INSTALLATION OF AN IN-SITU CAP AT A SUPERFUND SITE

A bay at a Superfund site has sediments contaminated with PAHs. Air modeling determined that a portion of the sediments, contaminated with high concentrations of naphthalene, would pose an air quality risk if dredged. The state environmental agency allowed that portion of sediments to be capped in-situ. A sand cap was designed that included a temporary surcharge load to consolidate the sediment. The surcharge would be removed after consolidation thus restoring the bathymetry to its original depth. The engineer incorporated Reactive Core Mat™ into the cap design to adsorb consolidation porewater contaminants. New installation techniques were developed by the contractor and the cap was completed on schedule, with the installation of ~11 acres of RCM taking only 16 days to deploy.

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Paper D-025, in: E.A. Foote and G.S. Durell (Conference Chairs), *Remediation of Contaminated Sediments—2007.* Proceedings of the Fourth International Conference on Remediation of Contaminated Sediments (Savannah, Georgia; January 2007). ISBN 978-1-57477-159-6, published by Battelle Press, Columbus, OH, www.battelle.org/bookstore.

Installation of an In-Situ Cap at a Superfund Site

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ABSTRACT: For approximately 70 years industrial facilities discharged PAHs into a bay and contaminated sediments at a Superfund site located in the Great Lakes Areas of Concern. NAPL is periodically transported to the surface by gas ebullition. Modeling by the consulting engineers indicated that dredging highly contaminated sediment in one area of the bay would result in failing air quality standards. Contaminant transport studies were conducted for capping of these contaminated sediments. In bench tests, a sand cap successfully prevented PAHs from entering the cap during the consolidation phase. The Record of Decision included in-situ capping of the highly contaminated sediments. The in-situ cap consists of a combination of sand and an activated carbon reactive mat. A permeable reactive mat was added to help adsorb contamination from the consolidation water. This case study documents the installation of sheet piling, the sand and reactive mat cap.

INTRODUCTION

Stryker Bay, located in Duluth, Minnesota, is a shallow flat-bottomed bay with an average water depth of 0.9 to 1.5 m (3 to 5 feet). From the 1890s to 1960 industrial activities on adjacent land to the north and east manufactured and refined coal tar and produced manufactured gas. PAH contaminants were discharged into the bay and contaminated sediments (MPCA, 2004). There are homes along the west side of the bay. Bubbles with sheen have been seen on the east side of the bay in the summertime. In 1983 the bay was added to the Federal Superfund list as part of the St. Louis River/Interlake/ Duluth Tar (SLRIDT) site (Figure 1).

FIGURE 1. Site map with area designations.

Modeling by the design firm indicated that dredging the portion of the bay sediments with naphthalene concentrations >1000 mg/kg would result in failure to achieve ambient air quality standards for the site (Huls and Costello, 2005). Capping of the sediment was studied by the design team for PAH migration by gas ebullition, groundwater advection and consolidation. Bench scale column tests were conducted to simulate the effectiveness of various capping schemes on minimizing PAH transport. Undisturbed 20 cm diameter by 1 m length sediment cores were set up. 3 foot (90 cm) thick sand caps were applied over the sediment and settlement was measured. A hydraulic head was applied through the columns similar to that measured in the bay. No measurable PAHs were detected into the sand capping material. Gas collection indicated more than 99% reduction in gas bubble transported PAHs.

The selected remedy in the Record of Decision was a dredge/cap hybrid design that consisted of a combination of environmental dredging, in-situ capping and dredged sediment containment (Figure 2). Dredging of approximately 224,000 cubic yards (171,000 cubic meters) of contaminated sediment would be conducted in approximately 25 acres (10 hectares) of the site, including 22 acres (8.9 hectares) in the bay. A 15-acre (6-hectare) CAD would be constructed in Slip 6 to contain the dredged sediment. After dredging, cover material would be placed on the dredged area to isolate residual contamination and provide an adequate habitat for benthic recolonization.

