Application for the 2014 WEDA Environmental Excellence Awards: Environmental Dredging

Project Title

Puget Sound Naval Shipyard and Intermediate Maintenance Facility O & M dredging contaminated sediment activated carbon amendment demonstration project.

Project Summary

Active, deep-water harbor areas with complicated infrastructure and logistical requirements pose a number of significant challenges to the effective use of traditional environmental dredging. In particular, areas underneath and immediately adjacent to pier and bulkhead infrastructure cannot be dredged without compromising infrastructure. Historically, these areas have often been ignored entirely due to these feasibility concerns, which results in potential recontamination of adjacent areas that are dredged to meet environmental goals or address ongoing operations & maintenance (O & M) needs.

Placement of in-situ treatment materials to address complicated or challenging areas of active harbor areas represents a promising and cost-effective new remediation technology complementing environmental and O & M dredging. In the application used in this project, a thin (2- to 3-inch) layer of an activated carbon treatment was added to a half-acre area underneath and adjacent to Pier 7 at the Puget Sound Naval Shipyard and Intermediate Maintenance Facility (PSNS & IMF). As demonstrated in laboratory bench scale tests, addition of the activated carbon decreases the bioavailability and environmental mobility of polychlorinated biphenyls (PCBs) by approximately 50 to 90%, resulting in an environmental risk reduction in the immediate area and reduction of PCB mobility and bioaccumulation in the food web. The remedial performance that is expected to be achieved is expected to be very cost-effective, as material and installation costs are less than most environmental dredging costs. Although this technology is described in EPA's Guidance for Contaminated Sediment Remediation (2005), at the time the project was initiated, full scale demonstrations, implementation and acceptance was generally lacking. However, this project has played a part in prompting a number of similar demonstrations, which have resulted in full-scale implementations of activated carbon as an *in situ* treatment for contaminated sediments. The primary objective of this project, which is funded by DoD's Environmental Security Technology Certification Program (ESTCP), the Navy's Environmental Sustainability Development to Integration (NESDI) Program, and Naval Facilities Engineering Command Northwest (NAVFAC NW), is to demonstrate and validate placement, stability, and performance of the reactive amendment for treatment of contaminated sediments to achieve environmental goals and reduce long-term O & M dredging costs.

The activated carbon amendment (AquaGate+PAC™ composite aggregate) was installed in October 2012 via spreading the amendment using a tug-operated, moored barge via a belt-type conveyor broadcast system. Post-application diver and Sediment Profile Imagery (SPI) surveys, conducted immediately and two weeks, three months, and ten months after the amendment, indicated that targeted application

rate of at least 2 to 3 inches of was attained in at least 75 to 90% of the demonstration footprint, even on the sides of steep sump slopes adjacent to the pier.

In terms of performance, the first of three major performance monitoring events (conducted at approximate annual intervals) has indicated success. *In situ* bioaccumulation and sediment porewater measurements have confirmed an approximate 90% reduction in PCB bioavailability and environmental mobility. Measurable increases of organic carbon content have been observed in surface sediment, with concentrations increasing by approximately 0.02 grams carbon/gram sediment or more, confirming carbon delivery, incorporation, and long-term resiliency in the sediment. Sediment Profile Imaging (SPI) and benthic census have indicated only temporary or insignificant side effects of the amendment on the native benthic fauna. Although additional monitoring events will repeat these performance assessments to provide data for two and three years post amendment, initial results indicate the success of this remedy technology.

Project Team

Principal Investigators and Project Owner

- US Navy Space and Naval Warfare Systems Center Pacific (SSC Pacific)
    - D. Bart Chadwick, Victoria Kirtay, Robert Johnston, Gunther Rose, Marienne Colvin, Renee Dolecal, Joel Guerrero.
    - The SSC Pacific Team, led by Dr. Chadwick and Ms. Kirtay, is the project lead and serve as the principal investigators responsible for the overall project and coordination of all team members. In addition, SSC Pacific team members are taking the lead in the majority of the technical engineering and remedy assessment technical tasks, including field sampling, experimental design, data analysis and reporting, *in situ* bioaccumulation testing, and other measurements.

