Construction Completion Report

Menominee River Sediment Removal Project Adjacent to the Tyco Fire Products LP Facility Marinette, Wisconsin

Prepared for

Tyco Fire Products LP

March 2014

CH2MHILL®

Sevenson Environmental Services, Inc.

Construction Completion Report

Document Control No. 473274.187

Revision 0

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March 2014

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Acronyms and Abbreviations

3D	three-dimensional
AOC	Administrative Order on Consent
BMP	best management practice
CCR	construction completion report
DDT	dichlorodiphenyl trichloroethane
DMR	discharge monitoring report
DMU	dredge management unit
DPT	direct-push technology
Foth	Foth Infrastructure & Environment, LLC
GLNPO	Great Lakes National Program Office
GLWQA	Great Lakes Water Quality Agreement
GPS	global positioning system
GWCTS	groundwater collection and treatment system
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MNR	monitored natural recovery
NTU	nephelometric turbidity unit
ppb	parts per billion
ppm	parts per million
PCB	polychlorinated biphenyl
QA	quality assurance
QC	quality control
RCRA	Resource Conservation and Recovery Act
RO	reverse osmosis
RTK	real-time kinematic
SCM	semi-consolidated material
Sevenson	Sevenson Environmental Services, Inc.
site	Tyco Fire Products LP facility at One Stanton Street, Marinette, Wisconsin
SOP	standard operating procedure
TCLP	toxicity characteristic leaching procedure
TSS	total suspended solids
Tyco	Tyco Fire Products LP
USEPA	United States Environmental Protection Agency

VBW	vertical barrier wall
VSEP	Vibratory Shear Enhanced Processing
WDNR	Wisconsin Department of Natural Resources
WPDES	Wisconsin Pollutant Discharge Elimination System
WWTP	wastewater treatment plant
yd^3	cubic yards
XRF	X-ray fluorescence

SECTION 1

Introduction

This construction completion report (CCR) was prepared to document the Menominee River sediment removal remediation activities implemented in 2012 and 2013 adjacent to the Tyco Fire Products LP (Tyco) facility at One Stanton Street, Marinette, Wisconsin (site; Figure 1). The corrective measures, and subsequently this CCR, were required pursuant to the Administrative Order on Consent (AOC) between Tyco and the U.S. Environmental Protection Agency (USEPA), dated February 26, 2009, as stated in Section VI, 11, d, to address sediment and semi-consolidated material (SCM) in the Menominee River containing arsenic concentrations greater than or equal to 50 milligrams per kilogram (mg/kg) or parts per million (ppm). This CCR describes the project background and objectives, summarizes the corrective measures completed, describes the construction activities performed, and documents the environmental monitoring and project results for the sediment removal remediation activities in 2012 and 2013. This CCR is organized into the following sections:

1. **Introduction**—Provides the site description and brief history, physical site characteristics, components of the selected remedy for the site, and the overall document organization.
2. **Summary of Activities Performed**—Provides a summary of milestones and major activities performed in 2012 and 2013.
3. **Construction Activities**—Presents the technical details of the sediment and SCM removal construction activities.
4. **Environmental Monitoring of Remediation Activities**—Presents the environmental monitoring activities conducted during the removal activities.
5. **References**—Provides the references cited in this report.

1.1 Site Description and History

The site is an active manufacturing facility in the city of Marinette in northeastern Wisconsin, adjacent to the southern shore of the Menominee River (Figure 1). The property is bordered by the Menominee River to the north; the 6th Street Slip and City of Marinette property to the east; Water Street, City of Marinette property, Marinette School District property, and residential properties to the south; and Stanton Street and Marinette Marine Corporation to the west.

The facility consists of approximately 63 acres, including a manufacturing area on the western part of the property and an undeveloped area to the east, referred to as the “wetlands area.” A fence surrounds both parts of the facility, and access is restricted. ChemDesign Corporation (a tenant to Tyco) also has manufacturing operations at the Tyco site.

The site initially was used for lumber mill operations, sawdust disposal, and storage of raw and cut lumber. Subsequently, the site began manufacturing operations in 1915, and included cattle feed, refrigerants, and specialty chemicals. One of which was an Arsenic-based agricultural herbicides that was manufactured at the facility between 1957 and 1977. Tyco acquired Ansul grandchild company of the company producing the arsenic-based herbicides in 1990. A byproduct of the manufacturing of this herbicide 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 and groundwater, as well as sediment and soils in the adjacent Menominee River. By 1978, the facility ceased production of arsenic-based herbicides, and since 1983 has produced only fire extinguishers and fire suppression systems.

1.2 Regulatory Background

Tyco has implemented a number of corrective measures through the Resource Conservation and Recovery Act (RCRA) program. Between 1999 and 2000, interim site corrective actions were completed including constructing a slurry wall and sheet pile sections around the Salt Vault and 8th Street Slip (Figure 1), respectively, to contain groundwater. These site features are now enclosed/contained and no longer used for their original purposes; therefore, they are referred to as the former Salt Vault and the former 8th Street Slip. An interim corrective action was conducted in the former 8th Street Slip, the slip was filled and covered with asphalt, and a groundwater monitoring program was established. Based on the results of the monitoring program, USEPA agreed to cease monitoring within these contained areas because the effectiveness of the barriers had been established.

Investigations conducted since 2006 have provided the information necessary to design corrective actions for the rest of the manufacturing area and the wetlands area at the site. The culmination of these investigations has been identifying additional corrective and remedial measures that have been implemented at the facility property as required by the AOC, including installing a vertical barrier wall (VBW) system to surround the facility (Figure 1), a groundwater collection and treatment system (GWCTS) to prevent flooding within the VBW, and a network of phyto-pumping tree plantings to supplement the GWCTS by removing additional groundwater.

Based on previous evaluations of the site conditions, feasible alternatives, potential costs, and input from federal, state, and local stakeholders, an excavation, stabilization, and offsite disposal remedy was the proposed alternative for remediation in the Menominee River. The remedial design is documented in the *Draft Final Design Report Menominee River Sediment Removal Project Adjacent to Tyco Fire Products LP Facility* (CH2M HILL 2012a). The design was completed based on the long-term goals for the Menominee River Great Lakes Water Quality Agreement (GLWQA):

- Protecting the aquatic ecosystem of the Menominee River and Harbor from the effects of toxic and conventional pollutants
- Maintaining a balanced aquatic and terrestrial community to ensure long-term health of the ecosystem
- Maintaining and enhancing 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

1.3 Project Description

Dredging, stabilization, and disposal corrective actions were implemented beginning in 2012 and completed in December 2013, in accordance with the agency approved design plans and specifications (CH2M HILL 2012a) to meet the requirements in the AOC. The AOC requires removing sediment and SCM in the Menominee River adjacent to the site with arsenic concentrations greater than or equal to 50 mg/kg. Glacial till and bedrock if encountered did not require removal and could be left in place. The corrective action activities were initially designed to be implemented in a phased approach; however, as the project progressed, the phases were no longer conducive to completing the work. Alternatively, removing sediment and SCM from the Menominee River focused on dredging the impacted material from dredge management units (DMUs) based on the following “sub-area” locations within the site (Figure 1):

- Main Channel
- Turning Basin
- South Channel
- Transition Areas
  - Transition Area 1
  - Transition Area 2
  - Transition Area 3

- 6th Street Slip

Figures 2 through 4 show the DMUs. Each DMU either was dredged to glacial till, dredged to design elevation and met the criteria of 50 mg/kg, or had to be re-dredged past the design elevation to meet the criteria of 50 mg/kg. Additional detail on the confirmation sampling and the DMUs is provided in the *Final Confirmation Sampling Plan* (CH2M HILL 2013a) and in Section 4.6 of this CCR. The key construction activities included the following:

- Sheet pile stabilization (required to allow dredging of soft sediment and SCM adjacent to the sheet pile wall)
- Mechanical dredging
- Sediment and SCM stabilization
- Offsite disposal
- Water treatment
- Restoration

In addition to the key construction activities, the AOC requires monitored natural recovery (MNR) to be used to manage areas where the remaining sediment contains between 20 and 50 mg/kg arsenic; the final remediation goal for site sediments is 20 mg/kg total arsenic by 2023, 10 years after completion of the sediment removal.

Discussions are ongoing with the USEPA Great Lakes National Program Office (GLNPO) and Wisconsin Department of Natural Resources (WDNR) regarding the implementation of a betterment remedy by dredging sediments with arsenic concentrations between 20 and 50 mg/kg, rather than managing these areas using MNR. No final decision on this approach has been made at this time.

An MNR work plan was submitted to the agency in October 2012 (CH2M HILL 2012b) in accordance with Section VI.11 paragraph e of the AOC, and agency comments were received on March 28, 2013 (USEPA 2013a). Finalization of the MNR plan is on hold until a decision has been reached on the implementation of the betterment remedy.

1.4 Permits

For the 2012 and 2013 dredging, sediment stabilization, wastewater treatment, and construction activities, several permits were required. They are summarized in Tables 1-1 and 1-2.

TABLE 1-1
Tyco Permit Summary
Menominee River Sediment Removal Project
Construction Completion Report

Permit	Agency	Activity Covered	Final Date of Approval	Valid Until	Modifications
Endangered Species Act, Section 7 Consultation	US Fish and Wildlife Service	All Activities	27-Sep-11	1-Dec-14	None
Section 404 Clean Water Act (GP-002-WI) and Section 10 Rivers and Harbors Act (Nationwide Permit #38)	United States Army Corps of Engineers	Dredging	19-Jun-12	31-May-16	VBW stability modification 12-Nov-12 South Channel dredging activities modification 23-Apr-13

TABLE 1-1
Tyco Permit Summary
Menominee River Sediment Removal Project
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Permit	Agency	Activity Covered	Final Date of Approval	Valid Until	Modifications
Section 106 Cultural Resources Consultation	State Historic Preservation Office, United States Army Corps of Engineers, Marinette County Historical Museum, City of Marinette, and the WDNR	City of Grand Haven Ship Wreck	18-Jun-12	18-Jun-14	None
Private Aids to Navigation	US Coast Guard	Placement of Buoys (Turbidity Monitors) in Menominee River	25-May-12	1-Dec-14	Update submitted 15-Oct-12 for VBW stability work
Hazardous Waste Remediation Variance	WDNR	Storage, stabilization and disposal of hazardous waste sediment	3-Jul-12	1-Feb-14	See Table 1-2
CWA Section 401 Water Quality Certification (IP-NE-2012-38-00422) / Chapter 30 Permit (IP-NE-2012-38-00425)	WDNR	Dredging	14-Jun-12 / 25-Jun-12	1-Feb-14	South Channel dredging activities modification approved 31-May-13
WPDES Wastewater Permit No. WI-0046558-05-0	WDNR	Dredging operations wastewater discharge	3-May-12	1-Apr-14	None
Construction Site Stormwater Runoff, WPDES Permit No. WI-S067831-4	WDNR	Erosion control and stormwater management activities at the site	24-May-12	24-May-15	Erosion control amendment 17-Apr-13 Parking lot area amendment submitted 22-Oct-13
Endangered Resource Review (ERR Log # 11-380)	WDNR - Bureau of Endangered Resources	All activities	11-Oct-11	No date given	None

