Boeing Plant 2 Sediment Remediation:

Remedial Dredging Methods to Manage the Risks of Residuals, Resuspension and Release: The Benefits and Costs

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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
- WODCON 2016 Environmental Excellence Award

Compliance - Cost Drivers

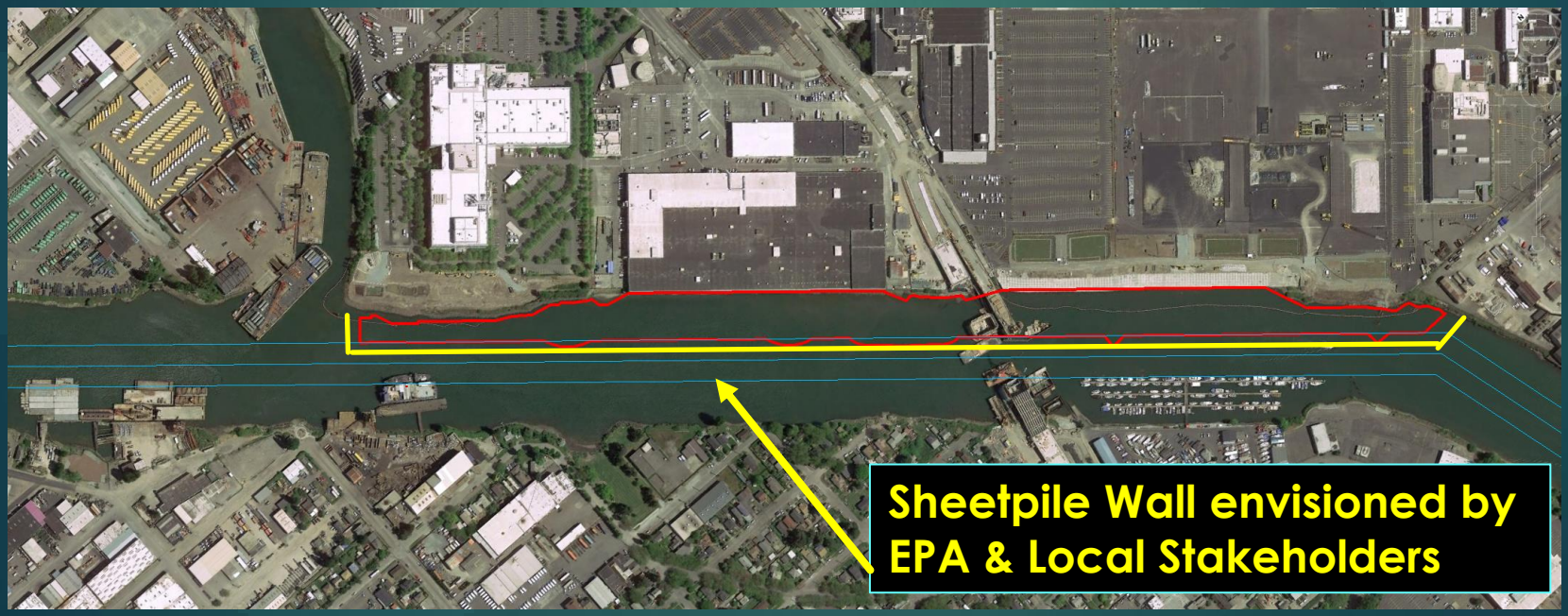
- Risk
  - Protect downstream from resuspension/release
  - Residuals
- RCRA Site
  - Permits required
  - State Implemented CWA 401
- Multiple Seasons
  - In Water Work Windows
  - Other Projects in Area
- Tribal Fishing
- Backfill to Pre-Project Grade

EPA: Just Build a **WALL** Around It..4.

