Ashtabula River Remediation Project Combines Contaminated Sediment Removal with Navigational Dredging

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ABSTRACT: The Ashtabula River Remediation Project was an extraordinarily important environmental dredging project that combined navigational dredging with contaminated sediment remediation. Over the course of the complete project, conducted in two phases during 14 months of dredging, about 640,000 yd^3 (489,315 m^3) of contaminated sediment, containing approximately 25,000 lbs (11,340 kg) of polychlorinated biphenyls (PCBs), was removed from the lower Ashtabula River and depth in the federally-authorized navigation channel (18 ft or 5.5 m) was restored. The project utilized hydraulic dredging in conjunction with geotextile tube dewatering and conventional treatment of the released water. Approximately 130,000 lineal ft (39,624 m) of geotextile tubes, placed in a specially-constructed 12.5 ac (50,586 m^2) Toxic Substances Control Act (TSCA) permitted landfill, were used to dewater the dredged sediment slurry. Challenges met during the project included: large amounts of debris in the river, a long overland sediment transfer pipeline and flow-through geotextile tube dewatering on enormous scale.

PROJECT OVERVIEW

The Ashtabula River Remediation is unique among environmental dredging projects, having been jointly accomplished under the direction of the United States Environmental Protection Agency (USEPA) and the United States Army Corps of Engineers (USACE). Although each agency's specific purpose for the project differed, their goal was the same – to remove years of accumulated, contaminated soft sediments from the lower Ashtabula River.

Phase I of the project, co-coordinated by USEPA and a non-federal sponsor, focused on the removal of 25,000 lbs (11,340 kg) of polychlorinated biphenyls (PCBs) and other contaminants found in 497,000 yd^3 (379,984 m^3) of sediment, located in an area of the river which stretched from the upper turning basin, downstream to the 5th Street Bridge.

Phase II of the project, the focus of this paper, was funded by the USACE, was aimed at restoring the federally authorized depth of 18 ft (5.5 m) in the navigation channel and involved the removal of 135,000 yd^3 (103,215 m^3) of contaminated sediment, beginning at the 5th Street Bridge and continuing 1,900 ft (579 m) downstream. In the spring of 2008, when active dredging operations began in Phase II of the project, maintenance dredging of the channel had not been performed since the 1960s because a suitable disposal site for the dredged sediment could not be found. Contaminants, including PCBs, metals, polycyclic aromatic hydrocarbons or PAHs, and low-level radionuclides, precluded the traditional method of open water disposal in Lake Erie.

The solution was found with the selection of the final remedial design for the Ashtabula River Remediation Project. A 12.5 ac (50,586 m^2) special sediment disposal facility was constructed to hold the entire 640,000 yd^3 (489,315 m^3) of contaminated sediment which were removed from the river during both phases of work. The sediment was removed from the river by hydraulic dredges and pumped through a nearly three mile long pipeline to the sediment disposal facility, called the Consolidation Facility or CF. Inside the CF, geotextile tubes dewatered the dredged sediment slurry. Water released from the geotextile tubes was collected in sump and treated in an on-site treatment plant, then discharged under NPDES permit back into the Ashtabula River.

The Phase II project team consisted of General Contractor de maximis, inc., dredging contractor J.F. Brennan Company, Inc., and geotextile tube dewatering and water treatment contractor Infrastructure Alternatives, Inc.

HYDRAULIC DREDGING AND DREDGED MATERIAL TRANSFER

Dredging and sediment transfer operations throughout the entire project were performed by J.F. Brennan Company, Inc. (JFB) of La Crosse, Wisconsin. A single 12 in (0.3 m) diameter swinging ladder cutter suction dredge was utilized for Phase II operations.

Areas Dredged. For Phase II of the project, the USACE utilized station line data previously used to outline and delineate the river for past work. The same station line data set was used in Phase I to allow for continuity of operational reporting and control. These station increments began in the Ashtabula Harbor at station line zero and followed the river southbound throughout the dredge area.

JFB divided the USACE-outlined project area into six dredge management units (DMUs) to facilitate scheduling and further breakdown day-to-day planning activities to keep the client and oversight team as up-to-date as possible. Each DMU was set up to be the width of one dredge cut, averaging 100 ft (30 m) wide, which correlated to three dredge sets wide for the dredge.