WPDES – Wisconsin Pollutant Discharge Elimination System

TABLE 1-2
Tyco Hazardous Waste Variance Modification Summary
Menominee River Sediment Removal Project
Construction Completion Report

Date	Agency	Title/Description
8/24/2012	WDNR	WDNR Class 1 Plan Modification Determination for the Storage and Treatment of Arsenic Contaminated Sediment Menominee River Sediment Removal Project Adjacent to the Tyco Fire Products LP Facility 1 Stanton Street, Marinette, Wisconsin WDNR BRRTS # 02-38-000011 USEPA # WID 006 125 215
10/16/2012	WDNR	Email approval for addition of woodchips to Bin 3
10/17/2012	WDNR	Email approval on using treated material that has passed TCLP criteria as berm material within the bins
10/19/2012	WDNR	Email response/approval for Sediment Management Process Operational Change (wood chip addition) and Dry Ferric Sulfate Pilot Test submitted 10/12/12
5/9/2013	WDNR	Class 1 Plan Modification Determination for the Storage and Treatment of Arsenic Contaminated Sediment Menominee River Sediment Removal Project Adjacent to the Tyco Fire Products LP Facility 1 Stanton Street, Marinette, Wisconsin WDNR BRRTS # 02-38-000011 USEPA # WID 006 125 215
5/14/2013	EPA	USEPA approval of technical memorandum "Dredged Material Treatability Study Results, Tyco Fire Products LP Menominee River Sediment Removal Project, Marinette, WI" dated 5/7/13, as prepared by CH2M HILL
7/18/2013	WDNR	Email response and response to comments between CH2M HILL and WDNR regarding Hazardous Waste Variance Modification Request dated 6/13/13
9/5/2013	WDNR	Email approval from WDNR regarding management of South Channel dredge material
11/25/2013	WDNR	Email approval of winter 2013 alternative decontamination operations

TCLP – toxicity characteristic leaching procedure
USEPA – United States Environmental Protection Agency

SECTION 2

Summary of Activities Performed

The following is a summary of the major construction activities preformed in chronological order during the 2012 and 2013 dredging activities.

2012 activities included the following:

- Mobilized equipment and personnel.
- Site preparation for dredging, processing and disposal operations.
- Installation of temporary water treatment system at the 6th Street Slip area.
- Installation of turbidity controls and monitoring equipment.
- Performed a bathymetric survey to document the pre-dredge sediment elevations.
- Mechanical dredging, stabilization and disposal of soft sediments in Turning Basin.
- Collection and treatment of wastewater through the temporary water treatment system.
- Performed ongoing monitoring activities consisting of monitoring turbidity and arsenic concentrations in the river, arsenic concentrations at two nearby drinking water plant intakes, arsenic concentrations in the water treatment system effluent, and stabilized sediment disposal parameters (mainly, total and toxicity characteristic leaching procedure (TCLP) arsenic, paint filter, and field soil strength testing).
- Performed a bathymetric survey to document the subsurface elevations at the end of the 2012 work season.
- Decontamination of site and equipment following dredging activities.
- Installation of the VBW stabilization support system through 2012/2013 winter months to prepare for 2013 dredge season.

2013 activities included the following:

- Completed installation of VBW stabilization support system.
- Mobilized equipment and personnel.
- Re-paved entire former Salt Vault area for use as a staging pad. Original asphalt was removed during the VBW stabilization structure installation.
- Performed site modifications to the site layout for the 2013 dredge season to more efficiently manage the sediment following treatment and allow for more storage capacity.
- Start-up activities for the temporary water treatment system in the 6th Street Slip area.
- Performed a bathymetric survey to document the pre-dredge sediment elevations.
- Re-Installed turbidity control devices (such as silt curtains) in the river.
- Mechanical dredging, stabilization and disposal of soft sediments and SCM in Turning Basin, Transition Areas and South Channel.
- Collection and treatment of wastewater through the temporary water treatment system.
- Performed ongoing monitoring activities consisting of monitoring turbidity and arsenic concentrations in the river, arsenic concentrations at two nearby drinking water plant intakes, arsenic concentrations in

the water treatment system effluent, and stabilized sediment disposal parameters (mainly, total and toxicity characteristic leaching procedure (TCLP) arsenic, paint filter, and field soil strength testing).

- Installation of bedding stone and rip-rap for long term support of vertical barrier wall.
- Decontamination of site and equipment following dredging activities as weather permitted.
- Shutdown site in December 2013. Remainder of decontamination, restoration and demobilization activities to resume as weather allows in spring 2014.

SECTION 3

Construction Activities

This section presents the technical details of sediment removal activities that occurred in 2012 and 2013. As stated previously, the work consisted of dredging, stabilization, and disposing of materials offsite, as well as the sheet pile stability work to allow for removal of materials along the VBW. The scope of this work was completed in accordance with design plans and specifications for the sediment removal and VBW sheet pile support construction activities (CH2M HILL 2012c, 2012d), which were accepted by USEPA.

Tyco contracted Sevenson Environmental Services, Inc. (Sevenson) of Niagara Falls, New York, to perform the construction activities for the sediment removal and VBW sheet pile stability work. Tyco subsequently contracted Foth Infrastructure & Environment, LLC (Foth) as the Tyco onsite representative to observe construction activities and verify implementation of the *Construction Quality Assurance Plan* (CH2M HILL 2012e) during project execution. CH2M HILL was contracted by Tyco to serve as the project engineer and provide support for the environmental monitoring activities discussed in Section 4.

The estimated volume removed for the total project in 2012 and 2013 is summarized in Table 3-1.

TABLE 3-1
Volume Removal Summary
Menominee River Sediment Removal Project
Construction Completion Report

Description	Total
Removed/Dredged (cubic yards)	259,046
Processed/Reprocessed* (tons) – includes sediment, debris, and chemicals	433,624
Hauled Offsite (tons) – includes all waste	472,035

*Reprocessed weight includes total weight of material reprocessed through the pugmill

The following appendix sections are included to further document the construction activities:

- **Appendix A, Final As-Built Drawings** – Includes drawings/figures to document the 2013 dredge season and VBW stability work.
- **Appendix B, Sevenson Wastewater Treatment System Operation Logs** – Sevenson completed daily logs of the wastewater treatment system operational data. The logs contain data on run time, gallons discharged, pH, tank levels, and flow rate.
- **Appendix C, Sevenson Daily Reports** – Sevenson completed daily construction reports throughout the 2012 and 2013 working season. The reports contain information on weather, daily activities and photographs, temporary water treatment flow and pH (this information also was reported in the water treatment system operations log [Appendix B]), subcontractor work and hours, equipment/materials delivered to the site, safety remarks, dredging activity, and sediment treatment information. The 2013 daily reports also include the dredge logs (the 2012 dredge logs are in Appendix G).
- **Appendix D, Waste Disposal Tracking Logs** – Presents the 2012 and 2013 logs that were updated with total tonnage for waste disposal.
- **Appendix E, Construction Site Inspection Reports** – The construction site inspection reports were completed weekly or within 24 hours after a precipitation event of 0.5 inches or greater. The reports contain the date and time of the inspection and the daily weather; the erosion control and stormwater management best management practices (BMPs) onsite, and any comments or recommendations about them at the time of the inspection were checked weekly.

- **Appendix F, Waste Inspection Forms** – The waste inspection forms document the condition of the bin walls, sump, asphalt paving, the containment curbing and berms, and other items in the containment zone.
- **Appendix G, 2012 Dredge Logs** – The 2012 dredge logs contain the daily dredge information, including Leudeke (Sevenson's subcontractor) shift crew, work and safety steps performed, equipment used, and a dredge figure.
- **Appendix H, 2012 and 2013 Photo Log** – Contains photographic documentation from the work completed in 2012 and 2013.

3.1 Preconstruction and Site Preparation Activities

The 2012 preconstruction and site preparation activities included the following:

- Equipment and personnel were mobilized to the site.
- The onsite project area was entirely paved with new and existing asphaltic concrete, and seams, joints, and cracks were filled with Sealmaster sealant. This included improvements to the existing asphalt surface in the former Salt Vault area for use in sediment processing and treated sediment staging.
- The primary sediment work area, consisting of the sediment treatment, storage, and loading area, was contained with a 6-inch-high asphaltic concrete curb and concrete Jersey barriers and sealed.
- Eleven sealed and curbed storage containment bins were constructed and other equipment was set up to allow for sediment processing (including offloading barge with water tank, drip tray, material handler, Warrior powerscreen, pugmill and conveyance system, chemical delivery silos, elevated excavator pad).
- The area was secured with 8-foot-tall gated chain-link fence and was monitored 24 hours a day by onsite security to control site access.
- Roads on the existing asphalt surface were demarcated for trucks to travel.
- A temporary mooring structure was constructed along the shoreline of the facility.
- A truck scale and truck wash was installed.
- A temporary water treatment system was constructed at the 6th Street Slip area. The existing parking area was seal coated, and the parking area was expanded through additional placement of asphaltic concrete directly east o f the existing parking area. This area also was contained with a 6-inch-high asphaltic concrete curb and concrete Jersey barriers and sealed.
- An existing access road was improved along the southern Tyco property boundary between the former 8th Street Slip area and the 6th Street Slip area to allow for more efficient traffic flow through the site.
- Turbidity monitoring equipment was installed in the river.
- A bathymetric survey was performed to document the pre-dredge sediment elevations.
- Turbidity control devices (such as silt curtains) were installed in the river.

A construction report was prepared by Sevenson and submitted on August 8, 2012, outlining the as-built conditions of the site at the start of the project, and included photographs, material specifications, material safety data sheets, and seal coat documentation. For additional details, see Appendix I for the Construction Report.

The 2013 preconstruction and site preparation activities included the following:

- Installation of VBW stabilization structures was completed.
- Equipment and personnel were mobilized to the site.

- The former Salt Vault area was repaved for use as a staging pad. Original asphalt was removed during the VBW stabilization structure installation.
- The following modifications were made to the site layout for the 2013 dredge season (Figure 1 in Appendix A) to more efficiently manage the sediment following treatment and allow for more storage capacity:
  - Removed soil pile located west of Building 59 and paved the area for use as crew parking during the dredge season.
  - Relocated and moved treated sediment bins to create additional bin space and increase capacity to approximately 2,000 cubic yards (yd^3) in each bin. Asphalt containment curbs were added at the open end of bins to contain sediments.
  - Bolstered loading platform and operations to handle 200 trucks per day for disposal.
  - Relocated security guard shack for traffic control.
  - Relocated existing scale and truck wash and added additional scale and truck wash to improve operational capacity of truck decontamination and scale operations.
  - Modified truck traffic operations. Two new roadways were installed to increase production of truck load-out and ease access to the personnel pier. The first road passed behind Building 59 to the south, and a paved ramp was constructed to accommodate trucks traveling into the load-out area. During sediment load-out, trucks traveled clockwise on the roadway, south of Building 59 passing over the ramp into the truck loading area. After being loaded, trucks continued through one of the two truck washes over the corresponding scale and proceeded offsite after manifesting. The second roadway was installed from the material staging area to Tyco's dock to increase access for the dry ferric additive to processing area and help eliminate interference with the sediment handling operations.
- Start-up activities began for the temporary water treatment system in the 6th Street Slip area.
- A bathymetric survey was performed to document the pre-dredge sediment elevations.
- Turbidity control devices (such as silt curtains) were reinstalled in the river.

