WATERTECTONICS

Utilizing Electrocoagulation (EC) & Chitosan Enhanced Sand Filtration (CESF) For Dredge Return Water Treatment on Superfund Sites in Western Washington

WEDA PACIFIC CHAPTER MEETING OCTOBER 21, 2016

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Outline

- Active Water Treatment (What)
- Treatment System Design Considerations (Why)
- Case Studies
  - Lower Duwamish Superfund Early Action Areas
  - Port of Ridgefield
  - Port of Tacoma

Active Treatment Approval


Cuyahoga River 1969 – AP Image

Ecology Develops CTAPE Protocol for formal evaluation of treatment technologies

Construction Stormwater Treatment Begins

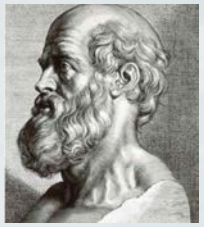
Industrial Process Water Treatment

Dredge Return Water Active Treatment
12/15/2013

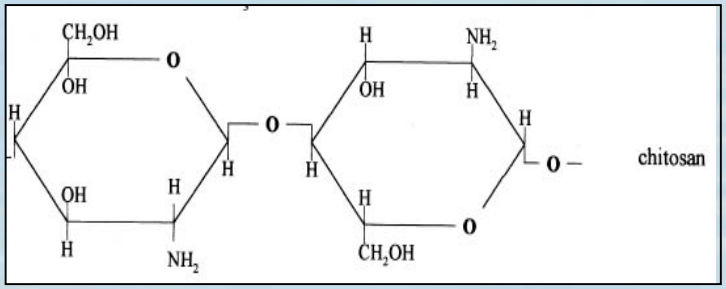
1500BC | 1700s | 1970 | 1995 | 2000 | 2005 | 2010 | 2015

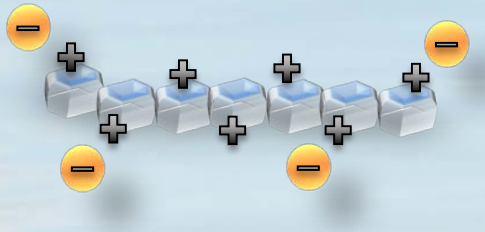
1/1/2003 **CESF Approval** 6/15/2008

9/1/2003 **EC Approval** 2/2/2010



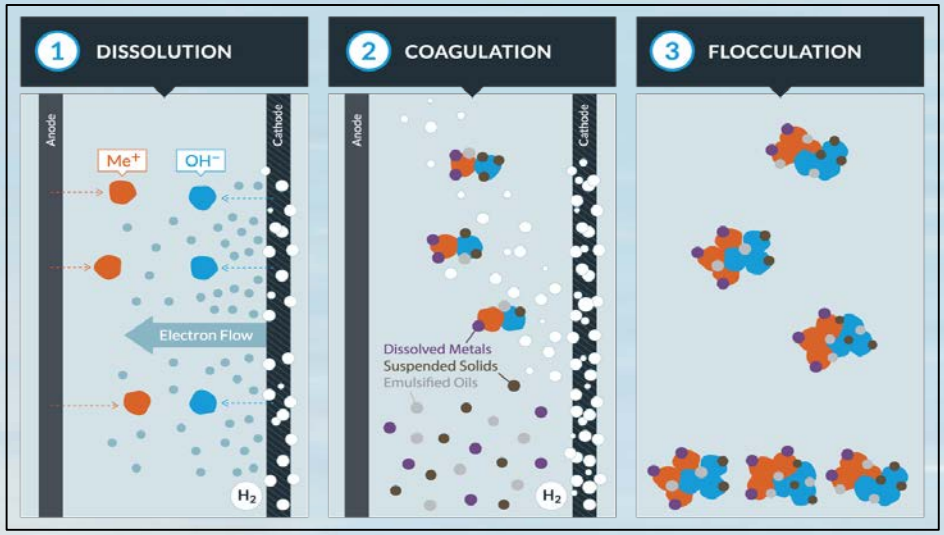
Active Treatment - CESF





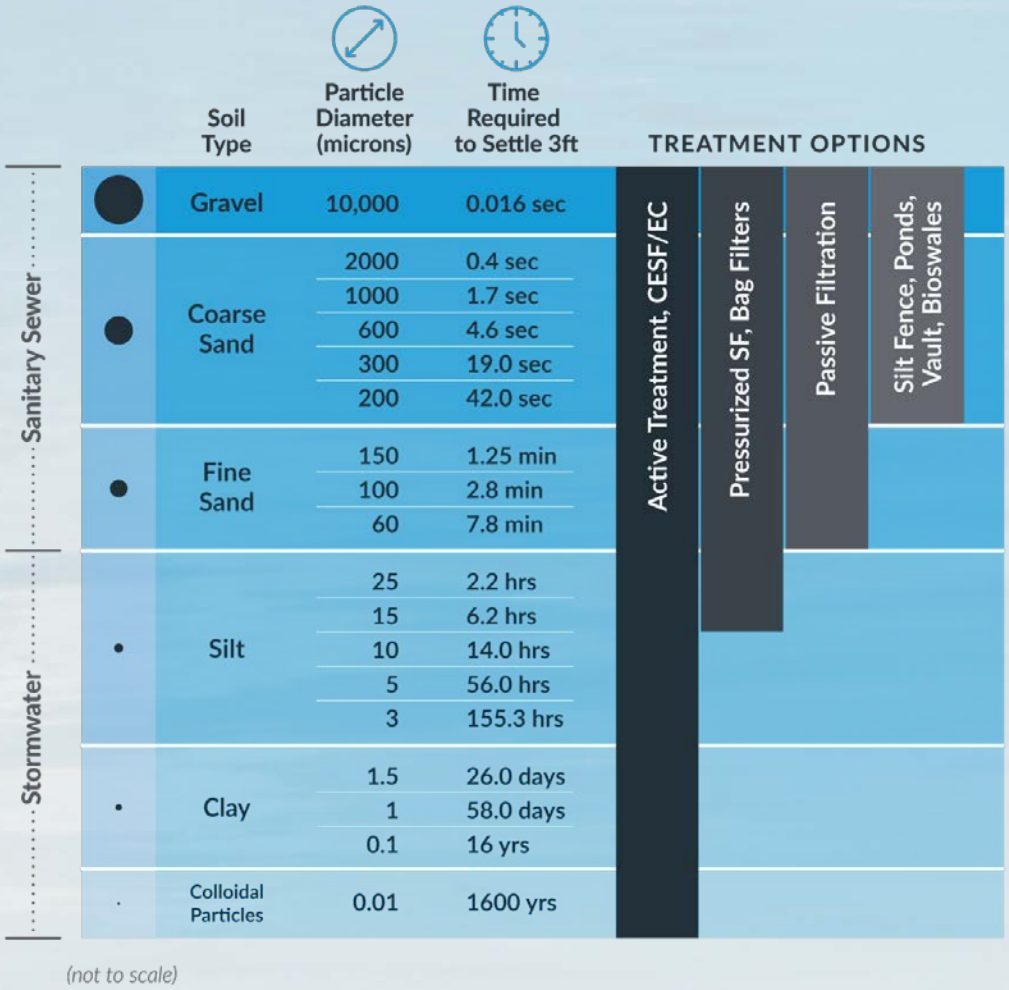
- Liquid Biopolymer (coagulant/flocculent) made from crab or shrimp shells.
- Used to remove Turbidity/TSS, Total Metals
- Implemented with Sand Filtration
- GULD approved by Ecology for fresh waters in 2007 and marine waters in 2013.