- Scour, Flooding, Navigation Impacts
- Extend duration

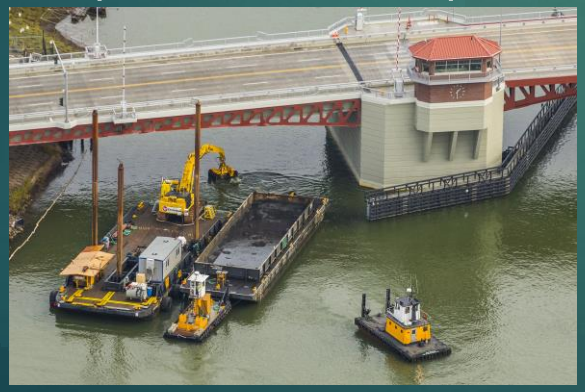
Alternate Approach

- **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

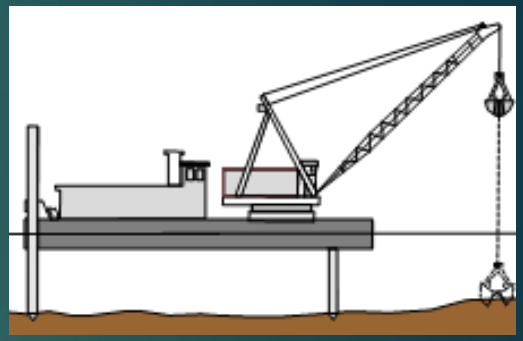


- Enclosed Environmental bucket
- No overfilled buckets
- Remove water from sediment barges and process – No Barge Overflow
- Place initial backfill
- Understanding by project staff
- Performance consistent with project objectives

Benefits of Excavator RDMs

Benefit of Improved Accuracy of Excavator

- DSOA Dredging Area: 16.3 Acres
- Overdepth reduced by 1/3 to 1/2 ft.
- Volume reduction: 9,000 to 13,000 CY
- Dredge/Landfill Savings: **$2M to $3M**



- Eliminate sheet pile walls and silt curtains
- Greatly reduced residuals / release / resuspension

Active Oversight and Monitoring

Dredge Engineer in Cab with Dredge Operator

Dredge Engineer

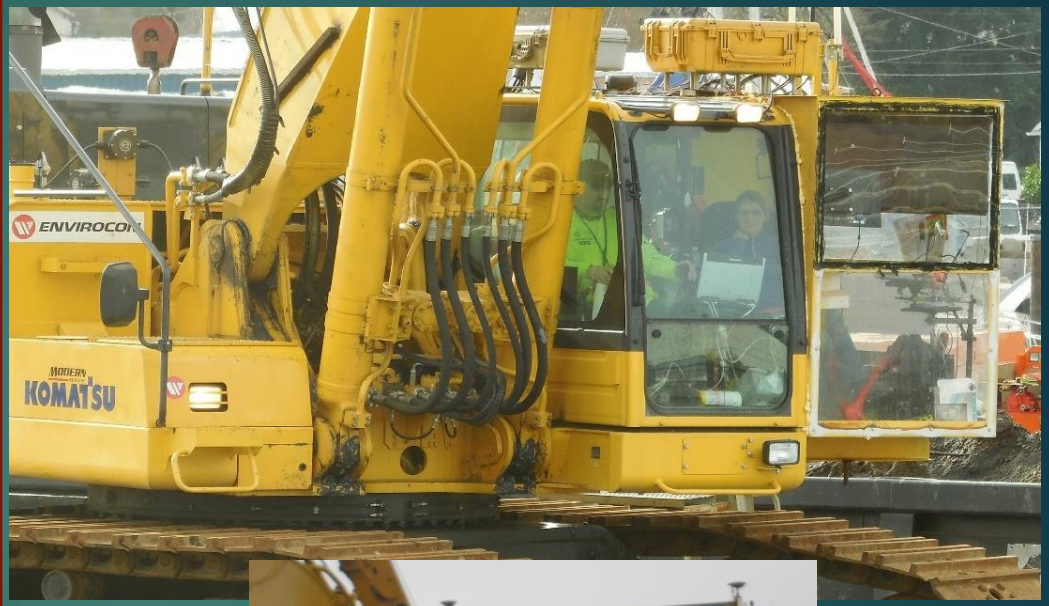
- Sequencing of Removal
- Consistent Application of RDMs
- Unanticipated Conditions
- Adaptive Management

Dredge Operator

- Precision Bucket Placement
- Productivity

Engineer-Operator Team

- Improved Environmental Outcomes
- Higher Production & Efficiency
- Reduced Overall Costs



Improved Accuracy of Excavator also Paid for Construction Oversight

Water Management - Remove Water from Barge, No Overflow

Remove dredge water from dredged material barges during dredging for processing and management as dredge return water.