Contaminants of Concern. Contaminants of concern in the sediment included PCBs, hexachlorobenzene, hexachlorobutadiene and low-level radionuclides such as uranium, radium and thorium. Original concentrations levels along with locations of “hot spots” were not supplied to JFB during the dredging process. Since dredging had not taken place in this area for several decades, it was viewed that all sediments removed during Phase II should be handled as if they were contaminated, regardless of the area in which the sediments were located. Due to the complex characteristics of the contaminants at hand and fluctuation of river flow and level, it was thought that contaminants could have been entrained in sediment throughout most of the dredged area.

Dredging Equipment Utilized. The dredge utilized in both Phases I & II for mass material removal was manufactured by Dredging Supply Company of New Orleans, Louisiana. It is equipped with a 750 hp (552 kW) main pump, RTK GPS system, and a multi-hull configuration that enables it to draft a maximum of 4 ft (1.2 m) when fully fueled.

TABLE 1: Phase II dredge production summary.

Dredge Production. Project production goals were agreed upon between the contracting team and the USACE taking into account a minimum 70% uptime for all water- and land-based operations.

Total yardage removed (actual)	144,214 yd^3 (110,260 m^3)
Total payable yardage (USACE)	132,904 yd^3 (101,612 m^3)
Effective pumping time (NOH)	1,089 hr
Gross operating hours (GOH)	1,591 hr
Total area covered	775,784 ft^2 (72,073 m^2)
Average flow rate	4,087 gal/min (15,471 L/m)

Environmental Controls. Surface water quality was visually monitored by dredging crews for the presence of turbidity plumes or re-suspended oil sheens, as it is not uncommon for oil sheen to develop from the disturbance of contaminated underlying sediments. Small periods of re-suspension occurred during the project; however, the majority of the time the river surface remained clean.

USACE established limitations for increased Total Suspended Solids (TSS) in the river downstream of the dredge (versus upstream TSS) to limit sediment re-suspension. Predetermined action levels established by the USACE were as follows:

1. Downstream TSS 25 mg/L greater than background, sustained for 1 hour – At this point, Best Management Practices (BMPs) would be assessed and turbidity control measures implemented as appropriate.
2. Downstream TSS 50 mg/L greater than background, sustained – At this point, dredging operations would be stopped and USACE notified.

A comparison of side-by-side TSS and turbidity analysis was used to determine the numerical relationship between TSS and turbidity in the river. Three turbidity monitoring stations, one upstream and two downstream of the dredge, were used to measure turbidity in the river every 15 minutes and signal the measurements via radio telemetry to a computer in the JFB field office where they were recorded.

Turbidity curtains available onsite, in the event that elevated turbidity caused by the dredging exceeded the shutdown threshold; however, throughout the course of the project, the dredge never needed to be shutdown due to elevated turbidity.

Dredged Material Conveyance. Once dredged sediments were passed through the dredge pump, they were sent through the sediment conveyance system on its way to the containment field. This conveyance system was made up of high density polyethylene (HDPE) pipeline running through multiple booster pump stations staged along the Fields Brook Corridor.

The 12 in (0.3 m) diameter dredge discharge pipe was constructed of SDR 17 HDPE pipe joined by thermal butt-fusion welds with a working pressure of 100 psi with a 2:1 factor of safety.

A barge-mounted 16 in (0.4 m) diameter booster pump was placed on sectional barges, roughly 1,600 ft (488 m) behind the dredge. It was secured to the eastern shoreline, out of the navigation channel, eliminating any hindrances to navigation on the river. The pipeline between the barge-mounted booster and the shoreline connection was SDR 11 HDPE (able to withstand higher discharge pressures from the booster).

Upon exiting the Ashtabula River, double-wall HDPE pipeline was used to contain any breaches in the inner sediment transport pipeline. Three land-based booster pumps were positioned along the length of the land-based pipeline. The first two pumps were

500 hp (368 kW) and the last was 750 hp (522 kW); a larger pump was needed at the last station to overcome increased head loss in the pipeline as the dredged material travelled up in elevation to the geotextile tubes stacked above grade in the CF.

GEOTEXTILE TUBE DEWATERING SYSTEM

Infrastructure Alternatives, Inc. (IAI) of Rockford, Michigan, was contracted to design, operate and maintain the geotextile tube dewatering system during both phases of the project and additionally, was responsible for chemical addition and water treatment operations during Phase II operations.

Geotextile tubes provided both dewatering of the dredged material and containment of the dewatered material inside the CF. The geotextile tubes filled in place inside the CF will remain there permanently; at the conclusion of the project, the CF was prepped for capping and closure.

