Final – Revision 2

Revised Barrier Wall Groundwater Monitoring Plan Update

Prepared for
Tyco Fire Products LP

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CH2MHILL®

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Acronyms and Abbreviations

°C	degree Celsius
μg/L	microgram per liter
AC	alternating current
AOC	Administrative Order on Consent
AOR	Agreement on Resolution of 2013 Five-Year Review Technical Issues
ASTM	ASTM International
bgs	below ground surface
BWGMP	Barrier Wall Groundwater Monitoring Plan
City	City of Marinette
CoC	chain-of-custody
CSM	Conceptual Site Model
CY	cubic yard
DPT	direct-push technology
DQO	data quality objective
EB	equipment blank
EPA	U.S. Environmental Protection Agency
FD	field duplicate
FOP	field operating procedure
ft/d	foot per day
ft/ft	foot per foot
ft/s	foot per second
ft^2	square foot
ft^3	cubic foot
GFM	groundwater flow model
GLLA	Great Lakes Legacy Act
GLNPO	Great Lake National Program Office
gpd	gallon per day
gpm	gallon per minute
GPR	ground penetrating radar
GPS	global positioning system
GWCTS	groundwater collection and treatment system
HASP	health and safety plan
HDPE	high-density polyethylene

HSA	hollow-stem auger
I/O	input and output
IDW	investigation-derived waste
IGLD85	International Great Lakes Datum 1985
L	liter
MDEQ	Michigan Department of Environmental Quality
MDNR	Michigan Department of Natural Resources
mg/kg	milligram per kilogram
mg/L	milligram per liter
mL	milliliter
mm	millimeter
MS	matrix spike
MSD	matrix spike duplicate
MSDS	Material Safety Data Sheet
NAD83	North American Datum of 1983
NAVD88	North American Vertical Datum 1988
NOAA	National Oceanic and Atmospheric Administration
NR 141	Natural Resources Chapter 141
NTU	nephelometric turbidity unit
O&M	operations and maintenance
PCC	portland cement concrete
PDOP	position dilution of precision
PDP	pump down program
PLC	programmable logic controller
ppb	part per billion
PPE	personal protective equipment
ppm	part per million
PVC	polyvinyl chloride
Q2	second quarter
QA	quality assurance
QAPP	Quality Assurance Project Plan (Earth Tech, 2006)
QC	quality control
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RFP	request for proposal

SCM	semi-consolidated materials
SES	Sevenson Environmental Services
site	Tyco Fire Products LP facility located at One Stanton Street, Marinette, Wisconsin
SNR	signal to noise
SOP	standard operating procedure
SOW	statement of work
TM	technical memorandum
TOC	top of casing
Tyco	Tyco Fire Products LP (formerly known as Ansul Incorporated)
U.S.	United States
URS	URS Corporation
USGS	U.S. Geological Survey
VBSW	vibrated beam slurry wall
WDNR	Wisconsin Department of Natural Resources
WPDES	Wisconsin Pollutant Discharge Elimination System

SECTION 1

Introduction

This Revised Barrier Wall Groundwater Monitoring Plan (BWGMP) Update has been prepared for the Tyco Fire Products LP (Tyco; formerly known as Ansul Incorporated) facility located at One Stanton Street, Marinette, Wisconsin (site), as shown in Figure 1-1. The objective of the BWGMP is to provide the approach to long-term monitoring of the effectiveness of the barrier at containing onsite groundwater. This plan is provided as required by the Administrative Order on Consent (AOC) between Tyco and the U.S. Environmental Protection Agency (EPA), dated February 26, 2009; and the April 23, 2014, Agreement on Resolution of 2013 Five-Year Review Technical Issues (AOR). This BWGMP replaces the January 2011 BWGMP (CH2M HILL, 2011b).

1.1 Barrier Wall Groundwater Monitoring Plan Objectives and Structure

As part of the AOR, Tyco agreed to implement the following activities:

- Barrier wall inspections, groundwater elevation monitoring, and water quality monitoring to demonstrate barrier wall effectiveness
- A pump down program (PDP) to lower water levels in the former Salt Vault and the former 8th Street Slip
- Enhanced monitoring of the Main Plant Area by calculating the potential amount of groundwater migration from the upland area that would impact the ability of the Menominee River sediments to remain less than the remedial action objective (RAO) of 20 parts per million (ppm) total arsenic and conducting groundwater dye testing to determine if any portion of the barrier wall is leaking
- Sample collection of post-dredging accumulated soft sediment in the main river channel outside the Main Plant Area and in the Turning Basin

This document is a monitoring plan detailing how these activities will be implemented, except for the groundwater seepage calculations, which were submitted as a separate technical memorandum (TM), entitled *Supplemental Evaluation: Potential for Recontamination of Menominee River Sediments due to Groundwater Migration from the Main Plant Area,* on July 30, 2014. EPA provided a response to the supplemental TM in October 2014 (EPA, 2014), and Tyco responded to EPA comments in April 2015 (CH2M HILL, 2015c).

A summary schedule of proposed activities and reports is provided in Table 1-1. The purpose of these activities is to measure the long-term effectiveness of the barrier walls in containing onsite groundwater. Barrier wall effectiveness will be indicated by collecting data that show:

- Groundwater elevations inside the barrier wall are independent of groundwater and river elevations outside the barrier wall.
- Total arsenic concentrations outside the barrier wall alignment are generally lower than those concentrations inside the barrier wall.
- Concentrations of total arsenic in bedrock wells located beneath the contained site area remain constant or decrease through time.
- Following the implementation of the PDP groundwater elevations within the former Salt Vault and former 8th Street Slip contained areas will have been lowered to within 0.5 foot or lower of the agreed

upon elevation of 577.5 feet International Great Lakes Datum 1985 (IGLD85) (target elevation; equal to 577.9 feet North American Vertical Datum 1988 [NAVD88]).

- Dye testing of the Main Plant Area indicates that the seepage, if any, is not likely to result in recontamination of sediments in the Menominee River above the cleanup criteria of 20 ppm total arsenic.
- Soft sediment samples of accumulated post-dredging sediment collected in 2018 contain total arsenic concentrations less than 20 ppm.

This report is organized into the following sections:

- **1. Introduction** – Provides the objectives of the BWGWMP, site description and brief history, site geology, the previously implemented remedy, contaminant distribution, and the document organization.
- **2. Barrier Wall Monitoring** – Description of the purpose, frequency, methods, equipment, reporting, and potential corrective actions associated with the proposed visual barrier wall inspections and survey, groundwater elevation monitoring, groundwater quality monitoring, and outfall investigation and potential monitoring.
- **3. Dye Testing** – Description of the proposed dye testing event for the Main Plant Area.
- **4. Pump Down Program** – Description of the proposed PDP for the former Salt Vault and former 8th Street Slip.
- **5. Sediment Monitoring** – Description of the proposed sediment sampling in the main river channel, Turning Basin, and Transition Area in support of the 2018 5-year review.

Sections 2 through 5 include the purpose, frequency, methods, equipment, reporting, and potential corrective actions for each element of the BWGMP.

1.2 Project Background, History, and Conceptual Site Model

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

The site consists of approximately 63 acres, including a manufacturing area on the western part of the property (the Main Plant Area), the former Salt Vault, the former 8th Street Slip east of the Main Plant Area, and an undeveloped area to the east, commonly known as the Wetlands Area. Site access is restricted and monitored by site security and a fence surrounds the site (currently being replaced or repaired as part of dredging restoration activities). Figure 1-2 shows the facility site plan.

The site initially was used for lumber mill operations, sawdust disposal, and raw and cut lumber storage. Subsequently, the site began manufacturing operations in 1915, and included cattle feed, refrigerants, and specialty chemicals, one of which was an arsenic-based agricultural herbicide that was manufactured at the facility between 1957 and 1977. Tyco acquired Ansul and the site 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.

The facility and associated impacts have been studied since 1974. Tyco has implemented a number of corrective measures through the Resource Conservation and Recovery Act (RCRA) program. Interim site corrective actions completed at the site include:

- In 1998 and 1999, a barrier wall consisting of sections of VBSW and sheet pile were constructed around the former Salt Vault and former 8th Street Slip (Figure 1-3) to contain groundwater (Dames and Moore, 1999).
- Soft sediments in the former 8th Street Slip were removed, the slip was filled and covered with asphalt, and a groundwater monitoring program was established as required as part of an interim agreement (EPA, 1998a) between Tyco and the EPA and agreed to in the 1998 Monitoring Plan (Dames and Moore, 1998). Based on the results of the monitoring program (Earth Tech, 2007), EPA agreed that the interim monitoring program could be discontinued within these contained areas because the effectiveness of the barriers had been established. Note that this statement is not proposing or assuming that EPA will accept discontinuing sitewide long-term groundwater monitoring presently or in the foreseeable future.

Pursuant to the AOC signed in February 2009, Tyco also has implemented the following comprehensive remedies:

- Multiple institutional controls for the site, including a deed restriction, restrictions on dredging in the Menominee River Turning Basin, and a City ordinance restricting anchoring within the contaminated sediment area. These controls are described in more detail in the *Five-Year Technical Review* (CH2M HILL, 2013a).
- Removal of three areas of offsite surficial soils with total arsenic concentrations greater than or equal to 16 milligrams per kilogram (mg/kg) in 2009-2010 (CH2M HILL, 2010d).
- Placement in 2009-2010 of cover materials over 11 areas of onsite surficial soils that had total arsenic concentrations greater than 32 mg/kg and subsequent inspections of the covered areas (CH2M HILL, 2010d).
- In 2012-2013, 259,000 cubic yards (CY) of sediments were dredged from the Menominee River. Sediments were removed until either glacial till or bedrock was encountered or remaining sediment concentrations were less than 50 mg/kg (CH2M HILL and SES, 2014).
- Control of access to the site, including an 8-foot-high fence and site security staff.
- Installation in 2009-2010 of a containment barrier around the perimeter of the site to contain arsenic-contaminated groundwater onsite, to the maximum extent possible (CH2M HILL, 2011a). More details on the containment barrier wall system are provided in Section 1.2.1.
- Maintenance of groundwater elevations to prevent surface flooding within the contained areas through an onsite groundwater collection and treatment system (GWCTS), including phyto-pumping and mechanical pumping systems. Extracted groundwater is treated by the mechanical GWCTS, which was brought online in October 2010 (CH2M HILL, 2011d), and zones of trees for phyto-pumping were planted in 2006, 2008, 2010, and 2013 (CH2M HILL, 2011e, 2013c).

Tyco, EPA, the Wisconsin Department of Natural Resources (WDNR), and Great Lake National Program Office (GLNPO) have substantially completed a Great Lakes Legacy Act (GLLA) project involving additional dredging in the Menominee River to remove sediments with total arsenic concentrations between 50 and 20 mg/kg pursuant to the GLLA Project Agreement for Remedial Action and Restoration of the Lower Menominee River Tyco Site, between Tyco, EPA, and WDNR finalized May 19, 2014. Dredging was completed in 2014; and final site restoration, decontamination, and cover placement will be completed in summer 2015.

1.2.1 Containment Barrier Wall

The containment barrier wall comprises the following three types of barrier systems and the connections between each:

1. Vibrated beam slurry wall (VBSW)
2. Thin diaphragm wall
3. Sheet pile wall

As part of an interim action between 1998 and 1999, steel sheet piling barrier walls were installed around the former 8th Street Slip and the northern portion of the former Salt Vault areas; a VBSW was installed on the western and southern sides of the former Salt Vault (Dames and Moore, 1999). As part of the AOC requirements, the VBSW and thin diaphragm walls were installed in 2009 and form the eastern, southern, and western boundaries of the containment structure. The sheet pile wall was installed in 2010 and is located along the northern property boundary, with a small portion along the western property boundary (CH2M HILL, 2011a). The 1998 to 1999 interim action barrier walls and the 2009 and 2010 walls effectively separate the site into four containment cells, as shown in Figure 1-3. The containment areas within the vertical barrier wall include:

- Main Plant Area
- Former Salt Vault
- Former 8th Street Slip
- Wetlands Area

The 1998-1999 and 2010 sheet pile wall interlock joints were sealed by a water-activated sealant (Adeka). The 2010 sheet pile walls also were factory welded in pairs. Sheet pile sections were joined to existing barriers (VBSW and Salt Vault barrier wall) using jet grout. Details on the containment barrier wall systems installed between 1998 and 1999 are provided in the *Interim Barrier Construction Report* (Dames and Moore, 1999), and details on the barriers installed in 2009 and 2010 are provided in the *Construction Completion Report, Containment Barrier Wall Installation* (CH2M HILL, 2011a).

To maintain containment barrier wall integrity to the highest degree possible, the following activities are prohibited along the alignment of the sheet pile wall to prevent problems, unless prior written approval is obtained from EPA:

- Removing or tampering with vertical barrier wall markers
- Removing the tieback lockoff nuts
- Excavating immediately near or adjacent to the barrier wall
- Cutting, welding, or other modifications to the sheet pile wall unless required for repairs or to address utility issues adjacent to the barrier wall

Containment Barrier Wall Inspections, Maintenance, and Monitoring to Date

Inspections and maintenance of the containment barrier wall have been performed in accordance with the *Operation and Maintenance Plan, Revision 1 for Onsite Groundwater Management, September 2010* (CH2M HILL, 2010a). Common maintenance activities have included the following:

- Identifying and filling settlement areas along the land side of the sheet pile wall using gravel, soil, or both
- Surface water runoff spillways blocked with hay or other debris that needs to be cleared
- Replacing missing vertical barrier wall markers along the VBSW

The most recent inspections were completed in May and November 2014 and June 2015. The May 2014 inspection details, including the inspection and maintenance log, a photo log, and a response to the EPA contractor report inspection observations completed by Kristi Root (Tetra Tech) provided to Tyco on June 4, 2014, was submitted to the EPA on June 30, 2014 (CH2M HILL, 2014a). The November 2014 inspection information is included in the quarterly report to EPA (Tyco, 2015). The June 2015 inspection includes a baseline survey (post-dredging conditions) of the wall; additional details will be included in the second quarter (Q2) quarterly report that will be submitted to EPA by July 15, 2015.

As required in the AOC, barrier wall groundwater monitoring has been conducted in accordance with the *Barrier Wall Groundwater Monitoring Plan* (CH2M HILL, 2011b) to evaluate the effectiveness of the containment barrier walls. This includes annually collecting groundwater samples from monitoring wells within and outside the barrier wall for analysis of total arsenic beginning in the Q2 2011. Water levels were collected quarterly the first year (2011) and have been collected semiannually subsequently (prior to sampling in Q2 and in the fourth quarter of the year). The sampling and water level data have been reported to EPA in quarterly reports (CH2M HILL, 2011f, 2011g, 2012e, 2012f, 2012g, 2013c, 2013d, and 2014c), and annual reports have been prepared to summarize the results and evaluate the barrier wall's effectiveness. Annual reports for 2011, 2012, and 2013 have been completed (CH2M HILL, 2012a, 2013a). Data from inspections conducted from 2011 through 2013 indicate the "barrier wall is an effective hydraulic barrier to overburden groundwater flow" (CH2M HILL, 2013a).

1.2.2 Site Geology and Hydrogeology

The Conceptual Site Model (CSM) for the site (Figure 1-4) schematically depicts the geology, hydrogeology, monitoring network, typical water levels, contaminant concentrations and distribution, remedy components, and sediment conditions in the Menominee River. Additional details are also provided in cross sections along the sheet pile barrier wall shoreline showing sheet pile toe information, and top of bedrock and till (Figures 1-5-A and 1-5-B1 to 1-5-B6).

In general, four material types (or layers) are present in the upland portion of the site (Figure 1-4). The upper soil layer generally comprises fill (sand and gravel with cinders, woodchips, brick, and glass). Beneath the fill is a layer of loose to medium dense alluvial deposits consisting of fine- to coarse-grained sand and gravel with varying amounts of silt (alluvium). Underlying the sand is a layer of dense silty sand to sandy silt (lacustrine silt), which transitions to an even denser sandy silt and clay (compacted glacial till deposit). Below this is dolomitic bedrock, generally at a depth of approximately 40 feet below ground surface (bgs). In the near-shore environment, there are also four distinct material types: soft sediment, semiconsolidated materials (SCM) (including fine- to medium-grained sands, analogous to the alluvial deposits in the upland area), glacial till, and dolomitic bedrock. Before the removal action, water depth in the river in the project area ranged from less than 1 foot in the southern channel to 26 feet in the main channel of the Menominee River.

Shallow groundwater is generally observed 3 to 8 feet bgs, and groundwater in the fill and alluvial deposits above the till, and to a lesser extent, the lacustrine silt, are hydraulically connected. The till beneath these strata acts as an aquitard, and the underlying bedrock aquifer appears to be confined and may be predominantly controlled by fracture flow. Groundwater within the contained area no longer flows to the river; flow direction is variable and is likely controlled by gradients induced by extraction wells and localized recharge within the footprint of the site. The direction of groundwater flow is affected outside the site because of the presence of the containment barrier wall. Shallow groundwater flow outside the site remains generally toward the river but is diverted to the east and west upgradient of the site, around the southern barrier wall. Groundwater flow in the bedrock aquifer, below the containment zone, is generally northeast toward the Menominee River. Flow in the bedrock aquifer appears to be dominated by fracture flow and, on average, has very low hydraulic conductivities and minimal horizontal hydraulic gradients.

For example, during the 2014 aquifer tests, BT-02 was determined to not intersect water-bearing fractures within the bedrock formation; thus, the hydraulic conductivity was below the threshold for performing an aquifer test. Another bedrock well, BT-01, did produce water during aquifer testing, and had an estimated hydraulic conductivity of 5 feet per day (ft/d); however, there was no response to pumping of BT-01 in other bedrock wells monitored 10, 93, and 228 feet from the well, indicating that the water-bearing fractures associated with BT-01 are "generally isolated from the wider bedrock formation, which appears to be a generally competent formation," with hydraulic conductivities much lower than 5.5 ft/d (CH2M HILL, 2014e). Previous estimates of the horizontal hydraulic conductivity of the bedrock ranged from 0.023 to 22 ft/d (URS, 2001), and other hydraulic tests ranged from impermeable (two borings) to 0.034 ft/day (STS, 1978 as reported in URS, 2001).

The following groundwater elevation contour maps were included in Attachment 1 (see Attachment 2 in the Addendum to the Five Year Technical Review document, dated December 30, 2013 – Revision 1) of the July 23, 2014 "Response to EPA Comments on the July 2, 2014 Five Year Technical Review Report dated December 30, 2013 and Addendum to Five Year Technical Review Report dated May 30, 2014" (CH2M HILL, 2014d):

- October 2009 Figures 7A and 7B
- March 2012 Figures 8A, 8B, and 8C
- November 2012Figures 2A-1, 2B-1, and 2C-1
- October 2013 Figures 2A-2, 2B-2, and 2C-2

1.2.3 Contaminant Distribution

Arsenic historically has been detected in soil and groundwater samples collected from the Main Plant Area, former Salt Vault, former 8th Street Slip, and Wetlands Area, as well as the Menominee River Turning Basin. Arsenic impacts to unsaturated soils also are widely distributed across the manufacturing area, primarily in areas formerly used for waste salt storage. Arsenic also has been detected in sediment samples collected from the Menominee River.

Arsenic has been identified throughout groundwater underlying the Main Plant Area, former Salt Vault, former 8th Street Slip, and Wetlands Area, with higher concentrations detected in the northern portions of the site. In addition, the distribution of arsenic in groundwater has been significantly influenced by the high salinity of the source material, which resulted in density-driven downward migration of contaminants. As such, the highest concentrations of arsenic in groundwater underlying the manufacturing area are located at depths of approximately 30 feet bgs—within the dense sandy silt and clay. Arsenic impacts to groundwater also are present within the Wetlands Area, although arsenic concentrations are generally lower than found in the rest of the manufacturing area. Arsenic also is detected in the bedrock groundwater, although generally at one to three orders of magnitude lower concentrations than shallower concentrations in the areas with the highest arsenic concentrations. The observed concentrations of arsenic in bedrock groundwater have been attributed to improperly constructed monitoring or pumping wells that were abandoned in the 1970s and 1980s (URS, 2001). Overall, concentrations inside the containment barrier walls are generally at least an order-of-magnitude higher than concentrations outside the barrier walls.

1.2.4 Contaminant Fate and Transport

Arsenic-contaminated groundwater in the Main Plant Area, former Salt Vault, former 8th Street Slip, and Wetlands Area is laterally contained by the vertical barrier walls that restrict the lateral transport of groundwater in the contained areas. The low-permeability lacustrine silt and glacial till underlying these areas limits the vertical transport of arsenic-contaminated groundwater into the bedrock. Vertical groundwater gradients within the contained areas are variable, and the distribution of upward and downward gradients is controlled by the ongoing shallow groundwater extraction efforts (CH2M HILL, 2013a). Previous groundwater contour maps of shallow- and medium-depth groundwater indicate that flow patterns within the contained areas are variable and likely controlled by areas of recharge (such as unpaved areas, or young phytoplots being irrigated) and extraction (extraction wells and phytoplots). Phytoplots have been installed at five locations to extract groundwater (CH2M HILL, 2011e).

The GWCTS installed in 2010 collects groundwater from a network of extraction wells in the contained areas, and has extracted 1.2 million gallons in 2011 to 6.9 million gallons in 2014 (CH2M HILL, 2013a; Tyco, 2015). Treated effluent from the GWCTS is discharged under a Wisconsin Pollutant Discharge Elimination

System (WPDES) permit through an outfall into the Menominee River, with a total arsenic discharge average of 0.3516 pounds per month (Tyco, 2014). Additional outfalls may serve as pathways for transport of arsenic-contaminated water out of the contained areas into the river and will be assessed as discussed in Section 2.4. A monitoring plan, repair plan, or a combination will then be developed to address this potential pathway and quantify the volume and loading of arsenic to the river from these potential pathways.

Remnant concentrations of arsenic in bedrock groundwater are likely related to the past existence of improperly constructed monitoring or pumping wells that were abandoned in the 1970s and 1980s. URS (2001) reported that, "Based on assessments of well integrity (CENTEC, 1981; STS, 1981), it was determined that well construction techniques used prior to 1980 had allowed leakage of impacted groundwater from the surficial sand and gravel aquifer into some of the underlying till or bedrock wells (e.g., Dock Well)." The Dock Well was completed in bedrock but drew poor-quality water from shallower surficial deposits due to either a faulty casing seal or leakage to bedrock. The Dock Well was "completely grouted and properly abandoned in accordance with state standards" prior to a 1978 report by STS (as reported in URS, 2001). Groundwater flow appears to be minimal in the bedrock, which generally has very low hydraulic conductivities, is not laterally continuous, and appears to be controlled by horizontal fracture patterns.

Sediments in the Menominee River have been affected by past arsenic contamination emanating from the site, likely due to a combination of historical (pre-barrier wall) shallow groundwater discharge and physical erosion of contaminated soils (and arsenic-salts) into the river. Sediment arsenic concentration profiles indicate that upwelling of arsenic-contaminated groundwater from the bedrock beneath the river has not resulted in the contamination of sediments. A series of dredging efforts has been undertaken to remove arsenic-contaminated soft and semiconsolidated sediments from the Menominee River, ultimately removing all such materials with concentrations greater than 20 mg/kg total arsenic. Current potential sources of arsenic contamination in sediments include upstream sources, discharge of arsenic-contaminated groundwater from noncontained areas, discharges from the GWCTS and other outfalls, and seepage from potential breaches in the barrier wall.

This BWGWMP includes elements to assess the discharges from outfalls and potential breaches in the barrier wall. Additionally, the PDP that will be initiated in the former Salt Vault and former 8th Street Slip represent the most heavily impacted areas. This will reduce water elevations in those cells to near or below the Menominee River ordinary low-water level. Thus, if there were a breach in the walls surrounding these cells, water would flow from the river (which is higher in elevation) into the cells, and transport of arsenic from these cells would not occur. In accordance with the AOR, pump-down of water levels to near the ordinary low-water level will not be performed in the Main Plant and Wetlands Areas. In lieu of this, careful monitoring of the effectiveness of the barrier wall in these areas will be performed to confirm that the barrier wall is effectively preventing transport of arsenic-contaminated groundwater into adjacent areas, including the Menominee River.

The potential effects on sediment concentrations are assessed in a separate TM on Sediment Recontamination Modeling (CH2M HILL, 2015c). Sediment sampling in 2018, as discussed in Section 5, will also be useful to determine whether recontamination of sediments in the Menominee River is occurring.

SECTION 2

Barrier Wall Monitoring

The activities to determine the effectiveness of the barrier walls installed at the site will include visual and survey inspections, evaluating water (groundwater and river stage) elevations and total arsenic concentrations in groundwater, investigating outfalls penetrating the barrier wall, and conducting a dye test of the effectiveness of the vertical barrier wall in the Main Plant Area. Visual and survey inspections have been conducted to date under the *Operation and Maintenance Plan, Revision 1 for Onsite Groundwater Management, September 2010* (CH2M HILL, 2010a). Groundwater monitoring, including elevation measurements and total arsenic sampling, have been conducted since 2011 in accordance with the original *Barrier Wall Groundwater Monitoring Plan* (CH2M HILL, 2011b). This section updates the plans for conducting the visual barrier wall inspection, surveys, groundwater monitoring, and outfall investigation. The dye test investigation is described in Section 3.

2.1 Visual Inspections and Surveys

2.1.1 Purpose

Inspections of the visible portions of the barrier walls will be conducted to assess the condition of the containment barrier walls and identify any visible leaks or integrity issues that would affect the onsite groundwater management required by the AOC. Additionally, the barrier wall along the river will be surveyed to document any changes to the barrier wall alignment that may affect its effectiveness.

2.1.2 Frequency

Spring

Semiannual visual inspections of the barrier wall in the Main Plant Area, the former Salt Vault, the former 8th Street Slip, and Wetlands Area will be conducted each spring; and a survey will be conducted.

Fall

Visual inspections of the Main Plant Area, the former Salt Vault, the former 8th Street Slip, and Wetlands Area barrier walls also will be conducted each fall. Once the target elevation associated with the PDP (Section 4) has been attained, the fall inspection of the former Salt Vault and former 8th Street Slip cells will not be required unless water levels rise above the target elevation.

2.1.3 Methods

Visual Inspection

Tyco or a designated representative will inspect the barrier walls and document the findings using photographs and an inspection log; an example is included as Appendix A. The inspections will evaluate the integrity and long-term functionality of the barrier wall. The barrier walls will be inspected both from the land side and the river side for the portion of the barrier wall along the river. At a minimum, the inspections will identify:

- Missing or loose bolts, nuts, or other hardware
- Excessive corrosion, including that observed around wall utility penetrations
- Ice damage
- Tilting or misalignment
- Settlement of the backfill immediately adjacent to the barrier wall
- Visible water leakage
- Missing vertical barrier wall markers
- Modifications, welding, or cutting done by others

Survey

Additionally, each spring, the amount of deflection at the top of the wall will be surveyed using stationary points that line up on tangent sections of the barrier wall. A post-installation measurement was conducted to establish baseline wall conditions and alignment against which the annual surveys will be compared. Barrier wall inspection survey points were established at each wall angle point. Intermediate inspection points were established using line-of-sight techniques to establish markings (dimples in the pile cap) along each section of the barrier wall. The markings were placed at 50-foot intervals.

Note that the sheet pile stability work completed in winter 2012/2013 resulted in removing and reinstalling the sheet pile cap, as well as structural tightening related to tie rod installation. Therefore, the previous baseline measurements are no longer accurate. After substantially completing the dredging and restoration activities, the line-of-sight markings along each section were reset in June 2015. Holes were drilled in the barrier wall cap so that permanent dimple points could be placed on the top of the sheet pile wall. Original point numbers and dimple points were not used since the new points would not be comparable to them. In addition, shots at each marking or dimple location from the control points also will be used to verify any movement and compared to the line-of-sight observations. Future surveys will be compared to the June 2015 survey results, which will represent the baseline following completion of dredging activities.

2.1.4 Equipment

Surveying work will be contracted to a professional land surveyor. This professional firm will choose equipment to meet survey accuracy requirements; thus, the equipment and the replacement frequency of that equipment will be the responsibility of the chosen firm.

Maintenance or repair of any portions of the containment barrier wall would be completed by a contractor that would be retained by Tyco or its designated representative. Exact equipment types, maintenance, and replacement requirements are not specified herein. The repair contractor would be responsible for determining equipment requirements and maintaining and replacing the required repair equipment.

2.1.5 Reporting

Daily Operating Logs

Use of daily operating logs is not relevant to barrier wall inspection events that occur infrequently. A barrier wall inspection log will be used. An example log is included in Appendix A.

Mechanism for Reporting Emergencies

Emergencies relative to the barrier wall will be reported to EPA via telephone and e-mail within 72 hours of knowledge of the occurrence. An example of an emergency in relation to the barrier wall would be that a river-going vessel hit the barrier wall, possibly causing damage. In this case, an indication would be given of what additional measures Tyco would take to collect information on the barrier wall’s condition following the incident.

Reporting of health or safety incidents will follow the health and safety plan (HASP) presented in Section 6.

Personnel and Maintenance Records

Personnel records regarding onsite employees during barrier wall inspection (maintenance) activities will be maintained in accordance with the current HASP. Tyco and the respective contractors and subcontractors will maintain personnel records relevant to and in accordance with state, federal, and local employment regulations.

Tyco will maintain the inspection logs. If repairs are needed, they will be documented in the inspection logs with copies maintained until site closure.