Supporting Team Members

- ENVIRON International Corporation: Victor Magar, Jason Conder, David Moore, Melissa Grover, and Jennifer Arblaster - WEDA Members and Nominating Entity
    - The ENVIRON team is providing support to SSC Pacific in the assessment of the amendment placement success, performance, and stability, including assistance to SSSC Pacific's field efforts (sediment coring, sediment porewater sampling and analysis, and benthic census), experimental design, and data analysis.
- Dalton, Olmsted and Fuglevand (DOF): Robert Webb, Richard May, and Paul Fuglevand – Sustaining WEDA Members
    - The DOF team provided support to SSC Pacific in the engineering placement design and construction oversight of the amendment.
- AquaBlok Ltd (AquaBlok): John Collins – WEDA Members
    - The AquaBlok team is provided support in optimization and production of the amended carbon material.
- Germano and Associates: Joe Germano, David Browning, and Ezra Beaver

    - The Germano and Associates team is providing support to SSC Pacific in the Sediment Profile Imagery (SPI) investigations to document amendment placement and benthic conditions.
- Hart Crowser: Brad Helland - WEDA Member
    - The Hart Crowser team is providing logistics support to SSC Pacific in the remedy monitoring and assessment phases of the project.
- AMEC: Kelly Tait and Chris Stransky - WEDA Members
    - The AMEC team is providing support to SSC Pacific in experimental design, sampling, and data analysis efforts associated with the in situ bioaccumulation testing.
- Nautillus: Adrienne Cibor – WEDA Members
    - The Nautillus team is providing support to SSC Pacific in experimental design, sampling, and data analysis efforts associated with the in situ bioaccumulation testing.
- PSNS & IMF Divers
    - Dive support for the project was provided by the PSNS & IMF Divers. Direct audio and video communication with the divers was very valuable to the scientific team, as the divers were able to communicate information about sea floor conditions and provide feedback on equipment performance and sampling conditions.

Environmental Benefits

Cleanup costs for contaminated sediments at DoD sediment sites are estimated to exceed $1B. Cost effective remedies for sediment remediation at contaminated DoD sites are limited, particularly for active harbor areas with complicated infrastructure and logistical requirements. At many of these sites, areas of contaminated sediment near infrastructure, which are often not feasible to address using environmental dredging or other conventional remedial technologies, threaten ongoing environmental dredging programs by directly recontaminating dredged areas or contributing to the overall cumulative environmental risks present at the entire site. Placement of an activated carbon amendment at active harbors successfully addresses these challenges. The activated carbon amendment reduces organic contaminant risks by irreversibly absorbing and sequestering available contaminants from the sediment matrix. Because only a thin layer (e.g., 2 inches) is added to the sediment, navigational and logistical harbor needs was not compromised. And because placement is relatively simple and no sediment is removed, impacts to existing infrastructure were insignificant. Additionally, at many harbors, the remedy can be applied underneath piers and in locations that other remedies are not feasible to apply. Simply put, this remedy approach provides a versatile and complementary approach to environmental dredging that is capable of revolutionizing the industry.

Innovation

The application of activated carbon amendments is at the cutting edge of new remedial technologies that go beyond traditional environmental protection efforts. At many active ports and harbors, remedial efforts in challenging areas (under piers and adjacent to infrastructure) is often postponed or not contemplated. This project breaks ground in demonstrating that these areas can be successfully

remediated in an active harbor, with a 90% reduction in environmental risks at a fraction of the cost that would have been associated with environmental dredging and associated infrastructure improvements. This project also demonstrated the ability of a diverse group of eight DoD and industry organizations to collaborate on a complex demonstration study involving cutting edge environmental engineering, chemistry, ecotoxicology, and ecology.

Economic Benefits

Estimated costs for installation of the amendment based on this full scale demonstration is approximately $11 per square foot, which is less expensive than most environmental dredging operations in open water areas, and an order of magnitude less expensive than dredging and associated demolition/construction costs associated with remediation adjacent or underneath harbor infrastructure. This technology has the potential to reduce long-term environmental liability and result in significant cost savings for O & M dredging via reduced disposal/dredged material management cost. Even under remedial strategies that do not necessitate action in areas adjacent to or underneath harbor infrastructure, applying this technology in these areas will reduce recontamination of adjacent areas that are dredged for environmental or navigational purposes, leading to lower frequencies of dredging, less risk or multiple dredging events, and decreased costs for dredged material assessment.