Active Treatment - EC



- Sacrificial ion (coagulant) driven from a metal plate, cleaving of water to make OH+ (dissolved metals) and electron flow between plates (de-emulsification, bacterial membrane lysing).
- Used to remove colloidal particles (Turbidity/TSS), total and dissolved metals, emulsified oils and bacteria
- Implemented with Sand Filtration
- WaveIonics carries GULD approval from WA Dept. of Ecology

Why Active Treatment



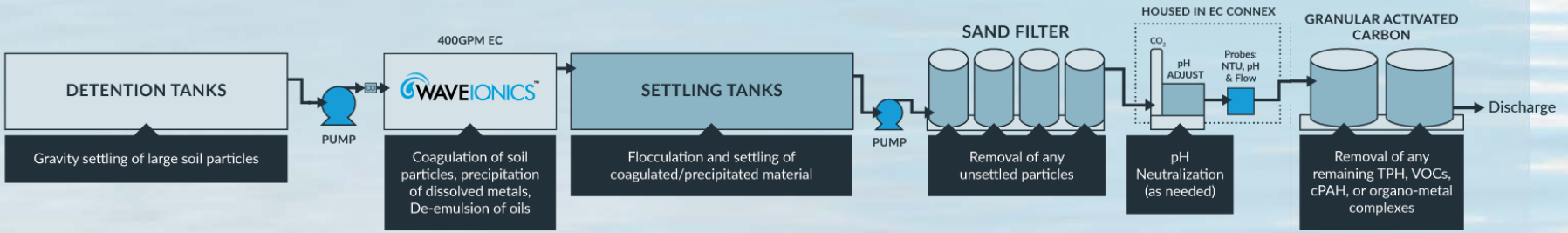
Building a Treatment Train

TREATMENT METHODS BY CONTAMINANT OF CONCERN – DREDGE RETURN WATER

Method	Suspended Solids (Low Turbidity)	Suspended Solids (High Turbidity)	Total Metals (attached to soil particle)	Dissolved Metals (free ions)	Organics (TPH, PCBs, PAH, TBT)	Pretreatment for Granular Activated Carbon (GAC)
Scuppers w/Filter Fabric	Possibly[1]	✗	✗	✗	✗	✗
Geotube®	✓	Possibly[1]	Possibly[2]	✗	✗	Possibly[2]
Geotube® w/Polymer Pretreat	✓	✓	✓	✓	Possibly[2]	Possibly[2]
Sand Filter	Possibly[1]	Possibly[1]	Possibly[2]	✗	Possibly[2]	Possibly[2]
Chitosan Enhanced Sand Filtration (CESF)	✓	✓	✓	✗	Possibly[2]	✓
Specialized Polymer & Sand Filtration	✓	✓	✓	✓	Possibly[2]	✓
EC	✓	✓	✓	✓	Likely[2,3]	✓
GAC[4]	N/A	N/A	N/A	✗	✓	N/A
Ion Exchange Resin[4]	N/A	N/A	N/A	✓[5]	✗	N/A

[1] If contaminant particle size is large enough to be captured
[2] If contaminants are attached to soil particles removal can be achieved
[3] If organics are attached to soil particles removal can be achieved. EC does destroy/precipitate some hydrophilic organic compounds, the full range of compounds is still under research
[4] Pretreatment required to remove turbidity and prevent blinding
[5] Not recommended for salt water application as salts will compete with metal ions and reduce performance