Reports to Agencies

Results of the semiannual inspections of the barrier walls of the Main Plant and Wetlands Areas, and if conducted, the former Salt Vault and former 8th Street Slip, will be summarized in a brief e-mail or in the quarterly report, and any actions necessary will be described. Following the fall inspection, inspection results will be provided in an annual inspection report that will be submitted within 45 days of the fall inspection date to EPA and WDNR. Written documentation and photographs of the semiannual inspections will be submitted as part of the annual inspection report. Any corrective actions or repairs will be documented in the inspection logs provided to EPA with the annual inspection report. Significant corrective measures, if required, will be performed and reported in a construction completion-type report.

2.1.6 Potential Corrective Actions

While previous barrier wall inspections have not identified issues with the integrity of the barrier wall, the results of future inspections may identify issues requiring evaluation in order to maintain the integrity of the containment barrier walls. Decisions for corrective action will be based on the nature and extent of the damage and the associated risks.

Multiple lines of investigation, such as groundwater elevation monitoring (Section 2.2), groundwater arsenic monitoring (Section 2.3), outfall investigation and monitoring (Section 2.4), and dye testing results (Section 3), may be used to determine whether leakage may be occurring. Any supplemental evaluations will be described to EPA before implementation. Corrective actions will depend on the location and nature of the leak and may include repairs, such as rewelding, patching, resealing, or regrouting affected areas or replacement of the leaking barrier wall section.

If significant corrective measures are required, EPA will be notified within 24 hours of discovery; and a proposed plan for corrective measures, along with a proposed schedule, will be presented to EPA as quickly as possible and within 60 days. Once EPA approves the proposed corrective measures, they would be implemented as quickly as possible and within 60 days, if possible. EPA will be notified within 24 hours of discovery if it is determined that corrective actions will take longer than 60 days, and an alternative schedule provided and interim measures, if possible, will be implemented.

Routine maintenance (such as bolt tightening or replacing missing wall markers) noted during the inspections or other times during the year will be completed as soon as practical and will generally be performed within 30 days. These routine maintenance and repair activities will be reported in the annual inspection reports submitted to EPA.

2.2 Groundwater Elevation Monitoring

2.2.1 Purpose

Groundwater elevation monitoring will be undertaken to demonstrate the independence of groundwater inside and outside the barrier walls in the Main Plant Area, former Salt Vault, former 8th Street Slip, and Wetlands Area. Additional groundwater elevation monitoring will also be conducted within and near the former Salt Vault and former 8th Street Slip, which will monitor groundwater elevations to determine compliance with the target elevation associated with the PDP (described in Section 4).

2.2.2 Frequency

Groundwater elevation data will be collected continuously from 21 monitoring wells and one staff gauge in the Menominee River in and adjacent to the Main Plant Area, former Salt Vault, former 8th Street Slip, and Wetlands Area using pressure transducers starting in 2015 once dredging activities are completed and new wells are installed (assuming the Revised BWGMP Update is approved in time to allow for all new monitoring well installations and repairs in 2015). Data from these pressure transducers will be downloaded quarterly, and manual water level measurements will be taken from those wells at the time of download. The monitoring network and frequency of groundwater elevation measurements will be re-evaluated during the 5-year review process, and any changes will only be made after EPA and WDNR review and approval of the proposed changes. EPA may also specify changes during the 5-year review process to be effective during the next 5-year review period.

2.2.3 Methods

Groundwater elevation monitoring will use the existing monitoring well network at the site supplemented with 11 new wells (3 shallow, 4 medium, and 4 bedrock/deep) to be installed near the barrier wall along the main river channel (Figure 2-1). The groundwater elevation measurement approach for monitoring the barrier wall effectiveness was developed in consideration of the following:

- Groundwater levels and river levels will be monitored continuously (every 30 minutes) in the selected wells.
- Paired shallow wells on all exterior edges of the Main Plant Area and Wetlands Area will be monitored.
- Deep wells near these shallow well pairs will also be monitored.
- River levels will be compared to groundwater levels in wells inside the barrier walls and adjacent to the river, including at seven new wells (3 shallow and 4 bedrock/deep) to be installed in 2015.

A description of the monitoring network, and methods for installing new wells and recording groundwater elevations, both manually and with pressure transducers, is provided in the following subsections.

Monitoring Well Network

The approximate depth intervals for existing wells screened at the site are depicted in Figure 1-4. The convention used for well names at this site is:

- P = Very shallow well installed for measuring head associated with what is believed to be a shallow fill or alluvial zone of perched water above the peat layer identified in the former Salt Vault
- S = Shallow wells – screened zone typically from 5 to 15 feet deep (10-foot screens) in the fill and alluvium
- M = Medium depth or intermediate wells – screened zone typically from 25 to 30 feet deep (5-foot screens) within the lacustrine sands and silts or within the underlying glacial till
- D = Deep wells installed and sealed within the uppermost portion of bedrock using a 5-foot-long screen

Note that some of the M-series wells are completed within the till, while other M-series wells are screened across the overlying lacustrine sands and silts. Past designations of wells focused on the completion depth rather than the stratigraphy; thus, some of the M-series wells were completed in low-permeability till, while some M-series wells were completed in the overlying lacustrine silt deposits. During development of the BWGMP Update, these wells were reviewed and segregated as either wells screened across till or wells screened across the lacustrine silt. The screened intervals and unit for the wells are presented in Table 2-1.

Monitoring tasks to determine the barrier wall effectiveness will consist of measuring and recording groundwater elevations from monitoring wells and river levels using a newly installed staff gauge, as shown in Figure 2-1 and listed in Table 2-1. The groundwater elevation monitoring will focus on demonstrating the independence of the shallow water table within the contained areas from the shallow groundwater and river outside the contained areas. While manual water levels will be collected from selected M-series wells during arsenic sampling, these data will not be used in the hydraulic evaluation of barrier wall effectiveness because these wells are either completed within the till aquitard or in the overlying lacustrine sands and silt that are hydraulically connected to the shallow aquifer. Wells included in the groundwater elevation monitoring program were chosen because of the presence of adjacent wells on the opposite side of the barrier wall for comparison of groundwater elevation trends or adjacent to the river for comparison to river elevation trends.

Groundwater elevations in the 21 selected wells will be recorded using pressure transducers. In addition to groundwater elevations, the river elevation will be recorded using a staff gauge and transducer. The staff gauge will be surveyed after installation and annually to assess possible changes to the staff gauge. The transducer will be useful for understanding the frequent changes in river levels and comparison to groundwater levels inside, outside, and deeper than the barrier wall. The river elevation data collected from the transducer and staff gauge also will be used for the PDP described in Section 4. River level data from the National Oceanic and Atmospheric Administration (NOAA) river gauge (9087088) located downstream of the site may also be used in conjunction with or in lieu of river levels measured at the site (for example, if ice in the river prevents installation or maintenance of the pressure gauge at the site).

Eleven new wells will be installed and monitored adjacent to the river; additionally, MW021S was recently damaged and will be replaced. Well construction methods are summarized in the following *Monitoring Well Construction* subsection. A review of existing wells was completed to determine which ones provided little useful data regarding barrier wall effectiveness because of their distance from the barrier wall and construction depth. During discussions with the EPA, it was determined that these wells will remain in place for now and will be evaluated in the future for abandonment in the annual or 5-year reports in order to reduce maintenance costs and the number of potential contaminant migration pathways. Wells will not be abandoned until it is confirmed that these wells are no longer needed for future use.

MW041D, which is completed in bedrock, has been consistently dry when monitored during previous barrier wall monitoring events. It appears that the bedrock in the area of the well is highly competent and not hydraulically connected to site groundwater. Since this well is dry and not providing any value for site evaluation, it is still proposed to be abandoned.

Because of site conditions, monitoring wells may need to be added or removed from the groundwater elevation monitoring network. Any changes to the well network used in Table 2-1 will be described in the annual monitoring report. Note that groundwater levels will also be measured during groundwater sampling events at all wells in the arsenic sampling program, as well as at upgradient wells MW013S, MW013M, and MW013D and cross-gradient wells MW022S and MW022M. While these groundwater levels will not be used in the hydraulic evaluation of the barrier wall effectiveness, they will be useful for assessing groundwater flow patterns outside and inside the barrier walls. These data will be used to develop potentiometric contour maps for the shallow overburden and bedrock units for inclusion in the annual monitoring report.

Monitoring Well Condition

During each monitoring event, assessment of monitoring network effectiveness will include visually inspecting the condition of site wells and noting potential problems, such as:

- Well covers fitting
- Lock functionality
- Cracked or gaping concrete pads or soil material that would allow surface water to infiltrate
- Moving, heaving, or cracked well casing material
- Obstructions inside well casing or screen during sampling
- Other potential problems

This information will be noted in a field data sheet or in the field logbook during collection of groundwater levels and samples. A determination will be made on a well-by-well basis as to whether the problem with a well's condition can be repaired or if that well needs to be replaced.

Monitoring Well Construction

A well driller licensed to install monitoring wells in Wisconsin will be contracted to install the proposed additional site wells.

Mobilization and Utility Clearance

A subsurface utility clearance will be completed at the various monitoring well locations and on the various properties involved. Three resources will be used to obtain clearance:

1. Digger's Hotline for public areas
2. A private, third-party utility locate for onsite areas

3. Facility staff

Ground-penetrating radar (GPR) will be required to identify tie rod locations and other potential impediments to installation of the monitoring and injection wells installed near the barrier wall.

Continuous Soil Sampling

Continuous soil sampling for logging and visual characterization will be performed at each drilling location to the bottom of the boring with a descriptive stratigraphic log provided (in Wisconsin-approved forms). Soil cuttings from the drilling process will be managed appropriately onsite and disposed offsite in accordance with applicable regulations.

Well Installation

Eleven new wells (3 shallow, 4 medium, and 4 bedrock/deep) and a replacement well for MW021S will be installed at the site in 2015. The four shallow wells (3 new and 1 replacement) will be approximately 15 feet deep and screened across the fill, alluvial sand, and water table (S-series wells). The four medium wells will be approximately 25 to 30 feet deep, and screened within the lacustrine sands and silts, immediately above the till unit (M-series wells). The four bedrock wells will have casing grouted with site-specific grout into the bedrock with 10 feet drilled out below the bottom of the casing (bedrock surface typically encountered around 40 feet bgs). The required grout mix design used at the site is 1 bag (94 pounds) Type II Portland Cement, 4.5 gallons water, and 2 cubic feet of fine sand. A superplasticizer, Sikament 686 (or equivalent), may be used to increase the fluidity of the grout for pumping into the borehole annulus (Appendix B).

The wells will be installed with hollow-stem augers (HSAs), sonic drilling, or direct-push technology (DPT) methods, in accordance with Wisconsin Administrative Code, Natural Resources Chapter 141 (NR 141). Stratigraphy will be recorded (at the deepest well only when in a well nest) during installation and used to document where the well screens will be located. For wells installed using HSA or sonic drilling techniques, well materials will consist of 2-inch-diameter polyvinyl chloride (PVC) risers and 10-foot-long (shallow) and 5-foot-long (medium and deep), 0.010-inch slot screens. Filter pack material will fill the annular space to approximately 1 foot above the top of the screen.

If it is not feasible to install a 2-inch-diameter well near the barrier wall due to tie-backs or other obstructions, Tyco will request a variance from WDNR for the shallow and medium wells to be installed using DPT with 1-inch-diameter PVC risers; and 10-foot-long, 0.010-inch slot prepacked screens will be used. The deep wells will be moved further back from the wall if obstructions restrict well constructability near the wall. To prevent grout from entering the screen, 1 foot of sand will be installed above the top of the prepacked screen. Site-specific grout will be placed above the filter pack to near surface.

Surface Completion, Protective Covers, and Locking Caps with Locks

The surface above the annular space seal will be completed in accordance with NR 141 (ground surface seal extends a minimum of 60 inches below grade [or as deep as possible if the shallow water table is less than 60 inches below grade] and its top is sloped away toward the land surface). Surface restoration will be identical in type to the material present before drilling, to the extent practicable. In addition, in grassy areas, a concrete pad will be constructed that is a minimum radius of 3 feet around the protective cover casing.

The wells will be equipped with protective covers in accordance with NR 141 and keyed-alike padlocks. Several wells will require flush-mount covers that are approved for heavy vehicle traffic. Stick-up completions will have at least three bollard posts that extend at least 3 feet below and 3 feet above grade. Bollard posts will be painted with a high-visibility color.

For concrete areas, concrete pad material for the pad encasing the wellheads will be ready-mixed conforming to ASTM International (ASTM) C94, Alternate 3. Concrete will be a dry-bagged premix variety and mixed with water in accordance with the manufacturer’s specifications. Concrete mix will be agitated and placed within 1.5 hours after mixing.

Well Development

The monitoring wells will be developed following installation. Development will be performed and documented in accordance with NR 141.21. Development methods will depend on the material the well is screened in per NR 141.

Decontamination and Purge Water

Decontamination and purge water generated during drilling and well development will be containerized in a tank or temporary container that can be transported to the individual well site locations. Water will be temporarily stored in appropriate containers and treated onsite using the onsite groundwater treatment system.

Site Surveying

A full network survey will be conducted in 2015 of all newly installed, repaired, and existing monitoring wells (included as part of the final agency-approved Revised BWGMP Update). Wells will be surveyed after sediment site restoration activities are complete and shortly after installation and repairs are completed so that groundwater elevations will be consistent and can be accurately measured across the site. The wells will be surveyed to document the location (Wisconsin State Plane Coordinate System, South Zone, North American Datum of 1983 [NAD83]) of the well and the vertical elevation data (both IGLD85 and NAVD88 data) for the top of well casing, top of protective cover, and ground surface. The elevation of the inner well casing will be taken at the permanent notch or mark on the top of the casing. If no notch or mark is present at the top of the inner well casing, then the elevation of the top of the inner casing will be taken at the northern side of the well casing and clearly marked. The well locations also will be recorded.

The staff gauge installed in the river also will be surveyed to document its vertical elevation. A point on the top of the barrier wall also will be surveyed so water level measurements can be made if the staff gauge is damaged.

The monitoring well network will be resurveyed every 5 years with the first year’s survey starting in 2015. Additionally, wells will be resurveyed as necessary because of well conditions or repairs made to wells.

Water Level Measurement

Pressure transducers, such as a Leveltroll or similar equipment, will be installed in the wells where continuous water level monitoring will be performed, as indicated in Figure 2-1 and Table 2-1. The wells included in the transducer measurement program may be adjusted based on site conditions, actual installation locations of new wells, or concerns about barrier wall effectiveness in certain areas. The wells selected for transducer installation include:

- Three shallow wells (new well MW117S, new well MW118S, and MW108S) and three deep wells (new well MW117D, new well MW118D, and MW108D) in the Main Plant Area adjacent to the river. These wells will be compared to river elevations.
- A set of wells along the western barrier wall of the Main Plant Area (MW105S and MW105D inside the contained area and MW040S outside the contained area).
- A set of wells along the southern barrier wall of the Main Plant Area (MW064S and MW064D inside the contained area and MW102S outside the contained area).
- One shallow well (MW115S) and one deep well (new well MW119D) in the former Salt Vault Area. These wells will be compared to river elevations.
- One shallow well (new well MW120S) and one deep well (new well MW120D) in the former 8th Street Slip Area. These wells will be compared to river elevations.

- Two sets of wells in the Wetlands Area along the downgradient barrier wall adjacent to the river (MW109S, MW109D, MW047S, and MW047D), which will be compared to river elevations. MW047S and MW047D also will be compared to MW100S outside the contained Wetlands Area.

Pressure transducers will be installed at least 5 feet below water level. At the time of installation, the water level will be measured manually using a water level meter and recorded in a field logbook. This water level, in conjunction with the surveyed top of casing (TOC) elevation, will be used to set the reference point for the pressure transducer, which will be set to record water levels as groundwater elevations. Transducers will be downloaded at least quarterly. Transducers will be set to record water levels once every 30 minutes.

The pressure transducer installed in the river near the staff gauge will be installed in an open-bottom pipe attached to the barrier wall. This transducer will be set to record water level information as gauge heights by entering the gauge height measured on the staff gauge at time of installation. The condition of this transducer will be checked at least monthly, and data will be downloaded quarterly. This transducer will be set to record water levels once every 30 minutes.

A Barotroll or similar barometric pressure measurement logger will be installed in a nearby unused well above the water table. This barometric pressure logger will be downloaded quarterly at the same time as the pressure transducers and used to adjust recorded water levels if necessary.

Manual water level measurements will be made using water level meters as detailed in the field operating procedures (FOPs) in the approved *Quality Assurance Project Plan* (QAPP) (Earth Tech, 2006).

2.2.4 Equipment

Equipment used to record groundwater monitoring well condition assessment will include a field sheet (Appendix C), logbook, or both in which well conditions will be described, as outlined in Section 2.2.3, *Monitoring Well Network*, as well as a waterproof writing instrument. The paper materials (or copies of them) will be maintained in the project's electronic or hard copy files in a dry and readable condition. If a logbook is filled, it will be replaced. If a writing instrument stops working, it will be replaced.

A professional land surveyor contracted to perform this scope of work will provide and maintain equipment to perform surveying of the elevations of the tops of the inner well casings and of staff gage reference elevations. Equipment will be chosen to meet survey accuracy requirements and is not specified herein, and any replacement frequency of that equipment will be the responsibility of the contracted surveyor.

Equipment used to take depth-to-water elevation measurements inside individual monitoring wells will include a steel tape marked with measurement units with an accuracy of 0.1 inch, an electronic monitoring well indicator, or both, as indicated in Appendix F of the approved QAPP (Earth Tech, 2006). This equipment will be maintained according to the manufacturer's instructions. If an electronic water level indicator is still nonfunctional after rudimentary fixes are attempted (battery replacement), the equipment will be replaced.

The pressure transducer and barometric pressure logger will be maintained according to manufacturer's instructions, and data will be downloaded quarterly to a laptop computer and desiccant and battery status will be checked. Calibration checks will be completed every 6 months when data is downloaded in the spring and fall. Calibration will be checked by taking a reading in air (should be 0.00) and comparing manual-water level measurement to transducer-measured water levels. If the difference is more than 0.1 feet, the calibration will be double-checked by taking more manual water level measurements to compare to transducer water levels. If there are continued issues with the transducer calibration, then the transducer will be sent back for factory re-calibration (or replaced with a new transducer). Additional inspections and maintenance will be conducted if necessary (for example, if desiccant is being consumed more quickly or manual and transducer readings are not matching up). The transducer will be inspected, cleaned, and maintained at this time, if needed (for example, replace O-rings, new desiccant or low battery). If necessary (for example, low battery or data recording issues), the pressure transducers will be switched out at this time.

2.2.5 Reporting

Daily Operating Logs

Daily logs used during monitoring well installation fieldwork will be structured identical to the bid sheet list so drilling progress and pay items can be tracked. Because well installation work has not yet been let to bid, this sheet is not provided in this version of the BWGMP. Records of personnel who are onsite during the drilling process, weather conditions, and other pertinent information will be noted in the field logbook per HASP requirements.

Use of daily operating logs is not relevant to groundwater monitoring events that occur infrequently. Groundwater elevation measurements associated with installing and downloading pressure transducer data will be recorded in field logbooks. Manual groundwater elevation measurements made during well sampling events will be recorded on a well sampling sheet. An example well sampling sheet is included in Appendix E of the approved QAPP (Earth Tech, 2006). The information specified by this form has been used to compile an updated sampling sheet included as Appendix C. Records of personnel who work at the site, weather conditions, and other pertinent information are noted in the field logbook per HASP requirements.

Mechanism for Reporting Emergencies

Reporting of health or safety incidents will be in accordance with the HASP (Section 6).

Personnel and Maintenance Records

Personnel records for onsite employees during groundwater monitoring activities will be maintained in accordance with the daily log in/log out sheets per Appendix E of the approved QAPP (Earth Tech, 2006) or using equivalent documentation methods in project field logbooks. Tyco and the respective contractors and subcontractors will maintain personnel records relevant to and in accordance with state, federal, and local employment regulations.

Observations regarding required well maintenance for monitoring wells will be noted on the monitoring well field sheet (Appendix C) or using an equivalent documentation method in the project field logbook. Field sampling and monitoring equipment (as listed in Appendix F of the approved QAPP [Earth Tech, 2006]) will be maintained in accordance with the manufacturer's specifications; nonfunctional field equipment will not be used and will be replaced at the earliest opportunity.

Reports to Agencies

The results of the hydraulic data evaluation will be included in an annual monitoring report to be submitted to EPA and WDNR each winter. Note that if data demonstrate potential seepage prior to submitting the annual monitoring report, EPA and WDNR will be notified within 24 hours and corrective actions taken, as indicated in Section 2.2.6, Subsection Barrier Wall Triggers. In addition, hydraulic data for the former Salt Vault and former 8th Street Slip will be provided in the quarterly reports, and water level and groundwater pumping data also will be summarized in the annual report, as indicated in Section 4.5.

Hydraulic data (water elevations) from the wells indicated in Figure 2-1 will be evaluated to confirm the groundwater system inside the barrier wall is acting independently of the groundwater system outside the barrier wall, as well as independently of the Menominee River stage, both for the previous year and to evaluate data trends over time. Evidence of independent systems will confirm the barrier wall is effectively containing site groundwater.

Groundwater and river elevation trend graphs will be produced for each set of wells monitored continuously using pressure transducers (that is, the shallow well inside the barrier wall, the deep well [if measured], and the well or river outside the barrier wall). Hydraulic heads will be corrected for groundwater salinity at the site as necessary to allow for an accurate comparison of hydraulic potentials. Data from wells with transducers will also be summarized in a separate cumulative data listing, although, due to the size of the data set, the data may be provided electronically only.

Manual groundwater elevations obtained during the semiannual or annual groundwater sampling events will be included in separate cumulative data table. In addition, Tyco has agreed to include the following components as part of future annual monitoring reports:

- A map showing locations of historical well locations and status of wells (Figure 1-2 of the BWGMP Update)
- A cross section along the barrier wall in the manufacturing area riverfront showing sheet pile toe information and lithology (Figure 1-5 of the BWGMP Update)
- Groundwater contour maps for each of semiannual or annual groundwater sampling event for the shallow and deep wells
- A summary of vertical gradient calculations using the manual water level data

2.2.6 Potential Corrective Actions

Monitoring Network Triggers

Well condition information will be evaluated to identify whether corrective action will be required for the monitoring network. The following conditions are triggers to initiate well repairs if they can be accomplished without affecting well integrity:

- Ill-fitting well covers
- Lock functionality
- Cracked or gaping concrete pads, or soil material that would allow surface water to infiltrate
- Moving, heaving, or cracked well casing material
- Obstructions inside well casing or screen during sampling
- Other potential problems related to the condition of the well

If well integrity may be affected by an attempted repair, a decision whether to replace the well will be made. The decision will follow the flow chart (Figure 2-2) and will consider the following questions:

- Is the well in the arsenic sampling program?
- If so, how many rounds of data have been collected from this well, and have the total arsenic results from this well been consistent through time (such as, is there anything additional that can be learned by replacing and continuing to sample this well)?
- If the well cannot be repaired, and evaluation of existing monitoring data indicates the well is probably no longer needed, a proposal will be made to EPA for review and approval to abandon the well and remove it from the monitoring network.

Barrier Wall Triggers

If the periodic evaluation of groundwater elevations in the Main Plant and Wetlands Areas using elevation trend graphs indicates groundwater conditions in the area within the barrier wall are not independent from those outside the barrier wall, further evaluation and/or corrective action will be pursued.

If the conditions during evaluation of the next round of data still indicate an issue with wall effectiveness:

- Notify the EPA within 24 hours of discovery, and conduct additional evaluation at the suspected section of concern.
- A plan for this additional evaluation will be submitted to EPA as quickly as possible and within 60 days before implementation.
- The goal of this evaluation is to demonstrate the presence, location, and magnitude of the potential leak.

- Once EPA approves the proposed plan, it would be implemented as quickly as possible and within 60 days, if possible.
- EPA will be notified within 24 hours of discovery if it is determined that the plan will take longer than 60 days, and an alternative schedule will be provided and interim measures, if possible, will be implemented.

If the additional evaluation confirms there is an issue with wall's effectiveness, and a potential risk from contaminant migration exists:

- Repair the barrier wall.
- The schedule will depend on the type of wall section involved (VBSW or sheet pile) and the location of that section.
- Details on corrective action to be followed for the barrier wall itself are discussed in Section 2.1.6.

The decisions will follow the flow chart included as Figure 2-3.

2.3 Groundwater Quality Monitoring

2.3.1 Purpose

Groundwater quality monitoring will be undertaken to assess the changes in total arsenic concentrations inside and outside the barrier in and around the Main Plant and Wetlands Areas. Total arsenic concentrations outside the barrier and beneath the low-permeability till (bedrock) should remain relatively lower in comparison to concentrations inside the barrier and should be stable or declining over time; thus, confirming the barrier system's effectiveness.

Because these areas will be effectively contained once the PDP is implemented, limited sampling for total arsenic has been included in the former Salt Vault and former 8th Street Slip areas to periodically document concentrations in these areas over time.

In addition, per EPA and WDNR's request, Tyco will conduct limited sampling and analysis of site groundwater for additional chemical parameters detected during historical groundwater sampling events to document that the concentrations of these constituents are stable or declining at the site. The additional parameter groundwater samples have been limited to VOCs at select locations, as they represent the constituents in site groundwater with the greatest potential for mobility. The metals and SVOCs detected at low levels in the past represent sparingly soluble constituents present as localized impacts within the interior of the contained site.

2.3.2 Frequency

Total arsenic groundwater sampling will be conducted semiannually during the spring quarter (April through June) and fall quarter (October through December) starting in fall 2015, after installation of the new monitoring wells (assuming the Revised BWGMP Update is approved in time to allow for all new installations and repairs in 2015), and extending to fall 2016. Sampling frequency will be decreased to annually (during the spring quarter) in 2017, unless increasing trends in total arsenic concentrations are observed; in which case, semiannual groundwater sampling will continue for at least 1 additional year. The sampling frequency for the site will be re-evaluated during the 2018 5-year review.

Baseline total arsenic groundwater samples will be collected during the first round of the sitewide sampling activities (fall 2015) from within areas where the PDP will be implemented. These wells include MW115P, MW115S, and MW119D within the former Salt Vault; and MW120S, MW120M, and MW120D within the former 8th Street Slip. Additional sampling of these wells will be conducted in 2016 and 2017 and prior to the 5-year reviews anticipated in 2018 and 2023; at which time, the sampling frequency will be assessed.

The sampling for additional chemical parameters will also be conducted during the first round of the sitewide sampling activities (fall 2015). Follow-on sampling will be conducted prior to the 5-year reviews anticipated in 2018 and 2023; at which time, the need for continuing, ceasing, or modifying the additional parameter sampling will be assessed. Any changes recommended will be submitted for review and approval by EPA and WDNR during the 2023 5-year review process.

2.3.3 Methods

Groundwater sampling and analysis of total arsenic content and additional parameters will be conducted at the subset of wells shown in Table 2-1 and Figure 2-1. Groundwater samples will be collected from the shallow (S-series), medium (M-series), and bedrock (D-series) wells to provide insight into the vertical distribution of total arsenic and the effectiveness of the barrier wall at different levels. S-series wells provide information on the shallow barrier wall effectiveness. M-series wells are classified as screened in either the till or lacustrine sand and silt units (Table 2-1). M-series wells screened in the lacustrine silt unit provide information on the effectiveness of the lower portions of the wall, while the M-series wells screened in the till and the D-series bedrock wells provide information on the total arsenic distribution at levels deeper than the barrier wall and below the glacial till.

The groundwater sampling approach for monitoring the barrier wall effectiveness of the Main Plant and Wetlands Areas was developed in consideration of the following:

- All S-series, M-series, and D-series paired well locations that straddle the Main Plant and Wetlands Areas (that is, there is a set of wells outside the barrier wall and inside the barrier wall) will be sampled.
- Most of the wells to be sampled have been monitored for total arsenic since 2011; thus, have longer-term records.
- The proposed monitoring well network will provide groundwater quality data on both sides of the barrier wall from the alluvial aquifer, till, and bedrock aquifer.
- Six wells to be installed in 2015 after dredging and restoration activities are complete (MW117S/M/D and MW118S/M/D) will provide shallow, medium, and bedrock groundwater quality data inside the Main Plant Area barrier wall adjacent to the main river channel.

Sampling Procedures

Data collection requirements are outlined in the approved QAPP (Earth Tech, 2006) and subsequent QAPP addendums (CH2M HILL, 2010b, 2012b, 2012c, 2013b). FOPs are provided in Appendix F of the approved QAPP (Earth Tech, 2006) and QAPP addendums.

Laboratory Analyses and Procedures

Laboratory tasks are described in the approved QAPP (Earth Tech, 2006) and QAPP addendums (CH2M HILL, 2010b, 2012b, 2012c, 2013b). Interpretation of laboratory tasks and their success or failure will be accomplished using data validation procedures outlined in the approved QAPP.

2.3.4 Equipment

Equipment used during groundwater monitoring well sampling, and the purging process that is accomplished before sample collection, is specified in Appendix F of the approved QAPP (Earth Tech, 2006). Purging and sampling equipment will be maintained either according to manufacturer’s instructions or replaced by the company owning the equipment when it is no longer functional.