3.2 Dredging

3.2.1 2012 Phase I Activities (Mechanical Dredging of Contaminated Soft Sediment in the Turning Basin)

Soft sediment containing total arsenic concentrations greater than or equal to 50 mg/kg located within the Turning Basin and small portions of the Main Channel and Transition Area 2 (Figure 1) was mechanically dredged using a crawler crane equipped with a cable arm dredge bucket and stabilized onsite. A summary of Phase I dredging activities are presented below:

- Mechanically dredged approximately 26,913 yd^3 of soft sediment in the Turning Basin using environmental and standard clamshell buckets, following BMPs, and loaded the sediment into watertight hopper barges.
- Transported sediment loaded hopper barges to the offloading area adjacent to the facility.
- Pumped free water off the dredged material to the temporary water treatment system.
- Offloaded dredged material from the hopper barges.
- Performed a bathymetric survey to document the subsurface elevations at the end of the 2012 work season.

3.2.2 2013 Dredging in the Turning Basin and Transition Areas

In 2013, dredge equipment was modified from that which was used in 2012 to accommodate the project's goal of completing the dredging work by the AOC deadline of November 1, 2013. Therefore, Sevenson demobilized the crane and clam dredge equipment and replaced them with two Komatsu PC800 hydraulic excavators to perform the dredging operations. Each dredge platform consisted of:

- A PC-800 each equipped with a boom and stick capable of reaching 30 feet below the water surface
- Level cut clamshell bucket (3.5 yd^3 Anvil model)
- Deck barge approximately 150 feet by 40 feet
- Dredgepack software system, real-time kinematic (RTK) global positioning system (GPS)
- Real-time display of bucket position
- Spuds raised and lowered using a hydraulic powered system

The Anvil level cut bucket was used in soft sediments. In areas where the SCM material was dredged, Anvil buckets were used where possible. In areas where the Anvil dredge bucket could not penetrate more compacted SCM material, a traditional toothed bucket was used.

Watertight, 1,000 yd^3 scows were used for transport of materials dredged in the Turning Basin and Transition Area. The scow dimensions were generally 168 feet long, 40 feet wide, and 14 feet high with a draft of approximately 11 feet when fully loaded. Six of these scows were used to provide adequate space for dredged materials to allow for continued dredging, pre-screening and onsite laboratory testing of materials for chemical dosage determination and scow offloading and processing (see Section 4.4.1 for additional details on pre-screening). The six scows were generally used as follows: two were being actively filled with dredge material, two were on standby, one was being dewatered, and one was being processed and offloaded at the dock.

This method of excavation and loading was used for the entire Turning Basin work and part of the Transition Areas. Portions of the Transition Areas were too shallow to accommodate the draft of the large scows. In these instances soft materials were dredged using four of Sevenson's custom built, 100 yd^3 hopper barges. They were built from two Flexifloats and have a hopper located in the center of them. Excavators removed the sediment and placed them into the hopper barges, which were then moved by push boats to the 8th Street Dock area where the hoppers were unloaded into a large scow where they could then be sampled and treated in the same manner as other sediments.

3.2.3 South Channel

The initially approved approach for the transfer and processing of soft sediment removed from the South Channel area included transferring soft sediment using Bin 11 as a temporary transfer area. Material was to be deposited in a containment structure constructed in Bin 11 and transferred using front-end loaders to the pugmill feed pit within the processing area. However, because of the substantial debris encountered during the start of dredging in the South Channel and the compactness (extensive equipment) of the sediment processing area, it was not possible to sufficiently screen the material before processing. In addition, because of the volume of equipment traffic in the processing area near Bin 11 (pugmills, dry ferric loading, bin material hauling), health and safety considerations required that the sediment transfer area be moved to a less congested area. The hazardous waste variance was subsequently modified and approved by WDNR in an email dated September 5, 2013, to allow for an alternative method of dredging in the South Channel, along with other applicable permit updates/modifications as indicated in Table 1-1.

Dredging of the South Channel area was conducted from water using barge-mounted excavators and from land using excavators on crane mats adjacent to the haul road. Sediment was loaded into trucks staged on the haul road and transferred to the sediment processing area. The South Channel was isolated from the Turning Basin and Transition Areas by a turbidity curtain placed at the upstream end of the South Channel. A berm was constructed near the abandoned railroad bridge at the eastern end of the South Channel to prevent migration of suspended sediment downstream. A turbidity curtain also was placed at the Ogden Street Bridge area when dredging to the east of the abandoned railroad bridge was conducted.

Dredging began at the upstream location (requiring soft sediment removal) and proceeded downstream. Off-road hauling trucks were used to transport excavated material from the South Channel area. The filled haul trucks proceeded west on the South Channel access road and exited the haul road onto the 6th Street parking lot, passing through a truck wash at the northern end of the 6th Street parking lot. The haul trucks then proceeded south through the 6th Street parking area and entered the Tyco property on the access road constructed in 2012 between 6th Street and 8th Street. The haul trucks then proceeded to the truck turnaround area located east of the processing area for offloading.

A transfer structure was constructed in the truck turnaround area to accommodate unloading of the dredged material removed from the South Channel. The transfer structure was constructed as a four-sided above-grade structure comprised of bin blocks approximately 8 feet high. The bin blocks were sealed at the base and joints with foam sealant to prevent migration of the material outside the structure and included a steel plate on the bottom, which is similar in construction to the feed pit installed in the sediment processing area. In addition, a Jersey barrier wall was installed around the structure and foam sealed as secondary containment.

In addition, as a preventative measure, the area between the edge of the truck turnaround and the sheet pile wall was asphalted to prevent sediment from contacting the soil surface if spillage occurred. A truck ramp to accommodate transfer of the material was constructed with fill placed in front of one of the transfer pit walls. The approximate dimensions of the transfer pit are 20 feet wide by 35 feet long with walls that are approximately 8 feet high. The haul trucks backed up to the edge of the transfer pit and unloaded the fresh dredge material into the transfer pit. The trucks were then washed after unloading the material. The fresh dredge material in the transfer pit was then collected with an excavator and transferred to a scow located adjacent to the shoreline. To prevent spillage of dredged sediment or dredge water, a drip pan was constructed to capture materials that may fall from the excavator bucket during the transfer operations. The filled scow was sampled for determination of appropriate chemical dosage and moved to the unloading dock where the material was offloaded for processing. Figure 1 in Appendix A provides the 2013 site layout with the South Channel modifications.

3.2.4 Debris Management

During 2012 and 2013, debris encountered during dredging consisted mostly of wood in the form of logs or planks, potentially from historical logging and lumber operations in the area. Stumps and vegetation also were encountered. Rocks were encountered to a lesser degree, but they became more prevalent as excavation proceeded into the lower SCM layer and into the glacial till surface area. Excavated sediment was passed over screens to remove debris larger than 2 inches. Debris was stockpiled on the processing pad until a large enough pile was accumulated to allow for efficient processing. The stockpiles were limited to less than 400 yd^3 in size pursuant to the hazardous waste variance.

Debris was screened to remove large rocks and residual sediment. Residual sediment was incorporated into the processing stream. Large rocks were power washed, wipe sampled, and loaded out as nonhazardous waste with other similarly passing sediments. Smaller wood debris and rocks were run through a rock crusher machine to reduce the debris for re-introduction into the processing and treatment train. The rock crusher was equipped with a magnet that removed ferrous metal debris, which was power washed, wipe sampled and recycled. Larger wood debris (logs, stumps, etc.) was ground into chips using a tub grinder, which were then also re-introduced in the processing treatment train.

3.2.5 Shipwreck Debris

During dredging of the 6th Street Slip area, the shipwreck *City of Grandhaven* was partially removed to allow for removal of sediment. The removal of the shipwreck was documented in accordance with the memorandum of agreement (MOA) between Tyco, the State Historic Preservation Office, United States

Army Corps of Engineers, Marinette County Historical Museum, City of Marinette, and WDNR. The shipwreck removal documentation required as part of the memorandum of agreement will be provided under separate cover and not included as part of the CCR.

The shipwreck debris was handled differently than other debris encountered because of the high content of metal fasteners and bindings it contained. The shipwreck debris was too large for the rock crusher and contained too much metal to be safely shredded in the tub grinder; therefore, the shipwreck debris was wipe sampled, found to be nonhazardous, and shipped to the landfill without treatment.

3.3 Dredged Material Stabilization

3.3.1 2012 Processing

The sediment treatment process treatment train included:

- Offloading barge with water tank, drip tray, Sennebogen material handler with Anvil hydraulic clamshell bucket
- Warrior powerscreen
- Portec pugmill and conveyance system
- Chemical delivery silos
- A redundant pugmill and silo system to be used during downtime of primary system
- 11 sealed and curbed storage bins
- Elevated excavator pad for loading dump trucks with treated sediment

At startup, the dredged material was loaded into watertight scows and moved adjacent to the unloading barge along the western side of the former 8th Street Slip cofferdam. Excess water was decanted and sent to the temporary wastewater treatment unit located at the 6th Street Boat Launch parking area. The remaining dredged material was transferred with a Sennebogen material handling excavator located on the unloading barge to a screening unit that segregated rocks and other debris from the sediment. The resultant sediment material passing through the screen was loaded by an excavator into the pug mill unit. The processing setup consisted of Portec pugmills fed by material silos holding dry reagents (Portland cement) and steel frac tanks holding liquid reagents (liquid ferric sulfate). As previously described, dredged debris not passing through the screen was subsequently shredded and mixed with soft sediment for treatment and disposal.

Reagents and pozzolanic materials were blended into the dredged material in the pug mill unit for stabilization to reduce leachable arsenic, eliminate free water, and provide strength gain of the material to acceptable standards for disposal in a Subtitle D nonhazardous waste landfill. The reagents and pozzolanic materials included ferric sulfate, sodium hypochlorite, and boiler ash. The dredged material was then moved to a storage bin to cure for a minimum of 3 days. See the Bin Tracking Log, Appendix J, for sediment amounts and treatment dosages.

During the treatment process, storage bins were used to place the treated material, and representative samples were collected for laboratory analysis. Summary tables of the 2012 results are included in Appendix K.

The stabilization process reduced the concentration of leachable arsenic in the sediment such that it passed the TCLP test with less than 5 milligrams per liter (mg/L) of total arsenic.

