Review of Mechanical and Hydraulic Dredging at Two Sediment Remediation Sites

PART V: Sediments

Chapter 8

REVIEW OF MECHANICAL AND HYDRAULIC DREDGING AT TWO SEDIMENT REMEDIATION SITES

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ABSTRACT

Tetra Tech assists the U.S. EPA Great Lakes National Program Office (GLNPO) with design and construction management of sediment remediation projects in the Great Lakes region. Tetra Tech is currently managing two sediment remediation projects for GLNPO: the West Branch of the Grand Calumet River (WBGCR) in Hammond, Indiana, and the Ottawa River in Toledo, Ohio.

The WBGCR flows through an industrialized area in northwest Indiana. Mechanical excavation of 32,000 cubic yards of sediment was completed in August 2010. The design for additional sections of the river is underway with construction planned for December 2010.

The Ottawa River is part of the Maumee River Area of Concern in northwest Ohio. Hydraulic dredging of about 250,000 yards of sediment from the Ottawa River commenced in May 2010 and is scheduled to be completed in November 2010. The principal contaminant of concern is polychlorinated biphenyls at concentrations both above and below 50 ppm.

This paper will compare and contrast the methods for sediment dredging, focusing on the specific site conditions that influenced selection of each approach as well as lessons learned during construction activities at both locations. Factors influencing remedy selection include sediment physical and chemical characteristics, site hydraulics, and site access.

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1. INTRODUCTION

Tetra Tech, as part of the joint venture SulTRAC, provides support to the U. S. Environmental Protection Agency (USEPA) Great Lakes National Program Office (GLNPO) for design and construction management at sediment remediation sites. The sediment projects are part of the Great Lakes Legacy Act funding program. The Act provides funding to take the necessary steps to clean up contaminated sediment in "Areas of Concern located wholly or partially in the United States," including specific funding designated for public outreach and research components. The GLNPO provides between 50 and 65 percent matching funds with non-federal public or private partners to facilitate remediation of contaminated sites.

Tetra Tech performed design and/or construction management at two contaminated sediment sites in 2010: the West Branch of the Grand Calumet River (WBGCR) in Indiana and the Ottawa River in Ohio. The principal partners on the WBGCR are the Indiana Departments of Environmental Management and Natural Resources. The non-federal partner funding sources are a trust fund established after settlement of natural resource damage claims and in-kind services, which is funding 35% of the construction cost. The principal partners on the Ottawa River are the Ottawa River Group (ORG), composed of several manufacturing firms with operations along the Ottawa River, and the City of Toledo, Ohio. The non-federal partners are providing 50% of the funding for the project design and construction cost.

1.1 WBGCR

The WBGCR flows through a heavily industrialized area in northwest Indiana with municipal and industrial influent accounting for 90% of the river's flow. The project area is divided into 7 reaches between Indianapolis Boulevard and the Indiana/Illinois State line with poly-aromatic hydrocarbons (PAHs) and metals the principal contaminants of concern. Mechanical excavation of 32,000 cubic yards of sediment from Reach 3 was completed in August 2010. The design for Reaches 4 and 5 is underway with construction start planned for December 2010, using mechanical excavation in the dry and mechanical dredging of submerged areas of the channel.

Reach 3 of the WBGCR lies within the corporate boundary of Hammond, Indiana. The reach is bounded on the east by Columbia Avenue and on the west by Calumet Avenue. Small commercial and residential properties line the south

bank while the north bank is occupied by Hammond Sanitary District (HSD) support facilities and baseball fields managed by the City of Hammond.

The HSD waste water treatment plant discharges an average of 50 million gallons per day approximately 2000 feet east of Reach 3. Five to ten percent of the HSD daily discharge flows west through Reach 3 with the remaining volume flowing east into the Indiana Harbor Canal. An additional source of water into Reach 3 is the Howard Avenue outfall, which is located on the south bank at the midpoint of Reach 3. During storm events the Howard Avenue outfall can discharge a flow of 50 cubic feet per second into the channel.

Prior to remediation, Reach 3 of the WBGCR was a shallow, meandering creek approximately 50 feet wide and 1-2 feet deep during most of the year. The remaining surface area within the 150-wide channel had been overgrown with vegetation, primarily invasive species including the common reed. During heavy rains water depth would rise to several feet, covering the vegetation from bank to bank.

