Boeing Plant 2 Sediment Remediation:

Post Remedy Monitoring and the Search for Long Term Success

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BATTELLE SEDIMENTS CONFERENCE
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NEW ORLEANS, LOUISIANA

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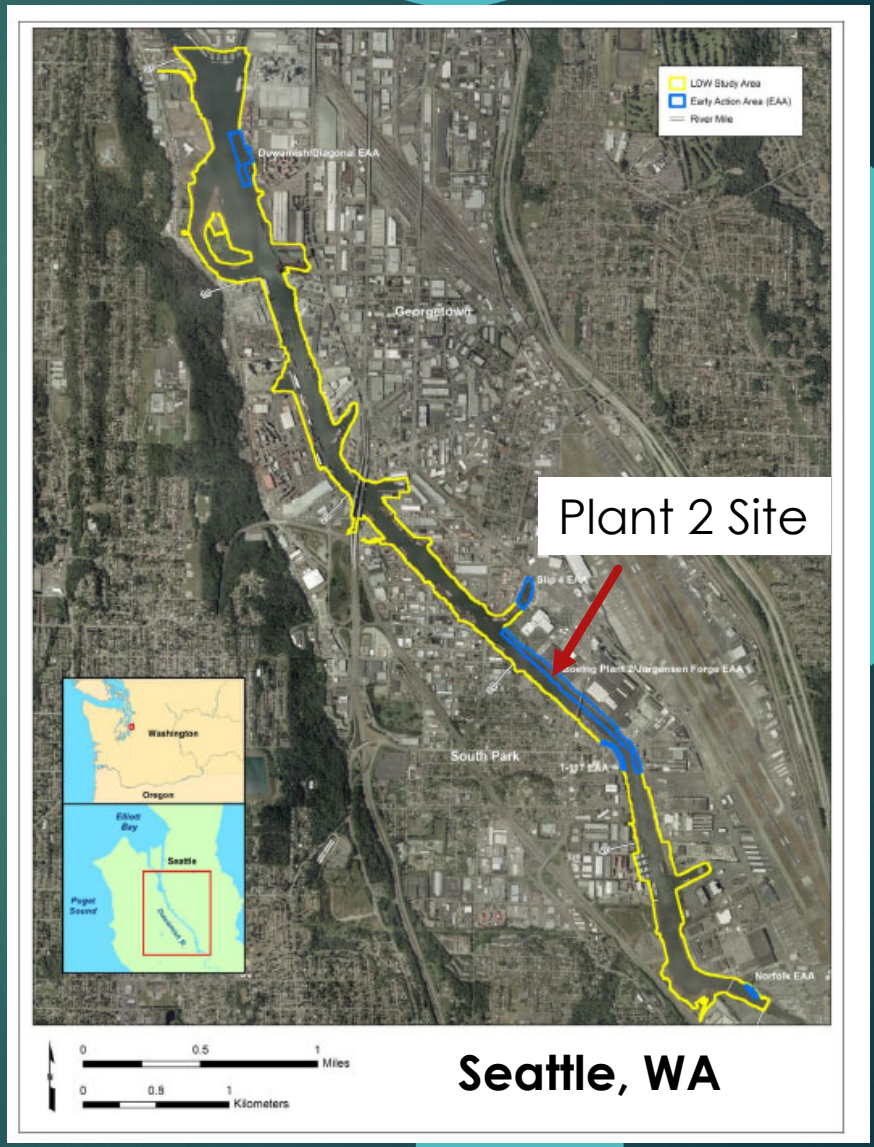
Boeing Plant 2 Project

- Duwamish Waterway Superfund Site - Early Action Area
- 3 dredging seasons (2013-2015)
- 125,000 M^3 (163,000 CY) of sediment removed
- 150,000 tonne (265,000 Tons) Backfill
- **No Measurable Post Dredging Residuals**
- Dredging 2015, WODCON 2016, Battelle 2017



Dredging/Landfilling Cost

Activity	Units	Quantity	Cost	Unit Cost
MOB/DEMOB (Start/End)			**$3.7 M**	
Additional MOB, Between Season Charges			**$5.1M**	
DREDGING	CY	163,000		
Open Water	CY	161,500	$6.1 M	**$38 per CY**
Under Bridge	CY	1000	$1.0 M	$1000 per CY
TSCA	CY	500	$0.5 M	$1000 per CY
Survey/Controls			$2.0 M	$12 per CY
Dredging Total			**$9.6 M**	**$59 per CY**
LANDFILLING WATER TREATMENT, SEDIMENT OFFLOAD, STABILIZATION, TRANSPORT & DISPOSAL	Tons Gallons	230,000 4.4 M	**$29.7M**	**$182 per CY**
SUBTOTAL MOB, DREDGING AND LANDFILLING			**$48.1 M**	**$295 per CY**

Landfilling Costs ~ 2-3x Dredging Costs
Water Treatment ~$7M increased costs – State CWA 401

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Other Costs

Activity	Units	Quantity	Cost	Unit Cost
BACKFILL	Tons	265,000		
Purchase & Deliver	Tons		$6.1 M	
Place w/ Derrick	CY		$7.0 M	
		Backfill Total	$13.1 M	**$80 per CY**
DERRICK- SUPPORT ACTIVITIES, OUTFALLS, ETC			$4.8 M	
CONSTRUCTION: MOB/DREDGE/ BACKFILL			$66.0 M	
CM/OVERSIGHT				
Sampling & Monitoring			$2.9 M	
Construction Oversight			$1.9 M	
Construction Management			$2.5 M	
		CM/Oversight Total	**$ 7.3M**	11% Const. Cost

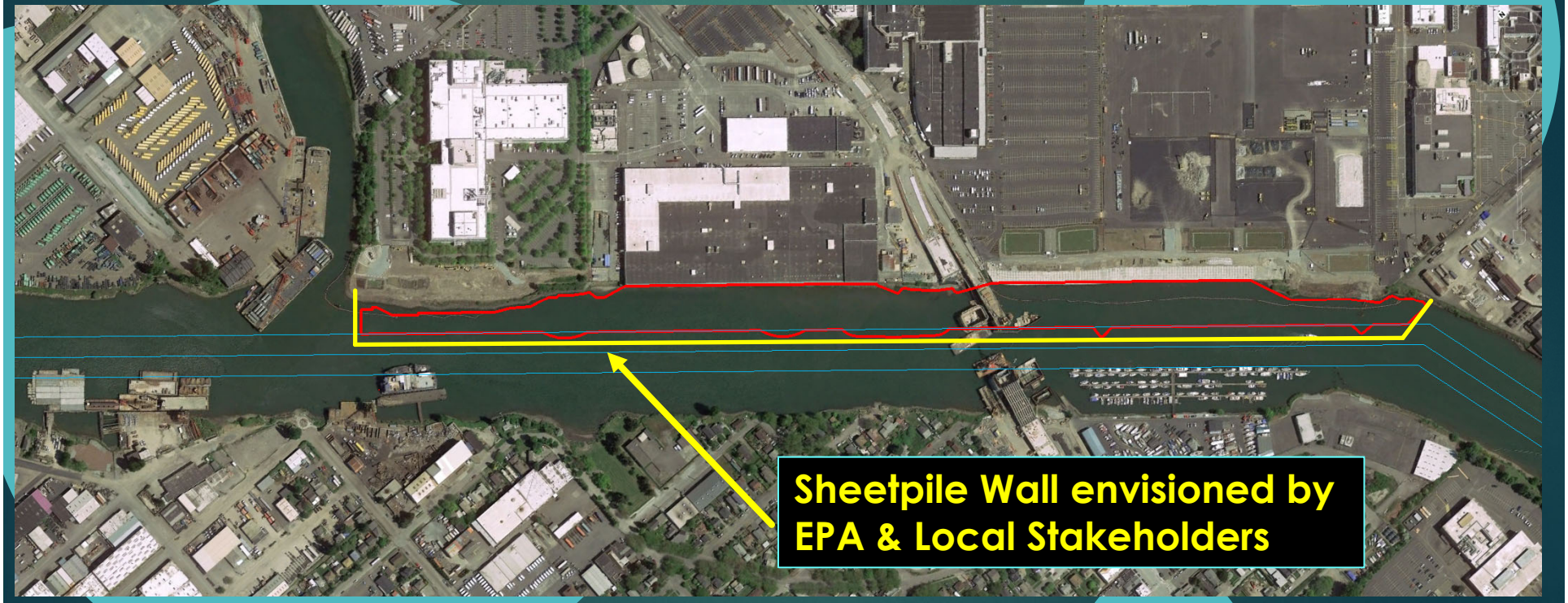
$73.3 M TOTAL Construction and CM/Oversight

EPA: Sheetpile Around It…..