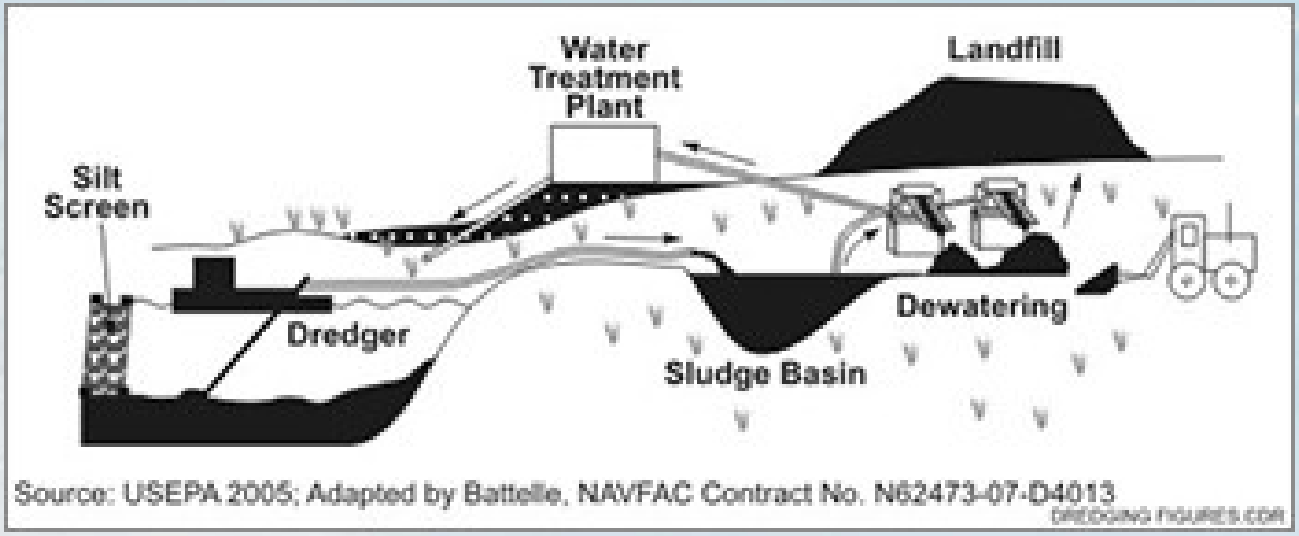
Building a Treatment Train



THE GOAL

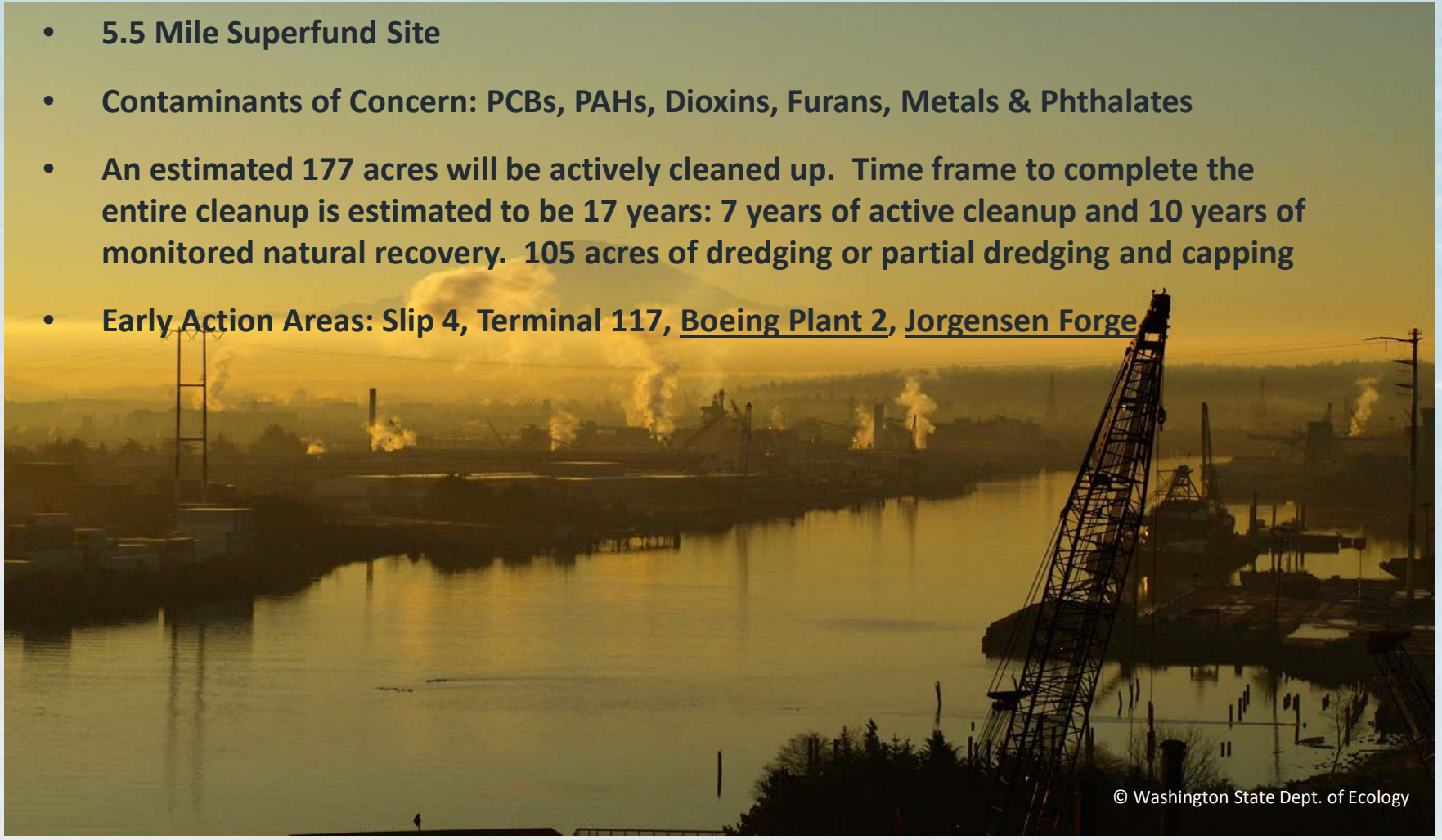
Traditional Management

- May require treatment for organics (PCBs/PAHs)
- Per gallon discharge fee



Lower Duwamish Water Way

- **5.5 Mile Superfund Site**
- **Contaminants of Concern: PCBs, PAHs, Dioxins, Furans, Metals & Phthalates**
- **An estimated 177 acres will be actively cleaned up. Time frame to complete the entire cleanup is estimated to be 17 years: 7 years of active cleanup and 10 years of monitored natural recovery. 105 acres of dredging or partial dredging and capping**
- **Early Action Areas: Slip 4, Terminal 117, Boeing Plant 2, Jorgensen Forge**