Two hazardous waste variance startup reports were completed in 2012. The first startup report outlined the initial 6 days of treatment for only the soft sediment in the Turning Basin and was submitted August 14, 2012. See Appendix L for the Turning Basin Soft Sediment Treatment Startup Report – July 2012. The second startup report outlined the sediment treatment process changes implemented from August 20 through

September 20, 2012. This report contained information regarding the original treatment process, the treatability study, the revised treatment process, and the plan for SCM treatment. See Appendix M for the Turning Basin Soft Sediment Treatment Process Modification Report – November 2012.

3.3.2 2013 Processing

In 2013, the following additional equipment was used to maximize efficiency and respond to issues encountered during 2012 processing operations:

- A second Sennebogen offloading material handler was used during offloading of fresh dredged sediments in the scows.
- Two rapid mix pugmills were purchased and installed to increase processing capacity and mixing efficiency.
- Two Bazooka Tube 100 portable transfers for super sacks of dry ferric sulfate were installed to deliver dry ferric sulfate to the pugmill.
- Additional trailers and forklifts were used to handle dry ferric in supersacks.

The sediment treatment process remained similar to that in 2012. Where possible, material was separated by material type, soft sediment and SCM, and by treatment required (chemical dosage needed to treat dredged material).

Loaded dredged material scows were transferred to an unloading station where water was decanted using a 4-inch trash pump. Decant water was allowed to settle out suspended sediment using weir tanks and transferred to the onsite temporary WWTP for treatment. The scow was then unloaded using two Sennebogen material handling excavators equipped with clamshell buckets over a drip pan to capture drips from the excavator buckets. Sediment was placed into a screening system where sediment passed through the screen and was conveyed into a feed pit. Oversize debris, separated from the sediment, was staged for later shredding and management. A second set of excavators transferred the screened material from the feed pit to the rapid mix pugmills, which incorporated Portland cement and ferric sulfate (dry or liquid) into the sediment in varying amounts as determined by the scow pre-screening analysis. Treated material exiting the pugmills was transferred by front-end loader to staging bins where it was sampled for pH, paint filter, total arsenic, and TCLP arsenic. The process pad had 11 staging bins that would hold approximately 2,000 yd^3 each, although one bin was primarily used for equipment access (Bin 11). If the treated material was within landfill disposal criteria for these analyses, it was loaded into trucks for transportation and offsite disposal. Summary tables of the 2013 results are included in Appendix N.

3.3.3 Reprocessing

Despite the successful completion of treatability testing of sediments prior to construction, during the 2012 dredging season, there were some issues with the sediment treatment process. A key issue was the treatment mix and a chemical interaction associated with the ferric sulfate (acidic) and the sodium hypochlorite (basic) during mixing in the treatment train. This treatability issue caused several bins to fail TCLP testing following treatment. As discussed in the Turning Basin Soft Sediment Treatment Process Modification (November 2012, Appendix M), an additional treatment study was performed and a new treatment mix of ferric sulfate and Portland cement was found to be the most appropriate approach for fresh dredged sediment treatment. After switching to this approach, bins were no longer failing the TCLP testing.

During the 2013 dredging season, only four bins out of approximately 200 bins failed the TCLP testing following initial treatment. The four bins of material were re-processed through the processing system adding additional quantities of ferric sulfate and Portland cement to stabilize the leachable arsenic in the sediments. Reprocessed materials were again collected in staging bins, resampled, and tested with passing results.

3.4 Loading Transportation and Offsite Disposal

After processed materials or debris sample results met disposal criteria, waste materials were loaded into dump trucks provided by licensed/permitted transportation companies for transport offsite and disposal at the Menominee Landfill in Menominee, Michigan.

To maintain storage space for continuous dredging operations, loading operations included two loading excavators, two onsite truck washes, and two onsite truck scales. Loading operations were typically performed 5 days per week for 12 to 14 hours per day. A typical loading day consisted of approximately 150 to 200 truckloads sent offsite for disposal.

Trucks had sealed tailgates and tarp covers to be sure the load was fully encapsulated and no materials were released during transport. Poly sheeting was used under trucks being loaded to ensure trucks stayed on clean roadways. During loading, any spilled materials were swept from truck bodies and tires before being allowed to leave the loading area. After leaving the loading area, trucks proceeded to a truck tire wash to clean any residual dust from the tires to minimize tracking material outside the contamination reduction zone and onto public roadways. After the tire wash, trucks went over a scale and were weighed to be sure they were carrying legal loads on public roads.

After leaving the site, loaded trucks proceeded through an established truck route, approved by the City of Marinette, to the Menominee Landfill where it was received and scaled before dumping the load.

The 2012 dredge season transported and disposed of approximately 48,000 tons of processed materials, while the 2013 dredge season consisted of nearly 17,000 truckloads and over 420,000 tons of processed materials and debris disposed.

3.5 Water Treatment

Sevenson installed and operated a 150-gallon per minute onsite WWTP to handle contaminated water generated from site activities. Contaminated water sources included water from dewatering of dredged materials, contact water from rain events, and decontamination water.

Water was generated on the process pad through decontamination of equipment leaving the contamination reduction zone, cleaning of equipment during maintenance periods, and contact precipitation. Water on the process pad was collected in sumps and pumped to a weir tank to allow solids to settle out before the water was pumped to the WWTP for treatment.

Water generated from the decanting of scows also was pumped to the same weir tank as the process pad water to settle solids before being pumped to the WWTP for treatment.

The onsite treatment system used a series of processes to treat water: pretreatment using coagulation/ filtration in geotextile tube filters and a separation process, and microfiltration before treatment in a two-stage reverse osmosis (RO) system. The permeate (product water) from this unit was routed to the effluent tank, and the concentrate (reject water) was routed to a holding tank. A vibratory shear enhanced processing (VSEP) unit then treated this reject water. The VSEP unit is a specialized membrane system that concentrates the waste stream so the total volume of the waste stream being sent offsite for disposal is reduced. Permeate from the VSEP unit was then routed to the effluent tank, and the concentrate routed to a holding tank for eventual offsite disposal.

During the 2012 dredge season, 1,563,328 gallons were discharged, and during the 2013 dredge season, 6,633,091 gallons were discharged.

3.6 Sheet Pile Stability

Between the 2012 and 2013 dredging seasons, a support system was installed along the existing VBW to allow for dredging of sediments immediately adjacent to it. A driven pile and deadman support system was installed to ensure there would be no deflection of the VBW when sediments were removed during dredging. A total of 192 soldier piles were installed and secured into bedrock with more than 1,500 linear feet of waler and 171 tiebacks installed to driven pile deadmen to secure the wall before 2013 dredging activities.

3.6.1 Sheet Pile Removal (Former 8th Street Slip)

The sheet pile containment structure on the northern end of the former 8th Street Slip consisted of an outer cofferdam and inner containment wall. The outer cofferdam was not installed to bedrock during the late 1990s installation and was not considered structurally stable to allow for removal of sediments near the base of the cofferdam. Therefore, soil between the cofferdam and inner containment was removed along the former 8th Street Slip, and the cofferdam was then removed. Soils were stockpiled in the sediment bins, tested, and disposed offsite. The steel piling removed was placed in a sediment bin and cleaned by removing gross soils and then power washing both sides of the sheets. The sheet pile was sampled using wipe tests and rinsate samples. The sample results were higher than the arsenic criteria for removing equipment offsite. Because of the weather and high cost of sandblasting the sheet pile, it was determined that the sheet pile could not be reused; therefore, the sheeting was sent to a recycling facility to be smelted.

Because the removal of the outer wall created a gap in the VBW, four new AZ26 sheet piles were installed to connect the VBW wall to the inner containment wall of the former 8th Street Slip.

3.6.2 Soldier Pile Installation

Sevenson's subcontractor Gillen/Michels was used to perform soldier pile installation. Multiple crews were used to install the caissons, perform the necessary soil and rock drilling, install the soldier piles, and backfill the piles. Gillen started by removing the existing sheet pile cap, then installing a caisson with a 24-inch inner diameter to the top of the glacial till and pumping out any contained water. The interior of the caisson was drilled out lifting and spinning drill spoils into an adjacent containment box. As it was drilled, the caisson was pushed to the top of bedrock and spoils collected. The containment box was cleaned out as necessary by Sevenson with an excavator and loader or truck for transfer to the material bins for storage testing and disposal.

After the caisson was drilled out through the glacial till layer to the top of bedrock, a second crew with a crane-mounted rock drilling attachment was used to drill into bedrock. Similar to the first crew, the drill spoils (rock chips) were spun into a containment box. This same crew subsequently installed the HP14xl17 soldier piles. The installed piles were leveled and concrete backfill was pumped in the drilled shaft using the tremie method up to the mudline. After the concrete was installed, the caisson was pulled for reuse by the first crew at another pile location.

3.6.3 Driven Pile Deadman Installation

Installation of the deadmen followed behind the soldier pile installation. Sevenson stripped topsoil, stockpiling it for later reuse and excavated a trench at the deadmen pile-line down to the bottom of the deadman wall waler. Gillen followed behind with a crew installing HP73 piles as detailed in the specifications at a distance of 60 feet from the containment sheet pile wall. The crew installed the piles to the necessary toe depth or cut them off to grade if refusal was observed.

3.6.4 Tie-Back and Waler Installation

Installation of the tiebacks and walers followed behind the driven pile deadmen installation. Sevenson excavated four to five tieback trenches at a time to minimize the open excavations. The material was transported and stored in the material bins. When each stage of tie rod installation was completed, soils were replaced and compacted. Stormwater entering these excavations was pumped to containment tanks for treatment at the temporary water treatment system. The tiebacks and walers were installed at the required elevations and as per the specifications and drawings. Walers on the outside of the containment sheet pile wall were shimmed to connect the soldier piles and welded by licensed personnel. The walers and tiebacks were fully completed and stressed before backfilling the trenches. All anchor rod nuts were then capped and filled with grout.

3.6.5 Final Backfill Placement

Following 2013 dredging activities bedding stone and rip-rap were placed adjacent to the VBW to provide long term support. Bedding stone was placed first to provide a stable base for rip-rap installation. Backfill materials were placed from the water to prescribed elevations. A portion of the rip-rap was left low to accommodate the draft of the unloading barge should dredging work continue next season. This remaining section will be completed either in the spring of 2014 or after the 2014 dredging season.

3.6.6 Material Disposal

Soils left after completing VBW stability work was stored in the material bins on the process pad and was sampled, loaded, and disposed as nonhazardous soils prior to mobilization for the 2013 dredging season.

3.6.7 Site Restoration

Areas of the site disturbed during the VBW support installation were backfilled and generally graded to pre-existing conditions, to the extent practicable. Along the coal dock, a new access road was constructed, and soil berms that were installed after the 2010 VBW construction activities were reinstalled, capped, and seeded. Much of the disturbed area was within the footprint of the process pad used for dredging and was backfilled, compacted, and paved over in preparation for 2013 dredging mobilization.

3.7 Issues and Changes Encountered

3.7.1 Dredged Material Processing Difficulties Encountered in 2012

The chemical interaction in the initial sediment treatment process was found to reduce the effectiveness of the treatment process, thereby delaying progress on the project. The chemical interaction was associated with the ferric sulfate and sodium hypochlorite mixing within the treatment train. Therefore, the sediment treatment process was modified by eliminating the ferric sulfate chemical addition.