- Scour, Flooding, Navigation Impacts
- Extend duration

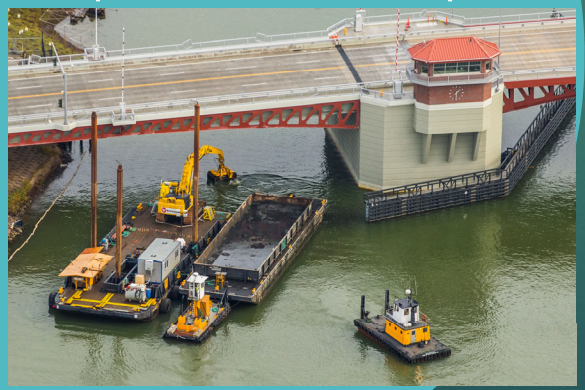
Alternate Approach

- **Remediation Dredging Methods (RDMs)**



Mechanical Dredging RDM's

- Accurate delineation of elevation of contamination (EOC)
- Precision dredge plan
- Dredge with excavator
- RTK-GPS based bucket positioning
- Stair-step cuts on slopes



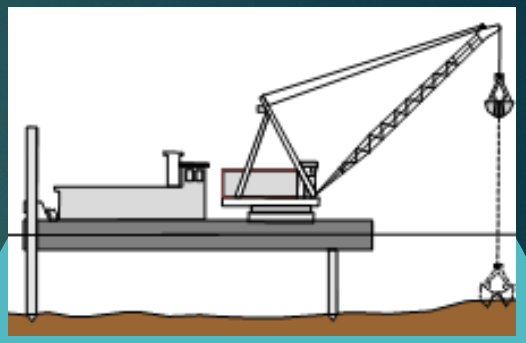
- Enclosed Environmental bucket
- No overfilled buckets
- Remove water from sediment barges and process – No Barge Overflow
- Place initial backfill
- Understanding by project staff
- Performance consistent with project objectives

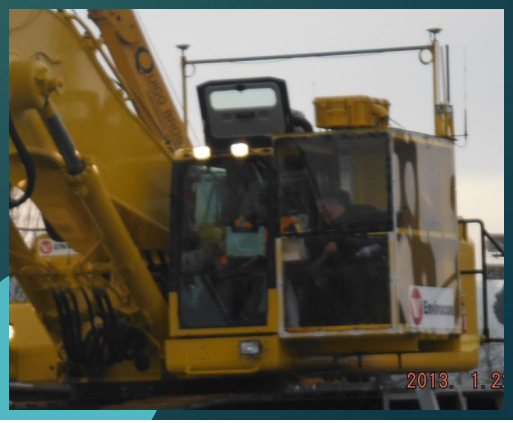
Benefits of Excavator RDMs

<u>Benefit of Improved Accuracy of Excavator</u>

- Dredging Area: 16.3 Acres
- Overdepth reduced by 1/3 to 1/2 ft.
- Volume reduction: 9,000 to 13,000 CY

- Eliminate sheet pile walls and silt curtains
- Greatly reduced residuals / release / resuspension
- Dredge/Landfill Savings: **$2M to $3M**





Actual Dredge Water System

RCRA Project

- State Issued Water Quality Certificate
- No chemical flocculants – Electro coagulation used
- Short term Water Quality Variances not allowed
- Regulated as NPDES Outfall
  - Marine Chronic Criteria at point of discharge

~$7M Cost Increase

Backfilling to Original Grade

- Restore subtidal elevations for habitat concerns
- 265,000 Tons Backfill Material
- Washed Backfill Material
- **5 NTU Over Background Limit**
- **$ 13 M**

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In-Water Work Seasons & Active Tribal Fishery

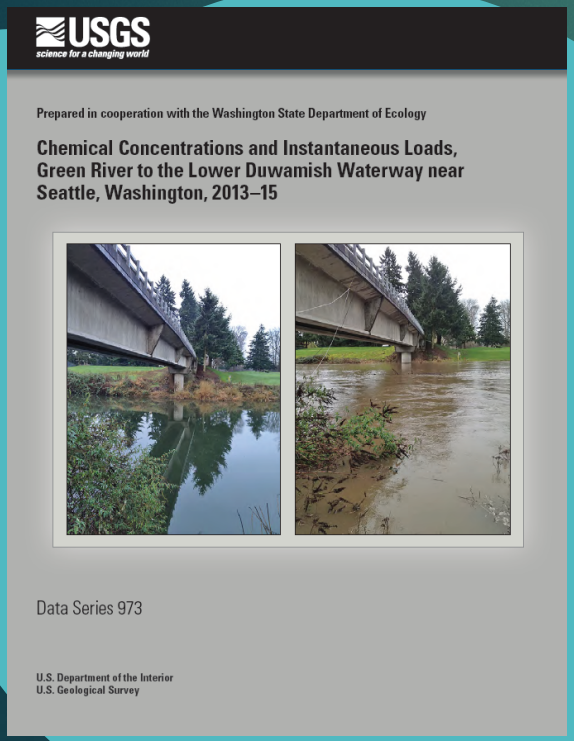
- Endangered Species Protection
- In water window typically September 1 – February 15 (5.5 months)
- Tribal Fishing Rights
  - Cannot impact fishers or nets
  - Reduces In-Water Season
- Actual Dredging Days
  - CS1 45 days
  - CS2 36 days
  - CS3 94 days

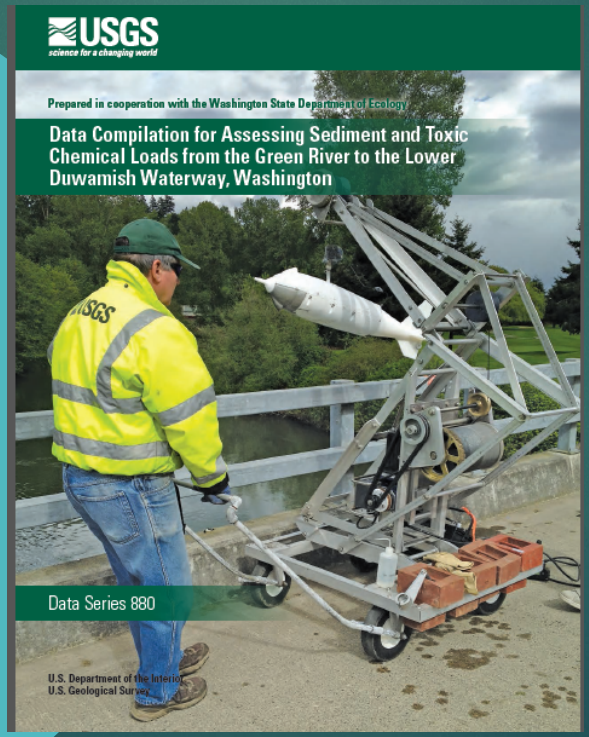
Sediment Remediation is **SEASONAL ACTIVITY**
Increases Project Durations and Costs
Dredging Over Multiple Seasons Increases Costs