Boeing Plant 2 EAA CS1

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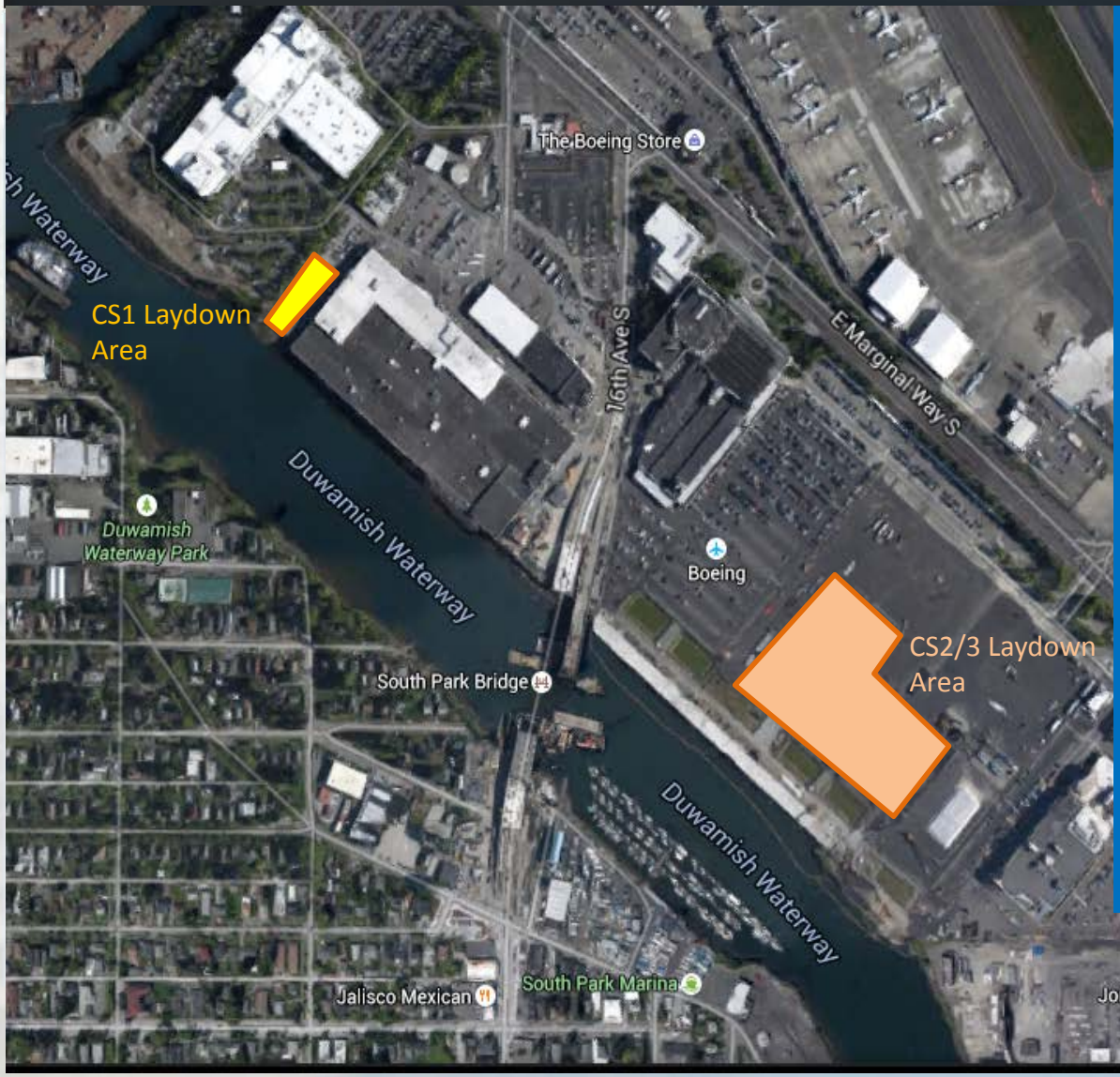
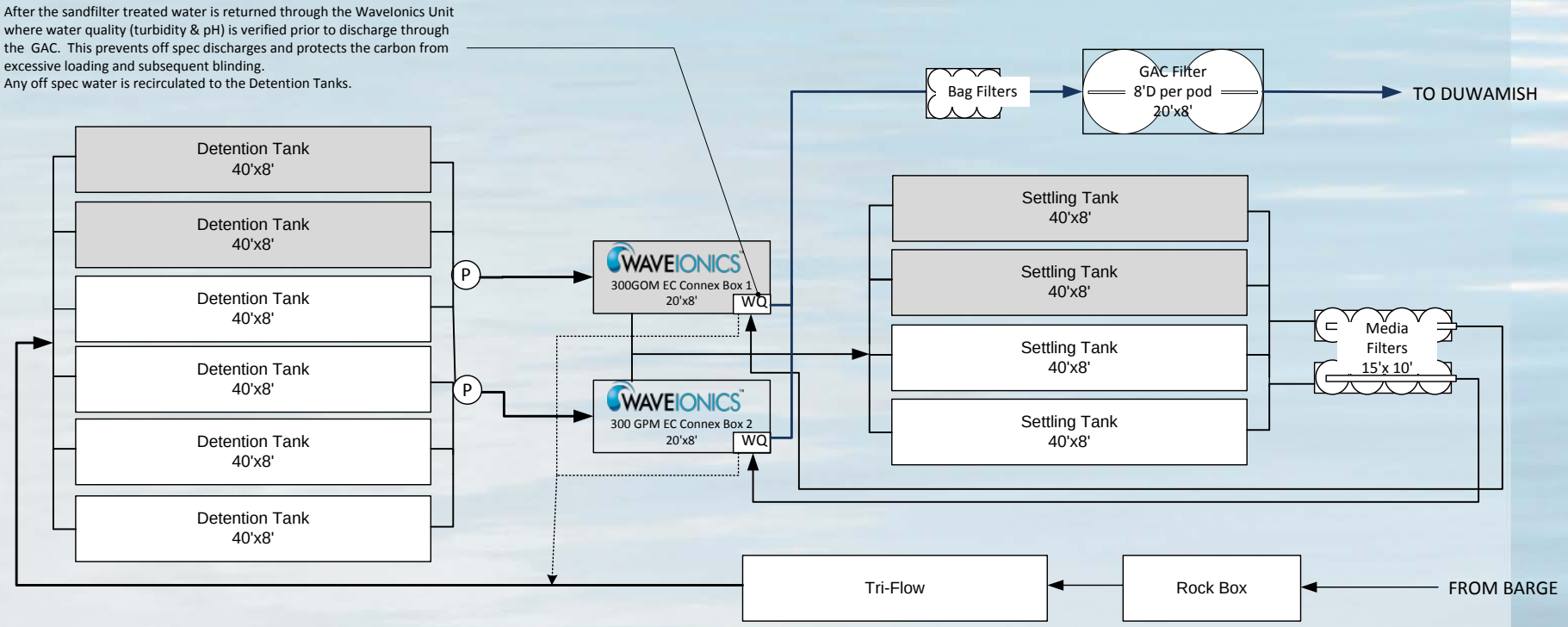


- Specified treatment approach not approved by Agencies
- Chemicals/Polymers not allowed
- Small Laydown Area
- Discharge to SS not allowed/cost prohibitive
- Considered “pilot season” for larger CS2/CS3
- WaveIonics EC technology selected as considered by Ecology as non-chemical, and carries GULD (TAPE Approval)

Boeing Plant 2 EAA CS1

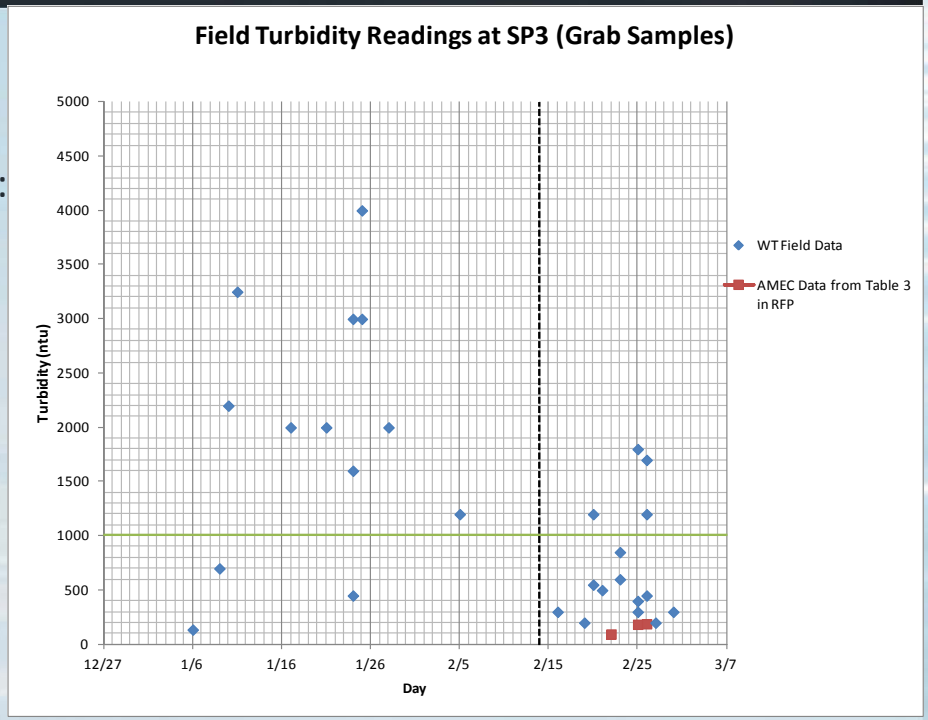


Boeing Plant 2 EAA CS1

HIGHLY VARIABLE INFLUENT

Over the project duration the following breakdown of turbidity was generally observed:

