LESSONS LEARNED MANAGING MULTIPLE WASTE STREAMS AT A SUPERFUND ALTERNATIVE SITE

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ABSTRACT

At the Cedar Creek Operable Unit 2A (CCOU2A) Superfund Alternative site in Cedarburg, Wisconsin, approximately 70,000 cu yds of PCB contaminated sediment were removed, processed and disposed of – all while maintaining separation of TSCA-regulated and non-TSCA material. Although the project was originally designed for mechanical dredging, the team of J. F. Brennan (Brennan), Infrastructure Alternatives (IAI), RAMS Contracting, Cardno and NRT was selected to perform the project under an alternate bid, which incorporated predominantly hydraulic dredging, minor mechanical dredging, geotextile tube dewatering, on-site water treatment process as well as habitat replacement and restoration.

Material removal, treatment, and disposal processes were all designed with the following goals in mind: (1) complete the work safely and expeditiously, increasing production and efficiency to reduce project schedule; (2) extract and process TSCA and non-TSCA material separately, without cross-contamination; and (3) utilize the smallest footprint possible. Project Managers Paul Olander and Brent Cardwell will describe the advantages of the hydraulic process, the challenges experienced during the performance of the project, and the results achieved.

Keywords: Hydraulic dredging, geotextile tubes, TSCA, contaminated sediment, PCB

INTRODUCTION

The Cedar Creek Operable Unit 2A (CCOU2A) Superfund Alternative project site is located in Cedarburg, Wisconsin. This project involved the removal and processing of contaminated sediment, with varying levels of polychlorinated biphenyl (PCB) contamination. One of the greatest challenges of this project was to extract and handle separately regulated waste streams, limiting the amount of excess material processed as TSCA waste, and preventing waste streams from mingling during processing.

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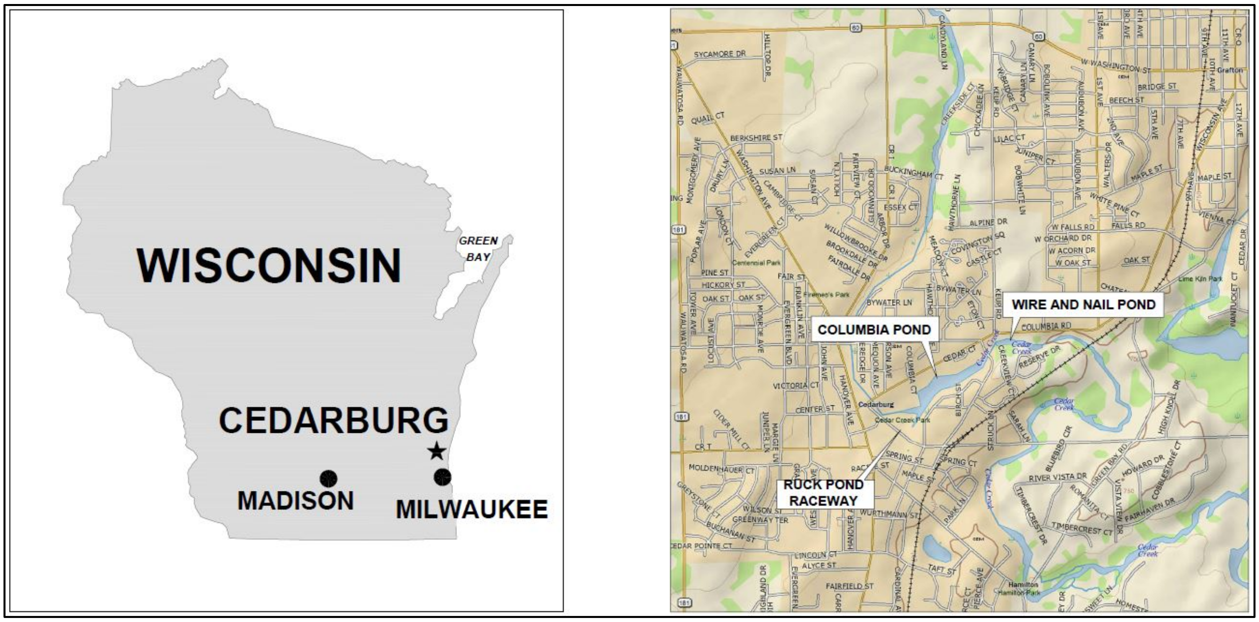

Figure 1: Location of the Work

Background Information

The sediments targeted by this project were contaminated by PCB-containing industrial products, decades ago. An extensive characterization of the Site has been performed over the past two decades, with the most recent pre-design investigation (PDI) sampling occurring in 2014 and 2015 (Anchor QEA, October 2016). PCB levels in the sediment, measured during the PDI ranged from non-detect to 345 mg/kg (Anchor QEA, June 2016). Sediments containing PCBs at concentrations in excess of 50 ppm are regulated under the Toxic Substances Control Act (TSCA) and must be disposed of in Resource Conservation and Recovery Act (RCRA) Subtitle C-licensed facility.