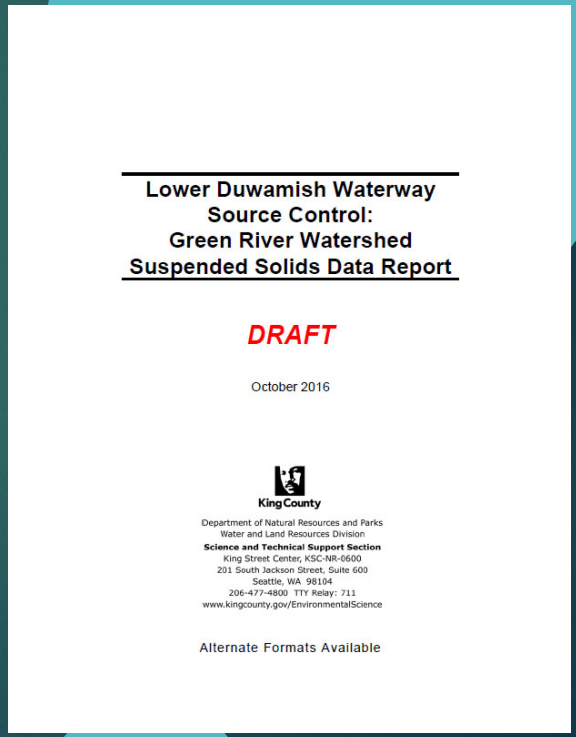
Added MOB/DEMOB/Standby (between seasons) & Tribal Payments $7M