- 50% of the time turbidity was >1000 ntu
- 14% of the time turbidity was 500 – 1000ntu
- 26% of the time turbidity was 300 – 500 ntu
- 10% of the time turbidity was <300 ntu



Influent Sample collected 2/11/13:

TSS = 58,000mg/L (measured by ALS)

NTU = 16,200 (measured with volumetric dilutions in laboratory setting)

Wide variations in turbidity and TSS were observed on a daily and even hourly basis. Factors included both the type of cut and type of material being dredged. Lower turbidity was observed when dredging in sandy areas which occurred during the first week and last couple weeks of CS1

Boeing Plant 2 EAA CS1

36,000 cubic yards of dredging
Operated for 48 days meeting all water quality discharge parameters
6,300,000 gallons treated and discharged back to the Duwamish Waterway

Envirocon

WQ Parameter	Acute Criteria	Chronic Criteria	DRWTS Effluent
Cadmium	40	8.8	0.027
Chromium	1100	50	0.22
Copper	4.8	3.1	0.44
Lead	210	8.1	0.05
Mercury	1.8	0.025	0.02
Silver	1.9	1.9	0.016
Zinc	90	81	5.78
Mercury	1.8	0.025	0.02
PCBs	10	0.03	0.010
Turbidity	5 ntu above background		≤5 ntu
pH	6.5-8.5s.u.		6.5-7.5

Boeing Plant 2 EAA CS1

Lessons Learned:

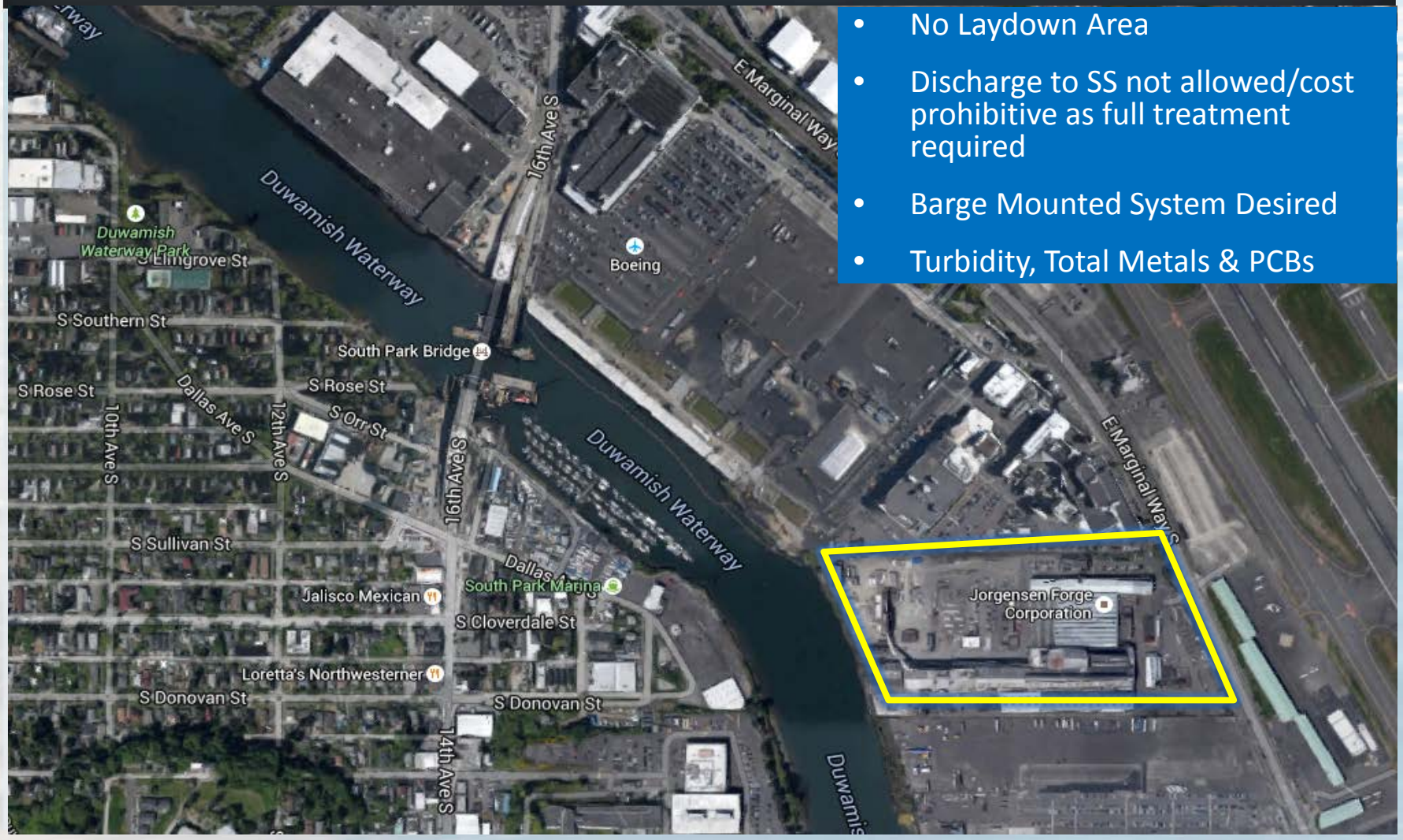
- Operational dewatering strategy from sediment barge to DRWTS is critical
- Having a reliable way to remove solids is also critical
- Plan for redundancy

These challenges were remedied in later CS2/CS3 by replacing detention tanks with large pre settling pond (~2M gallons) and large post treatment clarifier.

As a result, Influent turbidities prior to the EC system were very low – with the highest reading at 110ntu.