Schedule

Work first began on this project, with earthwork and site preparation, in October 2016. The first phase of dredging operations got underway in November 2016. After a winter shutdown, the second phase of dredging began in April and concluded in late October 2017. Sediment load out and on-going water treatment operations were still being performed, as of February 2018.

MAXIMIZED DREDGE PRODUCTION

Phase I Material Removal

As stated above, in November of 2016 remediation for the Cedar Creek- Operable Unit 2A commenced with the mechanical dredging of Ruck Pond Raceway. Operations for the project began here due to its orientation in the upstream portion of the Project limits. A mechanical remedy was chosen as most of the sediment was accessible from the banks and could be efficiently transferred to the onsite Sediment Processing Area (SPA). Remedial dredging activities within Ruck Pond Raceway continued from November through December with a total of approximately 5,500 cubic yards of contaminated sediment being removed by a series of excavators guided by RTK-GPS. In addition to the mechanical excavation, of the main body of Ruck Pond Raceway, the upstream, underground culvert sections were also remediated by use of high pressure washers and vacuum trucks.

Phase II Material Removal

The alternative bid developed by the contractor team for this project, changed the dredging method from mechanical to hydraulic, for the majority of the material to be removed. This was the material removed during Phase II dredging operations, in 2017. Utilizing the hydraulic dredging process provided the contractors an opportunity to lower cost to the owner by increasing the production rate, and shortening the schedule; but another major cost driver on this project (and most, if not all, contaminated sediment projects) was the disposal of the dredged material. It was critical to achieve higher dredging production while keeping waste streams with disparate disposal costs completely separate and limit the amount of material disposed of at higher cost.

The team developed methodology and techniques which focused on utilizing two dredges for the majority of the work in Columbia pond which held the largest volume of contaminated sediments onsite. Further, these dredges were utilized in a manner which kept one dredge in a bulk removal mode while the other targeted final or clean-up passes. Generally, the bulk removal dredge would be downstream, while the final pass dredge cleaned up behind. Each dredge then operated off of an independent discharge line which would allow each dredge to target TSCA or Non-TSCA delineated areas, as needed. The independent discharge lines met at a header system on the bank near the SPA which channeled the flow to either the TSCA or Non-TSCA dewatering pads. Eliminating the need to shut the entire system down to change waste streams saved the Project significant time over the life of the work.

Dredge Management Units

The project footprint, which encompassed Ruck Pond Raceway, Columbia Pond, Wire and Nail Pond as well as four isolated areas, were broken down into a total of 124 Dredge Management Units (DMUs). Polygons in which TSCA concentrations were identified were then overlaid onto the DMUs. As the dredges navigated through the removal process, the DMU and TSCA boundaries were delineated on the onboard computer system screen. This allowed the operators as well as the rest of the crew to clearly visualize which waste stream they were targeting as well as pre-plan work and movement for the upcoming days. An example of the DMU/TSCA Polygon layout for Columbia Pond is shown below.