Source Control

- Numerous studies to date
- Ongoing studies, actions
  - Outliers

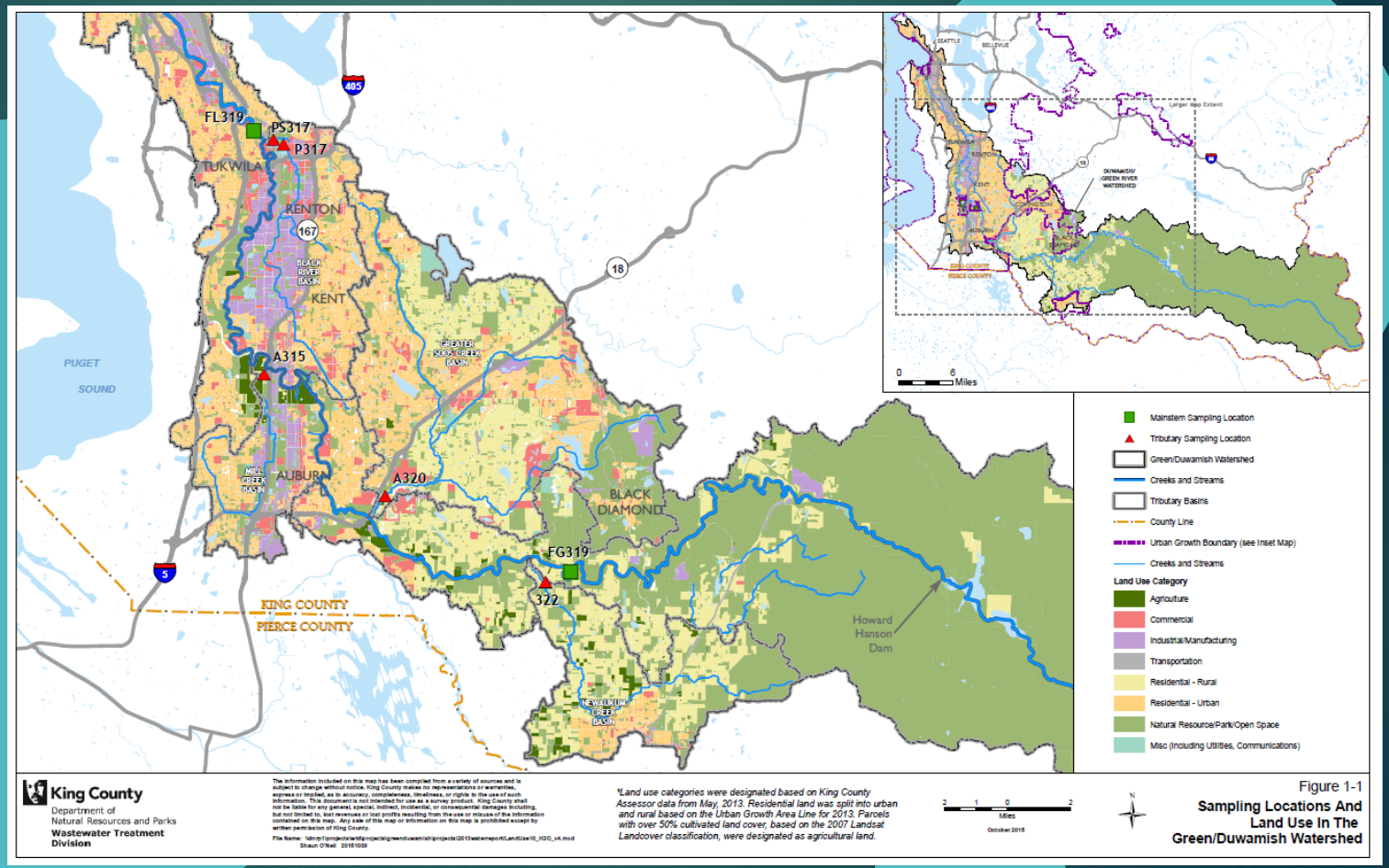






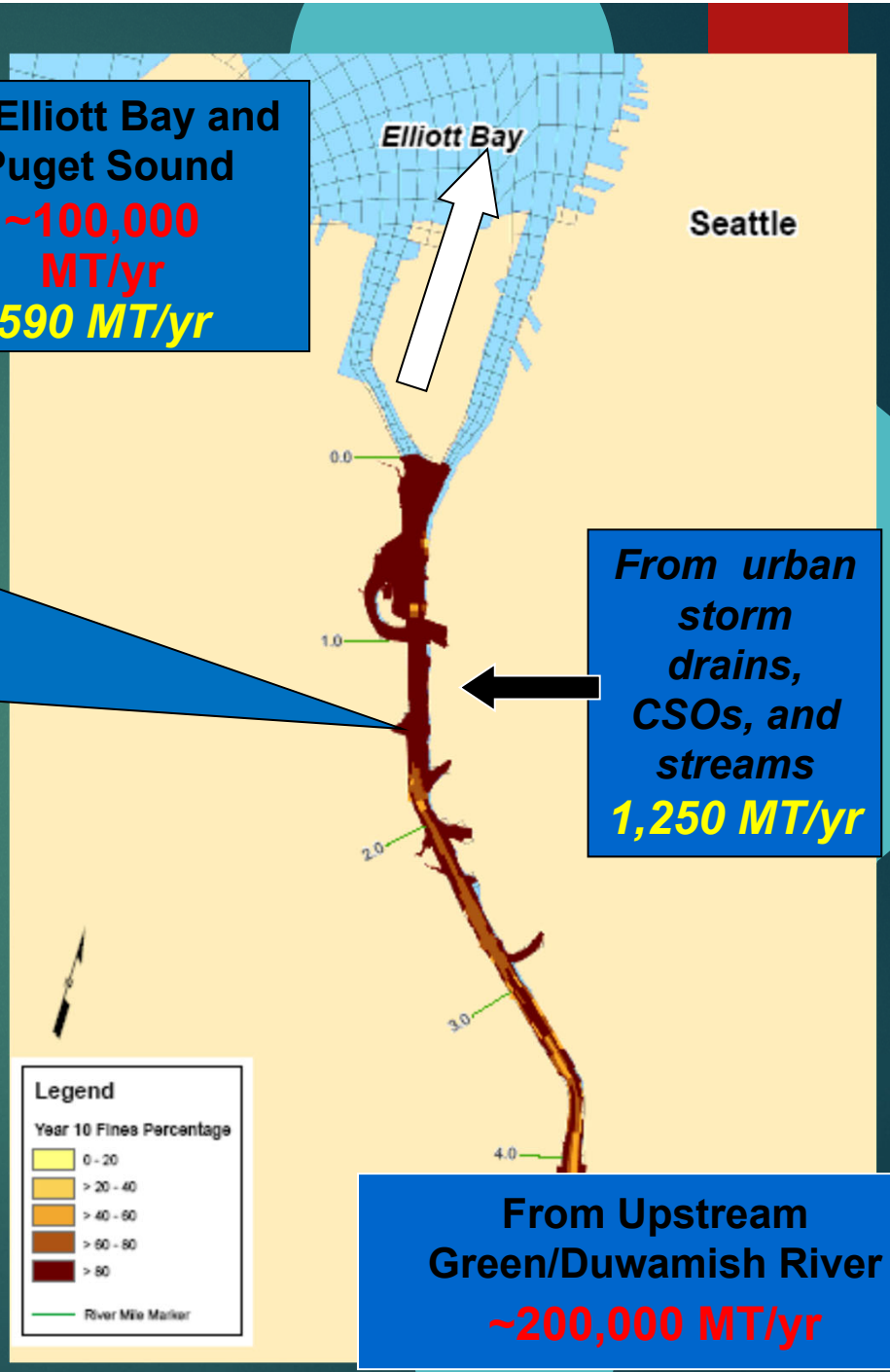
Source Control

- At Bottom of Large Mixed Use Watershed
- Source inputs to sediment concentrations



LDW Sediment Transport and Deposition

To Elliott Bay and Puget Sound
~100,000 MT/yr
590 MT/yr



From urban storm drains, CSOs, and streams
1,250 MT/yr

~100,000 MT/yr
660 MT/yr

Net <u>deposition</u> in the LDW
is about 100,000 metric tons of sediment from <u>upstream</u> per year

From Upstream Green/Duwamish River
~200,000 MT/yr

Red = from upstream
Yellow = from lateral
CSOs = combined sewer overflows
Units in metric tons/yr, averaged over 10-yr period

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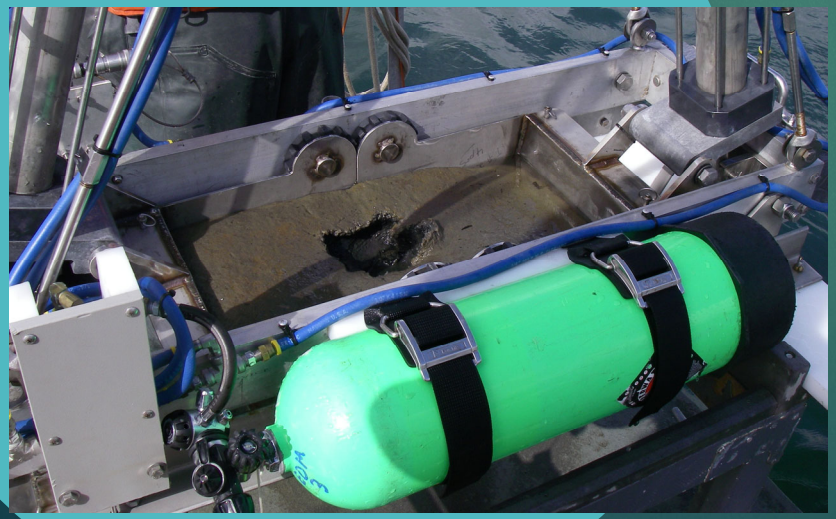
Post-Construction Monitoring

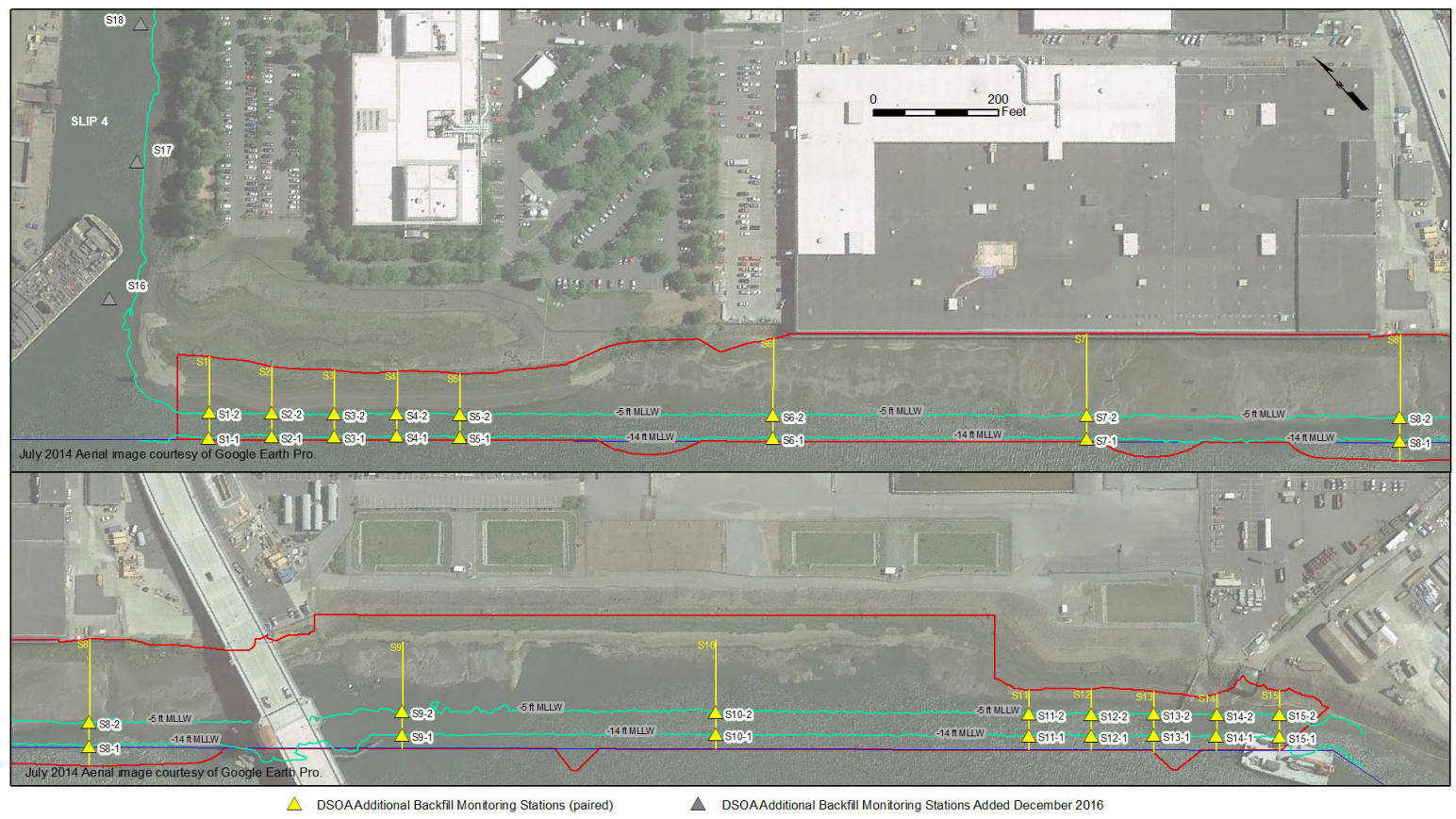
- Surface sediment sampling since construction
- Sand backfill readily distinguishable from depositional material
- Two ongoing monitoring programs
  - DSOA Additional Backfill Monitoring
  - Post-Construction Surface Sediment Monitoring