2.3.5 Reporting

Daily Operating Logs

Use of daily operating logs is not relevant to monitoring well sampling events that occur infrequently. Using well sampling sheets, filled out for individual wells, is more appropriate to indicate depth to water, well condition, field parameter readings, volumes to purge, and volumes purged. An example well sampling sheet is included in Appendix E of the approved QAPP (Earth Tech, 2006). The information specified by this form has been used to compile an updated sampling sheet included as Appendix C. Records of personnel who work at the site, weather conditions, and other pertinent information will be noted in the field logbook per HASP requirements.

Mechanism for Reporting Emergencies

Reporting of health or safety incidents will follow the HASP (Section 6).

Personnel and Maintenance Records

Personnel records about onsite employees during groundwater monitoring activities will be maintained in accordance with the daily log in/log out sheets per Appendix E of the approved QAPP (Earth Tech, 2006) or using equivalent documentation methods in project field logbooks. Tyco and the respective contractors and subcontractors will maintain personnel records relevant to and in accordance with state, federal, and local employment regulations.

Observations regarding required well maintenance for monitoring wells will be noted on the monitoring well field sheet (Appendix C) or using an equivalent documentation method in the project field logbook. Field sampling and monitoring equipment (as listed in Appendix F of the approved QAPP [Earth Tech, 2006]) will be maintained in accordance with the manufacturer’s specifications; nonfunctional field equipment will not be used and will be replaced at the earliest opportunity.

Reports to Agencies

The total arsenic and additional parameter (if collected that year) groundwater sampling results will be presented in the annual monitoring report to be submitted to WDNR and EPA each winter.

Total arsenic concentrations will be compared to the 2009 and 2011 baseline event results and subsequent BWGMP sampling events to identify trends and distribution of total arsenic in site groundwater since barrier wall construction. Total arsenic concentrations outside the barrier wall and within the bedrock should remain low in comparison to concentrations inside the barrier wall; thus, confirming barrier wall effectiveness.

Maps will be produced to indicate the total arsenic distribution in shallow, intermediate, and deep systems. Changes in the distribution will be noted; contaminant distribution within the contained areas may spread out as groundwater flow from upgradient is eliminated, is affected by pumping of the GWCTS, or both. In addition, concentrations detected outside the barrier wall and below the till may decrease or remain stable over time, as these wells will be isolated from the contained source areas.

Additional parameter concentrations will be compared to the 2000 and 2009 event results for related and nearby wells, and subsequent BWGMP sampling events will document that concentrations are stable or declining at the site.

2.3.6 Potential Corrective Actions

Additional actions will be undertaken if total arsenic distribution in shallow or intermediate groundwater indicate a suspected leak across a portion of the barrier wall. This determination will be based on a long-term increase in total arsenic concentrations, or an order of magnitude or higher short-term increase, in existing wells situated outside the barrier wall. This evaluation will be completed using various methods, which may include trend graphs, statistical analyses of the total arsenic concentrations at the wells in question, or some combination.

If this evaluation of groundwater concentrations indicates a potential leak, further evaluation of barrier wall effectiveness may be pursued by completing one or more of the following activities:

- Conduct a geochemical evaluation of alternative explanations for observed increases in total arsenic concentrations

- Install groundwater elevation transducers in well pairs (if not already present) near the section of concern
- Reconstruct groundwater elevation trend graphs using the next quarter of continuous groundwater elevation data
- Resample the well pair where data indicate the potential for increasing concentrations outside the barrier wall during an additional round (if not already on a semiannual sampling frequency) of water quality sampling 6 months following the initial sampling event
- Conduct a visual inspection of the relevant barrier wall portion for leaks (if the area of concern is along the sheet pile wall)

If multiple lines of evidence developed during subsequent evaluation still indicate an issue with wall effectiveness:

- Conduct additional evaluation of the section of concern.
- A plan for this additional evaluation will be submitted to EPA before implementation.
- The goal of this evaluation will be to demonstrate the presence, location, and magnitude of the potential leak.

If the additional evaluation confirms there is an issue with the barrier wall's effectiveness, the following corrective action may be undertaken:

- Repair the barrier wall.
- The schedule will depend on the type of wall section involved (VBSW or sheet pile) and the location of that section.
- Details on corrective actions to be followed for the barrier wall are discussed in Section 2.1.6.

The decisions will follow the flow chart included as Figure 2-3.

2.4 Outfall Investigation and Potential Monitoring

Tyco is evaluating the condition of the sewer lines connected to the outfalls penetrating through the barrier wall (see Figure 1 included in Appendix D) to determine whether they may serve as discharge points for arsenic to the river. CH2M HILL developed an outfall investigation document that was submitted to the EPA and WDNR on February 3, 2015 (CH2M HILL, 2015a). Agency comments to the outfall investigation document were received on February 23, 2015 (EPA, 2015a) and were responded to by Tyco on March 23, 2015 (Appendix D; CH2M HILL, 2015b). This document outlined a sampling and investigation strategy for the outfalls. EPA approved the document in a letter dated April 16, 2015 (EPA, 2015b), which is incorporated by reference. The first event proposed in the document was conducted on May 7, 2015, with the next event to occur in late summer. Based on the results of the evaluation of these two events, an outfall repair program, monitoring program, or both will be developed, if needed. Future work plans will be submitted to EPA for review and approval as addendums to the Revised BWGMP Update.

SECTION 3

Dye Testing

Pursuant to the AOR, EPA requested additional activities to determine the effectiveness of the barrier wall, which included performing a dye test to assess barrier wall effectiveness along the Menominee River. The dye testing results will be *qualitative* in nature: if dye is detected in the river exceeding background concentrations, it will indicate seepage across the barrier wall but will not indicate the size or exact location of the leak. Because of the length of the barrier wall, access difficulties to potential dye testing locations, and volume of dye required, the dye test is designed only to measure the effectiveness of representative portions of the barrier wall.

3.1 Purpose

Per the AOR, dye testing will be undertaken to assess the effectiveness of the barrier wall in the Main Plant Area. Dye will be added to groundwater within the Main Plant Area, and water samples will be collected periodically from the Menominee River to determine whether dye-affected groundwater has seeped across the barrier wall. If dye is detected in the river samples and confirmed to have originated in the contained area, seepage will be confirmed, and additional evaluations will be undertaken.

3.2 Frequency

The dye testing will be implemented following the completion of the outfall investigation and repair activities (if needed) discussed in Section 2.4 and installation of the new wells discussed in Section 2.2, both planned to be completed in late summer or fall 2015 (assuming the Revised BWGMP Update is approved in time to allow for all new monitoring well installations and repairs in 2015). Therefore, the dye testing will likely start in 2016, preferably in July or August to limit the amount of dye required, with river sampling extending into summer and fall 2016. Dye testing may be delayed if outfall repair and well installation activities have not been completed by this date. As agreed to in the AOR, if there are no total arsenic concentrations greater than 20 ppm in the sediment samples collected from the Menominee River in 2018, and the barrier wall inspections confirm there are no visible leaks or deflections, then additional dye testing will not be required.

3.3 Methods

3.3.1 Groundwater Dye Injections

Permitting

Adding fluorescent dye to the subsurface will require a permit application, fees, and approval from WDNR pursuant to Wisconsin Administrative Code 812.05; thus, a plan will be submitted to the WDNR at least 60 days prior to the anticipated start date. Prior to submission, WDNR staff will be contacted to verify the submissions are sent to the correct staff for review and approval. The plan may need to be adjusted to comply with WDNR requirements, and any changes will be communicated to the EPA. In addition, Tyco will notify the City (Brian Miller, Department of Public Works) and WDNR staff (Kristin DuFresne and Cheryl Bougie) at least 24 hours prior to the start of dye testing to allow for staff notifications in the event dye is released to the Menominee River and inquiries are made from the public.

Rhodamine WT dye will be used during testing, as it is widely applied in stormwater and sanitary sewer tests, as well as in open water hydrologic tests (in rivers, lakes, and estuaries), due to its lack of toxicity (Turner Designs, 2001). Rhodamine WT was removed from the Drinking Water Contaminant Candidate List in 1998 because the EPA anticipates no adverse health effects when the dye is used as a tracer (EPA, 1998b). The EPA recommends that the maximum Rhodamine WT concentration entering a drinking water plant be

10 micrograms per liter (μg/L) or less and 0.1 μg/L in drinking water (Turner Designs, undated). Based on the distance from the site to drinking water intakes, it is not anticipated that the proposed injections will impact any drinking water source facility. The drinking water intake for Marinette, Wisconsin is located in Green Bay, 3,000 feet north of the mouth of the Menominee River; and the drinking water intake for Menominee, Michigan is located more than 2.5 miles north of the mouth of the river (WDNR and MDNR, 1990). Any dye that leaves the site will enter the river and be subjected to significant dilution by the Menominee River prior to entering Green Bay, where it will be further diluted.

At an initial injection concentration of 40 milligram per liter (mg/L), within a 5-foot cube of river water near the wall, the peak concentration would be just over 10 μg/L in typical August flow conditions, while the average concentration once the Rhodamine WT dye fully mixes with the entire river flow would be under 0.1 μg/L.

At an initial injection concentration of 150 mg/L, the Rhodamine WT concentration within a 5-foot cube near the wall would be close to 50 μg/L if there were a 10-gallon per minute (gpm) leak, while the riverwide average concentration would be around 0.3 μg/L. The dye would become more diluted as it mixed with Lake Michigan waters in Green Bay. Thus, the Rhodamine WT concentration in drinking water will be less than 0.1 μg/L, even if there were significant seepage.

Rhodamine WT is commonly used by the U.S. Geological Survey (USGS) (Jackson and Lageman, 2014; Putnam and Long, 2007; McCarthy, 2009). Parker (1973) found that oyster eggs were not adversely affected when exposed to Rhodamine WT at concentrations up to 10 mg/L, and silver salmon and trout had no adverse effects when exposed at a concentration of 10 mg/L for 17.5 hours and when exposed at a concentration of 375 mg/L for an additional 3.2 hours. The Michigan Department of Environmental Quality (MDEQ) reviewed Rhodamine WT for aquatic toxicity concerns and has approved its use in Michigan surface waters at concentrations of 13 mg/L or less (MDEQ, 2015). Additional information on the suitability of Rhodamine WT for dye tracing in surface water is included in the Keystone Technical Bulletin 65 included in Appendix E. The Material Safety Data Sheet (MSDS) for Rhodamine WT and a Keystone Technical Data Sheet are also provided in Appendix E.

Injection Approach

The general approach will be to use DPT techniques to add a sufficient volume of dye into groundwater so that dye reaches the barrier wall from the DPT location. At each location shown in Figure 3-1, dye will be added over approximately 20 vertical feet (that is, from 5 to 25 feet bgs) so that sufficient dye concentration is in the most conductive layers. These conductive layers are the most likely to transmit larger amounts of water across a barrier wall leak, if any. The design volume of diluted dye will be based on adding one pore volume of diluted dye for the goal radius of influence. The goal radius of influence will be based on the distance of the DPT location to the barrier wall with an overlap of 1 foot (that is, an 11-foot goal radius of influence if the DPT is 10 feet from the barrier wall). Assuming an effective porosity of 0.20, for locations 5 feet from the barrier wall, approximately 3,400 gallons of diluted dye would be required; whereas, for locations 10 feet from the barrier wall, approximately 11,400 gallons of diluted dye would be required. During the tests near MW117S/MW117M and MW118S/MW118M, those wells will be monitored to determine when breakthrough has occurred at those wells to calculate the actual effective porosity and required dye volume for subsequent dye additions. These test locations will be conducted first in order to adjust (as necessary) the required dye volume for subsequent dye test locations.

The dye is expected to advect from the initial radius of influence based on an induced hydraulic gradient from groundwater mounding. If there is a 0.01 foot per foot (ft/ft) gradient, it is expected that the dye from a given injection point would be in contact with a length of approximately 45 feet of the barrier wall after 2 weeks

Additional information on the equations and assumptions used to calculate the dye volumes, radii of influence, and potential river concentrations were provided in the "Response to April 16, 2015 EPA

Comments 'Tyco Updated Dye Injection Information and Estimates Proposal CH2M HILL TM, dated March 13, 2015'" (CH2M HILL, 2015d), including a spreadsheet of all calculations in Attachment 1 of that document.

Dye Testing Locations

Nine dye testing locations will be spaced approximately every 167 feet along the barrier wall near the river within the Main Plant Area. Because of the presence of tie rods installed to support the barrier wall (spaced approximately every 9 feet), utilities, surface mounds, and old wood piers and piles adjacent to the barrier wall, DPT locations will be adjusted in the field as necessary.

Because the volume of dye required increases by the square of the distance from the barrier wall, dye testing locations will be positioned as close as possible to the barrier wall. Depending on the capacity of the aquifer to accept dye at a reasonable rate, multiple DPT rods may be advanced at each location. DPT locations will be recorded with a global positioning system (GPS) unit and marked on a map. Anticipated dye test locations are presented in Figure 3-1 and include five locations along the main channel and four locations along the Turning Basin.

Given the relatively low rates of pumping rates at EW-04 (average monthly rates since 2013 have been approximately 0.25 gpm) and its distance from the barrier wall (approximately 100 feet) it is unlikely that pumping of this well would significantly affect dye migration patterns. Nonetheless, the injection location originally proposed near MW108S has been moved to the north to reduce the likelihood of capture or diversion by EW-04 pumping. Attempts will be made, to the extent feasible, to reduce or stop pumping of EW-04 during and immediately after dye injection activities nearest EW-04. It is likely infeasible, however, to cease pumping EW-04 for the entire duration of the dye test monitoring.

Mobilization and Utility Clearance

A subsurface utility clearance will be completed at the injection locations. Multiple resources will be used to obtain clearance, including:

- Digger's Hotline
- A private third-party utility locate for onsite areas
- Facility staff

GPR will be required to identify tie rod locations and other potential impediments to installation of the injection points.

Groundwater Dye Concentrations and Preparation

Dye concentration and mass calculations have been made to balance the competing requirements of injecting sufficient dye to be detectable in the river if there is seepage from the wall while also minimizing potential dye concentrations in the river. The amount of dye required has been back-calculated as suggested by EPA, and the spreadsheet has been included as Attachment 1 of the "Response to April 16, 2015 EPA Comments 'Tyco Updated Dye Injection Information and Estimates Proposal CH2M HILL TM, dated March 13, 2015.'" Key variables that affect the dye concentration and mass include:

- Background fluorescence levels in the Menominee River
- Detection limit of the fluorometer
- Safety factor applied to calculations for nonideal field conditions that may affect the fluorometer detection limit
- Dilution factor of the Menominee River to any seepage through the wall, which is based on the amount of water expected to pass every minute through a theoretical 5 feet by 5 feet by 5 feet cube in the river adjacent to the wall

- Magnitude of the seepage through the wall
- Degree of adsorption and aquifer dilution of dye from injection location to wall
- Distance of injection location from the wall

Rhodamine WT will be the dye added, pending WDNR approval, to the selected locations in the Main Plant Area. This dye was selected for its relatively conservative behavior in groundwater, nontoxicity, and detectability at low concentrations using field equipment (0.01 part per billion [ppb] using the selected fluorometer). This dye also has high visibility as a red dye, which will facilitate observations of potential breakthrough. The target concentration of the tracer solution at the DPT location will be 40 mg/L, based on use of a 10AU field fluorometer with a detection limit of 0.01 ppb, a conservative calculation of the amount of aquifer dilution expected (5x), an assumed leakage of 0.2 gpm over a 25-square-foot (ft^2) section of the barrier wall, dilution in surface water (70,000x, based on a 125-cubic-foot [ft^3] mixing zone with 1.2 foot per second [ft/s] velocity based on typical May flows), and a safety factor (10x). Based on these assumptions, it is anticipated that a leakage rate of 0.2 gpm across a 25-ft^2 section of the barrier wall would result in detectable concentrations of Rhodamine WT at the surface water sampling locations located near the leak and within several feet of the barrier wall.

Rhodamine WT will be obtained in 20 percent concentrated form (stock solution) from a commercial supplier. A concentrated dye solution will be prepared in a polyethylene tank by diluting 20 percent Rhodamine WT into the goal injection volume of water. Because chlorine has been found to consume Rhodamine WT, unchlorinated water will be obtained from either onsite sources or tanker truck deliveries. A sample will be collected from the injection line and tested with the fluorometer to verify the concentration. The sample concentration range that the fluorometer can measure is 0.01 to 250 μg/L. Therefore, dilution using distilled water may be needed for the samples that may have a relatively high dye concentration.

Background samples will be collected from the Menominee River prior to initiation of the dye testing. If background fluorescence concentrations are greater than 0.4 ppb, then a handheld Aquafluor fluorometer (with a detection limit of 0.4 ppb) will be substituted, and a dye concentration of 150 mg/L (at the DPT location) will be used.

Dye Addition

The subcontractor will use its own injection equipment designed to work with its DPT rig. A potential injection approach is described in this section, but actual procedures will be based on the subcontractor’s equipment and experience. The tank of prepared dye will be connected to a pump (if used) with an inline flow meter, pressure gauge, and gate valves located between the pump and the DPT drive rods. Drive rods will be advanced by DPT to the target depths. Dye addition will be achieved through either an expendable tip or horizontal ports on the drive rods. If an expendable tip is used, dye addition through the drive rods will be achieved by removing the expendable tip once the target depth is reached, adding a portion of the dye, and then pulling up the drive rod to a shallower depth for further dye addition. If horizontal ports are used, the sleeve covering the ports will be retracted at the target depth, a portion of the dye will be added, and the drive rod will then be either advanced deeper or pulled up to the next dye addition interval.

Joints on the drive rods will be sealed with O-rings or equivalent to maintain pressures. Backpressure will be monitored at or near the top of the push rods so that the maximum pressure allowed by the formation is not exceeded. If necessary to achieve appropriate dye addition rates, multiple drive rods may be installed at injection locations and a manifold system used to add dye through the multiple points at the same time. Each pipe of the manifold system will have gate valves, flow valves, and pressure gauges to monitor dye addition rates and pressures.

If refusal is encountered during advancement of the drive rods, the DPT rig will be moved several feet (if safely possible), and another attempt will be made to install the drive rods. If refusal is encountered three times, the test location will be moved within 50 feet in either direction, and that will become the new test location.

This process will be repeated at each proposed DPT location until all locations have been completed. The DPT locations and depth intervals may be modified based on observations made in the field (for example, relocating points away from areas where dye surfacing occurs, or adjusting dye addition intervals based on experience at previous DPT locations).

With an anticipated dye addition rate of 3 gpm per rod, adding 3,400 and 11,400 gallons would be done in 23 and 76 hours, respectively. These times may be reduced if multiple drive rods can be advanced and used at the same time. If the dye addition rate is slower than expected, dye addition will be stopped after 48 hours, regardless of the total volume added. The tracer solution will be added continuously, recording flow rates using the inline flow meters, cumulative volume of dye added to the subsurface, and monitoring of water levels at nearby observation wells. To minimize the likelihood of the dye moving through preferential pathways, daylighting, fracturing the aquifer materials, or a combination of these, subsurface pressures will be monitored during dye addition, and flow rates will be adjusted to maintain dye addition under the calculated (with 60 percent safety factor) maximum pressure (Payne et al., 2008). If flow rates are slower than expected, pressures may be increased slowly above this 60 percent safety factor while carefully monitoring flow rates and daylighting. At each dye addition location, the following system operational parameters will be observed and recorded:

- Dye addition point identifiers
- Depth intervals used
- Start and end times
- Actual volumes added
- Pressures

Groundwater elevation responses will be monitored in nearby wells, if present, to assess potential mounding near the DPT locations. Once dye additions are complete, the drive rods will be withdrawn, the resulting voids will be sealed with the site-specific grout, and the surface will be restored to previously existing conditions, to the extent practicable.

Care will be taken to prevent spilling the dye, and spills will be cleaned up immediately, especially those near outfalls to the river. Care will be taken during injection activities, including use of secondary containment at dye storage locations, protection of any storm drains or sewers near injection sites, and careful monitoring during injection to limit daylighting of injected dye.

If a significant quantity of dye inadvertently enters the river, significant dilution would reduce average concentrations rapidly. For example, if the entire mass of dye to be injected at a location were inadvertently spilled into the river, the riverwide concentration would be 440 μg/L, and within 5 minutes, sufficient upstream water would have flowed through to reduce the average concentration to less than 100 μg/L. Any ongoing injection work will stop if <u>any</u> dye is observed in the river. Additional information regarding spill prevention procedures and contingency plans will be provided to EPA and WDNR prior to commencement of work.

3.3.2 River Sampling Locations

Following injection of the dye into the monitoring wells, near-shore sampling of the river along the barrier wall will be conducted. Before collecting samples, the barrier wall will be traversed to observe if any red dye is visible in the river. If dye is visible (the dye is visible at concentrations greater than approximately 100 ppm), samples will be collected at the observed location to confirm the presence of Rhodamine WT in the river. Otherwise, vertical sample transects will be collected adjacent to DPT locations, as well as at locations approximately 50 feet downstream and upstream of injection locations. A YSI 6820 (or equivalent) sonde with a YSI 6130 Rhodamine WT sensor will be used as a screening tool to select sample depths. The YSI sonde will be lowered through the water column to allow monitoring of Rhodamine WT concentrations in real-time. If no readings exceeding background levels are detected, only one sample per transect will be collected for confirmation analysis using the fluorometer. If there are detections exceeding background levels using the YSI, three samples at different depths will be collected for fluorometer analysis at the depths with the highest readings to confirm the YSI screening readings. To reduce the effect of dilution from the river, samples will be collected as close as possible to the barrier wall. Sample locations will be marked on the barrier wall and recorded using a GPS unit to allow reoccupation of the same sample locations during later sampling events. Anticipated sample locations are presented in Figure 3-1 and will be adjusted based on actual DPT locations and any locations where the red dye is observed.

In addition, background samples from the river will be collected periodically at the upstream end of the barrier wall and from the GWCTS effluent to determine if there are any interfering compounds that may affect transect sample analysis for the target dyes. If fluorescent compounds are detected in the background samples, the measured background concentration will be subtracted from all sample results.

3.3.3 Sample Collection and Analysis

Sampling will be conducted, when possible, from the land side of the barrier wall. If necessary, a boat will be used to collect water samples. Appropriate safety precautions will be used as detailed in the HASP (Section 6). The sampling may be conducted by Tyco staff, CH2M HILL personnel, or a subcontractor. The EPA and WDNR will be notified as to the entity who will be conducting the sampling prior to initiation of dye testing. A Standard Operating Procedure for collecting surface water samples will be prepared and submitted to EPA for approval.

Depth-discrete samples will be collected using either a decontaminated Kemmerer (or similar sampling device) or a peristaltic pump and tubing. The Kemmerer sampler is a cylinder with rubber stoppers that leave the ends of the sampler open while being lowered to the target sample depth. When the sampler is at the target depth, a weight “messenger” is dropped down the line that releases a latch and causes the rubber stoppers to close around the cylinder and retain a sample at the target depth. The sampler will then be retrieved, and the sample will be poured into the polystyrene cuvette. If a peristaltic pump is used, disposable tubing will be attached to a metal conduit or survey rod, lowered to the target depth, the pump will be turned on, and the sample will be collected in a polystyrene cuvette. If a peristaltic pump is used, tubing will be attached to a metal conduit with measurement marks on it. The tubing will be lowered to the target depth and the peristaltic pump turned on to collect the sample. A sufficient volume of water will be pumped through the tubing before sample collection so that residual water in the tubing is removed and the sampled water is representative of the target depth.

The sample in the polystyrene cuvette will be immediately analyzed in the field using a calibrated fluorometer (either a 10AU field fluorometer or a Turner Designs Aquafluor handheld fluorometer). These fluorometers work by shining a green light on the sample; if Rhodamine WT is present, the Rhodamine WT will absorb the green light and emit a red light that is then measured by the fluorometer. These fluorometers are capable of detecting Rhodamine WT at levels as low as 0.01 and 0.4 ppb, respectively. If concentrations are greater than 100 ppb, above which the fluorometer response is nonlinear, samples will be diluted with deionized water before analysis.

In addition to analysis for dye concentrations, the sample temperature and turbidity also will be measured and recorded, as these parameters can affect the fluorescence measurements. Turbidity will be measured with either the Aquafluor fluorometer or a YSI sonde. Samples initially will be measured for Rhodamine WT unfiltered; if turbidity values exceed 5 nephelometric turbidity units (NTU), then the sample will be field-filtered using a membrane filter and re-analyzed for both turbidity and Rhodamine WT concentration. Temperature will be measured with a thermometer and noted on the field sheet. Field-measured Rhodamine WT concentrations will be adjusted in the office, if necessary, for the sample temperature. Additional details on fluorometer sample measurement procedures are provided in the standard operating procedures (SOPs) and the user manuals provided in Appendix F.

Sample transects will be sampled 1 day after dye addition is completed at each location, and then at 1, 2, 4, 8, and 16 weeks following the final dye injection. If dye is detected, subsequent sampling events will not occur. Additional sampling, however, may be undertaken with a finer resolution to attempt to identify the location of any suspected section of concern. Field duplicate samples will be collected in accordance with the approved QAPP (Earth Tech, 2006).

Sample Nomenclature

A sample nomenclature system will be used to identify each sample, including quality assurance (QA)/ quality control (QC) samples. The sample identifier will be unique for each sample. The unique sample identifier will be used for tracking each sample within the chain-of-custody (CoC), database, and subsequent reports.

Each sample, regardless of analytical protocol, also will be assigned a site-specific identifier, including a sample depth for dye test samples and will be included on the sample label, traffic report, and CoC record.

The site-specific identifier is based on the following system:

- **Sample Type**—The first two letters indicate the type of sample location as follows:
  - GW = Groundwater sample.
  - SW = Surface water sample.
  - WD = Investigation-derived waste (IDW) characterization sample. An example of the first IDW characterization sample is WD-001, followed by WD-002.
  - EB = Equipment blank sample. An example of the first EB sample is EB-001, followed by EB-002.
- **Sample Number/Location**—The surface water samples locations will be numbered sequentially, as depicted in Figure 3-1. The sample also will be appended with the day, month, and year of collection to differentiate between sampling events.
  - An example surface water sample location is SW-002-051215, which indicates a sample collected at Location 2 on May 12, 2015.
- **Sample Depth**—The water depth from which the sample was collected will be added to the station location at the end after a dash:
  - The 5-foot-depth interval at the surface water location in the previous example is indicated as SW-002-051215-05.
- **QA/QC Identifier**—Field QA/QC samples will be identified using the following QA/QC identifiers:
  - Field duplicates will be identified as FD (for field duplicate), with a subsequent sequential number (for example, 001, 002, and so on) appended to the end. FD samples will be tracked in reference to the appropriate parent sample on the sampling sheet.

3.4 Equipment

DPT equipment, dye addition equipment, and a boat (if necessary) will be provided by qualified subcontractors, and the subcontractor's SOPs will be used for that equipment. The subcontractors and vendors have not been selected, but will be communicated to EPA during the request for proposal (RFP) process and prior to initiation of the dye testing. The fluorometer will be rented from an equipment supplier and equipped with channels to measure Rhodamine WT. The fluorometer will be calibrated either in the field or by the equipment supplier, and will be used and maintained in accordance with the manufacturer's instructions. Other sampling equipment (such as YSI sonde, peristaltic pump, and Kemmerer sampler) will either be provided by a subcontractor or rented from an equipment supplier, and will be maintained either according to manufacturer's instructions or replaced by the company owning the equipment when no longer functional.

3.5 Reporting

Daily Operating Logs

Use of daily operating logs is not relevant to events that occur infrequently. During dye addition, events will be recorded in field logbooks. Events to be recorded include mixing of dye; installation of injection equipment; and periodic measurements of dye addition rates, volumes, and water elevations. During river sampling events, the location, media, and parameters of samples collected in the field will be documented. The procedures include recording the acquisition of each sample for analysis, maintaining a file of parameter data generated as a result of sampling activities, and recording field sampling location survey data. Field notes at each location may include the following information (if applicable): date, time, personnel, weather conditions, station identification, x coordinate, y coordinate, z elevations (top of water), water depth, and sample descriptions. Collected water samples will be analyzed in the field and results recorded on the field sheet for Rhodamine WT concentration, temperature, and turbidity. Any deviations from the sampling plan or problems encountered during the dye testing also will be documented in the field notes. An example field sheet is provided in Appendix G.

Mechanism for Reporting Emergencies

Reporting of health or safety incidents will follow the HASP (Section 6).

Personnel and Maintenance Records

Personnel records about onsite employees during dye injection activities will be maintained in accordance with the daily log in/log out sheets per Appendix E of the approved QAPP (Earth Tech, 2006) or using equivalent documentation methods in project field logbooks. Tyco and the respective contractors and subcontractors will maintain personnel records relevant to and in accordance with state, federal, and local employment regulations.

Field sampling and monitoring equipment will be maintained in accordance with the manufacturer's specifications; nonfunctional field equipment will not be used and will be replaced at the earliest opportunity.

Reports to Agencies

EPA will be notified via e-mail if dye is detected exceeding background levels in samples collected from the river. Additionally, the results of the 2015 dye testing will be summarized in a brief report submitted to EPA and WDNR within 60 days of completing testing

3.6 Potential Corrective Actions

Any dye exceeding background levels that is detected in the receiving water (Menominee River) will be considered an indication that seepage from the site to the river may exist—either at a seam in the sheet pile wall or underneath the barrier wall. Sampling frequency or number of locations may be adjusted if a leak is detected to help better identify the leak location. Results will be reported to EPA, and additional assessment of the barrier wall will be conducted to determine the location, nature, and magnitude of the leak and whether repairs are needed. Such an assessment may rely on calculations, provided in the "Updated Supplemental Evaluation: Potential for Recontamination of Menominee River Sediments due to Groundwater Migration from the Main Plant Area" TM submitted on April 22, 2015 (CH2M HILL, 2015c), regarding the amount of groundwater seepage through the barrier wall that would result in sediment recontamination greater than 20 ppm in the Menominee River. The dye testing summary report will include recommendations to the EPA of proposed repairs, if necessary. Potential barrier wall corrective actions are presented in Section 2.1.6.

SECTION 4

Pump Down Program

4.1 Purpose

Pursuant to the AOR, Tyco will implement a PDP within the contained areas associated with the former Salt Vault and former 8th Street Slip to reduce groundwater levels near or below the ordinary low water mark of the Menominee River (target elevation). The goal of implementing this PDP is to eliminate the potential for outward migration of groundwater to the river from the contained areas; thus, preventing arsenic contamination within these areas from flowing to the river even if there was a compromised section of the barrier wall containing these areas.

4.2 Groundwater-level Monitoring Frequency

The PDP will be implemented in spring 2016 after dredging restoration activities are completed and will allow for a full season to conduct the initial PDP activities, with the target elevation achieved by December 31, 2017, or sooner if technically practicable. The PDP will operate as part of a long-term effort with the following phases:

- Drawdown phase, during which groundwater will be aggressively pumped from the former Salt Vault and former 8th Street Slip (collectively referred to as cells) until the target elevation is achieved; groundwater levels will be measured weekly during this phase.
- Interim shutdown phase, which covers any interim or seasonal shutdown of the temporary extraction system for durations greater than 4 weeks before achieving the target elevation; groundwater levels will be measured monthly during this phase.
- Post-drawdown phase, after the target elevation has been achieved and only groundwater level maintenance pumping is occurring; groundwater levels will be measured quarterly during this phase.

4.3 Methods

4.3.1 Target Elevation

The target elevation for groundwater in the former Salt Vault and former 8th Street Slip cells is the U.S. Army Corps of Engineers ordinary low water mark elevation of 577.5 feet or lower IGLD85. Because groundwater levels can fluctuate, Tyco will not be considered out of compliance if groundwater elevations range between 577.5 and 578.0 feet IGLD85. Past surveyed reference point elevations of well and groundwater elevations are based on NAVD88. For the site, elevations calculated using the IGLD85 are 0.4 foot lower than those calculated using NAVD88. Thus, the target elevation in the cells will be 577.9 feet NAVD88, with noncompliance occurring if the average groundwater elevation exceeds 578.4 feet NAVD88. Tyco will present data in both IGLD85 and NAVD88 during the PDP.

4.3.2 Extraction Approach

Variable-rate aquifer tests were conducted in spring 2014 on newly installed extraction wells in the former Salt Vault and former 8th Street Slip to evaluate the hydrogeologic characteristics within the cells. An existing numerical groundwater flow model (GFM) for the site was updated and used to analyze the aquifer test data and refine the GFM with a focus on the former Salt Vault and former 8th Street Slip areas. Details on the field activities and use of the GFM to assess the associated data was provided in a TM that was submitted to EPA and WDNR in July 2014 (CH2M HILL, 2014e).

The updated GFM was used to evaluate different groundwater extraction approaches in the cells to gain insight into the following:

- Groundwater pumping rates and durations required to decrease groundwater levels within the cells to the target elevation
- The network of extraction wells to be used in each cell during the drawdown phase
- The groundwater pumping rates that will be required to maintain groundwater levels after the target elevation is attained
- The extraction well(s) to be used to maintain groundwater levels at or below the target elevation

Although insights were gained from using the updated GFM, modifications to the PDP are expected based on field conditions and water management needs that will become evident during PDP implementation.

Former Salt Vault Extraction Approach

The average groundwater elevation in the former Salt Vault is approximately 584 feet NAVD88; thus, drawdown of approximately 6 feet will be required to meet the target elevation of 577.9 feet NAVD88. The proposed approach is to draw down the groundwater levels in one mobilization while managing the resulting offsite water disposal burden. It is anticipated that the target elevation can be achieved in approximately 4 months or less, with the drawdown phase starting in spring 2016 and completing before the onset of freezing conditions. If the target elevation is not achieved within this 4-month period and extends into the onset of freezing conditions, a portion of the system may be shut down for the winter (interim shutdown phase), with resumption of groundwater pumping in spring 2017.

Drawdown Phase

During the drawdown phase, it is anticipated that EW-03 and one of the recently installed extraction wells (such as EW-10, EW-11, EW-13, or EW-14) will be pumped at a combined time-weighted extraction rate of no more than approximately 5 gpm. This assumes continuous operation for 85 percent of the time during the 4-month period. The total estimated volume of groundwater that would need to be pumped from the former Salt Vault during the 4-month drawdown phase is no more than approximately 600,000 gallons. Extracted groundwater from EW-03 will be pumped into the GWCTS, while groundwater from the recently installed extraction wells will be pumped into temporary storage tanks and disposed of offsite. Existing monitoring wells screened within the fill and alluvial sand and lacustrine silt will be used to monitor groundwater levels near the extraction wells. During the drawdown phase, extraction wells may be turned off temporarily for 1 to 2 days to assess groundwater-level rebound and gain insights into the magnitude of maintenance groundwater pumping that will be required during the post-drawdown phase.

Post-drawdown Phase

After the groundwater levels have been drawn down to the target elevation, one or more extraction wells will be pumped as necessary to maintain target elevations. It is anticipated that groundwater levels will be maintained by pumping EW-03, which is already plumbed to the existing GWCTS at 3 gpm or less. A contingency will be included in the PDP plan and RFP documents that if EW-03 cannot maintain groundwater levels at or below the target elevation, an additional extraction well also will be connected to the GWCTS, if feasible. To ensure GWCTS compliance with its WPDES permit, a portion of the extracted groundwater may alternatively be disposed offsite under a short- or long-term operation rather than being treated at the GWCTS. Considering the difficulty of incorporating an additional extraction well and additional volume of higher-arsenic-concentration groundwater to the GWCTS' existing treatment capacity an assessment of the feasibility of this approach will be required before adding extraction wells to the GWCTS.

Former 8th Street Slip Extraction Approach

The average groundwater elevation in the former 8th Street Slip has been approximately 580 feet NAVD88; therefore, approximately 2 feet of drawdown will be required to attain the target elevation. It is assumed the PDP for the former 8th Street Slip will be implemented concurrently with the PDP for the former Salt Vault.

Drawdown Phase

During the drawdown phase, it is anticipated that EW-02 and one of the recently installed extraction wells (such as EW-08 or EW-09) will be pumped at a combined time-weighted extraction rate of no more than approximately 5 gpm. This assumes continuous operation for 85 percent of the time during the 4-month period. The total estimated volume of groundwater that would need to be pumped from the former 8th Street Slip during the 4-month drawdown phase is no more than approximately 600,000 gallons. Extracted groundwater from EW-02 will be pumped into the GWCTS, while groundwater from the recently installed extraction well will be pumped into temporary storage tanks and disposed of offsite. Existing monitoring wells screened within the fill and alluvial sand and lacustrine silt will be used to monitor groundwater levels near the extraction wells. During the drawdown phase, extraction wells may be turned off temporarily for 1 to 2 days to assess groundwater-level rebound and gain insights into the magnitude of maintenance groundwater pumping during the post-drawdown phase.

Post-drawdown Phase

EW-02 will be used to maintain groundwater elevations at or below the target elevation. It is anticipated that groundwater levels will be maintained by pumping EW-02 and possibly one other extraction well at a combined rate of 3 gpm or less. A contingency will be included in the PDP plan and RFP documents that one of the recently installed extraction wells may additionally be plumbed to the GWCTS, if feasible, to maintain groundwater levels. To ensure GWCTS compliance with its WPDES permit, a portion of the extracted groundwater may alternatively be disposed offsite under a short- or long-term operation rather than being treated at the GWCTS. Considering the difficulty of incorporating an additional extraction well and additional volume of higher-arsenic-concentration groundwater to the GWCTS' existing treatment capacity an assessment of the feasibility of this approach will be required before adding extraction wells to the GWCTS.

4.3.3 Target Elevation Measurement and Calculation

Groundwater elevations (in NAVD88 and IGLD85) in the former Salt Vault and former 8th Street Slip will be manually measured in the shallow monitoring wells listed in Table 4-1. The arithmetic average of the groundwater elevations in each cell will be calculated for comparison to the target elevation. Note that wells within the steepest part of the cone of depression of the extraction well(s) would not be used in the calculation (these water levels would not be representative of the typical areawide groundwater elevations), as indicated in Table 4-1.

River water levels recorded at the site stream gauge (Section 2.2) also will be reviewed for comparison to the ordinary low water mark identified for the NOAA gauge downstream of the site. Although groundwater elevations within the former Salt Vault and former 8th Street Slip are not expected to fluctuate due to river level fluctuations, transducers will be placed in MW002S and MW115S (MW116S or MW116P could be used instead of MW115S, if needed) in the former Salt Vault and MW120S in the former 8th Street Slip to provide a continuous record of groundwater levels over time. The data produced from these pressure transducers will be used to help understand the relationship, or lack thereof, between groundwater elevations within each cell and the river, as well as responses within the cell to other factors, such as precipitation and snowmelt events. Descriptions of the pressure transducer installation and maintenance are provided in Sections 2.2.3 and 2.2.4.

During the drawdown phase, groundwater levels will be measured weekly at wells within and adjacent to the cells. During any interim shutdown phase before achieving the target elevation, groundwater levels will be measured at least monthly at wells within and adjacent to the cells. After the target elevation has been attained during the post-drawdown phase, groundwater levels will be measured from only wells within the cells quarterly, although target elevation compliance may be assessed during this phase using only one continuously monitored well. The wells to be measured are listed in Table 4-1 and presented in Figure 4-1.

4.3.4 Water Disposal

Groundwater samples were collected from extraction wells during the recent aquifer testing. These samples were collected at the end of the pumping period (after either 8 or 24 hours of pumping) and provide useful information associated with arsenic concentrations that could be expected during longer-term pumping. These arsenic results were presented in an aquifer testing TM submitted to the EPA in July 2014 (CH2M HILL, 2014e). Groundwater extracted from the former Salt Vault and former 8th Street Slip will be disposed of either offsite or treated by the existing GWCTS.

Offsite Disposal

During the drawdown phase, groundwater from the newly installed extraction wells, and, depending on GWCTS treatment capabilities, perhaps the existing extraction wells, will be pumped into a fractionation tank or similar container. This water will then be transported for offsite disposal. Water will be characterized, labeled, and managed in accordance with applicable state and federal regulations.

It is estimated that no more than approximately 20,000 gallons per day (gpd) total will be extracted during the drawdown phase, with most of that water requiring offsite disposal.

Vendors have not been selected for offsite disposal, but will be communicated to EPA during the RFP process and prior to initiation of the PDP.

Onsite Treatment System

It is anticipated that during the post-drawdown phase, the existing extraction wells EW-03 and EW-02 will be used to maintain groundwater levels in the former Salt Vault and former 8th Street Slip, respectively, and extracted groundwater from these existing wells will be treated at the onsite GWCTS. . Fractionation tanks or similar containers will be used, if necessary, to manage GWCTS capacity or for transfer to offsite disposal locations. Water treated by the GWCTS is subject to the existing WPDES permit. Details on the operations of the GWCTS and monitoring requirements are presented in the *Revised Groundwater Collection and Treatment System Operation and Maintenance Manual* (CH2M HILL, 2011c). Considering the difficulty of incorporating an additional extraction well and additional volume of higher-arsenic-concentration groundwater to the GWCTS' existing treatment capacity will be required as part of the feasibility evaluation before adding extraction wells to the GWCTS.

It is anticipated that no more than approximately 5,000 gpd will be extracted from each cell during the post-drawdown phase.

4.4 Equipment

The PDP will include using extraction and monitoring wells previously installed at the site. Equipment associated with the drawdown phase will be similar to the extraction equipment described in the *Operation and Maintenance Plan* (CH2M HILL, 2010a). It is anticipated that a qualified dewatering contractor and electrician will be subcontracted to install the pumps and switches required to operate the extraction wells, as well as to provide the aboveground temporary storage tanks and associated switches. Tyco will provide to EPA the RFP and statement of work (SOW) documents for selection of the dewatering contractor at the same time as they are sent to bid by potential contractors.

The pumps and other equipment will be connected to the existing electrical system at the site. The pumps in each extraction well will be able to operate at a range of pumping rates and will be manually adjustable. Pumps will be Grundfos REDI-FLO3 models, or equivalent, and able to operate from approximately 0.5 to 14 gpm. Groundwater will be pumped from each extraction well to temporary storage tanks provided by a qualified subcontractor. The discharge from extraction wells will be piped into these tanks for storage until waste can be transported offsite. The temporary storage tanks will be placed in secondary containment liner berms, and double piping will provide secondary containment. Appropriate equipment will be provided by the selected transportation subcontractor to remove water from these tanks and transport it to the offsite disposal location. The hoses and pipes from the extraction wells to the temporary storage tanks, as well as the tank capacity, will be inspected at least daily to confirm equipment is working correctly and that there is available storage capacity in the tanks. The storage tanks will be outfitted with control switches that can shut off all pumps feeding into them if the storage tanks reach full capacity. The storage tanks and associated equipment will be removed following completion of the drawdown phase.

During the post-drawdown phase, transducers will be placed in the monitoring wells near the operational extraction wells, enabling the GWCTS operators to react to groundwater-level changes within each cell. Input and output (I/O) radios will be installed at the remote extraction wells to communicate with the programmable logic controllers (PLCs) located at the treatment building for monitoring and control of extraction well pumps and monitoring well groundwater-level transmitters. Remote I/O panels will have local emergency stop switches for each pump and will have local control of the extraction well pumps via the pump controller remote control.

During the post-drawdown phase, groundwater will be pumped from each extraction well through underground high-density polyethylene (HDPE) pipe to the groundwater treatment building at the northwestern corner of the site. Additional conveyance piping and electrical and control conduits, if required, would be installed in manners similar to those described in the *Final Groundwater Collection and Treatment System, Groundwater Collection Design* (CH2M HILL, 2010c).

Equipment used for groundwater-level measurement events will be similar to that described in Section 2.2.4.

4.5 Reporting

Daily Operating Logs

Operations and maintenance (O&M) procedures for the GWCTS are provided in the *Revised Groundwater Collection and Treatment System Operation and Maintenance Manual* (CH2M HILL, 2011c).

Inspection logs will be used instead of daily operating logs for daily inspections of the drawdown phase system. Tyco or a designated representative will complete and document the findings in the inspection log. Tyco will maintain the inspection logs. An example log is included in Appendix H.

Waste approval packages, manifests, and offsite disposal records for wastewater transported and disposed offsite will be maintained onsite by Tyco in accordance with state and federal regulations.

Mechanism for Reporting Emergencies

Reporting of health or safety incidents will follow the HASP (Section 6).

Emergency procedures associated with the GWCTS operation are provided in the *Operation and Maintenance Plan* (CH2M HILL, 2010a).

Emergency procedures associated with managing hazardous waste accumulation areas will be conducted in accordance with local, state, and federal regulations.

If, during the post-drawdown phase, groundwater elevations in either the former Salt Vault or former 8th Street Slip exceed the target elevation, EPA will be notified immediately via e-mail.

Personnel and Maintenance Records

Personnel records about onsite employees during the PDP implementation and monitoring activities will be maintained in accordance with the current HASP. Tyco and the respective contractors and subcontractors will maintain personnel records relevant to and in accordance with state, federal, and local employment regulations. Tyco will maintain the inspection and maintenance logs. An example log is included in Appendix H. The GWCTS logs will be maintained until site closure.

Reports to Agencies

Water elevation data will be provided in Tyco's quarterly reports. Water level and groundwater pumping data also will be summarized in the annual monitoring reports submitted each winter. Upon achieving the target elevations in the former 8th Street Slip, former Salt Vault, or both, Tyco will notify EPA and WDNR via e-mail.

Reports associated with operation of the GWCTS are described in the *Operation and Maintenance Plan* (CH2M HILL, 2010a).

4.6 Potential Corrective Actions

If an extraction pump fails, the broken pump will be removed and either repaired or replaced. The other extraction wells will remain in operation, and pumping rates may be adjusted to compensate for the offline well. Potential operational problems and corrective actions for the GWCTS are provided in the *Operation and Maintenance Plan* (CH2M HILL, 2010a). If the GWCTS is offline because of equipment failure or noncompliance with its discharge permit, groundwater extracted from the former Salt Vault and the former 8th Street Slip may be stored in temporary storage tanks for either later treatment by the GWCTS or offsite disposal, if necessary.

After drawdown to the target elevation has been achieved, exceedances of the target elevation will result in immediate notification to EPA. Within 30 days of notification, a plan will be prepared and submitted to restore groundwater levels within the affected cell to the target elevation as soon as practicable. After EPA approval, the plan will be implemented expeditiously and no later than 90 days after approval. If exceedances of the target elevation recur, Tyco will develop and submit a plan and schedule for EPA approval to investigate and address the root causes of the exceedances.

If the selected extraction wells are not inducing enough drawdown to achieve the target elevation, pumping rates may be increased, additional extraction wells may be brought online, recharge reduction efforts (that is, adding impermeable surfaces) may be implemented, an extension of time may be requested for pumping, or additional investigation of barrier wall effectiveness (and necessary repairs) may be conducted. If the target elevation cannot be attained by December 31, 2017, because of technical impracticability, Tyco will notify EPA and submit a plan and schedule for implementation, within 120 days of notification, to propose a technically practicable alternative means, if any, to address the then-prevailing conditions in the former Salt Vault and former 8th Street Slip.

SECTION 5

Sediment Monitoring

Pursuant to the AOR and in support of the 2018 and 2023 5-year technical review reports, sediment samples will be collected from accumulated post-dredging soft sediments in the Menominee River in 2018 and 2023. In 2012-2013, Tyco removed 259,000 CY of sediment and SCM from the river. Material was dredged to 50 ppm total arsenic in accordance with the RCRA corrective action requirements. In 2014, Tyco and GLNPO dredged 42,000 CY of soft sediment and SCM to a target total arsenic concentration of 20 ppm as part of a GLLA project. On average, twelve inches of a sand and activated carbon cover has been placed over portions of the exposed glacial till within the Turning Basin and Transition Area portions of the Menominee River that exceed total arsenic concentrations of 20 ppm. GLLA project dredging was concluded in 2014, with final backfill placement, cover placement, restoration, and decontamination activities completed in 2015.

5.1 Purpose

Sediment samples will be collected and analyzed to determine if post-dredging accumulated soft sediment contains total arsenic exceeding the 20 ppm cleanup goal. Project-specific data quality objectives (DQOs) are included within Section 1.4 of the *Confirmation Sampling Plan QAPP* submitted on July 24, 2012 (CH2M HILL, 2012d).

5.2 Frequency

Samples will be collected in summer 2018 at year 4.5 in support of the 2018 5-year technical review report. Sediment sampling will be repeated in support of each subsequent 5-year review. Following completion of the 2023 5-year technical review report or thereafter, Tyco may propose modifications increasing or decreasing the number, locations, or both of future samples of the sediment sampling component.

5.3 Methods

5.3.1 Approach

The following is an outline of the approach for the sampling rationale:

- Soft sediment core samples will be collected continuously using a vibracore or DPT sampling equipment until SCM, glacial till, or bedrock is encountered. Cores will be segmented into 0.5-foot intervals to allow for complete characterization of the accumulated soft sediment.
- Two sample intervals will be analyzed immediately for total arsenic: the 0- to 0.5-foot interval and the 0.5-foot interval collected 1 foot above the base of the accumulated sediment. If less than 12 inches of sediment have accumulated, both sampling intervals will be analyzed immediately. Results will be dry-weight corrected for comparison to the 20-ppm cleanup goal. Remaining intervals will be archived onsite or at the contracted laboratory pending receipt of the initial results.
- If total arsenic is detected exceeding 20 ppm in an analyzed core interval, analysis would be conducted on the next contiguous incremental archived 0.5-foot core. This procedure would be followed until a result of less than 20 ppm is confirmed.
- If the vibracore or DPT sampling equipment encounters refusal and cannot recover a sufficient sediment sample, an attempt will be made to collect a surface grab sample. If no material can be collected using these methods, then the sediment sample proposed for that location will be moved to an alternate location within 70 feet in any direction of the original planned location. If at the second location no sample can be obtained by vibracore, DPT or grab, this will be documented by photos and written statements and no samples will be collected from this area.

- If it is visually verified that glacial till or SCM is the surficial sediment (that is, no sediment has accumulated since dredging), then the sediment sample proposed for that location will be moved to an alternate location within 70 feet in any direction of the original planned location. If at the second location no sample can be obtained by vibracore, DPT or grab, this will be documented by photos and written statements and no samples will be collected from this area.

Tyco agreed in the AOR to collect and provide split samples to the Agencies so that the Agencies may analyze them along the full core thickness for total arsenic rather than the top and bottom interval. The Agencies are responsible for all packaging, shipping and analytical costs of analysis of their samples.

5.3.2 Locations

Three sediment cores from the post-dredging accumulated soft sediment will be taken approximately 10 feet away from the barrier wall in the main river channel outside the Main Plant Area. Fifteen sediment cores will be taken in the Turning Basin and transition areas in the area outside the riprap armoring areas. The proposed sample locations are presented in Figure 5-1.

5.3.3 Field Operations and Procedures

This section provides an overview of the equipment, operations, and procedures for the sediment sampling and surveying activities. It also references specific FOPs in Appendix I that provide step-by-step procedures for conducting the given field task. In instances where FOPs are not referenced, the text of that section will serve as the FOP.

The following tasks will be performed to complete the investigation objectives:

- **Mobilization and Demobilization—**These tasks will consist of site preparation (setting up the staging area) and mobilizing equipment to the site before the field activities. Upon completing fieldwork, personnel, equipment, and supplies will be demobilized (removed) from the site.
- **Sediment Sampling—**Sediment sampling will be performed using vibracore or DPT sampling equipment to obtain representative samples within the accumulated soft sediment. The sampling data collected will be used to confirm accumulated soft sediments are less than the total arsenic cleanup goal of 20 ppm.
- **Surveying—**Surveying of the actual sample collection locations will be performed concurrently with the sediment sampling. Surveying will include the necessary measurements to determine horizontal (x, y coordinated) positions of each sample location.

Mobilization and Demobilization

Before initiating fieldwork, the following preparatory activities must be completed:

- Obtain and transport the identified field supplies to the site (for example, personal protective equipment [PPE], sample containers, preservatives, sample forms, and other related items) and field monitoring equipment
- Set up temporary IDW storage equipment on the sampling vessel
- Mobilize subcontractor, supplies, and materials
- Confirm that analyses are scheduled through the contracted laboratory
- Confirm that field equipment is in proper working order and has received appropriate QC checks

Equipment and tools will be properly decontaminated before they are demobilized from the area. No site restoration activities are anticipated to be necessary.

Sediment Sampling

Positioning of Sampling Vessel

Positioning of the vessel will be accomplished using a GPS unit capable of a horizontal accuracy of ± 3 feet. Procedures for GPS requirements and operation are in FOP-01 (Appendix I).

Sediment Sampling Procedures

Sediment cores will be collected at three locations in the main river channel near the Main Plant Area approximately 10 feet away from the barrier wall. Fourteen additional samples will be collected from the Turning Basin and transition areas away from the riprap area. Proposed sediment core sample locations are presented in Figure 5-1 and listed in Table 5-1.

Once the sampling vessel is positioned within 10 feet of the selected location; the x, y coordinates; and z elevations of each sampling location will be surveyed to meet accuracy requirements, as described in FOP-01 of Appendix I.

Sediment cores will be collected using a vessel-mounted vibracoring device or DPT equipment. If a vibracorer is used, it will be fitted with a 4-inch-diameter polycarbonate (Lexan) core liner. If DPT equipment is used, procedures similar to those in FOP-2 (Appendix I) will be followed.

At each location, the depth to top of the soft sediment surface will be recorded so that accurate vibracore penetration measurements and the calculation of percent recovery can be made. Sediment thickness penetrated and recovered will be measured and recorded during the coring process. Each sediment core will be collected continuously in 0.5-foot sample intervals to the contact between soft accumulated sediment and underlying SCM, glacial till, or bedrock. SCM or glacial till will not be sampled, and care will be taken to not composite this material with overlying sediment.

Following advancement of the vibracore or DPT equipment, if the core recovery is less than 70 percent, the station will be resampled; if the second core does not yield at least 70 percent recovery, the core with the highest percentage recovery will be retained. If insufficient sample volume is present in the soft sediment interval of a core, soft sediment may be collected using a grab sampling device in an effort to obtain sufficient sample volume.

Necessary measurements (for example, x, y coordinates; water surface elevation; depth to sediment surface; and depth of boring) will be recorded on a field form for each sampling location, like the example presented in Appendix J.

Sample Processing and Characterization Procedures

Soft sediment will be visually characterized for sediment type, color, moisture content, texture, grain size and shape, consistency, visible evidence of staining, and any other observations. Digital photographs of each core will be taken to visually document the undisturbed core structure.

Collection of Samples for Analysis

The individual sample intervals from each sediment core collected will be homogenized. Once the sediment has been thoroughly homogenized, aliquots will be transferred to the appropriate sample containers and managed, as discussed in Section 5.3.4.

Sample Analyses

Cores will be analyzed for total arsenic. Each core will have a discrete analysis of a sample collected from the top 6 inches of the core, and a second discrete analysis in the 0.5-foot core taken 1 foot above the base of the accumulated soft sediment. The remaining portion of each core will be archived pending receipt of laboratory results. If total arsenic is detected exceeding 20 ppm in an analyzed core interval, analysis would be conducted on the next contiguous incremental archived 0.5-foot core. This procedure would be followed until a result of less than 20 ppm is confirmed.

Surveying

Sediment sampling locations will be referenced horizontally to the Wisconsin State Plane Coordinate System, South Zone, NAD83. Established benchmarks will be used to survey each sediment core location to a minimum horizontal tolerance of 3 feet and a vertical tolerance of 0.1 foot. Coordinates (x, y) and elevations (z) (in both NAVD88 and IGLD85) of the benchmarks used for surveying activities will be recorded in the same coordinate system and datum as the sample locations.

Sediment surface elevation will be determined by surveying the water elevation through using a series of surveyed staff gauges or by surveying the water surface at each location. Water depth measurements will be collected using a weighted tape or survey rod. To derive the sediment surface elevation, the water depth measurement will be subtracted from the surveyed water elevation.

Field Equipment Decontamination

Nondisposable sampling equipment will be decontaminated on arrival at the site and before each use. Dedicated, single-use sampling equipment will be used during sediment sample collection and processing where possible. Portions of the sampling device that will be used at the stations will be decontaminated between stations.

Investigation-derived Waste

IDW will consist of excess sediment and liquids generated during investigation and decontamination activities, as well as PPE. IDW will be segregated by waste type and stored in 55-gallon drums. Each drum will be labeled and staged in a secure location. After classification, the drums will be shipped offsite for disposal at an approved facility.

5.3.4 Sample Management

This section describes the procedures to be implemented so environmental samples are properly containerized, preserved, shipped, and otherwise handled in a manner that will maintain sample integrity. The techniques will result in representative samples and reduce the possibility of sample contamination from external sources.

Sample Nomenclature

A sample nomenclature system will be used to identify each sample, including QA/QC samples. The sample identifier will be unique for each sample. The unique sample identifier will be used for tracking each sample within the CoC, database, and subsequent reports.

Each sample, regardless of analytical protocol, also will be assigned a site-specific identifier, including a sample depth for subsurface sediment samples that will be included on the sample label, traffic report, and CoC record.

The site-specific identifier is based on the following system:

- **Sample Type—**The first two letters indicate the type of sample location as follows:
  - SD = Sediment sample.
  - WD = IDW characterization sample. An example of the first IDW characterization sample is WD-001, followed by WD-002.
  - EB = Equipment blank sample. An example of the first EB sample is EB-001, followed by EB-002.
- **Sample Number—**The sediment samples will be numbered sequentially, as depicted in Figure 5-1. The sample also will be appended with the year of collection to differentiate between sampling events.
  - An example sediment sample location is SD-002-2018.

- **Sample Depth—**The depth from which the sample was collected will be added to the station location at the end after a dash and with a forward slash (/) between the start and end depths:
  - The 0- to 0.5-foot interval at the previous sediment location example would be indicated as SD-2018-002-0.0/0.5.
- **QA/QC Identifier—**Field QA/QC samples will be identified using the following QA/QC identifiers:
  - Field duplicates, which are associated with the same station location as the native sample, will use a blind naming system on the CoC record to the laboratory to protect the integrity of the duplicate samples.
  - Duplicate samples will be identified as FD (for field duplicate), with a subsequent number (001, 002, and so on) appended to the end.
  - FD samples will be tracked in reference to the appropriate parent sample using an onsite sample tracking spreadsheet in accordance with Section 2.10.2 of the *Confirmation Sampling Plan QAPP* (CH2M HILL, 2012d).

Quality Assurance and Quality Control Samples

The contracted laboratories will have a QA/QC program to ensure the reliability and validity of the analyses being performed. Field sampling precision and bias will be evaluated by collecting the QA/QC samples as described in the following subsections. To comply with QA/QC sample collection frequency, the number of samples submitted for analysis will be tracked using an onsite sample tracking spreadsheet, as described within Section 2.10.2 of the *Confirmation Sampling Plan QAPP* (CH2M HILL, 2012d).

Field Duplicates

FD samples will be used to measure the heterogeneity of the sample matrix and the precision of the field sampling and analytical process. Duplicate samples will be collected from locations throughout the sampling area and from various depths at a frequency of 10 percent to assess sample variability, resulting in approximately three FD samples (10 percent of two sample intervals from 15 core locations).

Equipment Blanks

EBs will be collected and analyzed to determine whether the decontamination procedure has been adequately performed and whether cross-contamination of samples occurred from the equipment or residual decontamination solutions. One EB will be collected on each day of sampling per piece of nondedicated equipment used during field activities and analyzed for the same parameters as the sediment samples.

Matrix Spike and Matrix Spike Duplicate

Laboratories will use matrix spike (MS) and matrix spike duplicate (MSD) samples to assess the precision and accuracy of sample analysis. The laboratories will fortify MS/MSD samples in accordance with the specifications of the analytical methods. Sample containers will be filled and stored in the same manner as FD samples. The frequency for collecting MS/MSD samples will be at least 5 percent, resulting in approximately two MS/MSD samples (5 percent of two sample intervals from 15 core locations).

Temperature Blanks

A temperature blank will be included in each cooler to allow the laboratory receiving the shipment of samples to determine if the samples have been maintained at the proper temperature. Temperature blanks will consist of an unpreserved sample container filled with distilled water. One temperature blank will accompany each sample cooler being shipped to the laboratory.

Sample Handling

Sample handling, packaging, and shipping procedures are described in Appendix F of the approved QAPP (Earth Tech, 2006).

Equipment

The vibracore (including the vibracore motor, barrel, and core catchers) or DPT equipment, boat, GPS, and consumables associated with core collection (for example, core tubes and caps) will be provided by a qualified contractor and will be used in accordance with their SOPs. More details on the DPT and GPS equipment are included in the FOPs in Appendix I.

5.4 Reporting

Daily Operating Logs

The location, media, and parameters of samples collected in the field will be documented. The procedures include recording the acquisition of each sample for laboratory analysis, photographing sediment cores, completing CoC forms for the environmental samples and field QC samples, maintaining a file of parameter data generated as a result of sampling activities, and recording field sampling location survey data. Field notes at each location may include the following information (if applicable): date, time, personnel, weather conditions, station identification, x coordinate, y coordinate, z elevations (top of water or ice and top of sediment), water depth, core penetration depth, and sample descriptions. An example field log for sediment sampling is provided in Appendix J.

Mechanism for Reporting Emergencies

Reporting of health or safety incidents will follow the HASP (Section 6).

Personnel and Maintenance Records

Personnel records regarding onsite employees during sediment sampling activities will be maintained in accordance with the current HASP. Tyco and the respective contractors and subcontractors will maintain personnel records relevant to and in accordance with state, federal, and local employment regulations.

Tyco will maintain the sediment sampling logs. An example log is included in Appendix J.

Reports to Agencies

The data from these samples will be included in the 2018 5-year technical review report and in any subsequent 5-year technical reviews that include sediment sampling.

5.5 Potential Corrective Actions

If there are exceedances of the 20-mg/kg cleanup goal, potential corrective actions will be detailed in the 2018 5-year technical review report or subsequent 5-year technical review reports.

SECTION 6

Safety Plan

The contractors implementing the elements of this BWGMP have not been selected. Project-specific HASPs will be developed by the contractor or Tyco for each element. The HASPs will be consistent with Tyco's generic HASP for the site and address potential health and safety issues associated with the work. The HASPs will contain precautions that site personnel must take regarding equipment associated with the work and required tasks in the event of system failures. HASPs will be updated when new activities are defined and pursued.

General topics included in the HASPs will include site location and scope of work, health and safety risk analysis, field team organization and responsibilities, PPE, site control measures, decontamination procedures, emergency response plan, employee training, and medical monitoring. HASPs will be kept onsite during all field activities, and a copy will be maintained in the project files.

SECTION 7
References

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CH2M HILL. 2010c. *Final Groundwater Collection and Treatment System, Groundwater Collection Design, Tyco Fire Products LP Facility.* April.

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CH2M HILL. 2011a. *Construction Completion Report, Containment Barrier Wall Installation at the Tyco Fire Products LP Facility*. April 18.

CH2M HILL. 2011b. *Barrier Wall Groundwater Monitoring Plan, Tyco Fire Products LP, Stanton Street Facility*. January 25.

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Tables

TABLE 1-1 (Revised)

Proposed Schedule for Barrier Wall Effectiveness Evaluation Activities and Reports

Tyco Fire Products LP

Marinette, Wisconsin

Element	Section	Area	Frequency/Timing	Reporting
Barrier Wall Visual Inspection	2.1	Main Plant Wetlands	Each spring and fall	Brief email report after each inspection and Annual Inspection Report due 45 days after fall inspection
Barrier Wall Visual Inspection	2.1	Salt Vault 8th Street Slip	Each spring and fall until target elevation attained, then annually in the spring	Brief email report after each inspection and Annual Inspection Report due 45 days after fall inspection
Barrier Wall Survey	2.1	Main Plant Wetlands Salt Vault 8th Street Slip	Each spring	Brief email report after spring inspection and Annual Inspection Report due 45 days after fall inspection
Groundwater Elevation Monitoring	2.2	Main Plant Wetlands River Areas adjacent to Main Plant and Wetlands	Transducers will be installed in fall 2015 after completion of monitoring well installation* Measurements every 30 minutes from transducers in wells and river downloaded quarterly	Annual Monitoring Report each winter
Groundwater Quality Monitoring - Arsenic	2.3	Main Plant Wetlands Areas adjacent to Main Plant and Wetlands	Fall 2015* Spring and fall in 2016 Annually in 2017 and 2018 Re-evaluate frequency in 2018 5 year technical review	Annual Monitoring Report each winter
Groundwater Quality Monitoring - Other Parameters	2.3	Main Plant Wetlands Areas adjacent to Main Plant and Wetlands	Fall 2015* As part of annual sampling in 2018 Re-evaluate frequency in 2018 5 year technical review	Annual Monitoring Report each winter
Groundwater Quality Monitoring - Arsenic	2.3	Salt Vault 8th Street Slip	Fall 2015*, Fall 2016 As part of annual sampling in 2017 and 2018 Re-evaluate frequency in 2018 5 year technical review	Annual Monitoring Report each winter
Outfall Investigation	2.4	Main Plant	Spring 2015 and late summer 2015 initial evaluation	Final report due 45 days after completion of late summer event
Outfall Monitoring Plan	2.4	Main Plant	TBD	
Dye Testing Scope of Work (SOW) and Request for Proposal (RFP)	3	Main Plant	Winter 2015/2016	SOW and RFP with contractor/vendor list to Agency. Report to Agency selected contractor prior to initiating work.
Dye Testing Permitting and Application Fee	3	Main Plant	Submit 60 days prior to anticipated start date	Permit application and fee
Dye Testing Investigation Work Start Notification		Main Plant	24 hours prior to the start of dye testing	Tyco shall notify the City of Marinette (Brian Miller, DPW) and WDNR staff (Kristin DuFresne and Cheryl Bougie) to allow for staff notifications in the event dye is released to the Menominee River and inquiries are made from the public
Dye Testing Investigation	3	Main Plant	2016 (preferably July or August) with river sampling continuing into summer and fall 2016	Brief report 60 days after completion of testing
Pump Down Program Drawdown Phase SOW and RFP Provided to Agency and Contractors/Vendors	4	Salt Vault 8th Street Slip	Winter 2015/2016	SOW and RFP with contractor/vendor list to Agency. Report to Agency selected contractor prior to initiating work.
Pump Down Program Drawdown Phase	4	Salt Vault 8th Street Slip	Anticipated to start in spring 2016; Target elevation should be achieved by December 31, 2017; Groundwater elevation monitoring conducted weekly	Water elevation data in Quarterly Reports; Data will also be summarized in Annual Monitoring Report submitted each winter; Email notification when target elevation achieved
Pump Down Program Interim Phase Monitoring	4	Salt Vault 8th Street Slip	Starts if greater than 4 weeks of inactivity; Groundwater elevation monitoring conducted monthly	Water elevation data in Quarterly Reports; Data will also be summarized in Annual Monitoring Report submitted each winter; Email notification when target elevation achieved
Pump Down Program Post-Drawdown Phase	4	Salt Vault 8th Street Slip	Following attainment of target elevation; Groundwater elevation monitoring conducted quarterly	Water elevation data in Quarterly Reports; Data will also be summarized in Annual Monitoring Report submitted each winter; Immediate notification to EPA if target elevation exceeded;
Sediment Monitoring	5	Main River Channel Turning Basin	Summer 2018 and 2023; Modifications to sediment sampling may be proposed in 2023 5 year technical review	2018 and 2023 5 year technical review reports

Notes:* This work will start at the time indicated assuming the Revised BWGMP Update is approved in time to allow for all new installations and repairs in 2015

TABLE 2-1 (Revised)
Proposed Wells and Data Collection for Barrier Wall Monitoring
Tyco Fire Products LP
Marinette, Wisconsin

Well ID	Screened Unit	Proposed Data Collection and Frequecy: Hydraulic Monitoring to Assess Fluctuations Relative to River, Bedrock and other Areas beyond Containment	BEDROCK Total Arsenic Concentration Trend Monitoring: Leading Edge below Containment	BEDROCK Total Arsenic Concentration Trend Monitoring: Interior or Upgradient	UNCONSOLIDATED Total Arsenic Concentration Trend Monitoring	Additional Parameter Monitoring (added to program at request of USEPA)	Manual Head Measurements for Gradient and Flow Assessment	Added to Program at Request of USEPA	New Well Install	Detailed Location Description
MW003S	Shallow Alluvial				semi-annual		semi-annual			Outside northwest property boundary, outside of MainPlant Area barrier wall
MW013S	Shallow Alluvial						semi-annual			Southwestern portion of the property, outside barrier wall, background/upgradient
MW021S	Shallow Alluvial				semi-annual		semi-annual		X**	Outside southern portion of property boundary,outside of Wetlands Area barrier wall
MW022S	Shallow Alluvial						semi-annual			Southeastern portion of Wetlands Area, upgradient of contained area
MW040S	Shallow Alluvial	continuous			semi-annual		semi-annual			Southwestern side of Main Plant Area, outside ofcontained area
MW041S	Shallow Alluvial				semi-annual	VOCs every 5 yrs*	semi-annual			North-central portion of site, within contained area
MW045S	Shallow Alluvial					VOCs every 5 yrs*	semi-annual			North-central portion of site, within contained area
MW047S	Shallow Alluvial	continuous			semi-annual		semi-annual			Northern portion of Wetlands Area, within contained area
MW064S	Shallow Alluvial	continuous			semi-annual		semi-annual			Southern portion of Main Plant Area, within containedarea
MW100S	Shallow Alluvial	continuous			semi-annual		semi-annual			Eastern portion of property in Wetlands area, east ofcontained area
MW101S	Shallow Alluvial				semi-annual		semi-annual			Within southern portion of Wetlands area, within contained area
MW102S	Shallow Alluvial	continuous			semi-annual		semi-annual			Outside southern boundary of barrier wall, upgradientof contained zone
MW103S	Shallow Alluvial				semi-annual		semi-annual			South-southwest portion of Main Plant Area, within contained area
MW104S	Shallow Alluvial				semi-annual		semi-annual			South-southwestern portion of the Main Plant Area, outside contained area
MW105S	Shallow Alluvial	continuous			semi-annual		semi-annual			Southwestern portion of the Main Plant Area, within contained area
MW106S	Shallow Alluvial				semi-annual		semi-annual			Northwestern portion of the Main Plant Area, within contained area
MW108S	Shallow Alluvial	continuous			semi-annual	VOCs every 5 yrs*	semi-annual			Northern portion of the Main Plant Area, within contained area
MW109S	Shallow Alluvial	continuous			semi-annual		semi-annual			Northwest portion of the Wetlands Area, within contained area
MW115P (in lieu of MW119S)	Shallow Alluvial				annual*		semi-annual	X		Salt Vault between EW-13 and EW-14 along the river
MW117S	Shallow Alluvial	continuous			semi-annual	VOCs every 5 yrs*	semi-annual		X	Northern portion of the Main Plant Area, within contained area near river
MW118S	Shallow Alluvial	continuous			semi-annual		semi-annual		X	Northern portion of the Main Plant Area, within contained area near river
MW120S	Shallow Alluvial	continuous			annual*		semi-annual	X	X	8th Street Slip just inside the tie-backs for the sheet pile wall
MW003M	Till				semi-annual		semi-annual			Outside northwest property boundary, outside of MainPlant Area barrier wall
MW013M	Till						semi-annual			Southwestern portion of the property, outside barrier wall, background/upgradient
MW021M	Lacustrine				semi-annual		semi-annual	X		Outside southern portion of property boundary, outside of Wetlands Area barrier wal
MW022M	Lacustrine						semi-annual			Southeastern portion of Wetlands Area, upgradient of contained area
MW040M-R	Till				semi-annual		semi-annual			Southwestern side of Main Plant Area, outside ofcontained area
MW041M	Till				semi-annual	VOCs every 5 yrs*	semi-annual			North-central portion of Main Plant Area, withincontained area
MW045M	Till					VOCs every 5 yrs*	semi-annual			North-central portion of site, within contained area
MW047M	Till				semi-annual		semi-annual			Northern portion of Wetlands Area, within contained
MW064M	Lacustrine				semi-annual		semi-annual			Southern portion of Main Plant Area, within contained area
MW100M	Lacustrine				semi-annual		semi-annual			Eastern portion of property in Wetlands Area, east of contained area
MW101M	Lacustrine				semi-annual		semi-annual			Within southern portion of Wetlands area, within contained area
MW102M	Lacustrine				semi-annual		semi-annual			Outside southern boundary of Main Plant barrier wall, upgradient of contained zone
MW103M	Lacustrine				semi-annual		semi-annual			South-southwest portion of Main Plant Area, within contained area
MW104M	Lacustrine				semi-annual		semi-annual			South-southwestern portion of the Main Plant Area, outside contained area
MW105M	Till				semi-annual		semi-annual			Southwestern portion of the Main Plant Area, within contained area
MW106M	Till				semi-annual		semi-annual			Northwestern portion of the Main Plant Area, within contained area
MW107M	Lacustrine				semi-annual		semi-annual	x	x	Northern portion of the Main Plant Area, within contained area
MW108M	Till				semi-annual	VOCs every 5 yrs*	semi-annual			Northern portion of the Main Plant Area, within contained area
MW109M	Lacustrine				semi-annual		semi-annual			Northwest portion of the Wetlands Area, within contained area
MW115S (in lieu of MW119M)	Lacustrine	continuous			annual*		semi-annual	X		Salt Vault between EW-13 and EW-14 along the river
MW117M	Alluvial/Till				semi-annual	VOCs every 5 yrs*	semi-annual	X	X	Northern portion of the Main Plant Area, within contained area near river
MW118M	Alluvial/Till				semi-annual		semi-annual	X	X	Northern portion of the Main Plant Area, within contained area near river
MW120M	Alluvial/Till				annual*		semi-annual	X	X	8th Street Slip just inside the tie-backs for the sheet pile wall
MW003D	Bedrock			semi-annual			semi-annual			Outside northwest property boundary, outside of MainPlant Area barrier wall
MW013D	Bedrock						semi-annual			Southwestern portion of the property, outside barrier wall, background/upgradient
MW040D	Bedrock			semi-annual			semi-annual			Southwestern side of Main Plant Area, outside ofcontained area
MW047D	Bedrock	continuous	semi-annual				semi-annual			Northern portion of Wetlands Area, within containedarea
MW064D	Bedrock	continuous		semi-annual			semi-annual			Southern portion of Main Plant Area, within containedarea
MW100D	Bedrock			semi-annual			semi-annual			Eastern portion of property in Wetlands area, east ofcontained area
MW102D	Bedrock			semi-annual			semi-annual			Outside southern boundary of Main Plant barrier wall,outside of contained area
MW105D	Bedrock	continuous		semi-annual			semi-annual			Southwestern portion of the Main Plant Area, within contained area
MW106D	Bedrock			semi-annual			semi-annual			Northwestern portion of the Main Plant Area, within contained area
MW107D	Bedrock		semi-annual				semi-annual			Northern portion of the Main Plant Area, within contained area
MW108D	Bedrock	continuous	semi-annual				semi-annual			Northern portion of the Main Plant Area, within contained area
MW109D	Bedrock	continuous	semi-annual				semi-annual			Northwest portion of the Wetlands Area, within contained area
MW117D	Bedrock	continuous	semi-annual				semi-annual	X	X	Northern portion of the Main Plant Area, within contained area near river
MW118D	Bedrock	continuous	semi-annual				semi-annual	X	X	Northern portion of the Main Plant Area, within contained area near river
MW119D	Bedrock	continuous	annual*				semi-annual	X	X	Salt Vault between EW-13 and EW-14 along the river
MW120D	Bedrock	continuous	annual*				semi-annual	X	X	8th Street Slip just inside the tie-backs for the sheet pile wall
SG4	River	continuous					semi-annual			Turning Basin (to be installed)

Notes:
*Baseline event will occur in fall 2015, with additional sampling in 2016, 2017, 2018, and 2023
**MW021S is damaged and will be replaced with a new monitoring well
Continuous hydraulic monitoring is obtained with a pressure transducer that will record water levels every 30 minutes and be downloaded quarterly; manual water levels will be measured at the time of each download
Semi-annual monitoring starts in fall 2015 through fall 2016. Annual sampling would start in 2017 unless increasing trends in arsenic concentrations are observed, in which case semiannual groundwater sampling will continue for at least 1 additional year
VOCs - Volatile organic compounds
USEPA - U.S. Environmental Protection Agency

TABLE 4-1 (Revised)
Proposed Wells for Groundwater Elevation Monitoring at the Former Salt Vault and 8th Street Slip
Tyco Fire Products LP
Marinette, Wisconsin

Well ID	Screened Interval	Site Location	Use to Calculate Target Elevation*	Drawdown Phase	Interim Phase	Post-Drawdown Phase	Rationale/Notes
MW001S	Shallow alluvial	Salt Vault	x	x	x	x	
MW001M	Lacustrine	Salt Vault	x	x	x	x	
MW002S	Shallow alluvial	Salt Vault	x	x	x	x	Transducer
MW002M	Lacustrine	Salt Vault	x	x	x	x	
MW031S	Shallow alluvial	Salt Vault	x	x	x	x	
MW031M	Lacustrine	Salt Vault	x	x	x	x	
MW113S	Shallow alluvial	Salt Vault	x	x	x	x	
MW113M	Lacustrine	Salt Vault	x	x	x	x	
MW115S	Shallow alluvial	Salt Vault	x	x	x	x	Transducer
MW116S	Shallow alluvial	Salt Vault	x	x	x	x	Well condition being assessed; may use MW116P instead
MW115P	Peat	Salt Vault		x	x	x	Record response of perched water above peat layer
MW116P	Peat	Salt Vault		x	x	x	Record response of perched water above peat layer
MW032S	Shallow alluvial	Main Plant		x	x		Comparison to MW031S elevation
MW033S	Shallow alluvial	Main Plant		x	x		Comparison to MW001S elevation
MW034S	Shallow alluvial	8th Street Slip	x	x	x	x	
MW034M	Lacustrine	8th Street Slip	x	x	x	x	
MW036S	Shallow alluvial	8th Street Slip	x	x	x	x	
MW036M	Lacustrine	8th Street Slip	x	x	x	x	
MW038S	Shallow alluvial	8th Street Slip	x	x	x	x	
MW038M	Lacustrine	8th Street Slip	x	x	x	x	
MW120S	Shallow alluvial	8th Street Slip	x	x	x	x	Transducer; Newly installed well
MW120M	Lacustrine/Till	8th Street Slip	x	x	x	x	Newly installed well
MW004S	Shallow alluvial	Main Plant		x	x		Comparison to MW038S
MW035S	Shallow alluvial	Wetlands		x	x		Comparison to MW034S
MW037S	Shallow alluvial	Wetlands		x	x		Comparison to MW036S
MW039S	Shallow alluvial	Main Plant		x	x		Comparison to MW038S
MW119D	Bedrock	Salt Vault		x	x		Determine any effect on bedrock from drawdown pumping
MW120D	Bedrock	Wetlands		x	x		Determine any effect on bedrock from drawdown pumping
Staff Gauge	River	River		x	x	x	Transducer measurements of river elevation for comparison to Salt Vault and 8th Street Slip groundwater elevations

Notes:
ID - Identification
*Wells identified for target elevation calculation are for during the drawdown and interim phases. Only wells outside the steepest portion of the cone of depression will be included in the calculation of the average elevations. The average elevation of all suitable measured wells will be considered the calculated elevation to compare against the target elevation. The number of post-drawdown phase wells used for this calculation may be reduced and will be determined based on results observed during the drawdown phase.

TABLE 5-1 (Revised)
Proposed Sediment Sampling Locations and Coordinates
Tyco Fire Products LP
Marinette, Wisconsin

Sample ID	Location	x coordinate	y coordinate
SD-1	Main Channel	2584415	470616
SD-2	Main Channel	2584659	470540
SD-3	Main Channel	2584898	470456
SD-4	Main Channel	2585634	470296
SD-5	Turning Basin	2584997	470239
SD-6	Turning Basin	2585110	470215
SD-7	Turning Basin	2585247	470296
SD-8	Turning Basin	2584964	470066
SD-9	Turning Basin	2585122	470050
SD-10	Turning Basin	2585225	470123
SD-11	Turning Basin	2585493	470166
SD-12	Turning Basin	2585012	469945
SD-13	Turning Basin	2585334	470022
SD-14	Turning Basin	2585441	469948
SD-15	Turning Basin	2585215	469902
SD-16	Turning Basin	2585624	469851
SD-17	Turning Basin	2585862	469605
SD-18	Turning Basin	2585706	469824

Notes:
Coordinates are approximate and actual sample locations will be surveyed in the field
Coordinates are in NAD 83 State Plane Wisconsin Central - Survey Feet

Figures

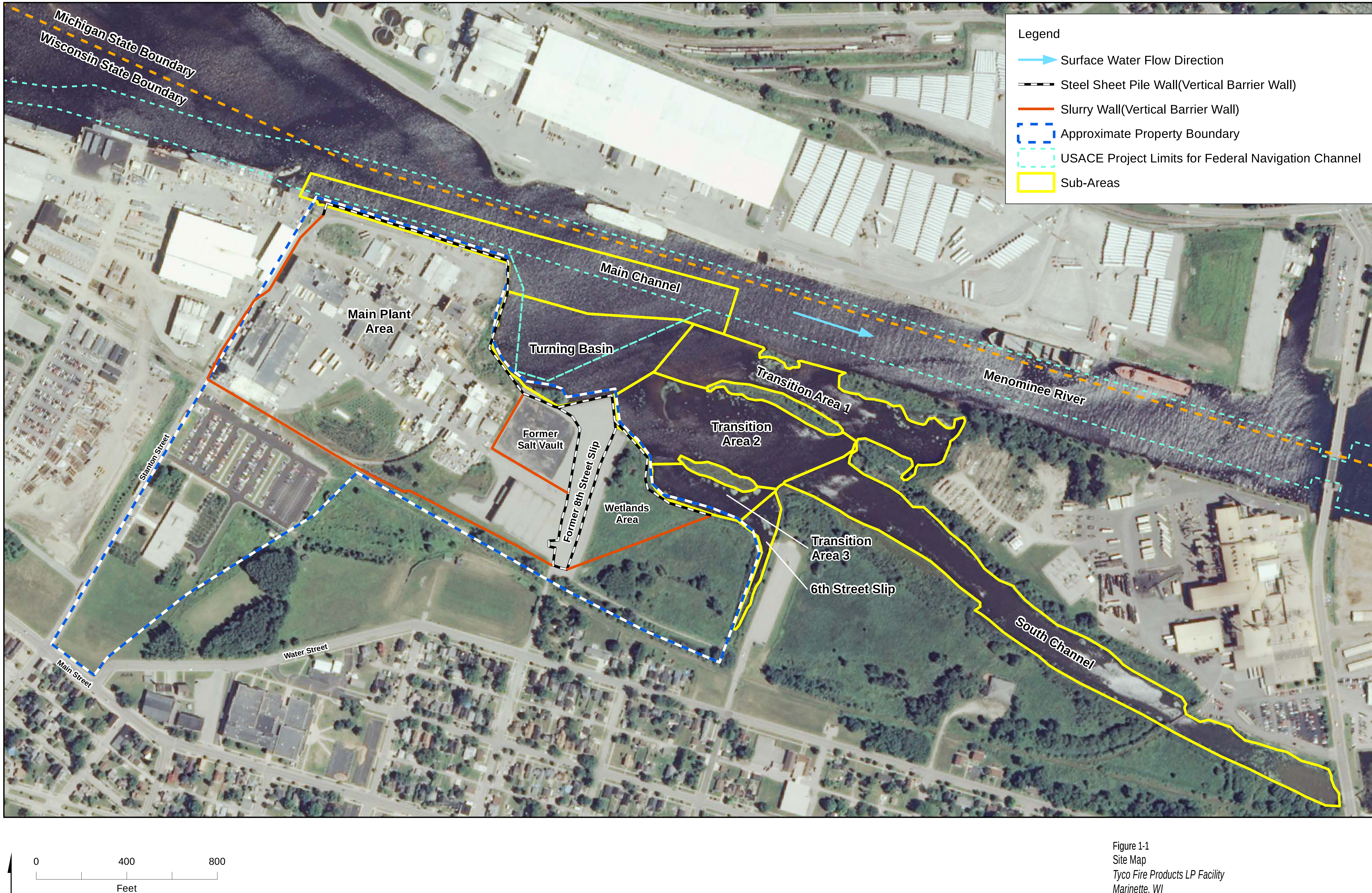
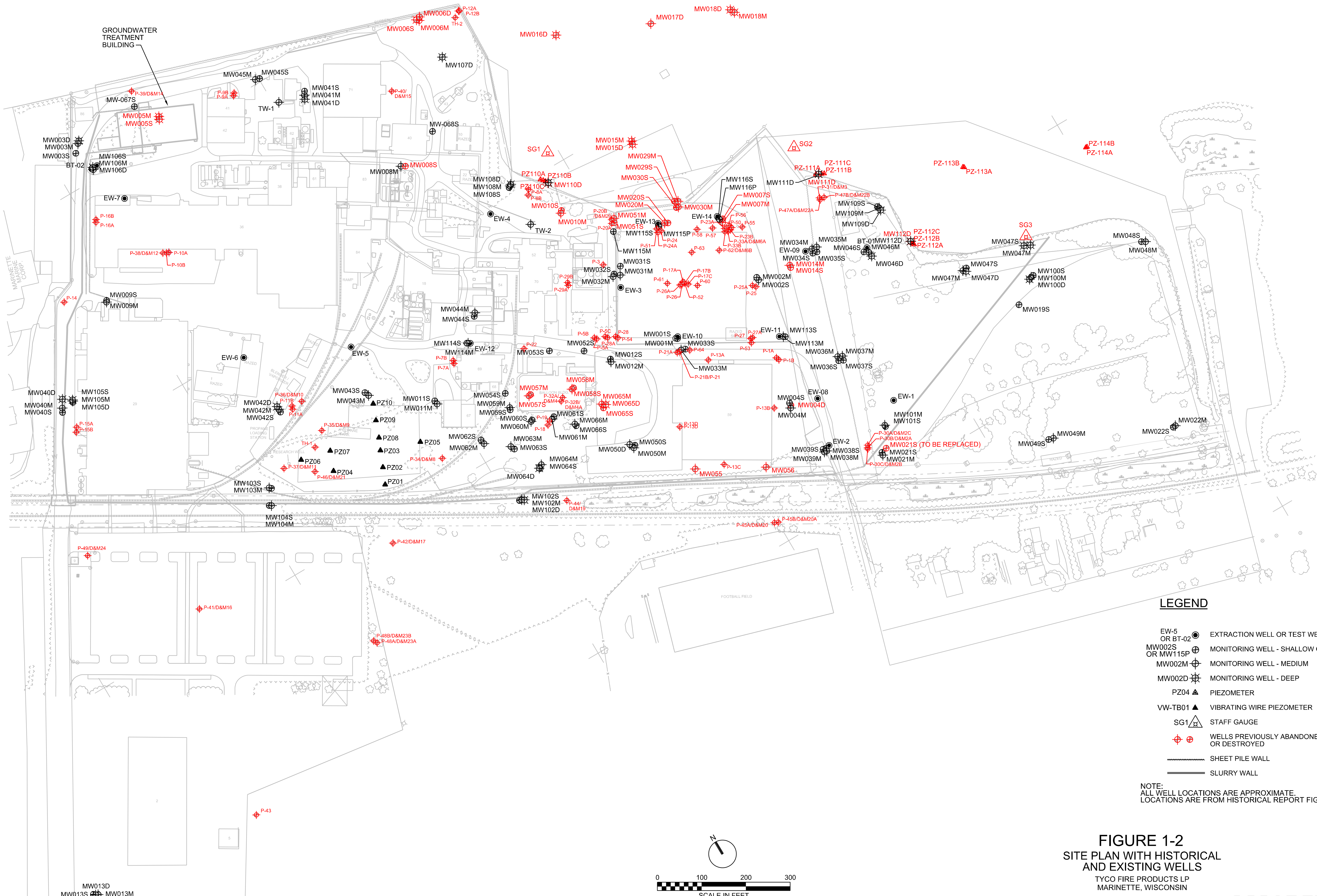


Figure 1-1
Site Map
Tyco Fire Products LP Facility
Marinette, WI

CH2MHILL



LEGEND

EW-5 OR BT-02	EXTRACTION WELL OR TEST WELL
MW002S OR MW115P	MONITORING WELL - SHALLOW OR PEAT
MW002M	MONITORING WELL - MEDIUM
MW002D	MONITORING WELL - DEEP
PZ04	PIEZOMETER
VW-TB01	VIBRATING WIRE PIEZOMETER
SG1	STAFF GAUGE
	WELLS PREVIOUSLY ABANDONED OR DESTROYED
	SHEET PILE WALL
	SLURRY WALL

NOTE:
ALL WELL LOCATIONS ARE APPROXIMATE.
LOCATIONS ARE FROM HISTORICAL REPORT FIGURES.

FIGURE 1-2
SITE PLAN WITH HISTORICAL AND EXISTING WELLS

TYCO FIRE PRODUCTS LP
MARINETTE, WISCONSIN

388522

CH2MHILL

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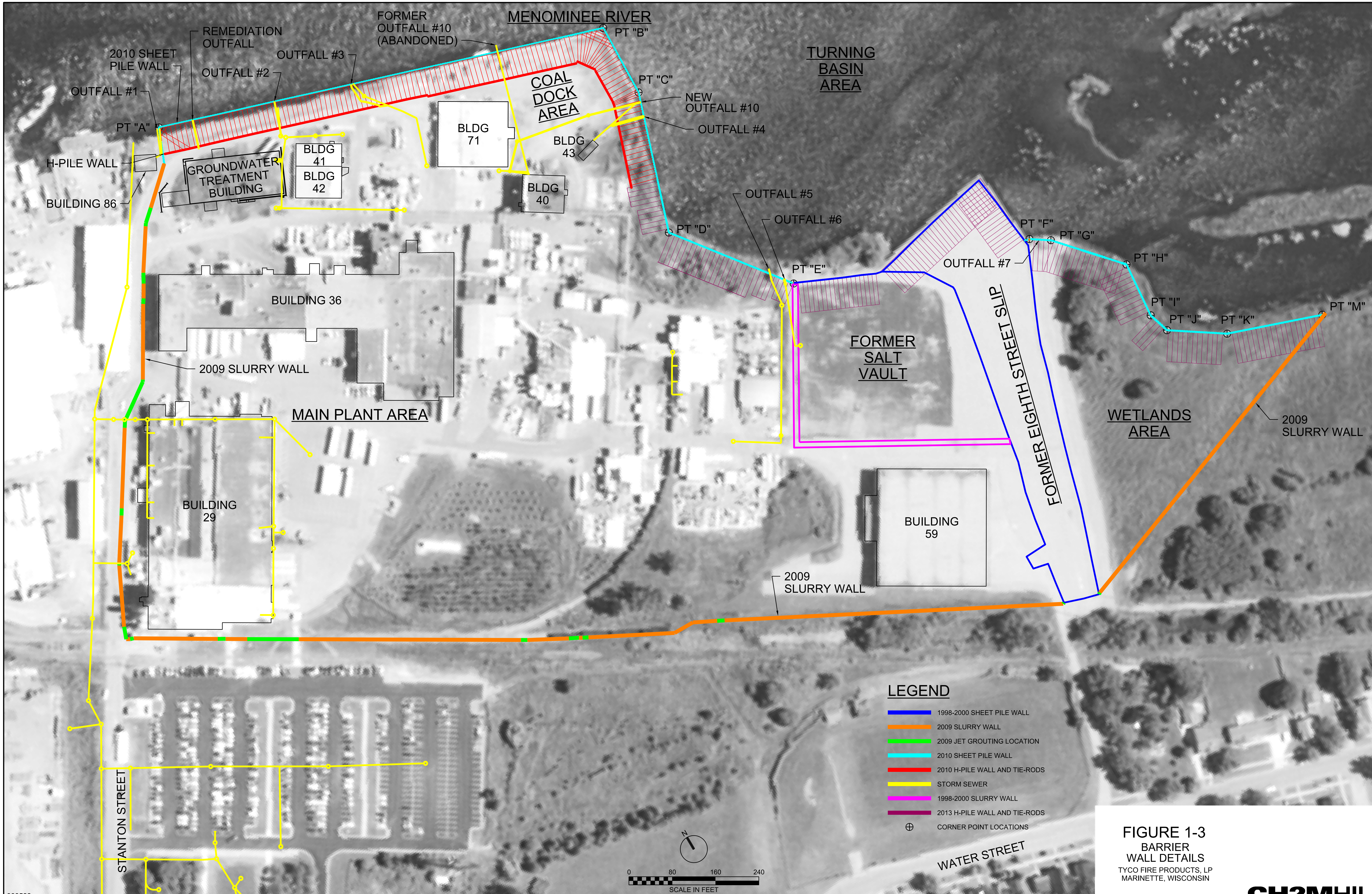

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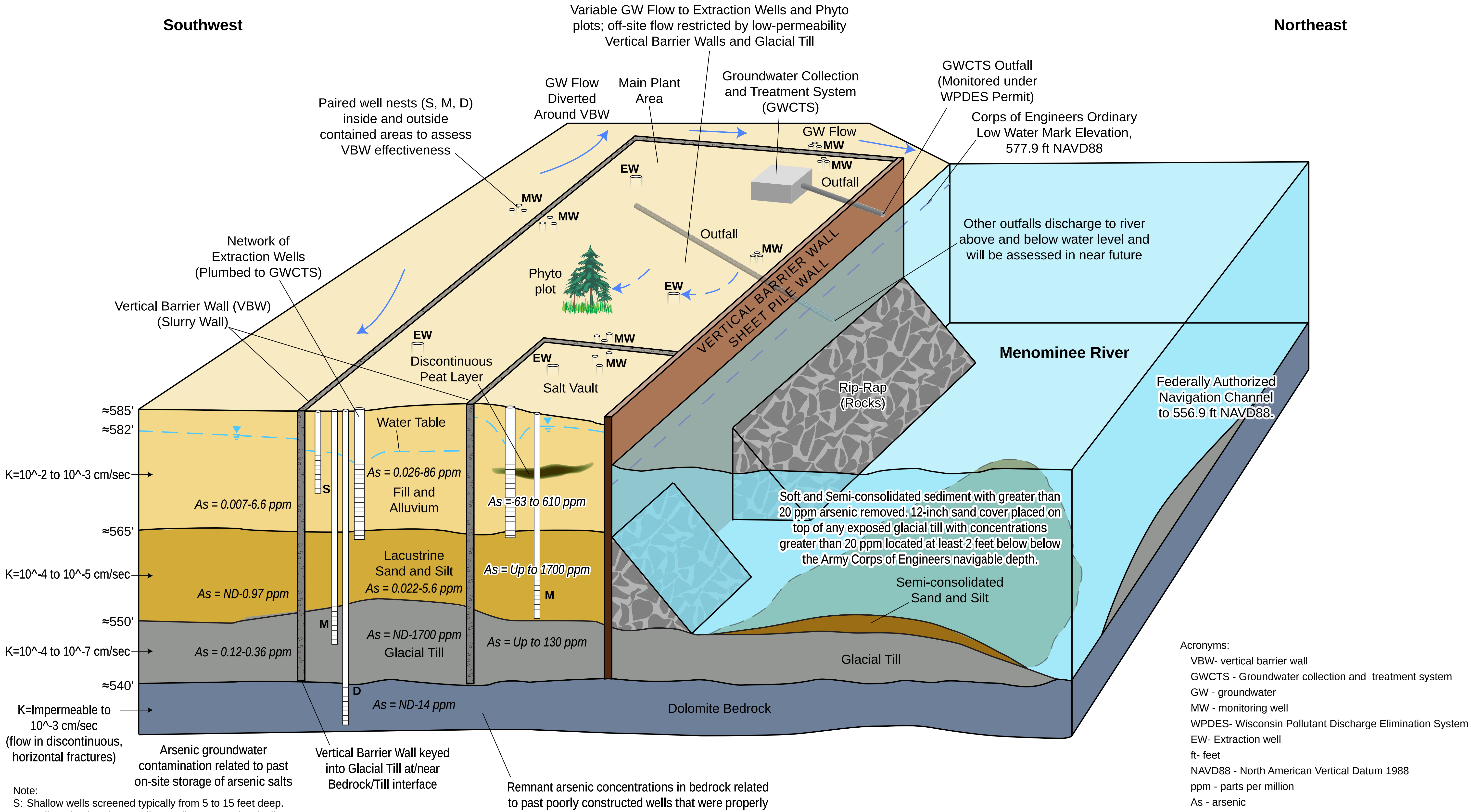


Note:
S: Shallow wells screened typically from 5 to 15 feet deep.
M: Medium depth or intermediate wells, screened typically from 25 to 30 feet deep.
D: Deep wells installed and sealed within the uppermost portion of bedrock using a 5-foot long screen.

Arsenic results are from 2013-2014 and represent highest and lowest arsenic concentrations detected in each area.

Bedrock concentrations are the range for the entire site since bedrock is located below the barrier wall system.

Recent arsenic concentrations in Wetlands and 8th St Slip areas		
Unit	Wetlands	8th St Slip
Alluvium	0.014 to 1.5 ppm	65 to 120 ppm
Lacustrine sand and silt	ND to 1800 ppm	No data
Till	Up to 2.6 ppm	No data

NOT TO SCALE

Acronyms:
VBW- vertical barrier wall
GWCTS - Groundwater collection and treatment system
GW - groundwater
MW - monitoring well
WPDES- Wisconsin Pollutant Discharge Elimination System
EW- Extraction well
ft- feet
NAVD88 - North American Vertical Datum 1988
ppm - parts per million
As - arsenic
cm/sec - centimeters per second

FIGURE 1-4
Conceptual Site Model Post-barrier Wall
Tyco Fire Products LP
Marinette, Wisconsin

CH2MHILL.

ES080910074051MKE TycoFireProducts_Fig2_ConceptualSiteModel_v10.ai 06.19.15 tdaus

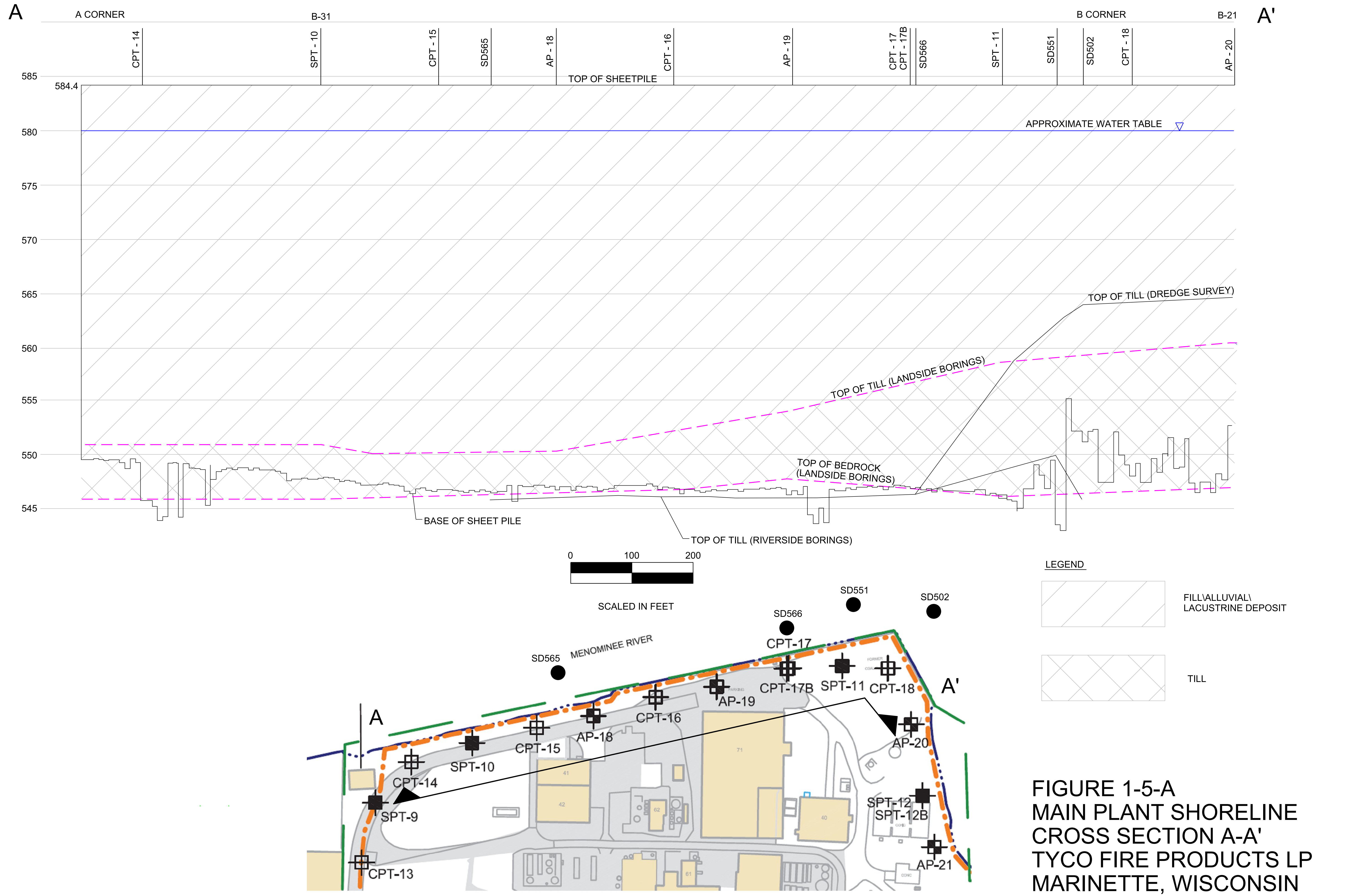


FIGURE 1-5-A
MAIN PLANT SHORELINE
CROSS SECTION A-A'
TYCO FIRE PRODUCTS LP
MARINETTE, WISCONSIN

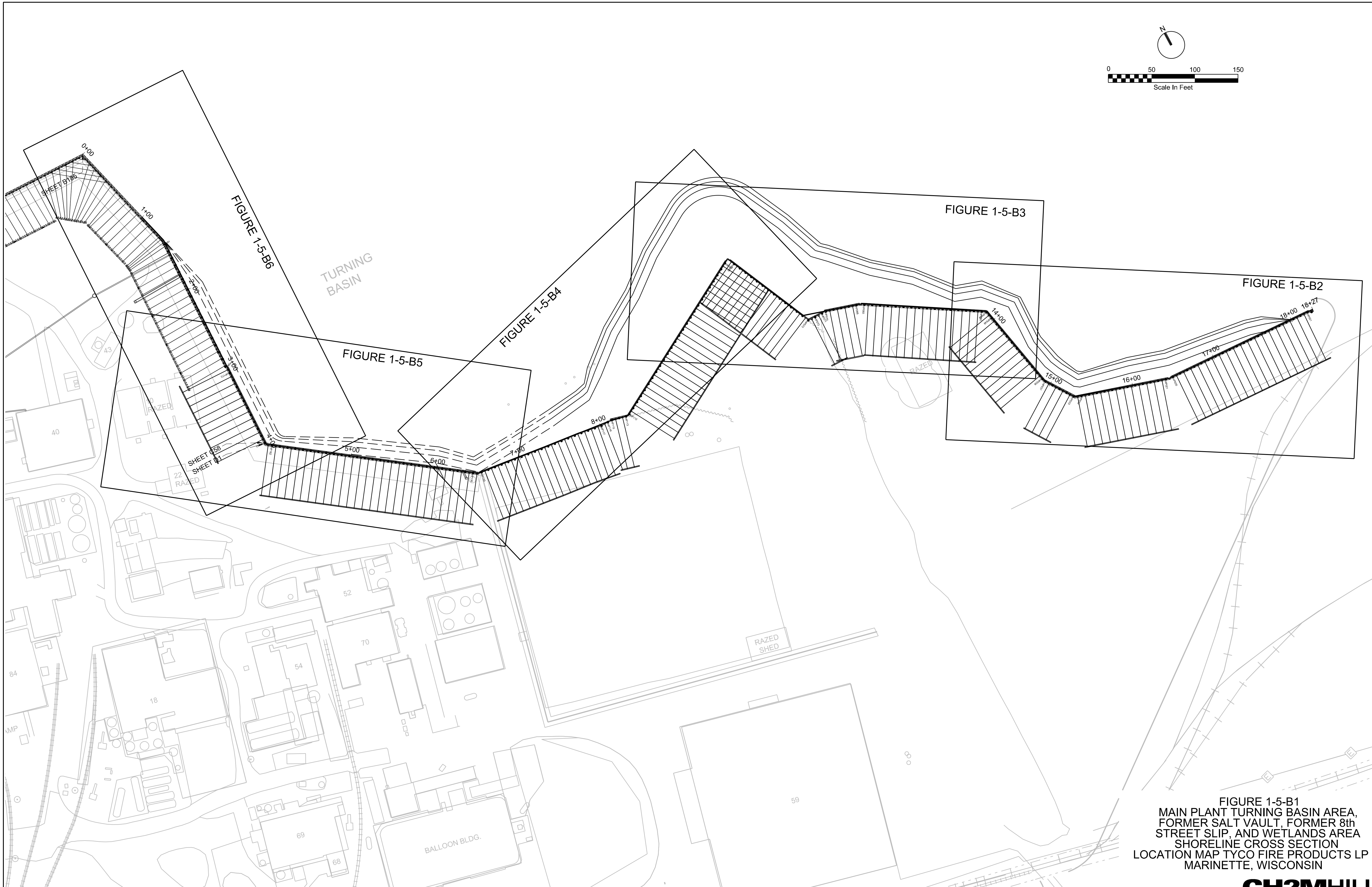
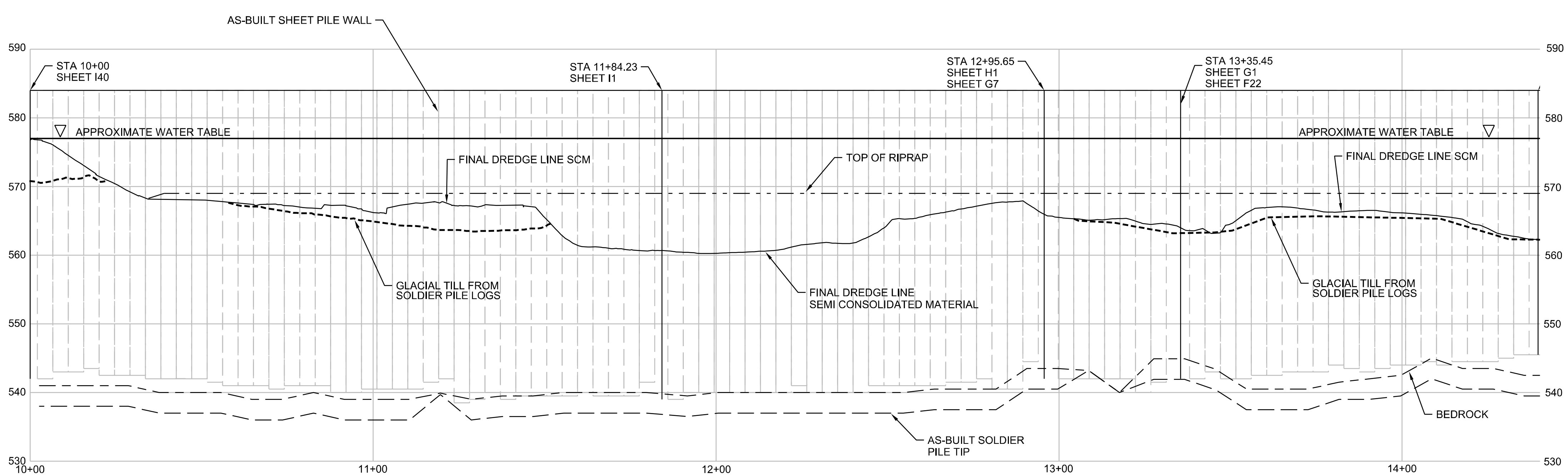


FIGURE 1-5-B1
MAIN PLANT TURNING BASIN AREA,
FORMER SALT VAULT, FORMER 8th
STREET SLIP, AND WETLANDS AREA
SHORELINE CROSS SECTION
LOCATION MAP TYCO FIRE PRODUCTS LP
MARINETTE, WISCONSIN

CH2MHILL.

PLAN



PROFILE

LEGEND

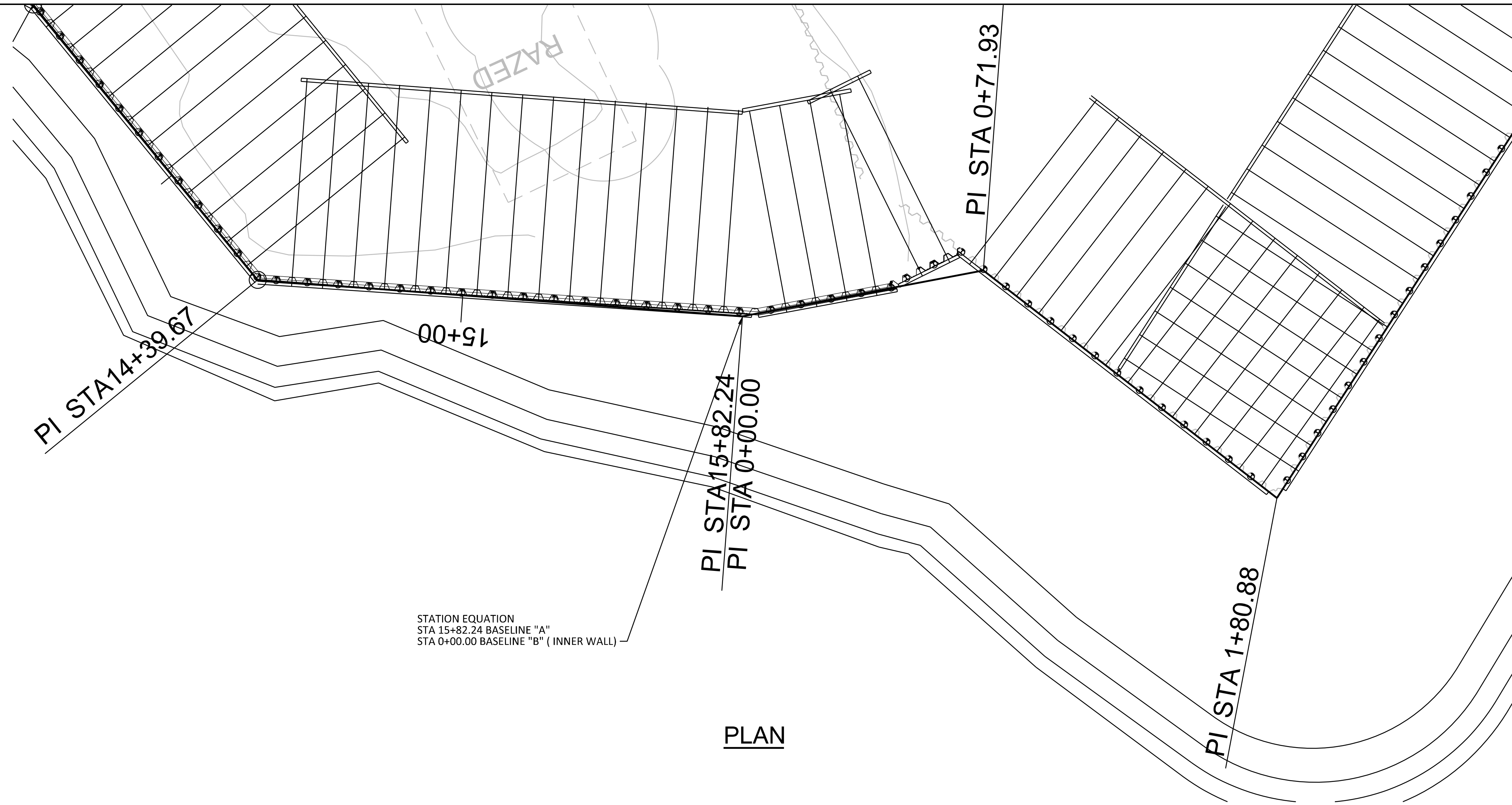
- TOP OF RIPRAP 2013/2015
- TOP OF GLACIAL TILL
- TOP OF BEDROCK
- AS-BUILT SOLDIER PILE TIP
- FINAL DREDGE LINE 2013/2014
- FINAL DREDGE LINE AND TOP OF GLACIAL TILL

NOTES:

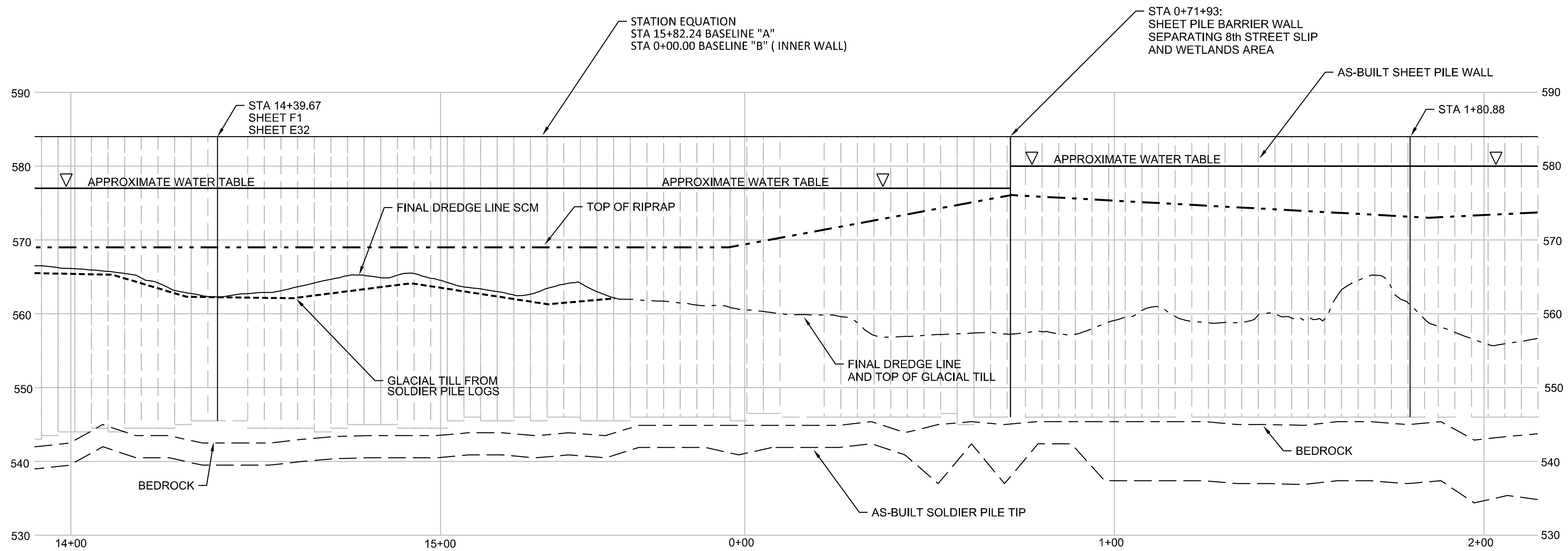
1. AS-BUILT SOLDIER PILE TIP, TOP OF BEDROCK AND SOME OF THE TOP OF GLACIAL TILL (AS INDICATED) HAS BEEN TAKEN FROM SEVENSON PILE DRILL LOG AS PART OF THE SHEET PILE STABILITY WORK CONDUCTED IN 2012 AND 2013.
2. DREDGE LINE BASED ON ACTUAL FINAL DREDGE DEPTH FROM 2013 OR 2014 AND NOTED GLACIAL TILL CONFIRMATION AREAS BASED ON CONFIRMATION OR VERIFICATION SAMPLING DURING DREDGING.
3. RIPRAP FROM ACTUAL 2013 OR 2015 AS-BUILT DRAWINGS.
4. AS-BUILT ELEVATIONS OF THE SHEET PILING SHOWN ON THE PROFILE ARE FROM THE 2010 CONSTRUCTION LOGS EXCEPT WITHIN THE 8TH STREET SLIP AREA THEY ARE FOR THE INNER SHEET PILE COFFERDAM CONSTRUCTED IN 1998 AND 1999.

FIGURE 1-5-B2
WETLANDS AREA CROSS SECTION
TYCO FIRE PRODUCTS LP
MARINETTE, WISCONSIN

CH2MHILL.



PLAN



PROFILE

LEGEND

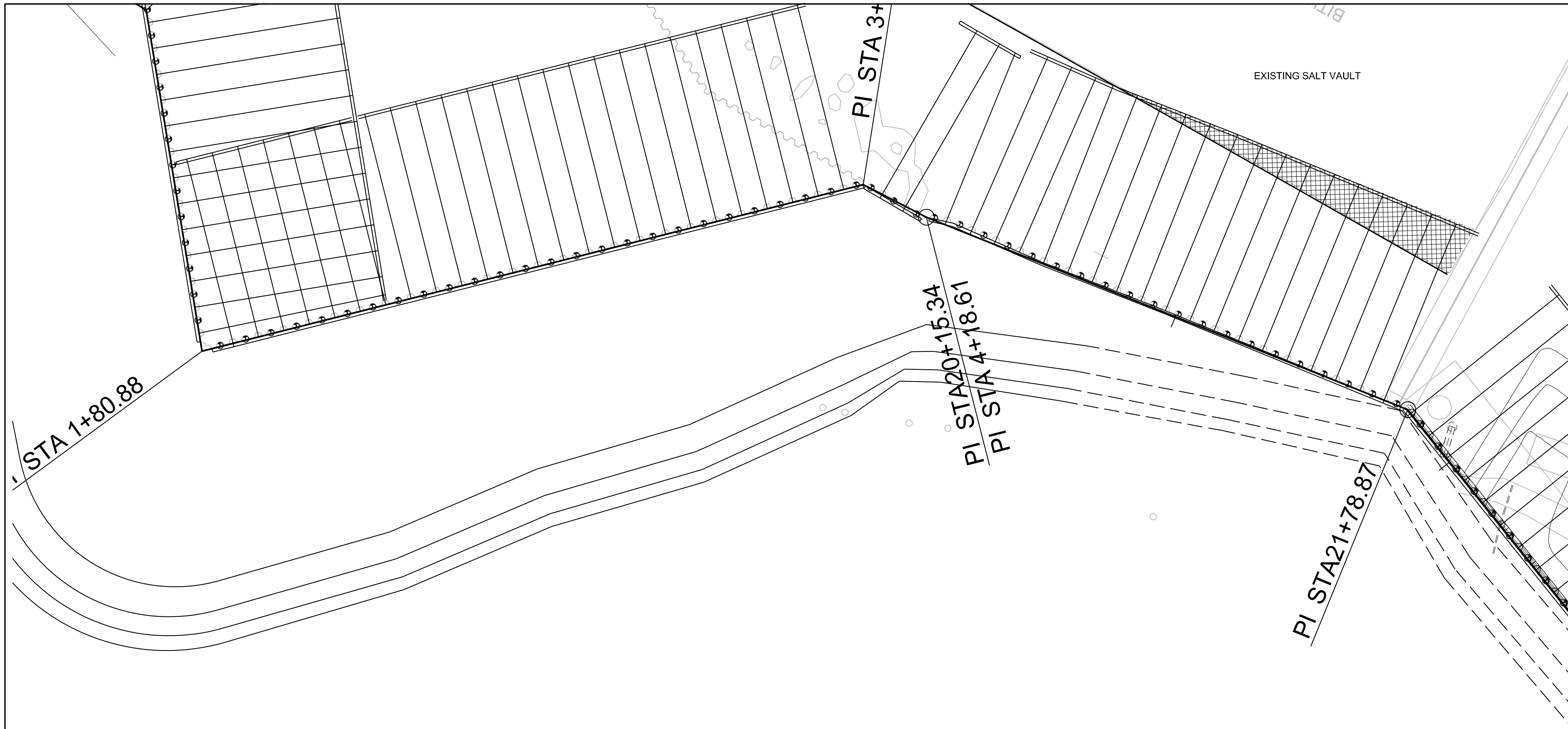
- TOP OF RIPRAP 2013/2015
- TOP OF GLACIAL TILL
- TOP OF BEDROCK
- AS-BUILT SOLDIER PILE TIP
- FINAL DREDGE LINE 2013/2014
- FINAL DREDGE LINE AND TOP OF GLACIAL TILL

NOTES:

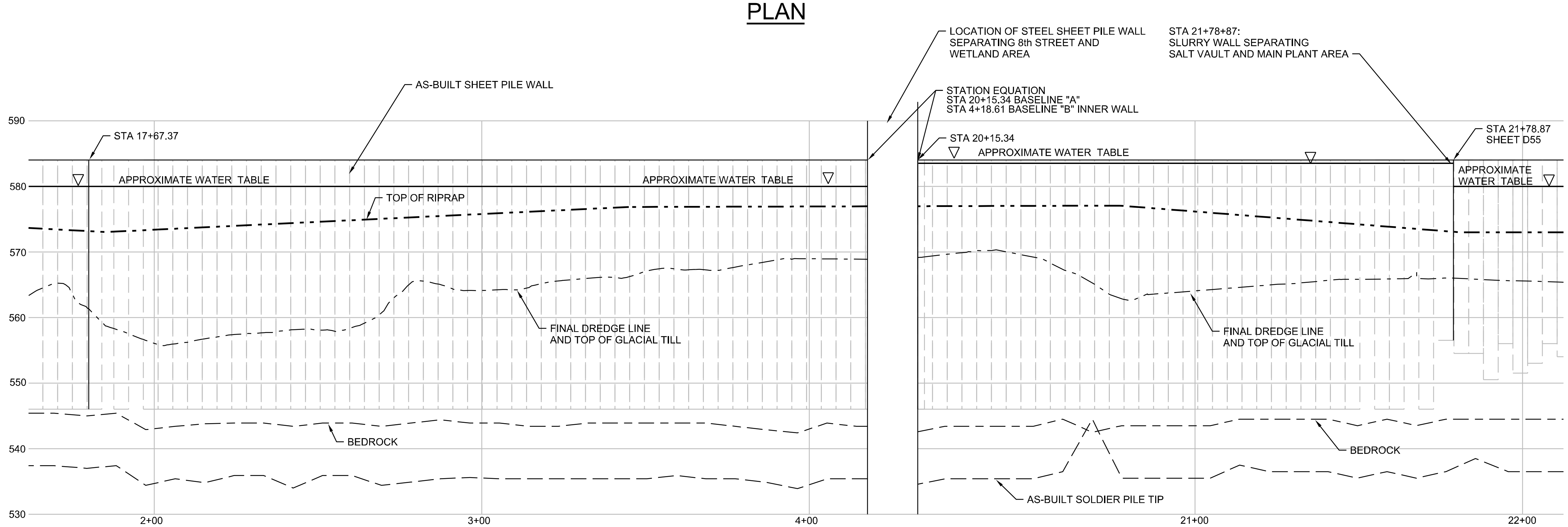
1. AS-BUILT SOLDIER PILE TIP, TOP OF BEDROCK AND SOME OF THE TOP OF GLACIAL TILL (AS INDICATED) HAS BEEN TAKEN FROM SEVENSON PILE DRILL LOG AS PART OF THE SHEET PILE STABILITY WORK CONDUCTED IN 2012 AND 2013.
2. DREDGE LINE BASED ON ACTUAL FINAL DREDGE DEPTH FROM 2013 OR 2014 AND NOTED GLACIAL TILL CONFIRMATION AREAS BASED ON CONFIRMATION OR VERIFICATION SAMPLING DURING DREDGING.
3. RIPRAP FROM ACTUAL 2013 OR 2015 AS-BUILT DRAWINGS.
4. AS-BUILT ELEVATIONS OF THE SHEET PILING SHOWN ON THE PROFILE ARE FROM THE 2010 CONSTRUCTION LOGS EXCEPT WITHIN THE 8TH STREET SLIP AREA THEY ARE FOR THE INNER SHEET PILE COFFERDAM CONSTRUCTED IN 1998 AND 1999.

FIGURE 1-5-B3
WETLANDS AREA AND FORMER
8th STREET SLIP CROSS SECTION
TYCO FIRE PRODUCTS LP
MARINETTE, WISCONSIN

CH2MHILL®



PLAN



PROFILE

LEGEND

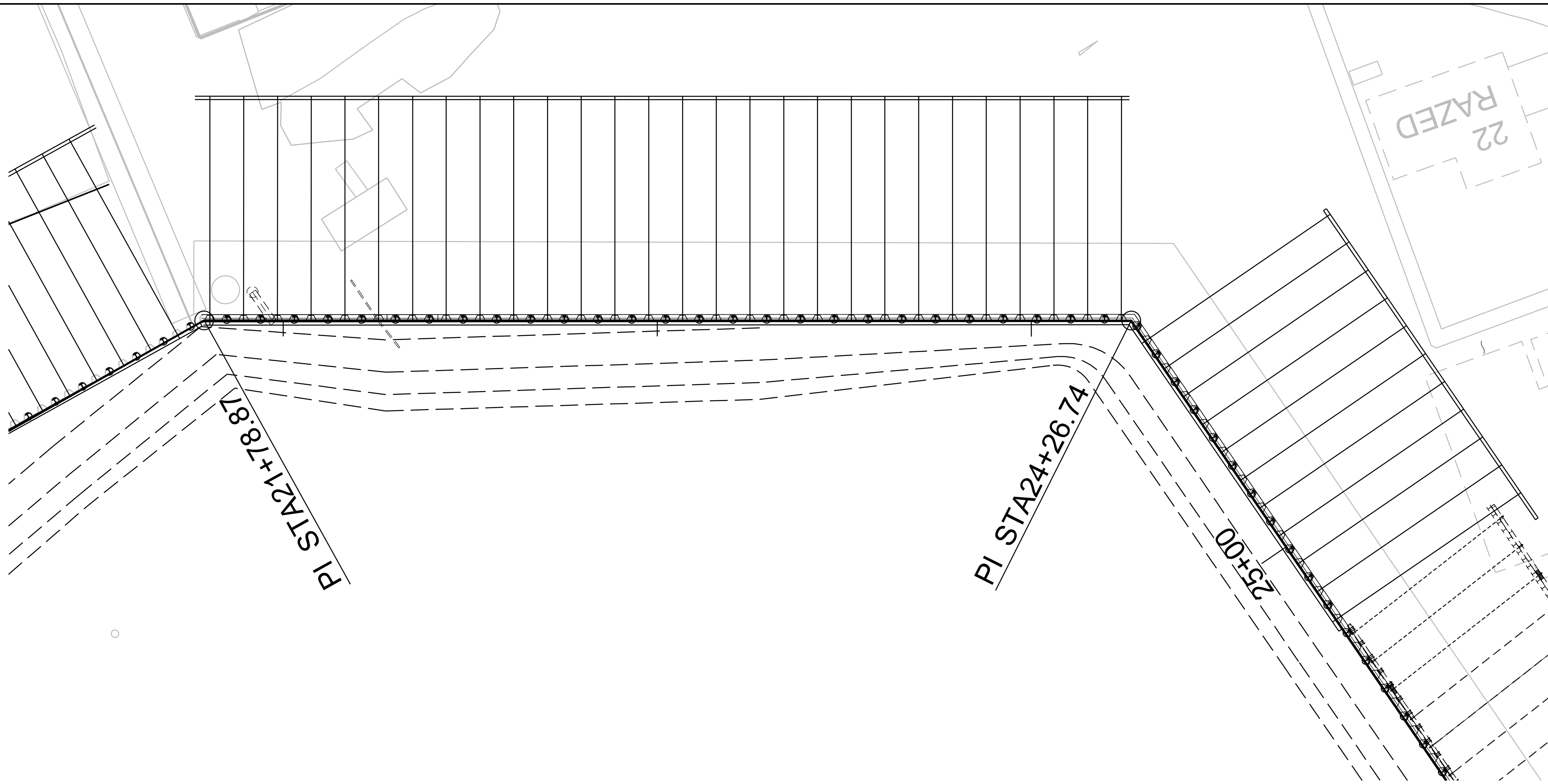
- TOP OF RIPRAP 2013/2015
- TOP OF GLACIAL TILL
- TOP OF BEDROCK
- AS-BUILT SOLDIER PILE TIP
- FINAL DREDGE LINE 2013/2014
- FINAL DREDGE LINE AND TOP OF GLACIAL TILL

NOTES:

1. AS-BUILT SOLDIER PILE TIP, TOP OF BEDROCK AND SOME OF THE TOP OF GLACIAL TILL (AS INDICATED) HAS BEEN TAKEN FROM SEVENSON PILE DRILL LOG AS PART OF THE SHEET PILE STABILITY WORK CONDUCTED IN 2012 AND 2013.
2. DREDGE LINE BASED ON ACTUAL FINAL DREDGE DEPTH FROM 2013 OR 2014 AND NOTED GLACIAL TILL CONFIRMATION AREAS BASED ON CONFIRMATION OR VERIFICATION SAMPLING DURING DREDGING.
3. RIPRAP FROM ACTUAL 2013 OR 2015 AS-BUILT DRAWINGS.
4. AS-BUILT ELEVATIONS OF THE SHEET PILING SHOWN ON THE PROFILE ARE FROM THE 2010 CONSTRUCTION LOGS EXCEPT WITHIN THE 8TH STREET SLIP AREA THEY ARE FOR THE INNER SHEET PILE COFFERDAM CONSTRUCTED IN 1998 AND 1999.

FIGURE 1-5-B4
FORMER 8th STREET SLIP
AND FORMER SALT VAULT
CROSS SECTION
TYCO FIRE PRODUCTS LP
MARINETTE, WISCONSIN

CH2MHILL®



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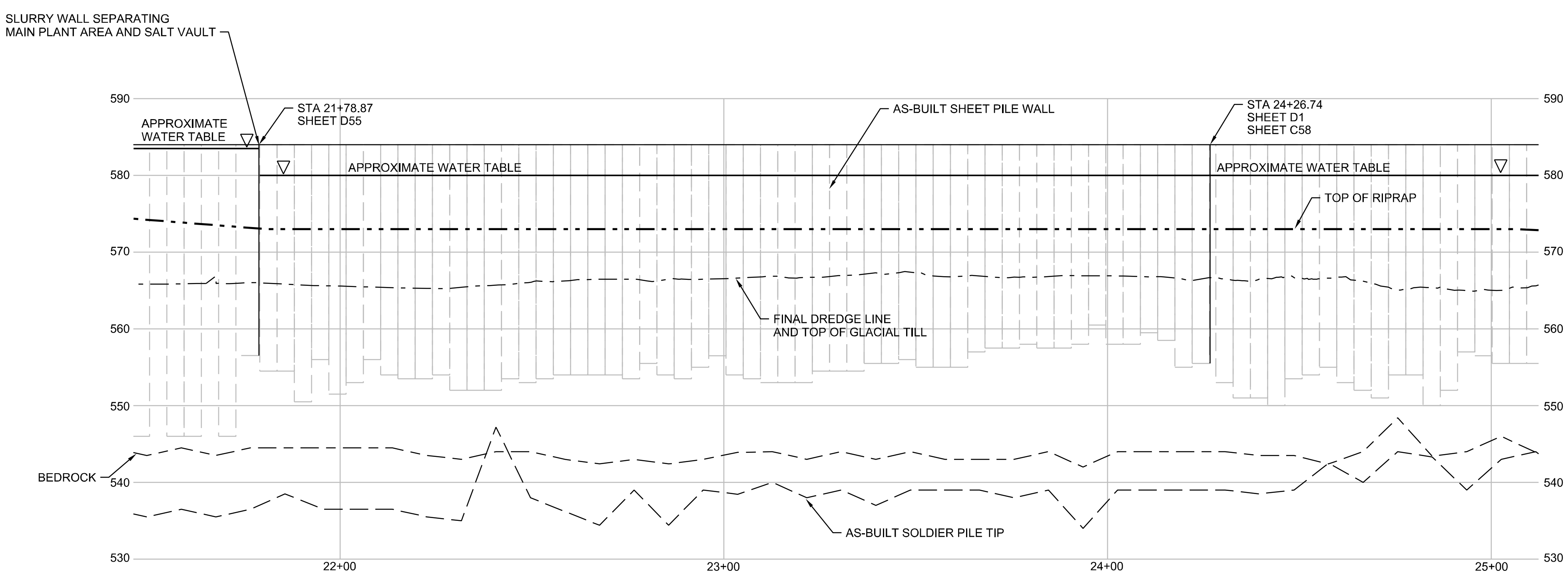


PROFILE

LEGEND

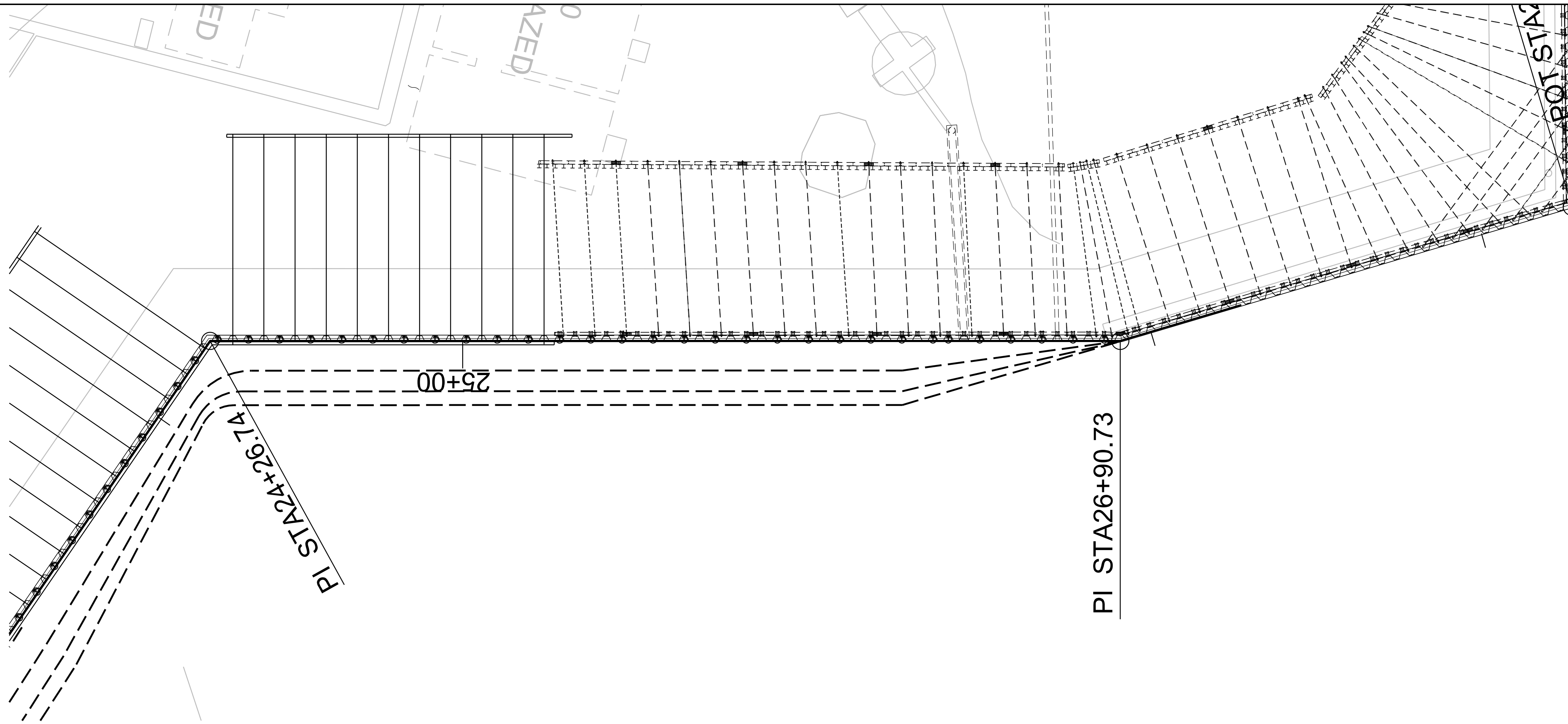
- TOP OF RIPRAP 2013/2015
- TOP OF GLACIAL TILL
- TOP OF BEDROCK
- AS-BUILT SOLDIER PILE TIP
- FINAL DREDGE LINE 2013/2014
- FINAL DREDGE LINE AND TOP OF GLACIAL TILL

NOTES:

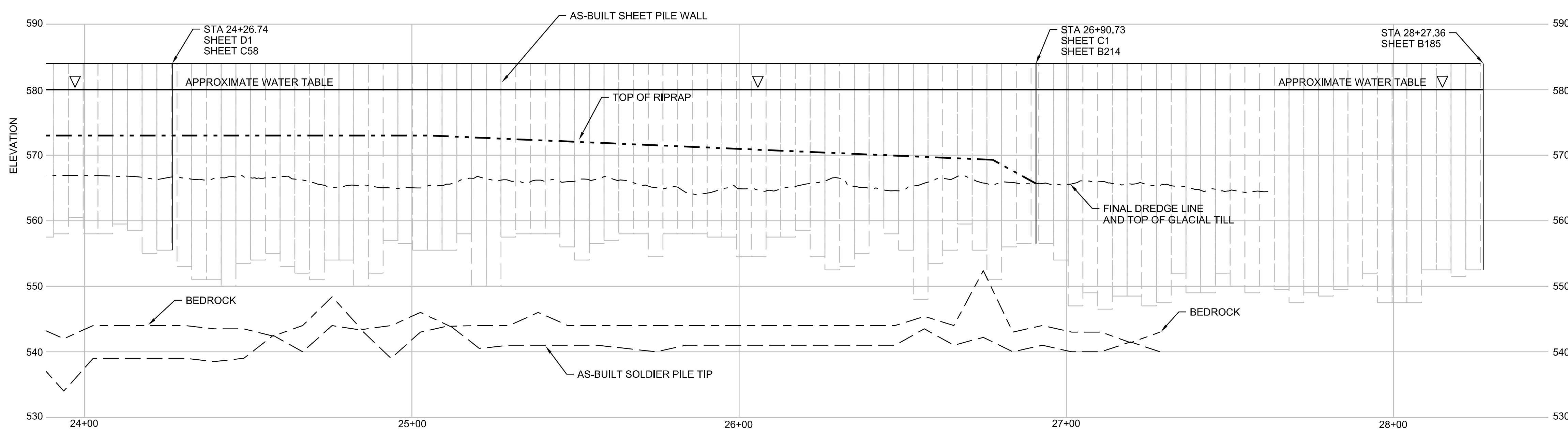
1. AS-BUILT SOLDIER PILE TIP, TOP OF BEDROCK AND SOME OF THE TOP OF GLACIAL TILL (AS INDICATED) HAS BEEN TAKEN FROM SEVENSON PILE DRILL LOG AS PART OF THE SHEET PILE STABILITY WORK CONDUCTED IN 2012 AND 2013.
2. DREDGE LINE BASED ON ACTUAL FINAL DREDGE DEPTH FROM 2013 OR 2014 AND NOTED GLACIAL TILL CONFIRMATION AREAS BASED ON CONFIRMATION OR VERIFICATION SAMPLING DURING DREDGING.
3. RIPRAP FROM ACTUAL 2013 OR 2015 AS-BUILT DRAWINGS.
4. AS-BUILT ELEVATIONS OF THE SHEET PILING SHOWN ON THE PROFILE ARE FROM THE 2010 CONSTRUCTION LOGS EXCEPT WITHIN THE 8TH STREET SLIP AREA THEY ARE FOR THE INNER SHEET PILE COFFERDAM CONSTRUCTED IN 1998 AND 1999.

FIGURE 1-5-B5
MAIN PLANT TURNING BASIN
AREA CROSS SECTION
TYCO FIRE PRODUCTS LP
MARINETTE, WISCONSIN

CH2MHILL®



PLAN



PROFILE

LEGEND

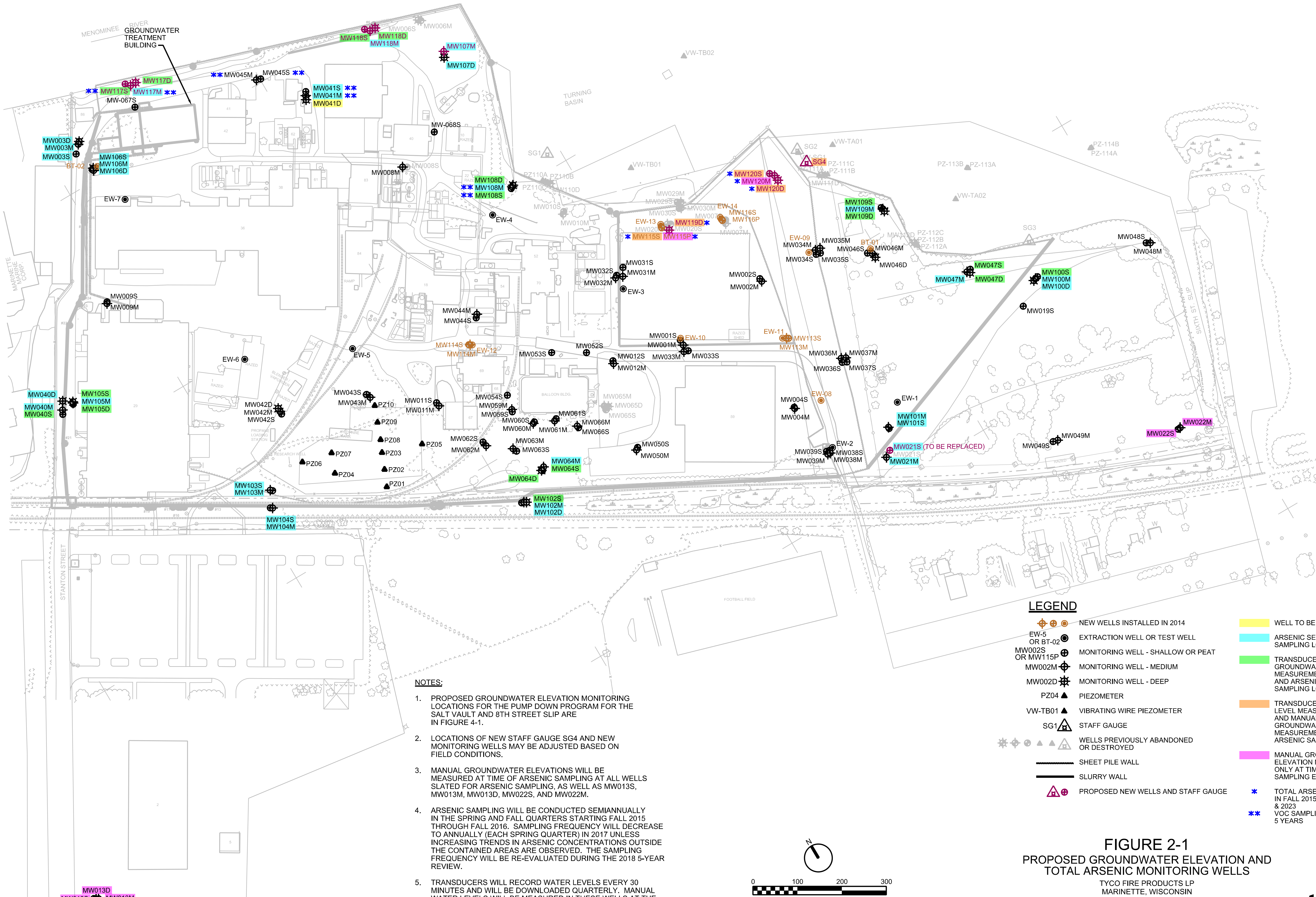
- TOP OF RIPRAP 2013/2015
- TOP OF GLACIAL TILL
- TOP OF BEDROCK
- AS-BUILT SOLDIER PILE TIP
- FINAL DREDGE LINE 2013/2014
- FINAL DREDGE LINE AND TOP OF GLACIAL TILL

NOTES:

1. AS-BUILT SOLDIER PILE TIP, TOP OF BEDROCK AND SOME OF THE TOP OF GLACIAL TILL (AS INDICATED) HAS BEEN TAKEN FROM SEVENSON PILE DRILL LOG AS PART OF THE SHEET PILE STABILITY WORK CONDUCTED IN 2012 AND 2013.
2. DREDGE LINE BASED ON ACTUAL FINAL DREDGE DEPTH FROM 2013 OR 2014 AND NOTED GLACIAL TILL CONFIRMATION AREAS BASED ON CONFIRMATION OR VERIFICATION SAMPLING DURING DREDGING.
3. RIPRAP FROM ACTUAL 2013 OR 2015 AS-BUILT DRAWINGS.
4. AS-BUILT ELEVATIONS OF THE SHEET PILING SHOWN ON THE PROFILE ARE FROM THE 2010 CONSTRUCTION LOGS EXCEPT WITHIN THE 8TH STREET SLIP AREA THEY ARE FOR THE INNER SHEET PILE COFFERDAM CONSTRUCTED IN 1998 AND 1999.

FIGURE 1-5-B6
MAIN PLANT TURNING BASIN
AREA CROSS SECTION
TYCO FIRE PRODUCTS LP
MARINETTE, WISCONSIN

CH2MHILL



LEGEND

- NEW WELLS INSTALLED IN 2014
- EW-5 OR BT-02 — EXTRACTION WELL OR TEST WELL
- MW002S OR MW115P — MONITORING WELL - SHALLOW OR PEAT
- MW002M — MONITORING WELL - MEDIUM
- MW002D — MONITORING WELL - DEEP
- PZ04 — PIEZOMETER
- VW-TB01 — VIBRATING WIRE PIEZOMETER
- SG1 — STAFF GAUGE
- WELLS PREVIOUSLY ABANDONED OR DESTROYED
- SHEET PILE WALL
- SLURRY WALL
- PROPOSED NEW WELLS AND STAFF GAUGE
- WELL TO BE ABANDONED
- ARSENIC SEMI-ANNUAL SAMPLING LOCATION
- TRANSDUCER GROUNDWATER ELEVATION MEASUREMENT LOCATION AND ARSENIC SEMI-ANNUAL SAMPLING LOCATION
- TRANSDUCER WATER LEVEL MEASUREMENT AND MANUAL GROUNDWATER ELEVATION MEASUREMENT AT TIME OF ARSENIC SAMPLING
- MANUAL GROUNDWATER ELEVATION MEASUREMENT ONLY AT TIME OF ARSENIC SAMPLING EVENTS
- * TOTAL ARSENIC SAMPLING IN FALL 2015,2016,2017,2018, & 2023
- ** VOC SAMPLING EVERY 5 YEARS

NOTES:

1. PROPOSED GROUNDWATER ELEVATION MONITORING LOCATIONS FOR THE PUMP DOWN PROGRAM FOR THE SALT VAULT AND 8TH STREET SLIP ARE IN FIGURE 4-1.
2. LOCATIONS OF NEW STAFF GAUGE SG4 AND NEW MONITORING WELLS MAY BE ADJUSTED BASED ON FIELD CONDITIONS.
3. MANUAL GROUNDWATER ELEVATIONS WILL BE MEASURED AT TIME OF ARSENIC SAMPLING AT ALL WELLS SLATED FOR ARSENIC SAMPLING, AS WELL AS MW013S, MW013M, MW013D, MW022S, AND MW022M.
4. ARSENIC SAMPLING WILL BE CONDUCTED SEMIANNUALLY IN THE SPRING AND FALL QUARTERS STARTING FALL 2015 THROUGH FALL 2016. SAMPLING FREQUENCY WILL DECREASE TO ANNUALLY (EACH SPRING QUARTER) IN 2017 UNLESS INCREASING TRENDS IN ARSENIC CONCENTRATIONS OUTSIDE THE CONTAINED AREAS ARE OBSERVED. THE SAMPLING FREQUENCY WILL BE RE-EVALUATED DURING THE 2018 5-YEAR REVIEW.
5. TRANSDUCERS WILL RECORD WATER LEVELS EVERY 30 MINUTES AND WILL BE DOWNLOADED QUARTERLY. MANUAL WATER LEVELS WILL BE MEASURED IN THESE WELLS AT THE TIME OF EACH DOWNLOAD.

N

0 100 200 300
SCALE IN FEET

FIGURE 2-1

PROPOSED GROUNDWATER ELEVATION AND TOTAL ARSENIC MONITORING WELLS

TYCO FIRE PRODUCTS LP
MARINETTE, WISCONSIN

388522

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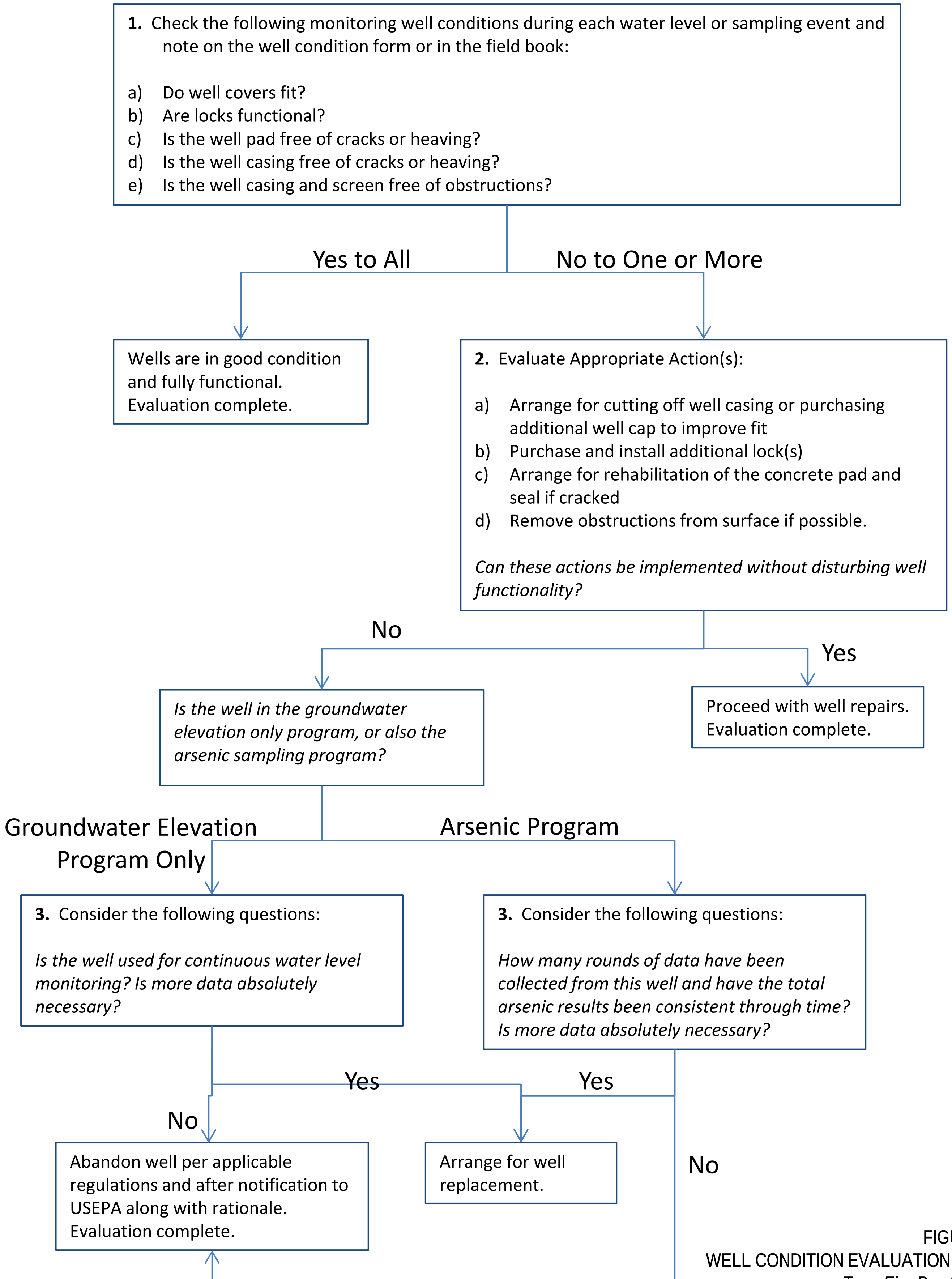

FIGURE 2-2
WELL CONDITION EVALUATION CHART
Tyco Fire Products LP
Marinette, Wisconsin

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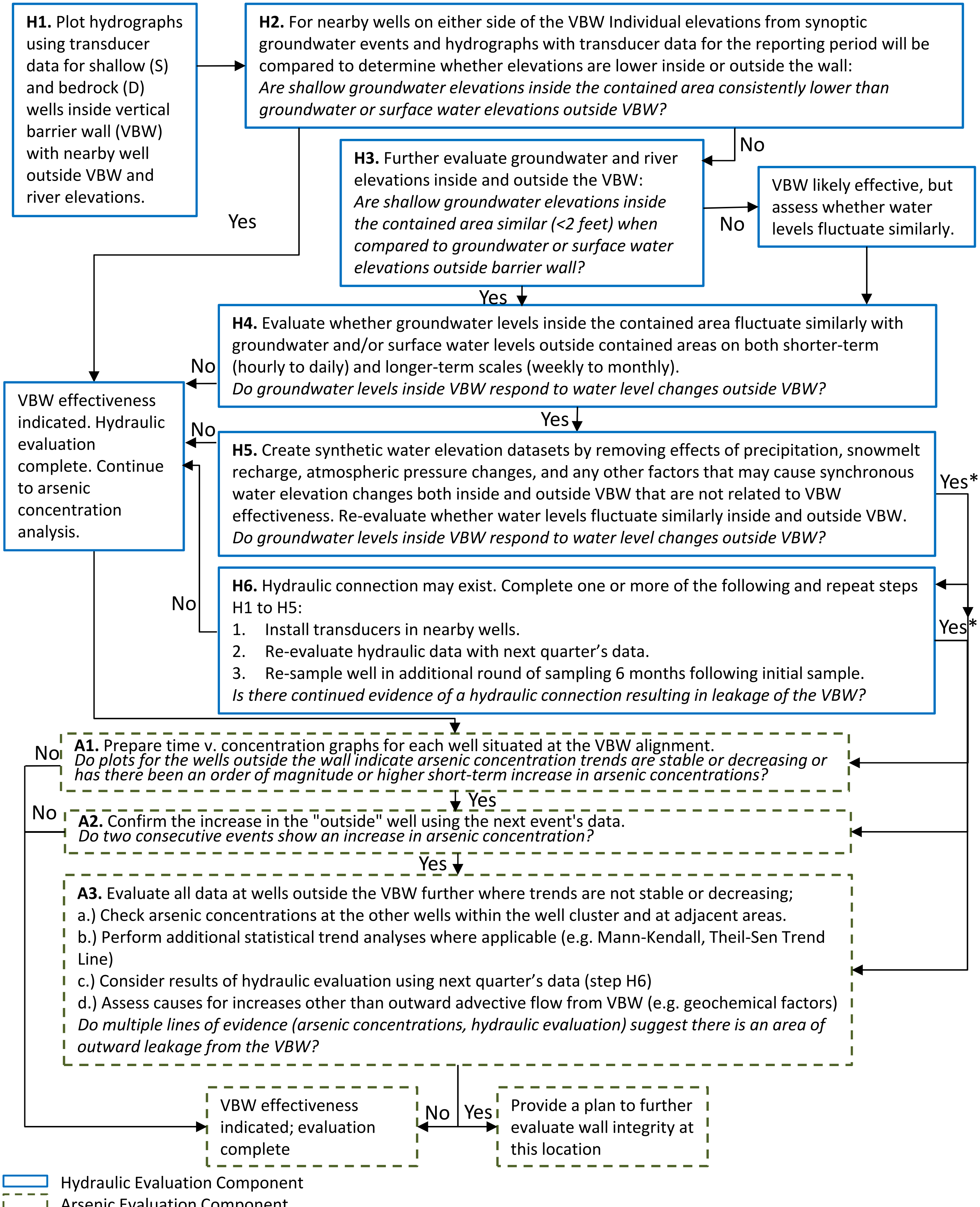
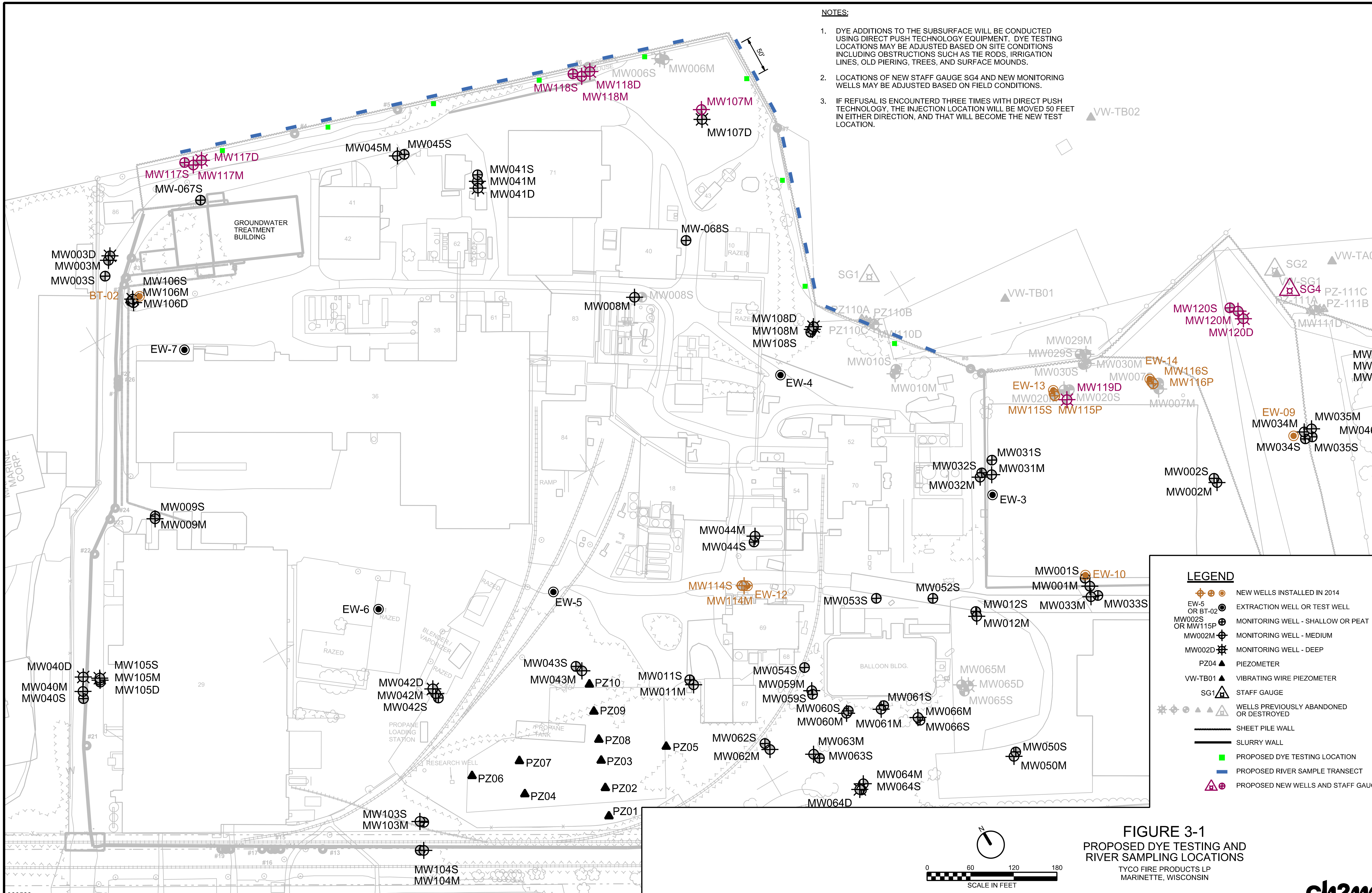


*If there is evidence of a hydraulic connection resulting in leakage from the VBW, the arsenic assessment will be carried through step A3, regardless of the results to questions A1 and A2.

FIGURE 2-3
BARRIER WALL EFFECTIVENESS EVALUATION DECISION-TREE
Tyco Fire Products LP
Marinette, Wisconsin

CH2MHILL



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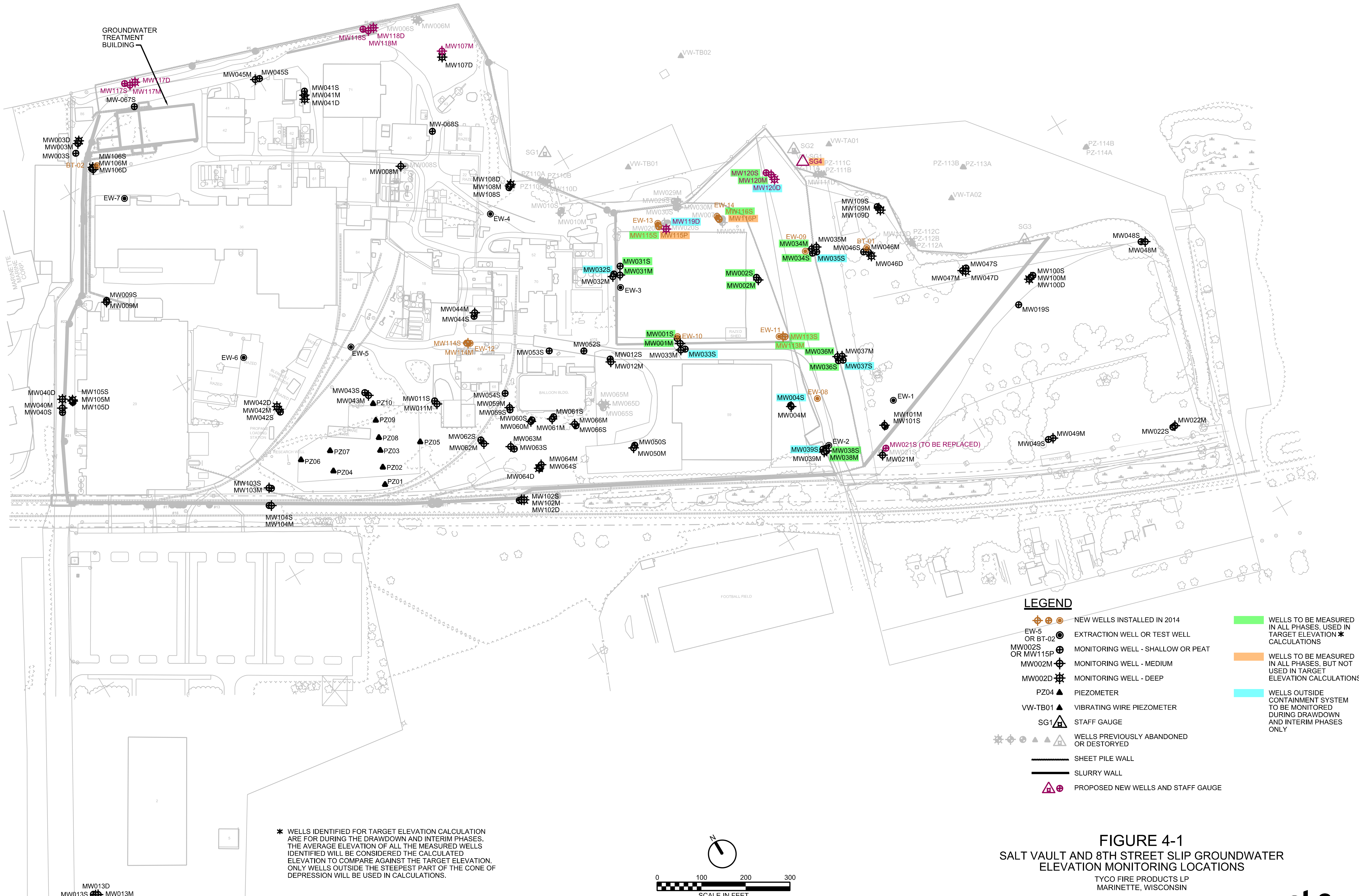

* WELLS IDENTIFIED FOR TARGET ELEVATION CALCULATION ARE FOR DURING THE DRAWDOWN AND INTERIM PHASES. THE AVERAGE ELEVATION OF ALL THE MEASURED WELLS IDENTIFIED WILL BE CONSIDERED THE CALCULATED ELEVATION TO COMPARE AGAINST THE TARGET ELEVATION. ONLY WELLS OUTSIDE THE STEEPEST PART OF THE CONE OF DEPRESSION WILL BE USED IN CALCULATIONS.

FIGURE 4-1
SALT VAULT AND 8TH STREET SLIP GROUNDWATER ELEVATION MONITORING LOCATIONS
TYCO FIRE PRODUCTS LP
MARINETTE, WISCONSIN

388522

ch2m

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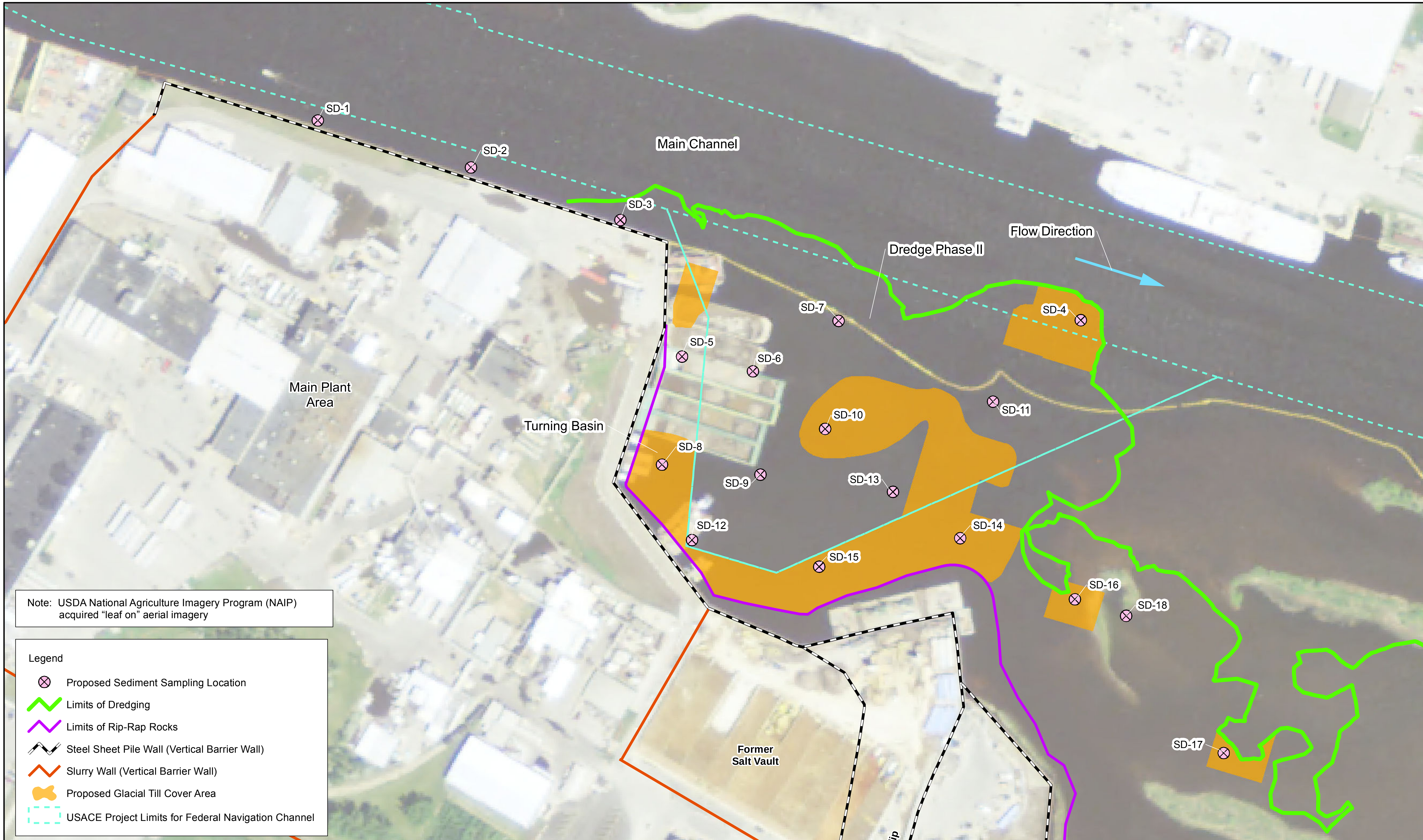


N

0 150 300

Feet

Figure 5-1
Proposed Sediment Sampling Locations
(Turning Basin, Main Channel, and Transition Area)
Tyco Fire Products LP Facility
Marinette, WI

Appendix A
Example Visual Barrier Wall Inspection Form

Vertical Barrier Wall Inspection and Maintenance Log

Tyco Fire Products LP
Marinette, Wisconsin

Inspection Performed by (name and company): ______________________________________

Inspection Date: _____________________________

Instructions for Inspector:

Review prior to and have available during inspection the following documents:

1) Operations and Maintenance Plan, Onsite Groundwater Management, Tyco Fire Products LP, Stanton Street Facility, Revision 1" (O&M plan), dated September 2010, and applicable addendums, if any
2) Record drawings for the sheet pile wall
3) Record drawings for vibrated beam slurry wall
4) As-built drawings for sediment sheet pile stability work
5) Vertical barrier wall (VBW) design drawings
6) Inspection report from most recent inspection

Check for:

- Missing or loose bolts or nuts
- Corrosion (buildup, pitting, in seams), including that observed around wall utility penetrations
- Fracture, fatigue (check welded areas), fabrication discontinuities, unforeseen loading
- Ice damage
- Tilting or misalignment
- Settlement of the backfill immediately adjacent to the wall(s)
- Visible water leakage
- Missing VBW markers
- Modifications/welding/cutting done by others

Critical areas: Corrosion-susceptible areas, intersecting welds, rivets/bolts/nuts, previous cracks repairs, locations of previous repair.
Notes: Record the locations, orientation and length of cracks/corrosions/deformities. Take photos of any deficiencies (from different viewpoints to show close up and far away) during both water-side and land-side inspections. General inspection photos from both the water-side and land-side inspections should be taken as well, even if there are no deficiencies, to show general VBW condition.

VBW Section	Inspected Water-Side?	Inspected Land-Side?	Deficiencies Observed? (Description)	Location/Stationing	Area with Reoccurring Issue?	Corrective Action Required	Date Corrective Action Completed
Point A to Point B							

VBW Section	Inspected Water-Side?	Inspected Land-Side?	Deficiencies Observed? (Description)	Location/Stationing	Area with Reoccurring Issue?	Corrective Action Required	Date Corrective Action Completed
Point B to Point C							
Point C to Point D							
Point D to Point E							

VBW Section	Inspected Water-Side?	Inspected Land-Side?	Deficiencies Observed? (Description)	Location/Stationing	Area with Reoccurring Issue?	Corrective Action Required	Date Corrective Action Completed
Point F to Point G							
Point G to Point H							
Point H to Point I							

VBW Section	Inspected Water-Side?	Inspected Land-Side?	Deficiencies Observed? (Description)	Location/Stationing	Area with Reoccurring Issue?	Corrective Action Required	Date Corrective Action Completed
Point I to Point J							
Point J to Point K							
Point K to Point M							

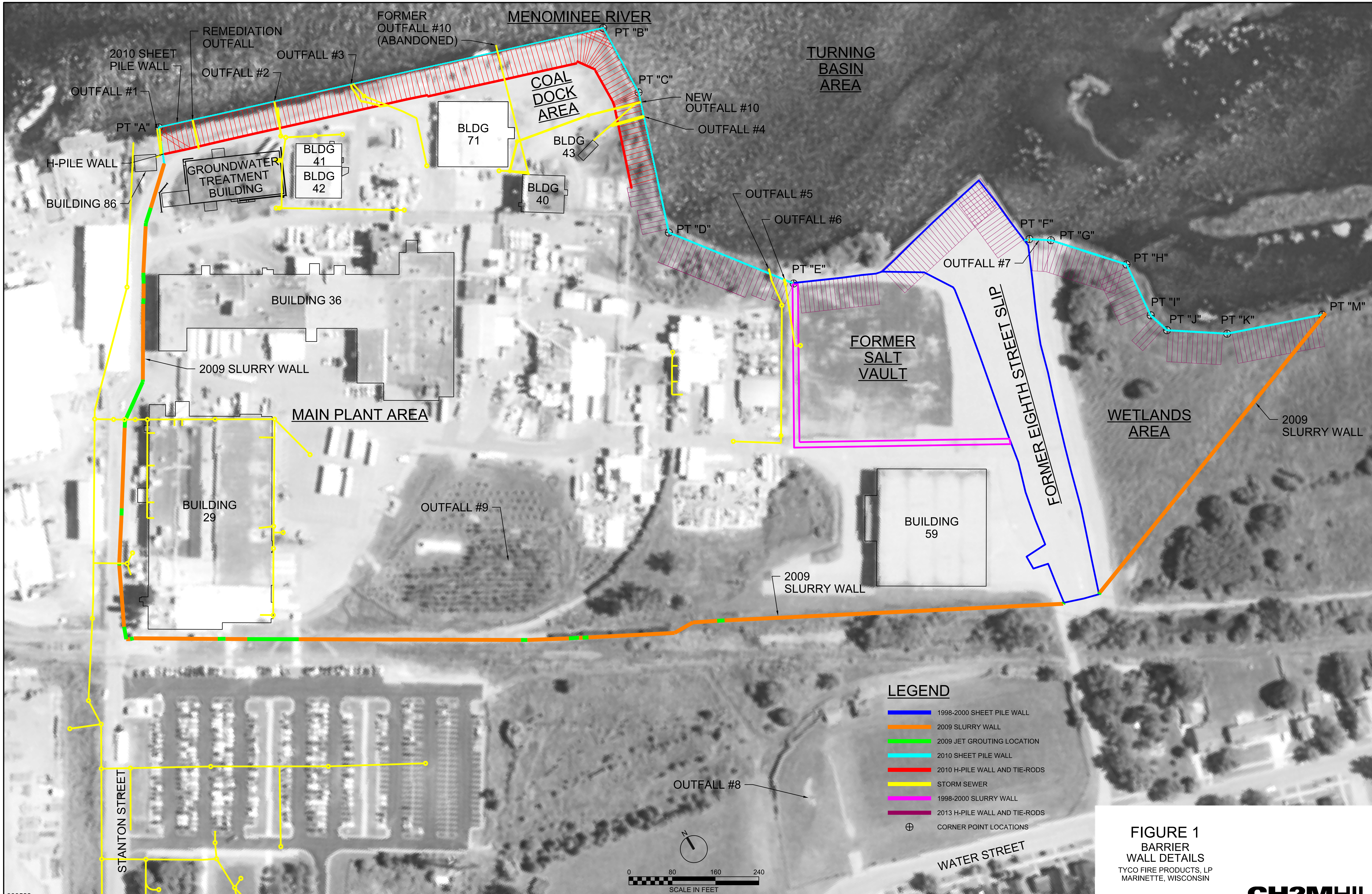
VBW Section	Inspected Water-Side?	Inspected Land-Side?	Deficiencies Observed? (Description)	Location/Stationing	Area with Reoccurring Issue?	Corrective Action Required	Date Corrective Action Completed
Former Salt Vault Area							
Former Eighth Street Slip Area							
Vibrated Beam Slurry Wall							

VBW Section	Inspected Water-Side?	Inspected Land-Side?	Deficiencies Observed? (Description)	Location/Stationing	Area with Reoccurring Issue?	Corrective Action Required	Date Corrective Action Completed

Photo Log

Photo #	Photo Location (VBW Section and Station Location)	Photo Description and Orientation

Photo #	Photo Location (VBW Section and Station Location)	Photo Description and Orientation



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