Sediment treatment using the addition of fly ash/bed boiler ash at a rate of 18 percent by weight and sodium hypochlorite at a rate of 5 percent by weight initially appeared effective, successfully treating the sediments to meet landfill criteria.

Following initial use of the ash and sodium hypochlorite chemical mix, it was found to be less effective than the results from two independent treatability studies. It was relatively ineffective on sediment containing high arsenic concentrations. Therefore, additional treatability studies were conducted to determine a more effective and consistent approach to treat the sediments.

The dredging activities ceased from August 20, 2012 through September 24, 2012 while additional treatability studies were conducted. During the cessation of dredging, the temporary water treatment system continued to process site stormwater. Some treated sediment bins were retreated in the pug mill and transported offsite once they passed criteria.

3.7.2 Dredged Material Processing Changes and Effects on the Process in 2012

Based on the results of the treatability studies (presented in the Turning Basin Soft Sediment Treatment Process Modification Report, November 2012 in Appendix M), a chemical mix including the addition of ferric sulfate at a rate of 25 percent by weight and Portland cement at a rate of 10 percent by weight was found to be the most appropriate approach for fresh dredged sediment treatment. This revised chemical mix was proven 100 percent effective at treating the sediments through the end of 2012.

3.7.3 2012 Notice of Noncompliance

A Notice of Noncompliance for the Hazardous Waste Remediation Variance was submitted by WDNR to Tyco on October 22, 2012. The notice presented five alleged violations and additional areas of concern. A letter from CH2M HILL sent on behalf of Tyco dated November 21, 2012, responded to the WDNR notice and indicated that the areas of alleged noncompliance and areas of concern had been addressed. In addition, a response to the notice, a technical memorandum regarding the sediment treatment studies completed in December 2012 and January 2013 (CH2M HILL 2013b), was submitted to the agencies for their review on February 1, 2013.

3.7.4 Water Treatment System Difficulties Encountered in 2012

The treatment system performed well and was achieving excellent ion rejection (of arsenic) in percent terms; however, the influent arsenic concentrations were higher than concentrations assumed for design of the system. Because the treatment system effectively operates by percent rejection, the high arsenic influent concentrations resulted in the effluent exceeding permit limits.

Exceedances of the arsenic effluent limit of 680 µg/L were observed periodically in the discharge samples from August 13 through September 4, 2012 (see the Wisconsin Pollutant Discharge Elimination System [WPDES] reports and letters in Appendix O) and a WDNR Notice of Noncompliance letter was submitted to Tyco on September 13, 2012, regarding the exceedances. Adjustments were made and the issue was resolved.

On October 15, 2012, the effluent discharge pipe split by a delivery driver who drove off the road and the effluent discharge line discharged for 3 minutes and then was immediately repaired. A notification for hazardous substance discharged (non-emergency) form was filled out and submitted to the agency and is included in Appendix O. No additional action was required.

3.7.5 Changes and Effects on the Water Treatment Process in 2012

An exceedance of the pH permit criteria was observed on August 13, 2012. Because of limited decant water generated during dredging and little to no rain, only a small volume of water was collected for treatment during the days immediately before August 13, 2012. The water to be treated was pumped into a 20,000-gallon holding tank. A caustic was pumped into this tank to mix with the water. On August 13, 2012, the water level in the tank was low; however, the caustic continued to be added at the same rate, thereby, increasing the pH. The operator identified this issue after the daily sample had been collected, and the system was shut down to wait for more water to be generated on the project.

A float switch in the 20,000-gallon holding tank near the discharge to stop the treatment system and the addition of caustic once the tank reaches 20 percent of its total volume.

To address the arsenic exceedances, initial operational improvements were identified that were implemented on September 6, 2012.

- The system piping was re-routed to run permeate from the VSEP unit back to the beginning of the water treatment system. This improved the influent water quality.
- Monitored conductivities of water entering and exiting the RO unit were conducted. By more closely observing these conductivity readings and correlating them to the effluent results, a relationship was observed between conductivity and arsenic concentrations that allowed the RO operator to better predict arsenic concentrations allowing for decisions to be made concerning the need to conduct additional water treatment.

See Appendix O for the WPDES noncompliance memorandum that addressed these issues.

3.7.6 Changes and Effects on the Dredged Material Process in 2013

Additional treatability studies were conducted during the winter of 2013 to further refine the treatment process. The results of the treatability studies were presented in the Dredged Material Treatability Study Results Technical Memorandum, dated February 1, 2013. The treatability study was revised on March 29, 2013, and finalized on May 7, 2013, to respond to USEPA comments received on March 6 and April 26, 2013. The May 7, 2013, technical memorandum was revised to include the requested USEPA changes as identified in the comments documents and represents the final version of the treatability study results. The revised technical memorandum was approved by USEPA on May 14, 2013.

Based on the results of the treatability study, the appropriate chemical to stabilize the arsenic in the sediment was dependent on the material type (soft sediment or semi-consolidated material) and specific arsenic content. Therefore, an approach was developed to screen the fresh dredged material before processing to select the chemical dose for treatment of the sediments.

Arsenic samples were collected from each scow prior to processing the sediment. The samples were subjected to X-ray fluorescence (XRF) screening to estimate total arsenic content and a “rapid” TCLP test, developed specifically for the project, to provide an estimate of leachable arsenic content of the material in each scow. Based on the results, a chemical dose consisting of ferric sulfate and Portland cement was selected for treatment of the sediment. The XRF screening and rapid TCLP were conducted by ECCS onsite to allow for rapid turnaround of the analytical results to make decisions on the appropriate chemical dose. The use of the screening tests and onsite laboratory greatly increased chemical dosing success and reduced the potential for dredging and processing downtime. In addition, because of the high water content of the soft sediment, dry ferric sulfate was used to treat the sediments; liquid ferric sulfate was used to treat SCM.

Sample collection of treated sediments was modified from the 2012 approach. Samples were collected from four locations for every 500 yd^3 of treated sediment. Sediments representing the approximate volume were collected from depths to approximately 4 feet and composited into a single sample for testing at the onsite laboratory to confirm the treated material met landfill criteria before offsite disposal. The sampling approach was consistent with the agency-approved standard operating procedure. The hazardous waste variance was modified and approved to allow for incorporation of these processes for sediment treatment.

In addition to the treatability study, a final hazardous modification request was submitted to WDNR on April 23, 2013, to request changes needed to modify the site layout, processing, and processed material sampling to complete the 2013 dredging activities. WDNR approved the changes May 9, 2013, in a plan modification to Tyco.

3.7.7 Dredging and Dredged Material Processing Difficulties Encountered in 2013

Dredging and processing activities generally went as planned in 2013. Relatively few issues were encountered that necessitated large scale changes.

One difficulty encountered was the presence of glacial till at higher elevations than anticipated. In accordance with the AOC, dredging of glacial till was not planned as part of the site active remediation. Therefore, dredging in these areas ceased once glacial till was encountered. Visual confirmation was performed to verify glacial till had been encountered. The presence of glacial till at shallower depths than anticipated slowed the dredging progress. However, because of the glacial till being encountered at higher elevations than planned, a reduced volume of material required removal.

A second difficulty encountered was the shallow water depth in the South Channel. The excavator barge drafted too deep to access the area, and dredging a path into the area would require removing material below the design elevations. The resolution was to excavate to design depth from the access road out as far as possible into the channel and have the excavator barge dredge a path into the South Channel to remove sediment not accessible from the land-based excavator. This required that some material from below the design elevations be removed. Sediments were hauled via truck to the truck turnaround area and dumped into a transfer pit constructed of sealed bin blocks. The material was transferred to a scow for transfer to the processing area. Modifications to the hazardous waste variance were necessary to obtain approval from the agency to implement the dredging and transfer processes the modification request was submitted on August 20, 2013, and was approved by WDNR via an email sent on September 5, 2013.

A third difficulty encountered was the availability of dry ferric sulfate to treat soft sediments during some portions of the year. The dry ferric sulfate for the project was obtained primarily from a European manufacturer. Packaging and shipping were delayed resulting in the need to treat some soft sediment with liquid ferric sulfate. This was anticipated and the May 9, 2013, hazardous waste variance plan modification allowed for the project to adjust for this change.

3.7.8 Water Treatment System Difficulties Encountered in 2013

In June and July 2013, the onsite water treatment plant experienced several exceedances of effluent discharge criteria that were potentially because of high-concentration free water in the scows being dewatered. Part of the corrective actions for this issue was to first install additional effluent holding tanks so effluent could be tested for compliance before being discharged. Geotextile tubes were then changed out and the speed and pressure at which the influent water was pushed through the geotextiles tubes was lowered to increase the capture of suspended solids.

Sevenson also attempted to determine the extent to which the arsenic entering the system, and particularly the exceedances, might be the result of the presence of inorganic arsenic in the wastewater. Onsite testing indicated significant inorganic arsenic is present, at least at times. Inorganic arsenic is not as efficiently removed as organic arsenic by membrane processes such as those installed at the site. Beginning August 14, 2013, Sevenson began to measure inorganic arsenic in the influent and RO permeate. The test for inorganic arsenic used a colorimetric Hach Total Arsenic Test (#77406). Conductivity was compared to inorganic arsenic to determine if an instantaneous conductivity reading could serve as a surrogate for inorganic arsenic to serve as an “early warning” to the treatment plant operators that additional steps might need to be taken to control arsenic and avoid exceedances.

Beginning on September 16, 2013, the operation of the WWTP was modified to minimize the potential for future exceedances. The modifications included storing the processed water in three temporary holding tanks. A grab sample (screening sample) was collected from each holding tank whenever filled and analyzed for total arsenic at the onsite project laboratory before discharge.

If screening samples were above criteria, the water was reprocessed through the RO unit and a subsequent screening sample was collected. This screening regimen continued for the duration of the project and was successful.

In addition to screening treated water, the water quality data that are logged at the WWTP to document turbidity, pH, and conductivity were reviewed and analyzed. Following this review of the system performance, coagulant metering rates at the WWTP were assessed and adjusted to accommodate changing conditions: water temperature, influent concentrations, and geobag replacement.

These issues and corrective measures are outlined in the noncompliance technical memorandums dated July 12, July 26, August 16, September 13, and November 7, 2013, that were submitted to WDNR as part of the WPDES permit and in response to a notice of noncompliance from WDNR dated August 21, 2013.

3.8 Decontamination, Demobilization and Final Site Restoration

3.8.1 2012 Winter Shutdown Decontamination and Demobilization

Dredging for the 2012 season was concluded at the end of October. In November and December 2012, the remaining dredged sediment was treated and loaded for offsite disposal. The equipment leaving the site was decontaminated and either rinsate or wipe tested to pass the cleanup standards of 1.4 mg/L (or ppm) as presented in the July 3, 2012, hazardous waste variance. Equipment remaining onsite during the winter shutdown was decontaminated to meet the 32 mg/kg (or ppm) criteria (per the hazardous waste variance) and equipment remaining at the 6th Street Slip location during winter shutdown was decontaminated to meet the 16 mg/kg (or ppm) criteria. See Appendix K for the decontamination sampling results.