DSOA Surface Sediment Monitoring

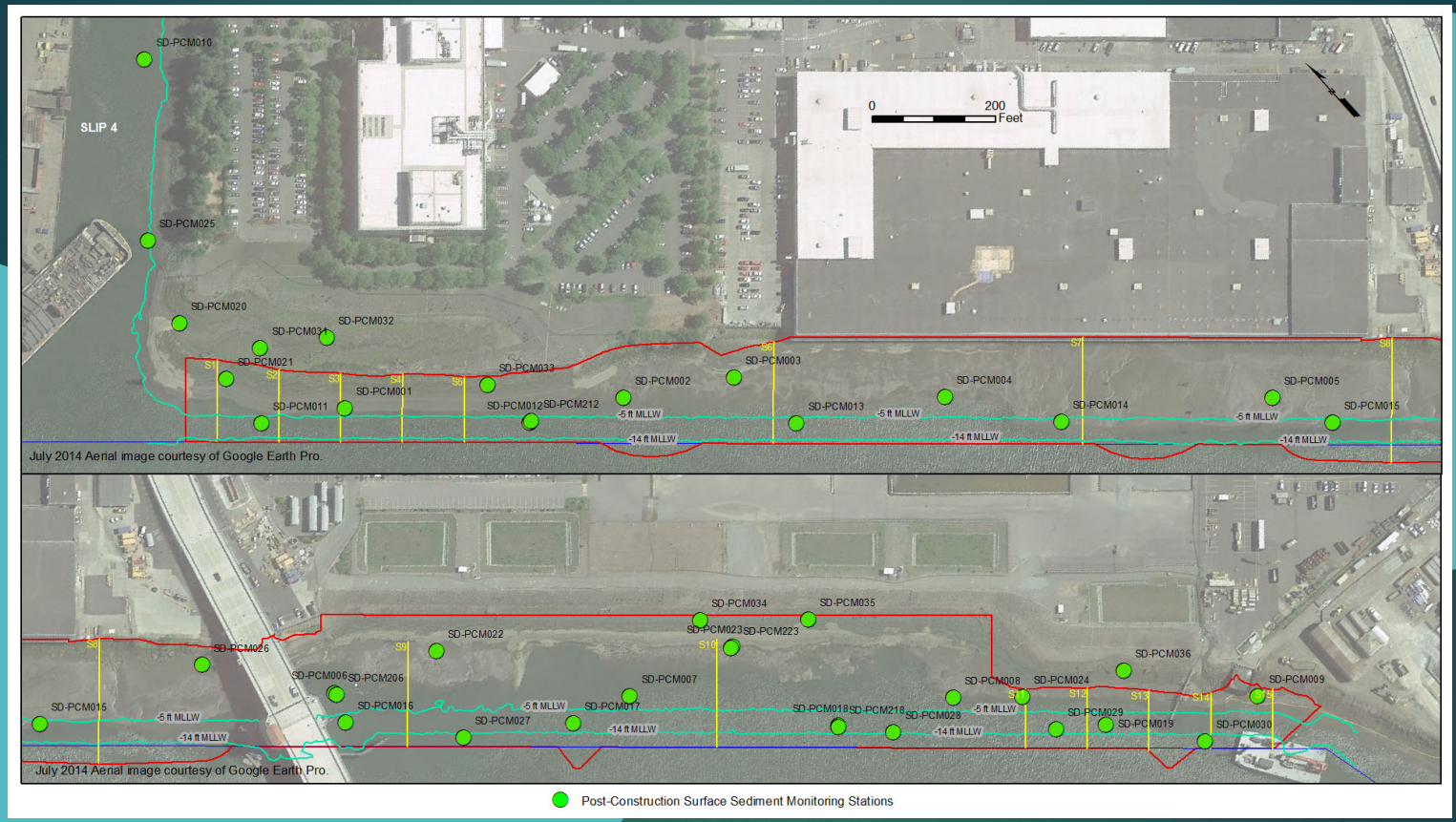
- **DSOA Additional Backfill Monitoring**
  - Construction was completed in March 2015 and sampling was conducted about monthly for the first year after remediation , then quarterly, currently semi-annually.
  - The additional monitoring is being conducted as per the EPA approved Additional Duwamish Sediment Other Area Backfill Sampling Work Plan (Amec Foster Wheeler and DOF 2015).
- **Post-Construction Surface Sediment Monitoring**
  - Conducted yearly at Year 0 (2015), Year 1 (2016), Year 3 (2018) and scheduled for Years 5, 7, and 10
  - The post construction monitoring is being conducted under the EPA approved Post-Construction Surface Sediment Monitoring Work Plan (AMEC et al. 2014)

DSOA Additional Backfill Monitoring Study Design



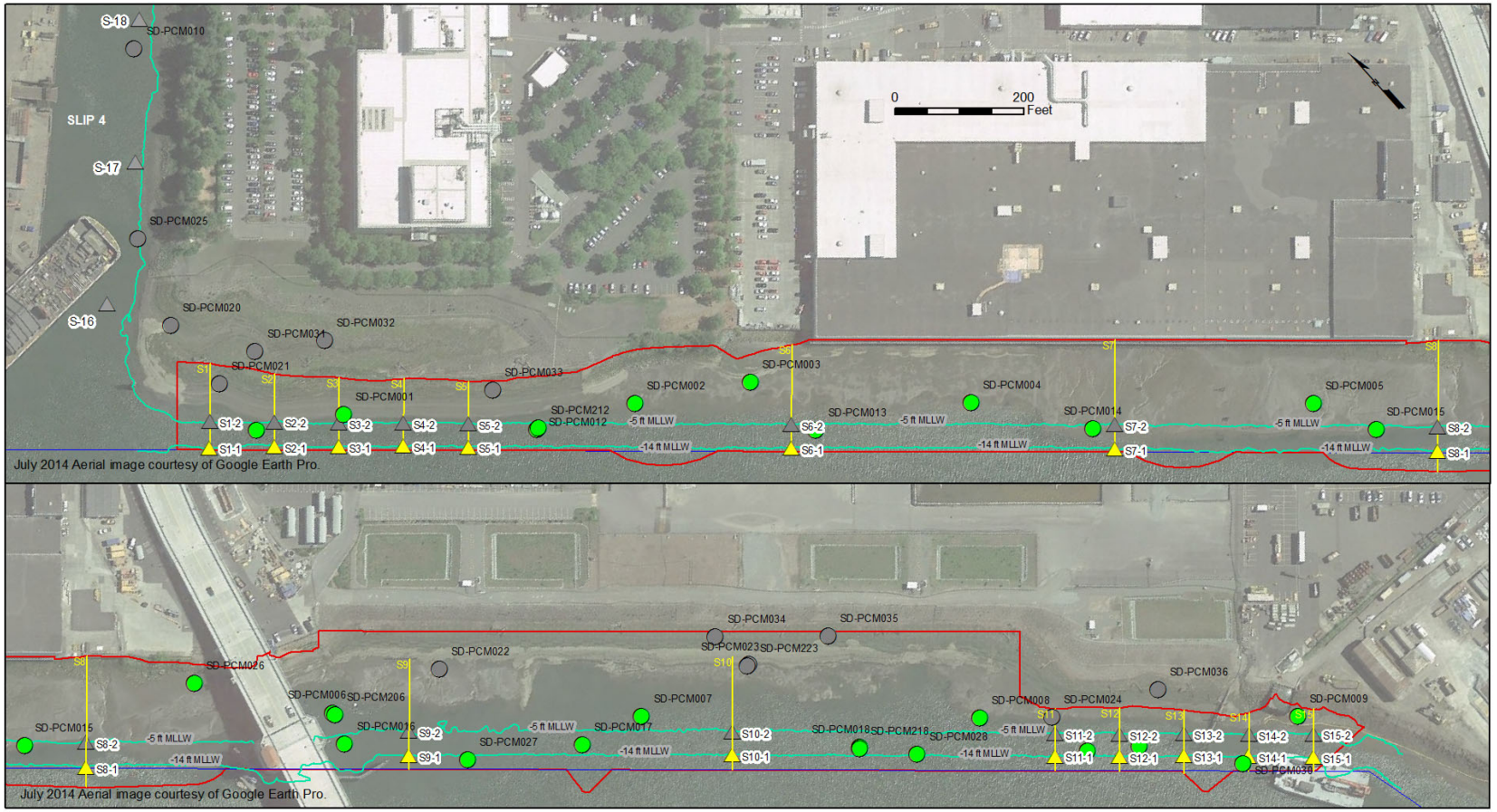
Paired inshore and offshore sample locations along -5 ft MLLW contour and -14 ft MLLW contour, respectively. Spacing between five pairs of stations at upstream and downstream ends was 100 ft. Spacing of the stations in the middle of the DSOA was 500 ft. Slip 4 stations added 12/16.