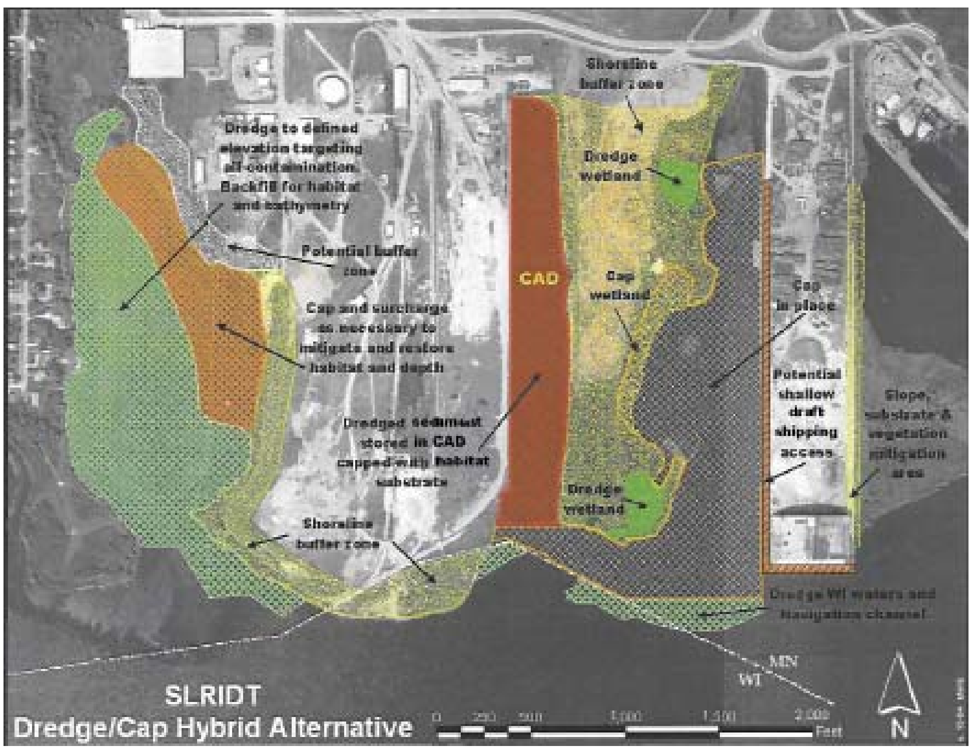

FIGURE 2. Dredge/cap hybrid selected remedy.

The 11 acres (4.5 hectares) of the bay containing the highest naphthalene concentrations would be capped to isolate contaminants and provide a suitable substrate for reestablishing habitat and then surcharged. Engineered control measures would be conducted to contain and minimize the release of sediment to protect adjacent water quality. The cap would be a 90 cm sand cap. Surcharging the cap area with an additional 6.5–8 ft (2–2.5 m) sand layer would compress and consolidate the underlying sediments. After consolidation is substantially complete, the surcharge material would be removed to achieve the desired pre-remediation water depth in the cap area of the bay. Additional bench tests were conducted by the design firm to determine the effect of the surcharge load. Based upon the results of these tests, an additional layer of activated carbon mat was included within the cap to adsorb PAH contamination from the temporary flow of consolidation water.

To prevent erosion of capped areas the entrance to the bay would be armored. The remedy also included coring and settlement monitoring in the cap area. Review of the remedy for compliance with objectives would occur every five years.

MATERIALS AND METHODS

The materials used in the capping operation at Stryker Bay included a sheet pile wall, sand and activated carbon mats. Remedial work at the site began in June 2006. For the engineered control measure during capping, a 1500 ft (500 m) long sheet pile wall was installed along the perimeter of the bubble and sheet area on the east side of the bay. The cross section of the cap was 0.5 ft (15 cm) sand/activated carbon mat/2.5 ft (75 cm) sand. An additional sand surcharge layer was also placed over the cap. The sand was placed in two ways. In near shore areas, sand was placed by backhoe bucket. In off shore areas, sand was pumped from land hydraulically through plastic pipe to a barge where the sand was then dispersed.