Previous experience – Sediment volume = 10 cm (4") over dredge area

Original Plan - Add Flocculent, Pump to Geotubes

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
- **$ 13 M**

Water Quality Criteria
5 NTU Above Background

- No exceedances during dredging
- Some exceedances during backfilling
- Washed backfill material
- **Slow placement rate to meet WQ criteria**

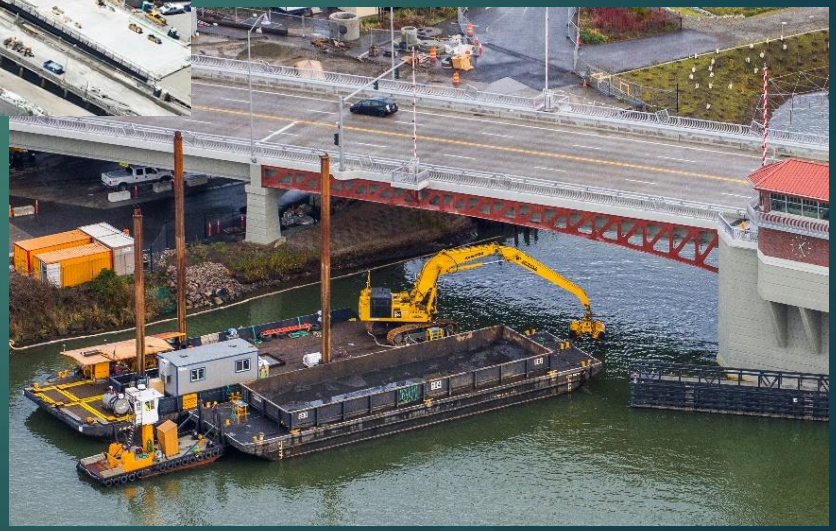
In-Water Work Seasons & Active Tribal Fishery

- Endangered Species Protection
- In water window typically September 1 – February 15 (5.5 months)
- Tribal Fishing Rights
  - Cannot impact fishers or nets
  - Can Reduce 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

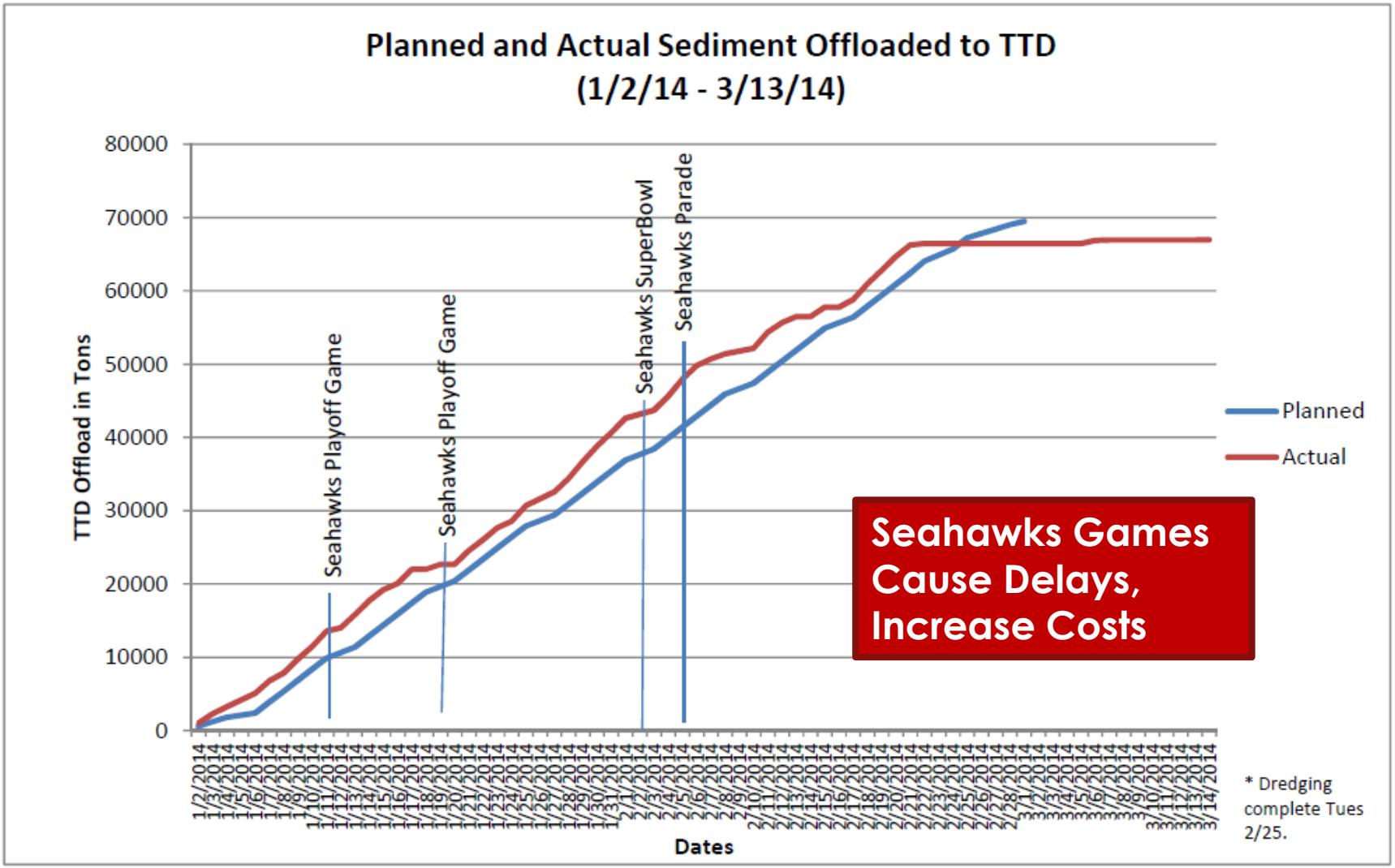
Added MOB/DEMOB/Standby (between seasons) & Tribal Payments $7M