The temporary water treatment system was shut down and prepared for the winter shutdown in mid-November. The RO units were "pickled" in preparation for cold temperatures. The geotubes used for solids dewatering were treated and disposed offsite.

3.8.2 2013 Winter Shutdown Decontamination and Demobilization

Dredging for the 2013 season was completed at the end of November. In December 2013, the remaining dredged sediment was treated and loaded for offsite disposal. The equipment leaving the site was decontaminated and either rinsate or wipe tested to pass the cleanup standards of 1.4 mg/L (or ppm) as presented in the July 3, 2012, hazardous waste variance. See Appendix N for the decontamination sampling results.

Because of the increasingly cold weather and the extension of the dredge season, a request to modify the decontamination approach for 2013 winter shutdown was submitted to WDNR in a revised letter dated November 18, 2013 (CH2M HILL 2013c), and approved in an email from WDNR dated November 25, 2013. The procedures outlined in the letter were followed and included the following general steps. The process pad, 6th Street area, and equipment remaining onsite during the winter were given a dry decontamination to remove gross dirt and limit airborne dust generation. Water decontamination was not possible because of extended days of below freezing temperatures. A small crew also was available during the winter months to perform equipment repairs and inspections of the site to respond to any water or dust concerns from contaminated areas. The temporary water treatment system was shut down and prepared for the winter shutdown at the beginning of December 2013. The RO units were "pickled" in preparation for cold temperatures. The geotubes used for solids dewatering were sampled and disposed offsite.

3.8.3 Final Site Decontamination and Restoration

Final site decontamination and site restoration activities were postponed and will be completed in 2014. Full decontamination as required in the hazardous waste variance will be undertaken prior to June 1, 2014, or after the betterment remedy is implemented, if it is mutually agreed to move forward with the betterment project. Once completed, the decontamination and restoration activities will be documented in a brief memorandum as an attachment to the quarterly report or provided to the agency or as part of a completion report for the betterment remedy.

SECTION 4

Environmental Monitoring of Remediation Activities

4.1 River Water Quality

Activities related to river water quality monitoring required by the WDNR Chapter 30 permit included turbidity monitoring equipment installation, baseline and daily surface water sampling (during dredging) for turbidity and total arsenic, and turbidity/total suspended solids (TSS) correlation sampling. These activities are outlined as part of the *March 2, 2012 Revised Technical Memorandum Arsenic Water Quality Analysis for Tyco Sediment Removal from the Menominee River, Marinette, WI, in Attachment 5 Monitoring River Water Quality* (CH2M HILL 2012f).

Continuous turbidity monitoring at three stations approximately 800 feet upstream, 320 feet downstream, and 1,000 feet downstream of the dredge area (Figure 5) was performed to demonstrate compliance with the project-specific TSS standard of less than 80 mg/L above background. Turbidity measurements in nephelometric turbidity units (NTUs) were recorded as a surrogate for TSS at the monitoring stations. In addition, three total arsenic grab samples per day were collected from each of the downstream monitoring locations 320 feet and 1,000 feet downstream of the project area. A daily 24-hour composite total arsenic sample, comprised of three grab samples composited together, was collected from the mouth of the river. Periodically, there were instances where three samples were not collected in 1 day because of adverse weather conditions that restricted boating on the river. A summary of the required sampling locations and type of sampling occurring at each sampling point during both pre-dredging/baseline and during dredging is included in Table 4-1.

TABLE 4-1
River Water Quality Sampling Points
Menominee River Sediment Removal Project
Construction Completion Report

	Sampling Point Upstream 1: 800 feet Upstream	**Sampling Point Downstream 2: 320 feet Downstream**	**Sampling Point Downstream 3: 1,000 feet Downstream**	**Sampling Point Downstream 4: Mouth of River**
	2 Weeks of Baseline Sampling in 2012 (June 27,2012 – July 11, 2012) 1 Week of Baseline Sampling in 2013 (April 25, 2013 – May 2, 2013)			
TSS	Continuous	Continuous	Continuous	None
Arsenic	One time only	3 grabs/week	3 grabs/week	Daily 24-hour composite sample
	Conducted While Dredging was Occurring			
TSS	Continuous	Continuous	Continuous	None
Arsenic	One at the start of dredging	3 grabs/day	3 grabs/day	Daily 24-hour composite sample (three grab samples of equal volume composited together)

Before establishing a project-specific TSS/turbidity relationship, it was assumed the turbidity readings at the monitoring stations had a one-to-one correlation to TSS. Therefore, a turbidity change of 80 NTUs would be equivalent to an increase in TSS of 80 mg/L. However, after commencing the dredging activities, turbidity monitoring was performed concurrently with TSS sampling to establish a project-specific TSS/turbidity correlation curve. This correlation was completed for soft sediment in 2012 and was evaluated for SCM in 2013. The 2012 soft sediment evaluation determined the project-specific TSS/turbidity correlation of 41 NTUs would be equal to the project-specific TSS standard of less than 80 mg/L above background (CH2M HILL 2012g). The 41 NTUs value was used throughout the project in 2012 during sediment dredging. Based on the findings of the 2013 SCM evaluation, a more conservative correlation value was calculated for SCM with the project-specific TSS/turbidity correlation at 38 NTUs equal to the project-specific TSS standard of less than 80 mg/L above background (CH2M HILL 2013d). The 38 NTUs value was used for the remainder of the 2013 work.

Exceedances of the 41 NTU threshold above background (Upstream 1) were measured during 2012 activities; however, they do not appear to be correlated with dredging activities and are summarized in the following:

- July 31, 2012 – Increased turbidity was recorded at the Downstream 2 monitor because of a large freighter using the Turning Basin. The freighter used the Turning Basin in the late afternoon and evening, and was then docked approximately 50 yards upstream of the Downstream 2 monitor.
- August 2, 2012 – An exceedance was noted at the Downstream 2 monitor, which was attributed to algae growth on the monitor. The algae was removed, and turbidity readings returned to normal range.
- August 4, 2012 – Increase at the Downstream 2 monitor was attributed to a heavy rain event and a stormwater effluent pipe, located close to the turbidity monitor that was discharging stormwater runoff.
- August 14, 2012 – The Downstream 3 monitor showed a turbidity increase; however, there were no dredging activities on this day.

Exceedances of the 38 NTU threshold above background (Upstream 1) were measured during 2013 activities; however, they also do not appear to be correlated with dredging activities and are summarized in the following:

- April 29 and 30, 2013 – There was an increase in turbidity at the Downstream 3 monitor because of the silt curtain being deployed. On April 30, 2013, there was another increase at this monitor; however, there were no dredging activities during this time.
- April 30 and May 1, 2013 – The upstream turbidity monitor showed a high turbidity value because of plant matter wrapped around the monitor. The material was removed, and turbidity readings returned to normal.
- May 10, 2013 – There was a short spike in turbidity at the Downstream 2 monitor because of increased boat traffic from fishing activities. A high number of fishing boats were observed on the river near the monitors during that time.
- May 24, 2013 – The Downstream 2 monitor showed a spike in turbidity because of the silt curtain being opened to bring in a scow.
- June 30, 2013 – The Downstream 2 monitor had an increase in turbidity attributed to the silt curtain being moved to accommodate a ship turning evolution in the Turning Basin.
- August 15, 2013 – The Downstream 3 monitor had an increase in turbidity attributed to the silt curtain seam being patched and shored up.
- August 28 through August 29, 2013 – The Downstream 3 monitor showed abnormal readings, and the monitor subsequently was serviced and replaced.

Appendix P contains the river water quality results, turbidity/TSS correlation memorandums, and river water quality trend graphs.

4.2 Drinking Water Plants

Samples from the nearby drinking water treatment plant systems were collected, and the required analytical laboratory testing was performed in accordance with the March 2, 2012, *Revised Technical Memorandum Arsenic Water Quality Analysis for Tyco Sediment Removal from the Menominee River, Marinette, WI, Attachment 5 Monitoring River Water Quality* (CH2M HILL 2012f).

Drinking water samples were collected three times per week from June 27, 2012 through October 18, 2012 and April 25, 2013 through November 22, 2013 (includes pre-dredging/establishing baseline and during dredging) at the raw water intake points for the drinking water plants in the cities of Marinette, Wisconsin and Menominee, Michigan. These grab samples were analyzed for arsenic and compared to the drinking water standard of 10 parts per billion (ppb); there were no exceedances of this standard throughout the project. Levels above 5 ppb (half the drinking water standard) also were evaluated and used as a trigger point for discussing potential operational changes that could be completed to reduce the rate at which arsenic was being resuspended before reaching the 10 ppb standard. There were a few results over 5 ppb; however, in all cases, the next result was lower or the analyte was detected in the laboratory trip blank. Appendixes K and Q contain the 2012 and 2013 analytical results, respectively.

4.3 Water Treatment System

Treatment system water samples were collected, and required analytical laboratory testing was performed in accordance with the Wisconsin Pollutant Discharge Elimination System (WPDES) permit requirements under General Permit WI-0046558-05-0. A summary of the required sampling is included in Table 4-2.

TABLE 4-2
WPDES/Temporary Treatment System Sampling
Menominee River Sediment Removal Project
Construction Completion Report

	Type of Sample	Frequency
Start-Up Sampling		
Chlordane, DDT (dichlorodiphenyl trichloroethane), Low Level Mercury, Toxaphene, Ammonia Nitrogen, Total Phosphorous	24-hour composite, collected by Isco sampler	Two the first week, then weekly for the next 4 weeks[1]
Oil and Grease	24-hour composite, collected by Isco sampler	Two the first week, then weekly for the next 4 weeks[1]
During Dredging Sampling		
Influent Total Arsenic	Grab from port to geotubes and prior to treatment	Daily for the first 2 weeks, then weekly or as needed[2]
Total Arsenic	24-hour composite, collected by Isco sampler	Daily
Flow	Estimated from the effluent flow meter	Daily
pH	Continuous	Daily
TSS	24-hour composite, collected by Isco sampler	Weekly
Ammonia Nitrogen, Total Phosphorous	24-hour composite, collected by Isco sampler	Monthly, after startup
Oil and Grease	Grab	Monthly, after start-up

Notes:
[1]Additional weekly or monthly sampling of these parameters was required based on the start-up results
[2] Influent monitoring for arsenic was recommended to evaluate treatment system performance, as needed, not a specific requirement of the WPDES permit

Toxaphene, DDT (dichlorodiphenyl trichloroethane), and chlordane sampling was discontinued on September 13, 2012, because results were all nondetect, and the method and reporting limits were deemed appropriate according to WDNR review. On September 13, 2012, ammonia and oil and grease continued to be monitored weekly, and phosphorous monitoring was reduced to monthly. In 2013, ammonia, oil and grease, and phosphorous were approved to be monitored monthly (in an email date May 31, 2013), while TSS continued to be monitored weekly. Weekly low-level mercury sampling was discontinued on August 13, 2013, after demonstrating through statistical evaluation that the low-level mercury results from 2012 through August 2013 were meeting the requirements and intent of the WPDES permit for low-level mercury (CH2M HILL 2013e).