Transferability

This remedial technology is fully transferrable to a variety of environmental and navigational dredging projects. In addition to reducing contaminant risks adjacent to and underneath complicated harbor infrastructure, this approach is transferrable to a variety of different applications, including remedial approaches in open water areas, reducing risks associated with dredging residuals, addressing stormwater outfall locations, and sequestration of chemicals during or prior to dredged material disposal.

Outreach and Education

This project is being broadly communicated to a broad array of stakeholders, including industry practitioners, regulators, and the scientific community. The project's engineering, logistical, financial, and remedial performance successes are being actively communicated in a variety of different approaches that target the environmental industry and regulatory stakeholders.

The project team has presented project results at several venues:

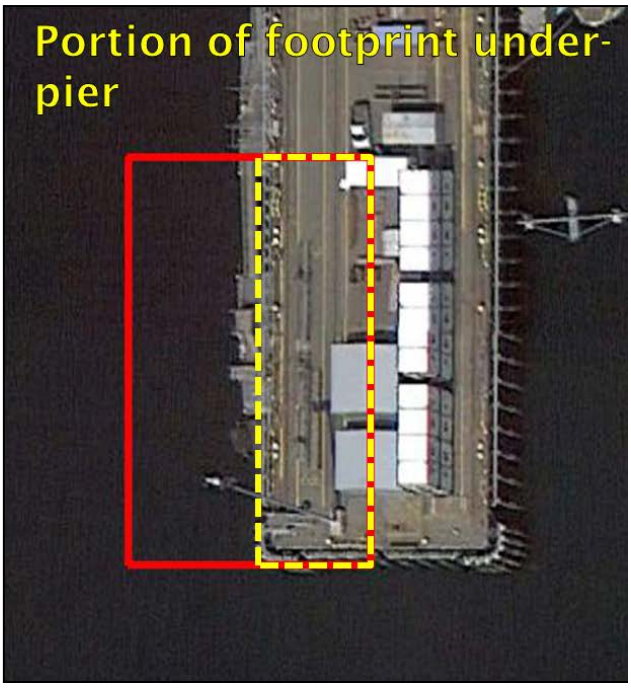
- Johnston, R.K., V. Kirtay, D.B. Chadwick, G.H. Rosen, J.M. Guerrero, J. Collins, C. Ortega, R. Webb, R. May, J. Germano, D. Browning, E. Beaver, M. Wicklein, J. Pittz, D.E. Leisle, L. Doyle, and L. Hsu, 2013. "B-024 Installing an Activated-Carbon Sediment Amendment at the Puget Sound Naval Shipyard and Intermediate Maintenance Facility, Bremerton, WA." In proceedings of the Seventh International Conference on Remediation of Contaminated Sediments (Dallas, TX; February 4–7, 2013). ISBN 978-0-9819730-6-7, ©2013 Battelle Memorial Institute, Columbus, OH.

- Kirtay, V., D.B. Chadwick, R.K. Johnston, G. Rosen, J. Guerrero, J. Conder, M. McMeechan, M. Wicklein, J. Pittz, J. Germano, J. Collins, and R. Webb, 2013." C-040 Demonstration of In Situ Treatment with Reactive Amendments for Contaminated Sediments in an Active DoD Harbor. "In proceedings of the Seventh International Conference on Remediation of Contaminated Sediments (Dallas, TX; February 4–7, 2013). ISBN 978-0-9819730-6-7, ©2013 Battelle Memorial Institute, Columbus, OH.
- Chadwick, D.B., Kirtay, V., Rosen, G., Guerrero, J., Magar, V., Conder, J.M., McMeechan, M., Wicklein, M., Pitz, J., Germano, J., Webb, R., Helland, B. 2013. Demonstration of in situ treatment with reactive amendments for contaminated sediments in active DoD harbors. Battelle Seventh International Conference on Remediation of Contaminated Sediments, Dallas, TX, February 2013.
- Conder, J., Kirtay, V., Grover, M., Chadwick, D.B., Magar, V., Moore, D. 2013. Demonstration of an activated carbon sediment amendment at the Puget Sound Naval Shipyard & Intermediate Maintenance Facility, Bremerton, WA. Western Dredging Association, Pacific Chapter Annual Meeting, Long Beach, CA, October 2013.
- Grover, M., Conder, J., Arblaster, J., Kirtay, V., Chadwick, D.B., Magar, V., Moore, D. 2013. Comparison of model estimated and measured concentrations of Polychlorinated Biphenyl (PCB) congeners in sediment porewater. Society of Environmental Toxicology and Chemistry (SETAC) North America Annual Meeting, Nashville, TN, November 2013.
- Conder, J.M., McMeechan, M., Kirtay, V., Arblaster, J., Magar, V., Chadwick,D.B. 2013. Two-week in situ method for measurement of PCBs in sediment porewater using SPME. Battelle Seventh International Conference on Remediation of Contaminated Sediments, Dallas, TX, February, 2013. John A.
- Collins, Robert K. Johnston, Chadwick, D.B., Kirtay, V., Rosen, G., Guerrero, J., Magar, V., Conder, J.M., McMeechan, M., Wicklein, M., Pitz, J., Germano, J., Webb, R., Helland, B. 2013. Demonstration of in situ treatment with reactive amendments for contaminated sediments in active DoD harbors. Sediment Management Work Group Meeting, Syracuse, NY, October 2, 2013.

