

FEDERAL REMEDIATION TECHNOLOGY ROUNDTABLE 2016 MEETING

CARBON AMENDMENTS – BREMERTON CASE STUDY

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SPAWAR

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SITE DESCRIPTION
PIER 7, PSNS&IMF, BNC, BREMERTON, WA, USA

- Active deep water shipyard, under pier areas
- Post-remedy monitoring identified continued presence of elevated PCB levels
- Desire to test alternative in situ treatment methods such as reactive amendments
- 0.5 acre target amendment area

TEST DESIGN
REACTIVE AMENDMENT

- AquaGate+ PAC™ (AquaBlok®, Toledo, Ohio)
- Coated aggregate
 - Coating: 5% Powder AC (PAC) with ~10% bentonite binder
 - Aggregate aids delivery of PAC to sediment surface
- 141 tons AquaGate placed
- Target: 2-4% TOC increase

PERFORMANCE ASSESSMENT
AMENDMENT SHIPMENT, STAGING AND PLACEMENT

Placement at night for low tide access to under pier area

Product staged in "Super Sacks"

Loader and hopper mixer

Truck-mounted conveyor system

Barge

PERFORMANCE ASSESSMENT
AMENDMENT SHIPMENT, STAGING AND PLACEMENT

Distributing under pier

Conveyor system distributing in berthing area

Distributing in berthing area

TEST DESIGN
MONITORING

- Baseline characterization 2 months prior to placement
- Placement verification 0.5 and 3 months post-placement
- 3 annual monitoring events 10, 21 and 33 months post-placement

| Measurement | Number of stations |
|--------------------------|-----------------------------|
| Tissue | 10 (1-MM – 10-MM) |
| PCBs | |
| Sediment Porewater | |
| Sediment | 5 (3-, 4-, 5-, 8-, 9-MM) |
| TOC and BC Content | |
| Grain Size | |
| Benthic Community Census | 42-51 (1-1 – 7-6) |
| PCBs | |
| Tissue | 4 |
| Hg/MoHg | |
| Sediment | 4 |
| Hg/MoHg | |
| SPI Survey | 4 |
| Benthic Community Census | |

(RBS-1 – RBS-4)

TEST DESIGN METHODS OVERVIEW

- In Situ Bioaccumulation
 - SEA Rings
 - Two species: *Macoma nasuta*; *Nephtys caecoides*
 - 14-day deployment
- In Situ Passive Sampling
 - SPME
 - 14-day deployment
- Sediment Cores
- Benthic Community Census
- SPI survey




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PERFORMANCE ASSESSMENT DEMONSTRATE PLACEMENT WITHIN TARGET AREA AT TARGET THICKNESS (SPI SURVEY)

0.5-month monitoring event

- ~ 70% of the target area received target thickness (5 cm) or more
- Thickness within target area: Average 11 cm Range 0.1 – 17 cm



Average Activated Amendment Cap Layer Thickness (cm)

- area with detectable thickness
- area with a trace

Red line indicates target amendment area

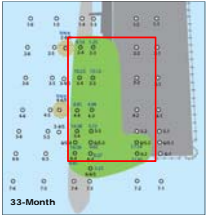
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PERFORMANCE ASSESSMENT DEMONSTRATE PLACEMENT WITHIN TARGET AREA AT TARGET THICKNESS (SPI SURVEY)

33 Month Event

- Lateral shift in amendment over time
- Average thickness lower in 33 month (8.8 cm)



Average Activated Amendment Cap Layer Thickness (cm)

- area with detectable thickness
- area with a trace

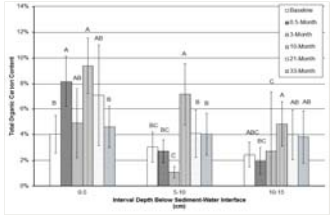
Red line indicates target amendment area

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PERFORMANCE ASSESSMENT CHANGE IN SURFACE SEDIMENT TOC CONTENT

- Able to track TOC
- TOC increases at 0-5 cm for all events
- TOC increases at 5-10 cm and 10-15 cm after 10 months



Total Organic Carbon (%)

Internal Depth Below Sediment-Water Interface (cm)

0.5 5-10 10-15

0.5 Month 6.5 Month 10.5 Month 33 Month

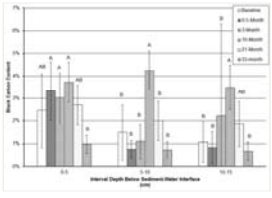
Error bars are 95% CL
Bars with the same letter indicate no statistical significant difference

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PERFORMANCE ASSESSMENT CHANGE IN SURFACE SEDIMENT AC CONTENT (AS BLACK C)

- Able to track Black Carbon
- BC increases at 0-5 cm from placement until 22 months
- BC increases at 5-10 cm at 10+ months
- BC increases at 10-15 cm at 10+ months



Black Carbon (%)

Internal Depth Below Sediment-Water Interface (cm)

0.5 5-10 10-15

0.5 Month 6.5 Month 10.5 Month 33 Month

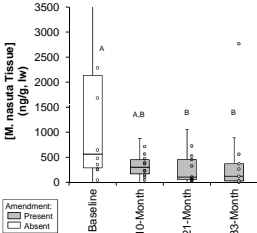
Error bars are 95% CL
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PERFORMANCE ASSESSMENT REDUCTION IN PCB BIOAVAILABILITY (M NASUTA)

Significant decreases in all post-placement monitoring events compared to baseline



(*M. nasuta* Tissue) (ng. lw)