Post-Construction Surface Sediment Monitoring Stations

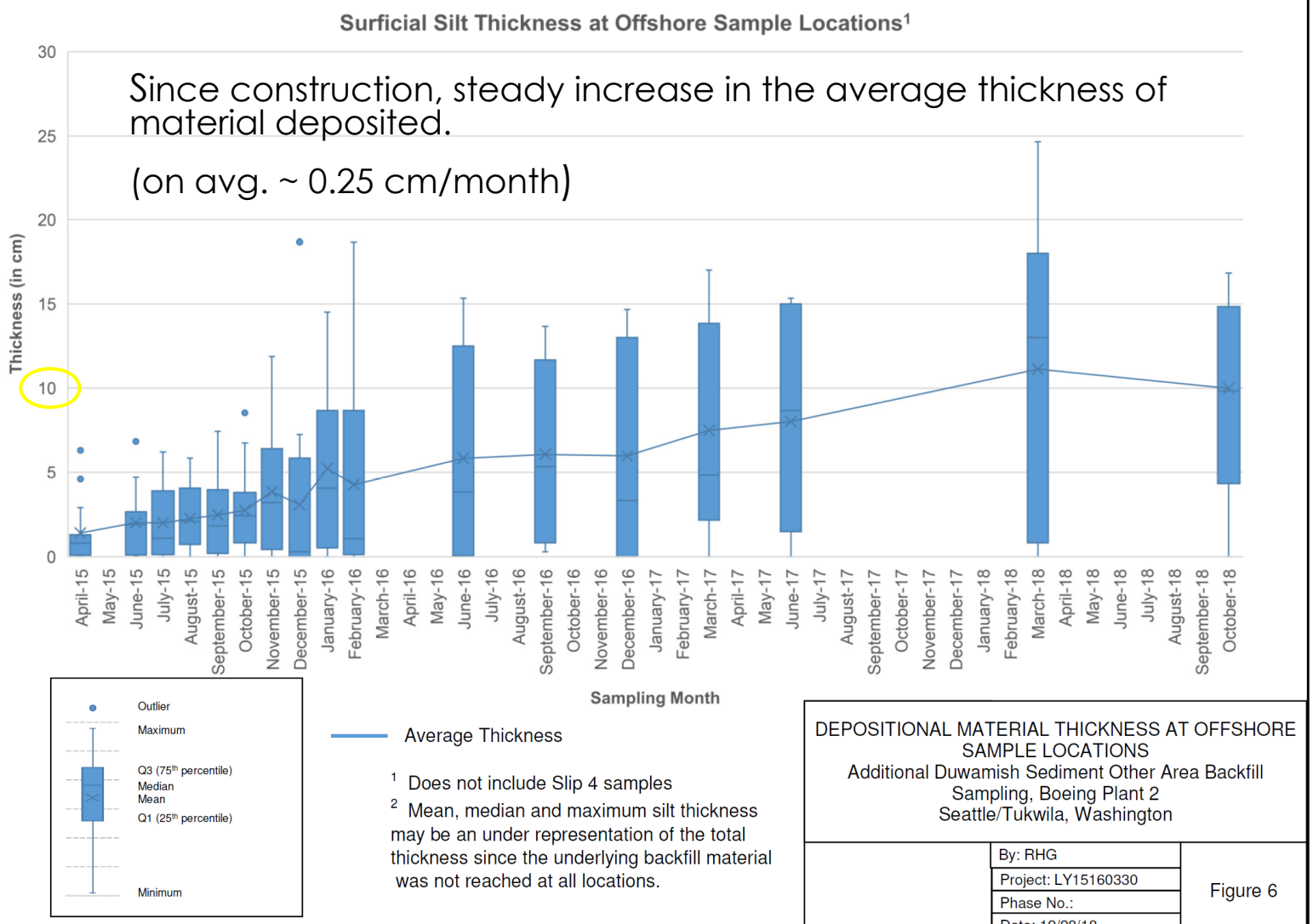


There are 36 long-term monitoring stations (+ 4 duplicates) located within the DSOA, within the North and South Site habitat areas, in Slip 4, and at outfalls.

Offshore DSOA Additional Backfill Stations and Subset of LTM Stations Used in Silt Thickness and PCB Presentations



Accumulation of Silt on the DSOA Backfill



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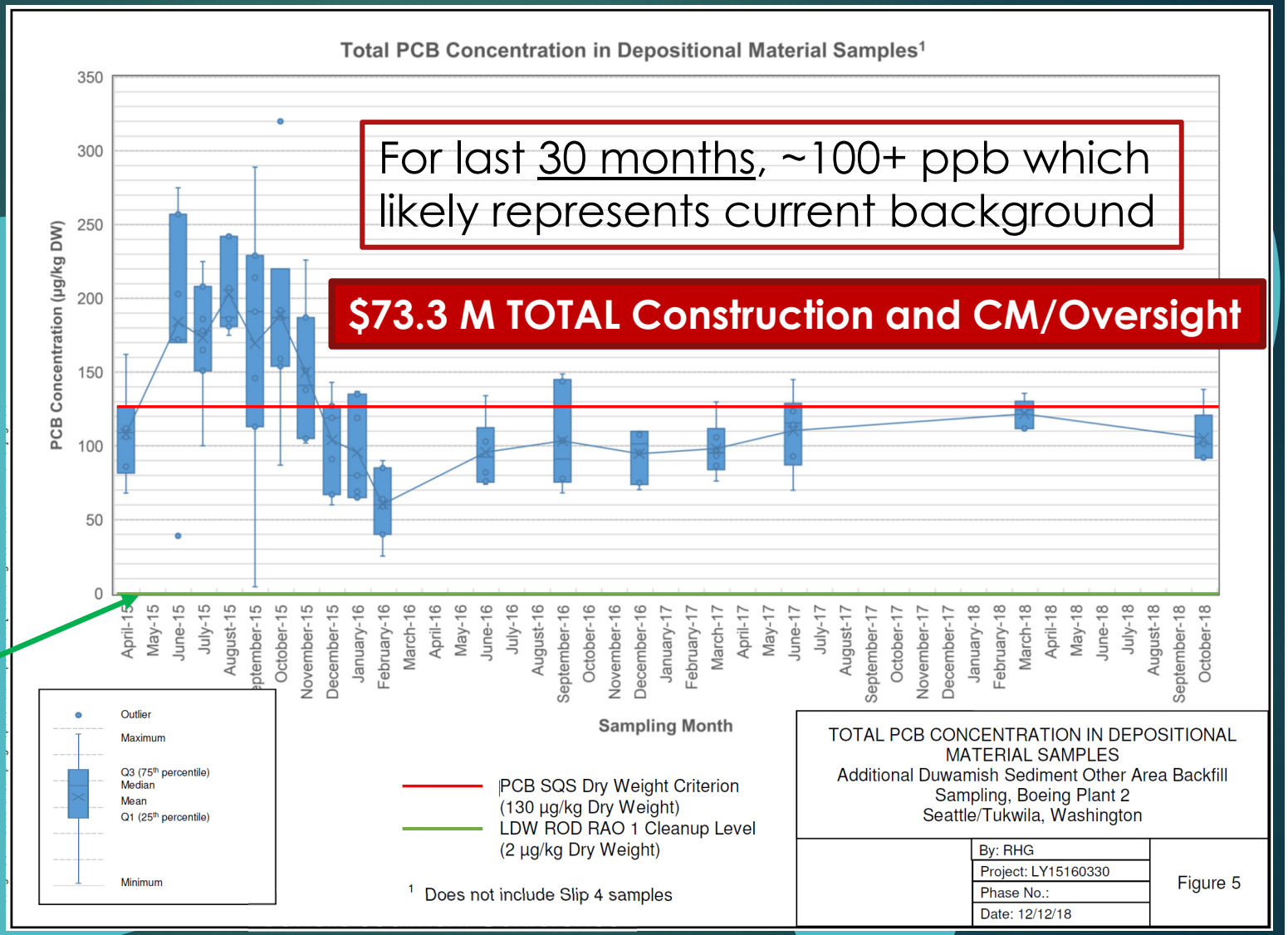
Average PCB Concentration in Depositional Layer