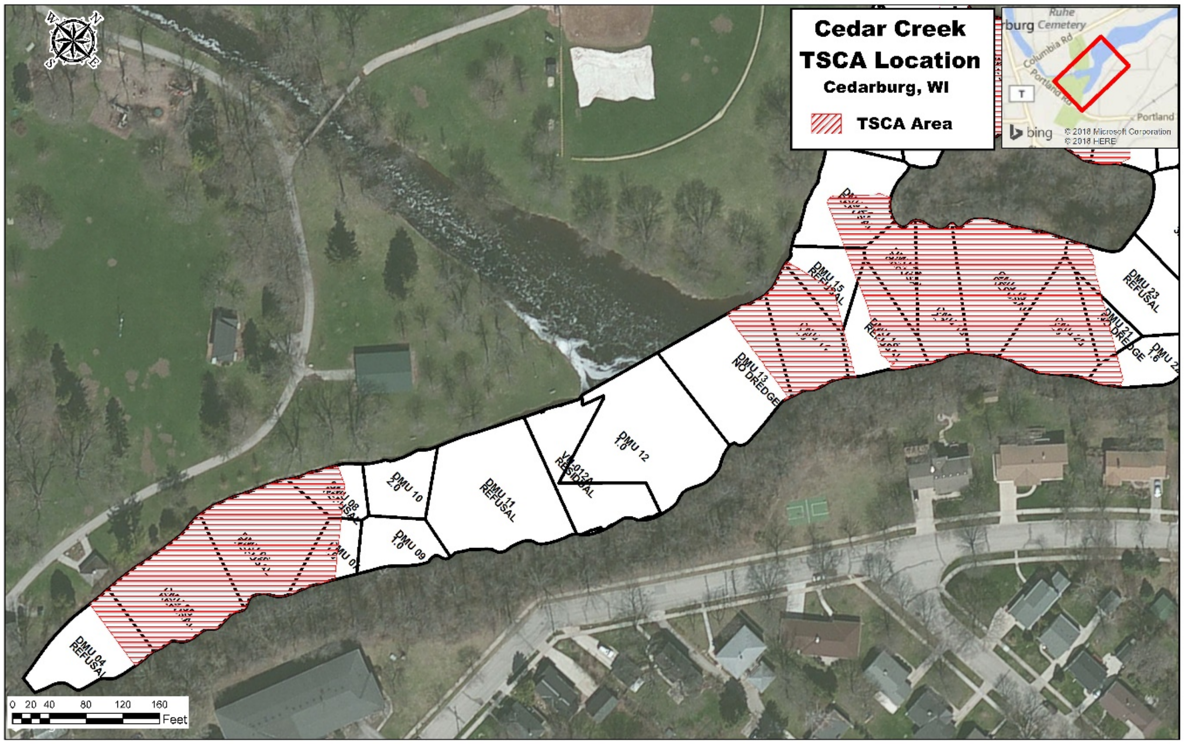

Figure 2. Example of DMU – TSCA Polygon Layout in Columbia Pond

Dredges

Both dredges Brennan utilized for the hydraulic removal of sediments are DSC Moray Class, 8” hydraulic, swinging ladder dredges which have been further modified for environmental remediation.

Figure 3. Dredges *Palm Beach* and *Fox River*

Managing Waste Streams, First from the Water

As the dredges moved from DMU to DMU, they moved from TSCA to non-TSCA polygons, and vice-versa. Each dredge moved each classification of material. This increased efficiency by reducing the amount of time spent moving the dredges between DMUs.

Both dredges were guided by precision RTK-GPS systems and sensors which were interfaced through the Hypack® DredgePack® Software and visualized in the cab of the operator’s lever room. Every day in which work was undertaken, a hydrographic survey was performed to map the progress of the remediation. This new data was then uploaded onto the computer system so operators and management could track progress throughout the process.

Before a dredge could begin moving non-TSCA material, after being in TSCA material, a flushing process was utilized to remove any residual sediment from the dredging attachment and discharge pipeline. Surface water was pumped by the dredge, through the pipeline, to the Sediment Processing Area, to rinse the equipment and ensure no TSCA material could be left in the conveyance system. For the majority of the work, a period of 30 minutes was utilized to flush the pipeline. For work that was undertaken in Wire and Nail Pond, 1 hour of flushing was utilized. When the flushing process was complete, the dredge could begin working in non-TSCA material. On a related note, the process for transitioning from non-TSCA to TSCA involved a flushing process as well but one of a shorter nature, generally 5-10 minutes, based on the length of discharge pipeline in the given system. This was conducted to make sure that all applicable material from each waste stream was placed correctly. For example, if operations were to switch to TSCA without a flushing period, residual non-TSCA sediments remaining in the pipeline would be treated and later disposed of as TSCA sediments, which are far more costly.

HIGH FLOW DREDGED MATERIAL PROCESSING

The sediment dewatering and water treatment systems were designed to process full flow from both dredges simultaneously – again, for efficiency. But it was not as simple as building a large facility. The landside operation was hamstrung by available space – the dewatering and water treatment operations had to fit in a small section of a public park, inside a residential area of Cedarburg.

Sediment Processing Area

The flow of hydraulically dredged material, both TSCA and non-TSCA, was dewatered in geotextile tubes in the Sediment Processing Area (SPA), constructed in Adlai Horn Park. The 600-ft. by 350-ft. SPA was sectioned into a TSCA Dewatering Pad, Non-TSCA Dewatering Pad, and Chemical Conditioning/Water Treatment Plant Area. These areas were carefully staged to maximize the space.

Figure 4. SPA Layout

Challenges of a Small Space

With a relatively small staging area at Adlai Horn Park, and being located on a busy residential street, communication with the trucking and delivery companies was critical. During mobilization, the trucking companies were instructed to call ahead and were called in as soon as the truck ahead of them was unloaded. Only one to two trucks were able to fit in the unloading area at one time.