In 2012, there was one exceedance of the permit criteria for pH, which was resolved quickly with a process change. There also were several exceedances of the permit criteria for arsenic, which were resolved by adding a VSEP unit, monitoring the conductivities entering and exiting the RO unit, and treating the water in batches instead of a continuous cycle. After these approaches were implemented, there were no more exceedances to the permit criteria in 2012.

In 2013, there was one exceedance of the permit criteria for pH, which was attributed to initial system startup. There also were several exceedances of the permit criteria for arsenic, which were resolved by temporarily storing treated water in a holding tank, while it was screened for total arsenic at the onsite laboratory. Adjustments also were made to the water treatment system to increase coagulation and arsenic removal by the microfilter.

Monthly discharge monitoring reports (DMRs) were submitted by the 15th of each month from July 2012 through November 2012 and July 2013 through December 2013, and technical memorandums detailing changes needed to operate the system more efficiently were submitted when required. Appendix O contains the WPDES reports and additional technical memorandums, and Appendixes K and Q contain the 2012 and 2013 data.

4.4 Stabilized Sediment Sampling and Analysis for Disposal (Hazardous Waste Variance and Landfill Requirements)

Samples from the stockpiles of stabilized sediment were analyzed in accordance with the July 3, 2012, WDNR hazardous waste remediation variance and landfill requirements. Appendix K contains the analytical and geotechnical results from Pace Laboratories, TestAmerica, and Coleman in 2012, and Appendix N contains the analytical results from ECCS in 2013. Appendix J contains the bin tracking logs from 2012 and 2013.

Pursuant to the hazardous waste remediation variance, the startup sampling of the stabilized soft sediment included analysis for TCLP volatile organic compounds, TCLP semivolatile organic compounds, TCLP RCRA metals, TCLP pesticides, TCLP herbicides, and polychlorinated biphenyls (PCBs). Pursuant to the landfill sampling requirements, the startup samples also were run for the Protocol B and Protocol DC lists and geotechnical analyses (strength and moisture, percent solids, grain size distribution, liquid limit, plastic limit, plasticity index of soils), and hydraulic conductivity testing. These samples were collected at a frequency of one per 300 yd^3 for the first 9 days of treatment in 2012. Additional information on startup sampling is in the *Turning Basin Soft Sediment Treatment Startup Report – July 2012* (CH2M HILL 2012h). Once the startup sampling was complete, the stabilized soft sediment was sampled at a reduced frequency of one per 500 yd^3. At least one sample was collected daily, and the analysis suite was reduced to pH, paint filter, total arsenic, and TCLP arsenic, with monthly sampling to be analyzed for the startup analytical suite (did not include the landfill sampling lists).

In 2013, the hazardous waste remediation variance was modified to include only analysis for pH, TCLP arsenic, total arsenic, and paint filter. A standard operating procedure (SOP) was developed, as a requirement during the finalizing of the modification, for sampling the treated sediment bins and was approved by USEPA in the final hazardous waste remediation variance modification dated May 9, 2013. This sampling procedure was followed throughout the 2013 dredging activities. A sampling frequency of one per 300 yd^3 was used until 4,200 yd^3 had been processed and had TCLP arsenic sample results all less than 5 mg/L, then it was reduced to one sample per 500 yd^3.

4.4.1 2013 Scow Material Pre-Screening

During the 2013 dredge season, before sediment processing, pre-screening was performed on the dredged material using the ECCS onsite laboratory. The pre-screening aided in determining chemical addition quantities and maximized success rates for treatment of the dredged material.

Representative samples (approximately one sample per 100 yd^3) were collected from each scow before offloading for the treatment phase. Each representative sample was homogenized, and subsamples were prepared for analysis of moisture content, XRF screening for total arsenic, "rapid" TCLP assessment for arsenic, and visual and physical assessment.

These analyses were used to differentiate soft sediment and SCM. Procedurally, the XRF testing occurred first, as it is the quickest test, providing rough order of magnitude total arsenic concentrations in a matter of minutes. As part of the screening process, a visual/physical examination of the dredged material was undertaken to assess its moisture and organic matter contents and consistency. This testing occurred in parallel with rapid TCLP testing (4-hour total duration), which also determined the moisture content (as percent solids) as part of the testing procedure. The physical examination also involved a field assessment of the grain size distribution (sands/silt/clay), dilatancy (moisture retention/drainage) and the organic matter content based on its apparent plasticity and/or slickness, which are directly proportional. Elevated TCLP arsenic and high water content and plasticity denoted soft sediment, whereas SCM with similar physical characteristics has significantly lower TCLP arsenic (typically less than 7.5 mg/L). SCM with elevated TCLP arsenic has been low plasticity, low moisture content.

The information obtained from the pre-screening was used to determine chemical quantities for incorporation during sediment processing. Chemical addition initially was determined based on treatability results completed between December 2012 and January 2013 and is presented in the *Revised Hazardous Waste Variance Modification Request,* April 2013 (CH2M HILL 2013f).

During dredging in spring 2013, some of the deeper SCM was observed to have different characteristics than material encountered in 2012 activities. A supplemental dredged material treatability study was performed, and the final study results were submitted on July 25, 2013 (CH2M HILL 2013g). It was determined that a minimum of 5 percent by weight dose of 60 percent ferric sulfate solution with 2.5 percent by weight Portland cement, was needed depending on the type of dredged material.

Ultimately, based on observations of the dredged material and the results of the pre-screening, a sliding scale of reagent dosing schemes for soft sediment and SCM was developed in the field. This sliding scale was able to accommodate the variability in the environmental quality of the incoming scows of dredge material. The predominant range of chemical dosage was 5 percent by weight and 25 percent by weight of the ferric sulfate solution and corresponding Portland cement doses was in the 2.5 percent by weight to 10 percent by weight, as needed.

4.5 Decontamination Sampling and Analysis

Decontamination samples were collected in 2012 and 2013 as part of hazardous waste remediation variance. These were either wipe samples or rinsate samples to confirm the site and equipment was decontaminated appropriately before demobilizing from the site (for equipment leaving throughout the project, seasonal shutdown, and final closure). Appendixes K and N contain the analytical results from 2012 and 2013.

The equipment that was sampled was not allowed offsite until it met the cleanup standard. The cleanup standards were as follows:

- Equipment going offsite – Wipe or rinsate samples were compared to the cleanup standard of 1.4 mg/L or ppm.
- Material/surfaces staying onsite – Wipe or rinsate samples were compared to the cleanup standard of 32 mg/kg or ppm.
- Material/surfaces staying at the 6th Street Slip – Wipe or rinsate samples were compared to the cleanup standard of 16 mg/kg or ppm.
- Debris going offsite (landfill)—Wipe or rinsate samples were compared to the clean up standard of 5 mg/L or ppm.

4.6 Sediment Confirmation Sampling and Analysis

Characterization of post-dredge surface conditions was determined by conducting confirmation sampling following dredging activities in accordance with the *Final Confirmation Sampling Plan* (CH2M HILL 2013a) approved by USEPA in a letter dated March 18, 2013. The specific objective of the confirmation sampling was to provide sufficient analytical data to determine whether the cleanup criteria of 50 mg/kg total arsenic was achieved or whether an additional dredging pass (cleanup pass) was necessary.

There were a total of 162 DMUs from which one to three sediment cores were collected per DMU (Figures 2, 3, and 4), depending on the DMU size. DMUs were determined by dividing each dredge phase/area into 70-foot by 70-foot (4,900 square feet [0.11-acre]) DMUs; however, some DMUs exceeded 4,900 square feet because of the irregular shoreline and dredge boundary. The DMU size of 70-by-70 feet had been selected in agreement with USEPA and is representative of approximately one-half the average distance between sample locations within the remedial investigation data set used to perform the three-dimensional (3D) geostatistical model from which the dredge prisms were created. Along the VBW, DMUs were realigned following approval of the *Final Confirmation Sampling Plan* (CH2M HILL 2013a) to accommodate placing the base and armor material along the toe. USEPA approved the DMU changes in an email dated August 27, 2013. Each VBW DMU was designed to represent approximately the same square footage (4,500 square feet) from which one sediment core was collected in each.

Confirmation sampling commenced from August 27 to November 16, 2013. Because of modifications in the dredging approach, which essentially eliminated the phased dredging approach, sampling was completed when dredging in general areas was completed.

Post-dredge sediment sampling was performed at each DMU on the post-dredged surface following bathymetric survey and confirmation that the designed dredge elevations had been achieved. Sediment cores were collected using a vessel mounted direct-push technology (DPT) rig in areas of dense sediments (SCM and/or till). In areas where there were softer sediments and shallow water depths, sediment cores were collected using manual push cores and a john boat. Sediment cores were shuttled to shore and processed onsite.

Cores were visually characterized for sediment type, color, moisture content, texture, particle size and shape, consistency, visible evidence of staining, and other observations. Each core was segmented into 0.5-foot sample intervals and was homogenized using pre-cleaned disposable utensils within aluminum pans. Before containerizing each sample, rocks and other debris were removed, and the sample was thoroughly mixed until uniform texture and color was achieved. If the last core sample was less than half the sample interval spacing (0.5 foot), it was included in the previous interval. If greater than half the respective interval spacing, it was processed as a separate sample. Any reusable equipment used during sample processing was decontaminated between samples. The sediment core field logs are provided in Appendix R.

The first two sample intervals (0 to 0.5 foot and 0.5 to 1 foot) were analyzed for total arsenic submitted to the onsite mobile laboratory run by ECCS Laboratories for 24-hour turnaround time. Results were dry-weight-corrected for comparison to the limit. Remaining intervals (below 1 foot) were archived onsite by

ECCS. If the 0- to 0.5-foot interval arsenic result was greater than the remedial action limit and the 0.5- to 1-foot interval was below the action limit, 0.5 foot of sediment within the DMU was re-dredged and the DMU was complete. If the 0.5- to 1-foot interval arsenic result was greater than the remedial action limit, the archived DMU sample intervals (greater than 1 foot) were analyzed to determine the depth of re-dredge in the DMU. If glacial till was encountered, it was visually verified and noted in the sediment logs; however, it was not analyzed for total arsenic. Fifty-seven DMUs encountered glacial till during the initial dredge pass, and the verification activities for these locations are described in four memorandums that were written to document the glacial till verification activities (CH2M HILL 2013h, 2013i, 2013j, 2013k). Six DMUs (I1, I2, I6, VBW009, VBW010, and VBW013) encountered glacial till during the re-dredge of sediments exceeding the remedial action limit. At DMUs VBW009, VBW010 and VBW013, glacial till was encountered and re-dredged to an elevation with samples less than 50 ppm arsenic; therefore, these three DMUs were dredged to the new elevation or to where till was encountered through visual confirmation.