LDW ROD RAO 1 Cleanup Level (2 µg/kg) [2 PPB]

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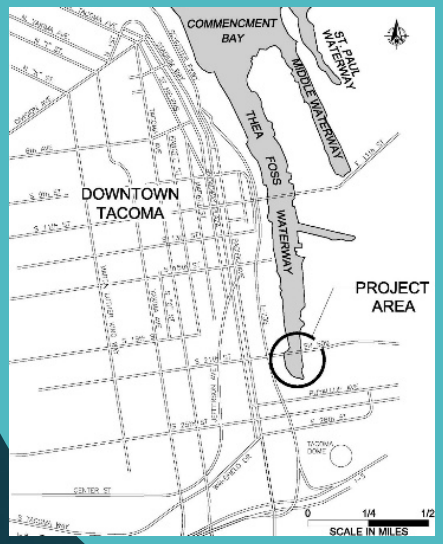
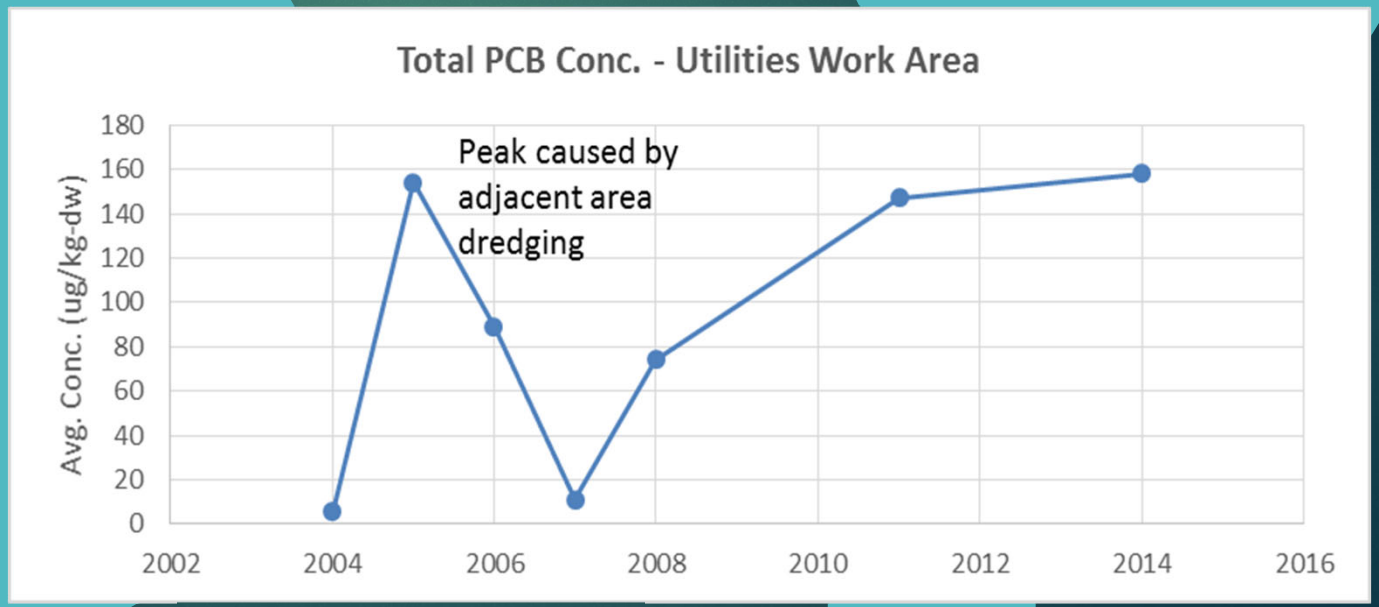
Average PCB Concentration in Depositional Layer

- Based on the data collected within the DSOA, post-remedial construction PCB concentrations in depositional material are about 100 ppb.
- The 100 ppb is about **50 times the RAO 1 cleanup level** of 2 ppb (protective of human health for consumption of seafood from the Lower Duwamish Waterway).
- The data indicates that the **cleanup levels in the ROD are not realistic** and do not account for actual PCB conditions in the Duwamish watershed.

Other Puget Sound Sites (EPA Region 10) Experiencing Recontamination

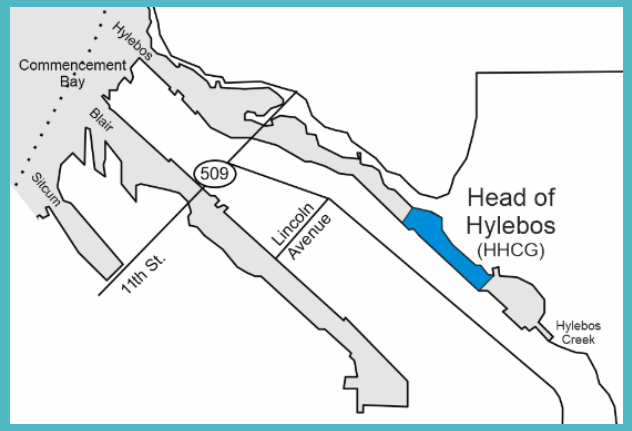
- Thea Foss Waterway
  - Sand cap placed in 2004
  - Monitoring shows underlying sediment has been isolated, but cap has been contaminated from top-down sources with average concentrations of 158 µg/kg-dw in 2014
  - Upstream and lateral sources are suspected as major cause of recontamination

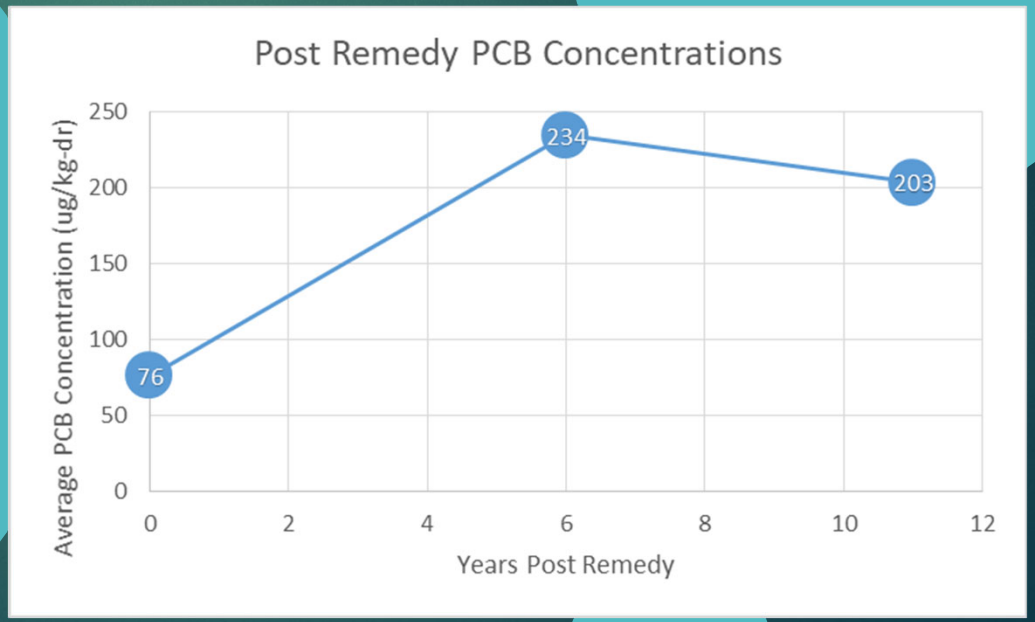




Other Puget Sound Sites (EPA Region 10) Experiencing Recontamination

- Head of Hylebos
  - 45 acres of dredging performed from 2003 to 2006
  - Has seen average PCB concentrations increase from 76 µg/kg-dw in 2006 to 234 µg/kg-dw in 2012, 203 µg/kg-dw in 2017