Reactive Mat. For this project, activated carbon Reactive Core Mats™ were constructed using a laminating method that encapsulates the activated carbon between two geotextiles within a nonwoven fiber core (Figure 3). The mat panel dimensions were 16 ft (5 m) wide × 82 ft (25 m) long. The activated carbon loading was 0.4 lb/ft^2 (2.0 kg/m^2) and the typical thickness of the mat was 11 mm. The reactive mat was rolled onto a core tube and then wrapped in a polyethylene bag. Two slings were attached one-third of the way from each end of the roll to facilitate shipping and handling.

The mats were constructed with polypropylene geotextiles. Since polypropylene is lighter than water, sand was added to the activated carbon so that the mats would sink. The contractor expressed interest in having the mat float for a limited period of time so that several roll panels could be attached before they sank. A bench scale sink tests were performed with different activated carbon-sand ratios. It was estimated that either a 50:50 or 60:40 activated carbon-to-sand ratio provided sufficient floating time.

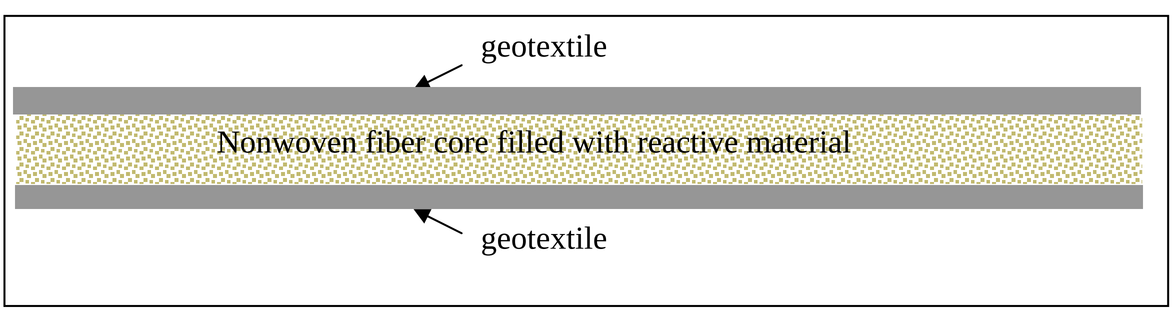

FIGURE 3. Cross section of laminated reactive mat.

Activated carbon can have over 100 times the adsorption capacity for organics as sand or organically-rich soil containing 3.8% carbon fraction (Murphy and Lowry, 2004). One factor with using reactive materials is their cost. By constructing a mat encapsulating the reactive material within geotextiles they can be used in a controlled and cost-effective manner. The reactive mat also combines the functions of reactive material and geotextiles. The potential benefits of geotextiles in this in-situ cap include: 1) preventing mixing of activated carbon with underlying sediments, 2) root barrier, 3) promoting uniform consolidation and 4) stabilizing the cap (Palermo, et al. 1998).

Deployment. Reactive mats may be deployed in a number of ways. In the Anacostia River demonstration project shoreline access was restricted so a barge based deployment technique was utilized (Olsta and Darlington, 2005). In that project, a barge mounted crane was used to position the rolls and unroll the reactive material mats underwater. The mats were first submerged for approximately 10 minutes to allow them to absorb water and displace entrained air. Then the rolls were positioned 1.5 ft (0.5 m) above the river bottom and the tail end of the panel was extended and anchored with a bucketful of sand. The crane swung across the area to be capped and unrolled the mat as it went. The installation was assisted and coordinated by having a diver in radio communication with the crane operator. The diver helped position the tail and confirmed adequate panel overlap.

At Stryker Bay, the shoreline was accessible so different techniques were used. Design called for a 3 ft (0.9 m) overlap near shore and a 1 ft (0.3 m) overlap further away from shore.

FIGURE 4. Reactive material mats being loaded onto barge.