Within the center of the WBGCR the soft sediment is about 10 feet deep. Vegetation along the sides of the river provides enough support for personnel, but can not support equipment without the use of composite mats or similar material. Because of the private property along the south bank, the river could only be accessed from the north bank.

1.2 Ottawa River

The Ottawa River is part of the Maumee River Area of Concern in northwest Ohio. Sediment remediation is focused on three sections of the lower 8.8 miles of the river, which have been impacted by historical municipal and industrial uses including several landfills within the project area. The project area is divided onto three reaches:

- Reach 2: River Mile (RM) 3.2 to RM 4.9
- Reach 3: RM 4.9 to RM 6.5
- Reach 4: RM 6.5 to RM 8.8

The river generally flows in a northeasterly direction through the project area. The banks are developed with structural material to form stable embankments for highways, and abutted by waste disposal sites and industrial properties throughout the project area. The banks throughout the targeted remediation area are often defined by concrete, riprap and sheet piling.

The lower Ottawa River is a lacustuary system in the area of RM 0.0 to approximately RM 6. This means that this section of the river is subject to a temporary change in flow direction resulting from the movement of water from

Lake Erie during wind-aided seiche events. In general, the river widens and lowers its gradient as it moves downstream, with the steepest and narrowest section being Reach 4, Reach 3 a transitional zone and Reach 2 being broad and flat.

In Reach 4, the river is narrow (average of 75 feet in width) and steep and has a deep channel where velocities and morphology tends to create erosive conditions. Water depths range from about 1 to 4 feet in mid channel. Reach 4 is recognized as a true riverine environment due to the lack of a lacustuary effect and consequently flows in one direction. In Reach 4, the presence of at least 14 major road and one rail crossings spanning the river and extensive sections of the shoreline has modified its form, and the river channel has been dredged, channelized and moved in places to accommodate road construction. The impact of these road crossings can create erosive conditions in this section of the river, especially in the lower portion of the reach.

Hydraulic dredging of about 250,000 yards of sediment from the Ottawa River commenced in May 2010 and is scheduled to be completed in November 2010. The principal contaminant of concern is polychlorinated biphenyls (PCBs) at concentrations both above and below 50 ppm, with lead, PAHs, and oil and grease also present within the sediment (Design Report, 2009).

2. MEANS AND METHODS

Several types of equipment have been developed for environmental dredging projects. Environmental dredging typically deals with smaller volumes and shallower cuts than navigational dredging projects. Environmental dredge projects may also have other operational constraints such as dewatering operations and contaminant re-suspension. (Palermo 2008). Site conditions and project partner requirements dictated the means and methods selected for the two sediment remediation projects. On the WBGCR mechanical excavation was selected while on the Ottawa River hydraulic dredging was the option agreed upon by the project partners. A more thorough review of dredge equipment and methods can be found in USEPA or US Army Corps of Engineer guidance documents.

2.1 WBGCR

Because of the limited amount of water flowing through the channel at most times during the year, mechanical excavation of the contaminated sediment in dry conditions was selected as the remedial option for Reach 3. Support facilities, to include project trailers, a dewatering pad, and waste water treatment plant, were

located in an upland area on HSD property. Access routes on the north bank were identified on the design drawings. Where possible, access routes used gaps in the tree line to minimize tree removal.

Sheet pile was initially installed at the east limit of the project area to reduce the inflow of water from the HSD. Additional sheet pile was installed at the Howard Avenue outfall to separate Reach 3 into an east and west segment. Initially the sheet pile at Howard Avenue directed storm water flows to the west, leaving the east dry for remediation. Once the east segment was complete, an additional sheet was installed at Howard Avenue to direct water east so that the west segment could be completed in the dry.

Although contaminated sediment within the channel is over 10 feet thick, only 3 feet were to be removed. The remaining sediment was covered by an engineered cap to isolate the contaminants of concern. The designed cap consisted of an activated carbon mat covered by 2 feet of granular material.

Bidders proposed several means and methods to remove sediment. The selected contractor proposed installing temporary sheeting at 200-foot intervals to provide additional stability during sediment removal and cap placement. Surface water within the excavation area would be pumped downstream from one section to the next to allow for sediment removal, cap placement, and restoration. Composite mats placed over the vegetated areas of the excavation area allowed a long stick excavator to reach the south bank. Excavated material was stockpiled within the excavation area and allowed to gravity drain prior to transfer to the sediment dewatering area.