PCBs in Municipal Products

REVISED

Pg. 12 Revised
July 21, 2015

Ecology Municipal Stormwater Grants of Regional or Statewide Significance
Grant No. G1400545

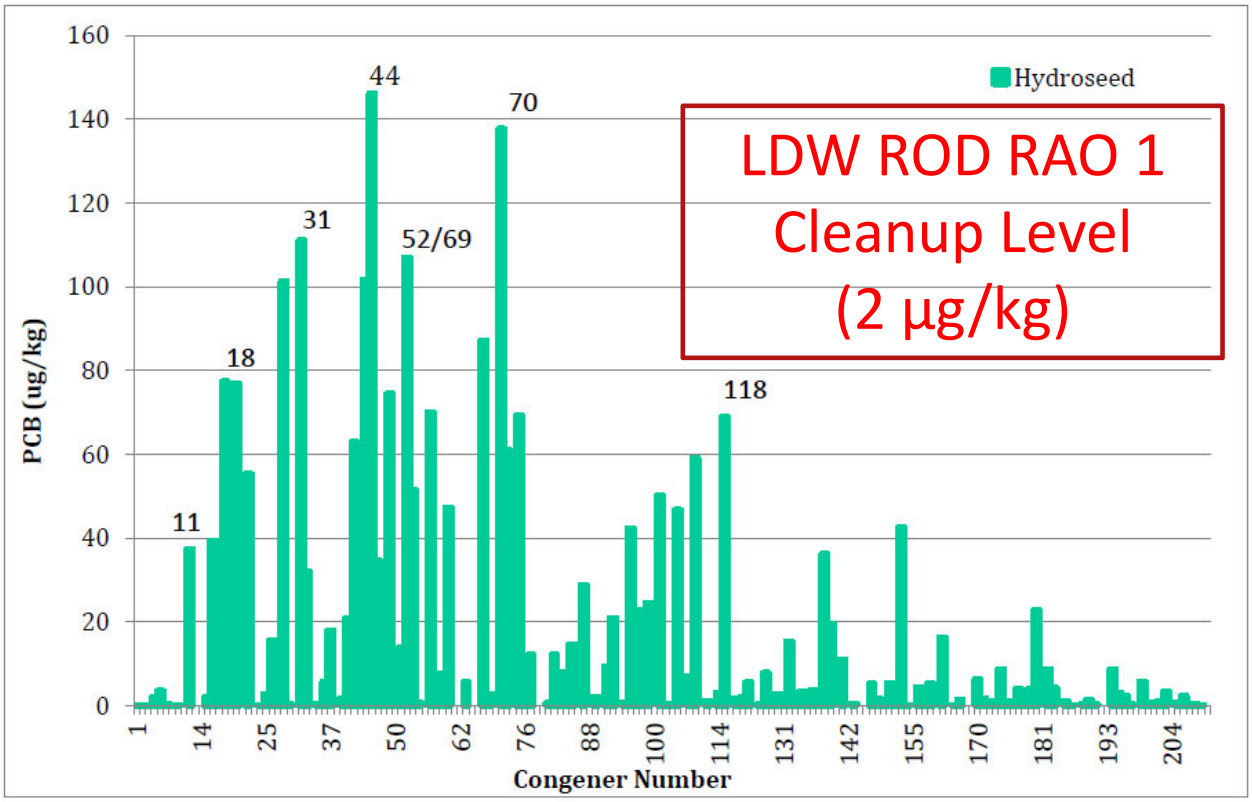
Prepared by:

City of Spokane
Wastewater Management Department

City of Spokane
Wastewater Management Department

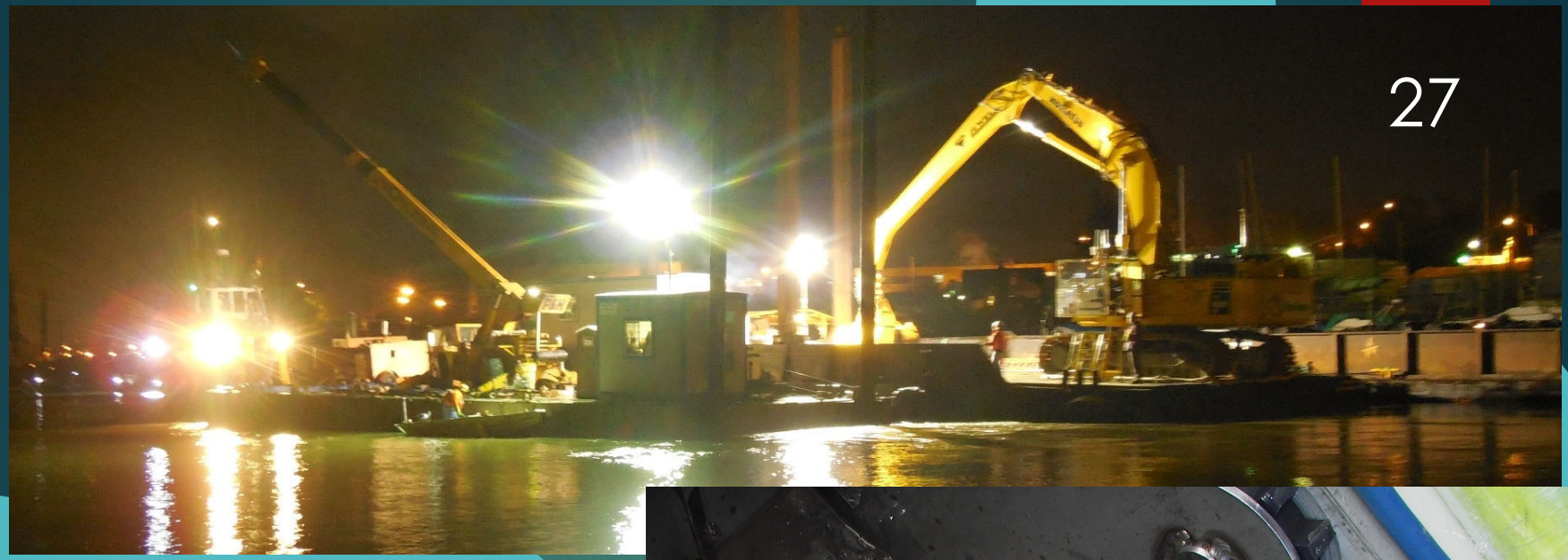
Hydroseed

A hydroseed mix was sampled due to the prevalent use of hydroseed in roadside projects and its typical green coloring. The sample was collected from a new 50 pound bag of Nature's Own Hydromulch, which was not yet mixed with seed, fertilizer, or other additive. The Nature's Own Hydromulch MSDS indicates that it is composed of primarily wood fiber material with green liquid and a surfactant. The sample contained shredded colored newspaper cellulose. Total PCBs detected in the sample was **2,509 ug/kg.** The following figures show the congeners detected and homologue patterns for the sample.



So, What Next? And Why?

- PCB cleanup levels are <10 ppb
- PCB concentrations in new sediment deposited at multiple Puget Sound sites typically 100-200 ppb
- EPA's RI/FS/RD process does not match empirical data
- What is needed
  - Cleanup levels that account for actual urban PCB conditions – empirical data
  - Achievable remedial actions that stand the test of time.
- Recontamination – The 5th "R"
  - Should it be the first?
- Maybe ROI?



Questions?

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