

**2014 Western Dredging Association Environmental  
Excellence award Nomination Application**

**Dredging and Processing Arsenic Contaminated Sediment  
Menominee River  
Marinette, Wisconsin**



**Project Owner:  
Tyco International Company**



**Nominated by:**



### **Nominating Entities**

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### **Project Owner**

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### **Award Category**

Environmental Dredging

### **Summary**

The dredging site is within the Lower Menominee River Area of Concern (AOC) in northern Wisconsin and is located next to an active manufacturing facility owned and operated by Tyco International producing fire protection products. The facility began operations in 1915 first as a lumber mill then producing cattle feed, refrigerants, and specialty chemicals throughout later years. Arsenic-based agricultural herbicides were manufactured at the facility between 1957 and 1977. A byproduct of the manufacturing of these herbicides was a salt that contained approximately 2 percent arsenic by weight and was stockpiled at several locations on the property. Some of this arsenic subsequently entered site soil, sediment and groundwater. By 1978 the facility ceased production of arsenic-based herbicides and since 1983 has produced only fire extinguishers and fire suppression systems. Tyco purchased the site from Ansul in 1990.

The 2012-13 dredging construction scope of work entailed:

- Dredging approximately 259,000 CY of organic arsenic impacted sediment using an environmental clamshell bucket (both Anvil and Cable Arm brands), and supplemented with a heavy digging clamshell bucket or conventional digging bucket when conditions warranted.
  - All soft sediments with arsenic concentrations greater than or equal to 50 milligrams per kilogram (mg/kg) will be removed.
  - Semi-consolidated materials with arsenic concentrations greater than or equal to 50 mg/kg will be removed.
  - Monitored natural recovery (MNR) will be implemented in the area where sediments have been removed to document anticipated further reductions in sediment arsenic concentrations to achieve USEPA's target concentration of 20 mg/kg.
- Pugmill processing of the dredged material with chemical additives and other absorbent materials (i.e. wood chips)
- Material staging post processing and sampling

- Offsite disposal as non-hazardous material following toxicity characteristic leaching procedure (TCLP) evaluation for arsenic

As the project evolved during the final stages of permitting with the State, design changes by the engineer and changes in the construction methods required that the stabilization approach evolve as well. During the 2012 season production was limited by the ability to treat the material and dispose of it as nonhazardous. Additional treatability studies were conducted following the first season of dredging (November 2012-February 2013) to reevaluate reagents, chemicals, and dosage rates on the sediment. With the new treatability study data the team made a joint determination of a new stabilization approach that not only included revised reagents and dosages, but also significant improvements to process equipment and the site layout that would allow for an increase in production levels to meet the dredge project's target completion date.

The presentation will summarize the treatability studies conducted in the lab to optimize the sediment processing and the dredging/processing techniques employed in 2013 to successfully complete the project. The presentation will also review the waste water treatment system installed for treatment of all barge decant water and site contact water for soluble organic arsenic.

### **Environmental Benefits**

In 1987, the federal governments of the United States and Canada adopted amendments to the Great Lakes Water Quality Agreement (GLWQA). One of these amendments, called "Annex 2 of the 1987 Protocol," directed the two countries to identify areas of concern that did not meet the objectives of the GLWQA. The Lower Menominee River was identified as being one of the 43 Great Lakes Areas of Concern (GLAOCs).

Long-term goals for the Menominee River GLAOC include:

- Protect human health and the environment;
- Protect the aquatic ecosystem of the Menominee River and Harbor from the effects of toxic and conventional pollutants;
- Maintain a balanced aquatic and terrestrial community to ensure long-term health of the ecosystem;
- Maintain and enhance recreational and commercial uses of the Menominee River and Harbor, consistent with the long-term maintenance of the natural resource base and a healthy economy.

Ultimately, the removal of the organic arsenic sediments will reduce the levels of arsenic in fish and limit the potential of humans coming into contact with the sediment through recreational activities.

### **Innovation**

During initial dredging, processed sediments were not consistently passing the TCLP test for arsenic concentrations required for offsite disposal as non-hazardous material. A large portion of the 2012 season was spent in the field trying to determine the optimum sediment processing design. In the fall of 2012 and the winter of 2013 an intensive lab-based treatability study was performed to supplement the lessons learned in the field.