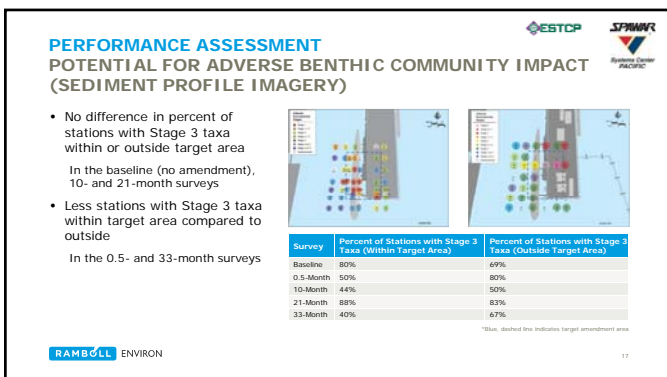
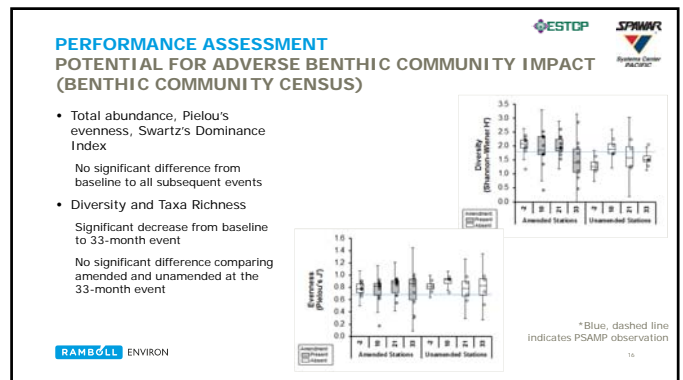
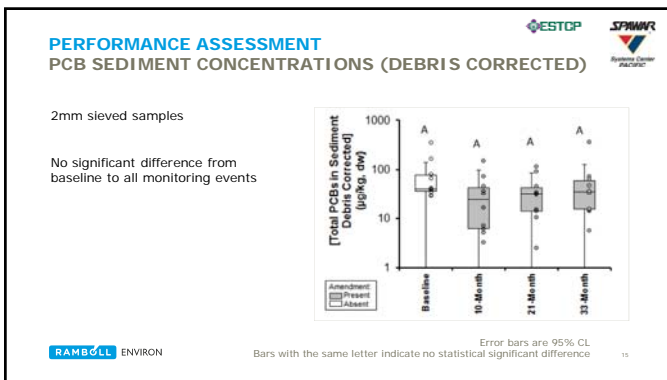
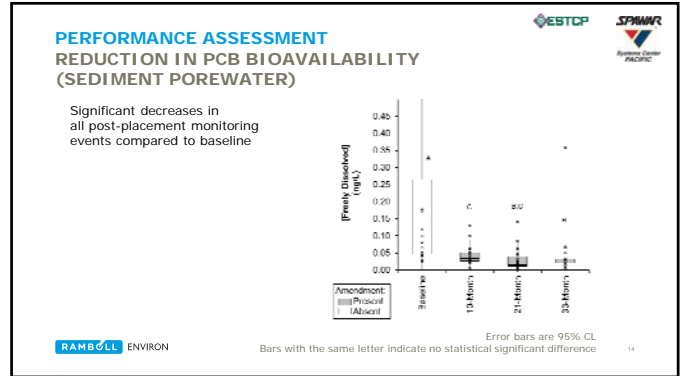
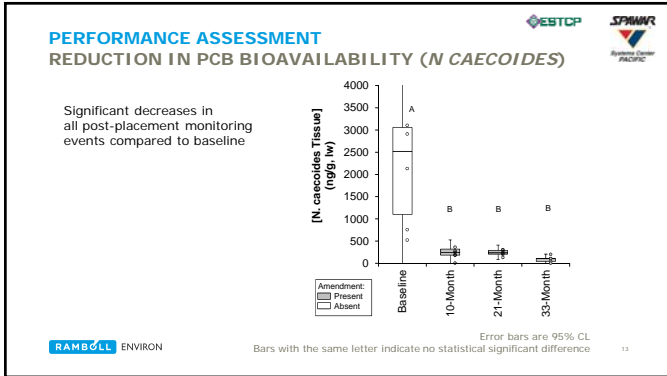
Amendment: Present (grey), Absent (white)

Baseline 10-Month 21-Month 33-Month

Error bars are 95% CL
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CONSTRUCTION COSTS

| Cost Element | Costs | |
|--|---|------------------|
| Placement | AquaGate \$2.90/sq. ft. (based on \$450/ton and areal amendment density of 12.9 lbs/sq. ft.) | \$63,000 |
| | Shipment | \$42,000 |
| Staging and placement of amendment | | \$140,000 |
| Verification of placement (SPI survey) | | \$34,000 |
| Total | | \$279,000 |
| Total per sq. ft. | | \$12.77 |

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KEY POINTS

- Achieved significant reductions in total PCBs in tissue
- Achieved significant reductions in total PCBs in porewater
- Achieved placement within target area and target thickness achieved
- Demonstrated stability and mixing of the activated carbon in the surface sediment over time
- Did not observe significant adverse impacts to the native benthic community

| Time Point | Percent Decrease From Baseline |
|------------|--------------------------------|
| 10-mo | 68% |
| 21-mo | 82% |
| 33-mo | 88% |
| 10-mo | 87% |
| 21-mo | 89% |
| 33-mo | 97% |
| 10-mo | 73% |
| 21-mo | 86% |
| 33-mo | 83% |

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- [http://www.serdp-estcp.org/Program-Areas/Environmental-Restoration/Contaminated-Sediments/ER-201131/ER-201131/\(language\)/eng-US](http://www.serdp-estcp.org/Program-Areas/Environmental-Restoration/Contaminated-Sediments/ER-201131/ER-201131/(language)/eng-US)
- Web search for "ER-201131"

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THANK YOU

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