International Journal of Soil, Sediment and Water

Volume 2 | Issue 1 Article 5

March 2009

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International Journal of Soil, Sediment and Water, vol 2, no 1, 2009
ISSN: 1940-3259

PCB AND HEAVY METAL SOIL REMEDIATION, FORMER BOAT YARD, SOUTH DARTMOUTH, MASSACHUSETTS

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ABSTRACT

PCB and Heavy Metal Soil Remediation, Former Boat Yard, South Dartmouth Massachusetts. Michael E. Martin & Marc J. Richards, Tighe & Bond Consulting Engineers. Heavy metals have been added to marine paint for more than 100-years to protect boats from biological, chemical and physical degradation. Polychlorinated biphenyls (PCBs) were added to marine paint starting in the 1940's to give the paint better adhesive properties and to provide anti-corrosion protection from moisture, chemicals and flames (approximately 2% composition of paint). The nature of the contamination at this project Site was primarily heavy metals and PCBs in soil and heavy metals in sediment. The source of soil contamination was from marine paint chips from repainting and maintenance activities conducted at the boatyard since the early 1900s.

The source of sediment impacts is believed to be stormwater discharges to the Apponagansett Bay from routine boatyard activities, including power washing of boats. The overall goal of the soil remediation was to reduce PCB and metals exposure point concentrations at the Site to levels that do not pose a risk to human health and the environment. The work had to be conducted during the winter months, so the remedial and construction activities did not interfere with daily marina operations. This paper describes the remediation activities performed at the Site to achieve the overall remediation goal, which included: the chemical treatment of soil to stabilize the soil (bind leachable lead), excavation and off-site disposal of impacted soils and the construction of a multi-layer asphalt cap containment system to restrict access to residual PCBs and heavy metals. Additionally, this paper will discuss the applicable environmental regulations governing the remediation. As a measure to minimize the potential for future contamination, this project also included the construction of a boat wash/washwater collection system to prevent future paint chip debris from entering the environment.

Keywords: Massachusetts Contingency Plan (MCP), Toxic Substance Control Act (TSCA), Polychlorinated Biphenyls (PCBs), heavy metals, and marina.

1. INTRODUCTION

The Site was developed in the early 1900's as a service facility for only one steam yacht. From 1940 to present, the Site has been operated as a commercial boatyard. The Site is located on Apponagansett Bay and consists of approximately 2.5 acres of land in a mixed residential and commercial setting.

Based on available research, marine paints reportedly contained PCBs from the 1940's until the manufacture of PCBs was terminated in the U.S. in 1977 because of evidence they build up in the environment and can cause harmful health effects. PCBs were used in paint formulations as drying oils (resins) and plasticizers or softening agents (liquids). Based on the historical use of the Site, it is likely that the PCBs present at the Site were generated from activities conducted at the Site from 1940 through 1977.

1.1 Conceptual Site Model – Paint Usage

Heavy metals have been added to marine paint for more than 100-years to protect boats from biological, chemical and physical degradation. The paints were designed to provide a boundary layer which would prevent organisms from attaching to the boat. Some paints were designed to slough off with the organisms. Historically, boats needed painting every year to provide this protection.

Paint chemistry changed to prolong the life of the paint and improve its antifouling and anticorrosive properties. Copper has been the primary compound used as a biocide in antifouling paints over the years (usually 10-30%, but as high as 50% composition of paint). Mercury and arsenic have also been used as a biocide in the past (reportedly 5% composition of paint).

Lead was added to marine paint as a stabilizer, biocide and anti-corrosive agent (typically 1-5% composition of paint). Zinc has generally replaced lead as an anti-corrosive agent.

Tributyltin (TBT, organic tin) was used primarily in the late 1960's to late 1980's to prolong the lifetime of the paint (about 10-15% of paint composition). Organic tins are still used on large ocean-going vessels.

PCBs were added to marine paint starting in the 1940's to give the paint better adhesive properties and to provide anti-corrosion protection from moisture, chemicals and flames (approximately 2% composition of paint). Chlorinated paraffin has gradually replaced PCBs in paints, but paint containing PCBs can still be found on some older ships. Natural sloughing of PCB paints was reduced because of the adhesive properties gained by the PCBs. This may account for the observation of very low concentration of PCBs in sediment, while metals were elevated due to sloughing and power washing of boats that has occurred in and over the water (Tighe & Bond, 2006).

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1.2 Nature and Extent of Site Contamination

The nature of the contamination was primarily heavy metals and PCBs in soil and heavy metals in sediment (Tighe & Bond, 2006). The source of soil contamination was from marine paint chips from repainting and repair conducted at the boatyard. The source of sediment contamination was likely from contaminated stormwater discharges from power washing of boats. Some contamination from marine paints may have also occurred from natural sloughing off of the paints from the bottom of the boats.