Sediment was transferred to the sediment dewatering area by articulated dump trucks. The dewatering pad was approximately 20,000 square feet and consisted of the following layers from bottom to top: two inches of sand, a 40-mil liner, four inches of crushed stone, geo grid, six inches of crushed stone, and a perimeter earthen berm. Lime, polymer, or other agents could be mixed into the sediment so that the material passed the Paint Filter Test. Waste water elutriated from the sediment was treated at an on-site treatment plant prior to discharge into the HSD treatment system. Dewatered sediment was sent by truck to the Newton County landfill in Newton County, Indiana.

Engineered cap placement consisted of a geo grid, granulated activated carbon mat, and 2 feet of granular material. Once a section was excavated and surveyed, the geo grid and then the activated carbon mat were rolled across the river perpendicular to the direction of flow. Adjacent mat panels were overlapped by 12 inches. After mat placement, the granular cover was placed over the geosynthetic layers. Initially the 24-inch cover was placed in a single 24-inch lift, pushed out from the north bank. This placement method was unsuccessful. A

telescoping belt conveyor was then used to distribute the granular cover in thinner layers over the geosynthetic material (Figure 1).

After cap placement, areas of the north and south bank disturbed by the remediation were seeded and replanted with trees and shrubs. The sheet pile installed at the east and west project limits was retained to support remediation at other sections of the WBGCR.

Figure 1. Granular cap placement by belt conveyor

2.2 Ottawa River

Hydraulic dredging was selected by the project partners for removal of 235,000 yards of sediment with PCBs under 50 ppm and 14,000 yards of greater than 50 ppm PCB sediment. SulTRAC managed procurement and construction oversight of the dredge and sediment delivery operation. SulTRAC also managed construction of two sediment dewatering facilities. The non-federal partner was responsible for land-side management, to include operation of the geotextile tube dewatering facilities and construction and management of the waste water treatment plant.

Sediment dewatering operations are sited on the Hoffman Road Landfill, owned by the City of Toledo. The sediment with PCB concentrations lower the 50 ppm will be dewatered and left in place within the landfill waste limit. Sediment exceeding 50 ppm and the waste water treatment plant are located outside the permitted solid waste footprint. Access to the Hoffman Road landfill was secured by the non-federal partner in December 2009, allowing construction of the waste water treatment plant and dewatering pads to commence in early 2010.

The landside facilities were substantially complete in April 2010. Upon completion of the pre-dredge survey, dredging operations began May 3, 2010. The contractor mobilized two 8-inch dredges and one 10-inch dredge. One 8-inch dredge and the 10-inch dredge would normally operate 24 hours per day, six days per week, with the second 8-inch dredge on standby in case one of the operating dredges needed to be taken off line (Figure 2).

Figure 2. Ten-inch hydraulic dredge working area in Reach 2

The clean up goals were established on the basis of Surface Weighted Area Concentrations (SWACs) for PCBs, PAH, and lead. The post-cleanup SWAC goals for all reaches are:

- 1.5 mg/kg for total PCBs
- 30 mg/kg for total PAHs
- 180 mg/kg for lead

The design process evaluated the distribution of concentrations of the constituents of concern to identify how to delineate areas for remedial action. The evaluation entailed the testing of several "cut line" options, to demonstrate the resulting volume of sediment removed, mass of contaminants removed, and resulting SWACs generated when different concentration limits were applied to dredging. This process determined that "cut lines" set to remove sediment observed, or projected to contain, greater than or equal to 5 mg/kg total PCB, 30 mg/kg PAH, and 200 mg/kg lead would be sufficient to attain SWAC concentrations at or below the post-cleanup goals.

The dredge limits for the project were established by delineating areas of sediment exceeding these concentrations, using physical limits of the sediment body as established by the river banks and the base of unconsolidated sediment. These delineated areas were designated as Dredge Management Units (DMUs), defined as running along certain lengths and widths of the river to a defined depth in the sediment body. There are seven DMUs in Reach 2, eighteen DMUs in Reach 3 and six DMUs in Reach 4.