Other Construction – Bridge



Other Construction

Other Factors



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

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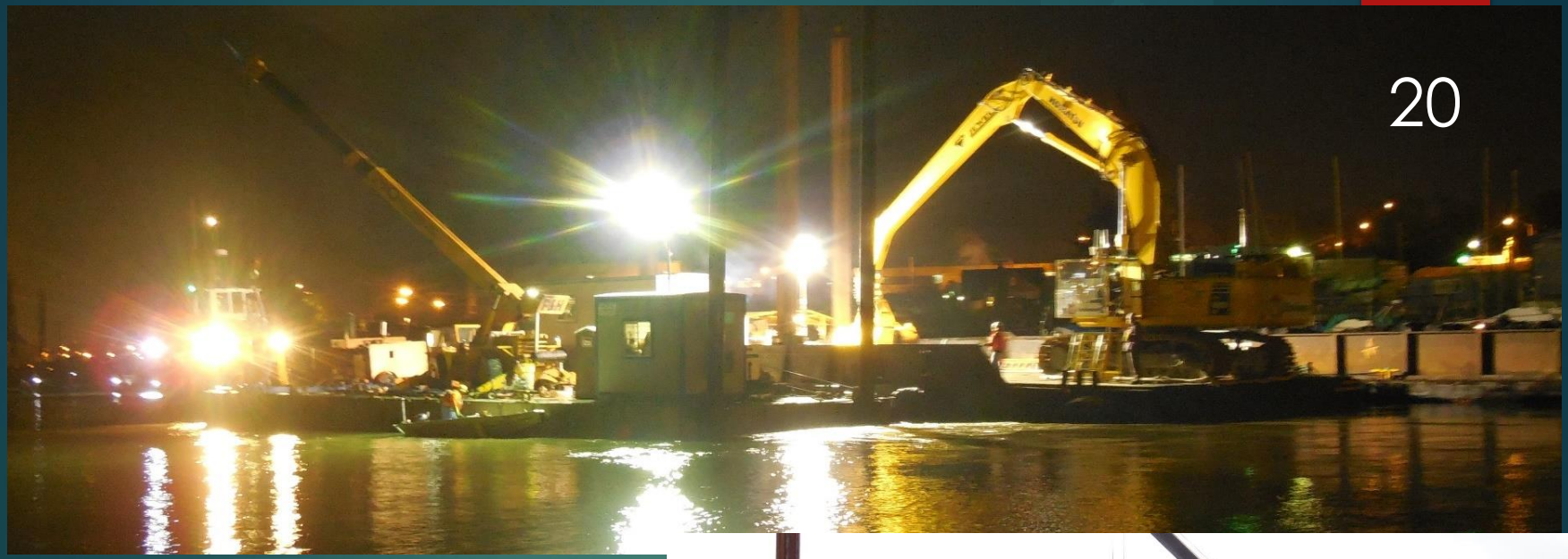
Summary

- Many Compliance Related Factors Drive Costs
- Factors Increasing Costs Often Not Readily Apparent
  - Seasonal Restrictions
  - Working Hours per Day
  - Backfill
  - Water Quality
  - Transload Capacity
- Improving Return on Investment



Questions?

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