Sampling results showed that the high concentrations of heavy metals and PCBs were primarily found in the top two feet of soil. These findings are consistent with the historical painting and scraping areas of the boat yard. The locations within the Site where elevated PCB concentrations exist were coincident with elevated heavy metals in soils and include the areas where the majority of the painting and sanding of boats had taken place in the past. The outdoor central boat yard area, where boat repair work was conducted exhibited the highest contaminant concentrations of the outdoor soil samples.

Based on the results of risk assessment performed for both human health and the environment, response actions were necessary for the soil contamination. Ecological risk assessments for the sediment impacts concluded that response actions were not necessary for the sediment.

1.3 Regulatory Programs

Based on the nature and location of the release, this project was subject to various regulatory programs including TSCA, RCRA, the MCP and the Wetlands Protection Act. Below is a brief summary of how each regulatory program applied to the Site:

- TSCA: the PCB concentration in the source material (marine paint) was greater than 50 parts-per-million (ppm)

- RCRA: the soil exhibited elevated levels of leachable lead, this regulatory program was avoided however, by treating the soil in-situ with a phosphate-based reagent to bind the lead prior to excavation, so the remediation waste generated during the response actions would not be considered a hazardous waste

- MCP: the concentrations of PCBs and heavy metals present in soil exceeded the applicable Reportable Concentrations (RCs), therefore the release was reportable to the State

- Massachusetts Wetlands Protection Act: since Apponagansett Bay abuts the Site to the west, the project required approval from the Dartmouth Conservation Commission.

2. MATERIALS AND METHODS

2.1 Soil Remediation Methodology

The primary objective of the remediation efforts were to remediate the central portion of the Site containing bulk PCB remediation waste to less than or equal to the 10 milligrams per kilogram (mg/kg) cleanup level for a *high occupancy area* as specified by TSCA. In addition, other portions of the Site were remediated to less than 1 mg/kg to allow for greater flexibility for future Site uses. Through the removal of PCB contaminated soil, metals in soil would also be reduced. To achieve these remediation goals, the following sequence of response actions were conducted at the Site:

2.1.1 Central Site Area

- Chemically stabilized soils in-situ with a liquid stabilizing phosphate-based reagent where PCB concentrations exist greater than or equal to 50 mg/kg to reduce leachable lead concentrations

- Collect composite soil samples from the greater than 50 mg/kg cells for TCLP lead analysis to demonstrate leachable lead concentrations were less than 5 milligrams per liter (mg/L)

- Upon receipt of laboratory results indicating TCLP lead results were less than 5 mg/L, cells with PCB concentrations greater than or equal to 50 mg/kg were excavated for off-site disposal

- Following excavation, confirmatory sidewall and base samples were collected and submitted for PCB analysis to confirm that remaining soil contained PCB concentrations less than 50 mg/kg

- Upon receipt of laboratory results indicating identified areas with PCBs concentrations greater than or equal to 50 mg/kg had been excavated, the remaining soil was chemically stabilized in-situ with liquid stabilizing phosphate-based reagent to reduce leachable lead concentrations

- Composite soil samples were collected from the stabilized soil areas and submitted for TCLP lead analysis to demonstrate leachable lead concentrations were less than 5 mg/L

- PCB contaminated soils with concentrations greater than 10 mg/kg were excavated for off-Site disposal until remediation goals were achieved

- Confirmatory sidewall and base samples from excavated cells were collected and submitted for PCB analysis to confirm that the remediation goals were achieved

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2.1.2 South End of Site, including Building Interior

Soils located within the earthen floor of a boat repair building, an abandoned boat ramp, and on the southwest corner of the Site, were excavated to achieve PCB residual concentrations of less than 1 mg/kg. Although the majority of these soils were less than 10 mg/kg, the objective for the south side of the property was to remove soils with PCB concentrations greater than 1 mg/kg. The rationale for this excavation scenario was to eliminate the need for the deed restriction on the south end of the property and allow for future unrestricted site development.

Contaminated soil with PCB concentrations greater than 10 mg/kg and less than 50 mg/kg was transported off-Site under a MassDEP Bill-of-Lading (BOL) documentation and disposed as PCB remediation waste in accordance with TSCA at the Turnkey Landfill (A Waste Management Company) in Rochester, New Hampshire. A total of 1,900 tons (1,300 cubic yards) was transported to the Turnkey landfill. Additionally, a total of 132 tons of soil (approximately 90 cubic yards) was transported off-site as TSCA waste (greater than 50 mg/kg PCBs) under Uniform Hazardous Waste Manifests to the CWM Chemical Services, LLC facility in Model City, New York for disposal as PCB remediation waste in accordance with TSCA.

2.1.3 Confirmatory Soil Sampling Methodology

Post excavation confirmatory soil samples were collected in accordance with the EPA-approved *Self Implementing PCB Cleanup Plan* and submitted for PCB analysis. A sampling grid, consisting of 10-foot by 10-foot cells was overlaid across the Site. Each cell was assigned with an alpha numeric identification. Excavation base samples were collected every 100 square feet (one base sample per cell). Sidewall samples were collected every 20 linear feet. A total of 573 samples were collected as part of confirmatory sampling and submitted for PCB analysis.