For the off shore 1 ft (0.3 m) overlap area, the reactive mat rolls were loaded onto a barge. A core pipe was inserted through the core tube and then a crane lifted the rolls utilizing the slings and placed the core pipe onto a set of six frames (Figure 4). The barge was guided perpendicular from the shore by rope between two fixed pieces of machinery (Figure 5). On the shoreline was a backhoe with a winch attached to the back of the bucket. Outside the sheet pile wall was a small craft and backhoe. The barge was pushed out to the wall by small motorized boats. The end of a reactive mat roll was temporarily attached to the sheet pile wall. The winch then pulled the barge toward the shore. As they went along, small slits were made in the mat at the appropriate overlap distance from the leading edge and conduit pipe was inserted and pushed into the underlying sediment. At the end of the roll panel, the barge was stopped and the end of the roll panel was stapled to the beginning of the next roll. Deployment took advantage of short-term buoyancy before the mat absorbs water and displaces air. The panels floated for approximately 45–60 minutes depending upon the wind conditions and resulting wave action over the windward side of the panel. This lack of tension allowed for easier stapling of the rolls. Once a row of panels was deploys, the lead end was released from the sheet pile wall and subsequently sank.

FIGURE 5. Reactive mat being deployed from barge.

The barge was then moved laterally by a small motorized boat and then toward the wall, into position for the next row of panels to be placed along the previous row of conduit pipe (Figure 6). Because of the conduit markers, no divers were needed to verify overlaps.

In the near shore area, most of the reactive mat rolls were suspended along the shoreline and unrolled out into position. Due to the irregular shape around curves in the shoreline, some pieces were cut to fit certain areas.

FIGURE 6. Barge being repositioned for next row of panels.

It took approximately 16 days to deploy the 11 acres (4.5 hectare) of reactive mat. The remaining sand cap and surcharge sand was placed over the next 11 weeks. After consolidation and preconstruction water depth is achieved, the surcharge material will be removed. Remediation of the entire SLRIDT site is expected to be completed in 2009.

CONCLUSIONS

Remedial solutions for contaminated sediments are becoming more multifaceted. Regulators are recognizing concerns related to dredging. Designers are utilizing the many tools that are available to them; such as laboratory testing, modeling and reactive/ adsorptive products. Consequently, combinations of remedial techniques and materials are being employed. At Stryker Bay, a hybrid dredge/cap design included a combination sand and activated carbon mat cap. Sand was placed both mechanically and hydraulically by the contractor. Both barge and land based deployment methods were used to install the activated carbon mat.

ACKNOWLEDGMENTS

Service Engineering Group was the lead design engineering firm for the project. Hard Hat Services, Inc. was the lead construction manager for the PRP group. Envirocon Inc. and M.C.M. Marine, Inc. were the subcontractors for the activated carbon mat deployment.

REFERENCES

Huls, H.. and M. Costello. 2005. "Dredging Assessments for Decision-Making for Remediation of Contaminated Sediments", Paper C3-04. In: R.F. Offenbuttel and P.J. White (Eds.), *Remediation of Contaminated Sediments-2005,* Battelle Press, Columbus, OH (CD format).

Minnesota Pollution Control Agency, 2004. "Record of Decision for the Sediment Operable Unit, St. Louis River/Interlake/Duluth Tar Site, Duluth, MN" www.pca.state.mn.us/publications/reports/slridt-soudecision.pdf .

Murphy, P. J., and G. V. Lowry. 2004. "In Place Management of PCB-Contaminated Sediments: Performance Evaluation and Field Placement of Sorbent-Amended Sediment Caps.", *Proceedings of Environmental Chemistry Division 228th ACS National Meeting,* pp. 629-636. American Chemical Society, Columbus, OH.

Olsta, J. T., and J. Darlington. 2005. "Reactive Material Mat for In-Situ Capping of Contaminated Sediment", Paper B6-05. In: R.F. Offenbuttel and P.J. White (Eds.), *Remediation of Contaminated Sediments-2005,* Battelle Press, Columbus, OH (CD format).

Palermo, M., S. Maynord, J. Miller, and D. Reible. 1998. *Guidance for In-Situ Subaqueous Capping of Contaminated Sediments.* U.S. Environmental Protection Agency, EPA 905/B-96/004, Great Lakes National Program Office, Chicago, IL.