The SPA footprint had to be large enough to fit the geotextile tubes, a sump large enough to hold geotextile tube filtrate produced by full production from both dredges, and storm water. The site roads, pad and sump were sized to very tight tolerances to fit in the available space.

Geotextile Tube Dewatering

The SPA and geotextile tube layout plan was designed to hold 75,375cubic yards of dredged slurry. Large circumference geotextile tubes were stacked in four layers in the Non-TSCA pad and three layers in the TSCA pad, to allow more material to be dewatered within the same footprint.

Table 1. Geotextile Tubes Data

Total No. Geotextile Tubes Deployed	42
Sizes of Geotextile Tubes Utilized	60 – 82.5 ft., dia. Up to 285 ft., length
Total Vol. Material Dewatered	70,555 cu yds
Time to Fill Each Tube	2 – 4 days

Maintaining Separation of TSCA and Non-TSCA Material

To ensure the flows of TSCA and Non-TSCA dredged material was conveyed from the dredge to the correct dewatering pad, contractors relied on a system of engineering controls, close communication and recordkeeping.

Engineering Control

The two pipelines that delivered dredge slurry from each dredge to the SPA for processing could carry either TSCA or Non-TSCA material, and at any time the two pipelines might be carrying the same type of waste stream or different. To keep TSCA material from inadvertently entering the Non-TSCA Dewatering Pad, the operations staff devised a lock-out/tag-out style system on flow control valves which were installed in the pipelines where they entered the SPA.

The valves could be configured to allow all flow (from both dredges) to flow to the Non-TSCA Dewatering Pad, or flow from one dredge to the Non-TSCA pad and flow from the other dredge to the TSCA pad. This system could also allow for both dredges to flow to the TSCA pad for short durations but this was never utilized during operations. The landside contractor and the dredging contractor shared responsibility for these valves, each carrying their own key to a padlock installed on chains wrapped around the flow control valves. The valves could not be moved without unlocking both padlocks and loosening the chains. This physical barrier prevented the valves from being accidentally turned and the two-lock set up ensured that each time the valves were realigned, a minimum of two pairs of eyes were checking the valves for the correct configuration.

Figure 5. Dredge Slurry Pipeline Flow Control Valves

Communication

Daily meetings kept everyone informed of the current position of the dredges and the classification of material that was being moved by each. Dredging and landside crew members utilized radios to freely communicate throughout each shift.

Recordkeeping

As mentioned above, dredge progress was tracked by daily hydrographic survey. At the end of each survey, mapped elevations were compared to design elevations to gauge progress. Isopachs were then created to visualize the extent of the progress. Volume calculations were also undertaken to track daily progress versus initial production goals.

Chemical Conditioning

Just as proper sizing of the sediment processing system is critical to maximizing dredging production rates, so is chemical conditioning of the dredge slurry. Chemical conditioning in a geotextile tube dewatering operation must be effective, even more so for a high flow system with stacking and limited footprint. The purpose of chemical conditioning is to create a large, sturdy floc in the sediment slurry, using chemistry to begin the process of separating free water from the solid material in the slurry.

Figure 6. Dredge slurry-polymer mixture

The first step in achieving favorable floc formation, is product selection. A single product was chosen for use on this project, a cationic (or positively-charged) emulsion polymer was applied to both the TSCA and Non-TSCA dredge slurry. This product was selected after extensive screening and bench testing.

The next step, is injecting the polymer product at the correct dose rate. This can be difficult because the flow of dredge slurry can vary greatly, as well as the amount of solid material in the slurry. The landside contractor utilized a polymer application system, controlled by a PLC, which received inputs from a dredged material flow meter and a density meter, as well as a target dose set by the system operator. The PLC processed these inputs, then adjusted the speed of the polymer application pump, in order to achieve the target dose for the flow of dredge slurry and concentration of solids flowing through the pipeline at that moment.

Table 2. Polymer Application.

Parameter	**Min.**	**Max.**	**Avg.**
Dredge Slurry Flow, GPM	800	2500	1700
Dredge Slurry, Percent Solids	0	20	3.4
Polymer Dose, Lbs./Dry Ton Solids	0	15	5.6

Another key variable in floc formation is mixing. Chemical products must be thoroughly mixed into the dredge flow in order to form floc throughout the volume, but must also be agitated enough to cause those floc pieces to stick together and increase in size. Too much agitation, however, will result in floc shearing and destruction of the floc pieces. So, it is important to select the chemical injection point where the slurry will have adequate pipe run and turbulence to thoroughly mix with the chemical product… but not overmix.