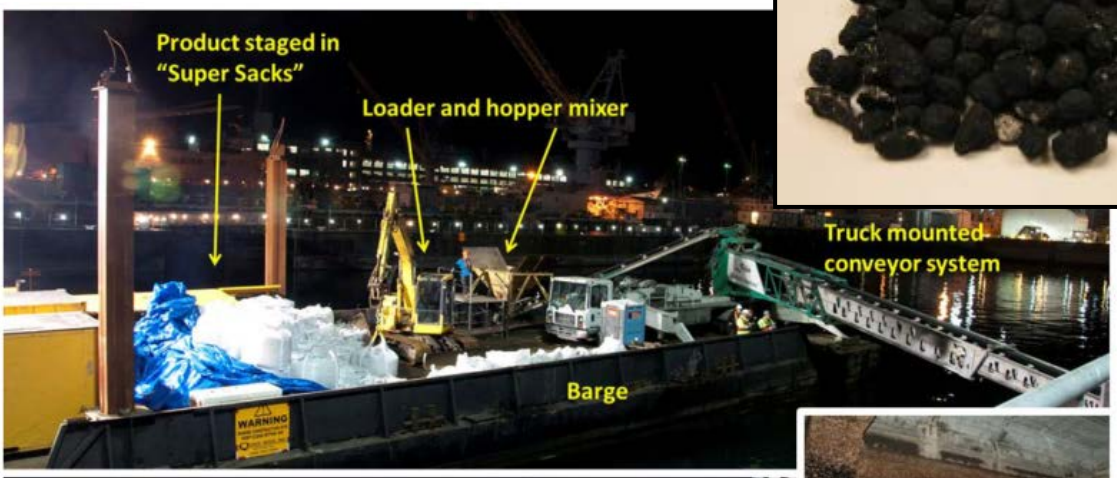
Attachment

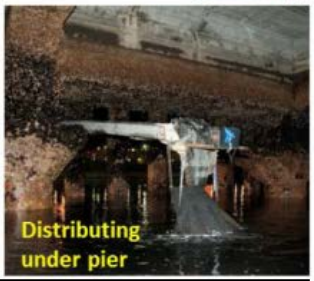
Puget Sound Naval Shipyard and Intermediate Maintenance Facility Activated Carbon Amendment

Project Location (Pier 7) and Remedial Design.



Application of the Aqua Gate Activated Carbon Amendment

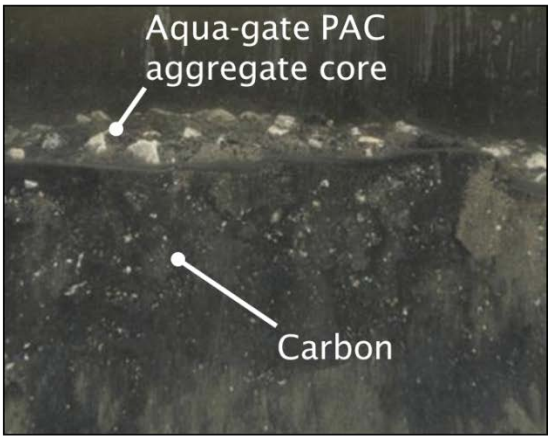




Results

Sediment Profile Image (approximate 1-foot deep profile image):

Before



2 Weeks Post Amendment

Monitoring data indicating an approximate 90% reduction in PCBs in sediment porewater and tissues of benthic organisms: