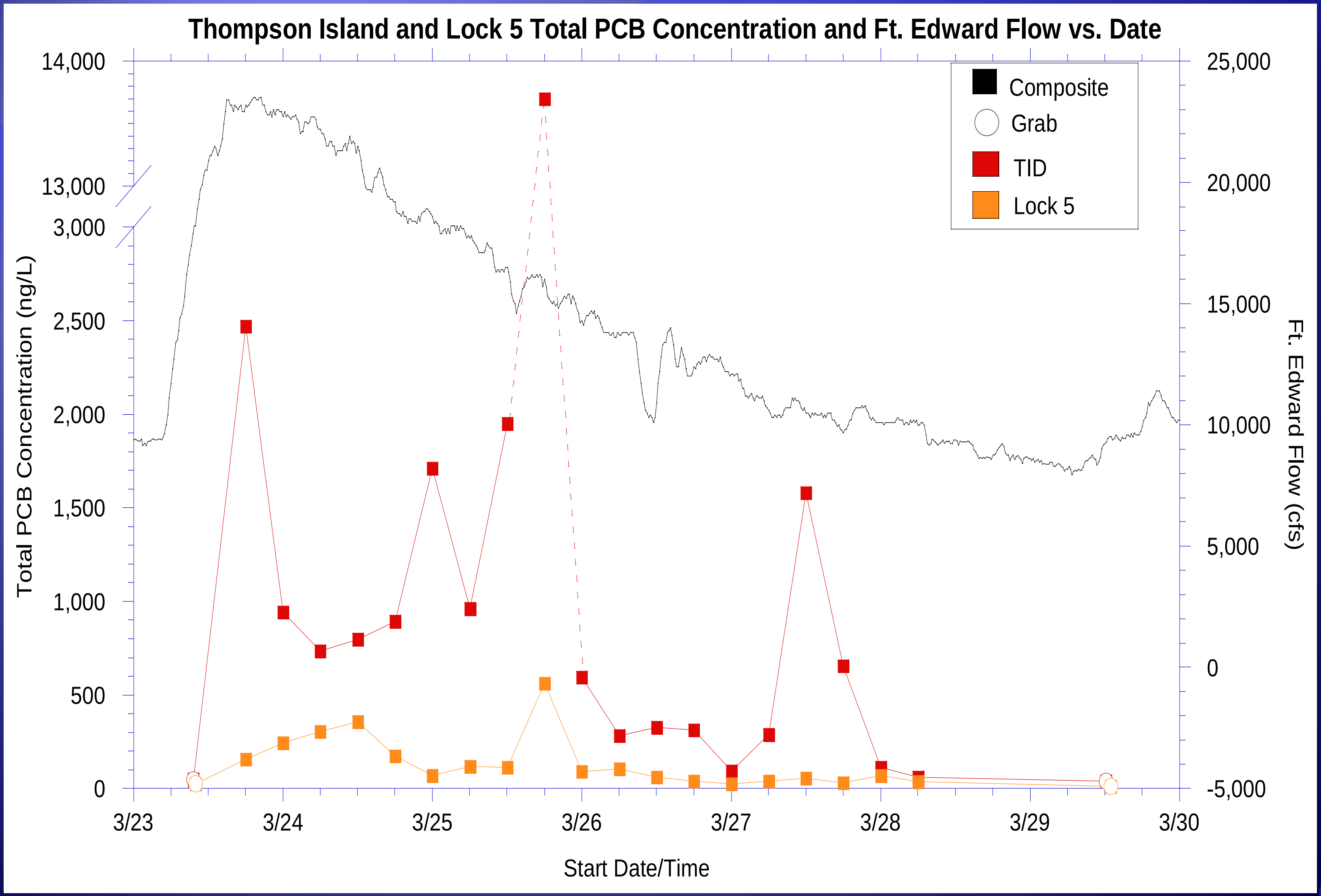


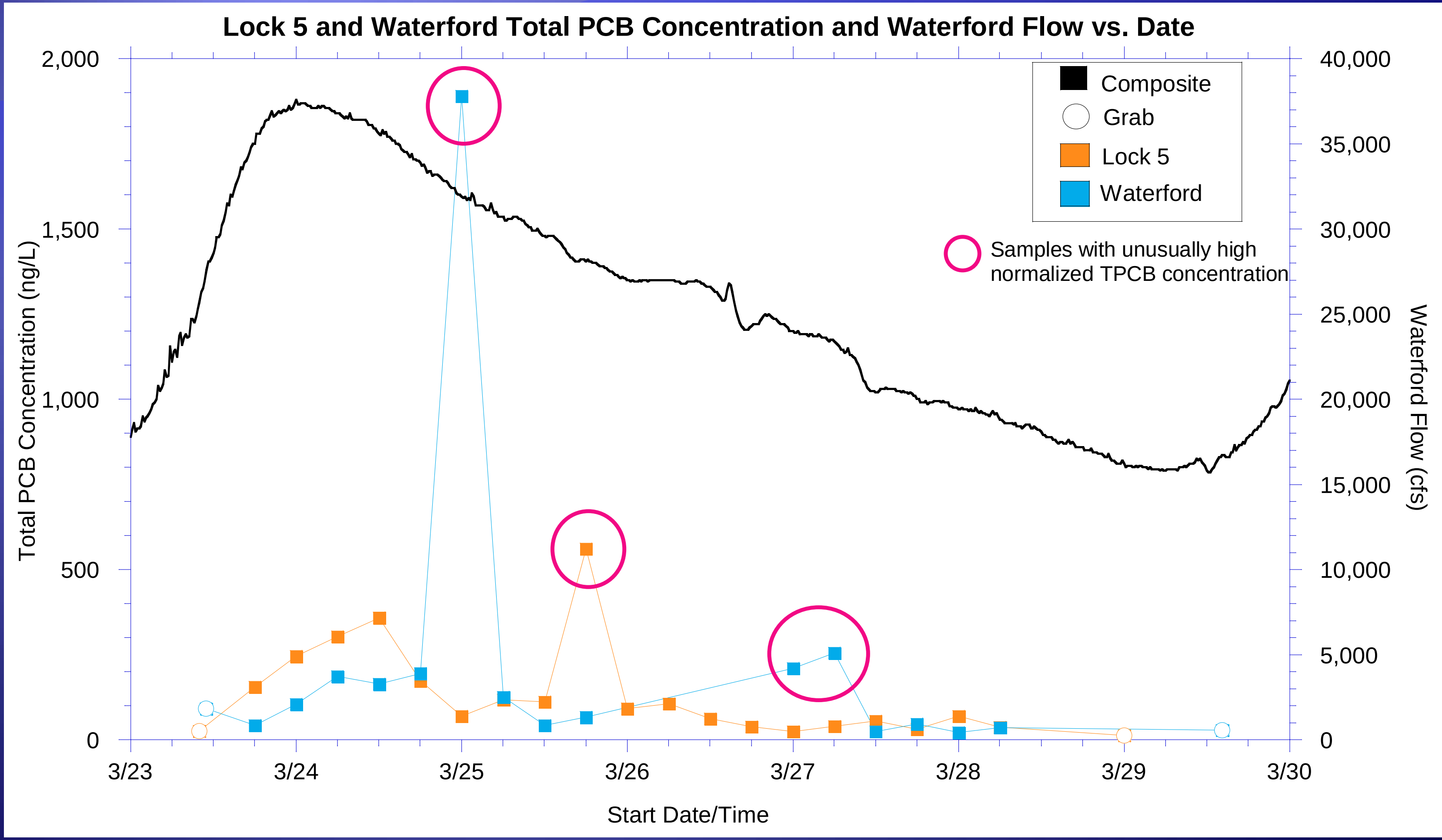
WATER COLUMN LOADS DURING AND AFTER DREDGING

Thompson Island and Lock 5 Total PCB Concentration
and Fort Edward Flow vs. Date

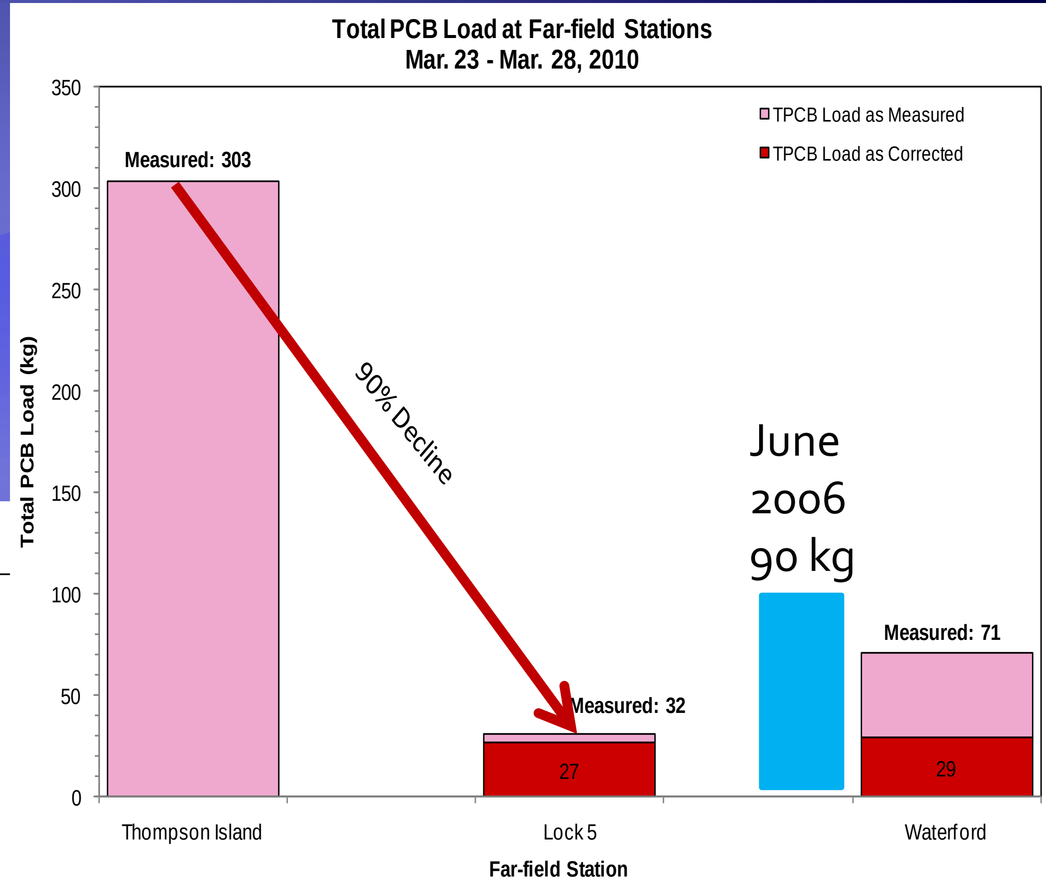


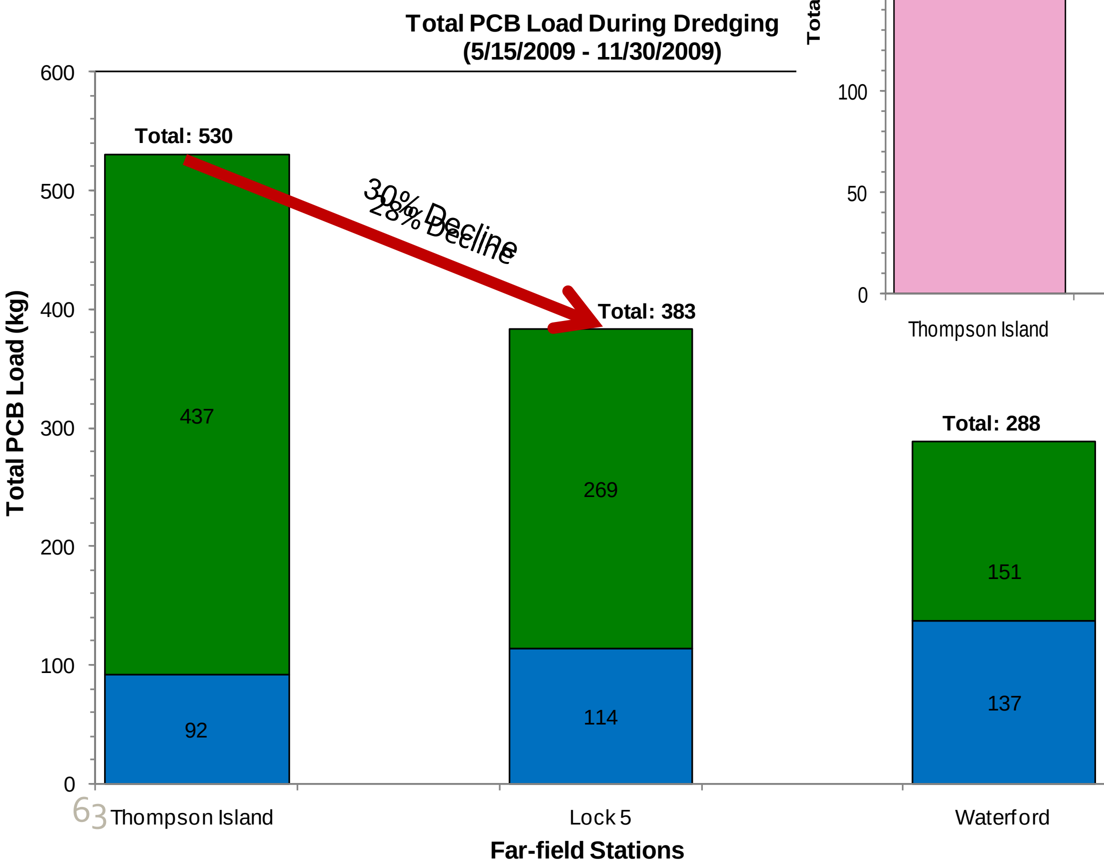
WATER COLUMN LOADS DURING AND AFTER DREDGING

Lock 5 and Waterford Total PCB Concentration
and Fort Edward Flow vs. Date

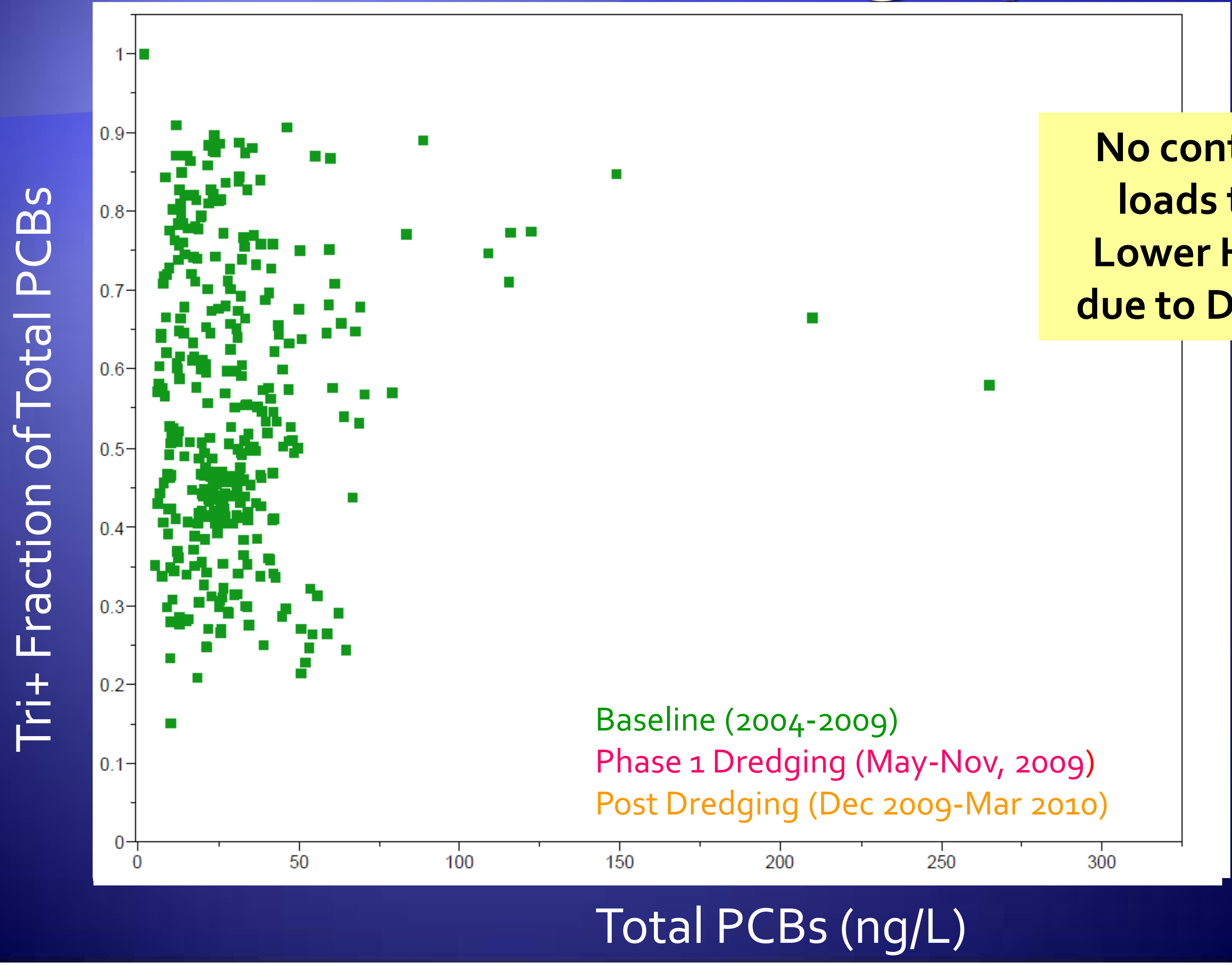


WATER COLUMN LOADS DURING AND AFTER DREDGING





Post-dredging Loads at Waterford have Baseline Fingerprint



No continuing loads to the Lower Hudson due to Dredging

PCB CONCENTRATIONS AT THE FAR-FIELD STATIONS: POST-DREDGING VS BASELINE

- Low flow concentrations have returned to baseline
- High flow concentrations have returned to baseline at Waterford
- High flow data at TI and Lock 5 are suspect, at best
- Geochemical fingerprint identifies recent concentrations as baseline