Geotextile Tube Header System. The flow of dredged sediment slurry arrived at the CF, flowing into the geotextile tube header system at an average rate of approximately 4,000 gal/min (15,142 L/min). The geotextile tube header system was comprised of a main 12 in (0.3 m) diameter HDPE header and 10 in (0.25 m) diameter branched HDPE sub-headers, referred to as mini-headers. The main header extended from the sediment transfer pipeline and ran around the outer perimeter of the CF. Twelve in (0.3 m) by 10 in (0.25 m) line tees directed flow from the main header into the mini-headers. Each mini-header divided flow among five or more geotextile tubes. Pinch valves installed after each line tee and ahead of each geotextile tube allowed operators to fill the group of tubes simultaneously or individually. Additional pinch valves were installed at each fill port of each geotextile tube, allowing operators to direct flow into one or more "zones" within the tube itself.

The mini-header design gave operators the flexibility to maximize every cubic yard of available volume in each geotextile tube and correct problems such as uneven filling in an individual tube, caused by coarse grain solids depositing near the upstream fill ports. It also provided "banks" of available geotextile tubes, rather than single tubes; this was a necessity for a system handling 4,000 gal/min (15,142 L/min) of dredged sediment slurry.

Chemical Conditioning of Dredged Sediment Slurry. In order to achieve the best possible dewatering in the geotextile tubes, the dredged sediment slurry was conditioned with flocculating chemicals (polymers). The chemicals and associated feed system used for this project were provided by SNF, Inc. of Riceboro, Georgia.

TABLE 2: Phase II chemical consumption.

Chemical	Added to	Purpose	Consumption
Cationic polymer	Dredged material slurry at CF	Primary flocculant	113,850 lbs (51,641 kg)
Secondary coagulant	Dredged material slurry at CF	Enhance flocculation	32,200 lbs (14,606 kg)
Aluminum-based anionic polymer	Weep water prior to lamella clarifiers	Flocculate TSS; neutralize any un-reacted cationic polymer	139,825 lbs (63,424 kg)

A dual chemistry approach was used to flocculate the dredged sediment slurry. The primary flocculant was a mid-weight, mid-charge cationic polymer, aided by a secondary coagulant. The cationic polymer product was purchased as a concentrated, dry powder and made down into a liquid solution on site. The secondary coagulant was purchased in liquid form.

The desired polymer dosage rate was determined by system operators through jar testing and was frequently adjusted to meet changing sediment types, dredged material flow rates and solids content. The combination of an automated feed system with diligent oversight by experienced water treatment operators prevented gross over- and under-feed situations from occurring, a key to successful geotextile tube dewatering.

Personnel routinely collected samples of sediment slurry post-chemical injection and evaluated floc formation and the appearance of separated water to verify the accuracy of the jar tests used to determine the dosage rate. Their goal was to create a medium to large-sized, sturdy floc particles. Downstream water treatment units were susceptible to polymer over-dose situations, therefore, operating techniques were used to target optimum to slightly low (under-dose) feed rates.

Sizing, Filling and Placement of Geotextile Tubes. Detailed plans were developed for filling the geotextile tubes in the CF, including the size and specific placement of every tube and the sequence for deploying the tubes. This was essential to ensure that not only all available space within the CF was utilized, but also to ensure stability in the stack of geotextile tubes.

TABLE 3: Phase II geotextile tube utilization.

Circumference of each tube	75 ft (23 m)
Maximum fill height of each tube	8 ft (2.4 m)
Individual tube lengths	80 – 275 ft (24 – 84 m)
Total lineal length of tubes utilized	130,000 ft (39,624 m)
Layers of tubes completed	5 (layers 6, 7, 8, 9 & 10)

Phase I operations ended with the filling of geotextile tubes in layer five inside the CF, with the top elevation of the stack approximately level with the top of the CF side walls. Phase II of the project began with the construction of layer six and ended with the completion of layer ten. To the knowledge of the project team, ten layers of stacked geotextile tubes are the most to ever be completed. Figures 1-a and 1-b, below, illustrate the general layout plan as developed prior to construction. (These figures are not to scale or "as-constructed" representations.)