CS1: 90% of time <300 ntu

Jorgensen Forge EAA

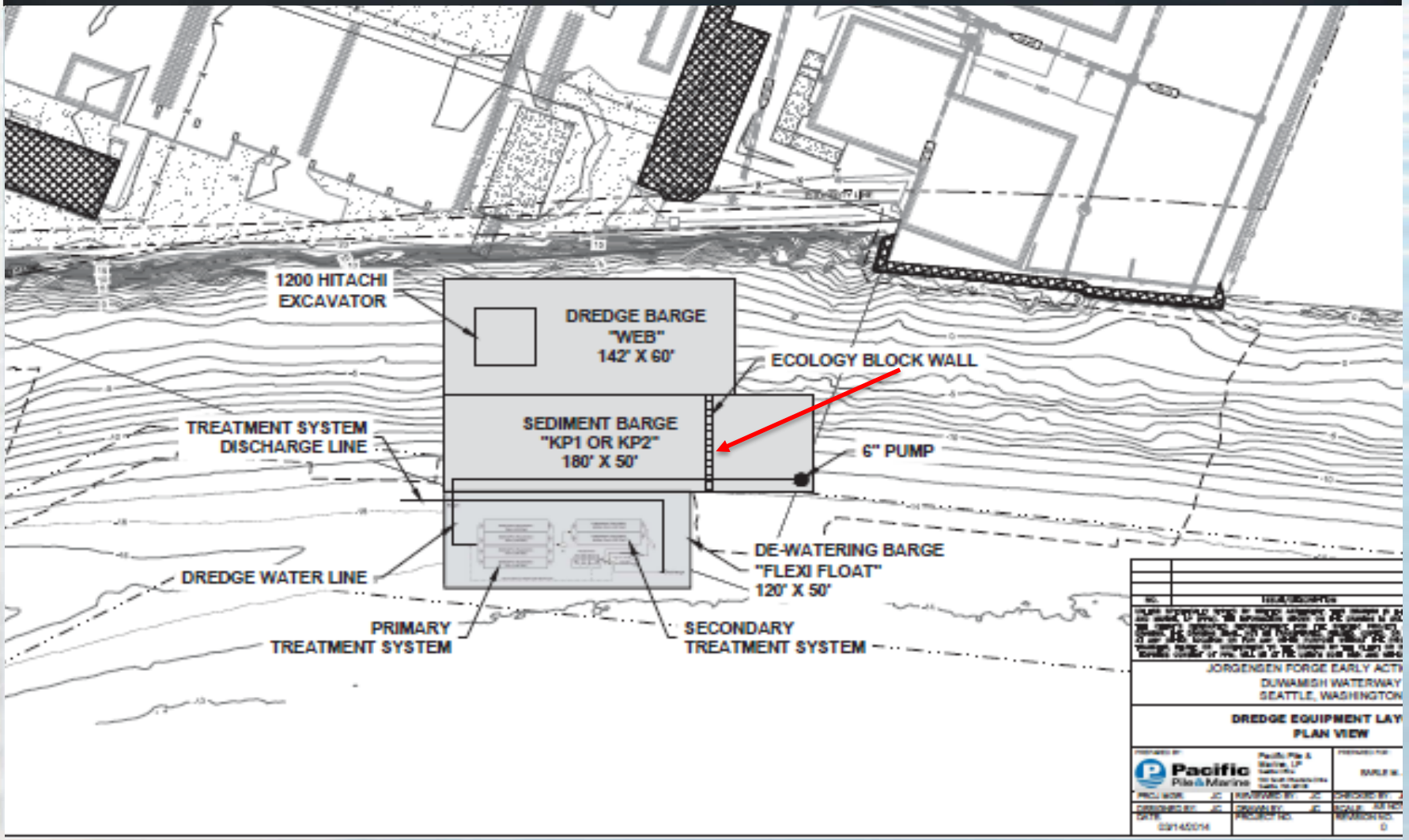


- No Laydown Area
- Discharge to SS not allowed/cost prohibitive as full treatment required
- Barge Mounted System Desired
- Turbidity, Total Metals & PCBs