Technical Summary

- Revised Load Standard
  - Lower River model simulation show no long term impact
- Temporal Trend
  - Sediment and water declining at about 10-15 year half lives
- Resuspension model:
  - Causes of resuspension are many and complex
  - Manageable process variables identified indicating resuspension can be reduced while meeting productivity standard
- Low flow concentrations have returned to baseline
- High flow concentrations have returned to baseline at Waterford

Technical Summary (Cont'd)

- DoC uncertainty
  - DoC characterization was both inaccurate and imprecise
  - Resuspension and productivity standards were negatively affected by the gross uncertainty in DoC characterization
  - Local DoC uncertainty (nugget effect) is on the order of ± 9 inches - must be addressed through a deeper setting of the cut line—i.e. , overcut
  - Incomplete cores are pervasive throughout Phases1 and 2 areas and need to be addressed in Phase 2

Monitoring Diagnostics

- Oil phase is uncharacterized and must be sampled
- Far field composite samplers are not yet suitable for high flow monitoring.
- Dissolved/ suspended/NAPL samples are needed at far field stations to better characterize loads.
- Discrete far-field samples will lend confidence to composite samplers

Comprehensive approach for managing uncertainties during Phase 2

- Overcut to improve PCB capture on 1st dredging pass
- More comprehensive post-dredging sampling
- Flexibility in Phase 2 schedule as volume estimate improves
- Alternate public water supply
- Resuspension monitoring diagnostics
- Oil phase study
- Adaptive management approach for operations

Inefficient Phase 1 Dredging Practices

- High percentage of 5-cy buckets less than 50% filled resulting from:
  - No overdredging allowance
  - Dredging precision in excess of DoC precision