The treatability study scope of work included two main elements:

- Conduct a comprehensive round of new mix designs and long-term curing studies to evaluate alternate reagents to more efficiently (and cost-effectively) treat the arsenic-containing soft dredged material (DM) and semi-consolidated material (SCM). Alternatives were sought for the 2012 dosing rate of up to 25 percent (by weight) of a 60 percent ferric sulfate solution plus 10 percent Portland cement added to the soft DM.

- Evaluate the potential for deploying a rapid, real-time assessment approach/tool for determining total arsenic, preliminary toxicity characteristic leaching procedure (TCLP) for arsenic, and moisture content of the DM and SCM in the scows before unloading. Having this data in advance would enable the team to optimize (lower) reagent dosing.

Both scope items were performed at the CH2M HILL Applied Services Laboratory in Corvallis, Oregon.

The first scope item sought to increase the overall treatment efficacy by identifying alternative reagent pairings (for the same DM conditions) that are more efficient to implement and results in lower overall unit cost without loss in treatment effectiveness.

The team conducted many internal and external discussions with reagent suppliers, technologists, and subject matter experts in an effort to identify suitable reagent alternatives. CH2M HILL retained an external subject matter expert (Dr. Larry Twidwell of Montana Tech) with knowledge of highly arsenic-impacted systems who assisted in the final selection of reagents and the specific geochemical and reagent deployment issues for sediment at the Tyco facility.

The second element of the scope of work involved testing two rapid assessment analytical techniques. The first study evaluated the development of a rapid total arsenic content assessment technique based on using a handheld (portable) X-ray fluorescence (XRF) device.

The second study successfully developed a rapid TCLP assessment technique to conservatively assess the TCLP arsenic leaching behavior of the DM within a 4-hour timeframe. This technique was referred to as a “mini-TCLP”. The mini-TCLP approach (reduced volume, reduced extraction period) was shown to be more conservative than the full TCLP results.

The arsenic-containing compounds in the DM and SCM contain arsenic(V), which must first be cleaved (oxidized) from its organic functional groups (e.g., moieties) for immobilization. Optimal conditions for arsenic(V) immobilization occur at mid-range pH values (3 to 8.5 standard units) and under oxidized conditions (high oxidation-reduction potential [ORP] or Eh). This is a very narrow range of environmental conditions (e.g., specified pH, ORP range, or “coordinate”) to target, and not many combinations of reagents can achieve this coordinate, irreversibly immobilize high levels of arsenic, and solidify the resulting mixture under said conditions.

Ferric iron is one of the most efficient means to immobilize arsenic, both through sorption and precipitation. CH2M HILL and Severson determined in the fall 2012 treatability study that ferric iron consistently and successfully treated the highly arsenic-impacted DM, while the combined use of wood chips (or small Portland cement dose) simultaneously reduced the DM moisture content to pass the paint filter test and improved its workability at the landfill. Moreover, using liquid ferric sulfate demonstrated that the arsenic immobilization reaction was almost instantaneous (based on 1-hour cure times).

### **Economic Benefits**

The benefits of the project are three fold. The first is the savings to the client through an innovative treatability study and analysis of results. The results optimized the mix design and a process was added to speed up the onsite processing by testing materials in the barges before they were brought to shore for stabilization. An appropriate mix design was determined before the DM barge made it to the unloading and processing facility. Having the mix design predetermined aided in:

- Saving time related to figuring out the mix before hand

- Saved money because the material were not overdosed, and
- Save storage space on land in the staging bins because materials did not have to be reprocessed.

The second benefit was the stimulation of the local economy. Over 80 people (total) were employed during the spring, summer, and fall of the 2012 and 2013 seasons. This translates to an increase in local commerce. During these seasonal operations nearly 50 full time positions were filled from the local unions. In addition, 31 unique subcontractors were used with a combined subcontract value greater than \$14 million in the “local” economies of Wisconsin and Michigan.

The third benefit was restoring the turning basin to it authorized depth which is part of the federal navigation channel typically maintained by the Unites Army Corps of Engineers. The turning basin is used by a local ship building company and other commercial operators on the waterway.

With the Tyco facility employing nearly 600 local residents, keeping the facility active and thriving is essential to the local community.

### **Transferability**

The approach taken to the treatability study can become a model for other projects that are currently in the design phase. By investing in site specific mix design and amendment studies, projects can be implemented more efficiently and cost effectively. The lessons learned on this project for processing and treating the dredge material can be used on similar projects.