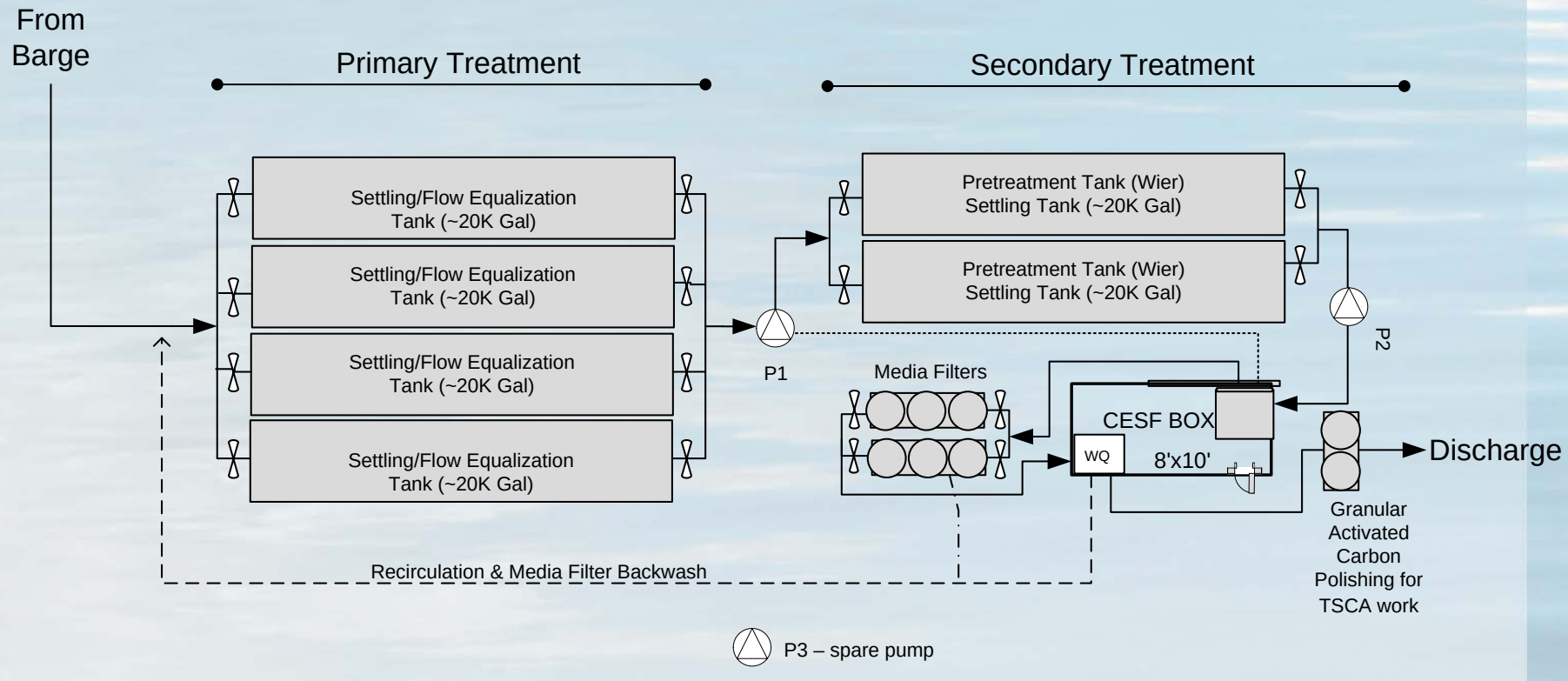
Jorgensen Forge EAA

Barge-Mounted Chitosan Enhanced Sand Filtration (CESF) system implemented…

Jorgensen Forge EAA



Jorgensen Forge EAA

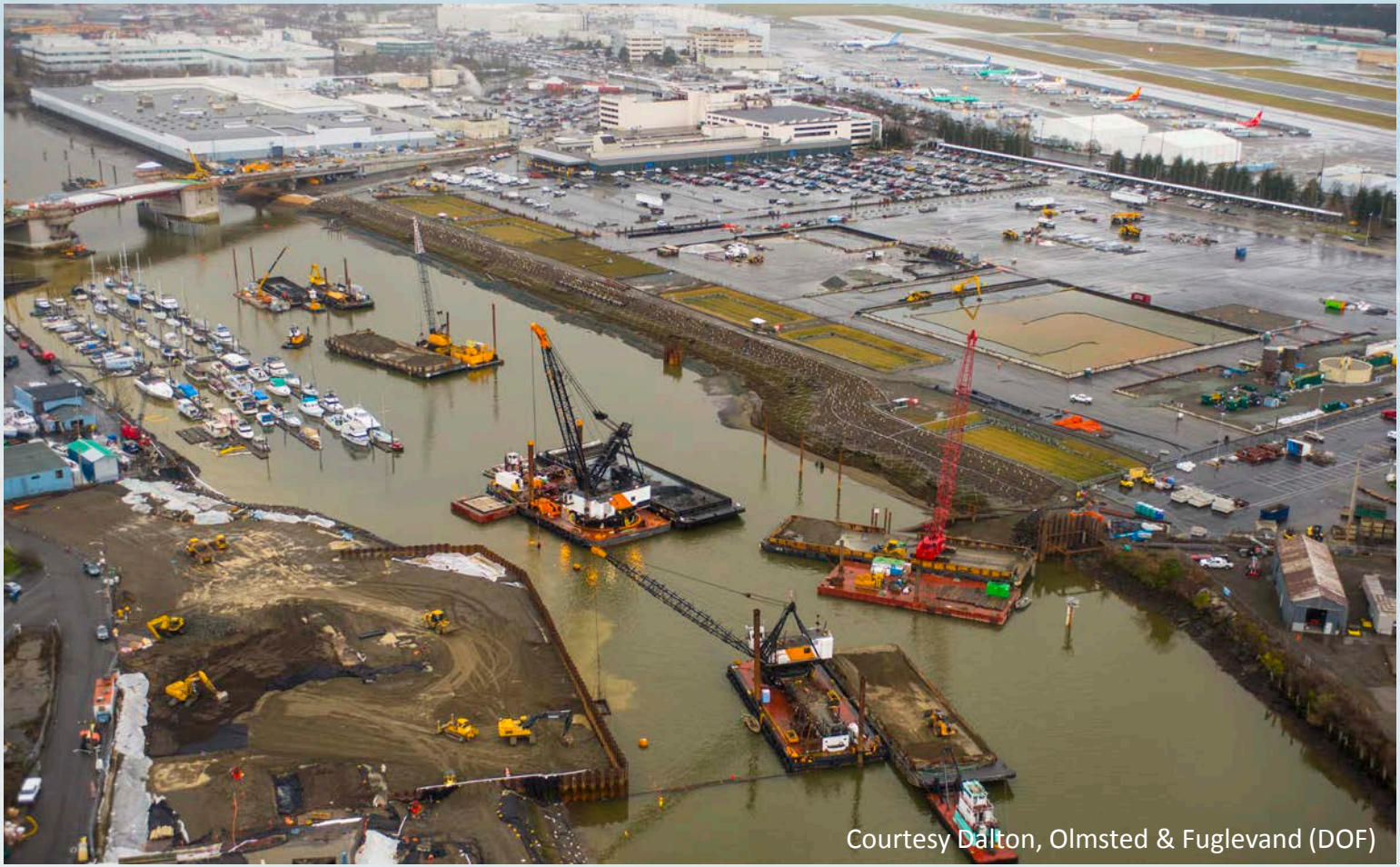


Jorgensen Forge EAA

12,500 cubic yards of dredging
Operated for 45 days meeting all water quality discharge parameters
5,183,000 gallons treated and discharged back to the Duwamish Waterway