In addition to PCBs, nine composite samples were analyzed for pesticides, antimony, copper, lead, mercury and/or tin analyses and three composite samples were submitted for TBT analysis (Tighe & Bond, 2007).

2.1.4 Sediment Sampling and Ecological Risk Assessment

As part of an ecological risk assessment, sediment samples were submitted for volatile organic compounds (VOCs), PCB aroclors, PCB congeners, polycyclic aromatic hydrocarbons (PAHs), and/or TBT laboratory analyses. Invertebrates were manually collected from the organic sediments in the intertidal zone near shore area and one from a background area. Composite samples were collected in the intertidal areas and one in the background area. The tissues were analyzed for mercury, PCBs, and TBT (Tighe & Bond, 2006).

2.1.5 Site Restoration

Upon receipt of laboratory results indicating that the remediation goals were achieved, Site capping and restoration activities were completed, which included (Tighe & Bond, 2007):

- Grading of the central portion of the Site
- Construction of the asphalt cap system in the portion of the Site subject to the deed restriction
- Construction of a centralized boat wash-water collection and treatment system
- Installation of storm water controls and utilities, and
- Construction of a concrete floor in the building that container the soil floor

2.1.6 Asphalt Cap System

A 1-foot thick asphalt cap system was constructed over the majority of the central excavation to restrict access to residual PCB contaminated soil to comply with TSCA requirements.

The area of the Site subject to the deed restriction is capped with a multi-layer cap system, which includes the following (Tighe & Bond, 2007):

- 6-inches of bituminous asphalt
- 6-inches of processed gravel with an orange warning barrier present within the center of the gravel layer, and
- Filter fabric over residual soil contamination

2.1.7 Boat Wash System

To mitigate future releases of heavy metals and paint residues to the environment resulting from power washing and boat maintenance activities, an 18-inch thick concrete boat launch pad, equipped with a wash water collection system was constructed on the southwestern portion of the property. The boat washwater collection system has been constructed to capture washwater (including sediment and marine paint chips) during the power washing of boats (Tighe & Bond, 2007).

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3. RESULTS AND DICUSSIONS

3.1 Confirmatory Soil Sampling Results

Laboratory analytical results indicated that PCB Aroclors 1254 and 1260 were detected in 75 percent of the 573 post-excavation samples collected throughout the Site. Detected concentrations of Aroclor 1254 ranged from 0.05 mg/kg to 9.8 mg/kg. Detected concentrations of Aroclor 1260 ranged from 0.07 mg/kg to 8.8 mg/kg. From the area not subject to the deed restriction, maximum detected concentrations of the Aroclors 1254 and 1260 were 0.80 mg/kg and 0.66 mg/kg, respectively. Based on the PCB confirmatory soil results received, remediation objectives were achieved for the Site (Tighe & Bond, 2007).

3.2 Sediment and Ecological Risk Assessment Results

Laboratory analytical results indicated that elevated concentrations of heavy metals (copper, lead, mercury, tin and zinc) were generally detected in the top 2-feet of sediment. Additionally low levels of PCBs (less than 1 mg/kg) were detected in shallow sediment. Laboratory results showed that the metal and PCB impacts were typically localized to the areas where boats were docked. Based on the results of the ecological risk assessment, remediation of sediment was not warranted. . A Stage II Environmental Risk Characterization was conducted in accordance with the MCP and determined that a condition of No Significant Risk to the aquatic environment existed, because sediment toxicity tests of benthic invertebrates, concentrations of chemicals in bivalve tissues collected from the Site, and modeling of concentrations in fish, shorebirds and wildlife, did not indicate a potential for biologically significant harm (Tighe & Bond, 2006).

4. SUMMARY AND CONCLUSIONS

Substantial soil remediation was performed and consisted of the excavation and off-site disposal of approximately 1,400 cubic yards (2,000 tons) of PCB and metal impacted soils. Laboratory analytical results for the 573 confirmatory soil samples collected at the Site indicated that residual PCB concentrations remain in the central portion of the Site at concentrations that could pose a risk to human health through direct skin contact or ingestion (per MCP and TSCA). This exposure pathway was eliminated through the implementation and maintenance of a deed restriction, which includes the construction and maintenance of an asphalt cap system to restrict access to residual soil contamination.

Response actions conducted at the Site were effective in eliminating ongoing sources of potential PCBs and metals associated with the release. PCBs are no longer used in marine paint and contact/ingestion of impacted soils has been eliminated through the implementation and maintenance of a deed restriction. Additionally, future releases of heavy metals to the environment resulting from power washing and boat maintenance activities has been eliminated through the paving of areas where future boat repair work may occur. In addition, a boat washwater collection

system has been constructed to capture water runoff (including sediment and marine paint chips) during the power washing of boats.

5. REFERENCES

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