Operators in the dewatering pads took grab samples from the dredge slurry pipelines and observed floc formation. If the operator observed small floc, cloudy separated water, or other unfavorable characteristics in the polymer-dredge slurry mixture, the operator would adjust the polymer feed, until the floc formation improved.

Figure 7. Dewatering Geotextile Tube

Stacking

Stacking geotextile tubes provides an opportunity to better utilize available space, but can also create operational challenges. The first row of geotextile tubes must be properly consolidated before another layer of tubes can be deployed and filled on top. Stacking too soon can lead to problems like poor dewatering in the stacked tubes, tubes shifting out of position, or ruptured fabric in the tubes that are being stacked upon. Therefore, the geotextile tube layout has to have enough capacity to allow adequate time for the material in the tubes to dewater and consolidate, before it becomes necessary to stack on them. Otherwise, the dewatering operation will inhibit dredge production and slow (or shut down) the entire project.

The landside contractor determined how many tubes, how many layers, and the sizes of the tubes in each layer, based on data such as: the volume of each waste stream, the footprint of the SPA, the maximum flow rate of each dredge, the expected percent solids of the dredged material, the scheduled number of dredging days and hours of dredging per day.

Figure 8. Aerial view of stacked tubes in the SPA

Filtrate Collection and Conveyance

The dewatering pads were designed such that filtrate from each pad drained to the same sump, a rectangle-shaped holding pond, between the two pads. Storm water that fell on the SPA drained to this sump, as well.

Water Treatment

A water treatment system was installed at the site to process all of the filtrate and storm water that collected in the sump between the dewatering pads. The system was sized to treat water at a maximum flow rate of 3,900 gallons per minute (or up to 4.32 million gallons per day, if operated 24 hours per day). A total of 231.94 million gallons of water have been treated since the start of hydraulic dredging in 2017.

The treatment system was designed with processes to remove suspended solids, colloidal solids, and dissolved organics.

Clarification

A pump conveyed water from the sump, into the inclined plate clarifiers for settling out of suspended solid material. This was the first step in treating water separated from the dredged material. Ferric chloride was introduced into the flow of water as it entered the clarifiers, to aid flocculation and settling. Weir overflow from the two clarifiers then flowed to two equalization tanks.

Figure 9. Inclined plate clarifiers

Filtration

From the equalization tanks, water was pumped, under pressure, through multi-media filters. The media beds in these filters were made up of layers of granular material, varying in size and chemical properties, to trap and separate solids from the flow of water.

After the multi-media filters, water was forced through bag filtration units, which use fine mesh bags to strain the water and capture even smaller solids than those removed by the multi-media filters.

Figure 10. Multi-media filters

Carbon Adsorption

The final step in the treatment process was carbon adsorption. The water was pumped through pressure vessels containing granular activated carbon or GAC. The GAC media has the ability to adsorb, or collect and hold organic contaminants such as PCBs on its surface. This is utilized as a polishing step, to ensure that no detectable PCBs are discharged.

Figure 11. Process samples from dredge slurry through treatment to final effluent.

The treatments system designed, installed and operated by the landside contractor maintained an excellent record of discharge permit compliance throughout the project. A Wisconsin Pollution Discharge Elimination System (WPDES) Permit Equivalency was issued by the state regulatory agency for this project, establishing the following treated water discharge quality parameters:

Table 3. Treated Water Quality Discharge Parameters

TSS, daily max. limit	10 mg/L
TSS, monthly avg. limit	5 mg/L
Oil and grease, daily max. limit[3]	15 mg/L
Total PCBs, daily max. limit	Non-detect or <0.003 ng/L

CONCLUSIONS

The contractor team was able to demonstrate, by their performance of this project, that hydraulic dredging to geotextile tubes is a viable option, even for sites with multiple waste streams, limited space for landside operations, and proximity to public spaces. Hydraulic dredging, in combination with geotextile tube dewatering, allowed material removal at an effective production rate, with the added benefit of transporting material in a closed-loop system, which drastically reduced the risk of public exposure to contaminants. And perhaps the greatest benefit to the project, was that hydraulic dredging to geotextile tubes allowed separate extraction and handling of TSCA-regulated and Non-TSCA material, with confidence and without incident.

REFERENCES

Anchor QEA, "Quality Assurance Project Plan: Cedar Creek Site – Operable Unit 2A" October 2016

Anchor QEA, "Basis of Design Report: Pre-Final Submittal – Cedar Creek Site – Operable Unit 2A" June 2016

CITATION

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[3] Oil and grease sampling was only required if a sheen was noted near the outfall.