Pacific Pile&Marine

Other Challenges

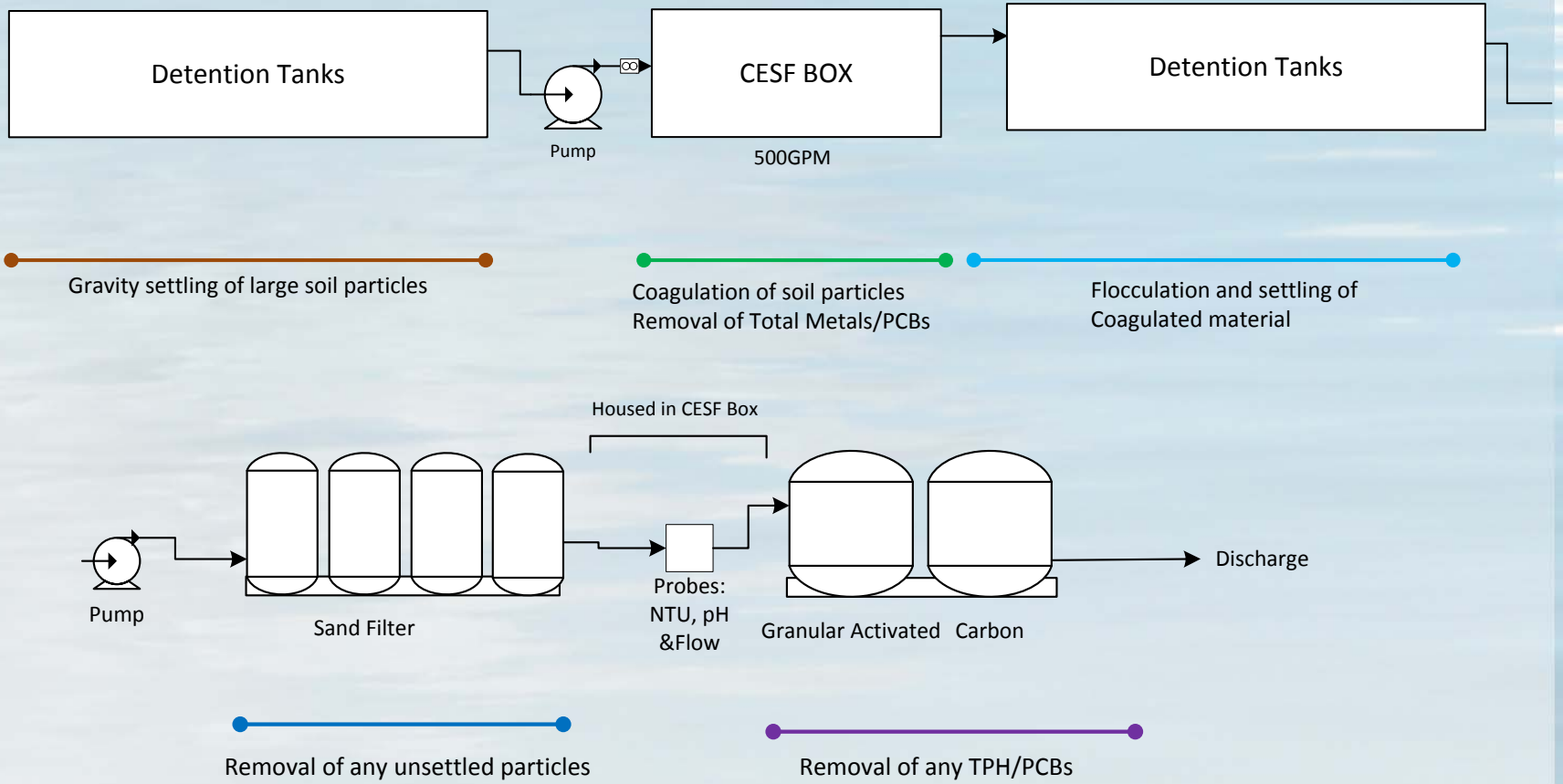


Port of Ridgefield

- Ridgefield National Wildlife Refuge
- Old Wood Processing & Treatment Site
- Dioxins, PCP, heavy metals, PAH, Creosols

Port of Ridgefield

PROCESS FLOW DIAGRAM



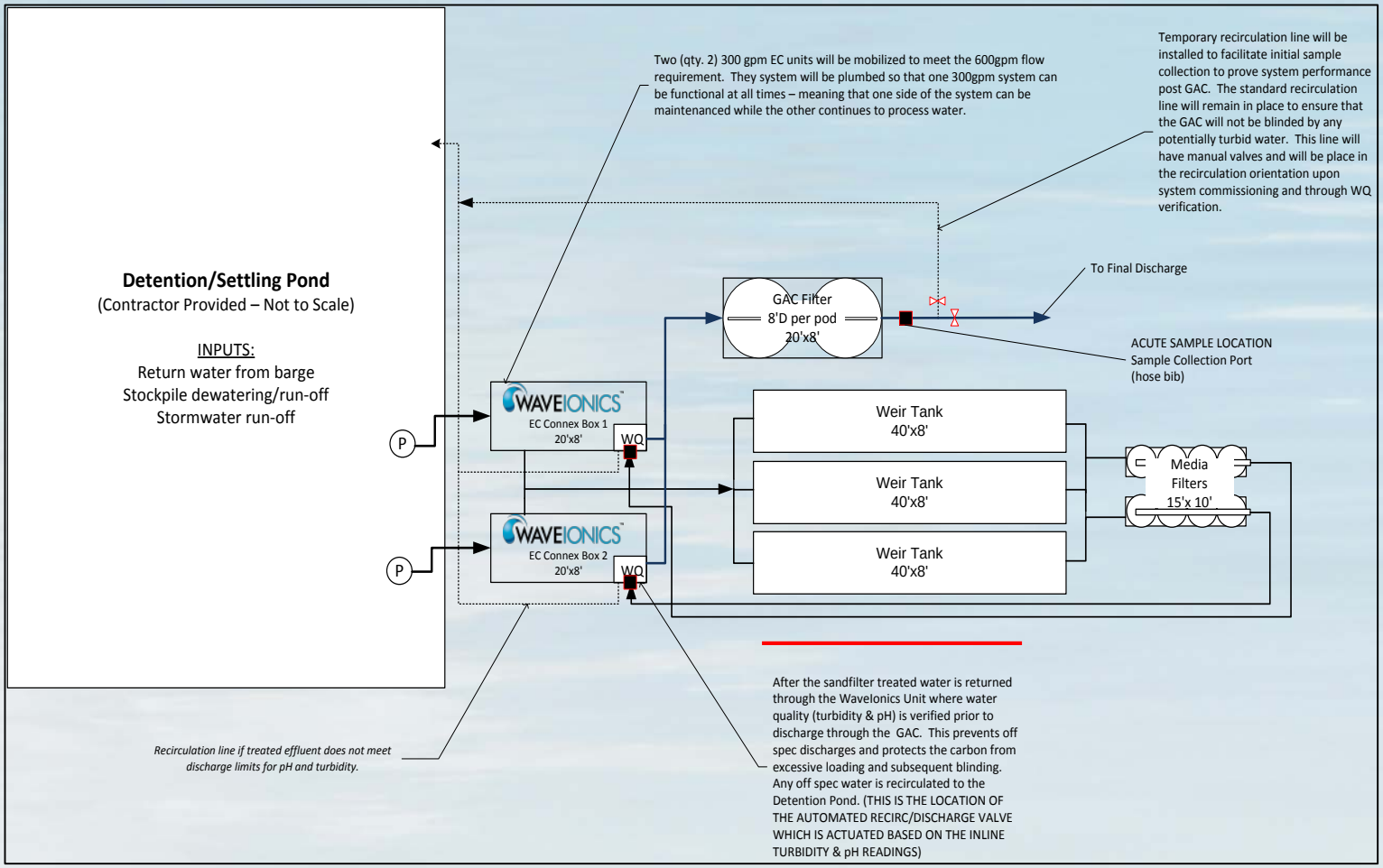
Port of Ridgefield

Final phase of nearly 20 year - $90M clean-up
Operated for 50 days meeting all water quality discharge parameters
5,000,000 gallons treated and discharged back to the Columbia River

Port of Tacoma Pier 4

- Discharge to SS not allowed/cost prohibitive as full treatment required
- Tributyltin (TBT)
- Laydown Area provided on neighboring property

Port of Tacoma Pier 4



Port of Tacoma Pier 4

49,000 cubic yards of dredging
Treated Dredge Return Water, site stormwater & transload facility
11,000,000 gallons treated and discharged back to the Commencement Bay meeting water quality limits

ORION MARINE GROUP

Summary

Site Characteristics Impacting Design:

- Schedule – Time Constraints
- Contaminants of Concern
  - Sediment Particle Size
  - Total vs Dissolved Metals
  - Organics
- WQ Discharge Standards
- Agency Approval
- Available Laydown Area
- Operational Concerns - Barge Off Loading Practices & Solids Management

Four Projects Completed with Active Treatment Technologies (WA GULD)
2 CESF & 2 EC

Cost started at $0.07/gallon,
3 years later $0.02/gallon

WATERTECTONICS

For more information please contact:

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