If DMU samples exceeded the remedial action limit, re-dredging occurred within the DMU to the lowest depth an exceedance occurred (even if there were "clean" results in between exceedances). If re-dredging was required below the depth of 4 feet, additional confirmation sampling was required of the post re-dredge surface and conducted in the same manner in which the initial confirmation samples were collected. Sample locations collected to represent post re-dredge surface sediments were randomly selected as required in the confirmation sampling plan and were not collected at the original confirmation sample location. Forty-six DMUs required additional dredging, of which four DMUs (K7, L7, N12, and VBW019) were re-dredged to depths greater than 4 feet, therefore requiring post re-dredge sampling. In DMUs K7 and L7, the re-dredge elevations in some areas were too deep for the onsite equipment to reach; therefore, additional samples were taken in each DMU to further delineate the re-dredge areas and elevations in K7 and L7. Resurveying and re-dredging activities were performed by Sevenson as described within the project specifications (CH2M HILL 2012c) and in Section 3.

Confirmation sampling results are summarized in Appendix N and Figures 2, 3 and 4 present the final DMUs and sampling locations. USEPA split sample results are included in Appendix S and sample locations shown on Figures 2 and 3. Confirmation sampling results of the final post-dredge surface are presented in Figures 6, 7, and 8. Post-dredge sampling and analyses were performed in accordance with the Confirmation Sampling Plan (CH2M HILL 2013a), the Confirmation Sampling Plan Quality Assurance Project Plan (QAPP) dated July 24, 2012 (CH2M HILL 2012i), and subsequent addendums to the QAPP. The revised QAPP Addendum 1 is dated August 23, 2013 (CH2M HILL 2013l).

SECTION 5
References

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Figures

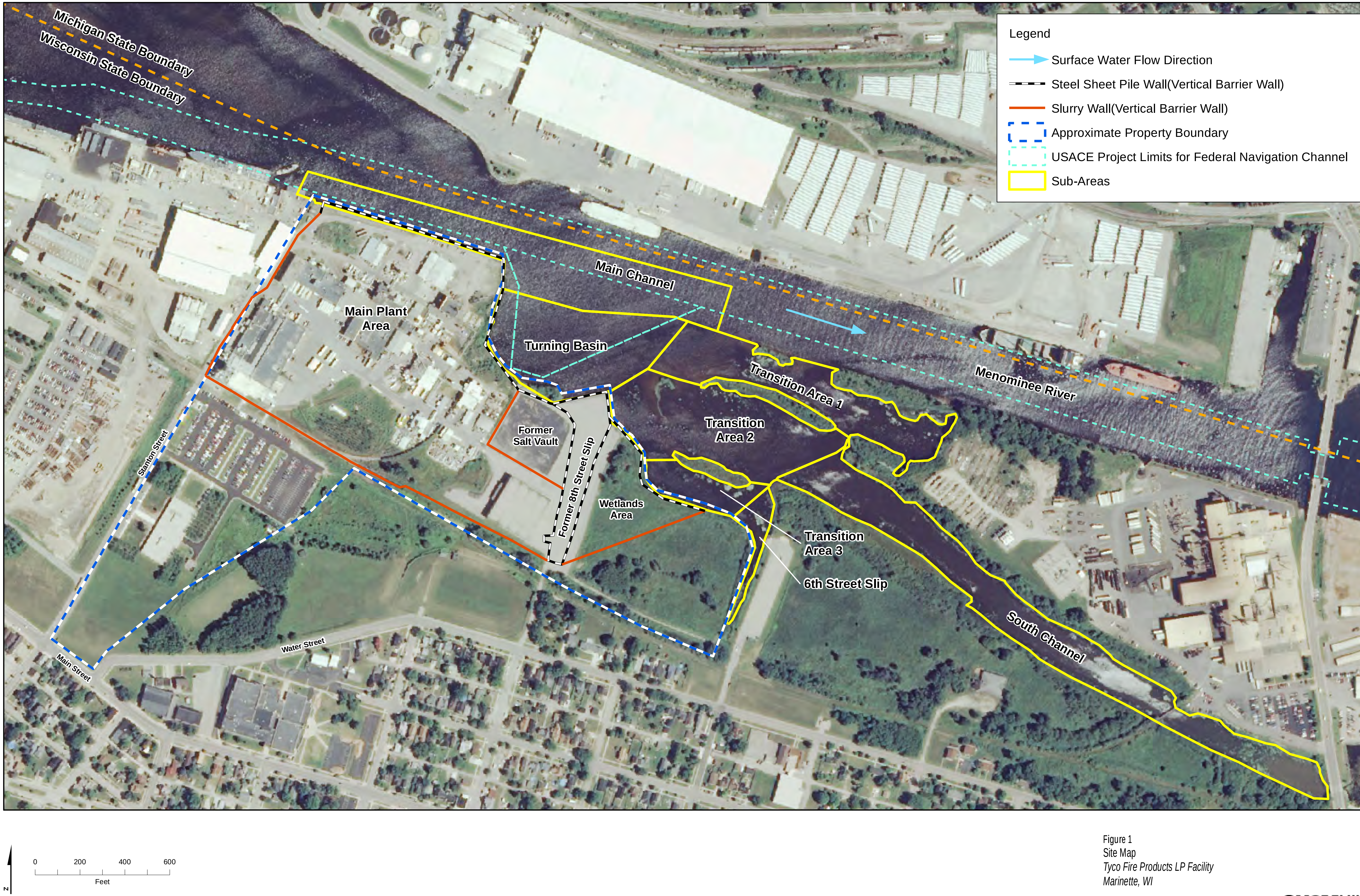

Figure 1
Site Map
Tyco Fire Products LP Facility
Marinette, WI

CH2MHILL

E:\TYCO\MAPFILES\DELIVERABLE_012312\FIGURE 01 - SITE MAP.MXD JHANSEN1 1/20/2012 3:52:06 PM

Figure 2
Confirmation Sampling and DMU Locations
Tyco Fire Products LP Facility
Marinette, WI

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E:\TYCO\MAPFILES\2014\CCR\FIGURE 02 - CONFIRMATION SAMPLING AND DMU LOCATIONS.MXD JHANSEN1 2/28/2014 2:23:11 PM

Figure 3
Confirmation Sampling and DMU Locations
Tyco Fire Products LP Facility
Marinette, WI

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Figure 4
Confirmation Sampling and DMU Locations
Tyco Fire Products LP Facility
Marinette, WI

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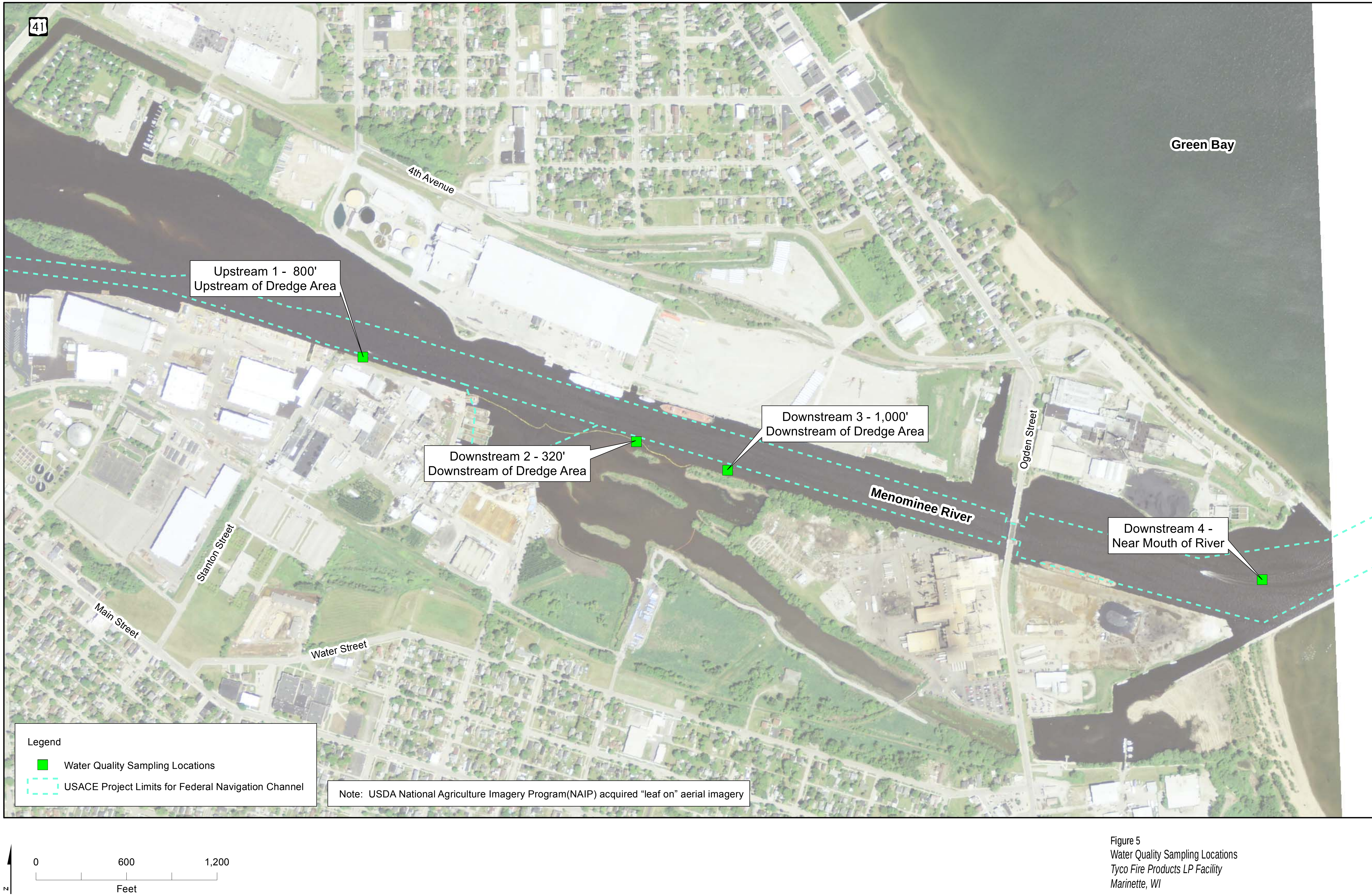

Figure 5
Water Quality Sampling Locations
Tyco Fire Products LP Facility
Marinette, WI

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E:\TYCO\MAPFILES\2014\CCR\FIGURE 05 - WATER QUALITY SAMPLING LOCATIONS.MXD JHANSEN1 2/28/2014 2:29:44 PM

Figure 6
Final Post-Dredge Confirmation Sampling Locations and Results
Tyco Fire Products LP Facility
Marinette, WI

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N

0 80 160

Feet

Figure 7
Final Post-Dredge Confirmation Sampling Locations and Results
Tyco Fire Products LP Facility
Marinette, WI

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0 100 200
Feet

Figure 8
Final Post-Dredge Confirmation Sampling Locations and Results
Tyco Fire Products LP Facility
Marinette, WI

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E:\TYCO\MAPFILES\2014\CCR\FIGURE 08 - FINAL POST-DREDGE CONFIRMATION SAMPLING LOCATIONS AND RESULTS.MXD JHANSEN1 2/28/2014 2:38:53 PM