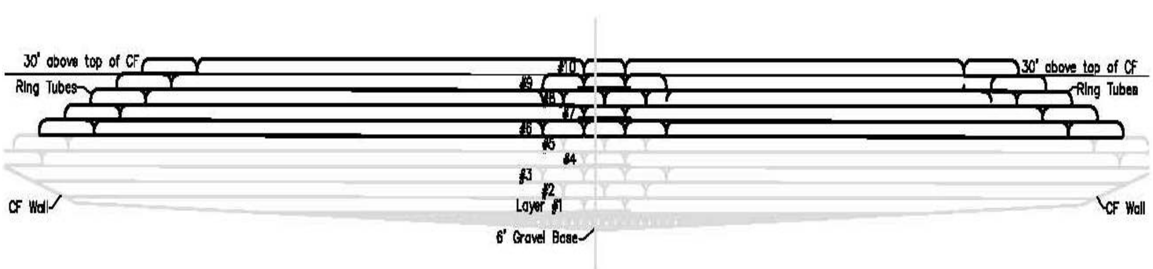

FIGURE 1-a: Phase II pre-construction geotextile tube layout plan, cross-section, 140 ft north of the weep water sump.

FIGURE 1-b: Expanded view of the left side of Figure 1-a.

In order to successfully place and fill geotextile tubes in layers six through ten, operating techniques had to address the following critical factors:

1. Stability of the stacked geotextile tubes. In Phase I, the sloped floor of the CF (designed to encourage weep water to flow toward the sump where it was collected for treatment) was leveled with the installation of the first layer of geotextile tubes and a gravel base at the low point of the floor. However, to ensure the stability of the stack of geotextile tubes in the upper layers and the tubes were placed as tightly together as possible, throughout the project, the first tubes deployed and filled in each layer were those at the low end of the CF, where the sump was located. This way, gravity worked to our advantage, pulling each consecutively placed tube in toward the stack. Additionally, each geotextile tube was placed on center over the seam where the sides of the two tubes beneath met and each consecutive layer of geotextile tubes was approximately 30 ft (9.1 m) shorter in length than those tubes in the layer below, leaving about 15 ft (4.6 m) of the tubes beneath exposed on either end. This gave the stack a pyramid shape.
2. Consolidation of the dewatered material within the geotextile tubes. It was essential that the material contained in the geotextile tubes be sufficiently dewatered before the tubes were stacked upon so that the bottom layer tubes could withstand the weight of the upper layers pressing down without suffering catastrophic structural failure. It was determined through consultations with two geotextile tube manufacturers that if the material inside the tubes could be dewatered to at least in-situ percent solids concentrations, the tubes in the lower layers would hold. Several hanging bag tests, a proposed ASTM standard for determining the ability of geotextile tubes to dewater a particular material, were conducted and the results confirmed that in-situ percent solids concentrations could be reached in a reasonable amount of time. Standard operational practice in the field called for allowing enough time for material within each tube to consolidate to in-situ percent solids before stacking upon those tubes. This strategy was proven effective as there were no tube failures due to the weight of the upper layers pressing down.
3. Structural integrity of the upper layers of geotextile tubes. The geotextile tubes filled in Phase I, layers one through five, were contained within the side walls of the CF; the side walls bolstered the ends of the tubes, helping to keep them in place, prevent ruptures and if a rupture were to occur, contain the spilled material. The geotextile tubes filled in Phase II, layers six through ten, were filled above the grade of the perimeter of the CF and did not have the benefit of butting up against the side walls. The outside ends of the upper layer tubes were unprotected, which could possibly lead to those tubes

rupturing or moving, due to the tremendous weight pressing down upon them from the tubes stacked above. To combat this, IAI dewatering crews installed "ring tubes," parallel to the CF perimeter and perpendicular to the ends of the rest of the tubes inside the CF. The ring tubes had a stabilizing effect by absorbing any outward pressure or momentum from the upper layer tubes and also provided several secondary benefits: (1) additional capacity for dredged material dewatering; (2) a barrier which could prevent material from spilling outside of the CF in the event of that an upper layer tube did rupture and (3) weep water conveyance to the sump.

4. Accessibility of the upper layers of geotextile tubes. In general, the layout plan for each layer of geotextile tubes began with tubes being placed at the southern end (low end) of the CF, crosswise on either side of the haul road, an open strip running down the center of the CF. The haul road provided heavy equipment and personnel with access to the tubes from inside the CF. After three layers of tubes were filled on either side of the haul road, the difference in elevation between the top of the stacked crosswise tubes and the haul road itself became too great for the heavy equipment in use on site to overcome. At that point, three layers of tubes were laid lengthwise down the center of the haul road, filling it in and bringing the elevation of the road up to that of the top of crosswise tubes. Although the haul road design had been abandoned by the end of Phase II, when the last layers of tubes were filled, it was extremely important earlier in the project, because it provided the access needed for heavy equipment to place geotextile tubes prior to deployment.