  - No apparent contractor incentive to dredge efficiently
- Project Impacts
  - Targeted areas not dredged in Phase I
  - Increased relative resuspension

Improving Phase 2 Dredging Practices

- More traditional dredging approach
  - Cut aggressively to DoC + overdepth
- Overdepth based upon
  - Dredge precision (without extending cycle time)
  - Precision of DoC definition
- Minimize bucket drainage

Contaminated Sediment Remediation Guidance

- We are in remedy implementation and our focus here is on potential modifications to the EPS – we are not here to re-open the remedy
- Adaptive Management Concepts
- Extensive new analysis of modeling – previous models (both EPA and GE's) under-predicted loads
- Model uncertainties
- Assess causes of resuspension
- Combination remedies - dredging, monitored natural recovery, and capping
- Extensive baseline, remedial and post remedial monitoring implemented, ongoing, and planned, respectively

Sediment Management Principles

- Control Sources Early
- Develop and Refine a Conceptual Site Model that Considers Sediment Stability
- Use an Iterative Approach in a Risk-Based Framework
- Carefully Evaluate the Assumptions and Uncertainties Associated with Site Characterization Data and Site Models
- Monitor During and After Sediment Remediation to Assess and Document Remedy Effectiveness

Proposed Tri+ PCB Load Standard for Phase 2

				Evaluation Level		**Control Level**	
				500 kg over life of project		1% of Actual Inventory	
				500	kg	670	kg
Phase 1 Transport at Waterford				60	kg	60	kg
Phase 2 Allotment				440	kg	610	kg
Phase 2 Dredging Period		5	Years	88	kg/yr	122	kg/yr
Less 5 percent Backfill and Closeout Period over Baseline		5%		4.4	kg	6.1	kg
Annual Dredging Season Allowance				84	kg/yr	116	kg/yr
Dredging Season 7 day Running Average		170	Days	**490**	**g/day**	**680**	**g/day**
Dredging Season	5/15	10/31					