Dredging began on DMUs with PCB concentrations lower than 50 ppm with one 8-inch dredge operating in Reach 4 and the 10-inch and standby 8-inch dredges working Reach 3. Once Reach 4 was complete, the 8-inch dredge would switch to sediment greater than 50 ppm in Reach 3. Sampling completed by USEPA identified additional areas of contamination within Reach 4 DMUs after the start of dredging operations. A fourth 8-inch dredge was mobilized to the site in August to remove the impacted sediment from three new DMUs.

3. RESULTS AND DISCUSSION

3.1 WBGCR

The final volume of sediment removed from the WBGCR was 32,142 cubic yards. Unusually heavy rains in the spring and through the summer delayed completion beyond the original schedule by three months. The sheet pile diversion structures were successful in directing most storm water flows away

from the open excavation area. The project specifications allowed for most storm water in the excavation zone to be pumped downstream after a 24-hour settling period. Water within one foot of the sediment surface was pumped into tanks, treated if necessary, and discharged to the HSD. Approximately 4.5 million gallons of water was sent to the HSD over the 9 month project.

Although the contractor planned to install temporary sheet pile at 200-foot intervals to provide additional stability during excavation and cap placement, this process was abandoned after the first two iterations. The sediment was generally firmer than the contractor anticipated. Temporary silt fence was installed below the excavation areas to minimize loss of contaminated sediment during storm events.

The design for the engineered cap consisted of an activated carbon mat covered by two feet of granular material. More than one bidder suggested a geo grid between the sediment and activated carbon mat. The addition of the geogrid provided some additional stability during cap placement. After unrolling the geo grid and activated carbon mat, the contractor initially attempted to spread the granular cap over the mat in a single 2 foot lift. Uncontrolled movement of the underlying sediment created small mud waves that disrupted the mat placement and final excavation elevation. Placement of the granular cover was modified by using a telescoping belt conveyor to distribute the granular cover in thinner layers over the geosynthetic material.

3.2 Ottawa River

Hydraulic dredging of the Ottawa River met project expectations through the summer of 2010 and is on schedule for a November 2010 completion. Dredge performance typically exceeded 90% efficiency. Landside operations also performed well with only minor issues at the geotextile bag dewatering pads and the water treatment plant. Dredging of sediment with PCB concentrations over 50 ppm was completed in September with 13,954 cubic yards removed. Once the greater than 50 ppm sediment is dewatered, the material will be loaded on trucks and sent to a licensed disposal facility in Michigan before the end of 2010.

Dredging of sediment below 50 ppm will continue until November 2010. Although placement of sand cover was anticipated for some areas, dredging has proven sufficient to meet the clean up objectives. Additional dredging below the original design elevation as well as dredging near some underground pipelines that cross the project area was required to meet these objectives.

Independent sampling of the project area by USEPA identified additional areas of contamination in Reach 4. Three additional DMUs, beyond the original six in this area, were established to manage removal of the new sediment

excavation zones. Since the dredge that had completed work in this area had already moved downstream into Reach 3, a third 8-inch dredge was mobilized to the site. Two of the three new DMUs were upstream of the original project limit in very shallow water. A Portadam® system was installed downstream of the dredge areas to increase the water depth and allow placement and operation of the new dredge.

Seiche effect would periodically push most of the water out of the Ottawa River creating an expansive mud flat. During these events dredging operations were halted. These periods seldom lasted more than one day.

4. CONCLUSION

Several remedial methods are available to address contaminated sediment sites. Mechanical excavation and hydraulic dredging are two methods shown to be effective on the WBGCR and Ottawa River, respectively.

Additional sections of the WBGCR are in various stages of design or construction, with both mechanical excavation and mechanical dredging planned for different sections of the river.

Completion of dredging on the Ottawa River is planned for November 2010. Sediment with PCB concentration of 50 ppm will be disposed at a licensed landfill in Michigan. Sediment with lower concentrations will remain within the dewatering pad limit and incorporated into the Hoffman Road landfill.

5. REFERENCES

Ottawa River Cleanup Plan Design Report, Conestoga Rovers and Associates, August 2009.

Palermo, Michael, R, Paul R. Schroeder, Trudy J. Estes, and Norman R. Francingues. Technical Guidelines for Environmental Dredging of contaminated Sediments. September 2008.