Weep Water Drainage and Collection. The floor of the CF was sloped promote drainage of weep water away from the geotextile tubes and to the sump where it was collected for treatment. IAI personnel anticipated, however, that as the CF became more and more full with filled geotextile tubes, there would be fewer and fewer channels whereby the weep water could migrate to the sump, which would lead to ponding. To combat this problem, IAI dewatering crews used portable centrifugal pumps, placed throughout the CF, to keep weep water moving to the sump.

WEEP WATER TREATMENT

Weep water was pumped from the sump in the CF at an average rate of 3,000 gal/min (11,356 L/min) to an on-site water treatment plant designed to remove any fine suspended solids and lingering organic contaminants before the water was returned to the Ashtabula River, under the conditions of NPDES permit issued by the Ohio Environmental Protection Agency. The water treatment plant was capable of treating up to 7,200,000 gal/day (27,254,965 L/day).

TABLE 4: Phase II average water treatment plant loading.

Influent flow rate	3,275 gal/min (12,397 L/min)
Weep water turbidity	94.4 NTU
Lamella clarifier effluent turbidity	16.1 NTU
Water treatment plant effluent turbidity	3 NTU

Weep water from the sump was injected with an aluminum-based anionic polymer, with two objectives: firstly, to flocculate suspended solids; and secondly, to neutralize any carryover of un-reacted cationic polymer in the weep water. A static mixer blended the polymer with the flow of weep water, which then passed into a series of seven inclined plate separators for removal of suspended solids. Effluent from the plate separators was split among five pressurized sand filters for polishing. In the last treatment step, sand filter effluent passed through five parallel trains of granular activated carbon (GAC) adsorption units (two units per train) for removal of any stray organic contaminants. A pipeline, approximately three miles long, delivered the water treatment plant effluent back to the Ashtabula River. Solids removed from the weep water in the clarification and filtration processes were disposed of in the CF.

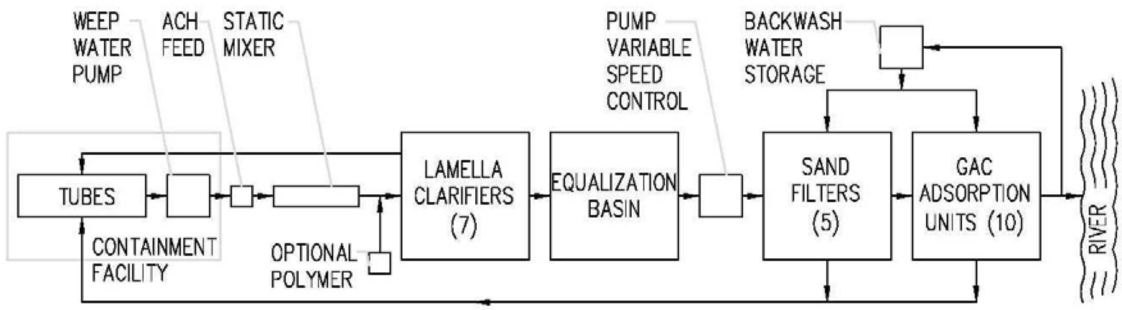

FIGURE 2: Water treatment plant process flow diagram.

SUMMARY

The navigational dredging, and associated sediment management, phase of this project (Phase II) represents the successful completion of an extraordinarily important environmental dredging project on the Ashtabula River. Over the course of both phases of the project, nearly 640,000 in-situ yd^3 (489,315 m^3) of contaminated sediments were removed, dewatered and disposed of. All told, approximately 130,000 lineal ft (39,624 m) of large circumference geotextile tubes were deployed and filled in the CF, a TSCA permitted landfill. This project demonstrated the viability of hydraulic dredging and geotextile tube dewatering in large scale environmental dredging projects. The project also represents the first time that large circumference geotextile tubes were stacked in ten layers. These stacked tubes were deployed and filled without compromising the stability of the filled tubes below. Additional challenges met during the project included the large amount of debris in the river and the long overland sediment transfer pipeline and booster pump system.

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