### **Outreach and Education**

The work at the Tyco facility is part of a larger AOC for the Menomonie River. A citizen advisory committee (CAC) was already in place prior to the proposed remediation at the Tyco facility. Representatives from the Tyco project regularly attend the CAC meetings to provide project updates. The project also has a site specific website to convey information to the public as the project progresses. Other community outreach activities included presentations to the City of Marinette, the Harbor Commission and numerous public meetings.

Other Outreach and community enhancement included:

- 40 hour Hazwoper certification for over 40 local residents adding valuable training to the workers skillset.
- Performing a detailed archeological survey of the sunken vessel in the Slip 6 area and providing a subsequent boat model to the local museum capturing a piece of local history
- Providing improvements for the fisherman and improvements to the local boat ramp with a more modern dock

## Vicinity and Location Map



CH2MHILL

## Mobilization and Staging of Containment Bins



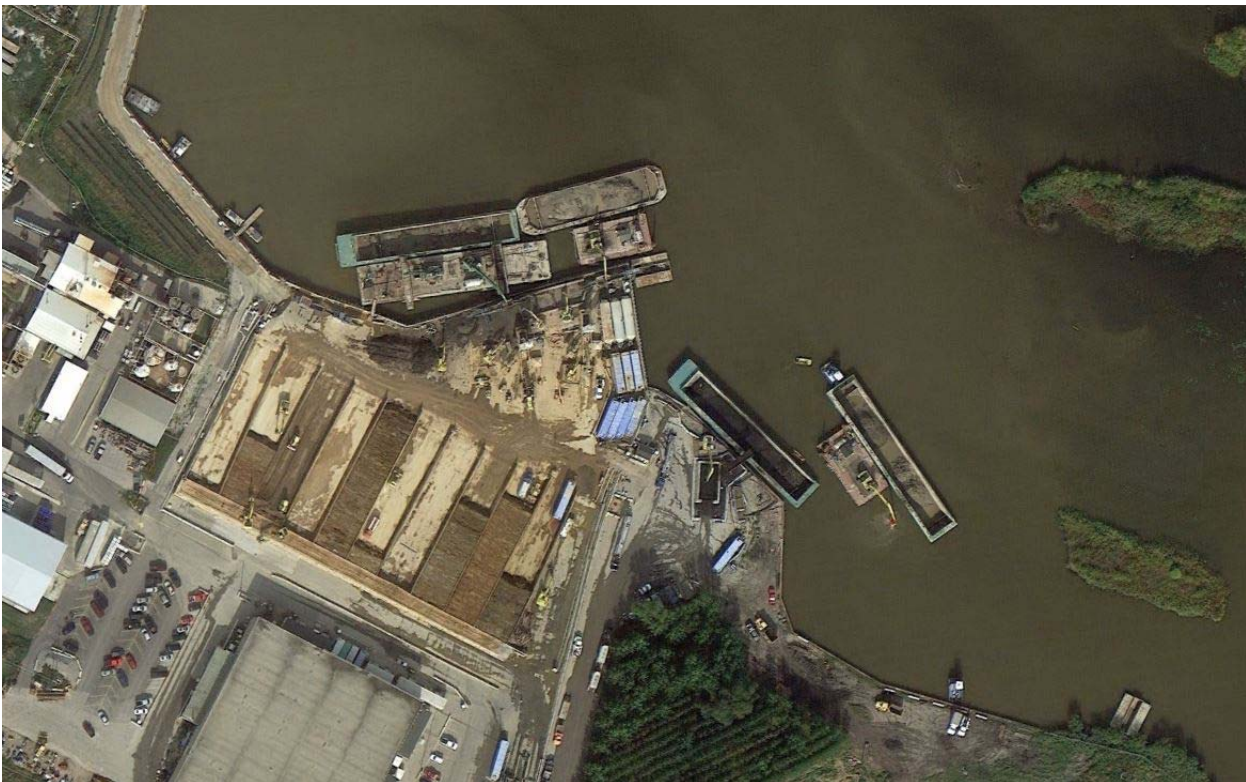
## Excavator Unloading Dredge Material Barges



**Transfer Processed Material from Containment Bins to Trucks for Disposal**



**Aerial View of Dredging, Offloading and Processing (source Google Earth)**



**View of the Pugmill Mixers and Chemical Storage Tanks**

